Massachusetts Bay outfall monitoring program: benthic biology and sedimentology baseline monitoring for 1997 and retrospective analysis of the 1992-1997 database

Massachusetts Water Resources Authority

Environmental Quality Department

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MASSACHUSETTS BAY OUTFALL MONITORING PROGRAM
Benthic Biology and Sedimentology Baseline Monitoring for 1997 and Retrospective Analysis of the 1992-1997 Database

submitted to

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EXECUTIVE SUMMARY

This report presents benthic biology and sedimentology data collected in 1997 as part of a monitoring program being performed to assess baseline conditions in Massachusetts Bay prior to discharges from the new sewage outfall now scheduled to begin operations in 1999. Samples have been collected since the summer of 1992 at stations located within 2 km of the new outfall (nearfield), between 2 and 8 km of the outfall (midfield), and at selected distant locations in Massachusetts and Cape Cod Bays (farfield). The data reported here include results of traditional benthic biology and sedimentology including sediment grain-size, *Clostridium perfringens* spore counts, and analyses of total organic carbon and nitrogen in soft-bottom sediments, results of sediment profile imaging at the same stations, and an analysis of photographs taken from a remotely operated vehicle in the hard-bottom areas in the vicinity of the outfall.

Sedimentology

Sediment texture at nearfield stations and most midfield stations has exhibited consistency over time. Nearfield stations consist of compacted (hard) fine rippled sands with low inventories of organic carbon (< 1% TOC) and *Clostridium perfringens* spores. Wave and current scouring of the bottom near the diffuser remove fines and produce bedload transport of sands and aerate the upper few centimeters of the bottom by ripple migration. The instability of the bottom leads to patchy mosaics of Stage I benthic successional seres as described with sediment profile imaging. Nearfield station NF24 is an exception to this generalization. This station is located in a depression that is isolated from bottom current scour. The dominant texture is a mixture of very fine sand, silt, and clay with an inventory of > 1% TOC. A mixture of Stage I and III species populate this low kinetic energy station and ventilation of the upper sediment column is related to bioturbation. This station is receiving sediment washed into the depression from the surrounding higher kinetic energy bottoms. This sediment focusing results in high sediment accumulation rates.

Midfield stations near the diffuser consist of rippled very fine sands and are less compacted than nearfield sands. These stations show a sand-over-mud stratigraphy; and provide a record of changing kinetic energy regimes at the facies boundary between the nearfield and midfield sampling areas. Aeration of the sediment column is related to a combination of ripple migration and bioturbation. The surficial organic carbon inventory of these stations can change over time related to changing kinetic conditions. This transitional area is both a kinetic energy gradient, a sediment facies gradient, and an ecological ecotone. These stations experience the greatest temporal and spatial variance in physical and biological properties.

Midfield stations located to the West, North, and South of the transitional area are relatively uncompacted muddy sands with variable organic carbon inventories. Sediment aeration is largely related to bioturbation. Successional seres are represented by a mixture of Stage I, II, and/or III seres.

Patterns in concentration of TOC and *Clostridium* spore counts when comparing stations and years in the nearfield and midfield are very similar to each other and are often directly correlated with the amount of silt and clay found in the samples.

Levels of TOC and *Clostridium* are low at all farfield stations and generally similar over time. Patterns of sediment texture at the eight farfield stations have been very consistent over time. In general, stations

FF1A and FF9 have the coarsest sediments; stations FF4, FF7, and FF11 have the finest sediments; and stations FF5, FF6, and FF14 have sediments that are intermediate in texture.

Soft-bottom Infaunal Communities

Benthic community parameters observed in 1997 were generally similar to those seen in previous baseline monitoring years, both in the vicinity of the new outfall and throughout Massachusetts and Cape Cod Bays. The fauna in the nearfield and midfield consists of a sand assemblage and two mud assemblages that are detectable in both single year (1997) and multiyear (1992-1997) analysis. The sand assemblage is characterized by the polychaete *Exogone hebes* and the amphipod *Crassicorophium crassicorne* in all analyses. Single year contributors include an oligochaete Enchytraeidae sp. 1, several polychaetes including *Polygordius* sp. 1, *Aglaophamus circinata*, and *Spiophanes bombyx*, the amphipod *Pseudunciola obliquua*, and the sand dollar *Echinarachnius parma*.

One mud assemblage is more or less characterized by a suite of six polychaetes, *Leitoscoloplos acutus, Mediomastus californiensis, Prionospio steenstrupi, Monticellina baptisteae, Ninoe nigripes*, and *Tharyx acutus*. The polychaetes *Exogone verugera, Dipolydora socialis*, and *Nephtys incisa* along with the amphipod *Photis pollex* prefer mixed sediments and constitute what may be termed the second mud assemblage. However, the species that define the mud assemblages are quite variable from year to year and sometimes shift in their contribution annually. For example, *Exogone verugera* often resides with the sand assemblage where it may at times be a major contributor.

Species diversity as measured by ES_{100} ranged from 16.87 to 33.66 in 1997 nearfield and midfield samples. There was little or no pattern in the distribution of diversity among these samples except that higher diversity stations were located in the northern half of the array and lower diversity stations in the southern half of the array.

Farfield benthic communities in 1997 were distributed among three station groups: (1) two stations (FF1A and 9) that are nearshore and close to the midfield array; (2) FF4, 5, 11, and 14 all offshore in the vicinity of Stellwagen Basin; and (3) FF6 and 7 in Cape Cod Bay. When combined with the nearfield and midfield samples, the farfield samples retained their identity and groupings demonstrating their distinctness and appropriateness as reference stations.

The nearshore farfield assemblage was characterized by species typically found in the nearfield and midfield such as *Prionospio steenstrupi, Spio limicola*, and *Dipolydora socialis*. The offshore assemblage was characterized by *Chaetozone setosa, Aricidea quadrilobata, Levinsenia gracilis*, and other polychaetes. The Cape Cod Bay assemblage was characterized by *Cossura longocirrata, Tharyx acutus, Euchone incolor*, and *Nucula annulata*.

Species richness (i.e., number of species recorded) was higher in 1996 and 1997 than in earlier years. This result may be due in part to better identification of juvenile polychaetes and molluscs. It will be of primary importance to maintain similar levels of taxonomic discrimination in the years after the outfall comes on line. Any apparent changes in species diversity should be evaluated first by comparison with the underlying database.

A comparison of the community results for a 1992-1996 multiyear analysis with 1997 data demonstrates that major assemblage patterns are similar with the same indicator species, but that contributions of these species and the appearance and disappearance of other species changes annually.

Calculation of an average species diversity suggests that diversity at the nearfield stations is slightly higher than average diversity at either midfield or farfield stations. Shannon-Wiener H′ values when averaged (± Standard Error of the Mean) over the period 1992-1997 were 2.69 ± 0.053 for the nearfield, 2.60 ± 0.043 for the midfield, and 2.58 ± 0.054 for the farfield. Hurlbert ES_{100} values averaged for the same period were 23.90 ± 0.583 for the nearfield, 22.03 ± 0.476 for the midfield, and 22.93 ± 0.0.530 for the farfield. Differences, however, are small with overlapping error bars.

Similar calculations for number of species and numbers of individuals suggest that the nearfield stations have the highest numbers of species ($\bar{x}$=68.13 ±2.6) versus the midfield ($\bar{x}$=63.15±1.8) and farfield ($\bar{x}$=57.35±1.8). The highest average densities, measured as individuals per 0.04 m^2 are in the midfield ($\bar{x}$=1951.98±121.93). Densities in the nearfield ($\bar{x}$=1897.83±137.17) and farfield ($\bar{x}$=1460.22±114.23) are less. Differences between the nearfield and midfield are small, and the error bars overlap. The differences with the farfield are greater, but still relatively small.

Hard-bottom Benthos

The nearfield hard-bottom benthic communities are temporally stable over the 1995-1997 sampling period. Community analysis of the 1996 and 1997 data sets yielded almost identical results. This temporal stability greatly enhances the utility of this data for detecting future change due to the outfall.

Location on the drumlins, depth, substratum type and habitat relief all appear to play a role in determining the structure of the benthic communities inhabiting hard-bottom areas in the vicinity of the outfall. Some taxa show strong preferences for specific habitats, while others are broadly distributed.

Some areas are homogeneous in terms of substratum type and the fauna inhabiting them, while other areas exhibit more patchiness. Some of the variability observed in the data may be related to difficulties in distinguishing between some of the categories of encrusting organisms that may encompass several species. However, a fair amount of the variability may be due to the inherently patchy nature of hard-bottom habitats and the fauna that inhabit them.

Analysis of the still photographs shows finer details of the benthic communities than can be discerned from the video tapes. The two techniques are complimentary in that the video survey provides greater areal coverage and the still photographs provide a more accurate assessment of the taxa inhabiting these areas. Both techniques are valuable for establishing baseline data.

As with the soft-bottom benthic community analysis, consistency in taxonomic identifications will be of primary importance in ensuring the ability to make comparisons between baseline and post-operational data.

The best potential indicator species for detecting change due to the outfall is the abundant and widely distributed coralline alga *Lithothamnion*. This alga was abundant in all areas of stable hard substrate and little sediment drape.

1.0 INTRODUCTION

1.1 Background of the MWRA Monitoring Program

The Massachusetts Water Resources Authority (MWRA) is responsible for the development of secondary sewage treatment facilities serving the greater metropolitan Boston area. A new outfall has been built offshore in Massachusetts Bay at a distance of 15 km from Deer Island and at a depth of 32 m. Secondary-treated effluent will be discharged from the new diffuser array beginning in 1999, but the water and sediment quality of Massachusetts Bay and Cape Cod Bay is not expected to be adversely impacted by the new discharge (EPA, 1988).

In order to monitor any potential effects from the new outfall, the MWRA developed an *Effluent Outfall Monitoring Plan* that describes the physical, chemical and biological monitoring necessary to evaluate the response of the ecosystem to the new outfall (MWRA, 1991). Studies conducted prior to the initiation of discharges from the new outfall are termed Baseline Monitoring and are intended to provide a database against which future changes can be assessed. Baseline Monitoring began in 1992 and has been conducted each year since then. The research and monitoring results to date have provided a reasonable understanding of existing conditions prior to the implementation of discharges from the new outfall. This understanding is crucial to the development of testable predictions for detecting outfall-induced changes once discharge begins.

1.2 Overview of the Present Study

The benthic monitoring program as initiated in 1992 included 10 special stations at farfield locations sampled for biology in May 1992, 20 stations in the nearfield sampled in August 1992, and 12 stations in the farfield also sampled in August 1992. At each of the August 1992 stations, samples were taken to evaluate sedimentary characteristics, benthic infaunal communities, microbiology, and chemical constituents. In addition, the sediment profile camera system was used to evaluate animal/sediment interactions and various physical properties of the sediments. The benthic biology program for the nearfield was essentially designed as a non-replicated spatial array while the farfield sampling design included three replicates at each station.

Achieving a good monitoring design for the nearfield area has been difficult due to the heterogeneity of habitats, and the sampling protocol has been modified several times to find the best approach. In 1993 the design for the nearfield was changed to include nine stations, with three replicates each. One of the farfield stations was dropped (Coats *et al.*, 1995a). In 1994, the non-replicated design was reinstated with retention of three replicated stations (Coats, 1995); that design was repeated in 1995, 1996, and 1997. The shift in station design presents some problems in comparing year-to-year trends because the 1993 nearfield design departs significantly from that of 1992 and 1994-96. Nevertheless, the six-year baseline database thus accumulated and the planned continuance in 1998 should permit a full assessment of natural processes in the nearfield prior to the initiation of effluent discharge in 1999.

Benthic community structure in soft-bottom areas of western Massachusetts Bay has been shown by monitoring to date to be strongly associated with sediment type, and is also apparently influenced by recent sediment transport events. Highly depositional muds tend to support a diverse fauna, often with more than 50 species present in a 0.04-m^2 grab sample. This mud assemblage is characterized by high abundances of the capitellid polychaete *Mediomastus californiensis*, accompanied by abundant spionid polychaetes and/or the paraonid polychaete *Aricidea catherinae*. The faunal assemblage in transitional sediments is relatively similar, but tends to show high dominance of one or more spionid polychaetes, for example *Prionospio steenstrupi* in 1987 (Blake *et al.*, 1987) and *Spio limicola* in 1992-1994 (Blake *et al.*, 1993; Coats, 1995). The sandy assemblage is characterized by fewer species and lower abundances, and tends to be dominated by the amphipod *Corophium crassicorne* and the syllid polychaetes *Exogone hebes* and *E. verugera*, among others (Blake *et al.*, 1993; Coats, 1995).

Benthic data from the farfield stations provide the first long-term integrated survey throughout the larger Massachusetts Bay and Cape Cod Bay ecosystem. All farfield stations in relatively deep water (>50 m) east of Cape Ann and throughout Stellwagen Basin show a diverse benthic assemblage, characterized by moderate dominance of spionid polychaetes (*Spio limicola* in 1992-94; *Prionospio steenstrupi* in 1995-96), as well as the paraonid polychaetes *Levinsenia gracilis* and *Aricidea quadrilobata*. This deep-water assemblage is so consistent and widespread that, after the first two years of monitoring, station FF1 was abandoned and the effort transferred to a new site (station FF1A) off Cape Ann at a depth similar to the nearfield, but so distant from the future outfall that no conceivable impact could be expected to occur.

The two farfield monitoring stations in Cape Cod Bay are in moderately deep water (about 35 m) and contain a distinct fauna, similar to communities observed in the late 1960s (Rhoads and Young, 1971; Young and Rhoads, 1971; Blake *et al.*, 1993; Coats, 1995). In addition to the spionids, these stations are characterized by moderate abundances of the polychaetes *Cossura longocirrata*, *Tharyx acutus*, and *Euchone incolor*.

The data collected from 1992 to the present allow comparison with earlier historical results to evaluate the consistency of benthic communities from year to year and to predict which components of the fauna might be most affected by sewage discharge. The studies also allow further refinement of the sampling requirements for a long-term monitoring program. Based upon data collected through 1994, Coats (1995) developed a framework for quantifying testable hypotheses for detecting changes in sediment contaminant concentrations and benthic communities in the nearfield, a 2-km zone around the outfall in which changes are most likely to occur once the outfall goes on line. A multivariate analysis based on PCA-H of Trueblood *et al.* (1994) is recommended to detect changes in benthic community structure. By "normalizing" PCA-H scores from baseline samples collected in the nearfield for the apparent effects of sediment grain size and organic carbon concentration, Coats developed a "detrended" (DPCA-H) space against which similarly transformed data from post-discharge samples in the nearfield could be tested for significant departure from baseline faunal composition (Coats, 1995).

Results from the present study, conducted during baseline year 1997, are intended to add to the definition of the baseline variability and enhance our understanding of the benthic environment under pre-disposal conditions. The study included the following elements: (1) physical and chemical analyses of sediments, including total organic carbon and nitrogen concentrations, sediment grain-size composition, and analysis of *Clostridium perfringens* spores as a marker of sewage; (2) sediment profile image analysis of the nearfield and midfield; (3) traditional soft-bottom benthic infaunal analysis; and (4) semi-quantitative characterization of the epifaunal and epiphytic organisms colonizing the widespread rocky-bottom environments in the immediate vicinity of the outfall, based on examination of 35-mm color photographs and video tapes.

2.0 METHODS

This section provides a brief account of the field, laboratory, and data management methods used during the study. A more detailed account can be found in the Combined Work/Quality Assurance Project Plan (CW/QAPP) (Blake and Hilbig, 1995).

2.1 Field Operations

2.1.1 Sampling Design and Location of Stations

The benthic monitoring program originally used a definition of the nearfield as a rectangle with sides 5 km (3 mi) from the outfall, with farfield stations lying outside the rectangle. Greater sophistication in spatial analyses has allowed discrimination among three subareas of the study area: the nearfield is 0-2 km, the midfield is 2-8 km, and the farfield is greater than 8 km from the new outfall. The nearfield coincides with the area that is most likely to be impacted according to the SEIS. The midfield and farfield are farther from the outfall and should not show impacts. Three stations, approximately 8 km from the nearshore end of the diffuser, were originally designated as farfield stations but are now considered to lie within the midfield area. The original designations for these stations (FF10, FF12, FF13) have been retained because there already are midfield stations MF10, MF12, and nearfield stations NF13. The reassignment of these three farfield stations was implemented in the 1996 program (Blake et al., 1996). The sampling design in the nearfield and midfield, established in 1994, represents a compromise between broad areal coverage and comparability of the data with previous studies in the same area. Table 1 shows the station designations in detail.

Table 1. Station designations and groupings.

Station Grouping	Distance from Outfall	Stations
nearfield (diffuser-induced changes are expected)	0-2 km	NF13, NF14, NF15, NF17, NF18, NF19, NF23, NF24
midfield (diffuser-induced changes are less likely)	2-8 km	MF2, MF4, MF5, MF7, MF8, MF9, MF10, MF12, MF16, MF20, MF21, MF22, FF10, FF12, FF13
farfield (diffuser-induced changes are highly unlikely)	>8 km	FF1A, FF4, FF5, FF6, FF7, FF9, FF11, FF14

Benthic grab samples for the analysis of macroinfauna and sedimentary characteristics were collected in August 1997 at 23 stations in close proximity to the diffuser (near- and midfield sites, Figure 1, Appendix A1) and 8 stations throughout Massachusetts and Cape Cod Bays (farfield sites, Figure 2, Appendix A1). To ensure good areal coverage, only single grab samples (one biology and one chemistry) were taken at each of 17 near- and midfield stations; and three replicate biology samples and two replicate chemistry samples were taken at the remaining 14 stations (2 nearfield, 4 midfield and 8 farfield).

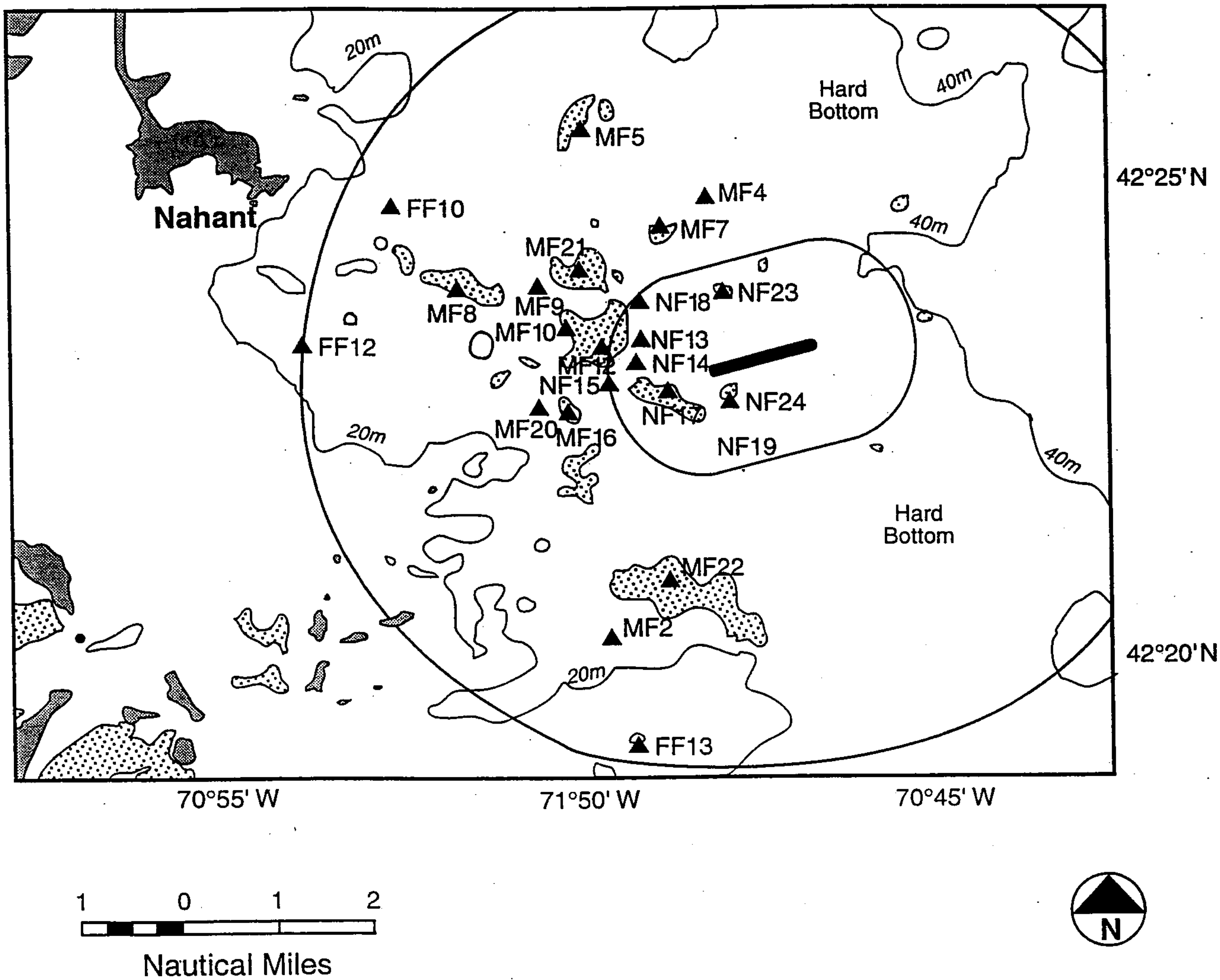


Figure 1. Station locations for grab samples in the nearfield and midfield. Diffuser is indicated by thick line; inner ellipse defines boundaries of nearfield; outer ellipse defines midfield.

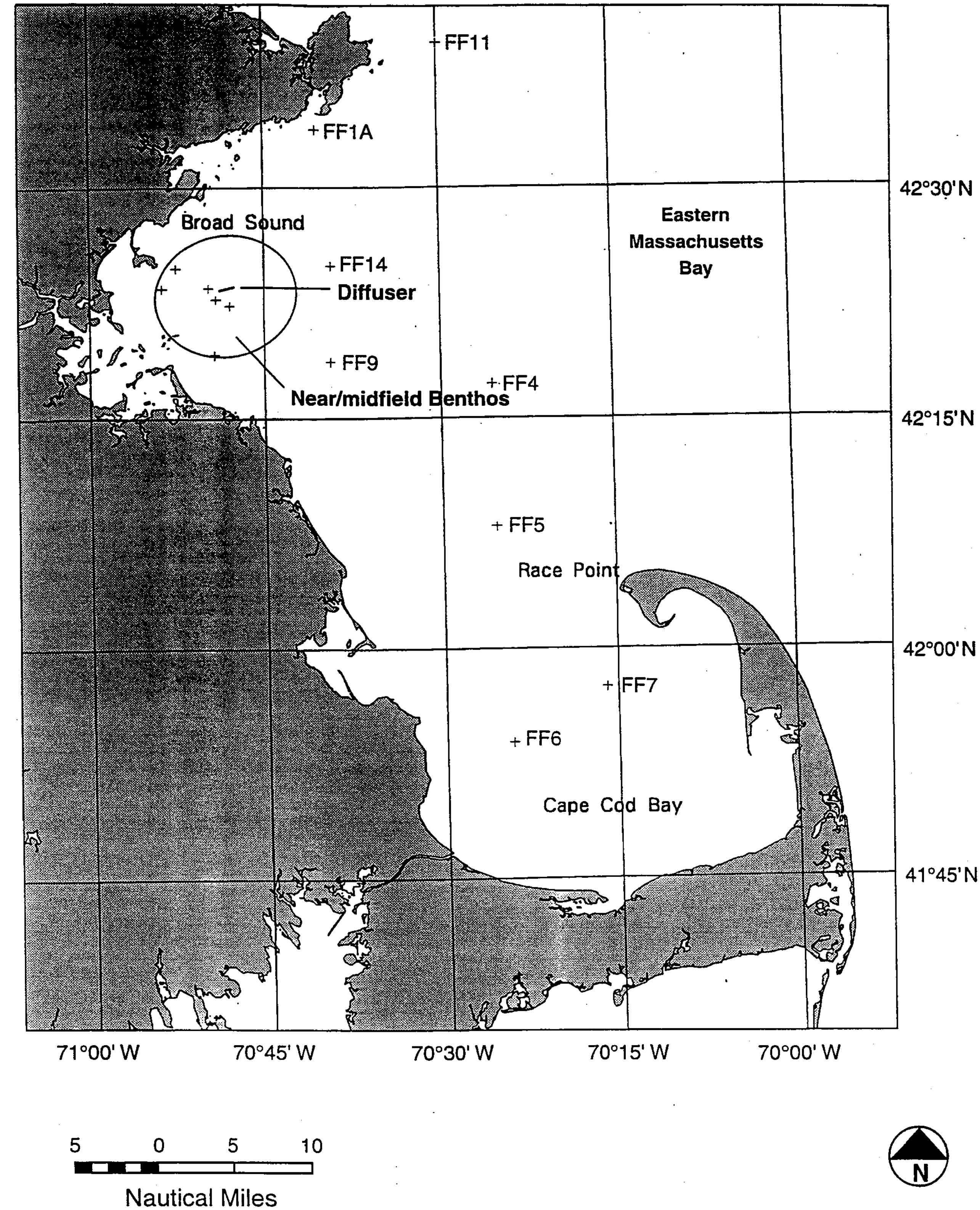


Figure 2. Station locations for farfield grab samples. Ellipse defines nearfield and midfield survey areas.

Camera surveys, including both video and still photographs, were made in hard-bottom areas where sampling with benthic grabs was not possible. A total of 23 stations were surveyed, 22 waypoints along 8 transects and Diffuser head #44, from June 11 to 14, 1997 (Appendix A-2; Figure 3). Four transects (T1, T2, T4 and T6) were located on drumlins on either side of the outfall diffuser and four transects (T7, T8, T9 and T10) were located on drumlins further away (reference sites). Three additional sites were added to the ones surveyed in 1996; two additional reference sites (T9 and T10) approximately half way between the diffuser and the two existing reference transects (T7 and T8), and diffuser head #44. The latter diffuser will not go online and thus provides a single non-operational site within the 54 operational diffusers and an opportunity of evaluate impacts directly within the outfall zone.

2.1.2 Navigation

Navigational positioning was accomplished with a Northstar 41X Differential GPS system with an accuracy of 5 to 15 m. If the vessel drifted more than 0.01 nmi (ca. 18 m) away from the reference coordinates, it was repositioned between replicate samples. The ship's position was logged every minute while underway and marked at the time of each touchdown of the grab or camera with the Maptech software.

2.1.3 Grab Sampling

A Kynar-coated 0.04-m² Ted Young grab was used for collection of all samples. The protocol for processing the biology samples was similar to that followed for the 1995 and 1996 surveys (see Hilbig *et al.*, 1996). From each chemistry grab, a subsample of the top 2 cm of sediment was collected, homogenized in a stainless steel bowl, and split into subsamples for *Clostridium perfringens*, total organic carbon (TOC) and sediment grain size analyses. All samples were kept cool on ice.

2.1.4 Sediment Profile Imaging

At each of the 23 nearfield and midfield stations, the sediment profiling camera was lowered to the seafloor; the camera was allowed to stay on the bottom for 12 sec (measured with a stop watch on board ship starting at the point at which the wire went slack), during which the camera's prism penetrated the sediment. Two photographs were taken each time: the first one was taken 2 sec after the frame settled on the bottom and the second one 10 sec later.

This protocol ensures that at least one useable photograph is produced during each lowering. If the bottom is very soft, the prism will over penetrate after 12 sec (no sediment-water interface on the photograph), but the first exposure, taken after 2 sec, will usually show the interface and will be suitable for a full analysis. If the sediment is compacted or mixed with rocks, the second exposure can be used for analysis because the prism will usually penetrate deep enough to allow for measurement of all required parameters.

After 12 seconds, the camera was lifted off the bottom, returned to the surface for a quick visual inspection, and lowered again for the next replicate set of two exposures. A total of four replicate sets (eight exposures) were taken at each station. At the end of a station, the camera was hauled back on deck for transit to the next station.

The survey in August produced very poor results as camera misalignment resulted in pictures that were largely out of focus. Consequently, the entire survey was repeated in October and it is the results of the latter survey that is reported herein. A total of 22 of 23 stations were successfully sampled. Station MF20 consisted of rocks and boulders and no data was obtained.

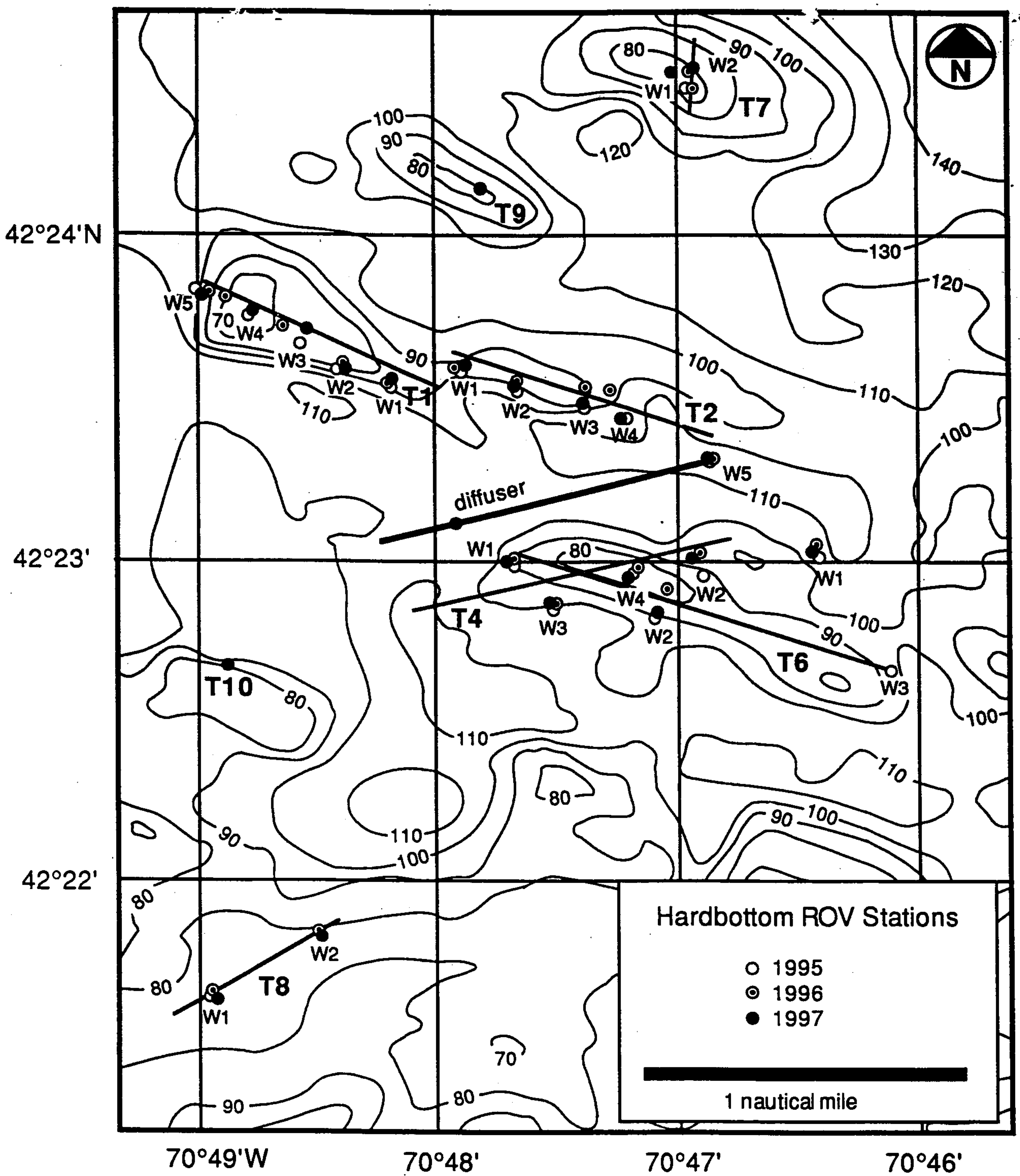


Figure 3. **Transects and waypoints surveyed for hard-bottom benthos. Inset shows survey area relative to Boston Harbor. Open circles: stations visited in 1995; filled circles: stations visited in 1996; squares are additional transects and waypoints visited in 1997.**

2.1.5 Video and 35-mm Still Photography

A Benthos MiniRover Mk II Remotely Operated Vehicle (ROV) was used to collect bottom photographs. The survey ship M/V *Christopher Andrew* was anchored at each waypoint and the ROV was lowered to the sea floor. Once on the sea floor, the ROV traveled in a northwesterly direction away from the ship. Depending on the relief of the sea floor, the ROV traveled 30 to 70 m away from the vessel before it ran out of tether.

The ROV was equipped with a color video camera, a 35-mm still camera and a strobe. The still camera and strobe were mounted on brackets on the outside of the ROV on either side of the video window. The camera was pointed forward and down, with its field-of-view overlapping slightly with the video image. Approximately 20 minutes of video tape and one 36-exposure roll of color slides were collected at each waypoint. The still photographs were taken at random intervals during this transit.

Appendix A-2 lists transects and waypoints visited during the 1997 hard-bottom survey; Figure 3 depicts their locations relative to the drumlin fields. Table 2 shows the photographic coverage obtained during the survey.

Eight transects and two diffuser heads were surveyed in 1997 (Table 2). Several changes were made relative to the 1996 sampling design. Two additional reference transects (T9 and T10) were established approximately half way between the outfall and two existing reference stations (T7 and T8). Diffuser #44 was surveyed because the diffuser heads were found to be colonized by dense concentrations of anemones and #44 will not go on line and hence provides us with a reference point directly on the line of diffusers. For each deployment, the survey vessel, M/V *Christopher Andrew*, anchored at waypoints along each transect where the Benthos MiniRover Mk II ROV, with attached 35-mm camera and strobe, was lowered over the side. Once the ROV reached the seafloor, real-time video was recorded on tape and observed on a monitor aboard the vessel. Still photographs were taken at random intervals, resulting in one 36-exposure roll per waypoint. A summary of the photographic coverage at the surveyed locations is presented in Table 2.

2.1.6 Sample Documentation, Custody, and Quality Assurance/Quality Control

Standard ENSR procedures for sample tracking and custody were followed. Prior to each field survey, preprinted labels were produced that were linked to ENSR's MWRA Harbor/Outfall Monitoring (HOM) database. All sample containers were labeled on the outside, and the macrofauna containers were also labeled on the inside. Information on the labels included the survey number, date, station and replicate number, sample type, and the laboratory to which the sample was to be delivered for analysis.

All pertinent information on field activities and sampling efforts was recorded into a bound, numbered logbook. The number of the logbook was entered into the MWRA HOM database. Entries were recorded in indelible ink and included at a minimum:

- Date and time of starting work
- Names of ship's crew and scientific party
- Sampling sites and activities and references to ship's navigation system
- Deviations, if any, from the survey plan
- Field observations such as weather and sea state

Chain-of-custody forms were created either electronically or by hand when samples left the ship or the custody of the scientist responsible for shipping. All coolers and boxes used for shipping were sealed with numbered chain-of-custody tape; the number on the tape was recorded on the chain-of-custody form.

Table 2. Photographic coverage at locations surveyed during the 1997 nearfield hard-bottom survey.

Transect	Waypoint	Location on drumlin	Depth (feet)	Depth (meters)	Video (min)	Stills (# frames)
1	1	TF-edge	85	26	29	30
	2	Top	84	26	25	32
	3	Top	71	22	24	25
	4	Top	66	20	24	31
	5	Flank	89	27	36	31
2	1	Top	87	27	23	28
	2	Top	92	28	23	30
	3	Top	86	26	22	32
	4	Flank	101	31	24	31
	5	Low/diffuser #2	111	34	35	31
4	1	Flank	107	33	27	32
	2	Flank	101	31	23	31
	3	Flank	105	32	24	30
4&6	4	Top	86	26	24	26
6	1	Flank	107	33	23	30
	2	Flank	101	31	25	27
7	1	Top	97	30	24	30
	2	Top	91	28	17	32
8	1	Top	85	26	24	28
	2	Top	81	25	23	30
9	1	Top	91	28	18	31
10	1	Top	79	24	40	29
Diffuser #44			110	34	20	27

2.2 Laboratory Methods: Sample Processing and Analysis

2.2.1 Benthic Infauna

About 48 h after the samples had been fixed in formalin, they were resieved on a 300-μm screen with fresh water and transferred to 70% alcohol for preservation. Before sorting, the samples were stained with a saturated alcoholic solution of Rose Bengal, a stain for proteins that enhances the visibility of organisms in the sediment. All animals, including fragments, were then removed from the sediment and sorted into major taxa, such as polychaetes, oligochaetes, mollusks, crustaceans, and echinoderms. Taxonomists then identified each taxon to the lowest practical level (usually to species) and enumerated each species.

2.2.2 Sediment Grain Size

Grain size was determined with a combination of wet and dry sieve and pipette analyses (NOAA, 1993a). The sediment was sieved through a sieve series based on the Wentworth grade scale, including mesh sizes of 2 mm (-1 phi), 1 mm (0 phi), 0.5 mm (1 phi), 0.25 mm (2 phi), 0.125 mm (3 phi), and 0.063 mm (4 phi). The sediment fraction retained on each sieve was weighed and reported as percent gravel (grain size >2 mm) and percent sand (grain size 2 mm to 0.063 mm). Sediment passing through the 0.063-mm sieve was further analyzed by pipette analysis to obtain percent silt (grain size 0.063 mm to 0.004 mm) and percent clay (grain size <0.004 mm). For the sand fraction, the weight percent for each phi size was also recorded.

2.2.3 Total Organic Carbon (TOC)

Analysis of TOC followed NOAA's procedures developed for the Mussel Watch Program (NOAA, 1993a). The sediment samples were dried to constant mass, exposed to HCl fumes to eliminate inorganic carbon, and TOC was measured with a CHN analyzer. Data on Total Organic Nitrogen (TON) and the C/N ratio were also provided.

2.2.4 Clostridium Spores

The enumeration of *Clostridium perfringens* spores was performed using methods developed by Emerson and Cabelli (1982) and modified by Saad (personal communication). The data were recorded as units of spores per gram dry weight of sediment.

2.2.5 Sediment Profile Image (SPI) Analysis

Three out of eight replicate images (see Section 2.1.4) from each nearfield and midfield station were analyzed with the ImagePro Plus software package. Each slide was digitized and then analyzed for parameters including penetration depth, surface roughness, apparent redox potential discontinuity (RPD), grain size major mode, successional stage of the infauna, the presence of methane bubbles, and biogenic features such as burrows and tubes. Any additional observations were entered into a comment field. The data were compiled on separate data sheets for each image and the organism-sediment index (OSI) was calculated (Rhoads and Germano, 1982).

A detailed account of the SPI parameters can be found in SAIC (1992); the following paragraph provides a brief characterization of these parameters. *Penetration depth* is measured from the bottom of the image to the sediment-water interface (maximally 20 cm) and is a measure for softness of the substratum, which depends on characteristics such as water content and grain size. *Surface roughness* is the difference between the least and greatest penetration depth across the sediment-water interface depicted on a slide (the width is 15 cm). It may be a measure for physical disturbance—natural or anthropogenic—or biological activity such as burrowing. The *apparent RPD depth* is measured from the sediment-water interface to the depth in the sediment at which there is a change in sediment color caused by the lack or absence of oxygen at depth; the color commonly changes from tan or brownish (ferric hydroxides) in the well-oxygenated surface layer to greyish (ferric hydroxides being reduced) or black (presence of sulfide, anoxic conditions) at a few mm to several cm depth. The RPD depth depends on a variety of physical and biological factors, such as currents, organic loading, and bioturbation by infaunal organisms, and is commonly used as a first-approximation measure for the health of a habitat. *Methane bubbles*, discernable by their strong reflectance (silvery color), form only under severely oxygen-depleted sediment conditions as a result of anaerobic bacterial metabolism. The *grain size major mode* is the dominant particle size in an image, measured visually by comparing the slide with a photograph of phi size classes. The *infaunal successional stages* are derived from a paradigm describing recolonization of disturbed habitats. Stage I organisms are those that live very close to the sediment-water interface, and they are pioneers because they do not require much oxidized sediment. By their feeding and burrowing activities these stage I organisms, often small annelids, deepen the RPD, preparing the sediment for somewhat larger animals to colonize, such as certain amphipods (stage II). Stage III organisms are large, deep-burrowing, head-down deposit feeders, such as large polychaetes and echinoderms, that aerate the sediment to several cm depth. Their presence indicates an equilibrium community and healthy environment.

2.2.6 Video and 35-mm Still Photography

Each 35-mm slide was projected and analyzed for sea-floor characteristics (i.e., substratum type and size class, and amount of sediment cover) and organisms. Most recognizable taxa were recorded and counted. Encrusting coralline algae were assessed as rough estimates of percent cover of available substratum. Several other taxa, including filamentous red algae, colonial hydroids, and small barnacles and/or spirorbid polychaetes, that were frequently too abundant to count reliably were assessed in terms of relative abundance. The following categories were used to assess abundances of taxa that were not counted on the still photographs:

Category	Percent cover	Numerical value assigned for analysis
rare	1-5	1
few	6-10	2
common	11-50	5
abundant	51-90	15
very abundant	>90	20

Organisms were identified to the lowest possible taxonomic level, about half of them to species, with the aid of pictorial keys and diver handbooks of the local fauna and algal flora (Martinez and Harlow, 1994; Weiss, 1995). Many of the encrusting organisms could not be identified to species, but were recognizable. These organisms were assigned to descriptive categories (e.g., "orange-tan encrusting"); however, each of these categories possibly includes several species. Due to the high relief of many of the habitats surveyed, all reported abundances should be considered to be extremely conservative. In many of the areas with large boulders, only about one-third of the available rock surfaces were visible; thus, actual faunal abundances in these areas are probably 2 to 3 times higher than the counts indicate. Of the total 684 still photographs taken during the survey, all were retained for subsequent analysis.

The video tapes were viewed to provide additional information about the uniformity of the environment. Notes on substratum size classes, bottom relief and relative degree of sediment drape were recorded. Large, clearly identifiable organisms (such as fish and large solitary organisms) were enumerated. Counts of encrusting forms were not attempted due to the general lack of resolution of the video footage.

2.3 Data Management and Analysis

2.3.1 Benthic Infauna

The raw data were entered directly into a QuattroPro spreadsheet or imported electronically. NODC codes and ENSR's alphanumeric codes were added and the data were converted into a database format suitable for statistical analyses. Juvenile and indeterminable organisms were included in calculations of density but were excluded from similarity and diversity measures.

Diversity was calculated as Shannon-Wiener index H′ and the associated evenness value J′ ; Brillouin's index H and its evenness value V; and with the rarefaction method (Sanders, 1968) as modified by Hurlbert (1971). The rarefaction technique is more sensitive to rare species than is the Shannon-Wiener index. The Shannon-Wiener index was calculated using both the base $\log_e$ and $\log_2$; the Brillouin's diversity index (H) presented here for the first time approximates H′ at base $\log_e$; for the rarefaction analyses, the number of individuals per replicate was set at defined points between 100 and 500.

May's Log-series alpha was calculated to approximate a perfect log series for each sample. This curve was then compared with the one generated by the Hurlbert's rarefaction method; the deviation values of 0.75 or more indicate a disturbed sample.

Benthic communities were analyzed using CNESS (chord-normalized expected species shared) which has been developed by G. Gallagher and is to related Grassle and Smith's (1976) NESS (normalized expected species shared). CNESS and NESS include several indices that can be made more or less sensitive to rare species in the community and as such are more versatile that other similarity measures such as the Bray-Curtis similarity which is influenced by dominant species. Both NESS and CNESS are calculated from the expected species shared (ESS) between two random draws of *m* individuals from two samples. For this project, *m* was calculated as 17 which is intermediate between CNESS 1 and 135 and is roughly equivalent to its relationship to Kendall's J as shown in Figure 4. Differences between CNESS and NESS are detailed in Trueblood *et al.* (1994).

PCA-H analysis is an ordination method for visualizing CNESS distances among samples. The PCA-H method produces two types of plots, both based on Gabriel (1971). The Euclidean distance biplot provides a two-dimensional projection of the major sources of CNESS variation. The species that contribute to CNESS variation can be determined using matrix methods adapted from Greenacre's correspondence analysis. These species are plotted as vectors in the Euclidean distance biplot. To show the association among species, the Gabriel covariance biplot is used. Species which co-occur plot with species vectors having very acute angles. Species which have discordant distributions plot with angles approaching 180 °. The cosine of the angles among species vectors in the covariance biplot can be clustered, as described in Trueblood *et al.* 1994.

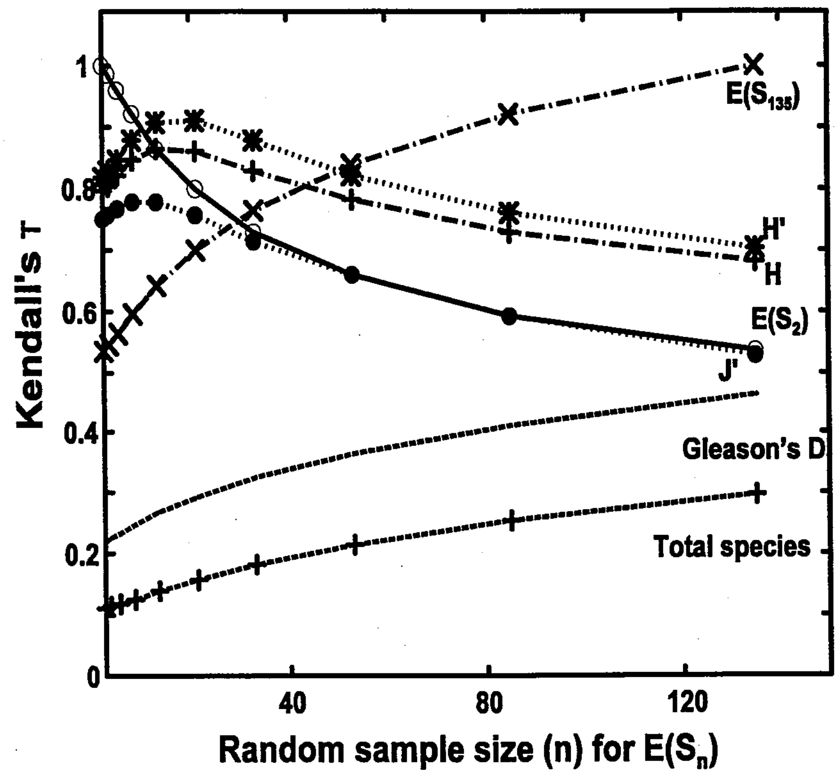


Figure 4. Kendall's τ rank-order correlation coefficients plotted as a function of random sample size (*m*) used to calculate CNESS. The non-parametric correlation between a variety of diversity indices and the Sanders-Hurlbert $E(S_n)$ is compared with a range of random sample sizes.

2.3.2 Still Photographs from Hard-bottom Survey

For the hard-bottom photographs, data were pooled from all slides taken at each waypoint. To facilitate comparisons among waypoints, species counts were normalized to mean number of individuals per slide to account for unequal numbers of slides. Hydroids and small barnacles and/or spirorbids were omitted from the data because they consisted of several species and could not be accurately assessed. Only taxa with abundances of ten or more individuals in the entire data set were retained for subsequent analyses. This process resulted in 47 out of the original 100 taxa being retained. Several taxa were pooled including juvenile and adult *Asterias vulgaris* and white and pink *Halocynthia pyriformis*.

Hierarchical classification was used to examine the data obtained from the still photographs. This analysis consisted of a pair wise comparison of the species composition of all waypoints using the percent similarity coefficient (Whitaker and Fairbanks, 1958). This coefficient was chosen because it relies on the relative proportion that each species contributes to the faunal composition, and is thus least sensitive to differences in sampling effort among locations. Unweighted pair-group clustering was used to group samples with similar species composition (Sokal and Sneath, 1963). This strategy has the advantage of being relatively conservative in clustering intensity, while avoiding excessive chaining (i.e., successive samples joining a group one at a time).

3.1 Benthic Soft-Bottom Communities and Sedimentology, Nearfield and Midfield

3.1.1 Sediment Grain Size

Grain-size composition of sediments collected in August 1997 from the 8 nearfield and 15 midfield stations, as determined by sieving and gravimetric analysis, is given in Appendix B1. Percentages of gravel, sand, silt, and clay are shown in Figure 5. In general, sediments from the nearfield stations were coarser-grained than those from the midfield stations. Nearfield sediments contained greater amounts of gravel, coarser sand particles, less silt, and less clay than did sediments from midfield stations.

Three nearfield stations had sediments with more than 95% sand and gravel (Figure 5), four additional stations had more than 80% sand and gravel. One station, NF18, had more than 25% gravel. Very coarse and coarse sands were present only in small amounts, totaling more than 6% only at one station (NF14). Medium and fine sands were the dominant sand fractions in the nearfield, except at NF 24 where the very fine sand fraction ranked first. Fine sand predominated at NF13, NF14, NF15, NF17, NF18, and NF19, while medium sand was the largest sand fraction at NF23. In contrast, sediments from station NF24 contained less than 30% sand and gravel and were very high in silt (52%) and clay (19%).

Very little gravel was present at midfield stations: MF20 had the highest percentage (9%). Sands in the midfield were composed, for the most part, of fine or very fine sand. Very fine sand was the dominant sand fraction at nine stations; four of these stations were sandy (>50% sand) with sediments containing a very fine sand fraction that ranged from 40% (MF10) to 64% (FF12). Very fine sand also was the largest sand fraction (range: 16% at MF12 to 32% at MF22) in the five stations with sediments containing the most silt (>40% silt). The remaining six stations were all sandy; fine sand was the dominant sand fraction at five of these stations with percentages ranging from 26% (MF7) to 73% (MF4) while medium sand predominated at MF2 (57%). Three stations had sediments low in silt and clay (<10%) and had a mean phi less than three. These low phi stations included the two sandiest stations, MF2 (93% sand) and MF4 (97% sand), as well as station MF20 that had sediments containing significant amounts of very coarse and coarse sand as well as gravel. Sediments from the remaining midfield stations were high in silt, with percentages ranging from 14% (FF10) to 52% (MF8), and contained low to moderate amounts of clay (from 4.6% at FF10 to 15.6% at MF12).

3.1.2 Total Organic Carbon and Carbon/Nitrogen Ratio

Sediments from the nearfield and midfield areas generally had low percentages of total organic carbon (TOC) (Figure 6, Appendix B2). In August 1997, 70% (16 stations) of all nearfield and midfield stations had TOC values less than 1%. All nearfield stations had TOC values less than 1% except the anomalous mud station NF24, which had 1.5% TOC. The proportion of organic matter (i.e. mud) generally increases in a westerly direction away from the diffuser. Midfield stations containing more than 1% TOC included MF8, MF12, MF16, and MF21 west of the nearfield area and midfield stations MF22 and FF13 to the south. The higher TOC stations reflect areas where detrital organic matter accumulates during periods of low kinetic energy. Low TOC stations do not accumulate organic detritus due to frequent washing and sorting of the bottom by currents.

The clear relationship of increasing TOC with increase in mean phi (i.e., decreasing grain size, as determined by laboratory analysis) is shown in Figure 7A ($r = 0.9133$, $r^2 = 0.8341$). Of the ten stations with a mean phi of less than 3 (fine and medium sand), eight had less than 0.5% TOC. Of the five

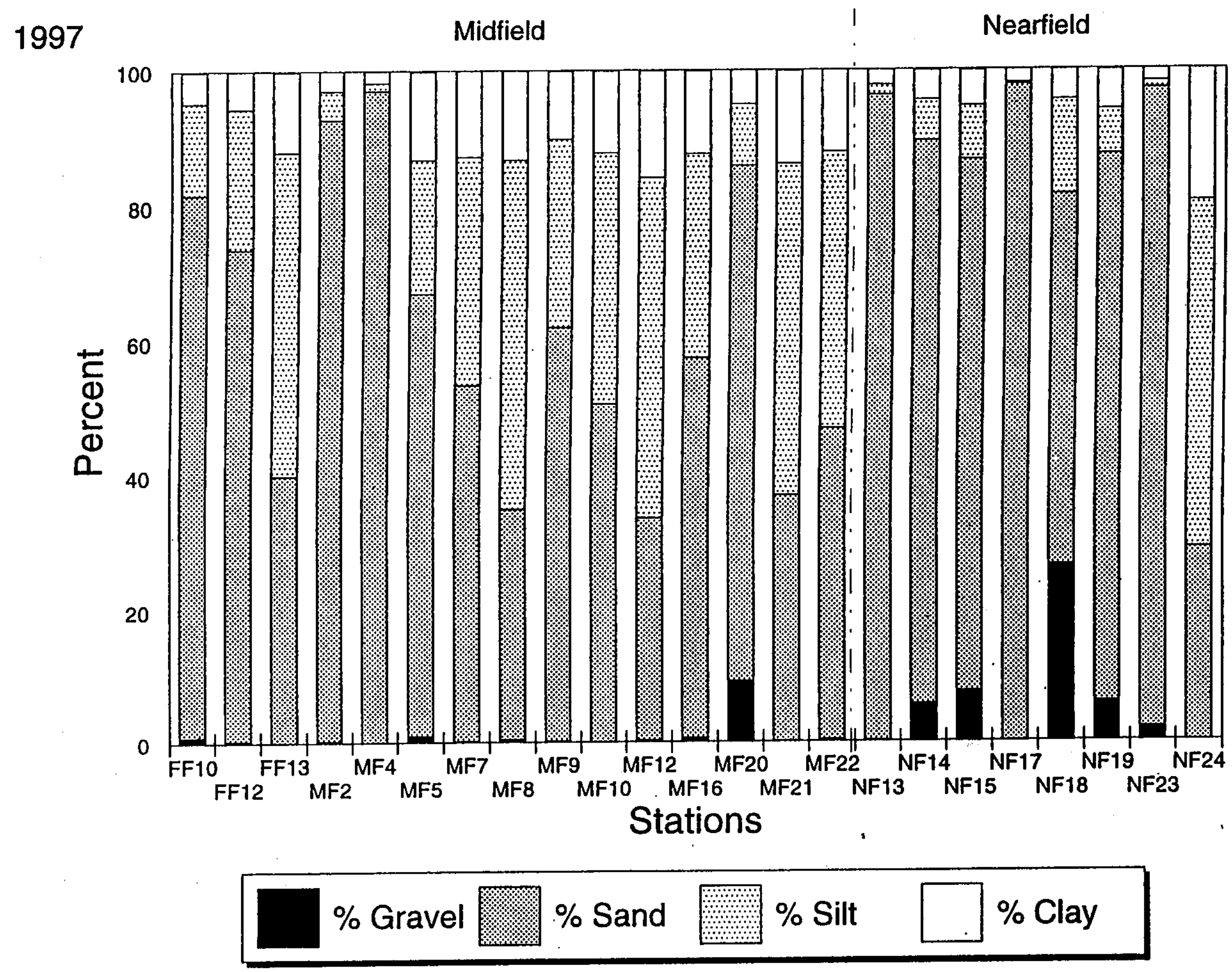


Figure 5. Grain-size composition of sediments from nearfield and midfield stations, August 1997.

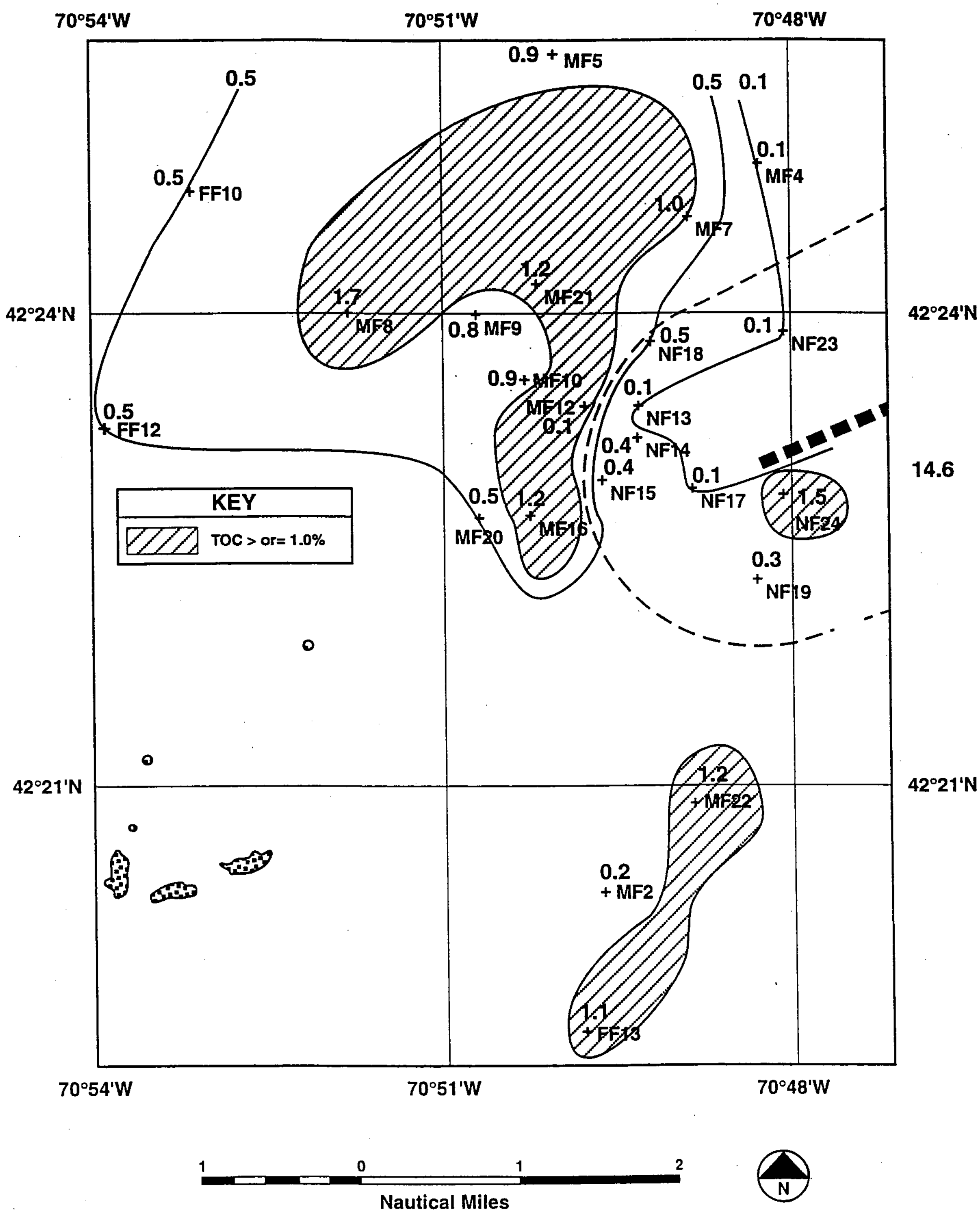
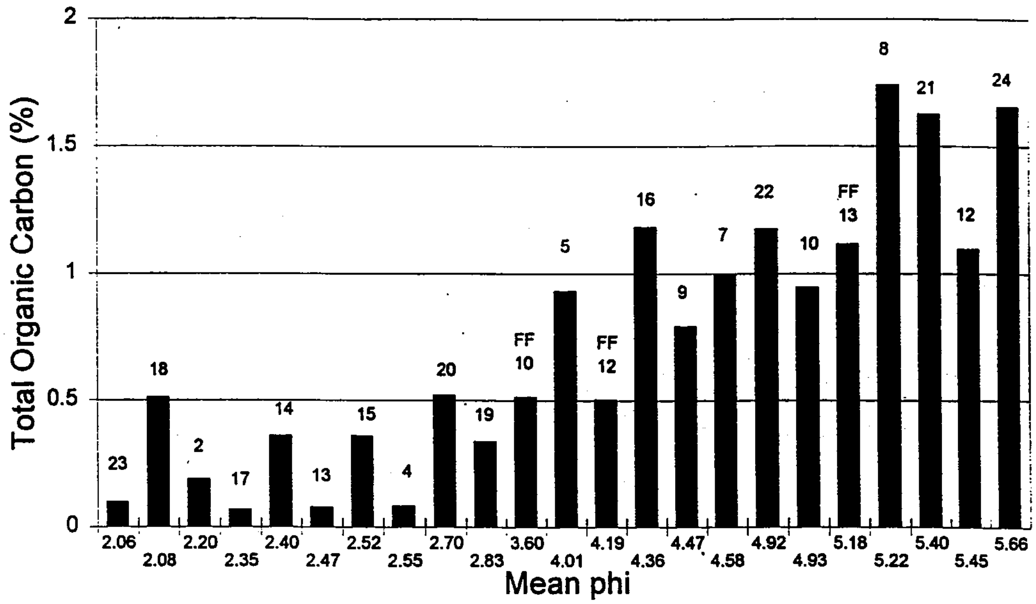


Figure 6. Areal distribution of total organic carbon (TOC) in nearfield and midfield sediments in August 1997.

A



B

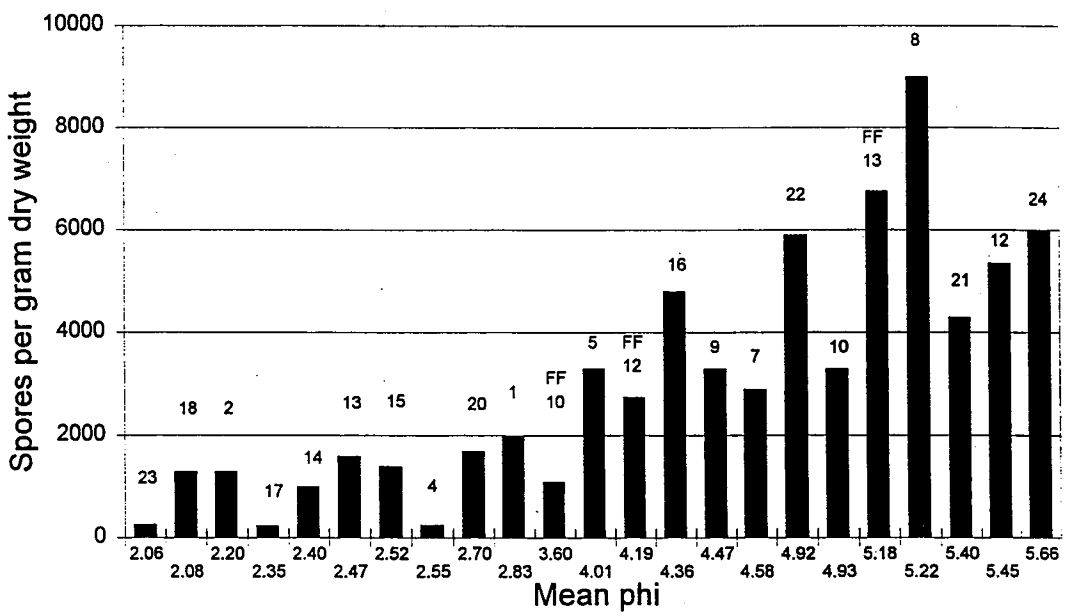


Figure 7. Total organic carbon concentration (A) and *Clostridium perfringens* spore counts (B) plotted against sediment grain size (mean phi) measured at the nearfield and midfield stations in August 1997. Numbers above the bars are station numbers.

stations with a mean phi greater than 5 (medium silt), all had a TOC greater than 1%, and three of these stations (MF8, MF 21, and NF24) had a TOC above 1.5%.

The weight percent of total organic nitrogen (TON) and carbon/nitrogen (C/N) ratios are given in Appendix B2. Total organic nitrogen was at or below the detection limit in sediments from three stations (MF2, NF13, and one replicate from NF17), and ranged from <0.041% (NF13) to 0.203 % (MF8). Excluding the three stations with low TOC, carbon/nitrogen ratios ranged from 9.11 at NF23 to 15.33 at MF12 (Figure 8). In 1997, no stations had a C/N ratio near 6, in contrast to 1996, when C/N ratio near 6 were found in sediments from five stations. This indicates the absence, in 1997, of fresh algal material (C/N ratio near 6) on the bottom. As the algal material decomposes the C/N ratio increases since nitrogen is recycled faster than carbon. A C/N greater than 15 is indicative of land plants or well-processed marine material.

3.1.3 Clostridium Spores

The density of *Clostridium perfringens* spores at nearfield and midfield stations ranged from low values of slightly over 200 at three stations (MF4, NF17, and NF23) to a high of 9000 (MF8) colony-forming units per gram dry weight of sediments (Figure 9, Appendix B3). In 1997, no sediments collected from the nearfield or midfield yielded densities less than 10^2 or more than 10^4 spores per gram, a much smaller range than found in 1995 and 1996. In general, the density of *Clostridium* spores increased with increasing mean phi (i.e., towards finer sediments) (Figure 7B; $r = 0.8608$, $r^2 = 0.7410$). Spore density was higher at stations with finer sediments and higher levels of TOC.

3.1.4 Sediment Profile Imaging

Gradients in Sediment Texture, Structure, and Hardness. Seven of the eight nearfield stations, located within 2 km of the diffuser site, showed evidence of a high kinetic-energy regime. Two stations (NF13 and NF23) were dominated by rippled fine sands (3-2 phi) (Fig. 10; Appendix B7) and four stations (NF14, NF15, NF17, and NF19) were dominated by rippled very fine sands (4-3 phi). Very fine sands also dominated station NF18 and, although rippling was not seen, there was evidence of local erosion. Station NF-24, located in a local depression, is an anomalous station that represents a relatively low kinetic energy bottom consisting of a mixture of silt and very fine sand. The proportion of sand at NF24 (29%, Fig. 4) in 1997 is similar to that measured in 1994 (31%) and 1996 (32%) but higher than the 10% measured in 1995 when clay (73%) predominated. The proportion of sand to mud at NF24 can be expected to vary from year to year based on how much of the surrounding sand bottom is resuspended and washed into the depression.

Midfield stations lying immediately west of the nearfield stations consist of very fine rippled sands (4-3 phi) with sand-over-mud stratigraphy (MF21, MF10, MF12, MF16). The sand-over-mud stratigraphy reflects the facies boundary between the clean washed sands of the nearfield area and muddier sediments in the midfield (e.g. MF8 and FF13; see Figure 5). Station MF20, with a granule to gravel bottom (< -1 phi), is an exception to this generalization as it is located on a local topographic high scoured by bottom currents. To the southwest, stations MF22, MF2, and FF13 consist of a mixture of very fine sand (4-3 phi) and silt-clay (≥ 4 phi).

The distribution of major textural modes is closely reflected in bottom hardness (Figure 11). Gradients in sediment hardness (compaction) are inferred from the penetration depth of the camera prism into the bottom. Nearfield stations tend to have penetration depths <4.0 cm with the exception of station NF24, the anomalous muddy sand and silt-clay station located in a local depression. This station had the deepest

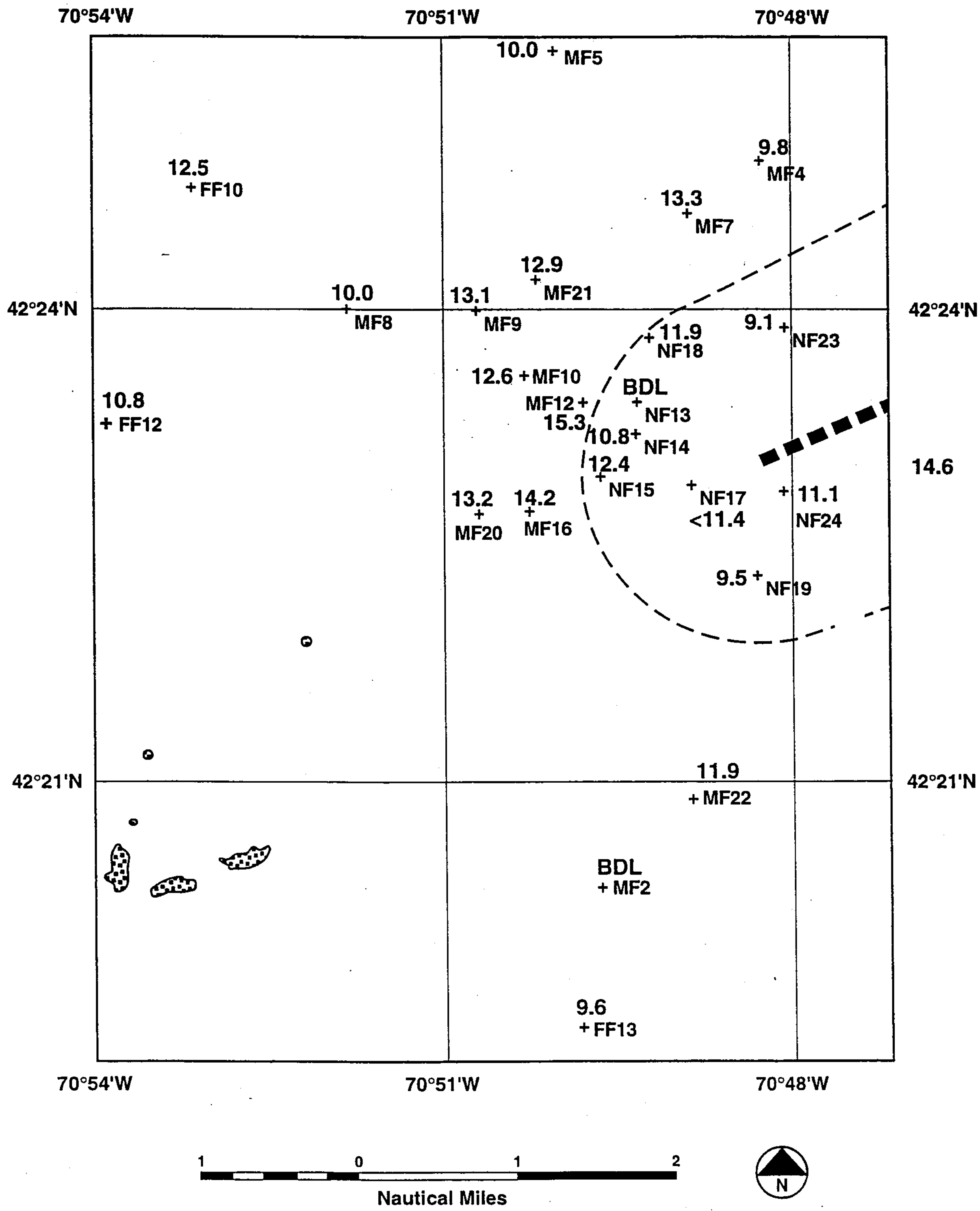


Figure 8. Carbon/nitrogen (C/N) ratio at nearfield and midfield stations in August 1997.

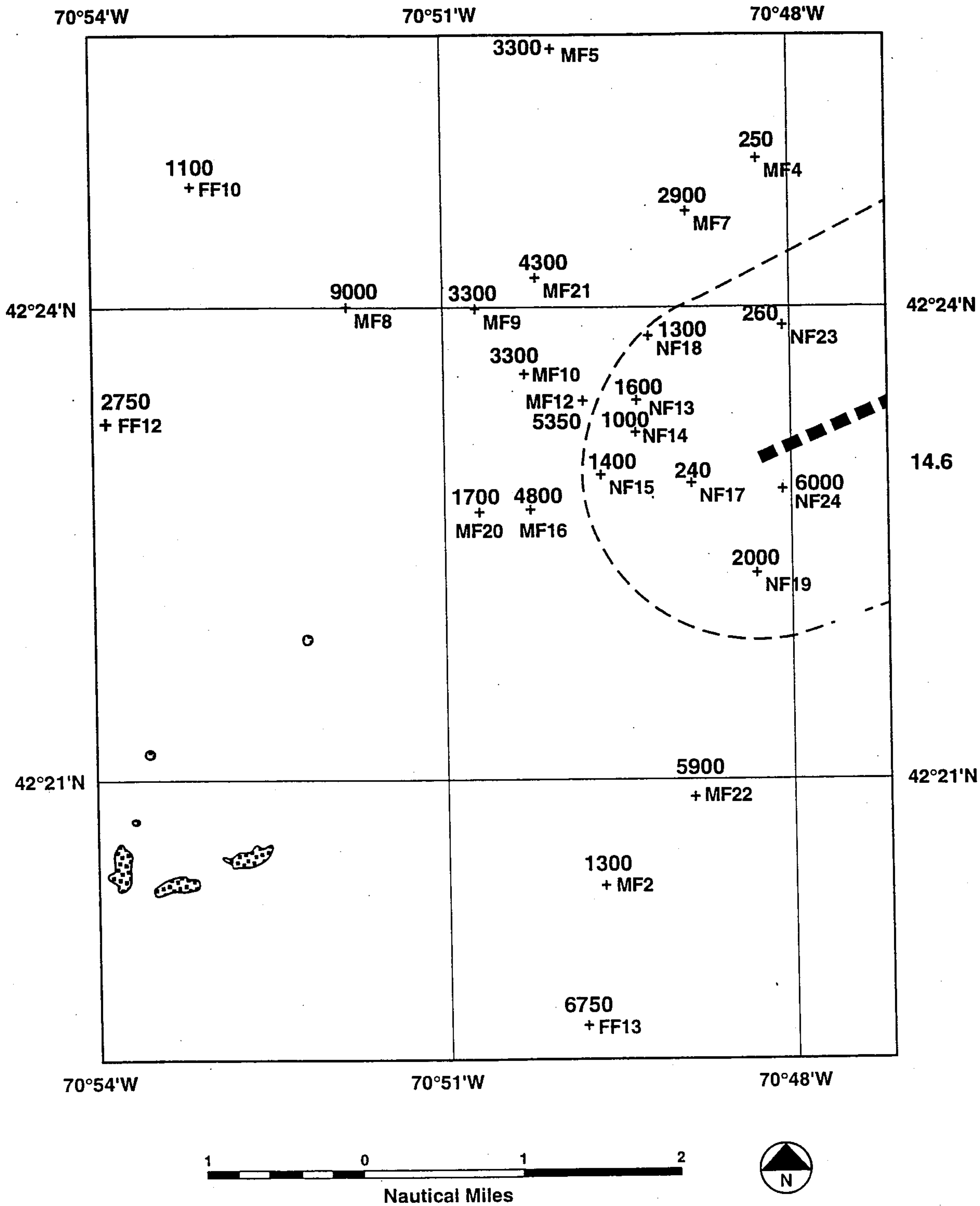


Figure 9. *Clostridium perfringens* spore counts per gram dry weight at nearfield and midfield stations in August 1997.

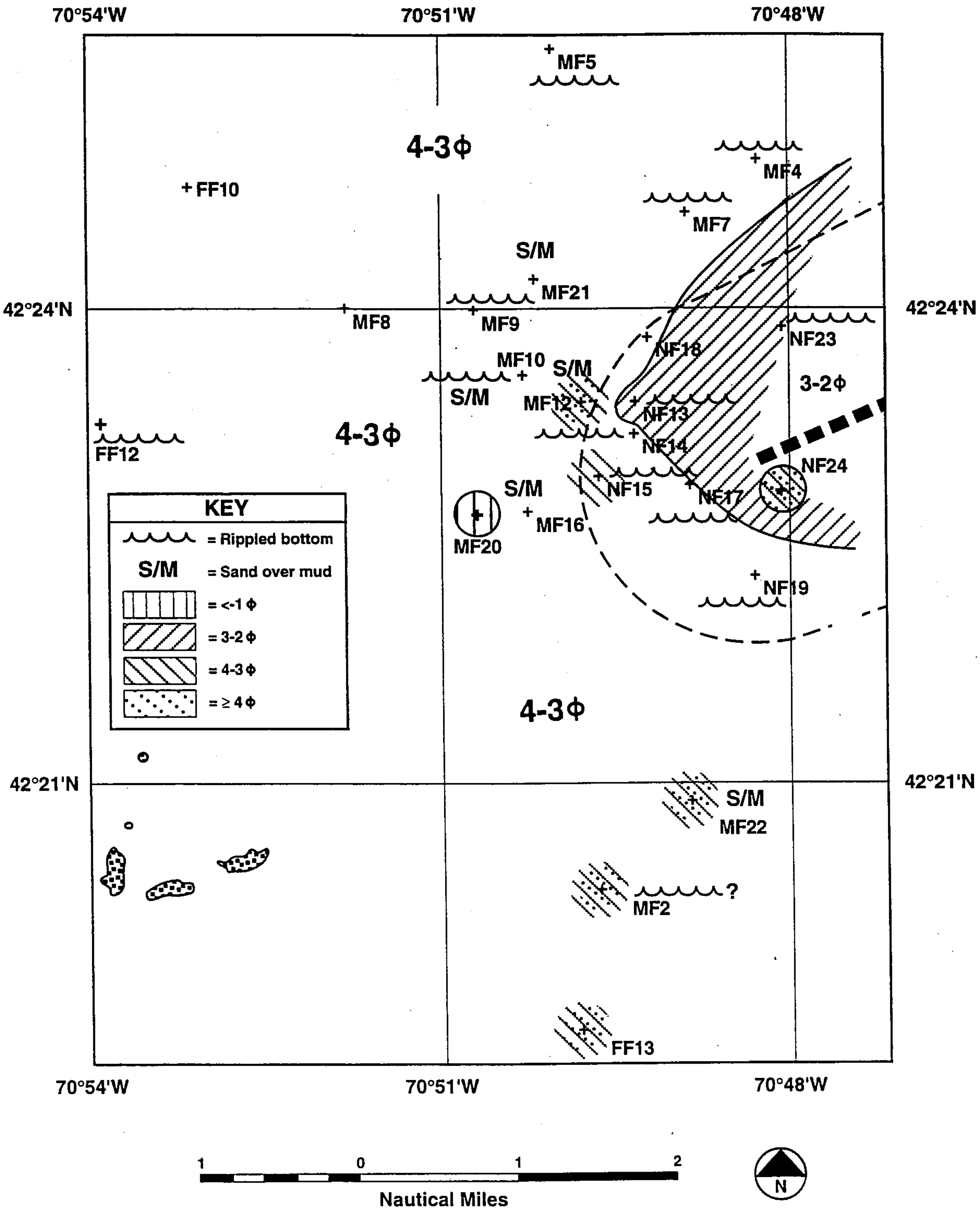


Figure 10. Sediment processes and major modal grain size in the nearfield and midfield, 1997.

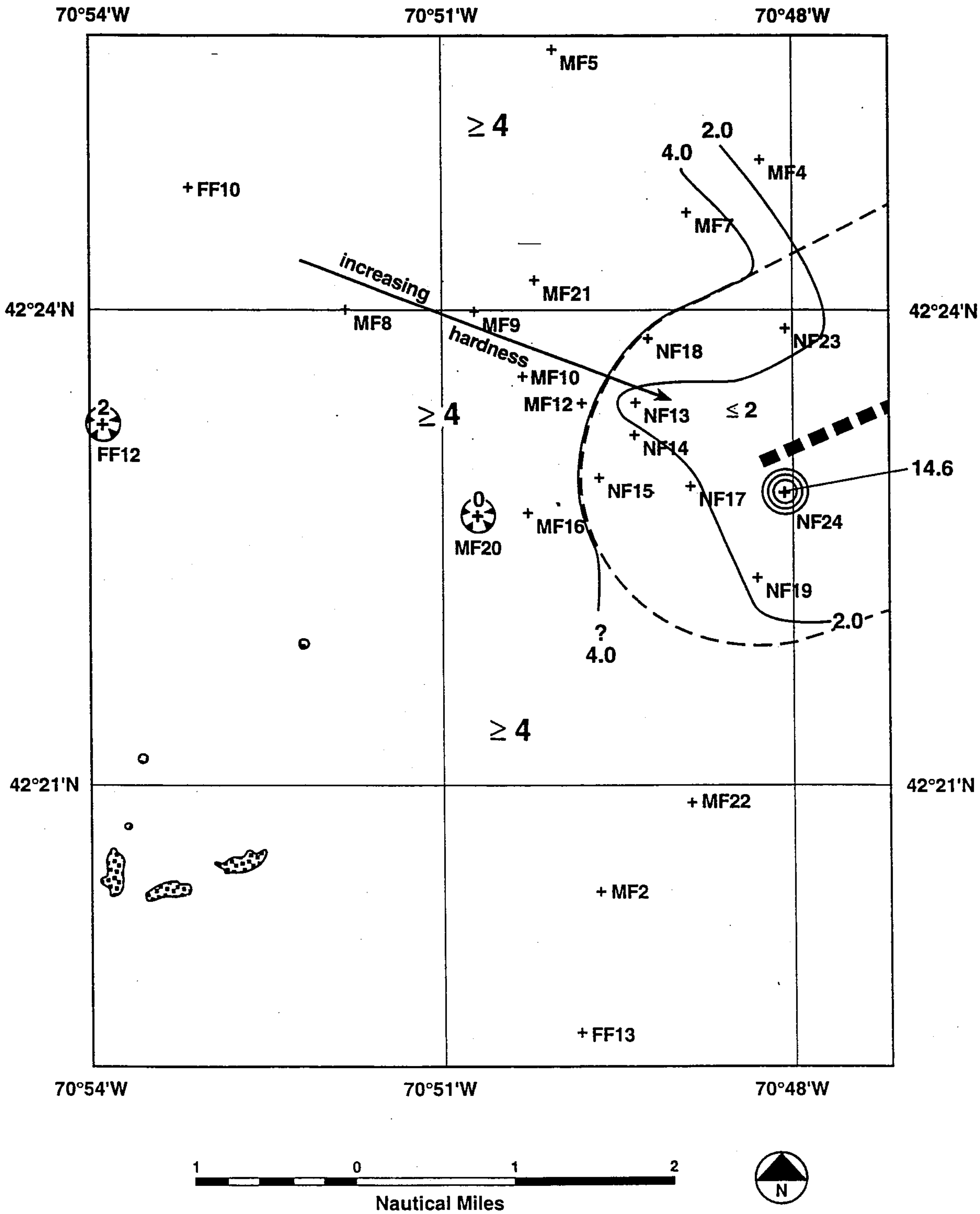


Figure 11. Penetration depth of the sediment profile imaging camera into the bottom at nearfield and midfield stations, 1997. Gradients in penetration depth reflect sediment compactness (shallow penetration = compact sediments; deep penetration = "soft" dilated fabrics).

penetration depth (14.5 cm). All midfield stations had penetration depths of ≥ 4 cm with the exception of MF20 (granule to gravel) and FF12 (rippled very fine sand). The overall distribution of sediment compactness reflects a relatively sharp gradient of increasing compactness at the nearfield-midfield boundary. This gradient corresponds to increasing modal grain size toward the diffuser field and physical sorting of sediments within the region of high kinetic energy. The bioturbational process is known to be able to decrease sediment compaction by formation of biogenic voids (Bokuniewicz, Gordon, and Rhoads, 1975; Rhoads and Boyer, 1982). Bioturbation is relatively more important in the muddy, very fine sand and silt-clay sediments of the midfield (≥ 4.0 cm penetration depth) than in physically reworked (rippled) fine sands of the nearfield (<4.0 cm penetration depth). The softness of the sediment at station NF24 is attributed both to bioturbation and to a high apparent sediment accumulation rate (Figure 11). High sediment accumulation rates of muddy sediment produce an under consolidated dilated fabric. The inference that station NF24 has a high sedimentation rate, based on sediment profile imaging, is supported by ^{234}Thorium data that shows high accumulation rates, especially after the passage of storms (M. Bothner, personal communication, 1998).

Figure 12 compares mean station penetration depth classes between August and October of 1997. The purpose of this comparison is to evaluate temporal consistency over a short period of time between sampling events. The variable of penetration depth was selected for comparison because it integrates the sum of the effects of grain-size and compaction. Most stations (n=18) had mean penetration depths that differed by less than 2.4 cm between August and October. The mean penetration depth at station MF16 was the same for both sampling dates. Twelve stations had mean penetration depths that were within 0.8 cm of each other; penetration depths in October were slightly less than those in August at four of these stations and slightly greater at seven stations. Stations FF13 and MF20 could not be compared over time as data were only available for one sampling period.

Mean penetration depths at MF2, MF21, and MF24 were different by more than 4 cm; in each case the camera prism penetrated the bottom deeper in October than in August. The frequency distributions of mean station penetration depth classes (Figure 12) show that in August, all analyzable stations (n=22) had mean penetration depths of less than 9.0 cm. The August trimodal distribution had a major mode (n=5) in the 1-1.99 cm class. In October, the frequency distribution was bimodal with the major mode (n=8) falling within the 1-1.99 and 2-2.99 depth classes. In October, two stations (MF22 and NF24) had mean penetration depths that fell outside (deeper) the envelope of values for other stations. With these two exceptions, the overall comparison of mean penetration depths between August and October shows them to be comparable given within station variability. Within station variability between the three station replicates can be 1 to 2 cm or more. The greatest temporal variability in station values is expected along the sediment "hardness" gradient shown in Figure 11, especially at those stations showing a sand-over-mud stratigraphy (Figure 10). The intercalation of sand (higher kinetic energy events) and mud (lower kinetic events) in the near midfield reflects the kinetic history of the bottom. Variability is therefore expected to be greatest when comparing before storm conditions with post-storm values (i.e. summer versus winter). Our August-October comparison did not straddle such a seasonal turbulence event and so minimal temporal differences were observed.

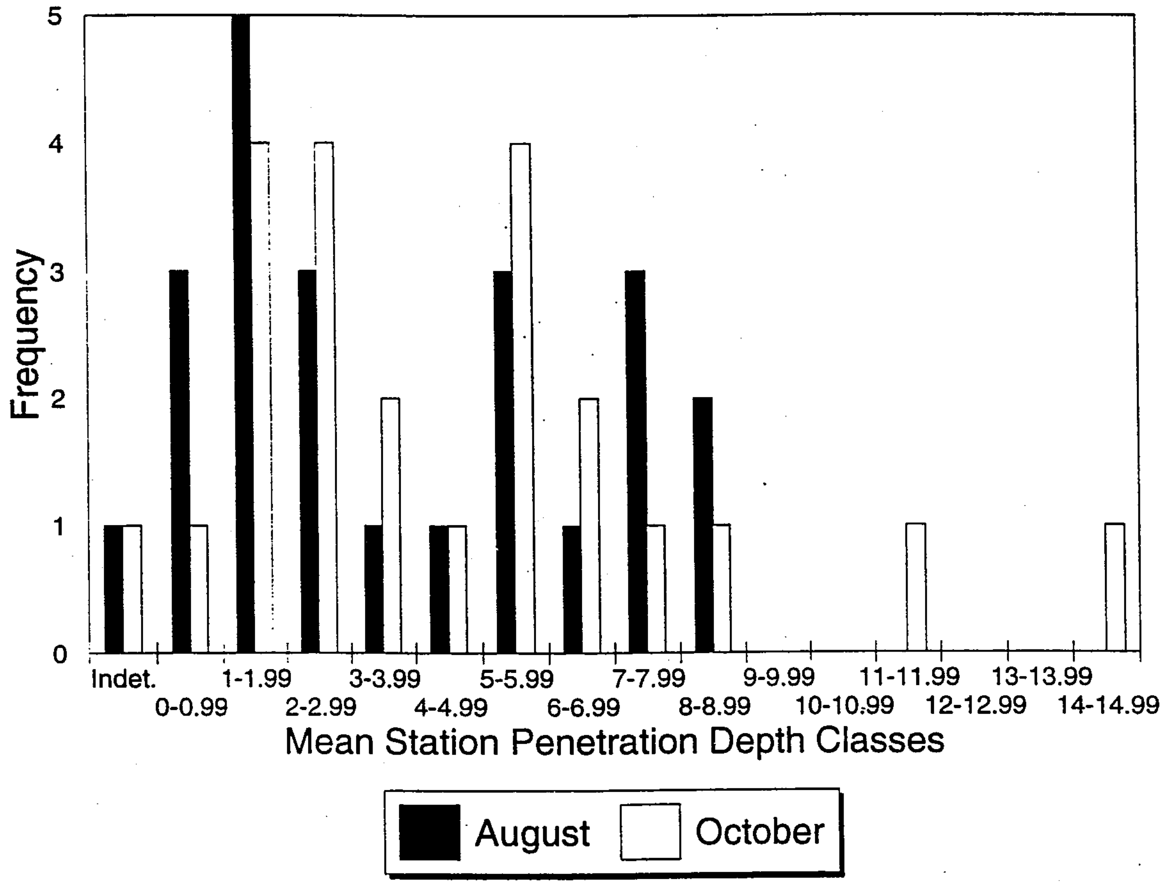


Figure 12. Penetration depth frequency distributions for August and October, 1997 based on nearfield and midfield station means.

Mean Apparent Redox Potential Discontinuity (RPD) Depths. Mixing of particles and fluids across the sediment-water interface promotes the penetration of oxygen into the bottom and advection of reduced metabolites out of the bottom. This phenomenon is called ventilation. The surficial zone of high ventilation is marked by a change in sediment color related to the spectral difference between ferric hydroxide (oxidized rust-colored iron coatings on sediment grains) and reduced iron at depth (grey to black iron sulfides). Mixing and ventilation can be related to physical processes such as bed-load transport of sand where the mixing depth is roughly equal to the ripple height or, alternatively, by biological mixing (bioturbation). Nearfield stations located closest to the diffuser have apparent RPD depths > 2.0 cm (Figure 13). These stations, with the exception of the muddy bioturbated station NF-24, consist of rippled fine sands (3-2 phi). RPD depths decrease to 1 to 2 cm at nearfield and midfield stations located near the western edge of the nearfield boundary. The depth of apparent RPDs is attributed to both physical reworking of the bottom by bed-load transport and bioturbation. As the diffuser area is approached from the west, physical reworking depths increase related to enhanced bedload transport. High rates of physical reworking result in coarser texture, removal of fines, lower TOC and *Clostridium* spore counts, and rippled bed forms (Figure 10), and sediment compactness (Figure 11). The sand-over-mud stratigraphy at stations proximal to the diffuser field reflects a facies boundary (Figure 10). During periods of intense mixing by waves and/or tidal currents the sand fraction is dispersed from the diffuser drumlin to the midfield. During lower kinetic energy periods, fine-grained sediments accumulate over sands. Stations MF2, FF10, and FF13 have mean apparent RPD depths > 2.0 cm suggesting that biological mixing is relatively more important at these stations, although station MF2 may also be rippled.

Most apparent RPD values fall within the range of 1 to 2 cm frequency class (Figure 14A). Values > 2.16 cm are located at stations proximal to the diffuser (high physical reworking) or at stations located in the northwest and southern quadrants (physical and/or biological ventilation).

Successional Stages. The distribution of successional seres is shown in Figure 15. Most stations (16 out of 23 or 70%) are dominated by early successional stages (I and/or II) while 30% of the stations contain evidence of Stage III seres. Stations showing evidence of Stage III infauna (subsurface feeding voids) form two clusters (MF5, MF12, MF21, NF18 and MF2, MF22). Station NF24 (the mud patch) is also populated by Stage III taxa.

Organism-Sediment Indices. Figure 16 is a contour map of OSI values for 1997. Past experience has shown that physical and/or chemical disturbance of the bottom often results in OSI values ≤ +6. The lowest OSI values are found within the ecotone at the outer edge of the nearfield (interpolated contour of OSI=3). This corresponds to the rippled fine-sand facies. OSI values generally increase away from the nearfield and proximal midfield to the western and southern edges of the midfield. Station NF24 is an anomaly as it has a relatively high OSI (7.33) because of its location in a low kinetic energy depression. Figure 14B compares OSI values over the period 1992, 1995, and 1997. The major OSI modes in 1992 and 1996 fall within the class intervals of OSI= 4.50 to 7.49. In 1997, the major mode is located within the 3.50-4.49 class with a subordinate mode at OSI= 5.50 to 6.49. Bimodality or polymodality of OSI values can be expected in the sampling area given the documented gradients in kinetic energy, mixing depths, sediment type, and successional stages. The sampled stations include a high kinetic energy area (diffuser stations except NF24), low kinetic energy areas (NF24, some midfield stations), and transitional stations located within the lithofacies and biofacies boundary between the high and low kinetic energy areas.

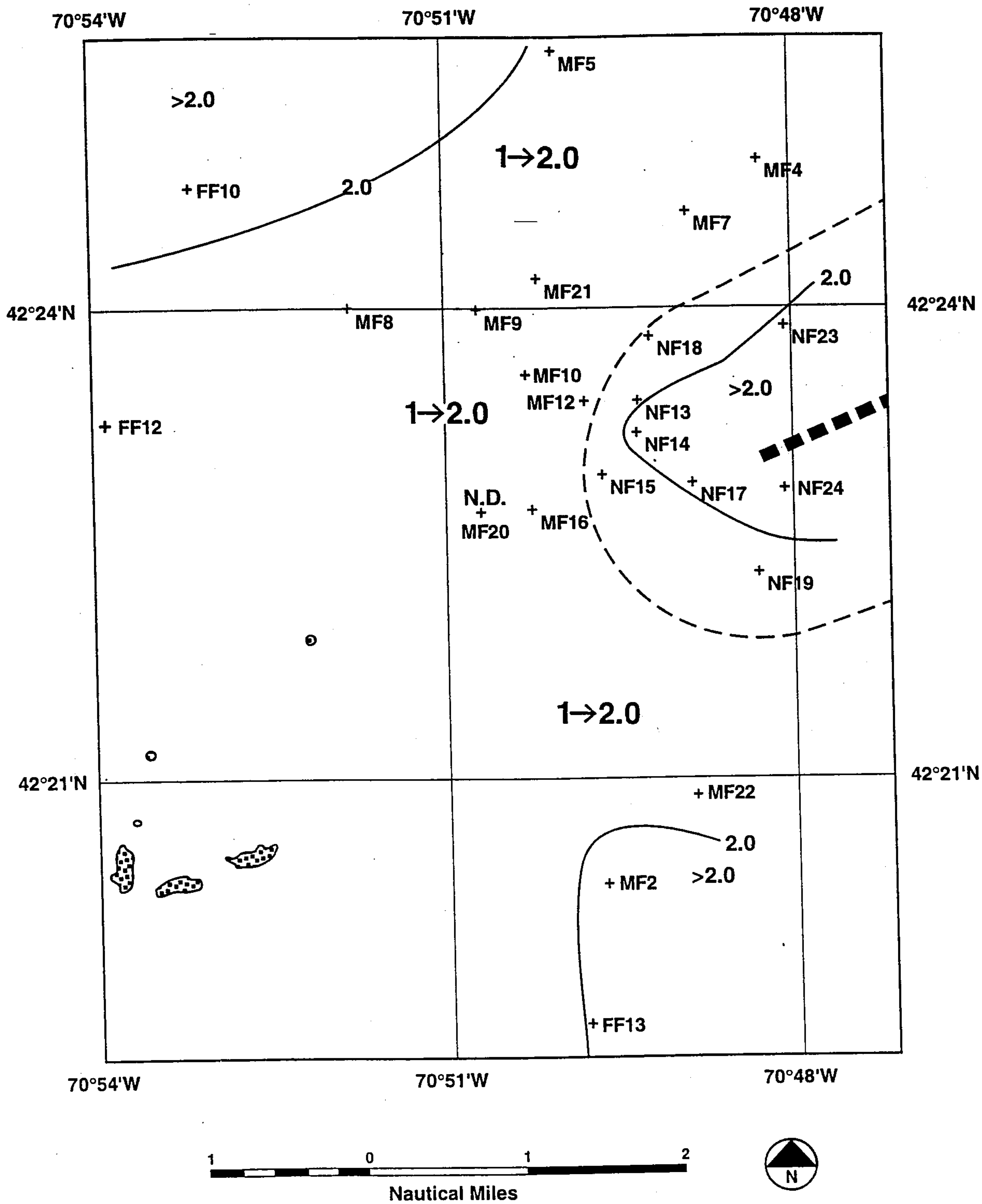
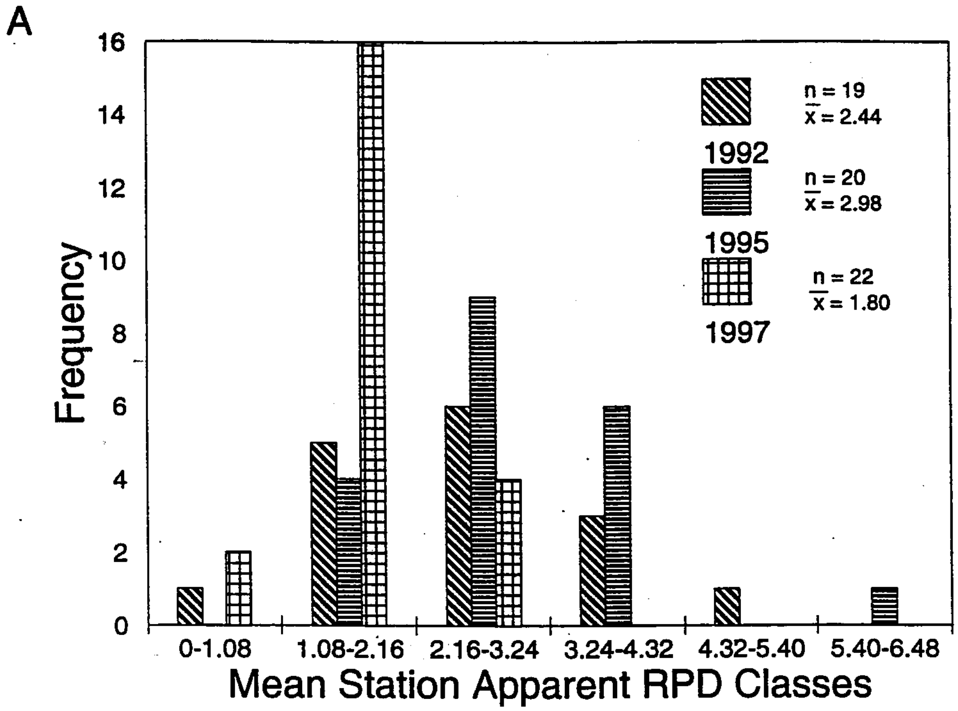


Figure 13. Distribution of mean apparent redox potential discontinuity (RPD) depths, 1997.



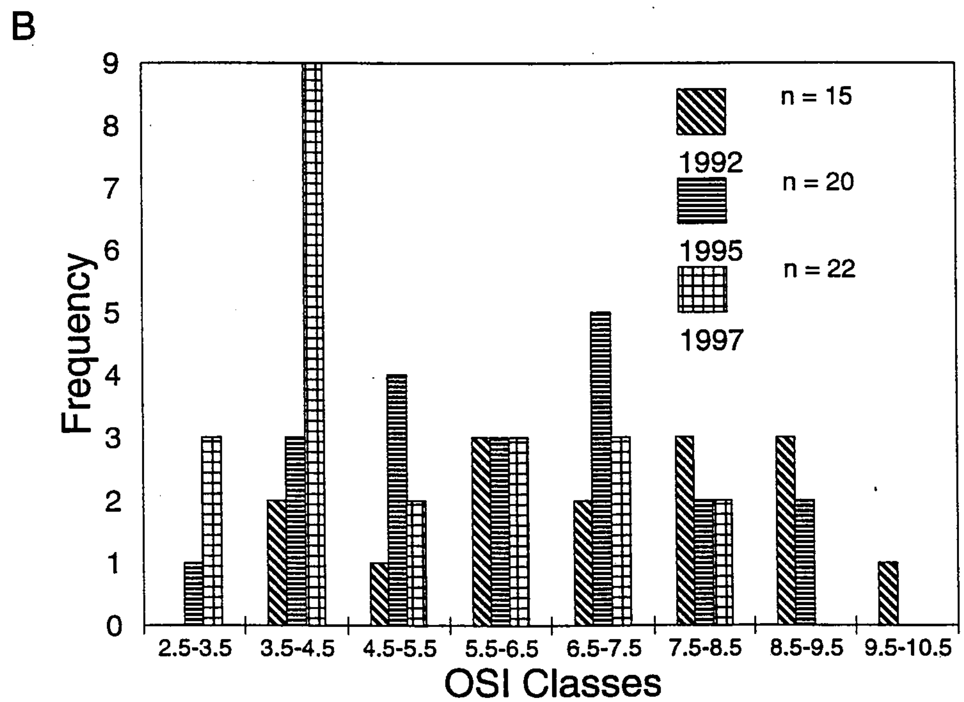


Figure 14. Frequency distributions of mean station apparent RPD depths (A) and organism-sediment indices (OSI) (B) in the nearfield and midfield 1992, 1995, and 1997. RPD values reflect vertical mixing in the upper few centimeters of the bottom; this mixing and aeration can be caused by bed-load transport (equal to sand-ripple height) or by bioturbation.

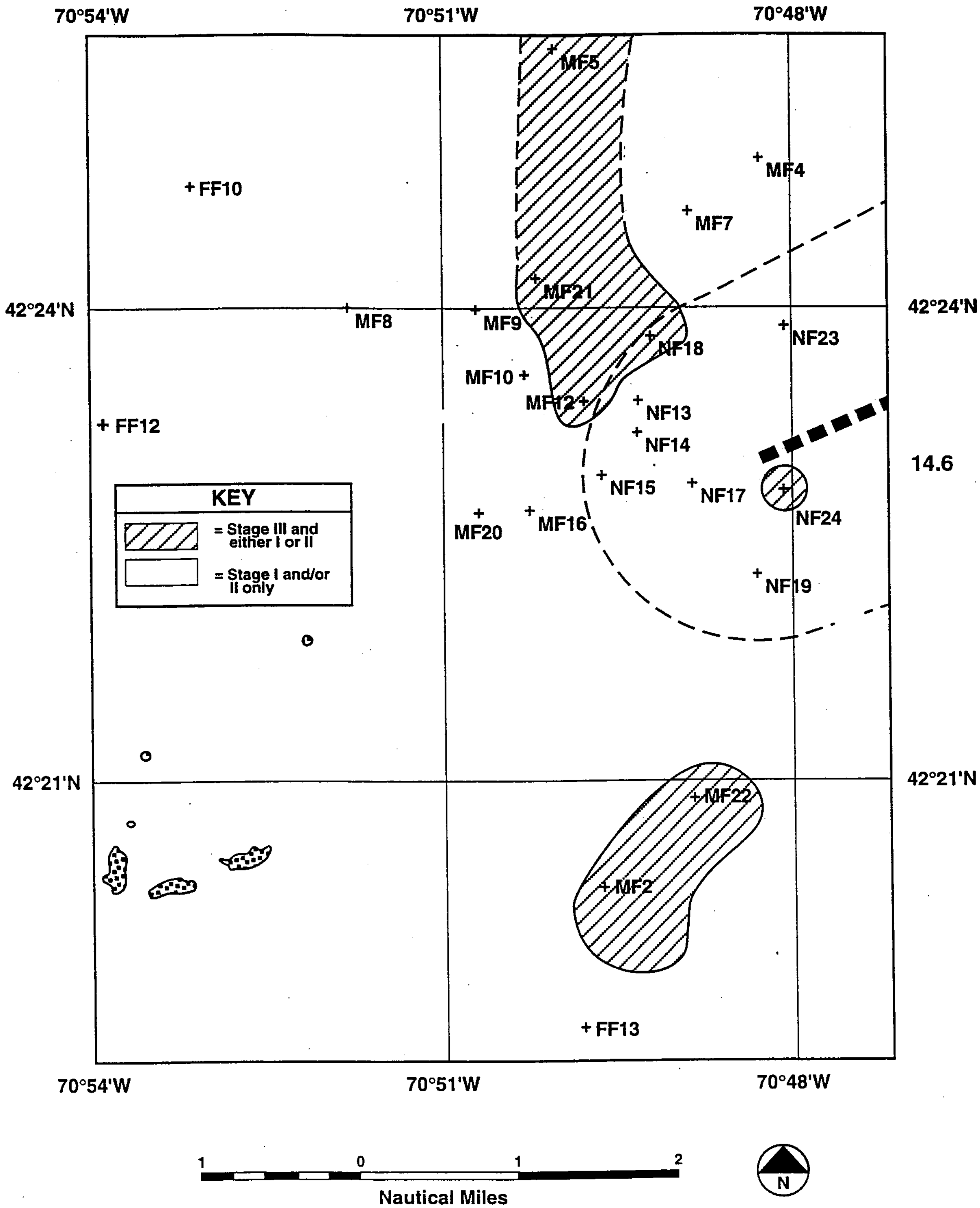


Figure 15. Distribution of infaunal successional stages at nearfield and midfield stations, 1997.

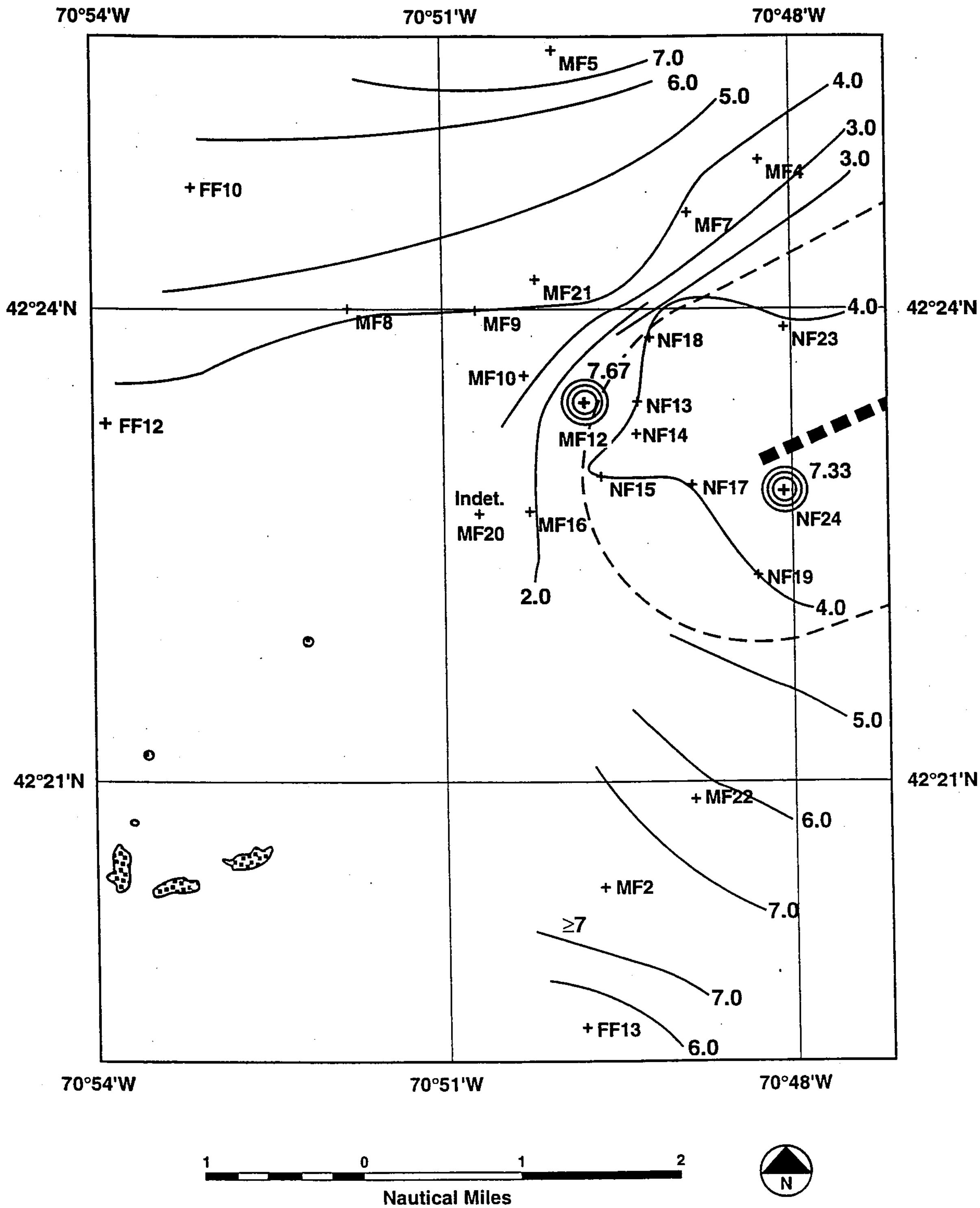


Figure 16. Organism-sediment indices (OSIs) at nearfield and midfield stations, 1997. Physically or chemically disturbed benthic habitats tend to have OSI values ≤ +6.

3.1.5 Benthic Infauna: Nearfield and Midfield

Taxonomic Composition. The benthic infauna of all of the 1997 samples taken in Massachusetts Bay and Cape Cod Bay totaled 292 species. The nearfield and midfield samples contained 247 species. Epifaunal species, such as limpets, barnacles, and caprellid amphipods were not included. Three taxa, *Flabelligera* spp., *Margarites* spp., and *Tetrastemma* spp. were included in this analysis because there were no identifications to the species level in these genera. Table 3 summarizes the breakdown of species into major taxonomic groups. As in previous years, annelids comprised nearly half the species, followed by arthropods, mollusks, and representatives of seven other phyla. The largest polychaete families were the Spionidae (12 species), the Maldanidae and Syllidae (each with 9 species), and Phyllodocidae (8 species). The largest arthropod orders were the Amphipoda (41 species) and the Isopoda and Cumacea (8 species each). The Bivalvia (28 species) and Gastropoda (17 species) dominated the Mollusca.

Table 3. Taxonomic composition of benthic infaunal samples collected in August 1997.

Taxonomic Group	Nearfield/Midfield		Entire Study Area	
	Number	Percent	Number	Percent
Annelida	115	46.6	129	44.2
Polychaeta	110	44.5	124	42.5
Oligochaeta	5	2.0	5	1.7
Arthropoda	62	25.1	72	24.7
Amphipoda	41	16.6	44	15.1
Isopoda	8	3.2	10	3.4
Cumacea	8	3.2	13	4.5
Other	5	2.0	5	1.7
Mollusca	46	18.6	59	20.2
Bivalvia	28	11.3	34	11.6
Gastropoda	17	6.9	23	7.9
Other	1	0.4	2	0.7
Remaining Species - representing 7 phyla	24	9.7	3	11.0
Total	247	100	292	100

Figure 17 shows the taxonomic composition by species and by individuals of samples taken at the nearfield and midfield stations. Polychaete species were the most numerous and accounted for 34% (NF13) to 55% (NF19) of species present (more than 50% at nine stations). Amphipod species ranged from 9% (MF20) to 26% (MF7) of species present and bivalve species ranged from 10% (MF7) to 19% (FF12 and MF10). Abundance of polychaete individuals ranged from less than 50% of the individuals at MF2, MF7, and NF17 to 94% at MF16 and NF24. Bivalves were least abundant at FF13 and NF (1-2%) and most numerous at MF2 (38%), one of the stations with low numbers of polychaetes. Amphipods had a range similar to that of bivalves being <2% at seven stations but 33% at NF17, another of the stations with low numbers of polychaetes.

Distribution and Density of Dominant Species. Polychaetes were the most abundant taxa at all 23 localities, with spionid polychaetes outnumbering all other polychaetes (and other taxa). This is consistent with previous years, however, species composition has changed. For example, *Spio limicola* was among the ten most abundant species at 14 of 23 stations in 1996, but only 10 in 1997. *Prionospio steenstrupi* was most abundant at stations FF12 and particularly FF13 with 7,891 individuals per 0.04 m^2 (Figure 18A). These high abundances cannot be correlated with grain size as stations FF12 had greater than 75% sand but FF13 had 40% sand with 40% silt. *Prionospio steenstrupi* was among the top 10 dominant species at 20 of 23 stations for 1996 and at all except NF17 in 1997. *Dipolydora socialis* was second most abundant and *Spio limicola* third ranked in 1997 (Figure 18A).

Among the capitellids, *Mediomastus californiensis* was the most common dominant species in both 1996 and 1997. The species was found at 19 of 23 midfield and nearfield stations in 1996 and at all stations in 1997. As is typical for Massachusetts Bay, the species of the so-called *Capitella* "complex" were rarely encountered, being most abundant at the nearshore station FF13 with 91 individuals per 0.04 m^2 (Figure 18B). Species of this complex are more typically found in nearshore estuarine habitats with high levels of organic carbon.

Cirratulid abundances varied greatly among stations. There were four abundant species with *Tharyx acutus* and *Aphelochaeta marioni* being most numerous. *Tharyx acutus* was most abundant at station FF12 (1669 individuals per 0.04 m^2). *Aphelochaeta marioni* was most abundant at MF12 with 697 individuals per 0.12 m^2 (Figure 19A)

The most abundant paraonid polychaete species were *Aricidea catherinae* and *Levinsenia gracilis*. *A. catherinae* was most abundant at station MF12 (274 individuals per 0.04 m^2) where the sediments were composed of 35% sand and 50 % silt. *L. gracilis* was most abundant at Station MF16 (144 individuals per 0.04 m^2) in sandier sediments (57% sand; 30% silt). In the nearfield, the highest number of paraonids were found at NF17 a very sandy station (98% sand). Other stations had low numbers of paraonids; total abundances ranged from four (Sta. MF7) to 325 (Sta. MF10) individuals per 0.04 m^2 (Figure 19B).

Syllids were most abundant at the nearfield stations with >75% sand content. *Exogone verugera* was the most abundant syllid as well as the top dominant species at station NF14 (80% sand). *Exogone hebes* was the second most abundant syllid and top dominant species at NF13 (95% sand). However, sandy habitat can not be used to as an indicator of preferred syllid habitat as stations MF2 and MF4 both had >90% sand but very few syllids (18 and 20 syllid individuals respectively). Other syllids, such as *Exogone longicirris*, were very rare at all stations. (Figure 20A).

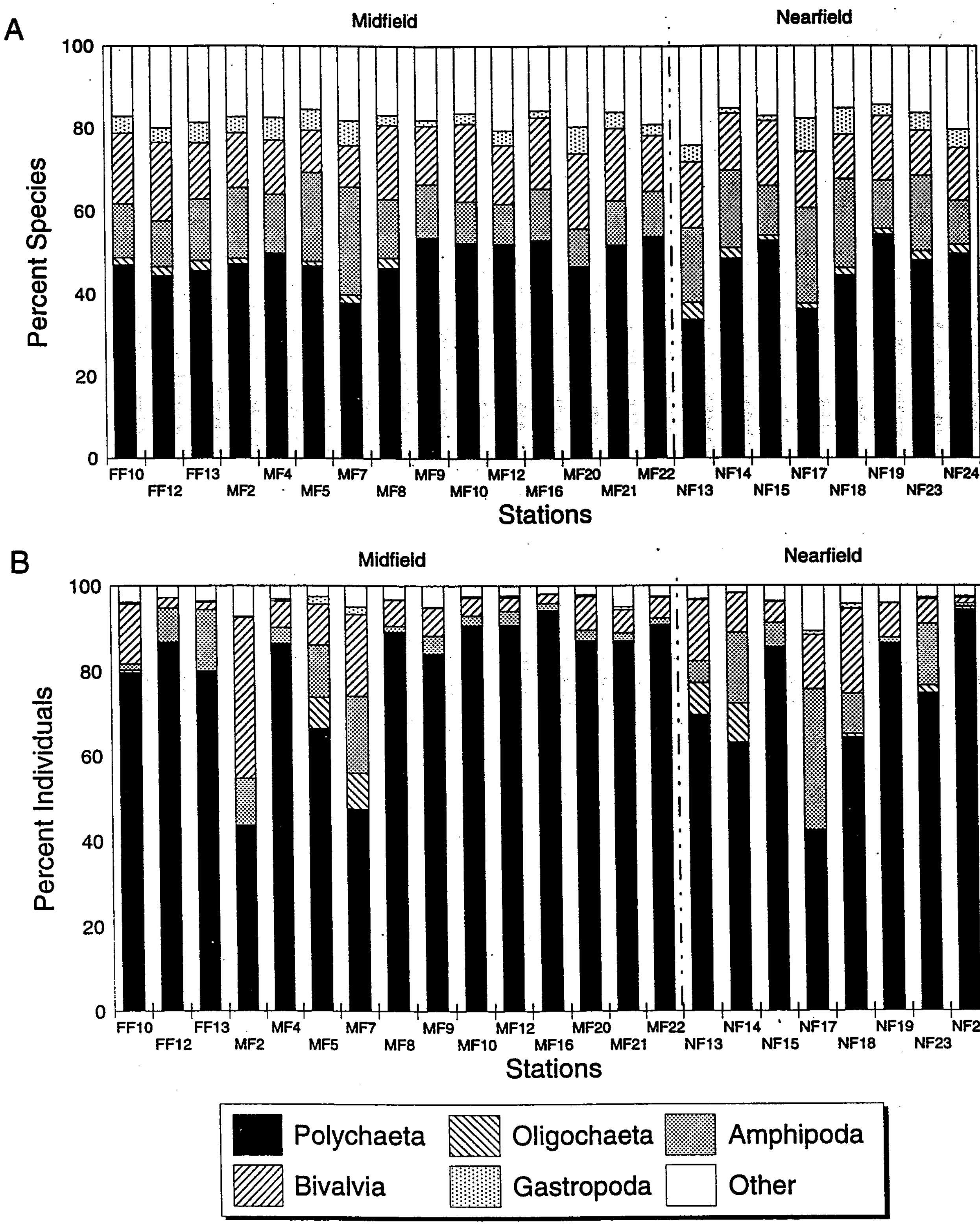


Figure 17. Taxonomic composition by percent species (A) and percent individuals (B) of benthic infauna samples taken at nearfield and midfield stations in August 1997.

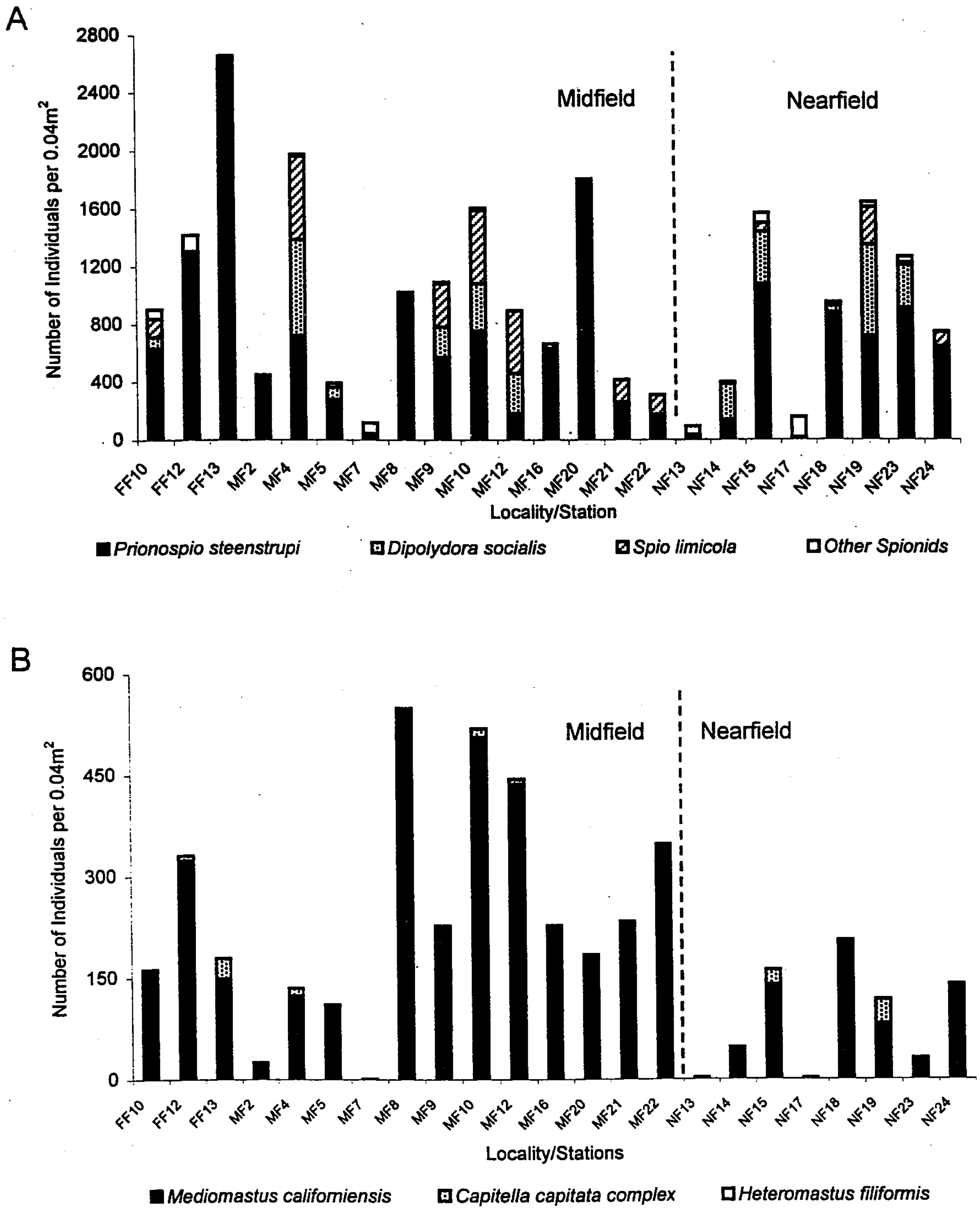


Figure 18. Densities of spionid (A) and capitellid (B) polychaetes at nearfield and midfield stations in August 1997.

