1999 outfall benthic monitoring report

Massachusetts Water Resources Authority

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1999 Outfall Benthic Monitoring Report

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Massachusetts Water Resources Authority
Environmental Quality Department
100 First Avenue
Charleston Navy Yard
Boston, MA 02129
(617) 242-6000

prepared by

Roy K. Kropp[1]
Robert J. Diaz[2]
Barbara Hecker[3]
Deirdre Dahlen[4]
Jeanine D. Boyle[4]
Kenneth E. Keay[5]
Carlton D. Hunt[4]

[1]Battelle Marine Sciences Laboratory
1529 West Sequim Bay Road
Sequim, WA 98382

[2]Diaz and Daughters
6198 Driftwood Lane
Ware Neck, VA 23178

[3]Hecker Environmental
26 Mullen Way
Falmouth, MA 02540

[4]Battelle
397 Washington Street
Duxbury, MA 02332

[5]Massachusetts Water Resources Authority
Environmental Quality Department
100 First Avenue
Charleston Navy Yard
Boston, MA 02129

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EXECUTIVE SUMMARY

The Outfall Benthic Surveys began in 1992 as part of the Benthic (Sea-Floor) Monitoring component of the MWRA Harbor and Outfall Monitoring (HOM) program. This study is designed to address three main concerns relative to the response of the benthic community to MWRA's relocation of the effluent discharge into Massachusetts Bay: eutrophication, contaminants, and particulate inputs. The Outfall Benthic Surveys provide quantitative measurements of benthic community structure and patterns of contaminant concentrations within sediments of Massachusetts and Cape Cod Bays. The pre-discharge monitoring has provided an extensive understanding of the baseline conditions and changes through time. After effluent discharge into the Bay begins, the focus of the program will change from the collection of baseline data to an evaluation of the effects of the discharge on the Bay ecosystems. Outfall surveys conducted after 2000 will provide the data required for a quantitative assessment of the effects of discharged effluent on sediment chemistry and benthic infauna communities. The objectives of the monitoring program following the initiation of effluent discharge into the Bay are (1) to monitor versus NPDES permit requirements, (2) to test whether or not the discharge-related impacts are within the limits predicted by the SEIS, and (3) to determine if changes in the system exceed Contingency Plan thresholds (MWRA 1997).

The 1999 outfall benthic survey was conducted before effluent discharge began at the new outfall and continued the collection of baseline data from each of the benthic monitoring program's four components: sediment profile images (SPI), geochemical properties, contaminants, and sewage tracers in sediment, benthic infaunal community, and hardbottom community. Sediment profile images (SPI) are collected to monitor the general condition of the soft-bottom benthic habitats in western Massachusetts Bay. In 1999, SPI were collected from 23 western Bay stations. Sediment geochemistry studies, conducted via the collection of sediment grab samples, consist of grain-size analysis, total organic carbon (TOC) content determination, and periodically contaminant concentration analyses. The presence of a sewage tracer, *Clostridium perfringens*, is quantified during these studies. Contaminant sampling and analysis as part of MWRA's baseline monitoring occurred annually from 1992 through 1995. In May 1996 the Outfall Monitoring Task Force determined the sediment contaminant baseline was adequate, and that analyses could stop until discharge resumed. At the time, outfall startup was expected to occur in 1997 or 1998. Given the delayed outfall startup, MWRA decided to supplement the baseline by collecting additional contaminant samples at all stations in August 1999. In addition samples at four stations for the contaminant special study were collected in August of 1999. The presence of a sewage tracer, *Clostridium perfringens*, was also quantified during these studies. Infaunal communities in Massachusetts Bay and Cape Cod Bay are monitored via the collection of samples from 20 Nearfield and 11 Farfield stations. All stations were sampled in 1999. Because of the preponderance of hard substrates in the vicinity of the outfall, semi-quantitative studies of the epifaunal communities associated with them are conducted yearly. In 1999, a remotely-operated vehicle was used to collect still photographs and videotapes from all hard-bottom stations except station T2-5 and Diffuser #44, which were located within a 1000-m zone of the outfall. These stations were not surveyed in 1999 because of work in the outfall tunnel. Summaries of the 1999 results from the components follow.

Sediment Profile Images

In 1999 the SPI study again included a "Quick Look" analysis. This analysis was developed to deliver rapid data turnaround to permit assessment of a benthic trigger, a 50% reduction of the depth of the redox potential discontinuity (RPD). The analysis involved examination of the profile images soon after completion of the survey. The results of the Quick Look analysis, which were reported separately, were found to be highly comparable to a more detailed computer-based analysis. The difference between the two analyses averaged 0.3 cm (SD = 0.35) for the 20 Nearfield stations that had measured RPD layer depths. The RPD depth differed between the two analyses by >1 cm at only one station-replicate

(NF22-2). A comparison of the within-station sensitivity of the Quick Look analysis showed that it had sufficient resolution to evaluate the RPD trigger.

The detailed SPI analysis showed that the average RPD value for 1999 (2.3 cm) was slightly deeper than it was for 1998. Statistical comparison of RPD values for the seven stations that were measured for all for years (1992, 1995, 1997, 1998, 1999) showed strong differences among years. Values for 1992, 1995, and 1999 differed from those for 1997 and 1998. Values for 1992 differed from those for all other years. While pioneering successional Stage I communities prevailed in the Nearfield in 1992 to 1997, stage II communities dominated in 1998 and 1999. The overall 1999 Nearfield average Organism-Sediment Index, which integrates several SPI parameters as a general measure of habitat condition, was statistically the same as those calculated in 1992, 1995, and 1998, but was higher (as was 1998) than the 1997 value. The low 1997 values might have reflected a seasonal change stress as SPI sampling was done in October rather than August. The 1999 SPI data showed that biological processes continued to increase in importance as a structuring mechanism of the Nearfield communities, a trend that likely began in 1995.

Sediment Geochemistry
Generally, the spatial distribution and temporal response of grain-size and total organic carbon (TOC) in 1999 were not substantially different from previous years (1992–1998). Total organic carbon content of the Nearfield sediments continued to be low as none contained > 1.5 % TOC by dry weight. However, *Clostridium perfringens* showed decreasing abundance in 1998 and 1999 from earlier years that suggested a “cleaner effluent” with less particulates is being discharged, possibly as a result of secondary treatment coming on-line in 1997.

The abundance of *Clostridium perfringens* decreased in 1998 and 1999 from earlier years and appeared to decrease with distance from Boston Harbor. Yearly means values of *Clostridium perfringens* (normalized to percent fines) for near-in stations (< 20 km) showed a decrease in abundance in 1998 and 1999 relative to earlier years. In contrast, stations further away from Deer Island Point (> 20 km) were on average relatively constant from 1992–1999. The constancy in results within distance classifications after normalization to fine grained sediments suggests the *Clostridium perfringens* abundance is strongly related to grain size.

Sediment Contaminants
Generally, the spatial distribution and temporal response of contaminant parameters in the 1999 Nearfield and Farfield were not substantially different from earlier years (1992–1998). Concentrations of organic and metal contaminants were generally low and the system was spatially variable. Variability was primarily controlled by grain size and TOC.

Baseline mean values in the Nearfield have been relatively consistent since 1992 and were well below MWRA thresholds. Baseline mean values in the Farfield were also relatively constant since 1992 and were generally less than Nearfield values. The temporal response of the baseline was similar for both Special Contaminant Study stations and the Nearfield, suggesting that the Special Contaminant Study stations are reasonably representative of the Nearfield.

To establish when significant increases above the baseline would be detected, a statistical value was established. The significant increase value was set as the 95^{th} percentile upper confidence limit (based on the “t” distribution) of the mean of the annual means. The significant increase values are well within the range of detection and MWRA thresholds are at least 2.4 times higher than the level of significant increase, suggesting that the ability to detect changes in contaminant concentrations prior to thresholds is high.

Infaunal Communities

Examination of the 1992–1997 infaunal dataset revealed that species diversity in Massachusetts Bay has increased during the course of the monitoring program. Diversity, as measured by log-series alpha and species richness (numbers of species), was significantly higher in 1998 that for the combined 1992–1997 Nearfield data. Infaunal abundance in 1998 was also somewhat higher than for the 1992–1997 period.

Multivariate analysis of the 1998 Nearfield data showed that the infaunal community could be separated into two primary groups of stations. The first group was comprised of samples from stations NF13, NF17, and NF23 and was distinguished by high abundances of the annelids *Polygordius* sp. A and *Spiophanes bombyx*. These species were associated primarily with medium to fine sand sediments. The second group of stations revealed by the multivariate analysis was complex and consisted of samples from the remaining Nearfield (here including stations FF10, FF12, and FF13). Key taxa included the annelids *Prionospio steenstrupi*, *Mediomastus californiensis*, and *Aricidea catherinae*. These taxa were associated with a wide range of sediments, ranging from medium sands to silt. Multivariate analysis of the 1998 Farfield data showed that the infaunal community could be divided into three dissimilar groups. The first group included stations FF01A and FF09, which were characterized by relatively high numbers of the annelid *Prionospio steenstrupi* and the nut clam *Nucula delphinodonta*. The second cluster group consisted of stations located along the eastern portions of the Bay from off Cape Ann to the north and in Cape Cod Bay to the south. This group was characterized by a variety of taxa including the annelids *Euchone incolor*, *Mediomastus californiensis*, *Aricidea quadrilobata*, and *Anobothrus gracilis*. The final cluster was comprised only of samples from station FF06 in Cape Cod Bay. Key taxa here were the annelids *Aricidea catherinae* and *Tharyx acutus* and the amphipod *Leptocheirus pinguis*.

Hard-bottom Communities

Classification analysis of the 1998 hard-bottom data showed that the community could be separated into three main groups of stations. The first group consisted primarily of moderate to high-relief drumlin top areas that had variable sediment drape. The encrusting coralline alga *Lithothamnion* was a common inhabitant of many areas that comprised this group. Other key taxa in Cluster 1 were the upright algae *Asparagopsis hamifera* and *Rhodymenia palmata*. Cluster 2 consisted of drumlin top and flank areas that had light to moderately-light sediment drape. *Lithothamnion* was the dominant taxon in this group. Cluster 3 consisted mainly of drumlin flank areas that had low to moderately-low relief and moderately-heavy sediment drape. Areas in this group were characterized by low abundances of algae and fish and had low to moderate abundances of invertebrates. The sea star *Asterias* was the most common taxon here. The hard-bottom communities near the outfall have been studied consistently for the past four years. During this time the communities, although spatially variable, have shown reasonable temporal stability.

1. INTRODUCTION

The Outfall Benthic Surveys began in 1992 as part of the Benthic (Sea-Floor) Monitoring component of the MWRA Harbor and Outfall Monitoring (HOM) program. This study is designed to address three main concerns relative to the response of the benthic community to MWRA's relocation of the effluent discharge into Massachusetts Bay: eutrophication, contaminants, and particulate inputs. The Outfall Benthic Surveys provide quantitative measurements of benthic community structure and patterns of contaminant concentrations within sediments of Massachusetts and Cape Cod Bays. The pre-discharge monitoring has provided an extensive understanding of the baseline conditions and changes through time. After effluent discharge into the Bay begins, the focus of the program will change from the collection of baseline data to an evaluation of the effects of the discharge on the Bay ecosystems. Outfall surveys conducted after 2000 will provide the data required for a quantitative assessment of the effects of discharged effluent on sediment chemistry and benthic infauna communities. The objectives of the monitoring program following the initiation of effluent discharge into the Bay are (1) to monitor versus NPDES permit requirements, (2) to test whether or not the discharge-related impacts are within the limits predicted by the SEIS, and (3) to determine if changes in the system exceed Contingency Plan thresholds (MWRA 1997).

The 1999 outfall benthic survey was conducted before effluent discharge began at the new outfall and continued the collection of baseline data from each of the benthic monitoring program's four components: sediment profile images (SPI), geochemical properties, contaminants, and sewage tracers in sediment, benthic infaunal community, and hardbottom community. The results and analyses of the sediment profile images collected from 23 western Bay stations are presented in Section 3. Sediment geochemistry studies, conducted via the collection of sediment grab samples, consist of grain-size analysis, total organic carbon (TOC) content determination, and periodically contaminant concentration analyses. Contaminant sampling and analysis as part of MWRA's baseline monitoring occurred annually from 1992 through 1995. In May 1996 the Outfall Monitoring Task Force determined the sediment contaminant baseline was adequate, and that analyses could stop until discharge resumed. At the time, outfall startup was expected to occur in 1997 or 1998. Given the delayed outfall startup, MWRA decided to supplement the baseline by collecting additional contaminant samples at all stations in August 1999. In addition samples at four stations for the contaminant special study were collected in August of 1999. The presence of a sewage tracer, *Clostridium perfringens*, was also quantified during these studies. These studies are presented in Section 4. Infaunal communities in Massachusetts Bay and Cape Cod Bay are monitored via the collection of samples from 20 Nearfield and 11 Farfield stations. All stations were visited in 1999. Analyses of the infaunal communities are described in Section 5 and include an evaluation of infaunal communities in relation to the suite of sediment geochemical parameters measured. Because of the preponderance of hard substrates in the vicinity of the outfall, semi-quantitative studies of the epifaunal communities associated with them are conducted yearly. In 1999, a remotely-operated vehicle was used to collect still photographs and videotapes from all hard-bottom stations except station T2-5 and Diffuser #44, which were located within a 1000-m zone of the outfall. These stations were not surveyed in 1999 because of work in the outfall tunnel. Analyses of the hard-bottom survey data constitute Section 6. This report also includes a programmatic evaluation of each of the components. This evaluation is presented in Section 7.

The raw data for all of these studies are available from MWRA.

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2. FIELD OPERATIONS

By Jeanine D. Boyle

2.1 Sampling Design

2.1.1 Soft-Bottom

Sediment Samples—The Nearfield benthic surveys, conducted annually in August, are designed to provide spatial coverage and local detail of faunal communities inhabiting depositional environments within about 8 km of the diffuser. Samples for sediment chemistry and benthic infauna were collected at 20 Nearfield stations (Figure 2-1). The target locations for the Nearfield stations are listed in the CW/QAPP (Kropp and Boyle 1998). The actual locations of each grab sample collected are listed in Appendix A-1.

Farfield benthic surveys, also conducted annually in August each year, are designed to contribute reference and early-warning data on soft-bottom habitats in Massachusetts and Cape Cod Bays. Grab samples were collected at 11 stations in Massachusetts and Cape Cod Bays (Figure 2-2) for infaunal and chemical analyses. The target locations for the Farfield stations are listed in the CW/QAPP (Kropp and Boyle 1998). The actual locations of each grab sample collected are listed in Appendix A-1.

The Nearfield Contaminant Special Study Surveys are designed to examine the possible short-term impacts of the new outfall discharge on sedimentary contaminant concentrations and their interrelationships with possible sedimentary organic carbon changes in depositional environments near the effluent outfall. In August 1999, samples were collected from the four Contaminant Special Study Stations, in conjunction with the August Nearfield/Farfield Survey. The Nearfield Contaminant Special Study stations include; NF08, NF22, NF24, and FF10. The historical (*i.e*., pre-1998) criteria used to select these four locations were:

- Historically, stations (except FF10) were comprised of fine grained material (>50% sand/silt);
- Stations were in relatively stable areas (except for FF10, grain size composition >50% sand/silt over the period monitored);
- Stations (except FF10) had high total organic carbon (TOC) content, relative to other locations nearby (at least 1% TOC);
- Stations were within the zone of increased particulate organic carbon deposition predicted by the Bay Eutrophication Model (BEM, Hydroqual and Normandeau, 1995); and
- Selection of these stations complements and expands on stations (NF12, NF17) periodically sampled by the USGS.

Stations FF10, NF08, and NF24 lie on a line extending to the northwest from the west end of the diffuser and along with NF12, separately sampled by the USGS, provide a spatial gradient extending from the diffuser (Figure 2-1). This gradient extends towards the predicted high deposition area. Station NF22 lies to the southwest of the west end of the diffuser and is along the projected long-term effluent transport path from the diffuser. Station FF10 extends the area of impact sampled under the contaminant special studies task and represents a Farfield location near the center of the high deposition location predicted by the BEM model and is a sandier location.

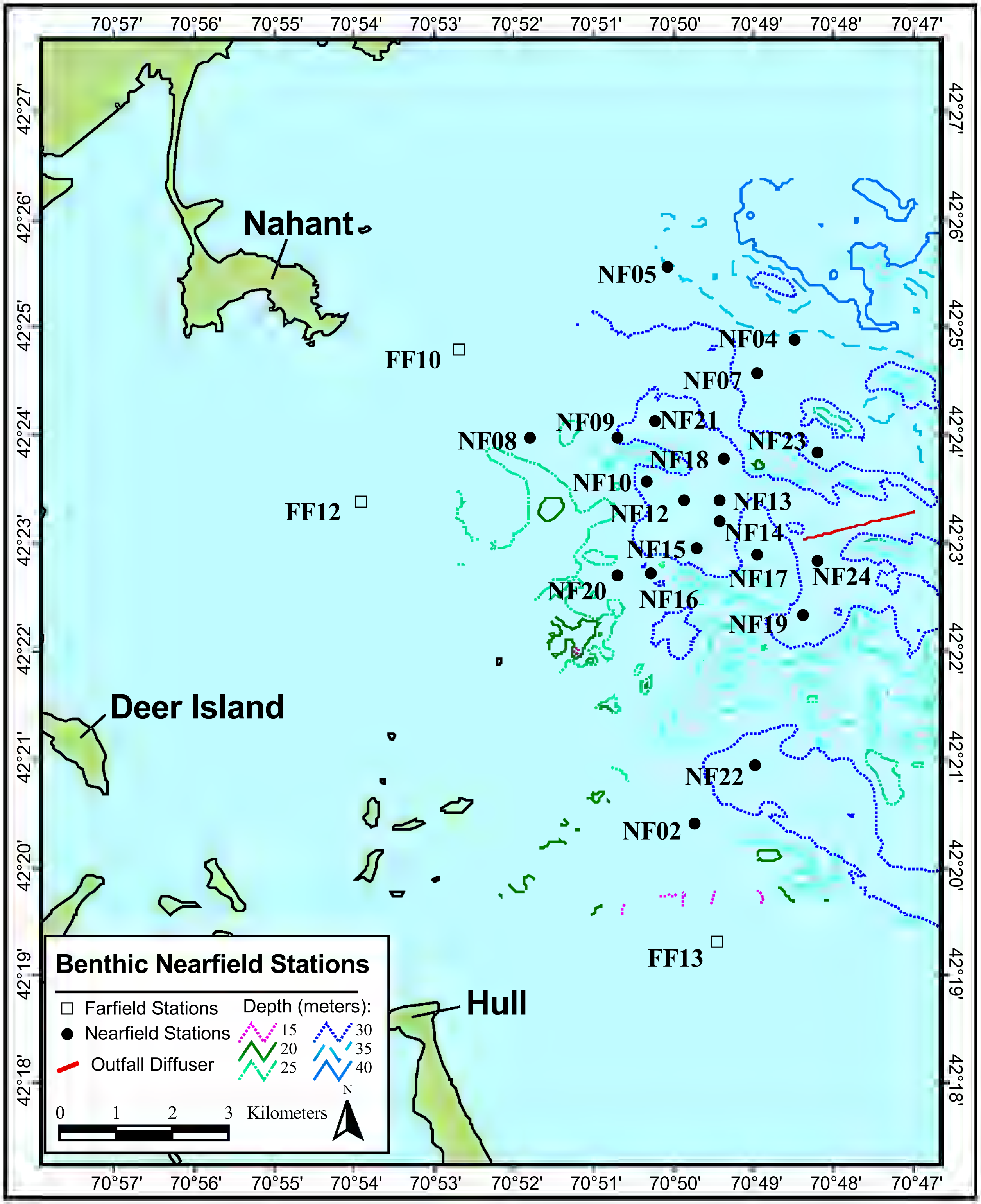


Figure 2-1. Locations of Nearfield and selected Farfield grab stations sampled in August 1999.

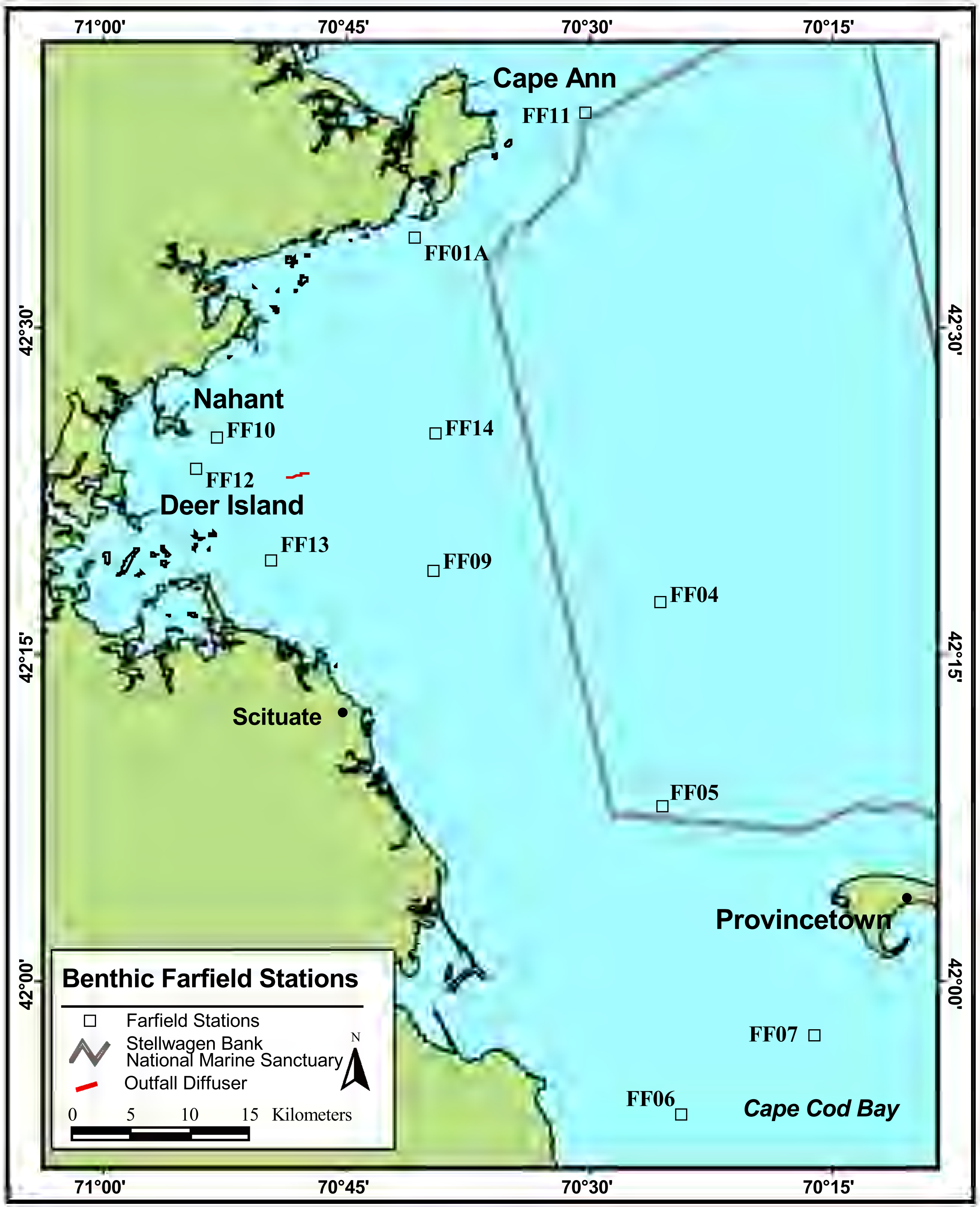


Figure 2-2. Locations of Farfield grab stations sampled in August 1999.

The actual locations of all grab samples collected on the contaminant special study survey are listed in Appendix A-1.

Sediment Profile Images—The Nearfield Sediment Profile Image surveys are conducted in August of each year at 20 Nearfield and 3 Farfield stations (Figure 2-1) to give an area-wide, qualitative/ semi-quantitative assessment of sediment quality and benthic community status that can be integrated with the results of the more localized, quantitative surveys to determine sedimentary conditions near the outfall. Furthermore, these surveys provide rapid comparison of benthic conditions to the benthic triggering thresholds. Traditional sediment profile imagery (35-mm slides) allows a faster evaluation of the benthos to be made than can be accomplished through traditional faunal analyses. A more rapid analysis of the SPI data was accomplished by fitting the profile camera prism with a digital video camera arranged to view the same sediment profile as the 35-mm film camera. The target locations for the SPI sampling are the same as those for the grab sampling effort. The actual locations of all sediment profile images collected are listed in Appendix A-2.

2.1.2 Hard-Bottom

Because of the relative rarity of depositional habitats in the Nearfield and in the vicinity of the diffusers, a continuing study of hard-bottom habitats has been implemented to supplement the soft-bottom studies. The Nearfield hard-bottom surveys are conducted in June of each year. Video tape footage and 35-mm slides were taken at 19 waypoints along six transects and at two additional discrete waypoint (T9-1 and T10-1). In preparation for the diffuser uncapping, the outfall area was designated a no-anchor zone in April 1999 and two historical waypoints, Diffuser 44 and T2-5, were not sampled this year (Figure 2-3). Actual coordinates for hard-bottom stations sampled in June 1999 are listed in Appendix A-3.

2.2 Surveys/Samples Collected

The dates of the outfall benthic surveys and the numbers of samples collected on them are listed in Table 2-1.

Table 2-1. Survey dates and numbers of samples collected on benthic surveys in 1999.

Survey	ID	Date(s)	Samples Collected								
			Inf	TOC	Gs	Cp	C	Tm	SPI	35	V
Nearfield Benthic	BN991	10, 11, 12, 13 Aug 1999	26	28	28	28	28	28	–	–	–
Farfield Benthic	BF991	11, 13 Aug 1999	33	23	23	23	23	23	–	–	–
SPI	BR991	24, 25, 26 Aug 1999	–	–	–	–			76	–	76
Hard-bottom	BH991	22, 23, 24 Jun 1999	–	–	–	–			–	756	42
Nearfield Contaminant[a]	BC992	10, 12, 13 Aug 1999	–	12	12	12	12	12	–	–	–

[a]Six samples collected during surveys BF/BN991 were used to supplement the six collected during survey BC992.

Key:

Inf, Infauna
Gs, grain size
C, contaminant
35, 35-mm slides (hard-bottom)
Tm, trace metals
TOC, total organic carbon
Cp, *Clostridium perfringens*
SPI, sediment profile images (slides)
V, video segments (hard-bottom)

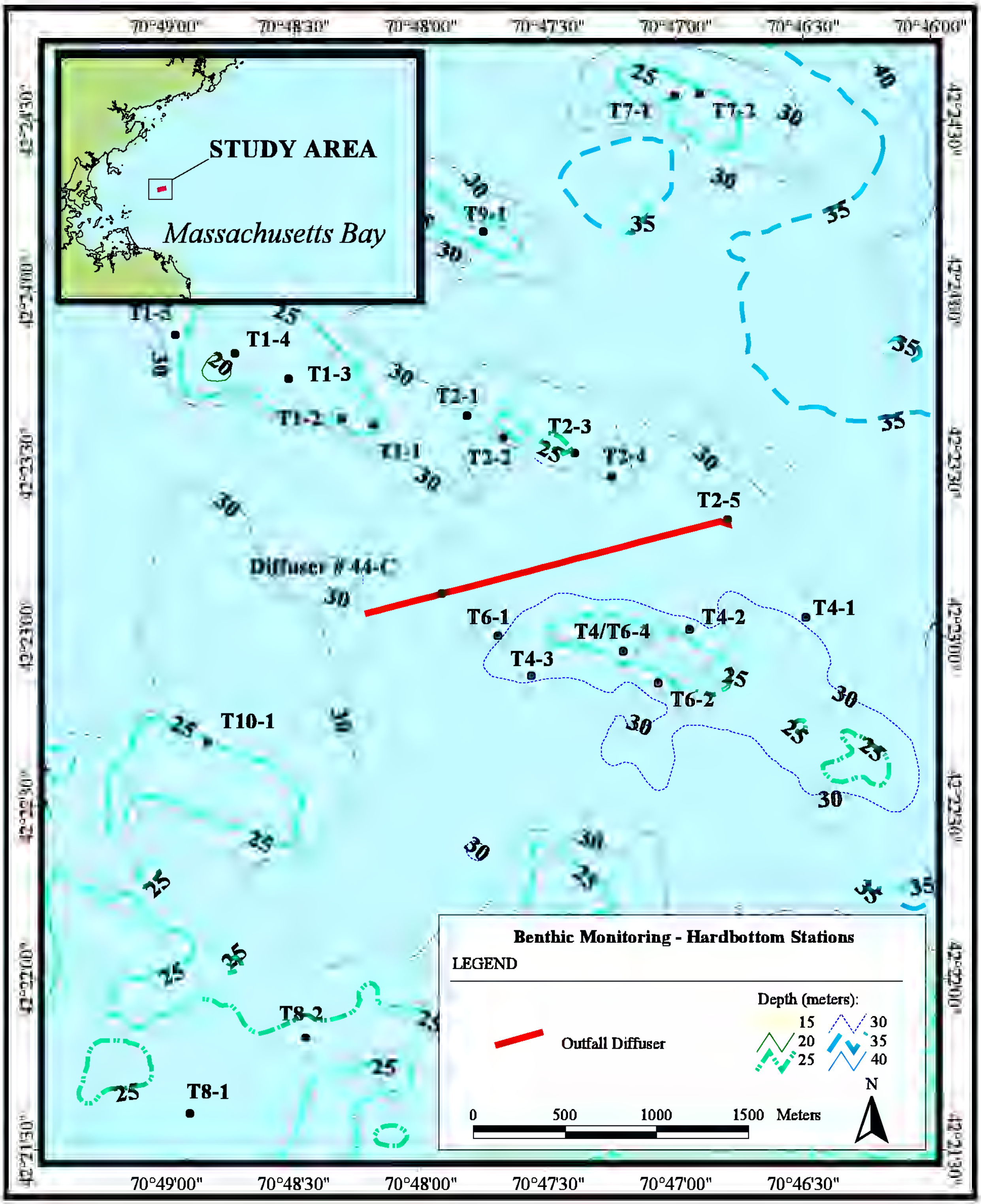


Figure 2-3. Locations of hard-bottom stations sampled in June 1999. Diffuser 44 and T2-5 were not sampled in 1999 because of the no-anchor zone established around the diffusers.

2.3 Field Methods Overview

The following is a brief overview of the methods and protocols used on the benthic surveys. More detailed descriptions of the methods are contained in the CW/QAPP (Kropp and Boyle 1998).

2.3.1 Vessel/ Navigation

Vessel positioning during benthic sample operations was accomplished with the BOSS Navigation system. This system consists of a Northstar differential global positioning system (DGPS) interfaced to the on-board BOSS computer. Data were recorded and reduced using NAVSAM data acquisition software. The GPS receiver has six dedicated channels and is capable of locking into six satellites at one time. The system was calibrated with coordinates obtained from USGS navigation charts at the beginning and end of each survey day.

At each sampling station, the vessel was positioned as close to target coordinates as possible. The NAVSAM navigation and sampling software collected and stored navigation data, time, and station depth every 2 seconds throughout the sampling event, and assigned a unique ID to each sample when the sampling instrument hit bottom. The display on the BOSS computer screen was set to show a radius of 30 m around the target station coordinates (6, 5-m rings) for all MWRA benthic surveys. A station radius of up to 30 m is considered acceptable for sediment sampling in Massachusetts Bay.

2.3.2 Grab Sampling

Nearfield/Farfield Benthic Surveys—At all 11 Farfield stations and 3 Nearfield stations (NF12, NF17, and NF24), a 0.04-m^2 modified van Veen grab sampler was used to collect 3 replicate samples for infaunal analysis and 2 replicate samples for *Clostridium perfringens*, sediment grain size, TOC, and contaminant analyses. At each of the remaining 17 Nearfield stations, 1 grab sample for infaunal analysis and one grab sample for *C. perfringens*, sediment grain size, TOC, and contaminant analyses were collected. Infaunal samples were sieved onboard the survey vessel over a 300-μm-mesh sieve and fixed in buffered formalin. The "chemistry" sample was skimmed off the top 2 cm of the grab by using a Kynar-coated scoop, and was homogenized in a clean glass bowl before being distributed to appropriate storage containers. The TOC samples were frozen, whereas the *C. perfringens* and grain size samples were placed on ice in coolers.

Sediment sampling at stations FF04 and FF05 in the Stellwagen Bank National Marine Sanctuary was conducted under Permit #SBNMS-D6-98.

Nearfield Contaminant Special Study—During the August Nearfield/Farfield benthic survey, additional sediment was collected from stations NF08, NF22, NF24, and FF10 to bring the total number of "chemistry" replicates (TOC, grain size, *Clostridium,* and contaminants) at those stations to three. Samples were collected from the top 2 cm of the Kynar-coated grab and processed as described above.

2.3.3 SPI

At each station, a Hulcher Model Minnie sediment profile camera fitted with a digital video camera, to allow for real-time viewing of the sediment profiles, was deployed three times. The profile camera was set to take two pictures, using Fujichrome 100P slide film, on each deployment at 2 and 12 seconds after bottom contact. In the event that sediments were soft the two-picture sequence would ensure that the sediment-water interface would be photographed before the prism window over penetrated. The combination of video and film cameras ensured accurate and reliable collection of sediment profile images. Any replicates that appeared to be disturbed during deployment were retaken. The videotape ran during each drop and was narrated in real time by the Senior Scientist, Dr. Robert Diaz, as the photos were taken. The narration included the station, time, approximate prism penetration depth, and a brief description of the substrate. In addition, the Oxidation-Reduction Potential Discontinuity was estimated by Dr. Diaz at each Nearfield station. These measurements were recorded in Dr. Diaz's log, and the Battelle Survey logbook. Each touch down of the camera was marked as an event on the NAVSAM©. The video image was recorded for use as part of the Quick Look analysis.

2.3.4 Hard-Bottom

The June 1999 hard-bottom survey of the Nearfield examined 19 waypoints distributed along 6 transects (T1, T2, T4, T6, T7, and T8), plus 2 additional waypoints (T9-1 and T10-1). A MiniRover MK II ROV equipped with a Benthos low-light, high-resolution video camera, a Benthos Model 3782 35-mm minicamera with strobe, 150 W halogen lamps, a compass, and a depth gauge was deployed from the survey vessel to obtain the necessary video and slides. The ROV was guided as close to the bottom as possible so that the clarity of the video and photographs was maximized. Approximately 20 minutes of video footage per waypoint were recorded along a randomly-selected heading. Along this route, still photographs were taken as selected by the Senior Scientist, Dr. Barbara Hecker, until an entire (36 exposure) roll of 35-mm film was exposed at each waypoint.

The date, time, and ROV depth were recorded on the videotapes and appeared on the video monitor during the recording. These data were not recorded on each photograph taken at the waypoints. These were recorded in a notebook and later transferred to the still slides. The start of and stop of each video tape, the start of each roll of film, and the capture of each 35-mm image were recorded as "events" on the NAVSAM© system. The time displayed on the video monitor (and recorded on the tape) was synchronized with the NAVSAM© clock. When a still photograph was taken, the event also was marked verbally on the video tape. The NAVSAM© produced labels that were attached to each video cartridge and each film canister. All slides were developed onboard to monitor camera proficiency. Slides were labeled manually at the lab after mounting. All slides were scanned into electronic images and copied onto a CD for archival.

3. 1999 SEDIMENT PROFILE CAMERA RECONNAISSANCE OF NEARFIELD BENTHIC HABITATS

by Robert J. Diaz

3.1 Materials and Methods

3.1.1 Quick Look Analysis

The Quick Look analysis was developed in 1998 to meet the needs of rapid data turn around for assessment of benthic triggers, one of which is an area wide 50% reduction in the average depth of the redox potential discontinuity (RPD) layer (MWRA 1997). The exposed film was developed 26 August, the last day of field operations, and the Quick Look analysis completed 30 August (Diaz 1999). See Kropp *et al*. (2000) for details on the Quick Look analysis.

3.1.2 Image Analysis

The sediment profile images were first analyzed visually by projecting the images and recording all features seen into a preformatted standardized spreadsheet file. The images were then digitized using a Nikon 2000 scanner and analyzed using the Adobe PhotoShop and NTIS Image programs. Data from each image were sequentially saved to a spreadsheet file for later analysis. Details of how these data were obtained can be found in Diaz and Schaffner (1988), Rhoads and Germano (1986), and Kropp *et al*. (2000).

3.2 Results and Discussion

3.2.1 Quick Look vs. Detailed Analyses

Overall there was a high degree of correspondence between the Quick Look and detailed analyses (Table 3-1). For example, the correlation between the two analyses for the apparent color RPD layer depth, one of the benthic trigger parameters (MWRA 1997), was 0.81 ($p < 0.001$) with the Quick Look analysis tending to be higher relative to the detailed analysis (paired t-test, $p = 0.01$). The difference between the two analyses averaged 0.3 cm (SD = 0.35) for the 20 Nearfield stations that had measured RPD layer depths (Table 3-2). At three clean sandy sediments stations (NF04, NF13 and NF17) the RPD layer was deeper than prism penetration. The RPD depth differed between the two analyses by >1 cm at only one station-replicate (NF22-2) (Table 3-1). About two-thirds of the replicate images with measured RPD depths had deeper values in the Quick Look analysis. Overestimation of RPD depth in the Quick Look analysis was related to the 0.5 cm resolution of the Quick Look and the overall light color and low contrast of sediment at many stations. Both of these problems were accounted for in the computer image analysis.

To test the sensitivity of the Quick Look analysis for estimating RPD depths, the station Quick Look value was expressed as a percentage of the computer analysis value (Table 3-2). For the 20 stations with measured RPD depths, only one station exceeded a difference of 50% (NF24). This indicated that the Quick Look analysis had sufficient resolution to estimate changes in RPD depths given the 50% change criteria.

Table 3-1. Comparison of August 1999 Nearfield apparent color RPDs from the Quick Look and detailed computer analyses of SPI images. Quick Look analysis was completed two days after fieldwork. Detailed analysis was completed 30 days after fieldwork. Delta is the difference between the two analyses. Negative sign indicates detailed analysis produced a deeper RPD layer depth estimate.

Station	Replicate	Quick Look RPD(cm)	Detailed RPD(cm)	Delta(cm)
FF10	1	IND*	IND	IND
FF10	2	3	2.2	0.8
FF10	3	2.5	2.2	0.3
FF12	1	2	1.3	0.7
FF12	2	2.5	1.7	0.8
FF12	3	2.5	1.9	0.6
FF13	1	IND	IND	IND
FF13	2	IND	IND	IND
FF13	3	1	1.0	0.0
FF13	4	2	1.2	0.8
FF13	5	3	2.4	0.6
NF02	1	IND	IND	IND
NF02	2	IND	IND	IND
NF02	3	IND	IND	IND
NF02	4	2	2.1	–0.1
NF04	1	>3*	>3.2	>–0.2
NF04	2	>4	>3.1	0.9
NF04	3	>4	>4.2	–0.2
NF05	1	2.5	2.3	0.2
NF05	2	2.5	2.2	0.3
NF05	3	3	3.5	–0.5
NF07	1	1.5	1.6	–0.1
NF07	2	1.5	2.1	–0.6
NF07	3	1	1.0	0.0
NF08	1	2	1.9	0.1
NF08	2	2	1.5	0.5
NF08	3	2	1.7	0.3
NF09	1	2	2.3	–0.3
NF09	2	2	1.4	0.6
NF09	3	2.5	2.0	0.5
NF10	1	2.5	1.6	0.9
NF10	2	2	2.5	–0.5
NF10	3	2	1.6	0.4
NF12	1	2.5	1.8	0.7
NF12	2	2	1.3	0.7
NF12	3	3	2.5	0.5
NF13	1	>3	>2.8	>0.2
NF13	2	>3	>2.8	0.2
NF13	3	>3	>2.5	0.5
NF14	1	4	4.6	–0.6

Station	Replicate	Quick Look RPD(cm)	Detailed RPD(cm)	Delta(cm)
NF14	2	3	3.0	0.0
NF14	3	2	2.1	–0.1
NF15	1	2.5	2.3	0.2
NF15	2	3	2.5	0.5
NF15	3	2.5	2.1	0.4
NF16	1	3	2.2	0.8
NF16	2	2	1.2	0.8
NF16	3	2.5	1.9	0.6
NF17	1	>4	>3.4	>0.6
NF17	2	>5	>5.2	–0.2
NF17	3	>3	>3.3	–0.3
NF18	1	3	2.6	0.4
NF18	2	2.5	2.5	0.0
NF18	3	3.5	2.9	0.6
NF19	1	1.5	1.5	0.0
NF19	2	1.5	1.6	–0.1
NF19	3	1	1.3	–0.3
NF20	1	3	3.4	–0.4
NF20	2	2	2.0	0.0
NF20	3	3	2.9	0.1
NF21	1	3	2.3	0.7
NF21	2	2.5	2.0	0.5
NF21	3	1.5	0.9	0.6
NF22	1	2.5	1.9	0.6
NF22	2	3.5	2.4	1.1
NF22	3	2.5	1.9	0.6
NF23	1	>4	>3.7	>0.3
NF23	2	>3	>2.7	0.3
NF23	3	4	4.4	–0.4
NF23	4	>3	>2.6	0.4
NF24	1	2	1.1	0.9
NF24	2	2	1.6	0.4
NF24	3	IND	IND	IND
NF24	4	IND	IND	IND

* IND = RPD was indeterminate.
> = RPD layer depth was greater than prism penetration

Table 3-2. Difference between Quick Look (QL) and detailed (D) computer analyses of the apparent color RPD layer depth from Nearfield stations, August 1999. Delta is the difference between QL and D. Negative sign indicates detailed analysis produced a deeper RPD layer depth estimate. Only images that had identifiable RPD layers were included.

Station	QL (cm)	D (cm)	Delta (cm)	Percent Difference
FF10	2.8	2.2	0.6	26.5
FF12	2.3	1.6	0.7	44.7
FF13	2.0	1.5	0.5	31.7
NF02	2.0	2.1	–0.1	–4.9
NF04	>3.7*	>3.5	–	–
NF05	2.7	2.7	0.0	–0.6
NF07	1.3	1.6	–0.2	–14.1
NF08	2.0	1.7	0.3	16.8
NF09	2.2	1.9	0.3	15.0
NF10	2.2	1.9	0.3	15.5
NF12	2.5	1.9	0.6	33.9
NF13	>3.0*	>2.7	–	–
NF14	3.0	3.3	–0.3	–8.0
NF15	2.7	2.3	0.4	17.4
NF16	2.5	1.8	0.7	42.1
NF17	>4.0*	>4.0	–	–
NF18	3.0	2.6	0.4	14.0
NF19	1.3	1.5	–0.1	–9.1
NF20	2.7	2.8	–0.1	–3.4
NF21	2.3	1.7	0.6	36.0
NF22	2.8	2.1	0.7	35.8
NF23	3.5	3.3	0.2	4.7
NF24	2.0	1.3	0.7	50.5
Grand Ave.	2.4	2.1	0.3	14.8
SD	0.5	0.6	0.3	–

* Not included in average, prism penetration too shallow to see RPD.

3.2.2 1999 Nearfield Image Data

At least three replicate sediment profile film images and taped video were collected at each of 23 Nearfield stations (Figure 2-1). A complete listing of sediment profile image (SPI) data can be found in Appendix B-1. Appendix B-2 provides a summary of within station variability for quantitative measurements; prism penetration, surface relief, RPD, OSI, and number of infauna, burrows, and voids. A station summary of SPI data is contained in Table 3-3.

Physical processes and sediments—Grain size ranged from cobbles and pebbles (FF13) to mixed sandy-silt-clay sediments (NF10) (Table 3-3, see Appendix 3-3 for image plates). Heterogeneous sediments, defined as those having more than two textural end-members (silt, sand, gravel, pebble, or cobble), occurred at nine stations. Homogeneous sandy sediments occurred at four stations (FF12, NF04, NF13, and NF17) and nine stations had homogeneous fine sediments (Table 3-3). Sediment layering, fine-sand layer over silty-clay, occurred at one station (NF05). The modal grain size descriptors were silty-fine-sand and fine-sand-silt-clay both with four stations. Within station variation of sediment type was high at the heterogeneous stations with individual replicates ranging from silty-fine-sand to pebbles (NF24) and low at fine sediment stations where all replicates had the same sediment type. Grain size for all three replicates was the same at 14 of the 23 stations (Appendix 3-1). The stations with the most spatial heterogeneity in sediment type were: FF10, FF13, NF02, NF23, and NF24 where each of the replicates had a different sediment type.

All nine stations with pebble or cobble sediments, indicative of high kinetic energy or transport bottoms, also had a fine sediment component. Pure sands and gravels, also indicative of higher bottom energy, were seen at four stations scattered over the study area (Figure 3-1). Bedforms typically associated with higher energy sandy bottoms were seen at two stations (NF04 and NF23). The lack of bedforms may be related to the lack of large storms over the winter of 1998–1999 that would have reshaped bottom sediments. Benthic organisms would tend to destroy physical structures such as bedforms during quiescent periods. Homogeneous finer sediments, fine-sand-silt-clay and silt-clay, were concentrated to the northwest of the diffused but also occurred to the south (Figure 3-1). Finest sediments that appeared to have been composed only of silts and clays (modal Phi > 6) occurred at four stations NF07, NF08, NF21 and NF22.

The correspondence between the SPI image and grab sediment analysis was good given the divergent approach with which the two methods sampled the sediments (Table 3-4). Both methods indicated the sediments were heterogeneous in some areas and homogeneous in other areas. The SPI images, which were from three replicates, were able to sample a larger area than the single grab sample and provided *in situ* information across the width and depth of the image. Therefore, the images provided better estimates of spatial and end member variability of the sediments, particularly for coarse sediments. The grab samples and grain-size analysis provided better estimates of fine sediment end members (Section 4). To compare the two methods the grab data were converted to a Wentworth classification as described in Folk (1974) and the shell, pebble, and cobble removed from the SPI data (Table 3-4). The very coarse end members were removed because the grab would not sample them.

Prism penetration and sediment grain size were closely related with lowest penetration at hard sand-gravel-pebble-shell bottoms (NF02). The range of average station penetration was 0.5 (NF02) to 21.6 cm (NF08) and reflected the dichotomy of benthic habitats, where habitats in the Nearfield area had either coarser heterogeneous or finer homogenous sediments (Table 3-3). Mixed and fine sediments, fine-sand-silt-clay and silt-clay, had highest penetration (NF08 and NF12).

In physically dominated sandy and coarse habitats surface relief (bed roughness) ranged from 0.9 to 6.8 cm and was caused by pebble/rocks or bedforms (NF02 or NF23). In muddy habitats surface relief was lower and ranged from 0.7 to 2.6 cm and was typically irregular surfaces, caused by biogenic activity of benthic organisms (NF16). Biological surface roughness ranged from feeding mounds (NF22) and tubes (NF09) to colonies of hydroids (FF10)

Apparent Color RPD Depth—Benthic habitat quality has long been associated with RPD layer depth, in particular relative to organic enrichment and successional stage (Pearson and Rosenberg 1978). As organic loading increases the RPD layer becomes shallower in response to increased sediment oxygen demand and the elimination of deep bioturbating fauna. Conversely, as successional stage advances the RPD layer depth increases. Based on this close association between organic loading, successional stage, and habitat quality RPD makes a good monitoring parameter. However, factors other than organic

Table 3-3. Station summary of SPI parameters for the August 1999 survey of the Nearfield area. Data from all replicates were averaged for quantitative parameters and summed for qualitative parameters (for example, the presence of tubes in one replicate resulted in a + for the station).

					Surface Features			Subsurface Features							
Stat	Pen. (cm)	SR (cm)	RPD (cm)	Sediment Type	Surface Features	Amp	StkA	Tubes	Layers	Wrm	Bur	Oxic Voids	Anaer Voids	Succ Stage	OSI
FF10	4.1	4.1	2.2	RK to SIFS	BIO/PHY	–	–	+	–	4.0	1.5	0.0	0.0	II	6.0
FF12	4.6	0.5	1.6	FS	BIO/PHY	–	–	+	–	8.0	6.7	0.0	0.0	II/III	6.7
FF13	1.7	2.9	1.5	RK to FSSI	BIO/PHY	–	–	+	–	3.3	1.7	0.0	0.0	II	5.7
NF02	0.5	6.8	2.1	RK to FSSI	PHY, SH	–	–	+	–	.	.	.	.	.	.
NF04	3.5	0.9	>3.5	FS, GR	BIO/PHY, SH	–	–	+	–	0.3	0.0	0.0	0.0	II	8.3
NF05	5.3	1.1	2.7	FS/SICL	BIO	+	+	+	GS	4.0	4.3	0.0	0.0	II	7.0
NF07	13.9	1.0	1.6	SIFS	BIO	–	+	MAT	–	7.0	9.3	1.3	0.3	II/III	6.3
NF08	21.6	0.7	1.7	SIFS	BIO	–	–	MAT	CL	7.3	6.7	0.0	0.3	II	5.7
NF09	11.6	1.7	1.9	FSSI	BIO	–	+	MAT	–	8.3	5.3	2.7	0.0	III	8.0
NF10	12.2	1.1	1.9	FSSICL	BIO	–	–	MAT	–	10.3	8.0	2.3	0.3	III	8.3
NF12	21.0	1.7	1.9	FSSICL	BIO	–	–	MAT	–	8.0	5.7	4.7	0.3	III	8.0
NF13	2.7	1.3	>2.7	FSMS	BIO/PHY, SH	–	–	+	–	0.0	0.0	0.0	0.0	II	7.0
NF14	5.7	1.2	3.3	PB to SIFS	BIO/PHY, SH	–	–	+	–	1.0	1.0	0.0	0.0	II/III	8.0
NF15	4.7	1.3	2.3	PB to FSSI	BIO/PHY, SH	–	–	+	–	1.7	2.0	0.3	0.0	II	6.7
NF16	16.2	2.6	1.8	FSSICL	BIO	–	–	MAT	–	8.7	5.3	1.7	1.0	II/III	7.0
NF17	4.0	1.3	>4.0	GR to FSMS	PHY,SH	–	–	+	–	0.0	0.0	0.0	0.0	II	8.5
NF18	8.9	2.5	2.6	PB to SIFS	BIO/PHY	–	–	+	–	2.3	2.7	1.7	0.0	II	6.7
NF19	3.3	1.1	1.5	FSSICL	BIO/PHY, SH	–	–	+	–	4.0	6.3	0.0	0.0	II	5.3
NF20	6.0	2.2	2.8	PB to SIFS	BIO/PHY	–	–	MAT	–	2.0	1.3	0.0	0.0	II	7.0
NF21	17.4	1.2	1.7	SIFS	BIO	–	–	MAT	–	7.0	8.3	2.7	1.0	II/III	7.7
NF22	13.2	1.5	2.1	SIFS	BIO	–	–	MAT	–	8.3	5.3	1.7	0.3	II/III	7.7
NF23	4.1	2.3	>3.4	PB to FSSICL	BIO/PHY, SH	–	–	+	–	0.5	0.0	0.0	0.0	I/II	7.0
NF24	5.4	3.0	1.3	PB to FSSICL	BIO/PHY	–	–	+	–	10.5	7.5	2.0	1.0	II/III	6.0

> At least one replicate had an RPD layer deeper than the prism penetration.

Table 3–3. Station summary of SPI parameters for the August 1999 survey of the Nearfield area.

Key:

Stat. = Station
Pen = Average prism penetration depth
SR = Average surface relief across the 15 cm width of the prism face plate
RPD = Average depth of the apparent color RPD
Sediment Type:

FS = Fine-sand	FS/SICL = Sand layer over silty	RK = Rock
FSMS = Fine-Medium-sand	GR = Gravel	SH = Shell
FSSICL = Fine-sand-silt-clay	PB = Pebble	SIFS = Silty Fine-sand

Surface Features = Predominant sediment surface structuring process: BIO = Biogenic, PHY = Physical
Amp = *Ampelisca* tubes
StkA = Stick amphipod biogenic structures, likely the genus *Dyopedos*
Tube = Worm tubes: MAT = tubes dense enough to form a mat over surface
Layers = Sediment layering: GS = Grain size layering, CL = Color layering
Wrm = Subsurface infaunal worms, average number per image
Burr = Infaunal burrows, average number per image
Oxic Voids = Water filled inclusions in sediment, active biogenic features, average number per image
Anaer Voids = Water filled inclusions in sediment, relic biogenic features, average number per image
SS = Estimated successional stage
OSI = Organism Sediment Index

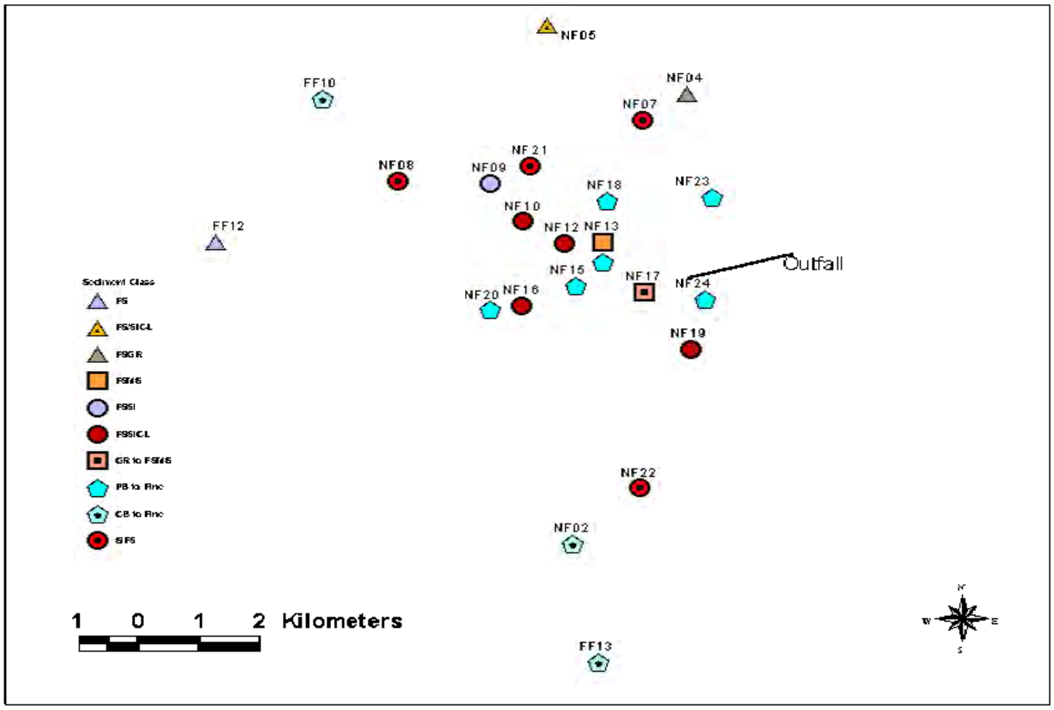


Figure 3-1. Distribution of estimated sediment types at Nearfield stations based on SPI, August 1999.

loading and successional stage can cause RPD layer depth to fluctuate. Seasonality, grain size, pore water flow, water quality (particularly dissolved oxygen), and intensity of bioturbation are all known to contribute to small scale spatial and temporal variation in RPD layer depth (Rhoads and Boyer 1982, Jones and Jago 1993, Diaz and Rosenberg 1995, Aller and Aller 1998).

Average apparent color RPD layer depth at the 23 stations ranged from 1.3 to > 4.0 cm (Table 3-3). The average RPD layer depth for all stations was 2.3 cm (0.73 SD, 0.15 SE) with the inclusion of stations that had shallow penetration, at least as minimal estimates of RPD depth. If the three shallow penetration sand stations were removed the average RPD layer depth was 2.0 cm (0.52 SD, 0.12 SE). The deepest RPD layers occurred in the vicinity of the outfall to the west and north (Figure 3-2). Porous sandy/gravelly sediments had the deepest apparent color RPD layer depths (NF17). In mixed sediments with high levels of biogenic activity (NF22) RPD layers also tended to be deeper. The shallowest average RPD layer occurred at station NF24. For an individual replicate the shallowest RPD was 0.9 cm at NF21-3 and the deepest measured RPD was 4.6 cm at NF14-3. The RPD layer was > 5.2 cm, the prism penetration depth, at station NF17-3 (Appendix 3-1). Biogenic activity deepened the penetration of oxic sediments at most stations with the deeper maximum RPD depths associated with oxidized sediments around burrow structures. Sediments that appeared to be oxic, lite-brown to reddish in color, extended > 10 cm below the sediment-water-interface at three stations (NF10, NF12, and NF21).