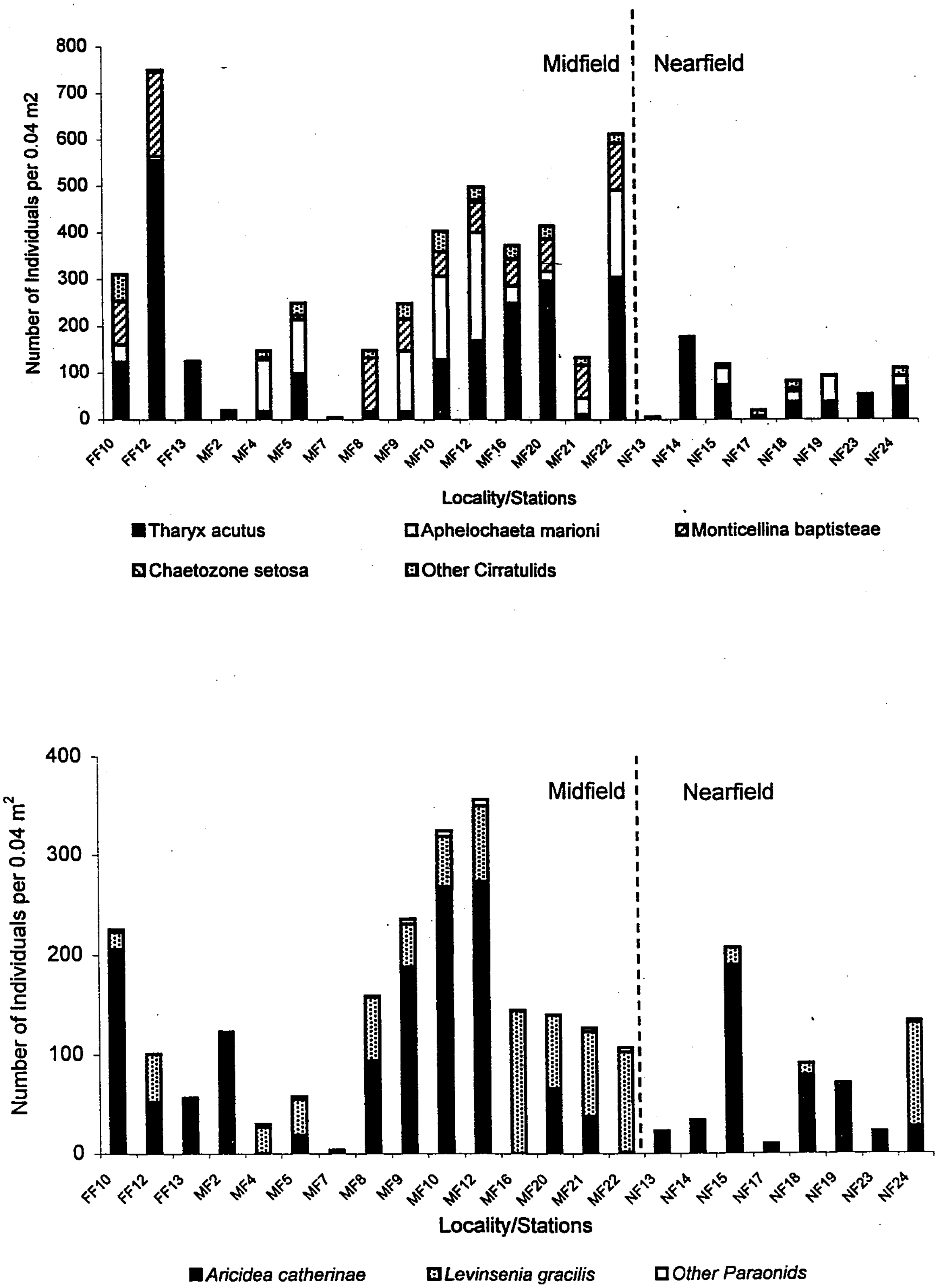


Figure 19. Densities of cirratulid (A) and paraonid (B) polychaetes at nearfield and midfield stations in August 1997.

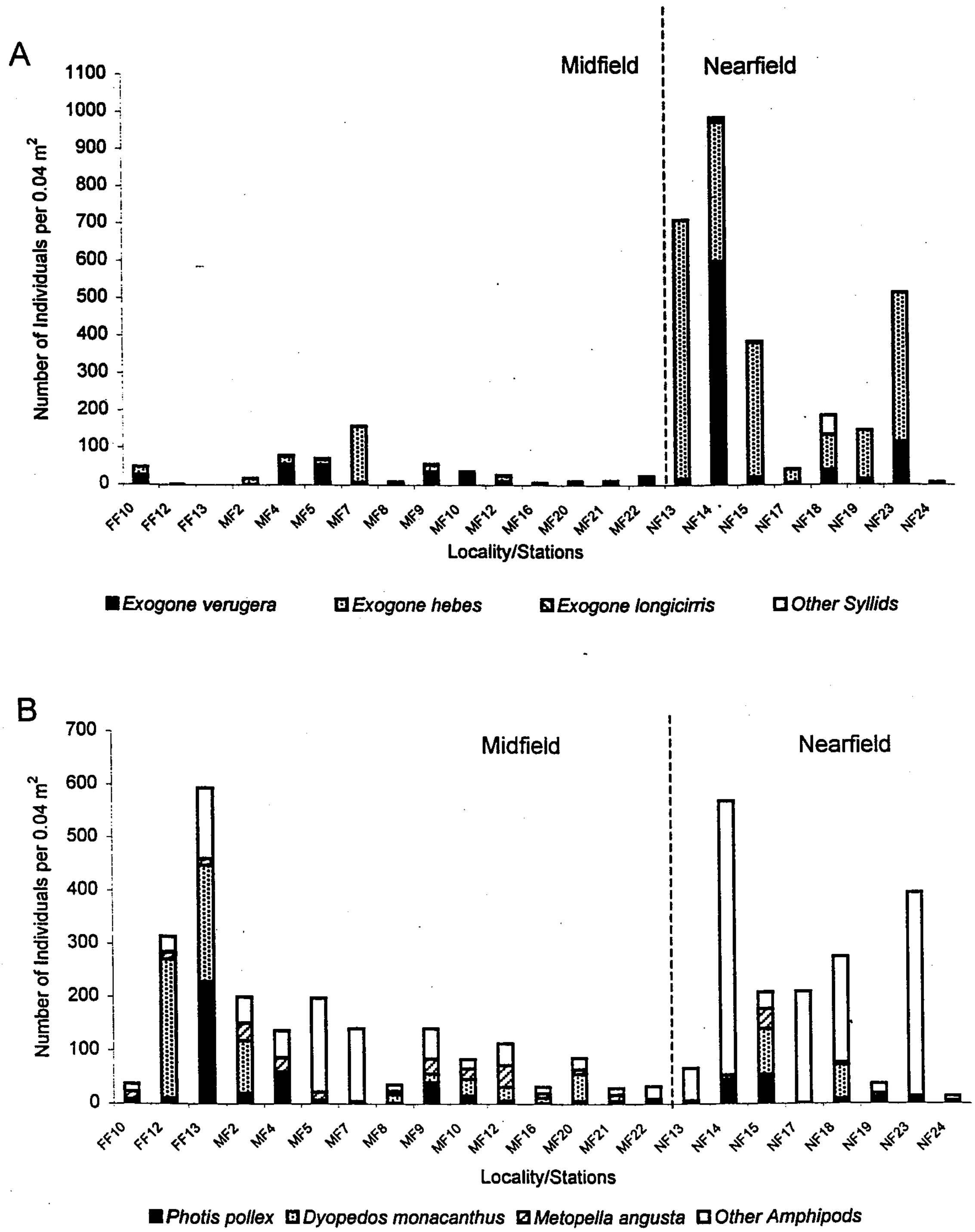


Figure 20. Densities of syllid polychaetes (A) and amphipod crustaceans (B) at nearfield and midfield stations in August 1997.

The lumbrinerid, *Ninoe nigripes*, was widespread and among the top ten dominant species at many of the nearfield and midfield stations (Appendices D-1, D-2).

Many species of amphipods were identified in 1997 and were most abundant at stations FF12, FF13, and NF14. In 1996 the stations that had the greatest abundance of amphipods were NF17 and NF23. *Dyopedos monacanthus* was the most abundant amphipod followed by *Photis pollex* (Figure 20B). Both species together had their greatest density at FF13, the same station with the highest numbers of *Prionospio steenstrupi*. Numbers of amphipods at any given station were relatively less in comparison with spionid polychaetes, especially at FF13, where the greatest number of amphipods identified was 1782 amphipod individuals per 0.04 m^2. The number of spionids identified at this station was much greater with over 7000 individuals per 0.04 m^2.

Numerous species of bivalves were identified and *Hiatella arctica*, *Nucula delphinodonta*, and *Cerastoderma pinnulatum* had similar abundances at many different stations. *H. arctica* was most abundant at station MF2 along with *C. pinnulatum* and was found at all 23 nearfield and midfield stations. *N. delphinodonta* was most abundant at FF10. In 1996 Station NF23 had the most bivalve species, whereas in 1997 the station with the most species of bivalves was FF10 (Figure 21).

The top ten dominant species for each station are presented in Appendix D. The contribution of each species relative to the total fauna (juveniles and indeterminates included) and to the identified species (juveniles and indeterminates excluded) is reported. Eight of the 23 stations had the number of unidentified species greater than 5% (no higher than 13.16%). This was caused by the inability to identify some taxa or juvenile animals to species. In the case of MF2, with 13.16% unidentified species, there were 183 unidentifiable bivalves that contributed to the density results but were not listed in the dominance tables.

The replicated station with the greatest number of species was station FF10, with a total of 123 identified taxa. Replicates 1, 2, and 3 of station FF10 had a total of 79, 92, and 108 identified taxa, respectively. The singleton (unreplicated) station that had the greatest number of species was station MF5 with 98 identified taxa, only ten less than replicate number 3 for station FF10. Although both sample number 3 from station FF10 and the sample from unreplicated station MF5 had comparable numbers of identified taxa, the total number of identified fauna from the replicated station was much greater, with a total of 123 identified taxa. The stations that had the lowest number of identified species were unreplicated stations NF13 and MF7 with 50 identified taxa. It is important to note that replicated stations NF17 and NF24 had 74 and 94 total taxa identified, respectively. These two stations also had individual samples with 53 and 54 taxa identified. As is usually found, more taxa are found with multiple sampling and unreplicated stations would certainly yield more identified taxa if the sampling efforts were increased.

Sediments at stations MF21 and MF12 both had 50% silt and >13% sand (mean phi >5.4 for both stations). These two stations shared 8 of the top ten fauna suggesting that these select muddy habitats. However, species such as *Prionospio steenstrupi, Mediomastus californiensis, Aphelochaeta marioni*, and *Spio limicola*, which were found at these stations, were also abundant in sandy sediments. This suggests that the dominant species from Massachusetts Bay can tolerate different environmental conditions and several types of habitats with very different grain sizes.

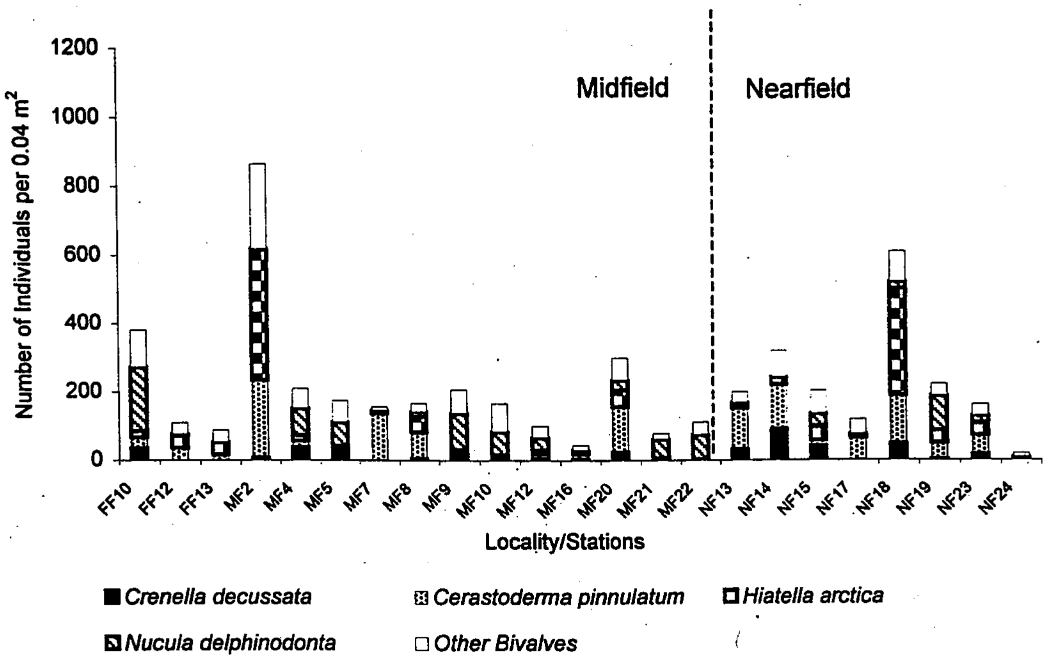


Figure 21. Densities of bivalve molluscs at nearfield and midfield stations in August 1997.

Species Richness and Diversity. The number of species identified from a grab sample ranged from 45 (Sta. NF17-1) to 112 (Sta. NF18) and the number of individuals counted per 0.04 m^2 ranged from 430 (Sta. NF17-1) to 4129 (Sta. FF13-2). Mean values for number of species and individuals identified to species are given in Table 4. There was little apparent pattern in the distribution of species richness or infaunal densities apart from the stations having the lowest values occurring at stations having high percentages of sand. In general the habitat is patchy and stations near the diffuser are influenced by sediment transport events.

Diversity was measured with two methods, Hurlbert's rarefaction and the Shannon-Wiener index H′ (including evenness J′). The results (Table 4) were similar with both methods. The number of expected species per 100 individuals ranged from 16.87 to 33.66 (Table 4). The highest diversity stations were MF5, MF9, NF18, and FF10; the lowest were NF13, MF16, MF20, NF24, FF12, and FF13. The only apparent trend is that stations with the highest diversities occurred in the northern half of the station array and the lowest in the southern half. Other calculated diversity estimates were similar. The variability of the infaunal diversity was comparable in both the nearfield and midfield areas. The Shannon-Wiener indices generally ranged from about 2.1 to 3.4 with one station (FF13) exhibiting a low diversity with H′ of 1.7 and six stations (MF5, MF9, NF14, NF18,MF20, and FF10) having relatively high diversities with H′ values over 3.0. Evenness (J′) was generally higher at stations with high H′.

Community Analysis (1997). For the 1997 near- and midfield community study, multivariate analysis included cluster analysis using CNESS and ordination using PCA-H with metric scaling that is based on CNESS distances. Cluster dendrograms demonstrate similarity among stations as well as the manner in which the 34 most important contributors to CNESS distances are themselves clustered. These clusters form the basis of the PCA-H output. PCA-H is used to depict the distribution of the stations and clusters in ordination space between six axes, three (1, 2, and 3) of which are presented. The results of UPGMA clustering of CNESS distances are shown by enclosing cluster members with hulls. A Gabriel Euclidian distance biplot, using the same three axes, shows the importance of individual species in each of the clusters. These species are included in a table (Table 5) that lists their contributions to the first six PCA-H axes. The 3-letter codes associated with each species name are found on the Gabriel biplots. Finally, a Gabriel covariance biplot is used to show the major species associations within each of the clusters. This sequence of analyses is used throughout this report. In addition, a summary table has been prepared that shows the physical and biological factors associated with each of the main clusters.

Three main clusters are present in the 1997 near- and midfield station data (Figure 22). Cluster 1 includes stations FF12, FF13, MF2, and NF18. The stations are characterized by a mixture of very fine sands (stations. MF2, NF18) and silts, low to moderate TOC levels, and moderate to high C/N ratios (Table 6). The fauna is dominated by *Prionospio steenstrupi*. Species which appear to define this assemblage include: *Owenia fusiformis*, *Dyopedos monacanthus*, *Photis pollex*, *Hiatella arctica*, *Phoronis architecta*, and *Nephtys incisa*. All of these species are among the 34 most important species (Table 5) and except *Hiatella arctica*, form a distinct cluster in the R-mode analysis (Fig. 23). Cluster 2 includes a large group of 14 stations that occur north, west, and south of the diffuser. These stations include four with fine sands (MF4, 20; NF 15, 19), one with very fine sand (FF10), and the remainder silty. All have moderate to low TOC and moderate to high C/N ratios (Table 6). The fauna of these stations is characterized by 11 species. Three spionids, *Dipolydora socialis*, *Prionospio steenstrupi*, and *Spio limicola*, seven other polychaetes, and the bivalve *Nucula delphinodonta* characterize this assemblage (Table 6). Cluster 3 includes MF7, NF13, 14, 17, and 23, all with high percentages of fine sand, low TOC, and moderate to high C/N ratios. The fauna is dominated by species more typically associated with sandy sediments including the syllid polychaete *Exogone hebes*, the spionid *Spiophanes bombyx*, and the amphipod *Crassicorophium crassicorne*. The R-mode cluster analysis (Figure 23) defines two main clusters of species that roughly correspond to a mud (Cluster A) and sand (Cluster B) assemblage.

Figures 24A, 25A, and 26A show the metric scaling of the cluster groups according to axes 1-2, 1-3, and 2-3. Members of clusters are connected with convex hulls. H_{max} is the theoretical point of maximum diversity. Increasing distance from that point represents lower diversity. Cluster 3 is the most distinct assemblage in all of the plots. Figure 24B, 25A, and 26A are the Euclidean biplots that show the most important species. The longer the length of the arrow, the greater the importance. In Figure 24B, for example, *Spio limicola* accounts for 10% of the variation in this plot, *Exogone hebes* accounts for 8%, and *Mediomastus californiensis* accounts for 7%. For axes 2 and 3, *Dipolydora socialis* is by far the most important contributor, contributing 16% to axis 2 and 21% to axis 3 (Table 5). *Dyopedos monacanthus* and *Spio limicola* are major contributors to axis 2 (both contributions are 17%).

The fauna is clearly divided into sand and fine sand to silt assemblages. Figures 27A-C are Gabriel covariance biplots which show faunal associations for axes 1-2, 1-3, and 2-3. Species which co-occur are joined with highly acute angles between vectors. For example, *Crassicorophium crassicorne* (Crc) and *Mediomastus californiensis* (Mec) are least likely to co-occur because they are 180° apart (Fig. 27A), whereas, *Pseudunciola obliquua* (Pso) and *Chiridotea tuftsi* (Cht) are likely to co-occur at all times.

Table 4. Community parameters of nearfield and midfield stations, August 1997.

Station	No. spp. (0.04m²)	No. indiv.+ (0.04 m²)	spp./50 ind.	spp./100 ind.	spp./500 ind.	H'	J'
MF2	76	1801	17.50	26.02	52.53	2.79	0.64
MF4	92	3408	17.20	25.28	52.32	2.79	0.62
MF5	98	1598	23.43	33.66	66.69	3.41	0.74
MF7	50	785	16.34	23.08	44.53	2.74	0.70
MF8	83	2714	14.26	20.11	43.04	2.40	0.54
MF9	78	3078	20.45	28.18	50.79	3.15	0.72
MF10	80	3742	16.47	22.71	44.87	2.81	0.64
MF12*	83(113)	2970	17.34	23.66	46.62	2.92	0.66
NF13	50	1314	13.04	18.36	35.78	2.04	0.52
NF14	80	3408	18.52	24.33	43.51	3.01	0.69
NF15	83	3649	18.72	26.56	48.79	2.89	0.65
MF16	64	2064	12.97	17.74	36.03	2.40	0.58
NF17*	49(74)	632	16.21	23.04	N/A	2.60	0.67
NF18	112	2846	20.29	29.91	63.03	3.03	0.64
NF19	77	2742	16.77	23.80	45.47	2.68	0.62
MF20	77	3398	13.35	19.23	39.31	2.10	0.48
MF21	75	1423	18.03	25.42	51.98	2.94	0.68
MF22	74	2295	16.37	21.74	42.73	2.85	0.66
NF23	92	2728	16.16	23.72	49.94	2.63	0.58
NF24*	61(94)	1395	13.44	19.46	42.93	2.14	0.52
FF10*	93(123)	2641	21.16	29.70	56.67	3.17	0.70
FF12*	73(90)	4007	14.39	19.72	39.15	2.50	0.58
FF13*	60(81)	4121	11.73	16.87	33.48	1.73	0.42

*replicated station, numbers are means per replicate. Species counts in parentheses represent total number of species in the three replicates combined.+ Number of individuals identified to species.

Table 5. The 34 most important contributors to CNESS (NESSm=17) distances in the 1997 MA Bay nearfield and midfield data. Cont is the contribution to overall CNESS distances; total Cont is the cumulative amount of CNESS variation explained by species (91% by the top 34 species). The final columns indicate the contribution of each species to each of the first six PCA-H axes.

Rank	Species	Spp. code	Cont	Total Cont	PCA-H Axis 1	2	3	4	5	6
1	*Spio limicola*	SpL	6	6	6	17	0	0	6	0
2	*Dipolydora socialis*	DiS	6	12	0	16	21	7	0	2
3	*Exogone hebes*	Exh	5	17	9	4	3	0	6	1
4	*Prionospio steenstrupi*	Prs	5	22	5	8	7	2	1	2
5	*Cerastoderma pinnulatum*	Cep	5	27	10	0	2	0	0	15
6	*Tharyx acutus*	Tha	5	31	4	4	1	3	16	7
7	*Mediomastus californiensis*	Mec	4	36	10	0	1	0	0	1
8	*Spiophanes bombyx*	SPB	4	40	8	0	7	5	1	1
9	*Ninoe nigripes*	Nin	4	44	7	0	6	0	3	3
10	*Owenia fusiformis*	Owf	4	47	0	1	0	37	3	0
11	*Dyopedos monacanthus*	Dym	4	51	0	17	2	4	1	0
12	*Pseudunciola obliquua*	Pso	3	54	4	0	8	0	9	3
13	*Levinsenia gracilis*	Leg	3	58	3	0	6	11	1	0
14	*Aricidea catherinae*	Arc	3	61	1	1	0	7	4	20
15	*Crassicorophium crassicorne*	Crc	3	64	7	1	1	0	0	1
16	*Aphelochaeta marioni*	Apm	3	66	3	6	0	0	0	1
17	*Euchone incolor*	Eui	3	69	4	3	2	0	0	0
18	*Photis pollex*	PhP	2	71	0	5	8	1	5	4
19	*Nucula delphinodonta*	Nud	2	74	1	4	0	3	0	1
20	*Hiatella arctica*	Hia	2	76	1	2	1	0	1	22
21	*Monticellina baptisteae*	Mob	2	78	2	0	4	6	3	1
22	Enchytraeidae sp. 1	En1	2	80	2	0	1	1	10	0
23	*Exogone verugera*	Exv	1	82	0	2	3	1	5	0
24	*Aglaophamus circinata*	Agc	1	83	3	0	0	0	0	0
25	*Unciola inermis*	Uni	1	84	1	0	2	1	4	0
26	*Ampharete acutifrons*	Ama	1	85	0	1	0	0	1	0
27	*Chiridotea tuftsi*	Cht	1	86	1	0	2	0	2	1
28	*Leitoscoloplos acutus*	Lea	1	87	1	0	1	0	0	0
29	*Phoronis architecta*	pha	1	88	0	1	1	0	1	1
30	Tubificidae sp 2 (Blake 1992)	Tu2	1	89	0	0	0	0	0	0
31	*Protomedeia fasciata*	Prf	1	89	0	0	1	1	2	1
32	*Nephtys incisa*	Nei	1	90	0	1	1	0	1	1
33	*Euchone elegans*	Eue	1	91	0	0	1	0	3	0
34	*Crenella decussata*	Crd	1	91	0	0	1	0	1	0

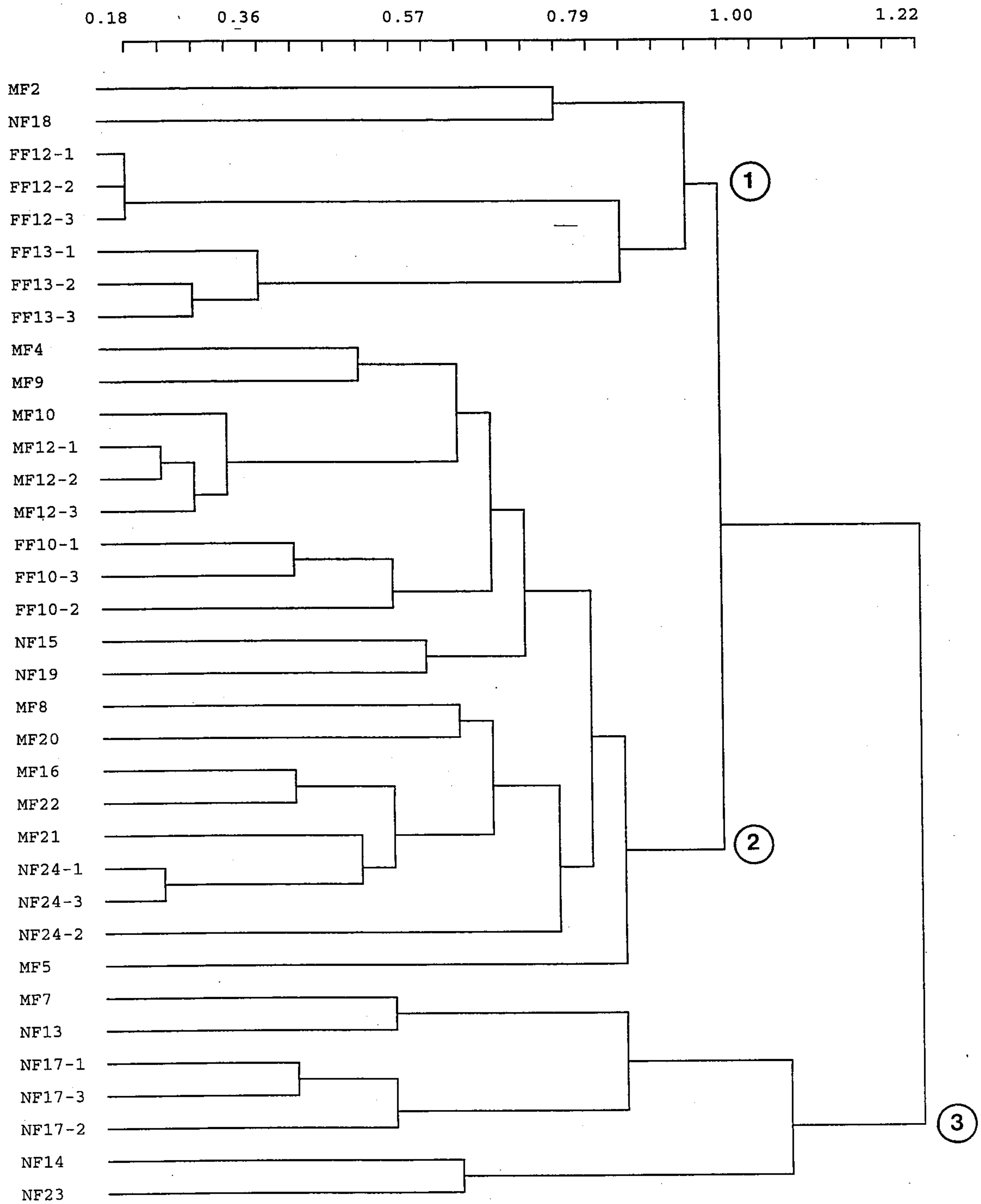


Figure 22. Cluster analysis of 1997 nearfield and midfield stations (CNESS, NESSm=17).

Table 6. Characterization of nearfield and midfield station clusters generated with CNESS dissimilarity measure.

Cluster	Stations	Location Depth (m)	Sediment Grain-Size Mean Phi, Percent Sand	Organic Carbon TOC, C/N Ratio	Infaunal Assemblage (ind./m²)*
1	FF12, 13 MF2, NF18	west and south of diffuser, disjunct depth: 19-35 m ($\bar{x}$ = 26.5)	mean phi (very fine sand): 2.08-5.22 ($\bar{x}$ = 3.8) percent sand: 38.8-92.7 ($\bar{x}$ = 62.5)	TOC low to moderate: 0.192-1.404 ($\bar{x}$ = 0.66) C/N moderate to high: 8.93-11.90 ($\bar{x}$ = 10.55) (MF2 excluded)	**4.** high *Prionospio steenstrupi* (40,600) **10.** high *Owenia fusiformis* (4500) **11.** high *Dyopedos monacanthus* (5000) **18.** high *Photis pollex* (2300) **20.** high *Hiatella arctica* (2900) **29.** high *Phoronis architecta* (1000) **32.** high *Nephtys incisa* (900)
2	FF10, MF4, 5, 8, 9, 10, 12, 16, 20, 21, 22, NF15, 19, 24	arc of stations: north, west and south of diffuser, ranging from mud patch close to diffuser to a distant midfield station depth: 27-37 m ($\bar{x}$ = 32.6)	mean phi (silt): 2.52-6.12 ($\bar{x}$ = 4.3) percent sand: 20.1 ($\bar{x}$ = 57.5)	TOC low to moderate: .085-1.949 ($\bar{x}$ = 0.98) C/N moderate to high: 9.53-18.49 ($\bar{x}$ = 12.21)	**1.** high *Spio limicola* (5100) **2.** high *Dipolydora socialis* (4200) **4.** high *Prionospio steenstrupi* (15,400) **6.** moderate *Tharyx acutus* (2900) **7.** high *Mediomastus californiensis* (6100) **9.** high *Ninoe nigripes* (3600) **13.** moderate *Levinsenia gracilis* (1550) **14.** high *Aricidea catherinae* (3100) **16.** moderate *Aphelochaeta marioni* (2200) **17.** high *Euchone incolor* (2400) **19.** high *Nucula delphinodonta* (1700)
3	MF7, NF13, 14, 17, 23	offshore, west and north of diffuser depth: 29-36 m ($\bar{x}$ = 32.8)	mean phi (fine sand): 2.06-4.58 ($\bar{x}$ = 2.7) percent sand: 53.5-98.2 ($\bar{x}$ = 87.5)	TOC low: 0.055-0.997 ($\bar{x}$ = 0.28) C/N moderate to high: 9.11-13.32 ($\bar{x}$ = 11.14) (NF13, NF17-2 exc.)	**3.** high *Exogone hebes* (6200) **4.** moderate *Prionospio steenstrupi* (4000) **5.** high *Cerastoderma pinnulatum* (2300) **8.** high *Spiophanes bombyx* (2100) **12.** high *Pseudunciola obliquua* (1500) **15.** high *Crassicorophium crassicorne* (1700) **22.** Enchytraeidae sp. 1 present (1700) **24.** moderate *Aglaophamus circinata* (800)

* Bold numbers indicate relative importance of species in nearfield and midfield CNESS cluster determinations.

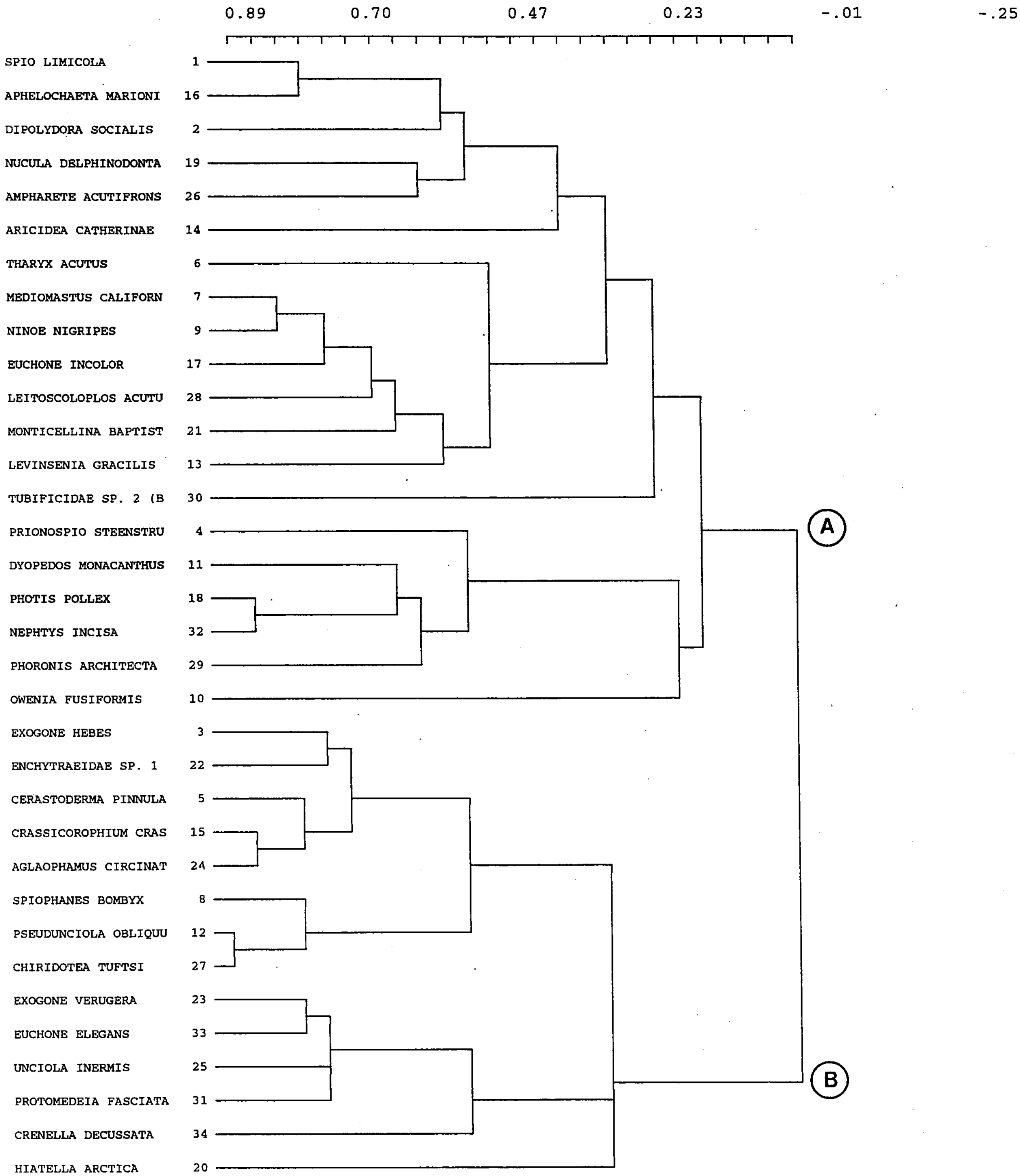


Figure 23. R-mode cluster analysis of the 34 most important species contributing to CNESS distances in the 1997 nearfield and midfield stations (CNESS, NESSm=17). The numbers indicate relative importance.

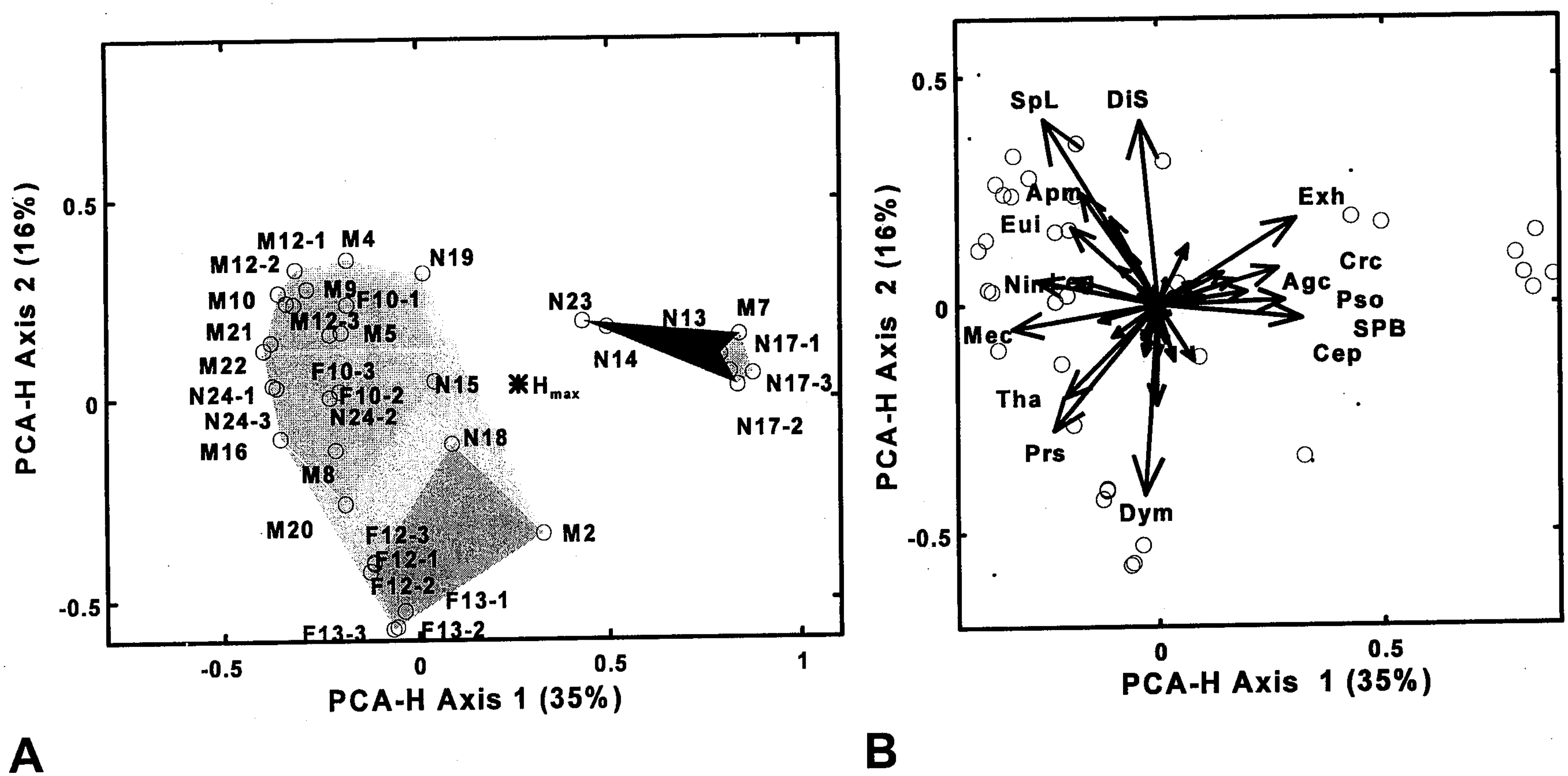


Figure 24. A, Metric scaling of CNESS (NESSm=17) distances among 1997 nearfield and midfield samples axes 1 and 2; B, Gabriel Euclidean distance biplot of the same data , among axes 1 and 2.

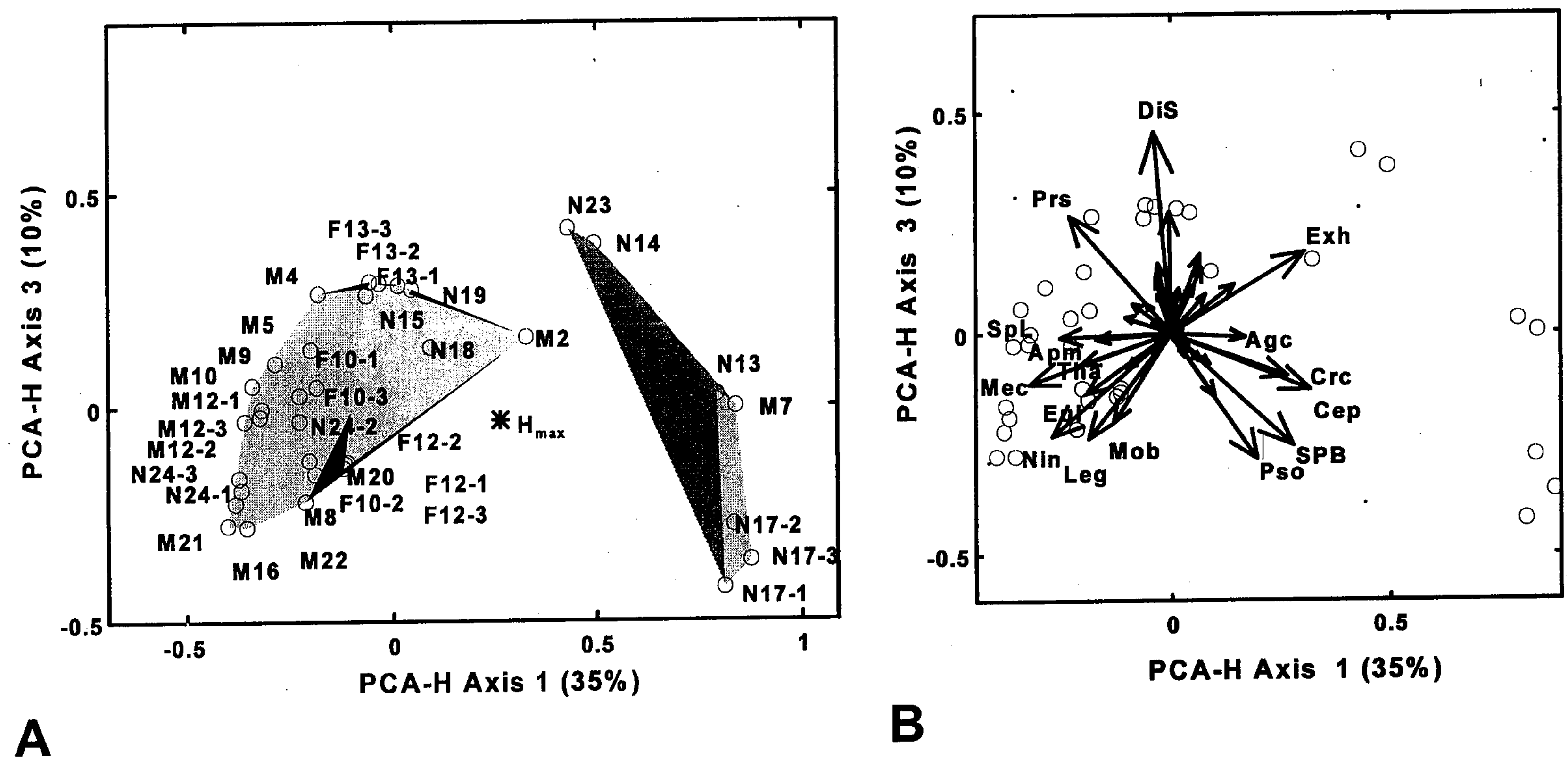
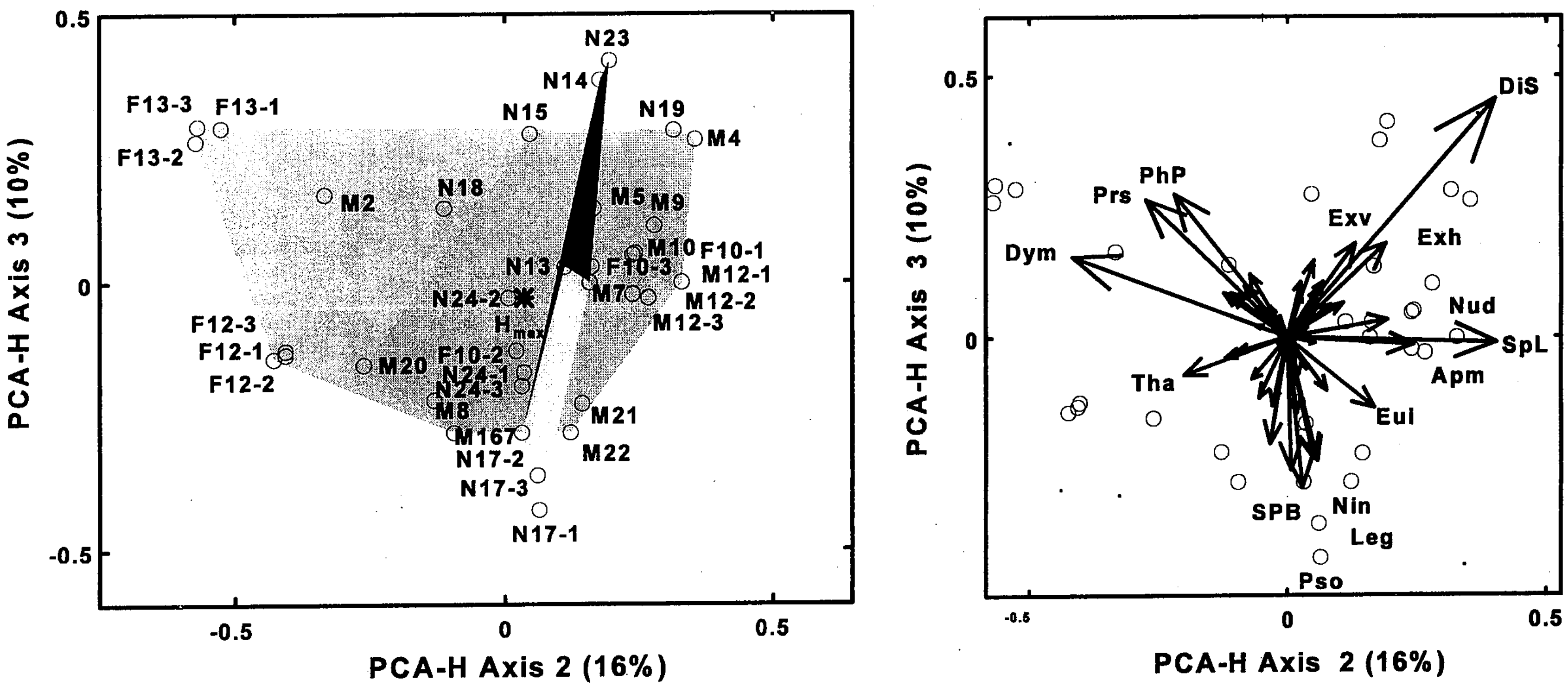


Figure 25. A, Metric scaling of CNESS (NESSm=17) distances among 1997 nearfield and midfield samples axes 1 and 3; B, Gabriel Euclidean distance biplot of the same data, among axes 1 and 3.



A

B

Figure 26. A, Metric scaling of CNESS (NESSm=17) distances among 1997 nearfield and midfield samples axes 2 and 3; B, Gabriel Euclidean distance biplot of the same samples, among axes 2 and 3.

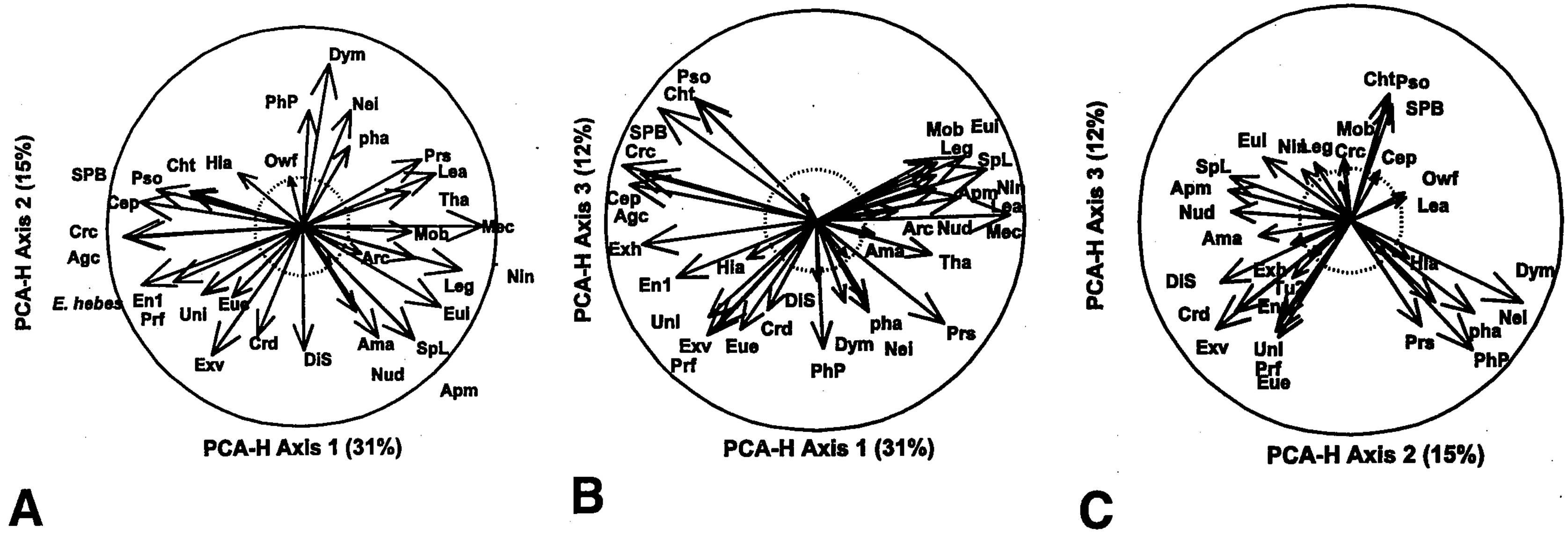


Figure 27. Gabriel covariance biplot for 1997 nearfield and midfield data: A, axes 1 and 2; B, axes 1 and 3; C, axes 2 and 3

3.2 Benthic Soft-bottom Communities and Sedimentology, Farfield

3.2.1 Sediment Grain Size

Sediment grain size composition at the eight farfield stations in Massachusetts Bay and Cape Cod Bay is given in detail in Appendix B4. Sediments from replicate samples were similar; the largest difference was seen at station FF5 (difference between replicates in mean phi was 0.8). The stations could be divided into three clusters according to mean phi and percent sand. The coarsest sediments (mean phi < 4.0; > 80% sand) were collected from stations FF1A, off Gloucester, and FF9 in western Massachusetts Bay; these stations are in depths less than 50 m and are 1 and 6 miles, respectively, from shore. Silty sediments (mean phi between 5.5 and 6.0; 20-40% sand) were collected from stations FF5, south of Stellwagen Basin, FF6, in Cape Cod Bay, FF11, off Cape Ann, and FF14 in western Massachusetts Bay; these stations are in depths ranging from 33-87 m and are 3.5 (FF11) to 8 (FF5 and FF14) miles offshore. The last two stations, FF4, Stellwagen Basin, and FF7, in Cape Cod Bay, had very silty sediments (mean phi 6.8-7.0; <10% sand); depths were 37m and 87m, respectively. FF4 with the finest sediments (consistent with 1995 and 1996 results) was one of the two deepest stations (87m) and the farthest offshore (13 miles).

Several stations have demonstrated consistency in sediment grain size between replicates and among years. Considering all replicates (5) analyzed for the last three years, sediments from station FF9, one of the sandiest stations, have consisted of 83-85% sand, those from FF11, 19-25% sand, and those from FF4, with the finest sediments, consistently have had <15% sand.

Sediments from Cape Cod Bay are variable from year to year. Sediments from both stations FF6 and FF7 were coarser in 1996 than in 1995. In 1997, sediments from station FF6 remained sandy with 38-41% sand (compared to 35-39% sand in 1996). Station FF7, however, with only 5-9% sand (compared to 35-39% sand in 1996), had returned to levels near those seen in 1995 (1% sand).

3.2.2 Total Organic Carbon and Carbon/Nitrogen Ratio

The total organic carbon (TOC) content of the sediments clearly is related to the sediment grain size. The same three clusters observed when considering sediment grain size from the farfield stations were also seen when the TOC results were examined. The two sandiest stations, FF1A and FF9, had sediments that were lowest in TOC (<0.50%). Sediments from the four intermediate stations contained intermediate amounts of TOC (1.1-1.8%). TOC values measured in sediments from the two siltiest stations, FF4 and FF7, were the highest (2.5%). Ranges and spatial patterns of TOC values were similar to those seen in 1995 and 1996. The C/N ratios ranged from a low of 9.21 at Cape Cod Bay station FF7 (this station also had the lowest value in 1996) to a high of 10.37 at the nearshore station off Gloucester FF1A (this station also had the highest value in 1996). Details of the TOC, TON, and C/N values at farfield stations are presented in Appendix B5.

3.2.3 Clostridium Spores

Densities of *Clostridium* spores fell within a fairly narrow range, from a low of 720 colony-forming spores per gram dry weight sediment at station FF1A to a high of 4100 at FF4. There is a suggestion of a trend towards higher densities of *Clostridium* spores with increasingly fine sediments. Station FF4 had the finest sediments, highest TOC values, and the highest density of *Clostridium* spores. Stations FF1A and FF9 had the coarsest sediments, lowest TOC values, and the lowest *Clostridium* spore counts. The remaining stations covered only a very small range (1300-2100) and did not follow this pattern perfectly. Details of the *Clostridium* spore analysis are given in Appendix B6.

3.2.4 Benthic Infauna

Taxonomic Composition. The benthic infauna of the 1997 farfield samples totaled 218 species. Epifaunal species, such as limpets, barnacles, and caprellid amphipods were excluded. Table 7 summarizes the breakdown of species into major taxonomic groups. As in previous years, annelids comprised nearly half of the species, followed by arthropods, mollusks, and representatives of eight other phyla. The Syllidae was the largest polychaete family (7 species) followed by the Cirratulidae, Maldanidae, and Spionidae (each with 6 species). The largest arthropod orders were the Amphipoda (36 species), Cumacea (10 species), and the Isopoda (9 species). The Bivalvia (25 species) and Gastropoda (12 species) comprised most of the Mollusca.

Table 7. Taxonomic composition of benthic infaunal samples collected in August 1997.

Taxonomic Group	Farfield		Entire Study Area	
	Number	Percent	Number	Percent
Annelida	96	44.0	129	44.2
Polychaeta	94	43.1	124	42.5
Oligochaeta	2	0.9	5	1.7
Arthropoda	58	26.6	72	24.7
Amphipoda	36	16.5	44	15.1
Isopoda	9	4.1	10	3.4
Cumacea	10	4.6	13	4.5
Other	3	1.4	5	1.7
Mollusca	39	17.9	59	20.2
Bivalvia	25	11.5	34	11.6
Gastropoda	12	5.5	23	7.9
Other	2	0.9	2	0.7
Remaining Species - representing 8 phyla	25	11.5	32	11.0
Total	218	100	292	100

Figure 28 shows the taxonomic composition by species and by individuals of samples taken at the farfield stations. Polychaete species were the most numerous and accounted for 41% (FF1A) to 50% (FF4) of species present. Amphipod species ranged from 10% (FF14) to 20% (FF1A) of species present and bivalve species ranged from 9% (FF5) to 16% (FF1A). Abundance of polychaete individuals ranged from 67% of the individuals at FF6 to 88% at FF4. Oligochaetes ranged from absent (FF9) to 5.5% at FF7 where they were the second most numerous group after the polychaetes. Bivalves were least abundant at FF7 (2%) and most numerous at FF1A (14%). Amphipods had a range similar to that of bivalves being <2% at seven stations but 33% at NF17, another of the stations with low numbers of polychaetes.

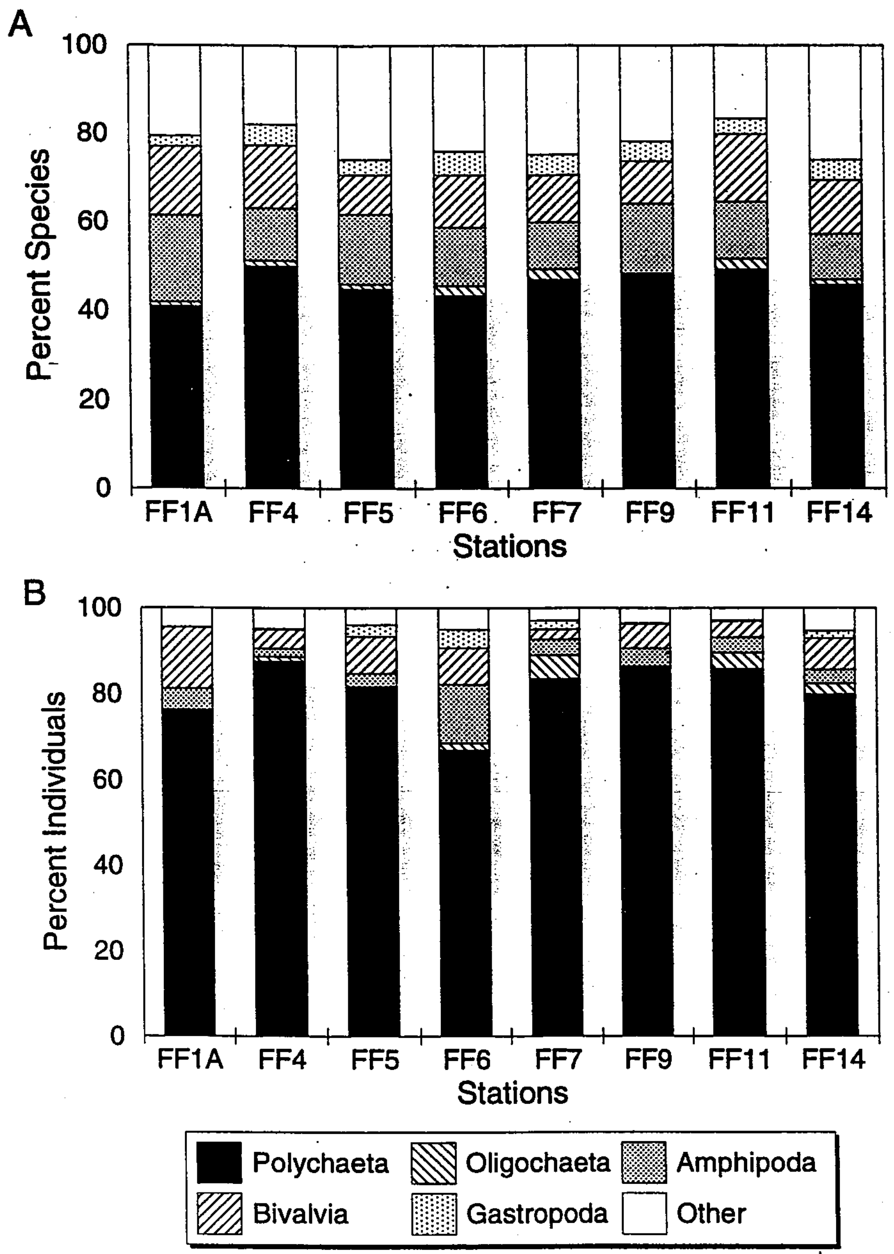


Figure 28.Taxonomic composition by species (A) and individuals (B) of benthic infaunal samples taken at farfield stations in August 1997.

Species Distribution and Density of Dominant Species-Farfield. All farfield stations were sampled in triplicate. These samples were analyzed and combined to make an area of 0.12 m^2. Polychaetes were the most abundant taxon at every farfield station with spionids outnumbering all other taxa by an order of magnitude. The most common spionid species were the same as in previous years. *Prionospio steenstrupi* ranked first at three stations of the six Massachusetts Bay stations. The remaining three had *Mediomastus californiensis* as the top dominant species. *Spio limicola* was less abundant at the farfield stations when compared to abundances at nearfield and midfield stations. This species was among the top ten dominant species for only three stations (two Massachusetts Bay stations, one Cape Cod Bay station). In 1996, *Spio limicola* was among the top ten dominant species at six of the eight stations. *Dipolydora socialis* was the second most abundant spionid, *Spio limicola* third. *D. socialis* had significant numbers only at station FF9 (western Massachusetts Bay) which had 82.7 % sand (Figure 29A).

Mediomastus californiensis was among the dominant taxa for all farfield stations both in 1996 and 1997, ranking among the top six species at all stations. *Capitella capitata* complex, at station FF6 (Cape Cod Bay), had 242 individuals per 0.12 m^2, the greatest abundance at any farfield, midfield, or nearfield station. These capitellids were rare at all other stations with their second greatest abundance at midfield station FF13 with a total of 91 individuals per 0.12 m^2 (Figure 29B).

Cirratulid abundances varied widely among stations. As at the nearfield and midfield stations *Tharyx acutus* was the most abundant species with its greatest numbers at FF7 (Cape Cod Bay). Unlike the nearfield and midfield stations where *Aphelochaeta marioni* ranked second, *Chaetozone setosa* was much more abundant at farfield stations. *A. marioni* and other cirratulids were far fewer in abundance throughout the farfield stations. *Chaetozone setosa* was most abundant at station FF4 (Stellwagen Basin) with 335 individuals per 0.12 m^2 (Figure 30A).

The species composition of paraonids in farfield samples were distinctly different from that of the nearfield and midfield where *Aricidea catherinae* was the most common species. At farfield stations FF4, FF5, FF9, FF11 and FF14, *Aricidea quadrilobata* and *Levinsenia gracilis* were the most abundant species. *A. catherinae* was present, but only at low abundances (< 200 individuals) at FF6 and FF7, the Cape Cod Bay stations, and at FF1A, off Cape Ann. Station FF11 had the highest abundance of paraonids, 483 individuals in 0.12 m^2. *Aricidea catherinae* was not present in samples from this station (Figure 30B).

Although syllids were most abundant at nearfield stations having >75% sand content, they were not very numerous in the farfield, even at stations having high percentages of sand. The western Massachusetts Bay station FF9 had the greatest abundance of syllids and a grain size of >80% sand. *Syllides longocirrata* was more abundant at farfield stations than at nearfield and midfield stations and was most abundant at Cape Cod Bay station FF7. *Exogone verugera* and *E. hebes* were both present at relatively low density at farfield stations (Figure 31A).

Among the amphipods, *Harpinia propinqua* was the most abundant species at farfield stations, whereas *Dyopedos monacanthus* was the most abundant species in the nearfield and midfield. *D. monacanthus* was unimportant in the farfield and *H. propinqua* was rare in the nearfield and midfield These results suggest that amphipod species composition exhibits a real difference between the nearshore and offshore environments. Station FF6 (Cape Cod Bay) had the greatest abundance of amphipods among the farfield stations. This station was composed of a mixture of sands ($\bar{x}$ = 40.6%) and clay ($\bar{x}$ = 42.0%) (Figure 31B).

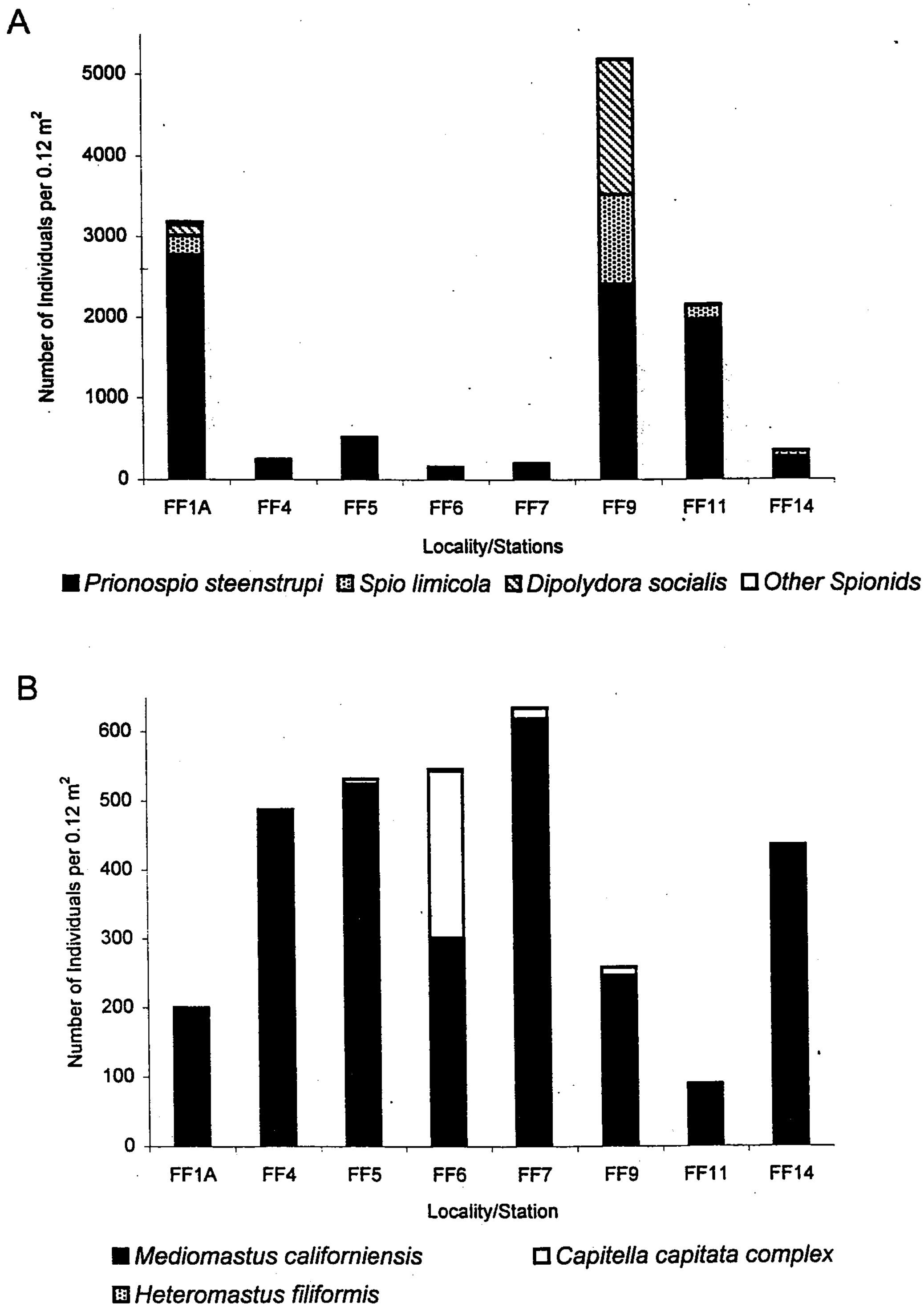


Figure 29. Densities of spionid (A) and capitellid (B) polychaetes at farfield stations in August 1997.

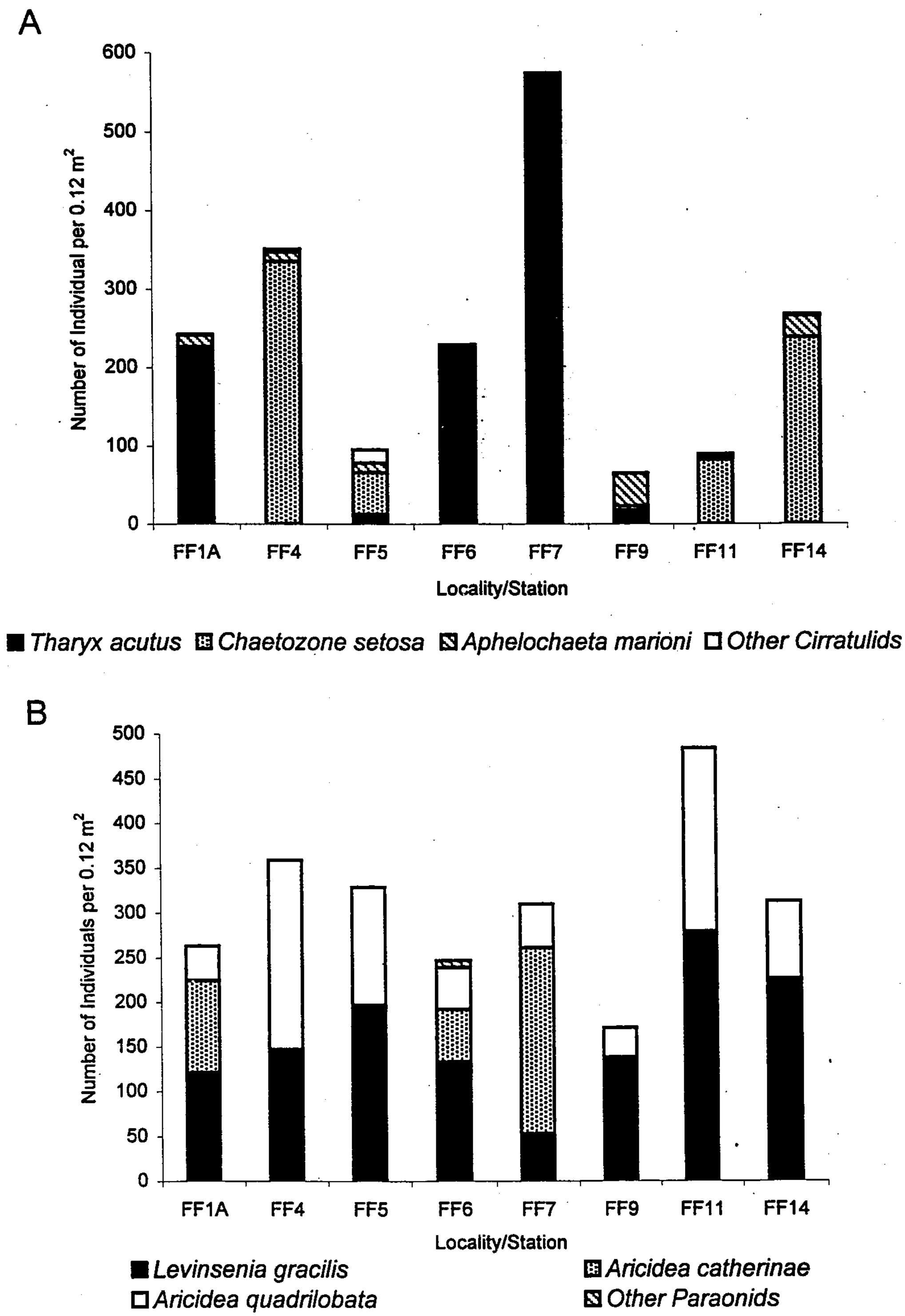


Figure 30. Densities of cirratulid (A) and paraonid (B) polychaetes at the farfield stations in August 1997.

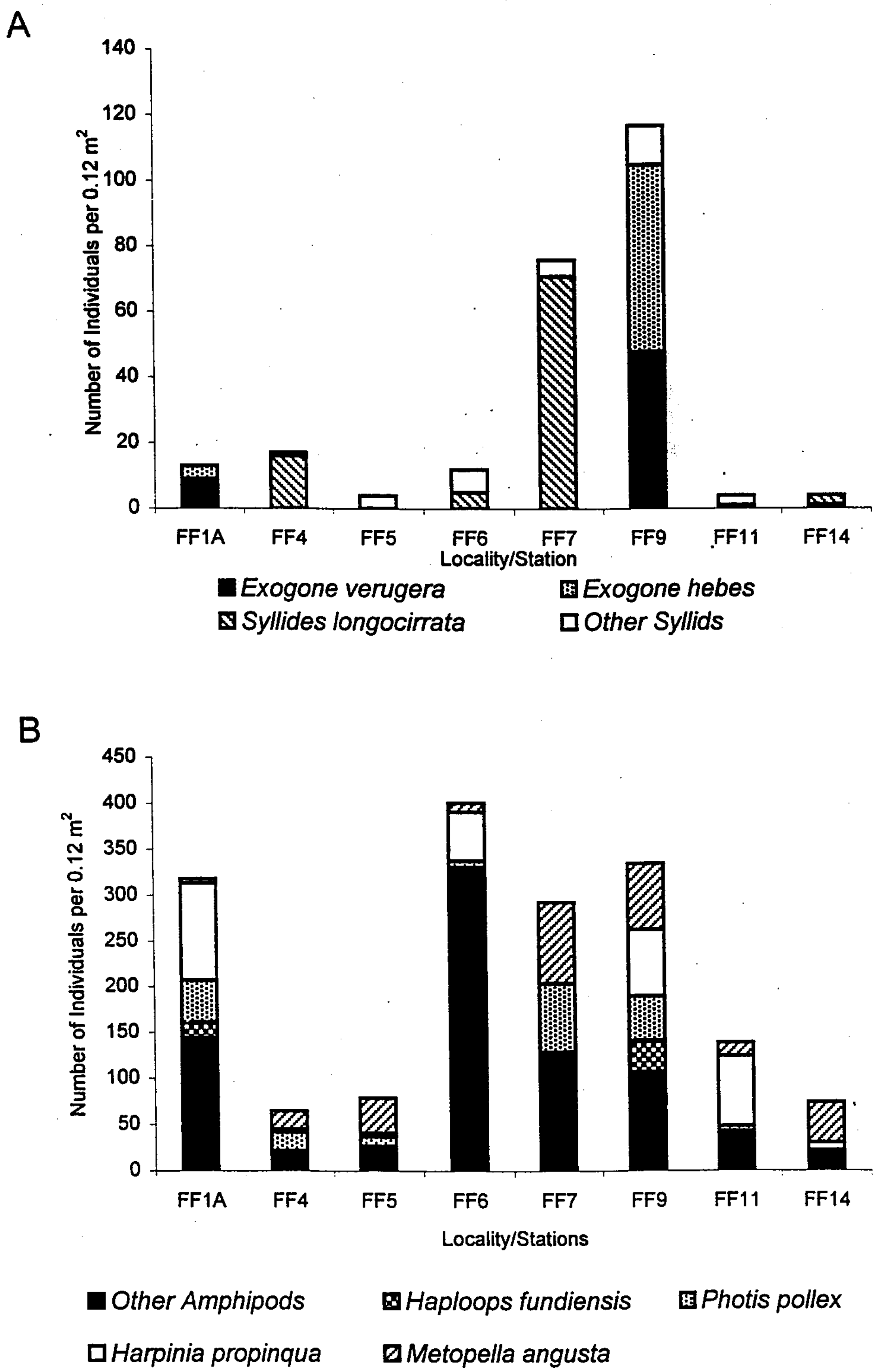


Figure 31. Densities of syllid polychaetes (A) and amphipod crustaceans (B) at the farfield stations in August 1997.

Numerous species of bivalves (25) were identified. *Hiatella arctica* and *Cerastoderma pinnulatum,* which were quite abundant in the midfield and nearfield, were rarely found in the farfield. *Nucula delphinodonta* was the most abundant bivalve in the farfield with nearly 500 individuals per 0.12 m^2 found at station FF1A. *Yoldia sapotilla*, also rarely found in the nearfield and midfield, was found at all farfield stations with numbers of individuals per 0.12 m^2 ranging from 20 (FF4) to 44 (FF9). As in 1996, bivalves were most abundant at station FF1A, the farfield station with sediments containing the greatest percentage of coarse sand (Figure 32).

The top ten dominant species for each station can be found in Appendix D-3. The contribution of each species relative to the total fauna (juveniles and indeterminates included) and for the identified species (juveniles and indeterminates excluded) is reported. The taxonomic analysis of the data was very complete, with all stations having 93% or more of the fauna fully identified to species. The few unidentified taxa were largely due to the inability to distinguish juveniles or damaged specimens.

The replicated farfield station with the greatest number of species (134) was station FF9; replicate numbers 1, 2, and 3 for station FF9 had 90, 104, and 99 identified taxa, respectively. The replicated farfield stations with the fewest species were stations FF4 and FF11 with 84 and 85 identified taxa, respectively.

Sediment grain-size composition varied among the farfield stations. Stations that had the highest percentage of sand were FF1A and FF9. Stations having the highest percentage of silt and clay were FF7 and FF4. Farfield data suggest that the dominant species from Massachusetts Bay and Cape Cod Bay can tolerate different environmental conditions and several types of habitats with very different grain sizes.

Species Richness and Diversity. In addition to the eight true farfield stations, Table 8 includes the three farfield stations now grouped with the midfield and MF12, NF17, and NF24 for comparison. All of these stations include three replicates and thus constitute stations that were sampled in the same manner. Comparison was made of the total number of species per station (replicates pooled) as well as the average number of species at each station. The number of species per 0.12 m^2 (pooled replicates) ranges from 74 to 134 among these stations; the same relationship holds for averages (49 to 97), i.e, station NF17 had the fewest species and station FF9 had the most whether the numbers were pooled or averaged. Station FF9 located southwest of the outfall location had the most species with 134; station NF17 in the nearfield area had the fewest with 74. However, offshore and throughout the farfield the total number of species per replicates pooled was usually between 80 and 90 per station. For density, the greatest abundances (identified taxa) are nearshore in the vicinity of the outfall where stations FF12 and FF13 have an average of 4007 and 4121 individuals per 0.04m^2. The numbers of individuals at the remainder of the stations throughout Massachusetts and Cape Cod Bay ranged from 782 (FF14) to 2970 (FF12).

The highest diversities, expressed as number of species per 100 individuals (Table 8), were found at stations FF6, FF10, and FF14. The lowest diversity was seen at station FF13, and was probably the result of the high relative abundance of the top dominant *Prionospio steenstrupi*, which accounted for over 50% of the total fauna. The Shannon-Wiener indices produced similar results.

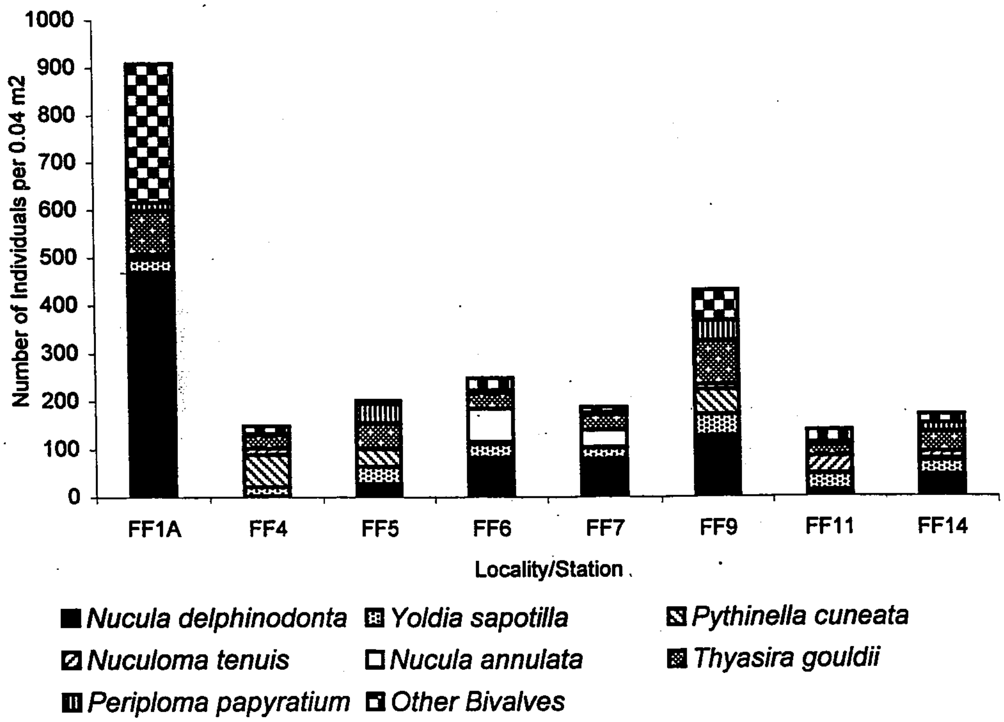


Figure 32. Densities of bivalve molluscs at the farfield stations in August 1997.

Table 8. Community parameters for farfield and replicated nearfield and midfield stations. Data averaged for three replicates.

Station	No. spp. (0.04m²)	No. indiv.+ (0.04 m²)	spp./50 ind.	spp./100 ind.	spp./500 ind.	H′	J′
FF1A	89(122)	2105	18.33	27.38	56.95	2.65	0.59
FF4	58(84)	1090	17.89	24.35	45.61	2.93	0.72
FF5	63(89)	795	19.94	28.91	55.16	2.96	0.72
FF6	62(92)	957	20.93	28.83	51.66	3.17	0.77
FF7	64(85)	2649	14.97	20.79	39.25	2.41	0.58
FF9	97(134)	2508	15.51	24.26	56.34	2.52	0.55
FF10*	93(123)	2641	21.16	29.70	56.67	3.17	0.70
FF11	61(85)	1239	14.66	21.63	45.79	2.16	0.52
FF12*	73(90)	4007	14.39	19.72	39.15	2.50	0.58
FF13*	60(81)	4121	11.73	16.87	33.48	1.73	0.42
FF14	64(89)	782	21.04	29.61	N/A	3.12	0.75
MF12	83(113)	2970	17.34	23.66	46.62	2.92	0.66
NF17	49(74)	632	16.21	23.04	N/A	2.60	0.67
NF24	61(94)	1395	13.44	19.46	42.93	2.14	0.52

*Included in midfield array as of 1996. Species counts in parentheses represent total number of species in the three replicates combined; + number of individuals identified to species.

Community Analysis: Farfield Stations. For the 1997 farfield analysis, two sets of data were used. The first included the eight stations considered true farfield and located outside the 8 km midfield area near the outfall diffuser. The second analysis included all of these stations plus all of the combined nearfield and midfield stations. The latter database is in essence a composite analysis of all of the 1997 Massachusetts Bay samples. The sequence of analyses is essentially the same as for the nearfield. CNESS clusters were generated both for stations and for the most important contributing species. Euclidean distance and covariance biplots were generated using PCA-H. These analyses define the similarity among stations, thus identifying patterns in the data that can be interpreted.

Farfield Stations (1997). Similarity analysis with CNESS produces three station groups (Figure 33) within which all replicates for each station cluster together before joining to another station. Cluster 1 includes stations FF1A and FF9 in depths of 32-49 m (Table 9). Both are close to the midfield array. Station 1A is located off Gloucester; station 9 is offshore and located south of the midfield. Both stations showed an affinity to the nearshore environment in 1995 and 1996 (Blake *et al.*, 1998; Hilbig *et al.*, 1996). These station are sandy ($\bar{x}$ = 82%), have a low TOC ($\bar{x}$ = 0.39), and a high C/N ratio ($\bar{x}$ = 10.24). Three spionid polychaetes, *Prionospio steenstrupi, Spio limicola*, and *Dipolydora socialis* characterize the fauna of these stations along with relatively high densities of the bivalves *Nucula delphinodonta* and *Thyasira gouldii* and the amphipod *Harpinia propinqua*. The burrowing polychaete *Aglaophamus circinata* also characterizes this cluster (Table 9). Cluster 2 includes stations FF4, 5, 11, and 14 all located offshore near Stellwagen Basin in 62-87 m. These stations are silty with only moderate levels of sand (% sand, $\bar{x}$=20.7), moderate TOC ($\bar{x}$=1.82), and moderate C/N ratios ($\bar{x}$=9.73). Six polychaetes and one oligochaete characterize this assemblage: *Chaetozone setosa, Aricidea quadrilobata, Levinsenia gracilis, Anobothrus gracilis, Mediomastus californiensis, Galathowenia oculata,* and *Tubificoides apectinatus* (Table 9). The third cluster includes farfield stations 6 and 7 in Cape Cod Bay. These stations consistently differ from those in Massachusetts Bay in both sediment and faunal composition. The sediments are silty with low percentages of sand ($\bar{x}$=23.1), moderately TOC ($\bar{x}$=1.78), and a moderately high C/N ratio ($\bar{x}$=9.25). The fauna is characterized by a suite of polychaetes, dominated *by Cossura longocirrata*, the oligochaete Tubificidae sp. 2, the amphipod *Leptocheirus pinguis*, and the bivalve *Nucula annulata* (Table 9).

The 36 most important species contributing to CNESS distances are shown in Table 10 and clustered in Figure 34 . Three species clusters are apparent including one that represents mixed sand/mud stations (Cluster A) and two mud assemblages (Clusters B and C).

Figures 35A, 36A, and 37A show the metric scaling of the cluster groups according to axes 1-2, 1-3, and 2-3. Members of clusters are connected with convex hulls. H_{max} is the theoretical point of maximum diversity. Increasing distance from that point represents lower diversity. All three clusters are clearly separated in the metric scaling plots for axes 1-2 and 2-3. Axis 1 accounts for 31% of the variance whereas axis 2 accounts for 27%. Cluster 3 is the most distinct assemblage in all three plots and represents the Cape Cod Bay stations. Figure 35B, 36B, and 37B are the Gabriel Euclidean biplots that the show the most important species. The longer the length of the arrow, the greater the importance. Species codes are defined in Table 10. In Figure 35B *Cossura longocirrata* accounts for 20% of the variation plotted in Axis 1, *Spio limicola* accounts for 13%, and *Prionospio steenstrupi* account for 17%. For axes 2 *Tharyx acutus* (10%) and *Chaetozone setosa* (17%), both cirratulid polychaetes, are the largest contributors. For axis 3, the paraonid polychaete *Levinsenia gracilis* (12%) and the sabellid polychaete *Euchone incolor* (18%) are the greatest contributors.

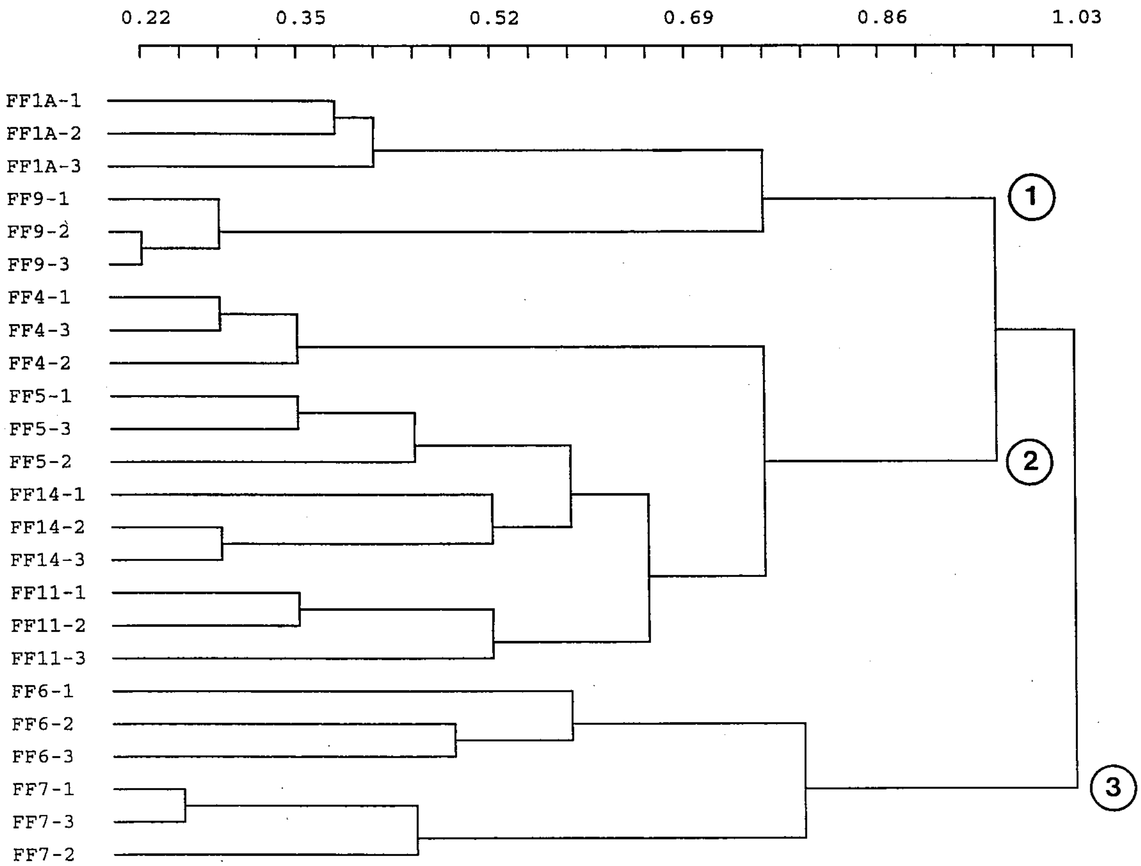


Figure 33. Cluster analysis of 1997 farfield stations (CNESS, NESSm=17).

Table 9. Characterization of farfield station clusters generated with CNESS dissimilarity measure.

Cluster	Stations	Location Depth (m)	Sediment Grain-Size Mean Phi, Percent Sand	Organic Carbon TOC, C/N Ratio	Infaunal Assemblage (ind./m²)*
1	FF1A, 9	nearshore near Gloucester, western Mass. Bay depth: 32-49 m ($\bar{x}$ = 40.5)	mean phi (very fine sand):3.20-3.69 ($\bar{x}$ = 3.5) percent sand: 79.9-83.3 ($\bar{x}$ = 82.0)	TOC low: 0.357-0.444 ($\bar{x}$ = 0.39) C/N high: 9.85-10.73 ($\bar{x}$ = 10.24)	**1.** high *Dipolydora socialis* (7500) **3.** moderate *Spio limicola* (5600) **4.** high *Prionospio steenstrupi* (21,600) **8.** moderate *Nucula delphinodonta* (2500) **15**. *Aglaophamus circinata* present (1200) **22**. high *Harpinia propinqua* (700) **34.** high *Thyasira gouldii* (800)
2	FF4, 5, 11, 14	offshore, near Stellwagen Basin depth: 61-87 m ($\bar{x}$ = 78.0)	mean phi (silt): 5.21-6.96 ($\bar{x}$ = 6.1) percent sand: 1.8-43.5 ($\bar{x}$ = 20.7)	TOC moderate: 1.453-2.536 ($\bar{x}$ = 1.82) C/N moderate: 9.52-10.29 ($\bar{x}$ = 9.73)	**6.** high *Chaetozone setosa* (1500) **7.** high *Aricidea quadrilobata* (1300) **9.** high *Levinsenia gracilis* (1800) **11**. high *Anobothrus gracilis* (1200) **16.** moderate *Mediomastus californiensis* (3200) **17.** high *Tubificoides apectinatus* (500) **18.** high *Galathowenia oculata* (400)
3	FF6, 7	Cape Cod Bay depth: 33-37 m ($\bar{x}$ = 35.0)	mean phi (silt): 5.49-6.92 ($\bar{x}$ = 6.2) percent sand: 4.9-41.0 ($\bar{x}$ = 23.1)	TOC moderate: 1.058-2.483 ($\bar{x}$ = 1.78) C/N moderate: 9.18-9.33 ($\bar{x}$ = 9.25)	**2.** high *Cossura longocirrata* (15,600) **5.** high *Tharyx acutus* (3300) **10**. high *Euchone incolor* (2500) **12.** high *Tubificidae* sp. 2 (2000) **13.** high *Capitella capitata* complex (1100) **14.** high *Leptocheirus pinguis* (1100) **19.** moderate *Aricidea catherinae* (11) **20.** moderate *Ninoe nigripes* (1300) **26.** high *Nephtys incisa* (2100) **29.** high *Nucula annulata* (400)

* Bold numbers indicate relative importance of species in farfield CNESS cluster determinations.

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Table 10. The 36 most important contributors to CNESS (NESSm=17) distances in the 1997 MA Bay Farfield data. Cont is the contribution to overall CNESS distances, Total Cont is the cumulative amount of CNESS variation explained by species (91% by the top 36 species). The final columns indicate the contribution of each species to each of the first six PCA-H axes.

Rank	Species	Spp. code	Cont	Total Cont	PCA-H Axis					
					1	2	3	4	5	6
1	*Dipolydora socialis*	DiS	7	7	9	9	9	11	7	0
2	*Cossura longocirrata*	Col	7	15	20	1	0	6	4	2
3	*Spio limicola*	SpL	6	21	13	4	0	9	0	0
4	*Prionospio steenstrupi*	Prs	6	27	17	0	1	1	3	0
5	*Tharyx acutus*	Tha	6	33	8	10	1	3	0	0
6	*Chaetozone setosa*	Chs	5	38	0	17	0	1	0	0
7	*Aricidea quadrilobata*	Arq	4	42	0	9	2	0	0	1
8	*Nucula delphinodonta*	Nud	4	46	0	6	1	15	0	4
9	*Levinsenia gracilis*	Leg	4	49	1	6	12	0	0	0
10	*Euchone incolor*	Eui	4	53	4	1	18	1	1	0
11	*Anobothrus gracilis*	AnG	3	56	0	7	4	4	10	6
12	Tubificidae sp. 2 (Blake 1992)	Tu2	3	59	6	1	1	2	5	1
13	*Capitella capitata* complex	Cap	3	62	1	1	6	1	10	0
14	*Leptocheirus pinguis*	Lep	3	65	1	1	8	0	13	5
15	*Aglaophamus circinata*	Agc	3	68	1	3	0	20	2	1
16	*Mediomastus californiensis*	Mec	2	70	2	2	0	0	5	13
17	*Tubificoides apectinatus*	Tua	2	72	0	2	3	1	9	5
18	*Galathowenia oculata*	Gao	2	74	0	2	3	0	1	9
19	*Aricidea catherinae*	Arc	2	76	2	2	0	1	1	0
20	*Ninoe nigripes*	Nin	2	77	1	2	1	2	1	1
21	*Apistobranchus tullbergi*	Apt	1	79	2	0	3	0	3	0
22	*Harpinia propinqua*	Hap	1	80	1	1	4	0	1	6
23	*Onoba pelagica*	Onp	1	81	1	0	2	0	1	7
24	*Apistobranchus typicus*	ApT	1	82	0	2	4	2	2	4
25	*Trochochaeta multisetosa*	Trm	1	83	0	2	1	0	1	1
26	*Nephtys incisa*	Nei	1	85	2	0	0	2	0	0
27	*Metopella angusta*	Mea	1	85	0	0	0	1	0	9
28	*Pythinella cuneata*	Pyc	1	86	0	1	1	0	3	0
29	*Nucula annulata*	Nua	1	87	1	0	2	0	2	0
30	*Sternaspis scutata*	Sts	1	88	0	1	1	0	1	1
31	*Terebellides atlantis*	TeA	1	88	1	0	2	0	3	0
32	*Pleurogonium inerme*	Pli	1	89	0	1	1	0	1	1
33	*Leitoscoloplos acutus*	Lea	1	90	0	1	0	0	0	2
34	*Thyasira gouldii*	Thg	1	90	0	0	0	1	1	2
35	*Cerastoderma pinnulatum*	Cep	1	91	0	1	0	2	0	0
36	*Asabellides oculata*	Aso	1	91	0	0	1	1	0	2

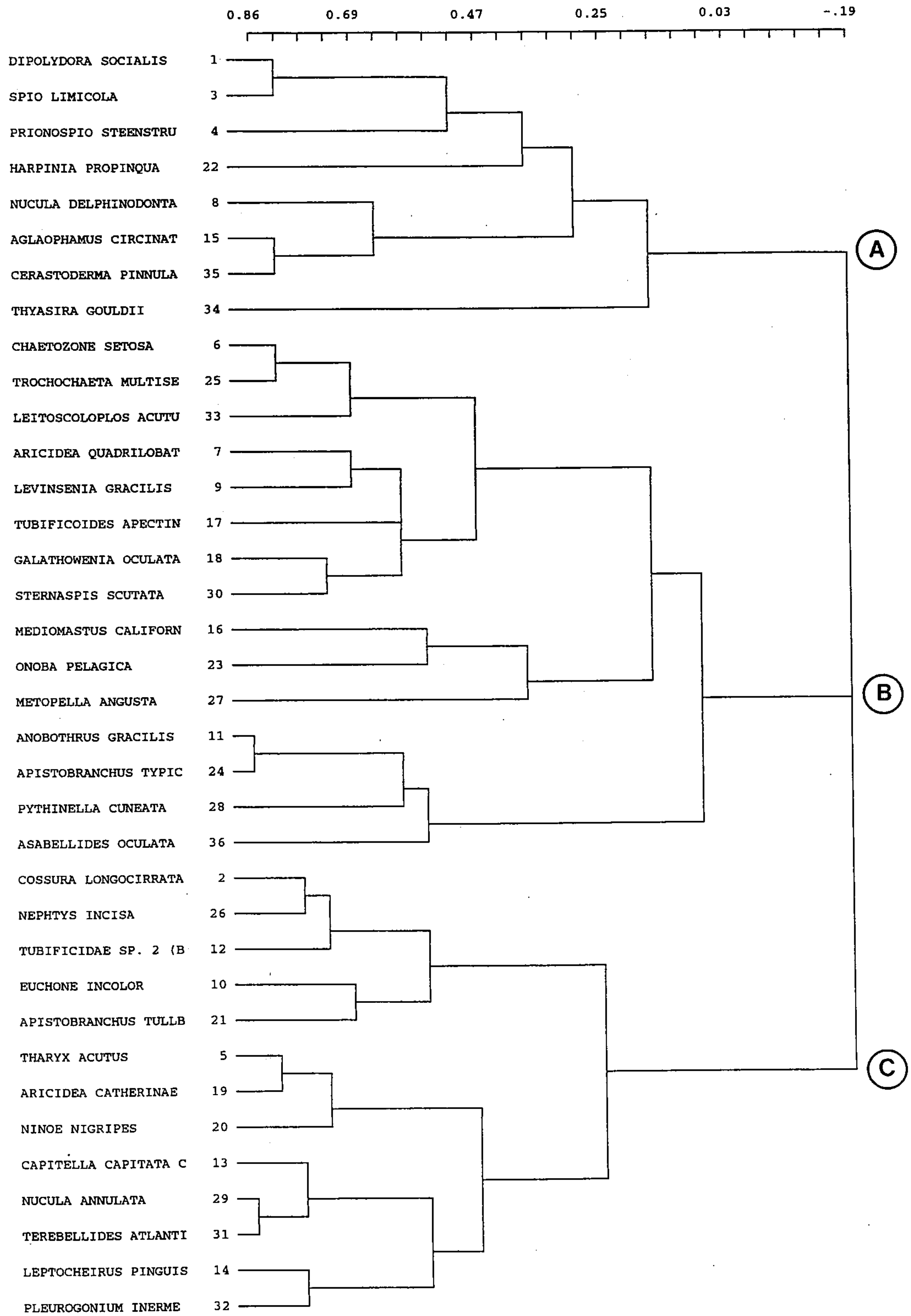


Figure 34. R-mode cluster analysis of the 36 most important species contributing to CNESS distances in the 1997 farfield stations (CNESS, NESSm=17). The numbers indicate relative importance.

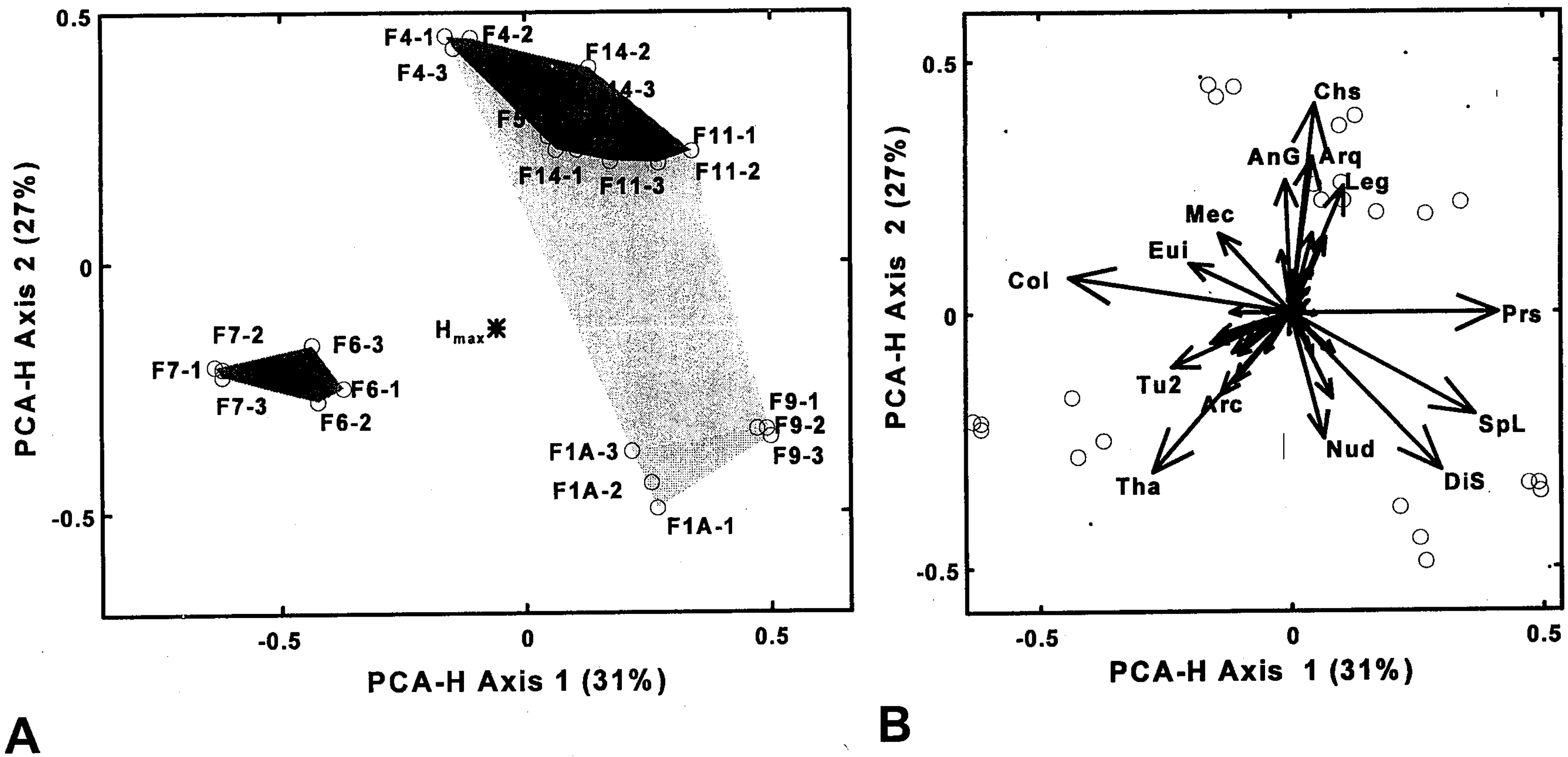


Figure 35. A, Metric scaling of CNESS (NESSm=17) distances among 1997 farfield samples axes 1 and 2; B, Gabriel Euclidean distance biplot of the farfield stations, among axes 1 and 2.

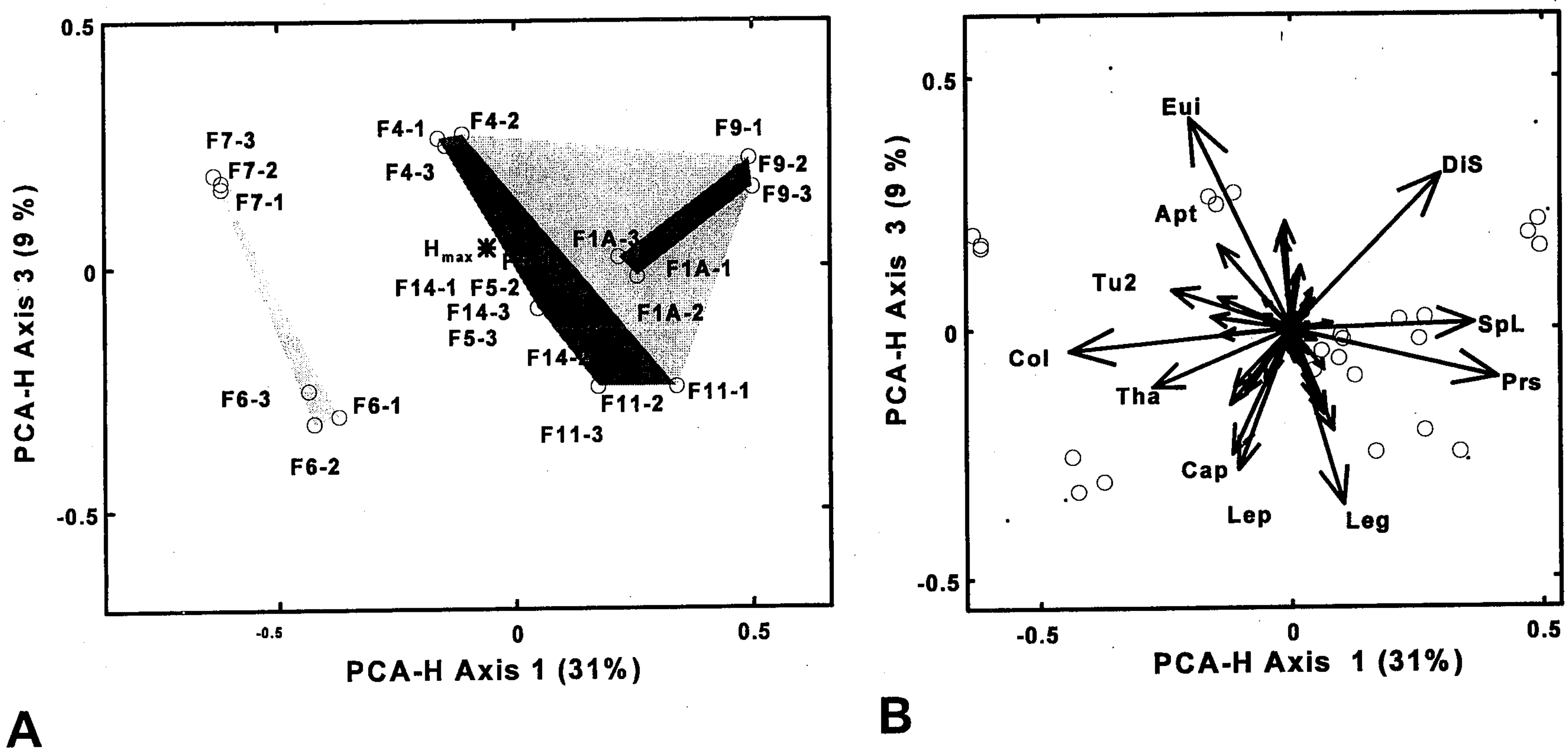


Figure 36. A, Metric scaling of CNESS (NESSm=17) distances among 1997 farfield samples axes 1 and 3; B, Gabriel Euclidean distance biplot of the farfield stations, among axes 1 and 3.

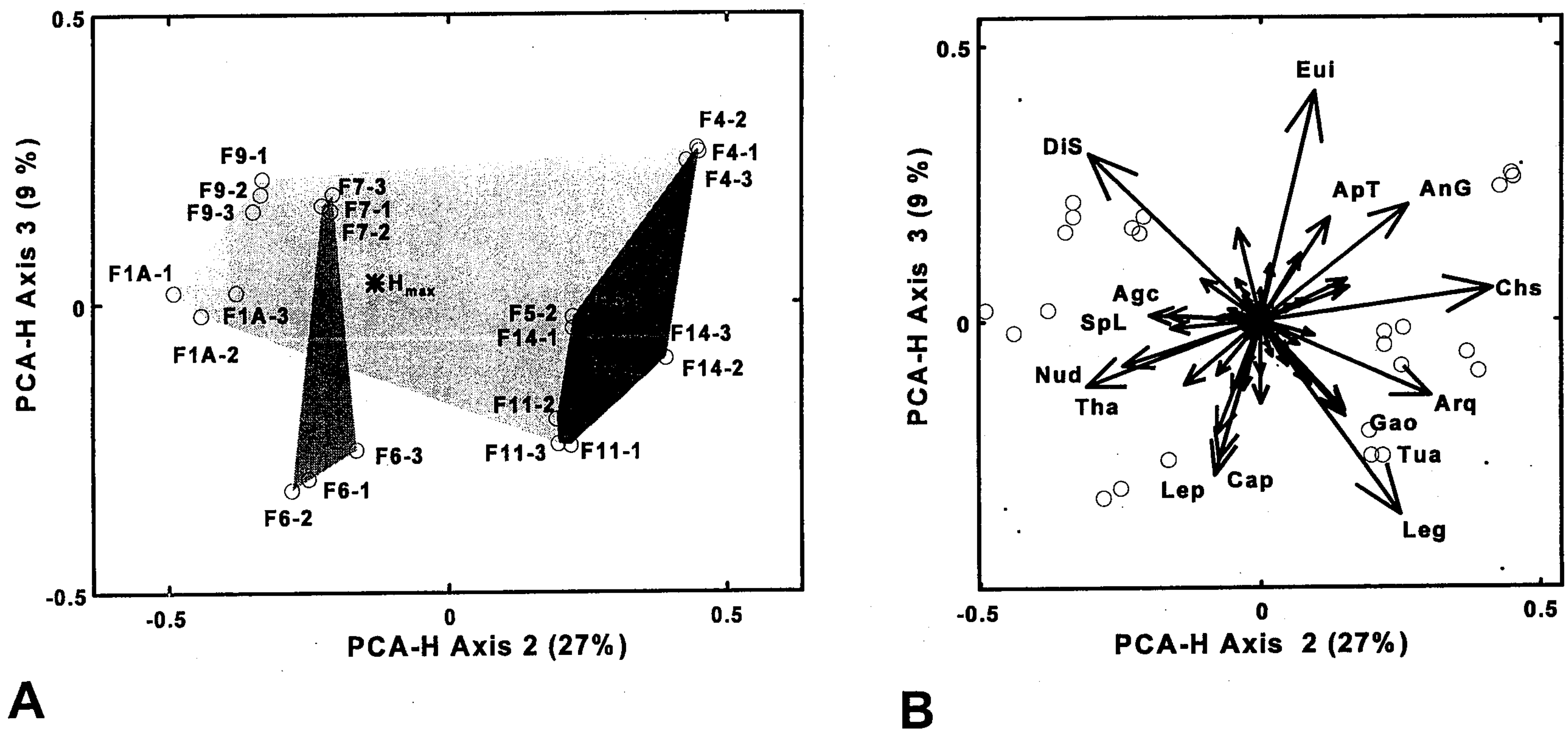


Figure 37. A, Metric scaling of CNESS (NESSm=17) distances among 1997 farfield samples axes 2 and 3; B, Gabriel Euclidean distance biplot of the farfield stations, among axes 2 and 3.

Figures 38A-C are Gabriel covariance biplots which show faunal associations for axes 1-2, 1-3, and 2-3. Species which co-occur are joined with highly acute angles between vectors; species at opposite sides of the figures with angles approaching 180° are least likely to be associated. The three station assemblages and three species clusters are clearly associated throughout this analysis. The three species assemblages are best depicted in Figure 38A (axes 1 and 2); at least one of these assemblages is also clearly defined in 38B and 38C.

All Massachusetts Bay Stations (1997). The cluster diagram for all Massachusetts Bay stations for 1997 is shown in Figure 39. The diagram is essentially a composite of the patterns previously exhibited for the nearfield and midfield and farfield analyses (see above). Six main clusters are apparent, with several subclusters. Cluster 1 includes all of the stations of FF Cluster 1 and NF cluster 2 and represents a nearshore mud assemblage. Cluster 1 is therefore, a large nearshore mud assemblage that includes FF1A and FF9. Clusters 2 and 3 are the same as NF Cluster 1, a group of nearshore stations having mixed sand and mud sediments and dominated by the spionid polychaete *Prionospio steenstrupi*. Cluster 4 is the same as FF cluster 2, a Stellwagen Basin assemblage with silty sediments. Cluster 5 is the Cape Cod Bay assemblage included as Cluster 3 in the farfield analysis. Cluster 6 is the nearfield sand assemblage included as cluster 3 in the nearfield and midfield analysis.

Figure 40 shows an R-mode cluster analysis of the 44 most important contributors to CNESS distances among all of the 59 Massachusetts Bay stations for 1997 (Table 11). The results define two mud assemblages (clusters A and B) and one sand assemblage (cluster C). The sand assemblage is essentially inclusive of the fauna that characterizes the sandy nearfield stations, whereas the two mud assemblages are more ubiquitous.

Figures 41A, 42A, and 43A show the metric scaling of the cluster groups according to axes 1-2, 1-3, and 2-3. Members of clusters are connected with convex hulls. H_{max} is the theoretical point of maximum diversity. Increasing distance from that point represents lower diversity. All of the station clusters are well defined, although only five are clearly confined by the hulls. Cluster 2 only includes two stations (MF2 and NF18) and these appear as outgroups. Figures 41B, 42B, and 43B are the Euclidean biplots that show the most important species. The longer the length of the arrow, the greater the importance. Figure 41B depicts three groups of species that characterize the main clusters in axes 1 and 2. *Dipolydora socialis* and *Spio limicola* account for 13 and 12 percent of the variation along axis 2 in this plot, whereas *Exogone hebes*, *Cerastoderma pinnulatum,* and *Mediomastus californiensis* account for 11, 11, and 10 percent along axis 1. Figure 43B depicts similar relationships for axes 2 and 3, where additionally, *Dipolydora socialis, Spio limicola,* and *Tharyx acutus* account for 13, 15, and 21 percent of the variation along axis 3.

These results clearly suggest that the selection of farfield stations as sentinels is appropriate because, except for FF1A and 9, there is little if any overlap in station signature with the nearfield and each major cluster defined in separate analyses remains distinctive when all of the samples are analyzed together. The similarity of a cluster of FF1A and 9 with a block of nearfield and nearfield stations suggests that if the fauna of the latter stations change and the farfield stations do not, then these changes might be attributed to the outfall.

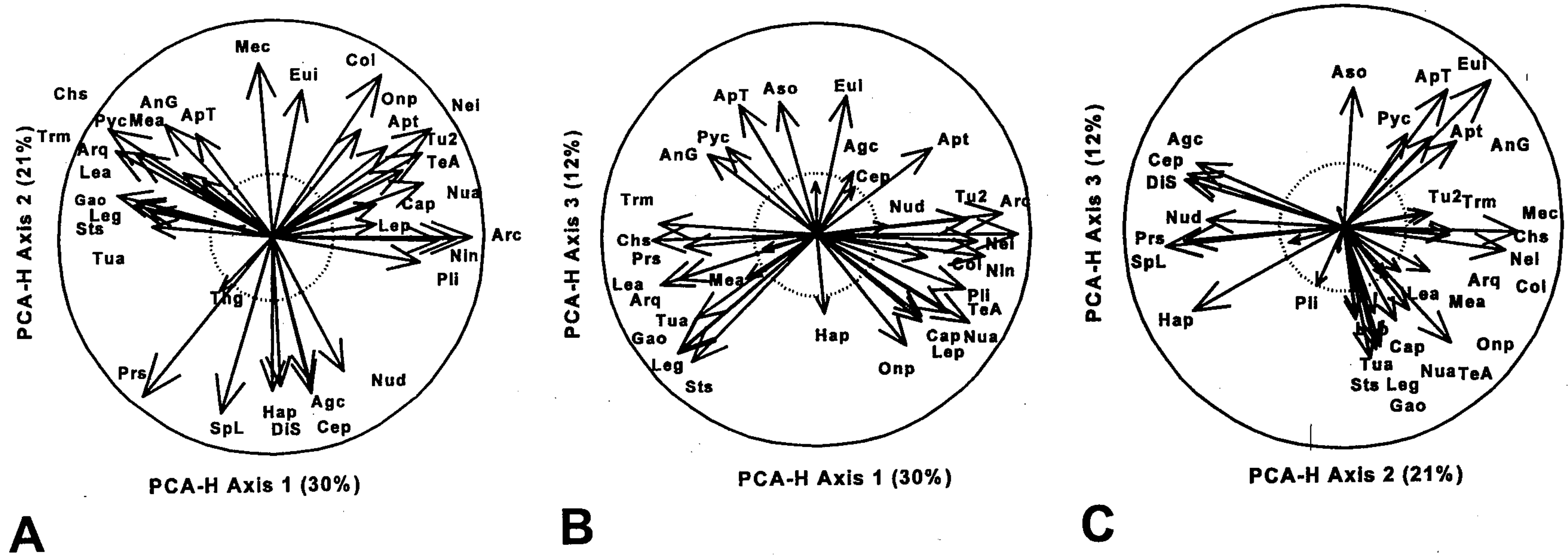


Figure 38. The Gabriel covariance biplots for the 1997 farfield data: A, axes 1 and 2; B, axes 1 and 3; C, axes 2 and 3.

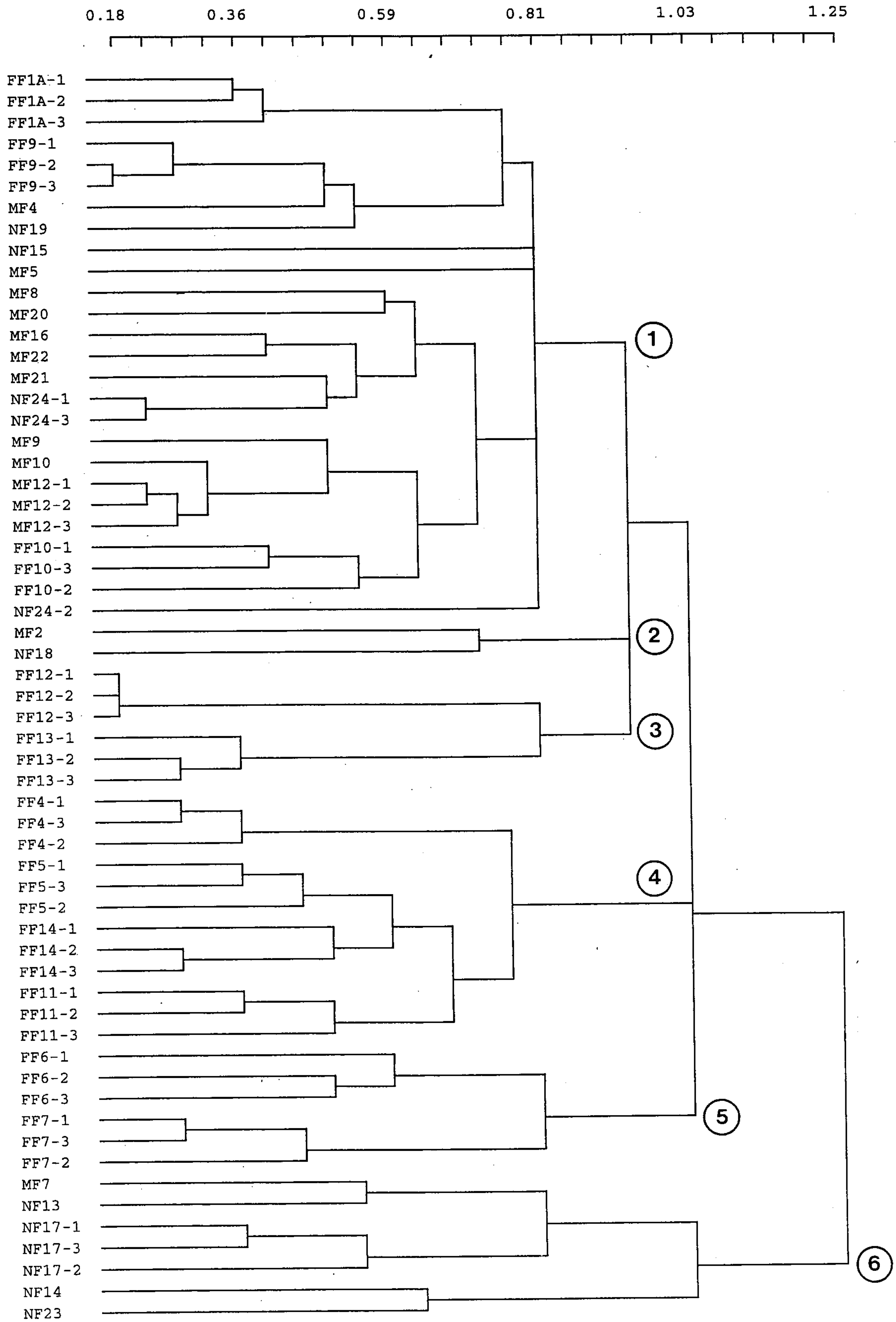


Figure 39. Cluster analysis of all 59 Massachusetts Bay stations for 1997 (CNESS, NESS m=17).