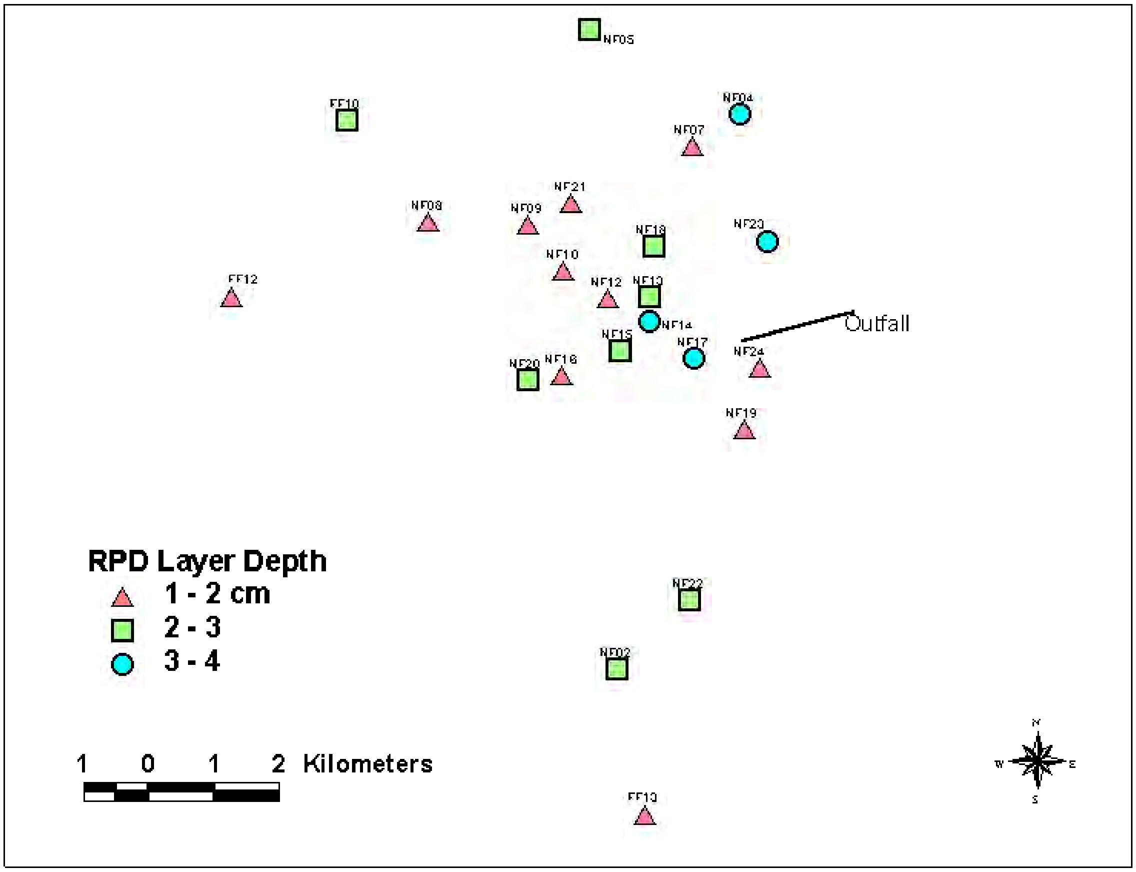


Figure 3-2. Distribution of estimated apparent color RPD layer depth, based on SPI, at Nearfield stations August 1999.

Within station variation in RPD layer depth was greater than the overall study area variation. To determine the degree of variation among the three replicates two statistics were evaluated. The coefficient of variation (CV) and a statistic derived from the range divided by the median, both statistics were expressed as a percentage (Appendix 3-2). These statistics provide estimates of variability independent of the mean and median, being parametric and nonparametric, respectively. Both were used because of the small sample size (three) at each station. For the 16 stations that had RPD measurements for all three replicate images the range was about 8 to 49% for the CV and 15 to 117% for the nonparametric statistic. None of the stations exceeded a CV of 50% while eight exceeded 50% for the nonparametric statistic. Higher variability in RPD layer depth at a station was related to two factors; small sample size and small-scale patchiness in sediment type and bioturbating fauna (Table 3-4; Sections 4 and 5). Station NF18 was representative of low RPD depth variation and FF13 representation of a high variation station (Appendix 3-2).

Comparison to RPD Threshold—The variance of the average station RPD layer was analyzed to determine the sensitivity of SPI for estimating a 50% change in the apparent color RPD over the study area. The MWRA (1997) has set this amount of change in the depth of the RPD layer as a critical trigger level for assessing outfall effects. Only 16 stations with RPD measurements for all three replicates were used in this analysis. At seven stations the RPD depth of at lease one replicates images could not be determined. To detect a 50% change in RPD layer depth over the study area from one year to the next with a 95% confidence interval and 90% power would require approximately eight stations. This assumed a *t*-test would be used to assess the significance of the difference between the current year average relative to the previous year and that the variance of the 1999 data was representative of the population of RPD depths (Zar 1999, pages 132-133). Ten stations would give a 95% confidence interval and power and 16 stations would increase the power to 99%.

Table 3-4. Comparison of sediment grain-size determined by SPI and grab analyses for 1999 Nearfield stations. Only sediment fractions from gravel to silt-clay are compared. Coarser sediments were sampled by SPI but not by grab. Percent gravel is based on total sample weight. Percentages of sand, silt, and clay are based only on the weight of those fractions.

SPI Data				Grab Data				
Station	Coarsest	Coarse to Fine*	Coarse to Fine	Mean Phi	Gravel %	Sand %	Silt %	Clay %
FF10	RK, PB, SH	GR, FSMS, SIFS	GR, FS, SI	3.0	21.1	75.6	19.0	5.5
FF12		FS	FSSI	3.8	5.0	73.4	18.2	8.4
FF13	RK, PB	GR, FS, FSSI	FSSICL	4.9	2.7	43.8	37.1	19.1
NF02	RK, PB	GR, FSSI	MS	1.8	1.4	95.1	2.5	2.3
NF04		GR, FS	FS	2.6	0.1	94.8	3.0	2.2
NF05		FS/SICL	FS, SI	3.2	1.0	82.8	14.7	2.5
NF07		SIFS	FSSI	3.9	1.8	66.0	23.8	10.1
NF08		SIFS	SIFS	5.5	2.0	26.9	60.9	12.3
NF09		FSSI	FSSI	4.0	0.4	61.4	27.4	11.1
NF10		FSSICL	FSSI	4.5	0.2	58.8	34.4	6.8
NF12		FSSICL	SICL	5.8	0.0	26.5	55.2	18.4
NF13		FSMS	FS	2.4	0.1	94.5	2.3	3.2
NF14	PB, SH	SIFS	GR, MS	1.9	13.1	88.2	9.7	2.2
NF15	PB, SH	GR, FS, FSSI	FS	2.5	4.0	88.0	11.6	0.4
NF16		FSSICL	FSSI	3.6	1.2	67.3	26.3	6.4
NF17		GR, MS, FSMS	FS	2.2	0.1	98.8	0.7	0.6
NF18	PB, SH	GR, SIFS	GR, CS, SI	0.6	51.2	78.1	18.2	3.7
NF19		FSSICL	FS	3.1	2.3	84.1	9.7	6.1
NF20	PB	SIFS	GR, FS, SI	2.8	11.4	74.9	16.6	8.5
NF21		SIFS	SIFS	5.3	0.0	39.4	50.3	10.3
NF22		SIFS	FSSI	4.3	4.0	55.0	33.5	11.6
NF23	PB, SH	GR, FSMS, FS, FSSICL	GR, MS	1.4	21.1	98.0	1.0	1.0
NF24	PB	FSSI, FSSICL, SIFS	FSSICL	5.2	0.2	37.5	47.7	14.8

* Composite of all sediment classes seen in the three replicate images.

Biogenic Activity—The sediment surface at about half the stations was dominated by a combination of biogenic and physical structures. The biology associated with activities of successional stage II and III fauna and physical associated with currents that lead to heterogeneous coarse/pebble/cobble sediments (Table 3-3). Biogenic surface features dominated at about 40% of the stations. The surface biogenic structures observed included biogenic whips or sticks made by amphipods (NF07), likely in the genus *Dyopedos* (Mattson and Cedhagen 1989). *Dyopedos monacanthus* occurred at seven grab stations in 1999 including NF07 (Section 5). Other biogenic features were small and large worm tubes (NF09), epibenthic organisms (NF15), burrow openings (NF14), feeding pits (NF), biogenic mounds (NF) and shells (NF16). Station NF02 was the only station with no evidence of biogenic activity in all three replicates.

Subsurface biogenic structures and actives were associated with infaunal organisms and included active oxic burrows (NF07), water filled oxic voids (NF12), and water filled anoxic voids (NF21). Free-burrowing infaunal worms occurred at all but three stations. At station NF24 the average number of worms was about 10 per image with a maximum of 15 worms at NF22-1 (Appendix 3-1 and 3-2).

Successional Stage and Organism Sediment Index—The modal successional stage was estimated to be Stage II and occurred at 50% of the stations. About 32% of the stations appeared to have combined traits of Stage II and III communities. The high degree of biogenic sediment reworking observed in many images was consistent with Stage II and III successional designation. Station NF23 had the lowest overall successional stage designation (Stage I/II) with little indication of subsurface biogenic activity other than a few worms (Table 3-3). Lower successional stage stations clustered around the western end of the outfall (Figure 3-3).

The average Organism Sediment Index (OSI) at the Nearfield stations was 7.0 (0.94 SD, 0.20 SE) and in the range just above levels indicative of communities under moderate stress. Rhoads and Germano (1986) developed the OSI for assessing stress in estuarine and coastal embayments and found that OSI values < 6 were associated with benthic communities under some form of moderate stress while higher values were associated with well-developed communities. Only three stations had OSI values < 6 (FF13, NF08, and NF19). Analysis of benthic community and other SPI data point to a lessening of physical stress over the Nearfield stations in 1998 relative to the last few years (Kropp *et al*. 2000). The OSI values were evenly spread from about 6 to 8, with an overall range of 5.3 (NF19) to 8.5 (NF17) (Figure 3-4, Table 3-3).

3.3 Summary of 1999 SPI Data

While the distribution of sediment textures at benthic habitats in the Nearfield study area appeared to be dominated by physical processes, surface features were dominated by biogenic activity. Even station NF02, which appeared completely dominated by physical processes, had an abundance of epifaunal organisms. Feeding mounds and tubes were the dominant surface biogenic structures and occurred at all but one station. Subsurface biogenic structures and organisms were also common and widely distributed. The predominance of biological activity at most stations was indicative of a well-developed fauna that was characterized as being intermediate to advanced in successional stage (Stage II to II/III). The organism sediment index also indicated that biological processes were dominating in areas that previously had been dominated by physical processes. Overall, it appeared that biological processes were more prominent in 1999 relative to the last few years.

Coarse sand/pebble/cobble sediments over much of the study area were heterogeneous and exhibited large within station variability from cobble to silty-sand. Finer silts and clays areas were more homogeneous. The sampling design, with 23 stations in the Nearfield area, provided more than sufficient statistical power for a *t*-test with a 95% confidence interval and 80% power to detect a 50% change in mean

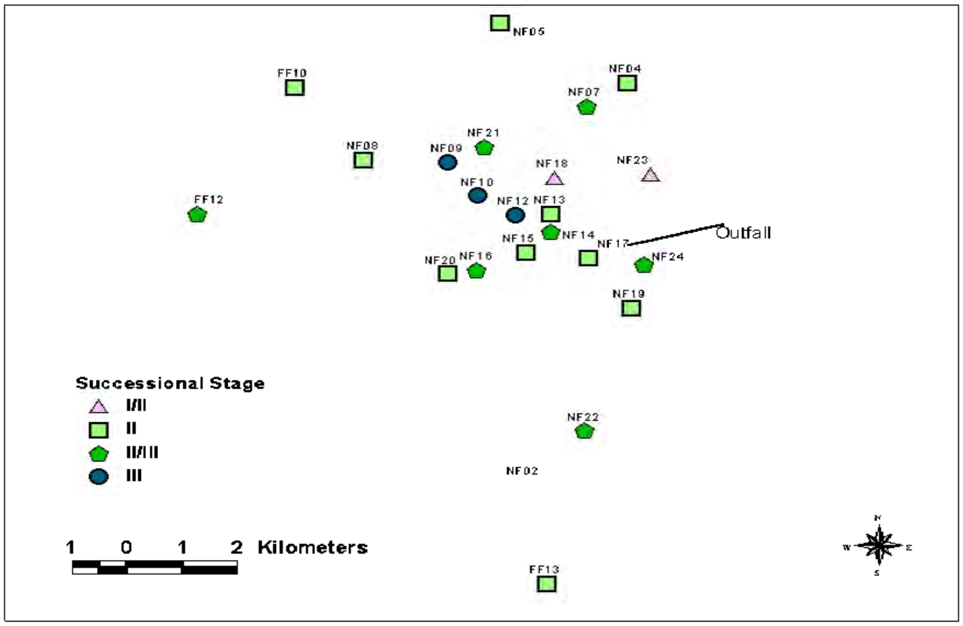


Figure 3-3. Distribution of estimated successional stage at Nearfield stations based on SPI, August 1999.

RPD layer depth over the entire study area from one year to the next. Based on the variation in the 1999 data, as few as three replicates at eight stations would yield a test with a 95% confidence interval and 90% power. With 16 stations power would increase to 99%.

3.4 Long-term Trends in Nearfield SPI Data

Sediment profile images have now been collected five times at Nearfield stations. The first SPI data was collected in 1992 (Blake *et al.* 1993) and again in 1995 (Hilbig *et al.* 1997), then annually from 1997 (Blake *et al.* 1998, Kropp *et al.* 2000).

Approximately 16 of the 23 Nearfield stations were primarily silty (4 to 5 Phi) to very-fine-sand (3 to 4 Phi). Nine of these finer-sediment stations, for example NF07 and NF22, were consistent through time with little or no variation in sediment type (Table 3-5). Grain size variation between the estimated major fine sediment descriptors (VFS, FSSI, SIFS, and FSSICL) was not more than one or two Phi units. The coarser-sediment stations NF13, NF17 and FF12 also exhibited little variation through time. Six fine sediment stations, for example NF14 and NF18, exhibited a coarsening trend with time that started in 1998 while only one station (NF19) appeared to be getting finer with the addition of the 1999 data. Four stations were consistently heterogeneous through time with sediments ranging from fines to cobbles depending on the year. Station NF02 was particularly variable, alternating between finer and coarser sediments from 1992 to 1999. Within a year station NF20 consistently had the most heterogeneous sediments (Table 3-5).

Assessment of the depth of the apparent color RPD through time was complicated by shallow prism penetration and/or coarse pebble/cobble sediments at 10 stations where at least one replicate image for one year had insufficient penetration to estimate the RPD. Six stations were also not sampled all five years. This leaves seven stations with a complete set of RPD measurement for all years. Yearly averages for estimated RPD layer depths were calculated for all stations with measured values and also for only the seven stations (NF05, NF07, NF08, NF09, NF10, NF12, and NF18) that had measured RPD for all five years.

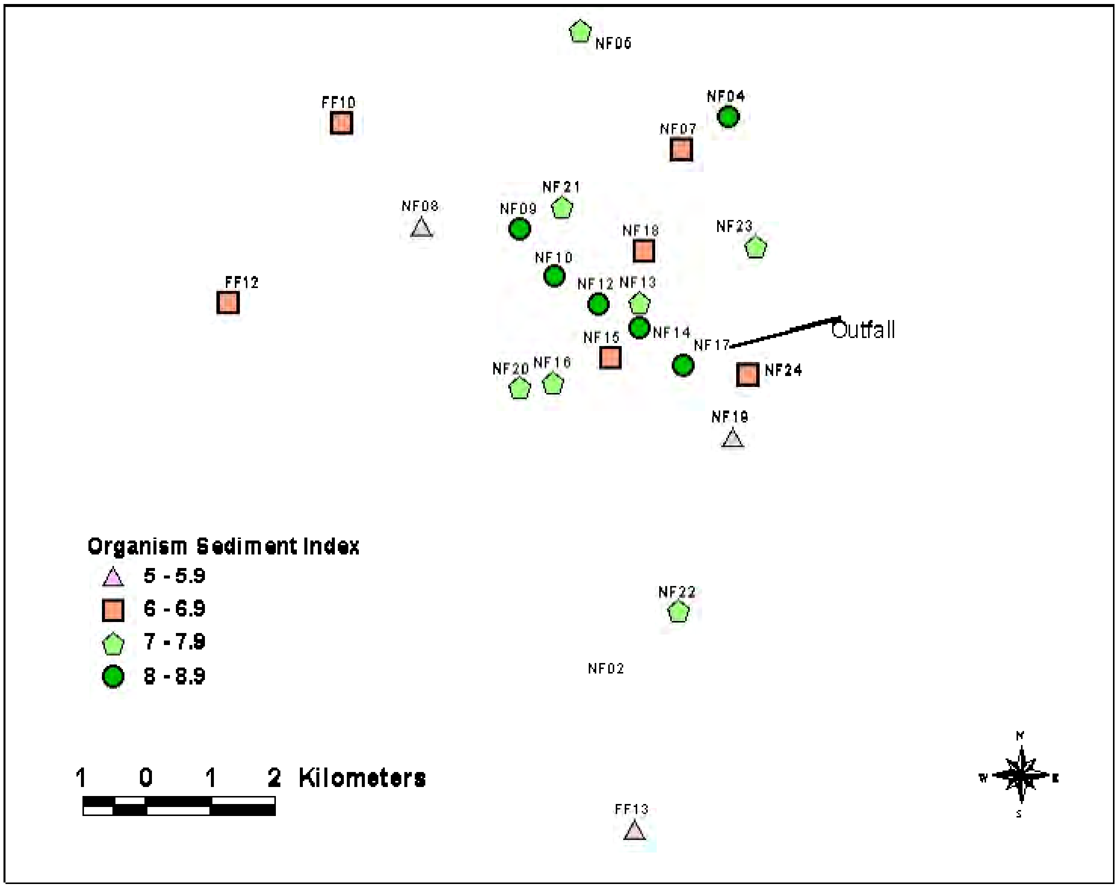


Figure 3-4. Distribution of the Organism Sediment Index (OSI), based on SPI, at Nearfield stations August 1999.

RPD	1992	1995	1997	1998	1999
All stations	2.6 (0.30)	2.5 (0.15)	1.7 (0.15)	1.6 (0.13)	2.0 (0.12)
Stations sampled every year	3.1 (0.45)	2.3 (0.20)	1.6 (0.08)	1.6 (0.16)	2.0 (0.16

These summaries point to a shallowing of the average RPD layer depth from 1992 to 1997–1998 and a possible deepening in 1999. However, while analysis of variance of data from the seven stations that had measured RPD's for all years (Table 3-6) indicated that there were strong differences between years (log transformation, df = 4, $F = 6.75$, $p = 0.0005$), there were no statistically distinct sets of years (Figure 3-5). For example, 1992, 1995, and 1999 were significantly different than 1997 and 1998, and 1992 was different than all other years. The shallowing trend in RPD from 1992 to 1995–1998 and the1999 deepening was likely linked to the interaction of physical and biological process at work in structuring bottom communities. Blake *et al.* (1998) and Kropp *et al.* (2000) concluded that bottom instability (waves and currents) leads to a patchy mosaic of successional Stage I pioneering communities, which are associated with shallower RPD measurements. Stage I communities dominated the Nearfield area from 1992 to 1997, with Stage II communities dominating in 1998 and 1999 (Table 3-7). It seemed that factors responsible for the depth of the RPD layer were acting at the regional scale in the Nearfield. There was no significant difference in mean RPD depth trends among the seven stations with year as a covariate (analysis of covariance, log transformation) (Figure 3-6).

Table 3-5 Historical description of sediment types, as determined from SPI, at Nearfield Stations, 1992–1999.

Station	1992	1995	1997	1998	1999
NF02	VFS	CS	SIFS	PB to GR	CB to FSSI
NF04	FS	FS	VFS	FS	GR to FS
NF05	FS	VFS	VFS	VFS	FS/SICL
NF07	VFS	VFS	VFS	VFS	SIFS
NF08	VFS	SIFS	VFS	VFS	SIFS
NF09	VFS	VFS	VFS	VFS	FSSI
NF10	VFS	VFS	VFS	VFS	FSSICL
NF12	VFS	SI	SIFS	SIFS	FSSICL
NF13	FS	FS to VFS	FS	PB to SIFS	FSMS
NF14	FS	VFS	VFS	PB to VFS	PB to SIFS
NF15	FS	VFS	VFS	GR to FS	PB to FSSI
NF16	VFS	SIFS	VFS	SIFS	FSSICL
NF17	FS	FS	FS	FS	GR to FSMS
NF18	VFS	VFS	VFS	GR to VFS	PB to SIFS
NF19	.*	CS to VFS	VFS	FSSICL	FSSICL
NF20	VFS	CS to VFS	GR to FSMS	GR to SICL	PB to SIFS
NF21	.	SIFS	VFS	SIFS	SIFS
NF22	.	SIFS	SIFS	SIFS	SIFS
NF23	.	CS to VFS	FS	FS	PB to FSSICL
NF24	.	SI	SIFS	FSSICL	PB to FSSICL
FF10	VFS	.	VFS	VFS	CB to SIFS
FF12	.	.	VFS	FS	FS
FF13	.	.	SIFS	SIFS	CB to FSSI

*Station not sampled.
CB = Cobble
CS = Coarse-sand, possibly gravel
FS = Fine-sand
FSSICL = Fine-sand-silt-clay
GR = Gravel
IND = Parameter indeterminate.
MS = Medium-sand
PB = Pebbles
SI = Silt
SICL = Silt-clay
SIFS = Silty-fine-sand
VFS = Very-fine-sand

In 1995 the first signs of amphipod tubes, characteristic of stage II community development, were seen in the Nearfield SPI images (Stations NF05, NF04, NF16, NF21, Hilbig *et al.* 1997). In 1998 and 1999, however, the wide spread occurrence of Stage II communities did not appear to lead to deeper RPD layers, nor did the increased occurrence of Stage III communities. There appeared to be an increase in the amount of surface and subsurface biogenic activity in 1998 that continued into 1999, relative to the other years, which accounted for the increase in the prevalence of Stage II and III successional stage communities. Most of the biogenic activity was related to burrowing organisms that created feeding mounds and pits in the sediment surface and small surface-tube-building worms, which were very abundant in 1999. There was also no increase in Stage II amphipods in the infaunal data from 1992 to 1999, with ampeliscid amphipods occurring in low numbers all years.

Table 3-6. Comparison of apparent color RPD depth (cm), as determined by SPI, Nearfield Stations, 1992–1999.

Station	1992	1995	1997	1998	1999
NF02	0.9	>2.7	2.7	IND	2.1
NF04	IND	>3.8	>1.4	>1.8	>3.5
NF05	4.1	1.8	1.4	1.3	2.7
NF07	2.9	1.6	1.7	0.8	1.6
NF08	2.1	2.8	1.8	1.8	1.7
NF09	1.7	2.7	1.8	1.9	1.9
NF10	4.1	2.9	1.3	1.7	1.9
NF12	4.8	2.3	1.6	2	1.9
NF13	2.2	>3.9	>1.9	>3.3	>2.7
NF14	2.6	>4.2	>3.1	0.8	3.3
NF15	2	3.3	>1.7	>2.2	2.3
NF16	2.3	>3.7	1.1	1.7	1.8
NF17	IND	>5.7	>2.1	>2.1	>4.0
NF18	2.3	1.8	1.4	1.7	2.6
NF19	.	2.2	>1.4	0.5	1.5
NF20	3.6	1.8	IND	1.9	2.8
NF21	.	2.9	2	1.3	1.7
NF22	.	2.8	0.7	1.9	2.1
NF23	.	3.3	>2.0	>2.9	>3.4
NF24	.	2.8	2.4	1.2	1.3
FF10	1.5	.	>3.0	2.3	2.2
FF12	.	.	>1.5	2.2	1.6
FF13	.	.	2.1	2.2	1.5

> Indicates that RPD layer in at least one replicate images, was deeper than prism penetration.

The Organism Sediment Index of Rhoads and Germano (1986) indicated that on average, for some the years, benthic communities in the Nearfield were subjected to some form of stress (OSI values < 6). Physical processes were the most likely source of stress since water and sediment quality within the Nearfield were always good (see Section 4). The average (SE) yearly OSI values were:

OSI	1992	1995	1997	1998	1999
All stations	6.8 (0.47)	6.1 (0.39)	4.8 (0.34)	6.4 (0.25)	7.0 (0.20)
Stations sampled every year	7.0 (0.52)	6.2 (0.53)	4.7 (0.44)	6.4 (0.28)	7.3 (0.25)

The lower values for 1997 may be related to the additional stress of seasonal change as some of the stations were sampled in October while those in the other years (and some 1997 stations) were sampled in August. Analysis of variance of data from all stations or just those 12 with OSI values for all years (Table 3-8) produced the same results and indicated there were strong differences between years in average OSI (for the latter analysis of only 12 stations, df = 4, $F = 5.87$, $p = 0.0005$). But similar to the RPD analysis, there were no statistically distinct sets of years (Figure 3-7). Yearly average OSI's were the same for 1992, 1995, 1998, and 1999, the last of which were significantly higher than 1997. 1995 and 1997 were also the same and significantly lower than 1992, 1998, and 1999. OSI values averaged by station indicated that there were no differences between stations (ANOVA, df = 11, $F = 1.27$, $p = 0.27$) (Figure 3-8).

Table 3-7. Estimated successional stage, as determined by SPI, at Nearfield stations, 1992–1999.

Station	1992	1995	1997	1998	1999
NF02	I	I	I-II on III	IND	IND
NF04	I	I-II	I-II	II	II
NF05	I	I-II	I on III	II-III	II
NF07	I-III	I	I	II-III	II-III
NF08	I-III	I	I-II	II-III	II
NF09	I-III	I on III	I	II-III	III
NF10	I	I-I on III	I-II	II-III	III
NF12	II-III	I-I on III	I-II on III	II-III	III
NF13	I	I	I	II	II
NF14	I	I	I	II-III	II-III
NF15	I	I	I	II-III	II
NF16	I	II-I on III	I	II-III	II-III
NF17	I	I	I	II	II
NF18	I	I	I-II on III	I-II	II
NF19	.*	I	I-II	I-II	II
NF20	I	I	I	II-III	II
NF21	.	II-I on III	I	II-III	II-III
NF22	.	I on III	I-II on III	II-III	II-III
NF23	.	I	I	II	I-II
NF24	.	I	I-I on III	II-III	II-III
FF10	I-III	.	I	II-III	II
FF12	.	.	I	II-III	II-III
FF13	.	.	I-II	II-III	II

* Station not sampled.
IND Parameter indeterminate.
I Stage I pioneering community
II Stage II intermediate community
III Stage III equilibrium community
I on III Stage I community at surface over Stage III community
II on III Stage II community at surface over Stage III community

Based on the sediment profile image data, the general physical and biological conditions at the Nearfield stations reflect the physically dynamic nature of the processes that dominate the area. The 1998 and 1999 data indicated an increasing trend in the importance of biological processes that may have started in 1995.

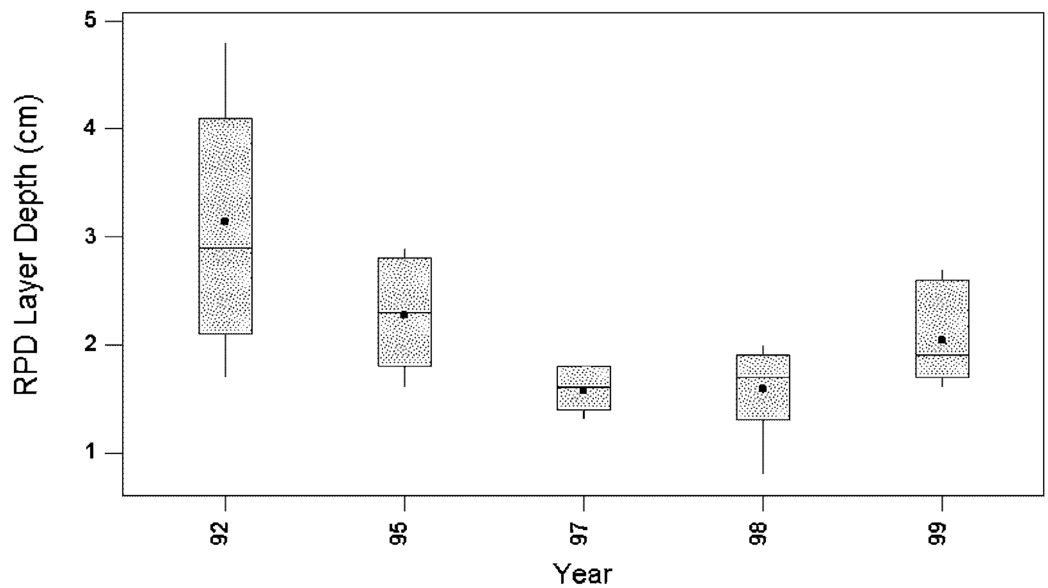


Figure 3-5. Box plot of apparent color RPD layer depth (cm) by year for the seven Nearfield stations that had no missing values from 1992 to 1999. Bar is median, dot is mean, box is interquartile range, and whiskers are total range of the station data.

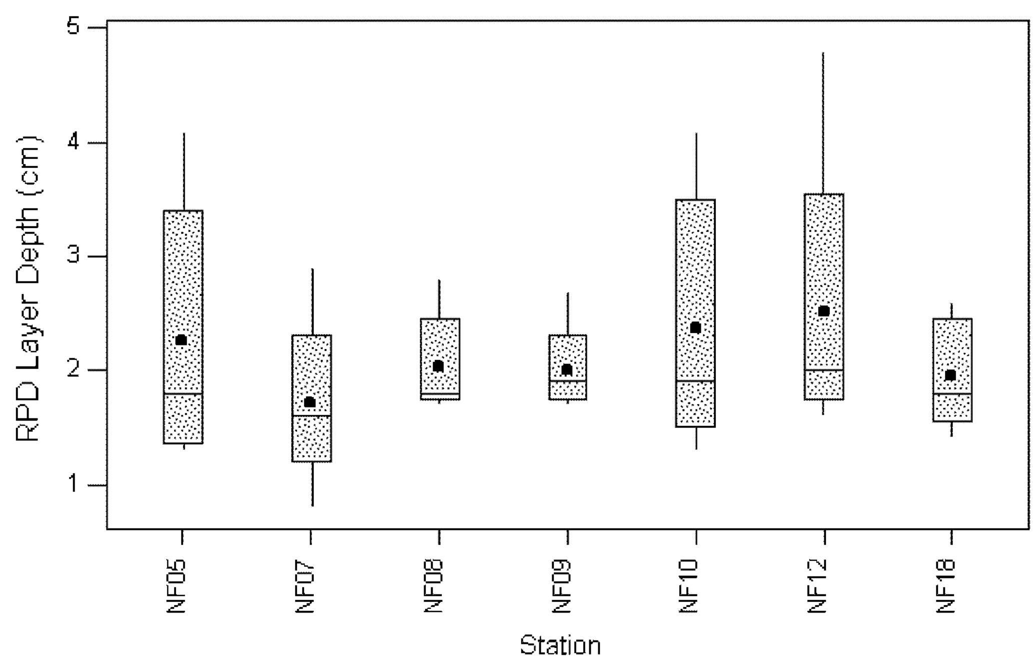


Figure 3-6. Box plot of apparent color RPD layer depth (cm) by station for the seven Nearfield stations that had no missing values from 1992 to 1999. Bar is median, dot is mean, box is interquartile range, and whiskers are total range of the yearly data for each station.

Based on the sediment profile image data, the general physical and biological conditions at the Nearfield stations reflect the physically dynamic nature of the processes that dominate the area. The 1998 and 1999 data indicated an increasing trend in the importance of biological processes that may have started in 1995.

Table 3-8. Organism Sediment Index, as determined by SPI, at Nearfield stations, 1992–1999.

Station	1992	1995	1997	1998	1999
NF02	4.0	5.0	7.5	IND	IND
NF04	IND	7.7	3.7	6.5	8.3
NF05	8.5	4.7	7.3	5.7	7.0
NF07	7.6	3.3	3.7	5.3	6.3
NF08	7.0	5.3	4.3	6.3	5.7
NF09	6.7	9.0	4.0	7.3	8.0
NF10	8.3	6.3	3.7	6.7	8.3
NF12	9.7	7.0	7.7	7.3	8.0
NF13	4.0	7.0	4.0	8.0	7.0
NF14	9.0	6.7	5.7	5.0	8.0
NF15	5.7	5.7	4.0	6.7	6.7
NF16	5.5	9.3	2.7	6.7	7.0
NF17	8.0	7.0	4.0	6.3	8.5
NF18	4.6	3.7	5.0	5.0	6.7
NF19	.	4.0	4.0	3.5	5.3
NF20	8.0	3.5	IND	6.5	7.0
NF21	.	7.0	2.0	6.3	7.7
NF22	.	7.7	6.3	6.7	7.7
NF23	.	6.0	4.0	7.7	7.0
NF24	.	5.3	7.3	4.7	6.0
FF10	5.5	.	5.5	7.3	6.0
FF12	.	.	3.7	7.7	6.7
FF13	.	.	6.0	8.0	5.7

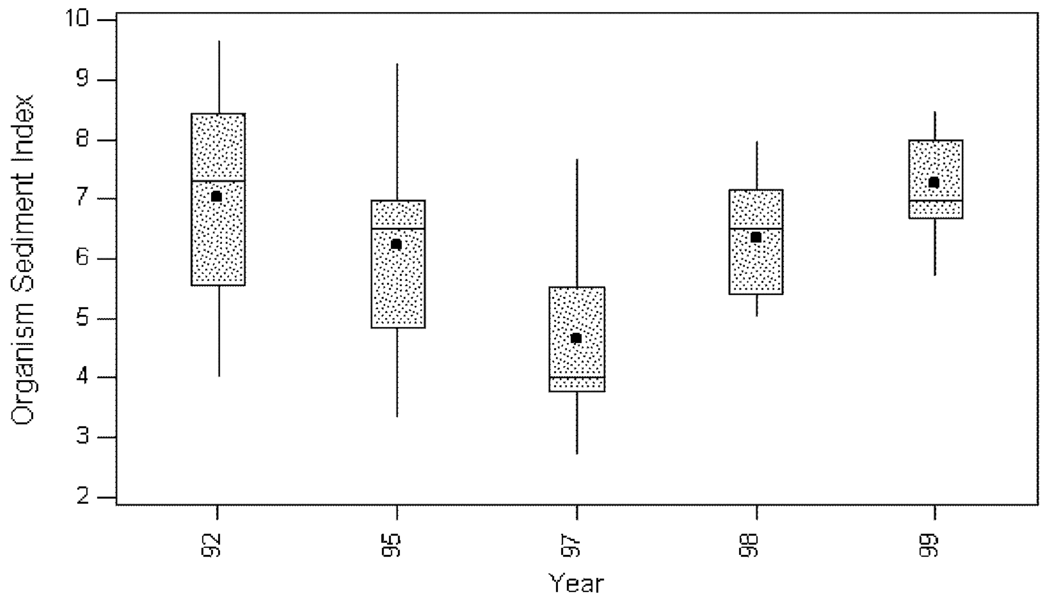


Figure 3-7. Boxplot of the Organism Sediment Index by year for seven Nearfield stations that had no missing values from 1992 to 1999. Bar is median, dot is mean, box is interquartile range, and whiskers are total range of station data.

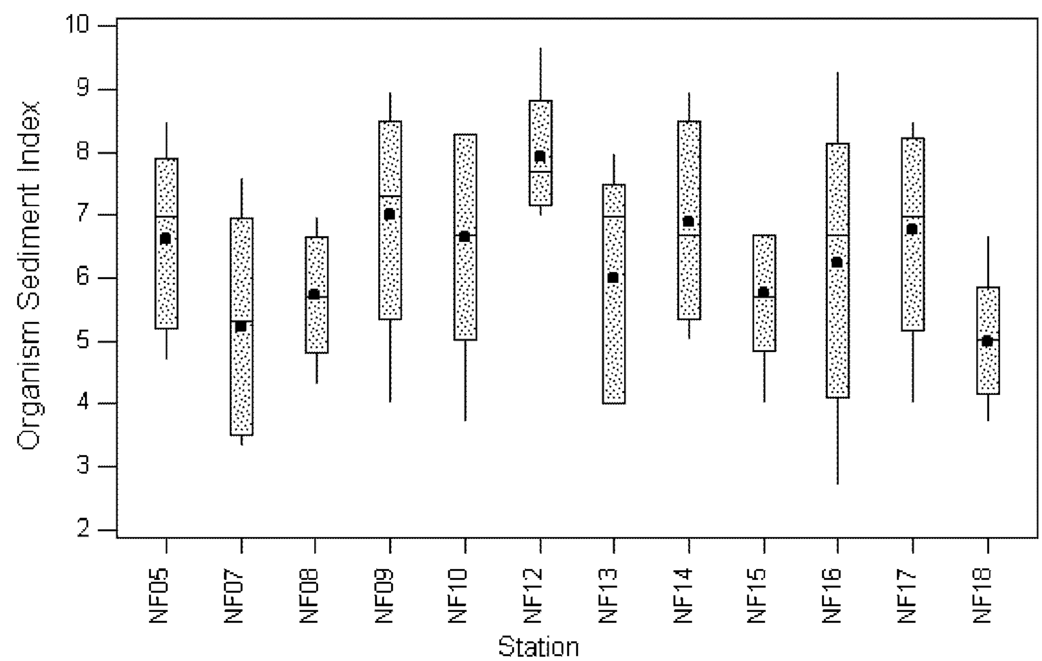


Figure 3-8. Box plot of the Organism Sediment Index by station for the twelve Nearfield stations that had no missing values from 1992 to 1999. Bar is median, dot is mean, box is interquartile range, and whiskers are total range of the station data.

4. ANALYTICAL CHEMISTRY

by Deirdre T. Dahlen and Carlton D. Hunt

with acknowledgement to Dr. Scott A. Stout (Battelle) for his support with the PCA

4.1 Methods

4.1.1 Grain Size, Total Organic Carbon, and *Clostridium perfringens*

Laboratory procedures followed those outlined in the Benthic Monitoring CW/QAPP (Kropp and Boyle 1998). Summaries of the procedures are provided below.

Grain Size—Samples were analyzed for grain size by a sequence of wet sieving and dry sieving. Methodologies followed Folk (1974). The sand/gravel fraction was separated from the mud fraction. This sand/gravel fraction was transferred to a 200-mL beaker, decanted, and dried overnight at 95 ºC. The dried sand/gravel fraction was mixed by hand to disaggregate the material, and then dry-sieved on stacked −1-, 0-, 1-, 2-, 3-, and 4-phi sieves. Each size class was weighed to the nearest 0.1 mg on a top-loading balance. Particles smaller than 4 phi were analyzed using the pipette method. Data were presented in weight percent by size class. In addition, the gravel:sand:silt:clay ratio and a numerical approximation of mean size and sorting (standard deviation) were calculated. Grain size determinations were made by GeoPlan Associates.

Total Organic Carbon—A portion of the sample to be analyzed for TOC content was dried at 70ºC for 24–36 hours and ground to a fine powder. The sample was treated with 10 % HCl to remove inorganic carbon and dried at 70 ºC for 24 hours. Between 10 and 500 mg of dry, finely ground, and homogenized sample were weighed to the nearest 0.1 mg and placed in a crucible that had been precombusted for 4 hours at 500 ºC. A Coulometric Carbon Analyzer was used to determine the TOC content of the samples. TOC determinations were performed by Applied Marine Sciences, Inc. according to SOP 9703.

***Clostridium perfringens*—**Sediment extraction methods for determination of *Clostridium perfringens* spores followed those developed by Emerson and Cabelli (1982), as modified by Saad (1992). The filters for enumeration of *Clostridium perfringens* spores were incubated anaerobically at 44.5 ºC for 24 hours. Following incubation, the filter was exposed to ammonium hydroxide for 15–30 seconds. Yellowish colonies that turn red to dark pink upon exposure were counted as *C. perfringens*. Data are reported here as colony-forming units (cfu) per gram dry weight of sediment. This analysis was performed by MTH Environmental Associates.

4.1.2 Contaminants

Analyses of sediments for organic constituents and metals were performed following methods outlined in Table 4-1. Samples were analyzed for the parameters listed in Table 4-2, including linear alkyl benzenes (LABs), polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCBs), chlorinated pesticides, and metals. Analytical methods followed general NS&T methodologies (Peven *et al*. 1993a, Peven *et al*. 1993b). More detailed information is provided in the CW/QAPP (Kropp and Boyle 1998).

Table 4-1. Parameters and methods of analysis for organic constituents and metals.

Parameter	Unit of Measurement	Method	Reference
Linear Alkylbenzenes	ng/g	GC/MS	Battelle SOP 5-157
Polycyclic Aromatic Hydrocarbons	ng/g	GC/MS	Battelle SOP 5-157
Polychlorinated Biphenyls/ Pesticides	ng/g	GC/ECD	Battelle SOP 5-128
Major Metals (Al, Fe)	% Dry Weight	EDXRF	KLM Technical Procedure 7-40.48
Trace Metals (Cr, Ni, Pb, Zn, Cu)	µg/g	EDXRF	KLM Technical Procedure 7-40.48
Trace Metals (Ag, Cd, and Hg)	µg/g	ICP-MS (Ag, Cd) CVAA (Hg) GFAA (as required)	Battelle SOP MSL-I-022 Battelle SOP MSL-I-016 Battelle SOP MSL-I-029

4.1.3 Statistical Analysis, Data Terms, and Data Treatments

Statistical Analysis—numerical analyses techniques to evaluate sediment chemical data included correlation and principal component analyses.

Correlation analysis was performed on sediment grain size, TOC, *Clostridium perfringens*, and contaminant data to examine the correlation between these parameters. Probability values were taken from Rohlf and Sokal (1969).

Principal component analysis (PCA) was employed to evaluate sediment grain size, TOC, *Clostridium perfringens* and contaminant data. All data were normalized prior to PCA analysis to remove effects of magnitude and give all parameters equal weight. Such analyses are an effective means of comparing the chemical data from many samples (Gabriel 1971, Boon *et al*. 1984, Wold *et al*. 1987, Oygard *et al*. 1988, Stout 1991, de Boer *et al*. 1993, Kannan *et al*. 1998). PCA has the additional advantage of being able to convey the complex chemical differences or similarities among many samples in a visual manner that is more easily understood.

PCA was performed by using Ein*Sight (Version 4.0; Infometrix, Inc., Seattle, WA).

PCA was used to visualize the intersample and intervariable relationships among the sediment chemical data. PCA yields a distribution of samples (*e.g.*, sediment samples) in *n*-dimensional space, where *n* is the number of variables (*e.g.*, PAH). The Euclidean distances between sample points on these factor score plots are representative of the variance captured in each PC. In simpler terms, samples that cluster together are chemically similar and outliers are chemically distinct. A factor loading is calculated for each variable (*e.g.*, PAH) contributing to each PC. A crossplot of the factor loadings for the first few PCs reveals the individual variables responsible for the variance in each PC.

Table 4-2. Sediment chemistry analytical parameters.

Parameter	Parameter	Parameter
Polycyclic Aromatic Hydrocarbons	**Polychlorinated Biphenyls**	Metals
Naphthalene	Cl2(8)	Al Aluminum
C_1-Naphthalenes	Cl3(18)	Cd Cadmium
C_2-Naphthalenes	Cl3(28)	Cr Chromium
C_3-Naphthalenes	Cl4(44)	Cu Copper
Acenaphthylene	Cl4(52)	Fe Iron
Acenaphthene	Cl4(66)	Pb Lead
Biphenyl	Cl4(77)	Hg Mercury
Dibenzofuran	Cl5(101)	Ni Nickel
Fluorene	Cl5(105)	Ag Silver
C_1-Fluorenes	Cl5(118)	Zn Zinc
C_2-Fluorenes	Cl5(126)	
C_3-Fluorenes	Cl6(128)	**Physical Sediment Parameters/Sewage Tracers**
Dibenzothiophene	Cl6(138)	Grain Size
C_1-Dibenzothiophenes	Cl6(153)	Gravel
C_2-Dibenzothiophenes	Cl7(170)	Sand
C_3-Dibenzothiophenes	Cl7(180)	Silt
Phenanthrene	Cl7(187)	Clay
Anthracene	Cl8(195)	phi<-1
C_1-Phenanthrenes/Anthracenes	Cl9(206)	−1<phi<0
C_2-Phenanthrenes/Anthracenes	Cl10(209)	0<phi<1
C_3-Phenanthrenes/Anthracenes		1<phi<2
C_4-Phenanthrenes/Anthracenes	Chlorinated Pesticides	2<phi<3
Fluoranthene	Aldrin	3<phi<4
Pyrene	Dieldrin	4<phi<8
C_1-Fluoranthenes/Pyrenes	Endrin	phi>8
Benz(a)anthracene	Hexachlorobenzene	Total Organic Carbon
Chrysene	Lindane	Clostridium perfringens
C_1-Chrysenes	Mirex	Linear Alkyl Benzenes
C_2-Chrysenes	2,4-DDD	Phenyl decanes (C_{10})
C_3-Chrysenes	2,4-DDE	Phenyl undecanes (C_{11})
C_4-Chrysenes	2,4-DDT	Phenyl dodecanes (C_{12})
Benzo(b)fluoranthene	4,4-DDD	Phenyl tridecanes (C_{13})
Benzo(k)fluoranthene	4,4-DDE	Phenyl tetradecanes (C_{14})
Benzo(e)pyrene	4,4-DDT	
Benzo(a)pyrene	DDMU	
Perylene	Cis-chlordane	
Indeno(1,2,3-c,d)pyrene	Heptachlor	
Dibenzo(a,h)anthracene	Heptachlorepoxide	
Benzo(g,h,I)perylene	Trans nonachlor	
Benzothiazole		

Data Terms—In the discussion of Nearfield results, the term Nearfield refers to all Nearfield stations plus Farfield stations FF10, FF12, and FF13. These Farfield stations were included in the Nearfield analyses because of the potential for transport of carbon from the Massachusetts Bay outfall (see the Bays Eutrophication Model, Fitzpatrick *et al*. 2000). Similarly, the term Farfield refers to all Farfield stations, excluding FF10, FF12, and FF13.

Data Treatments—In the discussion of bulk sediment and contaminant data, the following terms are used.

- Percent Fines – sum of percent silt and clay
- Total PAH – sum of all PAH compounds listed in Table 4-2, excluding Benzothiozole
- Total PCB – sum of all PCB congeners listed in Table 4-2
- Total Pesticide – sum of Aldrin, Dieldrin, Endrin, Hexachlorobenzene, Lindane, and Mirex
- Total DDT – sum of the six DDT, DDE, and DDD compounds listed in Table 4-2
- Total Chlordane – sum of Cis-chlordane, Heptaclor, Heptachlorepoxide, and Trans nonachlor
- Total LAB – sum of C_{10} – C_{14} LABs listed in Table 4-2

To determine these total values in sediment in cases where an individual analyte was not detected, a value of 0.0 was assigned to that analyte.

Mean parameter (*e.g*., total PAH) values were determined for three categories:

- Station Mean – Average of all station replicates; laboratory replicates were averaged to determine a single value prior to calculation of station means. Station means were determined for each parameter within a given sampling year. Station mean values were used in the PCA to determine if the spatial distribution of contaminants in the 1999 Nearfield and Farfield were substantially different than for previous years.
- Nearfield Baseline Mean – Average of all Nearfield stations including FF10, FF12, and FF13; each field sample replicate was treated as an individual sample. Nearfield baseline mean values were determined for each parameter within a given sampling year and were used to assess temporal trends in the Nearfield from 1992–1999.
- Farfield Baseline Mean – Average of all Farfield stations, excluding FF10, FF12, and FF13; each field sample replicate was treated as an individual sample. Farfield baseline mean values were determined for each parameter within a given sampling year and were used to assess temporal trends in the Farfield from 1992–1999.

Yearly "mean values" and 95 % confidence intervals were determined for *Clostridium perfringens* to evaluate the spatio/temporal distribution of *Clostridium perfringens* at all Nearfield and Farfield stations from 1992–1999. Yearly mean values were determined as a function of distance from Deer Island Point, as follows:

- < 20 km – Average of all stations that are within 20 km of Deer Island Point. Stations included all Nearfield stations plus Farfield stations FF10, FF12, and FF13.
- 20 km and < 40 km – Average of all stations that are more than 20 km, but less than 40 km of Deer Island Point. Stations included FF01A, FF09, and FF14.

- 40 km – Average of all stations that are more than 40 km from Deer Island Point. Stations included FF04, FF05, FF06, FF07, and FF11.

Sediment grain size results were evaluated by using ternary plots to visually display the distribution of sand, silt and clay in sediment collected from Nearfield and Farfield stations.

Results from sediment grain size, total organic carbon (TOC), *Clostridium perfringens*, and contaminant analyses were compared from all stations by using histogram plots.

The numerical approximate mean phi, referred to simply as mean phi in the text, was calculated by weighting each class fraction measured and summing the weighted fractions (Table 4-3).

Table 4-3. An example of numerical approximate mean phi determination.

phi Class	Weight Factor[1]	% Fraction Measured (station FF01A)	Weighted Fraction[2]
phi<-1	−1.5	0.06	−0.0009
−1<phi<0	−0.5	1.62	−0.0081
0<phi<1	0.5	10.54	0.0527
1<phi<2	1.5	14.56	0.218
2<phi<3	2.5	8.02	0.200
3<phi<4	3.5	54.09	1.893
4<phi<8	6	10.2	0.612
phi>8	9	0.9	0.081
Sum of weighted fractions Numerical approximate mean phi[3]			3.05

[1] Weight Factor represents middle of the phi class range
[2] Weighted Fraction = (Weight Factor)*(%Fraction Measure/100)
[3] Numerical approximate mean phi = Sum of weighted fractions

4.2 Results and Discussion

Bulk sediment and contaminant results for all Nearfield and Farfield samples were evaluated separately to examine spatial and temporal characteristics. Nearfield and Farfield station mean values are reported in Appendix C (bulk sediment — Appendix C-1; organic contaminants — Appendix C-2; metal contaminants — Appendix C-3). All sediment results are discussed in terms of dry weight using station, Nearfield baseline, and Farfield baseline mean values.

4.2.1 Nearfield Chemistry 1992–1999

Spatial Characteristics—PCA was performed on a multi-year/multi-parameter data set to determine if the spatial distribution of bulk sediment and contaminant parameters in 1999 was substantially different from 1992–1998 patterns. Physical and chemical data from all Nearfield stations plus FF10, FF12, and FF13 were included in the PCA. The physical and chemical parameters included in the data set were sand, silt, clay, TOC, *Clostridium perfringens*, total PAH, total PCB, total DDT, total LAB, and metals (Al, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Ag, Zn). PCA can only be performed on a common set of parameters. Because contaminant data were not available for 1996 and 1997, these sampling years were excluded from the PCA. In addition, only NF08, NF22, NF24, and FF10 were sampled in 1998. Only these stations from 1998 were included in the PCA.

The factor score cross plot generated by PCA showed some clustering of stations (Figure 4-1a, b). The accompanying factor loading cross plot revealed that the primary controlling variables included 1) total PAH, 2) *Clostridium perfringens*, and 3) metals and sand (Figure 4-1c). Approximately 67% of the variability in these data were accommodated by the first and second principal components. The silt content variable plotted closer to the middle of the factor loading cross plot and had less influence on the data set (Figure 4-1b). Many Nearfield stations from across all sampling years clustered in quadrants Q1 and Q3 of the cross plot (Figure 4-1a). The primary variables controlling this cluster of Nearfield stations included total PAH and *Clostridium perfringens*. Stations included in quadrant Q3 generally contained higher concentrations of total PAH and lower abundance of *Clostridium perfringens* relative to stations that clustered quadrant Q1. Nearfield stations NF02, NF04, NF13, NF17, NF19, and NF23 clustered in quadrants Q2 and Q4 of the cross plot (Figure 4-1a, b). The primary variables controlling this cluster of stations included sand, metals, and *Clostridium perfringens*. Nearfield stations included in this cluster were comprised of very sandy sediments (>90 % sand) that contained low concentrations of metals, *Clostridium perfringens*, and organics relative to other Nearfield stations. Figure 4-1 shows that each cluster group includes a mix of Nearfield stations across all sampling years, indicating that the spatial distribution of bulk sediment and contaminant parameters in 1999 was not substantially different from 1992–1998.

While the primary objective of the PCA was to determine if the spatial distribution of bulk sediment and contaminant parameters in 1999 was substantially different from earlier years, the PCA results also revealed that sediment grain size, sand content in particular, is a key controlling variable in the Nearfield. In particular, sandy sites had much lower concentrations of organic contaminants. These results are supported by evaluations made in previous reports (Kropp *et al*. 2000) which showed that sediment types, that is, sandy versus silty, are major factors influencing concentrations of contaminants in the Nearfield.

Temporal Characteristics—Nearfield baseline mean values and 95 % confidence intervals were determined for bulk sediment properties, *Clostridium perfringens*, and contaminant parameters as described in Section 4.1.3. With the exception of *Clostridium perfringens*, the temporal response of the baseline for bulk sediment and contaminant parameters showed relatively constant means without substantial variability (Figure 4-2). The 95 % confidence intervals generally overlapped across all sampling years, supporting the conclusions above that the spatial distribution of contaminants was not substantially different over time. The Nearfield baseline mean values for *Clostridium perfringens* showed lower abundance and less variability in 1998 and 1999 relative to earlier years (Figure 4-2). Trends in *Clostridium perfringens* are discussed in greater detail in Section 4.2.3.

4.2.2 Farfield Chemistry 1992–1999

Spatial Characteristics—PCA was performed on a multi-year/multi-parameter data set to determine if the spatial distribution of bulk sediment and contaminant parameters in the 1999 Farfield were substantially different from 1992–1998. Physical and chemical data from all Farfield stations excluding FF10, FF12, and FF13 were included in the PCA. The physical and chemical parameters included in the data set were sand, silt, clay, TOC, *Clostridium perfringens*, total PAH, total PCB, total DDT, total LAB, and metals (Al, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Ag, Zn). Data from 1996, 1997, and 1998 were excluded from the PCA because a complete data set with all common parameters (*i.e.*, contaminants) was not available.

The factor score cross plot showed a general spread of Farfield stations (Figure 4-3a) as opposed to the more distinctive clustering observed for the Nearfield (Figure 4-1a). Farfield stations clustered somewhat along the Factor 2 zero axis (Figure 4-3a). Primary controlling variables included total PAH and metals for Factor 1 and total PCB, total DDT, and sand for Factor 2 (Figure 4-3b). Approximately 67% of the

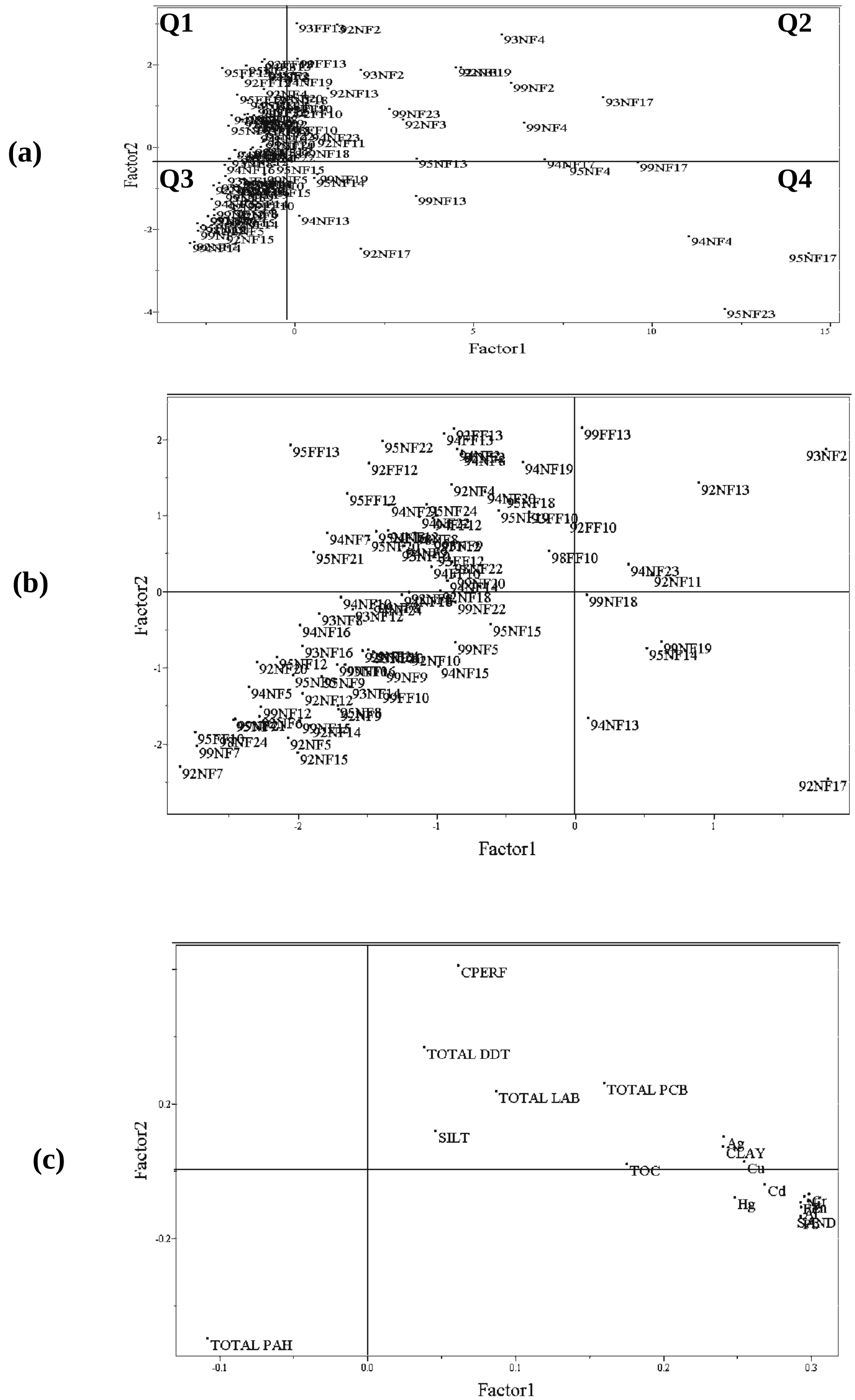


Figure 4-1. Results from the principle component analysis of the Nearfield from 1992 to 1999: (a) factor score plot showing distribution of stations, (b) close-up view of stations clustering in quadrants Q1 and Q3, and (c) factor loading plots with principal components.