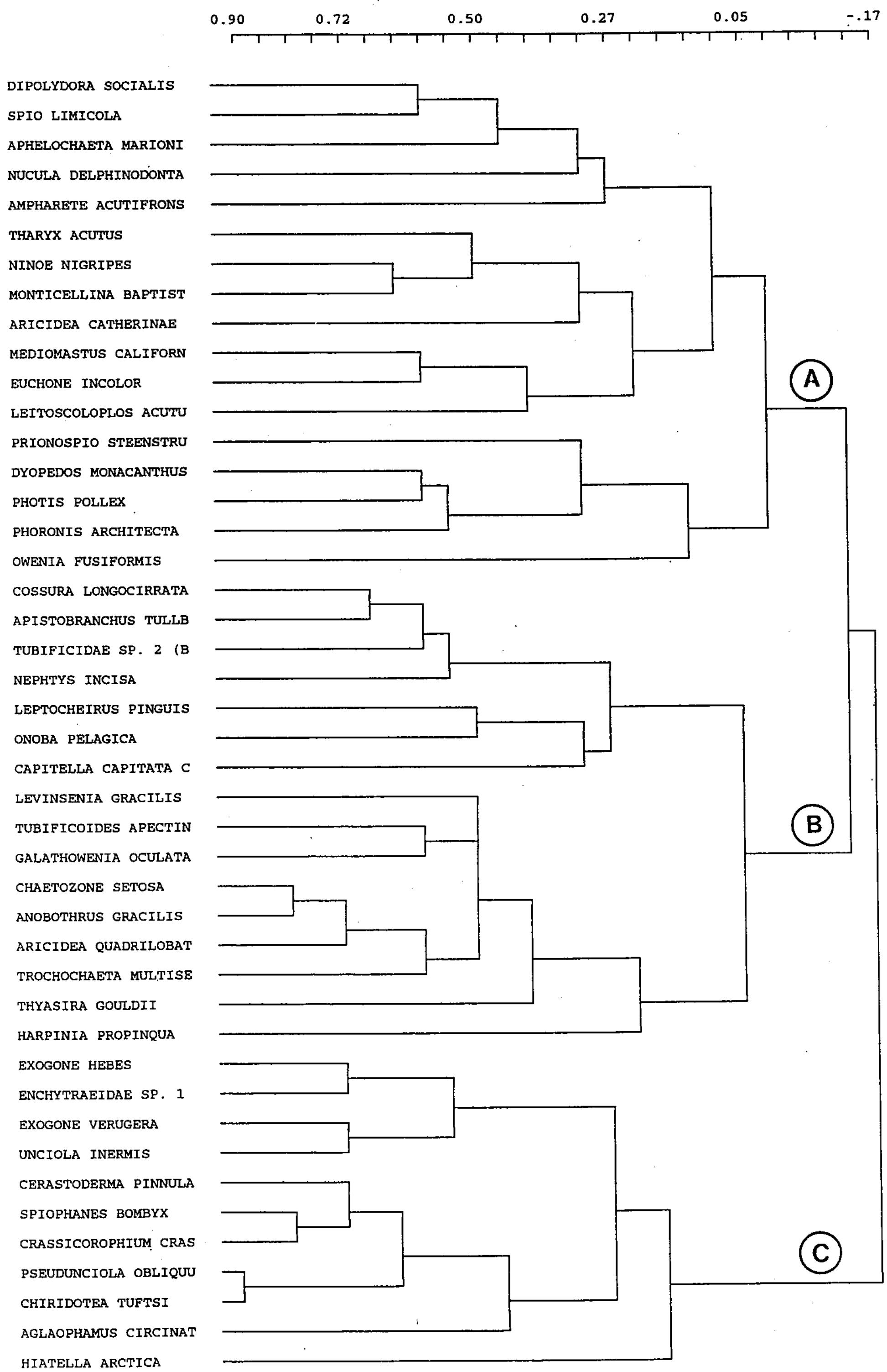


Figure 40. Cluster analysis of the 44 most important contributors to CNESS distances (NESSm=17) in the 1997 Massachusetts Bay stations.

Table 11. The 44 most important contributors to CNESS (NESSm=17) distances among all 59 1997 MA Bay samples for 1997. Cont is the contribution to overall CNESS distances, Total Cont is the cumulative amount of CNESS variation explained by species (90% by the top 44 species). The final columns indicate the contribution of each species to each of the first six PCA-H axes.

Rank	Species	Spp. code	Cont	Total Cont	PCA-H Axis 1	2	3	4	5	6
1	*Dipolydora socialis*	DiS	6	6	1	13	13	6	10	4
2	*Spio limicola*	SpL	5	11	2	12	15	4	1	3
3	*Prionospio steenstrupi*	Prs	5	16	2	5	4	28	1	2
4	*Tharyx acutus*	Tha	5	20	0	5	21	0	1	3
5	*Cossura longocirrata*	Col	4	25	4	9	4	7	8	0
6	*Levinsenia gracilis*	Leg	4	28	9	1	3	0	5	5
7	*Exogone hebes*	Exh	4	32	11	0	1	1	0	3
8	*Cerastoderma pinnulatum*	Cep	3	35	11	1	0	0	2	1
9	*Mediomastus californiensis*	Mec	3	39	10	0	2	0	2	4
10	*Ninoe nigripes*	Nin	3	42	2	6	4	1	7	0
11	*Aricidea catherinae*	Arc	3	44	0	5	3	1	0	1
12	*Spiophanes bombyx*	SPB	3	47	8	1	0	0	6	1
13	*Euchone incolor*	Eui	3	50	4	0	1	6	2	12
14	*Owenia fusiformis*	Owf	2	52	1	1	1	1	1	0
15	*Nucula delphinodonta*	Nud	2	55	0	3	0	3	0	9
16	*Chaetozone setosa*	Chs	2	57	2	7	2	0	1	3
17	*Aricidea quadrilobata*	Arq	2	60	4	6	2	0	0	0
18	*Dyopedos monacanthus*	Dym	2	62	0	1	4	14	1	2
19	*Pseudunciola obliquua*	Pso	2	64	3	2	0	0	4	2
20	*Aphelochaeta marioni*	Apm	2	66	0	4	0	2	2	3
21	*Crassicorophium crassicorne*	Crc	2	68	5	2	0	1	1	0
22	*Anobothrus gracilis*	AnG	2	69	1	3	1	0	0	4
23	*Monticellina baptisteae*	Mob	2	71	0	3	2	0	8	1
24	*Aglaophamus circinata*	Agc	2	72	3	0	0	0	0	4
25	*Hiatella arctica*	Hia	1	74	2	0	0	2	0	0
26	*Photis pollex*	PhP	1	75	0	0	0	4	8	1
27	Tubificidae sp. 2 (Blake 1992)	Tu2	1	77	0	0	3	3	2	0
28	Enchytraeidae sp. 1	En1	1	78	2	0	0	0	0	1
29	*Leptocheirus pinguis*	Lep	1	79	0	0	1	1	1	4
30	*Capitella capitata* complex	Cap	1	80	0	0	1	0	2	2
31	*Exogone verugera*	Exv	1	81	1	0	0	1	1	1
32	*Ampharete acutifrons*	Ama	1	82	0	1	0	0	0	0
33	*Tubificoides apectinatus*	Tua	1	83	0	1	1	0	0	0
34	*Nephtys incisa*	Nei	1	84	0	0	2	0	4	0
35	*Galathowenia oculata*	Gao	1	84	0	1	1	0	0	0
36	*Unciola inermis*	Uni	1	85	1	0	0	0	1	1
37	*Leitoscoloplos acutus*	Lea	1	86	0	0	0	1	2	1
38	*Harpinia propinqua*	Hap	1	86	0	0	1	0	1	6
39	*Onoba pelagica*	Onp	1	87	1	1	0	1	1	1
40	*Trochochaeta multisetosa*	Trm	1	87	1	0	1	0	0	1
41	*Chiridotea tuftsi*	Cht	1	88	1	0	0	0	1	0
42	*Apistobranchus tullbergi*	Apt	1	89	0	0	1	1	1	0
43	*Phoronis architecta*	pha	1	89	0	0	0	1	1	0
44	*Thyasira gouldii*	Thg	1	90	1	0	1	0	0	1

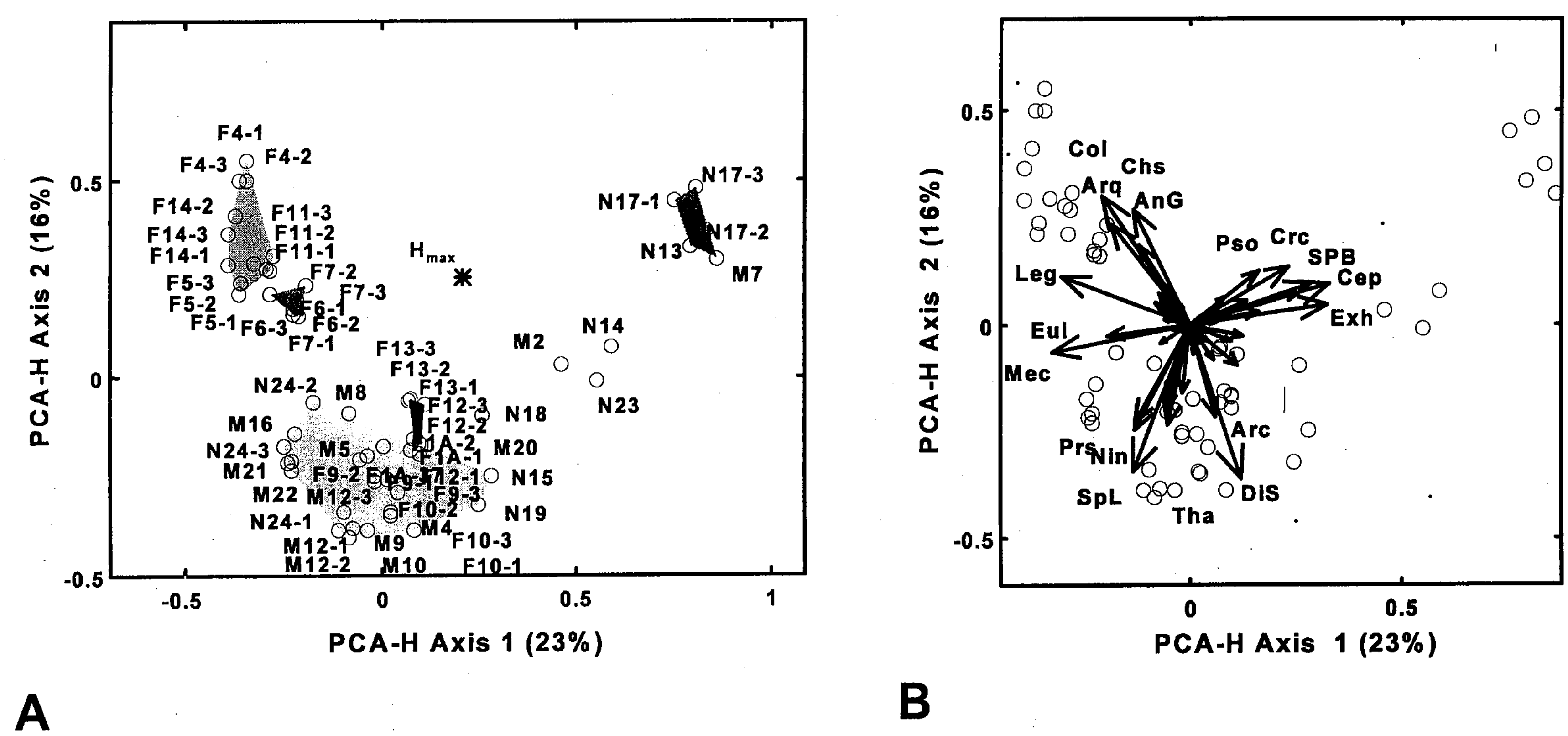


Figure 41. A, Metric scaling of CNESS (NESSm=17) distances among all 59 of the 1997 Massachusetts Bay samples for axes 1 and 2; B, Gabriel Euclidean distance biplot of the same stations, among axes 1 and 2.

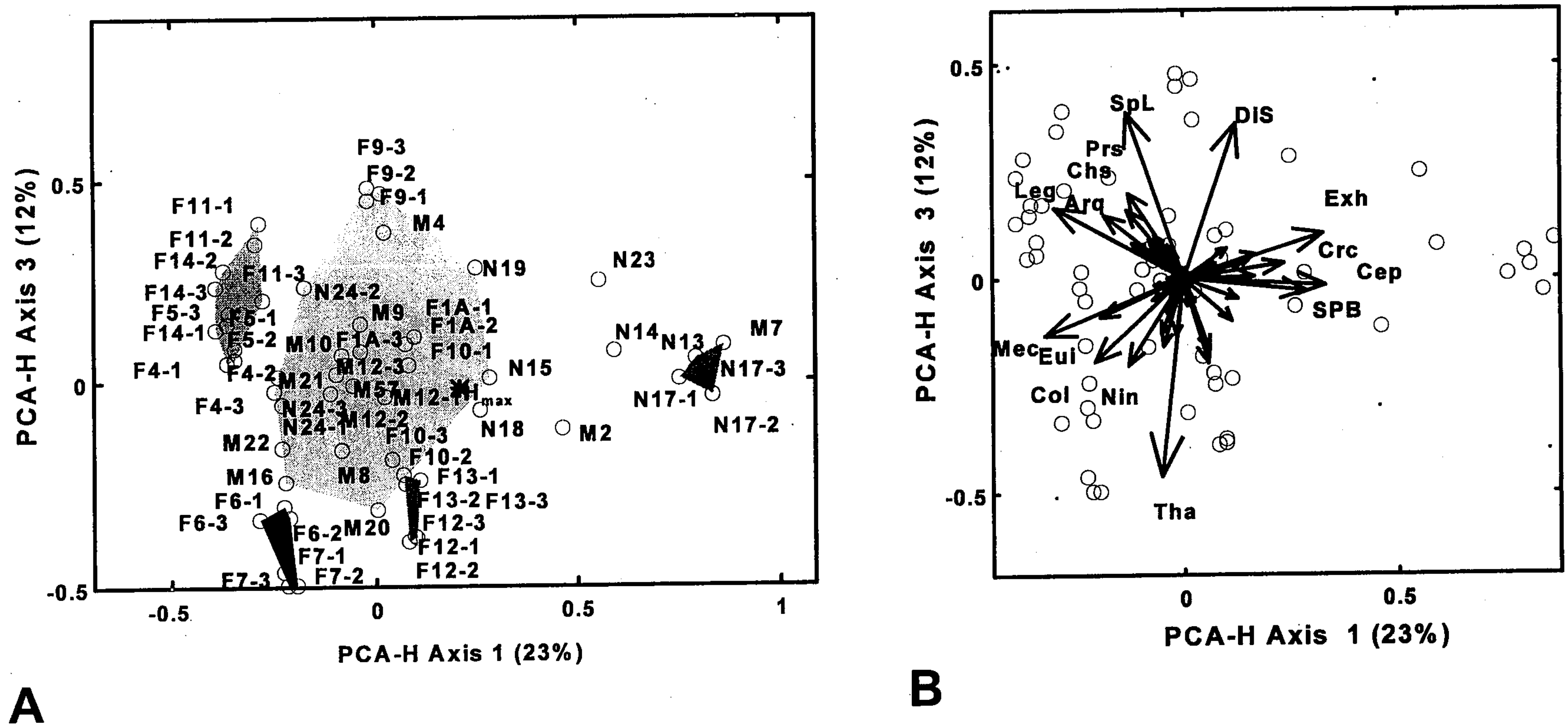


Figure 42. A, Metric scaling of CNESS (NESSm=17) distances among all 59 of the 1997 Massachusetts Bay samples for axes 1 and 3; B, Gabriel Euclidean distance biplot of the same stations, among axes 1 and 3.

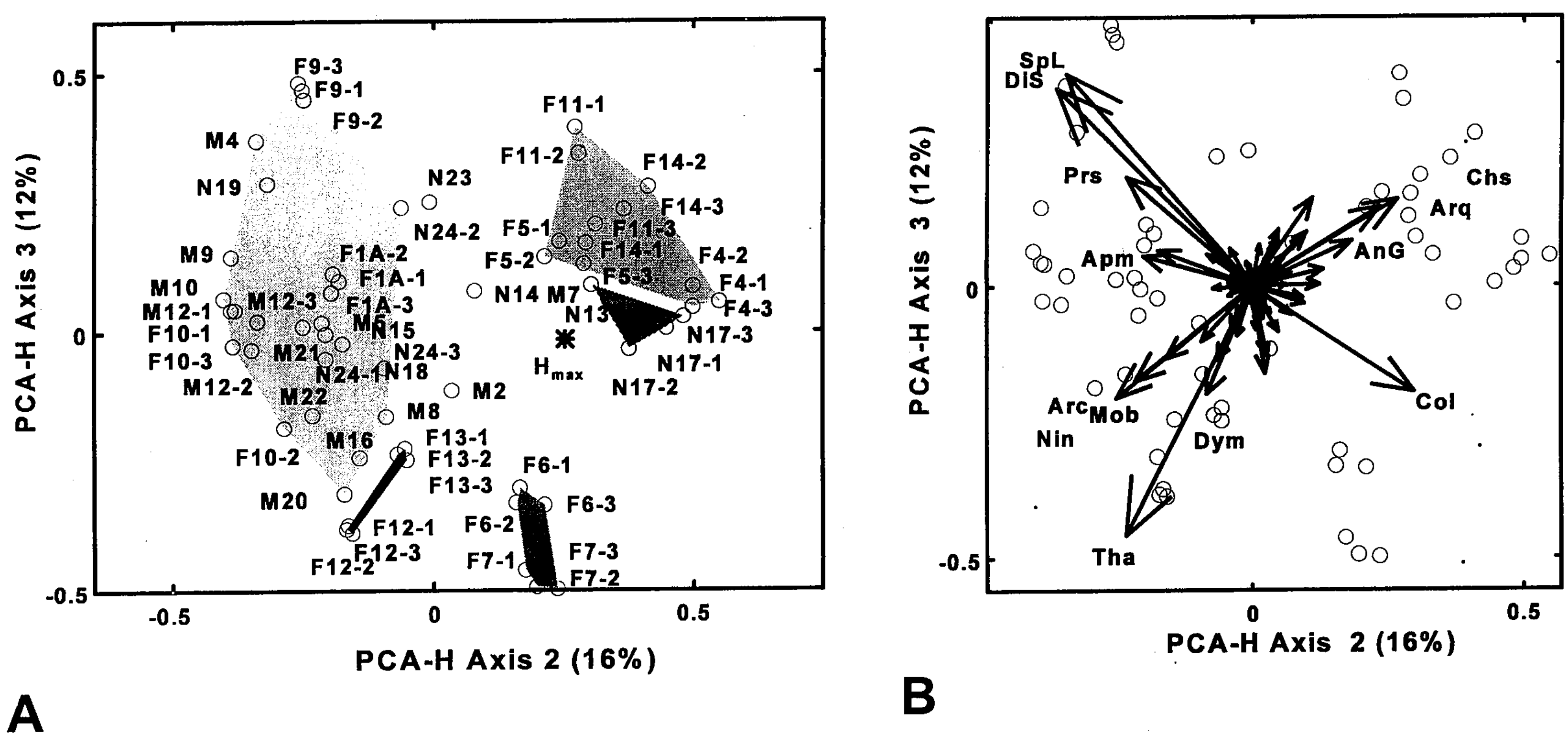


Figure 43. A, Metric scaling of CNESS (NESSm=17) distances among all 59 of the 1997 Massachusetts Bay samples for axes 2 and 3; B, Gabriel Euclidean distance biplot of the same stations, among axes 2 and 3.

3.3 Benthic Soft-bottom Communities: 1992-1997 Summary Results

3.3.1 Taxonomic Composition

The benthic infauna of Massachusetts Bay samples collected from 1992 through 1997 totaled 443 species (Appendix C-2). Eight of these species were identified only in the May 1992 samples that were not included in the 1992-1997 diversity and cluster analyses. The number of species identified in one year ranged from 221 (1993) to 289 (1997). Many species (118) were found in only one year and 56 of these were represented by single specimens. Of the remaining species, 55 were found in two years, 59 species in three years, 24 species in four years, 32 species in five years, and 148 species were found in all six years. The taxonomic composition of the benthic infauna was similar from year to year (Appendix C-2). Annelids comprised about half of the taxa, ranging from 44.3% in 1997 to 52.0% in 1993. Arthropods accounted for about one-quarter of the species, with a range of 21.0% in 1993 to 27.2% in 1996. The percentage of molluscan species ranged from 11.4% in 1995 to 20.1% in 1997. The remaining species, belonging to ten phyla, accounted for about 10% of the taxa, ranging from 9.1% in 1992 to 11.4% in 1996. Table 12 summarizes the breakdown of species into major taxonomic groups by number and percent.

3.3.2 Species Diversity

Species diversity indices for all 352 samples collected in Massachusetts Bay from 1992 to 1997 are presented in Appendix E; averages are provided for stations with three replicates. Details of each of these years have been presented in the various annual reports; results for 1997 are presented above. A review of long-term trends in species diversity is presented in the next section of this report.

3.3.3 Community Analysis for all Nearfield /Midfield Samples Combined (1992-1997)

A composite CNESS cluster analysis of nearfield and midfield samples collected from 1992 to 1997 is presented in Appendix F-1. The corresponding R-mode cluster based on the 38 most important contributing species (Table 13) is presented in Figure 44. The results in the latter figure suggest one sand assemblage and two or three mud assemblages. These results are better illustrated in the PCA-H outputs (Figures 45A-B, 46A-B, and 47A-B) where the metric scaling of the cluster groups according to axes 1-2, 1-3, and 2-3 are shown. These results are similar to those of the 1997 samples (see above) and as in the 1997 samples, the sand assemblage includes the nearfield stations, whereas the mud assemblages are more ubiquitous.

Because of the large number of samples, the station clusters are not as well defined as in the single-year analyses. Figure 45A represents the metric scaling of the station clusters around axes 1 and 2. The stations to the left represent the sandy stations and are verified according to the corresponding Gabriel Euclidean biplot (Figure 45B) where the two most important species on the left are *Crassicorophium crassicorne* and *Exogone hebes*. A similar relationship is shown in Figure 46A and B for axes 1 and 3. The distinction is less obvious in Figure 47A and B for axes 2 and 3.

Figure 48A-C represents the Gabriel covariance biplots that demonstrate faunal assemblages. Again, the sand and mud assemblages are separated rather easily in axes 1-2 and 1-3, less so with axes 2-3. One possible interpretation of these figures is that there is a gradation from the pure sand assemblage on the one hand to the pure mud assemblage on the other. For example, in Figure 48B, *C. crassicorne* and *Tharyx acutus* occur approximately 180° from one another. Species with more acute angles will be closer to one assemblage or the other and more likely to occur with that assemblage. As in the 1997 results, three spionids, *Spio limicola*, *Prionospio steenstrupi*, and *Dipolydora socialis* account for much of the variation (Table 13). *Spio limicola* accounts for 10% of axis 1 and 27% of axis 2; *Prionospio steenstrupi* accounts for 21% of axis 3; and *Dipolydora socialis* accounts for 17% of axis 2. The capitellid, *Mediomastus californiensis,* accounts for 14% of axis 1, *C. crassicorne* for 13% of axis 1, and *Exogone hebes* for 9% of axis 1.

3.3.4 Community Analysis for all Massachusetts Bay Samples Combined (1992-1997)

A composite cluster analysis of all 352 Massachusetts Bay stations collected from 1992-1997 is shown in Appendix F-2. At least six clusters and several outgroups are apparent. Although the large number of stations make these clusters difficult to interpret, they are better depicted in the PCA-H metric scaling diagrams of axes 1-2, 1-3, and 2-3 where the clusters are linked by convex hulls (Figures 49A, 50A, 51A). H_{max} is the theoretical point of maximum diversity. Increasing distance from that point represents lower diversity. A few of the stations are highlighted in larger bold letters for better definition. For axes 1-2, sand dwelling species are shown in the lower left of the figure (49A) and the strong relationship of *Exogone hebes* and *Crassicorophium crassicorne* to these clusters is apparent in the corresponding Gabriel Euclidean biplot (Figure 49B). Most of the stations in these clusters are the nearfield sandy stations and others that have mixed sand/silt sediments. The remaining clusters consist of stations with finer sediments, formed into two large groups. *Aricidea catherinae* and *Tharyx acutus* are species that characterize the dense station groups in the upper half of Figure 49A that include mostly nearshore stations, whereas *Cossura longocirrata* and *Aricidea quadrilobata*, at opposite poles nearly 180°, characterize the cluster on the right which is mostly composed of farfield stations. The clusters are perhaps better depicted in Figure 50A-B of axes 1 and 3. The plots of axes 2 and 3 also show clear relationships of species to station clusters (Figure 51A-B).

Species assemblages are shown in the Gabriel covariance biplots for the same three axes combinations (Figure 52). As has been apparent in the other analyses, there are generally three faunal assemblages in Massachusetts Bay: one composed of species found at sandy stations, and two at finer sediment locations. In this composite analysis, 45 species were found to explain 85% of the cumulative CNESS variation (Table 14). Several species are major contributors to the variation along individual axes: *Spio limicola* (axis 3, 27%), *Aricidea catherinae* (axes 2 and 3, each 9%), *Dipolydora socialis* (axis 3, 19%), *Tharyx acutus* (axis 2, 11%), *Cossura longocirrata* (axis 3, 9%), *Mediomastus californiensis* (axis 2, 15%), *Levinsenia gracilis* (axis 1, 12%), and *Aricidea quadrilobata* (axis 1, 11%).

Table 12. Taxonomic composition of benthic infaunal samples collected in Massachusetts Bay in August from 1992 through 1997.

Taxon	1992		1993		1994		1995		1996		1997*		1992-1997	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Annelida	142	51.4	115	52.0	113	49.1	132	51.8	125	45.3	128	44.3	209	47.1
Polychaeta	140	50.7	111	50.2	111	48.3	127	49.8	119	43.1	123	42.6	199	44.8
Oligochaeta	2	0.7	4	1.8	2	0.9	5	2.0	6	2.2	5	1.7	10	2.3
Arthropoda	58	21.0	50	22.6	58	25.2	65	25.5	75	27.2	72	24.9	103	23.2
Amphipoda	32	11.6	28	12.7	32	13.9	39	15.3	47	17.0	45	15.6	61	13.7
Isopoda	7	2.5	8	3.6	9	3.9	9	3.5	8	2.9	9	3.1	13	2.9
Cumacea	11	4.0	11	5.0	12	5.2	14	5.5	15	5.4	13	4.5	17	3.8
Other	8	2.9	3	1.4	5	2.2	3	1.2	5	1.8	5	1.7	12	2.7
Mollusca	51	18.5	34	15.4	38	16.5	29	11.4	49	17.8	58	20.1	86	19.6
Bivalvia	33	12.0	22	10.0	23	10.0	20	7.8	30	10.9	34	11.8	46	10.4
Gastropoda	16	5.8	10	4.5	13	5.7	8	3.1	17	6.2	22	7.6	38	8.8
Other	2	0.7	2	0.9	2	0.9	1	0.4	2	0.7	2	0.7	2	0.5
Remaining Species	25	9.1	22	10.0	21	9.1	29	11.4	27	9.8	31	10.7	45	10.1
Total	276	100	221	100	230	100	255	100	276	100	289	100	443	100

* Three taxa, *Flabelligera* spp., *Margarites* spp., and *Tetrastemma* spp., included in the 1997 results section were excluded from this overall analysis because identified species belonging to those genera were included within the multi-year data set.

Table 13. The 38 most important contributors to CNESS (NESSm=17) distances among all nearfield and midfield stations from 1992-1997. Cont is the contribution to overall CNESS distances, Total Cont is the cumulative amount of CNESS variation explained by species (87% by the top 38 species). The final columns indicate the contribution of each species to each of the first six PCA-H axes.

Rank	Species	Spp. code	Cont	Total Cont	PCA-H Axis					
					1	2	3	4	5	6
1	*Spio limicola*	SpL	7	7	10	27	2	1	1	1
2	*Prionospio steenstrupi*	Prs	6	13	8	1	21	25	0	8
3	*Dipolydora socialis*	DiS	5	18	1	17	8	16	12	2
4	*Mediomastus californiensis*	Mec	5	23	14	0	0	0	0	4
5	*Aricidea catherinae*	Arc	5	28	3	7	8	15	9	8
6	*Crassicorophium crassicorne*	Crc	4	32	13	0	5	2	1	3
7	*Exogone hebes*	Exh	4	36	9	4	1	0	8	5
8	*Tharyx acutus*	Tha	4	41	3	6	1	3	9	13
9	*Aphelochaeta marioni*	Apm	3	44	3	6	1	5	3	14
10	*Monticellina baptisteae*	Mob	3	47	4	0	8	1	0	1
11	*Ninoe nigripes*	Nin	3	50	5	0	2	2	1	0
12	*Exogone verugera*	Exv	3	52	1	6	2	0	12	0
13	*Hiatella arctica*	Hia	3	55	1	0	2	2	4	14
14	*Levinsenia gracilis*	Leg	2	57	3	0	8	1	0	2
15	*Nucula delphinodonta*	Nud	2	59	1	3	0	1	0	0
16	*Owenia fusiformis*	Owf	2	61	0	1	1	0	8	1
17	*Cerastoderma pinnulatum*	Cep	2	63	3	1	0	3	0	0
18	*Nephtys cornuta*	NEC	2	65	0	3	3	0	0	0
19	*Polygordius* sp. A	PoA	2	66	2	0	1	1	0	0
20	*Euchone incolor*	Eui	2	68	1	1	1	6	0	1
21	*Pseudunciola obliquua*	Pso	2	69	2	0	4	1	4	2
22	*Spiophanes bombyx*	SPB	2	71	2	1	1	1	6	3
23	*Crenella decussata*	Crd	1	72	0	2	0	0	3	0
24	*Dipolydora quadrilobata*	DiQ	1	74	0	2	2	2	0	0
25	*Leitoscoloplos acutus*	Lea	1	75	2	2	0	0	0	1
26	*Unciola inermis*	Uni	1	76	2	0	0	0	1	2
27	*Scoletoma hebes*	Sch	1	77	0	2	0	1	1	0
28	*Phyllodoce mucosa*	phm	1	78	0	2	2	0	0	0
29	Enchytraeidae sp. 1	En1	1	79	1	0	0	0	1	0
30	*Photis pollex*	PhP	1	80	0	1	3	0	0	0
31	Tubificidae sp. 2 (Blake 1992)	Tu2	1	81	0	0	0	0	1	0
32	*Dyopedos monacanthus*	Dym	1	82	0	1	2	0	0	0
33	*Asabellides oculata*	Aso	1	83	0	0	1	1	1	0
34	*Ampharete acutifrons*	Ama	1	84	0	1	0	0	0	1
35	*Phoronis architecta*	pha	1	85	0	0	2	0	1	1
36	*Chiridotea tuftsi*	Cht	1	85	1	0	1	0	1	1
37	*Aglaophamus circinata*	Agc	1	86	1	0	0	0	0	1
38	*Euclymene collaris*	Euc	1	87	1	0	0	0	1	0

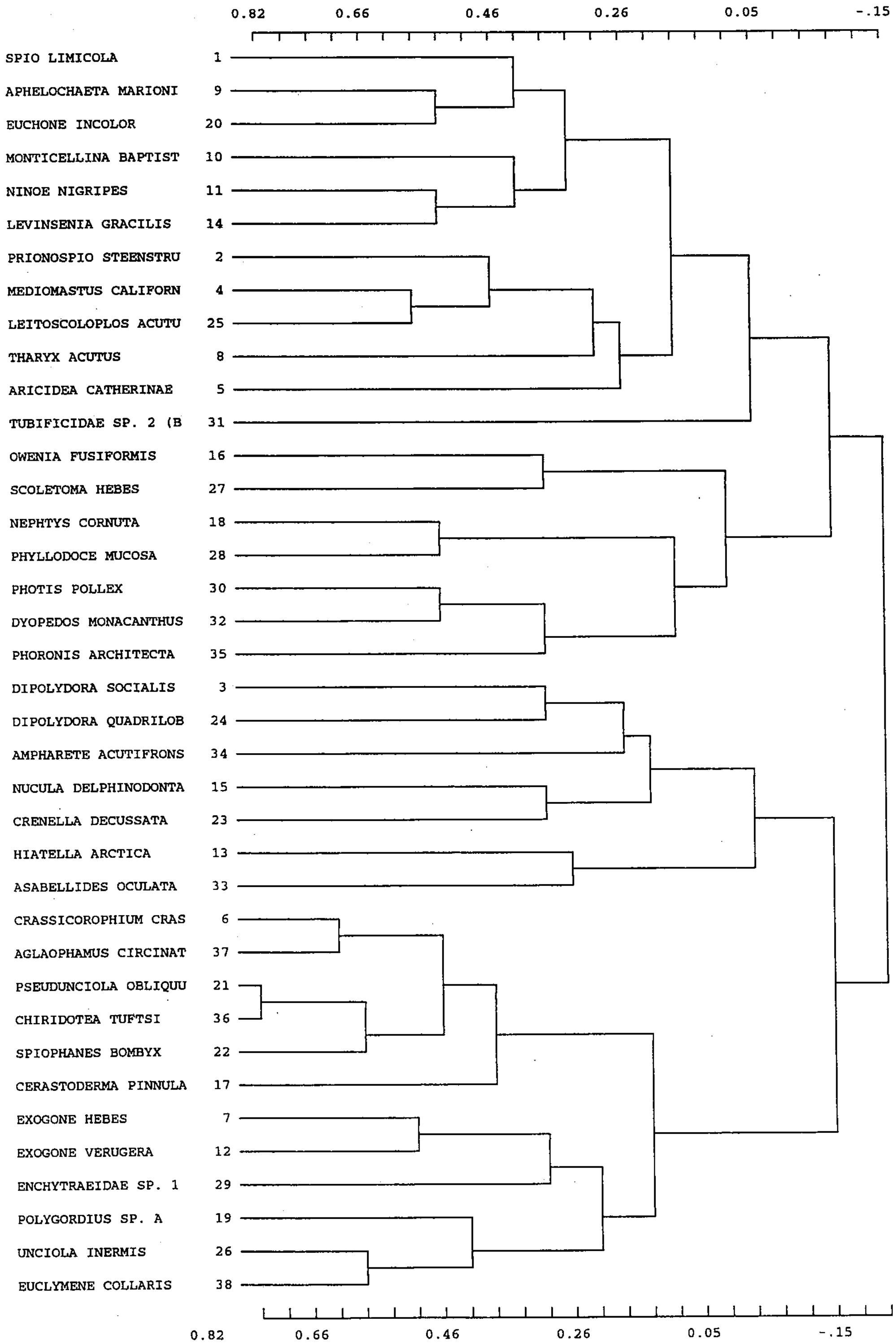


Figure 44. R-mode cluster analysis for the 38 species that contribute at least 0.5% to CNESS (NESSm=17) distances among samples for all 1992-1997 Massachusetts Bay nearfield stations. The numbers indicate relative importance.

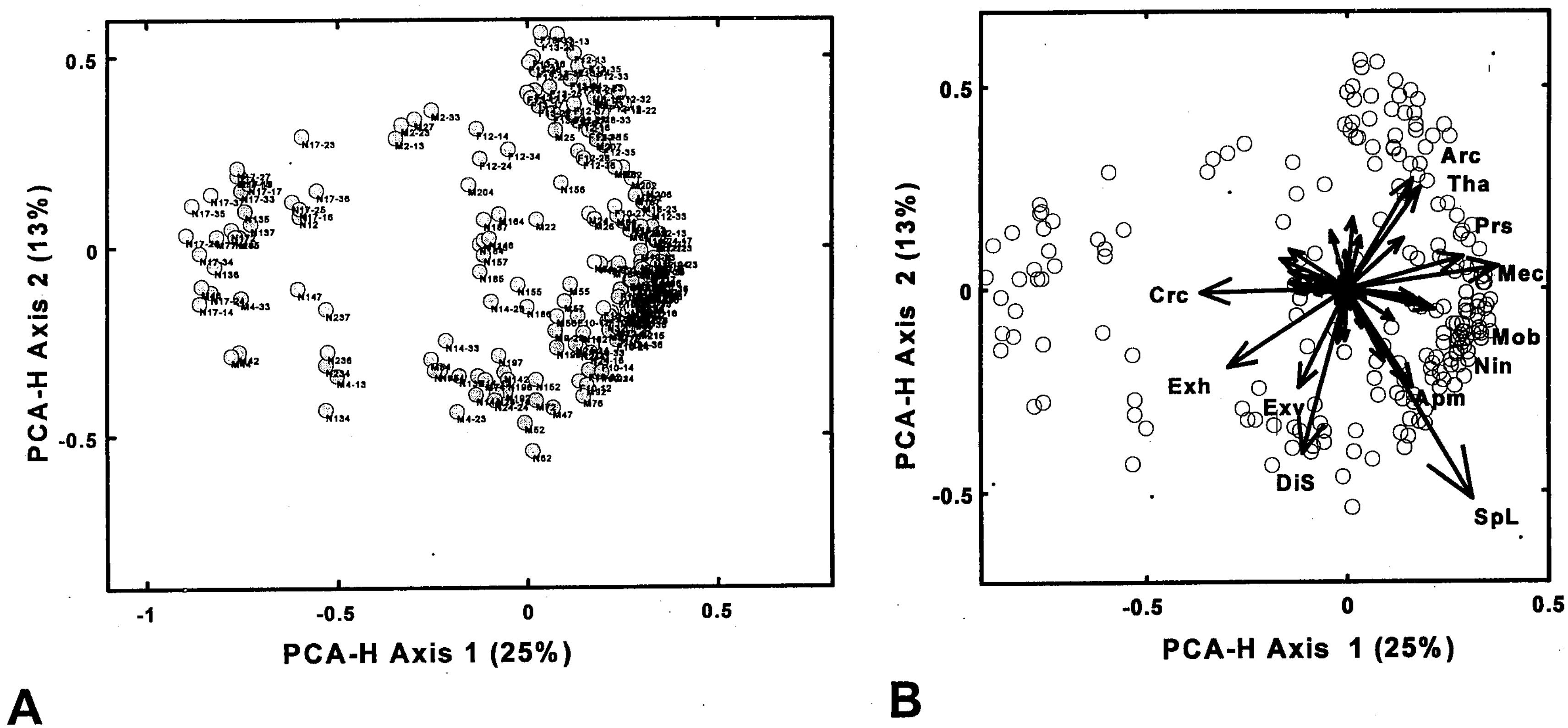


Figure 45. A, Metric scaling of CNESS (NESSm=17) distances among all Massachusetts Bay nearfield and midfield samples for axes 1 and 2; B, Gabriel Euclidean distance biplot of the same stations, among axes 1 and 2.

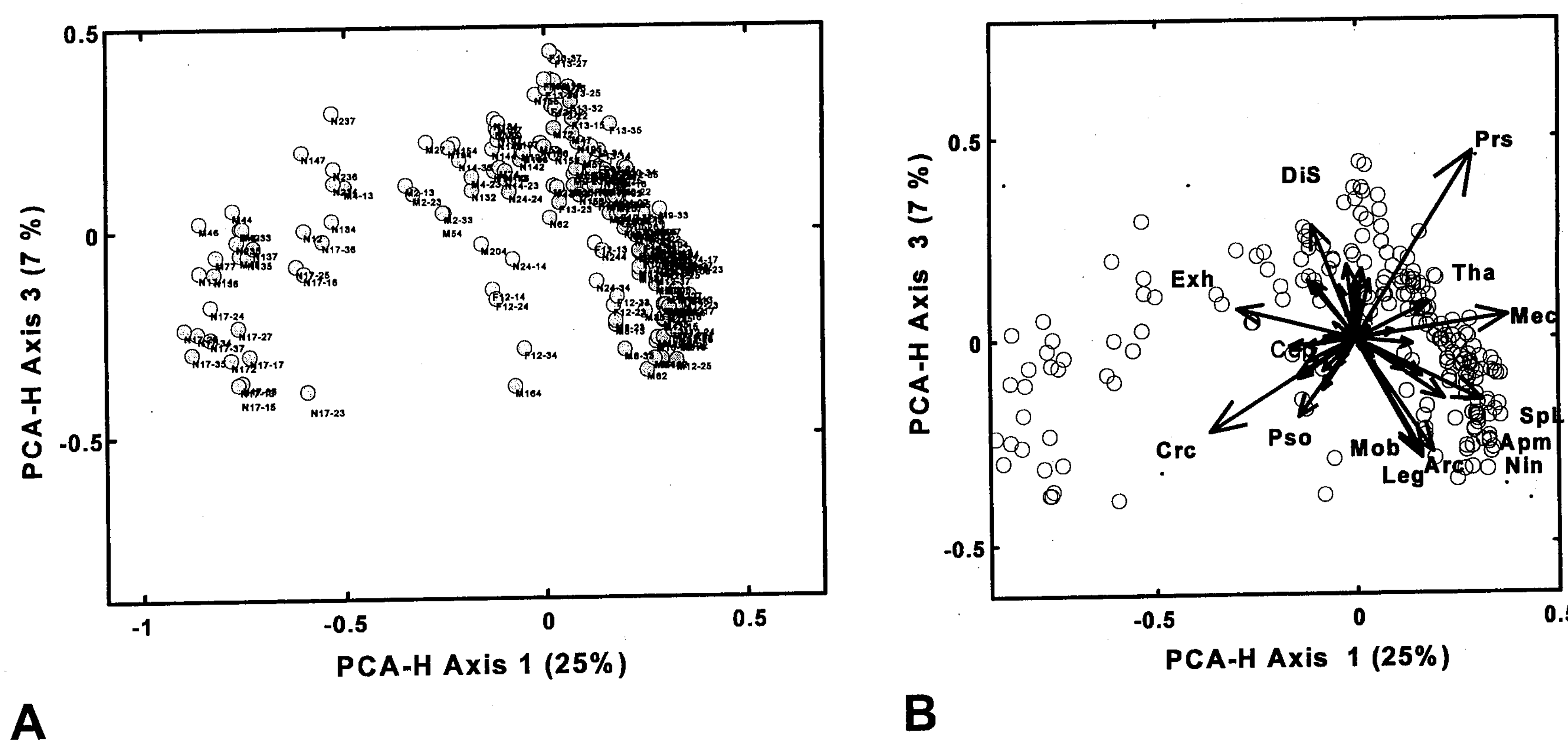
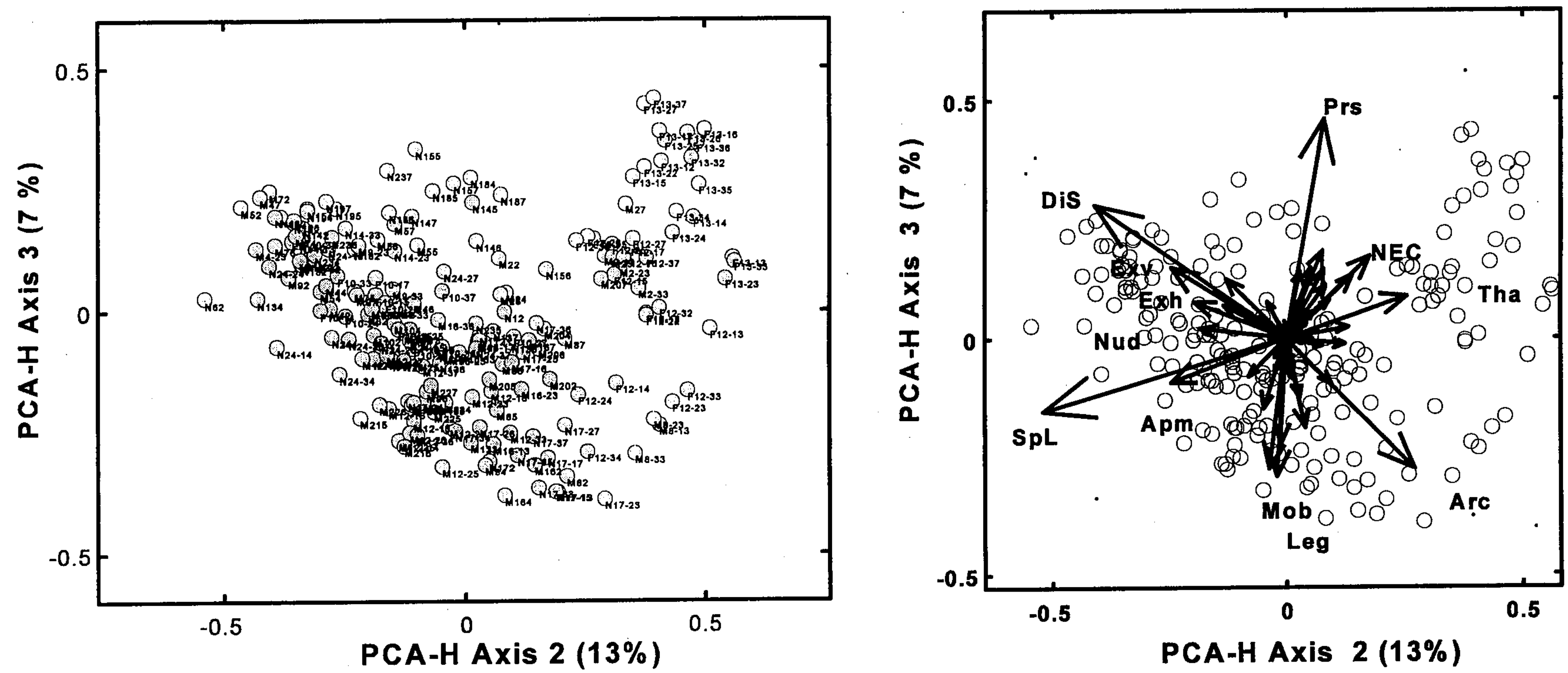


Figure 46. A, Metric scaling of CNESS (NESSm=17) distances among all Massachusetts Bay nearfield and midfield samples for axes 1 and 3; B, Gabriel Euclidean distance biplot of the same stations, among axes 1 and 3.



A

B

Figure 47. A, Metric scaling of CNESS (NESSm=17) distances among all Massachusetts Bay nearfield and midfield samples for axes 2 and 3; B, Gabriel Euclidean distance biplot of the same stations, among axes 2 and 3.

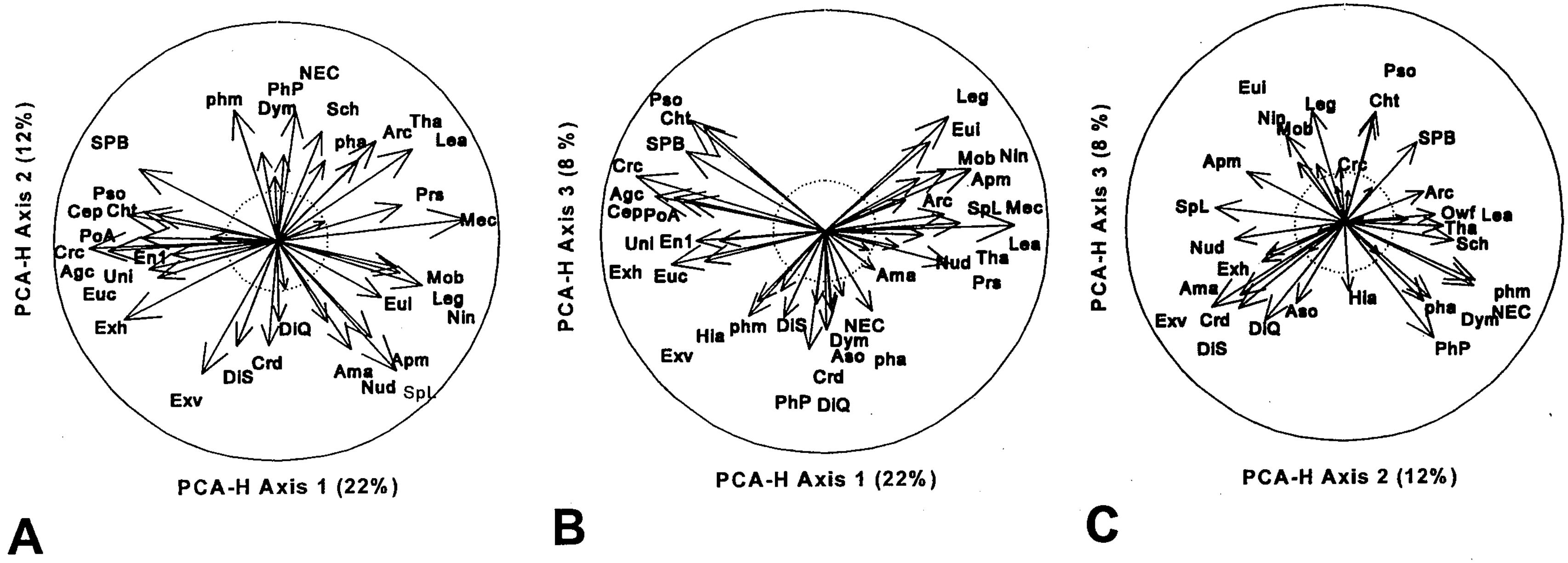
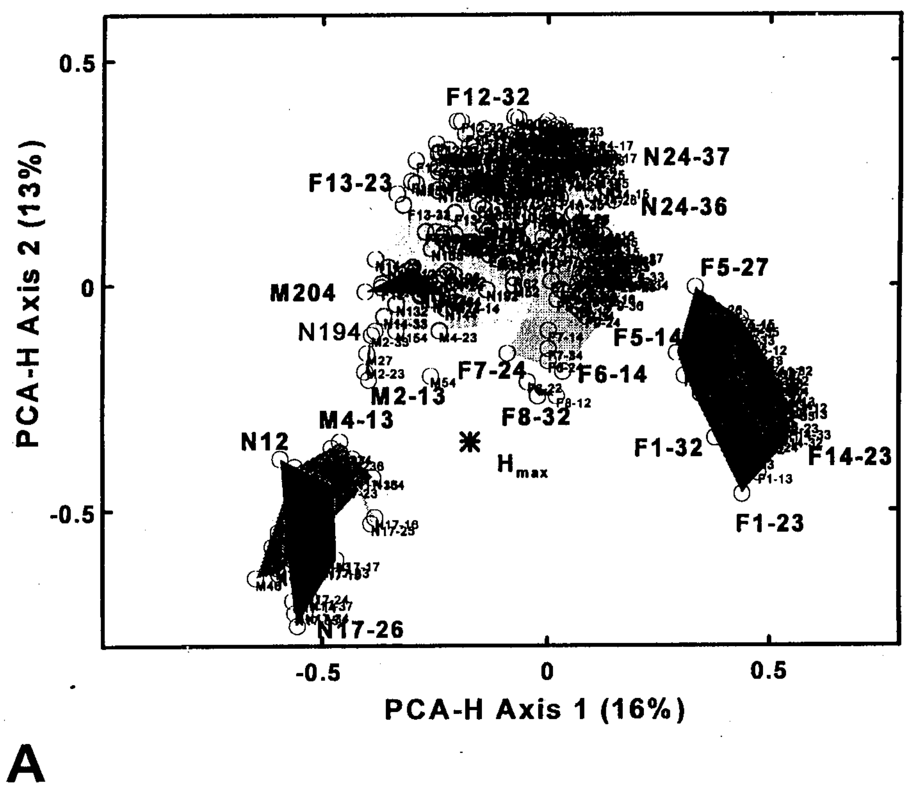


Figure 48. Gabriel covariance biplots for all 1992-1997 nearfield and midfield data: A, axes 1 and 2; B, axes 1 and 3; C, axes 2 and 3.



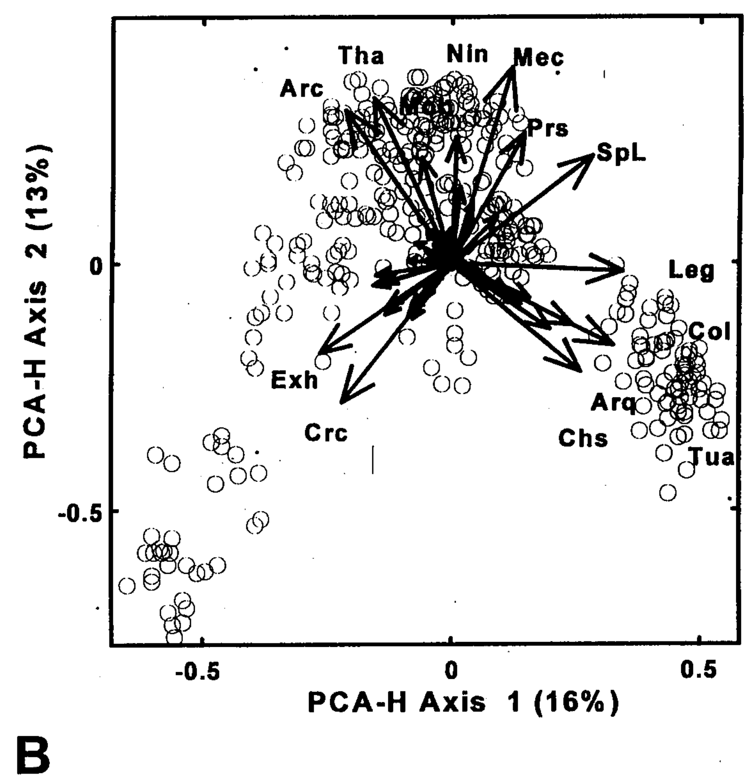


Figure 49. A, Metric scaling of CNESS (NESSm=17) distances among all 352 Massachusetts Bay samples combined (1992-1997) for axes 1 and 2; B, Gabriel Euclidean distance biplot of the same stations, among axes 1 and 2.

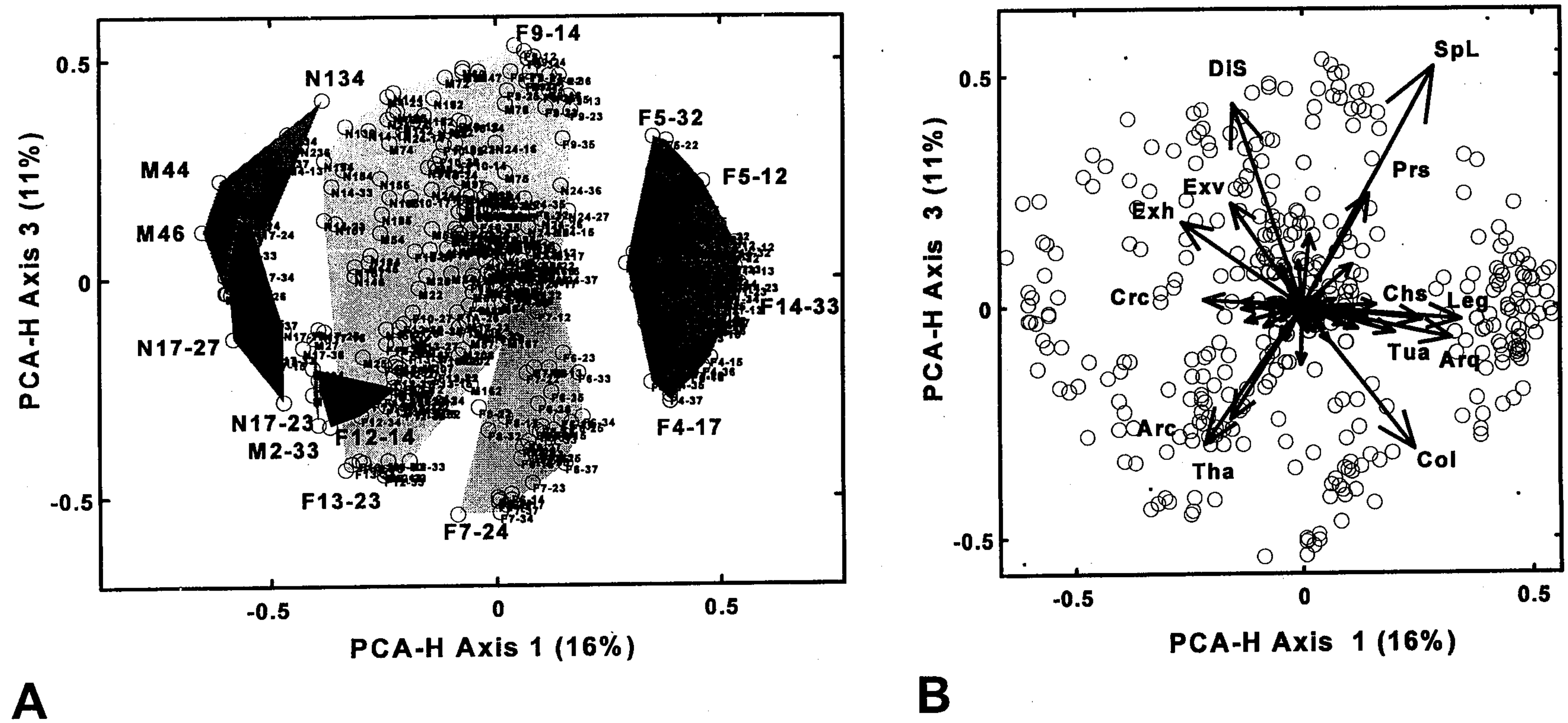


Figure 50. A, Metric scaling of CNESS (NESSm=17) distances among all 352 Massachusetts Bay samples combined (1992-1997) for axes 1 and 3; B, Gabriel Euclidean distance biplot of the same stations, among axes 1 and 3.

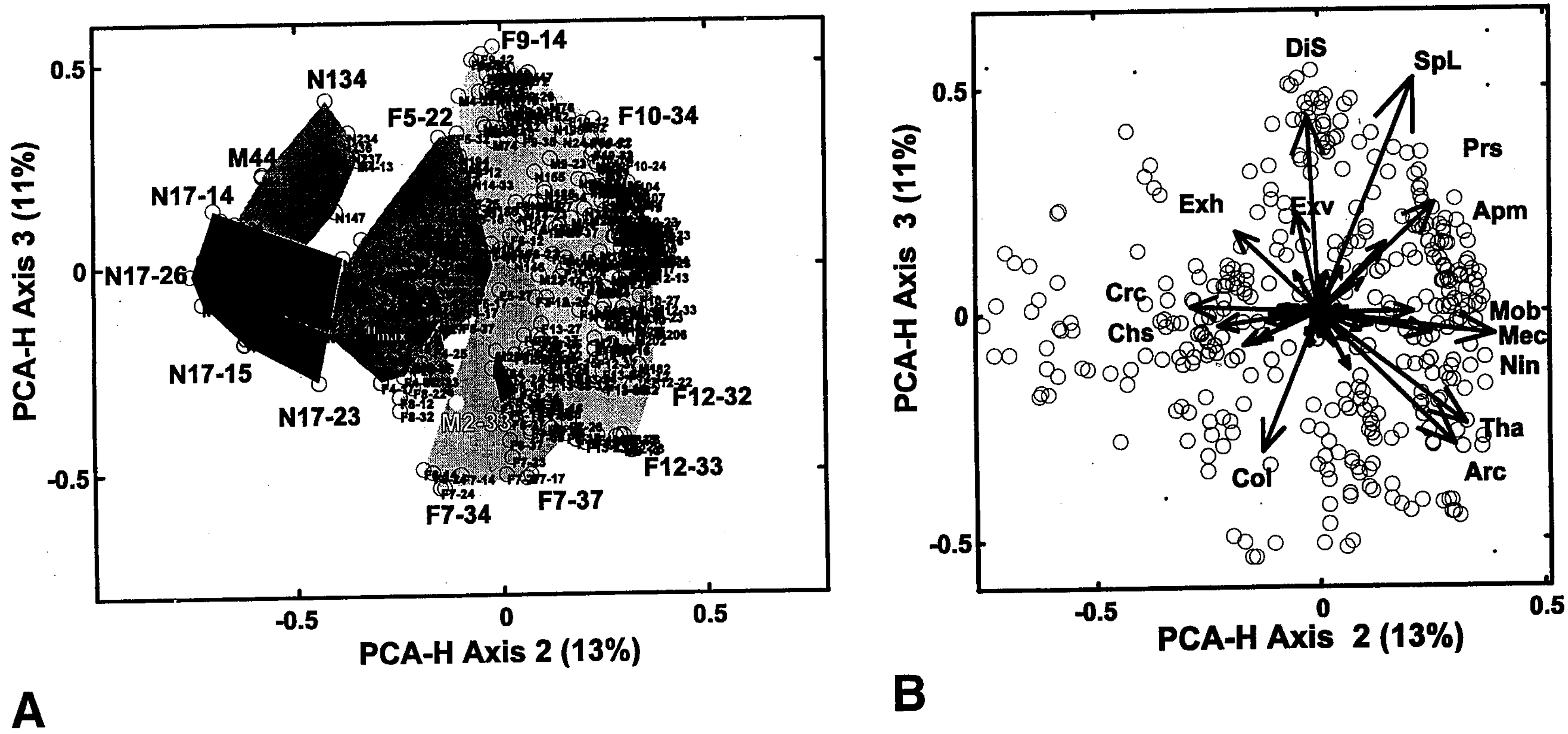


Figure 51. A, Metric scaling of CNESS (NESSm=17) distances among all 352 Massachusetts Bay samples combined (1992-1997) for axes 2 and 3; B, Gabriel Euclidean distance biplot of the same stations, among axes 2 and 3.

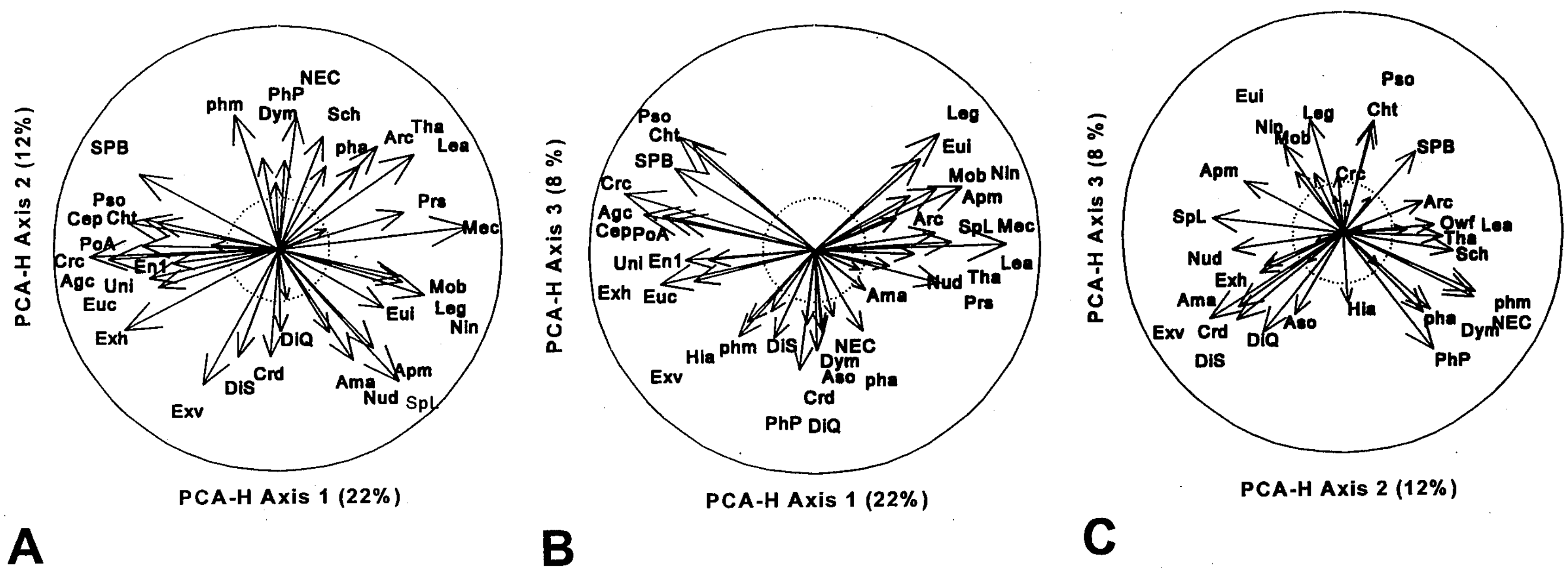


Figure 52. Gabriel covariance biplots for all 352 Massachusetts Bay samples combined (1992-1997): A, axes 1 and 2; B, axes 1 and 3; C, axes 2 and 3.

Table 14. The 45 most important contributors to CNESS (NESSm=17) distances among all 352 Massachusetts Bay samples collected from 1992-1997. Cont is the contribution to overall CNESS distances, Total Cont is the cumulative amount of CNESS variation explained by species (85% by the top 45 species). The final columns indicate the contribution of each species to each of the first six PCA-H axes.

Rank	Species	Spp. code	Cont	Total Cont	PCA-H Axis 1	2	3	4	5	6
1	*Spio limicola*	SpL	7	7	8	5	27	14	3	2
2	*Prionospio steenstrupi*	Prs	6	13	2	7	6	49	5	1
3	*Aricidea catherinae*	Arc	5	18	5	9	9	3	8	2
4	*Dipolydora socialis*	DiS	5	22	2	0	19	6	12	7
5	*Tharyx acutus*	Tha	4	27	3	11	6	0	6	1
6	*Cossura longocirrata*	Col	4	31	6	2	9	10	11	1
7	*Mediomastus californiensis*	Mec	4	34	1	15	0	0	0	2
8	*Levinsenia gracilis*	Leg	3	38	12	0	0	0	6	3
9	*Exogone hebes*	Exh	3	41	7	3	3	0	0	2
10	*Aricidea quadrilobata*	Arq	3	43	11	3	0	0	0	0
11	*Crassicorophium crassicorne*	Crc	3	46	5	8	0	0	1	1
12	*Chaetozone setosa*	Chs	2	48	7	5	0	1	1	1
13	*Monticellina baptisteae*	Mob	2	51	0	4	0	0	16	1
14	*Aphelochaeta marioni*	Apm	2	53	0	2	2	0	1	7
15	*Ninoe nigripes*	Nin	2	55	0	6	0	1	0	14
16	*Nucula delphinodonta*	Nud	2	57	0	1	1	0	1	13
17	*Exogone verugera*	Exv	2	59	2	0	5	0	0	2
18	*Tubificoides apectinatus*	Tua	2	61	4	2	0	1	2	3
19	*Euchone incolor*	Eui	2	63	1	1	0	0	2	7
20	*Hiatella arctica*	Hia	2	64	2	0	0	0	0	1
21	Tubificidae sp. 2 (Blake 1992)	Tu2	1	66	0	0	2	2	4	0
22	*Owenia fusiformis*	Owf	1	67	1	0	0	1	0	0
23	*Scalibregma inflatum*	Sci	1	68	1	0	1	0	0	2
24	*Cerastoderma pinnulatum*	Cep	1	69	2	1	0	1	0	1
25	*Leitoscoloplos acutus*	Lea	1	70	0	1	0	1	5	3
26	*Thyasira gouldii*	Thg	1	71	3	1	0	0	0	0
27	*Crenella decussata*	Crd	1	72	0	0	1	0	0	1
28	*Spiophanes bombyx*	SPB	1	73	2	1	0	0	0	0
29	*Anobothrus gracilis*	AnG	1	74	2	1	0	0	0	0
30	*Nephtys cornuta*	NEC	1	75	0	0	1	1	0	5
31	*Polygordius* sp. A	PoA	1	76	1	1	0	0	0	0
32	*Pseudunciola obliquua*	Pso	1	77	1	1	0	0	1	0
33	*Dipolydora quadrilobata*	DiQ	1	78	0	0	1	0	0	0
34	*Unciola inermis*	Uni	1	78	1	1	0	0	0	0
35	*Phyllodoce mucosa*	phm	1	79	1	0	0	1	0	3
36	*Scoletoma hebes*	Sch	1	80	0	0	0	0	0	1
37	*Maldane glebifex*	Mag	1	80	0	0	0	0	0	0
38	*Onoba pelagica*	Onp	1	81	0	0	1	1	1	1
39	*Ampharete acutifrons*	Ama	1	82	0	0	1	0	0	0
40	*Yoldia sapotilla*	Yos	1	82	1	0	0	0	0	0
41	*Photis pollex*	PhP	1	83	0	0	0	0	1	1
42	Enchytraeidae sp. 1	En1	1	83	0	0	0	0	0	0
43	*Asabellides oculata*	Aso	1	84	0	0	0	0	0	0
44	*Phoronis architecta*	pha	1	85	0	0	0	0	0	1
45	*Aglaophamus circinata*	Agc	1	85	1	1	0	0	0	0

3.4 Nearfield Hard-bottom Communities

Still photographs were obtained at all 23 waypoints. A total of 684 photographs were taken and used for data analysis. Video-tape coverage was also obtained at each of the 23 waypoints. The video coverage on transect 10 was not very good due to a problem with lighting during the transect, so the data should be viewed as representing minimal abundances. The video tape from diffuser #44 was not analyzed, since the objective of documenting pre-online conditions at this diffuser was adequately addressed by an analysis of the stills taken at the diffuser.

Habitat characterizations and dominant taxa determined separately from video images and still photographs were very similar, indicating that the still photographs were representative of the areas surveyed. Differences between the two types of coverage were mainly related to a higher occurrence of some sparsely distributed larger taxa observed in the greater geographic coverage afforded by the video tapes, and the higher occurrence of encrusting taxa afforded by the superior resolution of the still photographs.

3.4.1 Distribution of Habitat Types

The sea floor on the drumlin tops usually consisted of a mix of glacial erratics in the boulder and cobble size category. These areas generally had moderate to high relief with numerous boulders. An exception to this was one of the reference sites (T8) southwest of the diffuser, which consisted of a lower-relief cobble pavement only occasionally interrupted by boulders. In contrast, the sea floor at the new southwestern reference site (T10) was high-relief and mostly consisted of large boulders. Sediment drape on the tops of drumlins ranged from none to heavy, but was usually light. The sea floor on the flanks of drumlins generally consisted of a low-relief cobble pavement, interrupted occasionally by patches of boulders or gravel. Sediment drape in these regions ranged from a light dusting to a heavy mat-like cover, but generally tended to be heavier than on the top of drumlins. The sea floor in the vicinity of the diffuser heads (diffuser #2 at T2-WP5 and diffuser #44) consisted of angular rocks in the large cobble to small boulder category. Sediment drape near the diffusers tended to be moderate to heavy.

3.4.2 Distribution and Abundance of Epibenthic Flora and Fauna

A total of 100 taxa were seen on the visuals from this survey (Table 15). Eighty seven of these taxa were seen on the still photographs. A total of 15,639 invertebrates, 281 fish, and 10,002 algae were either counted or estimated from the still photographs (Table 16). The two most abundant taxa observed were two algae, the coralline red alga *Lithothamnion* spp. and the dulse alga *Rhodymenia palmata*, with abundances of 5646 individuals and 3064 individuals, respectively. The abundance of *Lithothamnion* spp. was estimated and should be viewed as being very conservative. Two other algae, a red filamentous alga *Asparagopsis hamifera* and the shotgun kelp *Agarum cribosum*, were also seen during this survey. The most abundant invertebrates observed on the still photographs were: the horse mussel *Modiolus modiolus* (2454 individuals), juveniles and adults of the northern sea star *Asterias vulgaris* (1647 and 414 individuals, respectively), the frilled anemone *Metridium senile* (1448 individuals), and the sea pork tunicate *Aplidium* spp. (1033 individuals). Other common invertebrate inhabitants of the drumlins included: barnacles (985 individuals), the blood sea star *Henricia sanguinolenta* (635 individuals), the drop of blood tunicate *Dendrodoa carnea* (572 individuals), brachiopods (395 individuals), the green sea urchin *Strongylocentrotus droebachiensis* (359 individuals), the sea peach tunicate *Halocynthia pyriformis* (307 individuals), the flat slipper limpet *Crepidula plana* (306 individuals), and a number of sponges and encrusting organisms. The most abundant fish observed in the still photographs was the cunner *Tautogolabrus adspersus* (258 individuals).

Table 15. Taxa observed during the 1997 nearfield hardbottom survey.

Taxon	Common Name
Algae	
Lithothamnion sp.	coralline algae
Asparagopsis hamifera	filamentous red algae
Rhodymenia palmata	dulse
Agarum cribrosum	shotgun kelp
Fauna	
Sponges	
sponge	
Aplysilla sulfurea	sponge (yellow encrust)
Halichondria panicea	crumb-of-bread sponge
Haliclona spp.	finger sponge
Melonanchora elliptica	warty sponge
Phakellia spp.	chalice sponge
Suberites spp.	fig sponge
white divided	sponge on brachiopod
orange/tan encrusting	
orange encrusting	
pale orange encrusting	
gold encrusting	
tan encrusting	
pink fuzzy encrusting	
dark red/brown encrusting	
white translucent	
cream encrusting	
rust-cream encrusting	
white chalice	
filamentous white encrusting	
Encrusting organisms	
general encrusting	
white translucent crust	
white crust	
Coelenterates	
hydroid	
Campanularia sp.	hydroid
Corymorpha pendula	solitary hydroid
Obelia geniculata	hydroid
anemone	
Fagesia lineata	lined anemone
Metridium senile	frilly anemone
Urticina felina	northern red anemone
Cerianthus borealis	northern cerianthid
Gersemia rubiformis	red soft coral
Mollusks	
gastropod	
Tonicella marmorea	mottled red chiton
Crepidula plana	flat slipper limpet
Notoacmaea testudinalis	tortoiseshell limpet
Buccinum undatum	waved whelk
Busycon carica	knobbed whelk
Busicotypus canaliculatus	channeled whelk
Neptunea decemcostata	ten-ridged whelk
nudibranch	
Coryphella sp.	nudibranch
bivalve	
Modiolus modiolus	horse mussel
Placopecten magellanicus	sea scallop
Arctica islandica	quahog
bivalve siphons	
Crustaceans	
Balanus spp.	acorn barnacle
Cancer spp.	Jonah or rock crab
Homarus americanus	lobster
Pagurus spp.	hermit crab
pycnogonid	
shrimp	
Echinoderms	
Strongylocentrotus droebachiensis	green sea urchin
starfish	
small white starfish	juvenile *Asterias*
Asterias vulgaris	northern sea star
Henricia sanguinolenta	blood star
Crossaster papposus	spiny sunstar
Solaster endeca	smooth sunstar
Pteraster militaria	winged sea star
Porania insignis	badge star
Ophiopholis aculeata	daisy brittle star
Psolus fabricii	scarlet holothurian
Tunicates	
tunicate	
Aplidium spp.	sea pork tunicate
Boltenia ovifera	stalked tunicate
Ciona intestinalis	sea vase tunicate
Dendrodoa carnea	drop of blood tunicate
Didemnum albidum	northern white crust tunicate
Halocynthia pyriformis	sea peach tunicate
white globular tunicate	
clear globular tunicate	
white *Halocynthia pyriformis*	
Bryozoans	
bryozoan	
?*Crisia* spp.	
Membranipora sp.	sea lace bryozoan
Miscellaneous	
Myxicola infundibulum	slime worm
polynoid	
sabellid	
spirorbids	
Terebratulina septentrionalis	northern lamp shell
Fish	
fish	
Anarhichas lupus	wolffish
Centropristis striata	black bass
Gadus morhua	cod
Hemitripterus americanus	sea raven
Myoxocephalus spp.	sculpin
Macrozoarces americanus	ocean pout
Pholis gunnellus	rock gunnel
Pleuronectes americanus	winter flounder
Pollachius virens	pollock
Prionotus spp.	sea robin
Tautoga onitis	tautog
Tautogolabrus adspersus	cunner

Table 16. List of taxa seen on still photographs, arranged in order of abundance.

Algae		*Urticina felina*	17
Lithothamnion sp.	5646	*Placopecten magellanicus*	17
Rhodymenia palmata	3064	filamentous white encrusting sponge	16
Asparagopsis hamifera	1220	*Ciona intestinalis*	16
Agarum cribrosum	72	*Ophiopholis aculeata*	15
Total algae	**10002**	white encrusting organism	14
		general starfish	14
Invertebrates		*Notoacmaea testudinalis*	13
Modiolus modiolus	2454	*Fagesia lineata*	10
juvenile *Asterias vulgaris*	1647	white translucent encrusting organism	9
Metridium senile	1448	general gastropod	9
Aplidium spp.	1033	*Crossaster papposus*	8
Balanus spp.	985	*Cerianthus borealis*	7
white translucent sponge	808	gold encrusting sponge	6
orange/tan encrusting sponge	757	*Melonanchora elliptica*	6
Henricia sanguinolenta	635	*Corymorpha pendula*	6
Dendrodoa carnea	572	*Buccinum undatum*	6
Asterias vulgaris	414	*Pteraster militaria*	5
general encrusting organism	407	nudibranch	4
Terebratulina septentrionalis	395	dark red/brown encrusting sponge	3
Strongylocentrotus droebachiensis	359	*Neptunea decemcostata*	3
Halocynthia pyriformis	307	sabellid polychaete	3
Crepidula plana	306	*Haliclona* spp.	2
orange encrusting sponge	232	*Phakellia* spp.	2
pale orange encrusting sponge	230	*Solaster endeca*	2
Myxicola infundibulum	229	general bryozoan	2
Didemnum albidum	221	*Coryphella* sp.	1
Tonicella marmorea	199	*Busycon canaliculatum*	1
Psolus fabricii	190	general bivalve	1
cream encrusting sponge	188	*Cancer* spp.	1
white globular tunicate	162	pycnogonid	1
tan encrusting sponge	144	general tunicate	1
Aplysilla sulfurea	140	*Boltenia ovifera*	1
clear globular tunicate	119	*Membranipora* sp.	1
bivalve siphons	104	polynoid polychaete	1
Gersemia rubiformis	102	**Total invertebrates**	**15639**
general anemone	90		
Suberites spp.	83	**Fish**	
pink fuzzy encrusting sponge	82	*Tautogolabrus adspersus*	258
white divided sponge on brachiopod	61	*Myoxocephalus spp.*	10
Halichondria panicea	57	*Macrozoarces americanus*	3
?*Crisia* spp.	55	*Pholis gunnellus*	3
Arctica islandica	43	general fish	2
Obelia geniculata	41	*Anarhichas lupus*	2
rust-cream encrusting sponge	35	*Pleuronectes americanus*	2
general sponge	33	*Hemitripterus americanus*	1
white chalice sponge	24	**Total fish**	**281**
Campanularia sp.	24		

Lithothamnion spp. was the most abundant and widely distributed taxon encountered during the survey. This encrusting red coralline alga was seen at all waypoints, except the two deepest (the two diffuser heads). Its abundance ranged from a mean of 4 percent cover at T6 WP1 to a mean of 96 percent cover at T1 WP3. *Lithothamnion* was the dominant inhabitant in areas that had minimal sediment drape on the rock surfaces. In contrast, the two other common algae, dulse and *Asparagopsis hamifera*, frequently dominated areas that had high relief with a moderate to heavy sediment drape. The reduced percent cover of *Lithothamnion* in these areas appears to be related to fine particles being trapped by the holdfasts of the upright algae and blanketing the rock surface. In areas with variable substrate characteristics, *Asparagopsis* and dulse frequently dominated the tops of boulders, while *Lithothamnion* dominated the cobbles and smaller boulders in between.

The horse mussel *Modiolus modiolus* was found at all but the two deepest sites (the two diffuser head areas). It was most abundant on the tops of shallower drumlins, where large numbers were observed nestled among cobbles and at the bases of boulders. Due to their cryptic nature of nesting in among rocks and frequently being almost totally buried, the observed mussel abundances are very conservative. The number of mussels is definitely underestimated in areas of high-relief, since bases of larger boulders were frequently not in the images. The northern sea star *Asterias vulgaris* was found at all of the surveyed sites. Juvenile *Asterias* were generally more abundant than adults. An exception to this was noticed at both diffuser head sites, where adults tended to dominate. In general, adult *A. vulgaris* were more abundant on sediment and cobbles, while juveniles were more abundant on boulders. Quite low abundances of both juvenile and adult *A. vulgaris* were found at all three of the northern reference sites (T7-1, T7-2, and T9-1). Reduced abundances of this sea star at these sites were not noted in the 1996 survey. The blood sea star *Henricia sanguinolenta* was also observed at all of the sites, and was most abundant on boulders in high-relief areas. The green sea urchin *Strongylocentrotus droebachiensis* was only found in the shallower sites and was most abundant in regions that had high coverage of *Lithothamnion*, on which it grazes. The frilled anemone *Metridium senile* was only found on the tops of very large boulders and on the diffuser heads. This anemone was exceptionally abundant on the top of diffuser #2 (T2-5). The sea pork tunicate *Aplidium* spp. was found at all sites except near the diffuser, and was most abundant at two of the southern reference sites (T8-1 and T8-2). Encrusting taxa were generally most abundant in high-relief areas with minimal sediment drape. This is not surprising since most juveniles of attached taxa require sediment-free surfaces for settlement. Additionally, clean rock surfaces are indicative of strong currents that provide adequate food supplies for suspension-feeding organisms. Large substrate size classes also provide a physically more stable environment than small size classes as they are more resistant to mechanical disturbance.

The fish fauna was totally dominated by the cunner *Tautogolabrus adspersus*, which was observed all 23 waypoints. This fish was most abundant in high-relief areas, where they tended to congregate among larger boulders. In areas that had patchy distributions of substrate size classes, *T. adspersus* was seen frequently only in the vicinity of boulders. Sculpin, *Myoxocephalus* spp., were observed at 17 of the sites and tended to be seen most often in areas that had low to moderate relief.

3.4.3 Community Structure

Classification of the 23 waypoints and 47 taxa (retained for analysis) defined four clusters (Figure 53). The two main clusters (1 and 2) further divide into more cohesive subgroups. The first cluster consists mainly of moderate to high-relief drumlin top areas, with variable sediment drape. The second cluster consists of both drumlin top and flank areas, with very light to moderate sediment drape. The third cluster consists of 3 drumlin flank areas, that had low to moderately-low relief and moderate to heavy sediment drape. The fourth cluster consists of the two diffuser areas. The clustering structure appears to be determined by a combination of drumlin topography, habitat relief, and sediment drape. Habitat characteristics and percent composition of dominant taxa for each of the cluster groups are presented in Table 17. Algal and faunal abundances tended to be higher on the tops of drumlins than on the flanks, and algal abundances were lowest in the vicinity of the diffuser.

The encrusting alga *Lithothamnion* was a common inhabitant of most of the areas in the first two clusters. Differences among the areas in these two clusters were mainly related to the relative proportion of encrusting and upright algae. The areas in cluster 1 were dominated by two upright algae, *Rhodymenia palmata* and *Asparagopsis hamifera*, while the areas in cluster 2 were dominated by *Lithothamnion*. This is not surprising since the sea floor of all except one area in cluster 1 had moderate to high relief, and upright algae appear to prefer the tops of boulders. Algae, and encrusting and sessile invertebrates, were relatively abundant in all of the areas in cluster 1. Differences among the areas reflected slight differences in the composition of the benthic communities inhabiting them. The new reference site southwest of the diffuser (T10-1) differed from the other areas in this cluster. The large boulders at this site supported numerous invertebrates and fish. These boulders also supported numerous individuals of the soft coral *Gersemia rubiformis*, which was not found elsewhere during this survey.

The areas in cluster 2 were characterized by either less or more variable relief than the areas in cluster 1. Sediment drape ranged from none to heavy, but generally tended to be light. All of the areas in this cluster were dominated by *Lithothamnion* and had few if any upright algae. However, the faunal composition of the communities inhabiting these areas did vary considerably. The numerous boulders at site T1-2 were inhabited by moderate numbers of a variety of sessile invertebrates and high numbers of fish. The two drumlin top areas in 2a supported relatively high abundances of *Modiolus modiolus*. In contrast, the areas in 2b and 2c generally supported lower abundances of algae, invertebrates and fish. The drumlin top areas in 2b consisted of low to moderate relief cobbles and smaller boulders that were incrusted with numerous *Aplidium* spp., while the low-relief drumlin flank areas in 2c supported high abundances of *Asterias vulgaris*.

Cluster 3 consisted of three drumlin flank areas with low to moderately-low relief and moderately heavy sediment drape. All of these areas supported low abundances of algae and fish, and moderate numbers of invertebrates. The sea star *Asterias vulgaris* was the most common inhabitant in these areas. Faunal differences were also observed between the two diffuser areas that were surveyed (cluster 4). The head of diffuser #2 supported a lush population of *Metridium senile*, while the surrounding rock rubble was inhabited by numerous adult *A. vulgaris*. In contrast, the head of diffuser #44 supported far fewer *M. senile* and a large number of sea-peach tunicates *Halocynthia pyriformis*. Diffuser #44 was also inhabited by a number of adult *A. vulgaris*, while the rock rubble around it was relatively depauperate.

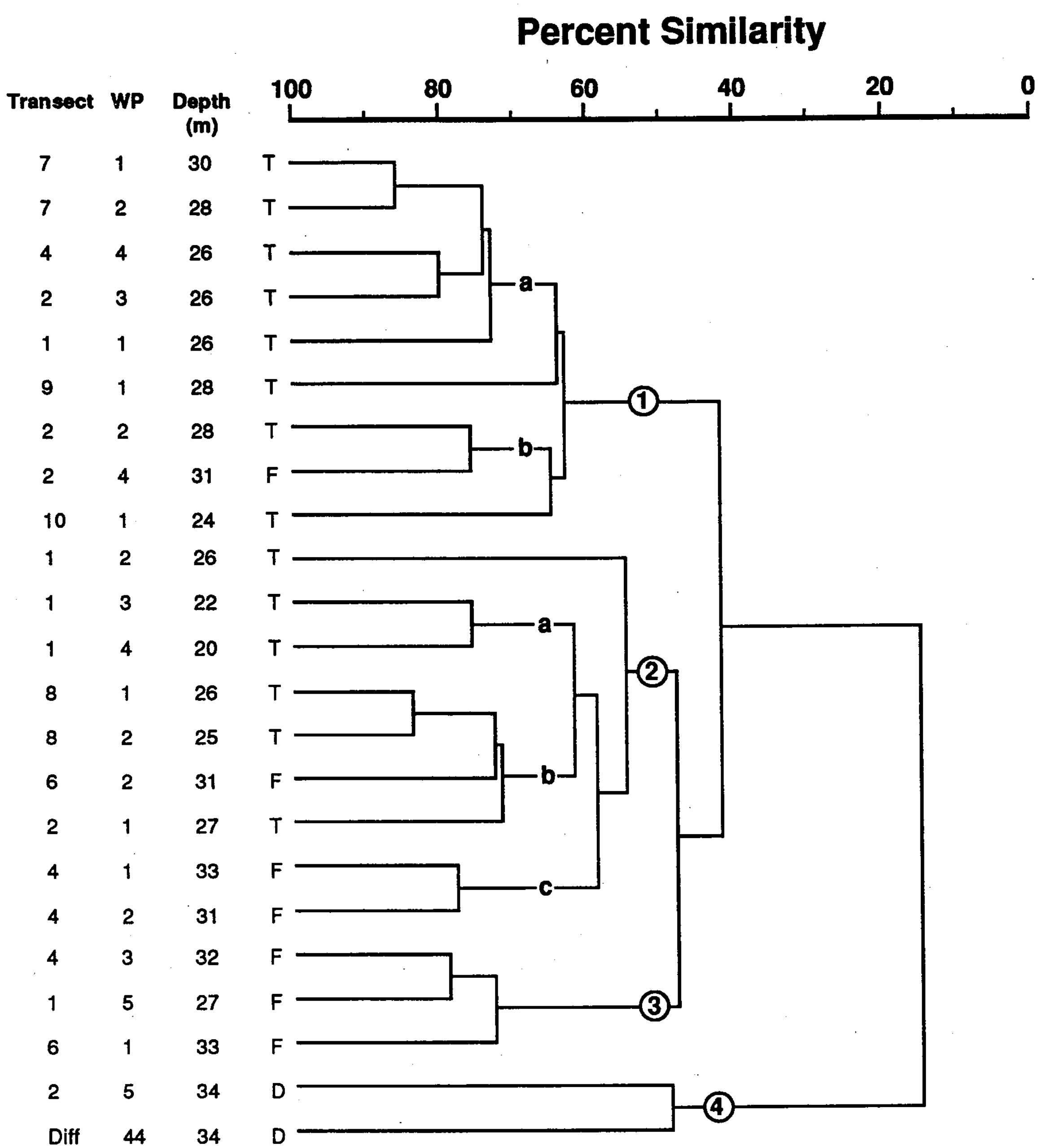


Figure 53. Cluster analysis of the 23 waypoints and 47 taxa (retained for analysis) for 1997 hard-bottom survey.

Table 17. Habitat characteristics and range of percent composition of selected taxa in the clusters defined by classification analysis. Ranges of algae, invertebrates, and fish are means of average number per picture.

	1				2				3	4	
	a	9-1	b	10-1	1-2	a	b	c		2-5	Diff 44
Depth	26-30	28	24-31	24	26	20-22	25-31	21-33	27-33	34	34
Habitat relief	L-H	H	M-H	H	MH	M-MH	L-M	L	L-ML		
Sediment drape	l-m	mh	m-h	h	l	c-l	l-m	m-h	m-h		
Location	T	T	T&F	T	T	T	T&F	F	F	D	D
Asparagopsis hamifera	**5-15**	**14**	**2-8**	**10**	2	0-1	0-2	-	-	-	-
Rhodymenia palmata	**18-24**	**32**	**27-29**	**23**	4	-	0-3	-	-	-	-
Lithothamnion spp.	19-24	15	7-12	4	**25**	**32-47**	**33-45**	**43-59**	9-18	-	-
Lithothamnion spp. (% cover)	41-67	40	13-27	12	72	83-96	33-75	16-53	4-12	-	-
Modiolus modiolus	4-12	5	5-5	9	13	**24-38**	2-12	0-1	3-4	-	-
Stongylocentrotus droebachiensis	0-1	-	-	-	4	**3-5**	0-3	0-2	1-5	-	-
Aplidium spp.	1-7	-	5-7	1	1	1-1	**5-16**	1-1	5-9	-	-
Asterias vulgaris	0-13	1	7-7	10	6	4-7	6-12	**19-22**	**22-25**	14	27
Metridium senile	0-1	-	1-1	1	11	0-3	-	-	-	**79**	**31**
Gersemia rubiformis	-	-	-	**6**	-	-	-	-	-	-	-
Halocynthia pyriformis	0-2	-	0-2	1	1	-	-	-	-	1	**29**
Algae	17.0-34.2	32.9	15.5-17.5	22.1	19.1	18.1-20.9	7.0-16.8	3.5-11.3	1.2-3.1	0.1	-
Encrusting invertebrates	5.8-9.7	7.0	12.5-15.0	14.6	4.9	1.4-2.7	4.2-14.1	1.7-3.0	5.7-8.0	1.1	1.4
Sessile invertebrates	8.7-12.2	13.4	7.1-10.1	14.8	24.8	12.5-30.0	3.6-11.1	1.3-1.5	2.9-3.2	31.7	12.6
Motile invertebrates	1.1-8.7	1.5	3.5-4.9	10.1	12.0	6.1-9.6	2.9-6.6	2.4-4.5	4.0-5.8	5.8	6.7
Fish	0.1-0.4	0.3	0.2-0.4	1.6	2.3	0.6-0.8	0.1-0.5	0.1-0.1	0.1-0.1	0.6	0.2
Total	37.1-65.1	55.0	38.7-47.8	63.3	63.2	38.9-63.8	19.4-49.2	9.0-20.4	14.0-19.6	39.3	20.9

4.0 DISCUSSION

4.1 Overview

Baseline monitoring of the soft-bottom benthic communities began in 1992 and will continue at least through 1998, thus providing a substantial database from which to characterize the dynamics of the physical environment and patterns of change in the benthic communities. Information content has been improved since 1992, including determination of sediment phi classes instead of simple sand-silt-clay percentages, thereby providing a finer scale of understanding of the sedimentary environment. In addition, taxonomic identification of the species comprising the benthic communities was refined and expanded in 1996 to include identification of juveniles of several polychaete and mollusc species, providing both a greater understanding of the species richness of the fauna and of the biological events contributing to the apparent dominance of a particular species. This level of discrimination needs to be maintained in the future in order to preclude misinterpretation of apparent changes in the benthic communities.

The sedimentary environment in the immediate vicinity of the outfall has been shown to be complex both physically and biologically, thus precluding a simple statistical comparison of pre- and post-discharge conditions. The diffuser or terminus of the outfall is situated in a hard-bottom environment that consists of drumlins alternating with swales or hollows. Much of the area immediately adjacent to the diffuser is a rocky habitat where pockets of sediment or depositional areas are rare. The soft-bottom study area lies mostly to the west of the diffuser, and grades westerly from sediments consisting primarily of sand to a finer-grained depositional area. Studies using the sediment profile camera and particle traps have revealed that sediment movement and deposition are dynamic processes throughout much of the nearfield study area. Because of these shifts in sediment cover, the benthic faunal assemblages are not entirely consistent from year to year and some stations exhibit wide swings in dominance of benthic species.

The MWRA is considering several hypotheses as a means to assess the impacts of sewage discharge in Massachusetts Bay. These hypotheses are:

1:*The average depth of oxygen penetration into nearfield and midfield soft-sediment habitats (as estimated by visual RPD measurements) will not decrease to half that measured during baseline monitoring.*

2:*Average concentrations of toxic contaminants in nearfield sediments will not increase to 90% of available EPA sediment quality criteria. For contaminants without EPA criteria, average concentrations will not increase to 90% of suggested PEL or NOAA ER-M guidelines, whichever is lower for a given contaminant.*

3:*Species abundance and diversity patterns measured in sediments 2-8 km (midfield stations) from the outfall will not appreciably depart from those measured during the baseline period.*

4:*Opportunistic taxa will not increase in midfield stations to 25% of the organisms present.*

A companion project is currently underway to develop tests for these hypotheses. A series of possible benthic indices are being developed using diversity comparison, functional group analysis, and multivariate analysis. These tests will be used to provide early warning of deleterious outfall effects.

4.2 Spatial and Temporal Trends in Sediment Texture, TOC, and *Clostridium*

The 1997 sediment profile imaging survey corroborated the surveys taken in 1992 and 1995 that defined clear kinetic boundaries between sedimentary regimes in the nearfield and midfield and indicated that sediment movement and deposition are dynamic processes throughout much of the study area (Blake, *et al.*, 1993; Hilbig *et al.*, 1996). As an example, images showing sand overlying mud have been obtained each year at several stations but the exact stations exhibiting this parameter have changed from year to year. Of the stations that have been surveyed three times, sand-over-mud stratigraphy was present only once at station MF7 (1992), twice at stations MF8, MF9, and MF10, and for all three years at stations MF12 and MF16. Such shifts in sediment cover alter the type of sediment available to the benthic infauna and to some degree can account for faunal differences seen from year to year.

Sediments from stations in the nearfield (within 2 km of the outfall) are usually coarser-grained than those collected in the midfield (2-8 km from the outfall). During the last three years, the mean phi at all nearfield stations except NF24 has been less than 3, whereas a mean phi of less than 3 has been seen in the midfield at only three stations, MF2 (1995, 1997), MF4 (1995, 1996, 1997), and MF20 (1997) (Hilbig, *et al.*, 1996; Blake, *et al.*, 1998). All samples from the seven sandy and gravelly nearfield stations and most samples from MF2, MF4, and MF20 cluster near the upper apex of the sand and gravel/silt/ clay tertiary diagram; the exception is the outlier representing the 1992 MF2 sample (Figure 54). Samples from the remaining midfield stations are aligned along the right-hand side of the tertiary diagram (indicating a low percentage of clay) and range from the sandy stations at the upper apex to silty stations MF8, MF12, and MF21 on the lower right.

In the nearfield, sediments from most stations were slightly finer (higher mean phi) in 1997 than they were in 1996. For example, sediments from nearfield stations NF13, NF14, and NF18 showed significantly lower amounts of gravel in 1997 compared to 1996, returning to levels seen in 1995. Nonetheless, the sediment texture at nearfield stations has exhibited great consistency over time. Station NF17 has been one of the most consistent over time in terms of sediment texture (Figure 55); this station is also one of the sandiest, with sediments containing more than 98% total sand in all years sampled. In the nearfield tertiary diagram (Figure 54) seven nearfield stations cluster together, for all six years of data, near the upper apex that is indicative of higher percentages of sand and gravel. Even samples from NF18, relocated in 1994 to a location 100m west of the 1992 position to avoid a rocky bottom, cluster together. The eighth station, NF24, has sediments that are consistently finer than those from the other nearfield stations, containing more than 65% silt/clay for all four years they have been sampled. NF24 samples collected in 1994, 1996, and 1997 cluster together in the nearfield tertiary diagram (Figure 54). However, 1995 was an anomalous year for station NF24 when sediments contained nearly 73% clay (Hilbig, *et al.*, 1996), a feature clearly seen in Figures 54 and 55.

In the midfield, between 1996 and 1997 only small changes, with no evident pattern, were seen (one of the most obvious was the disappearance of gravel at MF21 (Figure 55). Changes also occurred at sandy stations MF16 (less sand, more silt) and MF20 (more sand, less silt) and at silty stations MF 8 (more sand, less silt), and FF13 (less sand, more silt). Over the last six years, sediment texture at most midfield stations has been fairly consistent. The sandy sediments at MF2 and MF4, in particular, have been very

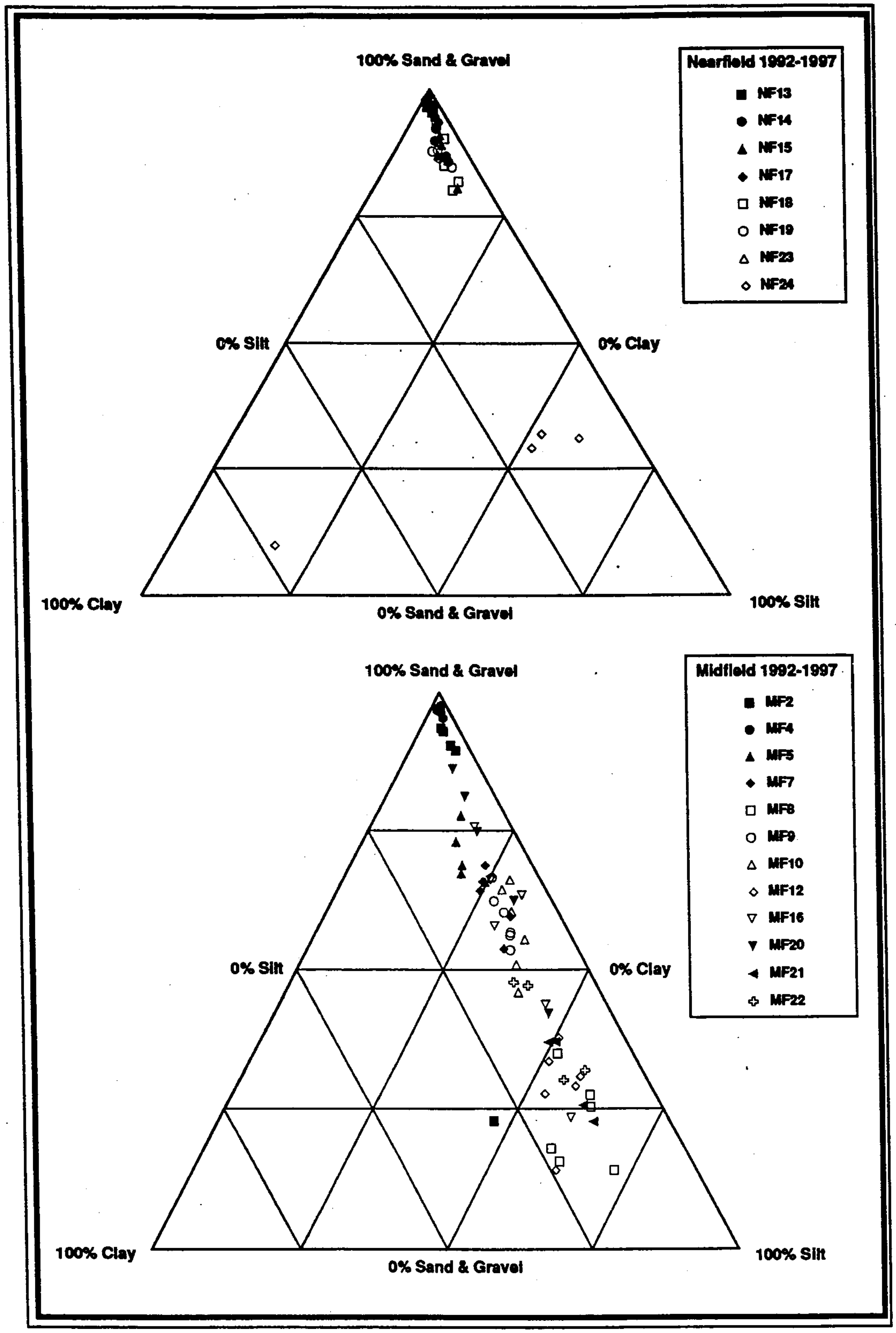


Figure 54. Sand/gravel/mud tertiary diagrams showing relative sediment composition at nearfield and midfield stations for 1992-1997 (FF10, FF12, and FF13 included as part of Fig. 57).

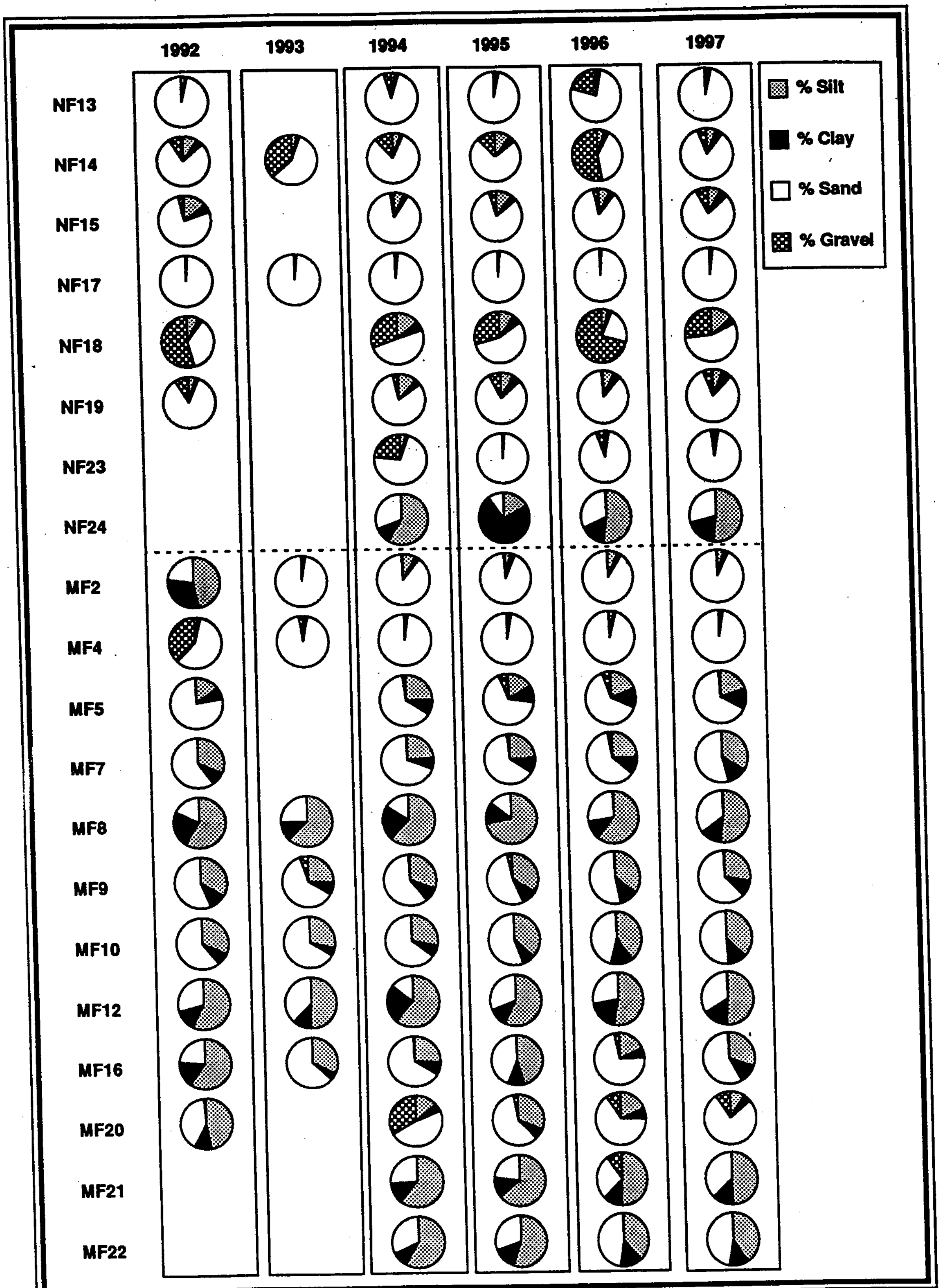


Figure 55. Sediment composition at nearfield and midfield stations for the period 1992-1997 (FF10, FF12, and FF13 included as part of Fig. 56).

constant (phi<3) since 1993, but quite different from the initial sediment texture recorded in 1992. The change in MF4 between 1992 and 1993 is explained by the relocation of the station location to a position 188 m west of the original position for the purpose of avoiding a rocky bottom (Coats, 1995b). This purpose was successfully achieved and the remaining five years of samples have been invariably sandy with little or no gravel present. There is no similar explanation for MF2, but an intense storm in December 1992 might suggest another explanation. Other anomalous differences in sediment texture include the large amount of gravel found in sediments from MF20 in 1994 and from FF13 in 1992. Although year-to-year changes in sediment texture at midfield stations have for the most part been fairly evenly divided between increases and decreases in mean phi, sediments from FF13 have become finer (increase in mean phi) every year, with gravel present in 1993 and an increasing percentage of sand every year thereafter (Figure 56). The three stations that fall along the southern and western edges of the midfield area, FF10, FF12, and FF13 are intermediate in sediment texture between the two farfield stations with the coarsest sediments and the remaining six with silty sediments, falling along the upper portion of the right-hand edge of the farfield tertiary diagram (Figure 57).

Patterns of sediment texture at the eight farfield stations have been very consistent over time (Figure 56). From 1996 to 1997, stations FF1A and FF9 continued to have the coarsest sediments (phi<4.0). Of the three stations with the siltiest sediments in 1996 (phi>6.0), sediments from two, FF4 and FF7, became slightly finer in 1997, while sediment from one, FF11, became slightly less fine (i.e. less clay). Sediments from stations FF5, FF6, and FF14 remained intermediate in texture. These patterns have also been quite consistent over the six-year time period studied. Samples from sandy station FF9 have shown remarkable agreement and cluster quite tightly in the upper triangle of the tertiary diagram (Figure 57). Samples from sandy station FF1A are less tightly clustered but all are in the upper half of the diagram. All mean values (lowest value recorded was 73% in one replicate) determined from silty station FF4 fall within the lowest portion of the tertiary diagram (more than >75% silt and clay). For silty stations FF7, FF11, and FF14, mean sample values for five of the six sampling years fall within the more than >75% silt and clay portion of the tertiary diagram. For these three stations the sandiest samples were all collected in 1993 (Figure 56). Sediments from stations FF5 and FF6 have been intermediate in texture and most mean values fall within the 50-75% silt and clay portion of the tertiary diagram; sediments from both stations were somewhat sandier (>50% sand) in 1993, while in 1995 sediments from station FF7 were siltier (Figure 56).

Values of total organic carbon (TOC) in the nearfield and midfield ranged from very low (<0.1%) to just over 3.1% at MF8 in 1992 (MF8 replicates in 1993 were 1.8 and 4.1%). Values for *Clostridium* spore counts ranged from very low (<100 counts per gram dry weight of sediments, e.g. NF17 in 1996) to a high of 17,000 at stations NF24 and FF13 in 1995.

Patterns in concentration of (TOC) and *Clostridium* spore counts when comparing stations and years in the nearfield and midfield are very similar to each other (Figures 58 and 59) and are often clearly related to the amount of silt and clay found in the samples. In general, the seven sandy nearfield stations show low values of TOC and *Clostridium.* Muddy station NF24 shows a peak in TOC and *Clostridium* in 1995, the anomalous year when sediments from NF24 contained more than 75% clay. The shift from fine to coarse sediments at station MF2 resulted in significantly lower concentrations of TOC and *Clostridium* after the peak seen in 1992. The other two midfield stations (MF4 and MF20) with samples yielding a mean phi <3 also show low values of TOC and *Clostridium.* Highest values of TOC and *Clostridium* at MF20 occurred in 1992, the year when total silt and clay at that station was highest (>50%). Consistently silty stations such as MF8, MF12, MF21, and MF22 show consistent values in TOC and *Clostridium,* with some exceptions, such as a very low value for *Clostridium* at MF8 in 1995

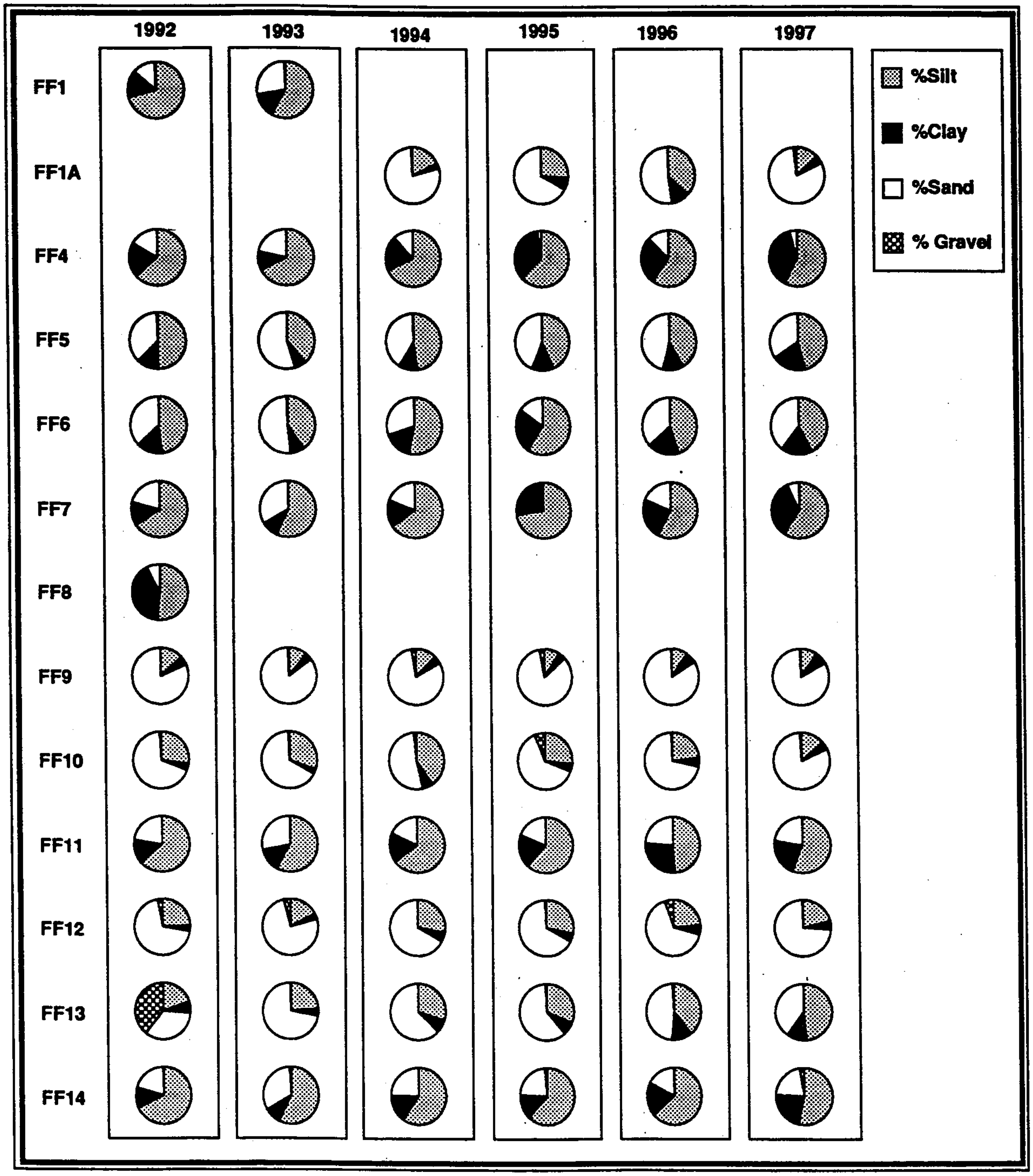


Figure 56. Sediment composition at farfield stations for the period 1992-1997.

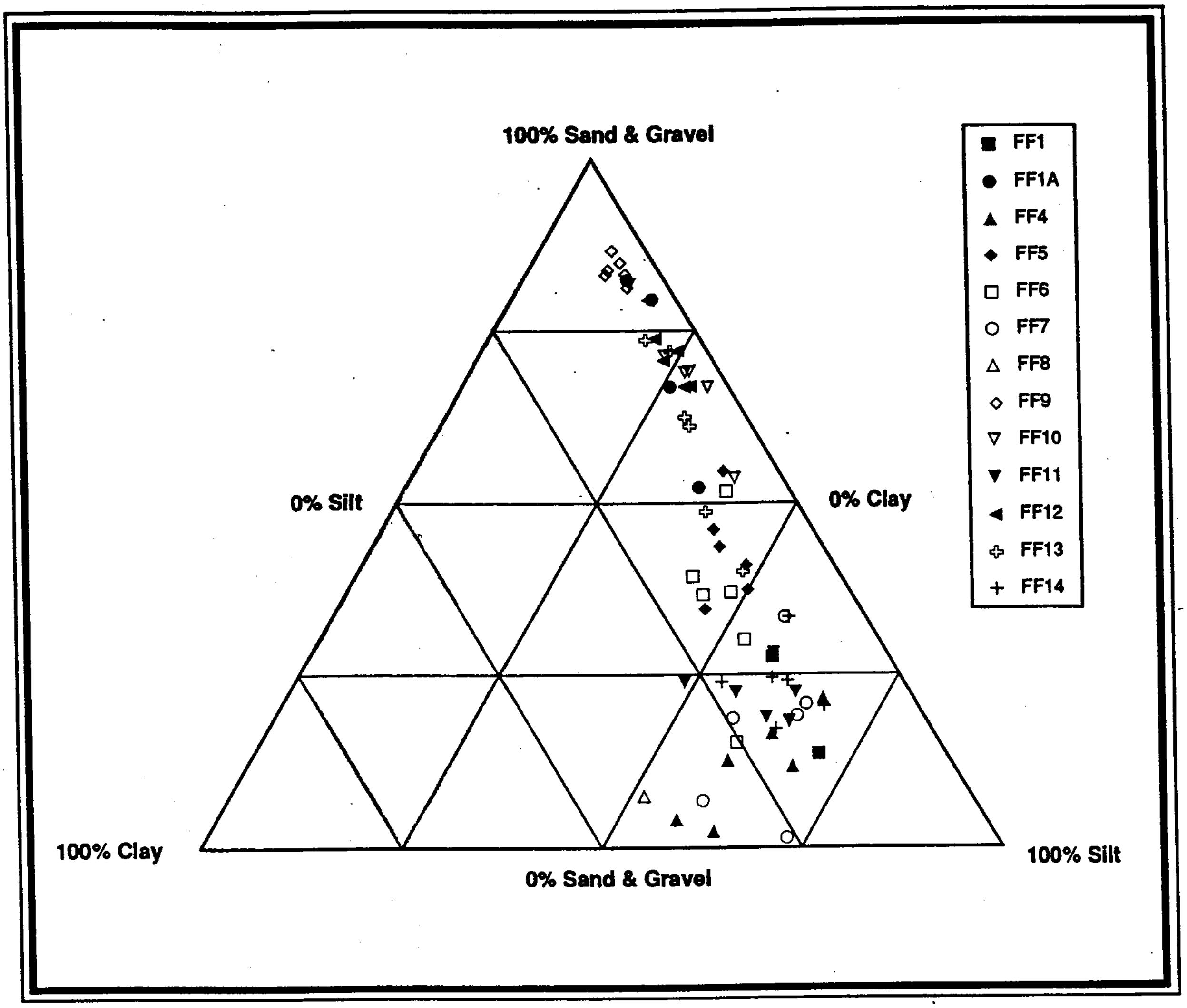


Figure 57. Sand/silt/clay tertiary diagram showing relative sediment composition at farfield stations for the period 1992-1997.

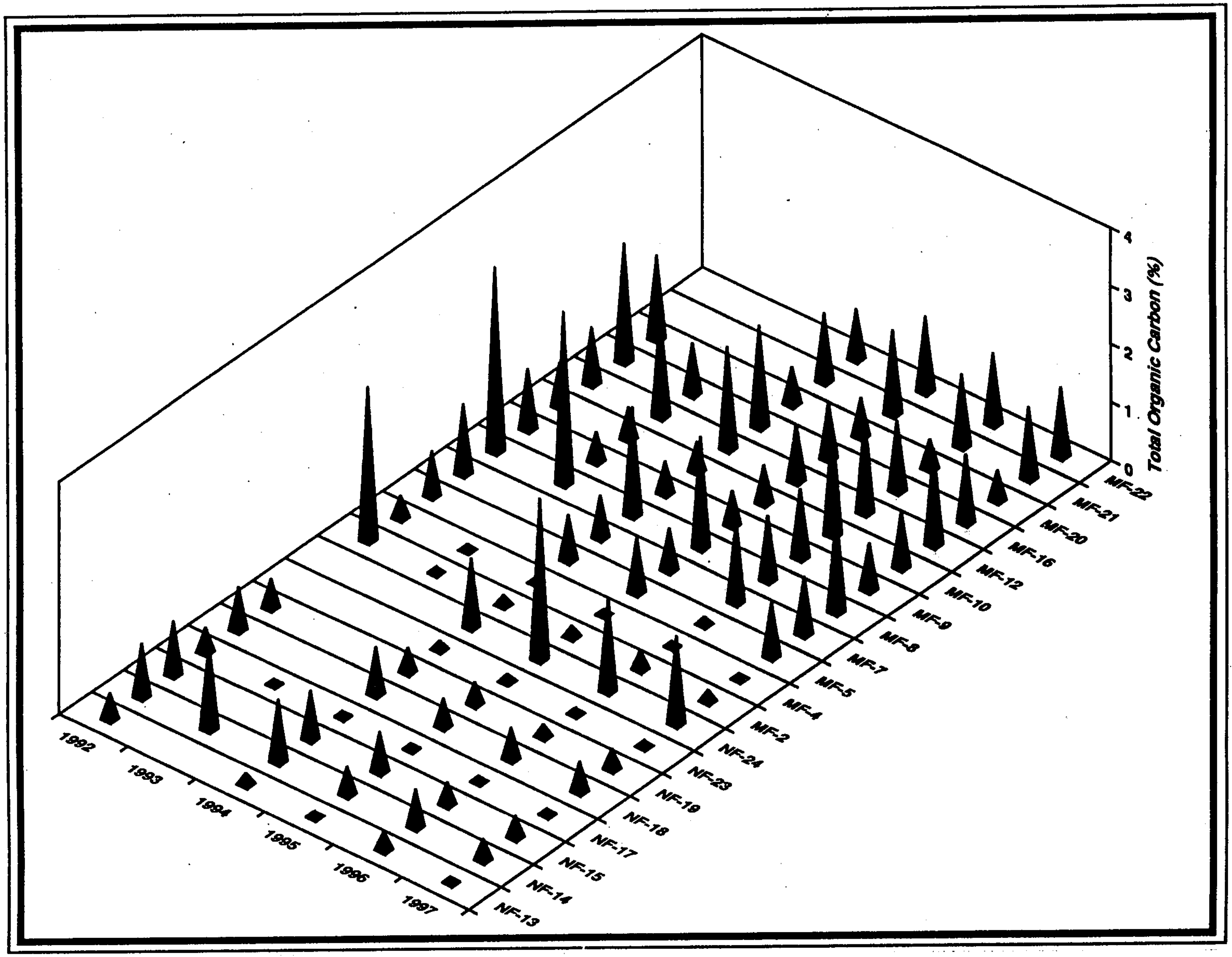


Figure 58. Total organic carbon concentrations at nearfield and midfield stations for the period 1992-1997 (see Figure 60 for the FF10, FF12, and FF13).