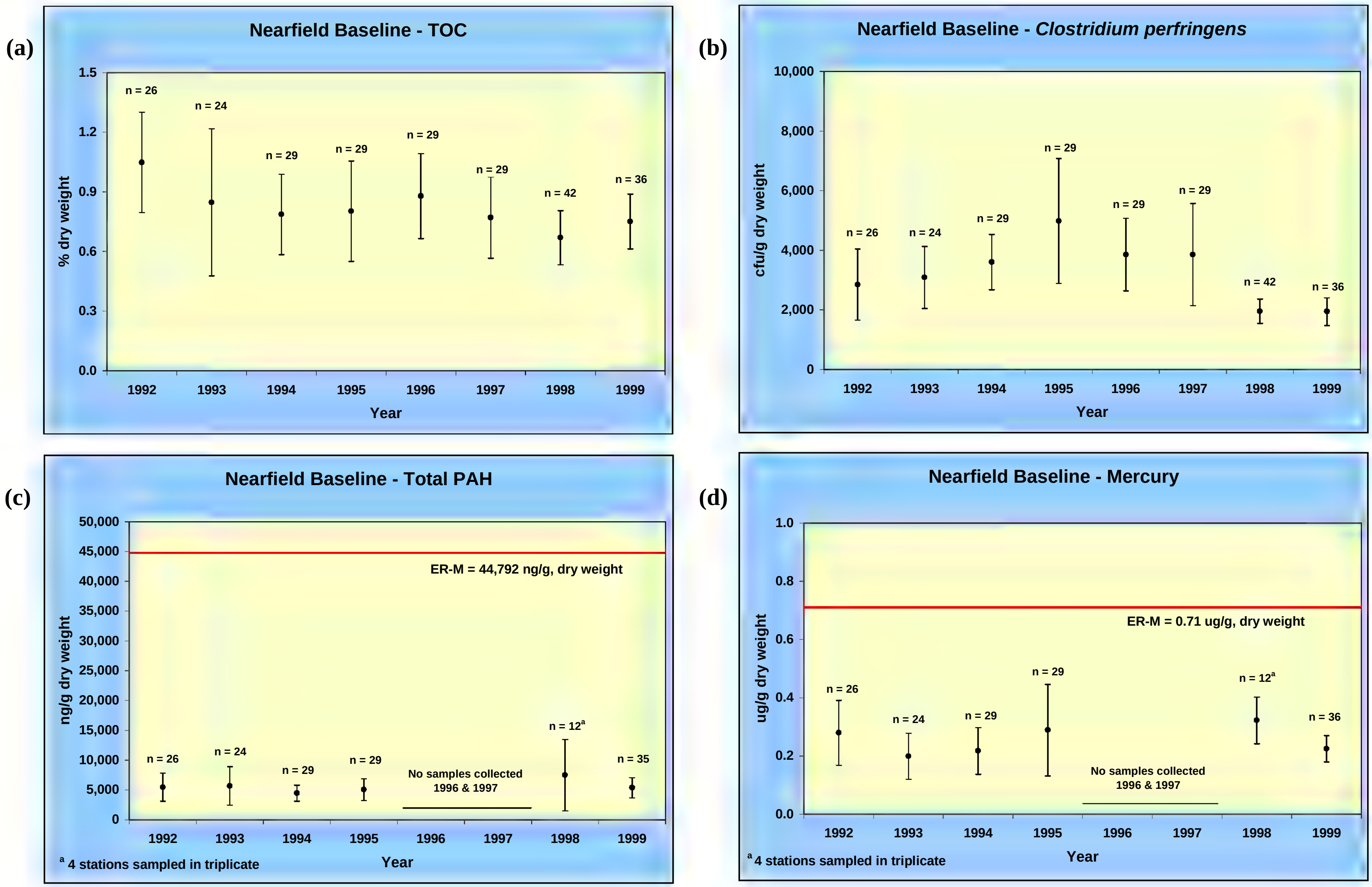


Figure 4-2. Nearfield baseline from 1992–1999 for TOC, *Clostridium perfringens*, total PAH, and mercury. Error bars depict 95% confidence intervals.

(a)

(b)

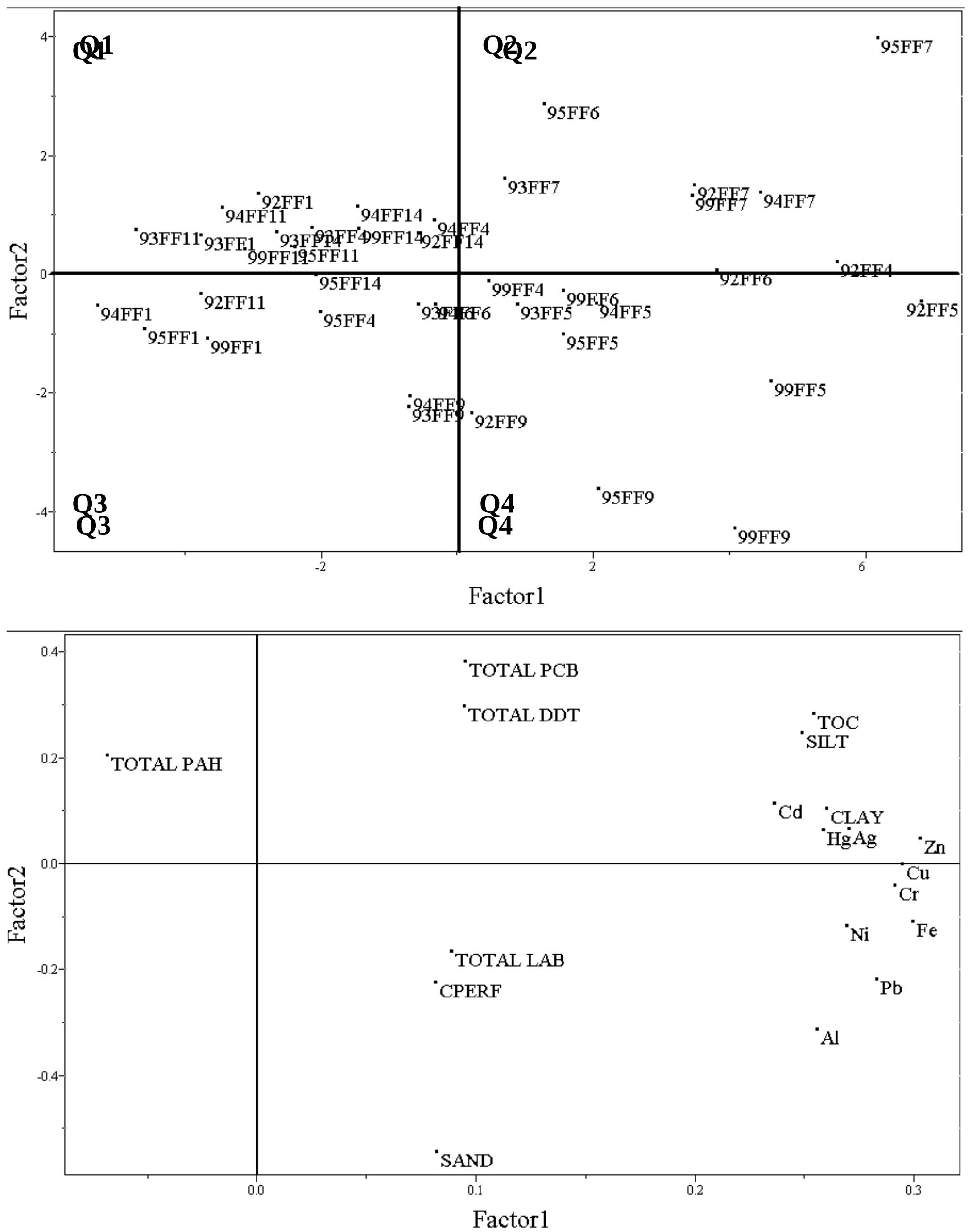


Figure 4-3. Results from the PCA of the Farfield for the period 1992–1999: (a) factor score plots showing distribution of stations, and (b) factor loading plots with principal components. (The original station FF01 – near the MBDS – was sampled only in 1992 and 1993; FF01a – off Gloucester – was sampled from 1994 to 1999)

variability in these data were accommodated by the first and second principal components. Total LAB and *Clostridium perfringens* variables plotted closer to the middle of the factor loading cross plot and had less influence on the data set (Figure 4-3b). The spread in Farfield stations, without any distinct clustering of stations by year, suggests that the spatial distribution of bulk sediment properties and contaminant parameters in the 1999 Farfield was not substantially different from 1992–1998.

However, perhaps the most striking aspect of the PCA is that Factor 1 almost perfectly separates the deepwater Farfield data into groups of northern and southern stations (Figure 4-3a). Northern Stellwagen Basin stations including station FF11 off Cape Anne and the original station FF01 (near the MBDS, sampled only in 1992 and 1993), as well as station FF14, generally clustered in quadrants Q1 and Q3 of the cross plot (Figure 4-3a), with negative Factor 1 loadings. Stations clustering in quadrants Q1, and Q3 to a lesser extent, contained higher concentrations of organic contaminants (*i.e.*, total PAH, total PCB, and total DDT) and were less sandy compared to other Farfield stations.

With few exceptions, all southern Stellwagen Basin and Cape Cod Bay stations (FF04 – FF07) for all years, as well as station FF09 (located between the Nearfield and Stellwagen Basin) clustered in quadrants Q2 and Q4 of the cross plot (Figure 4-3a), with near zero or positive Factor 1 loadings. Station FF07 (Cape Cod Bay) for all years clustered in quadrant Q2 of the cross plot (Figure 4-3a) and was characterized by higher concentrations of total DDT and total PCB with less sand content. Stations FF09 (located between the Nearfield and Stellwagen Basin) and FF05 (Stellwagen Basin) clustered in quadrant Q4 of the cross plot (Figure 4-3a) and were more sandy with lower concentrations of total PAH, total PCB, and total DDT relative to other Farfield stations.

Temporal Characteristics—Farfield baseline mean values and 95 % confidence intervals were determined for bulk sediment properties, *Clostridium perfringens*, and contaminant parameters as described in Section 4.1.3. Farfield baseline mean values for organic and some metal (Hg, Cu, Ag) contaminants were consistently less than Nearfield baseline mean values. Farfield baseline mean values for Pb, Cr, and Zn were fairly similar to Nearfield baseline mean values. In contrast, Farfield baseline mean values for Ni were generally 20–50 % higher than Nearfield baseline mean values.

With few exceptions (gravel, *Clostridium perfringens*), the temporal response of the baseline for bulk sediment and contaminant parameters showed fairly constant means without substantial variability (Figure 4-4). The 95 % confidence intervals generally overlapped across all sampling years, supporting the conclusions above that the spatial distribution of contaminants was not substantially different between sampling years. The Farfield baseline mean values for *Clostridium perfringens* were more variable across sampling years (Figure 4-4). Farfield baseline means in 1995–1997 were generally higher compared to yearly mean values determined in 1992–1994 and 1998–1999. Farfield baseline means decreased in abundance in 1998 and 1999 relative to 1995–1997. Trends in *Clostridium perfringens* are discussed in greater detail in Section 4.2.3.

4.2.3 Spatio/Temporal Response of *Clostridium perfringens* 1992–1999

The spatio/temporal distribution of *Clostridium perfringens* at all Nearfield and Farfield stations from 1992–1999 was evaluated to determine if the gradient in *Clostridium perfringens* observed by USGS (Parmenter and Bothner 1993) is consistent or has changed as harbor cleanup has proceeded. The USGS study observed decreasing spore density (normalized to percent fines) in bottom sediments with distance from Boston Harbor.

The gradient in *Clostridium perfringens* densities (raw and normalized to percent fines) with distance from Boston Harbor (defined as the Deer Island Light) was evaluated for the period 1992–1999. Each sampling year showed trends consistent with USGS findings and indicated that *Clostridium perfringens* densities decreased with distance from Boston Harbor. *Clostridium perfringens* showed a trend toward decreasing abundance in 1998 and 1999 from earlier years (Figure 4-5). There is a wide range in abundance of *Clostridium perfringens* for stations within 20 km of Deer Island Point (Figure 4-5). In contrast, stations further away from Deer Island Point consistently have lower spore densities (Figure 4-5). Variability in abundance of *Clostridium perfringens* at stations further from Deer Island Point decreased when results were normalized to percent fines, indicating that grain size is likely a major controlling factor (Figure 4-6).

Clostridium perfringens results were re-evaluated based on three distance classifications including a near-in group (< 20 km), mid-distance group (> 20 km but < 40 km) and far-distance group (> 40 km) from Deer Island Point. Yearly means (raw and normalized to percent fines) and 95 % confidence intervals were determined for the three distance classifications. Yearly means values of *Clostridium perfringens* (normalized to percent fines) for near-in stations (< 20 km) showed a decrease in abundance in 1998 and 1999 relative to earlier years (Figure 4-7). In contrast, stations further away from Deer Island Point (> 20 km) were on average relatively constant from 1992–1999 (Figure 4-7). The constancy in results within distance classifications after normalization to fine grained sediments suggests the *Clostridium perfringens* is preferentially attached to fine-grained particles and is transported with fine sediments. The decreasing abundance observed in 1998 and 1999 for near-in stations (< 20 km) does not appear to be method related, as the yearly means for all distance categories did not decrease equally. Instead, the trend toward decreasing abundance was most notable for stations within 20 km of Deer Island Point.

MTH Environmental Associates, the laboratory that performed the *C. perfringens* analyses was contacted to help address the following questions:

- *Have the methods used to determine spore densities changed from earlier years?*
- *What is the likely inter-laboratory variability and what level of differences would be considered "real?"*

MTH verified that the methods used to determine spore densities have not changed from earlier years. MTH indicated that there have been no studies looking at the issue of inter-laboratory variability with regard to *C. perfringens* levels in marine sediments. However, based on MTH's experience with marine sediments, observed decreases in abundance of 30% or more do suggest "real differences" in the system provided that samples have been collected and analyzed consistently over time. Further, this observation would be strengthened should trends in other effluent markers (*e.g.,* total LAB) show similar decreases over time. Trends in other effluent markers will be examined in the 2000 Outfall report.

C. perfringens abundance in 1998 and 1999 for near-in stations (<20 km) did decrease by more than 30% from abundances measured in earlier years. Further, Harbor wide concentrations of *C. perfringens* also showed decreasing abundance in August 1998 and 1999 compared to 1996-1997 values (Kropp *et al*. 2000). Thus, the decreasing abundance of *Clostridium perfringens* suggests that the removal of particulates initiated in 1997 by the secondary treatment may be causing the observed changes in 1998 and 1999. This is further supported by the decrease in total suspended solids (TSS) in the Deer Island effluent observed in 1998 (Werme and Hunt 2000).

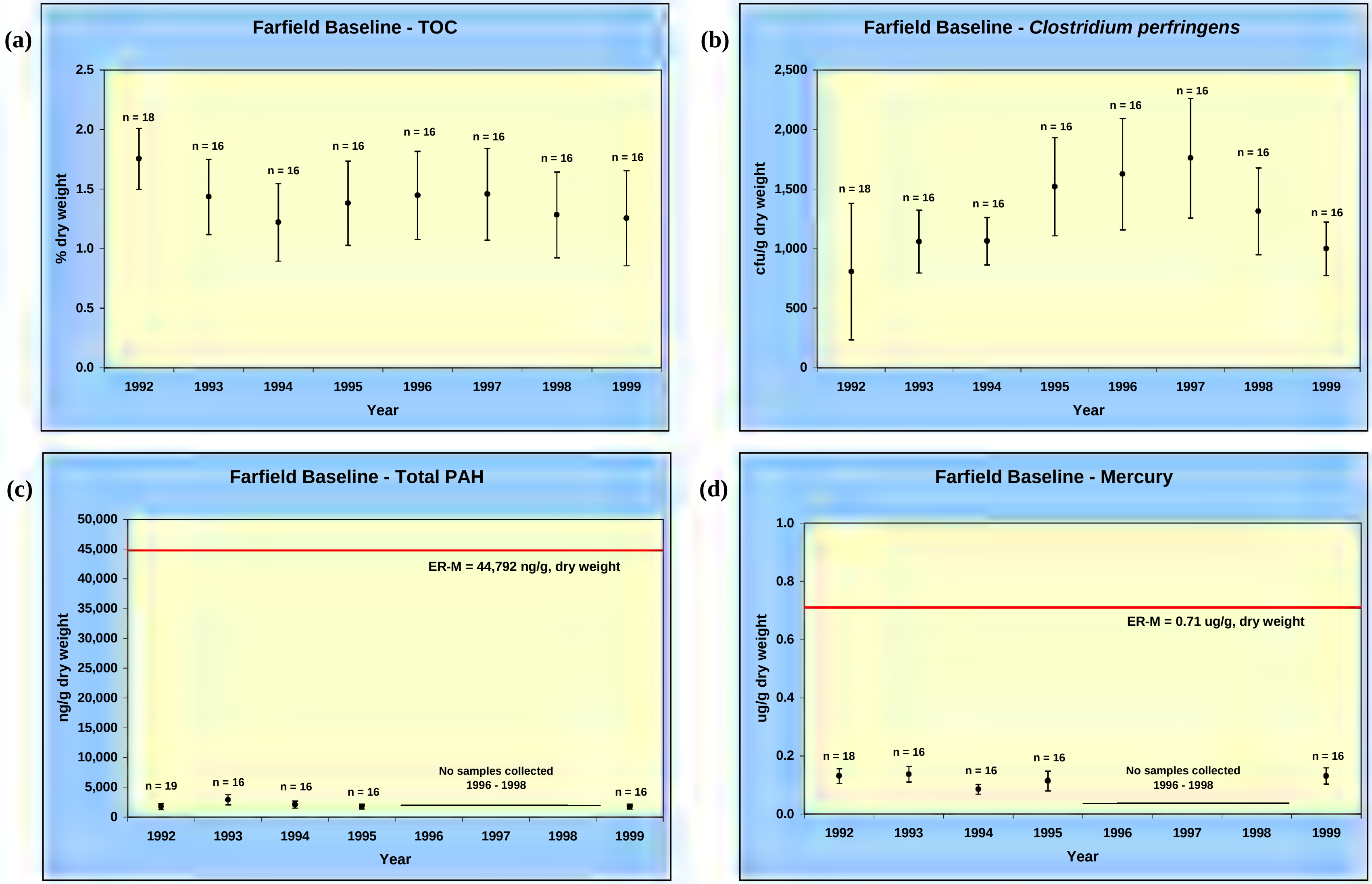


Figure 4-4. Farfield baseline for the period 1992–1999 for TOC, *Clostridium perfringens*, total PAH, and mercury. Error bars depict 95% confidence intervals.

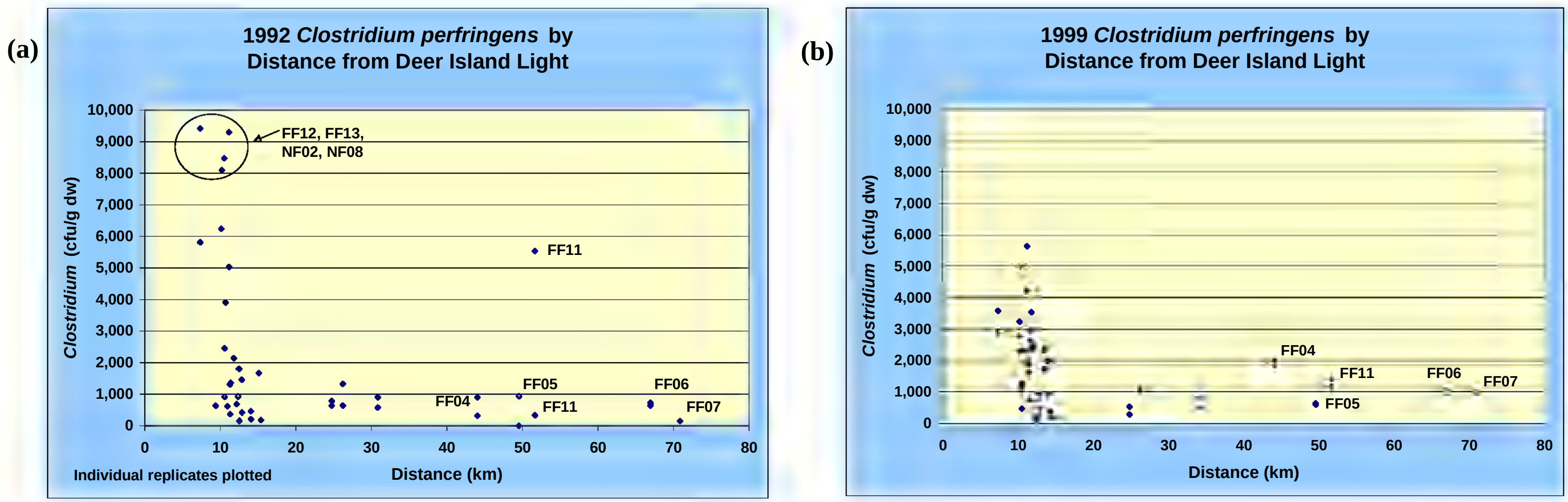


Figure 4-5. Distribution of *Clostridium perfringens* (raw) with distance from Deer Island Light in 1992 and 1999.

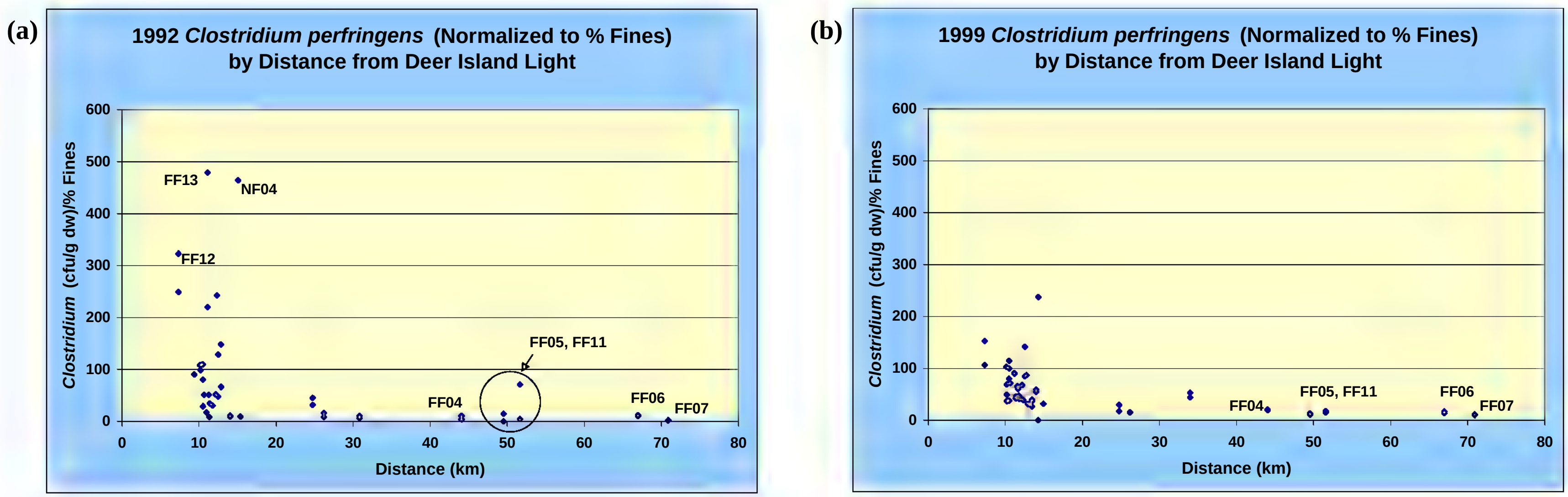


Figure 4-6. Distribution of *Clostridium perfringens* (normalized to percent fines) with distance from Deer Island Light in 1992 and 1999.

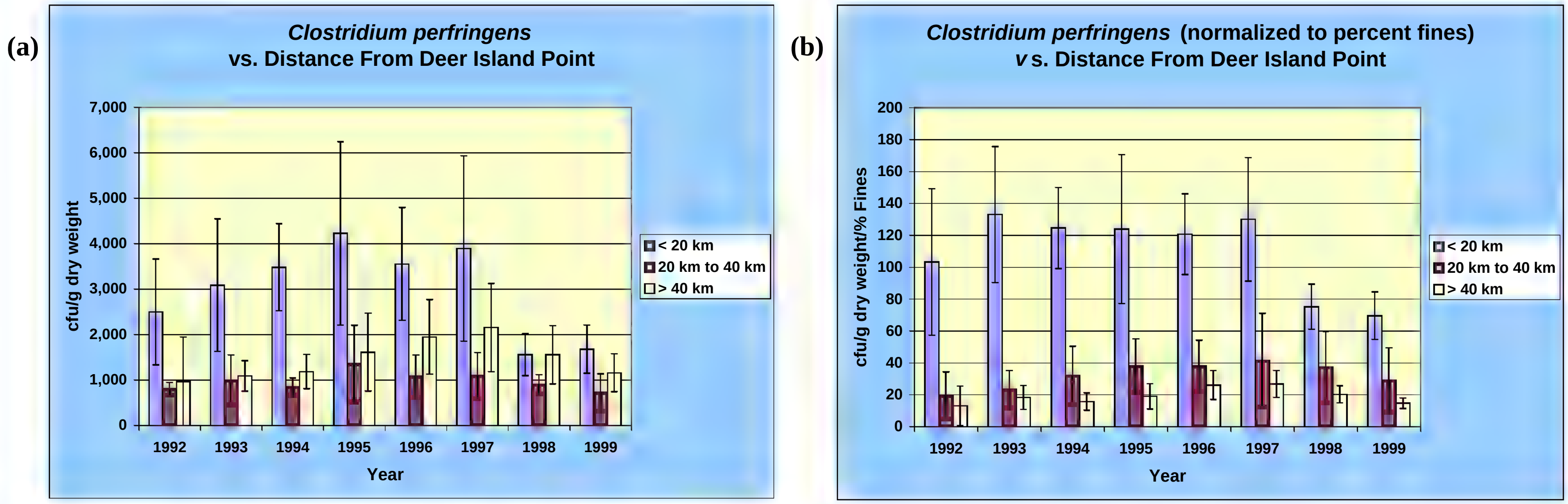


Figure 4-7. Yearly mean concentrations of *Clostridium perfringens* (raw and normalized to percent fines) by distance classification from Deer Island Light (1992–1999).

4.2.4 Chemistry Interrelationships

The correspondence within bulk sediment properties and against contaminants was evaluated for all Nearfield and Farfield stations by using correlation analysis.

Nearfield—Station mean values for Nearfield stations were used in the correlation analysis and the results are presented in Table 4-4. Grain size correlated strongly with TOC across all years ($r = 0.787$, $n = 108$, $p < 0.01$). Bulk sediment properties also correlated well with organic and metal contaminants across all years (Table 4-4, Figure 4-8). With few exceptions (total LAB, Cu, Pb), the correspondence between contaminants and bulk sediment properties was equally strong whether the correlation was performed against percent fines or TOC. The correlation coefficients for total LAB, Cu, and Pb were stronger (25–35 %) when the correlation was performed against TOC as compared to grain size. The evaluation confirms that the contaminant variability in the Nearfield is dominated by grain size and TOC.

Table 4-4. Correspondence within bulk sediment properties and against contaminants in the Nearfield, 1992–1999.

Parameter	Correspondence with Percent Fines			Correspondence with TOC		
	r	*n*	*p*	*r*	*n*	*p*
Percent Fines	1.000	108	<0.01	0.787	108	<0.01
TOC	0.787	108	<0.01	1.000	108	<0.01
Clostridium perfringens	0.641	108	<0.01	0.634	108	<0.01
Total PAH	0.657	108	<0.01	0.716	108	<0.01
Total PCB	0.690	108	<0.01	0.816	108	<0.01
Total DDT	0.725	108	<0.01	0.768	108	<0.01
Total LAB	0.506	108	<0.01	0.723	108	<0.01
Al	0.617	108	<0.01	0.537	108	<0.01
Cd	0.689	108	<0.01	0.807	108	<0.01
Cr	0.824	108	<0.01	0.889	108	<0.01
Cu	0.702	108	<0.01	0.892	108	<0.01
Fe	0.657	108	<0.01	0.684	108	<0.01
Pb	0.703	108	<0.01	0.894	108	<0.01
Hg	0.709	108	<0.01	0.812	108	<0.01
Ni	0.805	108	<0.01	0.760	108	<0.01
Ag	0.692	108	<0.01	0.822	108	<0.01
Zn	0.782	108	<0.01	0.885	108	<0.01

Farfield—Station mean values for Farfield stations were used in the correlation analysis and the results are presented in Table 4-5. Grain size and TOC were strongly correlated ($r = 0.896$, $n = 40$, $p < 0.01$). Although the relationships were high, the correspondence between bulk sediment properties and organic contaminants in the Farfield was generally not as strong as the correspondence observed in the Nearfield. This may suggest perhaps that the primary controlling variables in the Farfield are other than how depositional a station is. With few exceptions, the correspondence between bulk sediment and metals contaminants in the Farfield and Nearfield were more comparable.