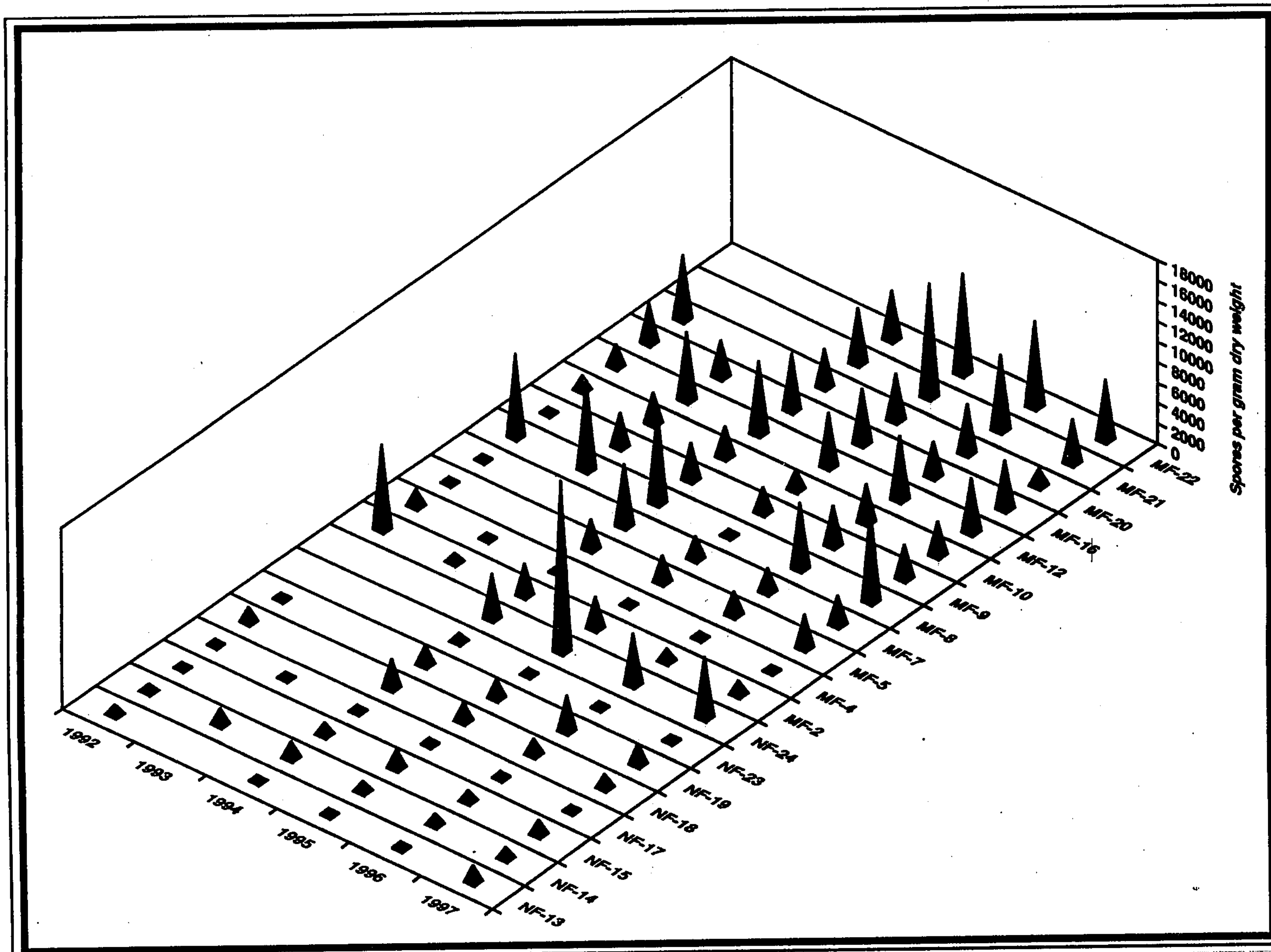


Figure 59. Densities of *Clostridium perfringens* spores at the nearfield and midfield stations for the period 1992-1996 (see Figure 61 for the FF10, FF12, and FF13).

when total silt and clay was quite high. Sandy stations FF10 and FF12 on the western edge of the midfield have fairly low to moderate values for TOC and *Clostridium* (Figure 60). Station FF13 on the southern edge of the midfield had an anomalously high peak in *Clostridium* spore count in 1995 (Figure 61), of the same order of magnitude as that seen at NF24 but without a concomitant increase in percent clay in the sediments.

Levels of TOC and *Clostridium* are low at all farfield stations (Figures 60 and 61). For the last six years, highest levels of TOC have been seen consistently at silty stations FF4 and FF7 (2.5% at both stations in 1997). Station FF4 also shows some small peaks in *Clostridium* spore count in years 1995 through 1997, when total silt and clay was very high. *Clostridium* spore counts in the farfield ranged from a low of 150 counts per gram dry weight sediment at Cape Cod Bay station FF7 in 1992 to a station mean of 4100 at station FF4 in Stellwagen Basin in 1997. The two Cape Cod Bay stations are indistinguishable from the six Massachusetts Bay stations in terms of these parameters and all stations are generally similar over time.

Sediment profile analysis of stations within the nearfield and midfield area, in conjunction with results from testing sediments collected at those stations for grain size, total organic carbon, and *Clostridium* spores, defines four general clusters of stations. Most nearfield stations consist of fine rippled sands that contain low levels of organic carbon and *Clostridium.* The exception is NF24, a station subjected to less current scour, with finer sediments and higher levels of organic carbon and *Clostridium* spores. Ripples and sand-over mud stratigraphy present at midfield stations near the diffuser provide evidence of changing kinetic energy regimes at the boundary between the nearfield and midfield. Stations in this transitional area experience the greatest temporal and spatial variance in sedimentological and faunal properties. Sediments from midfield stations west, north, and south of the transitional area are relatively soft muddy sands with levels of organic carbon and *Clostridium* spores that are variable but generally directly related to the amount of silt and clay present.

Given these generalizations, will monitoring these sedimentological parameters at these stations be sufficient to detect changes related to increased POC loading from the effluent diffuser? Further, what is the threshold of organic loading that would be expected to result in major changes in benthic structure and processes? How would these changes differentially affect the general facies patterns seen in the nearfield and midfield region? An analysis of organic loading and benthic responses (detailed in Appendix H) predicts that the existing baseline data and sampling station arrays are sufficient to document expected changes in benthic faunal structure, sedimentation rates of fine-grained organic detritus, TOC, and geochemical processes.

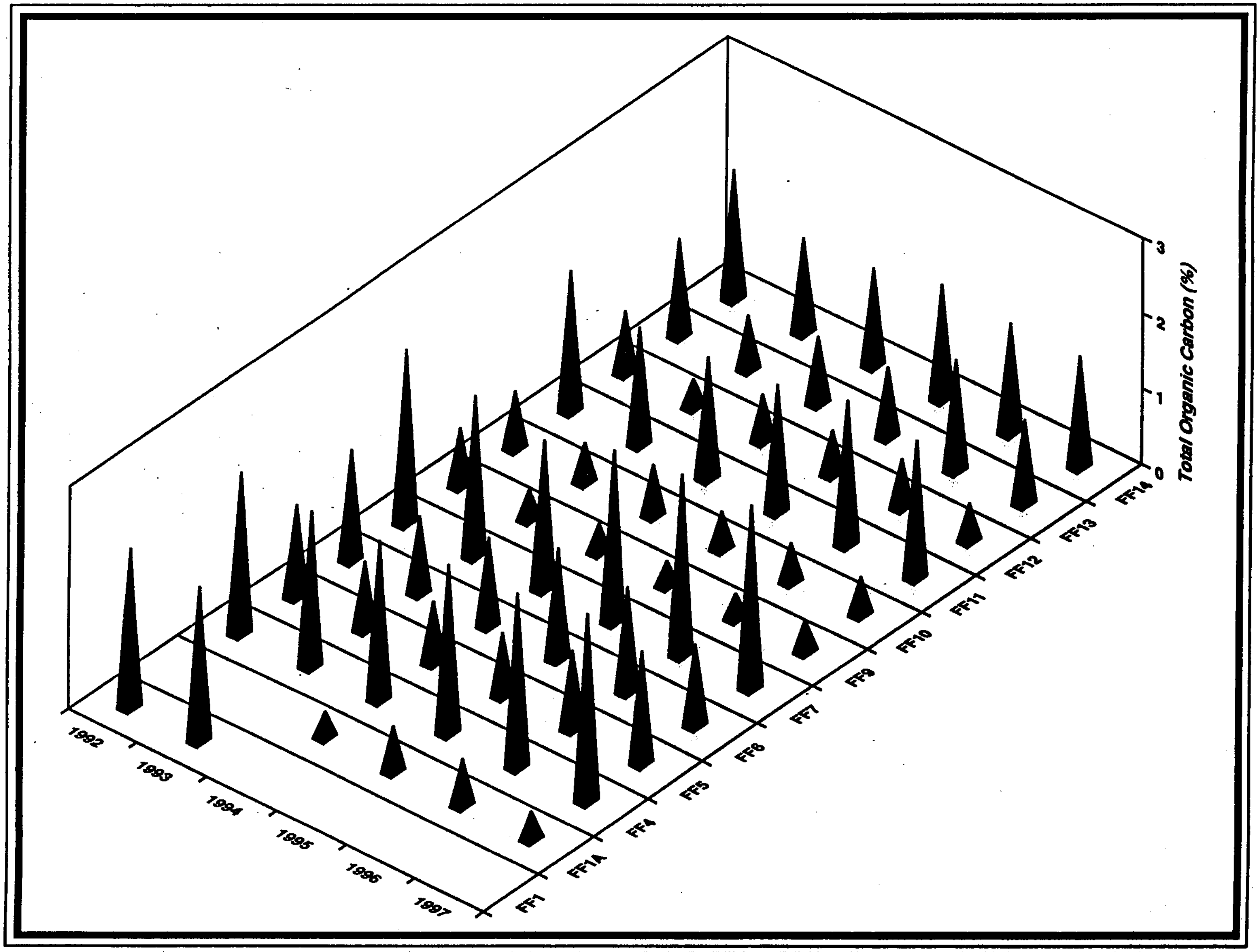


Figure 60. Total organic carbon concentrations at farfield stations for the period 1992-1997).

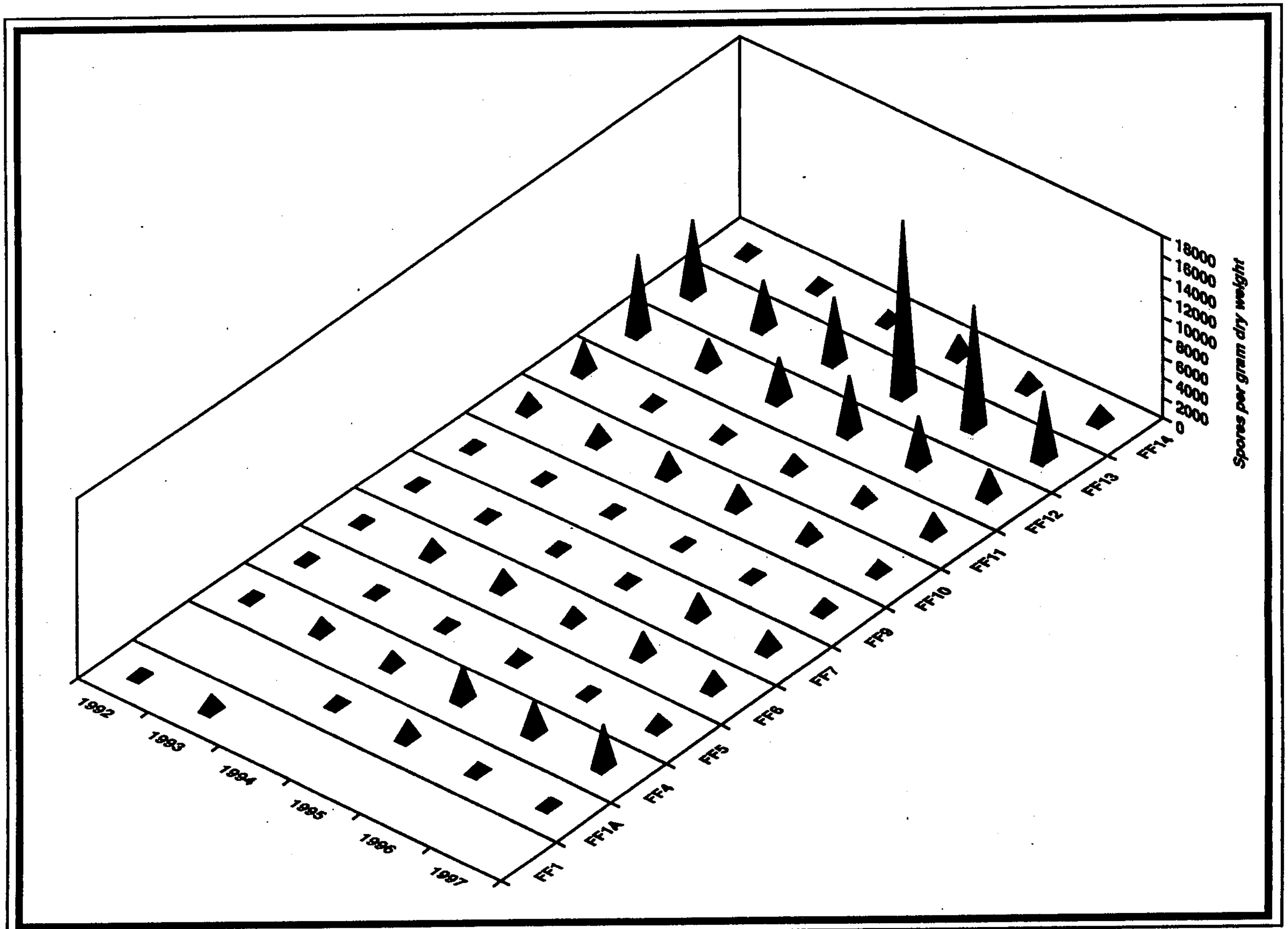


Figure 61. Densities of *Clostridium perfringens* spores at farfield stations for the period 1992-1997.

4.3 Spatial and Temporal Trends in Benthic Infauna

4.3.1 Nearfield and Midfield

The nearfield sampling array consists of eight stations and the midfield of 15 stations that are sampled annually with 0.04-m^2 grabs. Of these 23 stations, 17 are single, non-replicated samples and six stations are replicated with three samples each providing data on within-station variability as well as comparability with the farfield station array.

Benthic Faunal Assemblages. The results of community analysis of the nearfield stations suggests that, except for station NF24, the fauna is dominated by species that prefer sediments with a higher percentage of sand, whereas those in the midfield prefer higher percentages of silt and clay. The combined 1992-1997 results as well as those for 1997 alone support this observation. The year-to-year results presented in previous annual reports indicate that some stations, especially those transitional between nearfield and midfield may shift between sand and silt due to sediment transport events probably related to storm surge. Thus, a pattern emerges where one can characterize the benthic communities into a distinct sand assemblage and one or more silt assemblages. The latter are more variable.

In order to develop an index to monitor effects of the outfall, it will be important to determine how consistent this pattern is from year-to-year and whether the same species characterize the sand and mud assemblages. To test for consistency, a separate multivariate analyses using the 1992-1996 data has been developed that can be compared with that for 1997. These results are presented using metric scaling of CNESS distances to compare clusters, Euclidean distance biplots to show the importance of contributing species, and Gabriel covariance biplots to show the faunal assemblages (Figures 62-64). The comparison is limited to axes 1 and 2 as they contribute to most of the variance.

The station clusters and species ordination results for the 1992-1996 analysis are shown in Figure 62. The husks that link the clusters (Figure 62A) clearly show two separate station groupings. The smaller group of clusters on the left are nearfield stations that compose the sand assemblage. The larger group on the right are those stations that compose the mud assemblage(s). Thus, there is a very distinct separation that is clearly depicted in the graphical PCA-H outputs. The contribution of species to these clusters is shown in Figure 62B. The corophiid amphipod *Crassicorophium crassicorne* and the syllid polychaete *Exogone hebes* were the most important species in the historical samples characterizing the sandy assemblage. The other clusters are more complex. At the opposite side of the diagram a suite of six polychaetes, *Leitoscoloplos acutus, Mediomastus californiensis, Prionospio steenstrupi, Monticellina baptisteae, Ninoe nigripes,* and *Aphelochaeta marioni* characterize the mud assemblage. Species such as *Exogone verugera* and *Dipolydora socialis* prefer mixed sediments and their position on the graphic is thus intermediate between the two main assemblages with the more acute angles indicating affinities with both extremes.

The station clusters and species ordination for the 1997 samples are shown in Figure 63. Again, the husks that join the clusters (Figure 63A) show a clear separation into two main groupings. The smaller group of stations on the right of the diagram is the nearfield sand assemblage, whereas the group on the left represents the mud assemblage(s). The partitioning of the nearfield and midfield fauna into sand and mud assemblages is thus obvious again in the most current single year analysis. The contribution of species to these assemblages is shown in Figure 63B. The major contributors to the sand assemblage in 1997 were again the syllid *Exogone hebes* and the amphipod *Crassicorophium crassicorne*. However,

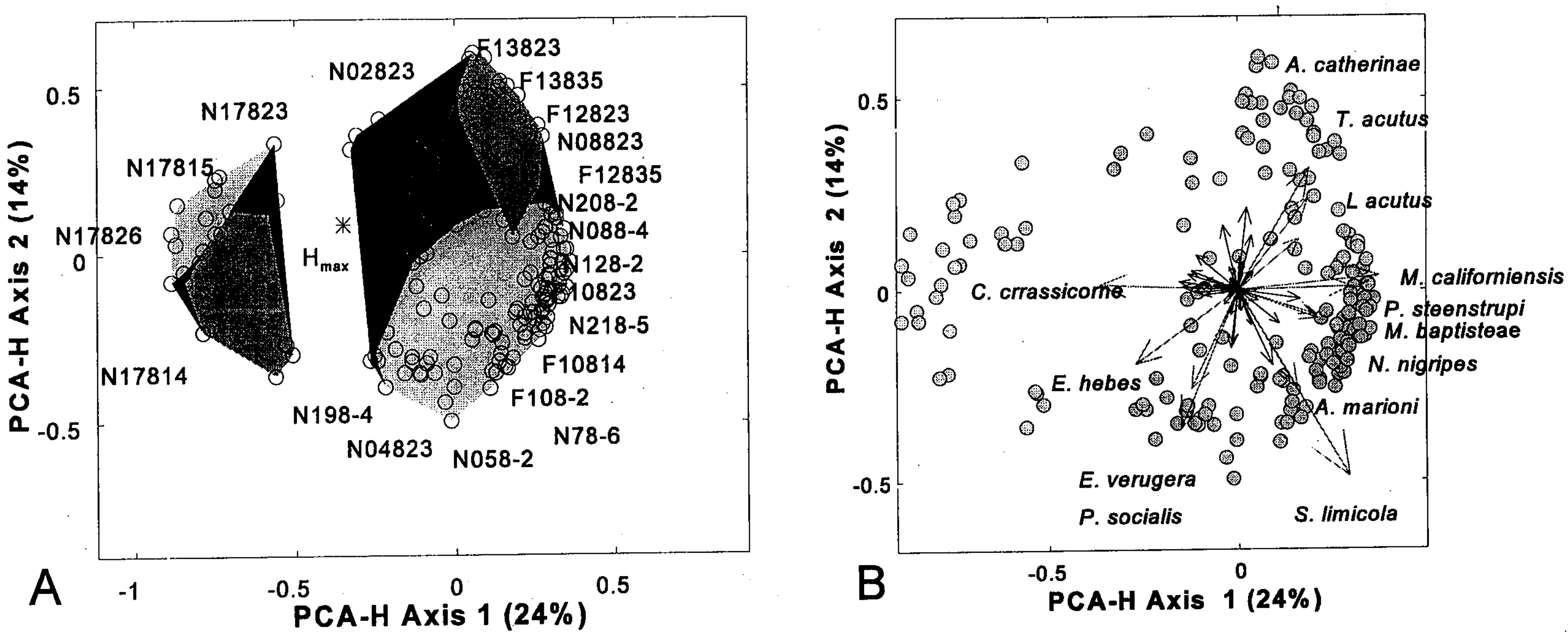


Figure 62. A, Metric scaling of CNESS (NESSm=20) distances among all 1992-1996 Massachusetts Bay nearfield and midfield samples for axes 1 and 2; B, Gabriel Euclidean distance biplot of the same stations, among axes 1 and 2.

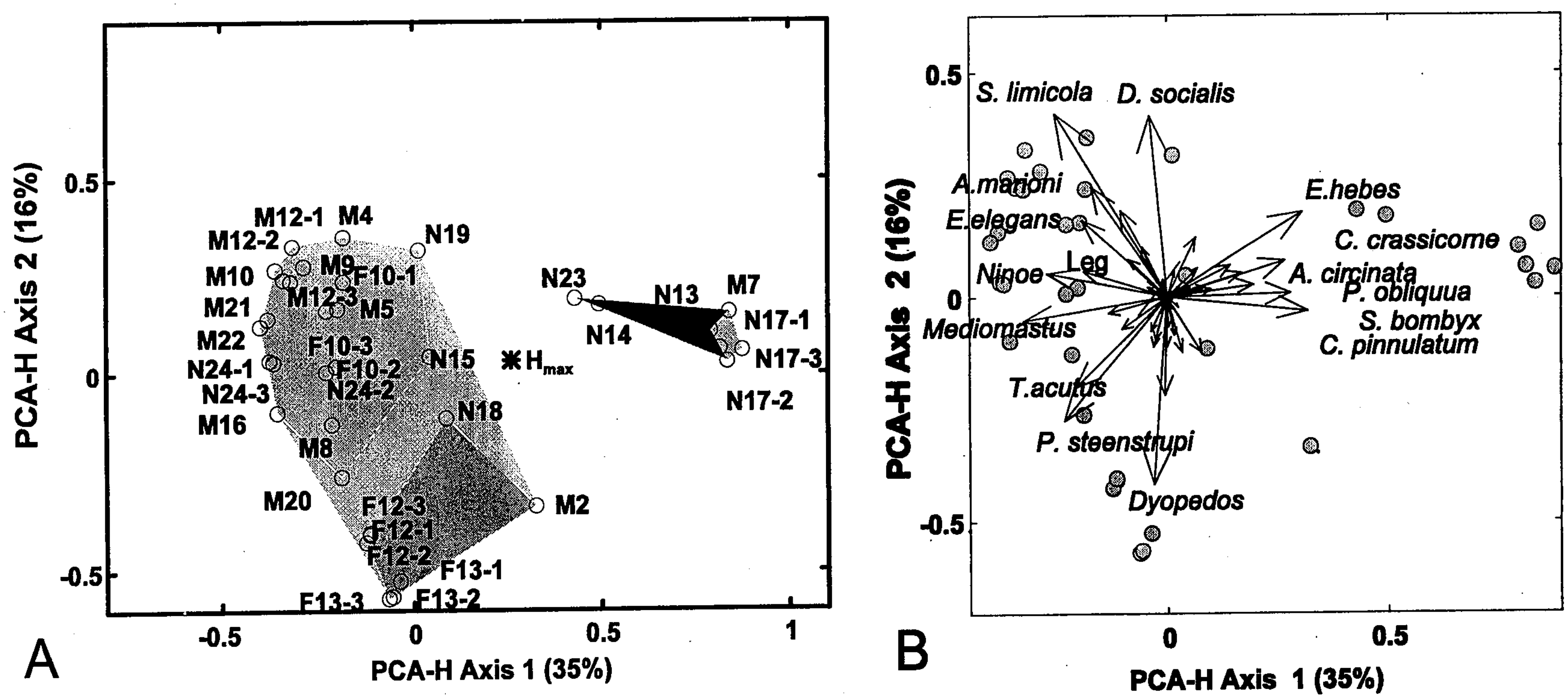


Figure 63. A, Metric scaling of CNESS (NESSm=17) distances among all 1997 Massachusetts Bay nearfield and midfield samples for axes 1 and 2; B, Gabriel Euclidean distance biplot of the same stations, among axes 1 and 2.

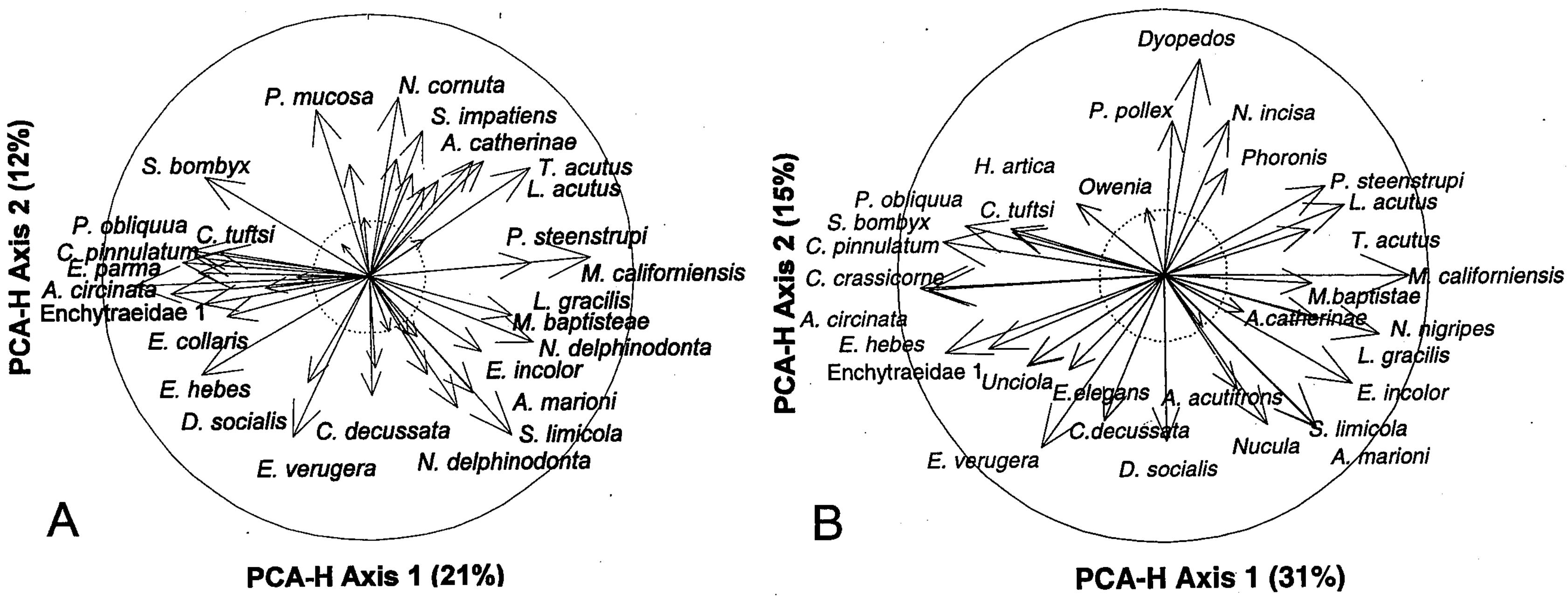


Figure 64. Gabriel covariance biplots for Massachusetts Bay nearfield and midfield samples: A, 1992-1996 combined results; B, 1997 results.

the polychaetes *Aglaophamus circinata* and *Spiophanes bombyx*, the amphipod *Pseudunciola obliquua*, and the bivalve *Cerastoderma pinnulatum* were other major contributing species in 1997. The mud assemblage was characterized by several polychaetes including *Aphelochaeta marioni, Euchone elegans, Levinsenia gracilis, Ninoe nigripes, Mediomastus californiensis*, and *Tharyx acutus*. Spionids such as *Dipolydora socialis, Spio limicola*, and *Prionospio steenstrupi* were intermediate species in mixed sediments along with the amphipod *Dyopedos monacanthus*.

A comparison of the faunal assemblages is best seen in the Gabriel covariance biplots for axes 1 and 2 that compare the multiyear 1992-1996 results with those of 1997 (Figure 64). The similarities in the main species that compose the sand fauna to the left of each figure are startling. The positions of several species are nearly identical in the two analyses and the majority of the main contributors are present in both analyses. One difference between 1997 and the multiyear analysis is the near absence of the sand dollar *Echinarachnius parma* in the 1997 analysis. Sand dollars, however, are highly motile and could have simply moved to adjacent locations.

For the mud assemblages the major contributors are also similar. Some obvious differences, however, are seen in the faunas that are intermediate between sand and mud. For example, *Nephtys cornuta* was replaced by *N. incisa* in 1997 and the amphipod *Dyopedos monacanthus* which was insignificant in the multiyear analysis was among the dominants in 1997.

In order to test the contributions of individual species between the multiyear analysis and that of 1997, their relative contributing ranks and percent contributions to PCA-H axes 1-3 were compared (Table 18). For the multiyear analysis (1992-1996), 40 species contribute to 86% of the variation in CNESS. For 1997, 34 species contribute to 91% of the same variation. The 40 species that are most important in the multiyear analysis are presented in descending order and compared to their ranks in 1997.

The ranks differ considerably and can be readily compared in Table 18. If the 1992-1996 results are taken as a long-term baseline, then differences in 1997 may be considered as an example of how the fauna of individual years differs in the relative contributions of single species. There are several important differences that are noteworthy. Among the top 10 species in the multiyear analysis, *Aricidea catherinae* (4), *Crassicorophium crassicorne* (5), and *Monticellina baptisteae* (10) fall to 14th, 15th, and 21st in the 1997 results. At least five of the top ranked multiyear species, *Nephtys cornuta* (16), *Polygordius* sp. A (17), *Dipolydora quadrilobata* (20), *Scoletoma impatiens* (24), and *Phyllodoce mucosa* (26), were not present among the most important contributors to 1997. Likewise, the amphipod *Dyopedos monacanthus* was ranked 11th in the 1997 results, but was rare in the multiyear analysis. Other species to be ranked as important contributors in 1997 but not in the multiyear analysis were *Protomedeia fasciata, Nephtys incisa*, and *Euchone elegans*.

The contributions by individual species to the variation along PCA-H axes 1-3 also differs between the multiyear and 1997 analyses. For example, the major contributors to axis 1 in the multiyear analysis were *Mediomastus californiensis* (mud), and *Crassicorophium crassicorne* (sand) whereas in the 1997 major contributors were *M. californiensis* (mud) and *Cerastoderma pinnulatum* (sand). For axis 2, *Spio limicola* and *Dipolydora socialis* were the greatest contributors in both the multiyear and 1997 results, but *Prionospio steenstrupi* which had <0.5% contribution in the multiyear analysis contributed 8% on axis 2 in 1997; *Aricidea catherinae* ranked 3rd in axis 2 for the multiyear analysis but was not an important contributor in 1997. Axis 3 showed less variation between the analyses.

Table 18. Comparative Ranks of Species Contributing the Most Variation to CNESS Distances in the 1992-1996 Analysis and the 1997 Analysis Alone.

Species	1992-1996				1997			
	Rank	Axis 1	Axis 2	Axis 3	Rank	Axis 1	Axis 2	Axis 3
Spio limicola	1	9	24	0	1	6	17	0
Dipolydora socialis	2	2	13	16	2	0	16	21
Prionospio steenstrupi	3	9	0	3	4	5	8	7
Aricidea catherinae	4	3	10	2	14	1	1	0
Crassicorophium crassicorne	5	14	0	7	15	7	1	1
Mediomastus californiensis	6	14	0	1	7	10	0	1
Exogone hebes	7	7	4	0	3	9	4	3
Tharyx acutus	8	3	6	3	6	4	4	1
Aphelochaeta marioni	9	2	7	3	16	3	6	0
Monticellina baptisteae	10	4	0	6	21	2	0	4
Exogone verugera	11	1	7	1	23	0	2	3
Ninoe nigripes	12	4	1	4	9	7	0	6
Hiatella arctica	13	1	0	4	20	1	2	1
Nucula delphinodonta	14	1	4	0	19	1	4	0
Levinsenia gracilis	15	3	0	9	13	3	0	6
Nephtys cornuta	16	0	5	5	NR	0	0	0
Polygordius sp. A	17	2	0	2	NR	0	0	0
Crenella decussata	18	0	2	1	34	0	0	1
Leitoscoloplos acutus	19	3	2	0	28	1	0	1
Dipolydora quadrilobata	20	0	2	4	NR	0	0	0
Owenia fusiformis	21	0	0	0	10	0	1	0
Unciola inermis	22	2	2	1	25	1	0	2
Euchone incolor	23	1	1	3	17	4	3	2
Scoletoma impatiens	24	0	0	1	NR	0	0	0
Pseudunciola obliquua	25	2	2	3	12	4	0	8
Phyllodoce mucosa	26	0	0	3	NR	0	0	0
Cerastoderma pinnulatum	27	1	1	0	5	10	0	2
Tubificidae sp. 2 (Blake 1992)	28	0	0	0	30	0	0	0
Spiophanes bombyx	29	1	1	1	8	8	0	7
Asabellides oculata	30	0	0	2	NR	0	0	0
Phoronis architecta	31	0	0	1	29	0	1	1
Ampharete acutifrons	32	0	0	0	26	0	1	0
Enchytraeidae sp. 1	33	0	0	0	22	2	0	1
Photis pollex	34	0	0	2	18	0	5	8
Euclymene collaris	35	1	1	0	NR	0	0	0
Chiridotea tuftsi	36	1	1	1	27	1	0	2
Aglaophamus circinata	37	1	1	0	24	3	0	0
Eteone longa	38	0	0	0	NR	0	0	0
Pholoe minuta	39	0	0	0	NR	0	0	0
Maldane glebifex	40	0	0	0	NR	0	0	0
Dyopedos monacanthus	NR	0	0	0	11	0	17	2
Protomedeia fasciata	NR	0	0	0	31	0	0	1
Nephtys incisa	NR	0	0	0	32	0	1	1
Euchone elegans	NR	0	0	0	33	0	0	1

The results of the analysis of the combined 1992-1997 database presented in Section 3.3.3 is compared with the 1992-1996 database, the former shows more similarity to the 1997 results presented alone (see Table 13). This should be expected as single year variations are added to the database.

These results provide a means to examine the relative contribution of individual species and groups of species to the annual faunal assemblage patterns. We have demonstrated in each summary report that individual species vary in density from year to year and they do so again here (see below), but until now, there has not been a method to understand the significance of population shifts in the community structure. Despite shifts in species composition, the same basic division of the nearfield and midfield into sand and mud assemblages in maintained. These results suggest that there is no single climax community in the nearfield and midfield, rather two or three faunal assemblages that vary on an annual basis and are maintained by more or less persistent environmental and physical conditions. One could postulate that if these environmental conditions were to change, then the assemblages will be altered to something else. We already see this in a small scale at stations that are transitional between the sandy nearfield and more muddy midfield. When finer sediments are transported eastward, then the sand assemblage contracts, likewise, a higher deposition of sand to the west enlarges the extent of the sand supported fauna. Careful study of the sediment grain-size and sediment profile results coupled with PCA-H analysis of the infaunal data should provide ready explanations for any shifts in the faunal assemblages that might be observed. This is the baseline condition in the vicinity of the new outfall. Major changes in the faunal assemblages that might be attributed the effluent should be easy to detect with this type of analysis.

Densities of Dominant Species. Ten species that characterize the nearfield and midfield have been selected in order to demonstrate long-term trends in their abundance at seven stations that represent different sedimentary environments. The species include eight polychaetes, one bivalve mollusc, and one amphipod. For each of these species there are different long-term trends which support the discussion in the previous section that annual variation in assemblages can be linked to shifts in abundance and relative importance of individual species.

Prionospio steenstrupi is consistently the most abundant spionid in Massachusetts Bay yet its importance has declined in some years to a second behind *Spio limicola* (Figure 65), the other dominant spionid. Densities of *S. limicola* have historically been very high (Blake *et al.*, 1989). Among the seven stations tracked as part of this summary, the highest densities of *P. steenstrupi* were achieved in 1997, whereas *S. limicola* densities were highest in 1994. Since 1992, there has been a general trend toward increasing densities of *P. steenstrupi* compared to highly variable trends for *S. limicola*. Another spionid, *Dipolydora socialis*, exhibits even more variability in density (Figure 66A). High densities of *D. socialis* were attained in 1992 and again 1997, the current monitoring years. Part of the reason for the greater fluctuation in densities of *S. limicola* and *D. socialis* may lie with sediment preference. The multivariate analysis suggests that these species prefer mixed sediment conditions in contrast to *P. steenstrupi* with is an indicator of muddy stations. An increase in the percent of sand might lead to higher population densities of *S. limicola* and *D. socialis* at the expense of *P. steenstrupi.*

Tharyx acutus is the most abundant cirratulid polychaete in Massachusetts Bay. Densities in 1997 generally are the highest yet recorded for this species since monitoring was initiated in 1992 (Figure 66B); the only exception among the stations tested is MF9. The apparent trend of increased abundance, however, should be tempered with the likelihood that taxonomic discrimination of juveniles was greatly enhanced during the processing of the 1997 samples.

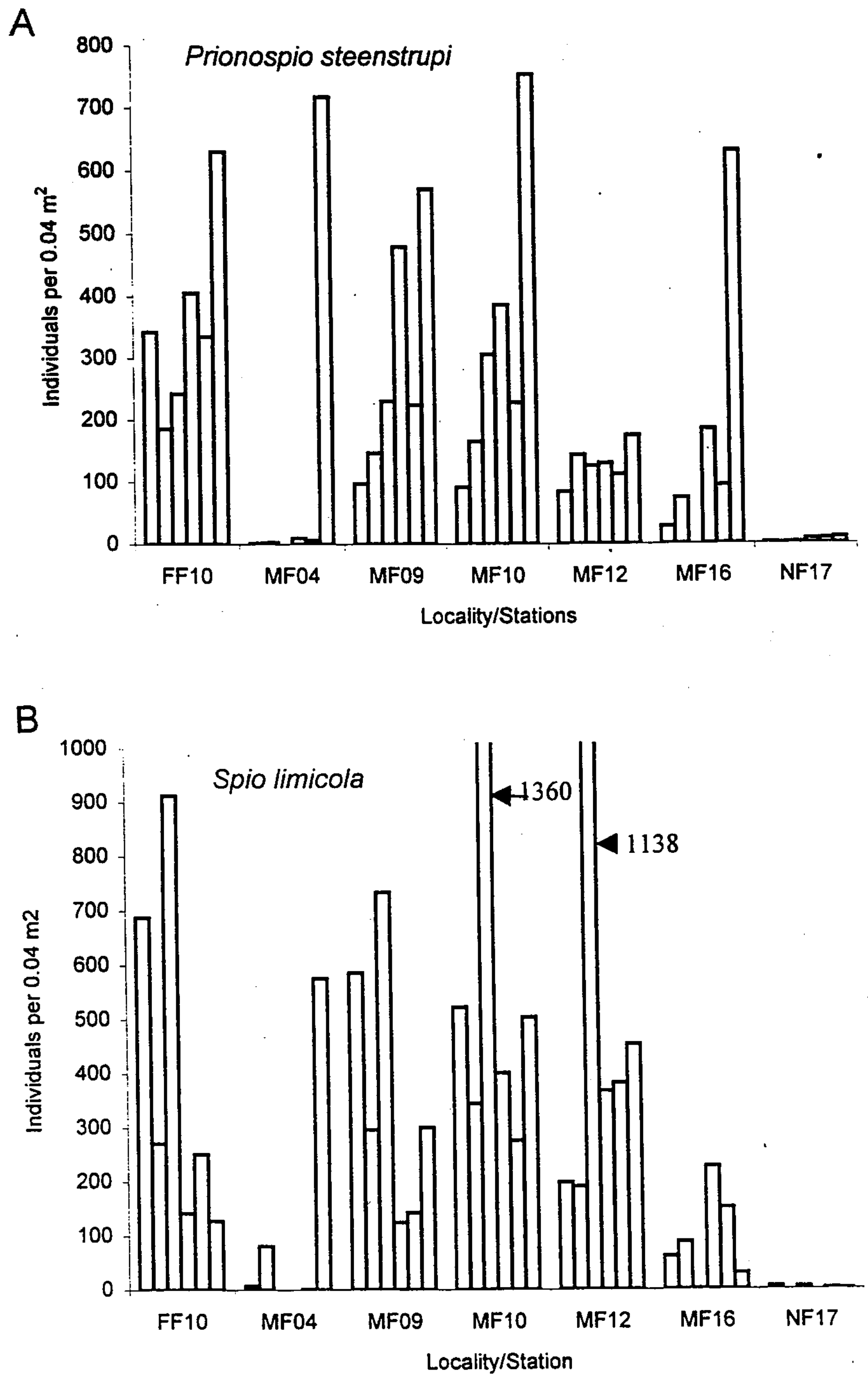


Figure 65. Relative abundances of *Prionospio steenstrupi* (A) and *Spio limicola* (B) at selected nearfield and midfield stations for the period 1992-1997.

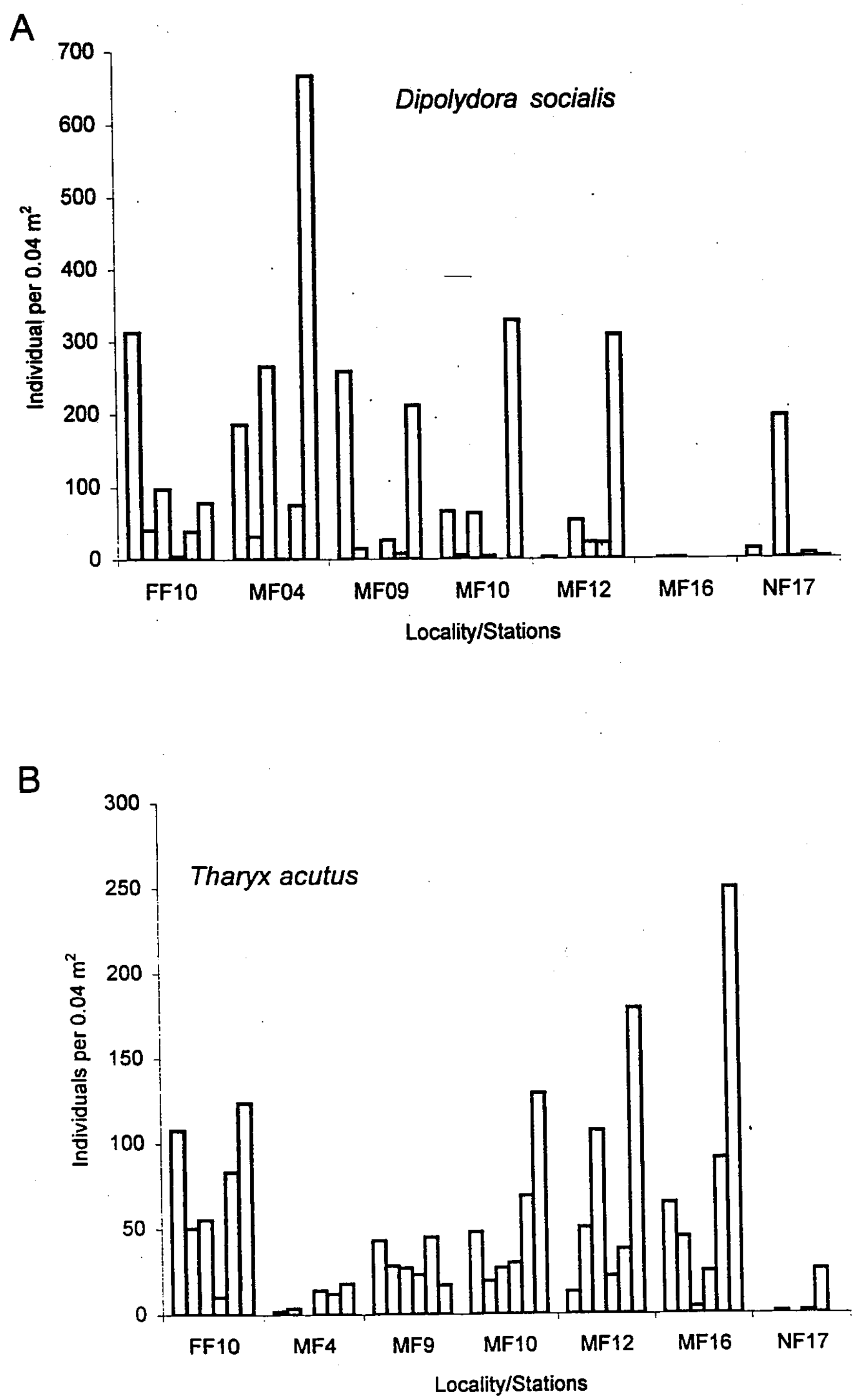


Figure 66. Relative abundances of *Dipolydora socialis* (A) and *Tharyx acutus* (B) at selected nearfield and midfield stations for the period 1992-1997.

The two syllids that characterize the sandier sediments of Massachusetts Bay are *Exogone hebes* and *E. verugera*, both small omnivorous polychaetes that are widespread in shelf sediments of the northeastern United States. In stations such as MF4 where the species is very abundant, *E. hebes* had its highest densities in 1994 (Figure 67A). *E. verugera* is more ubiquitous than *E. hebes*, occurring in high densities in mixed sediments as well as in sediments composed mostly of sand. At station M4 where both syllids occur together in high densities, the populations of *E. verugera* appear to be more consistent from year to year (Figure 67B). At other stations there was no one year in which *E. verugera* was consistently most abundant. It is likely that the species is highly sensitive to changing sedimentary conditions and shifts its populations accordingly.

Aricidea catherinae is the most important paraonid polychaete in the nearfield and midfield. The species was especially abundant in 1997 at stations FF10, MF9, MF10, and MF12, but declined at stations MF4 and MF16 since 1996 (Figure 68A). At station MF12 the species was has been consistently abundant with densities of around 200 (range = 179-274) individuals per $0.04m^2$ over the life of the program.

Mediomastus californiensis is the most abundant capitellid in Massachusetts Bay. Surprisingly, this species supports more stable year-to-year populations than the other polychaetes discussed here (Figure 68B). A notable decline occurred at four of the tested stations in 1993, but otherwise the populations have not experienced wide fluctuations.

Nucula delphinodonta, a bivalve mollusc, has experienced moderate populations swings from 1992-1997. At station FF10, the species exhibited highest densities in 1992 and 1997 (Fig. 69A). At the other stations tested the numbers of individuals were relatively low.

The amphipod *Dyopedos monacanthus* was rare at all of the tested stations until 1997 when relatively high numbers of individuals were recorded (Figure 69B). Although increased discrimination of juveniles during the identification process could account for the observed increase, it is unlikely for this species (I. Williams, in Litt.).

The population trends recorded for these ten species demonstrate again the dynamic nature of the faunal assemblages at individual stations. Station M12 can be used as an example. Over time, *Prionospio steenstrupi, Aricidea catherinae* and *Mediomastus californiensis* maintain relatively stable populations, whereas the other species are more variable. At station FF10, only *Exogone hebes* (in low densities) and *M. californiensis* maintain consistent population densities over time.

In order to fully understand the dynamics of these and other species that compose the faunal assemblages in the nearfield and midfield, more data is needed on their natural history requirements, reproduction, and timing of recruitment on an annual basis.

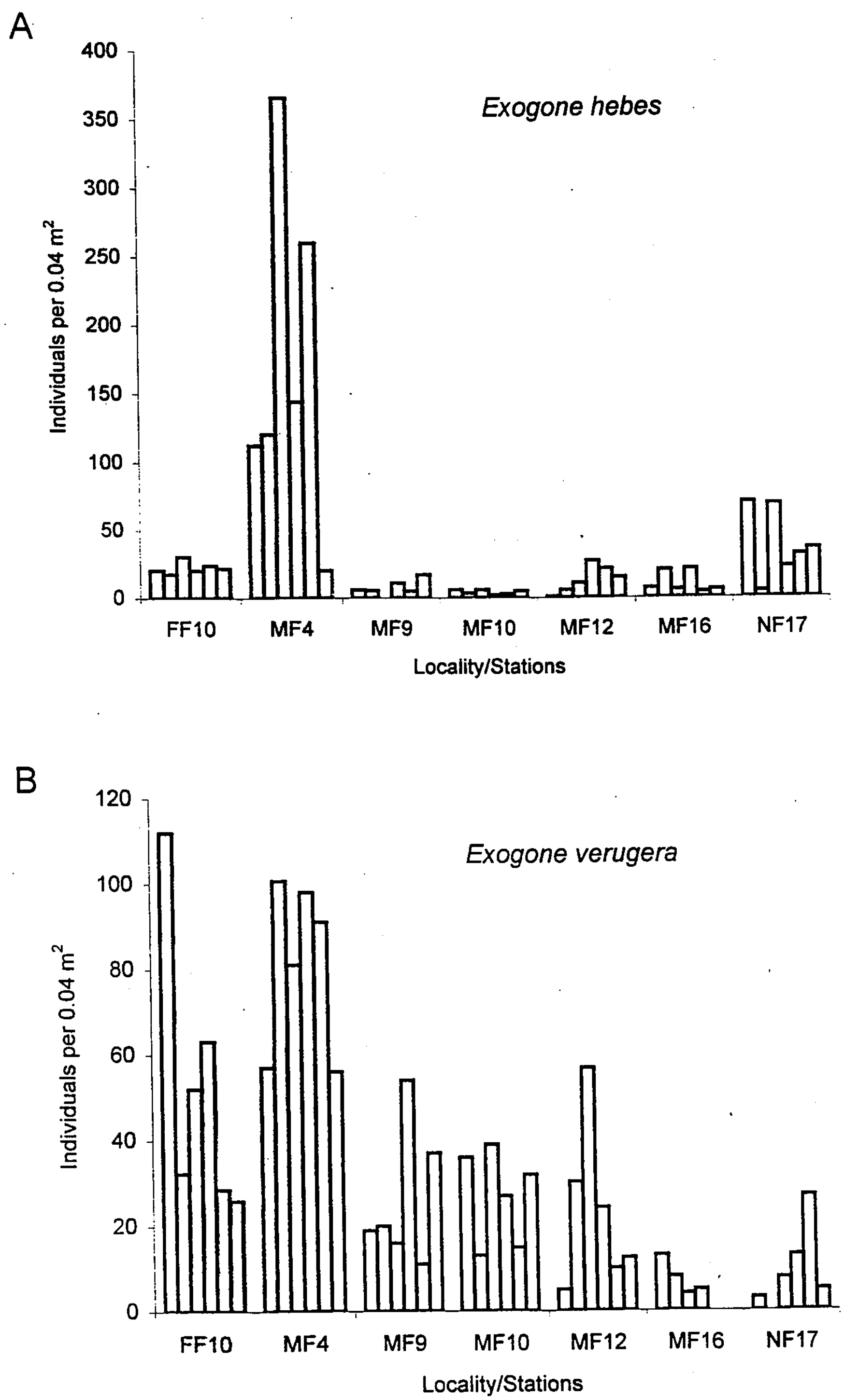


Figure 67. Relative abundances of *Exogone hebes* (A) and *Exogone verugera* (B) at selected nearfield and midfield stations for the period 1992-1997.

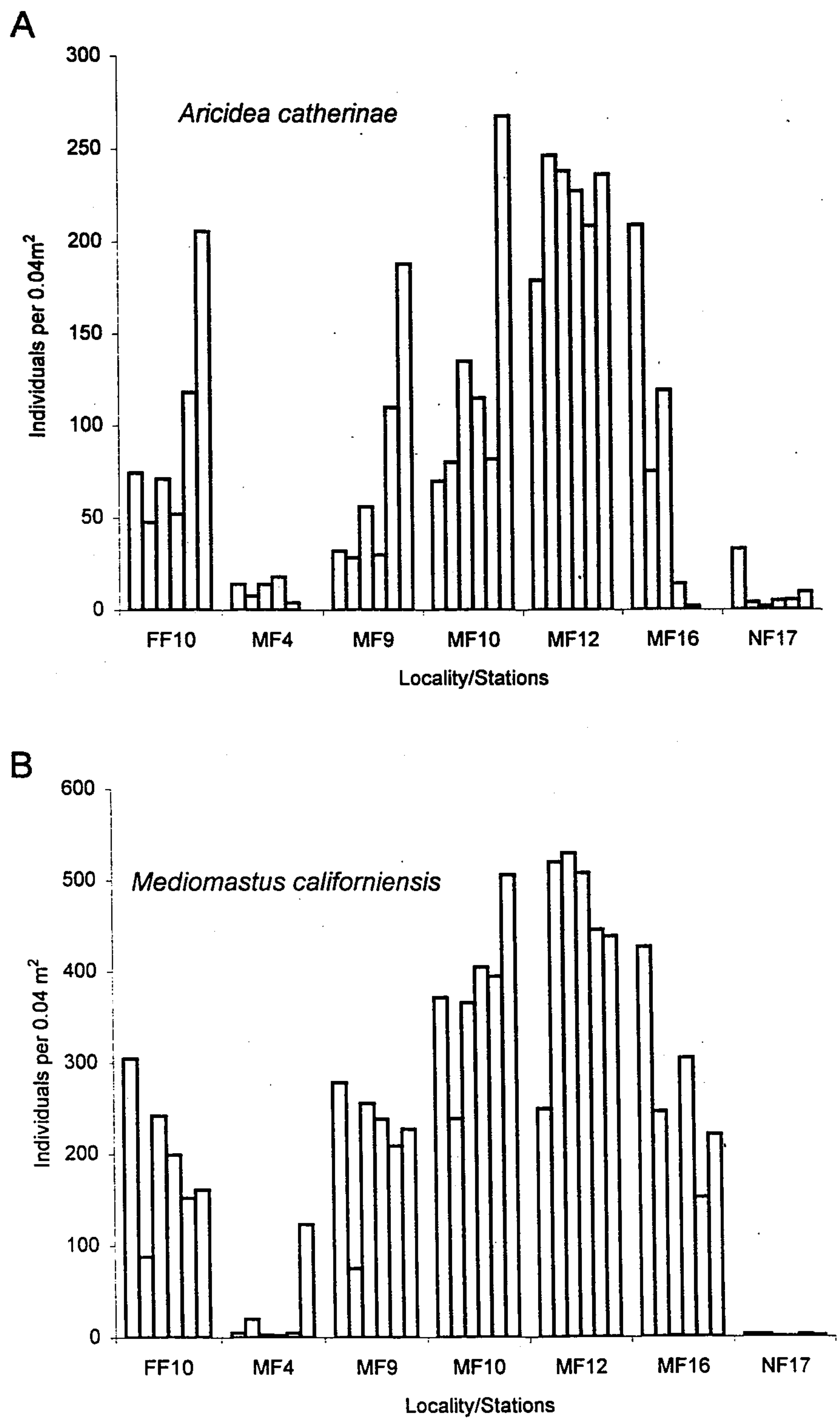
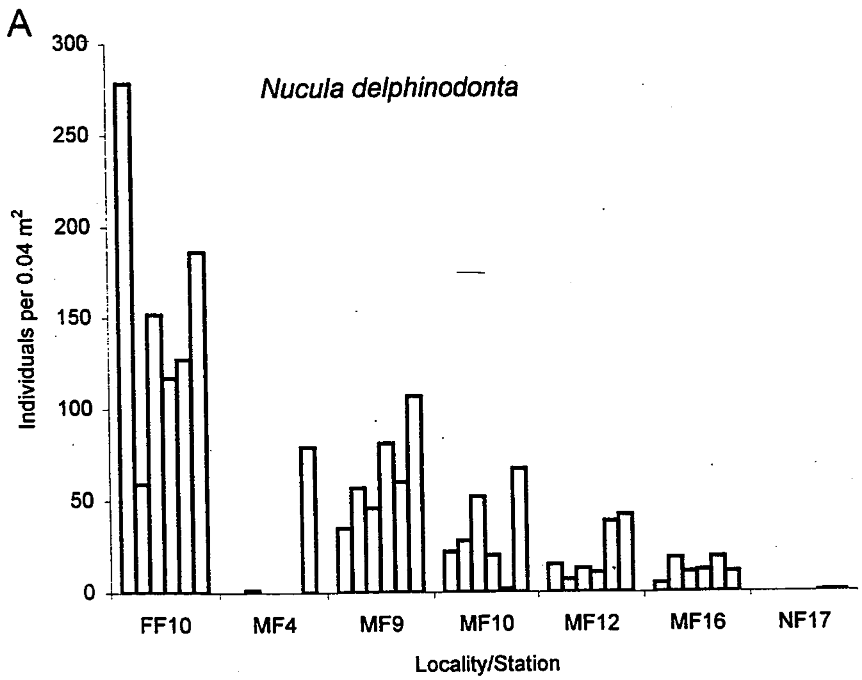


Figure 68. Relative abundances of *Aricidea catherinae* (A) and *Mediomastus californiensis* (B) at selected nearfield and midfield stations for the period 1992-1997.



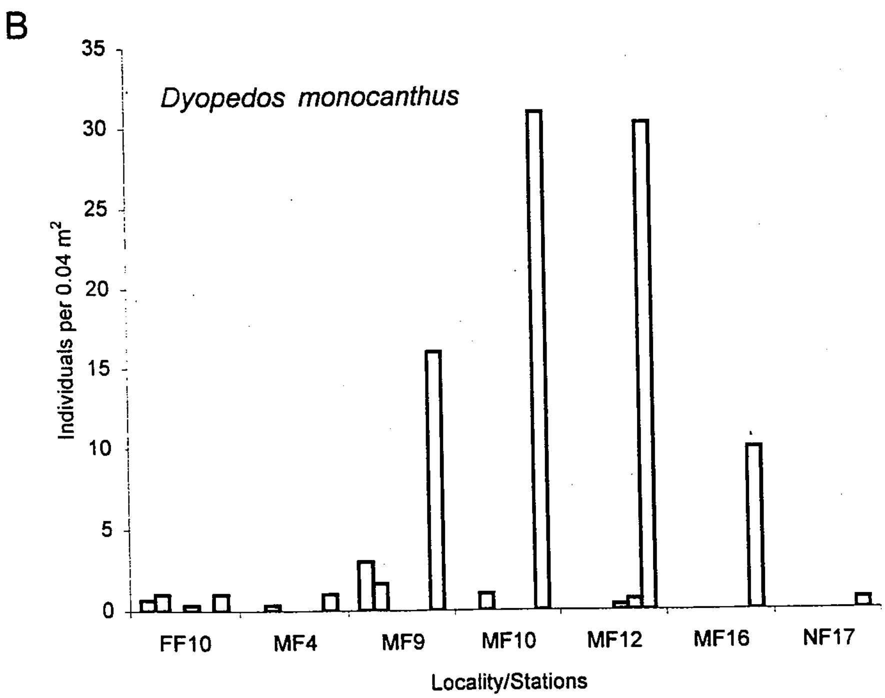


Figure 69. Relative abundances of *Nucula delphinodonta* (A) and *Dyopedos monacanthus* (B) at selected nearfield and midfield stations for the period 1992-1997.

Trends in Total Faunal Abundance. Summary statistics are presented for total density at each nearfield and midfield station from 1992 to 1997 (Figure 70). Each data point is density per 0.04 m^2. The bottom half of the figure shows the individual annual data points, whereas the upper figure shows the mean of these samples and the standard error of the mean.

Total densities vary widely from year to year at most stations. Station NF13 appears to be the most stable location on an annual basis and stations MF7, MF20, and NF19 exhibit the largest swings in density. When averaged, the stations with the lowest densities are NF17 ($\bar{x}$ = 1020) and MF16 ($\bar{x}$ = 1368); the highest mean densities are at station MF22 ($\bar{x}$ = 2909), only sampled for four years. When all of the nearfield and midfield samples are averaged among themselves, there is no difference in the grand means and the standard errors are insignificant (midfield: $\bar{x}$=1951.98±121.93; nearfield: $\bar{x}$=1897.83 ±137.17). These results suggest that there is no difference in density between the nearfield and midfield.

Trends in Species Richness. Summary statistics are presented for the total number of species recorded at each nearfield and midfield station from 1992 to 1997 (Figure 71). Each data point is the number of species per 0.04 m^2 grab sample. The lower figure shows the individual data points per year, whereas the upper figure shows the mean and standard error of those annual data points. Mean number of species per station ranges from a low of 25 (NF17 in 1993) to a high of 112 (NF18 in 1997) (Appendix E). The most consistent year where low number of species were recorded was 1994. Most stations exhibit wide swings in species counts on an annual basis, but averages per station indicate that some stations are generally richer than others. Station NF17 has the lowest average number of species and NF 18 has the highest. Both are nearfield stations. Cumulative averages of all nearfield and midfield samples suggests that more species are recorded from the nearfield, but standard errors indicate no statistical difference (nearfield: $\bar{x}$=68.13 ±2.6; midfield $\bar{x}$=63.15±1.8).

Trends in Species Diversity. Summary statistics are presented for species diversity as measured by the Shannon-Wiener (H') (Figure 72) and Hurlbert's rarefaction estimates (ES_{100}) (Figure 73). The lower figure in each analysis shows the individual data points for each year, whereas the upper figure shows the mean and standard error. Regardless of the diversity calculation used, the lowest diversities were in the 1994 samples and the highest in the 1996 and 1997 samples. Calculation of an average species diversity suggests that diversity at the nearfield stations is slightly higher than average diversity at midfield stations. Shannon-Wiener H' values when averaged (± Standard Error of the Mean) over the period 1992-1997 were 2.69 ± 0.053 for the nearfield and 2.60 ± 0.043 for the midfield. Hurlbert ES_{100} values averaged for the same period were 23.90 ± 0.583 for the nearfield and 22.03 ± 0.476 for the midfield. Differences, however, are small with overlapping error bars.

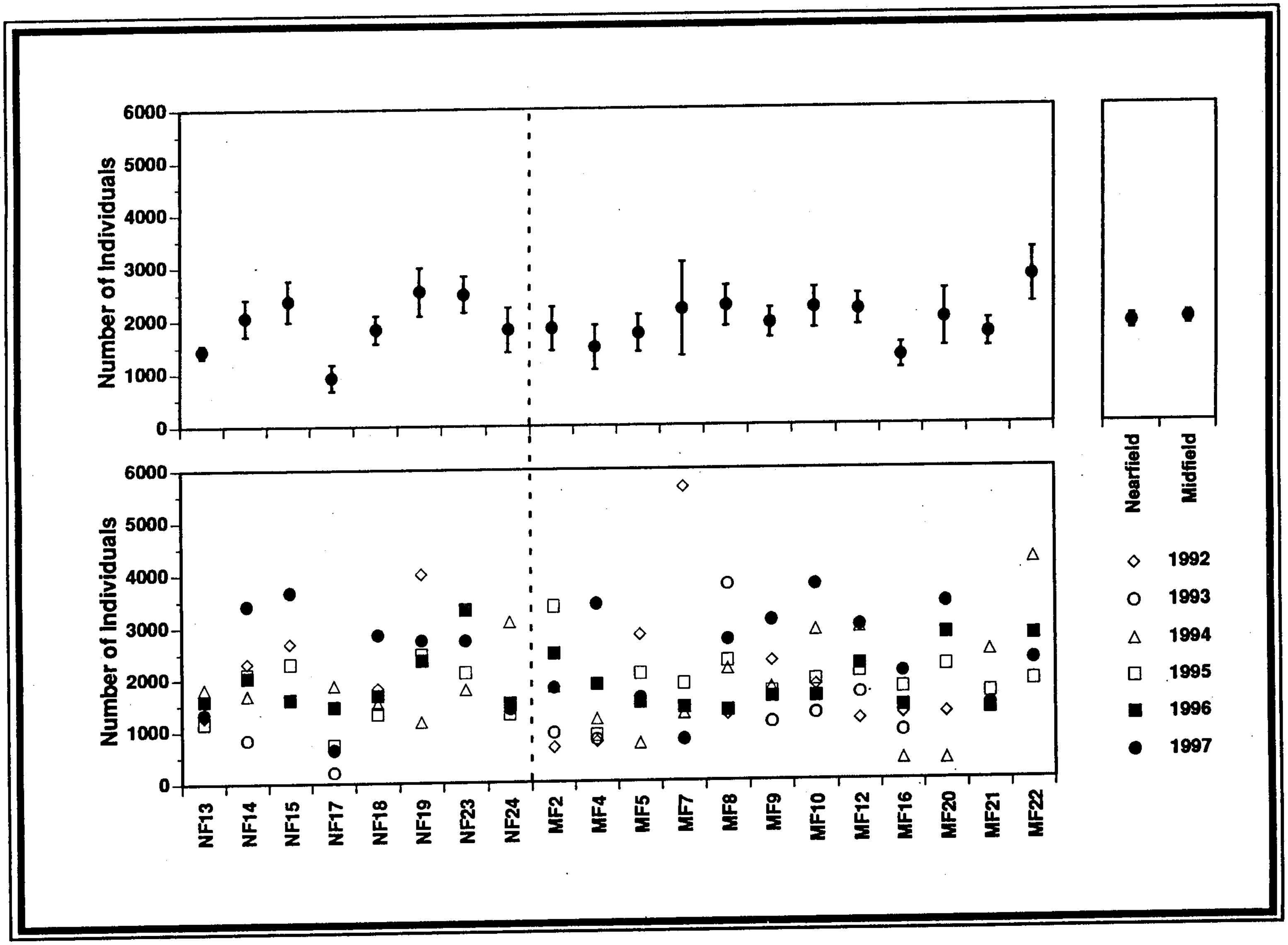


Figure 70. Infaunal densities at nearfield and midfield stations for the period 1992-1997. Top diagram shows the mean and standard error for each station; bottom diagram shows abundances for each year.

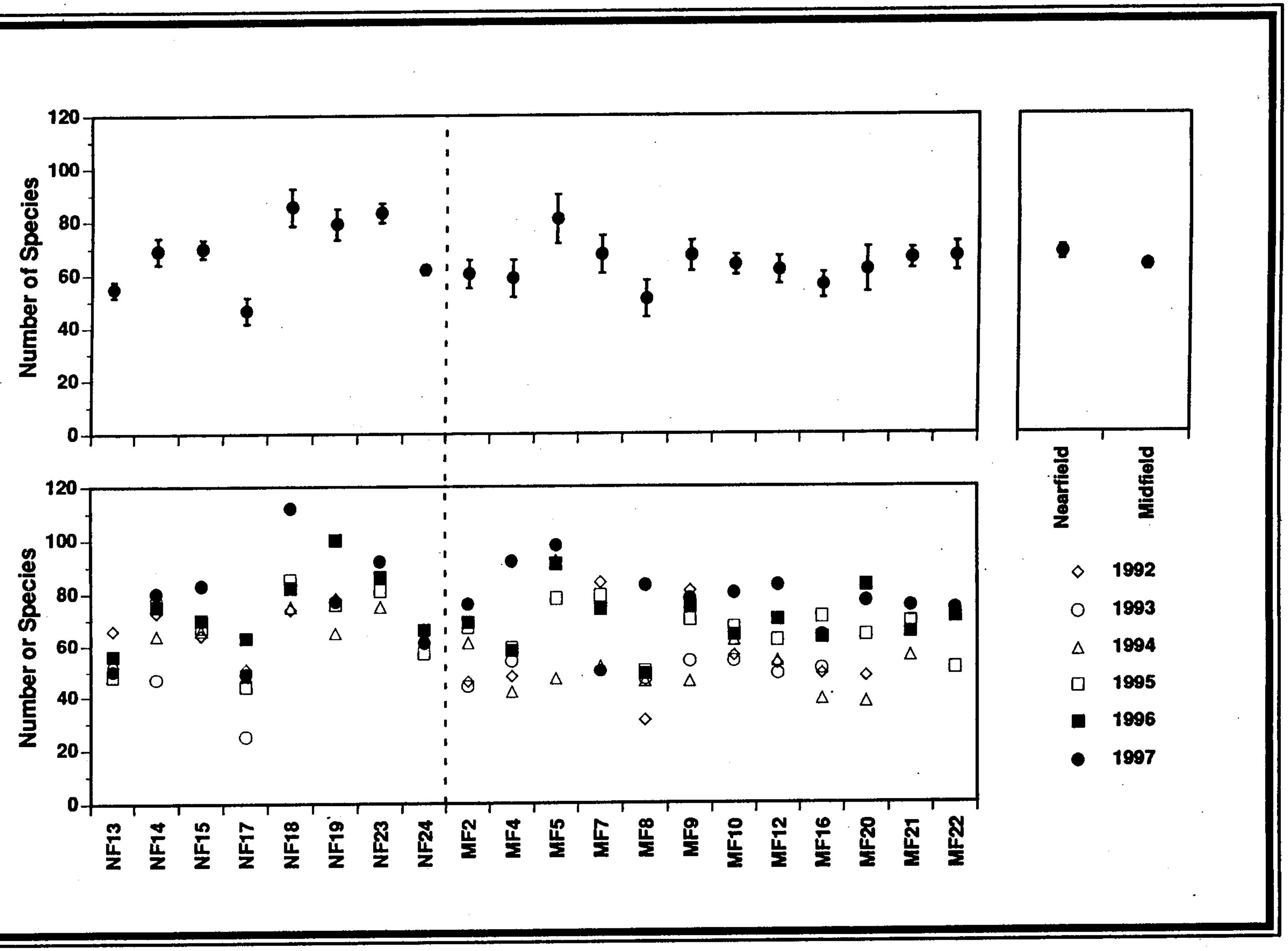


Figure 71. Number of species at nearfield and midfield stations for the period 1992-1997. Top diagram shows the mean and standard error for each station; bottom diagram shows values for each year.

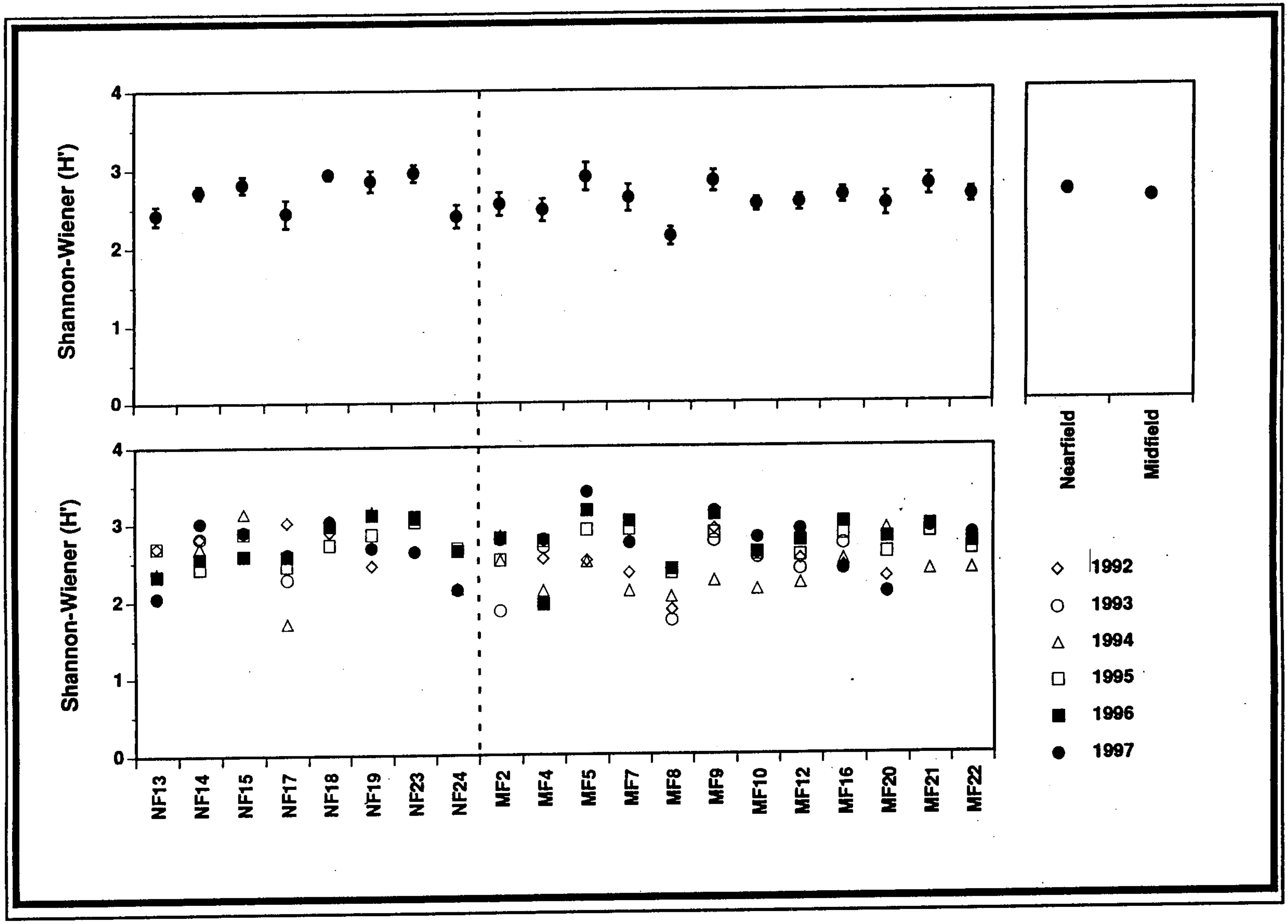


Figure 72. Shannon-Wiener diversity at nearfield and midfield stations for the period 1992-1997. Top diagram shows the mean and standard error for each station; bottom diagram shows H′ for each year.

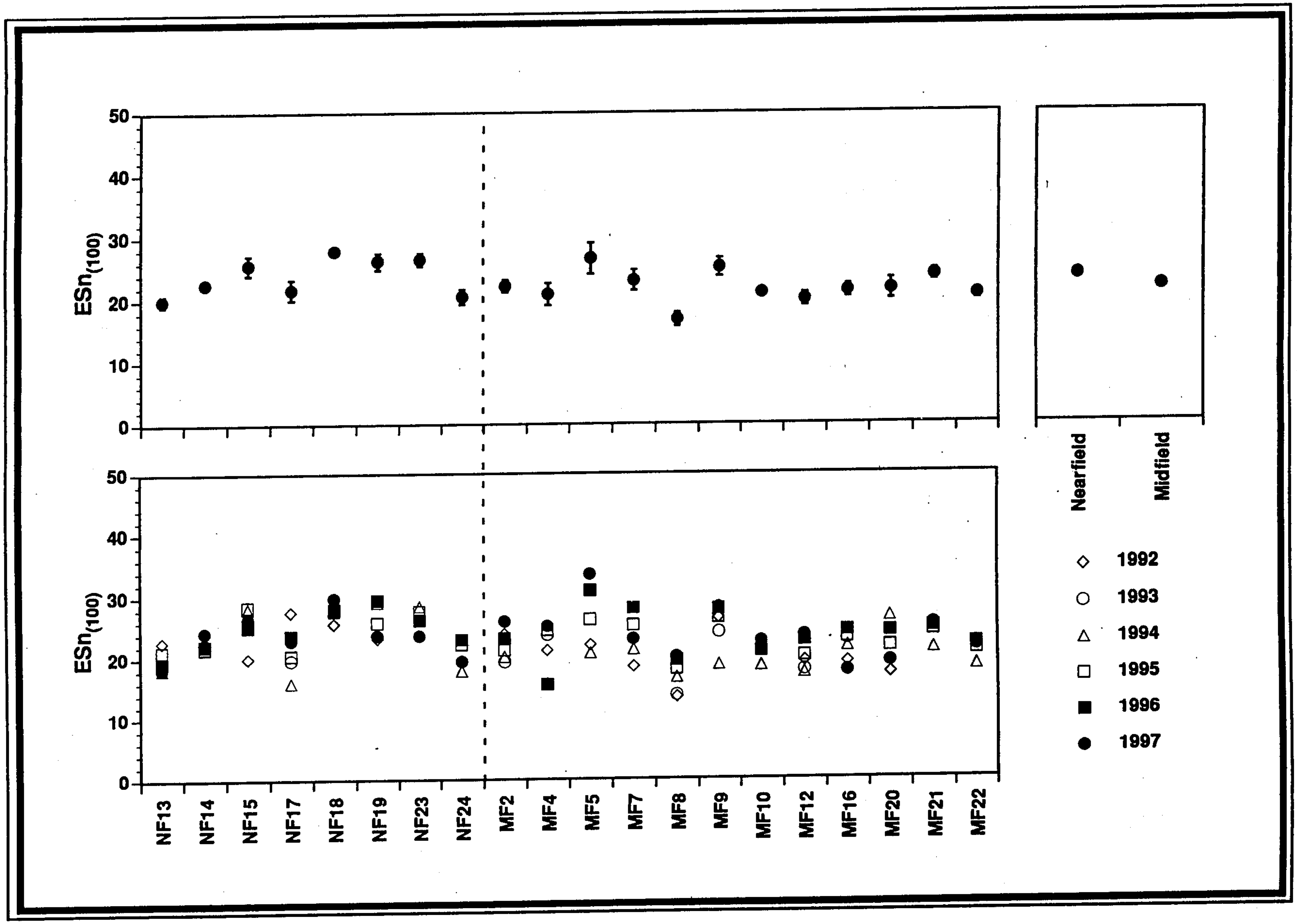


Figure 73. Hurlbert's rarefaction estimates (ES_{100}) at nearfield and midfield stations for the period 1992-1997. Top diagram shows the mean and standard error for each station; bottom diagram shows ES_{100} for each year.

4.3.2 Farfield

The farfield sampling program consists of eight stations where triplicate 0.04-m^2 grabs are collected and analyzed. Three stations that were originally part of the farfield design (FF10, FF12, and FF13) have been reclassified as midfield stations. These three stations are approximately 8 km from the outfall, but more importantly are nearshore of the diffuser array. In terms of faunal communities, at least two of these stations appear to be transitional between Boston Harbor and the rest of the nearfield and midfield stations. The eight remaining farfield stations are widely distributed in Massachusetts and Cape Cod Bays and ensure that changes due to natural processes will be documented in an area that is well beyond the area potentially impacted by the outfall. Most of the farfield stations appear to be more stable from year to year than the nearfield and midfield stations, being removed from the influence of the Harbor and nearshore sediment transport processes. However, there are still considerable year-to-year differences in faunal abundances and density of dominant species.

Faunal Assemblage Patterns. The cluster and ordination analyses of the farfield stations consistently demonstrate three clusters of stations. This result was apparent in both the 1996 results (Blake *et al.*, 1998) and for the present 1997 results (see above).

Stations FF1A and 9, near the midfield array, compose the first assemblage. Both stations showed an affinity to the nearshore environment in 1995 and 1996 (Hilbig *et al.*, 1996; Blake *et al.*, 1998). These stations are sandy and are dominated by the spionids *Prionospio steenstrupi, Spio limicola*, and *Dipolydora socialis.* Other characteristic species of this assemblage include the bivalves *Nucula delphinodonta* and *Thyasira gouldii*, the amphipod *Harpinia propinqua*, and the large burrowing polychaete *Aglaophamus circinata.*

Stations FF4, 5, 11, and 14 near Stellwagen Basin in 62-87 m compose the second assemblage. These stations are silty with only only moderate levels of sand, Six polychaetes and one oligochaete characterize this assemblage: *Chaetozone setosa, Aricidea quadrilobata, Levinsenia gracilis, Anobothrus gracilis, Mediomastus californiensis, Galathowenia oculata,* and *Tubificoides apectinatus*. The paraonids *A. quadrilobata* and *L. gracilis* are good indicators of a shelf fauna rather than *A. catherinae* which characterizes nearshore assemblages.

The third farfield assemblage is also the most consistent over time and comprises the two stations (FF6 and FF7) in Cape Cod Bay. These stations consistently differ from others in Massachusetts Bay in both sediment and faunal composition. The sediments are silty and the fauna is characterized by a suite of polychaetes dominated *by Cossura longocirrata*, the oligochaete Tubificidae sp. 2, the amphipod *Leptocheirus pinguis*, and the bivalve *Nucula annulata*.

The farfield stations retained their identity when combined with the nearfield and midfield samples in an all 1997 Massachusetts Bay analysis and in a 1992-1997 analysis proving that the offshore environment in Massachusetts Bay differs consistently from that of the nearshore (see results). This fact plus the less variable nature of these stations over time provides a good series of control or reference locations from which to gauge farfield effects of the outfall.

Densities of Dominant Species. The densities of ten species at five selected farfield stations from 1992-1997 were plotted in order to compare their relative densities over time. The results are similar to those of the nearfield and midfield plots presented in the previous section in that densities of individual species vary over time. No real pattern is evident except when single stations are compared and contrasted for the contributions of individual species.

For the three common spionids, no more than two species were ever abundant at any one station (Figures 74A-B and 75A): *Prionospio steenstrupi* and *Spio limicola* (station FF 9) and *P. steenstrupi* and *Dipolydora socialis* (FF12 and 13). Typically *S. limicola* and *D. socialis* do not occur abundantly together although *S. limicola* and *D. quadrilobata* were once very abundant in a sample taken in 1982 (Blake *et al.*, 1989).

The cirratulid *Tharyx acutus* (Fig. 75B) was either absent or highly variable at the stations tested in the present analysis. At FF9, the species was abundant in 1992, 1994, and 1997, but present in only low numbers otherwise. The species was abundant in 1992 at FF6, but rare at other times. The paraonid polychaete *A. catherinae* has generally declined in density at FF12 and 13 since 1992-1993 (Figure 76A). The capitellid *Mediomastus californiensis* has exhibited more stability in population density than other species examined (Figure 76B); this stable pattern was also evident in the nearfield and midfield results. The two syllid polychaetes *Exogone hebes* and *E. verugera* were abundant only at FF9 (Figure 77). *E. verugera* is the more abundant of the two and appears to have decreased in numbers since 1995.

The bivalve *Nucula delphinodonta* has exhibited a general increase in population density at FF6 and 9 since sampling was initiated in 1992 (Figure 78A). In contrast, the amphipod *Dyopedos monacanthus* was uncommon at stations FF12 and 13 until 1997 (Figure 78B).

Trends in Total Faunal Abundance. Summary statistics are presented for total density at each farfield station from 1992 to 1997 (Figure 79). Each data point is the number of individuals per 0.04 m^2. The bottom half of the figure shows the individual annual data points, whereas the upper figure presents the mean and standard error of the mean (vertical bar). In this graphic, stations FF10, 12, and 13 normally now grouped with the midfield stations and MF12, NF17, and NF24, replicated stations from the nearfield and midfield are included.

At first glance, densities at farfield stations appear to be as variable as at the nearfield and midfield stations (Figure 79). However, the most variable of these are, in fact, FF10, 12, and 13, now part of the midfield, and FF9, also a relatively nearshore station. Populations densities at stations located further offshore are less variable and tend to be lower than at nearshore stations. Stations FF4, 5, and 14 exhibited the least variability in population density over time.

The upper graphic indicates that some stations are more variable than others as shown by larger standard errors (Figure 79). Again, these reflect the nearshore FF stations as well as the replicated nearfield and midfield stations. However, when the grand means are taken, the true eight farfield stations and all of the replicated stations have essentially the same mean value and a very low standard error indicating that there is no statistical difference in the densities (farfield: $\bar{x}$=1460.22±114.23; all replicated stations: $\bar{x}$=1489.98±101).

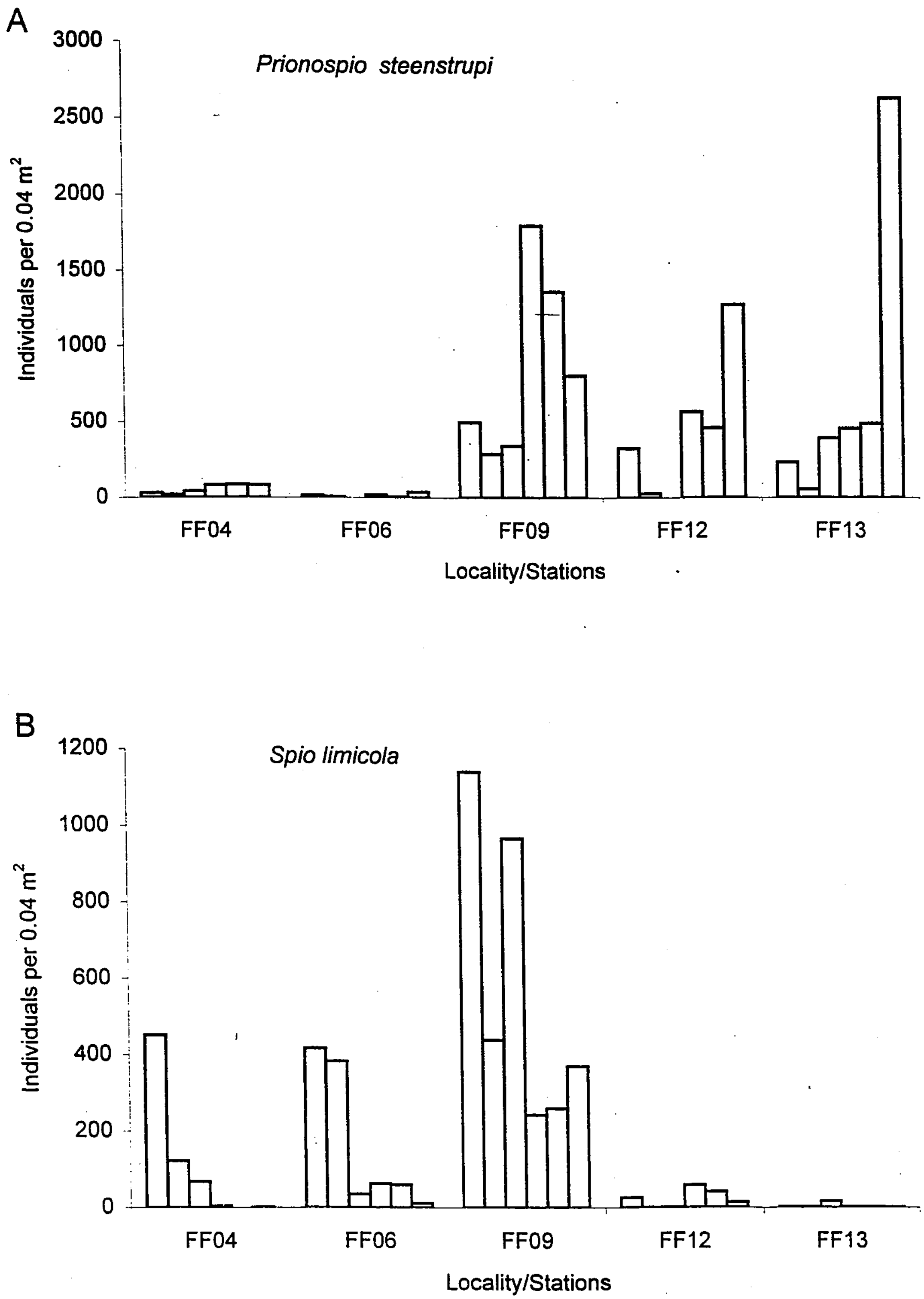


Figure 74. Relative abundances of *Prionospio steenstrupi* (A) and *Spio limicola* (B) at selected farfield stations for the period 1992-1997.

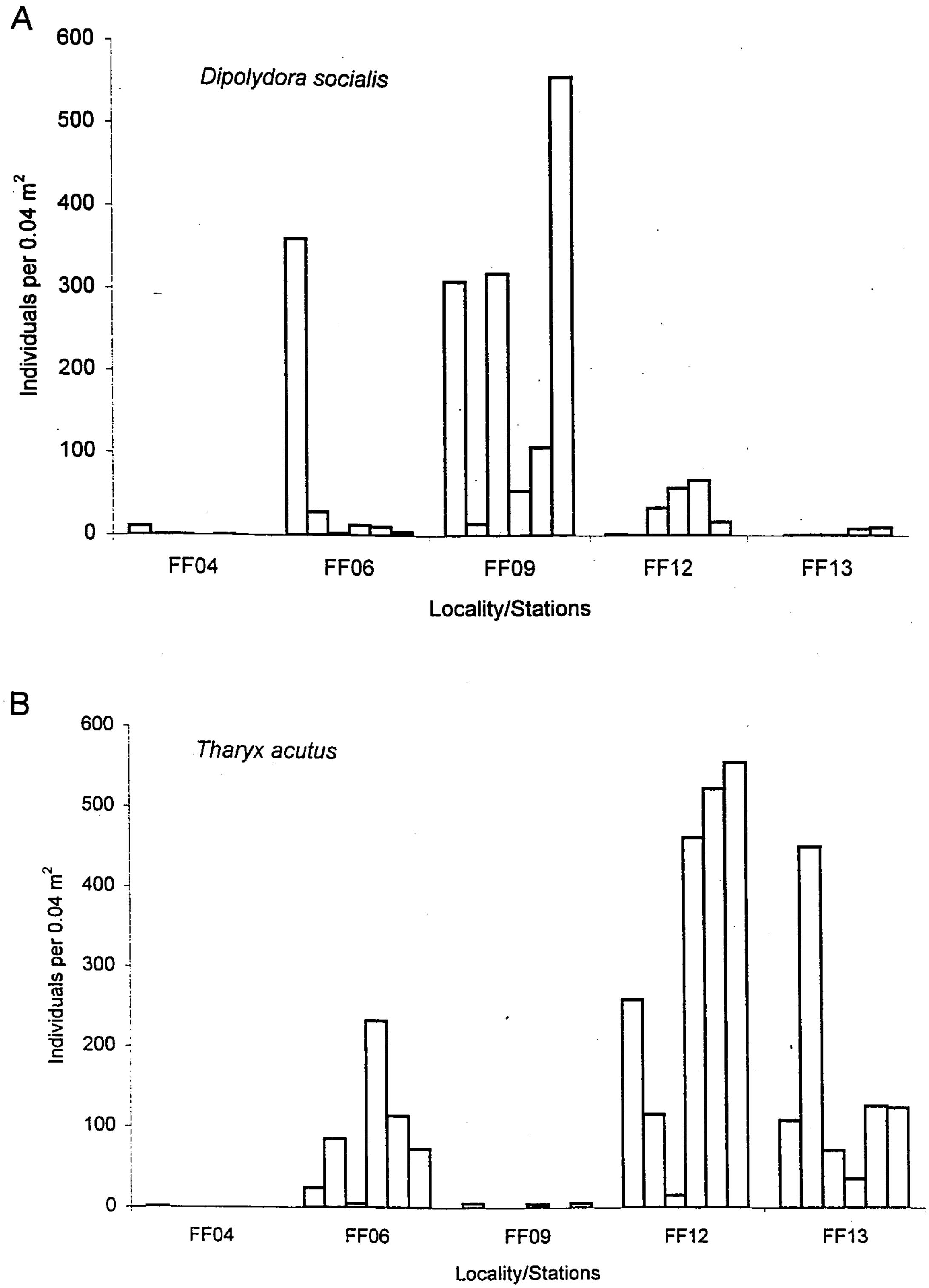


Figure 75. Relative abundances of *Dipolydora socialis* (A) and *Tharyx acutus* (B) at selected farfield stations for the period 1992-1997.

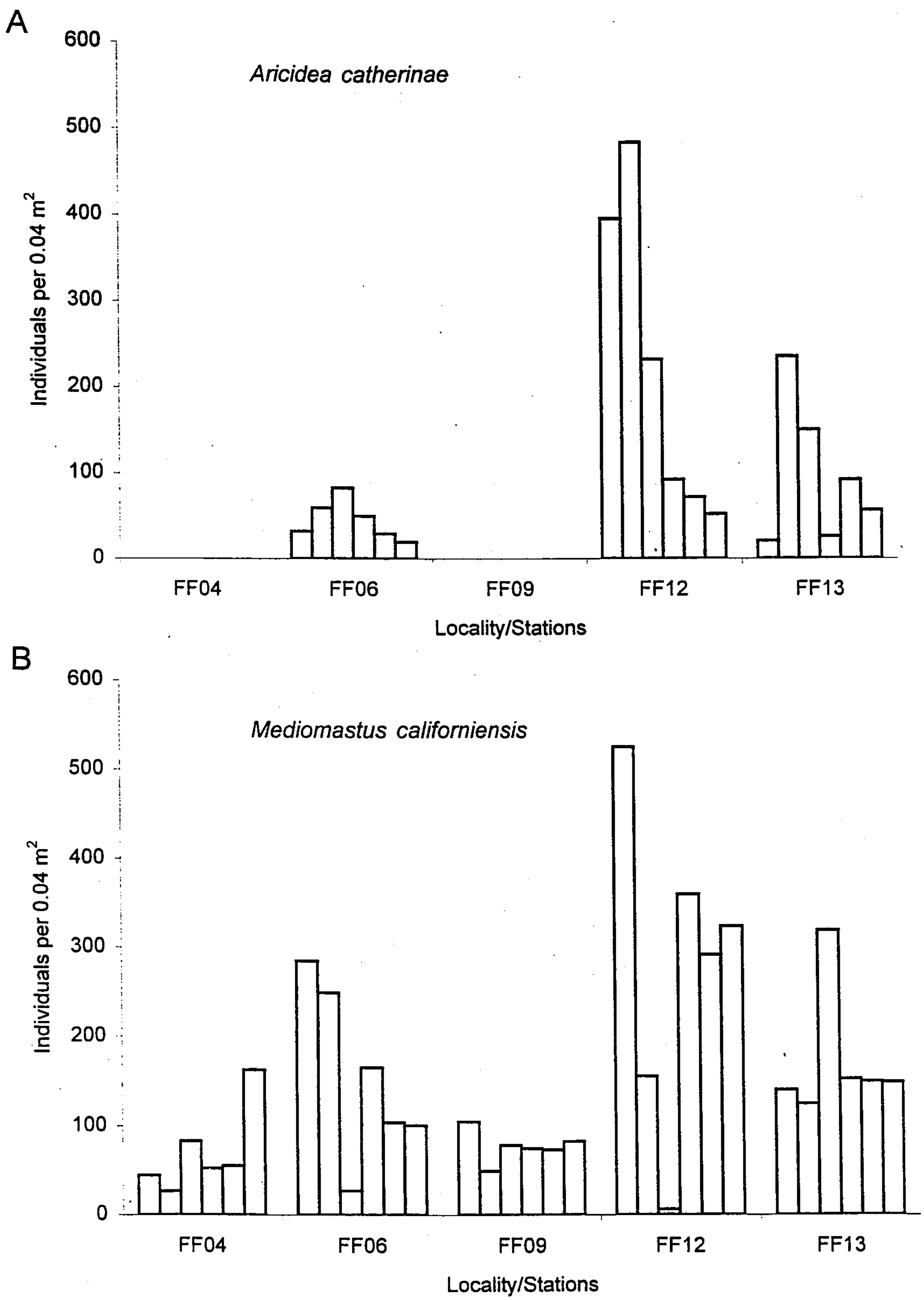
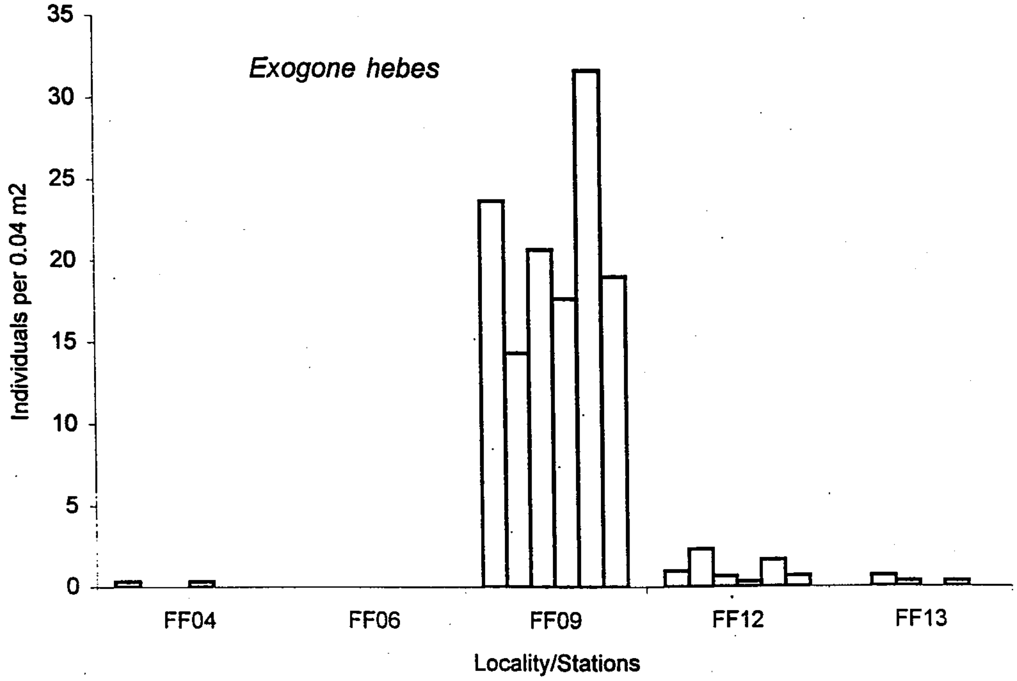


Figure 76. Relative abundances of *Aricidea catherinae* (A) and *Mediomastus californiensis* (B) at selected farfield stations for the period 1992-1997.

A



B

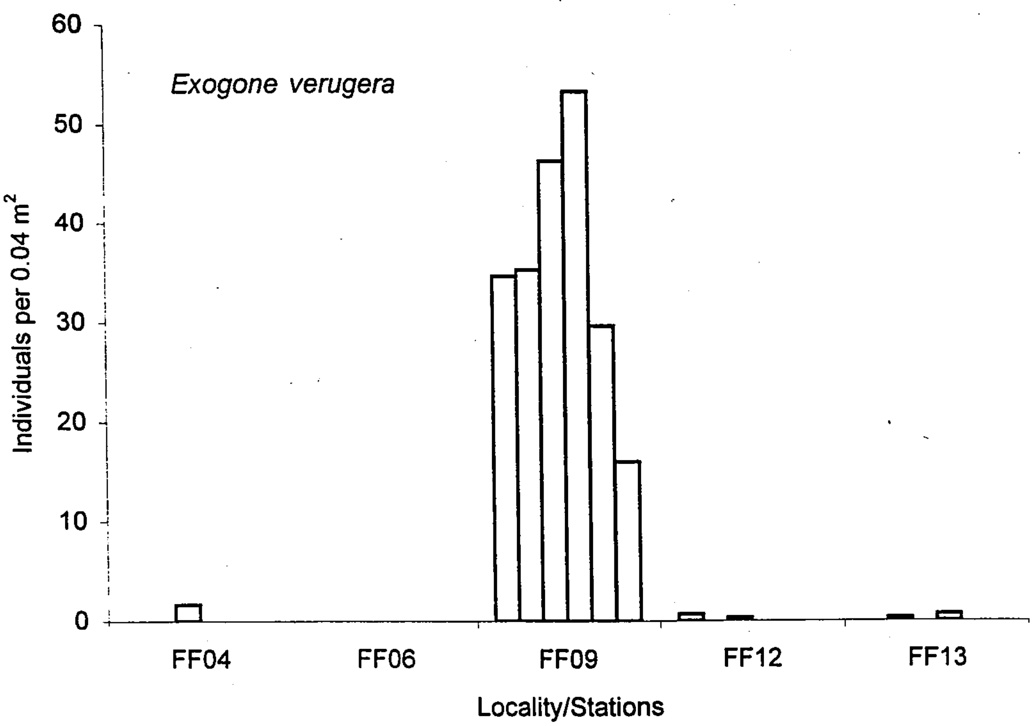
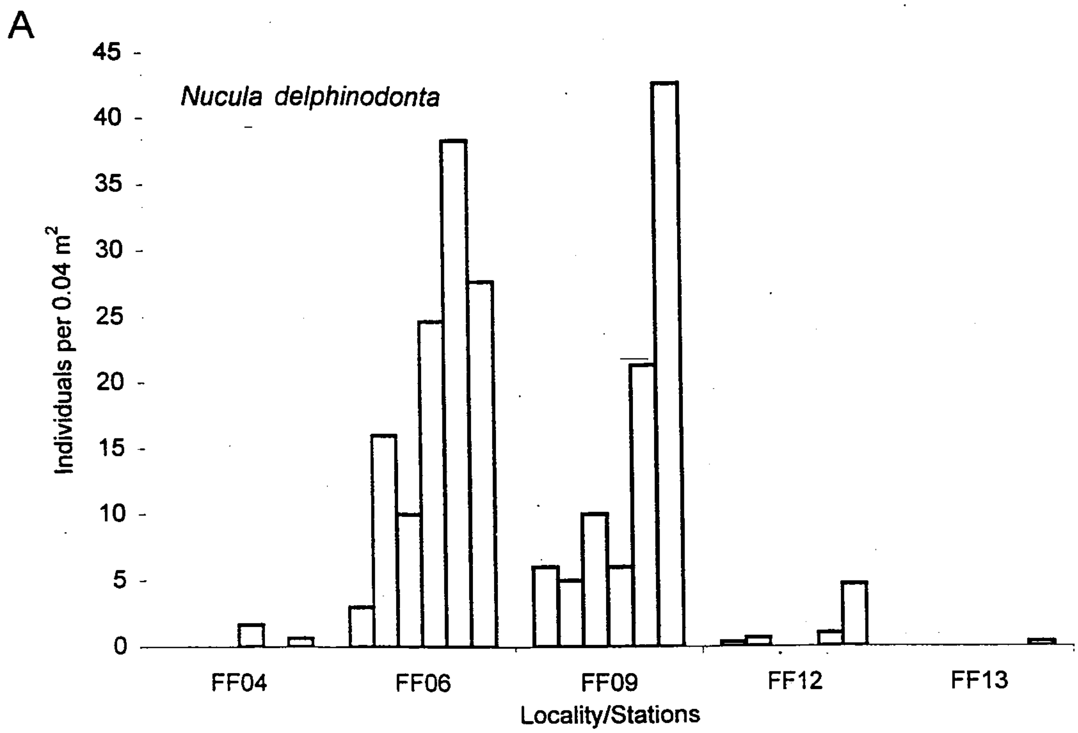


Figure 77. Relative abundances of *Exogone hebes* (A) and *Exogone verugera* (B) at selected farfield stations for the period 1992-1997.



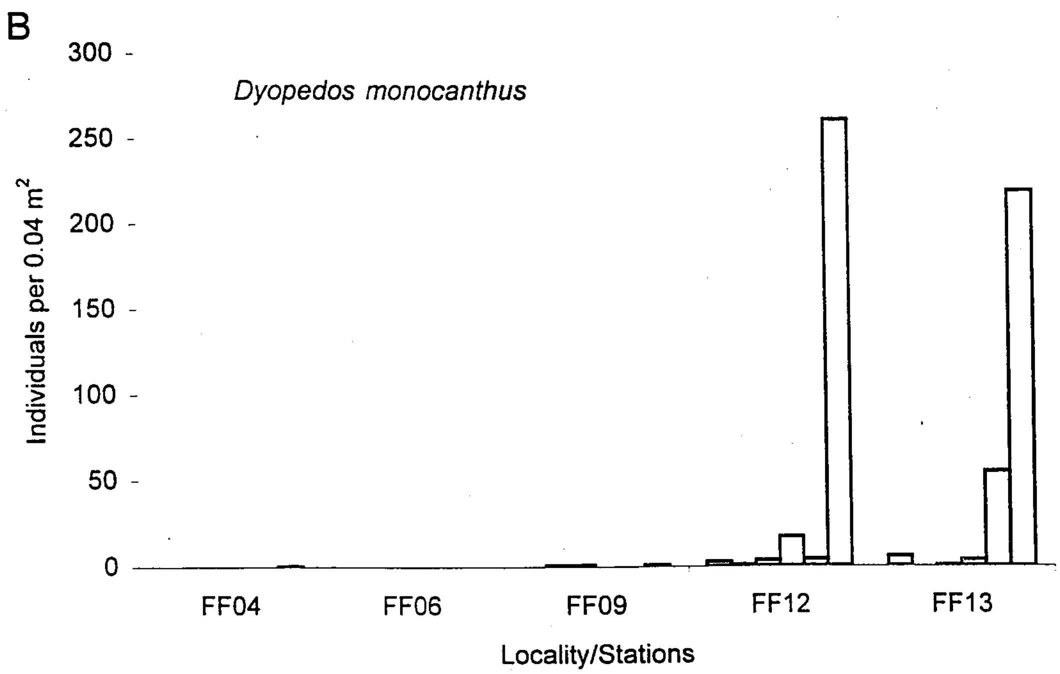


Figure 78. Relative abundances of *Nucula delphinodonta* (A) and *Dyopedos monacanthus* (B) at selected farfield stations for the period 1992-1997.

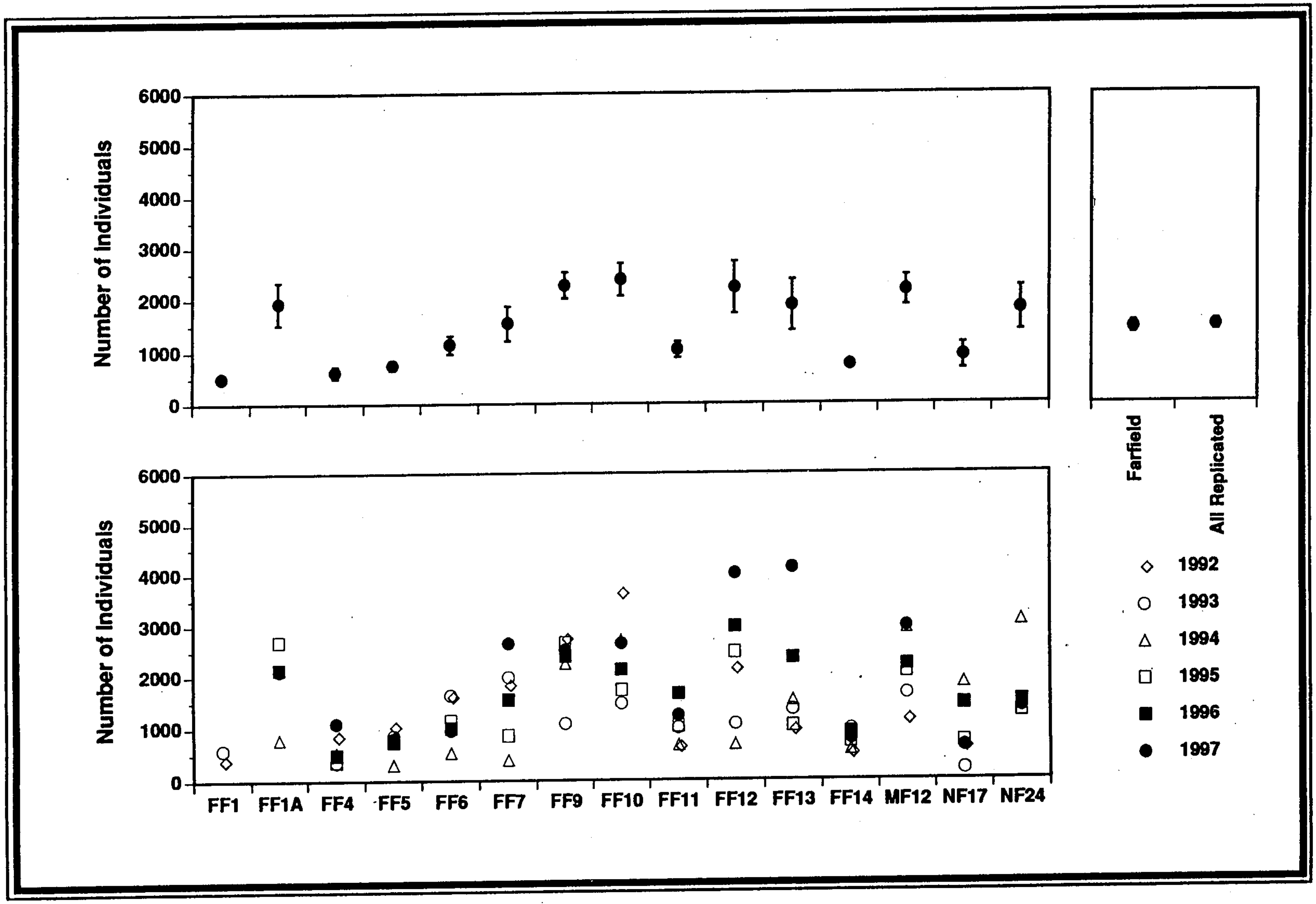


Figure 79. Infaunal densities (mean number of individuals per 0.04 m^2) at farfield stations and replicated nearfield and midfield stations for 1992-1996. Top diagram shows the mean and standard error for each station; bottom diagram shows abundances for each year.

Trends in Species Richness. Summary statistics are presented for the total number of species recorded at each farfield station from 1992 to 1997 (Figure 80). Each data point is based on the number of species per 0.04 m^2 grab sample. The lower figure represents the individual data points per year, whereas the upper figure represents the mean and standard error of those annual data points. In this presentation, stations FF10, 12, and 13 normally now grouped with the midfield stations and MF12, NF17, and NF24, replicated stations from the nearfield and midfield are included.

At most stations the fewest numbers of species were recorded in 1993 and 1994. Among the true farfield stations the mean number of species per $0.04m^2$ grab ranged from 30 at FF7 in 1994 to 97 at FF9 in 1997. The variability among individual stations with respect to the average number of species recorded over time is very comparable in that the standard errors are similar throughout. The grand means of the true farfield and all replicated stations are virtually identical and the standard error is very low (farfield: $\bar{x}$= 57.35±1.8; all replicated stations: $\bar{x}$=57.12±1.6).

Trends in Species Diversity. Summary statistics are presented for species diversity as measured by the Shannon-Wiener (H′) (Figure 81) and Hurlbert's rarefaction estimates (ES_{100}) (Figure 82). The lower graphic in each figure presents the individual data points for each year, whereas the upper graphic shows the mean and standard error. In this presentation, stations FF10, 12, and 13 normally now grouped with the midfield stations and MF12, NF17, and NF24, replicated stations from the nearfield and midfield are included.

Regardless of the diversity calculation used, the lowest diversities were distributed among the 1992, 1994, and 1995 samples; the highest diversities were mostly from 1996 and 1997. The greatest range of diversity for single stations was seen at FF1A and 5. The least variability in diversity at any single station was found at FF7. When averaged, standard errors are large only for those stations having a wide range of diversity (FF1A and 5); for the rest, the standard error is low. The grand means for all true farfield and all of the replicated stations are virtually identical and have very low standard errors (farfield: $\bar{x}$=2.58 ± 0.054; all replicated stations: $\bar{x}$=22.93 ± 0.0.530).

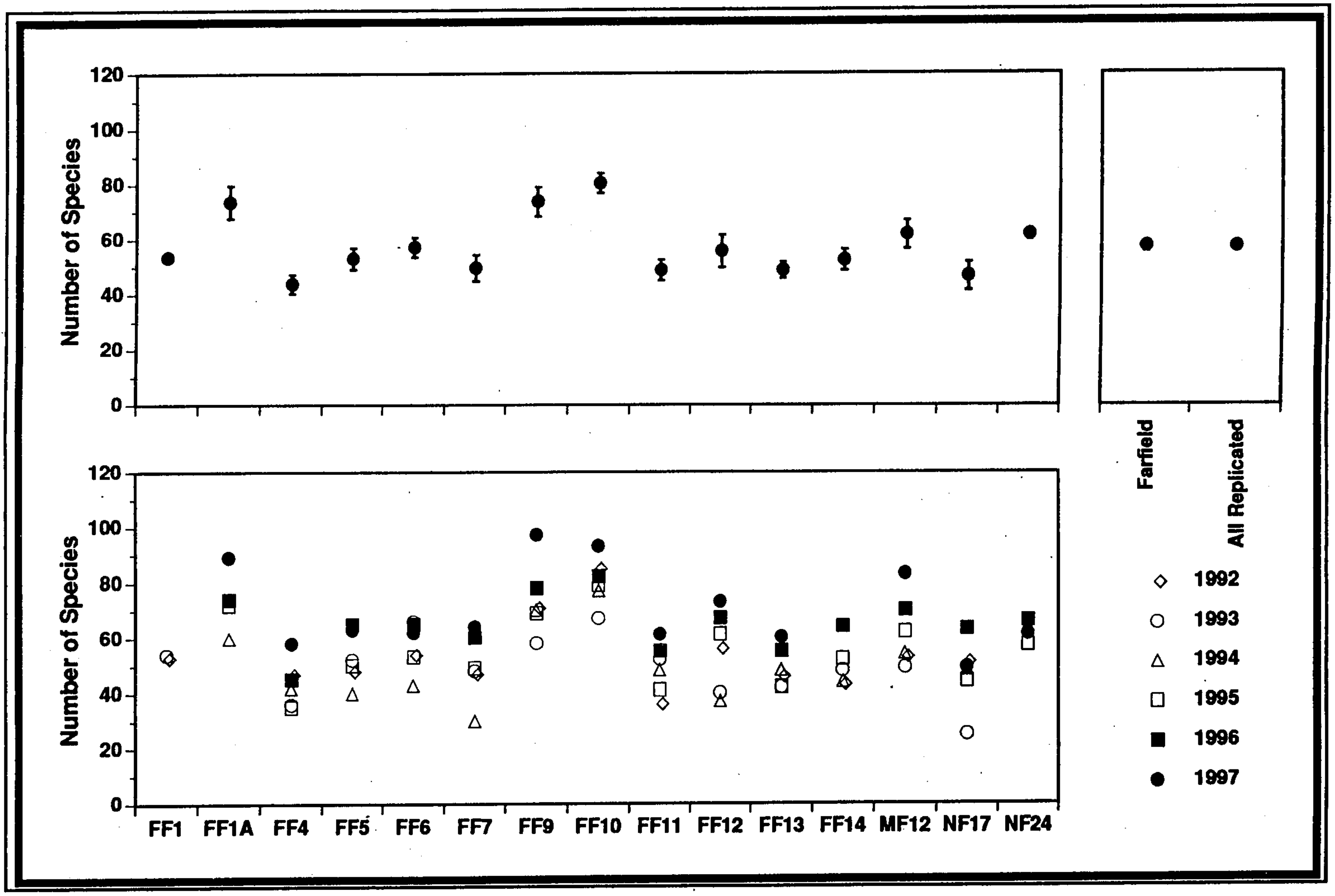


Figure 80. Number of species (mean number of individuals per 0.04 m^2) at farfield stations and replicated nearfield and midfield stations for 1992-1996. Top diagram shows the mean and standard error for each station; bottom diagram shows values for each year.

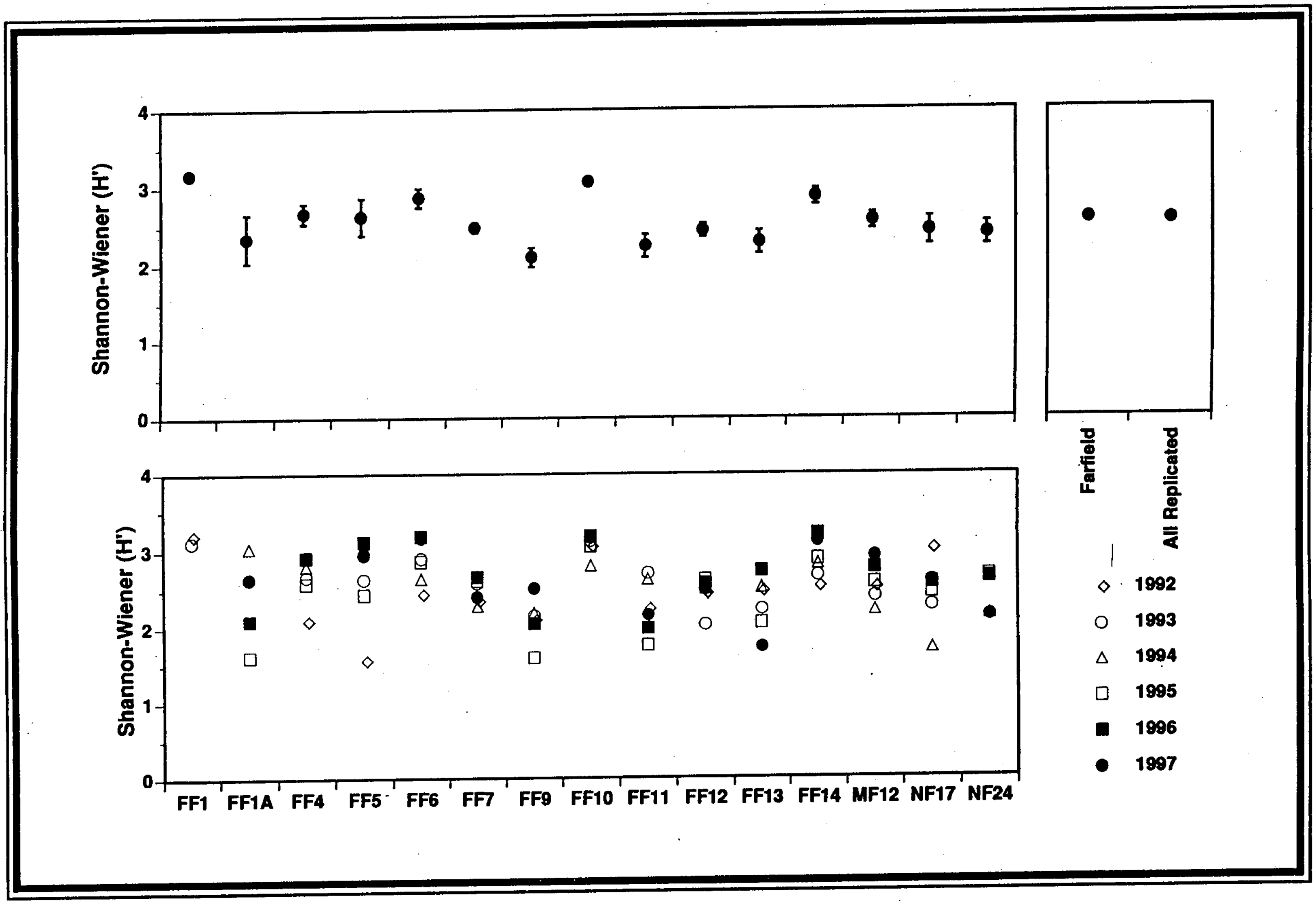


Figure 81. Shannon-Wiener diversity at farfield and replicated nearfield and midfield stations for the period 1992-1997. Top diagram shows the mean and standard error for each station; bottom diagram shows H′ for each year.

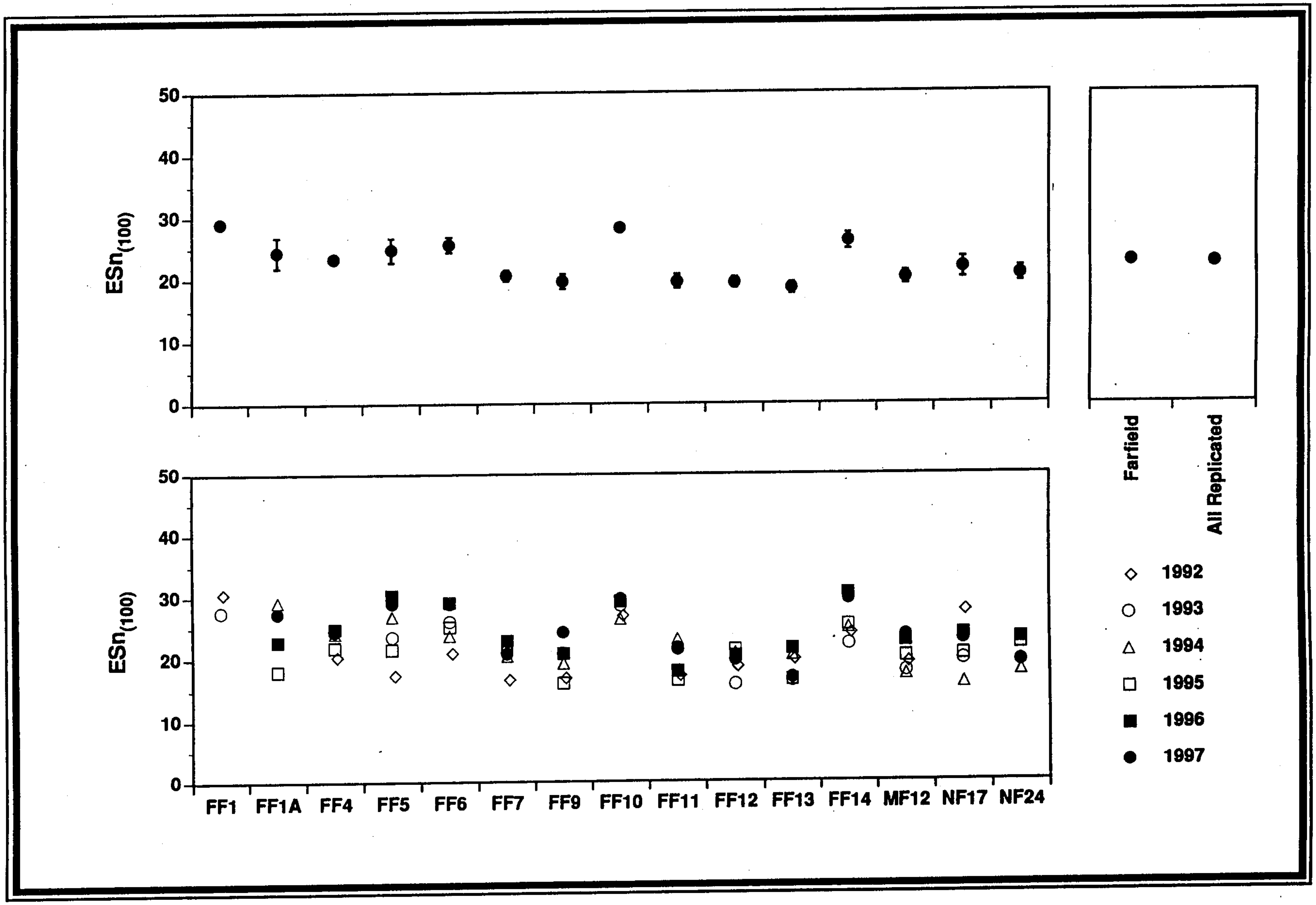


Figure 82. Hurlbert's rarefaction estimates (ES_{100}) at farfield and replicated nearfield and midfield stations for the period 1992-1997. Top diagram shows the mean and standard error for each station; bottom diagram shows ES_{100} for each year.

4.4 Spatial and Temporal Trends in the Nearfield Hard-Bottom Benthos

Analysis of three years of hard-bottom video and 35-mm images shows a temporally stable pattern in the structure of benthic communities inhabiting hard-bottom areas in the vicinity of the outfall. The hard-bottom habitats are spatially variable, but do show several consistent trends. Figure 83 shows the pattern of habitat characteristics observed during the 1995 to 1997 surveys. Location on the drumlins appeared to be a primary factor in determining habitat relief. The sea floor on the tops of drumlins usually consisted of a mix of boulders and cobbles. Habitat relief varied from high in areas dominated by boulders (T2, T4, T7, T9, and T10) to moderate in areas consisting of a mix of cobbles and boulders (T1 and T8). Sediment drape on the top of drumlins ranged from light to moderate at some locations (T1, T4, T7, and T8) and heavy at other locations (T2, and T9, T10). The sea floor on the flanks of drumlins was quite variable, but usually consisted of a cobble pavement with patches of sand and gravel and occasional boulders. Habitat relief of these areas ranged from low to moderate, depending on how many boulders were present (T1-1 and 5, T4-1, 2 and 3, and T6-1 and 2). Sediment drape in the drumlin flank areas usually ranged from moderate to heavy.

The benthic communities inhabiting the hard-bottom areas also showed a spatially consistent trend. Algae usually dominated the benthic communities on the tops of drumlins, while invertebrates (mostly encrusting or attached forms) were increasingly dominant down the flanks. The encrusting coralline alga *Lithothamnion* spp. was the most abundant and widely distributed alga encountered during this study. Its' distribution and abundance was temporally quite stable during the three years of this study. Figure 84 shows the percent cover of *Lithothamnion* spp. estimated from the 35-mm images taken in 1995, 1996 and 1997. It was most abundant on the top of drumlins (50 to 96 percent cover), less abundant on the flanks of drumlins (0 to 20 percent cover), and least abundant near the diffuser (0 to 2 percent cover). Percent cover of *Lithothamnion* spp. appeared mainly to be related to sediment drape; percent cover was highest in areas that had little sediment drape and lowest in areas with moderate to heavy sediment drape (Figure 85). This is not surprising, since its encrusting growth form makes it susceptible to smothering by fine particles.

In contrast, the abundance and distribution of three upright algae, the filamentous red alga *Asparagopsis hamifera*, the dulse *Rhodymenia palmata*, and the shotgun kelp *Agarum cribosum*, appeared mainly to be controlled by habitat relief. These algae were patchily distributed and were only abundant on the tops of boulders in areas of moderately-high to high relief. Figure 86 shows the relationship between *A. hamifera* and habitat relief. The abundance of *A. hamifera* increased with increasing habitat relief. Sediment drape in areas supporting high abundances of upright algae ranged from moderate to high. The holdfasts of the algae appeared to actively trap sediment, thereby excluding the encrusting *Lithothamnion* spp. Additionally, both invertebrates and fish (mainly the cunner, *Tautogolabrus adspersus*) were generally more abundant in areas of moderate to high relief and less abundant in areas of low relief.

The pattern of benthic community structure in the hard-bottom areas was remarkably consistent between 1996 and 1997. Figure 87 shows the distribution of benthic communities defined by hierarchical classification analysis. The dendrograms were remarkably similar between the two years, with only three waypoints differing in their cluster designations (T1-2, T1-5 and T6-2). In each of these three cases, a slightly different area in relation to drumlin topography was surveyed. Communities dominated by upright algae were found on the tops of drumlins on either side of the diffuser, at all 3 of the northern reference sites, and at the reference site just southwest of the diffuser (cluster 1). In contrast, *Lithothamnion* spp. dominated the benthic communities on top of a drumlin located northwest of the

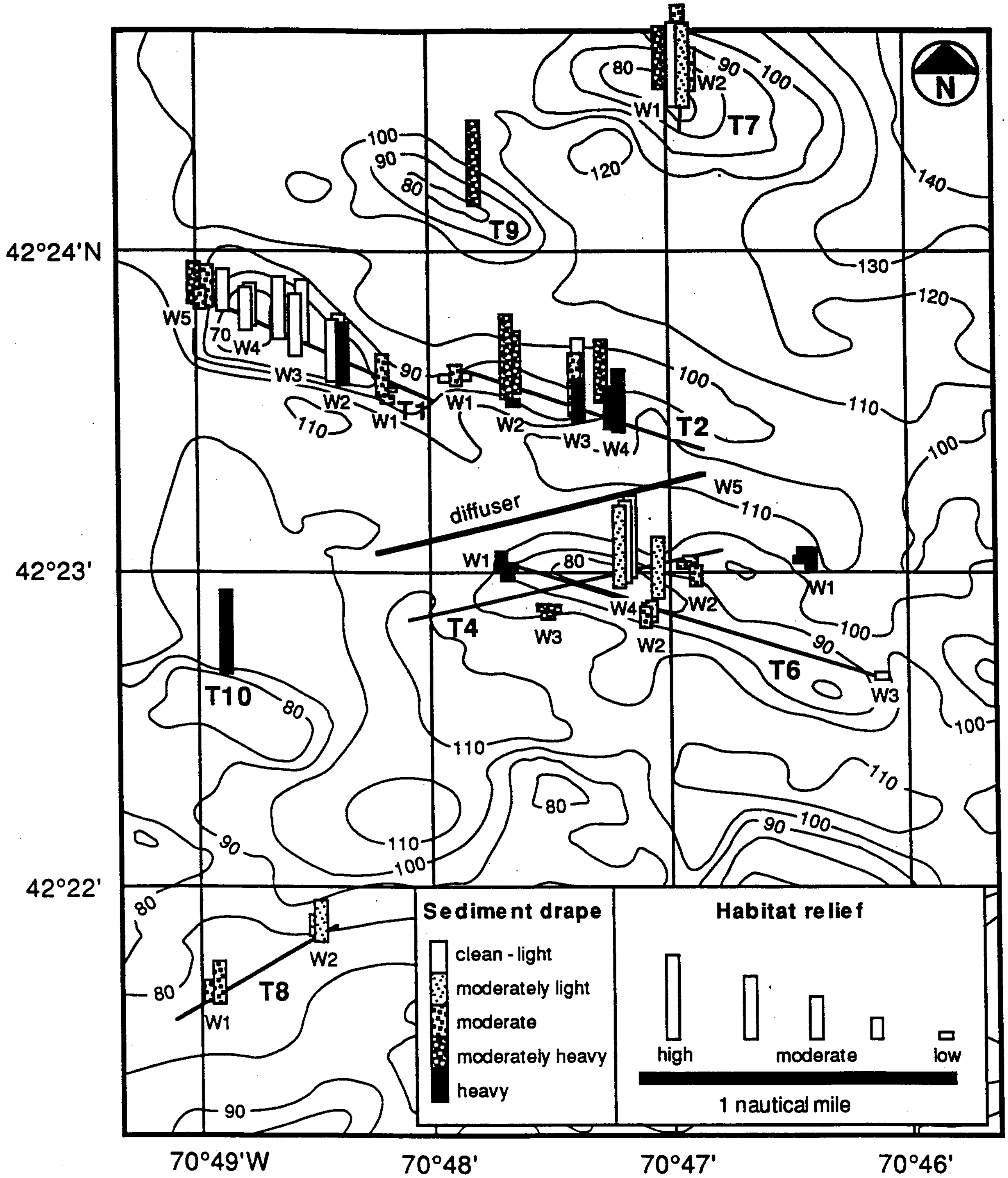


Figure 83. Sea floor characteristics, habitat relief and degree of sediment drape, determined from video and 35-mm images collected during the 3 years of nearfield hard-bottom surveys.

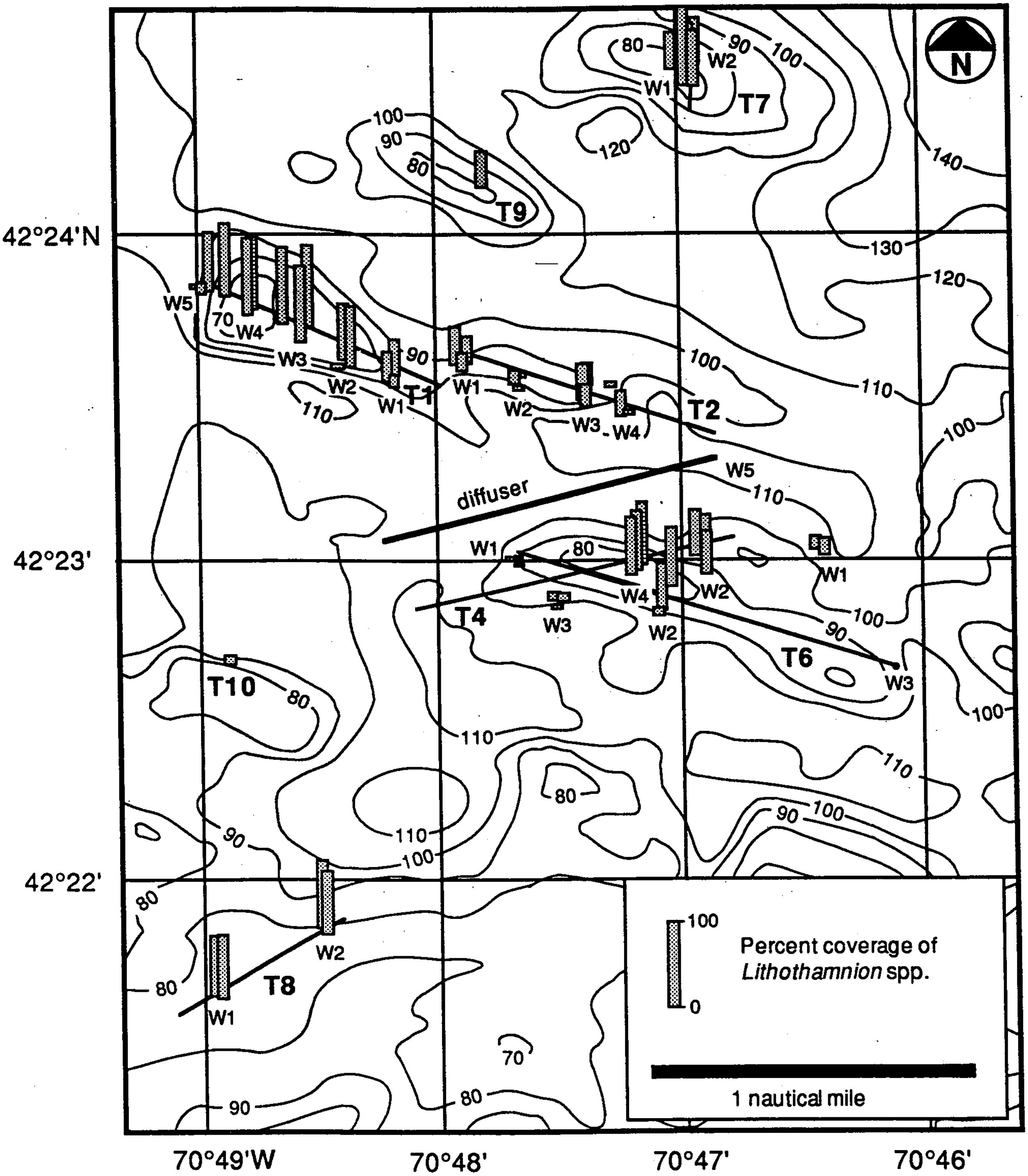


Figure 84. Percent cover of the encrusting coralline alga *Lithothamnion* spp. determined from 35-mm images collected during the 3 years of nearfield hard-bottom surveys.

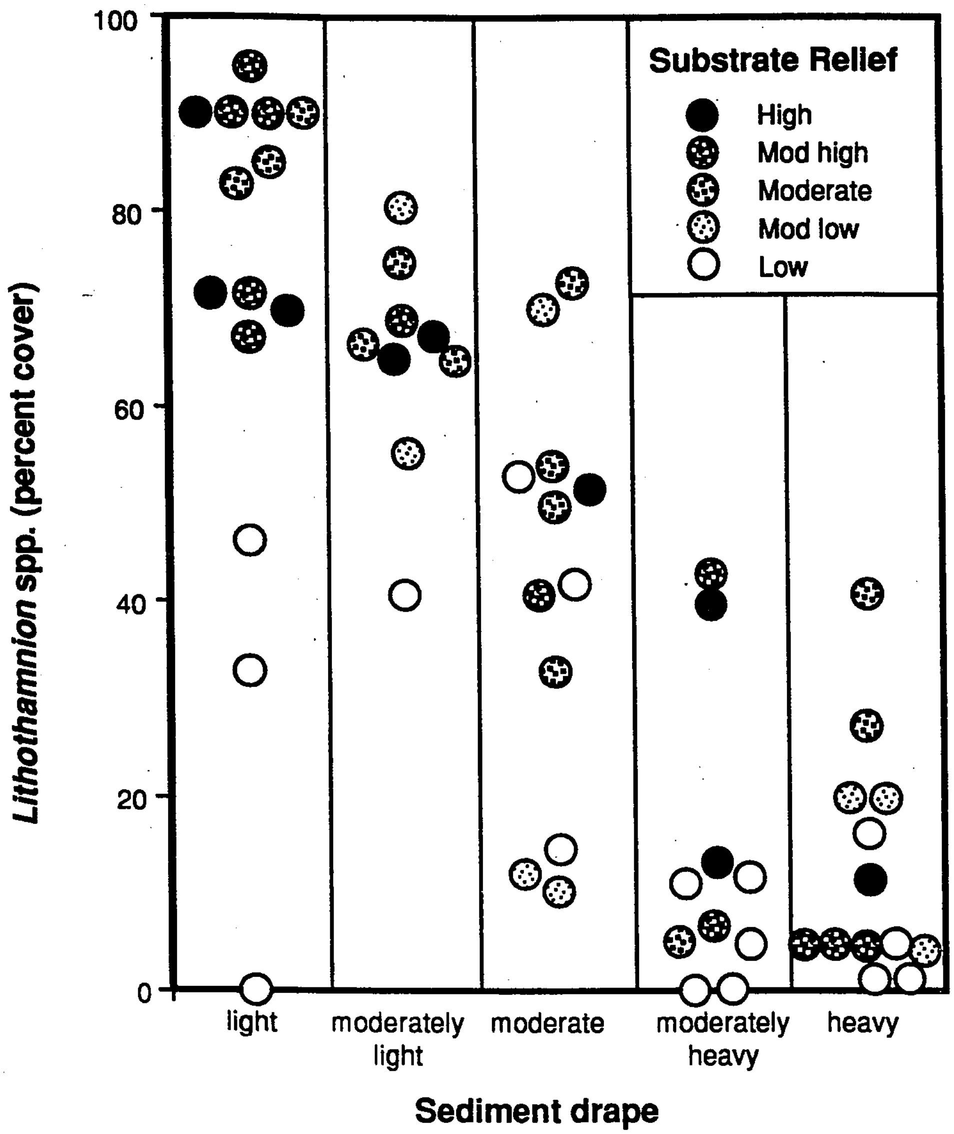


Figure 85. Percent cover of the encrusting coralline alga *Lithothamnion* spp. in relation to degree of sediment drape and habitat relief. Based on yearly averages of all 35-mm images taken at each waypoint.

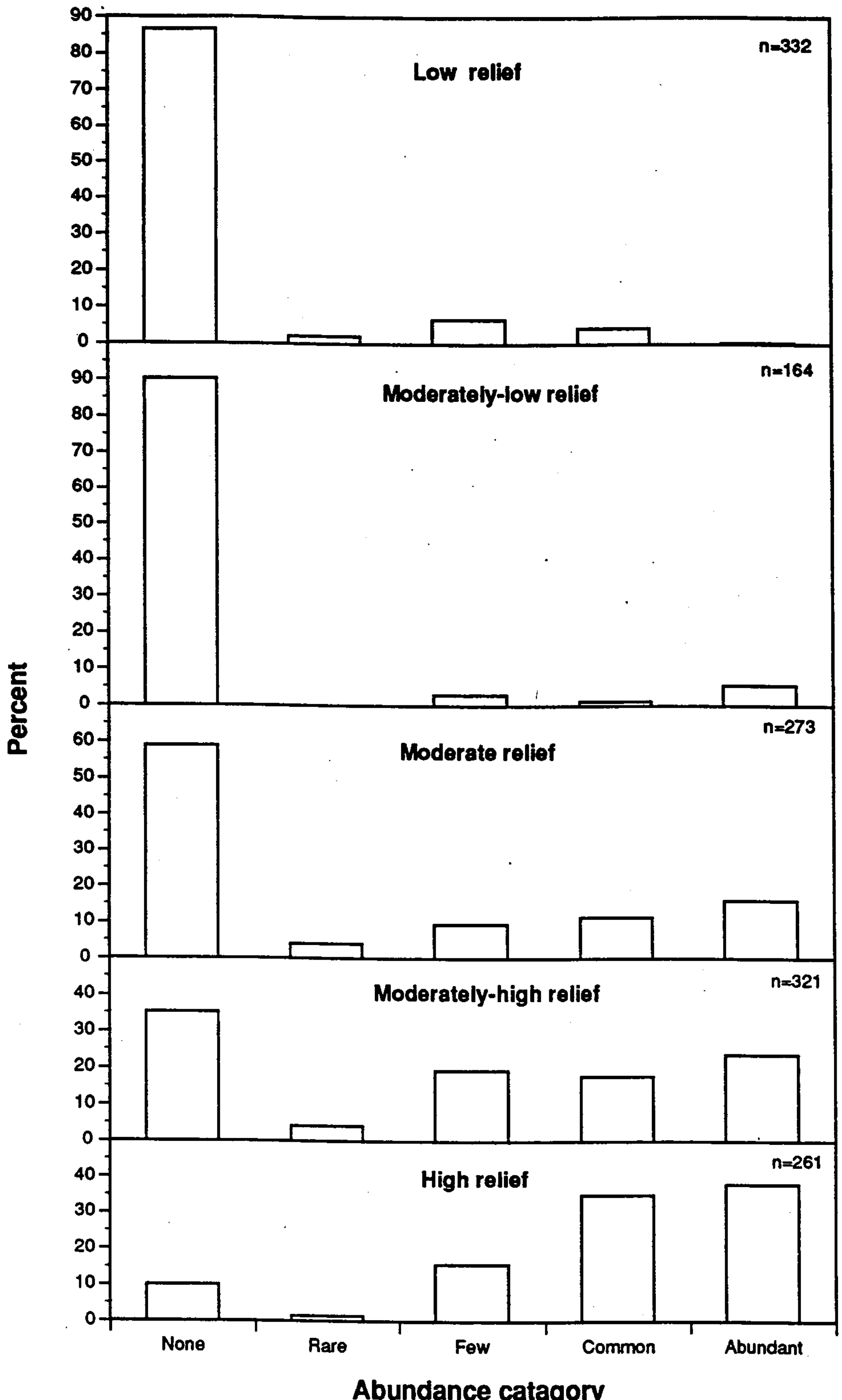


Figure 86. Relative abundance of the filamentous red alga *Asparagopsis hamifera* in relation to habitat relief. Based on individual 35-mm images taken during the 1995, 1996 and 1997 surveys.

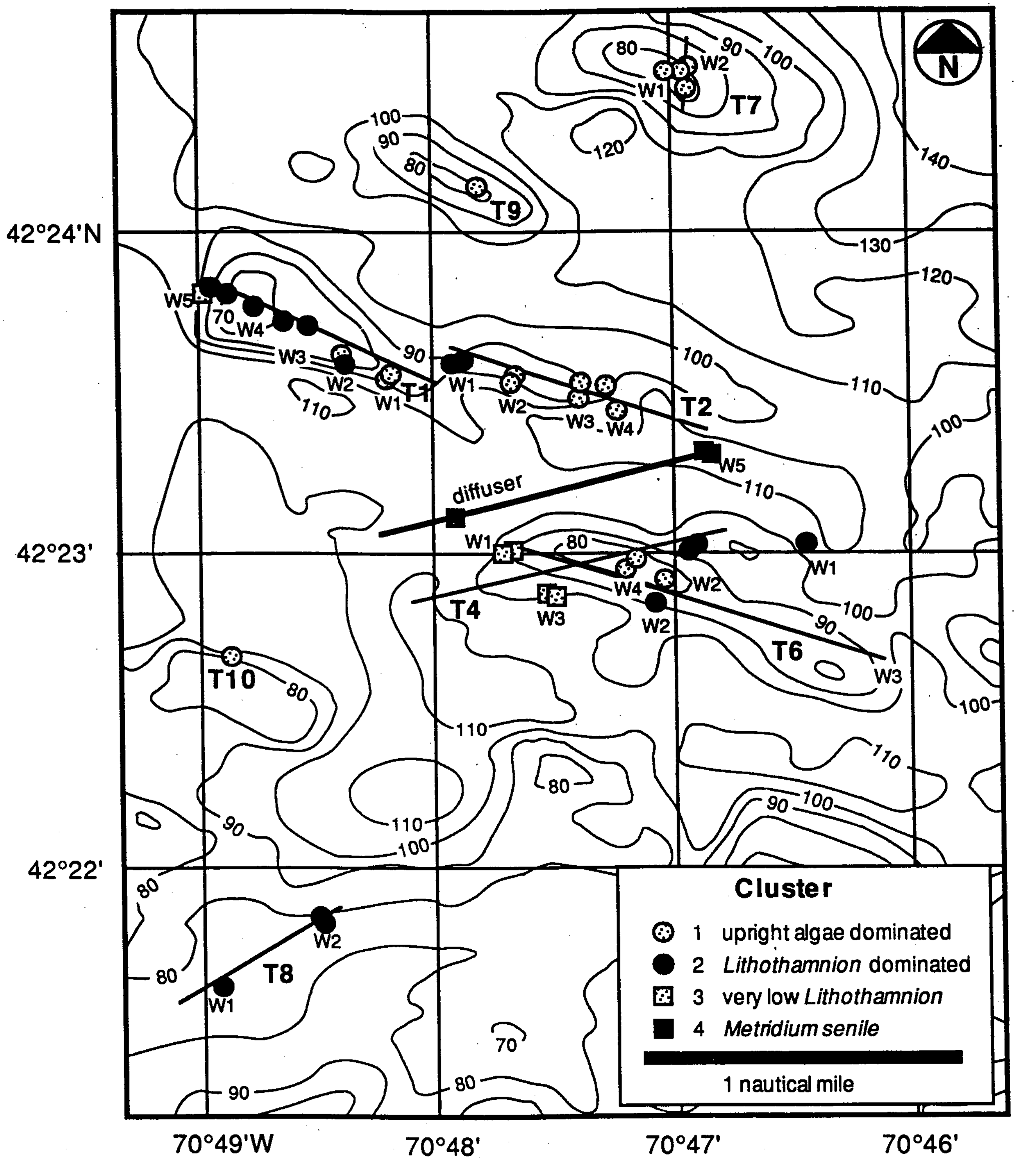


Figure 87. Map of benthic communities defined from hierarchical classification of the 35-mm images taken during the 1996 and 1997 surveys.

diffuser, at 2 of the southwestern reference sites, and at some of the drumlin flank sites (cluster 2). Two of the flank sites located just south of the diffuser had exceptionally low abundances of *Lithothamnion* spp. and were relatively depauperate (cluster 3). The two diffuser heads that were surveyed were colonized by *Metridium senile* and *Asterias vulgaris* (cluster 4). These cluster patterns also generally concur with the results obtained in 1995 . We did not attempt a direct community analysis comparison with the 1995 data because of the limited number and non-random collection of the 35-mm images during that year.

Our results are generally similar to those found by Coats *et al.* (1995a) from a video survey conducted in 1994. Four of the eight transects covered in this report (transects 1, 2, 4 and 6) were the same as those included in the 1994 survey. The 1994 survey consisted of nearly continuous video coverage along the transects, while the present design focuses on topographically selected points (waypoints) along the transects that included representative drumlin top and flank locations. Differences between the results of the two surveys appear to be related to visual resolution of the films and taxonomic designations. The 1995, 1996, and 1997 surveys, respectively, identified 76, 72, and 100 taxa, compared to 37 taxa identified from the 1994 video survey. Many of the additional taxa identified in the present study are encrusting and attached organisms. Rather than indicating changes in the benthic communities in this region, the difference in number of taxa is undoubtedly due to the greater resolution afforded by the ROV being closer to the sea floor in the present study (right on the bottom as opposed to an altitude of 1 to 3 meters). Coats *et al.* (1995a) identified an abundant pinnate red alga as *Rhodymenia* sp. A, this appears to be the filamentous red alga that we have identified as *Asparagopsis hamifera*. Additionally, their Porifera sp. A was an orange encrusting sponge, which is probably the orange/tan sponge commonly seen during the present study.

Another video survey of the area west of the new sewage outfall identified 23 taxa (Etter *et al.*, 1987). The lower number of species seen in that survey was probably due to habitat differences between the areas surveyed. The 1987 survey covered mostly depositional sediment areas, whereas the present study concentrated mostly on erosional hard substratum areas (drumlins). At any given depth, sediment generally supports fewer epifaunal species per unit area than does hard substrate (B. Hecker, pers. obs.). This may be related to the more limited availability of hard substrates in subtidal environments. Even in the deep sea, occasional hard surfaces (i.e., boulders, ship wrecks, airplane wrecks, and nuclear-waste drums) are almost always heavily colonized by attached taxa.

General faunal distribution patterns were similar among all the surveys. Algae are most abundant on the tops of drumlins. Coats *et al.* (1995a) reported that *Rhodymenia palmata*, *Rhodymenia* sp. A (a pinnate red alga), and *Agarum cribosum* were found together on hard substratums at shallower depths. We found that the benthic communities inhabiting drumlin tops are dominated by algae, that cobbles and smaller boulders are dominated by *Lithothamnion* spp. and that the tops of larger boulders are dominated by *Asparagopsis hamifera*. While Coats *et al.* (1995a) estimated percent cover of *Lithothamnion,* they did not discuss its' distribution. All three surveys also found that the anemone *Metridium senile* and the cunner *Tautogolabrus adspersus* were most abundant near large boulders. Coats *et al.* (1995) reported that the distribution of the green sea urchin *Strongylocentrotus droebrachiensis* was depth related, with the urchins being most abundant at shallower depths. We found a similar result in that this urchin was most abundant on the tops of drumlins, but we attribute this distribution to availability of their primary food source, the coralline alga *Lithothamnion* spp.

Due to the different overall focus of the Coats *et al.* (1995b) report, more detailed comparisons of community structure and the factors that control it can not be made. Moreover, use of a different navigational grid by Coats *et al.* (1995b) makes direct comparisons of respective transect locations difficult.

The three years of surveys show that the hard-bottom benthic communities near the outfall were relatively stable over the 1995 to 1997 time period. The remarkable similarity between the results of the 1996 and 1997 surveys indicate that substantial departures from baseline conditions should be detectable. The expanded emphasis on 35-mm images during the 1996 and 1997 surveys has enabled us to better resolve factors controlling the distribution of several of the dominant taxa. Larger boulders appeared to be the preferred substrate for upright algae and a number of attached invertebrate taxa. This is not surprising since larger rocks are less susceptible to mechanical disturbance. Boulders often were the dominant size class observed on the top of drumlins. In contrast, the distribution of the encrusting coralline alga *Lithothamnion* spp. appeared to be related primarily to degree of sediment drape. Not surprisingly, sediment loading also appeared to restrict the presence of many other encrusting and sessile taxa, which were frequently restricted to the sides and under hangs of boulders. Sediment drape was frequently heavier on the flanks of drumlins.

The amount of sediment drape on rocks frequently varied widely within sites, with totally clean rocks adjacent to rocks heavily covered with sediment. This resulted in a fair amount of small-scale within site heterogeneity in the distributions of many of the taxa. In terms of detecting habitat degradation as a result of the outfall coming on line, *Lithothamnion* spp. appears to hold the greatest promise as an indicator species. It appears to be the most predictable taxon in terms of abundance, distributional pattern, and habitat requirements. It is the least patchily distributed taxon and appears to dominate in all areas that are shallower than 110 ft and that have little sediment drape. Additionally, it is common in areas of both high and low relief. By focusing on *Lithothamnion* spp. as an indicator, it is quite likely that major changes in the benthic communities inhabiting the hard-bottom areas near the outfall could be detected.

Potential impacts might be anticipated in terms of changes in the amount of sediment reaching the sea floor. If materials discharged from the outfall were to accumulate in the vicinity of the drumlins, it is anticipated that this would result in a marked decrease in the percent coverage of *Lithothamnion* spp. If the discharges from the outfall alter properties of the water column that affect light penetration, then changes might be expected in the depth distribution of *Lithothamnion* spp. If water clarity were reduced it is expected that the lower depth limit of high coralline algal coverage would be reduced. Conversely, if water clarity were increased then it is expected that high coralline algal coverage would extend into some of the deeper areas.

5.0 Conclusions and Recommendations

The recommendations in this chapter are those of the authors of this report and not necessarily those of the MWRA.

5.1 Sedimentology

- Sediment texture at nearfield stations and most midfield stations has exhibited great consistency over time.

- Nearfield stations consist of compacted (hard) fine rippled sands with low inventories of organic carbon (< 1% TOC) and *Clostridium perfringens* spores. Wave and current scouring of the bottom near the diffuser remove fines and produce bedload transport of sands and aerate the upper few centimeters of the bottom by ripple migration. The instability of the bottom leads to patchy mosaics of Stage I benthic successional seres.

- Nearfield station NF24 is an exception to the above generalization. This station is located in a depression that is isolated from bottom current scour. The dominant texture is a mixture of very fine sand, silt, and clay with an inventory of > 1% TOC. A mixture of Stage I and III species populate this low kinetic energy station and ventilation of the upper sediment column is related to bioturbation. This station is receiving sediment washed into the depression from the surrounding higher kinetic energy bottoms. This sediment focusing results in high sediment accumulation rates.

- Midfield stations near the diffuser consist of rippled very fine sands and are less compacted than nearfield sands. These stations show a sand-over-mud stratigraphy; and provide a record of changing kinetic energy regimes at the facies boundary between the nearfield and midfield sampling areas. Aeration of the sediment column is related to a combination of ripple migration and bioturbation. The surficial organic carbon inventory of these stations can change over time related to changing kinetic conditions. This transitional area is both a kinetic energy gradient, a sediment facies gradient, and an ecological ecotone. These stations experience the greatest temporal and spatial variance in physical and biological properties.

- Midfield stations located to the West, North, and South of the transitional area are relatively uncompacted muddy sands with variable organic carbon inventories. Sediment aeration is largely related to bioturbation. Successional seres are represented by a mixture of Stage I, II, and/or III seres.

- Given these generalizations, are these data sufficient to detect changes related to increased POC loadings from the effluent diffuser? Further, what is the threshold of organic loading that would be expected to result in major changes in benthic structure and processes? How would these changes differentially effect the general facies patterns described above? An analysis of organic loading and benthic responses is given in Appendix H along with predictions of benthic effects.

- Patterns in concentration of TOC and *Clostridium* spore counts when comparing stations and years in the nearfield and midfield are very similar to each other and are often directly correlated with the amount of silt and clay found in the samples.

- Levels of TOC and *Clostridium* are low at all farfield stations and generally similar over time.

- Patterns of sediment texture at the eight farfield stations have been very consistent over time. In general, stations FF1A and FF9 have the coarsest sediments; stations FF4, FF7, and FF11 have the finest sediments; and stations FF5, FF6, and FF14 have sediments that are intermediate in texture.

5.2 Soft-bottom Infaunal Communities

- Benthic community parameters observed in 1997 were generally similar to those seen in previous baseline monitoring years, both in the vicinity of the new outfall and throughout Massachusetts and Cape Cod Bays. Three faunal assemblages have been identified in the nearfield and midfield study area. Of these, the *Exogone-Corophium* assemblage found at the coarse-sand stations is the most consistent. Nearfield stations NF4 and NF17 have been dominated by this fauna for all five years of monitoring.

- The fauna in the nearfield and midfield consists of a sand assemblage and two mud assemblages that are detectable in both single year (1997) and multiyear (1992-1997) analysis.

- The sand assemblage is characterized by the polychaete *Exogone hebes* and the amphipod *Crassicorophium crassicorne* in all analyses. Single year contributors include an oligochaete Enchytraeidae sp. 1, several polychaetes including *Polygordius* sp. 1, *Aglaophamus circinata*, and *Spiophanes bombyx*, the amphipod *Pseudunciola obliquua,* and the sand dollar *Echinarachnius parma*.

- One mud assemblage is more or less characterized by a suite of six polychaetes, *Leitoscoloplos acutus, Mediomastus californiensis, Prionospio steenstrupi, Monticellina baptisteae, Ninoe nigripes,* and *Tharyx acutus*.

- The polychaetes *Exogone verugera*, *Dipolydora socialis*, and *Nephtys incisa* along with the amphipod *Photis pollex* prefer mixed sediments and constitute what may be termed the second mud assemblage. However, the species that define mud assemblages are quite variable from year to year and sometimes shift in their contribution annually. For example, *Exogone verugera* often resides with the sand assemblage where it may at times be a major contributor.

- Species diversity as measured by ES_{100} ranged from 16.87 to 33.66 in 1997 nearfield and midfield samples. There was little or no pattern in the distribution of diversity among these samples except that higher diversity stations were located in the northern half of the array and lower diversity stations in the southern half of the array.

- Farfield benthic communities in 1997 were distributed among three station groups: (1) two stations (FF1A and 9) that are nearshore and close to the midfield array; (2) FF4, 5, 11, and 14 all offshore in the vicinity of Stellwagen Basin; and (3) FF6 and 7 in Cape Cod Bay.

- When combined with the nearfield and midfield samples, the farfield samples retained their identity and groupings demonstrating their distinctness and appropriateness as reference stations.

- The nearshore farfield assemblage was characterized by species typically found in the nearfield and midfield such as *Prionospio steenstrupi, Spio limicola*, and *Dipolydora socialis*. The offshore assemblage was characterized by *Chaetozone setosa, Aricidea quadrilobata, Levinsenia gracilis*, and other polychaetes. The Cape Cod Bay assemblage was characterized by *Cossura longocirrata, Tharyx acutus, Euchone incolor*, and *Nucula annulata*.

- Species richness (i.e., number of species recorded) was higher in 1996 and 1997 than in earlier years. This result may be due in part to better identification of juvenile polychaetes and molluscs. It will be of primary importance to maintain similar levels of taxonomic discrimination in the years after the outfall comes on line. Any apparent changes in species diversity should be evaluated first by comparison with the underlying database.

- A comparison of the community results for a 1992-1996 multiyear analysis with 1997 data demonstrates that major assemblage patterns are similar with the same indicator species, but that contributions of these species and the appearance and disappearance of other species changes annually.

- Calculation of an average species diversity suggests that diversity at the nearfield stations is slightly higher than average diversity at either midfield or farfield stations. Shannon-Wiener H′ values when averaged (± Standard Error of the Mean) over the period 1992-1997 were 2.69 ± 0.053 for the nearfield, 2.60 ± 0.043 for the midfield, and 2.58 ± 0.054 for the farfield. Hurlbert ES_{100} values averaged for the same period were 23.90 ± 0.583 for the nearfield, 22.03 ± 0.476 for the midfield, and 22.93 ± 0.0.530 for the farfield. Differences, however, are small with overlapping error bars.

- Similar calculations for number of species and numbers of individuals suggest that the nearfield stations have the highest numbers of species ($\bar{x}$=68.13 ±2.6) versus the midfield ($\bar{x}$=63.15±1.8) and farfield ($\bar{x}$=57.35±1.8). The highest average densities, measured as individuals per 0.04 m^2 are in the midfield ($\bar{x}$=1951.98±121.93). Densities in the nearfield ($\bar{x}$=1897.83±137.17) and farfield ($\bar{x}$=1460.22±114.23) are less. Differences between the nearfield and midfield are small, and the error bars overlap. The differences with the farfield are greater, but still relatively small.

5.3 Hard-bottom Benthos

- The nearfield hard-bottom benthic communities are temporally stable over the 1995-1997 sampling period. Community analysis of the 1996 and 1997 data sets yielded almost identical results. This temporal stability greatly enhances the utility of this data for detecting future change due to the outfall.

- Location on the drumlins, depth, substratum type and habitat relief all appear to play a role in determining the structure of the benthic communities inhabiting hard-bottom areas in the vicinity of the outfall. Some taxa show strong preferences for specific habitats, while others are broadly distributed.

- Some areas are homogeneous in terms of substratum type and the fauna inhabiting them, while other areas exhibit more patchiness. Some of the variability observed in the data may be related to difficulties in distinguishing between some of the categories of encrusting organisms that may encompass several species. However, a fair amount of the variability may be due to the inherently patchy nature of hard-bottom habitats and the fauna that inhabit them.

- Analysis of the still photographs shows finer details of the benthic communities than can be discerned from the video tapes. The two techniques are complimentary in that the video survey provides greater areal coverage and the still photographs provide a more accurate assessment of the taxa inhabiting these areas. Both techniques are valuable for establishing baseline data.

- As with the soft-bottom benthic community analysis, consistency in taxonomic identifications will be of primary importance in ensuring the ability to make comparisons between baseline and post-operational data.

- The best potential indicator species for detecting change due to the outfall is the abundant and widely distributed coralline alga *Lithothamnion*. This alga was abundant in all areas of stable hard substrate and little sediment drape.

6.0 Acknowledgments

The authors of this report would like to thank the many people who helped with all stages of sample collection and analysis as well as the generation of data and graphics that resulted in the production of this report. Frank Mirarchi and Chip Ryther provided services related to the research vessels used in this program. Vince Capone was the ROV pilot. Cove Corporation sorted the benthic infauna samples. The taxonomic staff of the ENSR Woods Hole office performed most of the faunal identifications, supported by Brigitte Hilbig (ENSR and Zoological Institute and Museum, Hamburg), Gene Ruff (Ruff Systematics), and Russ Winchell (Oceans Taxonomic Services). CHN analysis was provided by Brian Howes (CMAST); sediment grain size was analyzed by Peter Rosen (Geo/Plan Associates), and *Clostridium perfringens* spore counts were determined by BAL, Inc. Graphics support was provided by Helen Vickers (Graphics Plus). Paula Winchell assisted in the hard-bottom photographic analysis. Wendy Leo (MWRA) and Mel Higgins and Stephanie Kelly (ENSR) were instrumental in standardizing the faunal data so that the multiyear analysis could be completed. Nancy Maciolek read and commented on the draft of this document. Finally, we express our thanks to Ken Keay (MWRA) for his constant support and encouragement.

7.0 References

Blake, J.A., E.M. Baptiste, R.E. Ruff, B. Hilbig, B. Brown, R. Etter, and P. Nimeskern. 1987. Soft-bottom Benthos of Massachusetts Bay. Marine Ecology and Water Quality Field Studies for Outfall Siting. Deer Island Secondary Treatment Facilities Plan. Report to Camp Dresser and McKee, Inc., for the Massachusetts Water Resources Authority, Boston, MA. 109 pp. +22 Appendices.

Blake, J.A., B. Hecker, N.J. Maciolek, B. Hilbig, and I.P. Williams. 1997. Massachusetts Bay Outfall Monitoring Program: 1996 Benthic Biology and sedimentology. MWRA Enviro. Quality Dept. Tech. Rpt. Series No. 97-11. Massachusetts Water Resources Authority, Boston, MA. 104 pp., Appendices A-D.

Blake, J.A. and B. Hilbig. 1995. Combined Work/Quality Assurance Plan (CW/QAPP) for Benthic Monitoring: 1995-1997. MWRA Enviro. Quality Dept. Misc. Rpt. No. Ms-34. Massachusetts Water Resources Authority, Boston, MA. 68 pp.

Blake, J.A., B. Hilbig, and D.C. Rhoads. 1993. Massachusetts Bay Outfall Monitoring Program. Soft-Bottom Benthic Biology and Sedimentology. 1992 Baseline Conditions in Massachusetts and Cape Cod Bays. MWRA Enviro. Quality Dept. Tech. Rpt. No. 93-10. Massachusetts Water Resources Authority, Boston, MA. 108 pp + 4 Appendices.

Blake, J.A., N.J. Maciolek, and P. Rosen. 1989. Benthic infaunal communities of Boston Harbor. Report to the Massachusetts Water Resources Authority, Boston, MA.

Bokuniewicz, H. J., R,B. Gordon, and D.C. Rhoads, 1975. Mechanical properties of the sediment-water interface: Marine Geology, 18:263-278.

Coats, D.A. 1995. 1994 Annual Soft-Bottom Benthic Monitoring. Massachusetts Bay Outfall Studies. MWRA Enviro. Quality Dept. Tech. Rpt. Series No. 95-20. Massachusetts Water Resources Authority, Boston MA. 120 pp. + Appendices.

Coats, D.A., E. Imamura, and J.F. Campbell. 1995a. Annual Soft-bottom Benthic Monitoring. Massachusetts Bay Outfall Studies. MWRA Environmental Quality Dept. Tech. Rpt. Series No. 95-2. Massachusetts Water Resources Authority, Boston, MA. 85 pp + Appendices.

Coats, D.A., E. Imamura, and J.F. Campbell. 1995b. Hard-substrate Reconnaissance Survey S9404 Final Analysis Report. Massachusetts Bay Outfall Studies. MWRA Environmental Quality Dept. Tech. Rpt. Series No. 95-1. Massachusetts Water Resources Authority, Boston, MA 48 pp. + Appendices.

Emerson, D.J. and V.J. Cabelli. 1982. Extraction of *Clostridium perfringens* spore from bottom sediment samples. Applied Environmental Microbiology 44:1144-1149.

EPA. 1988. Boston Harbor Wastewater Conveyance System. Supplemental Environmental Impact Statement. Vol. I. U.S. Environmental Protection Agency, Region I, Boston, MA.

Etter, R., B. Hilbig, J.A. Blake, and B. Brown. 1987. Second Benthic Reconnaissance Cruise. Final report submitted to MWRA by Battelle Ocean Sciences. 44 pp. and 1 attachment.

Gabriel, K.R. 1971. The biplot graphic display of matrices with application to principal component analysis. Biometrika 58:453-467.

Grassle, J.F. and W. Smith. 1976. A similarity measure sensitive to the contribution of rare species and its use in investigation of variation in marine benthic communities. Oecologia 25:13-22.

Hilbig, B., J.A. Blake, E. Butler, B. Hecker, D.C. Rhoads, G. Wallace, and I.P. Williams. 1996. Massachusetts Bay Outfall Monitoring Program: 1995 Benthic Biology and Sedimentology. MWRA Enviro. Quality Dept. Tech. Rpt. Series No. 96-5. Massachusetts Water Resources Authority, Boston, MA. 230pp. + Appendices.

Hurlbert, S.H. 1971. The nonconcept of species diversity: a critique and alternative parameters. Ecology 52:577-586..

Martinez, A.J. and R.A. Harlow. 1994. Marine Life of the North Atlantic. Canada to New England. Privately published, 272 pp.

MWRA. 1991. Effluent Outfall Monitoring Plan Phase I: Baseline Studies. Massachusetts Water Resources Authority, Boston, MA. 45 pp.+Appendices A-C.

NOAA. 1993a. *Comprehensive Descriptions of Complementary Measurements.* Sampling and Analytical Methods of the National Status and Trends Program, National Benthic Surveillance and Mussel Watch Projects, 1984-1992 (Volume II). NOAA Technical Memorandum NOS/ORCA/CMBAD 711. 102 pp.

Rhoads, D.C., and L.F. Boyer, 1982. The effect of marine benthos on physical properties of sediments; a successional perspective: In, Animal-Sediment Relations (R.L. McCall and M.J.S. Tevesz, eds.), p. 3-52, Plenum Pub. Co., New York, N.Y.

Rhoads, D.C. and J.D. Germano. 1982. Characterization of the organism-sediment relations using sediment profile imaging: an efficient method of Remote Ecological Monitoring the Seafloor (REMOTS® system). Marine Ecology Progress Series 8:115-128.

Rhoads, D.C. and D.K. Young. 1971. Animal-sediment relations in Cape Cod Bay, Massachusetts. II. Reworking by *Molpadia oolitica* (Holothuroidea). Marine Biology 11:255-261.

SAIC. 1992. REMOTS® Sediment-Profile Photography Surveys of Boston Harbor, Dorchester, Quincy, Hingham, and Hull Bays: June 1989 and May 1990. Report to the Massachusetts Water Resources Authority, 45 pp.

Sanders, H.L. 1968. Marine benthic diversity: a comparative study. American Naturalist. 102:243-282..

Sokal, R.R. and P.H.A. Sneath. 1963. Principles of Numerical Taxonomy. Freeman Press, San Francisco, 573 pp.

Trueblood, D.D., E. D. Gallagher, and D.M. Gould. 1994. Three stages of seasonal succession on the Savin Hill Cove mudflat, Boston Harbor. Limnology and Oceanography 39:1440-1454..

Weiss, H.M. 1995. Marine animals of southern New England and New York. State Geological and Natural History Survey of Connecticut, Department of Environmental Protection, Bulletin 115.

Whitaker, R.H. and C.W. Fairbanks. 1987. A study of plankton copepod communities in the Columbia Basin, southeastern Washington. Ecology 54::46-65.

Young, D.K. and D.C. Rhoads. 1971. Animal-sediment relations in Cape Cod Bay, Massachusetts. I. A transect study.. Marine Biology 11:242-254..

List of Appendices

Appendix A

Station Data

Appendix A1. Target locations for nearfield, midfield, and farfield soft-bottom survey locations.

Station	Latitude	Longitude	Depth (m)
	Nearfield Stations		
NF13	42° 23.40′N	70° 49.35′W	33
NF14	42° 23.20′N	70° 49.36′W	33
NF15	42° 22.93′N	70° 49.67′W	32
NF17	42° 22.88′N	70° 48.89′W	29
NF18	42° 23.80′N	70° 49.31′W	35
NF19	42° 22.30′N	70° 48.30′W	32
NF23	42° 23.86′N	70° 48.10′W	36
NF24	42° 22.83′N	70° 48.10′W	37
	Midfield Stations		
FF10	42° 24.84′N	70° 52.72′W	27
FF12	42° 23.40′N	70° 53.98′W	22
FF13	42° 19.19′N	70° 49.38′W	19
MF2	42° 20.31′N	70° 49.69′W	30
MF4	42° 24.93′N	70° 48.39′W	36
MF5	42° 25.62′N	70° 50.03′W	36
MF7	42° 24.60′N	70° 48.89′W	33
MF8	42° 24.00′N	70° 51.81′W	32
MF9	42° 23.99′N	70° 50.69′W	29
MF10	42° 23.57′N	70° 50.29′W	35
MF12	42° 23.40′N	70° 49.83′W	34
MF16	42° 22.70′N	70° 50.26′W	29
MF20	42° 22.69′N	70° 50.69′W	28
MF21	42° 24.16′N	70° 50.19′W	33
MF22	42° 20.87′N	70° 48.90W	36
	Farfield Stations		
FF1A	42° 33.84′N	70° 40.55′W	32
FF4	42° 17.30′N	70° 25.50′W	87
FF5	42° 08.00′N	70° 25.35′W	61
FF6	41° 53.90′N	70° 24.20′W	33
FF7	41° 57.50′N	70° 16.00′W	37
FF9	42° 18.75′N	70° 39.40′W	49
FF11	42° 39.50′N	70° 30.00′W	87
FF14	42° 25.00′N	70° 39.29′W	77

Appendix A2. Transects and waypoints visited during the nearfield hard-bottom survey, June 1997.

Transect	Waypoint	Latitude	Longitude	Depth (m)	Date	Start Time
T1	1	42°23.606'N	70°48.201'W	26	6/11/97	17:07
T1	2	42°23.625'N	70°48.324'W	26	6/11/97	16:10
T1	3	42°23.741'N	70°48.532'W	22	6/11/97	15:12
T1	4	42°23.815'N	70°48.743'W	20	6/11/97	14:15
T1	5	42°23.869'N	70°48.978'W	27	6/11/97	12:18
T2	1	42°23.634'N	70°47.833'W	27	6/12/97	08:13
T2	2	42°23.570'N	70°47.688'W	28	6/12/97	09:24
T2	3	42°23.525'N	70°47.410'W	26	6/12/97	10:13
T2	4	42°23.457'N	70°47.265'W	31	6/12/97	11:13
T2- Diffuser #2	5(B)+	42°23.331'N	70°46.807'W	34	6/13/97	09:55
T4	1	42°23.046'N	70°46.502'W	33	6/13/97	08:11
T4	2	42°23.012'N	70°46.960'W	31	6/13/97	11:16
T4	3	42°22.877'N	70°47.580'W	32	6/13/97	12:40
T4/T6*	4	42°22.948'N	70°47.220'W	26	6/13/97	14:55
T6	1	42°22.993'N	70°47.712'W	33	6/13/97	13:32
T6	2	42°22.855'N	70°47.082'W	31	6/13/97	15:47
T7	1	42°24.565'N	70°47.015'W	30	6/12/97	17:33
T7	2	42°24.570'N	70°46.920'W	28	6/12/97	18:13
T8	1	42°21.602'N	70°48.920'W	26	6/14/97	08:14
T8	2	42°21.823'N	70°48.465'W	25	6/14/97	09:00
T9	1	42°24.170'N	70°47.768'W	28	6/12/97	16:45
T10	1	42°22.680'N	70°48.852'W	24	6/14/97	10:11
Diffuser # 44	--	42°23.116'N	70°47.931'W	34	6/13/97	16:55

+ Station repeated due to technical failure during first dive.

* The fourth waypoints for T4 and T6 are the same (i.e., intersection of the two transects).

Appendix B

Sediment Data

Appendix B1. **Grain-size composition of sediment from 23 Massachusetts Bay midfield and nearfield stations taken in August 1997. Data are percentages of total initial sample weight.**

Station	% Gravel	% Very Coarse Sand	% Coarse Sand	% Medium Sand	% Fine Sand	% Very Fine Sand	% Total Sand	% Silt	% Clay	Mean Phi
	>2.00 mm	>1.00 to 2.00 mm	>0.50 to 1.00 mm	>0.25 to 0.50 mm	>0.125 to 0.25 mm	>0.0625 to 0.125 mm	>0.0625 to 2.00 mm	>0.0039 to 0.0625 mm	<0.0039 mm	
	Phi < -1	-1 < Phi < 0	0 < Phi < 1	1 < Phi < 2	2 < Phi < 3	3 < Phi < 4	-1 < Phi <	4 < Phi < 8	Phi > 8	
Midfield										
FF-10 Rep. 1	1.39	0.39	0.72	5.44	28.63	47.05	82.2	11.7	4.7	3.55
FF-10 Rep. 2	0.39	0.45	1.19	7.08	27.39	43.57	79.7	15.5	4.4	3.64
FF-12 Rep. 1	0.57	0.09	0.23	1.36	6.71	60.45	68.8	24.0	6.6	4.33
FF-12 Rep. 2	0.06	0.17	0.52	0.89	8.38	68.32	78.3	17.3	4.4	4.05
FF-13 Rep. 1	0.03	0.07	0.24	1.20	12.23	27.69	41.4	44.8	13.7	5.22
FF-13 Rep. 2	0.08	0.18	0.43	2.33	12.40	23.49	38.8	51.1	10.0	5.13
MF-2	0.27	0.35	3.43	57.00	29.30	2.59	92.7	4.2	2.9	2.20
MF-4	0.00	0.06	0.25	16.63	73.08	7.02	97.1	1.2	1.7	2.55
MF-5	0.99	0.95	0.89	7.53	43.03	13.96	66.3	19.7	12.9	4.01
MF-7	0.22	0.43	0.81	6.96	26.08	19.25	53.5	33.7	12.6	4.58
MF-8	0.51	0.74	1.00	4.26	12.50	15.96	34.5	51.9	13.1	5.22
MF-9	0.25	0.71	1.15	3.15	13.39	43.63	62.0	27.8	9.9	4.47
MF-10	0.06	0.25	0.70	1.94	8.51	39.44	50.8	37.1	12.0	4.93
MF-12 Rep. 1	0.00	0.08	0.37	1.63	6.55	18.90	27.5	54.5	17.9	5.74
MF-12 Rep. 2	0.63	0.83	1.24	2.57	9.34	25.31	39.3	46.8	13.3	5.15
MF-16	0.65	0.99	0.82	8.26	29.27	17.78	57.1	30.1	12.1	4.36
MF-20	9.13	3.46	3.18	16.50	28.06	25.66	76.9	9.1	4.9	2.70
MF-21	0.16	0.16	0.30	1.02	3.74	31.70	36.9	49.3	13.6	5.40
MF-22	0.35	0.89	0.31	4.18	11.04	30.45	46.9	40.9	11.9	4.92

Appendix B1. Continued

Station	% Gravel	% Very Coarse Sand	% Coarse Sand	% Medium Sand	% Fine Sand	% Very Fine Sand	% Total Sand	% Silt	% Clay	Mean Phi
	>2.00 mm	>1.00 to 2.00 mm	>0.50 to 1.00 mm	>0.25 to 0.50 mm	>0.125 to 0.25 mm	>0.0625 to 0.125 mm	>0.0625 to 2.00 mm	>0.0039 to 0.0625 mm	<0.0039 mm	
	Phi < -1	-1 < Phi < 0	0 < Phi < 1	1 < Phi < 2	2 < Phi < 3	3 < Phi < 4	-1 < Phi <	4 < Phi < 8	Phi > 8	
					Nearfield					
NF-13	0.24	0.08	0.74	24.82	64.92	5.62	96.2	1.4	2.2	2.47
NF-14	5.66	1.80	4.24	27.52	45.10	5.40	84.1	5.9	4.3	2.40
NF-15	7.57	0.60	2.84	30.53	36.41	8.98	79.4	7.8	5.2	2.52
NF-17 Rep. 1	0.00	0.11	2.11	24.86	68.60	1.92	97.6	0.4	2.0	2.37
NF-17 Rep. 2	0.00	0.10	1.66	26.12	68.18	2.14	98.2	0.2	1.6	2.33
NF-18	26.73	1.89	0.95	18.16	19.72	14.35	55.1	13.9	4.3	2.08
NF-19	5.88	0.77	1.03	8.79	62.30	8.87	81.8	6.5	5.8	2.83
NF-23	2.04	0.27	1.37	49.35	42.03	2.13	95.2	1.1	1.7	2.06
NF-24 Rep. 1	0.00	0.08	0.17	4.28	7.71	7.84	20.1	53.5	26.4	6.12
NF-24 Rep. 2	0.00	0.19	0.15	4.80	9.82	23.30	38.3	49.7	12.0	5.20

Appendix B2. Total organic carbon (% C), total organic nitrogen (% N), and carbon/nitrogen ratio (C/N) in sediment samples from 23 Massachusetts Bay midfield and nearfield stations taken in August 1997.

Station; Replicate	Total Organic Carbon (% C)	Station Mean	Total Organic Nitrogen (% N)	Station Mean	Carbon Nitrogen Ratio (C/N)	Station Mean
Midfield						
FF-10; Rep. 1; Rep. 2	0.631; 0.400	0.516	0.054; 0.041	0.095	13.62; 11.46	12.54
FF-12; Rep. 1; Rep. 2	0.582; 0.425	0.504	0.060; 0.048	0.054	11.32; 10.36	10.84
FF-13; Rep. 1; Rep. 2	1.404; 0.829	1.117	0.183; 0.094	0.277	8.93; 10.24	9.59
MF-2	0.192	0.192	< 0.041	< 0.041	BDL	BDL
MF-4	0.085	0.085	0.010	0.010	9.83	9.83
MF-5	0.932	0.932	0.109	0.109	9.98	9.98
MF-7	0.997	0.997	0.087	0.087	13.32	13.32
MF-8	1.745	1.745	0.203	0.203	10.02	10.02
MF-9	0.793	0.793	0.071	0.071	13.10	13.10
MF-10	0.947	0.947	0.088	0.088	12.57	12.57
MF-12; Rep. 1; Rep. 2	1.502; 1.856	1.679	0.144; 0.117	0.131	12.17; 18.49	15.33
MF-16	1.183	1.183	0.097	0.097	14.22	14.22
MF-20	0.524	0.524	0.046	0.046	13.18	13.18
MF-21	1.225	1.225	0.110	0.110	12.94	12.94
MF-22	1.175	1.175	0.115	0.115	11.89	11.89
Nearfield						
NF-13	0.080	0.080	< 0.035	< 0.035	BDL	BDL
NF-14	0.362	0.362	0.039	0.039	10.79	10.79
NF-15	0.364	0.364	0.034	0.034	12.43	12.43
NF-17; Rep. 1; Rep. 2	0.087; 0.055	0.071	0.009; <0.047	<0.028	11.35; BDL	<11.35
NF-18	0.513	0.513	0.050	0.050	11.90	11.90
NF-19	0.340	0.340	0.042	0.042	9.53	9.53
NF-23	0.101	0.101	0.013	0.013	9.11	9.11
NF-24; Rep. 1; Rep. 2	1.949; 1.067	1.508	0.230; 0.101	0.166	9.87; 12.26	11.07

Appendix B3. *Clostridium perfringens* spore analysis of sediment samples from the 23 Massachusetts Bay midfield and nearfield stations taken in August 1997.

Station	% Water	Counts	Mean	Coefficient of Variation	*C. perfringens* Spores per Gram		
					Wet Weight	Dry weight	
						Sample Mean	Station Mean
FF-10 Rep. 1	23	13, 16	14.5	0.15	790	1000	1100
FF-10 Rep. 2	21	19, 20	19.5	0.04	960	1200	
FF-12 Rep. 1	32	57, 68	62.5	0.12	2500	3700	2750
FF-12 Rep. 2	32	30, 27	28.5	0.07	1200	1800	
FF-13 Rep. 1	39	58, 51	54.5	0.09	5200	8500	6750
FF-13 Rep. 2	30	34, 40	37.0	0.11	3500	5000	
MF-2	24	121, 107	114.0	0.09	980	1300	1300
MF-4	24	20, 18	19.0	0.07	190	250	250
MF-5	28	20, 21	20.5	0.03	2300	3300	3300
MF-7	27	25, 27	26.0	0.05	2100	2900	2900
MF-8	40	59, 52	55.5	0.09	5400	9000	9000
MF-9	35	19, 25	22.0	0.19	2100	3300	3300
MF-10	41	19, 18	18.5	0.04	1900	3300	3300
MF-12 Rep. 1	42	47, 39	43.0	0.13	3900	6700	5350
MF-12 Rep. 2	37	23, 25	24.0	0.06	2500	4000	
MF-16	24	58, 57	57.5	0.01	3700	4800	4800
MF-20	28	29, 24	26.5	0.13	1200	1700	1700
MF-21	33	63, 58	60.5	0.06	2800	4200	4300
MF-21 Dup.	30	33, 31	32.0	0.04	3000	4400	
MF-22	36	75, 80	77.5	0.05	3800	5900	5900
NF-13	24	26, 25	25.5	0.03	1200	1600	1600
NF-14	27	13, 19	16.0	0.27	760	1000	1000
NF-15	27	26, 22	24.0	0.12	1000	1400	1400
NF-17 Rep. 1	23	49, 45	47.0	0.06	230	300	240
NF-17 Rep. 2	22	29, 33	31.0	0.09	140	180	
NF-18	21	24, 21	22.5	0.09	1000	1300	1300
NF-19	19	34, 31	32.5	0.07	1600	2000	2000
NF-23	23	23, 22	22.5	0.03	200	260	260
NF-24 Rep. 1	48	54, 57	55.5	0.04	5000	9700	6000
NF-24 Rep. 2	38	15, 14	14.5	0.05	1400	2300	

Appendix B4. **Grain-size composition of sediment from eight Massachusetts Bay and Cape Cod Bay farfield stations taken in August 1997. Data are percentages of total initial sample weight.**

Station	% Gravel	% Very Coarse Sand	% Coarse Sand	% Medium Sand	% Fine Sand	% Very Fine Sand	% Total Sand	% Silt	% Clay	Mean Phi
	>2.00 mm	>1.00 to 2.00 mm	>0.50 to 1.00 mm	>0.25 to 0.50 mm	>0.125 to 0.25 mm	>0.0625 to 0.125 mm	>0.0625 to 2.00 mm	>0.0039 to 0.0625 mm	<0.0039 mm	
	Phi < -1	-1 < Phi < 0	0 < Phi < 1	1 < Phi < 2	2 < Phi < 3	3 < Phi < 4	-1 < Phi <	4 < Phi < 8	Phi > 8	
FF-1A Rep. 1	1.39	1.17	11.57	14.89	8.79	45.65	82.1	12.1	4.4	3.20
FF-1A Rep. 2	1.46	0.84	4.17	14.13	7.51	53.23	79.9	14.0	4.7	3.52
FF-4 Rep. 1	0.00	0.09	0.17	0.95	1.72	3.35	6.3	55.0	38.7	6.96
FF-4 Rep. 2	0.00	0.16	0.48	0.48	0.72	0.00	1.8	59.5	38.7	7.08
FF-5 Rep. 1	0.00	0.05	0.25	0.44	3.06	22.04	25.8	50.3	23.9	6.02
FF-5 Rep. 2	0.00	0.15	0.72	2.98	6.41	33.27	43.5	41.5	15.0	5.21
FF-6 Rep. 1	0.24	0.14	0.14	0.31	3.98	33.11	37.7	43.2	18.9	5.55
FF-6 Rep. 2	0.00	0.00	0.03	0.17	2.48	38.31	41.0	40.9	18.1	5.49
FF-7 Rep. 1	0.00	0.00	0.15	0.46	0.84	3.42	4.9	59.8	35.4	6.92
FF-7 Rep. 2	0.00	0.00	0.56	0.91	2.31	4.82	8.6	58.8	32.6	6.71
FF-9 Rep. 1	0.24	0.17	0.57	3.21	35.75	42.98	82.7	9.6	7.5	3.69
FF-9 Rep. 2	0.20	0.29	0.73	4.17	36.86	41.24	83.3	9.6	6.9	3.62
FF-11 Rep. 1	0.00	0.05	0.10	0.34	2.74	17.44	20.7	55.6	23.7	6.16
FF-11 Rep. 2	0.00	0.08	0.12	0.81	4.40	18.74	24.1	55.8	20.0	5.93
FF-14 Rep. 1	1.57	0.53	1.00	2.53	4.20	13.20	21.5	53.1	23.9	5.92
FF-14 Rep. 2	3.34	0.48	1.08	2.18	3.88	13.83	21.5	53.4	21.8	5.73

Appendix B5. Total organic carbon (% C), total organic nitrogen (% N), and carbon/nitrogen ratio (C/N) in sediment samples from eight Massachusetts Bay and Cape Cod Bay farfield stations taken in August 1997.

Station; Replicate	Total Organic Carbon (% C)	Station Mean	Total Organic Nitrogen (% N)	Station Mean	Carbon Nitrogen Ratio (C/N)	Station Mean
			Farfield			
FF-1A; Rep. 1; Rep. 2	0.378; 0.357	0.368	0.041; 0.042	0.042	10.73; 10.01	10.37
FF-4; Rep. 1; Rep. 2	2.454; 2.536	2.495	0.301; 0.305	0.303	9.52; 9.70	9.61
FF-5; Rep. 1; Rep. 2	1.468; 1.526	1.497	0.184; 0.193	0.189	9.32; 9.22	9.27
FF-6; Rep. 1; Rep. 2	1.128; 1.058	1.093	0.142; 0.132	0.137	9.25; 9.33	9.29
FF-7; Rep. 1; Rep. 2	2.483; 2.452	2.468	0.313; 0.311	0.312	9.24; 9.18	9.21
FF-9; Rep. 1; Rep. 2	0.444; 0.400	0.422	0.050; 0.047	0.049	10.35; 9.85	10.10
FF-11; Rep. 1; Rep. 2	1.719; 1.949	1.834	0.200; 0.232	0.216	10.01; 9.79	9.90
FF-14; Rep. 1; Rep. 2	1.453; 1.473	1.463	0.165; 0.172	0.169	10.29; 9.97	10.13

Appendix B6. ***Clostridium perfringens*** **spore analysis of sediment samples from eight Massachusetts Bay and Cape Cod Bay farfield stations taken in August 1997.**

Station	% Water	Counts	Mean	Coefficient of Variation	*C. perfringens* Spores per Gram		
					Wet Weight	Dry weight	
						Sample Mean	Station Mean
FF-1A Rep. 1	31	10, 8	9.0	0.16	520	750	720
FF-1A Rep. 2	30	13, 9	11.0	0.26	480	690	
FF-4 Rep. 1	41	15, 12	13.5	0.16	1400	4100	
FF-4 Rep.1 Dup.	67	11, 10	10.5	0.07	1000	3100	4100
FF-4 Rep. 2	66	18, 18	18.0	0.00	1600	4600	
FF-5 Rep. 1	50	7, 7	7.0	0.00	670	1300	1300
FF-5 Rep. 2	37	9, 9	9.0	0.00	830	1300	
FF-6 Rep. 1	42	14, 8	11.0	0.39	1000	1700	1750
FF-6 Rep. 2	41	16, 19	17.5	0.12	1000	1800	
FF-7 Rep. 1	65	8, 6	7.0	0.20	640	1800	1800
FF-7 Rep. 2	64	5, 8	6.5	0.33	630	1800	
FF-9 Rep. 1	35	18, 14	16.0	0.18	890	1400	1180
FF-9 Rep. 2	34	15, 14	14.5	0.05	630	960	
FF-11 Rep. 1	58	14, 12	13.0	0.11	1200	2800	
FF-11 Rep. 1 Dup.	59	7, 11	9.0	0.31	900	2200	2100
FF-11 Rep. 2	55	9, 6	7.5	0.28	780	1700	
FF-14 Rep. 1	50	5, 7	6.0	0.24	550	1100	1500
FF-14 Rep. 2	49	8, 12	10.01	0.28	980	1900	

Appendix B7

SPI raw data

HOM-1997 NEARFIELD SEDIMENT PROFILE SURVEY RESULTS

Stat_ID	Replicate	Penetration Depth (cm)			Boundary Roughness		Grain Size (phi)			Redox Potential Discontinuity (RPD) Depth (cm)			
					Thickness	Type			Major	Replicates			Station
		Minimum	Maximum	Mean	(cm)		Minimum	Maximum	Mode	Minimum	Maximum	Mean	Mean
FF10	B*	4.87	5.69	5.38	0.82	Indeterminate	>4	<-1	4 to 3	Indeterminate	Indeterminate	Indeterminate	
FF10	C*	4.28	5.53	5.03	1.25	Indeterminate	>4	3 to 2	4 to 3	1.86	5.06	3.68	>3.01
FF10	B	1.56	3.04	2.34	1.48	Physical	>4	<-1	1 to 0	>1.56	>3.04	>2.34	
FF12	A	1.26	2.26	1.76	1.00	Physical	>4	3 to 2	4 to 3	1.01	>2.08	>1.59	
FF12	B	1.42	2.58	1.79	1.16	Physical	>4	2 to 1	4 to 3	0.41	2.17	1.36	>1.54
FF12	D	1.92	2.89	2.45	0.97	Physical	>4	3 to 2	4 to 3	0.31	2.48	1.66	
FF13	A*	5.88	6.38	6.15	0.50	Biological	>4	3 to 2	4 to 3	Indeterminate	Indeterminate	Indeterminate	
FF13	B*	6.95	8.30	7.76	1.35	Biological	>4	3 to 2	>4	0.13	5.63	2.04	2.12
FF13	C*	7.92	8.33	8.13	0.41	Biological	>4	3 to 2	4 to 3	0.91	6.32	2.20	
MF02	A	7.83	8.49	8.21	0.66	Biological	>4	2 to 1	>4	2.14	7.08	3.29	
MF02	B	0.00	1.57	0.68	1.57	Physical	4 to 3	1 to 0	4 to 3	Indeterminate	Indeterminate	Indeterminate	2.71
MF02	C	9.25	9.84	9.56	0.59	Biological	>4	3 to 2	>4	0.85	7.99	2.12	
MF04	A	1.01	2.58	1.55	1.57	Physical	>4	2 to 1	4 to 3	>1.01	>2.58	>1.55	
MF04	B	0.47	0.98	0.69	0.51	Physical	4 to 3	3 to 2	4 to 3	>0.47	>0.98	>0.69	>1.38
MF04	C	1.42	2.23	1.91	0.81	Physical	4 to 3	2 to 1	4 to 3	>1.42	>2.23	>1.91	
MF05	A	4.03	4.37	4.21	0.34	Biological	>4	3 to 2	4 to 3	0.50	3.30	1.25	
MF05	B	3.68	4.97	4.49	1.29	Physical	>4	3 to 2	4 to 3	0.19	4.21	1.18	1.37
MF05	D	5.69	6.19	5.90	0.50	Physical	>4	4 to 3	4 to 3	0.44	3.62	1.67	
MF07	A	4.18	4.78	4.41	0.60	Physical	>4	3 to 2	4 to 3	0.03	4.37	1.99	
MF07	B	5.06	5.60	5.36	0.54	Indeterminate	>4	3 to 2	4 to 3	0.47	5.00	2.00	1.71
MF07	C	5.53	6.29	6.07	0.76	Biological	>4	3 to 2	4 to 3	0.28	5.47	1.14	
MF08	A	5.85	6.35	6.07	0.50	Biological	>4	3 to 2	4 to 3	0.50	5.63	1.67	
MF08	B	7.48	8.21	7.86	0.73	Biological	>4	3 to 2	4 to 3	0.53	5.79	2.13	1.80
MF08	C	8.87	9.62	9.26	0.75	Biological	>4	3 to 2	4 to 3	0.44	5.94	1.61	
MF09	A	4.69	6.07	5.43	1.38	Physical	>4	2 to 1	4 to 3	0.82	4.47	1.86	
MF09	B	5.13	5.88	5.44	0.75	Physical	>4	3 to 2	4 to 3	0.28	4.56	0.92	1.76
MF09	C*	5.45	6.25	5.80	0.80	Physical	>4	3 to 2	4 to 3	0.25	4.82	2.50	
MF10	A	6.23	6.67	6.46	0.44	Physical	>4	3 to 2	4 to 3	0.38	6.29	1.25	
MF10	B	4.84	6.35	5.86	1.51	Physical	>4	3 to 2	4 to 3	0.03	4.31	1.18	1.28
MF10	C	4.34	6.04	5.34	1.70	Biological	>4	2 to 1	4 to 3	0.06	3.71	1.40	
MF12	A	9.50	10.28	9.98	0.78	Biological	>4	3 to 2	>4	0.38	5.85	2.15	
MF12	B	7.61	8.99	8.23	1.38	Indeterminate	>4	3 to 2	>4	0.44	3.02	1.51	1.55
MF12	C	7.08	8.72	8.33	1.64	Indeterminate	>4	2 to 1	4 to 3	0.16	4.37	1.00	
MF16	B	3.92	4.87	4.49	0.95	Indeterminate	>4	2 to 1	4 to 3	0.25	3.77	0.99	
MF16	C	5.33	6.09	5.80	0.76	Indeterminate	>4	3 to 2	4 to 3	0.16	4.25	1.50	1.06
MF16	D'	5.47	6.51	6.06	1.04	Biological	>4	3 to 2	4 to 3	0.13	3.96	0.70	

HOM-1997 NEARFIELD SEDIMENT PROFILE SURVEY RESULTS

Stat_ID	Replicate	Penetration Depth (cm)			Boundary Roughness		Grain Size (phi)			Redox Potential Discontinuity (RPD) Depth (cm)			
					Thickness	Type			Major	Replicates			Station
		Minimum	Maximum	Mean	(cm)		Minimum	Maximum	Mode	Minimum	Maximum	Mean	Mean
MF20	C	0.00	0.00	0.00	0.00	Indeterminate	4 to 3	<-1	<-1	Indeterminate	Indeterminate	Indeterminate	Indeterminate
MF20	D	0.00	0.00	0.00	0.00	Indeterminate	4 to 3	<-1	<-1	Indeterminate	Indeterminate	Indeterminate	
MF21	A	7.26	7.55	7.38	0.29	Biological	>4	3 to 2	4 to 3	0.09	4.84	1.07	
MF21	B	6.26	6.95	6.60	0.69	Biological	>4	3 to 2	4 to 3	0.06	3.43	2.00	1.20
MF21	C	5.19	5.85	5.48	0.66	Physical	>4	3 to 2	4 to 3	0.00	2.17	0.53	
MF22	A	6.45	8.27	7.33	1.82	Indeterminate	>4	2 to 1	4 to 3	0.09	1.73	0.40	
MF22	B	12.39	13.33	12.68	0.94	Biological	>4	1 to 0	4 to 3	0.00	5.28	0.59	0.66
MF22	C	13.05	14.12	13.57	1.07	Biological	>4	2 to 1	>4	0.00	4.65	1.00	
NF13	A	1.38	2.80	2.07	1.42	Physical	4 to 3	2 to 1	3 to 2	>1.38	>2.80	>2.07	
NF13	B	1.35	2.39	1.82	1.04	Physical	4 to 3	2 to 1	3 to 2	>1.35	>2.80	>1.82	>1.92
NF13	C	1.42	2.26	1.87	0.84	Physical	4 to 3	<-1	3 to 2	>1.42	>2.26	>1.87	
NF14	A	2.08	3.05	2.67	0.97	Physical	4 to 3	1 to 0	4 to 3	>2.08	>3.05	>2.67	
NF14	B	2.17	3.80	3.06	1.63	Physical	>4	<-1	4 to 3	>2.17	>3.80	>3.06	>3.07
NF14	C	2.92	3.84	3.48	0.92	Physical	>4	<-1	4 to 3	>2.92	>3.84	>3.48	
NF15	A	1.92	3.36	2.65	1.44	Physical	4 to 3	<-1	4 to 3	>1.92	>3.36	>2.65	
NF15	B'	0.47	0.97	0.76	0.50	Physical	4 to 3	2 to 1	3 to 2	>0.47	>0.97	>0.76	>1.71
NF15	D*	4.62	5.44	4.97	0.82	Indeterminate	4 to 3	2 to 1	4 to 3	Indeterminate	Indeterminate	Indeterminate	
NF17	G	1.54	2.61	2.02	1.07	Physical	4 to 3	2 to 1	4 to 3	>1.54	>2.61	>2.02	
NF17	H	1.73	2.30	1.97	0.57	Physical	4 to 3	2 to 1	3 to 2	>1.73	>2.30	>1.97	>2.13
NF17	I	1.82	3.02	2.40	1.20	Physical	>4	2 to 1	4 to 3	>1.82	>3.02	>2.40	
NF18	A	3.27	5.13	4.13	1.86	Indeterminate	>4	<-1	4 to 3	0.16	3.58	1.51	
NF18	B	3.74	4.47	4.08	0.73	Physical	>4	<-1	4 to 3	0.22	2.70	1.37	1.44
NF18	C	3.21	4.09	3.52	0.88	Physical	>4	<-1	4 to 3	0.50	3.46	1.45	
NF19	A	0.00	1.51	0.64	1.51	Physical	>4	3 to 2	4 to 3	>0.00	>1.51	>0.64	
NF19	B	0.00	1.26	0.30	1.26	Physical	4 to 3	<-1	4 to 3	>0.00	>1.26	>0.48	>1.39
NF19	C	3.87	4.72	4.23	0.85	Physical	>4	3 to 2	4 to 3	0.00	4.69	3.04	
NF23	B	1.54	2.77	2.14	1.23	Physical	4 to 3	2 to 1	3 to 2	>1.54	>2.77	>2.14	
NF23	C	2.20	3.30	2.83	1.10	Physical	4 to 3	2 to 1	3 to 2	>2.20	>3.30	>2.83	>2.13
NF23	D	0.56	2.28	1.42	1.72	Physical	4 to 3	2 to 1	3 to 2	>0.56	>2.28	>1.42	
NF24	A	14.47	15.06	14.71	0.59	Biological	>4	3 to 2	4 to 3	0.94	5.00	3.62	
NF24	B	13.99	14.37	14.18	0.38	Biological	>4	3 to 2	>4	0.00	4.94	1.93	2.39
NF24	C	14.25	15.50	14.77	1.25	Biological	>4	3 to 2	>4	0.00	8.65	1.62	
* August sample		Remaining samples taken in October											

HOM-1997 NEARFIELD SEDIMENT PROFILE SURVEY RESULTS

Stat_ID	Replicate	Methane Bubbles	Anoxia Low DO	Successional Stage	Organism Sediment Index (OSI)	Comments
FF10	B*	0	No	Stage I	Indeterminate	Pebbles on surface
FF10	C*	0	No	Stage I	6	Poor image, mean RPD is best estimate, stage I's present
FF10	B	0	No	Stage I	5	Poorly sorted sand and gravel
FF12	A	0	No	Stage I	4	Low penetration; rippled
FF12	B	0	No	Stage I	3	Low penetration; stabilized ripples?
FF12	D	0	No	Stage I	4	Stabilized ripple?
FF13	A*	0	No	Stage I	Indeterminate	Podocerid tubes on surface
FF13	B*	0	No	Stage II	6	Podocerid tubes on surface
FF13	C*	0	No	Stage II	6	Podocerid tubes on surface
MF02	A	0	No	Stage II on III	10	Pelletized sand over mud; sulphidic below RPD
MF02	B	0	No	Indeterminate	Indeterminate	Poor sorting; rippled?
MF02	C	0	No	Stage I - II	5	Sand (3 cm) over mud; sulphidic below RPD
MF04	A	0	No	Stage I - II	5	Low penetration; rippled; stabilized bedform
MF04	B	0	No	Stage I	2	Low penetration; rippled; stabilized bedform
MF04	C	0	No	Stage I	4	Low penetration; rippled
MF05	A	0	No	Stage I on III	7	Sand (2.5 cm) over mud; some large tubes
MF05	B	0	No	Stage I on III	7	Rippled
MF05	D	0	No	Stage I on III	8	Sand (3 cm) over mud; rippled
MF07	A	0	No	Stage I	4	Rippled
MF07	B	0	No	Stage I	4	Sand (4 cm) over mud
MF07	C	0	No	Stage I	3	Polychaetes
MF08	A	0	No	Stage I	4	Sand (3.5 cm) over mud
MF08	B	0	No	Stage I - II	5	Sand (4.5 cm) over mud
MF08	C	0	No	Stage I	4	Sand (7cm) over mud; rebound
MF09	A	0	No	Stage I	4	Sand (4.5 cm) over mud; rippled?; retrograde amphipod tubes?
MF09	B	0	No	Stage I	3	Sand (4 cm) over mud; rippled; rebound
MF09	C*	0	No	Stage I	5	Rippled?
MF10	A	0	No	Stage I	3	Sand (3.5 cm) over mud; rippled
MF10	B	0	No	Stage I - II	4	Rippled
MF10	C	0	No	Stage I - II	4	Sand (2 cm) over mud; biol. feeding pit
MF12	A	0	No	Stage II on III	8	Sand (4 cm) over mud; small reduced active feeding void; tube mat
MF12	B	0	No	Stage II on III	8	Sand (2 cm) over mud; large reduced active feeding void
MF12	C	0	No	Stage I on III	7	Sand (2 cm) over mud; possible Molpadia mound?; rebound
MF16	B	0	No	Stage I	3	Sand (3 cm) over mud
MF16	C	0	No	Stage I	3	Sand (2 cm) over mud
MF16	D'	0	No	Stage I	2	Sand (1-2 cm) over mud

HOM-1997 NEARFIELD SEDIMENT PROFILE SURVEY RESULTS

Stat_ID	Replicate	Methane Bubbles	Anoxia Low DO	Successional Stage	Organism Sediment Index (OSI)	Comments
MF20	C	0	No	Stage I	Indeterminate	No penetration; hard ground; mud-draped rocks; tube mat
MF20	D	0	No	Stage I	Indeterminate	No penetration; hard ground; mud-draped rocks
MF21	A	0	No	Stage I on III	7	Sand (3 cm) over mud; stabilized ripple?
MF21	B	0	No	Indeterminate	Indeterminate	Sand (3 cm) over mud
MF21	C	0	No	Stage I	2	Sand (2.5 cm) over mud; pull-away
MF22	A	0	No	Stage I on III	6	Sand (3.5cm) over mud; rebounded RPD?
MF22	B	0	No	Stage II on III	6	Sand (6cm) over mud; lots of tubes
MF22	C	0	No	Stage II on III	7	Sand (3 cm) over mud; v. sulfidic at mid-depth
NF13	A	0	No	Stage I	4	Low penetration; stabilized ripple?
NF13	B	0	No	Stage I	4	Stabilized ripples?
NF13	C	0	No	Stage I	4	Poor sorting; sand with pebbles on surface; tube mat; rippled
NF14	A	0	No	Stage I	5	Poor sorting; rippled, stabilized?
NF14	B	0	No	Stage I	6	Poor sorting; scour lag
NF14	C	0	No	Stage I	6	Poor sorting; some pebbles; rippled
NF15	A	0	No	Stage I	5	Poor sorting; pebbles; erosional
NF15	B'	0	No	Stage I	3	Very low penetration; rippled
NF15	D*	0	No	Stage I	Indeterminate	Poor image; tube mat
NF17	G	0	No	Stage I	4	Low penetration; rippled
NF17	H	0	No	Stage I	4	Low penetration; shell hash; rippled
NF17	I	0	No	Stage I	4	Low penetration; rippled
NF18	A	0	No	Stage I - II	5	Pebble on surface; juvenile amphipods?
NF18	B	0	No	Stage I on III	7	Rock on surface; local erosion
NF18	C	0	No	Stage I	3	Rocks on surface
NF19	A	0	No	Stage I - II	3	Very low penetration; rippled
NF19	B	0	No	Stage I - II	3	Very low penetration; rocks, pebbles, shell lag; poor sorting
NF19	C	0	No	Stage I	6	Rippled
NF23	B	0	No	Stage I	4	Low penetration; ripples
NF23	C	0	No	Stage I	5	Rippled
NF23	D	0	No	Stage I	3	Rippled
NF24	A	0	No	Stage I on III	10	Sand (8-11 cm) over mud; sulfitic at 8-11 cm depth
NF24	B	0	No	Stage I	4	Sand (3 cm) over mud; sulfitic at 11 - >15 cm depth
NF24	C	0	No	Stage I on III	8	Sand (2 cm) over mud; sulfitic at 4-13 cm depth
* August sample		Remaining samples taken in October				

Appendix C-1

All Species, with Authors, Identified from 1995/1996/1997 Benthic Infaunal Samples (All Nearfield, Midfield, and Farfield Stations)

Table 1. List of Species from the 1995/96/97 Nearfield/Farfield Samples

CNIDARIA
- Actiniaria sp. 2
- *Ceriantheopsis americana* (Verrill, 1866)
- *Cerianthus borealis* Verrill, 1873
- *Corymorpha pendula* L. Agassiz, 1862
- *Edwardsia elegans* Verrill, 1869
- *Halcampa duodecimcirrata* (Sars, 1851)

PLATYHELMINTHES
- Turbellaria spp.

NEMERTEA
- *Amphiporus angulatus* (Fabricius, 1774)
- *Amphiporus groenlandicus* Oersted, 1844
- *Carinomella lactea* Coe, 1905
- *Cephalothricidae* sp. 1
- *Cerebratulus lacteus* (Leidy, 1851)
- *Lineus pallidus* Verrill, 1879
- *Micrura* sp.
- Nemertea sp. 2
- Nemertea sp. 5
- Nemertea sp. 7
- *Tetrastemma vittatum* Verrill, 1874
- *Tubulanus pellucidus* (Coe, 1895)

PRIAPULA
- *Priapulus caudatus* Lamarck, 1816

SIPUNCULA
- *Nephasoma diaphanes* (Gerould, 1913)
- *Phascolion strombi* (Montagu, 1804)

ECHIURA
- *Echiurus echiurus* (Pallas, 1767)

ANNELIDA
- Polychaeta
  - Ampharetidae
    - *Ampharete acutifrons* Grube, 1860
    - *Ampharete finmarchica* (Sars, 1864)
    - *Ampharete lindstroemi* Malmgren, 1867
    - *Amphicteis gunneri* (Sars, 1835)
    - *Anobothrus gracilis* (Malmgren, 1866)
    - *Asabellides oculata* (Webster, 1879)
    - *Melinna cristata* (Sars, 1851)
  - Amphinomidae
    - *Paramphinome jeffreysii* (McIntosh, 1868)
  - Aphroditidae
    - *Aphrodita* spp.
  - Apistobranchidae
    - *Apistobranchus tullbergi* (Théel, 1879)
    - *Apistobranchus typicus* (Webster & Benedict, 1887)
  - Capitellidae
    - *Capitella capitata* complex (Fabricius, 1780)
    - *Heteromastus filiformis* (Claparède, 1864)
    - *Mediomastus californiensis* Hartman, 1944
  - Chaetopteridae
    - *Spiochaetopterus oculatus* Webster, 1879
  - Chrysopetalidae
    - *Dysponetus pygmaeus* Levinsen, 1879
  - Cirratulidae
    - *Aphelochaeta marioni* (Saint-Joseph, 1894)
    - *Aphelochaeta monilaris* (Hartman, 1960)
    - *Caulleriella* sp. B
    - *Chaetozone setosa* Malmgren, 1867
    - *Chaetozone vivipara* (Christie, 1985)
    - *Cirratulus cirratus* (O.F. Müller, 1776)
    - *Monticellina baptisteae* Blake, 1991
    - *Monticellina dorsobranchialis* (Kirkegaard, 1959)
    - *Tharyx acutus* Webster & Benedict, 1887
  - Cossuridae
    - *Cossura longocirrata* Webster & Benedict, 1887
  - Dorvilleidae
    - *Dorvillea sociabilis* (Webster, 1879)
    - *Ophryotrocha* cf. *labronica* La Greca & Bacci, 1962
    - *Ophryotrocha* sp. 1
    - *Parougia caeca* (Webster & Benedict, 1884)
  - Flabelligeridae
    - *Brada incrustata* Støp Bowitz, 1948
    - *Brada villosa* (Rathke, 1843)
    - *Diplocirrus hirsutus* (Hansen, 1879)
    - *Flabelligera* spp.
    - *Pherusa affinis* (Leidy, 1855)
  - Glyceridae
    - *Glycera capitata* Oersted, 1843
  - Goniadidae
    - *Goniada maculata* Oersted, 1843
  - Hesionidae
    - *Microphthalmus aberrans* (Webster & Benedict, 1887)
    - *Microphthalmus listensis* Westheide, 1967
  - Lumbrineridae
    - *Ninoe nigripes* Verrill, 1873
    - *Paraninoe brevipes* (McIntosh, 1903)
    - *Scoletoma fragilis* (O.F. Müller, 1776)
    - *Scoletoma hebes* (Verrill, 1880)
  - Maldanidae
    - *Axiothella catenata* (Malmgren, 1865)
    - *Clymenella torquata* (Leidy, 1855)
    - *Clymenura* sp. A
    - *Euclymene collaris* (Claparède, 1870)
    - *Maldane glebifex* Grube, 1860
    - *Maldane sarsi* Malmgren, 1865
    - *Petaloproctus tenuis* (Théel, 1879)
    - *Praxillella gracilis* (Sars, 1861)
    - *Praxillella praetermissa* (Malmgren, 1866)
    - *Praxillura ornata* Verrill, 1880
    - *Rhodine loveni* Malmgren, 1865
  - Nephtyidae
    - *Aglaophamus circinata* (Verrill, 1874)
    - *Nephtys caeca* (Fabricius, 1780)
    - *Nephtys ciliata* (O.F. Müller, 1776)
    - *Nephtys cornuta* Berkeley & Berkeley, 1945
    - *Nephtys discors* Ehlers, 1868
    - *Nephtys incisa* Malmgren, 1865
    - *Nephtys paradoxa* Malm, 1874
  - Nereididae
    - *Neanthes virens* (Sars, 1835)
    - *Nereis grayi* Pettibone, 1956
    - *Nereis procera* Ehlers, 1868
    - *Nereis zonata* Malmgren, 1867
  - Oenonidae
    - *Drilonereis magna* Webster & Benedict, 1887
    - *Labrorostratus parasiticus* Saint-Joseph, 1888
  - Opheliidae
    - *Ophelina acuminata* Oersted, 1843
  - Orbiniidae
    - *Leitoscoloplos acutus* (Verrill, 1873)
    - *Leitoscoloplos* sp. B
    - *Scoloplos acmeceps* Chamberlin, 1919
    - *Scoloplos armiger* (O.F. Müller, 1776)
    - *Scoloplos (Leodamas) ?rubra* (Webster, 1879)
  - Oweniidae
    - *Galathowenia oculata* (Zachs, 1923)
    - *Myriochele heeri* Malmgren, 1867
    - *Owenia fusiformis* Delle Chiaje, 1844

Paraonidae
Aricidea catherinae Laubier, 1967
Aricidea minuta Southward, 1956
Aricidea quadrilobata Webster & Benedict, 1887
Levinsenia gracilis (Tauber, 1879)
Paradoneis lyra (Southern, 1914)
Pectinariidae
Pectinaria granulata (Linnaeus, 1767)
Pholoidae
Pholoe minuta (Fabricius, 1780)
Pholoe tecta Stimpson, 1854
Phyllodocidae
Eteone flava (Fabricius, 1780)
Eteone heteropoda Hartman, 1951
Eteone longa (Fabricius, 1780)
Mystides borealis Théel, 1879
Paranaitis speciosa (Webster, 1880)
Phyllodoce arenae Webster, 1879
Phyllodoce groenlandica Oersted, 1843
Phyllodoce maculata (Linnaeus, 1767)
Phyllodoce mucosa Oersted, 1843
Pilargiidae
Ancistrosyllis groenlandica McIntosh, 1879
Polygordiidae
Polygordius sp. A
Polynoidae
Arcteobia anticostiensis (McIntosh, 1874)
Austrolaenilla mollis (Sars, 1872)
Bylgides sarsi (Kinberg, 1865)
Enipo gracilis Verrill, 1874
Enipo torelli (Malmgren, 1865)
Gattyana amondseni (Malmgren, 1867)
Gattyana cirrosa (Pallas, 1766)
Harmothoe extenuata (Grube, 1840)
Harmothoe imbricata (Linnaeus, 1767)
Hartmania moorei Pettibone, 1955
Sabellidae
Chone duneri Malmgren, 1867
Chone infundibuliformis Krøyer, 1856
Chone cf. *magna* (Moore, 1923)
Euchone elegans Verrill, 1873
Euchone incolor Hartman, 1978
Euchone papillosa (Sars, 1851)
Laonome kroeyeri Malmgren, 1866
Myxicola infundibulum (Renier, 1804)
Scalibregmatidae
Scalibregma inflatum Rathke, 1843
Sphaerodoridae
Sphaerodoridium sp. A
Sphaerodoropsis minuta (Webster & Benedict, 1887)
Spionidae
Laonice cirrata (Sars, 1851)
Laonice sp. 1
Dipolydora caulleryi (Mesnil, 1897)
Dipolydora concharum (Verrill, 1880)
Dipolydora quadrilobata (Jacobi, 1883)
Dipolydora socialis (Schmarda, 1861)
Polydora websteri Hartman, 1943
Prionospio steenstrupi Malmgren, 1867
Pygospio elegans Claperède, 1863
Scolelepis squamata (Müller, 1806)
Spio filicornis (O.F. Müller, 1776)
Spio limicola Verrill, 1880
Spio setosa Verrill, 1873
Spio thulini Maciolek, 1990
Spiophanes bombyx (Claparède, 1870)
Spiophanes kroeyeri Grube, 1860
Streblospio benedicti Webster, 1879
Sternaspidae
Sternaspis scutata (Otto, 1821)

Syllidae
Exogone hebes (Webster & Benedict, 1884)
Exogone longicirris (Webster & Benedict, 1887)
Exogone verugera (Claparède, 1868)
Pionosyllis sp. A
Sphaerosyllis brevifrons Webster & Benedict, 1884
Sphaerosyllis longicauda Webster & Bendict, 1887
Syllides convoluta Webster & Benedict, 1884
Syllides japonica Imajima, 1966
Syllides longocirrata Oersted, 1845
Typosyllis sp. 1
Terebellidae
Lanassa venusta venusta (Malm, 1874)
Nicolea zostericola (Oersted, 1844)
Pista cristata (O.F. Müller, 1776)
Polycirrus eximius (Leidy, 1855)
Polycirrus cf. *haematodes* (Claparède, 1864)
Polycirrus medusa Grube, 1850
Proclea graffii (Langerhans, 1880)
Trichobranchidae
Terebellides atlantis Williams, 1984
Terebellides stroemi Sars, 1835
Trichobranchus glacialis Malmgren, 1866
Trochochaetidae
Trochochaeta carica (Birula, 1897)
Trochochaeta multisetosa (Oersted, 1844)

Oligochaeta
Tubificidae
Adelodrilus sp. 1
Adelodrilus sp. 2
Tubificidae sp. 2
Tubificidae sp. 4
Tubificoides apectinatus Brinkhurst, 1965
Tubificoides sp. 1
Enchytraeidae
Enchytraeidae sp. 1

CRUSTACEA
Amphipoda
Ampeliscidae
Ampelisca abdita Mills, 1864
Ampelisca macrocephala Lilljeborg, 1852
Ampelisca vadorum Milla, 1963
Byblis gaimardi (Krøyer, 1847)
Haploops fundiensis Wildish & Dickinson, 1982
Amphilochidae
Gitanopsis arctica Sars, 1895
Aoridae
Leptocheirus pinguis (Stimpson, 1853)
Argissidae
Argissa hamatipes (Norman, 1869)
Caprellidae
Aeginina longicornis (Krøyer, 1842-43)
Caprella linearis (Linnaeus, 1767)
Mayerella limicola Huntsman, 1915
Paracaprella tenuis Mayer, 1903
Corophiidae
Monocorophium acherusicum (Costa, 1857)
Crassicorophium crassicorne (Bruzelius,1859)
Monocorophium insidiosum (Crawford, 1937)
Monocorophium tuberculatum (Shoemaker, 1834)
Pseudunciola obliquua (Shoemaker, 1949)
Unciola inermis Shoemaker, 1942
Unciola irrorata Say, 1818
Gammaridae
Gamarellus angulosus (Rathke, 1843)
Gammarus spp.
Haustoriidae
Acanthohaustorius millsi Bousfield, 1965

Isaeidae
Photis pollex Walker, 1895
Protomedeia fasciata Krøyer, 1842
Ischyroceridae
Erichthonius rubricornis Smith, 1873
Ischyrocerus anguipes Krøyer, 1838
Jassa marmorata Holmes, 1903
Lysianassidae
Anonyx lilljeborgi Boeck, 1871
Hippomedon propinquus Sars, 1895
Hippomedon serratus Holmes, 1905
Orchomene pinguis (Boeck, 1861)
Orchomenella groenlandica (Hansen, 1887)
Orchomenella minuta Krøyer, 1846
Melitidae
Casco bigelowi (Blake, 1929)
Maera loveni (Bruzelius, 1859)
Melita nr. *dentata* (Krøyer, 1842)
Melita sp. 1
Oedicerotidae
Bathymedon obtusifrons (Hansen, 1887)
Deflexilodes intermedius (Shoemaker, 1830)
Deflexilodes tesselatus (Schneider, 1884)
Deflexilodes tuberculatus (Boeck, 1870)
Monoculodes packardi Boeck, 1871
Monoculodes sp. 1
Westwoodilla brevicalcar Goës, 1866
Phoxocephalidae
Eobrolgus spinosus (Holmes, 1905)
Harpinia propinqua Sars, 1895
Harpiniopsis sp. 1
Phoxocephalus holbolli (Krøyer, 1842)
Rhepoxynius hudsoni Barnard & Barnard, 1982
Pleustidae
Pleusymtes glaber (Boeck, 1861)
Stenopleustes inermis Shoemaker, 1949
Podoceridae
Dulichia falcata (Bate, 1857)
Dyopedos monacanthus (Metzger, 1875)
Paradulichia typica Boeck, 1870
Pontogeneiidae
Pontogeneia inermis (Krøyer, 1842)
Stenothoidae
Metopella angusta Shoemaker, 1949
Proboloides holmesi Bousfield, 1973
Synopiidae
Syrrhoe crenulata (Goës, 1866)

Cirripedia
Balanidae
Balanus crenatus Bruguiere, 1789

Cumacea
Diastylidae
Diastylis cornuifer (Blake, 1929)
Diastylis polita (S.I. Smith, 1879)
Diastylis quadrispinosa (Sars, 1871)
Diastylis sculpta Sars, 1871
Leptostylis cf. *ampullacea* (Lilljeborg, 1855)
Leptostylis longimana (Sars, 1865)
Lampropidae
Lamprops quadriplicata S.I. Smith, 1879
Leuconidae
Eudorella hispida Sars, 1871
Eudorella pusilla Sars, 1871
Eudorellopsis deformis (Krøyer, 1846)
Leucon acutirostris Sars, 1865
Leucon fulvus Sars, 1865
Nannastacidae
Campylaspis rubicunda (Lilljeborg, 1855)
Campylaspis nr. *sulcata* Sars, 1869
Pseudocumatidae
Petalosarsia declivis (Sars, 1865)

Decapoda
Axiidae
Axius serratus Stimpson, 1852
Cancridae
Cancer borealis Stimpson, 1859
Crangonidae
Crangon septemspinosa (Say, 1818)
Paguridae
Pagurus acadianus Benedict, 1901

Isopoda
Anthuriidae
Ptilanthura tenuis Harger, 1879
Chaetiliidae
Chiridotea tuftsi (Stimpson, 1883)
Cirolanidae
Politolana polita (Stimpson, 1853)
Idoteidae
Edotia montosa (Stimpson, 1853)
Idotea balthica (Pallas, 1772)
Munnidae
Munna sp. 1
Munnopsidae
Baeonectes muticus (Sars, 1964)g
Paramunnidae
Pleurogonium inerme Sars, 1882
Pleurogonium rubicundum (Sars, 1863)
Pleurogonium spinosissimum (Sars, 1866)

Mysidacea
Mysidae
Erythrops erythrophthalma (Göes, 1863)
Neomysis americana (S.I. Smith, 1873)

Tanaidacea
Nototanaidae
Tanaissus psammophilus (Wallace, 1919)

MOLLUSCA
Aplacophora
Chaetodermatidae
Chaetoderma nitidulum canadense (Nierstrasz, 1902)

Bivalvia
Arctidae
Arctica islandica (Linnaeus, 1767)
Astartidae
Astarte borealis (Schumacher, 1817)
Astarte undata Gould, 1841
Cardiidae
Cerastoderma pinnulatum (Conrad, 1831)
Carditidae
Cyclocardia borealis (Conrad, 1831)
Hiatellidae
Hiatella arctica (Linnaeus, 1767)
Lyonsiidae
Lyonsia arenosa Möller, 1842
Mactridae
Spisula solidissima (Dillwyn, 1817)
Montacutidae
Pythinella cuneata Dall, 1899
Myidae
Mya arenaria Linnaeus, 1758

Mytilidae
Crenella decussata (Montagu, 1808)
Crenella glandula (Totten, 1834)
Modiolus modiolus (Linnaeus, 1758)
Musculus discors (Linnaeus, 1767)
Musculus niger (Gray, 1824)
Mytilus edulis Linnaeus, 1758
Nuculidae
Nucula annulata Hampson, 1971
Nucula delphinodonta Mighels & Adams, 1842
Nuculoma tenuis (Montagu, 1808)
Nuculanidae
Megayoldia thraciaeformis (Storer, 1838)
Nuculana nr. *messanensis* (Seguenza, 1877)
Nuculana pernula (Müller, 1771)
Yoldia sapotilla (Gould, 1841)
Yoldiella lucida Lovén,1846
Pandoridae
Pandora glacialis Leach, 1819
Pandora nr. *inflata* Boss & Merrill, 1965
Pectinidae
Placopecten magellanicus (Gmelin, 1791)
Periplomatidae
Periploma papyratium (Say, 1822)
Solemyidae
Solemya sp.
Solenidae
Ensis directus Conrad, 1843
Siliqua costata Say, 1822
Tellinidae
Macoma balthica (Linnaeus, 1758)
Tellina agilis Stimpson, 1857
Thyasiridae
Thyasira gouldii Philippi, 1845
Thyasira nr. *minutus* (Verrill & Bush, 1898)
Thraciidae
Asthenothaerus hemphilli Dall, 1886
Bushia elegans (Dall, 1886)
Thracia conradi Couthouy, 1838
Veneridae
Pitar morrhuana Linsley, 1848

Gastropoda
Nudibranchia
Corambidae
Doridella sp.

Opisthobranchia
Acteocinidae
Acteocina canaliculata (Say, 1822)
Cylichnidae
Cylichna alba (Brown, 1827)
Cylichna gouldi (Couthouy, 1839)
Diaphanidae
Diaphana minuta (Brown, 1827)
Epitoniidae
Epitonium greenlandicum (Perry, 1811)
Retusidae
Retusa obtusa (Montagu, 1807)

Prosobranchia
Buccinidae
Colus parvus (Verrill and Smith, 1882)
Colus pubescens (Verrill, 1882)
Colus pygmaeus (Gould, 1841)
Naptunea spp.
Calyptraeidae
Crepidula fornicata (Linnaeus, 1758)
Lacunidae
Lacuna vincta (Montagu, 1803)
Nassariidae
Ilyanassa trivittata (Sars, 1822)
Muricidae
Urosalpinx spp.
Naticidae
Euspira immaculata (Totten, 1835)
Euspira heros (Say, 1822)
Polinices pallidus Broderip and Sowerby, 1829
Pyramidellidae
Odostomia gibbosa Bush, 1909
Odostomia sulcosa (Mighels, 1843)
Rissoidae
Alvania sp. 2
Onoba mighelsi (Stimpson, 1851)
Onoba pelagica (Stimpson, 1851)
Pusillina harpa (Verrill, 1880)
Pusillina pseudoareolata (Warén, 1974)
Trochidae
Margarites costalis (Gould, 1841)
Solariella obscura (Couthouy, 1838)
Turridae
Oenopota harpularia (Couthouy, 1838)
Oenopota incisula Verrill, 1882
Oenopota pyramidalis (Ström, 1788)
Propebela exarata (Möller, 1842)

Polyplacophora
Polyplacophora spp.

Scaphopoda
Dentaliidae
Dentalium entale Linnaeus, 1758

PHORONIDA
Phoronis architecta Andrews, 1890

ECHINODERMATA
Asteroidea
Ctenodiscus crispatus (Retzius, 1805)
Henricia sanguinolenta (O.F. Müller, 1776)

Echinoidea
Echinarachnius parma (Lamarck, 1816)

Holothuroidea
Molpadia oolitica (Pourtalès, 1851)\

Ophiuroidea
Axiognathus squamatus (Delle Chiaje, 1828)
Ophiocten sericeum (Forbes, 1852)
Ophiothrix angulata (Say, 1825)
Ophiura sarsi Lütken, 1855
Ophiura sp. A

HEMICHORDATA
Stereobalanus canadensis (Spengel, 1893)

CHORDATA
Ascidiacea
Molgulidae
Molgula manhattensis (DeKay, 1843)
Bostrichobranchus pilularis (Verrill, 1871)
Styelidae
Cnemidocarpa mollis (Stimpson, 1852)

Appendix C-2

All species, NODC codes, and totals for each year, 1992-1997.
(All Nearfield, Midfield, and Farfield Stations)

ALL MASSACHUSETTS BAY

TAXON	STAT_ARRIV NODC CODE	Total Aug_92	Total Aug_93	Total Aug_94	Total Aug_95	Total Aug_96	Total Aug_97	No. yrs. present	
CNIDARIA									
CORYMORPHA PENDULA	3703250104					2	4	2	
CERIANTHUS BOREALIS	3743010102				48	26	5	3	
CERIANTHEOPSIS AMERICANUS	3743010201	5	6	1	8	1	27	6	
ACTINIARIA SP. 1 (BLAKE 1992)	3758SP01	1						1	
ACTINIARIA SP. 2 (BLAKE 1992)	3758SP02	100	54	45			76	4	
ACTINIARIA SP. 3 (BLAKE 1992)	3758SP03	1						1	
ACTINIARIA SP. 4 (BLAKE 1992)	3758SP04							0	(May_92)
ACTINIARIA SP. 5 (BLAKE 1992)	3758SP05							0	(May_92)
ACTINIARIA SP. 6 (KROPP 1995)	3758SP06		4					1	
EDWARDSIA ELEGANS	3759010101	44	39	70	82	152	95	6	
HALCAMPA DUODECIMCIRRATA	3759040102				2		1	2	
PLATYHELMINTHES									
TURBELLARIA SP.1 (KROPP 1995)	3901SP01		1	1				2	
TURBELLARIA SP.2 (KROPP 1995)	3901SP02			1				1	
NEMERTEA									
TUBULANUS PELLUCIDUS	4302010104	25	3	11	8	7	17	6	
CARINOMELLA LACTEA	4302010201	47	55	27	139	123	168	6	
CEPHALOTHRICIDAE SP. 1	430203SP01				95	248	187	3	
CEREBRATULUS LACTEUS	4303020209	55	68	126	123	57	46	6	
LINEUS PALLIDUS	4303020405				4	2	1	3	
MICRURA SPP.	43030205SPP	353	724	285	339	385	337	6	
AMPHIPORUS ANGULATUS	4306050101	140	180	101	125	31	189	6	
AMPHIPORUS GROENLANDICUS	4306050124				2	4	13	3	
TETRASTEMMA VITTATUM	4306060216	17	6	31	11	22		5	
NEMERTEA SP. 2	43SP02	8	24	55	21	6	68	6	
NEMERTEA SP. 4	43SP04		1					1	
NEMERTEA SP. 5	43SP05				467	402	204	3	
NEMERTEA SP. 7	43SP07				28			1	
POLYCHAETA									
APHRODITA SPP.	50010101SPP				1	4		2	
ARCTEOBIA ANTICOSTIENSIS	5001020301	6		23	6	3	15	5	
GATTYANA AMONDSENI	5001020601	1		52	51	48	57	5	
GATTYANA CIRROSA	5001020603	13	58	9			3	4	
HARMOTHOE EXTENUATA	5001020803				1	1	8	3	
HARMOTHOE IMBRICATA	5001020806	10		6	1	1	2	5	
ENIPO GRACILIS	5001021502					1		1	
HARTMANIA MOOREI	5001022001			2	5	10		3	
ENIPO TORELLI	5001022103	38	42	18	3	14	58	6	
AUSTROLAENILLA MOLLIS	5001022401				1		1	2	
BYLGIDES GROENLANDICUS	50010255GROE		11					1	
BYLGIDES SARSI	50010255SARS	1				2	1	3	
PHOLOE MINUTA	5001060101	249	279	723	646	505	254	6	
PHOLOE TECTA	50010601TECT						255	1	
DYSPONETUS PYGMAEUS	5001080201				3	6	1	3	
PARAMPHINOME JEFFREYSII	5001100401	16	11	2	1	7	2	6	
PHYLLODOCE GROENLANDICA	5001130102			3	1		2	3	
PHYLLODOCE MUCOSA	5001130104	216	564	284	830	384	431	6	
PHYLLODOCE MACULATA	5001130106	31	23	32	16	7	28	6	
ETEONE FLAVA	5001130204				5			1	
ETEONE LONGA	5001130205	112	238	824	452	327	207	6	
ETEONE HETEROPODA	5001130207					3	1	2	
EULALIA VIRIDIS	5001130301		1					1	
EULALIA BILINEATA	5001130304	1		1				2	
MYSTIDES BOREALIS	5001130501	1	10	1	1	13	8	6	
PARANAITIS SPECIOSA	5001130801		1		3	7	14	4	
EUMIDA SANQUINEA	5001131101	2						1	
PHYLLODOCE ARENAE	5001131410	2	20	11	3	1	18	6	
GYPTIS CF. VITTATA	5001210103	1						1	
MICROPHTHALMUS SCZELKOWII	5001210201	6	9	17				3	
MICROPHTHALMUS ABERRANS	5001210202				15	11	8	3	

ALL MASSACHUSETTS BAY

TAXON	STAT_ARRIV NODC CODE	Total Aug_92	Total Aug_93	Total Aug_94	Total Aug_95	Total Aug_96	Total Aug_97	No. yrs. present	
MICROPHTHALMUS LISTENSIS	5001210203				5	12		2	
ANCISTOSYLLIS GROENLANDICA	5001220104	9	1	3			1	4	
SYNELMIS KLATTI	5001220501	6						1	
PIONOSYLLIS SP. A	50012302SP01	41			65	61	58	4	
SYLLIS ALTERNATA	5001230501	16						1	
TYPOSYLLIS SP. 1 (BLAKE 1992)	50012305SP01	14	11	23	4	10	7	6	
EXOGONE VERUGERA	5001230706	1854	891	1515	1559	1369	1210	6	
EXOGONE HEBES	5001230707	1305	1028	2177	1891	2170	2597	6	
EXOGONE LONGICIRRIS	5001230711	18	4	24	7	34	5	6	
SPHAEROSYLLIS BREVIFRONS	5001230801	13	2	35	36	133	11	6	
SPHAEROSYLLIS LONGICAUDA	5001230817	35	26	63	90	47	30	6	
SYLLIDES JAPONICA	5001231501	34	19	97	23	11	22	6	
SYLLIDES LONGOCIRRATA	5001231503	85	245	74	92	132	96	6	
SYLLIDES CONVOLUTA	50012315CON						1	1	
NEANTHES VIRENS	5001240302		1	1	1			3	
NEREIS PROCERA	5001240404					5		1	
NEREIS ZONATA	5001240406	2			4		3	3	
NEREIS GRAYI	5001240409	21	5	92	53	166	58	6	
WEBSTERINEREIS TRIDENTATA	5001241001	2						1	
NEPHTYS CILIATA	5001250102	15	10	6	8	5	12	6	
NEPHTYS CAECA	5001250103	19	1	3	5	7	7	6	
NEPHTYS CORNUTA	5001250104	139	455	259	384	962	8	6	
NEPHTYS DISCORS	5001250108	2			1			2	
NEPHTYS PARADOXA	5001250110				1		1	2	
NEPHTYS INCISA	5001250115	107	151	254	216	151	827	6	
AGLAOPHAMUS CIRCINATA	5001250304	147	68	116	41	128	643	6	
SPHAERODOROPSIS MINUTA	5001260201	13	25	12	81	8	9	6	
SPHAERODORIDIUM CLAPAREDII	5001260401	5						1	
SPHAERODORIDIUM SP. A	50012604SP01					85	64	2	
GLYCERA CAPITATA	5001270101		1	6	5	6	2	5	
GONIADA MACULATA	5001280202	17	24	20	10	23	18	6	
ONUPHIS OPALINA	5001290108	2						1	
LUMBRINERIS TENUIS	5001310113	3						1	
SCOLETOMA IMPATIENS	5001310115	24						1	
SCOLETOMA HEBES	5001310140	237	301	343	321	723	470	6	
SCOLETOMA FRAGILIS	50013101FRAG	65	68	28	38	66	63	6	
NINOE NIGRIPES	5001310204	1972	1717	1130	1682	4209	4122	6	
PARANINOE BREVIPES	5001310204						2	1	
ERANNO SPP.	500131ERASPP			1				1	
ABYSSONINOE WINSNESAE	500131WINS		4					1	
DRILONEREIS FILUM	5001330101		1					1	
DRILONEREIS LONGA	5001330103			1				1	
DRILONEREIS MAGNA	5001330105				2		1	2	
LABROROSTRATUS PARASITICUS	5001330901					1		1	
DORVILLEA SOCIABILIS	5001360108	20	1		6	1		4	
OPHRYOTROCHA CF. LABRONICA	5001360402CF	7			1	4		3	
OPHRYOTROCHA BIFIDA	5001360413	1						1	
OPHRYOTROCHA SP. 1	50013604SP01					13	54	2	
PAROUGIA CAECA	5001360505	320	252	240	590	752	475	6	
MEIODORVILLEA MINUTA	5001360601	14						1	
SCOLOPLOS ARMIGER	5001400301	70	101	149	28	9	10	6	
LEITOSCOLOPLOS ACUTUS	5001400305	967	1552	977	1173	1098	1165	6	
SCOLOPLOS (LEODAMAS) ?RUBRA	5001400307CF					29	1	2	
SCOLOPLOS ACMECEPS	5001400311				8	9	19	3	
LEITOSCOLOPLOS SP.B	50014016SP01	61	4	26	138	124	73	6	
ARICIDEA CATHERINAE	5001410208	4074	10456	3852	3891	2771	3459	6	
ARICIDEA QUADRILOBATA	5001410217	611	1718	714	746	817	865	6	
ARICIDEA MINUTA	5001410220	10	1	3	20	16	9	6	
ARICIDEA CERRUTII	50014102CERR			14				1	
CIRROPHORUS FURCATUS	5001410606							0	(May_92)
LEVINSENIA GRACILIS	5001410801	1643	1617	1521	2432	2272	2695	6	

ALL MASSACHUSETTS BAY	STAT_ARRIV	Total Aug_92	Total Aug_93	Total Aug_94	Total Aug_95	Total Aug_96	Total Aug_97	No. yrs. present
TAXON	NODC CODE							
PARADONEIS LYRA	5001411201	7				52		2
PARADONEIS ELIASONI	5001411205	7						1
APISTOBRANCHUS TULLBERGI	5001420101	210	209	100			405	4
APISTOBRANCHUS TYPICUS	5001420103				319	307	201	3
LAONICE CIRRATA	5001430201	11	1	2	7	9	3	6
LAONICE SP. 1 (BLAKE 1992)	50014302SP01	4		1	6			3
DIPOLYDORA SOCIALIS	5001430402	8588	648	6346	907	1608	5906	6
DIPOLYDORA CAULLERYI	5001430404	2	2	1		3	4	5
DIPOLYDORA QUADRILOBATA	5001430408	1959	293	669	226	160	82	6
POLYDORA WEBSTERI	5001430412					9	6	2
DIPOLYDORA CONCHARUM	5001430414					3		1
POLYDORA CORNUTA	5001430448	434	10					2
PRIONOSPIO STEENSTRUPI	5001430506	7729	4105	5560	26266	22822	34854	6
PRIONOSPIO CIRRIFERA	50014305CIRR		2	10				2
SPIO FILICORNIS	5001430701	45	64	36	26	33		5
SPIO SETOSA	5001430704			3			5	2
SPIO LIMICOLA	5001430707	22197	9628	17740	6776	6324	5869	6
SPIO THULINI	5001430709	19	60	86	8	12		5
SPIOPHANES BOMBYX	5001431001	149	138	334	447	405	1322	6
SPIOPHANES KROEYERI	5001431002	21	5	6	7	1	2	6
PYGOSPIO ELEGANS	5001431302	72	9	117			1	4
STREBLOSPIO BENEDICTI	5001431801	1	4		1			3
SCOLELEPIS SQUAMATA	5001432001	1					1	2
SCOLELEPIS FOLIOSA	5001432007			1				1
SPIONID SP. A	500143SP01		1					1
TROCHOCHAETA CARICA	5001450201	77	29	16	8	8	2	6
TROCHOCHAETA WATSONI	5001450202	3						1
TROCHOCHAETA MULTISETOSA	5001450203	1	79	31	53		604	5
SPIOCHAETOPTERUS OCULATUS	5001490303					1		1
CIRRATULUS CIRRATUS	5001500101	1	3	2	1			4
CAULLERIELLA SP. B	50015002SP02				2			1
APHELOCHAETA MONILARIS	5001500301	108	72	60	5	44	15	6
THARYX ACUTUS	5001500305	2676	5419	1680	4457	4410	5681	6
APHELOCHAETA MARIONI	5001500307	977	558	1289	2389	3545	1979	6
MONTICELLINA DORSOBRANCHIALIS	5001500310	196	234	158	241	324	250	6
MONTICELLINA BAPTISTEAE	50015003BAPT	1088	1237	2572	2287	1323	1583	6
THARYX SP. A	50015003SP02	9						1
CHAETOZONE SETOSA	5001500401	398	916	522	566	968	777	6
CHAETOZONE VIVIPARA	50015004VIVI		11		10	1		3
COSSURA LONGOCIRRATA	5001520101	1429	2220	1034	1261	2144	4154	6
BRADA VILLOSA	5001540102	10	2	1			4	4
BRADA INCRUSTATA	5001540107				1			1
FLABELLIGERA AFFINIS	5001540202	7						1
PHERUSA PLUMOSA	5001540302	1						1
PHERUSA AFFINIS	5001540304	8	2	24	8	5	9	6
DIPLOCIRRUS LONGISETOSUS	5001540401	4						1
DIPLOCIRRUS HIRSUTUS	5001540402	1	7	1	1		1	5
SCALIBREGMA INFLATUM	5001570101	1256	147	703	224	454	41	6
OPHELINA ABRANCHIATA	5001580601	10						1
OPHELINA ACUMINATA	5001580607	9	11	1	25	14	10	6
STERNASPIS SCUTATA	5001590101	58	87	21	243	212	116	6
CAPITELLA CAPITATA COMPLEX	5001600101	252	260	631	320	145	528	6
HETEROMASTUS FILIFORMIS	5001600201	144	22	134	60	86	7	6
MEDIOMASTUS CALIFORNIENSIS	5001600402	10574	8240	6508	9569	8251	9541	6
BARANTOLLA AMERICANA	5001600601	3						1
BARANTOLLA SP. A (BLAKE 1992)	50016006SP01	2						1
CLYMENELLA TORQUATA	5001630202	150	45	33	67	85	265	6
MALDANE SARSI	5001630301			311	277	160	142	4
MALDANE GLEBIFEX	5001630302	563	608	31	15			4
PETALOPROCTUS TENUIS	5001630701				2	2	1	3
AXIOTHELLA CATENATA	5001630801		8		3		3	3

ALL MASSACHUSETTS BAY

TAXON	STAT_ARRIV NODC CODE	Total Aug_92	Total Aug_93	Total Aug_94	Total Aug_95	Total Aug_96	Total Aug_97	No. yrs. present	
PRAXILLELLA GRACILIS	5001630901	2	12	11	17	13	7	6	
PRAXILLELLA PRAETERMISSA	5001630902	22	128	105	126	52	89	6	
PRAXILLELLA AFFINIS	5001630903	34						1	
RHODINE BITORQUATA	5001631001	2						1	
RHODINE LOVENI	5001631003	31	6	25	74	28	49	6	
EUCLYMENE COLLARIS	5001631102	101	73	79	177	473	152	6	
CLYMENURA POLARIS	5001631202	8						1	
CLYMENURA SP. A (BLAKE 1992)	50016312SP01		4	2	7	16	4	5	
PRAXILLURA ORNATA	5001631803	37	7	20	24	8	15	6	
OWENIA FUSIFORMIS	5001640102	530	45	107	940	2571	2156	6	
MYRIOCHELE HEERI	5001640201		2		1	4	62	4	
GALATHOWENIA OCULATA	5001640402	66	10	30	90	176	317	6	
PECTINARIA GOULDI	5001660302	5		1				2	
PECTINARIA GRANULATA	5001660303	3	9	11	2	4	5	6	
AMPHARETE ACUTIFRONS	5001670208	1600	139	213	308	309	775	6	
AMPHARETE LINDSTROEMI	5001670213				14	38	5	3	
AMPHARETE FINMARCHICA	5001670214	49	2	11	10	148	24	6	
AMPHICTEIS GUNNERI	5001670303	1			1			2	
MELINNA CRISTATA	5001670501	3	1	7	6	2	2	6	
ANOBOTHRUS GRACILIS	5001670701	245	421	238	174	309	654	6	
ASABELLIDES OCULATA	5001670802	584	275	749	113	91	370	6	
AMPHITRITE CIRRATA	5001680101			1				1	
NICOLEA ZOSTERICOLA	5001680602	2					2	2	
PISTA CRISTATA	5001680701	2			1			2	
POLYCIRRUS MEDUSA	5001680802	6	7		2	1		4	
POLYCIRRUS EXIMIUS	5001680804	96	15		13		1	4	
POLYCIRRUS CF. HAEMATODES	5001680805					1		1	
POLYCIRRUS PHOSPHOREUS	5001680807			1				1	
LANASSA VENUSTA VENUSTA	500168130201					7		1	
PROCLEA GRAFFII	5001681702	3	1		11	6		4	
TEREBELLIDES STROEMI	5001690101	4	4	4	2	8	22	6	
TEREBELLIDES ATLANTIS	5001690105	112	358	24	74	369	136	6	
TRICHOBRANCHUS GLACIALIS	5001690201	1					1	2	
TRICHOBRANCHUS ROSEUS	5001690202	7						1	
CHONE INFUNDIBULIFORMIS	5001700102	1			1			2	
CHONE DUNERI	5001700104	3	3	7	29	10	25	6	
CHONE CF. MAGNA	5001700106						2	1	
EUCHONE PAPILLOSA	5001700202				1			1	
EUCHONE INCOLOR	5001700204	1015	480	238	1267	2317	3246	6	
EUCHONE ELEGANS	5001700205	91	128	4	20	28	295	6	
MYXICOLA INFUNDIBULUM	5001700502				1			1	
POTAMILLA NEGLECTA	5001700601	1						1	
POTAMILLA RENIFORMIS	5001700609		3					1	
LAONOME KROEYERI	5001701401	204	7	41	73	79	86	6	
POTAMETHUS SP. 1 (BLAKE 1992)	50017022SP01							0	(May_92)
POLYGORDIUS SP. A	50020501SP01	20	2	379	925	821	136	6	
OLIGOCHAETA									
ENCHYTRAEIDAE SP. 1	500901SP01				676	201	481	3	
ENCHYTRAEIDAE SP. 3 (KROPP 1995)	500901SP03		1					1	
TUBIFICOIDES NR. PSEUDOGASTER	5009020403		4					1	
LIMNODRILOIDES MEDIOPORUS	5009020701							0	(May_92)
TUBIFICOIDES APECTINATUS	5009020906	457	1267	327	520	715	271	6	
TUBIFICOIDES SP. 1	50090209SP01						32	1	
ADELODRILUS SP. 1	50090210SP01				14	22	47	3	
ADELODRILUS SP. 2	50090210SP02				45	8		2	
TUBIFICIDAE SP. 2 (BLAKE 1992)	500902SP02	995	404	156	1133	944	703	6	
TUBIFICIDAE SP. 4	500902SP04					104		1	
GASTROPODA									
MARGARITES COSTALIS	5102100315				22	1		2	
SOLARIELLA OBSCURA	5102100402	8		16			18	3	
LACUNA VINCTA	5103090305						40	1	