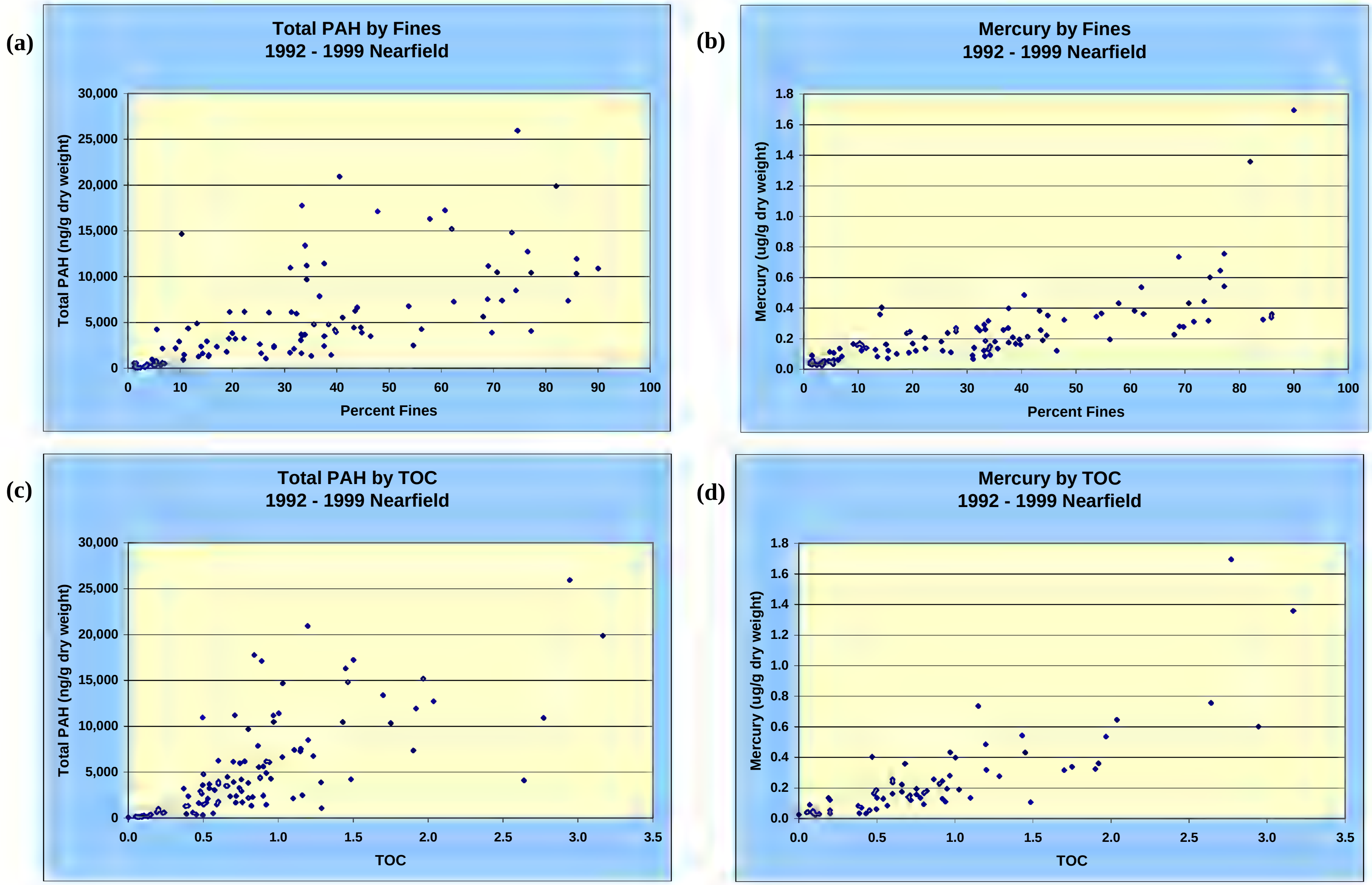


Figure 4-8. Correspondence between bulk sediment properties and representative contaminants (total PAH, mercury) in the Nearfield for the period 1992–1999.

Table 4-5. Correlation coefficients within bulk sediment properties and against contaminants in the Farfield 1992–1999 (excluding FF10, FF12, FF13).

Parameter	Correspondence against Percent Fines			Correspondence against TOC		
	r	***n***	***p***	***r***	***n***	***p***
Percent Fines	1.000	40	<0.01	0.896	40	<0.01
TOC	0.896	40	<0.01	1.000	40	<0.01
Clostridium perfringens	0.410	40	<0.05	0.331	40	<0.05
Total PAH	0.387	40	<0.05	0.434	40	<0.01
Total PCB	0.501	40	<0.01	0.439	40	<0.01
Total DDT	0.585	40	<0.01	0.499	40	<0.01
Total LAB	0.083	40	>0.05	0.012	40	>0.05
Al	0.623	40	<0.01	0.697	40	<0.01
Cd	0.574	40	<0.01	0.698	40	<0.01
Cr	0.808	40	<0.01	0.852	40	<0.01
Cu	0.819	40	<0.01	0.877	40	<0.01
Fe	0.805	40	<0.01	0.924	40	<0.01
Pb	0.761	40	<0.01	0.849	40	<0.01
Hg	0.742	40	<0.01	0.760	40	<0.01
Ni	0.762	40	<0.01	0.895	40	<0.01
Ag	0.571	40	<0.01	0.554	40	<0.01
Zn	0.870	40	<0.01	0.951	40	<0.01

4.2.5 Special Contaminant Study 1998–1999

The Special Contaminant Study was initiated in October 1998 with continued sampling in August 1999. Sediment samples were collected in triplicate at NF08, NF22, NF24, and FF10 to address possible short-term transport and impact with a focus on high TOC/depositional areas.

Bulk sediment and contaminant results from the replicate analyses of sediment samples are reported in Table 4-6 and Appendix C. Data are presented as station mean values and standard deviation of the triplicate analyses. All results are reported on a dry weight basis to three significant figures.

Grain Size—Patterns in sediment texture from October 1998 to August 1999 were variable at some stations (NF08, FF10), and more consistent at others (NF22, NF24) (Figure 4-9; Table 4-6). Sediment from NF08 contained considerably more silt and less sand in August 1999 compared to October 1998. Sediment from FF10 contained greater amounts of gravel in August 1999 compared to October 1998. With some exceptions, the relative variability between sample triplicates was fairly consistent between October 1998 and August 1999. The relative variability in silt content between sample triplicates at NF08 was approximately six times less variable in August 1999 compared to October 1998 results (Table 4-6). Sand and clay composition at NF22 was also two to three times more variable in August 1999 compared to October 1998 results, whereas sand, clay, and silt composition at NF24 was three to eight times less variable in August 1999 compared to October 1998 results (Table 4-6).

Table 4-6. Special contaminant study bulk sediment and contaminant parameters determined in October 1998 and August 1999.

Parameter	Units (dry weight)	ER-M[a]	NF08				NF22				NF24				FF10			
			1998		1999		1998		1999		1998		1999		1998		1999	
			Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
Total PAH[b,c]	ng/g	44,792	6760	2350	7400	1480	3900	705	4430	606	17100	20200	7260	805	2120	135	3230	1930
Total PCB[b]	ng/g	180	26.9	7.14	18.7	6.48	11.1	2.68	12.1	3	20.7	9.79	12.6	0.694	5.88	1.87	2.62	0.448
Total DDT[b]	ng/g	46.1	11	10.7	6.32	7.01	2.51	0.443	2.56	0.389	3.96	2.01	6.28	6.77	2.22	1.9	0.587	0.302
Total Chlordane[b]	ng/g	6[d,e]	0.681	0.123	0.378	0.0782	0.266	0.0573	0.238	0.206	0.274	0.266	0.127	0.22	0.103	0.0901	0.0281	0.0487
Total Pesticide[b]	ng/g	NA	0.737	0.24	0.0824	0.0736	0.141	0.122	0.176	0.306	0.227	0.283	ND	NA	0.00617	0.0107	ND	NA
Total LAB[b]	ng/g	NR	290	53.3	128	22.2	184	18.9	91.3	8.27	191	54.8	72.7	15.4	79.2	12.6	25.6	14.2
Dieldrin	ng/g	8	0.329	0.0604	ND	NA	0.129	0.112	0.176	0.306	0.181	0.243	ND	NA	ND	NA	ND	NA
Al	pct	NR	5.86	0.262	5.52	0.387	5.9	0.0208	6.01	0.224	5.74	1.04	5.74	0.371	5.32	0.0208	5.07	0.335
Cd	µg/g	9.6	0.244	0.0599	0.221	0.0363	0.107	0.0198	0.109	0.00613	0.108	0.0687	0.103	0.0188	0.0646	0.064	0.0713	0.0104
Cr	µg/g	370	119	14.8	95.4	20.6	73.4	8.78	74	8.75	95.1	56.2	83	9.14	70.1	8.33	56.9	11.4
Cu	µg/g	270	32.4	3.71	32.4	7.6	21.8	2.68	25.4	2.75	31.2	9.58	32.9	2.42	15.1	2.93	20.6	10.8
Fe	pct	NR	2.78	0.164	2.61	0.166	2.57	0.0839	2.66	0.0814	2.52	0.803	2.73	0.0819	1.83	0.109	2.05	0.311
Pb	µg/g	218	49.6	2.96	50.9	6.22	40	2.9	45.9	1.51	55.4	23.5	68.3	9.76	31.4	1.51	28.5	3.03
Hg	µg/g	0.71	0.344	0.0485	0.311	0.0849	0.351	0.0695	0.381	0.112	0.322	0.179	0.362	0.0889	0.272	0.256	0.107	0.00673
Ni	µg/g	51.6	21.8	1.04	19.1	4.05	19.8	3.1	23.2	2.66	19.9	7.8	24.2	2.7	15	1.7	17.7	9.99
Ag	µg/g	3.7	0.901	0.17	0.918	0.223	0.593	0.101	0.66	0.0961	0.698	0.427	0.488	0.0403	0.302	0.0128	0.269	0.0554
Zn	µg/g	410	81.1	8.04	79.4	15.2	63.4	3.35	65.6	1.01	72.3	28.4	79.1	5.77	43.8	1.97	55.9	12.9
Sand	pct	NR	48.5	13.8	26.3	6.53	51.8	1.28	52.8	3.66	38.7	34.7	37.5	4.28	49	19.8	59.6	18.7
Gravel	pct	NR	1.7	2.94	2.03	3.44	2.5	4.07	3.97	3.6	0.667	0.833	0.167	0.289	1.02	1.36	21.1	17.6
Silt	pct	NR	38.6	13.8	59.6	3.65	34.6	5.18	32.2	3.76	46.1	28.9	47.7	5.88	39	17.3	15	10.3
Clay	pct	NR	11.1	2.85	12	2.85	11.1	0.777	11.1	1.93	14.5	8.38	14.7	2.72	11	3.87	4.33	1.96
Fines[b]	pct	NR	49.8	16.7	71.6	5.19	45.8	5.96	43.3	5.47	60.6	37.2	62.4	4.16	49.9	21.2	19.3	12.3
Mean phi	pct	NR	4.71	0.816	5.48	0.202	4.50	0.479	4.32	0.323	5.05	1.52	5.19	0.103	4.27	0.966	2.27	1.22
TOC	pct	NR	1.31	0.275	1.11	0.285	0.693	0.19	0.88	0.171	1.07	0.51	1.15	0.0577	0.493	0.0907	0.54	0.137
Clostridium	cfu/gdw	NR	4590	361	3660	1150	3230	534	2660	315	2610	1760	2140	354	1630	180	1190	72.1

[a] From Long *et al*. (1995)
[b] Grain size and contaminant groups defined in Section 4.1.3
[c] Total PAH reported was calculated from an extended list of individual PAHs that were not included in the ERM total PAH group (Long 1995)
[d] ERM value is for Total Chlordane
[e] From Long and Morgan (1991)

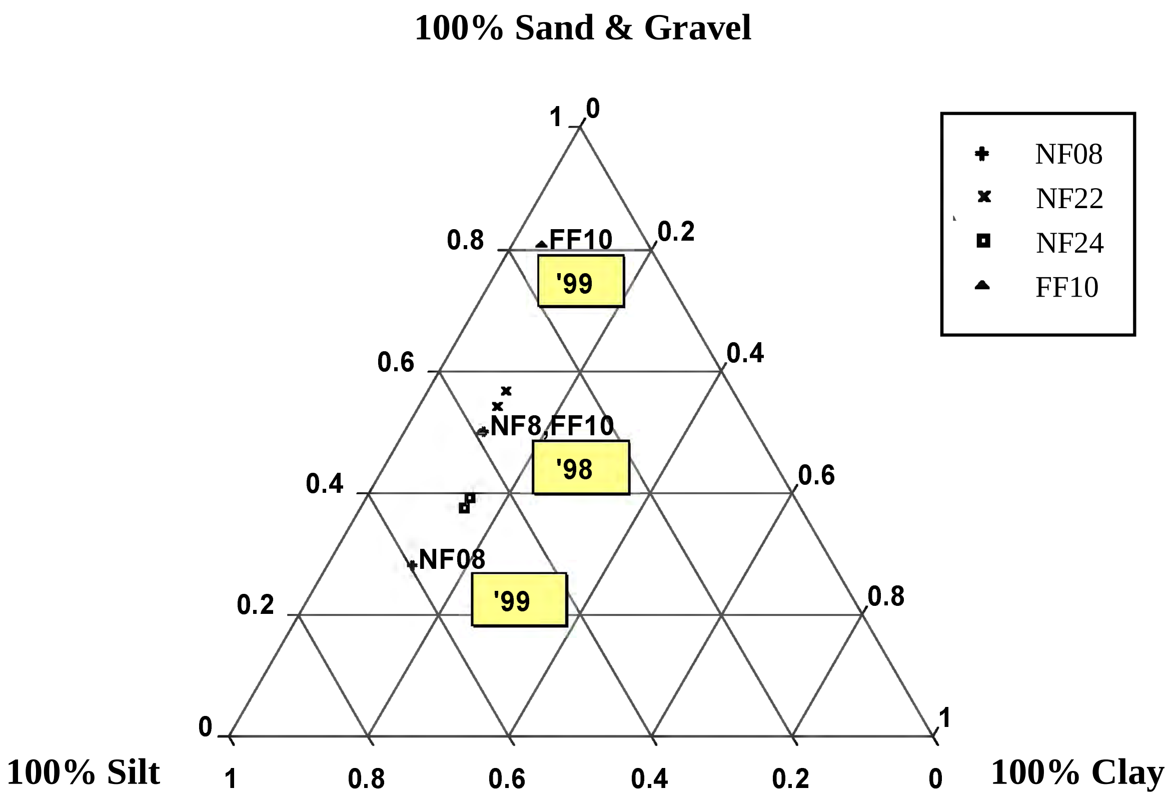


Figure 4-9. Grain size composition at Special Contaminant Study stations in 1998 and 1999.

TOC—Station mean concentrations of TOC for each of the four Contaminannt Special Study stations from October 1998 and August 1999, as well as TOC results for the same stations analyzed as part of the Nearfield in August 1998, are shown in Figure 4-10. With the exception of station NF24, concentrations of TOC were generally consistent from 1998 to 1999 (Figure 4-10). Mean concentration of TOC at station NF24 in October 1998 and August 1999 were approximately two times higher compared to August 1998 levels (Figure 4-10). With the exception of NF24, the relative variability between sample triplicates was fairly consistent from October 1998 to August 1999 (Table 4-6). Relative variability between sample triplicates at NF24 was approximately 10× less in August 1999 compared to October 1998 results (Table 4-6).

***Clostridium perfringens*—**Station mean abundances of *Clostridium perfringens* for each of the four Contaminant Special Study stations from October 1998 and August 1999, as well as spore density results for the same stations analyzed as part of the Nearfield in August 1998, are shown in Figure 4-11. With the exception of station NF24, patterns in *Clostridium perfringens* densities were consistent from October 1998 to August 1999. However, overall densities were 20 to 40 % lower in August 1999 compared to October 1998 levels (Figure 4-11). With the exception of station NF24, *Clostridium perfringens* densities were 5 to 25% lower in August 1999 compared to August 1998 levels (Figure 4-11). *Clostridium perfingens* densities at station NF24 were approximately 35% lower in August 1998 compared to

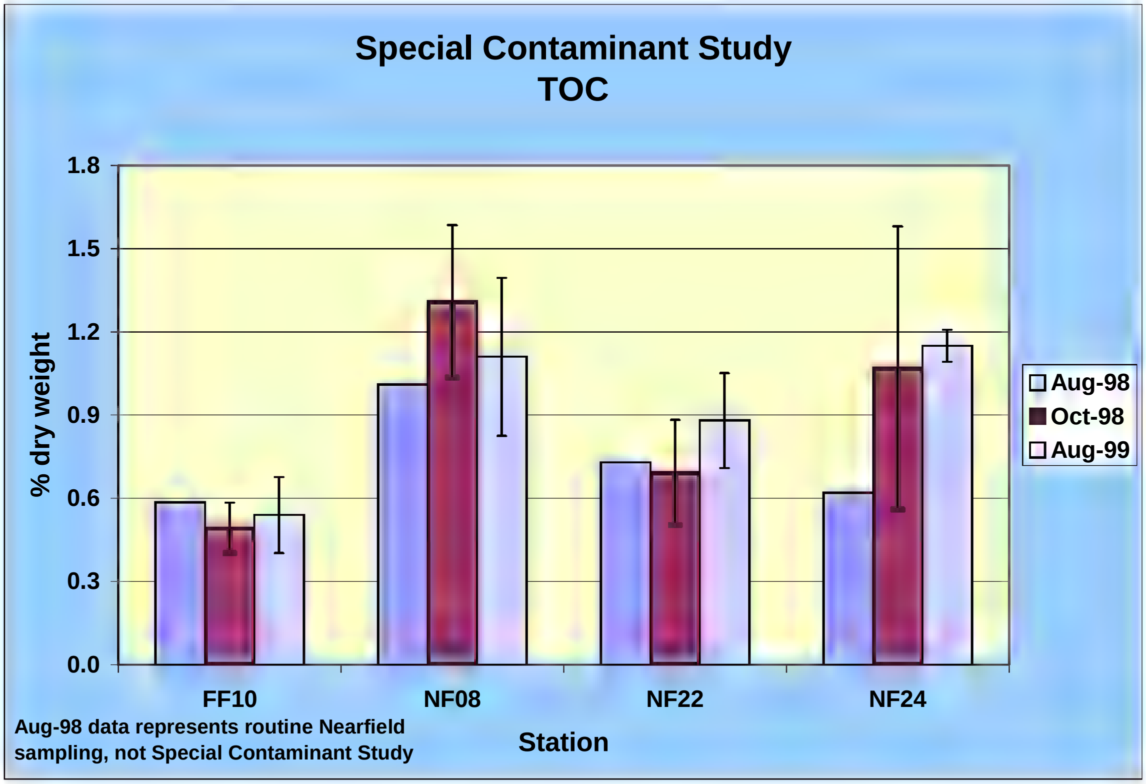


Figure 4-10. TOC content at Special Contaminant Study stations in August 1998, October 1998 and August 1999.

August 1999 levels (Figure 4-11). With the exception of NF08, precision between sample triplicates was tighter in August 1999 compared to October 1998 (Table 4-6, Figure 4-11). The relative variability between sample triplicates at NF08 was approximately four times greater in August 1999 compared to October 1998.

Contaminants—With the exception of NF24, station mean values for total PAH were generally consistent between October 1998 and August 1999 (Figure 4-12). Concentrations of total PAH at NF24 in August 1999 decreased by more than 50 % from October 1998 levels. However, one of the replicates from NF24 had anomalously high PAH content in October 1998 and had this replicate been excluded then the station mean values for total PAH would be fairly constant from October 1998 to August 1999. With the exception of NF22, station mean values for total PCB were consistently 30 to 40 % lower in August 1999 compared to October 1998 values (Figure 4-12). Concentrations of total DDT decreased in August 1999 at FF10 and NF08, increased at NF24 and remained fairly constant at NF22. Station mean values for total LAB decreased by more than 50 % at all stations in August 1999 compared to October 1998 values. With few exceptions, station mean values for metals were consistent between October 1998 and August 1999 (Table 4-6, Figure 4-12).

Relative variability between sample triplicates was fairly consistent from October 1998 to August 1999 at some stations (NF08, NF22), and less consistent at others (FF10, NF24). Relative variability between sample triplicates for total PAH, total LAB, and most metals (excluding Cd, Hg) was higher in August 1999 at FF10, and lower at NF24 for total PAH, total PCB, and metals (Table 4-6).

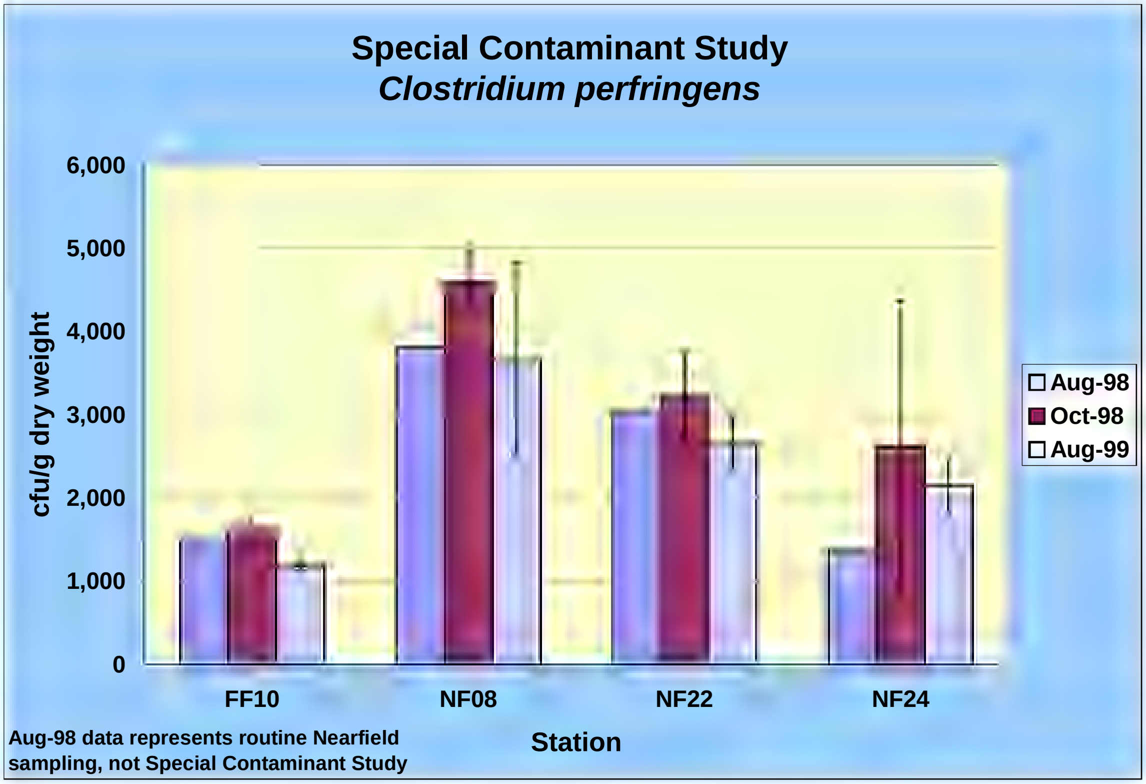


Figure 4-11. *Clostridium perfringens* density (cfu/gdw) at Special Contaminant Study stations in August 1998, October 1998 and August 1999.

Chemistry Interrelationships—Correspondence within bulk sediment properties and against contaminants was evaluated for all Special Contaminant Study stations (NF08, NF22, NF24, FF10) sampled in October 1998 and August 1999. Correspondence was evaluated using the individual replicates from each station, not station mean values. Grain size was strongly correlated with TOC for both sampling years, however the correspondence in August 1999 was considerably stronger (October 1998: $r = 0.549$, $n = 12$, $p > 0.05$; August 1999: $r = 0.836$, $n = 12$, $p < 0.01$) (Figure 4-13). Organic and metal contaminants correlated well with bulk sediment parameters, indicating that variability was primarily controlled by grain size and TOC (Figures 4-14). However, the correspondence between grain size and contaminants was considerably stronger in August 1999 compared to October 1998. In contrast, the correspondence between TOC and most contaminants was generally stronger in October 1998 compared to August 1999 (Figure 4-14).

Comparison to Nearfield— Data from all Special Contaminant Study stations (NF08, NF22, NF24, FF10) were averaged by year to determine yearly mean values and associated 95 % confidence intervals. Yearly mean values from October 1998 and August 1999 for the Special Contaminant Study were then compared to Nearfield baseline mean values from 1992 to 1999 to address the question *"how well do the*

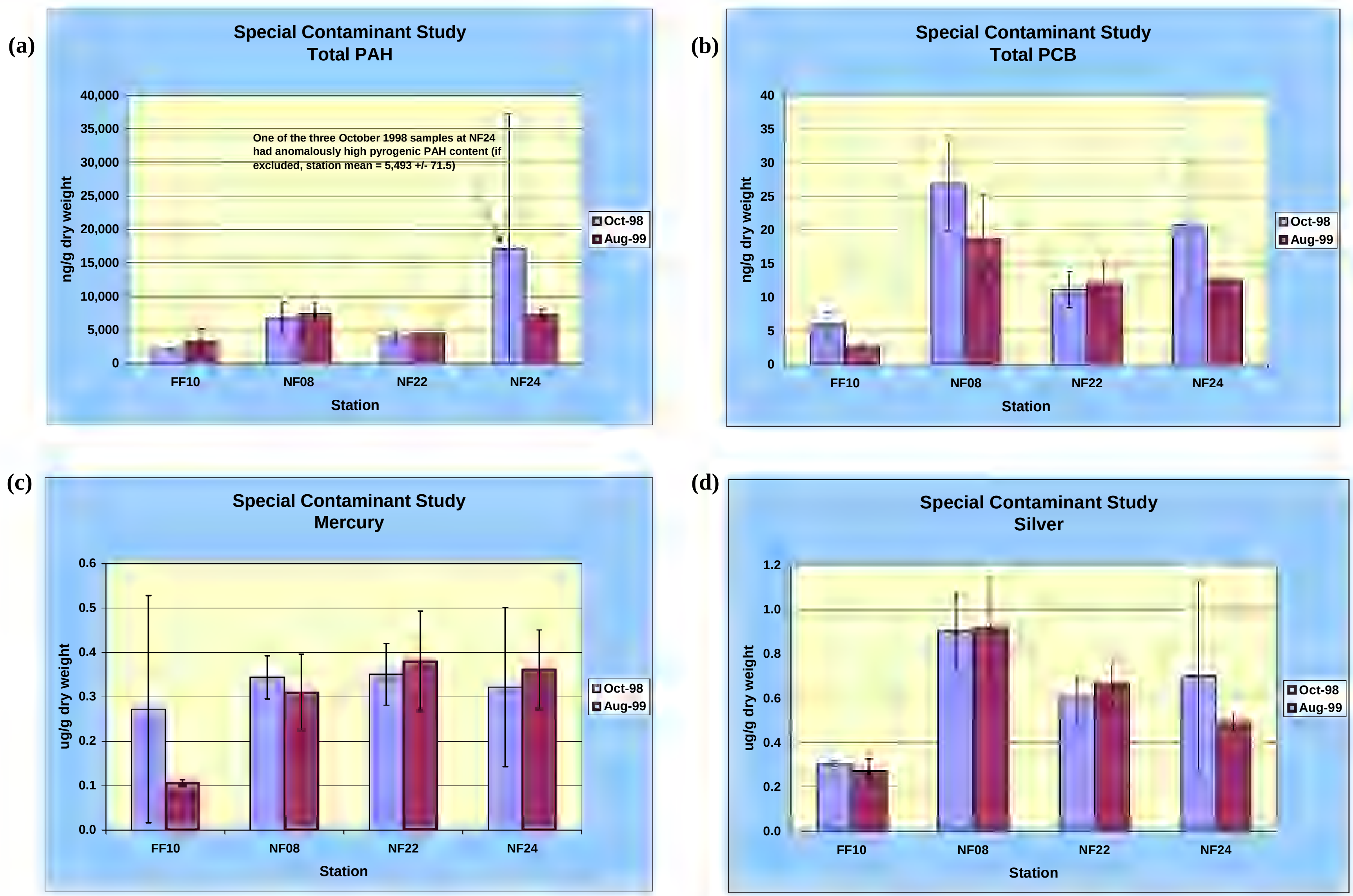


Figure 4-12. Distribution of representative contaminants (total PAH, total PCB, mercury, silver) at Special Contaminant Study stations in 1998 and 1999.

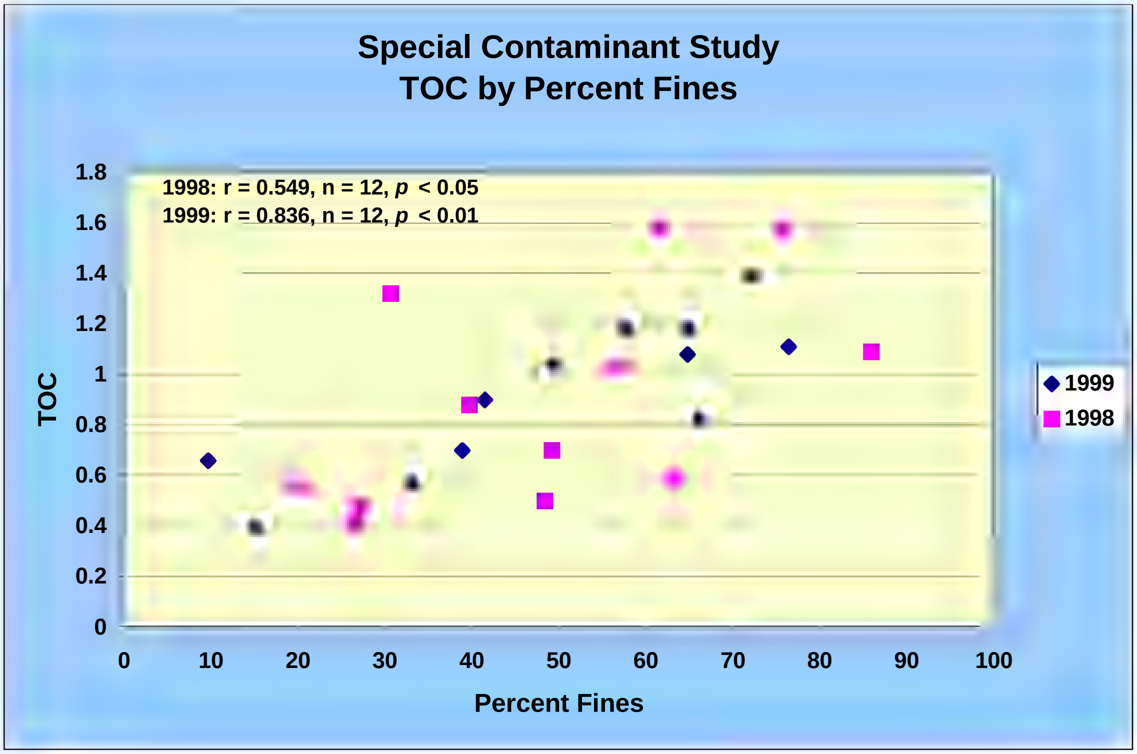


Figure 4-13. Correspondence within bulk sediment properties at Special Contaminant Study stations in October 1998 and August 1999.

Special Contaminant Study stations represent the Nearfield?". The temporal response of the baseline for representative organic and metal contaminants was similar for both the Special Contaminant Study stations and the Nearfield (Figure 4-15). The 95 % confidence intervals generally overlapped across all sampling years, further suggesting that the four Special Contaminant Study stations are reasonably representative of the Nearfield.

4.3 Comparison of Baseline Data to Thresholds

Baselines levels of contaminants in the Nearfield were established for contaminants in sediment based on the mean aerial distribution for Nearfield stations. Baseline and 95 % confidence intervals were determined for each sampling year from 1992–1999 and were evaluated against the MWRA monitoring thresholds based on the Long *et al*. (1995) ER-M values (Table 4-7). Note that Nearfield contaminant results from 1998 are only available for the Contaminant Special Study stations (FF10, NF08, NF22, and NF24). These data are included in Table 4-7 and Figure 4-16 for illustrative purposes only; formal threshold testing will only be conducted when contaminant data are available for all nearfield stations. The temporal response of the baseline for organic and metal contaminants showed relatively constant means without substantial variability (see Figure 4-16 for representative parameters). Baseline mean values for any given year (*i.e.*, 1999) were generally representative of the baseline over time (1992–1999) and were well below ER-M thresholds (Table 4-7).

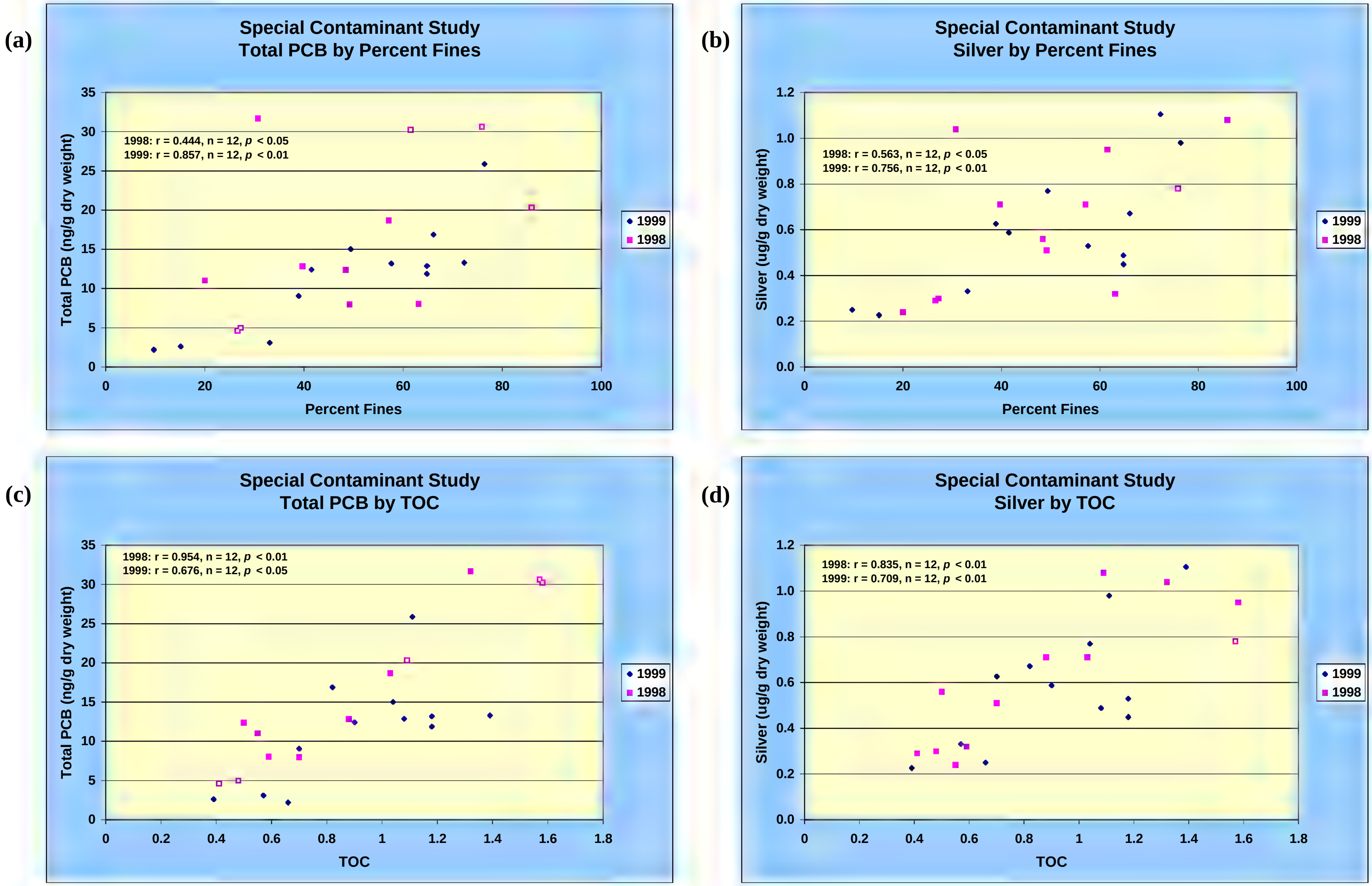


Figure 4-14. Correspondence between bulk sediment properties and representative contaminants (total PCB, silver) at Special Contaminant Study stations in 1998 and 1999.

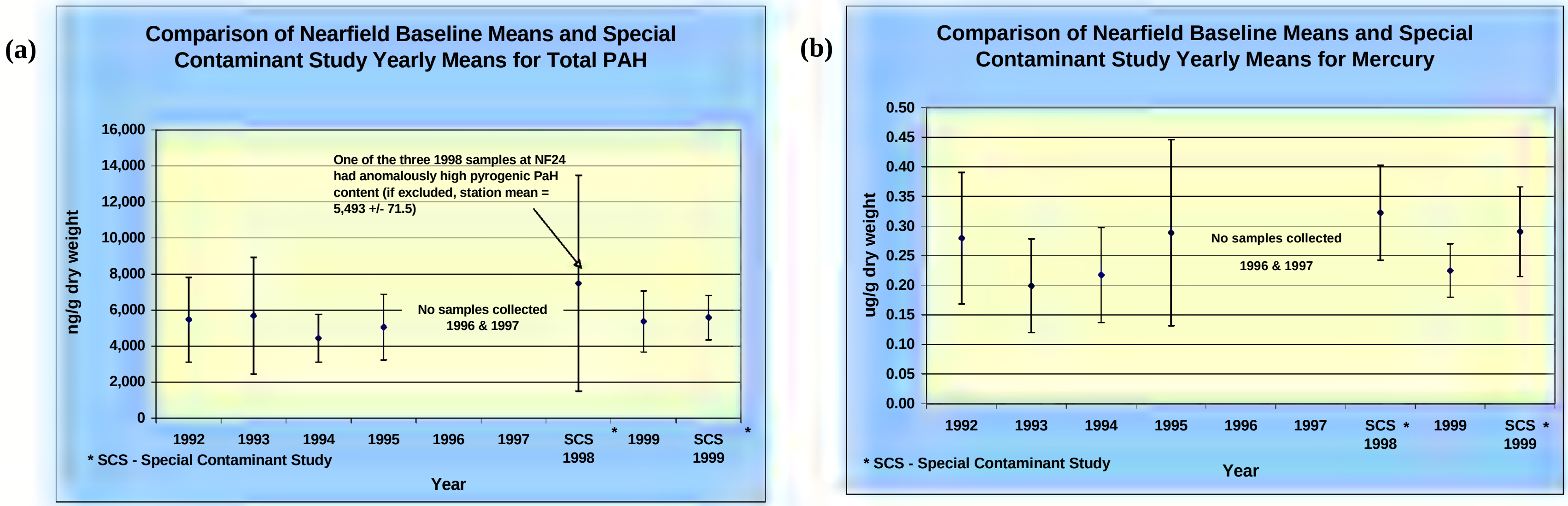


Figure 4-15. Comparison of Special Contaminant Study and Nearfield baseline mean values for total PAH (a) and mercury (b).

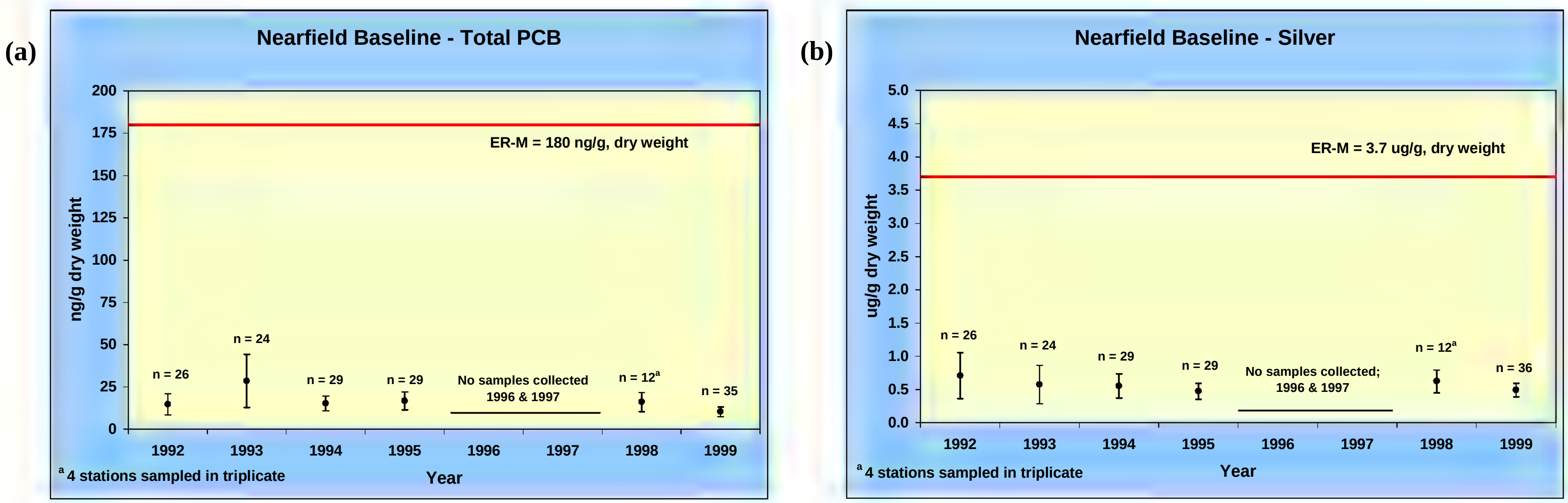


Figure 4-16. Baseline comparison to thresholds in the Nearfield for the period 1992–1999.

Table 4-7. Comparison of Nearfield baseline mean concentrations and thresholds for the period 1992–1999. 1998 data not threshold relevant and included for illustrative purposes only.

Parameter	Units (dry weight)	ER-M[a]	1992		1993		1994		1995		1996		1997		1998 [b]		1999	
			Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev	Mean	Stdev
Total PAH[c,d]	ng/g	44792	5460	6130	5690	8090	4430	3650	5050	5020	NA	NA	NA	NA	7480	10600	5360	5130
Total PCB[c]	ng/g	180	14.7	16.3	28.6	39.1	15.2	11.9	16.7	14.5	NA	NA	NA	NA	16.1	10.1	10.3	8.66
Total DDT[c]	ng/g	46.1	3.3	3.5	3.82	5.44	5.27	6.53	2.65	3.15	NA	NA	NA	NA	4.93	6.03	2.7	3.2
Total Chlordane[c]	ng/g	6[e,f]	0.108	0.322	0.52	0.652	0.862	0.826	0.465	1.26	NA	NA	NA	NA	0.331	0.259	0.175	0.193
Total Pesticide[c]	ng/g	NA	1.18	2.11	1.12	0.993	4.04	2.85	0.345	0.501	NA	NA	NA	NA	0.278	0.333	0.0664	0.152
Total LAB[c]	ng/g	NR	299	542	392	568	221	282	82.5	97.2	NA	NA	NA	NA	252	84.7	144	60.2
Al	µg/g	NR	5.26	0.686	4.97	0.938	5.14	1.13	4.55	1.02	NA	NA	NA	NA	5.69	0.511	4.98	0.858
Cd	µg/g	9.6	0.189	0.218	0.228	0.255	0.153	0.136	0.175	0.123	NA	NA	NA	NA	0.131	0.0856	0.0896	0.0644
Cr	µg/g	370	85.1	56	80.2	60.1	86.8	44.6	64.8	39.6	NA	NA	NA	NA	88.5	31.7	61.9	23.3
Cu	µg/g	270	27.6	23.9	26.1	19.2	22.8	12.5	19.2	13.1	NA	NA	NA	NA	25	8.63	23.2	9.33
Fe	µg/g	NR	2.31	0.733	2.15	0.829	2.25	0.676	1.8	0.535	NA	NA	NA	NA	2.41	0.507	2.33	0.446
Pb	µg/g	218	47.2	23.6	42.9	20.7	43.8	14.5	43	17	NA	NA	NA	NA	44	14	44.2	13.8
Hg	µg/g	0.71	0.28	0.29	0.199	0.198	0.217	0.22	0.289	0.432	NA	NA	NA	NA	0.322	0.142	0.225	0.138
Ni	µg/g	51.6	18.2	7.63	18.5	8.9	17	7.49	15.5	6.32	NA	NA	NA	NA	19.1	4.48	17.3	6.82
Ag	µg/g	3.7	0.707	0.902	0.575	0.719	0.553	0.495	0.471	0.332	NA	NA	NA	NA	0.624	0.302	0.493	0.314
Zn	µg/g	410	69.7	45	60.8	38.8	56.9	23.7	56.6	27.2	NA	NA	NA	NA	64.8	19	59.2	19.1
Gravel	pct	NR	8.04	17.3	4.03	10.7	4.08	9.09	3.3	6.5	7.02	16	2.21	5.31	6.68	15.7	5.9	11.3
Sand	pct	NR	59.5	23.6	68	22.8	60	26.1	61.4	26.9	59.7	24.5	64.7	24	61.1	23	59.6	23.5
Silt	pct	NR	24.7	18.3	23.1	20.2	28.1	22.1	25.5	21.5	24.9	19.6	24.5	19.6	24.6	18.7	26.2	19.8
Clay	pct	NR	7.74	6.95	4.88	3.98	7.79	6.55	9.8	14.4	8.31	5.9	8.56	5.88	7.59	5.52	8.3	5.92
Fines[c]	pct	NR	33.5	24.2	28	23.7	35.9	27.7	35.3	28	33.2	25	33.1	24.9	32.2	23.6	34.5	24.9
TOC	pct	NR	1.05	0.656	0.847	0.924	0.786	0.555	0.802	0.695	0.878	0.588	0.77	0.562	0.669	0.45	0.75	0.422
Clostridium	cfu/g	NR	2850	3110	3090	2600	3600	2540	4980	5750	3850	3350	3850	4720	1950	1350	1940	1410

[a] From Long *et al*. (1995)
[b] Four stations sampled in triplicate (special contaminant study).
[c] Grain size and contaminant groups defined in Section 4.1.3
[d] Total PAH reported was calculated from an extended list of individual PAHs that were not included in the ERM total PAH group (Long 1995)
[e] ERM value is for Total Chlordane
[f] From Long and Morgan (1991)
NA = Not applicable
NR = Not regulated

Table 4-8. Comparison of baseline mean concentrations, significantly increased levels, and threshold at the Nearfield.

Parameter	Baseline Mean[a]	Baseline Standard Error	N	Significant Increase[b]	Warning Level[c]	Ratio between Threshold and Significant Increase
Total PAH[d,e]	5200	217	5	5660	44792	7.9
Total PCB[d]	17.1	3.05	5	23.6	180	7.6
Total DDT[d]	3.55	0.482	5	4.57	46.1	10.1
Total Chlordane[d]	0.426	0.135	5	0.714	6[f,g]	8.4
Cd	0.167	0.0229	5	0.216	9.6	44.5
Cr	75.8	5.2	5	86.9	370	4.3
Cu	23.8	1.44	5	26.8	270	10.1
Pb	44.2	0.784	5	45.9	218	4.8
Hg	0.242	0.0178	5	0.28	0.71	2.5
Ni	17.3	0.519	5	18.4	51.6	2.8
Ag	0.56	0.0415	5	0.648	3.7	5.7
Zn	60.6	2.39	5	65.7	410	6.2
Clostridium perfringens	3260	365	8	3950	NR	-

[a] Mean concentration of Annual Means, 1992–1995 and 1999 (Contaminants; no 1996 and 1997 data; October 1998 Contaminant Special Study data not used in determination of Baseline Mean)
[b] The significant increase is the concentration at which an increase from the baseline mean is considered statistically significant at the 0.05 level (*i.e.*, 95th percent UCL = mean + $t_{0.1,n-1}$ * S.E.).
[c] Based on ER-M sediment quality guidelines from Long *et al*. (1995)
[d] Contaminant groups defined in Section 4.1.3
[e] Total PAH reported was calculated from an extended list of individual PAHs that were not included in the ERM total PAH group (Long 1995)
[f] ERM value is for Total Chlordane
[g] From Long and Morgan (1991)

To establish when significant increases above the baseline would be detected, a statistical value was established. The significant increase value was set as the 95th percentile upper confidence limit (based on the "t" distribution) of the mean of the annual means. The significant increase values are well within the range of detection; suggesting change can be detected well in advance of threshold issues (Table 4-8). Moreover, each threshold is at least 2.4 times higher than the level of significant increase.

4.4 Conclusions

The PCA, the *Clostridium perfringens* regional analysis, and the correlation analyses all support the picture of two areas with very different factors influencing contaminant concentrations. In the Nearfield, with Mass Bay, there are a series of stations with very heterogeneous sediments in relatively close proximity to the historic leading source of contaminants (*i.e.*, Boston Harbor). Nearfield stations are for the most part equidistant from the source and the major factors influencing concentration of contaminants and sewage tracers are grain size factors, such as how depositional the site is. This is supported by the Nearfield PCA which showed that the primary factors responsible for the variance in the data were Factor 1 (sand, total PAH) and to a lesser extent Factor 2 (*Clostridium perfringens*).

In contrast, the Farfield stations are for the most part less heterogeneous in terms of sediments but are substantially more dispersed. The *Clostridium perfringens* regional analysis shows that a controlling factor in concentrations in the Farfield appears to be proximity to the historic source of sewage contaminants. This was supported by the Farfield PCA results, in which Factor 1 groups the stations more or less along a north-south alignment.

The above picture of the two disparate regions with different controlling factors agrees well with the correlation analyses run on the data from the two regions. Correlations between contaminants and the bulk sediment properties (that appear to control contaminant concentrations in that region) are quite high, with r^2 of 50% or higher for most parameters. Those correlations were generally weaker for Farfield stations (organic contaminants in particular), further supporting the evaluation of the primary controlling variables in the Fairfield being other than how depositional a station is.

Within each of these distinct regions, the spatial distribution of bulk sediment properties and contaminant parameters in 1999 was not substantially different from previous years (1992-1998). Similarly, with the exception of *Clostridium perfringens*, the temporal response of bulk sediment properties and contaminants was not substantially different over time. *Clostridium perfringens* abundances decreased in 1998 and 1999 for stations located closer to the Harbor (20-km of Deer Island Point), suggesting that a "cleaner effluent" with fewer particulates is being discharged possibly as a result of secondary treatment coming on-line in 1997. Baseline mean values for organic and metal contaminants in the Nearfield were well below the MWRA thresholds.

5. 1999 SOFT-BOTTOM INFAUNAL COMMUNITIES

by Robert J. Diaz, Roy K. Kropp, and Kenneth E. Keay

5.1 Methods

5.1.1 Laboratory Analyses

Samples were rinsed with fresh water over 300-μm-mesh screens and transferred to 70–80% ethanol for sorting and storage. To facilitate the sorting process, all samples were stained in a saturated, alcoholic solution of Rose Bengal at least overnight, but no longer than 48 h. After rinsing with clean alcohol, small amounts of the sample were placed in glass dishes, and all organisms, including anterior fragments of polychaetes, were removed and sorted to major taxonomic categories such as polychaetes, arthropods, and mollusks. After samples were sorted, the organisms were sent to taxonomists (Appendix D-1) for identification and enumeration. Identifications were made at the lowest practical taxonomic level, usually species.

5.1.2 Data Analyses

Preliminary Data Treatment—Prior to performing any of the analyses of the 1999 and 1992–1999 MWRA datasets, several modifications were made. Several non-infaunal taxa were excluded from all analyses (listed in Appendix D-2). Data for several taxa were pooled. Usually this involved pooling data for a taxon identified to a level higher than species (*e.g*., genus) with those data for a species within the higher taxon. This pooling was done only when only a single species of the higher taxon was identified. For example, *Byblis gaimardi* (an amphipod) was the only species of the genus found, so that any amphipods identified only to the genus (*Byblis* spp.) were treated as if they were *B. gaimardi*. Because the identification of some taxa has been inconsistent through the duration of the project, data for some species were pooled to a higher-level taxon. For example, Turbellarians were identified to species in 1993 and 1994, but have only been identified to phylum during the other years of the program. Therefore, data for Turbellaria sp. 1 and sp. 2 were pooled with data for Turbellaria spp. All such changes are listed in Appendix D-2.

Calculations of abundance included all taxa occurring in each sample. Calculations based on species (diversity, evenness, number of species) included only those taxa identified to species level or treated as such (Appendix D-2). Prior to such analyses, the data were scanned and a few taxa identified to a taxonomic level other than species (*e.g*., genus) were chosen (because they were unique) to be included in the species-level calculations. These are listed in Appendix D-2.

Designation of Nearfield and Farfield stations—For these analyses, the stations termed “Nearfield” include all stations having NF designations plus stations FF10, FF12, and FF13. This was done to allow all western Massachusetts Bay Stations to be included in a single analysis. Stations termed “Farfield” include all stations having FF designations, except stations FF10, FF12, and FF13.

5.1.3 Diversity Analysis

The software package BioDiversity Professional, Version 2 (© 1997 The Natural History Museum / Scottish Association for Marine Science) was used to perform calculations of total species, log-series alpha, Shannon’s Diversity Index (H'), the maximum H' (Hmax), and Pielou’s Evenness (J'). Calculations made by the software were validated by comparing values for these parameters and for total individuals calculated for the 1998 Nearfield and Farfield infaunal data (Kropp *et al.* 2000) with those made by BioDiversity Pro. Calculations made by BioDiversity for all parameters except log-series alpha were the same as those reported in (Kropp *et al.* 2000). Values calculated by BioDiversity Pro for log-series alpha were 0.01–0.02 higher than those previously reported. However, when rounded to 0.1, both sets of calculations yielded the same values. The results of the validation are given in Appendix D-3. BioDiversity Pro is available at http://www.nhm.ac.uk/zoology/bdpro. Magurran (1988) describes all of the diversity indices used here.

Shannon's *H'* was calculated by using $\log_2$ because that is closest to Shannon's original intent. Pielou's (1966) *J'*, which is the observed *H'* divided by Hmax, is a measure of the evenness component of diversity. BioDiversity Pro also provides a calculation of abundance that includes only species-level taxa. This number was compared to the abundance calculations based on all taxa to determine the proportion of the Massachusetts Bay infauna that was identifiable to species.

5.1.4 Cluster & Ordination

Cluster analyses were preformed with the program COMPAH96 (available on E. Gallagher's web page, http://www.es.umb.edu/edgwebp.htm), originally developed at the Virginia Institute of Marine Science in the early 1970's. The station and species cluster groups were generated using unweighted pair group mean average sorting (UPGMA) and chord normalized expected species shared (CNESS) to express dissimilarity (Gallagher 1998). For calculation of CNESS the random sample size constant was set to 15 (Kropp *et al.* 2000).

Results of the station and species clusters were compared by using nodal analysis, which examines the original data matrix rearranged into a two-way table based on the cluster defined groups. Constancy, a measure of the association of species with stations (Fager 1963), was calculated from the nodal table based on the proportions of the number of occurrences of species in the station group to the total possible number of such occurrences (Boesch 1977):

$$C_{ij} = a_{ij} / (n_i \cdot n_j)$$

Where a_{ij} is the actual number of occurrences of members of species group i in station group j, n_i is the total number of species in group i, and n_j is the number of stations in group j. Constancy will range from 0.0 when none of the species in a species group occurred in a station group to 1.0 when all of the species in a species group occurred in all of the stations of a station group. Fidelity, a measure of the constancy of species in a station group compared to the constancy over all station groups (Fager 1963), was used to indicate the degree to which species prefer station groups (Boesch 1977):

$$F_{ij} = (a_{ij}\sum n_j) / (n_j \sum a_{ij})$$

where a_{ij} and n_j are the same as defined for the constancy index. Fidelity is 1.0 when the constancy of a species group in a station group is equal to its overall constancy, > 1.0 when its constancy in a station group is greater than that overall, and < 1.0 when its constancy is less than its overall constancy. Values of F > 2.0 suggest strong preference of species for a station group and values < 0.7 suggest avoidance of these species from the station group in question (Boesch 1977).

Discriminant analysis was used for predicting cluster group membership based on sediment, SPI, hydrocarbon, and heavy metal data. After subtraction of group means, variables highly correlated with other predictors in each of these four data sets were eliminated from the analysis. Linear discriminant functions were extracted using within group covariance and posterior probability of membership predicted using squared distance function (D^2). The smaller the D^2 the more likely the station belongs in the predicted group rather than the original cluster group.

5.2 Results and Discussion

5.2.1 1999 Nearfield Descriptive Community Measures

Abundance—Among individual Nearfield samples collected in 1999, infaunal abundance varied about four-fold, ranging from 1,342 to 5,080 individuals/0.04 m^2 (33,550–127,000/m^2) at stations FF13 (rep 1) and NF19, respectively (Table 5-1). Among the 6 replicated Nearfield stations, mean abundance per sample (± standard deviation, sd) ranged from 1,980 (± 129) to 3,658 (± 220) individuals/0.04 m^2 at stations NF12 and NF24, respectively (Figure 5-1).

Table 5-1. Summary of ecological parameters calculated for samples collected from the Nearfield, August 1999.

Station	Replicate	Abundance (Total)	(Species[a])	Proportion Identified	Total Species	*H'*	*J'*	Log-series Alpha	Hmax
FF10	1	3375	2966	88%	96	3.50	0.53	19.0	6.59
FF10	2	2658	2457	92%	76	3.27	0.52	14.9	6.25
FF10	3	2710	2444	90%	89	4.22	0.65	18.1	6.48
FF12	1	2611	2480	95%	59	2.75	0.47	10.9	5.88
FF12	2	3197	3007	94%	58	2.80	0.48	10.2	5.86
FF12	3	3424	3215	94%	67	2.99	0.49	12.0	6.07
FF13	1	1342	1239	92%	47	2.92	0.53	9.7	5.56
FF13	2	2986	2820	94%	60	2.75	0.47	10.8	5.91
FF13	3	2348	2224	95%	58	3.14	0.54	10.9	5.86
NF02	1	4040	3813	94%	77	3.80	0.61	13.7	6.27
NF04	1	1795	1528	85%	73	4.21	0.68	16.0	6.19
NF05	1	1367	1282	94%	70	4.28	0.70	15.9	6.13
NF07	1	2916	2692	92%	82	3.68	0.58	16.0	6.36
NF08	1	2223	2050	92%	60	2.85	0.48	11.6	5.91
NF09	1	1670	1506	90%	75	4.42	0.71	16.6	6.23
NF10	1	3633	3415	94%	78	4.05	0.64	14.2	6.29
NF12	1	1969	1781	90%	65	4.09	0.68	13.3	6.02
NF12	2	1856	1646	89%	59	4.18	0.71	12.0	5.88
NF12	3	2114	1874	89%	64	4.35	0.73	12.8	6.00
NF13	1	2702	2162	80%	69	4.20	0.69	13.6	6.11
NF14	1	3472	3186	92%	85	3.37	0.53	16.1	6.41
NF15	1	2920	2781	95%	60	3.02	0.51	10.8	5.91
NF16	1	2500	2399	96%	67	2.97	0.49	12.8	6.07
NF17	1	2164	1968	91%	59	3.56	0.60	11.5	5.88
NF17	2	2145	1963	92%	55	3.64	0.63	10.5	5.78
NF17	3	1674	1572	94%	49	3.57	0.64	9.6	5.62
NF18	1	3518	3170	90%	90	3.53	0.54	17.3	6.49
NF19	1	5080	4746	93%	87	2.72	0.42	15.1	6.44
NF20	1	2938	2771	94%	69	2.76	0.45	12.8	6.11
NF21	1	3111	2883	93%	75	3.04	0.49	14.1	6.23
NF22	1	1877	1622	86%	61	3.86	0.65	12.5	5.93
NF23	1	2907	2324	80%	75	4.28	0.69	14.8	6.23
NF24	1	3474	3329	96%	57	2.59	0.44	9.8	5.83
NF24	2	3901	3789	97%	71	2.59	0.42	12.4	6.15
NF24	3	3598	3452	96%	67	2.22	0.37	11.8	6.07
	Total	96215	88556	92%					

[a]Abundance of individuals identified to species level.