ALL MASSACHUSETTS BAY TAXON	STAT_ARRIV NODC CODE	Total Aug_92	Total Aug_93	Total Aug_94	Total Aug_95	Total Aug_96	Total Aug_97	No. yrs. present
PUSILLINA HARPA	5103200127	3				10	42	3
ALVANIA SP. 2	51032001SP02				6			1
ONOBA PELAGICA	5103202113	77	394	169	140	336	348	6
ONOBA MIGHELSI	5103202115	1				6	26	3
PUSILLINA PSEUDOAREOLATA	5103202301	4					1	2
RISSOIDAE SP. A (KROPP 1995)	510320SP01			8				1
SKENEOPSIS PLANORBIS	5103240102	1						1
EPITONIUM GREENLANDICUM	5103500102						1	1
POLINICES PALLADUS	5103760402		1				1	2
EUSPIRA IMMACULATA	5103760408						2	1
EUSPIRA HEROS	5103761201						4	1
UROSALPINX SPP.	51050103SPP				2			1
COLUS PUBESCENS	5105050326	1					1	2
COLUS PYGMAEUS	5105050328	2	2	1		7		4
COLUS PARVUS	5105050335						4	1
COLUS SP. A (KROPP 1995)	51050503SP01			1				1
NEPTUNEA SPP.	51050508SPP					1		1
ILYANASSA TRIVITTATA	5105080202	2		18	35	26	124	5
OENOPOTA HARPULARIA	5106020409					1	3	2
OENOPOTA PYRIMIDALIS	5106020410	1	3				2	3
OENOPOTA INCISULA	5106020426	10	7	11		12	14	5
OENOPOTA CF. CANCELLATUS	5106020443CF			1				1
PROPEBELA TURRICULA	5106020601		1					1
PROPEBELA EXARATA	5106020603	4		1		4	6	4
TURRIDAE SP. A (KROPP 1995)	510602SP01			1				1
ODOSTOMIA SULCOSA	5108010133					2		1
ODOSTOMIA GIBBOSA	5108011504						1	1
ACTEOCINA CANALICULATA	5110040103					2	3	2
CYLICHNA ALBA	5110040203	17	38	7	1	2	1	6
CYLICHNA GOULDI	5110040206	8	52	18	11	32	62	6
DIAPHANA MINUTA	5110090101	7				25	26	3
RETUSA OBTUSA	5110130101	11			5	3		3
DORIDELLA SPP.	51310702SPP					1		1
GASTROPODA SP. A	51SP01		2	1				2
GASTROPODA SP.2 (KROPP 1995)	51SP02		1					1
APLACOPHORA								
CHAETODERMA NITIDULUM CANADENSE	5402010102	5	7	6	1	9	7	6
BIVALVIA								
NUCULOMA TENUIS	5502020201	32	103	53	1	175	103	6
NUCULA ANNULATA	5502020205	53	162	72	60	46	105	6
NUCULA DELPHINODONTA	5502020206	1219	793	1301	1179	1851	2233	6
NUCULOMA GRANULOSA	5502020216	1						1
NUCULANA PERNULA	5502040201		6	2			3	3
NUCULANA NR. MESSANENSIS	5502040220CF					1	1	2
NUCULANA SP. 1 (BLAKE 1992)	55020402SP01	2						1
MEGAYOLDIA THRACIAEFORMIS	5502040507	20	63	21		26	17	5
YOLDIA SAPOTILLA	5502040513	185	329	196	19	514	290	6
YOLDIELLA LUCIDA	5502040611	11				3	1	3
SOLEMYA SPP.	5504010100				1			1
ARCIDAE SPP.	550601SPP	1						1
MYTILUS EDULIS	5507010101	19	99	109	5	39	63	6
CRENELLA DECUSSATA	5507010201	546	677	801		639	577	5
CRENELLA GLANDULA	5507010203	2	1	86	433	232	56	6
MUSCULUS NIGER	5507010401	14	7	10	1		1	5
MUSCULUS DISCORS	5507010402	3				5	2	3
MODIOLUS MODIOLUS	5507010601						11	1
PLACOPECTEN MAGELLANICUS	5509050901	6		22			4	3
THYASIRA GOULDII	5515020301	465	577	302	462	525	503	6
THYASIRA NR. MINUTUS	55150203MINU	5				7	2	3
PYTHINELLA CUNEATA	5515090301	1				85	300	3
CYCLOCARDIA BOREALIS	5515170106		10	18	11	37	22	5

ALL MASSACHUSETTS BAY

TAXON	STAT_ARRIV NODC CODE	Total Aug_92	Total Aug_93	Total Aug_94	Total Aug_95	Total Aug_96	Total Aug_97	No. yrs. present	
ASTARTE BOREALIS	5515190101					1		1	
ASTARTE UNDATA	5515190113	122	113	194	120	380	363	6	
CERASTODERMA PINNULATUM	5515220601	169	110	86	507	861	1716	6	
SPISULA SOLIDISSIMA	5515250102				2			1	
MULINIA LATERALIS	5515250301	1						1	
SILIQUA COSTATA	5515290105					2	3	2	
ENSIS DIRECTUS	5515290301	64	19			89	53	4	
MACOMA BALTHICA	5515310116	2	1			1		3	
TELLINA AGILIS	5515310205	1					2	2	
ARCTICA ISLANDICA	5515390101	273	164	294	235	206	118	6	
PITAR MORRHUANA	5515471201	3	3	1	8	9	38	6	
MYA ARENARIA	5517010201	24	30	75	31	40	29	6	
CYRTODARIA SILIQUA	5517060102	1						1	
HIATELLA ARCTICA	5517060201	213	2323	1043	163	624	1415	6	
PANDORA GLACIALIS	5520020101						1	1	
PANDORA NR. INFLATA	5520020109CF					1	1	2	
LYONSIA ARENOSA	5520050201	12	1	15	14	21	47	6	
PERIPLOMA FRAGILE	5520070102							0	(May_92)
PERIPLOMA PAPYRATIUM	5520070104	95	106	66		214	328	5	
ASTHENOTHAERUS HEMPHILLI	5520080102	4		3	74	30	2	5	
THRACIA CONRADI	5520080209	23				23	49	3	
BUSHIA ELEGANS	5520080301				22			1	
BIVALVIA SP. A (KROPP 1995)	55SP02			9				1	
SCAPHOPODA									
DENTALIUM ENTALE	5601010201	131	85	4		112	98	5	
PYCNOGONIDA									
NYMPHON GROSSIPES	6001010101	2						1	
MYSIDACEA									
MYSIS MIXTA	6153011401	1		4				2	
NEOMYSIS AMERICANA	6153011508					3		1	
ERYTHROPS ERYTHROPHTHALMA	6153012301			1		34	14	3	
CUMACEA									
LAMPROPS QUADRIPLICATA	6154010105	3	5	7	11	2	3	6	
LEUCON FULVUS	6154040104				2	9	19	3	
LEUCON ACUTIROSTRIS	6154040106	9	18	41	17	18	21	6	
EUDORELLA HISPIDA	6154040208				4	59	46	3	
EUDORELLA PUSILLA	6154040211	60	113	59	23	77	67	6	
EUDORELLA HIRSUTA	61540402HIRS		2					1	
EUDORELLOPSIS DEFORMIS	6154040304	5	3	4	3	2	1	6	
DIASTYLIS POLITA	6154050121	1			2	28		3	
DIASTYLIS QUADRISPINOSA	6154050126	5	9	11	13	10	5	6	
DIASTYLIS SCULPTA	6154050127	22	11	97	72	130	57	6	
DIASTYLIS ABBREVIATA	6154050129		4	3				2	
DIASTYLIS CORNUIFER	6154050130	5		1	4	19	25	5	
LEPTOSTYLIS CF. AMPULLACEA	6154050403CF			4	1	31		3	
LEPTOSTYLIS LONGIMANA	6154050404	5	33	10	15	30	12	6	
PETALOSARSIA DECLIVIS	6154060101	16	5	27	74	33	129	6	
CAMPYLASPIS RUBICUNDA	6154070103	9	10	25	8	20	19	6	
CAMPYLASPIS NR. SULCATA	61540701SUCF					6	5	2	
TANAIDACEA									
ANARTHRURA CF. SIMPLEX	6157000101							0	(May_92)
TANAISSUS PSAMMOPHILUS	6157020402	31	3	40	81	26	78	6	
ISOPODA									
GNATHIA CERINA	6159010111			1				1	
PTILANTHURA TENUIS	6160010301	123	138	131	173	85	98	6	
POLITOLANA POLITA	6161011203	11	22	36	15	8	23	6	
IDOTEA BALTHICA	6162020308				1			1	
CHIRIDOTEA TUFTSI	6162020503	31	48	38	61	18	79	6	
EDOTIA MONTOSA	6162020701		188	450	296	263	311	5	
EDOTIA TRILOBA	6162020703	175	2	1				3	
MUNNA SP. 1	61631201SP01				3	8	63	3	

ALL MASSACHUSETTS BAY

TAXON	STAT_ARRIV NODC CODE	Total Aug_92	Total Aug_93	Total Aug_94	Total Aug_95	Total Aug_96	Total Aug_97	No. yrs. present
DYOPEDOS MONACANTHUS	6169440104	115	23	140	97	186	1929	6
DULICHIA FALCATA	6169440109				8	5	17	3
PARADULICHIA TYPICA	6169440302				7	6	60	3
METOPELLA ANGUSTA	6169480306	70	193	157	206	711	766	6
PROBOLOIDES HOLMESI	6169480801	1				3		2
SYRRHOE CRENULATA	6169500301	7	2	8	10	27	24	6
DECAPODA								
AXIUS SERRATUS	6183020301		1				1	2
DECAPODA SP. 1 (BLAKE 1992)	6175SP01	1						1
EUALUS PUSIOLUS	6179160408	1						1
CRANGON SEPTEMSPINOSA	6179220103	3		12			22	3
PAGURUS ACADIANUS	6183060226	1			2	2		3
CANCER BOREALIS	6188030107	5	2	34	15	36	19	6
SIPUNCULIDA								
NEPHASOMA DIAPHANES	7200020305	1	1			9	1	4
PHASCOLION STROMBI	7200020401	21	13	26	14	18	21	6
ECHIURIDA								
ECHIURUS ECHIURUS	7301020201					1		1
PRIAPULIDA								
PRIAPULUS CAUDATUS	7400010101	1	12	5	3	5	4	6
PHORONIDA								
PHORONIS ARCHITECTA	7700010203	490	150	265	462	1416	783	6
ECHINODERMATA								
CTENODISCUS CRISPATUS	8107020101	10	5	2	5	8	8	6
HENRICIA SANGUINOLENTA	8114040111		3				1	2
OPHIOCTEN SERICEUM	8127010401				1			1
OPHIURA SARSI	8127010610	23		29	55	58	62	5
OPHIURA ROBUSTA	8127010611	39	243	68				3
OPHIURA SP. A	81270106SP02	143				13		2
AXIOGNATHUS SQUAMATA	8129030202				1	1	9	3
OPHIOTHRIX ANGULATA	8129040102						5	1
ECHINARACHNIUS PARMA	8155020101	35	9	134	59	100	58	6
MOLPADIA OOLITICA	8179010102	2			2	1	1	4
HEMICHORDATA								
STEREOBALANUS CANADENSIS	8201010201	7		1	8	31	35	5
CHORDATA								
CNEMIDOCARPA MOLLIS	8406010303				1		8	2
MOLGULA MANHATTENSIS	8406030108	39			16		15	3
BOSTRICHOBRANCHUS PILULARIS	8406030501	31	1	38	30		9	5

	Aug92_97	Aug_92	Aug_93	Aug_94	Aug_95	Aug_96	Aug_97
Total number of species	443	276	221	230	255	276	289
Total number of samples	352	56	60	59	59	59	59
Annelida	209	142	115	113	132	125	128
Polychaeta	199	140	111	111	127	119	123
Oligochaeta	10	2	4	2	5	6	5
Arthropoda	103	58	50	58	65	75	72
Amphipoda	61	32	28	32	39	47	45
Isopoda	13	7	8	9	9	8	9
Cumacea	17	11	11	12	14	15	13
Other	12	8	3	5	3	5	5
Mollusca	86	51	34	38	29	49	58
Bivalvia	46	33	22	23	20	30	34
Gastropoda	38	16	10	13	8	17	22
Other	2	2	2	2	1	2	2
Remaining species - 10 phyla	45	25	22	21	29	27	31

Appendix D-1

Dominant Species at Nearfield Stations

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. 0.04m^{-2})
Station NF 13 – Single Sample				
1	*Exogone hebes* (P)	30.32	52.89	695
2	*Cerastoderma pinnulatum* (B)	20.94	9.13	120
3	*Enchytraeidae* sp. 1 (O)	13.92	7.38	97
4	*Spiophanes bombyx* (P)	3.10	4.49	59
5	*Aglaophamus circinata* (P)	2.55	3.73	49
6	*Crassicorophium crassicorne* (A)	1.73	3.27	43
7	*Prionospio steenstrupi* (P)	1.61	2.59	34
8	*Crenella decussata* (B)	1.17	2.36	31
9	*Aricidea catherinae* (P)	0.92	1.75	23
10	*Crenella glandula* (B)	0.90	1.29	17
	Top 10 Identified Taxa	86.65	88.89	1168.00
	Remaining Identified Taxa (40)	10.83	11.11	146
	Total Number of Identified Taxa (50)	97.48	100.00	1314
	Total Number of Unidentified Taxa (13)	2.52	-	34
	Total Number of All Taxa (63)	100.00	-	1348
Station NF 14 – Single Sample				
1	*Exogone verugera* (P)	17.33	17.66	602
2	*Exogone hebes* (P)	10.74	10.94	373
3	*Euchone elegans* (P)	7.95	8.10	276
4	*Enchytraeidae sp. 1* (O)	7.66	7.81	266
5	*Dipolydora socialis* (P)	7.08	7.22	246
6	*Unciola inermis* (A)	5.04	5.13	175
7	*Tharyx acutus* (P)	4.92	5.02	171
8	*Protomedeia fasciata* (A)	4.49	4.58	156
9	*Prionospio steenstrupi* (P)	3.97	4.05	138
10	*Crassicorophium crassicorne* (A)	3.89	3.96	135
	Top 10 Identified Taxa	73.08	74.47	2538
	Remaining Identified Taxa (70)	25.05	25.53	870
	Total Number of Identified Taxa (80)	98.13	100.00	3408
	Total Number of Unidentified Taxa (13)	1.87	-	65
	Total Number of All Taxa (93)	100.00	-	3473

Station NF 15 – Single Sample				
Rank	**Species**	**Percent of Total Fauna**	**Percent of Identified Fauna**	**Density (Ind. 0.04m^{-2})**
1	*Prionospio steenstrupi* (P)	27.86	29.41	1073
2	*Dipolydora socialis* (P)	9.42	9.95	363
3	*Exogone hebes* (P)	9.37	9.89	361
4	*Owenia fusiformis* (P)	6.41	6.77	247
5	*Aricidea catherinae* (P)	4.93	5.21	190
6	*Mediomastus californiensis* (P)	3.61	3.81	139
7	*Euchone incolo* (P)	3.04	3.21	117
8	*Ninoe nigripes* (P)	2.57	2.71	99
9	*Dyopedos monacanthus* (A)	2.21	2.33	85
10	*Tharyx acutus* (P)	1.92	2.03	74
	Top 10 Identified Taxa	71.34	75.31	2748
	Remaining Identified Taxa (79)	23.39	24.69	901
	Total Number of Identified Taxa (89)	94.73	100.00	3649
	Total Number of Unidentified Taxa (23)	5.27	-	203
	Total Number of All Taxa (112)	100.00	-	3852

Station NF 17 – Replicated Sample				
Rank	**Species**	**Percent of Total Fauna**	**Percent of Identified Fauna**	**Density (Ind. 0.12m^{-2})**
1	*Spiophanes bombyx* (P)	19.61	22.46	427
2	*Pseudunciola obliquua* (A)	18.79	21.51	409
3	*Cerastoderma pinnulatum* (B)	8.82	10.10	192
4	*Crassicorophium crassicorne* (A)	6.29	7.21	137
5	*Exogone hebes* (P)	4.96	5.68	108
6	*Chiridotea tuftsi* (I)	4.64	3.95	75
7	*Owenia fusiformis* (P)	3.45	2.37	45
8	*Aglaophamus circinata* (P)	2.16	2.31	44
9	*Tanaissus psammophilus* (C)	2.07	1.84	35
10	*Echinarachnius parma* (E)	2.02	1.79	34
	Top 10 Identified Taxa	72.81	79.22	1506
	Remaining Identified Taxa (64)	18.14	20.78	395
	Total Number of Identified Taxa (74)	90.95	100.00	1901
	Total Number of Unidentified Taxa (19)	9.05	-	276
	Total Number of All Taxa (93)	100.00	-	2177

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. 0.04m^{-2})
Station NF 18 – Single Station				
1	*Prionospio steenstrupi* (P)	28.68	30.82	877
2	*Hiatella arctica* (B)	10.24	11.00	313
3	*Mediomastus californiensis* (P)	6.61	7.10	202
4	*Cerastoderma pinnulatum* (B)	4.58	4.92	140
5	*Ninoe nigripes* (P)	3.92	4.22	120
6	*Exogone hebes* (P)	3.04	3.27	93
7	*Protomedeia fasciata* (A)	3.01	3.23	92
8	*Aricidea catherinae* (P)	2.58	2.78	79
9	*Asabellides oculata* (P)	2.29	2.46	70
10	*Dyopedos monacanthus* (A)	2.06	2.21	63
	Top 10 Identified Taxa	67.00	72.00	2049
	Remaining Identified Taxa (75)	26.06	28.00	797
	Total Number of Identified Taxa (112)	93.06	100.00	2846
	Total Number of Unidentified Taxa (31)	6.94	-	212
	Total Number of All Taxa (116)	100.00	-	3058
Station NF 19 – Single Sample				
1	*Prionospio steenstrupi* (P)	25.16	26.00	713
2	*Dipolydora socialis* (P)	22.34	23.09	633
3	*Spio limicola* (P)	9.14	9.45	259
4	*Exogone hebes* (P)	4.62	4.78	131
5	*Nucula delphinodonta* (B)	3.56	3.68	101
6	*Mediomastus californiensis* (P)	2.86	2.95	81
7	*Aricidea catherinae* (P)	2.36	2.44	67
8	*Euchone incolor* (P)	2.36	2.44	67
9	*Aglaophamus circinata* (P)	2.08	2.15	59
10	*Phoronis architecta* (PH)	2.08	2.15	59
	Top 10 Identified Taxa	76.57	79.14	2170
	Remaining Identified Taxa (67)	20.18	20.86	572
	Total Number of Identified Taxa (77)	96.75	100.00	2742
	Total Number of Unidentified Taxa (17)	3.25	-	92
	Total Number of All Taxa (94)	100.00	-	2834

Station NF 23 – Single Sample				
Rank	**Species**	**Percent of Total Fauna**	**Percent of Identified Fauna**	**Density (Ind. 0.04m^{-2})**
1	*Prionospio steenstrupi* (P)	32.45	33.27	909
2	*Exogone hebes* (P)	14.32	14.68	401
3	*Dipolydora socialis* (P)	10.53	10.80	295
4	*Unciola inermis* (A)	8.21	8.42	230
5	*Exogone verugera* (P)	4.11	4.21	115
6	*Crassicorophium crassicorne* (A)	2.36	2.42	66
7	*Cerastoderma pinnulatum* (B)	1.96	2.01	55
8	*Aglaophamus circinata* (P)	1.82	1.87	51
9	*Protomedeia fasciata* (A)	1.82	1.87	51
10	*Enchytraeidae sp. 1* (O)	1.68	1.72	47
	Top 10 Identified Taxa	79.26	81.26	2220
	Remaining Identified Taxa (83)	18.28	18.74	512
	Total Number of Identified Taxa (93)	97.56	100.00	2732
	Total Number of Unidentified Taxa (15)	2.44	-	69
	Total Number of All Taxa (108)	100.00	-	2801

Station NF 24 – Replicated Sample				
Rank	**Species**	**Percent of Total Fauna**	**Percent of Identified Fauna**	**Density (Ind. 0.12m^{-2})**
1	*Prionospio steenstrupi* (P)	44.24	45.91	1921
2	*Mediomastus californiensis* (P)	9.51	9.87	413
3	*Levinsenia gracilis* (P)	7.21	7.48	313
4	*Spio limicola* (P)	6.86	7.12	298
5	*Tharyx acutus* (P)	4.72	4.90	205
6	*Ninoe nigripes* (P)	4.12	4.28	179
7	*Euchone incolor* (P)	2.30	2.39	100
8	*Aricidea catherinae* (P)	1.87	1.94	81
9	*Aphelochaeta marioni* (P)	1.68	1.74	73
10	*Leitoscoloplos acutus* (P)	1.45	1.51	63
	Top 10 Identified Taxa	83.97	87.14	3646
	Remaining Identified Taxa (84)	12.28	12.86	538
	Total Number of Identified Taxa (94)	96.25	100.00	4184
	Total Number of Unidentified Taxa (20)	3.75	-	158
	Total Number of All Taxa (114)	100.00	-	4342

Appendix D-2

Dominant Species at Midfield Stations

Station MF 2 – Single Sample				
Rank	**Species**	**Percent of Total Fauna**	**Percent of Identified Fauna**	**Density (Ind. 0.04m^{-2})**
1	*Prionospio steenstrupi* (P)	19.77	22.77	410
2	*Hiatella arctica* (B)	18.42	21.21	382
3	*Cerastoderma pinnulatum* (B)	10.90	12.55	226
4	*Aricidea catherinae* (P)	8.82	6.83	123
5	*Dyopedos monacanthus* (A)	5.93	5.44	98
6	*Phyllodoce mucosa* (P)	4.73	2.28	41
7	*Owenia fusiformis* (P)	1.98	2.00	36
8	*Metopella angusta* (A)	1.74	1.83	33
9	*Pythinella cuneata* (B)	1.59	1.61	29
10	*Aglaophamus circinata* (P)	1.54	1.28	23
	Top 10 Identified Taxa	67.55	77.79	1401
	Remaining Identified Taxa (66)	19.29	22.21	400
	Total Number of Identified Taxa (76)	86.84	100.00	1801
	Total Number of Unidentified Taxa (25)	13.16	-	273
	Total Number of All Taxa (91)	100.00	-	2074
Station MF 4 – Single Sample				
1	*Prionospio steenstrupi* (P)	20.42	21.07	718
2	*Dipolydora socialis* (P)	19.00	19.60	668
3	*Spio limicola* (P)	16.35	16.87	575
4	*Ampharete acutifrons* (P)	6.23	6.43	219
5	*Mediomastus californiensis* (P)	3.50	3.61	123
6	*Aphelochaeta marioni* (P)	3.16	3.26	111
7	*Ninoe nigripes* (P)	2.56	2.64	90
8	*Nucula delphinodonta* (B)	2.25	2.32	79
9	*Euchone incolor* (P)	1.91	1.97	67
10	*Photis pollex* (A)	1.68	1.73	59
	Top 10 Identified Taxa	77.05	79.49	2709
	Remaining Identified Taxa (67)	19.88	20.51	699
	Total Number of Identified Taxa (77)	96.93	100.00	3408
	Total Number of Unidentified Taxa (31)	3.07	-	108
	Total Number of All Taxa (108)	100.00	-	3516

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. 0.04m^{-2})
Station MF 5 - Single Sample				
1	*Prionospio steenstrupi* (P)	16.24	17.40	278
2	*Tubificidae* sp. 2 (O)	6.83	7.32	117
3	*Aphelochaeta marioni* (P)	6.72	7.20	115
4	*Mediomastus californiensis* (P)	6.37	6.82	109
5	*Tharyx acutus* (P)	5.78	6.20	99
6	*Dipolydora socialis* (P)	4.85	5.19	83
7	*Nucula delphinodonta* (B)	4.03	4.32	69
8	*Leptocheirus pinguis* (A)	3.45	3.69	59
9	*Exogone verugera* (P)	3.15	3.38	54
10	*Ninoe nigripes* (P)	2.57	2.75	44
	Top 10 Identified Taxa	59.99	64.27	1027
	Remaining Identified Taxa (88)	33.35	64.27	571
	Total Number of Identified Taxa (98)	93.34	100.00	1598
	Total Number of Unidentified Taxa (17)	6.66	-	114
	Total Number of All Taxa (115)	100.00	-	1712
Station MF 7 – Single Sample				
1	*Exogone hebes* (P)	18.60	19.74	151
2	*Cerastoderma pinnulatum* (B)	16.75	17.78	136
3	*Crassicorophium crassicorne* (A)	12.19	12.94	99
4	*Spiophanes bombyx* (P)	9.11	9.67	74
5	*Enchytraeidae* sp. 1 (O)	8.13	8.63	66
6	*Aglaophamus circinata* (P)	5.17	5.49	42
7	*Dipolydora socialis* (P)	3.45	3.66	28
8	*Owenia fusiformis* (P)	3.45	3.66	28
9	*Tanaissus psammophilus* (C)	2.09	2.22	17
10	*Prionospio steenstrupi* (P)	2.09	1.44	11
	Top 10 Identified Taxa	81.29	85.23	652
	Remaining Identified Taxa (40)	16.38	17.39	133
	Total Number of Identified Taxa (50)	97.67	100.00	785
	Total Number of Unidentified Taxa (6)	2.33	-	27
	Total Number of All Taxa (56)	100.00	-	812

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. 0.04m^{-2})
MF 8 – Single Sample				
1	*Prionospio steenstrupi* (P)	35.89	36.76	998
2	*Mediomastus californiensis* (P)	19.63	20.11	546
3	*Ninoe nigripes* (P)	6.15	6.30	171
4	*Leitoscoloplos acutus* (P)	5.47	5.60	152
5	*Monticellina baptisteae* (P)	4.14	4.24	115
6	*Euchone incolor* (P)	4.03	4.13	112
7	*Aricidea catherinae* (P)	3.38	3.46	94
8	*Cerastoderma pinnulatum* (B)	2.73	2.80	76
9	*Levinsenia gracilis* (P)	2.30	2.36	64
10	*Hiatella arctica* (B)	1.65	1.69	46
	Top 10 Identified Taxa	85.36	87.44	2374
	Remaining Identified Taxa (74)	12.26	12.56	341
	Total Number of Identified Taxa (84)	97.62	100.00	2715
	Total Number of Unidentified Taxa (15)	2.38	-	66
	Total Number of All Taxa (99)	100.00	-	2781
MF 9 – Single Sample				
1	*Prionospio steenstrupi* (P)	18.02	18.55	571
2	*Spio limicola* (P)	9.47	9.75	300
3	*Mediomastus californiensis* (P)	7.17	7.37	227
4	*Dipolydora socialis*(P)	6.69	6.89	212
5	*Ninoe nigripes* (P)	6.44	6.63	204
6	*Aricidea catherinae* (P)	5.93	6.11	188
7	*Ampharete acutifrons* (P)	5.33	5.49	169
8	*Aphelochaeta marioni* (P)	4.14	4.26	131
9	*Nucula delphinodonta* (B)	3.38	3.48	107
10	*Euchone incolor* (P)	3.03	3.12	96
	Top 10 Identified Taxa	69.60	71.64	2205
	Remaining Identified Taxa (68)	27.56	28.36	873
	Total Number of Identified Taxa (78)	97.46	100.00	3078
	Total Number of Unidentified Taxa (17)	2.54	-	90
	Total Number of All Taxa (95)	100.00	-	3168

Station MF 10 – Single Sample				
Rank	**Species**	**Percent of Total Fauna**	**Percent of Identified Fauna**	**Density (Ind. 0.04m^{-2})**
1	*Prionospio steenstrupi* (P)	18.71	20.15	754
2	*Mediomastus californiensis* (P)	12.55	13.52	506
3	*Spio limicola* (P)	12.48	13.44	503
4	*Dipolydora socialis* (P)	8.16	8.79	329
5	*Aricidea catherinae* (P)	6.65	7.16	268
6	*Ninoe nigripes* (P)	5.76	6.20	232
7	*Aphelochaeta marioni* (P)	4.94	4.73	177
8	*Euchone incolor* (P)	4.39	3.71	139
9	*Tharyx acutus* (P)	3.45	3.45	129
10	*Nucula delphinodonta* (B)	3.20	1.79	67
	Top 10 Identified Taxa	80.28	82.95	3104
	Remaining Identified Taxa (70)	15.83	17.05	638
	Total Number of Identified Taxa (80)	96.11	100.00	3742
	Total Number of Unidentified Taxa (17)	3.89	-	289
	Total Number of All Taxa (97)	100.00	-	4031

Station MF 12 – Replicated Sample				
Rank	**Species**	**Percent of Total Fauna**	**Percent of Identified Fauna**	**Density (Ind. 0.12m^{-2})**
1	*Mediomastus californiensis* (P)	13.84	14.68	1308
2	*Spio limicola* (P)	13.77	14.61	1302
3	*Dipolydora socialis* (P)	8.84	9.38	836
4	*Aricidea catherinae* (P)	8.69	9.21	821
5	*Aphelochaeta marioni* (P)	7.37	7.82	697
6	*Prionospio steenstrupi* (P)	5.70	6.05	539
7	*Tharyx acutus* (P)	5.37	5.70	508
8	*Ninoe nigripes* (P)	5.17	5.49	489
9	*Euchone incolor* (P)	4.94	5.24	467
10	*Levinsenia gracilis* (P)	2.42	2.57	229
	Top 10 Identified Taxa	76.13	19.25	7196
	Remaining Identified Taxa (103)	18.14	14.88	1715
	Total Number of Identified Taxa (113)	94.27	100.00	8911
	Total Number of Unidentified Taxa (28)	5.73	-	541
	Total Number of All Taxa (141)	100.00	-	9452

Station MF 16 – Single Sample				
Rank	**Species**	**Percent of Total Fauna**	**Percent of Identified Fauna**	**Density (Ind. 0.04m^{-2})**
1	*Prionospio steenstrupi* (P)	30.25	30.62	632
2	*Ninoe nigripes* (P)	12.92	13.08	270
3	*Tharyx acutus* (P)	11.97	12.11	250
4	*Mediomastus californiensis* (P)	10.58	10.71	221
5	*Euchone incolor* (P)	8.66	8.77	181
6	*Levinsenia gracilis* (P)	6.89	6.98	144
7	*Monticellina baptisteae* (P)	2.73	2.76	57
8	*Aphelochaeta marioni* (P)	1.77	1.79	37
9	*Leitoscoloplos acutus* (P)	1.77	1.79	37
10	*Spio limicola* (P)	1.44	1.45	30
	Top 10 Identified Taxa	88.99	90.07	1859.00
	Remaining Identified Taxa (54)	9.81	9.93	205
	Total Number of Identified Taxa (64)	98.80	100.00	2064
	Total Number of Unidentified Taxa (9)	1.20	-	25
	Total Number of All Taxa (75)	100.00	-	2089
	MF 20 – Single Sample			
1	*Prionospio steenstrupi* (P)	51.62	52.56	1786
2	*Tharyx acutus* (P)	8.58	8.74	297
3	*Ninoe nigripes* (P)	7.69	7.83	266
4	*Mediomastus californiensis* (P)	5.29	5.39	183
5	*Cerastoderma pinnulatum* (B)	3.82	3.88	132
6	*Levinsenia gracilis* (P)	2.14	2.18	74
7	*Monticellina baptisteae* (P)	1.99	2.03	69
8	*Aricidea catherinae* (P)	1.91	1.94	66
9	*Dyopedos monacanthus* (A)	1.47	1.50	51
10	*Hiatella arctica* (B)	1.42	1.44	49
	Top 10 Identified Taxa	85.92	87.49	2973
	Remaining Identified Taxa (67)	12.28	12.51	425
	Total Number of Identified Taxa (77)	98.20	100.00	3398
	Total Number of Unidentified Taxa (14)	1.80	-	62
	Total Number of All Taxa (91)	100.00	-	3460

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. 0.04m^{-2})
Station MF21 – Single Sample				
1	*Prionospio steenstrupi* (P)	17.15	18.13	258
2	*Mediomastus californiensis* (P)	15.43	16.30	232
3	*Spio limicola* (P)	10.17	10.75	153
4	*Ninoe nigripes* (P)	8.31	8.78	125
5	*Levinsenia gracilis* (P)	5.65	5.97	85
6	*Euchone incolor* (P)	5.05	5.34	76
7	*Monticellina baptisteae* (P)	4.72	4.99	71
8	*Nucula delphinodonta* (B)	3.59	3.79	54
9	*Aricidea catherinae* (P)	2.53	2.67	38
10	*Aphelochaeta marioni* (P)	2.33	2.46	35
	Top 10 Identified Taxa	74.93	79.20	1127
	Remaining Identified Taxa (65)	19.68	20.80	296
	Total Number of Identified Taxa (75)	94.61	100.00	1423
	Total Number of Unidentified Taxa (16)	5.39	-	81
	Total Number of All Taxa (91)	100.00	-	1504
Station MF22 – Single Sample				
1	*Mediomastus californiensis* (P)	14.47	14.90	342
2	*Tharyx acutus* (P)	12.91	13.29	305
3	*Ninoe nigripes* (P)	11.43	11.76	270
4	*Euchone incolor* (P)	9.52	9.80	225
5	*Aphelochaeta marioni* (P)	8.00	8.24	189
6	*Prionospio steenstrupi* (P)	7.15	7.36	169
7	*Spio limicola* (P)	5.67	5.84	134
8	*Levinsenia gracilis* (P)	4.32	4.44	102
9	*Monticellina baptisteae* (P)	4.27	4.40	101
10	*Nucula delphinodonta* (B)	3.05	3.14	72
	Top 10 Identified Taxa	80.79	83.18	1909
	Remaining Identified Taxa (64)	16.34	16.82	386
	Total Number of Identified Taxa (74)	97.13	100.00	2295
	Total Number of Unidentified Taxa (12)	2.87	-	68
	Total Number of All Taxa (86)	100.00	-	2363

Station FF 10 - Replicated Sample - off Nahant				
Rank	**Species**	**Percent of Total Fauna**	**Percent of Identified Fauna**	**Density (Ind. $0.12m^{-2}$)**
1	*Prionospio steenstrupi* (P)	22.65	23.87	1891
2	*Aricidea catherinae* (P)	7.39	7.79	617
3	*Nucula delphinodonta* (B)	6.70	7.06	559
4	*Mediomastus californiensis* (P)	5.79	6.10	483
5	*Spio limicola* (P)	4.58	4.82	382
6	*Ninoe nigripes* (P)	4.56	4.81	381
7	*Tharyx acutus* (P)	4.44	4.68	371
8	*Monticellina baptisteae* (P)	3.32	3.50	277
9	*Dipolydora socialis* (P)	2.83	2.98	236
10	*Euchone incolor* (P)	2.55	2.69	213
	Top 10 Identified Taxa	64.80	68.28	5410
	Remaining Identified Taxa (113)	30.10	31.72	2513
	Total Number of Identified Taxa (123)	94.90	100.00	7923
	Total Number of Unidentified Taxa (25)	5.10	-	426
	Total Number of All Taxa (148)	100.00	-	8349
FF 12 - Replicated Sample - off Nahant				
1	*Prionospio steenstrupi* (P)	31.31	31.77	3819
2	*Tharyx acutus* (P)	13.68	13.88	1669
3	*Owenia fusiformis* (P)	11.45	11.61	1396
4	*Mediomastus californiensis* (P)	7.95	8.07	970
5	*Dyopedos monacanthus* (A)	6.40	6.49	780
6	*Monticellina baptisteae* (P)	4.47	4.53	545
7	*Ninoe nigripes* (P)	3.84	3.89	468
8	*Spiophanes bombyx* (P)	2.62	2.66	320
9	*Scoletoma hebes* (P)	2.42	2.45	295
10	*Leitoscoloplos acutus* (P)	1.43	1.45	174
	Top 10 Identified Taxa	85.57	86.81	10436
	Remaining Identified Taxa (80)	13.00	13.19	1586
	Total Number of Identified Taxa (90)	98.57	100.00	12022
	Total Number of Unidentified Taxa (18)	1.43	-	174
	Total Number of All Taxa (108)	100.00	-	12196

Station FF-13 - off Hull (Midfield area)				
Rank	**Species**	**Percent of Total Fauna**	**Percent of Identified Fauna**	**Density (Ind. 0.12m^{-2})**
1	*Prionospio steenstrupi* (P)	62.56	63.83	7891
2	*Photis pollex* (A)	5.45	5.56	687
3	*Dyopedos monacanthus* (A)	5.19	5.30	655
4	*Mediomastus californiensis* (P)	3.54	3.61	446
5	*Tharyx acutus* (P)	2.96	3.03	374
6	*Nephtys incisa* (P)	2.12	2.16	267
7	*Phoronis architecta* (PH)	1.78	1.81	224
8	*Ampelisca abdita* (A)	1.63	1.66	205
9	*Aricidea catherinae* (P)	1.35	1.38	170
10	*Phyllodoce mucosa* (P)	1.27	1.29	160
	Top 10 Identified Taxa	87.83	89.62	11079
	Remaining Identified Taxa (71)	10.17	10.38	1283
	Total Number of Identified Taxa (81)	98.00	100.00	12362
	Total Number of Unidentified Taxa (19)	2.00	-	252
	Total Number of All Taxa (100)	100.00	-	12614

Appendix D-3

Dominant Species at Farfield Stations

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. 0.12m^{-2})
Station FF 1A - off Gloucester				
1	*Prionospio steenstrupi* (P)	42.57	43.90	2773
2	*Nucula delphinodonta* (B)	7.20	7.43	469
3	*Aglaophamus circinata* (P)	4.44	4.58	289
4	*Spio limicola* (P)	3.67	3.78	239
5	*Tharyx acutus* (P)	3.47	3.58	226
6	*Mediomastus californiensis* (P)	3.04	3.13	198
7	*Ninoe nigripes* (P)	2.27	2.34	148
8	*Dipolydora socialis* (I))	2.01	2.07	131
9	*Levinsenia gracilis* (P)	1.86	1.92	121
10	*Harpinia propinqua* (A)	1.63	1.68	106
	Top 10 Identified Taxa	72.15	74.41	4700
	Remaining Identified Taxa (112)	24.81	25.59	1616
	Total Number of Identified Taxa (122)	96.96	100.00	6316
	Total Number of Unidentified Taxa (26)	3.04	-	198
	Total Number of All Taxa (148)	100.00	-	6514
Station FF 4 - Stellwagen Bank				
1	*Mediomastus californiensis* (P)	14.05	14.89	487
2	*Anobothrus gracilis* (P)	12.37	13.12	429
3	*Chaetozone setosa* (P)	9.66	10.24	335
4	*Euchone incolor* (P)	8.45	8.96	293
5	*Prionospio steenstrupi* (P)	7.12	7.55	247
6	*Cossura longocirrata* (P)	6.29	6.67	218
7	*Aricidea quadrilobata* (P)	6.11	6.48	212
8	*Levinsenia gracilis* (P)	4.24	4.50	147
9	*Apistobranchus typicus* (P)	3.78	4.01	131
10	*Trochochaeta multisetosa* (P)	2.88	2.35	77
	Top 10 Identified Taxa	74.30	78.78	2576
	Remaining Identified Taxa (77)	20.02	21.22	694
	Total Number of Identified Taxa (87)	94.32	100.00	3270
	Total Number of Unidentified Taxa (19)	5.68	-	197
	Total Number of All Taxa (106)	100.00	-	3467

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. $0.12m^{-2}$)
Station FF 5 - Stellwagen Basin				
1	*Mediomastus californiensis* (P)	20.78	22.02	525
2	*Prionospio steenstrupi* (P)	18.92	20.05	478
3	*Levinsenia gracilis* (P)	7.80	8.26	197
4	*Aricidea quadrilobata* (P)	5.22	5.54	132
5	*Euchone incolor* (P)	3.09	3.27	78
6	*Galathowenia oculata* (P)	2.33	2.47	59
7	*Chaetozone setosa* (P)	2.10	2.22	53
8	*Thyasira gouldii* (B)	2.06	2.18	52
9	*Anobothrus gracilis* (P)	1.94	2.06	49
10	*Ninoe nigripes* (P)	1.94	2.06	49
	Top 10 Identified Taxa	66.17	70.13	1672
	Remaining Identified Taxa (79)	28.18	29.87	712
	Total Number of Identified Taxa (89)	94.34	100.00	2384
	Total Number of Unidentified Taxa (23)	5.66	-	143
	Total Number of All Taxa (112)	100.00	-	2527
Station FF 6 - Cape Cod Bay				
1	*Cossura longocirrata* (P)	10.67	11.11	319
2	*Mediomastus californiensis* (P)	10.10	10.52	302
3	*Leptocheirus pinguis* (A)	8.66	9.02	259
4	*Capitella capitata complex* (P)	8.09	8.43	242
5	*Tharyx acutus* (P)	7.36	7.66	220
6	*Ninoe nigripes* (P)	4.48	4.67	134
7	*Levinsenia gracilis* (P)	4.45	4.63	133
8	*Prionospio steenstrupi* (P)	3.68	3.83	110
9	*Onoba pelagica* (G)	2.98	3.10	89
10	*Nucula delphinodonta* (B)	2.78	2.89	83
	Top 10 Identified Taxa	63.24	65.87	1891
	Remaining Identified Taxa (82)	32.78	34.13	980
	Total Number of Identified Taxa (92)	96.02	100.00	2871
	Total Number of Unidentified Taxa (27)	3.98	-	119
	Total Number of All Taxa (119)	100.00	-	2990

Station FF 7 - Cape Cod Bay				
Rank	**Species**	**Percent of Total Fauna**	**Percent of Identified Fauna**	**Density (Ind. 0.12m^{-2})**
1	*Cossura longocirrata* (P)	40.91	43.05	3421
2	*Mediomastus californiensis* (P)	7.40	7.79	619
3	*Euchone incolor* (P)	6.85	7.21	573
4	*Tharyx acutus* (P)	6.83	7.19	571
5	*Tubificidae* sp. 2 (P)	5.17	5.44	432
6	*Apistobranchus tullbergi* (P)	3.47	3.65	290
7	*Nephtys incisa* (P)	2.80	2.94	234
8	*Aricidea catherinae* (P)	2.49	2.62	208
9	*Ninoe nigripes* (P)	2.10	2.21	176
10	*Prionospio steenstrupi* (P)	1.94	2.04	162
	Top 10 Identified Taxa	79.95	84.14	6686
	Remaining Identified Taxa (75)	15.07	15.86	1260
	Total Number of Identified Taxa (85)	95.01	100.00	7946
	Total Number of Unidentified Taxa (31)	4.99	-	417
	Total Number of All Taxa (116)	100.00	-	8363
Station FF 9 - western Massachusetts Bay				
1	*Prionospio steenstrupi* (P)	30.32	32.10	2416
2	*Dipolydora socialis* (P)	20.94	22.18	1669
3	*Spio limicola* (P)	13.92	14.74	1109
4	*Mediomastus californiensis* (P)	3.10	3.28	247
5	*Levinsenia gracilis* (P)	2.55	1.83	138
6	*Nucula delphinodonta* (G)	1.73	1.70	128
7	*Thyasira gouldii* (B)	1.61	1.24	93
8	*Harpinia propinqua* (A)	1.17	0.97	73
9	*Metopella angusta* (A)	0.92	0.96	72
10	*Euchone incolor* (P)	0.90	0.92	69
	Top 10 Identified Taxa	75.47	79.91	6014
	Remaining Identified Taxa (124)	18.97	20.09	1512
	Total Number of Identified Taxa (134)	94.44	100.00	7526
	Total Number of Unidentified Taxa (35)	5.56	-	443
	Total Number of All Taxa (169)	100.00	-	7969

Station FF 11 - Cape Ann				
Rank	**Species**	**Percent of Total Fauna**	**Percent of Identified Fauna**	**Density (Ind. 0.12m^{-2})**
1	*Prionospio steenstrupi* (P)	51.38	53.12	1974
2	*Levinsenia gracilis* (P)	7.26	7.51	279
3	*Aricidea quadrilobata (P)*	5.34	5.52	205
4	*Spio limicola* (P)	4.61	4.76	177
5	*Tubificoides apectinatus* (O)	3.51	3.63	135
6	*Mediomastus californiensis (P)*	2.32	2.40	89
7	*Chaetozone setosa* (P)	2.13	2.21	82
8	*Harpinia propinqua* (A)	1.98	2.05	76
9	*Cossura longocirrata* (P)	1.95	2.02	75
10	*Galathowenia oculata* (P)	1.85	1.91	71
	Top 10 Identified Taxa	82.33	85.12	3163
	Remaining Identified Taxa (75)	14.39	14.88	553
	Total Number of Identified Taxa (85)	96.72	100.00	3716
	Total Number of Unidentified Taxa (20)	3.28	-	126
	Total Number of All Taxa (105)	100.00	-	3842
Station FF 14 - western Massachusetts Bay				
1	*Mediomastus californiensis* (P)	17.44	18.58	436
2	*Prionospio steenstrupi* (P)	10.92	11.63	273
3	*Chaetozone setosa* (P)	9.52	10.14	238
4	*Levinsenia gracilis* (P)	9.00	9.59	225
5	*Aricidea quadrilobata* (P)	3.48	3.71	87
6	*Cossura longocirrata* (P)	3.24	3.45	81
7	*Spio limicola* (P)	3.08	3.28	77
8	*Galathowenia oculata* (P)	2.76	2.94	69
9	*Trochochaeta multisetosa* (P)	2.76	2.94	69
10	*Anobothrus gracilis* (P)	2.48	2.64	62
	Top 10 Identified Taxa	64.68	68.90	1617
	Remaining Identified Taxa (79)	29.20	31.10	730
	Total Number of Identified Taxa (89)	93.88	100.00	2347
	Total Number of Unidentified Taxa (17)	6.12	-	153
	Total Number of All Taxa (106)	100.00	-	2500

Appendix E

Density, Diversity, and Species Richness Data

All Massachusetts Bay Samples Collected in 1992 - 1997

Appendix E. Density and Diversity/Richness Calculations for all Massachusetts Bay Samples (1992-1997)

Station Labels: MF, NF, FF							Shannon's				Brillouin's		Sanders-Hurlbert							Glea-	Log-Series		
Smpl	Orig.	Month-	New	Rep	No.	No.	log2		Natural log				2	10	17	50	100	200	500	son's	alpha	devia-	max.
No.	Label	Year	Label		Ind.	Spp	H'	J'	H'	J'	H	V	(ESn) = 0 if total < n							D		tion	dev.
1	MF2	Aug-97	MF2	0	1801	76	4.03	0.64	2.79	0.65	2.72	0.64	1.88	6.50	9.11	17.50	26.02	36.77	52.53	10.14	16.08	0.76	0.24
2	MF4	Aug-97	MF4	0	3408	92	4.03	0.62	2.79	0.62	2.74	0.62	1.88	6.49	9.06	17.20	25.28	35.72	52.32	11.31	17.42	0.73	0.27
3	MF5	Aug-97	MF5	0	1598	98	4.92	0.74	3.41	0.74	3.31	0.74	1.94	7.93	11.82	23.43	33.66	46.25	66.69	13.29	23.04	0.87	0.13
4	MF7	Aug-97	MF7	0	785	50	3.95	0.70	2.74	0.70	2.63	0.70	1.90	6.72	9.27	16.34	23.08	31.91	44.53	7.50	11.89	0.84	0.16
5	MF8	Aug-97	MF8	0	2714	83	3.46	0.54	2.40	0.54	2.35	0.54	1.81	5.64	7.80	14.26	20.11	28.08	43.04	10.50	16.19	0.62	0.38
6	MF9	Aug-97	MF9	0	3078	78	4.54	0.72	3.15	0.72	3.10	0.72	1.93	7.58	11.01	20.45	28.18	37.27	50.79	9.71	14.56	0.94	0.06
7	MF10	Aug-97	MF10	0	3742	80	4.05	0.64	2.81	0.64	2.77	0.64	1.90	6.84	9.49	16.47	22.71	30.96	44.87	9.72	14.37	0.76	0.24
8	MF12	Aug-97	MF12-1	1	2507	77	4.15	0.66	2.88	0.66	2.82	0.66	1.91	7.03	9.81	17.00	23.38	31.94	46.53	9.84	15.03	0.76	0.24
9	MF12	Aug-97	MF12-2	2	3745	87	4.25	0.66	2.95	0.66	2.90	0.66	1.92	7.28	10.23	17.38	23.30	31.02	44.44	10.57	15.92	0.74	0.26
10	MF12	Aug-97	MF12-3	3	2658	86	4.23	0.66	2.93	0.66	2.87	0.66	1.91	7.11	9.99	17.64	24.30	33.17	48.90	10.91	17.00	0.74	0.26
	Averages				2970	83	4.21	0.66	2.92	0.66	2.87	0.66	1.91	7.14	10.01	17.34	23.66	32.04	46.62	10.44	15.98	0.75	0.25
11	MF16	Aug-97	MF16	0	2064	64	3.46	0.58	2.40	0.58	2.35	0.58	1.85	5.94	7.92	12.97	17.74	24.30	36.03	8.39	12.52	0.64	0.36
12	MF20	Aug-97	MF20	0	3398	77	3.03	0.48	2.10	0.48	2.06	0.48	1.70	4.97	7.03	13.35	19.23	26.72	39.31	9.47	14.01	0.62	0.38
13	MF21	Aug-97	MF21	0	1423	75	4.23	0.68	2.94	0.68	2.85	0.68	1.91	7.06	9.96	18.03	25.42	35.22	51.98	10.33	16.87	0.77	0.23
14	MF22	Aug-97	MF22	0	2295	74	4.11	0.66	2.85	0.66	2.79	0.66	1.91	7.10	9.85	16.37	21.74	29.07	42.73	9.56	14.62	0.72	0.28
15	FF10	Aug-97	FF10-1	1	1412	79	4.83	0.77	3.35	0.77	3.25	0.77	1.95	8.02	11.88	22.69	31.40	41.48	57.60	10.89	18.07	0.92	0.08
16	FF10	Aug-97	FF10-2	2	3110	92	4.28	0.66	2.96	0.66	2.91	0.66	1.89	6.97	10.11	19.31	27.15	36.73	52.34	11.44	17.80	0.81	0.19
17	FF10	Aug-97	FF10-3	3	3401	108	4.63	0.68	3.21	0.68	3.15	0.68	1.91	7.44	10.96	21.48	30.56	41.78	60.09	13.28	21.25	0.83	0.17
	Averages				2641	93	4.58	0.70	3.17	0.70	3.10	0.70	1.92	7.48	10.98	21.16	29.70	40.00	56.67	11.87	19.04	0.85	0.15
18	FF12	Aug-97	FF12-1	1	3913	77	3.64	0.58	2.52	0.58	2.49	0.58	1.85	6.11	8.39	14.56	20.02	27.19	39.63	9.31	13.59	0.69	0.31
19	FF12	Aug-97	FF12-2	2	4032	71	3.57	0.58	2.47	0.58	2.44	0.58	1.85	6.01	8.14	13.95	19.22	26.25	38.53	8.55	12.24	0.70	0.30
20	FF12	Aug-97	FF12-3	3	4077	72	3.63	0.59	2.52	0.59	2.48	0.59	1.85	6.12	8.44	14.65	19.93	26.80	39.27	8.66	12.42	0.73	0.27
	Averages				4007	73	3.61	0.58	2.50	0.58	2.47	0.58	1.85	6.08	8.32	14.39	19.72	26.75	39.15	8.84	12.75	0.70	0.30
21	FF13	Aug-97	FF13-1	1	4166	60	2.40	0.41	1.66	0.41	1.63	0.40	1.55	4.02	5.74	11.47	16.70	23.19	33.86	7.20	9.93	0.58	0.42
22	FF13	Aug-97	FF13-2	2	4729	60	2.49	0.42	1.72	0.42	1.70	0.42	1.58	4.17	5.93	11.61	16.78	23.10	33.21	7.09	9.69	0.60	0.40
23	FF13	Aug-97	FF13-3	3	3467	59	2.63	0.45	1.82	0.45	1.79	0.44	1.62	4.41	6.27	12.09	17.14	23.27	33.36	7.24	10.10	0.63	0.37
	Averages				4121	60	2.50	0.42	1.73	0.42	1.71	0.42	1.58	4.20	5.98	11.73	16.87	23.19	33.48	7.18	9.91	0.60	0.40
24	NF13	Aug-97	NF13	0	1314	50	2.94	0.52	2.04	0.52	1.98	0.52	1.70	4.94	6.97	13.04	18.36	24.97	35.78	6.96	10.29	0.70	0.30
25	NF14	Aug-97	NF14	0	3408	80	4.34	0.69	3.01	0.69	2.96	0.69	1.92	7.43	10.60	18.52	24.33	31.31	43.51	9.84	14.67	0.79	0.21
26	NF15	Aug-97	NF15	0	3649	83	4.16	0.65	2.89	0.65	2.84	0.65	1.88	6.80	9.78	18.72	26.56	35.61	48.79	10.12	15.12	0.85	0.15
27	NF17	Aug-97	NF17-1	1	430	45	3.45	0.63	2.39	0.63	2.25	0.62	1.80	5.73	8.09	15.54	22.59	31.70	0.00	7.42	12.66	0.75	0.25
28	NF17	Aug-97	NF17-2	2	639	52	4.19	0.74	2.90	0.74	2.78	0.73	1.91	7.15	10.07	18.06	25.25	34.14	48.18	8.05	13.38	0.87	0.13
29	NF17	Aug-97	NF17-3	3	828	51	3.62	0.64	2.51	0.64	2.41	0.64	1.85	6.06	8.35	15.03	21.29	29.32	42.78	7.59	12.01	0.76	0.24
	Averages				632.3	49	3.75	0.67	2.60	0.67	2.48	0.66	1.85	6.31	8.83	16.21	23.04	31.72	30.32	7.69	12.68	0.79	0.21
30	NF18	Aug-97	NF18	0	2846	112	4.37	0.64	3.03	0.64	2.96	0.64	1.88	6.87	10.06	20.29	29.91	42.18	63.03	14.08	23.26	0.76	0.24

Station Labels: MF, NF, FF							Shannon's				Brillouin's		Sanders-Hurlbert							Glea-	Log-Series		
							log2		Natural log				2	10	17	50	100	200	500	son's	alpha	devia-	max.
Smpl	Orig.	Month-	New	Rep	No.	No.							(ESn) = 0 if total < n							D		tion	dev.
No.	Label	Year	Label		Ind.	Spp	H'	J'	H'	J'	H	V											
31	NF19	Aug-97	NF19	0	2742	77	3.87	0.62	2.68	0.62	2.63	0.62	1.86	6.30	8.84	16.77	23.80	31.97	45.47	9.73	14.71	0.77	0.23
32	NF23	Aug-97	NF23	0	2728	92	3.80	0.58	2.63	0.58	2.58	0.58	1.84	6.12	8.55	16.16	23.72	33.56	49.94	11.63	18.37	0.68	0.32
33	NF24	Aug-97	NF24-1	1	2292	73	3.37	0.55	2.34	0.55	2.29	0.54	1.79	5.60	7.76	13.84	19.36	27.00	41.46	9.43	14.38	0.64	0.36
34	NF24	Aug-97	NF24-2	2	755	54	2.55	0.44	1.76	0.44	1.66	0.43	1.57	4.14	5.97	12.56	19.57	29.37	46.28	8.15	13.32	0.55	0.45
35	NF24	Aug-97	NF24-3	3	1137	56	3.35	0.58	2.32	0.58	2.24	0.57	1.79	5.62	7.81	13.91	19.45	27.10	41.07	7.96	12.35	0.70	0.30
	Averages				1395	61	3.09	0.52	2.14	0.52	2.06	0.52	1.72	5.12	7.18	13.44	19.46	27.83	42.93	8.51	13.35	0.63	0.37
36	FF1A	Aug-97	FF1A-1	1	1860	89	3.71	0.57	2.57	0.57	2.49	0.57	1.78	5.80	8.49	17.47	26.19	37.37	55.76	11.82	19.48	0.69	0.31
37	FF1A	Aug-97	FF1A-2	2	1997	88	3.86	0.60	2.68	0.60	2.60	0.59	1.79	5.99	8.92	18.85	28.06	39.56	58.28	11.58	18.83	0.74	0.26
38	FF1A	Aug-97	FF1A-3	3	2459	89	3.90	0.60	2.71	0.60	2.64	0.60	1.80	6.08	8.96	18.67	27.88	39.22	56.82	11.40	18.09	0.75	0.25
	Averages				2105	89	3.82	0.59	2.65	0.59	2.58	0.59	1.79	5.96	8.79	18.33	27.38	38.72	56.95	11.60	18.80	0.73	0.27
39	FF4	Aug-97	FF4-1	1	1382	62	4.23	0.71	2.93	0.71	2.85	0.71	1.92	7.26	10.18	17.48	23.89	32.21	45.47	8.57	13.33	0.83	0.17
40	FF4	Aug-97	FF4-2	2	1006	58	4.31	0.74	2.99	0.74	2.89	0.74	1.92	7.35	10.49	18.77	25.42	33.68	46.85	8.39	13.39	0.89	0.11
41	FF4	Aug-97	FF4-3	3	882	54	4.14	0.72	2.87	0.72	2.77	0.72	1.91	7.10	9.98	17.42	23.74	31.79	44.51	7.96	12.69	0.85	0.15
	Averages				1090	58	4.22	0.72	2.93	0.72	2.84	0.72	1.92	7.24	10.22	17.89	24.35	32.56	45.61	8.31	13.14	0.86	0.14
42	FF5	Aug-97	FF5-1	1	960	73	4.48	0.72	3.10	0.72	2.98	0.72	1.91	7.25	10.57	21.00	30.45	41.63	59.16	10.63	18.36	0.87	0.13
43	FF5	Aug-97	FF5-2	2	916	63	3.81	0.64	2.64	0.64	2.53	0.63	1.84	6.06	8.61	17.40	26.16	36.85	52.58	9.24	15.34	0.75	0.25
44	FF5	Aug-97	FF5-3	3	508	54	4.53	0.79	3.14	0.79	2.97	0.79	1.93	7.61	11.11	21.41	30.13	39.76	53.75	8.67	15.28	0.96	0.04
	Averages				794.7	63	4.27	0.72	2.96	0.72	2.83	0.71	1.89	6.97	10.09	19.94	28.91	39.42	55.16	9.51	16.33	0.86	0.14
45	FF6	Aug-97	FF6-1	1	1121	74	4.63	0.75	3.21	0.75	3.10	0.75	1.94	7.73	11.27	21.22	29.49	39.32	55.53	10.54	17.79	0.88	0.12
46	FF6	Aug-97	FF6-2	2	1070	66	4.71	0.78	3.26	0.78	3.16	0.78	1.94	7.83	11.51	22.04	30.87	40.91	55.71	9.46	15.54	1.03	0.03
47	FF6	Aug-97	FF6-3	3	679	47	4.37	0.79	3.03	0.79	2.91	0.79	1.93	7.54	10.84	19.53	26.13	33.31	43.73	7.21	11.47	1.05	0.05
	Averages				956.7	62	4.57	0.77	3.17	0.77	3.06	0.77	1.93	7.70	11.21	20.93	28.83	37.85	51.66	9.07	14.94	0.98	0.07
48	FF7	Aug-97	FF7-1	1	1987	63	3.82	0.64	2.65	0.64	2.59	0.64	1.85	6.36	9.01	16.52	22.86	30.69	42.96	8.30	12.39	0.83	0.17
49	FF7	Aug-97	FF7-2	2	3970	72	3.20	0.52	2.22	0.52	2.19	0.52	1.74	5.29	7.55	14.33	20.02	26.57	37.01	8.69	12.49	0.70	0.30
50	FF7	Aug-97	FF7-3	3	1989	56	3.42	0.59	2.37	0.59	2.32	0.59	1.81	5.75	7.95	14.05	19.48	26.40	37.79	7.37	10.71	0.76	0.24
	Averages				2649	64	3.48	0.58	2.41	0.58	2.36	0.58	1.80	5.80	8.17	14.97	20.79	27.89	39.25	8.12	11.86	0.76	0.24
51	FF9	Aug-97	FF9-1	1	2428	90	3.60	0.56	2.50	0.56	2.44	0.55	1.83	5.62	7.68	15.12	23.43	34.71	53.03	11.55	18.41	0.61	0.39
52	FF9	Aug-97	FF9-2	2	2645	104	3.71	0.55	2.57	0.55	2.51	0.55	1.81	5.70	8.00	16.17	25.44	38.43	59.64	13.20	21.59	0.61	0.39
53	FF9	Aug-97	FF9-3	3	2452	98	3.61	0.55	2.50	0.55	2.44	0.54	1.82	5.57	7.64	15.23	23.93	36.11	56.34	12.56	20.43	0.59	0.41
	Averages				2508	97	3.64	0.55	2.52	0.55	2.46	0.55	1.82	5.63	7.77	15.51	24.26	36.42	56.34	12.43	20.14	0.61	0.39
54	FF11	Aug-97	FF11-1	1	1984	63	3.11	0.52	2.16	0.52	2.10	0.52	1.72	5.12	7.25	13.73	19.71	27.36	39.90	8.30	12.40	0.67	0.33
55	FF11	Aug-97	FF11-2	2	766	60	3.56	0.60	2.47	0.60	2.35	0.60	1.77	5.73	8.39	16.99	24.88	34.87	51.29	9.03	15.24	0.74	0.26
56	FF11	Aug-97	FF11-3	3	966	61	2.68	0.45	1.85	0.45	1.76	0.44	1.59	4.31	6.28	13.26	20.31	29.61	46.17	8.88	14.47	0.56	0.44
	Averages				1239	61	3.12	0.52	2.16	0.52	2.07	0.52	1.69	5.06	7.30	14.66	21.63	30.61	45.79	8.74	14.04	0.66	0.34
57	FF14	Aug-97	FF14-1	1	353	53	4.59	0.80	3.18	0.80	2.96	0.80	1.93	7.65	11.36	22.81	32.33	42.82	0.00	9.03	17.30	0.96	0.04
58	FF14	Aug-97	FF14-2	2	822	72	4.64	0.75	3.21	0.75	3.08	0.75	1.93	7.67	11.19	21.41	30.52	41.71	60.00	10.73	19.00	0.87	0.13
59	FF14	Aug-97	FF14-3	3	1172	67	4.26	0.70	2.95	0.70	2.86	0.70	1.91	7.14	10.21	18.91	25.99	33.95	48.03	9.48	15.43	0.83	0.17
	Averages				782.3	64	4.50	0.75	3.12	0.75	2.97	0.75	1.92	7.49	10.92	21.04	29.61	39.49	36.01	9.75	17.24	0.89	0.11

Station Labels: MF, NF, FF							Shannon's				Brillouin's		Sanders-Hurlbert							Glea-	Log-Series		
Smpl	Orig.	Month-	New	Rep	No.	No.	log2		Natural log				2	10	17	50	100	200	500	son's	alpha	devia-	max.
No.	Label	Year	Label		Ind.	Spp	H'	J'	H'	J'	H	V	(ESn) = 0 if total < n							D		tion	dev.
60	NF2	Aug-96	MF2	0	2466	69	4.06	0.66	2.81	0.66	2.76	0.66	1.90	6.86	9.64	17.16	23.25	30.49	42.34	8.83	13.17	0.76	0.24
61	NF4	Aug-96	MF4	0	1865	58	2.82	0.48	1.95	0.48	1.90	0.48	1.71	4.77	6.46	11.21	15.65	22.10	34.47	7.70	11.36	0.82	0.18
62	NF5	Aug-96	MF5	0	1508	91	4.58	0.70	3.17	0.70	3.07	0.70	1.91	7.32	10.64	20.91	30.99	44.48	66.21	12.43	21.29	0.77	0.23
63	NF7	Aug-96	MF7	0	1399	74	4.38	0.70	3.03	0.70	2.94	0.70	1.91	7.19	10.29	19.52	28.15	38.70	54.97	10.22	16.66	0.75	0.25
64	NF8	Aug-96	MF8	0	1338	49	3.47	0.62	2.40	0.62	2.34	0.62	1.84	5.84	7.90	14.01	19.54	25.97	36.06	6.81	9.99	0.74	0.26
65	NF9	Aug-96	MF9	0	1600	75	4.49	0.72	3.11	0.72	3.03	0.72	1.93	7.47	10.72	19.74	27.98	38.78	55.40	10.17	16.32	0.77	0.23
66	NF10	Aug-96	MF10	0	1599	64	3.77	0.63	2.62	0.63	2.55	0.63	1.87	6.37	8.72	15.19	20.97	28.58	42.18	8.68	13.35	0.82	0.18
67	NF12	Aug-96	MF12-1	1	2075	70	3.99	0.65	2.77	0.65	2.71	0.65	1.89	6.71	9.30	16.48	22.86	31.01	45.14	9.17	13.98	0.59	0.41
68	NF12	Aug-96	MF12-2	2	2013	68	3.87	0.64	2.68	0.64	2.63	0.64	1.88	6.55	9.05	15.82	21.69	29.07	41.79	8.94	13.59	0.85	0.15
69	NF12	Aug-96	MF12-3	3	2582	72	4.11	0.67	2.85	0.67	2.80	0.67	1.90	6.93	9.69	17.15	23.62	31.69	44.66	9.16	13.74	0.82	0.18
	Averages				2223	70	3.99	0.65	2.77	0.65	2.71	0.65	1.89	6.73	9.35	16.48	22.72	30.59	43.86	9.09	13.77	0.75	0.25
70	NF16	Aug-96	MF16	0	1399	63	4.34	0.73	3.01	0.73	2.93	0.73	1.93	7.50	10.64	18.21	24.32	32.11	44.78	8.70	13.56	0.77	0.23
71	NF20	Aug-96	MF20	0	2809	83	4.05	0.64	2.81	0.64	2.76	0.63	1.88	6.71	9.47	17.29	24.21	33.08	47.60	10.45	16.05	0.76	0.24
72	NF21	Aug-96	MF21	0	1337	65	4.29	0.71	2.97	0.71	2.89	0.71	1.92	7.30	10.42	18.58	24.90	32.71	46.40	9.03	14.29	0.90	0.10
73	NF22	Aug-96	MF22	0	2765	71	3.96	0.64	2.74	0.64	2.70	0.64	1.89	6.69	9.24	16.13	22.20	29.85	42.10	8.96	13.29	0.66	0.34
74	FF10	Aug-96	FF10-1	1	2590	83	4.51	0.71	3.12	0.71	3.06	0.71	1.93	7.56	10.86	19.65	27.09	36.47	51.75	10.56	16.37	0.78	0.22
75	FF10	Aug-96	FF10-2	2	1953	79	4.66	0.74	3.23	0.74	3.16	0.74	1.93	7.65	11.23	21.79	30.66	40.57	55.22	10.43	16.52	0.76	0.24
76	FF10	Aug-96	FF10-3	3	1842	84	4.58	0.72	3.17	0.72	3.09	0.72	1.92	7.51	10.93	20.88	29.66	40.01	55.74	11.17	18.14	0.71	0.29
	Averages				2128	82	4.58	0.72	3.18	0.72	3.10	0.72	1.93	7.57	11.01	20.78	29.14	39.02	54.23	10.72	17.01	0.75	0.25
77	FF12	Aug-96	FF12-1	1	3190	74	3.96	0.64	2.74	0.64	2.70	0.64	1.89	6.71	9.25	16.11	22.08	29.34	41.25	9.17	13.54	0.69	0.31
78	FF12	Aug-96	FF12-2	2	2538	65	3.53	0.59	2.45	0.59	2.40	0.59	1.85	5.90	7.96	14.01	19.80	27.09	39.10	8.29	12.16	0.81	0.19
79	FF12	Aug-96	FF12-3	3	3205	62	3.63	0.61	2.52	0.61	2.48	0.61	1.87	6.19	8.36	14.10	19.17	25.80	36.81	7.68	10.90	0.75	0.25
	Averages				2978	67	3.71	0.61	2.57	0.61	2.53	0.61	1.87	6.27	8.52	14.74	20.35	27.41	39.05	8.38	12.20	0.75	0.25
80	FF13	Aug-96	FF13-1	1	2432	52	3.86	0.68	2.68	0.68	2.64	0.68	1.89	6.68	9.31	15.90	20.68	26.39	35.53	6.67	9.34	0.77	0.23
81	FF13	Aug-96	FF13-2	2	1948	55	3.69	0.64	2.56	0.64	2.51	0.64	1.87	6.30	8.54	14.51	19.69	26.37	37.63	7.26	10.52	0.73	0.27
82	FF13	Aug-96	FF13-3	3	2678	57	4.32	0.74	2.99	0.74	2.95	0.74	1.93	7.47	10.67	18.59	24.23	30.48	39.63	7.22	10.23	0.86	0.14
	Averages				2353	55	3.96	0.69	2.74	0.69	2.70	0.68	1.90	6.82	9.51	16.33	21.53	27.74	37.59	7.05	10.03	0.79	0.21
83	NF13	Aug-96	NF13	0	1583	56	3.34	0.58	2.32	0.58	2.26	0.57	1.82	5.51	7.40	13.34	19.37	27.18	39.10	7.60	11.32	0.84	0.16
84	NF14	Aug-96	NF14	0	2032	75	3.67	0.59	2.54	0.59	2.48	0.59	1.83	6.00	8.41	15.63	22.23	30.86	46.02	9.85	15.32	0.79	0.21
85	NF15	Aug-96	NF15	0	1602	70	3.72	0.61	2.58	0.61	2.51	0.61	1.80	5.96	8.62	17.15	25.20	35.51	50.82	9.49	14.94	0.90	0.10
86	NF17	Aug-96	NF17-1	1	1440	70	3.92	0.64	2.72	0.64	2.64	0.64	1.85	6.28	8.95	17.80	26.16	36.03	50.62	9.63	15.39	0.79	0.21
87	NF17	Aug-96	NF17-2	2	1184	55	2.90	0.50	2.01	0.50	1.94	0.50	1.66	4.80	6.91	13.58	19.44	26.69	39.77	7.77	11.94	1.07	0.07
88	NF17	Aug-96	NF17-3	3	1740	65	4.30	0.71	2.98	0.71	2.91	0.71	1.92	7.24	10.33	18.81	25.79	33.96	46.18	8.71	13.32	0.85	0.15
	Averages				1455	63	3.71	0.62	2.57	0.62	2.50	0.62	1.81	6.11	8.73	16.73	23.80	32.23	45.52	8.70	13.55	0.90	0.15
89	NF18	Aug-96	NF18	0	1672	82	4.28	0.67	2.97	0.67	2.89	0.67	1.88	6.95	10.20	20.05	28.11	37.44	53.29	11.05	18.07	0.85	0.15
90	NF19	Aug-96	NF19	0	2349	100	4.49	0.68	3.11	0.68	3.04	0.67	1.91	7.22	10.48	20.30	29.56	41.58	60.48	12.88	21.20	0.71	0.29
91	NF23	Aug-96	NF23	0	3316	86	4.45	0.69	3.09	0.69	3.04	0.69	1.93	7.52	10.81	19.45	26.26	34.46	47.70	10.61	16.13	0.75	0.25

Station Labels: MF, NF, FF							Shannon's				Brillouin's		Sanders-Hurlbert							Glea-	Log-Series		
Smpl	Orig.	Month-	New	Rep	No.	No.	log2		Natural log				2	10	17	50	100	200	500	son's	alpha	devia-	max.
No.	Label	Year	Label		Ind.	Spp	H'	J'	H'	J'	H	V	(ESn) = 0 if total < n							D		tion	dev.
92	NF24	Aug-96	NF24-1	1	1696	66	3.80	0.63	2.63	0.63	2.57	0.63	1.85	6.18	8.67	16.52	23.91	32.89	46.32	8.88	13.67	0.95	0.05
93	NF24	Aug-96	NF24-2	2	1461	73	3.92	0.63	2.71	0.63	2.63	0.63	1.87	6.44	9.02	16.76	23.83	32.78	47.93	10.02	16.17	0.87	0.13
94	NF24	Aug-96	NF24-3	3	1353	58	3.69	0.63	2.56	0.63	2.49	0.63	1.86	6.15	8.37	14.99	21.46	30.02	43.70	8.04	12.32	0.83	0.17
	Averages				1503	66	3.80	0.63	2.64	0.63	2.56	0.63	1.86	6.26	8.69	16.09	23.07	31.90	45.99	8.98	14.05	0.88	0.12
95	FF1A	Aug-96	FF1A-1	1	2007	71	3.01	0.49	2.09	0.49	2.03	0.49	1.64	4.74	7.02	15.21	23.17	32.69	46.36	9.34	14.35	0.59	0.41
96	FF1A	Aug-96	FF1A-2	2	2311	74	3.14	0.51	2.17	0.51	2.12	0.50	1.68	4.94	7.18	14.84	22.62	33.10	49.67	9.55	14.59	0.54	0.46
97	FF1A	Aug-96	FF1A-3	3	2109	76	2.92	0.47	2.03	0.47	1.97	0.46	1.62	4.58	6.75	14.64	22.57	32.61	48.55	9.93	15.43	0.63	0.37
	Averages				2142	74	3.02	0.49	2.10	0.49	2.04	0.48	1.64	4.75	6.99	14.90	22.79	32.80	48.20	9.61	14.79	0.59	0.41
98	FF4	Aug-96	FF4-1	1	518	46	4.23	0.77	2.93	0.77	2.79	0.77	1.92	7.34	10.44	18.39	24.49	32.01	45.40	7.36	12.19	0.95	0.05
99	FF4	Aug-96	FF4-2	2	445	49	4.29	0.76	2.98	0.76	2.81	0.76	1.92	7.39	10.55	19.00	26.10	35.22	0.00	8.04	14.06	0.95	0.05
100	FF4	Aug-96	FF4-3	3	502	41	4.11	0.77	2.85	0.77	2.72	0.77	1.91	7.14	10.14	18.03	24.05	30.78	40.95	6.59	10.56	1.03	0.03
	Averages				488.3	45	4.21	0.77	2.92	0.77	2.77	0.77	1.92	7.29	10.38	18.47	24.88	32.67	28.78	7.33	12.27	0.98	0.04
101	FF5	Aug-96	FF5-1	1	568	59	4.54	0.77	3.15	0.77	2.98	0.77	1.92	7.53	11.11	21.82	30.59	40.46	56.47	9.30	16.55	0.59	0.41
102	FF5	Aug-96	FF5-2	2	616	66	4.53	0.75	3.14	0.75	2.98	0.75	1.91	7.28	10.70	22.12	33.02	45.43	62.09	10.28	18.74	0.64	0.36
103	FF5	Aug-96	FF5-3	3	1024	69	4.42	0.72	3.06	0.72	2.96	0.72	1.92	7.41	10.78	20.06	27.25	35.94	52.13	9.95	16.70	0.62	0.38
	Averages				736	65	4.50	0.75	3.12	0.75	2.97	0.75	1.91	7.40	10.86	21.33	30.29	40.61	56.90	9.84	17.33	0.62	0.38
104	FF6	Aug-96	FF6-1	1	1083	71	4.71	0.77	3.26	0.77	3.15	0.77	1.94	7.83	11.46	21.58	30.48	41.58	58.12	10.16	17.04	0.65	0.35
105	FF6	Aug-96	FF6-2	2	844	56	4.44	0.76	3.08	0.76	2.96	0.76	1.92	7.48	10.84	20.27	28.11	37.16	49.49	8.31	13.49	0.61	0.39
106	FF6	Aug-96	FF6-3	3	1059	68	4.64	0.76	3.22	0.76	3.11	0.76	1.94	7.85	11.42	20.77	28.71	38.86	54.10	9.76	16.21	0.66	0.34
	Averages				995.3	65	4.60	0.76	3.19	0.76	3.08	0.76	1.93	7.72	11.24	20.88	29.10	39.20	53.90	9.41	15.58	0.64	0.36
107	FF7	Aug-96	FF7-1	1	1468	61	4.08	0.69	2.83	0.69	2.75	0.69	1.88	6.78	9.72	18.13	25.21	33.65	46.26	8.37	12.85	1.03	0.03
108	FF7	Aug-96	FF7-2	2	1869	61	3.76	0.63	2.61	0.63	2.55	0.63	1.86	6.36	8.90	15.69	21.21	28.31	40.51	8.10	12.08	0.89	0.11
109	FF7	Aug-96	FF7-3	3	1304	57	3.73	0.64	2.59	0.64	2.51	0.64	1.84	6.27	8.88	16.14	22.07	29.31	41.25	7.95	12.17	0.91	0.09
	Averages				1547	60	3.86	0.65	2.67	0.65	2.61	0.65	1.86	6.47	9.17	16.66	22.83	30.42	42.67	8.14	12.37	0.94	0.08
110	FF9	Aug-96	FF9-1	1	1883	73	3.10	0.50	2.15	0.50	2.09	0.50	1.69	4.94	7.12	14.53	21.87	31.27	46.64	9.68	15.10	0.90	0.10
111	FF9	Aug-96	FF9-2	2	2849	81	2.66	0.42	1.84	0.42	1.79	0.42	1.59	4.26	6.11	12.49	19.03	27.92	43.66	10.18	15.52	0.97	0.03
112	FF9	Aug-96	FF9-3	3	2445	81	3.10	0.49	2.15	0.49	2.09	0.49	1.70	4.89	6.94	14.04	21.35	30.74	45.70	10.38	16.11	0.92	0.08
	Averages				2392	78	2.95	0.47	2.05	0.47	1.99	0.47	1.66	4.70	6.72	13.69	20.75	29.98	45.33	10.08	15.58	0.93	0.07
113	FF11	Aug-96	FF11-1	1	1407	66	3.17	0.52	2.20	0.52	2.12	0.52	1.71	5.11	7.38	14.75	21.66	30.44	45.15	9.10	14.36	0.81	0.19
114	FF11	Aug-96	FF11-2	2	1171	47	2.77	0.50	1.92	0.50	1.86	0.49	1.73	4.58	6.10	10.98	15.70	22.04	33.57	6.65	9.81	0.79	0.21
115	FF11	Aug-96	FF11-3	3	2398	51	2.62	0.46	1.82	0.46	1.78	0.46	1.63	4.45	6.25	11.69	16.44	22.35	32.06	6.55	9.15	0.89	0.11
	Averages				1659	55	2.85	0.49	1.98	0.49	1.92	0.49	1.69	4.71	6.58	12.47	17.93	24.94	36.93	7.44	11.11	0.83	0.17
116	FF14	Aug-96	FF14-1	1	556	57	4.69	0.80	3.25	0.80	3.09	0.81	1.94	7.91	11.67	22.29	30.85	40.63	55.37	9.02	15.91	0.83	0.17
117	FF14	Aug-96	FF14-2	2	1005	75	4.82	0.77	3.34	0.77	3.21	0.77	1.94	7.87	11.72	23.32	33.03	43.85	60.30	10.85	18.75	0.88	0.12
118	FF14	Aug-96	FF14-3	3	1151	61	4.39	0.74	3.05	0.74	2.95	0.74	1.92	7.34	10.61	19.99	27.66	36.41	49.78	8.65	13.74	0.95	0.05
	Averages				904	64	4.63	0.77	3.21	0.77	3.09	0.77	1.93	7.71	11.33	21.87	30.51	40.30	55.15	9.51	16.13	0.89	0.11

Station Labels: MF, NF, FF							Shannon's				Brillouin's		Sanders-Hurlbert							Glea-	Log-Series		
Smpl	Orig.	Month-	New	Rep	No.	No.	log2		Natural log				2	10	17	50	100	200	500	son's	alpha	devia-	max.
No.	Label	Year	Label		Ind.	Spp	H'	J'	H'	J'	H	V	(ESn) = 0 if total < n							D		tion	dev.
119	NF2	Aug-95	MF2	0	3365	67	3.64	0.60	2.52	0.60	2.49	0.60	1.85	6.05	8.32	15.05	21.36	28.94	39.79	8.25	11.85	0.82	0.18
120	NF4	Aug-95	MF4	0	872	59	3.99	0.68	2.77	0.68	2.66	0.68	1.89	6.64	9.23	17.11	24.63	33.91	48.92	8.71	14.30	0.81	0.19
121	NF5	Aug-95	MF5	0	2072	78	4.20	0.67	2.91	0.67	2.85	0.67	1.89	6.91	9.83	18.38	26.32	36.15	50.97	10.21	16.01	0.77	0.23
122	NF7	Aug-95	MF7	0	1862	79	4.21	0.67	2.92	0.67	2.84	0.67	1.91	7.00	9.86	18.01	25.29	34.26	49.64	10.49	16.73	0.78	0.22
123	NF8	Aug-95	MF8	0	2301	50	3.38	0.60	2.35	0.60	2.31	0.60	1.84	5.74	7.69	13.20	18.09	24.22	33.97	6.46	9.02	0.85	0.15
124	NF9	Aug-95	MF9	0	1698	70	4.14	0.68	2.87	0.68	2.80	0.67	1.88	6.78	9.73	18.61	26.53	35.96	49.48	9.41	14.72	0.81	0.19
125	NF10	Aug-95	MF10	0	1928	67	3.74	0.62	2.59	0.62	2.53	0.62	1.86	6.17	8.45	15.53	22.08	29.93	42.73	8.86	13.48	0.71	0.29
126	NF12	Aug-95	MF12-1	1	2206	66	3.84	0.64	2.66	0.64	2.61	0.64	1.88	6.52	8.93	15.40	21.23	28.63	40.90	8.57	12.80	0.74	0.26
127	NF12	Aug-95	MF12-2	2	1893	61	3.56	0.60	2.47	0.60	2.41	0.60	1.85	6.07	8.21	13.80	18.73	25.31	37.26	8.08	12.05	0.75	0.25
128	NF12	Aug-95	MF12-3	3	2126	60	3.79	0.64	2.62	0.64	2.57	0.64	1.88	6.45	8.82	15.10	20.67	27.72	39.14	7.83	11.48	0.69	0.31
	Averages				2075	62	3.73	0.63	2.58	0.63	2.53	0.62	1.87	6.35	8.65	14.77	20.21	27.22	39.10	8.16	12.11	0.73	0.27
129	NF16	Aug-95	MF16	0	1756	71	4.11	0.67	2.85	0.67	2.78	0.67	1.91	6.99	9.72	16.89	23.28	31.41	44.54	9.50	14.85	0.78	0.22
130	NF20	Aug-95	MF20	0	2188	64	3.76	0.63	2.61	0.63	2.55	0.63	1.86	6.29	8.70	15.58	21.70	29.25	41.11	8.32	12.35	0.88	0.12
131	NF21	Aug-95	MF21	0	1657	69	4.16	0.68	2.88	0.68	2.81	0.68	1.91	7.01	9.84	17.54	24.36	32.98	47.00	9.31	14.54	0.67	0.33
132	NF22	Aug-95	MF22	0	1887	51	3.82	0.67	2.65	0.67	2.60	0.67	1.88	6.55	9.02	15.71	21.16	27.21	36.03	6.76	9.66	0.90	0.10
133	FF10	Aug-95	FF10-1	1	1987	86	4.68	0.73	3.24	0.73	3.16	0.73	1.93	7.58	11.07	21.67	31.57	43.46	59.69	11.32	18.31	0.76	0.24
134	FF10	Aug-95	FF10-2	2	1611	76	4.38	0.70	3.03	0.70	2.95	0.70	1.90	7.11	10.34	20.19	29.03	39.54	54.71	10.29	16.57	0.78	0.22
135	FF10	Aug-95	FF10-3	3	1578	74	4.21	0.68	2.92	0.68	2.83	0.68	1.89	6.85	9.81	18.79	27.30	38.00	53.71	10.05	16.10	0.75	0.25
	Averages				1725	79	4.42	0.70	3.06	0.70	2.98	0.70	1.90	7.18	10.41	20.22	29.30	40.33	56.04	10.55	17.00	0.77	0.23
136	FF12	Aug-95	FF12-1	1	2247	59	3.81	0.65	2.64	0.65	2.60	0.65	1.88	6.54	9.02	15.62	20.74	26.45	35.66	7.65	11.10	0.65	0.35
137	FF12	Aug-95	FF12-2	2	2851	67	3.91	0.64	2.71	0.64	2.66	0.64	1.88	6.56	9.05	16.18	22.54	30.08	41.69	8.42	12.29	0.70	0.30
138	FF12	Aug-95	FF12-3	3	2327	58	3.63	0.62	2.51	0.62	2.47	0.62	1.86	6.05	8.25	14.88	20.79	27.70	38.38	7.48	10.78	0.82	0.18
	Averages				2475	61	3.78	0.64	2.62	0.64	2.58	0.64	1.87	6.38	8.77	15.56	21.36	28.08	38.58	7.85	11.39	0.73	0.27
139	FF13	Aug-95	FF13-1	1	768	31	2.77	0.56	1.92	0.56	1.86	0.56	1.77	4.89	6.29	9.78	13.11	17.73	26.25	4.67	6.48	0.90	0.10
140	FF13	Aug-95	FF13-2	2	1168	45	2.80	0.51	1.94	0.51	1.88	0.51	1.71	4.71	6.38	11.62	16.67	22.89	32.72	6.37	9.29	0.87	0.13
141	FF13	Aug-95	FF13-3	3	1166	49	3.30	0.59	2.29	0.59	2.22	0.59	1.79	5.49	7.60	14.03	19.95	27.37	38.55	6.94	10.35	0.83	0.17
	Averages				1034	42	2.96	0.55	2.05	0.55	1.99	0.55	1.76	5.03	6.76	11.81	16.58	22.66	32.50	5.99	8.71	0.87	0.13
142	NF13	Aug-95	NF13	0	1149	48	3.88	0.69	2.69	0.69	2.62	0.69	1.89	6.69	9.22	15.88	21.25	27.70	37.65	6.81	10.13	0.82	0.18
143	NF14	Aug-95	NF14	0	2091	76	3.49	0.56	2.42	0.56	2.36	0.56	1.80	5.67	7.95	14.93	21.75	30.92	46.32	9.94	15.47	0.81	0.19
144	NF15	Aug-95	NF15	0	2298	67	4.14	0.68	2.87	0.68	2.82	0.68	1.86	6.68	9.86	19.96	28.49	37.28	48.22	8.66	12.92	0.78	0.22
145	NF17	Aug-95	NF17-1	1	719	40	3.28	0.62	2.28	0.62	2.19	0.61	1.82	5.61	7.57	13.12	17.99	24.56	35.78	6.08	9.14	0.77	0.23
146	NF17	Aug-95	NF17-2	2	786	55	3.90	0.67	2.70	0.67	2.59	0.67	1.85	6.41	9.27	18.10	25.60	34.11	47.21	8.25	13.47	0.90	0.10
147	NF17	Aug-95	NF17-3	3	653	37	3.41	0.65	2.36	0.65	2.28	0.65	1.85	5.92	7.96	13.41	17.95	23.83	33.75	5.71	8.50	0.85	0.15
	Averages				719.3	44	3.53	0.65	2.45	0.65	2.35	0.65	1.84	5.98	8.27	14.88	20.51	27.50	38.91	6.68	10.37	0.84	0.16
148	NF18	Aug-95	NF18	0	1316	85	3.93	0.61	2.72	0.61	2.62	0.61	1.82	6.14	8.93	18.28	27.84	40.66	61.49	11.83	20.30	0.79	0.21
149	NF19	Aug-95	NF19	0	2456	76	4.12	0.66	2.86	0.66	2.80	0.66	1.89	6.76	9.54	17.98	25.85	35.21	48.65	9.74	14.86	0.82	0.18
150	NF23	Aug-95	NF23	0	2114	81	4.35	0.69	3.02	0.69	2.95	0.69	1.91	7.13	10.19	19.32	27.73	38.13	53.69	10.58	16.71	0.79	0.21

Station Labels: MF, NF, FF							Shannon's				Brillouin's		Sanders-Hurlbert							Glea-	Log-Series		
Smpl	Orig.	Month-	New	Rep	No.	No.	log2		Natural log				2	10	17	50	100	200	500	son's	alpha	devia-	max.
No.	Label	Year	Label		Ind.	Spp	H'	J'	H'	J'	H	V	(ESn) = 0 if total < n							D		tion	dev.
151	NF24	Aug-95	NF24-1	1	688	51	3.87	0.68	2.68	0.68	2.57	0.68	1.88	6.57	9.08	16.05	22.50	31.37	46.03	7.81	12.72	0.84	0.16
152	NF24	Aug-95	NF24-2	2	1368	60	3.85	0.65	2.67	0.65	2.60	0.65	1.87	6.49	9.02	15.92	22.10	30.31	43.97	8.31	12.82	0.77	0.23
153	NF24	Aug-95	NF24-3	3	1850	61	3.85	0.65	2.67	0.65	2.61	0.65	1.88	6.47	8.93	15.89	22.16	30.09	42.21	8.11	12.12	0.80	0.20
	Averages				1302	57	3.86	0.66	2.67	0.66	2.59	0.66	1.88	6.51	9.01	15.96	22.25	30.59	44.07	8.07	12.55	0.80	0.20
154	FF1A	Aug-95	FF1A-1	1	2748	74	2.03	0.33	1.41	0.33	1.36	0.32	1.42	3.31	4.79	10.58	17.00	25.78	40.38	9.35	14.00	0.57	0.43
155	FF1A	Aug-95	FF1A-2	2	2934	68	2.45	0.40	1.70	0.40	1.66	0.40	1.54	3.99	5.75	11.92	18.20	26.46	39.43	8.52	12.44	0.94	0.06
156	FF1A	Aug-95	FF1A-3	3	2377	73	2.50	0.40	1.73	0.40	1.68	0.40	1.54	4.04	5.88	12.49	19.05	27.24	40.64	9.39	14.25	0.43	0.57
	Averages				2686	72	2.32	0.38	1.61	0.38	1.57	0.37	1.50	3.78	5.47	11.67	18.08	26.49	40.15	9.08	13.56	0.65	0.35
157	FF4	Aug-95	FF4-1	1	508	37	3.64	0.70	2.53	0.70	2.41	0.70	1.86	6.33	8.72	15.10	20.42	26.63	36.79	5.94	9.18	0.54	0.46
158	FF4	Aug-95	FF4-2	2	329	40	4.00	0.75	2.77	0.75	2.60	0.75	1.90	6.87	9.69	17.87	24.82	32.93	0.00	6.90	11.93	0.53	0.47
159	FF4	Aug-95	FF4-3	3	250	29	3.56	0.73	2.47	0.73	2.30	0.73	1.87	6.29	8.57	14.83	20.15	26.62	0.00	5.25	8.49	0.61	0.39
	Averages				362	35	3.74	0.73	2.59	0.73	2.44	0.73	1.88	6.50	8.99	15.93	21.80	28.73	12.26	6.03	9.87	0.56	0.44
160	FF5	Aug-95	FF5-1	1	860	43	3.24	0.60	2.24	0.60	2.17	0.59	1.80	5.56	7.59	12.94	17.62	23.98	35.10	6.36	9.53	0.70	0.30
161	FF5	Aug-95	FF5-2	2	725	56	3.54	0.61	2.46	0.61	2.34	0.61	1.80	5.79	8.20	15.87	23.10	32.19	48.01	8.50	14.16	0.62	0.38
162	FF5	Aug-95	FF5-3	3	727	51	3.80	0.67	2.64	0.67	2.52	0.67	1.85	6.33	8.99	16.96	23.86	32.01	45.02	7.74	12.50	0.90	0.10
	Averages				771	50	3.53	0.63	2.44	0.63	2.34	0.62	1.82	5.90	8.26	15.26	21.52	29.39	42.71	7.54	12.06	0.74	0.26
163	FF6	Aug-95	FF6-1	1	1408	48	3.84	0.69	2.66	0.69	2.60	0.69	1.88	6.52	9.01	16.05	22.17	29.30	39.00	6.62	9.61	0.90	0.10
164	FF6	Aug-95	FF6-2	2	1066	54	4.30	0.75	2.98	0.75	2.89	0.75	1.92	7.28	10.40	19.20	26.45	34.32	45.10	7.75	12.01	0.89	0.11
165	FF6	Aug-95	FF6-3	3	944	56	4.29	0.74	2.97	0.74	2.87	0.74	1.91	7.21	10.34	19.28	26.66	34.97	47.09	8.18	13.03	0.42	0.58
	Averages				1139	53	4.14	0.72	2.87	0.72	2.79	0.72	1.90	7.00	9.92	18.18	25.09	32.86	43.73	7.51	11.55	0.73	0.27
166	FF7	Aug-95	FF7-1	1	636	49	4.14	0.74	2.87	0.74	2.75	0.74	1.91	7.10	10.00	17.73	24.49	32.87	45.59	7.59	12.38	0.48	0.52
167	FF7	Aug-95	FF7-2	2	777	50	3.52	0.62	2.44	0.62	2.34	0.62	1.84	5.87	8.03	14.61	20.70	28.32	41.77	7.51	11.93	0.89	0.11
168	FF7	Aug-95	FF7-3	3	1167	47	3.70	0.67	2.56	0.67	2.49	0.66	1.87	6.33	8.65	15.02	20.27	26.58	36.63	6.66	9.82	0.90	0.10
	Averages				860	49	3.78	0.68	2.62	0.68	2.53	0.67	1.87	6.43	8.89	15.79	21.82	29.26	41.33	7.25	11.38	0.76	0.24
169	FF9	Aug-95	FF9-1	1	2528	70	2.74	0.45	1.90	0.45	1.86	0.44	1.64	4.46	6.28	12.46	18.55	26.23	38.88	8.93	13.33	0.90	0.10
170	FF9	Aug-95	FF9-2	2	3014	65	1.76	0.29	1.22	0.29	1.19	0.29	1.39	3.06	4.31	8.81	13.56	20.30	33.10	8.11	11.70	0.74	0.26
171	FF9	Aug-95	FF9-3	3	2429	72	2.36	0.38	1.64	0.38	1.59	0.38	1.56	3.90	5.44	10.62	16.07	23.84	38.10	9.24	13.94	0.73	0.27
	Averages				2657	69	2.29	0.37	1.59	0.37	1.54	0.37	1.53	3.81	5.34	10.63	16.06	23.46	36.69	8.76	12.99	0.79	0.21
172	FF11	Aug-95	FF11-1	1	718	39	2.46	0.46	1.70	0.46	1.62	0.46	1.62	4.18	5.76	10.89	15.98	22.32	33.18	5.93	8.85	0.83	0.17
173	FF11	Aug-95	FF11-2	2	950	39	2.70	0.51	1.87	0.51	1.81	0.51	1.65	4.60	6.51	12.35	17.49	23.63	32.72	5.69	8.19	0.89	0.11
174	FF11	Aug-95	FF11-3	3	1417	45	2.44	0.44	1.69	0.44	1.64	0.44	1.59	4.17	5.85	11.12	16.00	22.04	31.29	6.20	8.86	0.74	0.26
	Averages				1028	41	2.53	0.47	1.76	0.47	1.69	0.47	1.62	4.32	6.04	11.45	16.49	22.66	32.39	5.94	8.63	0.82	0.18
175	FF14	Aug-95	FF14-1	1	608	48	4.05	0.72	2.80	0.72	2.68	0.72	1.89	6.80	9.66	18.06	25.33	34.03	45.89	7.49	12.22	0.85	0.15
176	FF14	Aug-95	FF14-2	2	919	56	4.30	0.74	2.98	0.74	2.88	0.74	1.92	7.34	10.48	18.83	25.36	33.21	46.37	8.21	13.14	0.91	0.09
177	FF14	Aug-95	FF14-3	3	630	51	4.18	0.74	2.90	0.74	2.77	0.74	1.91	7.12	10.08	18.22	25.33	34.15	47.80	7.91	13.10	0.97	0.03
	Averages				719	52	4.18	0.73	2.89	0.73	2.78	0.73	1.91	7.09	10.07	18.37	25.34	33.80	46.69	7.87	12.82	0.91	0.09

Station Labels: MF, NF, FF							Shannon's				Brillouin's		Sanders-Hurlbert							Glea-	Log-Series		
Smpl	Orig.	Month-	New	Rep	No.	No.	log2		Natural log				2	10	17	50	100	200	500	son's	alpha	devia-	max.
No.	Label	Year	Label		Ind.	Spp	H'	J'	H'	J'	H	V	(ESn) = 0 if total < n							D		tion	dev.
178	NF02	Aug-94	MF2	0	1823	61	3.63	0.61	2.52	0.61	2.46	0.61	1.86	6.08	8.19	14.25	20.30	28.42	41.64	8.12	12.16	0.63	0.37
179	NF04	Aug-94	MF4	0	1191	42	3.07	0.57	2.13	0.57	2.07	0.57	1.81	5.22	6.78	11.45	15.87	21.45	30.53	5.93	8.48	0.66	0.34
180	NF05	Aug-94	MF5	0	717	47	3.61	0.65	2.50	0.65	2.40	0.65	1.85	6.12	8.45	14.92	20.79	28.61	41.30	7.15	11.28	0.81	0.19
181	NF07	Aug-94	MF7	0	1285	52	3.06	0.54	2.12	0.54	2.05	0.53	1.68	4.99	7.26	14.69	21.36	29.14	40.27	7.26	10.88	0.82	0.18
182	NF08	Aug-94	MF8	0	2153	46	2.96	0.53	2.05	0.54	2.01	0.53	1.76	4.94	6.61	11.84	16.75	22.59	31.19	5.99	8.26	0.95	0.05
183	NF09	Aug-94	MF9	0	1792	46	3.24	0.59	2.25	0.59	2.20	0.58	1.79	5.46	7.51	13.61	18.81	24.37	32.11	6.14	8.61	1.05	0.05
184	NF10	Aug-94	MF10	0	2885	62	3.09	0.52	2.14	0.52	2.11	0.52	1.74	5.14	7.11	13.13	18.66	25.26	35.22	7.78	11.15	1.08	0.08
185	NF12	Aug-94	MF12-1	1	2618	52	2.97	0.52	2.06	0.52	2.02	0.52	1.74	4.99	6.82	12.27	17.06	22.78	31.77	6.61	9.20	0.84	0.16
186	NF12	Aug-94	MF12-2	2	3196	54	3.14	0.55	2.18	0.55	2.15	0.55	1.80	5.34	7.18	12.34	16.62	21.75	30.12	6.69	9.23	0.96	0.04
187	NF12	Aug-94	MF12-3	3	3018	55	3.48	0.60	2.41	0.60	2.38	0.60	1.84	5.93	8.07	13.87	18.66	24.40	33.68	6.86	9.55	0.73	0.27
	Averages				2944	54	3.20	0.56	2.22	0.56	2.18	0.56	1.79	5.42	7.36	12.83	17.44	22.97	31.85	6.72	9.33	0.84	0.16
188	NF16	Aug-94	MF16	0	391	39	3.65	0.69	2.53	0.69	2.39	0.69	1.86	6.24	8.69	15.73	21.80	29.43	0.00	6.53	10.78	0.79	0.21
189	NF20	Aug-94	MF20	0	378	38	4.23	0.81	2.93	0.81	2.77	0.80	1.91	7.28	10.54	19.74	26.65	33.14	0.00	6.40	10.53	0.72	0.28
190	NFMB01	Aug-94	NF21	0	2476	56	3.45	0.59	2.39	0.59	2.35	0.59	1.79	5.69	8.03	15.08	21.41	28.91	39.57	7.17	10.19	0.70	0.30
191	NFMB03	Aug-94	NF22	0	4222	72	3.46	0.56	2.40	0.56	2.37	0.56	1.85	5.81	7.70	13.12	18.55	25.70	37.44	8.62	12.33	0.68	0.32
192	FF10	Aug-94	FF10-1	1	1582	66	4.22	0.70	2.92	0.70	2.85	0.70	1.90	6.93	9.88	18.82	27.05	36.85	50.53	8.96	13.92	0.86	0.14
193	FF10	Aug-94	FF10-2	2	3238	80	3.86	0.61	2.68	0.61	2.63	0.61	1.82	6.20	9.06	18.04	25.75	34.55	47.83	9.90	14.84	0.80	0.20
194	FF10	Aug-94	FF10-3	3	3309	85	4.07	0.63	2.82	0.63	2.77	0.63	1.86	6.58	9.47	18.36	26.30	35.70	49.81	10.49	15.91	0.71	0.29
	Averages				2710	77	4.05	0.65	2.81	0.65	2.75	0.65	1.86	6.57	9.47	18.41	26.37	35.70	49.39	9.78	14.89	0.79	0.21
195	FF12	Aug-94	FF12-1	1	365	32	3.92	0.78	2.72	0.78	2.57	0.78	1.90	6.89	9.69	17.01	22.49	27.89	0.00	5.42	8.45	0.90	0.10
196	FF12	Aug-94	FF12-2	2	989	38	3.63	0.69	2.51	0.69	2.44	0.69	1.86	6.32	8.75	14.92	19.55	24.50	31.59	5.51	7.84	0.54	0.46
197	FF12	Aug-94	FF12-3	3	670	40	3.31	0.62	2.29	0.62	2.20	0.62	1.78	5.59	7.93	14.83	20.50	26.97	36.85	6.15	9.33	0.61	0.39
	Averages				674.7	37	3.62	0.70	2.51	0.70	2.40	0.70	1.84	6.27	8.79	15.59	20.85	26.45	22.81	5.69	8.54	0.69	0.31
198	FF13	Aug-94	FF13-1	1	1630	54	3.76	0.65	2.61	0.65	2.55	0.65	1.88	6.43	8.79	15.16	20.72	27.46	37.64	7.30	10.74	0.73	0.27
199	FF13	Aug-94	FF13-2	2	1739	48	3.74	0.67	2.59	0.67	2.54	0.67	1.87	6.36	8.83	15.73	21.43	27.74	36.25	6.43	9.14	0.96	0.04
200	FF13	Aug-94	FF13-3	3	1212	43	3.40	0.63	2.35	0.63	2.29	0.62	1.83	5.72	7.84	14.08	19.32	25.47	34.45	6.06	8.70	0.70	0.30
	Averages				1527	48	3.63	0.65	2.52	0.65	2.46	0.65	1.86	6.17	8.49	14.99	20.49	26.89	36.11	6.60	9.52	0.80	0.20
201	NF13	Aug-94	NF13	0	1818	54	3.40	0.59	2.36	0.59	2.30	0.59	1.84	5.74	7.66	13.24	18.36	24.67	35.27	7.19	10.46	0.70	0.30
202	NF14	Aug-94	NF14	0	1683	64	3.89	0.65	2.69	0.65	2.63	0.65	1.88	6.48	8.90	15.95	22.76	31.67	45.70	8.62	13.17	0.83	0.17
203	NF15	Aug-94	NF15	0	1589	66	4.54	0.75	3.14	0.75	3.07	0.75	1.93	7.62	11.01	20.33	28.25	37.56	50.97	8.95	13.90	0.78	0.22
204	NF17	Aug-94	NF17-1	1	2159	57	2.96	0.51	2.05	0.51	2.01	0.51	1.72	4.89	6.78	12.74	18.31	25.35	36.82	7.42	10.74	0.91	0.09
205	NF17	Aug-94	NF17-2	2	2219	47	2.12	0.38	1.47	0.38	1.44	0.38	1.52	3.69	5.12	9.74	14.11	19.75	29.37	6.10	8.43	0.82	0.18
206	NF17	Aug-94	NF17-3	3	1222	39	2.34	0.44	1.62	0.44	1.57	0.44	1.56	4.05	5.75	11.11	15.61	20.88	29.29	5.49	7.68	0.73	0.27
	Averages				1867	48	2.47	0.44	1.71	0.44	1.67	0.44	1.60	4.21	5.88	11.20	16.01	22.00	31.83	6.34	8.95	0.82	0.18
207	NF18	Aug-94	NF18	0	1525	75	4.40	0.71	3.05	0.71	2.96	0.71	1.91	7.21	10.40	19.79	28.30	39.05	55.73	10.23	16.54	0.81	0.19
208	NF19	Aug-94	NF19	0	1159	65	4.56	0.76	3.16	0.76	3.06	0.76	1.92	7.61	11.19	21.32	29.20	38.04	51.22	9.21	14.88	0.56	0.44
209	NFS3	Aug-94	NF23	0	1777	75	4.43	0.71	3.07	0.71	2.99	0.71	1.91	7.27	10.53	20.24	28.62	38.05	51.98	10.02	15.86	0.66	0.34

Station Labels: MF, NF, FF							Shannon's				Brillouin's		Sanders-Hurlbert							Glea-	Log-Series		
Smpl	Orig.	Month-	New	Rep	No.	No.	log2		Natural log				2	10	17	50	100	200	500	son's	alpha	devia-	max.
No.	Label	Year	Label		Ind.	Spp	H'	J'	H'	J'	H	V	(ESn) = 0 if total < n							D		tion	dev.
210	NFS4	Aug-94	NF24-1	1	4252	71	3.04	0.49	2.11	0.49	2.08	0.49	1.81	5.06	6.44	10.67	15.18	21.68	33.99	8.50	12.11	0.81	0.19
211	NFS4	Aug-94	NF24-2	2	2988	69	3.10	0.51	2.15	0.51	2.11	0.51	1.77	4.93	6.71	12.85	19.06	27.06	39.54	8.62	12.61	0.88	0.12
212	NFS4	Aug-94	NF24-3	3	2004	53	3.23	0.56	2.24	0.56	2.19	0.56	1.79	5.25	7.20	13.69	19.71	26.68	36.08	6.97	9.99	0.79	0.21
	Averages				3081	64	3.12	0.52	2.16	0.52	2.12	0.52	1.79	5.08	6.78	12.40	17.98	25.14	36.54	8.03	11.57	0.82	0.18
213	FF1A	Aug-94	FF1A-1	1	438	44	4.34	0.79	3.01	0.79	2.84	0.79	1.91	7.36	10.81	20.74	28.13	35.71	0.00	7.23	12.19	0.86	0.14
214	FF1A	Aug-94	FF1A-2	2	954	68	4.31	0.71	2.99	0.71	2.88	0.71	1.90	7.06	10.26	20.05	28.53	38.32	54.52	9.91	16.75	0.90	0.10
215	FF1A	Aug-94	FF1A-3	3	977	69	4.57	0.75	3.17	0.75	3.05	0.75	1.92	7.47	10.93	21.57	30.98	41.31	56.36	10.02	16.95	0.87	0.13
	Averages				789.7	60	4.41	0.75	3.05	0.75	2.92	0.75	1.91	7.30	10.67	20.79	29.21	38.45	36.96	9.06	15.30	0.88	0.12
216	FF04	Aug-94	FF4-1	1	447	44	4.11	0.75	2.85	0.75	2.69	0.75	1.91	7.03	9.93	18.11	25.30	33.64	0.00	7.21	12.10	1.08	0.08
217	FF04	Aug-94	FF4-2	2	446	42	4.34	0.80	3.01	0.80	2.85	0.80	1.93	7.55	10.84	19.39	26.20	33.52	0.00	6.88	11.37	0.98	0.02
218	FF04	Aug-94	FF4-3	3	701	41	3.75	0.70	2.60	0.70	2.50	0.70	1.88	6.48	8.85	15.26	20.85	27.61	37.43	6.26	9.50	0.75	0.25
	Averages				531.3	42	4.07	0.75	2.82	0.75	2.68	0.75	1.91	7.02	9.87	17.59	24.12	31.59	12.48	6.78	10.99	0.94	0.12
219	FF05	Aug-94	FF5-1	1	273	36	4.34	0.84	3.01	0.84	2.81	0.84	1.94	7.73	11.13	19.41	25.44	32.31	0.00	6.42	11.10	0.85	0.15
220	FF05	Aug-94	FF5-2	2	332	38	4.27	0.81	2.96	0.81	2.78	0.81	1.92	7.46	10.75	19.48	25.78	32.46	0.00	6.55	11.07	0.92	0.08
221	FF05	Aug-94	FF5-3	3	325	45	4.65	0.85	3.22	0.85	3.01	0.85	1.95	8.08	11.95	22.12	29.43	37.76	0.00	7.78	14.17	1.05	0.05
	Averages				310	40	4.42	0.83	3.06	0.83	2.87	0.83	1.94	7.76	11.27	20.33	26.88	34.18	0.00	6.91	12.11	0.94	0.09
222	FF06	Aug-94	FF6-1	1	276	38	3.84	0.73	2.66	0.73	2.47	0.73	1.87	6.56	9.27	17.39	24.55	33.20	0.00	6.76	11.94	0.88	0.12
223	FF06	Aug-94	FF6-3	3	920	57	4.22	0.72	2.93	0.72	2.82	0.72	1.90	7.05	10.06	18.97	26.76	35.57	48.19	8.35	13.44	0.57	0.43
224	FF06	Aug-94	FF6-2	2	393	33	3.42	0.68	2.37	0.68	2.24	0.67	1.83	5.89	8.09	14.39	19.77	26.21	0.00	5.52	8.58	0.60	0.40
	Averages				529.7	43	3.83	0.71	2.65	0.71	2.51	0.71	1.87	6.50	9.14	16.92	23.70	31.66	16.06	6.88	11.32	0.68	0.32
225	FF07	Aug-94	FF7-1	1	157	27	3.77	0.79	2.61	0.79	2.37	0.79	1.89	6.69	9.45	17.34	23.33	0.00	0.00	5.34	9.39	0.66	0.34
226	FF07	Aug-94	FF7-2	2	593	33	2.92	0.58	2.02	0.58	1.93	0.57	1.75	4.79	6.54	12.64	18.39	24.76	32.05	5.17	7.54	0.91	0.09
227	FF07	Aug-94	FF7-3	3	413	30	3.21	0.65	2.23	0.65	2.11	0.65	1.80	5.42	7.47	14.03	19.50	25.00	0.00	4.98	7.43	1.05	0.05
	Averages				387.7	30	3.30	0.68	2.29	0.68	2.14	0.67	1.81	5.63	7.82	14.67	20.41	16.59	10.68	5.16	8.12	0.87	0.16
228	FF09	Aug-94	FF9-1	1	2373	69	2.97	0.49	2.06	0.49	2.01	0.48	1.73	4.78	6.46	12.11	18.38	27.26	42.33	8.88	13.29	0.91	0.09
229	FF09	Aug-94	FF9-2	2	2412	73	3.20	0.52	2.21	0.52	2.16	0.51	1.78	5.18	6.99	12.85	19.15	27.91	42.41	9.37	14.20	0.81	0.19
230	FF09	Aug-94	FF9-3	3	1978	67	3.36	0.55	2.33	0.55	2.27	0.55	1.80	5.49	7.51	13.79	20.14	28.69	42.73	8.83	13.40	0.76	0.24
	Averages				2254	70	3.18	0.52	2.20	0.52	2.15	0.52	1.77	5.15	6.99	12.92	19.22	27.95	42.49	9.03	13.63	0.82	0.18
231	FF11	Aug-94	FF11-1	1	611	48	3.72	0.67	2.58	0.67	2.46	0.66	1.85	6.27	8.78	15.99	22.52	30.68	44.45	7.48	12.20	0.91	0.09
232	FF11	Aug-94	FF11-2	2	459	54	3.88	0.67	2.69	0.67	2.53	0.67	1.87	6.43	9.04	17.02	25.14	36.56	0.00	8.81	15.90	1.04	0.04
233	FF11	Aug-94	FF11-3	3	946	43	3.80	0.70	2.64	0.70	2.56	0.70	1.88	6.53	9.01	15.68	21.49	28.39	37.88	6.28	9.28	0.86	0.14
	Averages				672	48	3.80	0.68	2.63	0.68	2.51	0.68	1.87	6.41	8.94	16.23	23.05	31.88	27.45	7.52	12.46	0.94	0.09
234	FF14	Aug-94	FF14-1	1	256	40	4.00	0.75	2.77	0.75	2.56	0.75	1.88	6.85	9.93	18.82	26.17	35.79	0.00	7.21	13.30	1.07	0.07
235	FF14	Aug-94	FF14-2	2	850	47	4.29	0.77	2.97	0.77	2.88	0.77	1.92	7.41	10.58	18.83	25.04	31.87	41.72	6.97	10.72	1.05	0.05
236	FF14	Aug-94	FF14-3	3	614	46	3.96	0.72	2.75	0.72	2.63	0.72	1.88	6.76	9.67	17.57	23.63	30.69	42.68	7.17	11.51	0.92	0.08
	Averages				573.3	44	4.08	0.75	2.83	0.75	2.69	0.75	1.89	7.01	10.06	18.41	24.95	32.79	28.13	7.12	11.84	1.01	0.07

Station Labels: MF, NF, FF							Shannon's				Brillouin's		Sanders-Hurlbert							Glea-	Log-Series		
Smpl	Orig.	Month-	New	Rep	No.	No.	log2		Natural log				2	10	17	50	100	200	500	son's	alpha	devia-	max.
No.	Label	Year	Label		Ind.	Spp	H'	J'	H'	J'	H	V	(ESn) = 0 if total < n							D		tion	dev.
237	NF02	Aug-93	MF2-1	1	601	46	2.71	0.49	1.88	0.49	1.77	0.48	1.61	4.44	6.46	13.54	20.55	29.38	43.09	7.19	11.60	0.84	0.16
238	NF02	Aug-93	MF2-2	2	1670	50	2.30	0.41	1.60	0.41	1.55	0.40	1.52	3.87	5.58	11.50	17.02	23.65	34.20	6.74	9.70	0.86	0.14
239	NF02	Aug-93	MF2-3	3	504	36	3.09	0.60	2.14	0.60	2.03	0.59	1.72	5.22	7.49	14.53	20.55	27.34	35.94	5.79	8.87	0.89	0.11
	Averages				925	44	2.70	0.50	1.87	0.50	1.78	0.49	1.62	4.51	6.51	13.19	19.38	26.79	37.74	6.57	10.06	0.86	0.14
240	NF04	Aug-93	MF4-1	1	706	50	4.06	0.72	2.81	0.72	2.70	0.72	1.91	6.99	9.74	16.92	23.20	31.25	44.29	7.62	12.29	0.61	0.39
241	NF04	Aug-93	MF4-2	2	546	53	3.80	0.66	2.64	0.66	2.49	0.66	1.83	6.22	8.97	17.70	26.03	36.18	51.36	8.41	14.50	0.56	0.44
242	NF04	Aug-93	MF4-3	3	1123	58	3.80	0.65	2.63	0.65	2.55	0.65	1.87	6.36	8.73	15.66	22.21	30.69	44.54	8.26	12.97	0.78	0.22
	Averages				791.7	54	3.89	0.68	2.69	0.68	2.58	0.68	1.87	6.52	9.14	16.76	23.81	32.71	46.73	8.10	13.25	0.65	0.35
243	NF08	Aug-93	MF8-1	1	4929	49	2.48	0.44	1.72	0.44	1.70	0.44	1.70	4.10	5.30	9.30	13.31	18.43	26.43	5.76	7.56	0.74	0.26
244	NF08	Aug-93	MF8-2	2	3489	43	2.31	0.43	1.60	0.43	1.58	0.42	1.61	4.03	5.44	9.60	13.38	18.00	25.30	5.27	6.91	0.76	0.24
245	NF08	Aug-93	MF8-3	3	2854	48	2.75	0.49	1.90	0.49	1.87	0.49	1.73	4.64	6.11	10.53	14.86	20.50	29.82	6.03	8.20	0.76	0.24
	Averages				3757	47	2.51	0.45	1.74	0.45	1.72	0.45	1.68	4.26	5.62	9.81	13.85	18.98	27.18	5.69	7.55	0.75	0.25
246	NF09	Aug-93	MF9-1	1	935	44	3.94	0.72	2.73	0.72	2.65	0.72	1.90	6.85	9.48	16.21	21.62	27.78	37.21	6.43	9.58	0.77	0.23
247	NF09	Aug-93	MF9-2	2	1387	65	4.07	0.68	2.82	0.68	2.74	0.67	1.87	6.66	9.58	18.48	26.38	35.55	48.94	8.98	14.14	0.95	0.05
248	NF09	Aug-93	MF9-3	3	989	54	3.98	0.69	2.76	0.69	2.67	0.69	1.88	6.66	9.44	17.52	24.32	32.37	44.71	7.83	12.27	0.80	0.20
	Averages				1104	54	4.00	0.70	2.77	0.70	2.68	0.70	1.88	6.72	9.50	17.40	24.11	31.90	43.62	7.75	12.00	0.84	0.16
249	NF10	Aug-93	MF10-1	1	1250	58	3.95	0.67	2.73	0.67	2.66	0.67	1.88	6.63	9.35	16.99	23.41	31.25	43.88	8.13	12.59	0.85	0.15
250	NF10	Aug-93	MF10-2	2	872	48	3.54	0.63	2.46	0.63	2.37	0.63	1.84	5.90	8.10	14.85	21.04	28.76	40.95	7.09	10.93	0.65	0.35
251	NF10	Aug-93	MF10-3	3	1694	56	3.54	0.61	2.45	0.61	2.40	0.61	1.85	5.96	8.05	14.09	19.63	26.63	37.87	7.53	11.13	0.64	0.36
	Averages				1272	54	3.68	0.64	2.55	0.64	2.47	0.64	1.86	6.16	8.50	15.31	21.36	28.88	40.90	7.58	11.55	0.71	0.29
252	NF12	Aug-93	MF12-1	1	1319	51	3.74	0.66	2.59	0.66	2.52	0.66	1.88	6.45	8.80	14.88	19.86	26.09	37.13	7.10	10.54	0.59	0.41
253	NF12	Aug-93	MF12-2	2	1327	46	3.35	0.61	2.32	0.61	2.27	0.61	1.83	5.79	7.79	13.02	17.38	22.69	32.26	6.40	9.25	0.88	0.12
254	NF12	Aug-93	MF12-3	3	2323	50	3.29	0.58	2.28	0.58	2.24	0.58	1.83	5.69	7.64	12.58	16.41	21.16	29.37	6.45	9.00	0.85	0.15
	Averages				1656	49	3.46	0.62	2.40	0.62	2.34	0.61	1.85	5.97	8.08	13.49	17.88	23.31	32.92	6.65	9.60	0.77	0.23
255	NF16	Aug-93	MF16-1	1	595	41	3.74	0.70	2.59	0.70	2.49	0.70	1.88	6.51	8.88	15.08	20.37	26.98	38.44	6.42	9.99	0.92	0.08
256	NF16	Aug-93	MF16-2	2	992	53	3.85	0.67	2.67	0.67	2.58	0.67	1.86	6.48	9.24	16.92	23.21	30.91	43.21	7.68	11.96	0.63	0.37
257	NF16	Aug-93	MF16-3	3	1169	60	4.21	0.71	2.92	0.71	2.83	0.71	1.91	7.11	10.16	18.55	25.30	33.45	46.29	8.49	13.39	0.73	0.27
	Averages				918.7	51	3.94	0.69	2.73	0.69	2.63	0.69	1.88	6.70	9.42	16.85	22.96	30.45	42.65	7.53	11.78	0.76	0.24
258	FF10	Aug-93	FF10-1	1	1129	66	4.49	0.74	3.11	0.74	3.01	0.74	1.92	7.47	10.84	20.52	28.75	38.39	52.68	9.39	15.30	0.82	0.18
259	FF10	Aug-93	FF10-2	2	1313	63	4.44	0.74	3.08	0.74	2.99	0.74	1.92	7.44	10.75	20.01	27.62	36.40	49.31	8.77	13.80	0.66	0.34
260	FF10	Aug-93	FF10-3	3	1988	72	4.62	0.75	3.20	0.75	3.13	0.75	1.93	7.70	11.32	21.57	29.37	37.60	49.74	9.48	14.64	1.12	0.12
	Averages				1477	67	4.52	0.74	3.13	0.74	3.05	0.74	1.93	7.54	10.97	20.70	28.58	37.46	50.58	9.21	14.58	0.87	0.21
261	FF12	Aug-93	FF12-1	1	973	41	3.40	0.64	2.36	0.64	2.29	0.63	1.84	5.83	7.88	13.61	18.29	23.98	33.42	5.96	8.67	0.97	0.03
262	FF12	Aug-93	FF12-2	2	823	35	2.81	0.55	1.95	0.55	1.88	0.54	1.72	4.89	6.61	11.17	15.38	21.02	30.08	5.21	7.42	0.84	0.16
263	FF12	Aug-93	FF12-3	3	1429	43	2.59	0.48	1.80	0.48	1.75	0.48	1.69	4.50	6.01	10.10	13.78	18.83	28.35	5.92	8.35	0.93	0.07
	Averages				1075	40	2.94	0.55	2.03	0.55	1.97	0.55	1.75	5.07	6.83	11.63	15.82	21.28	30.62	5.70	8.15	0.91	0.09
264	FF13	Aug-93	FF13-1	1	1465	43	3.11	0.57	2.15	0.57	2.10	0.57	1.79	5.36	7.21	12.01	16.20	21.76	30.60	5.90	8.30	0.87	0.13
265	FF13	Aug-93	FF13-2	2	918	40	3.31	0.62	2.30	0.62	2.23	0.62	1.84	5.74	7.57	12.42	16.68	22.49	32.69	5.86	8.53	0.73	0.27
266	FF13	Aug-93	FF13-3	3	1659	44	3.26	0.60	2.26	0.60	2.21	0.60	1.83	5.65	7.53	12.34	16.32	21.35	29.84	5.93	8.30	0.76	0.24
	Averages				1347	42	3.23	0.60	2.24	0.60	2.18	0.60	1.82	5.58	7.44	12.25	16.40	21.87	31.04	5.90	8.38	0.79	0.21

Station Labels: MF, NF, FF							Shannon's				Brillouin's		Sanders-Hurlbert							Glea-son's	Log-Series		
Smpl No.	Orig. Label	Month-Year	New Label	Rep	No. Ind.	No. Spp	log2 H'	log2 J'	Natural log H'	Natural log J'	H	V	2	10	17	50	100	200	500	D	alpha	devia-tion	max. dev.
													(ESn) = 0 if total < n										
267	NF14	Aug-93	NF14-1	1	1070	43	3.79	0.70	2.63	0.70	2.56	0.70	1.89	6.64	9.10	14.96	19.60	25.75	35.63	6.16	8.98	0.80	0.20
268	NF14	Aug-93	NF14-2	2	572	45	4.24	0.77	2.94	0.77	2.81	0.77	1.93	7.41	10.50	18.11	24.25	31.86	43.26	7.09	11.45	0.75	0.25
269	NF14	Aug-93	NF14-3	3	846	54	4.13	0.72	2.86	0.72	2.76	0.72	1.91	7.10	10.02	17.46	23.44	31.19	44.66	8.01	12.85	0.78	0.22
	Averages				829.3	47	4.05	0.73	2.81	0.73	2.71	0.73	1.91	7.05	9.87	16.84	22.43	29.60	41.18	7.09	11.09	0.78	0.22
270	NF17	Aug-93	NF17-1	1	135	25	3.61	0.78	2.50	0.78	2.25	0.77	1.85	6.49	9.35	16.94	22.25	0.00	0.00	5.10	9.03	0.93	0.07
271	NF17	Aug-93	NF17-2	2	137	23	3.92	0.87	2.71	0.87	2.47	0.86	1.92	7.23	10.20	17.17	21.32	0.00	0.00	4.67	7.91	0.95	0.05
272	NF17	Aug-93	NF17-3	3	327	27	2.33	0.49	1.61	0.49	1.50	0.48	1.59	4.11	5.76	11.00	15.74	21.69	0.00	4.66	6.98	0.84	0.16
	Averages				199.7	25	3.29	0.71	2.28	0.71	2.07	0.71	1.78	5.95	8.44	15.04	19.77	7.23	0.00	4.81	7.97	0.91	0.09
273	FF01	Aug-93	FF1-1	1	495	52	4.50	0.79	3.12	0.79	2.96	0.79	1.94	7.74	11.22	20.36	27.77	36.94	0.00	8.38	14.65	0.77	0.23
274	FF01	Aug-93	FF1-2	2	688	55	4.39	0.76	3.05	0.76	2.92	0.76	1.93	7.55	10.79	19.04	26.10	35.47	50.38	8.42	14.07	0.83	0.17
275	FF01	Aug-93	FF1-3	3	602	56	4.59	0.79	3.18	0.79	3.03	0.79	1.94	7.82	11.40	21.05	28.83	37.64	52.26	8.75	15.09	0.83	0.17
	Averages				595	54	4.49	0.78	3.12	0.78	2.97	0.78	1.94	7.71	11.14	20.15	27.56	36.68	34.21	8.52	14.60	0.81	0.19
276	FF04	Aug-93	FF4-1	1	593	38	3.53	0.67	2.45	0.67	2.34	0.67	1.81	6.00	8.66	16.24	21.94	28.21	36.71	5.95	9.05	0.55	0.45
277	FF04	Aug-93	FF4-2	2	162	32	3.98	0.80	2.76	0.80	2.49	0.79	1.89	6.95	10.12	19.51	26.80	0.00	0.00	6.29	11.95	0.88	0.12
278	FF04	Aug-93	FF4-3	3	300	37	4.09	0.79	2.84	0.79	2.65	0.78	1.90	7.11	10.19	18.67	25.28	32.41	0.00	6.49	11.10	0.92	0.08
	Averages				351.7	36	3.87	0.75	2.68	0.75	2.49	0.75	1.87	6.69	9.66	18.14	24.67	20.21	12.24	6.24	10.70	0.79	0.21
279	FF05	Aug-93	FF5-1	1	840	49	3.61	0.64	2.50	0.64	2.41	0.64	1.83	6.02	8.48	15.78	22.21	30.14	42.30	7.28	11.35	0.84	0.16
280	FF05	Aug-93	FF5-2	2	870	57	3.94	0.67	2.73	0.67	2.62	0.67	1.87	6.55	9.30	17.30	24.39	33.26	47.87	8.42	13.67	0.89	0.11
281	FF05	Aug-93	FF5-3	3	877	51	3.89	0.69	2.70	0.69	2.60	0.68	1.86	6.52	9.34	17.43	24.01	31.61	43.52	7.53	11.80	0.91	0.09
	Averages				862.3	52	3.81	0.67	2.64	0.67	2.54	0.67	1.85	6.36	9.04	16.84	23.54	31.67	44.56	7.74	12.27	0.88	0.12
282	FF06	Aug-93	FF6-1	1	1123	59	4.27	0.73	2.96	0.73	2.87	0.73	1.91	7.15	10.22	19.08	26.73	35.71	47.80	8.40	13.26	1.02	0.02
283	FF06	Aug-93	FF6-2	2	2001	72	4.27	0.69	2.96	0.69	2.90	0.69	1.90	7.04	10.08	19.03	26.91	36.44	50.55	9.47	14.61	0.96	0.04
284	FF06	Aug-93	FF6-3	3	1786	68	4.06	0.67	2.82	0.67	2.75	0.67	1.89	6.78	9.57	17.45	24.40	33.06	46.77	9.08	14.00	0.89	0.11
	Averages				1637	66	4.20	0.70	2.91	0.70	2.84	0.69	1.90	6.99	9.96	18.52	26.02	35.07	48.37	8.98	13.96	0.96	0.06
285	FF07	Aug-93	FF7-1	1	2443	49	3.45	0.62	2.39	0.62	2.36	0.61	1.85	5.83	7.85	13.78	19.01	24.98	33.37	6.28	8.68	0.89	0.11
286	FF07	Aug-93	FF7-2	2	857	42	4.00	0.74	2.77	0.74	2.68	0.74	1.90	6.89	9.67	17.18	22.98	29.36	37.88	6.22	9.25	1.04	0.04
287	FF07	Aug-93	FF7-3	3	2664	53	3.75	0.66	2.60	0.66	2.56	0.65	1.87	6.36	8.76	15.51	21.39	28.07	37.09	6.72	9.38	0.82	0.18
	Averages				1988	48	3.74	0.67	2.59	0.67	2.53	0.67	1.87	6.36	8.76	15.49	21.13	27.47	36.11	6.41	9.10	0.92	0.11
288	FF09	Aug-93	FF9-1	1	1272	62	2.88	0.48	1.99	0.48	1.92	0.48	1.72	4.47	6.08	12.27	19.10	28.36	43.69	8.67	13.64	0.82	0.18
289	FF09	Aug-93	FF9-2	2	826	59	3.39	0.58	2.35	0.58	2.24	0.57	1.79	5.36	7.50	15.13	23.12	33.74	49.80	8.78	14.54	0.88	0.12
290	FF09	Aug-93	FF9-3	3	1144	54	3.07	0.53	2.13	0.53	2.05	0.53	1.71	5.02	7.10	13.77	20.22	28.50	41.51	7.67	11.77	0.92	0.08
	Averages				1081	58	3.11	0.53	2.16	0.53	2.07	0.53	1.74	4.95	6.89	13.72	20.82	30.20	45.00	8.38	13.32	0.87	0.13
291	FF11	Aug-93	FF11-1	1	1019	48	3.81	0.68	2.64	0.68	2.56	0.68	1.89	6.61	9.08	15.31	20.39	26.89	38.02	6.93	10.46	0.89	0.11
292	FF11	Aug-93	FF11-2	2	1112	55	4.06	0.70	2.81	0.70	2.73	0.70	1.91	7.02	9.78	16.69	22.26	29.25	41.09	7.84	12.15	0.83	0.17
293	FF11	Aug-93	FF11-3	3	874	54	3.84	0.67	2.66	0.67	2.57	0.67	1.89	6.55	8.99	15.63	21.69	29.61	43.60	7.97	12.72	0.81	0.19
	Averages				1002	52	3.90	0.68	2.71	0.68	2.62	0.68	1.89	6.73	9.28	15.88	21.45	28.58	40.90	7.58	11.78	0.84	0.16
294	FF14	Aug-93	FF14-1	1	807	45	3.83	0.70	2.65	0.70	2.56	0.69	1.86	6.46	9.11	16.72	23.18	30.78	40.64	6.72	10.28	0.68	0.32
295	FF14	Aug-93	FF14-2	2	1121	52	3.93	0.69	2.73	0.69	2.65	0.69	1.88	6.65	9.36	16.93	23.29	30.80	41.96	7.41	11.28	0.67	0.33
296	FF14	Aug-93	FF14-3	3	993	46	3.84	0.70	2.66	0.70	2.59	0.70	1.90	6.71	9.15	15.19	20.27	26.61	36.93	6.67	9.98	0.94	0.06
	Averages				973.7	48	3.87	0.69	2.68	0.69	2.60	0.69	1.88	6.60	9.21	16.28	22.24	29.40	39.84	6.93	10.52	0.76	0.24

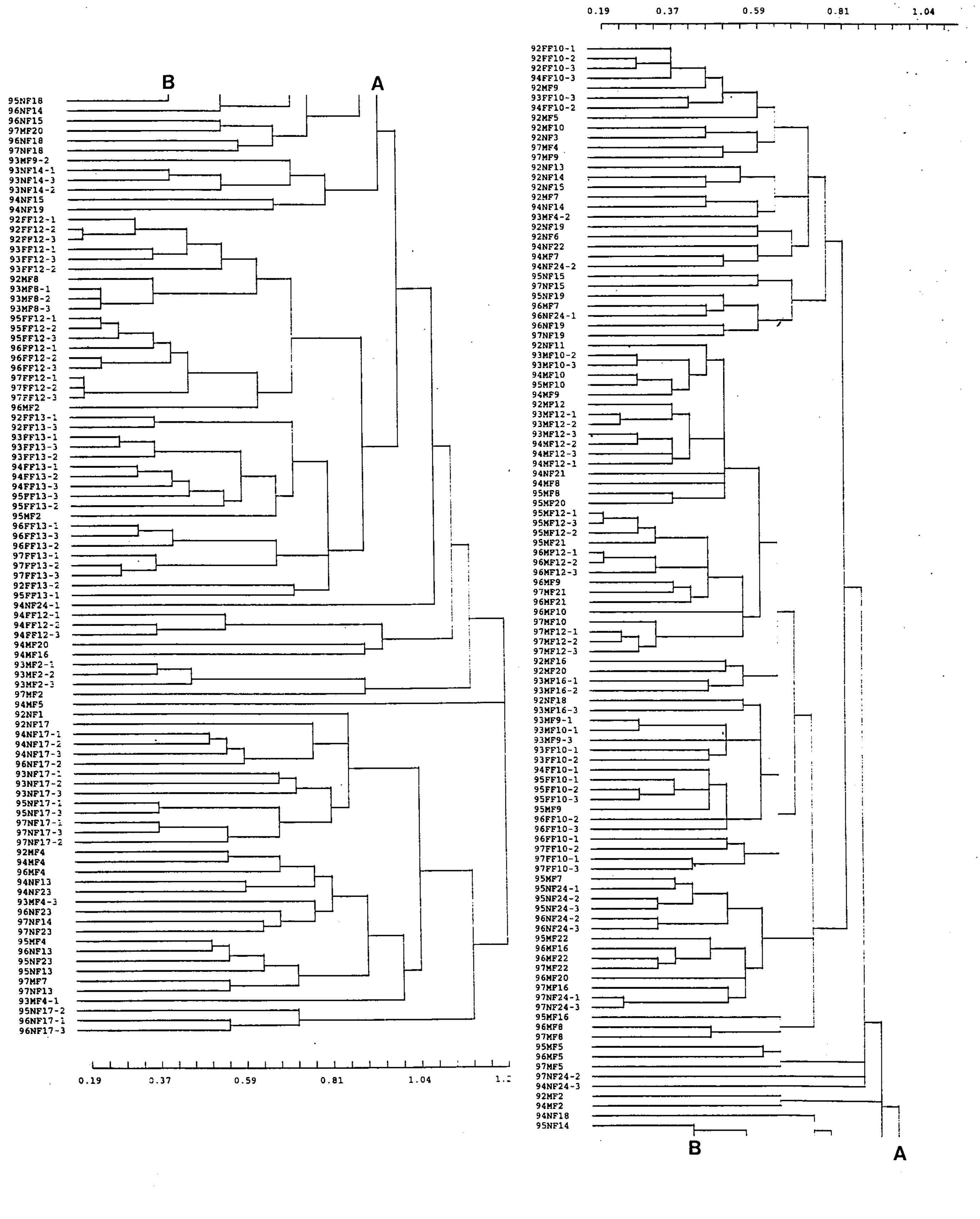
Station Labels: MF, NF, FF							Shannon's				Brillouin's		Sanders-Hurlbert							Glea-son's	Log-Series		
Smpl	Orig.	Month-	New	Rep	No.	No.	log2		Natural log				2	10	17	50	100	200	500		alpha	devia-	max.
No.	Label	Year	Label		Ind.	Spp	H'	J'	H'	J'	H	V	(ESn) = 0 if total < n							D		tion	dev.
297	NF01	Aug-92	NF1	0	1079	60	4.21	0.71	2.92	0.71	2.82	0.71	1.91	7.07	10.01	18.37	25.62	34.22	47.79	8.59	13.70	0.72	0.28
298	NF02	Aug-92	MF2	0	655	46	4.09	0.74	2.84	0.74	2.72	0.74	1.90	7.03	9.99	17.83	23.99	31.26	42.36	7.09	11.28	0.71	0.29
299	NF03	Aug-92	NF3	0	3100	69	3.95	0.65	2.74	0.65	2.69	0.65	1.89	6.68	9.23	16.15	22.23	29.80	41.32	8.58	12.51	0.77	0.23
300	NF04	Aug-92	MF4	0	755	48	3.66	0.66	2.54	0.66	2.44	0.65	1.86	6.18	8.44	15.12	21.30	28.98	41.34	7.24	11.41	0.87	0.13
301	NF05	Aug-92	MF5	0	2828	92	3.64	0.56	2.52	0.56	2.46	0.56	1.84	5.78	7.85	14.74	22.15	32.57	51.13	11.58	18.21	0.74	0.26
302	NF06	Aug-92	NF6	0	3330	65	2.80	0.47	1.94	0.47	1.91	0.46	1.73	4.53	6.07	11.23	16.33	23.16	34.85	8.01	11.45	0.88	0.12
303	NF07	Aug-92	MF7	0	5641	84	3.40	0.53	2.35	0.53	2.33	0.53	1.83	5.64	7.54	12.99	18.52	26.09	39.23	9.72	14.00	0.93	0.07
304	NF08	Aug-92	MF8	0	1261	31	2.71	0.55	1.88	0.55	1.83	0.54	1.74	4.75	6.24	10.27	13.52	17.35	23.74	4.34	5.75	0.80	0.20
305	NF09	Aug-92	MF9	0	2294	81	4.22	0.67	2.93	0.67	2.87	0.67	1.89	6.94	9.94	18.76	26.45	35.61	49.62	10.47	16.36	0.79	0.21
306	NF10	Aug-92	MF10	0	1827	56	3.74	0.64	2.59	0.64	2.54	0.64	1.86	6.30	8.82	15.98	21.47	27.44	37.42	7.46	10.93	0.62	0.38
307	NF11	Aug-92	NF11	0	1576	74	3.69	0.59	2.56	0.59	2.49	0.59	1.84	5.99	8.31	15.59	22.74	32.10	47.92	10.05	16.11	0.57	0.43
308	NF12	Aug-92	MF12	0	1157	53	3.65	0.64	2.53	0.64	2.46	0.64	1.88	6.27	8.38	13.97	19.34	26.48	38.80	7.51	11.46	0.61	0.39
309	NF16	Aug-92	MF16	0	1261	49	3.53	0.63	2.44	0.63	2.38	0.63	1.84	6.02	8.32	14.42	19.19	25.33	36.32	6.86	10.14	0.69	0.31
310	NF20	Aug-92	MF20	0	1273	48	3.32	0.59	2.30	0.59	2.24	0.59	1.83	5.67	7.56	12.73	17.33	23.50	34.63	6.71	9.86	0.73	0.27
311	FF10	Aug-92	FF10-1	1	3631	82	4.17	0.66	2.89	0.66	2.85	0.66	1.90	6.92	9.79	17.91	25.20	34.04	47.69	10.00	14.91	0.81	0.19
312	FF10	Aug-92	FF10-2	2	3486	90	4.54	0.70	3.15	0.70	3.10	0.70	1.93	7.56	10.93	20.24	28.11	37.36	51.32	11.03	16.87	0.91	0.09
313	FF10	Aug-92	FF10-3	3	3749	82	4.51	0.71	3.13	0.71	3.08	0.71	1.93	7.56	10.92	20.03	27.51	36.34	49.43	9.96	14.81	0.86	0.14
	Averages				3622	85	4.41	0.69	3.06	0.69	3.01	0.69	1.92	7.35	10.55	19.39	26.94	35.91	49.48	10.33	15.53	0.86	0.14
314	FF12	Aug-92	FF12-1	1	1552	53	3.68	0.64	2.55	0.64	2.49	0.64	1.86	6.26	8.57	14.90	20.54	27.24	37.56	7.21	10.62	0.82	0.18
315	FF12	Aug-92	FF12-2	2	2093	58	3.55	0.61	2.46	0.61	2.41	0.60	1.86	6.05	8.11	13.79	18.79	24.91	35.36	7.59	11.05	0.78	0.22
316	FF12	Aug-92	FF12-3	3	2812	57	3.37	0.58	2.33	0.58	2.30	0.58	1.85	5.76	7.51	12.37	16.90	22.67	32.68	7.18	10.12	0.82	0.18
	Averages				2152	56	3.53	0.61	2.45	0.61	2.40	0.61	1.86	6.02	8.06	13.69	18.74	24.94	35.20	7.33	10.60	0.81	0.19
317	FF13	Aug-92	FF13-1	1	1142	52	3.54	0.62	2.46	0.62	2.38	0.62	1.86	6.00	8.07	14.04	19.55	26.37	37.87	7.39	11.23	0.85	0.15
318	FF13	Aug-92	FF13-2	2	396	34	3.56	0.70	2.47	0.70	2.34	0.70	1.86	6.12	8.35	15.01	20.69	27.06	0.00	5.68	8.91	0.69	0.31
319	FF13	Aug-92	FF13-3	3	1339	51	3.62	0.64	2.51	0.64	2.44	0.64	1.87	6.21	8.38	14.14	19.28	25.96	36.88	7.08	10.50	0.73	0.27
	Averages				959	46	3.57	0.65	2.48	0.65	2.39	0.65	1.86	6.11	8.27	14.40	19.84	26.46	24.92	6.72	10.21	0.75	0.25
320	NF13	Aug-92	NF13	0	1272	66	3.88	0.64	2.69	0.64	2.60	0.64	1.88	6.45	8.95	16.26	22.82	31.20	46.05	9.23	14.78	0.75	0.25
321	NF14	Aug-92	NF14	0	2313	73	4.05	0.65	2.81	0.65	2.75	0.65	1.90	6.89	9.52	16.34	22.40	30.40	44.24	9.42	14.34	0.75	0.25
322	NF15	Aug-92	NF15	0	2694	64	3.71	0.62	2.57	0.62	2.53	0.62	1.87	6.27	8.46	14.44	20.06	27.81	40.88	8.10	11.77	0.74	0.26
323	NF17	Aug-92	NF17	0	624	51	4.36	0.77	3.02	0.77	2.88	0.77	1.92	7.37	10.59	19.72	27.69	36.93	48.55	7.92	13.14	0.79	0.21
324	NF18	Aug-92	NF18	0	1819	74	4.16	0.67	2.89	0.67	2.82	0.67	1.89	6.88	9.78	18.33	25.75	34.55	48.40	9.86	15.50	0.96	0.04
325	NF19	Aug-92	NF19	0	3992	78	3.54	0.56	2.45	0.56	2.42	0.56	1.81	5.58	7.82	15.66	23.28	32.46	45.93	9.41	13.74	0.82	0.18
326	FF01	Aug-92	FF1-1	1	404	51	4.61	0.81	3.20	0.81	3.00	0.81	1.94	7.87	11.56	21.72	29.90	39.66	0.00	8.50	15.45	0.77	0.23
327	FF01	Aug-92	FF1-2	2	440	55	4.63	0.80	3.21	0.80	3.02	0.80	1.94	7.78	11.45	22.00	31.01	41.71	0.00	9.04	16.59	0.55	0.45
328	FF01	Aug-92	FF1-3	3	355	52	4.66	0.82	3.23	0.82	3.01	0.82	1.94	7.92	11.67	22.28	31.12	41.70	0.00	8.86	16.79	0.57	0.43
	Averages				399.7	53	4.63	0.81	3.21	0.81	3.01	0.81	1.94	7.86	11.56	22.00	30.68	41.02	0.00	8.80	16.28	0.63	0.37

Station Labels: MF, NF, FF							Shannon's				Brillouin's		Sanders-Hurlbert							Glea-	Log-Series		
Smpl	Orig.	Month-	New	Rep	No.	No.	log2		Natural log				2	10	17	50	100	200	500	son's	alpha	devia-	max.
No.	Label	Year	Label		Ind.	Spp	H'	J'	H'	J'	H	V	(ESn) = 0 if total < n							D		tion	dev.
329	FF04	Aug-92	FF4-1	1	808	54	3.05	0.53	2.12	0.53	2.01	0.52	1.67	4.94	7.23	14.99	22.27	31.18	45.44	8.07	13.03	0.58	0.42
330	FF04	Aug-92	FF4-2	2	539	38	3.03	0.58	2.10	0.58	1.99	0.57	1.71	5.15	7.42	14.22	19.43	25.42	36.82	6.04	9.33	0.87	0.13
331	FF04	Aug-92	FF4-3	3	1212	49	3.01	0.54	2.08	0.54	2.02	0.53	1.71	4.95	6.96	13.50	19.56	26.62	36.91	6.90	10.25	0.89	0.11
	Averages				853	47	3.03	0.55	2.10	0.55	2.01	0.54	1.70	5.01	7.20	14.23	20.42	27.74	39.72	7.00	10.87	0.78	0.22
332	FF05	Aug-92	FF5-1	1	1250	50	2.38	0.42	1.65	0.42	1.59	0.42	1.53	3.95	5.73	12.03	18.12	25.62	37.23	7.01	10.43	0.79	0.21
333	FF05	Aug-92	FF5-2	2	862	41	2.05	0.38	1.42	0.38	1.35	0.37	1.46	3.50	5.05	10.75	16.41	23.32	33.88	6.07	8.96	0.96	0.04
334	FF05	Aug-92	FF5-3	3	984	54	2.35	0.41	1.63	0.41	1.55	0.40	1.52	3.89	5.63	11.74	17.78	25.79	40.34	7.84	12.28	0.95	0.05
	Averages				1032	48	2.26	0.40	1.57	0.40	1.49	0.40	1.51	3.78	5.47	11.51	17.44	24.91	37.15	6.97	10.56	0.90	0.10
335	FF06	Aug-92	FF6-1	1	1459	53	3.59	0.63	2.49	0.63	2.43	0.63	1.85	5.95	8.08	14.77	21.30	29.08	40.15	7.27	10.78	0.96	0.04
336	FF06	Aug-92	FF6-2	2	1404	48	3.65	0.65	2.53	0.65	2.47	0.65	1.86	6.14	8.35	15.02	21.09	28.06	37.94	6.62	9.62	0.85	0.15
337	FF06	Aug-92	FF6-3	3	1951	61	3.37	0.57	2.34	0.57	2.28	0.57	1.82	5.43	7.30	13.74	20.59	29.29	42.06	8.05	11.96	0.74	0.26
	Averages				1605	54	3.54	0.62	2.45	0.62	2.39	0.61	1.84	5.84	7.91	14.51	20.99	28.81	40.05	7.32	10.79	0.85	0.15
338	FF07	Aug-92	FF7-1	1	1259	44	3.27	0.60	2.27	0.60	2.21	0.60	1.82	5.62	7.54	12.68	16.91	22.18	31.43	6.16	8.87	0.72	0.28
339	FF07	Aug-92	FF7-2	2	1261	48	3.42	0.61	2.37	0.61	2.31	0.61	1.87	5.99	7.79	12.18	16.32	21.87	32.13	6.72	9.88	0.90	0.10
340	FF07	Aug-92	FF7-3	3	2989	48	3.51	0.63	2.43	0.63	2.40	0.63	1.87	6.15	8.10	12.80	17.04	22.28	30.43	6.00	8.12	0.83	0.17
	Averages				1836	47	3.40	0.61	2.36	0.61	2.31	0.61	1.85	5.92	7.81	12.55	16.76	22.11	31.33	6.30	8.96	0.82	0.18
341	FF08	Aug-92	FF8-1	1	220	29	3.26	0.67	2.26	0.67	2.08	0.67	1.83	5.55	7.45	13.96	20.48	27.96	0.00	5.38	8.94	0.78	0.22
342	FF08	Aug-92	FF8-2	2	231	36	3.76	0.73	2.61	0.73	2.40	0.72	1.88	6.43	8.92	16.84	24.42	33.76	0.00	6.61	11.95	0.80	0.20
343	FF08	Aug-92	FF8-3	3	179	41	4.26	0.80	2.95	0.80	2.66	0.79	1.91	7.27	10.55	21.16	31.13	0.00	0.00	7.90	16.63	0.68	0.32
	Averages				210	35	3.76	0.73	2.61	0.73	2.38	0.73	1.87	6.42	8.97	17.32	25.34	20.57	0.00	6.63	12.51	0.75	0.25
344	FF09	Aug-92	FF9-1	1	2661	75	3.14	0.50	2.18	0.50	2.13	0.50	1.77	5.08	6.84	12.61	18.65	26.87	40.81	9.51	14.34	0.75	0.25
345	FF09	Aug-92	FF9-2	2	2840	74	3.05	0.49	2.11	0.49	2.07	0.49	1.77	4.96	6.67	12.05	17.26	24.51	38.26	9.31	13.90	0.70	0.30
346	FF09	Aug-92	FF9-3	3	2726	65	2.96	0.49	2.05	0.49	2.01	0.49	1.76	5.05	6.68	10.86	14.92	21.16	33.71	8.22	11.96	0.76	0.24
	Averages				2742	71	3.05	0.50	2.11	0.50	2.07	0.49	1.77	5.03	6.73	11.84	16.94	24.18	37.59	9.01	13.40	0.74	0.26
347	FF11	Aug-92	FF11-1	1	541	39	3.31	0.63	2.29	0.63	2.19	0.62	1.84	5.69	7.48	12.50	17.38	24.42	37.61	6.20	9.64	0.66	0.34
348	FF11	Aug-92	FF11-2	2	402	30	3.02	0.62	2.09	0.62	1.99	0.61	1.81	5.16	6.70	11.58	16.42	22.66	0.00	5.00	7.50	0.53	0.47
349	FF11	Aug-92	FF11-3	3	981	39	3.43	0.65	2.38	0.65	2.31	0.65	1.85	5.93	7.98	13.51	18.02	23.21	31.42	5.66	8.12	0.52	0.48
	Averages				641.3	36	3.25	0.63	2.25	0.63	2.16	0.63	1.83	5.59	7.39	12.53	17.27	23.43	23.01	5.62	8.42	0.57	0.43
350	FF14	Aug-92	FF14-1	1	592	39	3.23	0.61	2.24	0.61	2.13	0.61	1.75	5.39	7.74	15.19	21.65	28.49	37.33	6.11	9.37	0.56	0.44
351	FF14	Aug-92	FF14-2	2	403	44	3.91	0.72	2.71	0.72	2.54	0.71	1.84	6.52	9.58	18.87	26.44	35.05	0.00	7.33	12.58	0.67	0.33
352	FF14	Aug-92	FF14-3	3	535	46	3.87	0.70	2.68	0.70	2.55	0.70	1.86	6.52	9.30	17.45	24.25	32.09	44.92	7.32	12.06	0.84	0.16
	Averages				510	43	3.67	0.68	2.54	0.68	2.41	0.67	1.82	6.14	8.87	17.17	24.11	31.88	27.42	6.92	11.34	0.69	0.31

Appendix F-1

Cluster Analysis of all Nearfield and Midfield Samples for the period 1992-1997

(CNESS, NESSm=17) performed with UPGMA sorting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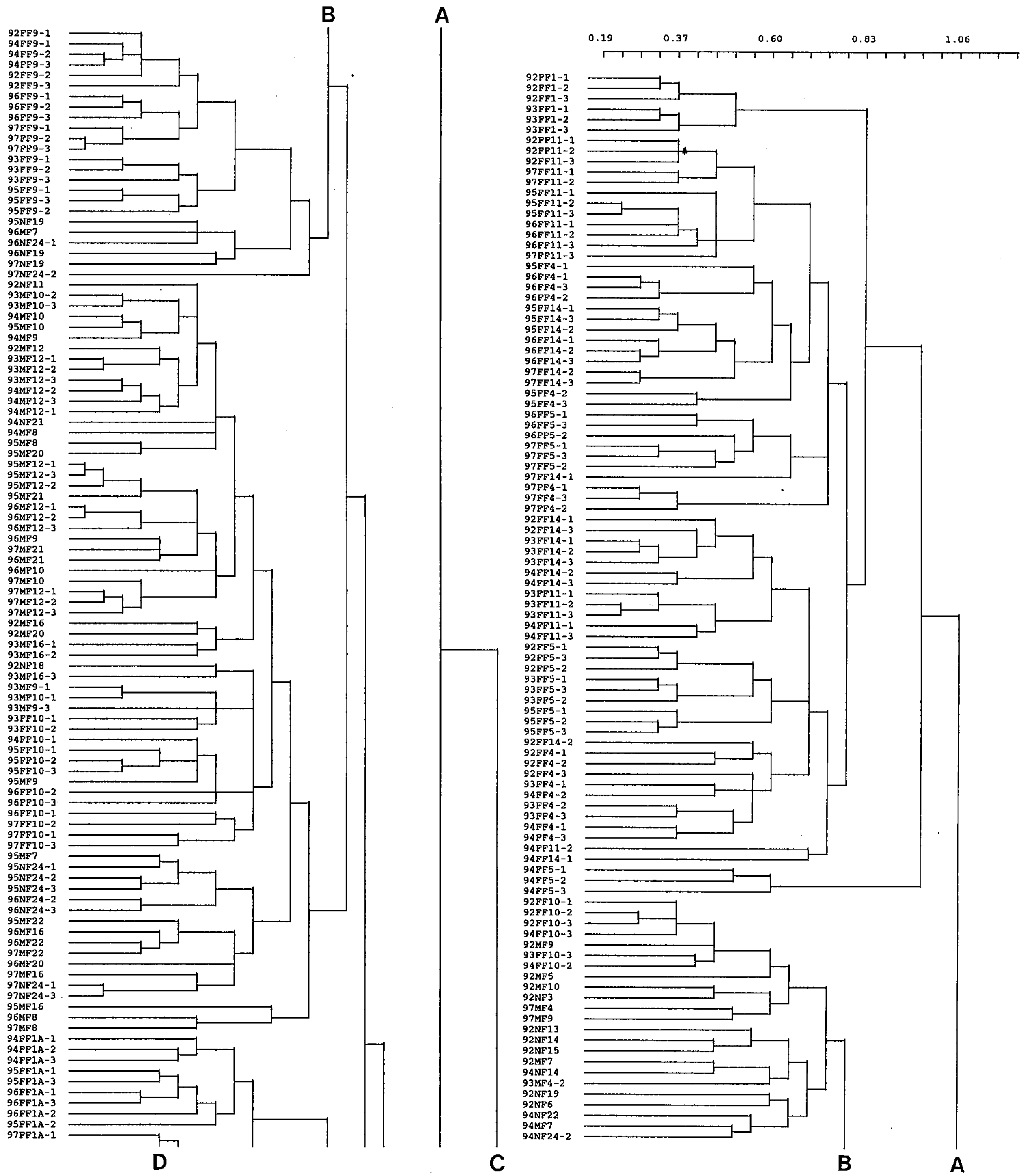
A

Appendix F-2

Cluster Analysis of all 352 Massachusetts Bay Samples for the period 1992-1997

(CNESS, NESSm=17)



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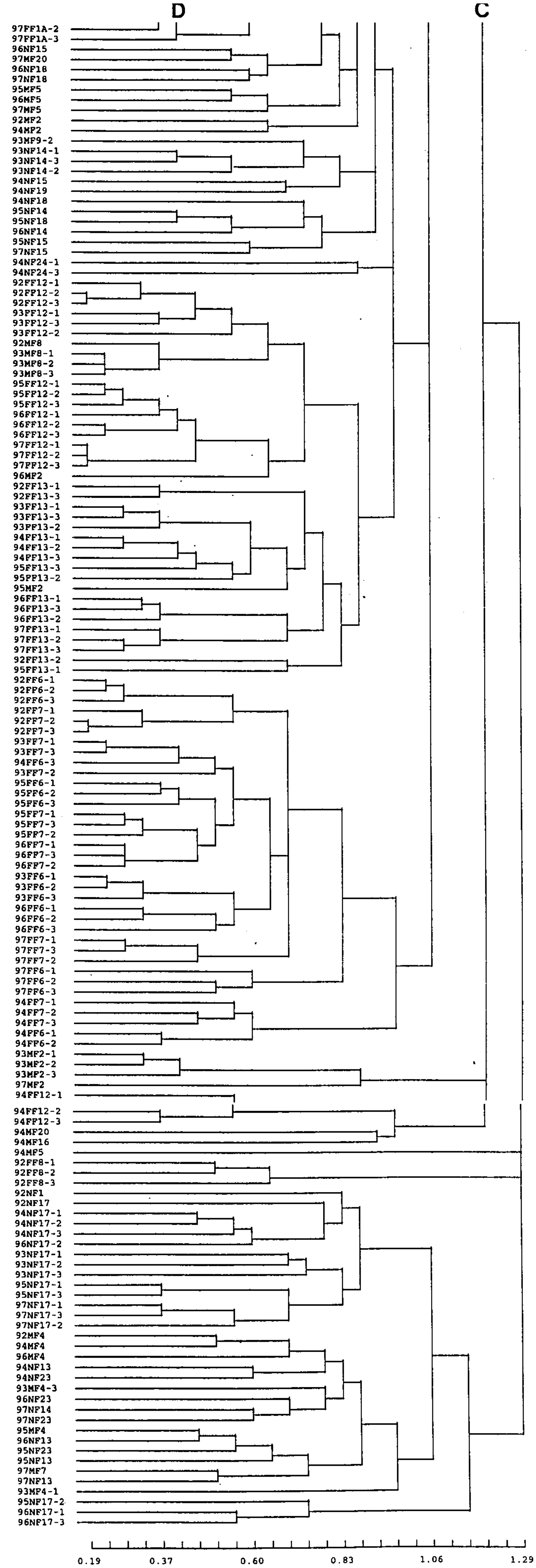
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1.29

Appendix G-1

1995 Infaunal Abundance

Nearfield, Midfield, and Farfield

Raw infaunal abundance data for samples collected from the Mass Bay Nearfield in August 1995.

MASS BAY - AUGUST 1995 NEARFIELD	NF13	NF14	NF15	NF17-1	NF17-2	NF17-3	NF18	NF19	NF23	NF24-1	NF24-2	NF24-3	Total
TOTAL/REPLICATE	1383	2249	2427	817	1061	759	1437	2609	2569	734	1462	1970	19477
TOTAL/STATION	1383	2249	2427		2637		1437	2609	2569		4166		
TAXON													
CNIDARIA													
ACTINIARIA SPP.	3												3
CERIANTHEOPSIS AMERICANUS		1										1	2
CERIANTHUS BOREALIS		2				1	6	1		1	1	6	18
EDWARDSIA ELEGANS		1		1			1		1	2	1		7
PLATYHELMINTHES													
TURBELLARIA SPP.					11								11
NEMERTEA													
AMPHIPORUS ANGULATUS		1							7		6	9	23
AMPHIPORUS SPP.				4				1	4		2		11
CARINOMELLA LACTEA					1								1
CEPHALOTHRICIDAE SP. 1				1	1	1		5	3		5	12	28
CEREBRATULUS LACTEUS			2								12	12	26
MICRURA SPP.		6	5		2		5	5	1	4	4	12	44
NEMERTEA SP. 2		1											1
NEMERTEA SP. 5		14	14				8	8	6	3	3	5	61
NEMERTEA SP. 7					28								28
NEMERTEA SPP.			2	13	14	2	1		6	1	1	1	41
TETRASTEMMA VITTATUM											1		1
POLYCHAETA													
AGLAOPHAMUS CIRCINATA	10			4	4	3		1	9				31
AMPHARETE ACUTIFRONS		26	31				4	27	1	3		3	95
AMPHARETE FINMARCHICA			3		3				2				8
AMPHARETE LINDSTROMI		5		1									6
AMPHARETE SPP.								4					4
AMPHARETIDAE SPP.		49	33				17	45	2	1	5	5	157
ANOBOTHRUS GRACILIS		4					1	5			4	1	15
APHELOCHAETA MARIONI		4	26		1		11	419		58	155	211	885
APISTOBRANCHUS TYPICUS							7	5		1	4	6	23
ARCTEOBIA ANTICOSTIENSIS		1						1	1				3
ARICIDEA CATHERINAE	34	48	22	5	10		24	20	38	1	1	1	204
ARICIDEA MINUTA							1	1		3		11	16
ARICIDEA QUADRILOBATA										2	3	6	11
ASABELLIDES OCULATA							2		4				6
AUTOLYTINAE SPP.			1										1
CAPITELLA CAPITATA COMPLEX			18				2	26		5	2	6	59
CAULLERIELLA SP. B					2								2
CHAETOZONE SETOSA				4	24	3			13		2	11	57
CHONE DUNERI		2					2	1			2	1	8
CIRRATULIDAE SPP.			5		3	2	7				1		18
CIRRATULUS CIRRATUS							1						1
CLYMENURA SP. A (BLAKE 1992)					3	1			2				6
COSSURA LONGOCIRRATA											2		2
DIPOLYDORA QUADRILOBATA			48					13					61
DIPOLYDORA SOCIALIS			87			2	18	148			2		257
DRILONEREIS MAGNA		1											1
ETEONE LONGA		3	17		1		6	18		2	8	8	63
EUCHONE ELEGANS			1					1	14			1	17
EUCHONE INCOLOR		23	23				11	39	1	22	63	86	268
EUCLYMENE COLLARIS	11	21	32	2	33	4	24	1	14				142

Raw infaunal abundance data for samples collected from the Mass Bay Nearfield in August 1995.

MASS BAY - AUGUST 1995 NEARFIELD	NF13	NF14	NF15	NF17-1	NF17-2	NF17-3	NF18	NF19	NF23	NF24-1	NF24-2	NF24-3	Total
EUCLYMENINAE SPP.	29		11	4	63	2	7	2	2				120
EXOGONE HEBES	206	260	128	13	8	46	119	79	383	3	10	17	1272
EXOGONE LONGICIRRIS	1				1				4				6
EXOGONE SPP.	1												1
EXOGONE VERUGERA	70	155	72	2	28	9	93	34	166	3	3	24	659
GALATHOWENIA OCULATA			1						3				4
GATTYANA AMONDSENI			1				1			3		5	10
GLYCERA CAPITATA					1				3				4
GONIADA MACULATA		1					1						2
GONIADA SPP.								1					1
HARMOTHOINAE SPP.		1					2	1		1	2	3	10
HETEROMASTUS FILIFORMIS										2			2
LAONICE SP. 1 (BLAKE 1992)		2											2
LAONICE SPP.								2					2
LAONOME KROEYERI			13				1	10	1		4	4	33
LEITOSCOLOPLOS ACUTUS		7	27				12	39		6	19	24	134
LEITOSCOLOPLOS SP.B		6	5				3	6		1	17	13	51
LEVINSENIA GRACILIS		2	2				6	3		59	62	37	171
LUMBRINERIDAE SPP.		6	3	5			9				1	2	26
MALDANE SARSI										1			1
MALDANIDAE SPP.				2									2
MEDIOMASTUS CALIFORNIENSIS		190	203		1		98	166	6	44	80	112	900
MICROPHTHALMUS ABERRANS											3		3
MICROPHTHALMUS LISTENSIS					5								5
MONTICELLINA BAPTISTEAE	11	9	26							4	54	137	241
MONTICELLINA DORSOBRANCHIALIS		3					7	10		11	6	3	40
NEPHTYIDAE SPP.	20	1	19	13	14	19	17	14	44	15	20	10	206
NEPHTYS CAECA						3							3
NEPHTYS CILIATA								1					1
NEPHTYS DISCORS							1						1
NEPHTYS INCISA		5					5	5		13	3	3	34
NEREIDIDAE SPP.		1	3			1	1	3			1	1	11
NEREIS GRAYI	1	2					4	3					10
NEREIS ZONATA							2						2
NINOE NIGRIPES		62	24	25			25		1	19	34	42	232
OPHELINA ACUMINATA			1					2					3
OWENIA FUSIFORMIS	2		69	2	2	1		19	15				110
PARANAITIS SPECIOSA								1					1
PARAONIDAE SPP.	1												1
PAROUGIA CAECA	1	7	7	1	9	1	10	13		5	7	23	84
PECTINARIA GRANULATA							2						2
PECTINARIA SPP.								3	3	1	1	1	9
PETALOPROCTUS TENUIS							2						2
PHERUSA AFFINIS			1				1						2
PHERUSA SPP.		1	1										2
PHOLOE MINUTA	1	28	25		2		28	46	1	29	31	62	253
PHOLOE SPP.									6				6
PHOLOE TECTA									1				1
PHYLLODOCE MACULATA	4								11				15
PHYLLODOCE MUCOSA	44	16	81	33	5	24	15	43	41	3	12	3	320
PHYLLODOCIDAE SPP.								1					1
PIONOSYLLIS SP. A		12	6				42	2					62
POLYCIRRUS EXIMIUS					1				6				7

Raw infaunal abundance data for samples collected from the Mass Bay Nearfield in August 1995.

MASS BAY - AUGUST 1995 NEARFIELD	NF13	NF14	NF15	NF17-1	NF17-2	NF17-3	NF18	NF19	NF23	NF24-1	NF24-2	NF24-3	Total
POLYCIRRUS MEDUSA							2						2
POLYCIRRUS SPP.			8				1	18	14	4	8	8	61
POLYGORDIUS SP. A	191	3	11	90	277	98	1	29	78		1	2	781
PRIONOSPIO STEENSTRUPI	47	862	804	2	17	3	526	567	26	155	169	395	3573
PROCLEA GRAFFII									1				1
SCALIBREGMA INFLATUM							2	1					3
SCOLETOMA FRAGILIS							4						4
SCOLETOMA HEBES												2	2
SCOLOPLOS ACMECEPS					1								1
SCOLOPLOS ARMIGER	2				1	1							4
SPHAERODOROPSIS MINUTA		3	4					5		3	1	6	22
SPHAEROSYLLIS BREVIFRONS	3	1			23				9				36
SPHAEROSYLLIS LONGICAUDA		9	7	1	3		3	5			1	2	31
SPIO FILICORNIS		7	9				5	1					22
SPIO LIMICOLA		5	81				10	295		136	385	402	1314
SPIO THULINI	1			3		1	2						7
SPIOPHANES BOMBYX	37	1	24	24	10	27		10	12	2	1	1	149
STERNASPIS SCUTATA										1	1		2
SYLLIDAE SPP.			1										1
SYLLIDES JAPONICA		1											1
SYLLIDES LONGOCIRRATA					3								3
THARYX ACUTUS	2	5	47		5		6	79	22	45	122	66	399
TROCHOCHAETA MULTISETOSA		1	1				1					2	5
TYPOSYLLIS SP. 1 (BLAKE 1992)							4						4
TYPOSYLLIS SPP.		3					3	1				1	8
OLIGOCHAETA													
ADELODRILUS SP. 1	1								13				14
ADELODRILUS SP. 2					45								45
ENCHYTRAEIDAE SP. 1	86				12				393				491
OLIGOCHAETA SPP.				1	1								2
TUBIFICIDAE SP. 2 (BLAKE 1992)		66	3		13		4	1		2		7	96
TUBIFICIDAE SPP.	2												2
TUBIFICOIDES APECTINATUS	1	1	3				9	3	1	3	1	7	29
GASTROPODA													
ALVANIA SP. 2							3		1				4
COLUS SPP.							1						1
CYLICHNA ALBA									1				1
CYLICHNA GOULDI					1				3			1	5
GASTROPODA SPP.		1		2		2	1	1	5				12
ILYANASSA TRIVITTATA			5			3	3	12	1				24
MARGARITES COSTALIS				3	1	1			17				22
UROSALPINX SPP.									1				1
BIVALVIA													
ARCTICA ISLANDICA	6	3	5			1			1	1	5	12	34
ASTARTE SPP.										2			2
ASTARTE UNDATA		9					11	3	13		9	8	53
ASTHENOTHAERUS HEMPHILLI		1						1			2		4
BIVALVIA SPP.	52	75	29	32	123	44	33	54	103	1	11	30	587
CERASTODERMA PINNULATUM	44		13	31	30	26	7	6	53				210
CRENELLA GLANDULA		74			3		33	3	16	2	2		133
CRENELLA SPP.		6											6
CYCLOCARDIA BOREALIS									4	1	5		10
HIATELLA ARCTICA	5	4	4	3	10		3	1	68				98

Raw infaunal abundance data for samples collected from the Mass Bay Nearfield in August 1995.

MASS BAY - AUGUST 1995 NEARFIELD	NF13	NF14	NF15	NF17-1	NF17-2	NF17-3	NF18	NF19	NF23	NF24-1	NF24-2	NF24-3	Total
LYONSIA ARENOSA	2	1					1	4	4			1	13
LYONSIA SPP.						1							1
MYA ARENARIA		1	1										2
NUCULA DELPHINODONTA		1	34				12	21	12			1	81
NUCULA SPP.		3	2				15	18	1	14	19	31	103
PANDORA SPP.												1	1
PITAR MORRHUANA								1					1
SPISULA SOLIDISSIMA	1								1				2
THRACIIDAE SPP.									1				1
THYASIRA GOULDII			5										5
YOLDIA SPP.		1						2			4	14	21
SCAPHAPODA													
SCAPHOPODA SPP.											2	1	3
CIRRIPEDIA													
BALANUS CRENATUS		1	1										2
MYSIDACEA													
MYSIDACEA SPP.										5	4		9
CUMACEA													
CAMPYLASPIS RUBICUNDA		1									1		2
DIASTYLIS QUADRISPINOSA							1		3	1			5
DIASTYLIS SCULPTA	5	4	1	2			1		1				14
DIASTYLIS SPP.		2	2			2	2	1	2				11
EUDORELLA PUSILLA		1	1							1			3
EUDORELLA SPP.			5	1									6
EUDORELLOPSIS DEFORMIS				2		1							3
LAMPROPS QUADRIPLICATA				1	1						1		3
PETALOSARSIA DECLIVIS	8	6	1	2			1	3	9			1	31
TANAIDACEA													
TANAISSUS PSAMMOPHILUS	5			5		4			64				78
ISOPODA													
CHIRIDOTEA TUFTSI				33	1	24							58
EDOTIA MONTOSA	7	10	39				5	15	13	8	10	1	108
MUNNA SP. 1								1					1
PLEUROGONIUM RUBICUNDUM	1	13	10				4	24			1	7	60
PLEUROGONIUM SPINOSISSIMUM							1						1
PLEUROGONIUM SPP.							2		2		1		5
POLITOLANA POLITA	10			3		1			1				15
PTILANTHURA TENUIS	8	1				1		1	4				15
AMPHIPODA													
ACANTHOHAUSTORIUS MILLSI				3	4	3							10
AMPELISCA MACROCEPHALA			2	1		1		1	6				11
AMPHIPODA SPP.									11				11
ANONYX LILLJEBORGI					3								3
ARGISSA HAMATIPES	5	7	2			2		10	1	1	3		31
CAPRELLA LINEARIS								5					5
CASCO BIGELOWI										2			2
COROPHIIDAE SPP.	120	1							206				327
CRASSICOROPHIUM CRASSICORNE	198			133	17	195	2		157				702
DEFLEXILODES TUBERCULATUS										1			1
DULICHIA FALCATA							1	5	1				7
DYOPEDOS MONACANTHUS		3	6				1	1					11
ERICTHONIUS RUBRICORNIS		1			12		3		40				56
HAPLOOPS FUNDIENSIS			1				3						4

Raw infaunal abundance data for samples collected from the Mass Bay Nearfield in August 1995.

MASS BAY - AUGUST 1995 NEARFIELD	NF13	NF14	NF15	NF17-1	NF17-2	NF17-3	NF18	NF19	NF23	NF24-1	NF24-2	NF24-3	Total
HARPINIA PROPINQUA							9				3		12
HIPPOMEDON PROPINQUUS	1		1									1	3
HIPPOMEDON SERRATUS	1			1	1	6			3				12
LEPTOCHEIRUS PINGUIS							1		12			1	14
METOPELLA ANGUSTA		4	46					6	2	1	6		65
MONOCULODES SP. 1	1	1		1	1		4	3	2				13
ORCHOMENE PINGUIS	1											1	2
PARADULICHIA TYPICA							2	1				1	4
PHOTIS POLLEX	29	11	43					16	14		1	1	115
PHOXOCEPHALUS HOLBOLLI				4	7	3			3				17
PROTOMEDEIA FASCIATA	2	1		1			1		46				51
PSEUDUNCIOLA OBLIQUUA				253		112							365
RHEPOXYNIUS HUDSONI				3		11			1				15
STENOPLEUSTES INERMIS	3	19	20		1		1	13	24	1			82
SYRRHOE CRENULATA					1		1		2				4
UNCIOLA INERMIS	7			3	99	4	1		171		1		286
UNCIOLA IRRORATA		1	1										2
UNCIOLA SPP.	3			15		2			3				23
WESTWOODILLA BREVICALCAR	1	1						1	9				12
DECAPODA													
PAGURUS ACADIANUS					1		1						2
CANCER BOREALIS				1			2	1					4
SIPUNCULA													
SIPUNCULA SPP.								1			2		3
PRIAPULIDA													
PRIAPULUS CAUDATUS										1			1
PHORONIDA													
PHORONIS ARCHITECTA		14	38				4	38	3	5	9	2	113
ECHINODERMATA													
CTENODISCUS CRISPATUS											1		1
ECHINARACHNIUS PARMA	5		1	16	6	25			2			1	56
MOLPADIA OOLITICA										2			2
OPHIOCTEN SERICEUM									1				1
OPHIURA SARSI		1					2	1					4
OPHIURA SPP.	3	6	3	1			2	9	1	1		9	35
OPHIUROIDEA SPP.											8		8
HEMICHORDATA													
STEREOBALANUS CANADENSIS		1											1
CHORDATA													
BOSTRICHOBRANCHUS PILULARIS	26		3										29
MOLGULA MANHATTENSIS									10				10
MOLGULA SPP.				5	46	29		6	38		1	2	127

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MASS BAY - AUGUST 1995 MIDFIELD	MF2	MF4	MF5	MF7	MF8	MF9	MF10	MF12-1	MF12-2	MF12-3	MF16	MF20	MF21	MF22	FF10-1	FF10-2	FF10-3	FF12-1	FF12-2	FF12-3	FF13-1	FF13-2	FF13-3	Total
TOTAL/REPLICATE	3492	1004	2219	1943	2366	1810	2105	2288	2026	2265	1897	2307	1858	2034	2225	1830	1811	2299	2889	2408	863	1214	1201	46354
TOTAL/STATION	3492	1004	2219	1943	2366	1810	2105		6579		1897	2307	1858	2034		5866			7596			3278		
TAXON																								
CNIDARIA																								
ACTINIARIA SPP.			1										1			1								3
CERIANTHEOPSIS AMERICANUS							1				1	2		1			1							6
CERIANTHIDAE SPP.	4											1					1						1	7
CERIANTHUS BOREALIS		1	2	2	7	3	1	2		1	2				2	1	1	1		1		1		28
EDWARDSIA ELEGANS	12		1		2	1		3		2	1	2		1		3		6	3	5	2	2	1	47
PLATYHELMINTHES																								
TURBELLARIA SPP.															1									1
NEMERTEA																								
AMPHIPORUS ANGULATUS	1	5			13	1	3	4	5		2	1	15	3		1	1	1	8	4				68
AMPHIPORUS GROENLANDICUS		1		1																				2
AMPHIPORUS SPP.	2	1			1		1					2		1			1		1	2		1		13
CARINOMELLA LACTEA	1				11		1	5	1	7	13	8	2	17	3		1	9	17	10				106
CEPHALOTHRICIDAE SP. 1	1	3		6	2			4	2	11	1		5											35
CEREBRATULUS LACTEUS	2			1	23	1	6	2	1		6	4	4		5		4	3	8	7	1	1	4	83
MICRURA SPP.	1	1	5	11	7	7	15	8	15	15	11	18	12	8	12	12	15	3	5	4			6	191
NEMERTEA SP. 2					2	2				2	1	2			3			1	1					14
NEMERTEA SP. 5	3		12	2	4	14	3	18	8	18	31	17	8	9	12		6		4	12		11	4	196
NEMERTEA SPP.	2	15	1			3	1		2	7	7			2	4	2	1	1	1				2	51
TETRASTEMMA VITTATUM					2				1		1			1										5
POLYCHAETA																								
AGLAOPHAMUS CIRCINATA	5	3																	2					10
AMPHARETE ACUTIFRONS			6	28		10	7	4	3	8	2	1	11	1	36	14	23		1	6				161
AMPHARETE FINMARCHICA		1																	1					2
AMPHARETE LINDSTROMI			2							1	1				1			1	2					8
AMPHARETE SPP.											5				1									6
AMPHARETIDAE SPP.			5	5	2	28	41		12	5	1	7	19	25	34	59	20	3	2	4				272
ANOBOTHRUS GRACILIS			2	3		1				1			3	1	3	1	3							18
APHELOCHAETA MARIONI	34		231	175		99	39	154	65	167	17	5	185	129	20	25	11	7	7	6				1376
APHELOCHAETA MONILARIS																						1		1
APHRODITA SPP.													1											1
APISTOBRANCHUS TYPICUS			14	4	4	1	1	1	4		1		1		1									32
ARCTEOBIA ANTICOSTIENSIS																		1						1
ARICIDEA CATHERINAE	1067	18	24	5	552	30	115	257	206	220	14	182	117	29	44	61	51	104	123	51	19	15	44	3348
ARICIDEA QUADRILOBATA				1			4	5	7	5	1		3	12	2	1	6							47
ASABELLIDES OCULATA	2		2			1						6	2		24	10	19	6	18	1		1	1	93
CAPITELLA CAPITATA COMPLEX	18		6	3	4	6	15	5	7	3	6	5	7	8	10		1	6	9	10	55	29	9	222
CAPITELLIDAE SPP.												2												2
CHAETOZONE SETOSA		13	4	2		2				1												2		24
CHAETOZONE VIVIPARA			8				2																	10
CHONE DUNERI			1	3	2		2	6	1				1		2				1	1				20
CHONE INFUNDIBULIFORMIS																			1					1
CIRRATULIDAE SPP.						15	53						2	2						1		2		75
CLYMENELLA TORQUATA						5	4								14	25	11	2	3	3				67
CLYMENURA SP. A (BLAKE 1992)		1																						1
COSSURA LONGOCIRRATA			1						1	1	1		2	2	5									13
DIPOLYDORA QUADRILOBATA	17		4	21		1	1	3							95	9		1	8	3				163
DIPOLYDORA SOCIALIS	44	1	22	49		26	4	40	1	27		1	19		14		1	43	86	43	1	1		423
DORVILLEA SOCIABILIS									1															1
DRILONEREIS MAGNA													1											1
ENIPO TORELLI								1	1	1														3
ETEONE FLAVA																				2		2		4

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MASS BAY - AUGUST 1995 MIDFIELD	MF2	MF4	MF5	MF7	MF8	MF9	MF10	MF12-1	MF12-2	MF12-3	MF16	MF20	MF21	MF22	FF10-1	FF10-2	FF10-3	FF12-1	FF12-2	FF12-3	FF13-1	FF13-2	FF13-3	Total
ETEONE LONGA	31		3	17	17	14	15	5	10	22	22	23	9	25	20	11	4	25	22	28	4	10	7	344
EUCHONE ELEGANS		3																						3
EUCHONE INCOLOR	1	2	16	45	42	25	26	33	48	40	93	81	45	51	28	31	26	18	23	25			1	700
EUCLYMENE COLLARIS	1	31	2									1												35
EUCLYMENINAE SPP.	5	2				1		1		3	1	1	7	7		6	13							47
EXOGONE HEBES	51	144	33	30	68	11	2	30	18	33	21	26	11	19	15	31	14			1				558
EXOGONE VERUGERA		98	184	37	7	54	27	30	13	30	5	7	42	11	75	51	63				2			736
GALATHOWENIA OCULATA	6	4	10	4	1	3	3	1	1	1	2	2	4	1	1	1	2	2	1			2	2	54
GATTYANA AMONDSENI	1			2	1		1		1			3	3	1	1		2	1			1			18
GLYCERA CAPITATA		1																						1
GONIADA MACULATA																1	1							2
GONIADA SPP.							1		1	1	1			1										5
HARMOTHOE EXTENUATA				1																				1
HARMOTHOE IMBRICATA	1																							1
HARMOTHOINAE SPP.			2	1		2	1		3	2				4	1						1			17
HARTMANIA MOOREI																		1						1
HETEROMASTUS FILIFORMIS					7						1	2		2		1	1				2		1	17
LAONICE CIRRATA																1			1					2
LAONICE SP. 1 (BLAKE 1992)												1												1
LAONOME KROEYERI				1	4	1	3	8	1		1	1	1	2	2		1		1					27
LEITOSCOLOPLOS ACUTUS	39		15	27	67	31	44	24	43	45	63	42	14	31	40	34	3	87	54	76		35	46	860
LEITOSCOLOPLOS SP.B	4			13	17	10	1		1	2	4	1	1	1				6	13	11		1	1	87
LEVINSENIA GRACILIS	3		26	84	68	23	41	91	109	105	137	69	52	141	9	16	19	20	25	17			1	1056
LUMBRINERIDAE SPP.			9	17	24	21	41	30	33	60	67	59	54	39	38	17	27	3	4	54			2	599
MALDANE GLEBIFEX															7	4	2							13
MALDANE SARSI			11	1	1	50	54					1	28		33	20	12							211
MALDANE SPP.			1			6	5								14	3	4							33
MALDANIDAE SPP.								1		2														3
MEDIOMASTUS CALIFORNIENSIS	245	2	171	206	655	238	405	467	564	493	305	384	227	439	215	180	203	336	367	375	137	121	199	6934
MELINNA CRISTATA			1										1		1									3
MICROPHTHALMUS ABERRANS				1											1						6		4	12
MONTICELLINA BAPTISTEAE			43	12	138	94	62	193	211	174	234	118	135	21	159	83	117	96	111	21		1	1	2024
MONTICELLINA DORSOBRANCHIALIS				47	11	10	5	8	3	2	12	23	4	7	22	21	12		14					201
NEANTHES VIRENS																		1						1
NEPHTYIDAE SPP.	7	51	7	3	8	2	5	3	24	7	30	11	25	33	4	1	10	21	14	7	1	12	3	289
NEPHTYS CAECA	1																	1						2
NEPHTYS CILIATA	2																			4				6
NEPHTYS CORNUTA					2	2	2	14	3	5	1	3				1			6		79	192	72	382
NEPHTYS INCISA			2	4	5	11	8	18	9	6	5	1	4	5	8	6	4	9	2	6	1		2	116
NEREIDIDAE SPP.		1	1	1		1	1					1												6
NEREIS GRAYI	2		5		1			1							1	3		1	1	1				16
NEREIS ZONATA						1							1											2
NINOE NIGRIPES	23		18	53	39	45	52	39	38	41	56	48	41	79	49	83	60	33	35	44	5	3	9	893
OPHELINA ACUMINATA			1																1					2
OPHRYOTROCHA CF. LABRONICA													1											1
ORBINIIDAE SPP.		2																						2
OWENIA FUSIFORMIS	11	26	3	4			3	1		6	1		2		23		2	177	299	133	1			692
PARANAITIS SPECIOSA									1	1														2
PAROUGIA CAECA	1	1	33	13	22	18	18	26	29	17	20	20	28	59	11	11	20	10	4	11	1		5	378
PECTINARIA SPP.							1																	1
PHERUSA AFFINIS			1												1						2			4
PHERUSA SPP.	2				1	1	1		1	1			1		1				2	2		1		14
PHOLOE MINUTA	4	1	19	39	15	10	8	2	2	4	8	20	8	9	15	11	16	2	7	5		6	3	214
PHOLOE SPP.																		1						1
PHYLLODOCE ARENAE																			1	1			1	3

Raw infaunal abundance data for samples collected from the Mass Bay Midfield in August 1995.

MASS BAY - AUGUST 1995 MIDFIELD	MF2	MF4	MF5	MF7	MF8	MF9	MF10	MF12-1	MF12-2	MF12-3	MF16	MF20	MF21	MF22	FF10-1	FF10-2	FF10-3	FF12-1	FF12-2	FF12-3	FF13-1	FF13-2	FF13-3	Total
PHYLLODOCE MACULATA		1																						1
PHYLLODOCE MUCOSA	204	9	14	10	4	9	11	10	5	6	8	5	5	21	7	2	3	50	42	28	6	28	18	505
PIONOSYLLIS SP. A					1							1							1					3
POLYCIRRUS EXIMIUS	2	2									2													6
POLYCIRRUS SPP.			2	1		1	4	18	7	3	9	2	7		7		2	3		2	1	5	1	75
POLYGORDIUS SP. A	81	12								1		1		3	1	3		7	7				1	117
PRAXILLELLA GRACILIS														1										1
PRAXILLELLA PRAETERMISSA															11	10	14							35
PRAXILLURA ORNATA			1																					1
PRIONOSPIO STEENSTRUPI	435	10	526	343	258	479	386	148	112	129	185	625	128	54	359	427	430	550	618	535	319	580	478	8114
PROCLEA GRAFFII			1																					1
RHODINE LOVENI			4			2									14	5	10							35
SCALIBREGMA INFLATUM			1	1		1					1								1					5
SCOLETOMA FRAGILIS			1			3	1		1	1		1	1	1	1	1	3							15
SCOLETOMA HEBES							1				2	6	1		14	23	10	53	104	70	2	10	16	312
SCOLOPLOS ACMECEPS		4												3										7
SCOLOPLOS ARMIGER															2	2	3							7
SPHAERODOROPSIS MINUTA	3		1	2		4	2	5		3			1		2	3	1		1					28
SPHAEROSYLLIS LONGICAUDA		1	18	1	1	2	1	2	1	5	2	10	1	1	1	2								49
SPIO FILICORNIS				1				1					1					1						4
SPIO LIMICOLA	104		55	317	170	124	400	420	284	396	227	212	333	280	207	107	110	59	46	73	2	1	3	3930
SPIO SPP.															1									1
SPIOPHANES BOMBYX	40	7	1	2	6	1	4	1	1	1	2	2	1		12	5	6	82	45	59	1	9	5	293
SPIOPHANES KROEYERI			1			1	1		1									1						5
STERNASPIS SCUTATA				1							1						2							4
SYLLIDES JAPONICA			1																					1
TEREBELLIDAE SPP.	1															4				1				6
TEREBELLIDES ATLANTIS			1	2																				3
TEREBELLIDES STROEMI			1																					1
THARYX ACUTUS	523	14	190	122		23	30	49	8	9	25	21		289	18	9	4	317	519	551	13	11	84	2829
TROCHOCHAETA MULTISETOSA		1		1		1	2	10	2	6	12		6	3						1	1			46
TROCHOCHAETA SPP.										1														1
TYPOSYLLIS SPP.										1														1
OLIGOCHAETA																								
ENCHYTRAEIDAE SP. 1		185																						185
TUBIFICIDAE SP. 2 (BLAKE 1992)	22				14		2	1	3	4	105	80	2	50	8		6		2		86	6	25	416
TUBIFICOIDES APECTINATUS	27			2	6			2	3		1	1	8	3					4	4	1	5	9	76
GASTROPODA																								
ALVANIA SP. 2			2																					2
CREPIDULA FORNICATA				1															1					2
GASTROPODA SPP.	2					1		1					1		1	3	4						1	14
ILYANASSA TRIVITTATA																1	3					1		5
MARGARITES SPP.		4																						4
ONOBA PELAGICA			7										14		9	12	11							53
UROSALPINX SPP.			1																					1
POLYPLACOPHORA																								
POLYPLACOPHORA SPP.													1											1
BIVALVIA																								
ARCTICA ISLANDICA	8			5	1				3	7	22	20	2	8	5	4	2	25	40	16			2	170
ASTARTE UNDATA		3	12	6		4					2				9	2	7							45
ASTHENOTHAERUS HEMPHILLI			2	1		5	3	1	3	1	2	4	2		2	5	1		1	1				34
BIVALVIA SPP.	99	52	46	3	6	16	6	6	8	9	6	25	7	5		17	29	3	1	5	90	24	13	476
BUSHIA ELEGANS						10	5	2		1					4									22
CERASTODERMA PINNULATUM	12	26	3	4				1		1	1	6			5	2	2	7	6	6		2	2	86
CRENELLA GLANDULA	3	1	89	12		15	15	2	4	4	8	16	11	2	25	18	9							234

Raw infaunal abundance data for samples collected from the Mass Bay Midfield in August 1995.

MASS BAY - AUGUST 1995 MIDFIELD	MF2	MF4	MF5	MF7	MF8	MF9	MF10	MF12-1	MF12-2	MF12-3	MF16	MF20	MF21	MF22	FF10-1	FF10-2	FF10-3	FF12-1	FF12-2	FF12-3	FF13-1	FF13-2	FF13-3	Total
CRENELLA SPP.				3		4			1	1					13	2								24
CYCLOCARDIA BOREALIS		1																						1
HIATELLA ARCTICA	17		6	2	1	2		3				5	1		4	2		1	4	1	1	1	1	52
LYONSIA ARENOSA																1								1
MUSCULUS NIGER															1									1
MUSCULUS SPP.											1													1
MYA ARENARIA				2		1	2		1	6	1		3	3	1	1	2	1		1	1		1	27
MYTILIDAE SPP.																				1	1			2
MYTILUS EDULIS												1										1	2	4
NUCULA DELPHINODONTA	2		65	19	6	81	20	10	8	14	12	3	50	32	125	107	119							673
NUCULA SPP.			66	16	21		11	6	29	31	6	3	61	20	106	92	115	12	7					602
PECTINIDAE SPP.				1																				1
PITAR MORRHUANA	2			1				1							1									5
THRACIIDAE SPP.	1						1		2	2	2		1	4		2								15
THYASIRA GOULDII			46	4		7	2	1					9	1	14	18		1	1	1				105
YOLDIA SAPOTILLA						1											2							3
YOLDIA SPP.			1	6	1	6	1	3		1	3	2	4	3	4	5	3	1	2					46
SCAPHOPODA																								
SCAPHOPODA SPP.			1	1																				2
MYSIDACEA																								
MYSIDACEA SPP.																			1				1	2
CUMACEA																								
CAMPYLASPIS RUBICUNDA						1	1	1				1												4
DIASTYLIS QUADRISPINOSA		1	1													1								3
DIASTYLIS SCULPTA	11	1	1					4		1						2	1	1		2		7	19	50
DIASTYLIS SPP.		2	2								1							1		1				7
EUDORELLA PUSILLA																	1							1
EUDORELLA SPP.											1				1		1							3
LAMPROPS QUADRIPLICATA	1														1				5	1				8
LEPTOSTYLIS LONGIMANA											1													1
PETALOSARSIA DECLIVIS		11	11	3		1	1				1													28
TANAIDACEA																								
TANAISSUS PSAMMOPHILUS		3																						3
ISOPODA																								
CHIRIDOTEA TUFTSI		3																						3
EDOTIA MONTOSA	50	3	3	1		8	3				9	5			13	8	11	3	8	6		1	6	138
IDOTEA BALTHICA																	1							1
MUNNA SP. 1	1																							1
PLEUROGONIUM INERME	5												1											6
PLEUROGONIUM RUBICUNDUM	47			5		3	1	1	1		1	3						1	8	4		7	4	86
PLEUROGONIUM SPINOSISSIMUM																1					2			3
PLEUROGONIUM SPP.						1									1	2		3					8	15
PTILANTHURA TENUIS		15	15						1						31	18	21							101
AMPHIPODA																								
AMPELISCA ABDITA	6										1							1			3	30	27	68
AMPELISCA MACROCEPHALA	1	4	4	1		1	1				2	1			2	3	5			1				26
AMPHIPODA SPP.																							1	1
ANONYX LILLJEBORGI						1									1	1								3
ARGISSA HAMATIPES	7	4	4		2	5				2		2	4		2	2	1	3	5	2		1	6	52
CAPRELLA LINEARIS				19									1								1			21
CAPRELLIDAE SPP.													9											9
CASCO BIGELOWI											1			2										3
COROPHIIDAE SPP.			1												3	1	1							6
CRASSICOROPHIUM CRASSICORNE		128		3				1																132
DULICHIA FALCATA				1																				1

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MASS BAY - AUGUST 1995 MIDFIELD	MF2	MF4	MF5	MF7	MF8	MF9	MF10	MF12-1	MF12-2	MF12-3	MF16	MF20	MF21	MF22	FF10-1	FF10-2	FF10-3	FF12-1	FF12-2	FF12-3	FF13-1	FF13-2	FF13-3	Total
DYOPEDOS MONACANTHUS	18			1				1							1			11	37	3		2	9	83
ERICTHONIUS RUBRICORNIS		6																						6
HAPLOOPS FUNDIENSIS				2			2								1	5	7							17
HARPINIA PROPINQUA											7				1	4								12
HIPPOMEDON PROPINQUUS				3		6			6															15
HIPPOMEDON SERRATUS		2																						2
LEPTOCHEIRUS PINGUIS							1	1								1	1	1					1	6
METOPELLA ANGUSTA	40				1	12	1	5	2	2	1	2	1		3	2	4		1	2		3	3	85
MONOCOROPHIUM TUBERCULATUM	1																					1		2
MONOCULODES SP. 1	1	1	1					1					2		1	5						1		13
ORCHOMENE PINGUIS	2			1																		1	1	5
PARADULICHIA TYPICA				2																				2
PHOTIS POLLEX	33	4	4	1		4	3				2	6	1		5	11	5	1	6	2		6	6	100
PONTOGENEIA INERMIS																			3					3
PROTOMEDEIA FASCIATA	6	19	19															1						45
STENOPLEUSTES INERMIS	5	3	3	1	3	1	1		1	3	1		4		5	3	2	1	2					39
SYRRHOE CRENULATA		2																						2
UNCIOLA INERMIS		17										2												19
UNCIOLA IRRORATA				1																		1	4	6
UNCIOLA SPP.	1	1	1																1	1			2	7
WESTWOODILLA BREVICALCAR		3						2	1				1											7
DECAPODA																								
CANCER BOREALIS	1	2	2	2						1						1				2				11
SIPUNCULA																								
PHASCOLION STROMBI															1	1	1							3
SIPUNCULA SPP.					1										1	1								3
PHORONIDA																								
PHORONIS ARCHITECTA	9		9	11	4	17	21	5	3	4	3	15	2	4	11	6	18	47	38	27	11	15	9	289
ECHINODERMATA																								
AXIOGNATHUS SQUAMATUS				1																				1
CTENODISCUS CRISPATUS								1																1
ECHINARACHNIUS PARMA		1																						1
HOLOTHUROIDEA SPP.															1									1
OPHIURA SARSI			1																					1
OPHIURA SPP.	1	1		3		3	2	12	10	2		1		1			1		1					38
OPHIUROIDEA SPP.															1	1						1		3
HEMICHORDATA																								
STEREOBALANUS CANADENSIS									3															3
CHORDATA																								
BOSTRICHOBRANCHUS PILULARIS											1													1
CNEMIDOCARPA MOLLIS		1																						1
MOLGULA MANHATTENSIS				3											1									4
MOLGULA SPP.								1				2												3

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MASS BAY - AUGUST 1995 FARFIELD	FF1A-1	FF1A-2	FF1A-3	FF4-1	FF4-2	FF4-3	FF5-1	FF5-2	FF5-3	FF6-1	FF6-2	FF6-3	FF7-1	FF7-2	FF7-3	FF9-1	FF9-2	FF9-3	FF11-1	FF11-2	FF11-3	FF14-1	FF14-2	FF14-3	Total
TOTAL/REPLICATE	2903	3157	2464	612	373	267	1024	822	920	1578	1301	1043	684	860	1307	2656	3289	2524	765	974	1509	699	1116	745	33592
TOTAL/STATION		8524			1252			2766			3922			2851			8469			3248			2560		
TAXON																									
CNIDARIA																									
CERIANTHUS BOREALIS	1														1										2
EDWARDSIA ELEGANS	21	2	3														1	1							28
HALCAMPA DUODECIMCIRRATA																	1	1							2
PLATYHELMINTHES																									
TURBELLARIA SPP.					1																				1
NEMERTEA																									
AMPHIPORUS ANGULATUS	1	2										12	3	2	4	2	3	3					2		34
AMPHIPORUS SPP.	1	2																					1		4
CARINOMELLA LACTEA		1	2	1	4	3	1		1	1			2	3	4			1	1			5	1	1	32
CEPHALOTHRICIDAE SP. 1	1	1	2	1	3		1		2							2		1		1	4	4	5	4	32
CEREBRATULUS LACTEUS				1					1	1	2	2	4		1							2			14
LINEUS PALLIDUS											2	2													4
MICRURA SPP.	4	11	3	3	5	1	4	2		6	7	2	5	4	5	3	5	12	1	6	7	2	3	3	104
NEMERTEA SP. 2	3	2	1																						6
NEMERTEA SP. 5	5	4	7	8	15	1		17	21	2	5	6	1	1	6	27	6	14	14	2	6	8	21	13	210
NEMERTEA SPP.	1			7	3					1	6	4			3		4					5	2		36
TETRASTEMMA SPP.	1	1																							2
TETRASTEMMA VITTATUM														1							1			3	5
TUBULANUS PELLUCIDUS				2	1	2																1		2	8
POLYCHAETA																									
AMPHARETE ACUTIFRONS	14	8	7						7		2	2	1	1	2	4	1	3							52
AMPHARETIDAE SPP.	14	23	13	18	6	4	17	8	27	5	2	1	2	2	9	14	20	1	4	2	12	3	2	3	212
AMPHICTEIS GUNNERI																	1								1
AMPHITRITINAE SPP.										1															1
ANOBOTHRUS GRACILIS	7	9	11	4	9	2	1	8	17	5	4	10	7	3	16	3	8	2	1	6	1	4	1	2	141
APHELOCHAETA MARIONI	5	4	2		1	2	2		1	10	7	6		1		47	5	7		2	2	6	8	10	128
APHELOCHAETA MONILARIS														2								1	1		4
APISTOBRANCHUS TYPICUS	10	14	25	3			1	4	1	25	35	37	25	20	59	1							3	1	264
ARCTEOBIA ANTICOSTIENSIS								1									1								2
ARICIDEA CATHERINAE	19	34	27							94	33	23	36	18	55										339
ARICIDEA MINUTA											1	1						2							4
ARICIDEA QUADRILOBATA	12	19	23	50	6	4	44	18	34	58	68	36	34	11	39	8	5	5	12	60	54	14	51	23	688
ASABELLIDES OCULATA	5	5	1													3									14
AUSTROLAENILLA MOLLIS																		1							1
AXIOTHELLA CATENATA									1							1			1						3
BRADA INCRUSTATA																1									1
BRADA SPP.																3									3
BYLGIDES SPP.						1	1															1			3
CAPITELLA CAPITATA COMPLEX	1	6	2				1		1	2		4	3	10	2	3	2		1		1				39
CHAETOZONE SETOSA				42	15	19	11	13	21	2	2		1			9	1		11	33	44	55	126	80	485
CHONE DUNERI		1																							1
CHONE SPP.																		1					1		2
CIRRATULIDAE SPP.		1		11													13		2						27
COSSURA LONGOCIRRATA				52	20	17	12	10	9	242	140	78	127	173	262	1	3	1	14	12	11	21	25	16	1246
DIPLOCIRRUS HIRSUTUS																							1		1
DIPLOCIRRUS SPP.																1	1				1	1	2	1	7
DIPOLYDORA QUADRILOBATA																	2								2
DIPOLYDORA SOCIALIS			1				3	6	7	9	9	20	3	1	5	60	91	12							227
DORVILLEA SOCIABILIS								1								2						2			5
DYSPONETUS PYGMAEUS				2	1																				3
ETEONE FLAVA											1														1

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MASS BAY - AUGUST 1995 FARFIELD	FF1A-1	FF1A-2	FF1A-3	FF4-1	FF4-2	FF4-3	FF5-1	FF5-2	FF5-3	FF6-1	FF6-2	FF6-3	FF7-1	FF7-2	FF7-3	FF9-1	FF9-2	FF9-3	FF11-1	FF11-2	FF11-3	FF14-1	FF14-2	FF14-3	Total
ETEONE LONGA				1				2			5	6				11		8		2	3	2	2	3	45
EUCHONE INCOLOR	20	23	11	10		1	3	3	2	32	29	27	11	8	12	8	9	6	10	15	26	5	21	7	299
EUCHONE PAPILLOSA					1																				1
EUCLYMENINAE SPP.		1	2				1	4		1		1	1			1		4			3	2	2	2	25
EXOGONE HEBES	1	2	2		1			1								23	8	22			1				61
EXOGONE LONGICIRRIS	1																								1
EXOGONE VERUGERA																52	66	42	1		1		1	1	164
GALATHOWENIA OCULATA			1			1	2	2			1	3		1		3		1		5	2	4	3	3	32
GATTYANA AMONDSENI	2	1						8	1	1		2			1	1	1	2			2			1	23
GONIADA MACULATA	1	2	2																1						6
GONIADA SPP.							1	1									2					1		1	6
HARMOTHOINAE SPP.		1			2		14	3	5	1		3		1	1		1		1	1	3	7	6	2	52
HARTMANIA MOOREI									1					1					1		1				4
HETEROMASTUS FILIFORMIS				4	3	8	1	1	1			1	1			1		1	1	5	2	5	2	4	41
LAONICE CIRRATA																1		1		2	1				5
LAONICE SP. 1 (BLAKE 1992)							1										1		1						3
LAONOME KROEYERI			2									1				2	5	1	1		1				13
LEITOSCOLOPLOS ACUTUS	1	6	3	6	9	4	7	6	6	1	1					13	9	9	2	16	19	14	30	17	179
LEVINSENIA GRACILIS	17	20	28	21	60	62	95	62	73	16	23	24	6	22	11	87	31	85	95	53	88	103	41	82	1205
LUMBRINERIDAE SPP.	11	13		9					3		67	35	2	1		2	5	5		4	7	1	1		166
MALDANE GLEBIFEX																				2					2
MALDANE SARSI	16	4	19	1	7	1	1											5		3	2	1	3	2	65
MALDANE SPP.	4		5																	1	1	1	1	2	15
MALDANIDAE SPP.																	12	17							29
MEDIOMASTUS CALIFORNIENSIS	70	98	63	63	45	49	55	32	36	183	166	146	77	89	170	79	42	103	5	17	13	32	52	50	1735
MELINNA CRISTATA					1			1																1	3
MONTICELLINA BAPTISTEAE																						4	18		22
MYRIOCHELE HEERI																1									1
MYSTIDES BOREALIS												1													1
MYXICOLA INFUNDIBULUM					1																				1
NEPHTYIDAE SPP.	17	4	15	6	6	1	5	11	11	115	96	36	26	35	80	10	12	9	5	1	5	14	11	3	534
NEPHTYS CILIATA			1																						1
NEPHTYS CORNUTA		1	1																						2
NEPHTYS INCISA				4	3	1		2	7	2	3	3	7	7	8	6	2	3				2	4	2	66
NEPHTYS PARADOXA																					1				1
NEREIDIDAE SPP.	1						1	1																	3
NEREIS GRAYI		2	4	1					1							8	7	4							27
NINOE NIGRIPES	32	40	74	1	9	6	24	14	23	102	33	29	18	18	46	23	7	27	4	7	11	2	2	5	557
OPHELINA ACUMINATA	2	2	1													4	6	4			1				20
ORBINIIDAE SPP.					3																				3
OWENIA FUSIFORMIS	9	125	2						1														1		138
PARAMPHINOME JEFFREYSII					1																				1
PARAONIDAE SPP.			1																						1
PAROUGIA CAECA	3	9	4	5	2	3	5	4	1	5	10	15	2			11	4	8	4	11	8	3	8	3	128
PHERUSA AFFINIS			1																		1				2
PHERUSA SPP.										3	4	1	1	3	2										14
PHOLOE MINUTA	14	17	18		1		6	1	3	6	5	5	1	4	6	30	17	12	4	6	12	5	5	1	179
PHOLOE SPP.	1																			1					2
PHOLOE TECTA																					1				1
PHYLLODOCE GROENLANDICA																								1	1
PHYLLODOCE MUCOSA								1								1		2					1		5
PISTA CRISTATA								1																	1
POLYCIRRUS SPP.							1	2			4	1					8	1							17
POLYDORA SPP.			1																						1
POLYGORDIUS SP. A	2	3	3							11		2		1	1	2	1	1							27

Raw infaunal abundance data for samples collected from the Mass Bay Farfield in August 1995.

MASS BAY - AUGUST 1995 FARFIELD	FF1A-1	FF1A-2	FF1A-3	FF4-1	FF4-2	FF4-3	FF5-1	FF5-2	FF5-3	FF6-1	FF6-2	FF6-3	FF7-1	FF7-2	FF7-3	FF9-1	FF9-2	FF9-3	FF11-1	FF11-2	FF11-3	FF14-1	FF14-2	FF14-3	Total
PRAXILLELLA GRACILIS					1			2											1	4	5		1	2	16
PRAXILLELLA PRAETERMISSA	8	29	36				6		1	2		1				1		3	1	2				1	91
PRAXILLURA ORNATA	1		1													6	11	4							23
PRIONOSPIO STEENSTRUPI	2080	1967	1596	151	65	32	348	291	245	36	10	11	15	14	27	1467	2337	1589	430	550	889	151	157	121	14579
PROCLEA GRAFFII											3	5		1											9
RHODINE LOVENI			1								1	1				20	11	5							39
SABELLIDAE SPP.			1																						1
SCALIBREGMA INFLATUM	1		1		2		59	23	14			1				17	16	13	3		1	23	32	10	216
SCOLETOMA FRAGILIS	1	1				1	1		2		2	3					1			1	2	2		2	19
SCOLETOMA HEBES		1									4	1					1								7
SCOLOPLOS ARMIGER																7	3	7							17
SPHAERODOROPSIS MINUTA	3	6	2							3			1	1	2	1	3	6					2	1	31
SPHAEROSYLLIS LONGICAUDA	1										1		1				5	2							10
SPIO LIMICOLA	28	19	38	11	1		96	105	92	43	72	75	54	29	39	328	145	257	9	21	19	10	20	21	1532
SPIO THULINI																				1					1
SPIONIDAE SPP.																1									1
SPIOPHANES BOMBYX	3	1	1																						5
SPIOPHANES KROEYERI																					1		1		2
STERNASPIS SCUTATA			1	1	1	1	2	2	11		2			1	1				6	15	15	31	108	39	237
STREBLOSPIO BENEDICTI	1																								1
SYLLIDES JAPONICA								3	5		2	7			2	1	1								21
SYLLIDES LONGOCIRRATA				9	10	8				7	7	6	11	6	19						2		2	2	89
TEREBELLIDAE SPP.	4	1							4	1					2	2									14
TEREBELLIDES ATLANTIS	1						2	1	3	9	18	29	3	2	2							1			71
TEREBELLIDES SPP.					1	1	4	2				4		3				1	1		1	1	7	7	33
TEREBELLIDES STROEMI																1									1
THARYX ACUTUS	73	165	109					1		338	170	192	55	50	63		4	9							1229
TROCHOCHAETA CARICA				1	1	1	1		2															2	8
TROCHOCHAETA MULTISETOSA													1		1										2
TROCHOCHAETA SPP.				1			2		1							1	4	2		1	6	7	4	5	34
OLIGOCHAETA																									
TUBIFICIDAE SP. 2 (BLAKE 1992)										20	12	46	67	233	242							1			621
TUBIFICOIDES APECTINATUS		1		17	7	10	5	9	6					2					49	71	120	23	54	41	415
GASTROPODA																									
BUCCINIDAE SPP.		2	1																						3
CYLICHNA GOULDI				1															2				1	2	6
GASTROPODA SPP.		1					1	2	1	4	17	3		3			2	1					2	1	38
ILYANASSA TRIVITTATA	1	2	2								1														6
NUDIBRANCHIA SPP.																					1				1
ONOBA PELAGICA				1			1	1	5	14	39	1	4	6	2					2		2	5	4	87
RETUSA OBTUSA							2		3																5
POLYPLACOPHORA																									
POLYPLACOPHORA SPP.	1	2																						1	4
APLACOPHORA																									
CHAETODERMA NITIDULUM CANADENSE			1																						1
APLACOPHORA SPP.																			1	1	1				3
BIVALVIA																									
ARCTICA ISLANDICA	4	14	10	1								2													31
ASTARTE UNDATA		1														6	15								22
ASTHENOTHAERUS HEMPHILLI	9	1	2					1	6	5	1	2			2	1	1	1		1		3			36
BIVALVIA SPP.	19	30	5				3	10	28	6	6		2			5	97	6	5	1	11	14	34	7	289
CERASTODERMA PINNULATUM	35	19	3													50	50	51	1	1	1				211
CRENELLA GLANDULA	11	26	17									1					5						4	2	66
CRENELLA SPP.																5		1							6
HIATELLA ARCTICA	5	3	2													1		2							13

Raw infaunal abundance data for samples collected from the Mass Bay Farfield in August 1995.

MASS BAY - AUGUST 1995 FARFIELD	FF1A-1	FF1A-2	FF1A-3	FF4-1	FF4-2	FF4-3	FF5-1	FF5-2	FF5-3	FF6-1	FF6-2	FF6-3	FF7-1	FF7-2	FF7-3	FF9-1	FF9-2	FF9-3	FF11-1	FF11-2	FF11-3	FF14-1	FF14-2	FF14-3	Total
MUSCULUS SPP.																1									1
MYA ARENARIA											1												1		2
MYTILUS EDULIS	1																								1
NUCULA ANNULATA										19	20	13	2	2	2				2						60
NUCULA DELPHINODONTA	62	66	63	2	3		7	4	17	36	25	13	8	9	12	12	1	5	13	1	7	10	35	14	425
NUCULA SPP.	73	135	30	3			64	28	67	20	18	3	7	7	12	59	56	36	18	7	8	11	51	40	753
NUCULANA SPP.				1																					1
NUCULOMA TENUIS								1																	1
PITAR MORRHUANA											1		1												2
SOLEMYA SPP.	1																								1
THRACIIDAE SPP.			9				10	2									1						4		26
THYASIRA GOULDII	26	29	35	13	3		33	21	18	12	22	9	6	2	12	13	11	13	3	4	15	23	20	9	352
YOLDIA SAPOTILLA							2	2		1						1				3		2	5		16
YOLDIA SPP.	3	3		18	13	5	12	13	37	6	6	1	2	3	9	20	24	6	5	1	12	3	21	10	233
SCAPHOPODA																									
SCAPHOPODA SPP.				28	9	4	1	4	1							1			2		2		12	12	76
MUSIDACEA																									
MYSIDACEA SPP.											3	2		2	1		3	1							12
CUMACEA																									
CAMPYLASPIS RUBICUNDA								1		1															2
DIASTYLIS CORNUIFER		1											1				1	1							4
DIASTYLIS POLITA			2																						2
DIASTYLIS QUADRISPINOSA	2		1															2							5
DIASTYLIS SCULPTA		4	1																			1	1	1	8
DIASTYLIS SPP.	2									1															3
EUDORELLA HISPIDA							2												1	1					4
EUDORELLA PUSILLA	1						2			4			8	1		1		2							19
EUDORELLA SPP.			1				2	2			2	2	2	15	11	1			1	1	3	9	12	9	73
LEPTOSTYLIS AMPULLACEA														1											1
LEPTOSTYLIS LONGIMANA										10			3	1											14
LEUCON ACUTIROSTRIS					1	2														1		3	6	4	17
LEUCON FULVUS								1	1																2
LEUCON SPP.								1																	1
PETALOSARSIA DECLIVIS	6	4	4														1								15
ISOPODA																									
EDOTIA MONTOSA	5	19	16						2							2	5					1			50
MUNNA SP. 1																		1							1
PLEUROGONIUM INERME	1									2			1					2							6
PLEUROGONIUM RUBICUNDUM	2						1	3					1		1							1			9
PLEUROGONIUM SPINOSISSIMUM																3									3
PLEUROGONIUM SPP.									1		2				6	1	2				1				13
PTILANTHURA TENUIS	16	22	18															1							57
AMPHIPODA																									
AEGININA LONGICORNIS			1																						1
AMPELISCA ABDITA																							1		1
AMPELISCA MACROCEPHALA	4	2	5													1	1	2							15
AMPHIPODA SPP.		1					5						3												9
ANONYX LILLJEBORGI			3											1		1	1								6
ARGISSA HAMATIPES	2	2	2								2	1	2	1	1			1							14
BATHYMEDON OBTUSIFRONS																			1	1			3		5
BYBLIS NR. GAIMARDI							1		2														2	1	6
CAPRELLA LINEARIS												2		1	1										4
CASCO BIGELOWI																1		2							3
COROPHIIDAE SPP.							18																		18
CRASSICOROPHIUM CRASSICORNE			1																						1

Raw infaunal abundance data for samples collected from the Mass Bay Farfield in August 1995.

MASS BAY - AUGUST 1995 FARFIELD	FF1A-1	FF1A-2	FF1A-3	FF4-1	FF4-2	FF4-3	FF5-1	FF5-2	FF5-3	FF6-1	FF6-2	FF6-3	FF7-1	FF7-2	FF7-3	FF9-1	FF9-2	FF9-3	FF11-1	FF11-2	FF11-3	FF14-1	FF14-2	FF14-3	Total
DEFLEXILODES INTERMEDIUS						1			1																2
DYOPEDOS MONACANTHUS													1	1	1										3
ERICTHONIUS RUBRICORNIS					1																				1
HAPLOOPS FUNDIENSIS	5	1	2		2	1		3	2		3	1				1	3	1						1	26
HARPINIA PROPINQUA	4	8	17	11	6	6	6	13	4	5	1	4				25	9	17	8	4	9	4	6	6	173
HIPPOMEDON PROPINQUUS	1																1					1	2		5
ISCHYROCERUS ANGUIPES		1	2					1										1							5
LEPTOCHEIRUS PINGUIS					1			3		1								1							6
MAERA LOVENI								1																	1
MELITA NR. DENTATA								1																	1
METOPELLA ANGUSTA	6	7	2					1	2	5	14	1	2	2	1	2	3				1	5	1	1	56
MONOCULODES SP. 1	2	2								2			2						1				1		10
ORCHOMENE PINGUIS	1															1			1						3
PARADULICHIA TYPICA																1									1
PHOTIS POLLEX	9	14	11	1				1		8	13	1	1	1	6	5	1	1					1		74
PLEUSYMTES GLABER																		1							1
PROTOMEDEIA FASCIATA	1	2	1																						4
STENOPLEUSTES INERMIS	12	3	6								6		2	3	1										33
SYRRHOE CRENULATA																	4								4
UNCIOLA IRRORATA	1	1						1									3	7							13
WESTWOODILLA BREVICALCAR	1		1													3		1							6
SIPUNCULA																									
PHASCOLION STROMBI	2	3	1	2													1	1				1			11
SIPUNCULA SPP.	1	1		1				1						1	1		8	3	1	1	7	3	12	8	49
PRIAPULIDA																									
PRIAPULUS CAUDATUS																								2	2
PHORONIDA																									
PHORONIS ARCHITECTA	8	9	3				1	1	2	5	9	7	2	1	2	3	5	2							60
ECHINODERMATA																									
CTENODISCUS CRISPATUS							1	1										1							3
ECHINARACHNIUS PARMA																	2								2
HOLOTHUROIDEA SPP.									1																1
OPHIURA SARSI								5		4	10	4	6	3	6	1		1			3	2	5		50
OPHIURA SPP.			2				1		6	5	2			6	2						6	7	9	1	47
OPHIUROIDEA SPP.				1		1		2											1	1					6
HEMICHORDATA																									
STEREOBALANUS CANADENSIS									1					1	2										4
CHORDATA																									
MOLGULA MANHATTENSIS															2										2
MOLGULA SPP.	1	1																							2

Appendix G-2

1996 Infaunal Abundance

Nearfield, Midfield, and Farfield

Raw infaunal abundance data for samples collected from the Mass Bay Nearfield in August 1996.

MASS BAY - AUGUST 1996 NEARFIELD	NF13	NF14	NF15	NF17-1	NF17-2	NF17-3	NF18	NF19	NF23	NF24-1	NF24-2	NF24-3	Total
TOTAL/REPLICATE	1639	2124	1661	1640	1381	1925	1813	2458	3622	1767	1561	1446	23037
TOTAL/STATION	1639	2124	1661		4946		1813	2458	3622		4774		
TAXON													
CNIDARIA													
ACTINIARIA SPP.		1			1						1	4	7
CERIANTHEOPSIS AMERICANUS				1									1
CERIANTHIDAE SPP.		1						1	4		1	2	9
CERIANTHUS BOREALIS	1		2					1				1	5
CORYMORPHA PENDULA				2									2
EDWARDSIA ELEGANS	1	1						2		1		1	6
NEMERTEA													
AMPHIPORUS ANGULATUS			1					1			1		3
AMPHIPORUS GROENLANDICUS												1	1
AMPHIPORUS SPP.												1	1
CARINOMELLA LACTEA			1					1	1				3
CEPHALOTHRICIDAE SP. 1		1	1	21	3	25	2	6	2	4	10	7	82
CEREBRATULUS LACTEUS		1	1						1		1	3	7
MICRURA SPP.		8	12				6	7			4	8	45
NEMERTEA SP. 2			1										1
NEMERTEA SP. 5	6	2	5	3		7	1	13	3	1	3	5	49
NEMERTEA SPP.	2	2	1	5	15	22			1	3	4	4	59
TETRASTEMMA SPP.	1	1											2
POLYCHAETA													
AGLAOPHAMUS CIRCINATA	46			2	15	8		2	16				89
AMPHARETE ACUTIFRONS		38					40	4	1	1			84
AMPHARETE FINMARCHICA		18	3	51	1	28		5		3	1		110
AMPHARETE LINDSTROMI	1			15		14	2						32
AMPHARETE SPP.								2					2
AMPHARETIDAE SPP.		36	21	7	2	8	43	44	17	16	10	10	214
ANOBOTHRUS GRACILIS	2	1					1	1					5
APHELOCHAETA MARIONI		4	37		2		48	157	3	348	382	336	1317
APHELOCHAETA MONILARIS		2											2
APHRODITA SPP.											2		2
APISTOBRANCHUS TYPICUS	32	7						13		3	6	3	64
ARICIDEA CATHERINAE	10	120	65	10		6	22	54	8	5	19	6	325
ARICIDEA MINUTA								1					1
ARICIDEA QUADRILOBATA											4		4
ARICIDEA SPP.				1									1
ASABELLIDES OCULATA	1	4		1		10	14						30
CAPITELLA CAPITATA COMPLEX								2		2	4	3	11
CHAETOZONE SETOSA	5			14	21	1	1		2		1	3	48
CHAETOZONE SPP.					4								4
CHONE DUNERI		1	1					1	1				4
CIRRATULIDAE SPP.				13			48	3				2	66
CLYMENURA SP. A (BLAKE 1992)				10	2	4							16
COSSURA LONGOCIRRATA			2								1		3
DIPOLYDORA CAULLERYI		1		1		1							3
DIPOLYDORA CONCHARUM							2						2
DIPOLYDORA QUADRILOBATA								7	17				24
DIPOLYDORA SOCIALIS		17	2		18		69	169	157	59			491
ENIPO TORELLI											1	1	2
ETEONE HETEROPODA											1		1
ETEONE LONGA		4	4				5	10		5	7	8	43
EUCHONE ELEGANS		1				1			23				25
EUCHONE INCOLOR		49	48				63	56	8	55	70	100	449
EUCLYMENE COLLARIS	17	6	7	100	1	221		14	56				422
EUCLYMENINAE SPP.	1	3		2	1	7		3		1			18

Raw infaunal abundance data for samples collected from the Mass Bay Nearfield in August 1996.

MASS BAY - AUGUST 1996 NEARFIELD	NF13	NF14	NF15	NF17-1	NF17-2	NF17-3	NF18	NF19	NF23	NF24-1	NF24-2	NF24-3	Total
EXOGONE HEBES	480	310	68	17	76	1	64	214	250	12	9	6	1507
EXOGONE LONGICIRRIS		1		1	1	1	1		28				33
EXOGONE VERUGERA	148	59	7	19	6	56	29	118	418	8	3	2	873
GALATHOWENIA OCULATA	2	1			3	1	2		1	2		2	14
GATTYANA AMONDSENI		1					1	2		3	5	1	13
GLYCERA CAPITATA				3		1			2				6
GLYCERIDAE SPP.	1			3		2							6
GONIADA MACULATA								2	1				3
GONIADIDAE SPP.		1						1		1	1	1	5
HARMOTHOE IMBRICATA							1						1
HARMOTHOINAE SPP.				1		7		2	2	1	1	1	15
HETEROMASTUS FILIFORMIS												2	2
LABROROSTRATUS PARASITICUS									1				1
LAONICE SPP.										1			1
LAONOME KROEYERI							3	1	7	7	2		20
LEITOSCOLOPLOS ACUTUS			10					9		24	10	8	61
LEITOSCOLOPLOS SP.B			2				3	12		5	15	18	55
LEITOSCOLOPLOS SPP.								2					2
LEVINSENIA GRACILIS		4	6		1	1	2	6		10	36	40	106
LUMBRINERIDAE SPP.		2						2		2		2	8
MALDANE SARSI												6	6
MALDANIDAE SPP.	2			137	2	110		6	28				285
MEDIOMASTUS CALIFORNIENSIS	3	163	175	5	1	2	71	121	28	91	101	82	843
MICROPHTHALMUS ABERRANS						2		1			1		4
MICROPHTHALMUS LISTENSIS						12							12
MONTICELLINA BAPTISTEAE	3		5	3		1	2	2					16
MONTICELLINA DORSOBRANCHIALIS	1	1	10			1	19	7	1	3	35	6	84
MYSTIDES BOREALIS									1				1
NEPHTYIDAE SPP.		13	12	13	3		7	11	15	8	31	21	134
NEPHTYS CAECA				2	2								4
NEPHTYS INCISA		1					4	1	2		9	3	20
NEREIDIDAE SPP.	2	1							10	1	1		15
NEREIS GRAYI		24	13	1			9	20	3			1	71
NEREIS PROCERA								4					4
NINOE NIGRIPES		109	73				147	51		27	70	41	518
OPHELINA ACUMINATA							1						1
ORBINIIDAE SPP.							5				34	19	58
OWENIA FUSIFORMIS				18	24	3		6					51
PARADONEIS LYRA				36		16							52
PARANAITIS SPECIOSA		1						1			1		3
PAROUGIA CAECA		15	23	25	1	16	21	20		6	22	14	163
PECTINARIA GRANULATA							1	1		1			3
PECTINARIA SPP.				1						3			4
PETALOPROCTUS TENUIS								2					2
PHERUSA SPP.			1										1
PHOLOE MINUTA	4	15	10	6	1	8	12	25	30	16	46	22	195
PHOLOE SPP.												1	1
PHYLLODOCE ARENAE					1								1
PHYLLODOCE MACULATA									6				6
PHYLLODOCE MUCOSA	5	11	3		3		5	23	2	14	1	6	73
PHYLLODOCE SPP.					1			4	24	3			32
PHYLLODOCIDAE SPP.	2			1									3
PIONOSYLLIS SP. A		14	3	1			24	12		2			56
POLYCIRRUS SPP.	1	8	3			1	7	1	13			5	39
POLYGORDIUS SP. A	15	3	3	442	33	229	4	13	3	2	1	2	750
PRAXILLELLA PRAETERMISSA				1									1
PRIONOSPIO STEENSTRUPI	6	733	666	8	4	12	518	579	253	504	297	266	3846

Raw infaunal abundance data for samples collected from the Mass Bay Nearfield in August 1996.

MASS BAY - AUGUST 1996 NEARFIELD	NF13	NF14	NF15	NF17-1	NF17-2	NF17-3	NF18	NF19	NF23	NF24-1	NF24-2	NF24-3	Total
RHODINE LOVENI								2					2
SABELLIDAE SPP.				1		4			4				9
SCALIBREGMA INFLATUM	2	1		3		1	25	21	32	16	2	12	115
SCOLETOMA FRAGILIS		3	2				2	6			5	5	23
SCOLETOMA HEBES		1										2	3
SCOLOPLOS (LEODAMAS) ?RUBRA				5	2	22							29
SCOLOPLOS ACMECEPS	1												1
SCOLOPLOS SPP.				1									1
SPHAERODORIDIUM SP. A		2					4	3	3	2	2		16
SPHAERODOROPSIS MINUTA									1				1
SPHAEROSYLLIS BREVIFRONS				17	1	71	1	1	42				133
SPHAEROSYLLIS LONGICAUDA		3	1	3		6	1	6	11		1		32
SPIO FILICORNIS		1	3	1		2	8	1		1			17
SPIO LIMICOLA		7	11		2	1	47	194	161	160	120	211	914
SPIO THULINI				5		6							11
SPIONIDAE SPP.								2					2
SPIOPHANES BOMBYX	13		4	2	40	3		12		1	1		76
SYLLIDAE SPP.									1				1
SYLLIDES LONGOCIRRATA				12		6	1		5				24
TEREBELLIDAE SPP.			5					1				5	11
TEREBELLIDES ATLANTIS											2		2
TEREBELLIDES SPP.		2									1		3
TEREBELLIDES STROEMI											3		3
THARYX ACUTUS	16	5	85	2		75	61	17	80	28	10	13	392
TROCHOCHAETA SPP.							3	1		2	5	2	13
TYPOSYLLIS SP. 1 (BLAKE 1992)			1					1	6				8
TYPOSYLLIS SPP.								1	3				4
OLIGOCHAETA													
ADELODRILUS SP. 1	9								11				20
ADELODRILUS SP. 2				3		5							8
ENCHYTRAEIDAE SP. 1	165			4	1	28							198
OLIGOCHAETA SPP.				1									1
TUBIFICIDAE SP. 2 (BLAKE 1992)		46	11			2	9	17	3	17	23	4	132
TUBIFICIDAE SP. 4				8		96							104
TUBIFICOIDES APECTINATUS	1	4	3		2		3	3	1	14		1	32
GASTROPODA													
DIAPHANA MINUTA				2		4	1						7
EUSPIRA HEROS					3								3
GASTROPODA SPP.		2		2	1				4				9
ILYANASSA TRIVITTATA				2		3	2	3		2	1		13
MARGARITES COSTALIS									1				1
NEPTUNEA SPP.									1				1
ODOSTOMIA SULCOSA									1				1
OENOPOTA HARPULARIA							1						1
OENOPOTA INCISULA							1						1
ONOBA MIGHELSI									1		1		2
BIVALVIA													
ARCTICA ISLANDICA	7		22	2				1	1	26	4	2	65
ASTARTE BOREALIS						1							1
ASTARTE UNDATA	1	7	7	4			13	17	65	60	25	17	216
ASTHENOTHAERUS HEMPHILLI				15	5	10							30
BIVALVIA SPP.		5	5		28	1		9	44	3		1	96
CERASTODERMA PINNULATUM	45	48	44	32	18	94	45	36	25	2			389
CRENELLA DECUSSATA	17	66	13	4			37	10	187	20	1	4	359
CRENELLA GLANDULA	4	1		36		66	1	5	111	2			226
CRENELLA SPP.					1								1
CYCLOCARDIA BOREALIS								2	9	13	3	6	33

Raw infaunal abundance data for samples collected from the Mass Bay Nearfield in August 1996.

MASS BAY - AUGUST 1996 NEARFIELD	NF13	NF14	NF15	NF17-1	NF17-2	NF17-3	NF18	NF19	NF23	NF24-1	NF24-2	NF24-3	Total
ENSIS DIRECTUS	10	6	7					2	2				27
HIATELLA ARCTICA	9	8	16	25	28	95	95	22	49	6			353
LYONSIA ARENOSA		3	6					2					11
LYONSIA SPP.							1	1		2			4
MEGAYOLDIA THRACIAEFORMIS											1		1
MUSCULUS DISCORS							2						2
MYA ARENARIA			3					1	2	1			7
MYTILIDAE SPP.	1	5	1			20	3		5	2			37
MYTILUS EDULIS			1										1
NUCULA DELPHINODONTA	8	5	8	1			31	54	31	32	11	35	216
NUCULA SPP.										11			11
NUCULOMA TENUIS											9	1	10
PECTINIDAE SPP.						1							1
PERIPLOMA PAPYRATEUM		1					1	2					4
PITAR MORRHUANA										1	1	1	3
PYTHINELLA CUNEATA	9			3		15	5	1	3	7			43
SILIQUA COSTATA							1						1
THRACIA CONRADI	1									1	1		3
THYASIRA GOULDII		1	1										2
YOLDIA SAPOTILLA							1	1		4	20	5	31
SCAPHOPODA													
DENTALIUM ENTALE											3	2	5
CIRRIPEDIA													
BALANUS SPP.							1						1
CUMACEA													
CAMPYLASPIS RUBICUNDA								1			1		2
DIASTYLIS POLITA		2					1						3
DIASTYLIS QUADRISPINOSA	1						1		1				3
DIASTYLIS SCULPTA	1	1			2						1		5
DIASTYLIS SPP.		5	2		1		2		1	5			16
EUDORELLA PUSILLA	1	1	1				2	1	1				7
EUDORELLOPSIS DEFORMIS					2								2
LAMPROPS QUADRIPLICATA								1					1
PETALOSARSIA DECLIVIS	1		1				2	6		1	3		14
TANAIDACEA													
TANAISSUS PSAMMOPHILUS	3			1	11				1				16
ISOPODA													
CHIRIDOTEA TUFTSI					17								17
EDOTIA MONTOSA	5	3	1	1	1		1	16	1	14	1	3	47
MUNNA SP. 1							2	1	2				5
PLEUROGONIUM INERME			3						7	1			11
PLEUROGONIUM RUBICUNDUM		5	12				6	16	1	2	2	1	45
PLEUROGONIUM SPINOSISSIMUM				1			5	2	9				17
PLEUROGONIUM SPP.		1						4		1			6
POLITOLANA POLITA					3	1							4
PTILANTHURA TENUIS	3		8	1		1		1	4	1			19
AMPHIPODA													
ACANTHOHAUSTORIUS MILLSI					1								1
AEGININA LONGICORNIS										1			1
AMPELISCA MACROCEPHALA		3	1		2		2			1			9
ANONYX LILLJEBORGI				1		4							5
ARGISSA HAMATIPES	2	2	5	1	4		2	6		1	1		24
CASCO BIGELOWI											2	2	4
COROPHIIDAE SPP.	42				136		3		116				297
CRASSICOROPHIUM CRASSICORNE	406	1	10	15	672	6	1	1	546	4			1662
DEFLEXILODES INTERMEDIUS			1					1					2
DEFLEXILODES TUBERCULATUS		1	1	19		26	1		3				51

Raw infaunal abundance data for samples collected from the Mass Bay Nearfield in August 1996.

MASS BAY - AUGUST 1996 NEARFIELD	NF13	NF14	NF15	NF17-1	NF17-2	NF17-3	NF18	NF19	NF23	NF24-1	NF24-2	NF24-3	Total
DULICHIA FALCATA									3				3
DYOPEDOS MONACANTHUS							1	1					2
EOBROLGUS SPINOSUS					1								1
ERICTHONIUS RUBRICORNIS	1	3		8	2	24		2	129	2	1	1	173
HAPLOOPS FUNDIENSIS		2											2
HARPINIA PROPINQUA								1	2		1		4
HIPPOMEDON PROPINQUUS	7					1							8
HIPPOMEDON SERRATUS				1									1
LEPTOCHEIRUS PINGUIS					1				28				29
METOPELLA ANGUSTA		4	10				9	33		14	12	6	88
MONOCOROPHIUM INSIDIOSUM				1									1
MONOCOROPHIUM TUBERCULATUM					1								1
MONOCULODES SP. 1					1								1
MONOCULODES SPP.							1						1
ORCHOMENELLA MINUTA						4		1					5
PHOTIS POLLEX	2	5	8		3		3	13		1			35
PHOXOCEPHALUS HOLBOLLI	1			2	10	2							15
PLEUSYMTES GLABER											1		1
PROBOLOIDES HOLMESI									1				1
PROTOMEDEIA FASCIATA	4	16		1	2	3	9	5	141	3	1		185
PSEUDUNCIOLA OBLIQUUA			1		51					2			54
RHEPOXYNIUS HUDSONI					1								1
STENOPLEUSTES INERMIS	1	1	7					5	9				23
SYRRHOE CRENULATA				11		1			8				20
UNCIOLA INERMIS	17			294	5	323			203				842
UNCIOLA IRRORATA				65	3	41	1		18				128
UNCIOLA SPP.									12				12
WESTWOODILLA BREVICALCAR							1				1		2
DECAPODA													
CANCER BOREALIS		4		1		2			4				11
PAGURUS ACADIANUS									1				1
PAGURUS SPP.							1	1					2
SIPUNCULA													
NEPHASOMA DIAPHANES									9				9
PHASCOLION STROMBI								2	1			1	4
SIPUNCULA SPP.			1						2	1	1	1	6
PRIAPULIDA													
PRIAPULUS CAUDATUS												1	1
PHORONIDA													
PHORONIS ARCHITECTA	1	7	12				3	8		9		3	43
ECHINODERMATA													
ASTEROIDEA SPP.				1	1	2	1	1					6
AXIOGNATHUS SQUAMATUS								1					1
CTENODISCUS CRISPATUS											1		1
ECHINARACHNIUS PARMA	19			6	66								91
ECHINOIDEA SPP.			1							1			2
OPHIURA SARSI									2				2
OPHIUROIDEA SPP.		3	6				10	6		2	7	11	45
HEMICHORDATA													
STEREOBALANUS CANADENSIS			1					1					2
CHORDATA													
ASCIDEACEA SPP.											2		2
MOLGULA SPP.	1			10			5						16

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MASS BAY - AUGUST 1996 MIDFIELD	MF2	MF4	MF5	MF7	MF8	MF9	MF10	MF12-1	MF12-2	MF12-3	MF16	MF20	MF21	MF22	FF10-1	FF10-2	FF10-3	FF12-1	FF12-2	FF12-3	FF13-1	FF13-2	FF13-3	Total
TOTAL/REPLICATE	2545	1955	1603	1478	1443	1755	1680	2156	2099	2751	1483	2906	1437	2944	2716	2066	1940	3297	2682	3291	2485	1972	2728	51412
TOTAL/STATION	2545	1955	1603	1478	1443	1755	1680		7006		1483	2906	1437	2944		6722			9270			7185		
TAXON																								
CNIDARA																								
ACTINIARIA SPP.						2				4					1	1					3			11
CERIANTHIDAE SPP.					1				1		1	2	1		3	1	1	2	1	2		2		18
CERIANTHUS BOREALIS	1		2		1	5	2			1		4				2	2			1				21
EDWARDSIA ELEGANS	2							1				3			3	4	1	3	6	5		3	3	34
HYDROZOA SPP.																	1							1
PLATYHELMINTHES																								
TURBELLARIA SPP.	1												1											2
NEMERTEA																								
AMPHIPORUS ANGULATUS					12			4			1		4	2		2	1							26
AMPHIPORUS GROENLANDICUS															1									1
AMPHIPORUS SPP.	2									2				1	1			13		4	1	1		25
CARINOMELLA LACTEA	3				20	1		6	5	6	3	17	2	15		1	1	7	3	10				100
CEPHALOTHRICIDAE SP. 1	1	3		5	13	6	4	2	4	8	4	1	2	15									1	69
CEREBRATULUS LACTEUS					10		1	2	1		1	8	4	6	2	1	2		1		1		2	42
MICRURA SPP.	11		8	6	9	15	19	14	15	19	5	14	4	17	7	21	11	7	1	2	13	9	11	238
NEMERTEA SP. 2										3		2												5
NEMERTEA SP. 5	1	1	4	3	9	5	1	4	2	20	7	28		13	6	3	2	4	2	4	5	2	5	131
NEMERTEA SPP.		1	1		8	2	3	2		4	1	4	1	2	4					3				36
TETRASTEMMA VITTATUM													1											1
POLYCHAETA																								
AGLAOPHAMUS CIRCINATA		39																						39
AMPHARETE ACUTIFRONS	13		7	9		23	60	8		2	16	6	12	27	2	3		1	5	1				195
AMPHARETE FINMARCHICA	5	5		4		1				1					1	3	1	3	5	3		2		34
AMPHARETE LINDSTROMI	3																	1	2					6
AMPHARETIDAE SPP.	31		18	30	2	73	31	22	30	17	2	12	32	27	39	45	82	13	4	11			2	523
ANOBOTHRUS GRACILIS			6			1		1							1	3	3	1						16
APHELOCHAETA MARIONI	106		201	133		90	107	271	219	169	143	15	64	169	336	44		3	8	17		1		2096
APHELOCHAETA MONILARIS						3											29		6	2		2		42
APHRODITA SPP.				1																				1
APISTOBRANCHUS TYPICUS			8	2	1	14	2	4	2	8	3	8		2	2	5	7							68
ARCTEOBIA ANTICOSTIENSIS			1						1					1										3
ARICIDEA CATHERINAE	187	4	10	1	21	110	82	188	197	241	2	119	67	2	159	74	121	191	18	7	97	66	114	2078
ARICIDEA QUADRILOBATA			4	2		1	1	2	6.	5	5	1	7	2	1	1	2	3						43
ARICIDEA SPP.						1																		1
ASABELLIDES OCULATA		1	3	1											1		1				3			10
BRADA SPP.																	1			1				2
CAPITELLA CAPITATA COMPLEX	2		2		2	3	1		4	7		1	2	2	5	1		6	3	3	13	22	30	109
CHAETOZONE SETOSA				10		2	1	14	5	1			4			77								114
CHONE DUNERI								1				1					1		1	1				5
CHONE SPP.			1												1									2
CIRRATULIDAE SPP.			27				11			50		26	12	63					3					192
CLYMENELLA TORQUATA															6	19	34	3	4	18				84
COSSURA LONGOCIRRATA	1					1	19	2		2	1				1									27
DIPLOCIRRUS SPP.														1										1
DIPOLYDORA CONCHARUM																1								1
DIPOLYDORA QUADRILOBATA	3		2	3											23	21	2	13	24	21	1	10.	10	133
DIPOLYDORA SOCIALIS	22	75	21	131		8		36	18	13				7	42	53	21	89	49	62	12	4	9	672
DORVILLEA SOCIABILIS							1																	1
DORVILLEIDAE SPP.			1	1																				2
ENIPO TORELLI	2							1	1	2		1	1	3										11
ETEONE HETEROPODA																							2	2
ETEONE LONGA	4		4	5	5	6	5	4	1	9	8	18	5	5	15	8	6	12	14	20	9	4	13	180

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MASS BAY - AUGUST 1996 MIDFIELD	MF2	MF4	MF5	MF7	MF8	MF9	MF10	MF12-1	MF12-2	MF12-3	MF16	MF20	MF21	MF22	FF10-1	FF10-2	FF10-3	FF12-1	FF12-2	FF12-3	FF13-1	FF13-2	FF13-3	Total
ETEONE SPP.	1					1	1	1						2										6
EUCHONE ELEGANS		3																						3
EUCHONE INCOLOR	37	2	12	36	40	48	12	87	76	119	102	149	79	219	26	33	21	30	18	27		1	1	1175
EUCLYMENE COLLARIS																	50	1						51
EUCLYMENINAE SPP.	7					2		1	1	2	1			1	22	23			7	2		1		70
EXOGONE HEBES	29	260	8	23	32	5	3	24	21	19	4	14	20	26	25	25	21	2	2	1		1		565
EXOGONE LONGICIRRIS																	1							1
EXOGONE VERUGERA	1	91	111	30	3	11	15	13	6	11		5	1	18	21	54	11							402
FLABELLIGERIDAE SPP.														1		1		2	1	2				7
GALATHOWENIA OCULATA	1	2	9		1	4		3	1	2	1	1	2	3	3	1				4		3	2	43
GATTYANA AMONDSENI			4	2		1	2				1	1	2	2	1									16
GLYCERIDAE SPP.		1											1											2
GONIADA MACULATA			2							1		1		1			1	1	2					9
GONIADIDAE SPP.										1														1
HARMOTHOE EXTENUATA				1																				1
HARMOTHOINAE SPP.	1			1	1		2		2	1			1		1	1	2					1		14
HARTMANIA MOOREI															1									1
HETEROMASTUS FILIFORMIS						1		1	2		1	2										2		9
LANASSA VENUSTA VENUSTA							1		1	1			1											4
LAONICE CIRRATA			2									1						2						5
LAONOME KROEYERI	1				2	13	2	2	3	8	1	2		4	2			1		2			1	44
LEITOSCOLOPLOS ACUTUS	29		9	5	36	13	32	39	32	46	34	50	34	45	77	31	45	60	30	31	90	36	124	928
LEITOSCOLOPLOS SP.B				5	5	5	3	2				7	3	2	6	4	2	4	6	6	2	5	2	69
LEVINSENIA GRACILIS	24	1	26	38	25	43	20	92	133	99	94	55	59	114	3	7	30	44	22	12	2			943
LUMBRINERIDAE SPP.	3	1	8	4	12			10	2	2	5	3		15	3	1		1	87				1	158
MALDANE SARSI			19	23		27	2			2			8			4	31							116
MALDANIDAE SPP.		1														3								4
MEDIOMASTUS CALIFORNIENSIS	191	5	123	111	397	209	395	433	514	392	152	298	201	379	122	168	166	342	248	283	152	121	176	5578
MICROPHTHALMUS ABERRANS													1								2	4		7
MONTICELLINA BAPTISTEAE	1		8		107	87	23	23	26	58	55	136	92	36	99	123	96	28	122	169			5	1294
MONTICELLINA DORSOBRANCHIALIS	2		6	17	17	15	6	7	1	10	14	15	1	22	12	24	47	8	3	3	2		5	237
NEPHTYIDAE SPP.	4	1	9	17	41	16	10	16	13	30	48	25	20	29	15	12	8	37	19	23	2			395
NEPHTYS CAECA	1																		1	1				3
NEPHTYS CILIATA																		2	1	2				5
NEPHTYS CORNUTA						5		8	5												344	401	199	962
NEPHTYS INCISA			4	3		3	2	5	7	7	8	2	4	5	2	2	3		2	5	1	2	2	69
NEREIDIDAE SPP.	2							2		1	1		1											7
NEREIS GRAYI	13		4	2	1							5			5	6	1	6	4	9				56
NEREIS PROCERA																	1							1
NINOE NIGRIPES	92		31	41	197	184	90	75	75	305	151	351	87	534	187	59	71	128	54	142	13	7	36	2910
OPHELINA ACUMINATA															1			1						2
OPHRYOTROCHA CF. LABRONICA									1				1											2
OPHRYOTROCHA SPP.													1											1
ORBINIIDAE SPP.				6	31	33			1									21	16	22				130
OWENIA FUSIFORMIS	409	4	2			6		4	3	4		2	1		27	10	15	439	749	827				2502
PARANAITIS SPECIOSA						1								1										2
PARAONIDAE SPP.													1											1
PAROUGIA CAECA	42		21	9	38	11	11	16	35	31	34	29	21	76	10	17	10	20	7	16	2	2	3	461
PECTINARIA GRANULATA												1												1
PHERUSA AFFINIS			1				1	1				1							1					5
PHERUSA SPP.																		1					1	2
PHOLOE MINUTA	13	3	3	20	3	6	5	5	5	9	11	27	15	10	9	10	6	5	3	2	1	2	2	175
PHYLLODOCE MACULATA																			1					1
PHYLLODOCE MUCOSA	35	2	2	3	1	1		2	3	1	1			12	3	2		24	17	18	57	58	42	284
PHYLLODOCE SPP.	7	4		1			3								1	1								17
PHYLLODOCIDAE SPP.																			2					2

Raw infaunal abundance data for samples collected from the Mass Bay Midfield in August 1996.

MASS BAY - AUGUST 1996 MIDFIELD	MF2	MF4	MF5	MF7	MF8	MF9	MF10	MF12-1	MF12-2	MF12-3	MF16	MF20	MF21	MF22	FF10-1	FF10-2	FF10-3	FF12-1	FF12-2	FF12-3	FF13-1	FF13-2	FF13-3	Total
PIONOSYLLIS SP. A			3			1								1										5
POLYCIRRUS SPP.		6			1		3			9	1	3	6	7							4		3	43
POLYGORDIUS SP. A	24	3	2	2					2	1				2	5		1	2	3	1		1		49
PRAXILLELLA GRACILIS								2						1	1	1								5
PRAXILLELLA PRAETERMISSA															1	2	2		1					6
PRIONOSPIO STEENSTRUPI	556	6	322	276	261	224	228	114	96	126	94	765	75	90	300	352	353	474	388	519	635	411	431	7096
RHODINE LOVENI			5		1			3	1	2						1		2						15
SABELLIDAE SPP.	2	3		1	2	2	4	1		9		6		8	10	5	1							54
SCALIBREGMA INFLATUM			2	12	3	10	6	12	11	22	13	4	8	22	8	6	2	2	1	3				147
SCOLETOMA FRAGILIS	1		1			1			1	2	1	3	4	2			1							17
SCOLETOMA HEBES	4									1	3	15			81	41	26	182	45	166	71	29	53	717
SCOLOPLOS ACMECEPS	5	1																						6
SCOLOPLOS ARMIGER				1																				1
SPHAERODORIDIUM SP. A	2	1	4	5	1	1	1	1	5	5		7	1	7	2	2	1	2			2		2	52
SPHAEROSYLLIS LONGICAUDA			5	1			1		1			1												9
SPIO FILICORNIS										1		2						1	4	6	1	1		16
SPIO LIMICOLA	178	1	20	198	19	142	276	351	290	504	151	84	244	499	323	242	188	40	34	53	1	6		3844
SPIO THULINI		1																						1
SPIOCHAETOPTERUS OCULATUS											1													1
SPIONIDAE SPP.												3			1	1			1		2			8
SPIOPHANES BOMBYX	62	8		2	3					1	1	1		1	8	24	18	54	49	42	8	2	16	300
STERNASPIS SCUTATA										1														1
SYLLIDES JAPONICA														1										1
SYLLIDES LONGOCIRRATA			5						1															6
TEREBELLIDAE SPP.						3				2						1		3				1		10
TEREBELLIDES ATLANTIS			1				2				3			3										9
TEREBELLIDES SPP.	1									2					2	1								6
TEREBELLIDES STROEMI								1	1															2
THARYX ACUTUS	100	12	35	23	3	45	69	37	36	40	91	195	30	166	187	27	36	653	430	487	115	104	162	3083
TROCHOCHAETA SPP.						2	2	3	10	6	11	1	2	11	1	1		1		3	6	2	4	66
TYPOSYLLIS SP. 1 (BLAKE 1992)																1								1
OLIGOCHAETA																								
ADELODRILUS SP. 1		2																						2
ENCHYTRAEIDAE SP. 1		3																						3
OLIGOCHAETA SPP.												1											1	2
TUBIFICIDAE SP. 2 (BLAKE 1992)					12	8	2	7	4	3	68	108	24	10	60	27	8		4		23	6	11	385
TUBIFICOIDES APECTINATUS					3			3	1	1		1	6	7	3			5	2	4	10	8	5	59
TUBIFICOIDES SPP.	1																							1
GASTROPODA																								
CREPIDULA FORNICATA	1			2					2			1										1	3	10
CYLICHNA ALBA				1																				1
DIAPHANA MINUTA			1	1			2					1		1	2			1			1		1	11
EUSPIRA HEROS		1												1										2
GASTROPODA SPP.		3	1								1		1		2						2	1		11
ILYANASSA TRIVITTATA			3												1	2	1		1				1	9
ODOSTOMIA SULCOSA		1																						1
OENOPOTA INCISULA	1		1						1						1									4
ONOBA MIGHELSI			2								1				1									4
ONOBA PELAGICA			8		1	4				2					3	6	7							31
PROPEBELA EXARATA			2																					2
RETUSA OBTUSA																				1				1
POLYPLACOPHORA																								
POLYPLACOPHORA SPP.												1												1
BIVALVIA																								
ARCTICA ISLANDICA	10					1			1		14	4	1		27	8	7	17	8	13			1	112
ASTARTE UNDATA	2	3	7	7	1	7		2		2	9	15	1	6	29	12	16				1			120

Raw infaunal abundance data for samples collected from the Mass Bay Midfield in August 1996.

MASS BAY - AUGUST 1996 MIDFIELD	MF2	MF4	MF5	MF7	MF8	MF9	MF10	MF12-1	MF12-2	MF12-3	MF16	MF20	MF21	MF22	FF10-1	FF10-2	FF10-3	FF12-1	FF12-2	FF12-3	FF13-1	FF13-2	FF13-3	Total
BIVALVIA SPP.		2	2		1	2			1		1		1		4	1		2	1	4			2	24
CERASTODERMA PINNULATUM	9	127	12	4	2	2	5	1	1			7	1		7	6		46	15	10	8	3	16	282
CRENELLA DECUSSATA	5		80	14	2	8	1	4	2	4	11	8	8	1	28	6	19							201
CRENELLA GLANDULA		4										2												6
CYCLOCARDIA BOREALIS		1		1					1															3
ENSIS DIRECTUS	4	10			1		4				1	3						19	5		6	1	8	62
HIATELLA ARCTICA	9	131	5	4		3		2		1		2			2	2	1	12	13	11	8	1	45	252
LYONSIA ARENOSA															4	2	3							9
LYONSIA SPP.											1	2				1		1						5
MUSCULUS DISCORS	2																							2
MUSCULUS SPP.																		1		3				4
MYA ARENARIA	1			2		1		1	3	8		1	5	1			1	1					1	26
MYTILIDAE SPP.	2	33	4		1	1							1	1	4									47
MYTILUS EDULIS											2							2		1	11	7	12	35
NUCULA DELPHINODONTA	72		86	39	5	60	2	48	39	29	19	24	48	59	129	94	159		2	1				915
NUCULA SPP.																					2		1	3
NUCULOMA TENUIS			6	2				2		4	4	2	5	6	2		1							34
PANDORA NR. INFLATA											1													1
PERIPLOMA PAPYRATEUM	1		2	1		15	3	7	14	8	1	4	3	8	2	1	3	4						77
PITAR MORRHUANA	1															1		2					2	6
PYTHINELLA CUNEATA	3			1		2											2		1	2	4	3		18
THRACIA CONRADI	1							1					2		4		2	4	1	2		1		18
THRACIIDAE SPP.															2	1								3
THYASIRA GOULDII	1		44	7		10	1	1					1	1	5	4	15	1	1					92
THYASIRA SPP.	6														1		1	1		1				10
YOLDIA SAPOTILLA	3		2	12	2	5		4	11	7	5	2	6	4	2	2	4	1	1	1				74
SCAPHOPODA																								
DENTALIUM ENTALE						4	1	3	1	2			2	2										15
CUMACEA																								
CAMPYLASPIS RUBICUNDA				2			3	2	1			1		1		1	1	1						13
DIASTYLIS CORNUIFER						1				1														2
DIASTYLIS POLITA												1				1		1			2	2	18	25
DIASTYLIS QUADRISPINOSA			1												3		1							5
DIASTYLIS SCULPTA										1		5						1		2	7	8	101	125
DIASTYLIS SPP.		12	2							1											2		12	29
EUDORELLA PUSILLA			2												1									3
LAMPROPS QUADRIPLICATA																		1						1
PETALOSARSIA DECLIVIS		1	1								1	1				1								5
TANAIDACEA																								
TANAISSUS PSAMMOPHILUS		10																						10
ISOPODA																								
CHIRIDOTEA TUFTSI		1																						1
EDOTIA MONTOSA	3	2		6		4	2				4	49		1	24	33	1	9	3	2	16		9	168
MUNNA SP. 1				1																				1
PLEUROGONIUM INERME			3	4						1		1			7						4	6	21	47
PLEUROGONIUM RUBICUNDUM	5		1	13		4	10	8	2	19	1	7	1	3	16	12	5	4		1	62	30	109	313
PLEUROGONIUM SPP.	5		2			9	2	1	3		3	2	1	4		4		2	2	4	25	12	16	97
POLITOLANA POLITA		4																						4
PTILANTHURA TENUIS			3	5									2		5	7	11							33
AMPHIPODA																								
AEGININA LONGICORNIS			1																					1
AMPELISCA ABDITA	2																	2			162	152	127	445
AMPELISCA MACROCEPHALA	2	2	4	4		5	1									3	4							25
AMPHIPODA SPP.	1								1															2
ANONYX LILLJEBORGI				1																				1
ARGISSA HAMATIPES		1	1	3		3	2	2			5	16		2	3	8	3	12	5	4	21	8	29	128

Raw infaunal abundance data for samples collected from the Mass Bay Midfield in August 1996.

MASS BAY - AUGUST 1996 MIDFIELD	MF2	MF4	MF5	MF7	MF8	MF9	MF10	MF12-1	MF12-2	MF12-3	MF16	MF20	MF21	MF22	FF10-1	FF10-2	FF10-3	FF12-1	FF12-2	FF12-3	FF13-1	FF13-2	FF13-3	Total
CAPRELLIDAE SPP.			16																					16
CASCO BIGELOWI						1	2				2					1	1							7
COROPHIIDAE SPP.		13											1											14
CRASSICOROPHIUM CRASSICORNE		944								1							1							946
DEFLEXILODES INTERMEDIUS			2		3	3	6	4	3		1		1	1										24
DEFLEXILODES TESSELATUS													1											1
DEFLEXILODES TUBERCULATUS								1				2				1		1				1		6
DULICHIA FALCATA			1												1									2
DYOPEDOS MONACANTHUS	1		1							2								9		3	75	10	79	180
ERICTHONIUS RUBRICORNIS		2	10																					12
GAMMARELLUS ANGULOSUS						1			2	2														5
GAMMARUS SPP.									1															1
GITANOPSIS ARCTICA			2																					2
HAPLOOPS FUNDIENSIS			54	7												2	7							70
HARPINIA PROPINQUA			12	1		2										6	10							31
HIPPOMEDON PROPINQUUS				1	1		1						1											4
HIPPOMEDON SERRATUS		1																						1
ISCHYROCERUS ANGUIPES																					1		3	4
JASSA MARMORATA											1								1					2
LEPTOCHEIRUS PINGUIS		2	6				1						38									1	1	49
MAYERELLA LIMICOLA				10		1		10	14	18			8											61
MELITA NR. DENTATA											1													1
METOPELLA ANGUSTA	5	5	13	19	2	9	23	35	9	62	17	17	2	24	19		5	66	1	14	13	12	48	420
MONOCOROPHIUM ACHERUSICUM							1						1											2
MONOCOROPHIUM INSIDIOSUM												1												1
MONOCULODES SP. 1	2	1					2					3					2							10
MONOCULODES SPP.										4					2		1	1					1	9
ORCHOMENELLA MINUTA			1									3	1		12			1			2	11	4	35
PARADULICHIA TYPICA				1											1		1							3
PHOTIS POLLEX	12	16	2	4	1	4	3		1	5	2	8			7	19	4	2	2	2	192	56	321	663
PROTOMEDEIA FASCIATA		24	1								1	1		1										28
STENOPLEUSTES INERMIS		1	4	2	1	5			4	16	1	1		4	2	2	5	2		4				54
SYRRHOE CRENULATA		3	2										1											6
UNCIOLA INERMIS		13	11																					24
UNCIOLA IRRORATA		1																			3	6	8	18
WESTWOODILLA BREVICALCAR		3	2	1								2		1										9
DECAPODA																								
CANCER BOREALIS	7	1	1			1		2					1				1		7		2	1	1	25
PAGURUS ACADIANUS														1										1
SIPUNCULA																								
PHASCOLION STROMBI			1														2							3
SIPUNCULA SPP.						2		2	1	1						6								12
PRIAPULIDA																								
PRIAPULUS CAUDATUS			1																					1
PHORONIDA																								
PHORONIS ARCHITECTA	82	1	9	22	2	9	5	6	32	53	5	27		27	5	57	23	56	65	113	143	290	232	1264
ECHINODERMATA																								
ASTEROIDEA SPP.							1				1							1			3		1	7
ECHINARACHNIUS PARMA		9																						9
ECHINOIDEA SPP.					1																			1
OPHIURA SP. A							2																	2
OPHIUROIDEA SPP.	1	9	2	6	3	3	8	10	4	3	6	5	7	6	5	2		1			1	2	1	85
HEMICHORDATA																								
STEREOBALANUS CANADENSIS				1				1	3															5
CHORDATA																								
MOLGULA SPP.															1			3		1			1	6

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MASS BAY - AUGUST 1996 FARFIELD	FF1A-1	FF1A-2	FF1A-3	FF4-1	FF4-2	FF4-3	FF5-1	FF5-2	FF5-3	FF6-1	FF6-2	FF6-3	FF7-1	FF7-2	FF7-3	FF9-1	FF9-2	FF9-3	FF11-1	FF11-2	FF11-3	FF14-1	FF14-2	FF14-3	Total
TOTAL/REPLICATE	2088	2421	2190	554	488	532	625	659	1098	1158	944	1183	1585	1926	1374	1940	3059	2583	1544	1216	2434	634	1091	1177	34503
TOTAL/STATION		6699			1574			2382			3285			4885			7582			5194			2902		
TAXON																									
CNIDARIA																									
ACTINIARIA SPP.								3			1		3		1	2	2	1							13
EDWARDSIA ELEGANS	31	48	26				1									3	1						2		112
PLATYHELMINTHES																									
TURBELLARIA SPP.																								1	1
NEMERTEA																									
AMPHIPORUS ANGULATUS																		1		1					2
AMPHIPORUS GROENLANDICUS								1		1															2
AMPHIPORUS SPP.		1							2							1						1			5
CARINOMELLA LACTEA		2		1				3	1				2	2	3				1			1	3	1	20
CEPHALOTHRICIDAE SP. 1	4	1	3	2	2	5	10	8	16			1	1	2		7	4	8	1	1		5	9	7	97
CEREBRATULUS LACTEUS										3		1		1	2				1						8
LINEUS PALLIDUS														2											2
MICRURA SPP.	2	9	4	1	3	2		2	1	5	3	8	7	7	7	5	12	4	2	1	8	3	6		102
NEMERTEA SP. 5		9	3	17	10	19	6	5	20		6	5	5	5	2	19	13	27	4		10	3	21	13	222
NEMERTEA SPP.						1				3	5	3	2	3			3	1	1	1	1	3	9	3	39
TETRASTEMMA VITTATUM																			5		9		7		21
TUBULANUS PELLUCIDUS				3	3	1																			7
POLYCHAETA																									
AMPHARETE ACUTIFRONS	1	1	4		1			11	3				1	3		1	1	3							30
AMPHARETE FINMARCHICA														1		1		2							4
AMPHARETIDAE SPP.	19	30	14	5	14	10	25	8	35	3	18	17	11	1	11		102	55	1	1	6	21	5	8	420
ANOBOTHRUS GRACILIS	7	11	3	9	11	9	37	8	73	4	1	5	3	2		5	1	4	12	3	18	2	35	25	288
APHELOCHAETA MARIONI	4	3	12	3						9	12	7	2	1		16	7	22	1	1		5	8	19	132
APHRODITA SPP.	1																								1
APISTOBRANCHUS TYPICUS	10	7	31	1	2		7	5	12	3	1	6	47	9	19	3	1	1					4	6	175
ARICIDEA CATHERINAE	21	25	23							62	16	11	43	99	68										368
ARICIDEA MINUTA										4	5	5				1									15
ARICIDEA QUADRILOBATA	34	12	23	38	25	33	18	8	72	23	21	12	12	16	9	3	7	11	60	51	169	23	33	57	770
ASABELLIDES OCULATA	12	12	9					1	1								3	5					8		51
BRADA SPP.																3	3								6
BYLGIDES SARSI																			1			1			2
CAPITELLA CAPITATA COMPLEX	1	3						3	1							1	4	1	4	1	5		1		25
CAPITELLIDAE SPP.									1																1
CHAETOZONE SETOSA	4	1	4	71	43	62	15	14	38	3	4				2	18	7	13	35	31	49	63	121	208	806
CHAETOZONE VIVIPARA																								1	1
CHONE DUNERI																		1							1
CIRRATULIDAE SPP.			12	4																			4		20
CLYMENELLA TORQUATA											1														1
COSSURA LONGOCIRRATA				24	16	21	11	13	11	129	94	105	429	603	465	2		1	44	25	58	12	23	28	2114
DIPLOCIRRUS SPP.								1	2			2	4	2	2	1						1			15
DIPOLYDORA QUADRILOBATA			1							1			1												3
DIPOLYDORA SOCIALIS	5	4	7			1	1	10	48	12	6	14	6		1	81	123	117	2		3	1	1	2	445
DYSPONETUS PYGMAEUS							1		1										2	2					6
ENIPO GRACILIS																				1					1
ENIPO TORELLI			1																						1
ETEONE LONGA	13	7	8		1	2	2	2		10	2	10		8	1	6	7	3	2	2	11	2	1	4	104
ETEONE SPP.			1																				1		2
EUCHONE INCOLOR	13	17	32	18	15	23	16	10	41	11	12	5	48	110	69	10	64	28	19	5	65	14	25	23	693
EUCLYMENINAE SPP.	2	1			1	1	1		2	1			1			3	1	1	2	1	1	2		4	25
EXOGONE HEBES	1		2													41	25	29							98
EXOGONE VERUGERA	1		1													30	38	21				1		2	94

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MASS BAY - AUGUST 1996 FARFIELD	FF1A-1	FF1A-2	FF1A-3	FF4-1	FF4-2	FF4-3	FF5-1	FF5-2	FF5-3	FF6-1	FF6-2	FF6-3	FF7-1	FF7-2	FF7-3	FF9-1	FF9-2	FF9-3	FF11-1	FF11-2	FF11-3	FF14-1	FF14-2	FF14-3	Total
FLABELLIGERIDAE SPP.										3	2	3	1		5							1			15
GALATHOWENIA OCULATA	1	4	1	1	4		2	9	6	3	5	1	1	1	1	1	3		18	2	7	15	14	19	119
GATTYANA AMONDSENI	1		5					2	1			2				4	3					1			19
GLYCERIDAE SPP.																		1							1
GONIADA MACULATA			5		1	1	1									2								1	11
GONIADIDAE SPP.	1		1		1													2	1						6
HARMOTHOINAE SPP.	1	2		1	1		1	1		1	5	6	2	1	1		2	3	2	4			1		35
HARTMANIA MOOREI							1		2					1					1				1	3	9
HETEROMASTUS FILIFORMIS					3			1	1											4	4	12	18	32	75
LANASSA VENUSTA VENUSTA										3															3
LAONICE CIRRATA	1		1											1						1					4
LAONOME KROEYERI								3									6	2	1		1	1	1		15
LEITOSCOLOPLOS ACUTUS	1	12	2		1	2	10	3	2							4	4	8	3	10	9	7	15	16	109
LEVINSENIA GRACILIS	43	35	39	21	39	43	24	53	53	42	28	21	10	9	15	54	48	38	78	303	59	49	58	61	1223
LUMBRINERIDAE SPP.			2			1	2		2		2	1	6	4		2	4								26
MALDANE SARSI	12	5	2													3	3	1	2	4		2	2	2	38
MALDANIDAE SPP.								1								13	28	14							56
MEDIOMASTUS CALIFORNIENSIS	50	53	78	55	70	41	55	104	65	125	72	115	158	218	116	75	88	56	23	21	56	27	48	61	1830
MELINNA CRISTATA				1																			1		2
MONTICELLINA BAPTISTEAE	1				1			1		3	3	3					1								13
MONTICELLINA DORSOBRANCHIALIS		1	1	1																					3
MYRIOCHELE HEERI																		1					1	2	4
MYSTIDES BOREALIS							2			2	1	2	1	3	1										12
NEPHTYIDAE SPP.	33	23	24	6	2	6	1	10	8	12	12	10	27	27	30		2	5	19	9	11	14	11		302
NEPHTYS INCISA		2			3	6	2	1	3		4	3	3	6	2	2	6	4	2	2	1	2	4	4	62
NEREIDIDAE SPP.			1																						1
NEREIS GRAYI	2	1					1									6	19	10							39
NINOE NIGRIPES	47	68	37	15	4	7	11	19	11	97	53	58	65	80	70	26	53	22	8	8	10	2	4	6	781
OPHELINA ACUMINATA	1	2						1									3	1	2	1					11
OPHRYOTROCHA CF. LABRONICA				1													1								2
OPHRYOTROCHA SP. 1					2	1											1		1	2		1	1	4	13
ORBINIIDAE SPP.	1	1	1	8	10	2	3	7	8							2	9	4	1						57
OWENIA FUSIFORMIS	1	6	11																						18
PARAMPHINOME JEFFREYSII				1	1	3																2			7
PARANAITIS SPECIOSA												2													2
PAROUGIA CAECA	1	4	3	7		5	4	4	3	8	3		13	8	3	7	10	3	10	5	18	2	5	2	128
PECTINARIA SPP.			1																						1
PHERUSA SPP.																	1								1
PHOLOE MINUTA	19	10	13						2	3	3	5	8	7	6	6	8	14	7	3	17		2	2	135
PHYLLODOCE MUCOSA	7	4	1				1	2	1	1						3		7							27
PHYLLODOCE SPP.	3	3	4					2				1				3	4	2				1			23
PHYLLODOCIDAE SPP.											1						1								2
POLYCIRRUS CF. HAEMATODES																	1								1
POLYCIRRUS MEDUSA				1																					1
POLYCIRRUS SPP.		1					1	1			1		3	2	1										10
POLYDORA SPP.										1													1		2
POLYDORA WEBSTERI																	3	6							9
POLYGORDIUS SP. A		2	9					7								1	3								22
PRAXILLELLA GRACILIS												1							1	1	2	1	1	1	8
PRAXILLELLA PRAETERMISSA	14	16	3					1	3	1						3		1	1	1	1				45
PRAXILLURA ORNATA																1	5	2							8
PRIONOSPIO STEENSTRUPI	1196	1281	1294	86	65	110	130	135	236	7	6	1	35	48	29	1026	1794	1271	741	516	1422	79	174	198	11880
PROCLEA GRAFFII										4	1						1								6
RHODINE LOVENI										3	1	1				2	2	2							11
SABELLIDAE SPP.		8	6	2										4			2	1	2				1	1	27

Raw infaunal abundance data for samples collected from the Mass Bay Farfield in August 1996.

MASS BAY - AUGUST 1996 FARFIELD	FF1A-1	FF1A-2	FF1A-3	FF4-1	FF4-2	FF4-3	FF5-1	FF5-2	FF5-3	FF6-1	FF6-2	FF6-3	FF7-1	FF7-2	FF7-3	FF9-1	FF9-2	FF9-3	FF11-1	FF11-2	FF11-3	FF14-1	FF14-2	FF14-3	Total
SCALIBREGMA INFLATUM		2	5	5	3	10	1	8	3	1	1	1	6	3	1	21	27	80			1	5	5	3	192
SCOLETOMA FRAGILIS		1	3	1		1			2	2		4	3	4			1	2	1		1				26
SCOLETOMA HEBES										1								2							3
SCOLOPLOS ACMECEPS	1		1																						2
SCOLOPLOS ARMIGER																2	6								8
SPHAERODORIDIUM SP. A	1	2	1							1	1	1	4	1	2	1	1	1							17
SPHAERODOROPSIS MINUTA																3	1	2	1						7
SPHAEROSYLLIS LONGICAUDA												5					1								6
SPIO LIMICOLA	52	16	21				21	27	36	65	48	67	76	97	57	188	234	359	30	12	104	11	25	20	1566
SPIOPHANES BOMBYX	10	13	6																						29
SPIOPHANES KROEYERI																			1						1
STERNASPIS SCUTATA			1	1	1		8					3	2	2	1				25	4	15	30	58	60	211
SYLLIDES JAPONICA				2	1	1				3			3												10
SYLLIDES LONGOCIRRATA				2	1	5	1		1	4			28	32	18				2		2		1	5	102
TEREBELLIDAE SPP.						1					1				2			1							5
TEREBELLIDES ATLANTIS		1	1				3	1		68	40	69	48	87	35		1				2		2		358
TEREBELLIDES SPP.				1	2		9		1	28	22	26	14	5	10	2		4							124
TEREBELLIDES STROEMI							2														1				3
THARYX ACUTUS	66	117	70							93	166	84	106	172	56								3	2	935
TROCHOCHAETA CARICA					1	5													1				1		8
TROCHOCHAETA SPP.		1		2	9	4	4	1	5	1	1		1			4	2	3	2	1	2	4	4	2	53
TYPOSYLLIS SP. 1 (BLAKE 1992)																1									1
OLIGOCHAETA																									
TUBIFICIDAE SP. 2 (BLAKE 1992)										23	17	81	118	70	118										427
TUBIFICOIDES APECTINATUS			1	26	20	16	2	4	2	1	2								120	86	188	34	41	81	624
GASTROPODA																									
ACTEOCINA CANALICULATA									1				1												2
COLUS PYGMAEUS		1	2													1	2	1							7
CREPIDULA FORNICATA			3									2					1					3	1		10
CYLICHNA ALBA												1													1
CYLICHNA GOULDI				1				4	2				1						1			5	14	4	32
DIAPHANA MINUTA		2								1		1			2								1		7
DORIDELLA SPP.																								1	1
GASTROPODA SPP.	1	7	2						1	2		23				1									37
ILYANASSA TRIVITTATA	1	3																							4
OENOPOTA INCISULA		1			1				2						1				1				1		7
ONOBA PELAGICA					1		10	11	12	38	52	78	9	13	19				5	1	2	10	26	18	305
PROPEBELA EXARATA																		2							2
PUSILLINA HARPA										2		3	1	1	2			1							10
RETUSA OBTUSA															1						1				2
APLACOPHORA																									
CHAETODERMA NITIDULUM CANADENSE	1		1		1		1										1			1		1	1	1	9
BIVALVIA																									
ARCTICA ISLANDICA	10	8	10										1												29
ASTARTE UNDATA	8	10	3						1							8	4	8	2						44
BIVALVIA SPP.		2			1				1	3			3		1	1	4						1		17
CERASTODERMA PINNULATUM	14	99	36		1								1			18	7	12			2				190
CRENELLA DECUSSATA	14	29	17					1			1	1	4				1	2				4	4	1	79
CYCLOCARDIA BOREALIS																1									1
HIATELLA ARCTICA	2	2	8		1				1							1	2	1					1		19
LYONSIA ARENOSA										1															1
LYONSIA SPP.	3	1									1														5
MACOMA BALTHICA																	1								1
MEGAYOLDIA THRACIAEFORMIS				4		4	1	1											3	2	3	3	1	3	25
MUSCULUS DISCORS																1									1

Raw infaunal abundance data for samples collected from the Mass Bay Farfield in August 1996.

MASS BAY - AUGUST 1996 FARFIELD	FF1A-1	FF1A-2	FF1A-3	FF4-1	FF4-2	FF4-3	FF5-1	FF5-2	FF5-3	FF6-1	FF6-2	FF6-3	FF7-1	FF7-2	FF7-3	FF9-1	FF9-2	FF9-3	FF11-1	FF11-2	FF11-3	FF14-1	FF14-2	FF14-3	Total
MUSCULUS SPP.																					1				1
MYA ARENARIA												1		1					1	2		1		1	7
MYTILIDAE SPP.		1														1	2								4
MYTILUS EDULIS																			1		1		1		3
NUCULA ANNULATA										12	4	6	7	15	2										46
NUCULA DELPHINODONTA	89	177	95				16	5	22	43	32	40	27	34	20	16	24	24	7	1	3	10	19	16	720
NUCULA SPP.										3	4		10				5	1	1			9	22		55
NUCULANA NR. MESSANENSIS																			1						1
NUCULOMA TENUIS	1	3	3	9	9	5	1	3	2							1	4	4	11		8	19	14	34	131
PERIPLOMA PAPYRATEUM	14	9	9		7		18	10	27	4	4	1		1		3	2	4		1		9	7	3	133
PYTHINELLA CUNEATA					1				1				3		1	7	8	2					1		24
SILIQUA COSTATA			1																						1
THRACIA CONRADI	1														1										2
THRACIIDAE SPP.																							1		1
THYASIRA GOULDI	32	11	19	13	21	16	18	15	29	15	14	25	17	8	11	22	11	23	6	4	10	25	32	34	431
THYASIRA NR. MINUTUS						1													5	1					7
THYASIRA SPP.																		1							1
YOLDIA SAPOTILLA	15	4	3	35	26	21	38	17	69	4	11	5	19	18	8	17	16	30	14		3	16	12	8	409
YOLDIELLA LUCIDA												1							1			1			3
SCAPHOPODA																									
DENTALIUM ENTALE				19	6	9	13	8	4					1		3	3	1				11	12	2	92
CIRRIPEDIA																									
BALANUS SPP.									1																1
MYSIDACEA																									
ERYTHROPS ERYTHROPHTHALMA					1		1	2		4	2	6		3	3			1	5	2				4	34
NEOMYSIS AMERICANA															3										3
CUMACEA																									
CAMPYLASPIS NR. SULCATA										3	1		1	1											6
CAMPYLASPIS RUBICUNDA									1													1	3		5
DIASTYLIS CORNUIFER							1	1	1	2	1	1	4	3									1	2	17
DIASTYLIS QUADRISPINOSA																	1	1							2
DIASTYLIS SPP.	7	8	4							1															20
EUDORELLA HISPIDA						1	5	5	3	4	4	9		1	1				6	7	1	5	3	4	59
EUDORELLA PUSILLA	5	2	3	1			1	1		10	8	1	14	3	7	2	5	4							67
EUDORELLA SPP.						1				4	4	1	25	2	1				2	1					41
LEPTOSTYLIS AMPULLACEA							4	5	3	14	2			3											31
LEPTOSTYLIS LONGIMANA								2		4	7	9	3		1	1	1				1			1	30
LEPTOSTYLIS SPP.											5	5			1	1	1	5				1	1		20
LEUCON ACUTIROSTRIS				5	2	2	1					1							1				2	4	18
LEUCON FULVUS								6	2												1				9
PETALOSARSIA DECLIVIS	3	8	3																						14
ISOPODA																									
EDOTIA MONTOSA	23	12	4				1		1				1			1	4	1							48
MUNNA SP. 1																		2							2
PLEUROGONIUM INERME	1	1	1				4			1		2	2	2	2										16
PLEUROGONIUM RUBICUNDUM		5		1				5	18	1		1	6	3	1	1	2	1	5	2	4	2	12	5	75
PLEUROGONIUM SPINOSISSIMUM																	2	1							3
PLEUROGONIUM SPP.	3	10			1					5	4	5		1		6	4	5	2		1		4		51
PTILANTHURA TENUIS	4	15	13														1								33
AMPHIPODA																									
AMPELISCA ABDITA																					1				1
AMPELISCA MACROCEPHALA	3	6	6													1	3	1							20
ANONYX LILLJEBORGI																		1							1
ARGISSA HAMATIPES	5	3		1						2	1	2	3	3	2	4	3	1							30
BATHYMEDON OBTUSIFRONS				2			2	3												2	2	2		1	14

Raw infaunal abundance data for samples collected from the Mass Bay Farfield in August 1996.

MASS BAY - AUGUST 1996 FARFIELD	FF1A-1	FF1A-2	FF1A-3	FF4-1	FF4-2	FF4-3	FF5-1	FF5-2	FF5-3	FF6-1	FF6-2	FF6-3	FF7-1	FF7-2	FF7-3	FF9-1	FF9-2	FF9-3	FF11-1	FF11-2	FF11-3	FF14-1	FF14-2	FF14-3	Total
BYBLIS NR. GAIMARDI				1				1	1							1	3						1		8
CAPRELLIDAE SPP.											2	2		1			1								6
CASCO BIGELOWI			1														3								4
COROPHIIDAE SPP.																					1		1		2
CRASSICOROPHIUM CRASSICORNE					6	1													1						8
DEFLEXILODES INTERMEDIUS			2					2	3	4	2	7	1	2	4									1	28
DEFLEXILODES TESSELATUS										1													1		2
DYOPEDOS MONACANTHUS													3		1										4
ERICTHONIUS RUBRICORNIS									1									1							2
HAPLOOPS FUNDIENSIS	1	1	2	2	1		3	1	5	1		1				9	11	11				1			50
HARPINIA PROPINQUA	27	18	29	2	2	2	6	6	22	7	8	27			1	33	29	43	33	25	19	2	7	5	353
HIPPOMEDON PROPINQUUS										1												1	2		4
ISCHYROCERUS ANGUIPES																	1	1							2
LEPTOCHEIRUS PINGUIS												71					1								72
MELITA NR. DENTATA								1																	1
METOPELLA ANGUSTA	8	5	2	1		1	6	4	7	18	26	9	9	10	11	7	10	21	7	8	4	2	16	11	203
MONOCULODES PACKARDI						1			1														3	4	9
MONOCULODES SP. 1	7	14	3				1	1		1	2	1		1									2		33
MONOCULODES SPP.															2	2	7	8	8	5			2		34
ORCHOMENELLA MINUTA			1							15		2	3												21
PARACAPRELLA TENUIS			1																						1
PARADULICHIA TYPICA									1							1		1							3
PHOTIS POLLEX	10	6	3	3	1		1		1	10	8	9	10	2	4	3	3	6	4			3	1		88
PROBOLOIDES HOLMESI							2																		2
PROTOMEDEIA FASCIATA	1	6	3															4							14
STENOPLEUSTES INERMIS	6	4								2	2	1	11	15	6	3		6							56
SYRRHOE CRENULATA	1																								1
UNCIOLA INERMIS		4																							4
UNCIOLA IRRORATA																2	1	1							4
UNCIOLA SPP.		1						1									1	1							4
WESTWOODILLA BREVICALCAR	1																								1
SIPUNCULA																									
PHASCOLION STROMBI		1	1					1	1							2		5							11
SIPUNCULA SPP.						1		4			1		1		1	2	4	9	23	2	1	3	5	4	61
ECHIURA																									
ECHIURUS ECHIURUS																						1			1
PRIAPULIDA																									
PRIAPULUS CAUDATUS																							3		3
PHORONIDA																									
PHORONIS ARCHITECTA	4	10	13				2	2	2	9	5	4			1	16	23	18							109
ECHINODERMATA																									
ASTEROIDEA SPP.	1		1									1					4	1							8
CTENODISCUS CRISPATUS								1	1													2	3		7
ECHINOIDEA SPP.					1				2									2							5
MOLPADIA OOLITICA									1																1
OPHIURA SARSI		1					1	1	2	5	8	7	10	2	8				6		2		1	2	56
OPHIURA SP. A				3	1	1													3				3		11
OPHIURA SPP.							10																		10
OPHIUROIDEA SPP.	3	4	1	7		2		2	2	4	8	16	2	4	1	7	6	6	70	20	11	14	10	3	203
HEMICHORDATA																									
STEREOBALANUS CANADENSIS	2				3	2	3		1				1	2	1	2		1	1	1	4				24
CHORDATA																									
ASCIDEACEA SPP.																		1							1
MOLGULA SPP.	3	5	2					1	1				1				4						1		18

Appendix G-3

1997 Infaunal Abundance

Nearfield, Midfield, and Farfield

Raw infaunal abundance data for samples collected from the Mass Bay Nearfield in August 1997.

NEARFIELD	NF13	NF14	NF15	NF17-1	NF17-2	NF17-3	NF18	NF19	NF23	NF24-1	NF24-2	NF24-3	Total
TOTAL/REPLICATE	1348	3473	3852	455	737	985	3058	2834	2801	2328	838	1176	23885
TOTAL/STATION	1348	3473	3852		2177		3058	2834	2801		4342		
TAXON													
CNIDARIA													
ACTINIARIA SP. 2									6				6
ACTINIARIA SPP.			1				1				1	2	5
CERIANTHEOPSIS AMERICANUS	2	1				1	4			3			11
CERIANTHIDAE SPP.		1											1
CERIANTHUS BOREALIS								3					3
EDWARDSIA ELEGANS		4	1				2	3	3		1		14
HYDROZOA SPP.			1										1
PLATYHELMINTHES													
TURBELLARIA SPP.					1								1
NEMERTEA													
AMPHIPORUS ANGULATUS		4	4				1			3	2	2	16
AMPHIPORUS SPP.	2												2
CEPHALOTHRICIDAE SP. 1	1						3	2	1	3	4	4	18
CEREBRATULUS LACTEUS										3			3
MICRURA SPP.			3				5	3	2	11	2	9	35
NEMERTEA SP. 2		4	1		1			5			4	1	16
NEMERTEA SP. 5	7												7
NEMERTEA SPP.	4	6	4			2		3	5	3	1		28
TETRASTEMMA SPP.					3	1			4				8
POLYCHAETA													
AGLAOPHAMUS CIRCINATA	49	50	2	11	17	16		59	51	2			257
AMPHARETE ACUTIFRONS		7	20				12	3	1	21	1	3	68
AMPHARETE FINMARCHICA		6	3	1			5		1				16
AMPHARETIDAE SPP.	1	7	13				15	1	1	16	3	2	59
APHELOCHAETA MARIONI		2	37				22	56	7	52	6	15	197
APISTOBRANCHUS SPP.								1	2	2		1	6
APISTOBRANCHUS TULLBERGI										1		2	3
APISTOBRANCHUS TYPICUS							3		2	1			6
ARICIDEA CATHERINAE	23	33	190	2	26	1	79	67	21	60	1	20	523
ARICIDEA MINUTA												1	1
ARICIDEA QUADRILOBATA										4	1	2	7
ASABELLIDES OCULATA	11	2		1	2	2	70		2	6	3	3	102
CAPITELLA CAPITATA COMPLEX			22				3	36		1	3	1	66
CHAETOZONE SETOSA	5	4		2	7	11			5				34
CHONE DUNERI						1	4	1	3				9
CIRRATULIDAE SPP.			1	5	9	25	8		1				49
CLYMENELLA TORQUATA			19										19
CLYMENURA SP. A					1	1	1						3
COSSURA LONGOCIRRATA				1								2	3
DIPOLYDORA CAULLERYI											3		3
DIPOLYDORA QUADRILOBATA		2						2	2				6
DIPOLYDORA SOCIALIS		246	363	1	1	3	46	633	295		8		1596
ENIPO TORELLI										1		1	2
ETEONE LONGA			3				7	2	2	6	3	2	25
EUCHONE ELEGANS		276							19				295
EUCHONE INCOLOR	1	4	117				15	67	16	57	4	39	320
EUCLYMENE COLLARIS	6	113	12	2	2	3	3		9				150
EUCLYMENINAE SPP.		8	10		4	4	1		3				30
EXOGONE HEBES	695	373	361	10	63	35	93	131	401	12	1	3	2178
EXOGONE LONGICIRRIS		2					1						3
EXOGONE VERUGERA	17	602	21	1	4	10	40	15	115		2	1	828

Raw infaunal abundance data for samples collected from the Mass Bay Nearfield in August 1997.

NEARFIELD	NF13	NF14	NF15	NF17-1	NF17-2	NF17-3	NF18	NF19	NF23	NF24-1	NF24-2	NF24-3	Total
GALATHOWENIA OCULATA	3		2	1	3	2			3				14
GATTYANA AMONDSENI			1							2	3		6
GATTYANA CIRROSA											1		1
GATTYANA SPP.								1					1
GLYCERA CAPITATA		2											2
GONIADA MACULATA			1				1		1				3
GONIADA SPP.										1			1
HARMOTHOE EXTENUATA			2				1	1					4
HARMOTHOINAE SPP.							3						3
LAONICE CIRRATA								1	1				2
LAONOME KROEYERI			3				1	9	5				18
LEITOSCOLOPLOS ACUTUS			27				7	13	1	30	5	28	111
LEITOSCOLOPLOS SP. B			3				2	7	2	2	1		17
LEVINSENIA GRACILIS		1	17				12	4	1	156	55	102	348
LUMBRINERIDAE SPP.							1					1	2
MALDANE SARSI										6			6
MALDANIDAE SPP.			3										3
MEDIOMASTUS CALIFORNIENSIS	2	47	139	3	1	1	202	81	31	288	27	98	920
MONTICELLINA BAPTISTEAE	1	1	6				8		1	1			18
MONTICELLINA DORSOBRANCHIALIS							7	1	6	33	4	16	67
MYSTIDES BOREALIS		1											1
NEPHTYIDAE SPP.			11	8	16	13	4	33	11	1	54	2	153
NEPHTYS CAECA					2	1		1	3				7
NEPHTYS CORNUTA	1			1									2
NEPHTYS INCISA		1	44				1	3		13	1	5	68
NEREIDIDAE SPP.									1				1
NEREIS GRAYI	1	3	9				3	4	1				21
NINOE NIGRIPES			99				120	32		114	12	53	430
OWENIA FUSIFORMIS			247		45		2	37	7	6			344
PARANAITIS SPECIOSA			3				3					1	7
PAROUGIA CAECA		1	3	1	1	2	9	8	1	5	3	8	42
PECTINARIA GRANULATA							3						3
PECTINARIA SPP.							4		1	1	4		10
PETALOPROCTUS TENUIS							1						1
PHERUSA SPP.	1						1					1	3
PHOLOE MINUTA			10				11	3		7	14	2	47
PHOLOE SPP.		2	4		1		4	1	1		7	2	22
PHOLOE TECTA		3	6				26	3	3	9	16	9	75
PHYLLODOCE ARENAE		8		2				1					11
PHYLLODOCE GROENLANDICA								1	1				2
PHYLLODOCE MACULATA		9	5				2	3	1				20
PHYLLODOCE MUCOSA	1	18	35			6	2	16	13	5	1	1	98
PHYLLODOCE SPP.		18	51	1	2		14	19	20				125
PIONOSYLLIS SP. A		1	1				44						46
POLYCIRRUS SPP.	3	3	5	2		2	5		3	1	2	2	28
POLYGORDIUS SP. A	7	2	5	10	11	10		23	4				72
PRIONOSPIO STEENSTRUPI	34	138	1073	6	14	11	877	713	909	950	492	479	5696
PYGOSPIO ELEGANS							1						1
SCALIBREGMA INFLATUM		2					2						4
SCOLETOMA FRAGILIS			4				3	1		4			12
SCOLOPLOS ACMECEPS			1		2		2	2		2			9
SCOLOPLOS ARMIGER				1				2	3				6
SCOLOPLOS SPP.			1			2							3
SPHAERODORIDIUM SP. A			2				1	2			1		6
SPHAEROSYLLIS BREVIFRONS		6		1		1							8

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NEARFIELD	NF13	NF14	NF15	NF17-1	NF17-2	NF17-3	NF18	NF19	NF23	NF24-1	NF24-2	NF24-3	Total
SPHAEROSYLLIS LONGICAUDA		1	2				4			1			8
SPIO LIMICOLA		10	60	2			20	259	17	175	21	102	666
SPIO SETOSA								2	3				5
SPIONIDAE SPP.			26						1				27
SPIOPHANES BOMBYX	59	1	69	175	102	150	4	30	36	1	1	1	629
STERNASPIS SCUTATA										2			2
SYLLIDES CONVOLUTA		1											1
SYLLIDES JAPONICA										1			1
TEREBELLIDAE SPP.						1							1
TEREBELLIDES ATLANTIS										2		1	3
TEREBELLIDES STROEMI									1				1
THARYX ACUTUS		171	74				37	37	33	138	2	65	557
TROCHOCHAETA MULTISETOSA		1	3				4		2	2	11		23
TYPOSYLLIS SP. 1		1					4		1				6
OLIGOCHAETA													
ADELODRILUS SP. 1	1	44							2				47
ENCHYTRAEIDAE SP. 1	97	266			2				47				412
TUBIFICIDAE SP. 2							4			15	1	4	24
TUBIFICIDAE SPP.		4	3			1							8
TUBIFICOIDES APECTINATUS			1					2					3
TUBIFICOIDES SP. 1							19			6	1	1	27
GASTROPODA													
CEPHALASPIDEA SPP.								1					1
CREPIDULA FORNICATA	1	1	5		1			3		1	3	2	17
DIAPHANA MINUTA						2	3				1		6
EUSPIRA HEROS						3		1					4
EUSPIRA IMMACULATA				1	1								2
GASTROPODA SPP.	1		4		12	35	5	2		2			61
ILYANASSA TRIVITTATA	1	3	6		2	2	3	3	4	1	3	4	32
LACUNA VINCTA	3				2					1	2	1	9
NATICIDAE SPP.					1								1
ODOSTOMIA GIBBOSA							1						1
OENOPOTA HARPULARIA							2						2
OENOPOTA INCISULA							1		1	1	2		5
ONOBA MIGHELSI							23						23
PROPEBALA EXARATA									1				1
PUSILLINA PSEUDOAREOLATA							1						1
SOLARIELLA OBSCURA				3	1	2			4				10
BIVALVIA													
ANOMIA SPP.							2						2
ANOMIA SQUAMULA							1						1
ARCTICA ISLANDICA	1	2	4			1	1	4	2				15
ASTARTE UNDATA	1	34	20	1	2	1	31	9	11	9	1		120
ASTHENOTHAERUS HEMPHILLI						1							1
BIVALVIA SPP.	1		2			11	8					1	23
CERASTODERMA PINNULATUM	120	129	16	41	82	69	140	47	55		2	1	702
CRENELLA DECUSSATA	31	91	41				48	2	16				229
CRENELLA GLANDULA	17	23			4	1	1		6				52
CRENELLA SPP.				1									1
CYCLOCARDIA BOREALIS		2						2	9	1			14
ENSIS DIRECTUS	3	1	2		3								9
HIATELLA ARCTICA	11	23	42	1	12	20	313	37	38	1	2	3	503
LYONSIA ARENOSA			5				5	4					14
MODIOLUS MODIOLUS							4						4
MUSCULUS DISCORS									1				1

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NEARFIELD	NF13	NF14	NF15	NF17-1	NF17-2	NF17-3	NF18	NF19	NF23	NF24-1	NF24-2	NF24-3	Total
MUSCULUS NIGER							1						1
MYA ARENARIA		2	2							1			5
MYTILIDAE SPP.	8	3	23	4	42	55	21	3	4	3	1		167
MYTILUS EDULIS			1							1			2
NUCULA DELPHINODONTA	5		36	1			20	101	19	8	3	4	197
NUCULOMA TENUIS										2		1	3
PECTINIDAE SPP.	2						11	1					14
PERIPLOMA PAPYRATIUM					1		1						2
PITAR MORRHUANA								1				1	2
PYTHINELLA CUNEATA		10	6			3		7	1				27
THRACIA CONRADI		1	1				2	4		1			9
THYASIRA GOULDII			3							1			4
YOLDIA SAPOTILLA								1		4	2	3	10
SCAPHOPODA													
DENTALIUM ENTALE										2			2
CIRRIPEDIA													
BALANUS CRENATUS							23						23
MYSIDACEA													
ERYTHROPS ERYTHROPHTHALMA			1										1
CUMACEA													
CAMPYLASPIS RUBICUNDA								1					1
DIASTYLIS CORNUIFER												1	1
DIASTYLIS SCULPTA	3	4		1	1	2	2		1				14
DIASTYLIS SPP.	5	7		4	6	4	9	1	14				50
EUDORELLA PUSILLA		4											4
EUDORELLA SPP.								1					1
EUDORELLOPSIS DEFORMIS					1								1
LAMPROPS QUADRIPLICATA	1												1
PETALOSARSIA DECLIVIS	10	9	5	2	6	9	8	3	7	2		6	67
TANAIDACEA													
TANAISSUS PSAMMOPHILUS	6	2		8	11	16			15				58
ISOPODA													
CHIRIDOTEA TUFTSI				17	9	49							75
EDOTIA MONTOSA	1	11	27		5	3	1	24		5		3	80
MUNNA SP. 1							50				4	2	56
PLEUROGONIUM INERME			2				9		1				12
PLEUROGONIUM RUBICUNDUM		10	32				18	5		3	4	4	76
PLEUROGONIUM SPINOSISSIMUM							10						10
PLEUROGONIUM SPP.			18				41	3			2		64
POLITOLANA POLITA	3			5	8	4			1				21
PTILANTHURA TENUIS	4		4		1	1			13	1			24
AMPHIPODA													
ACANTHOHAUSTORIUS MILLSI				8	1	5							14
AEGININA LONGICORNIS							1				1		2
AMPELISCA MACROCEPHALA	2				1								3
AMPHIPODA SPP.							2						2
ANONYX LILLJEBORGI								3					3
ARGISSA HAMATIPES	8	2	8	2	1	1	3	2	1	3	2	4	37
COROPHIIDAE SPP.							2	1			4	1	8
CRASSICOROPHIUM CRASSICORNE	43	135		17	44	76	2	1	66				384
DEFLEXILODES TUBERCULATUS							21						21
DULICHIA FALCATA							1			1	2		4
DYOPEDOS MONACANTHUS		7	85		2		63	2	4				163
ERICHTHONIUS RUBRICORNIS	1	28		2	2		11	2	18	2		1	67
GITANOPSIS ARCTICA							1						1

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NEARFIELD	NF13	NF14	NF15	NF17-1	NF17-2	NF17-3	NF18	NF19	NF23	NF24-1	NF24-2	NF24-3	Total
HARPINIA PROPINQUA			1				11		1				13
HIPPOMEDON PROPINQUUS				2	2	2							6
HIPPOMEDON SERRATUS									2				2
ISCHYROCERUS ANGUIPES							8						8
LEPTOCHEIRUS PINGUIS		2					4		1				7
MELITA NR. DENTATA							3				1		4
MELITA SP. 1							1						1
METOPELLA ANGUSTA	1	1	38				5	7	1	6		6	65
MONOCULODES PACKARDI						1							1
MONOCULODES SP. 1			2						2		1		5
ORCHOMENELLA MINUTA		5	1				4						10
PARADULICHIA TYPICA							3					1	4
PHOTIS POLLEX	5	46	55				9	10	8	1		1	135
PHOXOCEPHALIDAE SPP.		1											1
PHOXOCEPHALUS HOLBOLLI		2		1	4	3	1		1				12
PLEUSTES PANOPLUS									1				1
PLEUSTIDAE SPP.			2										2
PLEUSYMTES GLABER							2						2
PODOCERIDAE SPP.			2									1	3
PROTOMEDEIA FASCIATA	5	156	4	1	1		92	6	51		1		317
PSEUDUNCIOLA OBLIQUUA				60	91	258	1						410
RHEPOXYNIUS HUDSONI				10	4	1							15
STENOPLEUSTES INERMIS		5	10	1			1	3	7	1			28
SYRRHOE CRENULATA	1	3				2	3		1				10
UNCIOLA INERMIS		175			3	3	16		230				427
UNCIOLA IRRORATA		1		3	8	6							18
UNCIOLA SPP.							2						2
WESTWOODILLA BREVICALCAR	1	1	1	1			3		2				9
DECAPODA													
AXIUS SERRATUS							1						1
CANCER BOREALIS	1	2	2				2						7
CRANGON SEPTEMSPINOSA			1									1	2
SIPUNCULA													
PHASCOLION STROMBI			1					1	1				3
SIPUNCULA SPP.			1										1
PHORONIDA													
PHORONIS ARCHITECTA			48					59	1	4			112
ECHINODERMATA													
AXIOGNATHUS SQUAMATUS							1			5			6
ECHINARACHNIUS PARMA	1			6	16	12			13				48
ECHINOIDEA SPP.	1								1				2
HENRICIA SANGUINOLENTA							1						1
OPHIOTHRIX ANGULATA							4						4
OPHIUROIDEA SPP.	4	4	12				19	17		5		21	82
HEMICHORDATA													
STEREOBALANUS CANADENSIS										1			1
CHORDATA													
ASCIDIACEA SPP.						1							1
CNEMIDOCARPA MOLLIS												2	2
MOLGULA MANHATTENSIS		1				1			6				8
MOLGULA SPP.							4						4

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MASS BAY - AUGUST 1996 MIDFIELD	MF2	MF4	MF5	MF7	MF8	MF9	MF10	MF12-1	MF12-2	MF12-3	MF16	MF20	MF21	MF22	FF10-1	FF10-2	FF10-3	FF12-1	FF12-2	FF12-3	FF13-1	FF13-2	FF13-3	Total
TOTAL/REPLICATE	2074	3516	1712	812	2781	3168	4031	2593	3930	2929	2089	3460	1504	2363	1517	3217	3615	3970	4100	4126	4255	4834	3525	70121
TOTAL/STATION	2074	3516	1712	812	2781	3168	4031		9452		2089	3460	1504	2363		8349			12196			12614		
TAXON																								
CNIDARA																								
ACTINIARIA SP. 2	18	1							1						4	6	5	4	4	1	6	7	3	60
ACTINIARIA SPP.			2						1															3
CERIANTHEOPSIS AMERICANUS					4	4	2				2	2		1										15
CORYMORPHA PENDULA	4																							4
EDWARDSIA ELEGANS	14		1	1		4			1		1				2	2	1	3	1	1	8	8	2	50
HALCAMPA DUODECIMCIRRATA		1																						1
HYDROZOA SPP.						1				1					1									3
PLATYHELMINTHES																								
TURBELLARIA SPP.					1					1											1			3
NEMERTEA																								
AMPHIPORUS ANGULATUS		5		3	14	8	7	2	5	15	5	1	10	10		5	2	3		2	7	2		106
CARINOMELLA LACTEA					14	3	4	7	10	5	5	12	10	9	2	9	3	11	12	14				130
CEPHALOTHRICIDAE SP. 1	7	7	1		7	7	2	3	4	6	6	2	9	5	2	5	1	1	1			1	1	78
CEREBRATULUS LACTEUS					8	2	4	4			3	2	7	1		5		1		4	2			43
LINEUS PALLIDUS					1																			1
MICRURA SPP.		13	6		21	12	17	7	7	13	7	9	16	9	10	13	11	8	6	3	7	6	5	206
NEMERTEA SP. 2	21	2			4							5	6	1	2	6	3							50
NEMERTEA SP. 5										1						6	11	12	28	28	5	6		97
NEMERTEA SPP.	7		6		5	1	7	7	3	6		7	5	3		2		6		1	2		1	69
POLYCHAETA																								
AGLAOPHAMUS CIRCINATA	23			42				2										6	9	6	1	2		91
AMPHARETE ACUTIFRONS	2	219	30		4	169	5	7	5	2		3	15	14	11	26	114	3	3	8				640
AMPHARETE FINMARCHICA	1												1					1	2					5
AMPHARETE LINDSTROEMI						1									2	1	1							5
AMPHARETIDAE SPP.		33	30		7	18	199	26	74	124	1	2	22	32	42	7	25	2	3	1			1	649
ANOBOTHRUS GRACILIS			1													1								2
APHELOCHAETA MARIONI	3	111	115		7	131	177	193	379	125	37	21	35	189	34	48	30	16	7	4		1		1663
APHELOCHAETA MONILARIS															4	6								10
APISTOBRANCHUS SPP.		2				3	5	1	2	1		1	7											22
APISTOBRANCHUS TULLBERGI	1	4	1				3	4	2	5					1	1	4							26
APISTOBRANCHUS TYPICUS		1	3		1	1	9	1	4	1				1	2	2	1							27
ARCTEOBIA ANTICOSTIENSIS			2					2		1				2										7
ARICIDEA CATHERINAE	123		19	3	94	188	268	185	251	385		66	38	1	65	277	275	40	13	104	104	40	26	2565
ARICIDEA QUADRILOBATA		3	2		1	5	6	8	7	4	1		4	4	1	1	7							54
ASABELLIDES OCULATA	1	13	10		33						5	5			16	28	22	4	11	5		1	1	155
AUSTROLAENILLA MOLLIS												1												1
CAPITELLA CAPITATA COMPLEX	4	11	1		2		13	8	12	2	5	1	1	5			3	8	7	8	21	23	47	182
CHAETOZONE SETOSA	2		8			2		7	7				1				1							28
CHONE CF. MAGNA									1											1				2
CHONE DUNERI	1	1	3		2			1		1		1			2	1	3							16
CIRRATULIDAE SPP.	1	4	16		14	17	40	30	11	26	7		6		16	24	94			1				307
CLYMENELLA TORQUATA						58	30								34	11	92	15	3	3				246
CLYMENURA SP. A				1																				1
COSSURA LONGOCIRRATA	1		1					2	1	1			2					1						9
DIPOLYDORA CAULLERYI					1																			1
DIPOLYDORA QUADRILOBATA		2													24	2	23	5	3	9	1	3	4	76
DIPOLYDORA SOCIALIS	11	668	83	28		212	329	358	290	188				4	104	3	129	22	6	21	13	11	7	2487
DORVILLEIDAE SPP.								1	2	2									1					6
DRILONEREIS MAGNA																						1		1
ENIPO TORELLI		1	2			2		4	3	1			1	3			2	1		1	2		1	24
ETEONE HETEROPODA											1													1
ETEONE LONGA		9	4				9	5	12	6	1	3	6	5	1	5	6	6	7	7	8	9	6	115
EUCHONE INCOLOR	5	67	16		112	96	139	123	234	110	181	39	76	225	33	69	111	41	22	33	1		2	1735
EUCLYMENE COLLARIS	1									1														2

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MASS BAY - AUGUST 1996 MIDFIELD	MF2	MF4	MF5	MF7	MF8	MF9	MF10	MF12-1	MF12-2	MF12-3	MF16	MF20	MF21	MF22	FF10-1	FF10-2	FF10-3	FF12-1	FF12-2	FF12-3	FF13-1	FF13-2	FF13-3	Total
EUCLYMENINAE SPP.	32		1				3	1	2				2		23	2	33							99
EXOGONE HEBES	16	20	14	151	5	17	5	20	11	10	6	4	4	8	15	16	34	2						358
EXOGONE LONGICIRRIS	1													1										2
EXOGONE VERUGERA	1	56	54	7	1	37	32	4	23	4		6	9	12	22	17	39							324
FLABELLIGERA SPP.					1																			1
GALATHOWENIA OCULATA		6	12	4	4	2	1		4	5	1		5	6	2	1	1	1			5	4		64
GATTYANA AMONDSENI		2	3			2		4	2				1	2	2	2	2							22
GONIADA MACULATA		1	2									1												4
GONIADA SPP.								1			2													3
GONIADIDAE SPP.					1	1										1	3							6
HARMOTHOE EXTENUATA												1												1
HARMOTHOE IMBRICATA												2												2
HARMOTHOINAE SPP.	1	2			1							1	1		2									8
HETEROMASTUS FILIFORMIS					1			2			1													4
LAONOME KROEYERI		2	2		3	2	1	2	2	2	1		4		3	1	10				1		1	37
LEITOSCOLOPLOS ACUTUS	4	9	5		152	31	44	24	43	50	37	22	30	38	9	60	34	58	50	66	21	65	52	904
LEITOSCOLOPLOS SP. B	1				9		4		1	4		1			5	13		3	6	4				51
LEITOSCOLOPLOS SPP.					2					1						3	1			1				8
LEVINSENIA GRACILIS		27	36	1	64	43	51	54	72	103	144	74	85	102	15	15	21	41	42	63	1			1054
LUMBRINERIDAE SPP.		1	2		1	7	1	1	4	1	2	2	9	3	10	19	4	13	15	14				109
MALDANE SARSI		22	4			61	7						2		4	1	1							102
MALDANIDAE SPP.																	1						1	2
MEDIOMASTUS CALIFORNIENSIS	21	123	109	1	546	227	506	371	509	428	221	183	232	342	70	197	216	302	346	322	103	226	117	5718
MICROPHTHALMUS ABERRANS																					2		5	7
MICROPHTHALMUS SPP.																						3		3
MONTICELLINA BAPTISTEAE	2	4	2		115	67	53	47	94	56	57	69	71	101	44	126	107	174	206	165			1	1561
MONTICELLINA DORSOBRANCHIALIS		11	10		2	15	5	6	3	8	22	29	10	20	1	10	16	6	4	2			2	182
MYRIOCHELE HEERI	10																							10
MYSTIDES BOREALIS													1											1
NEPHTYIDAE SPP.		16	2		8	9	4	1	9	20	4	1	8	6	2	10	3	20	13	16	47	42	21	262
NEPHTYS CILIATA																			2					2
NEPHTYS CORNUTA	3	1					1																1	6
NEPHTYS INCISA		2	9		3	3	3	7	14	9	13	3	17	5	1	9	8	7	2		104	79	84	382
NEPHTYS SPP.																						2	1	3
NEREIDIDAE SPP.							1						1	1		2								5
NEREIS GRAYI	1		1				1			1	1		1	1	1		4		1	3				16
NEREIS ZONATA		3																						3
NICOLEA ZOSTERICOLA			1																					1
NINOE NIGRIPES	2	90	44		171	204	232	157	256	76	270	266	125	270	54	165	162	154	165	149	21	29	7	3069
OPHELINA ACUMINATA									1							1	1							3
OWENIA FUSIFORMIS	36	13		28	1	40	4	22	10	16	1		2		86	4	41	382	493	521			6	1706
PARANAITIS SPECIOSA					1					1	1						1							4
PARAONIDAE SPP.			1																					1
PAROUGIA CAECA		16	18	1	17	13	14	17	33	17	16	23	19	64	2	8	11	5	4	8	2	1		309
PECTINARIA GRANULATA	1																							1
PHERUSA AFFINIS									2								2	2	1					7
PHERUSA SPP.	2				6	1					1	2						3	1		9	5	5	35
PHOLOE MINUTA	1	32	1		5	13	3		11	6	2	2	7	3	3	1	5	3	1	9	3	4	1	116
PHOLOE SPP.		9	4		1				1	2				1		2								20
PHOLOE TECTA		10			15	8	2		10	8	1	3	4	2		4	6	1	2	3	6	1	1	87
PHYLLODOCE ARENAE	1			4																				5
PHYLLODOCE MACULATA		3								1											2	1	1	8
PHYLLODOCE MUCOSA	41	10		5		4	8		5	9	1	4			1	2	5	10	4	13	59	59	42	282
PHYLLODOCE SPP.		6					9			2	1	2	1			1				3	8		6	39
PHYLLODOCIDAE SPP.									4									1				3		8
PIONOSYLLIS SP. A		1	2			2			1	3				1										10
POLYCIRRUS EXIMIUS	1																							1
POLYCIRRUS SPP.	4	7	1	2		4	5	4	22	29	2		2	3		2	10		1	1	5	7	4	115

Raw infaunal abundance data for samples collected from the Mass Bay Midfield in August 1997.

MASS BAY - AUGUST 1996 MIDFIELD	MF2	MF4	MF5	MF7	MF8	MF9	MF10	MF12-1	MF12-2	MF12-3	MF16	MF20	MF21	MF22	FF10-1	FF10-2	FF10-3	FF12-1	FF12-2	FF12-3	FF13-1	FF13-2	FF13-3	Total
POLYDORA WEBSTERI												6												6
POLYGORDIUS SP. A	15	1		3		2	1							2		2	3	1	1	1	1			33
PRAXILLELLA GRACILIS										1							1							2
PRAXILLELLA PRAETERMISSA						2		2	1	1		1			5	1	15							28
PRAXILLURA ORNATA			1																					1
PRIONOSPIO STEENSTRUPI	410	718	278	11	998	571	754	121	223	195	632	1786	258	169	178	897	816	1250	1225	1344	2762	3019	2110	20725
RHODINE LOVENI			6		1		1	2					1		2		3							16
SABELLIDAE SPP.																1								1
SCALIBREGMA INFLATUM		2	3				1		2	4			1		1		1							15
SCOLELEPIS SQUAMATA																					1			1
SCOLETOMA FRAGILIS					1	6	3	1	5	1	1	2	2	3	1									26
SCOLETOMA HEBES					2		4	1			4	17	3	1	13	33	44	97	91	107	7	15	29	468
SCOLOPLOS (LEODAMAS) ?RUBRA				1																				1
SCOLOPLOS ACMECEPS		1			5	1										1	1							9
SCOLOPLOS SPP.										1														1
SPHAERODORIDIUM SP. A		5				3	1	1	4	6	1			1	1	2	4					1		30
SPHAERODOROPSIS MINUTA			1																					1
SPHAEROSYLLIS BREVIFRONS										1				1										2
SPHAEROSYLLIS LONGICAUDA		2	1		3	1		1	1	1		1		1			1							13
SPIO LIMICOLA	5	575	30	4	16	300	503	393	532	377	30	7	153	134	102	142	138	17	12	14		1	1	3486
SPIOPHANES BOMBYX	21	10		74	9	9	19	2	1	1	1	5	3		29	54	68	115	85	120	16	11		653
SPIOPHANES KROEYERI						1																		1
SYLLIDES JAPONICA											1			1										2
TEREBELLIDES ATLANTIS					1				1				1	4										7
TEREBELLIDES SPP.									1	1														2
TEREBELLIDES STROEMI			2												1									3
THARYX ACUTUS	12	18	99	5	11	17	129	104	264	140	250	297	11	305	61	195	115	574	666	429	133	110	131	4076
TROCHOCHAETA MULTISETOSA		44	12			20	17	23	47	31	2	7		36	3	4	18	7	6	6	19	14	17	333
TYPOSYLLIS SP. 1								1																1
OLIGOCHAETA																								
ENCHYTRAEIDAE SP. 1	3			66																				69
OLIGOCHAETA SPP.										1														1
TUBIFICIDAE SP. 2			117		2											35	18	1	2	3	4	6	12	200
TUBIFICOIDES APECTINATUS																2	1	1		4	6	11	2	27
TUBIFICOIDES SP. 1					5																			5
GASTROPODA																								
ACTEOCINA CANALICULATA															2	1								3
CEPHALASPIDEA SPP.																4								4
COLUS PARVUS			1																					1
CREPIDULA FORNICATA	3			2			1		2		1	3	1	6	3	4	10	2	2	4	4	4	1	53
CYLICHNA ALBA		1																						1
DIAPHANA MINUTA	2	1						1	2			1						4	1	1		1		14
GASTROPODA SPP.		2	5	1			1								2							4	2	17
ILYANASSA TRIVITTATA	1	4	2	4	1		9	9	3	6	1	5	2	1	10	1	3	5		3	8	9	2	89
LACUNA VINCTA	2	3		1	2			2	3	8		1	1	4		1							3	31
MARGARITES SPP.								1																1
OENOPOTA HARPULARIA												1												1
OENOPOTA INCISULA							1										2		1				1	5
ONOBA MIGHELSI			2									1												3
ONOBA PELAGICA		7	20			3							7		5	1	6							49
PROPEBALA EXARATA			2																					2
SOLARIELLA OBSCURA				8																				8
BIVALVIA																								
ARCTICA ISLANDICA	5		1	3	4		5	2	1	3	2	1		3	8	20	3	2	7	4			1	75
ASTARTE UNDATA		15	8		1	12	7	3	5	2	6	14	1	16	34	54	30			1				209
ASTHENOTHAERUS HEMPHILLI																1								1
BIVALVIA SPP.	183		22	4		2	1		1	1			1		1		3	1	2			6		228
CERASTODERMA PINNULATUM	226	18		136	76	6	2	11	5	19	13	132	1		2	85	5	42	30	31	18	16	12	886

Raw infaunal abundance data for samples collected from the Mass Bay Midfield in August 1997.

MASS BAY - AUGUST 1996 MIDFIELD	MF2	MF4	MF5	MF7	MF8	MF9	MF10	MF12-1	MF12-2	MF12-3	MF16	MF20	MF21	MF22	FF10-1	FF10-2	FF10-3	FF12-1	FF12-2	FF12-3	FF13-1	FF13-2	FF13-3	Total
CRENELLA DECUSSATA	7	38	33		5	16	12	7	3	5	4	24	3	1	30	45	31	1						265
CRENELLA GLANDULA												1				2	1							4
CYCLOCARDIA BOREALIS		4							1						1	2								8
ENSIS DIRECTUS	18			1	4							1				1		4	1	5	3	3	3	44
HIATELLA ARCTICA	382	16	8	9	46	8	2	8	15	15	1	49	2	1	2	52	4	22	54	32	35	60	15	838
LYONSIA ARENOSA		1											1		10	5	1		1					19
LYONSIA SPP.						1																		1
MODIOLUS MODIOLUS												5												5
MUSCULUS DISCORS			1																					1
MYA ARENARIA	2				2		2	2	1				1	1				1	1	1				14
MYTILIDAE SPP.		1				2	3	1	3	4		32			3	21	6	6	26	5	3	17	13	146
MYTILUS EDULIS	10				1		1	1			1	4					2	1	9	2	7	10	5	54
NUCULA DELPHINODONTA	2	79	69		15	107	67	32	58	20	11	29	54	72	147	167	245	3	9	2			1	1189
NUCULOMA TENUIS		1	1		1	1	3	1	1				2			2	1					1		15
PANDORA GLACIALIS																		1						1
PANDORA NR. INFLATA																1								1
PECTINIDAE SPP.					2														1	1				4
PERIPLOMA PAPYRATIUM			1		1	34	43	18	14	10	2	2	3	5	20	13	20	1	3	2	1			193
PITAR MORRHUANA		1			3	1	3	2	1	1	1		2		4	6	4		2	1				32
PLACOPECTEN MAGELLANICUS			2																					2
PYTHINELLA CUNEATA	29			4	3		2	5	2		1	4				16	3	2	1	2	14	9	7	104
SILIQUA COSTATA																	1		1					2
TELLINA AGILIS	1																						1	2
THRACIA CONRADI		4			1	3	7	1	1				2	2	3	2	4							30
THYASIRA GOULDII		26	29		2	13	5	2	1	4		1	2	4	2	5	6			1				103
YOLDIA SAPOTILLA		6				1	1	1	2	3	2	1	3	6	1	2	4		1	2	2	1		39
SCAPHOPODA																								
DENTALIUM ENTALE		1							4	1			5											11
MYSIDACEA																								
ERYTHROPS ERYTHROPHTHALMA				1	1																			2
CUMACEA																								
CAMPYLASPIS RUBICUNDA		1					3		2	1			1	1	2			1						12
DIASTYLIS CORNUIFER		1					2																	3
DIASTYLIS QUADRISPINOSA			1														1							2
DIASTYLIS SCULPTA	10								1		1	2						1	1		5	16	6	43
DIASTYLIS SPP.	7			17								4		1				1	3	1	8	9	1	52
EUDORELLA PUSILLA			3		1							1			2		3			3				13
EUDORELLA SPP.					5												14							19
LAMPROPS QUADRIPLICATA																1		1						2
LEPTOSTYLIS SPP.			10														2							12
PETALOSARSIA DECLIVIS		1	3	4	1	13				1		3	1				3							30
TANAIDACEA																								
TANAISSUS PSAMMOPHILUS				17						2														19
ISOPODA																								
CHIRIDOTEA TUFTSI				3																				3
EDOTIA MONTOSA	4	12			2	8	18					4		1	10	20	56	25	21	5	5	8	4	203
MUNNA SP. 1			1					1	1	2														5
PLEUROGONIUM INERME	13	2	3			1	2	1	1	3								1	3	4	17	12	10	73
PLEUROGONIUM RUBICUNDUM	16	20	3		4	13	4	13	13	6	7	1	2	2		3	8	4	5	8	29	8	10	179
PLEUROGONIUM SPINOSISSIMUM		2	2			2				1				1			3							11
PLEUROGONIUM SPP.		3	8			6	3	1	8		1	1	1	1		1	4	1				1	1	41
POLITOLANA POLITA				1																				1
PTILANTHURA TENUIS		9	1	2					1						8	4	13							38
AMPHIPODA																								
AMPELISCA ABDITA	12			3														8	3	4	72	82	51	235
AMPELISCA MACROCEPHALA		5	6			5					1					3	6							26
AMPELISCA VADORUM	1																							1
AMPHIPODA SPP.	1	3				7	1																	12

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MASS BAY - AUGUST 1996 MIDFIELD	MF2	MF4	MF5	MF7	MF8	MF9	MF10	MF12-1	MF12-2	MF12-3	MF16	MF20	MF21	MF22	FF10-1	FF10-2	FF10-3	FF12-1	FF12-2	FF12-3	FF13-1	FF13-2	FF13-3	Total
ANONYX LILLJEBORGI							1	1																2
ARGISSA HAMATIPES	6	3	1	1	1	7	1		1	1	8	15	2	2	1	2	3	6	13	7	42	35	35	193
CASCO BIGELOWI		2	1									3	1	2			1							10
COROPHIIDAE SPP.			1																					1
CRASSICOROPHIUM CRASSICORNE	8			99								1												108
DEFLEXILODES INTERMEDIUS					2											1	1							4
DEFLEXILODES SPP.	1					1																		2
DEFLEXILODES TUBERCULATUS	1		1	2	1		1						2	1			1							10
DULICHIA FALCATA			4			1			2	1	1													9
DYOPEDOS MONACANTHUS	98	1			16	16	31	25	40	13	10	51	4	1	1	1	1	291	213	276	157	333	165	1744
ERICHTHONIUS RUBRICORNIS			15	2																				17
GITANOPSIS ARCTICA			1																					1
HAPLOOPS FUNDIENSIS		2	21			1	2										5							31
HARPINIA PROPINQUA		12	14			2		5									8							41
HIPPOMEDON PROPINQUUS											1													1
HIPPOMEDON SERRATUS				2																				2
ISCHYROCERUS ANGUIPES			5		1													2	2	2	1	2	3	18
LEPTOCHEIRUS PINGUIS	3		59										1	18								3		84
MAYERELLA LIMICOLA		4						2	11	36			5											58
METOPELLA ANGUSTA	33	26	15		7	28	20	14	61	48	9	9	12	7	2	19	19	12	14	15	9	12	17	408
MONOCULODES SP. 1					2			1	1	1						2	3							10
ORCHOMENELLA GROENLANDICA		1																						1
ORCHOMENELLA MINUTA		1	3			2				2							1			6	7	5	10	37
PARADULICHIA TYPICA		1	1		1				1	1					1									6
PHOTIS POLLEX	20	59	7	4	1	40	15	3	8	5	1	5	1	1		7	17	3	14	15	249	189	249	913
PHOXOCEPHALUS HOLBOLLI																		1	6				3	10
PLEUSYMTES GLABER			2																					2
PODOCERIDAE SPP.										1														1
PONTOGENEIA INERMIS																						1		1
PROTOMEDEIA FASCIATA	6		7	8								2					1				1			25
RHEPOXYNIUS HUDSONI				1																				1
STENOPLEUSTES INERMIS	4	12	2		2	31	11	11	24	18	1		2	1	1		3	1	4					128
SYRRHOE CRENULATA		5	1	4	1												1							12
UNCIOLA INERMIS	3			9																				12
UNCIOLA IRRORATA	3		30	4	1													6	11	6	16	25	8	110
WESTWOODILLA BREVICALCAR			1	2																				3
DECAPODA																								
CANCER BOREALIS	1		3					1				1						1		1		1		9
CRANGON SEPTEMSPINOSA	4					1	1			1		1	1	2	1		2			2	1	1	2	20
SIPUNCULA																								
PHASCOLION STROMBI			2							2							1							5
SIPUNCULA SPP.			2		2				1					1										6
PHORONIDA																								
PHORONIS ARCHITECTA	12	25	6			73	24		40	2	1	27		11	9	2	29	34	38	14	1	108	115	571
ECHINODERMATA																								
ECHINARACHNIUS PARMA	4			6																				10
ECHINOIDEA SPP.	1	1										1										1		4
OPHIOTHRIX ANGULATA																					1			1
OPHIUROIDEA SPP.	5	14	1	1	10	9	5	8	23	10	3	3	9	10		1	1	1			2	1		117
HEMICHORDATA																								
ENTEROPNEUSTA SPP.	1																							1
STEREOBALANUS CANADENSIS					2			1	1	1			1	3										9
CHORDATA																								
ASCIDIACEA SPP.	24																							24
MOLGULA MANHATTENSIS			5																					5

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MASS BAY - AUGUST 1997 FARFIELD	FF1A-1	FF1A-2	FF1A-3	FF4-1	FF4-2	FF4-3	FF5-1	FF5-2	FF5-3	FF6-1	FF6-2	FF6-3	FF7-1	FF7-2	FF7-3	FF9-1	FF9-2	FF9-3	FF11-1	FF11-2	FF11-3	FF14-1	FF14-2	FF14-3	Total
TOTAL/REPLICATE	1926	2059	2529	1463	1042	962	1043	953	531	1170	1116	704	2164	4144	2055	2627	2761	2581	2024	825	993	407	864	1229	38172
TOTAL/STATION		6514			3467			2527			2990			8363			7969			3842			2500		
TAXON																									
PORIFERA																									
PORIFERA SPP.													1												1
CNIDARIA																									
ACTINIARIA SP. 2							4				4			1				1							10
ACTINIARIA SPP.									1																1
CERIANTHEOPSIS AMERICANUS										1															1
CERIANTHUS BOREALIS	2																								2
EDWARDSIA ELEGANS	9	2	12				1	1					1		1	2	1	1							31
HYDROZOA SPP.							1				1		1	5											8
PLATYHELMINTHES																									
TURBELLARIA SPP.													2	1											3
NEMERTEA																									
AMPHIPORUS ANGULATUS		4	2		17			7		9	3		3	2	1		1	3	2		3		10		67
AMPHIPORUS GROENLANDICUS								2	2												9				13
AMPHIPORUS SPP.												1													1
CARINOMELLA LACTEA	1	3		2	5	1	1				2		8	7	5								2	1	38
CEPHALOTHRICIDAE SP. 1		3	2		3	5	6	4	2	1			2	2	2	25	15	10				3	1	5	91
MICRURA SPP.	5	6	5	7	7	10	2	2		2	5	1	8	2	5		11	5	6	1	3			3	96
NEMERTEA SP. 2			1				1																		2
NEMERTEA SP. 5			6			3								20	2	10	15	10	8	4	10	4	5	3	100
NEMERTEA SPP.	2	2		8		2	3	2	1	5	3	2	7	12	2		5		2						58
TETRASTEMMA SPP.										1								1							2
TUBULANUS PELLUCIDUS				4	1	3										2	1		1	1	2		1	1	17
POLYCHAETA																									
AGLAOPHAMUS CIRCINATA	135	92	62														6								295
AMPHARETE ACUTIFRONS	5	2	7	1			4	26	7							2		13							67
AMPHARETE FINMARCHICA																1	2								3
AMPHARETE SPP.														1											1
AMPHARETIDAE SPP.	10	5	7	25	11	64	12	9								99	40	64	3	6	1	6	8	25	395
ANCISTROSYLLIS GROENLANDICA																					1				1
ANOBOTHRUS GRACILIS	8	6	17	182	174	73	15	14	20	12	12	3		1	2	4	12	16	15	2	2	5	27	30	652
APHELOCHAETA MARIONI	2	4	9	2	9	1	4	8		1	1		2		2	17	8	17	2	1	1	1	7	20	119
APHELOCHAETA MONILARIS					1				1		3														5
APISTOBRANCHUS SPP.	5	10	5	7			1			1	3	4	7	10	4		1	1					1		60
APISTOBRANCHUS TULLBERGI	7	13	12	10	4	18	3	4	1		7	2	69	172	49			1					3	1	376
APISTOBRANCHUS TYPICUS		2	12	59	37	35	6	6	3					1	1		1	2				1	2		168
ARCTEOBIA ANTICOSTIENSIS	1		1	1			1									2	2								8
ARICIDEA CATHERINAE	31	39	33							16	30	13	99	51	58							1			371
ARICIDEA MINUTA										2	2	4													8
ARICIDEA QUADRILOBATA	7	12	20	112	47	53	62	26	44	14	17	16	13	12	24	3	17	13	134	53	18	5	35	47	804
ASABELLIDES OCULATA		7	36	25	29											2	13	1							113
AXIOTHELLA CATENATA																		1			1			1	3
BRADA VILLOSA														1		2	1								4
BYLGIDES SARSI																							1		1
CAPITELLA CAPITATA COMPLEX	2				1			6	1	1	156	85	1	13	2	7	4	1							280
CHAETOZONE SETOSA				158	56	121	18	21	14			2				2	3		44	21	17	17	101	120	715
CIRRATULIDAE SPP.				2			7	8	1										3				1		22
COSSURA LONGOCIRRATA	1			120	43	55	11	6	9	123	93	103	677	1964	780			1	19	19	37	13	29	39	4142
DIPLOCIRRUS HIRSUTUS																		1							1
DIPLOCIRRUS SPP.										1	1		3		1		1					1			8
DIPOLYDORA SOCIALIS	49	44	38				3	1		7	6					675	387	607	1	2	1		1	1	1823
DORVILLEIDAE SPP.															1		2								3

Raw infaunal abundance data for samples collected from the Mass Bay Farfield in August 1997.

MASS BAY - AUGUST 1997 FARFIELD	FF1A-1	FF1A-2	FF1A-3	FF4-1	FF4-2	FF4-3	FF5-1	FF5-2	FF5-3	FF6-1	FF6-2	FF6-3	FF7-1	FF7-2	FF7-3	FF9-1	FF9-2	FF9-3	FF11-1	FF11-2	FF11-3	FF14-1	FF14-2	FF14-3	Total
DYSPONETUS PYGMAEUS							1																		1
ENIPO TORELLI		2	4	1	2			3	3	1		3	1	1			2	2	1	2	2		1	1	32
ETEONE LONGA	6	5	4	4	1	4		1	2	1	3	1	4	1	2	3	8	6	3	1	2	1	2	2	67
EUCHONE INCOLOR	18	22	45	125	97	71	38	23	17	4	13	11	183	200	190	24	25	20	15	6	3	7	7	27	1191
EUCLYMENINAE SPP.	2			3	1		3	3	2		4					10	2	15		2			2	1	50
EXOGONE HEBES		3	1													21	24	12							61
EXOGONE VERUGERA	2	1	6													12	22	14					1		58
GALATHOWENIA OCULATA				3	4	1	34	8	17			5	5	1	1	4	7	9	49	10	12	12	36	21	239
GATTYANA AMONDSENI		2	2							7	6					5	4	1			1			1	29
GATTYANA CIRROSA										2															2
GONIADA MACULATA		2	1	1				1	1								2	1	1					1	11
GONIADA SPP.			2																						2
GONIADIDAE SPP.																						1			1
HARMOTHOE EXTENUATA													2				1								3
HARMOTHOINAE SPP.	3	3								1			1	1		3	1	3					2		18
HETEROMASTUS FILIFORMIS										1		1							1						3
LAONICE CIRRATA	1																								1
LAONOME KROEYERI	2	1	2		1	1										9	5	9						1	31
LEITOSCOLOPLOS ACUTUS	6	8	5	11	5	8	10	18	4							6	5	4	3	5	9	8	16	19	150
LEITOSCOLOPLOS SP. B																1	3	1							5
LEVINSENIA GRACILIS	23	46	52	51	57	39	66	71	60	44	44	45	24	19	10	49	41	48	187	33	59	13	97	115	1293
LUMBRINERIDAE SPP.		2				1					3		27	19	20		1	1	1	1					76
MALDANE SARSI				1												19	5	1	4		2			2	34
MALDANIDAE SPP.														1	1	7	3	1							13
MEDIOMASTUS CALIFORNIENSIS	40	60	98	174	143	170	180	294	51	145	86	71	194	255	170	82	101	64	40	27	22	72	111	253	2903
MELINNA CRISTATA				1																			1		2
MICROPHTHALMUS ABERRANS																	1								1
MONTICELLINA BAPTISTEAE						1						2												1	4
MONTICELLINA DORSOBRANCHIALIS			1																						1
MYRIOCHELE HEERI																27	14	11							52
MYRIOCHELE SPP.	4		2																						6
MYSTIDES BOREALIS										2			1		2		1								6
NEPHTYIDAE SPP.	2	7	12	6	8	4	7		4	15	6		18	23	13	9	8			5	8	18	8	11	192
NEPHTYS CILIATA														2					1	7					10
NEPHTYS INCISA	1	1		12	2	7	1	4	2	19	17	23	66	125	43	15	6	11	8		1	1	2	10	377
NEPHTYS PARADOXA																			1						1
NEREIDIDAE SPP.		1																							1
NEREIS GRAYI		1	5		1												6	8							21
NICOLEA ZOSTERICOLA														1											1
NINOE NIGRIPES	29	47	72	8	3	14	16	13	20	56	41	37	66	51	59	9	31	24	8	2	7	2	2	6	623
OPHELINA ACUMINATA		2														1						1	2	1	7
OPHRYOTROCHA SP. 1				17	8	5		1	1					1					3	1	2	5	8	2	54
OWENIA FUSIFORMIS	15	13	66				1									9			1	1					106
OWENIIDAE SPP.				1							1														2
PARAMPHINOME JEFFREYSII				2																					2
PARANAITIS SPECIOSA																1	2								3
PARANINOE BREVIPES										2															2
PAROUGIA CAECA	1	3	4	3	5	4	8	4	2	9	4	4	14	4	7	5	9	6	7	5	12		1	3	124
PECTINARIA GRANULATA		1																							1
PHERUSA AFFINIS												1					1								2
PHERUSA SPP.					1								3	22			1			1					28
PHOLOE MINUTA	5	11	18	1		1	2	3	1	4	7	1	3	5	1	7	7	2	3	2	4	2	1		91
PHOLOE SPP.	1	4	4	1		1				1	1		1	5		1	9	2		1	1				33
PHOLOE TECTA		3	4	1			3	1		3	2		1	29	1	10	20	13		2					93
PHYLLODOCE ARENAE			1															1							2

Raw infaunal abundance data for samples collected from the Mass Bay Farfield in August 1997.

MASS BAY - AUGUST 1997 FARFIELD	FF1A-1	FF1A-2	FF1A-3	FF4-1	FF4-2	FF4-3	FF5-1	FF5-2	FF5-3	FF6-1	FF6-2	FF6-3	FF7-1	FF7-2	FF7-3	FF9-1	FF9-2	FF9-3	FF11-1	FF11-2	FF11-3	FF14-1	FF14-2	FF14-3	Total
PHYLLODOCE MUCOSA		4	1				6									20	10	10							51
PHYLLODOCE SPP.	2	1					2										3								8
PHYLLODOCIDAE SPP.										1					2										3
PIONOSYLLIS SP. A																1	1								2
POLYCIRRUS SPP.	2			7	1	2		3					2		1	4	2	1							25
POLYGORDIUS SP. A	1	3	8										3	6	10										31
PRAXILLELLA GRACILIS																			1	3	1				5
PRAXILLELLA PRAETERMISSA	16	5				1	8	5	1								1	8	5		1	1	8	1	61
PRAXILLURA ORNATA	2																6	6							14
PRIONOSPIO STEENSTRUPI	840	898	1035	106	66	75	188	201	89	47	34	29	25	96	41	646	1007	763	1004	355	615	48	78	147	8433
RHODINE LOVENI											3					7	16	7							33
SABELLIDAE SPP.				1														1							2
SCALIBREGMA INFLATUM				4	1		2	2	1							3	2	4		1		1		1	22
SCOLETOMA FRAGILIS	1		5							1	4		2	3		2	4	1		1	1				25
SCOLETOMA HEBES																					1			1	2
SCOLOPLOS ACMECEPS																	1								1
SCOLOPLOS ARMIGER								1								3									4
SCOLOPLOS SPP.																	1								1
SPHAERODORIDIUM SP. A	1	2	6							1			3	2	3	4	3	2	1						28
SPHAERODOROPSIS MINUTA																4	2						1	1	8
SPHAEROSYLLIS BREVIFRONS														1											1
SPHAEROSYLLIS LONGICAUDA														1		4	3	1							9
SPIO LIMICOLA	68	81	90	1		1	19	11	11	12	16	6	20	6	12	372	385	352	123	45	9	9	32	36	1717
SPIOPHANES BOMBYX	11	14	13											2											40
SPIOPHANES KROEYERI	1																								1
STERNASPIS SCUTATA	1						3	5	5	1	2				3				21	13	4	6	17	33	114
SYLLIDES JAPONICA					1		1	2	1	2	3	2	2	1		1	1			1	1				19
SYLLIDES LONGOCIRRATA				8		8				4	1		26	32	13				1				2	1	96
TEREBELLIDAE SPP.				2									1				2								5
TEREBELLIDES ATLANTIS		1		4	9		1	1	4	32	27	18	9	2	14		2		1				1		126
TEREBELLIDES SPP.				4	3	1	8	8	2	1	1		2	4		3	1					1	1	1	41
TEREBELLIDES STROEMI				4	2	1	2	3	5												1				18
THARYX ACUTUS	74	74	78				2	2	9	87	80	53	92	339	140		11	7							1048
TRICHOBRANCHUS GLACIALIS													1												1
TROCHOCHAETA CARICA						1										1									2
TROCHOCHAETA MULTISETOSA	2	2	3	18	37	22	7	17	4	1	2	1	1			16	16	13	10	5	2	10	28	31	248
OLIGOCHAETA																									
TUBIFICIDAE SP. 2										8	21	15	137	82	213					3					479
TUBIFICIDAE SPP.										1															1
TUBIFICOIDES APECTINATUS		1		16	14	5	2			1		1	1	4	2				86	24	25	2	18	39	241
GASTROPODA																									
CEPHALASPIDEA SPP.							1							3					1						5
COLUS PARVUS			1													1		1							3
COLUS PUBESCENS				1																					1
CREPIDULA FORNICATA	1															3	1	1				3			9
CYLICHNA GOULDI					1		16	3	9	3	5		9	2	2				2	1		2	3	4	62
DIAPHANA MINUTA										1			1	2		1	1								6
EPITONIUM GREENLANDICUM																1									1
GASTROPODA SPP.	2						1		1		2		3	2				2				2	2		17
ILYANASSA TRIVITTATA	1									1												1			3
NUDIBRANCHIA SPP.																				1					1
OENOPOTA INCISULA		2														1		1							4
OENOPOTA PYRAMIDALIS																							2		2
ONOBA PELAGICA				2	2	1	17	10	7	51	19	19	35	71	24		1		5	4	1	13	7	10	299
POLINICES PALLADUS				1																					1

Raw infaunal abundance data for samples collected from the Mass Bay Farfield in August 1997.

MASS BAY - AUGUST 1997 FARFIELD	FF1A-1	FF1A-2	FF1A-3	FF4-1	FF4-2	FF4-3	FF5-1	FF5-2	FF5-3	FF6-1	FF6-2	FF6-3	FF7-1	FF7-2	FF7-3	FF9-1	FF9-2	FF9-3	FF11-1	FF11-2	FF11-3	FF14-1	FF14-2	FF14-3	Total
PROPEBALA EXARATA																1	1	1							3
PUSILLINA HARPA							4			19	3	2	2	9	2					1					42
APLACOPHORA																									
CHAETODERMA NITIDULUM CANADENSE			1					1										1	2	1		1			7
BIVALVIA																									
ARCTICA ISLANDICA	6	8	8															1	3	2					28
ASTARTE UNDATA	5	5	11													5	2	4	2						34
BIVALVIA SPP.			2								1					2				1					6
CERASTODERMA PINNULATUM	21	56	12							3	2			2		8	13	8	1	1			1		128
CRENELLA DECUSSATA	8	13	35							2	5					2	1	6				4	6	1	83
HIATELLA ARCTICA	21	18	20				4	1		2	2					4	2								74
LYONSIA ARENOSA	3	4	5							1	1														14
LYONSIA SPP.											1			1											2
MEGAYOLDIA THRACIAEFORMIS				3	3														5	2	2		2		17
MODIOLUS MODIOLUS	2																								2
MYA ARENARIA		1	1			1		1				1	2	2						1					10
MYTILIDAE SPP.	4	3	2	3				1		4					2	1	1								21
MYTILUS EDULIS	3	1	2																		1				7
NUCULA ANNULATA										17	26	26	15	12	9										105
NUCULA DELPHINODONTA	141	86	242	1	1		21	2	5	37	29	17	53	14	13	28	49	51	6	4	2	15	11	19	847
NUCULA SPP.												1													1
NUCULANA NR. MESSANENSIS					1																				1
NUCULANA PERNULA						1																1	1		3
NUCULANA SPP.																								1	1
NUCULOMA TENUIS	4	1	3	6	5	2	1		1							1	7	2	22	9	6	6	5	4	85
PECTINIDAE SPP.	1	1	1														1								4
PERIPLOMA PAPYRATIUM	7	5	5	1	1	1	25	6	9	1	1	4	2	2		4	21	16	4		1	3	9	5	133
PITAR MORRHUANA			1										1	1				1							4
PLACOPECTEN MAGELLANICUS	1		1																						2
PYTHINELLA CUNEATA	1	1		23	38	6	20	10	7	4	1			1		40	9	3		1		1	2	1	169
SILIQUA COSTATA	1																								1
THRACIA CONRADI	1	2	2		1													2					2		10
THRACIIDAE SPP.																					1				1
THYASIRA GOULDII	31	17	45	10	8	10	22	14	16	8	11	13	14	13	6	14	51	28	17	4	2	2	16	24	396
THYASIRA NR. MINUTUS																			2						2
THYASIRA SPP.																			2						2
YOLDIA SAPOTILLA	5	7	15	4	6	10	12	12	12	9	9	10	9	10	4	6	13	25	20	13	1	7	8	14	241
YOLDIA SPP.				2																					2
YOLDIELLA LUCIDA				1																					1
SCAPHOPODA																									
DENTALIUM ENTALE			1	28	14	3	4	1	1							1	1		1	4	2	6	5	13	85
MYSIDACEA																									
ERYTHROPS ERYTHROPHTHALMA							1			2		2			1				1	1	2			1	11
CUMACEA																									
CAMPYLASPIS NR. SULCATA										1	2		1										1		5
CAMPYLASPIS RUBICUNDA																1	3	2							6
DIASTYLIS CORNUIFER										1	7		7	4	1							1			21
DIASTYLIS QUADRISPINOSA	1															1		1							3
DIASTYLIS SPP.	8	12	19				1	1		1															42
EUDORELLA HISPIDA							1	3	3	6	3				3				15	2	4	1	4	1	46
EUDORELLA PUSILLA	5	6	6				2	1	2	2	2		4	4		4	5	3				1	2	1	50
EUDORELLA SPP.			5	1						6	3	6	74	40	9				4	1		1			150
LEPTOSTYLIS LONGIMANA							2				1		1		3	1		1					2	1	12
LEPTOSTYLIS SPP.											3	3	6	1	2	16	2	8	1	1		3			46
LEUCON ACUTIROSTRIS				5	3	3														1		6	1	2	21

Raw infaunal abundance data for samples collected from the Mass Bay Farfield in August 1997.

MASS BAY - AUGUST 1997 FARFIELD	FF1A-1	FF1A-2	FF1A-3	FF4-1	FF4-2	FF4-3	FF5-1	FF5-2	FF5-3	FF6-1	FF6-2	FF6-3	FF7-1	FF7-2	FF7-3	FF9-1	FF9-2	FF9-3	FF11-1	FF11-2	FF11-3	FF14-1	FF14-2	FF14-3	Total
LEUCON FULVUS						1	1													6		6	1	4	19
LEUCON SPP.					1		10		1															2	14
PETALOSARSIA DECLIVIS	3	26	1														1	1							32
TANAIDACEA																									
TANAISSUS PSAMMOPHILUS														1											1
ISOPODA																									
BAEONECTES MUTICUS																	1								1
CHIRIDOTEA TUFTSI			1																						1
EDOTIA MONTOSA	1	11	2				1						2	3		2	2	4							28
MUNNA SP. 1		1															1								2
PLEUROGONIUM INERME	4	20	14							34	23	5		48	2	4		9					1	1	165
PLEUROGONIUM RUBICUNDUM	8	10	11	6	3	1	10	1	4				6	20		2	2	1	2	2			6	3	98
PLEUROGONIUM SPINOSISSIMUM							4			3	1					1	6	4							19
PLEUROGONIUM SPP.	1						1			1			2			4	3								12
POLITOLANA POLITA																		1							1
PTILANTHURA TENUIS	10	13	12			1																			36
AMPHIPODA																									
AEGININA LONGICORNIS	2																								2
AMPELISCA ABDITA	2		1	1			2		1																7
AMPELISCA MACROCEPHALA	5	2														6	1	3							17
AMPHIPODA SPP.	1	1	1														1		1						5
ANONYX LILLJEBORGI		2								2			1							1					6
ARGISSA HAMATIPES	2	5	4					1		1	1		2	1	3	1	6	8				1		1	37
BATHYMEDON OBTUSIFRONS				1	2	2		1											4	8	4	3	5		30
BYBLIS GAIMARDI									1								1	1							3
CAPRELLIDAE SPP.							2																		2
CASCO BIGELOWI																1	1	1							3
COROPHIIDAE SPP.																		2							2
CRASSICOROPHIUM CRASSICORNE																		2							2
DEFLEXILODES INTERMEDIUS	1																	1				1	1	1	5
DEFLEXILODES SPP.						3	1						1	2	1	4	8		6	1					27
DEFLEXILODES TESSELATUS							1	2		1															4
DEFLEXILODES TUBERCULATUS														1											1
DULICHIA FALCATA		1	1														2								4
DYOPEDOS MONACANTHUS	1	1		1			3						9		3	2	1				1				22
ERICHTHONIUS RUBRICORNIS			4														1	2							7
GITANOPSIS ARCTICA																		1							1
HAPLOOPS FUNDIENSIS	2	5	10		1	2	1		2							15	13	6	1		1				59
HARPINIA PROPINQUA	24	54	28	2	1		3		1	31	20	2				24	15	34	34	25	17	2	4	2	323
HARPINIOPSIS SP. 1	1																								1
HIPPOMEDON PROPINQUUS	2																								2
LEPTOCHEIRUS PINGUIS							1			145	114					1									261
MAYERELLA LIMICOLA								2		1	2	6	5		1	3									20
MELITA NR. DENTATA										1															1
MELITIDAE SPP.											1														1
METOPELLA ANGUSTA	1	4		5	10	5	26	4	8		2	8	11	71	7	14	28	30	3	7	5	15	9	20	293
MONOCULODES PACKARDI					1														7	1	2	1	1	2	15
MONOCULODES SP. 1	10	4	7									1		2	2										26
MONOCULODES SPP.					1																				1
ORCHOMENELLA GROENLANDICA																					1				1
ORCHOMENELLA MINUTA			1				1			27	10			1										3	43
PARADULICHIA TYPICA	41	1	4				1											3							50
PHOTIS POLLEX	15	19	12	9	5	6	4	4	2	1	2	4	9	57	9	22	17	10	1	1	3		1		213
PLEUSYMTES GLABER	1									1								1							3
PONTOGENEIA INERMIS	1																								1

Raw infaunal abundance data for samples collected from the Mass Bay Farfield in August 1997.

MASS BAY - AUGUST 1997 FARFIELD	FF1A-1	FF1A-2	FF1A-3	FF4-1	FF4-2	FF4-3	FF5-1	FF5-2	FF5-3	FF6-1	FF6-2	FF6-3	FF7-1	FF7-2	FF7-3	FF9-1	FF9-2	FF9-3	FF11-1	FF11-2	FF11-3	FF14-1	FF14-2	FF14-3	Total
PROTOMEDEIA FASCIATA	3	4																			1				8
PSEUDUNCIOLA OBLIQUUA																1									1
STENOPLEUSTES INERMIS		4	4	4	1	1	3		1	11	3	3	11	72	11	3	9	5					1		147
SYRRHOE CRENULATA	1	1																							2
UNCIOLA IRRORATA	10		1			1										1	9	2							24
UNCIOLA SPP.		1	1													2		4							8
WESTWOODILLA BREVICALCAR	2		2													5	1		2		1				13
DECAPODA																									
CANCER BOREALIS	1		1														1								3
SIPUNCULA																									
NEPHASOMA DIAPHANES																	1								1
PHASCOLION STROMBI	1	2	1						1							1	3	4							13
SIPUNCULA SPP.		2	1	1	1											5	4	1	1	2	9	2	1	5	35
PRIAPULIDA																									
PRIAPULUS CAUDATUS										1												1		2	4
PHORONIDA																									
PHORONIS ARCHITECTA	1	12	12		3	4	1	2	1		2			1	2	36	11	10				1	1		100
ECHINODERMATA																									
ASTEROIDEA SPP.							1										1								2
AXIOGNATHUS SQUAMATUS																							1	2	3
CTENODISCUS CRISPATUS				1		2	1										2						1	1	8
ECHINOIDEA SPP.							4			1	2			2	1	1	3			2					16
HOLOTHUROIDEA SPP.														1			1								2
MOLPADIA OOLITICA												1													1
OPHIURA SARSI	5	1	1	2						4	3	2	6	13	10	2	4	3	1	3	1		1		62
OPHIUROIDEA SPP.	13	7	6	7	8	2	17		10	7	7	2	10	18	5	22	7	21	15	34	7	16	16	11	268
HEMICHORDATA																									
STEREOBALANUS CANADENSIS		1	2	4	2		1	4			1		2	3	1		1	1		1	1				25
CHORDATA																									
BOSTRICHOBRANCHUS PILULARIS													3	6											9
CNEMIDOCARPA MOLLIS	1	2						2		1															6
MOLGULA MANHATTENSIS											2														2

Appendix H

A Paradigm Relating Organic Carbon Loadings to Benthic Processes

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Baseline data for the nearfield and midfield show the natural variability of the system under current fluxes of particulate organic carbon (POC) to the bottom. A major question arises, are the baseline data sufficient to detect changes in the system once the diffuser effluent comes on line? This appendix presents an attempt to predict changes in benthic baseline data that can be expected to take place if certain threshold enrichment conditions are exceeded within the zone of initial dilution (ZID). Further, if significant enrichment takes place, what are the likely changes that may take place in benthic processes? The analysis presented here was developed for the Orange County Sanitation District, San Diego, California to predict the impact of increased solids loadings on benthic conditions on the adjacent shelf. That analysis has been modified here to reflect existing and predicted conditions at the Massachusetts Bay outfall.

Subcritical Organic Loading Rates (Oligotrophic to Mesotrophic Benthic Conditions)
The ecological response model presented here is not based on a species-by-species analysis. Rather, we look at the effect of organic loading on functional groups of benthic organisms and how they interact with sediments. In sediments where the input rate of organic detritus is more-or-less balanced with benthic metabolism, the sediment column is deeply bioturbated (10-20 cm) by sessile or mobile head-down deposit feeders (Stage III macrofauna). Examples include infaunal polychaetes represented by maldanids, pectinariids, infaunal ophiuroids and holothurians, and irregular urchins). Taxonomic examples are given in Pearson and Rosenberg, 1978 and Rhoads *et al.*, 1978. At relatively low rates of organic carbon loading, deep bioturbation stimulates microbial mineralization of buried organic substrates. This is called "microbial gardening" (Yingst and Rhoads, 1979). Mixing of particles and fluids to depth within the sediment column results in organic substrates being alternatively exposed to oxidative and reductive redox conditions. Cyclic redox patterns result in a more efficient remineralization than exposure of organic substrates to constant redox environments (Aller, 1994). This phenomenon is analogous to "composting" of leaf litter. At high rates of organic loading, microbial gardening is compromised by the inability of deep bioturbators to control pore-water chemistry (Pearson, 1982). Subsurface microbial gardening requires that pore waters within the sediment column be highly exchanged through bioturbational irrigation. The weight/weight ratio of fluid bioturbation (pore-water pumping) is typically 100 to 500 times that of particle bioturbation (Aller, 1977). Therefore, pore-water profiles are typically vertical (non-Fickian) with respect to sulphate and nitrate (Aller, 1982; Rice and Rhoads, 1989).

There is a metabolic cost for maintenance of high rates of pore-water irrigation, a "cost" shared by a population of Stage III deep head-down feeders (Aller, 1982). The metabolic cost is recovered by a net release of food to bioturbating macrofauna through the gardening effect. The cost is shared by all of the individuals involved with vertical pore-water irrigation. The process is manifested by close spacing of the bioturbators so that the half distance between burrows results in an overlap of zones of bioadvection. In short, this process of sharing the work to maintain highly advected pore waters requires dense assemblages of head-down species. The bioturbational processes outlined above are analogous to tertiary sewage treatment where mechanical stirring and aeration of sludge is done prior to discharge to minimize COD and BOD.

Critical to Supercritical Organic Loading Rates (Eutrophic Benthic Conditions)
If the sedimentation rate of labile organic carbon exceeds the ability of Stage III deep head-down bioturbators to maintain highly exchanged pore waters, the recycling system collapses. This is a step function. Typically, deep bioturbators are either abundant, for the reason described above, or they are absent. The spatial/temporal point where this recycling system collapses is defined as the **critical loading rate.**

Supercritical loading rates promote the accumulation of reduced labile organic matter. This accumulation can be accelerated by dense tube fields of small near-surface suspension and deposit feeding organisms (e.g Stage I spionid and capitellid polychaetes, tubificid oligochaetes, and Stage II tubicolous amphipods). The suite of enrichment species is well known and is summarized by Pearson and Rosenberg (1978). Pore-water profiles show that only the upper 1 cm (or less) of the sediment column is advected. Below this thin mixing zone pore-water profiles closely fit calculated Fickian diffusion curves (Aller, 1982). The entire sediment column may be sulfitic with the release of hydrogen sulfide, ammonia, molecular nitrogen, and ammonia. Release of these anaerobic metabolites places a potentially large oxygen demand on water within the benthic boundary layer resulting in hypoxia or anoxia. Organic storage systems tend to depress dissolved oxygen concentrations near the bottom, and chemical by-products (including methane, ammonia, and sulfides) can accumulate to concentrations that are toxic to bottom organisms. Thus, it is important to understand the assimilative capacity of these environments so that limits to anthropogenic inputs like the MWRA's wastewater discharge can be based on rational criteria. Critical management and regulatory decisions rely on establishing appropriately safe limits, the effects of which can then be monitored over time.

In summary, supercritical organic loading rates result in the sediment column being a long-term storage system for reactive organic matter. Stage III deep head-down deposit feeders may not return to these bottom types until organic loading rates are dramatically decreased and the sediment column is purged of high inventories of reduced metabolites. Recolonization can take several years (Mattsson and Linden, 1983).

What is Important to Know About Organic Loading to the Marine Environment, and How Does This Relate to the MWRA's Discharge?

This section reviews literature and data that address the capacity of benthic systems to process inputs of organic carbon without significant adverse impacts. These data are then compared to input levels (discharge amounts) proposed by the MWRA to determine whether any significant impacts are predicted, and at what levels of organic loading.

Healthy bottom communities typically are able to process natural inputs by degrading and recycling organic material and nutrients at a rate that minimizes long-term accumulation. However, if the input rate exceeds a critical loading level, accumulation can occur and the bottom environment changes from a nutrient recycling system to a degraded organic "storage" system. The **critical threshold loading rates** are defined as the loading rate above which sediment quality is clearly degraded. The definition of a **degraded** condition is the inability of the ambient benthic fauna to aerobically metabolize and recycle most of the accumulating organic matter. Supercritical loading rates dramatically change organism-sediment interactions in a way that promotes benthic storage of reduced sediment and promotes anaerobic decomposition processes leading to high oxygen demand. There is a non-linear relationship between primary production in the water column and the percent of that production respired at the sediment surface. At production rates below about 200 g C m^{-2} yr^{-1}, (and at all mixed layer water depths), benthic respiration accounts for a larger proportion of oxidation and remineralization than at higher loading rates (Hargrave, 1973). The non-linearity of this phenomenon may go far in explaining the rapid change in the efficiency of benthic processing of POC at different loading rates and why organic storage takes place above critical thresholds of loading (e.g. Appendix H, Table 1).

The analysis presented here specifically looks at the effect of organic loading on functional groups of benthic organisms and how they interact with sediments.. In particular, some groups of bottom invertebrates are important as deep "bioturbators" (mixers and aerators of sediments) that facilitate aerobic decomposition of organic material. As such, they strongly influence sediment pore-water profiles and particle chemistry. This biogenic activity has been likened to a natural "tertiary sewage treatment" system. However, many species involved in this type of bioturbation have a relatively low tolerance for high rates of organic loading (above some "critical loading rate").

Once critical loading rates are exceeded, Stage III deep and active bioturbators die and are typically replaced by small, near-surface feeding, Stage I enrichment species. Dense tube mats produced by these opportunistic species trap reduced (oxygen depleted) sediments within the bottom. These "storage systems" degrade the benthic environment due to diffusion of reduced metabolites into the overlying water column. In extreme cases, low-oxygen conditions (hypoxia/anoxia) may develop near the benthic boundary layer as a result of high chemical and biological oxygen demand associated with these sediments.

What Are Safe Organic Loading Rates for the MWRA Outfall Study Region?
Safe rates, summarized in the following section, are based on experimental and observational data on critical threshold values of organic carbon loading in benthic ecosystems.

Critical Loading Rates; Experimental and Observational Data
A large literature exists on organic carbon loading rates and an equally large literature exists on benthic community sediment processing. However, papers quantitatively linking carbon flux to benthic metabolic processes, including bioturbation, are rare. The best data come from controlled laboratory mesocosm studies (MERL tanks at the Univ. of Rhode Island) and results of monitoring intensive mariculture operations (salmonids and blue mussels). The range of values is given in Appendix H, Table 1 with data sources. The threshold critical loading rate according to Table 1 is in the range of 300 to ca. 500 g C m $^{-2}$ yr $^{-1}$. We chose the median threshold value of 400 g C m $^{-2}$ yr $^{-1}$ for the following analysis.

Table 1. Critical organic carbon loading rates based on experimental and observational data.

RATE (g C_{org} m $^{-2}$ yr $^{-1}$)	NOTES	REFERENCES
≥ 550	URI MERl tank enrichment using sewage sludge with attendant changes in the benthic community	Maughan, 1986 and Maughan and Oviatt, 1993
> 300	Salmonid culture. Circa 300 for early enrichment. 7000 value for Stage I to azoic status	Pearson as reported in Gowen & Bradbury, 1987
ca. ≥ 300	Wood pulp effluent	Pearson, 1982; Pearson & Rosenberg, 1978
> 365	Mussel culture. Values of 876-1350 clearly compromised the ability of the benthos to aerobically degrade and recycle organic matter	Dahlback and Gunnarsson, 1981
ca. 300	Salmonid culture in western Ireland	Brendan O'Connor, Aquafact Ltd, Galway, Ireland

Projected POC Loading Rates for the MWRA Outfall

The Bays Eutrophication Model (BEM) presents estimates of particulate organic carbon loading for the diffuser site (Hydroqual, 1995) after the outfall becomes operational. Annual month-by-month flux values were predicted for four stations extending from the mouth of Boston Harbor to the open Bay. Values used here are representative of those from the station closest to the outfall, Station 5, (see Figure 7-24 of Hydroqual, 1995). These flux values combined background (baseline) sedimentation of planktic organic matter with detrital production related to effluent loading. Projections show that the sum of these fluxes will be lowest in winter (December to March) and highest in April through November. The model predicts that during the early spring, summer and fall, when flux values are highest, particulate organic carbon loading will range from ca. 90 to 180 mg C m^{-2} day^{-1} (33 g C m^{-2} yr^{-1} and 66 g C m^{-2} y r^{-1}, respectively). These projected values are only 17% of the critical loading rates (400 g C m^{-2} yr^{-1}) presented in Appendix H, Table 1. If this flux were to be uniformly distributed over the bottom, our benthic eutrophication model would predict that the loading rates would be subcritical; i.e. no detectable benthic impact would be seen.

The BEM model integrates fluxes over large areas and therefore does not accurately predict local spatial variability. The bottom in the vicinity of the outfall is non-depositional and falls within the erosional and reworked facies of Knebel and Circe, 1995. Therefore it is reasonable to expect that organic detritus falling to the bottom will be redistributed from the nearfield to the midfield. The mechanisms of redistribution include bedload transport and near-bottom resuspension cycles. Depletion of detrital organic matter from the top of the diffuser drumlin to the flanks will result in fine-grained sediment focusing. Stations that presently have the highest TOC inventories can be expected to receive the greatest increase in particulate organic carbon (POC) after the diffuser comes on-line.

In summary, the most difficult task of predicting benthic effects is estimating the "redistribution coefficient" of POC from the clean washed sands of the nearfield area to midfield stations.

Potential Benthic Effects of Projected POC Fluxes

We predict that post-depositional sediment focusing will have the earliest and greatest effect at station NF24. This high-deposition rate low-kinetic energy depression is already receiving sand and mud from adjacent nearfield stations. Enhanced POC deposition at NF24 can be expected to result in retrograde succession (Stage III to I or Azoic (Rhoads and Germano, 1986). The retrograde event can be expected to be accompanied by rebound in the apparent RPD as the inventory of sedimentary sulfides builds up resulting in lower OSIs (<<+6) than historical baseline values. Sediment oxygen demand may also increase. During early stages of POC loading, standing stocks of infauna and species richness may increase temporarily as detrital food resources are enhanced (the ecotonal condition, *sensu* Pearson and Rosenberg, 1978). However, if the annual loading exceeds the critical rate, species richness can be expected subsequently to be depressed (loss of Stage III species). Standing stocks of Stage I and II species may remain at high values or decrease to near zero if hypoxia/anoxia develops at the sediment-water interface.

Midfield stations located closest to the diffuser can also be expected to receive redistributed POC from the nearfield. If the flux of POC approaches or exceeds the critical organic loading rate, the following changes in benthic processes may be predicted. Focusing of organic matter from the nearfield to the midfield may be manifested by an increase in the inventory of mud relative to sand as identified in baseline stratigraphic couplets, i.e. rippled very fine sand-over-mud. Also, enhanced organic input should result in an increase in standing stocks of detritivores, especially Stage I and II species. Dense assemblages of Stage I and II species increase sedimentation rates of fines by active filtration of organic matter from the benthic boundary layer, bind organic matter into tubes, and trap fine-grained sediment between the tubes by modifying near-bottom flow (skimming flow *sensu* Rhoads and Boyer, 1982). Midfield stations can be expected to develop extensive tube mats that can physically stabilize the bottom. During the summer, bedload transport may be reduced to nil as biological stabilization of the sediment-water interface arrests ripple migration.

The stations at the western and southern edges of the midfield area are the least likely to receive supercritical POC loadings and therefore may serve as reference areas. If POC loading rates approach, but do not exceed, the critical loading rate, Stage II seres (tubicolous amphipods) may populate those midfield stations furthest from the nearfield area. Distributions of *Ampelisca abdita* are typically located at the edges of eutrophic areas of the bottom. This ecotonal amphipod gradient has been noted in the MWRA Boston Harbor monitoring program and in Narragansett Bay (Valente *et al*., 1992). Baseline data for the midfield shows that tube-dwelling amphipods are present in the area but are presently only a minor faunal component. As organic fluxes increase by focusing, one would expect dense mats of amphipods to develop just outside of the area of maximum loading.

In summary, the existing baseline data and sampling station arrays are sufficient to document expected changes in benthic faunal structure, sedimentation rates of fine-grained organic detritus, TOC, and geochemical processes. It is difficult to predict long-term sediment focusing rates (and hence benthic responses) relative to the proposed values in Appendix H, Table 1. Nevertheless, the above analysis serves as a paradigm to be tested with real data following operation of the MWRA diffuser outfall.

References Cited

Aller, R.C., 1977. The influence of macrobenthos on chemical diagenesis of marine sediments: PhD thesis, Dept. of Geology-Geophysics, Yale University, New Haven, CT, 600 pgs.

Aller, R.C., 1982. The effects of macrobenthos on chemical properties of marine sediment and overlying water: In, Animal-Sediment Relations; the Biogenic Alteration of Sediments (P.L. McCall and M.J.S. Tevesz, eds.), Topics in Geobiology, v. 2, pp. 53-102.

Aller, R.C., 1994. Bioturbation and remineralization of sedimentary organic matter: effects of redox oscillation: Chemical Geology, 114, 331-345.

Dahlback, B. and L.A.H. Gunnarsson, 1981. Sedimentation and sulfate reduction under a mussel culture: Marine Biol., 63, 269-275.

Gowen, R.J., and N.B. Bradbury, 1987. Ecological impact of salmonid farming in coastal waters: Oceanogr. and Mar. Biology; An annual review, 25. 563-575.

Hargrave, B.T., 1973. Coupling carbon flow through some pelagic and benthic communities: Fish. Res. Board of Can., 30, 1317-1326.

Hydroqual, 1995. A water quality model for Massachusetts and Cape Cod Bays: Calibration of the bays eutrophication model (BEM), MWRA Enviro. Quality Dept. Tech Rpt/ Series No. 95-8. Massachusetts Water Resources Authority, Boston MA, 402 pgs.

Knebel, H.J., and R.C. Circe, 1995. Seafloor environments within the Boston Harbor-Massachusetts Bay sedimentary system: a regional synthesis: Jour. Coastal Res., v. 11, 230-251.

Mattsson, J., and O. Linden, 1983. Benthic macrofauna succession under mussels, *Mytilus edulis* L. (Bivalvia), cultured on hanging long lines: Sarsia, 628, 97-102.

Maughan, J., 1986. Relationship between macrobenthic infauna and organic carbon: PhD dissertation, University of Rhode Island, Kingston, RI, 213 pgs.

Maughan, J., and C. Oviatt, 1993. Sediment and benthic response to waste water solids in a marine microcosm: Water Environ. Res., 65, 679-889

O'Connor, B., 1998. Personal communication regarding unpublished data on estimated critical organic carbon loading rates under salmon cages in embayments on the West coast of Ireland: Aquafact Ltd., Galway, Ireland.

Pearson, T.H., 1982. The Loch EIL Project: Assessment and synthesis with a discussion of certain biological questions arising from a study of the organic pollution of sediments: J. exp. mar. Biol. Ecol., 57, 93-124.

Pearson, T.H. and R. Rosenberg, 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment: Oceanogr. and Marine Biology; An Annual Review, 16. 229-311.

Rhoads, D.C., P.L. McCall, and J.Y. Yingst, 1978. The ecology of seafloor disturbance: Am. Sci., v.66, pp. 577-586.

Rhoads, D.C., and J.D. Germano. 1986. Interpreting long-term changes in benthic community structure: a new protocol: Hydrobiologia, 142, 291-308.

Rhoads, D.C., and L.F. Boyer, 1982. The effects of marine benthos on physical properties of sediments, a successional perspective: In, Animal-Sediment Relations (R.L. McCall and M.J.S. Tevesz, eds.), p. 3-52, Plenum Pub. Co., New York, N.Y.

Rice, D.L. and D.C. Rhoads, 1989. Early diagenesis of organic matter and the nutritional value of sediment: In, Ecology of Marine Deposit Feeders (G. Lopez, G. Taghon, and J. Levinton, eds): Lecture Notes on Coastal and Estuarine Studies, Springer Verlag, pp 59-97.

Valente, R.M., D.C. Rhoads, J.D. Germano, and V.J. Cabelli, 1992. Mapping of benthic enrichment patterns in Narragansett Bay, Rhode Island: Estuaries, 15, pp1-17.

Yingst, J.Y., and D.C. Rhoads, 1979. The role of bioturbation in the enhancement of bacterial growth rates in marine sediments: In, Food Chain Dynamics (K. Tenore and B. Coull, eds.), Belle Baruch Symposium, Univ. S. Carolina Press, Columbia, S. Carolina, pp.407-421.

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