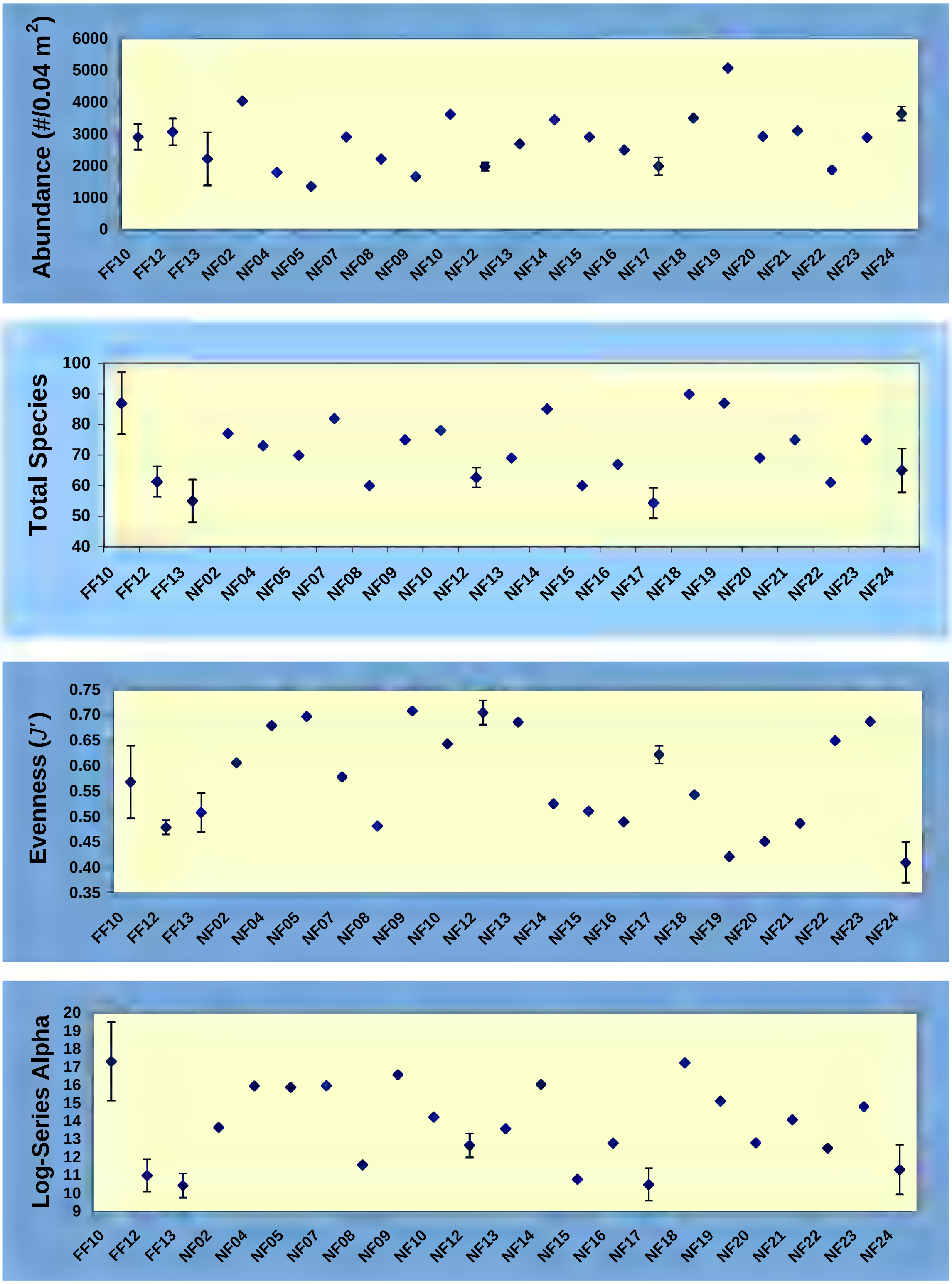


Figure 5-1. Infaunal total abundance, numbers of species, evenness, and log-series alpha values for 1999 Nearfield stations. For replicated stations the mean and standard deviation are shown.

Annelid worms were the most abundant higher-level infaunal taxon among the 1999 Nearfield samples (Table 5-2). Annelids accounted for more than 80 % of the infauna at 15 of the Nearfield stations, with the highest percentage (96.8 %) at stations NF24. Crustaceans (no pycnogonids were found in the 1999 Nearfield samples) typically were the second highest contributors to infaunal abundance. The highest proportions of crustaceans occurred at stations NF17 (54.1%) and NF13 (43.8 %). Molluscs were relatively important contributors (19.3 %) to infaunal abundance at station NF02.

Table 5-2. Abundance (#/0.04m^2) and relative contribution of higher-level taxa at Nearfield stations sampled in August, 1999.

	Total Abundance[a]					Percent			
	Annelida	Crustacea	Mollusca	Other	Total	Annelida	Crustacea	Mollusca	Other
FF10[b]	2010	297	290	25	2622	76.7%	11.3%	11.1%	1.0%
FF12[b]	2720	96	34	51	2901	93.8%	3.3%	1.2%	1.8%
FF13[b]	1774	212	67	41	2094	84.7%	10.1%	3.2%	2.0%
NF02	2864	147	737	65	3813	75.1%	3.9%	19.3%	1.7%
NF04	1051	355	91	31	1528	68.8%	23.2%	6.0%	2.0%
NF05	848	290	135	9	1282	66.1%	22.6%	10.5%	0.7%
NF07	2310	188	173	21	2692	85.8%	7.0%	6.4%	0.8%
NF08	1899	64	37	50	2050	92.6%	3.1%	1.8%	2.4%
NF09	1251	54	183	18	1506	83.1%	3.6%	12.2%	1.2%
NF10	3051	119	209	36	3415	89.3%	3.5%	6.1%	1.1%
NF12[b]	1565	54	110	38	1767	88.6%	3.1%	6.2%	2.2%
NF13	1019	947	180	16	2162	47.1%	43.8%	8.3%	0.7%
NF14	2562	340	257	27	3186	80.4%	10.7%	8.1%	0.8%
NF15	2653	48	49	31	2781	95.4%	1.7%	1.8%	1.1%
NF16	2241	70	49	39	2399	93.4%	2.9%	2.0%	1.6%
NF17[b]	627	992	149	67	1834	34.2%	54.1%	8.1%	3.6%
NF18	2178	882	90	20	3170	68.7%	27.8%	2.8%	0.6%
NF19	4296	206	219	25	4746	90.5%	4.3%	4.6%	0.5%
NF20	2631	51	58	31	2771	94.9%	1.8%	2.1%	1.1%
NF21	2710	57	74	42	2883	94.0%	2.0%	2.6%	1.5%
NF22	1463	16	111	32	1622	90.2%	1.0%	6.8%	2.0%
NF23	1407	632	274	11	2324	60.5%	27.2%	11.8%	0.5%
NF24[b]	3409	48	35	32	3523	96.8%	1.4%	1.0%	0.9%

[a]Abundance of individuals identified to species level.
[b]Values are averages of three replicates.

Numbers of Species—The total numbers of species per individual Nearfield sample collected in 1999 varied slightly more than two-fold, ranging from 47 to 96 at station FF13 (rep 1) and station FF10 (rep 1), respectively (Table 5-1). Among the 6 replicated Nearfield stations, mean (± sd) numbers of species per sample ranged from 54 (± 5.0) to 87 (± 10.1) species at stations NF17 and FF10, respectively (Figure 5-1).

Among the higher-level taxa, annelid worms contributed the highest percentage of species, accounting for about 47–63 % of the species collected at each Nearfield station (Table 5-3). Crustaceans and molluscs accounted for about 12–37 % and about 10–20 % of the species collected at each Nearfield station, respectively.

Diversity—As measured by the Shannon index (*H'*), diversity among individual Nearfield samples collected in 1999 varied from about 2.2 at stations NF24 (Rep 3) to about 4.4 at station NF09 (Table 5-1). Evenness (*J'*) among all Nearfield samples ranged from about 0.4 (NF24, all reps; NF 19) to slightly greater than 0.7 (NF12, 2 reps; NF09). Within-station variation was low at all replicated stations except FF10 (Figure 5-1). Log-series alpha varied considerably among Nearfield stations, ranging from 9.6 at station NF17 (Rep 3) to 19.0 at station FF10 (Rep 1). As for evenness, within-station variation in log-series alpha among replicated stations was high at station FF10 (Figure 5-1).

Table 5-3. Number of species and relative contribution of higher-level taxa at Nearfield stations sampled in August 1999.

	Total Species					Percent			
	Annelida	Crustacea	Mollusca	Other	Total	Annelida	Crustacea	Mollusca	Other
FF10[a]	45	23	13	6	87	51.7%	26.1%	14.9%	7.3%
FF12[a]	36	13	7	5	61	59.2%	20.7%	11.4%	8.7%
FF13[a]	28	15	6	6	55	50.9%	27.3%	11.5%	10.3%
NF02	45	15	10	7	77	58.4%	19.5%	13.0%	9.1%
NF04	36	23	10	4	73	49.3%	31.5%	13.7%	5.5%
NF05	35	20	9	6	70	50.0%	28.6%	12.9%	8.6%
NF07	45	21	9	7	82	54.9%	25.6%	11.0%	8.5%
NF08	34	12	7	7	60	56.7%	20.0%	11.7%	11.7%
NF09	40	16	15	4	75	53.3%	21.3%	20.0%	5.3%
NF10	42	16	14	6	78	53.8%	20.5%	17.9%	7.7%
NF12[a]	38	8	11	6	63	60.6%	12.8%	17.6%	9.0%
NF13	36	21	9	3	69	52.2%	30.4%	13.0%	4.3%
NF14	44	22	13	6	85	51.8%	25.9%	15.3%	7.1%
NF15	37	11	8	4	60	61.7%	18.3%	13.3%	6.7%
NF16	38	14	9	6	67	56.7%	20.9%	13.4%	9.0%
NF17[a]	25	20	5	4	54	46.6%	36.8%	9.8%	6.7%
NF18	44	30	10	6	90	48.9%	33.3%	11.1%	6.7%
NF19	47	20	14	6	87	54.0%	23.0%	16.1%	6.9%
NF20	40	15	7	7	69	58.0%	21.7%	10.1%	10.1%
NF21	45	14	10	6	75	60.0%	18.7%	13.3%	8.0%
NF22	37	7	12	5	61	60.7%	11.5%	19.7%	8.2%
NF23	36	21	13	5	75	48.0%	28.0%	17.3%	6.7%
NF24[a]	41	10	8	6	65	62.6%	15.9%	12.8%	8.7%

[a]Values are averages of three replicates.

Most Abundant Species—The 12 most abundant species (Appendix D-4) accounted for about 79–93% of the infaunal abundance at Nearfield stations in 1999. Polychaetes predominated at most Nearfield stations. The spionid polychaete *Prionospio steenstrupi* was the most abundant species at 17 Nearfield stations, as it was in 1998 (Kropp *et al.* 2000). Where it was the most common species, *P. steenstrupi* accounted for 19–63% of the infaunal abundance. The numerical dominance of *P. steenstrupi* in the Nearfield was further demonstrated by its occurrence among the five most numerous species at four of the six stations where it was not ranked first. *Dipolydora socialis* was the most abundant species at stations NF04 and NF05. *D. socialis* also was among the 12 most abundant taxa at 8 other Nearfield stations in 1999. The numerical importance of *Dipolydora socialis* in the Nearfield in 1999 contrasts with its occurrence in 1998, during which the species ranked among the 12 most abundant taxa at only 5 stations. *Dipolydora socialis* also was numerically important in 1997 as it occurred among the 10 most abundant species at 11 Nearfield stations (Blake *et al.* 1998). *Euchone incolor* was numerically dominant at station NF22.

The amphipod *Unciola inermis* was the most abundant species at stations NF13 and NF23. *U. inermis* was among the most abundant species at five additional Nearfield stations. The corophiid amphipod *Crassicorophium crassicorne* was the most abundant species at station NF17 and was among the top 12 species at 4 other Nearfield stations. The numerical importance of crustaceans in general was somewhat higher in 1999 than it was in 1998. Crustaceans ranked among the top-12 species at 12 Nearfield stations in 1998 and at 16 stations in 1999.

The northern dwarf-cockle *Cerastoderma pinnulatum* and the nutclam *Nucula delphinodonta* were the most abundant molluscs, occurring among the most abundant species at seven and nine stations, respectively.

One Nearfield station showed considerably different numerically dominant taxa in 1999 than were reported for 1998 (Kropp *et al.* 2000). At station NF04 only 4 of the 12 most abundant taxa in 1998 were ranked in the top 12 in 1999. Furthermore, only two (*Prionospio steenstrupi* and *Dipolydora socialis*) of the most numerous species found at this station in 1997 were among the most common found there in 1999. These were the two most abundant species at this station in all three years. Conversely, many stations showed relative consistency in the predominant species found in 1998 and 1999. For example, all 12 abundant species at stations NF12 in 1998 were ranked in the top 12 in 1999. At 8 stations, FF12, NF05, NF08, NF09, NF10, NF14, NF22, and NF24, at least 9 of the most common species in 1998 were among the 12 most abundant in 1999.

5.2.2 1999 Farfield Descriptive Community Measures

Abundance—Among individual Farfield samples collected in 1999, infaunal abundance varied about eight-fold, ranging from 1,034 to 8,563 individuals/0.04 m^2 (25,850–214,075/m^2) at stations FF04 (rep 2) and FF11 (rep 2), respectively (Table 5-4). Mean (± sd) abundance among Farfield stations ranged from 1,091 (± 92) to 5,654 (± 2,598) individuals/0.04 m^2 at stations FF04 and FF11, respectively (Figure 5-2).

Table 5-4. Summary of ecological parameters calculated for samples collected from the Farfield, August 1999.

Station	Replicate	Abundance (Total)	(Species[a])	Proportion Identified	Total Species	*H'*	*J'*	Log-series Alpha	Hmax
FF01A	1	4503	4233	94%	84	2.84	0.44	14.9	6.39
FF01A	2	3679	3426	93%	80	3.03	0.48	14.7	6.32
FF01A	3	4510	4220	94%	93	3.07	0.47	16.8	6.54
FF04	1	1041	923	89%	58	4.44	0.76	13.7	5.86
FF04	2	1034	865	84%	67	4.46	0.74	17.0	6.07
FF04	3	1197	1083	90%	54	4.37	0.76	12.0	5.76
FF05	1	2761	2324	84%	73	4.10	0.66	14.3	6.19
FF05	2	1933	1682	87%	66	4.27	0.71	13.7	6.04
FF05	3	2621	2306	88%	77	4.44	0.71	15.4	6.27
FF06	1	1250	1141	91%	52	4.00	0.70	11.2	5.70
FF06	2	1275	1161	91%	50	3.98	0.71	10.6	5.64
FF06	3	1124	984	88%	49	3.81	0.68	10.9	5.62
FF07	1	2608	2515	96%	57	2.93	0.50	10.4	5.83
FF07	2	2600	2561	99%	53	3.14	0.55	9.5	5.73
FF07	3	1740	1658	95%	50	3.49	0.62	9.7	5.64
FF09	1	2340	2092	89%	96	3.94	0.60	20.8	6.59
FF09	2	2731	2412	88%	90	3.70	0.57	18.5	6.49
FF09	3	1335	1206	90%	64	3.96	0.66	14.4	6.00
FF11	1	4831	4525	94%	72	2.27	0.37	12.2	6.17
FF11	2	8563	7788	91%	78	3.08	0.49	12.1	6.29
FF11	3	3567	3289	92%	68	2.88	0.47	12.1	6.09
FF14	1	2945	2416	82%	82	4.44	0.70	16.4	6.36
FF14	2	2050	1528	75%	67	4.58	0.76	14.3	6.07
FF14	3	1445	1152	80%	63	4.21	0.70	14.3	5.98
	Total	63683	57490	90%					

[a] Abundance of individuals identified to species level.

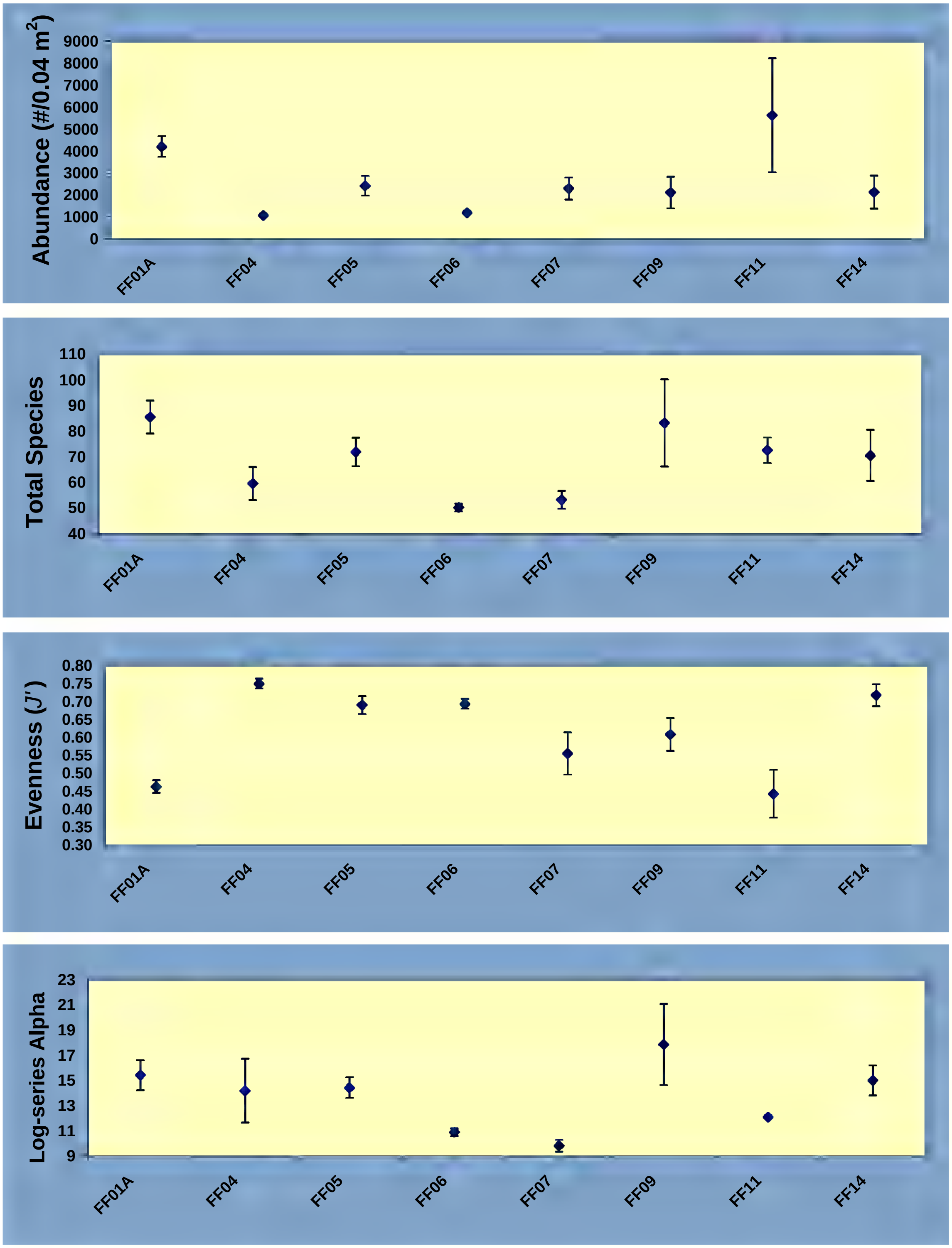


Figure 5-2. Infaunal total abundance, numbers of species, evenness, and log-series alpha values for 1999 Farfield stations. For replicated stations the mean and standard deviation are shown.

Annelid worms were the most abundant major infaunal taxon among the 1999 Farfield samples (Table 5-5. Annelids accounted for more than 80 % of the infauna at all but one of the Farfield stations, with the highest percentage (95.3 %) at stations FF07. At station FF06, annelids accounted for slightly less than half (about 47 %) of the total infaunal abundance. Molluscs typically were the second highest contributors to infaunal abundance. The highest proportions of molluscs occurred at stations FF05 (12.3 %). Crustaceans were relatively important contributors (43.6 %) to infaunal abundance only at station FF06. At most stations, crustaceans accounted for less than 5 % of the total abundance.

Table 5-5. Abundance (#/0.04m^2) and relative contribution of higher-level taxa at Farfield stations sampled in August 1999. Average values are shown.

	Total Abundance[a]					Percent			
	Annelida	Crustacea	Mollusca	Other	Total	Annelida	Crustacea	Mollusca	Other
FF11	4809	98	240	53	5201	92.5%	1.9%	4.6%	1.0%
FF01A	3375	151	386	48	3960	85.2%	3.8%	9.7%	1.2%
FF14	1453	69	159	18	1699	85.5%	4.1%	9.3%	1.1%
FF09	1620	101	152	30	1903	85.1%	5.3%	8.0%	1.6%
FF04	801	47	65	44	957	83.7%	4.9%	6.8%	4.6%
FF05	1707	98	260	40	2104	81.1%	4.6%	12.3%	1.9%
FF07	2138	34	41	31	2245	95.3%	1.5%	1.8%	1.4%
FF06	516	477	82	20	1095	47.1%	43.6%	7.5%	1.8%

[a]Abundance of individuals identified to species level.

Numbers of Species—The total numbers of species per individual Farfield sample collected in 1999 varied slightly less than two-fold, ranging from 49 to 96 at station FF06 (rep 3) and FF09 (rep 1), respectively (Table 5-4). Among the Farfield stations, mean (± sd) numbers of species ranged from 50 (± 1.5) to 86 (± 6.7) at FF06 and FF01A, respectively (Figure 5-2).

Among the higher-level taxa, annelid worms contributed the highest percentage of species, accounting for about 48–59 % of the species collected at each Farfield station (Table 5-6). Crustaceans (no pycnogonids occurred in the 1999 Farfield samples) and molluscs accounted for about 17–24 % and about 11–19 % of the species collected at each Farfield station, respectively.

Table 5-6. Number of species and relative contribution of higher-level taxa at Farfield stations sampled in August 1999. Average values are shown..

	Total Species					Percent			
	Annelida	Crustacea	Mollusca	Other	Total	Annelida	Crustacea	Mollusca	Other
FF11	40	12	14	6	73	55.5%	17.0%	18.8%	8.7%
FF01A	41	21	15	9	86	48.2%	24.1%	17.1%	10.5%
FF14	38	14	11	8	71	54.2%	19.3%	15.6%	10.8%
FF09	42	20	13	8	83	50.8%	23.6%	16.0%	9.6%
FF04	35	12	7	6	60	59.2%	19.6%	11.2%	10.1%
FF05	40	16	10	7	72	55.1%	21.8%	13.9%	9.3%
FF07	32	9	7	5	53	59.4%	17.5%	13.1%	10.0%
FF06	26	11	8	5	50	51.0%	22.5%	16.6%	9.9%

Diversity—Diversity, as measured by the Shannon Index (H') was fairly consistent across the Farfield (Table 5-4), as H' values among individual samples ranged from 2.27 (station FF11, rep 1) to 4.58 (station FF14, rep 2). Evenness (J') for individual samples ranged from about 0.4 (stations FF11, rep 1 and

FF01A, rep 1) to about 0.8 (stations FF04, reps 1 and 3 and FF14, rep2). Within-station variation was generally small, except for stations FF07, FF09, and FF11 (Figure 5-2). Values for log-series alpha ranged from 9.5 (station FF07, rep 2) to 20.8 (station FF09, rep 1). Within-stations variation was relatively high at five stations (Figure 5-2).

Most Abundant Species—The 12 most abundant species (Appendix D-4) accounted for about 76–91 % of the infaunal abundance at Farfield stations in 1999. The sabellid polychaete *Euchone incolor* was the most abundant species at 4 stations (FF04, FF05, FF07, FF14) and ranked in the top 12 at 3 others (FF01A, FF09, FF11). The only station where *Euchone incolor* was not among the 12 most abundant species was FF06, in inner Cape Cod Bay. *Prionospio steenstrupi*, a spionid polychaete was the most abundant species at two stations, FF01A, and FF11, located in the northern portion of the Bay. *Dipolydora socialis* was the top-ranked species at station FF09, whereas *Leptocheirus pinguis*, an aorid amphipod, was the most numerous at station FF06.

Composition of the 12 most abundant species in 1999 was generally consistent with that found in 1998. At 5 of the 12 Farfield stations, 9 of the most abundant species found in 1999 also were ranked in 1998. The most abundant species in 1999 was the same as found in 1998 at 10 stations. At station FF09, *Prionospio steenstrupi* was top-ranked in 1998, but was second to *Dipolydora socialis* in 1999. At station FF14 in 1999, *Euchone incolor* replaced *Anobothrus gracilis* as the most abundant species.

5.2.3 1999 Nearfield Multivariate Analysis

Nearfield Station Patterns—Station cluster analysis of the 1999 Nearfield data with all 35 grabs, 23 stations with one replicate and six stations with three replicates, indicated that within station similarity was stronger than between stations. At the six-group level (approximately 0.8 CNESS dissimilarity) replicates for a give station were all in the same cluster group (Figure 5-3). The replicates from station NF17 formed an exclusive group (VI). All replicates from FF10 and FF13 were in group I. The largest station group was II, which contained all replicates form FF12 (IIa), NF12 (IIb), and NF24 (IIc) (Figure 5-3). Since replicates from a station were closely associated, the analysis was simplified by removing the second and third replicate, as data reduction stratagem analogous to having only collected the first replicate at each station and giving equal weight to each station in defining patterns and associations. At the six-group level (approximately 0.8 CNESS dissimilarity) station cluster analysis based on the first rep from each station was virtually identical to the all-replicate analysis (Figure 5-4). The only difference was station NF20 that moved from group I to group IIc.

The grouping of stations reflected the strong influence of sediment type and biogenic activity in structuring communities in the Nearfield. Station group I was composed of heterogeneous sediment stations dominated by both biogenic and physical processes (Table 5-7, see Sections 3 and 4). The largest station group was II, which was composed of the finer sediment stations. Subgroup IIa was sandier than the other two subgroups. Subgroups IIb and IIc had the softest and finest sediment, and shallowest RPD layer depths. Surfaces at group II stations were all dominated by biogenic structures. Groups III and IV were both single station groups, NF05 and NF02 respectively. NF05 was fine-sand layered over silty sediments, possibly in a sedimentary transition area. NF02 had heterogeneous sediment and was physically dominated. Group V was composed of sand stations with deep RPD layers with evidence of both biogenic and physical activity. Group VI was a single station group, NF17, which was had a deep RPD and physically dominated sandy sediments.

Stat	Rep	Abund	Spp	Gravel %	Fines %	Mean phi	TOC %	Clostridium #/gdw
FF10	1	2966	96	21	19	3.0	0.5	1200
NF14	1	3186	85	13	10	1.9	1.0	700
FF10	3	2444	89					
NF18	1	3170	90	51	11	0.6	0.6	900
FF10	2	3007	58					
FF13	1	1239	47	3	55	4.9	1.2	4900
NF20	1	2771	69	11	22	2.8	0.7	2300
FF13	2	2820	60					
FF13	3	2224	58					
FF12	1	2480	59	5	25	3.8	0.5	3200
FF12	2	3007	58					
FF12	3	3215	67					
NF15	1	2781	60	4	12	2.5	0.9	800
NF07	1	2692	82	2	33	3.9	0.8	2000
NF19	1	4746	87	2	16	3.1	0.5	500
NF09	1	1506	75	0	38	4.0	0.5	1600
NF10	1	3415	78	0	41	4.5	0.9	1900
NF12	1	1781	65	0	74	5.8	1.5	3200
NF12	2	1646	59					
NF12	3	1874	64					
NF08	1	2050	60	2	72	5.5	1.1	3700
NF16	1	2399	67	1	32	3.6	0.7	2300
NF24	1	3329	57	0	62	5.2	1.1	2100
NF24	2	3789	71					
NF24	3	3452	67					
NF21	1	2883	75	0	61	5.3	1.5	2500
NF22	1	1622	61	4	43	4.3	0.9	2700
NF05	1	1282	70	1	17	3.2	0.4	900
NF02	1	3813	77	1	5	1.8	0.2	500
NF04	1	1528	73	0	5	2.6	0.1	200
NF13	1	2162	69	0	6	2.4	0.2	200
NF23	1	2324	75	21	2	1.4	0.2	300
NF17	1	1968	59	0	1	2.2	0.1	100
NF17	2	1963	55					
NF17	3	1572	49					

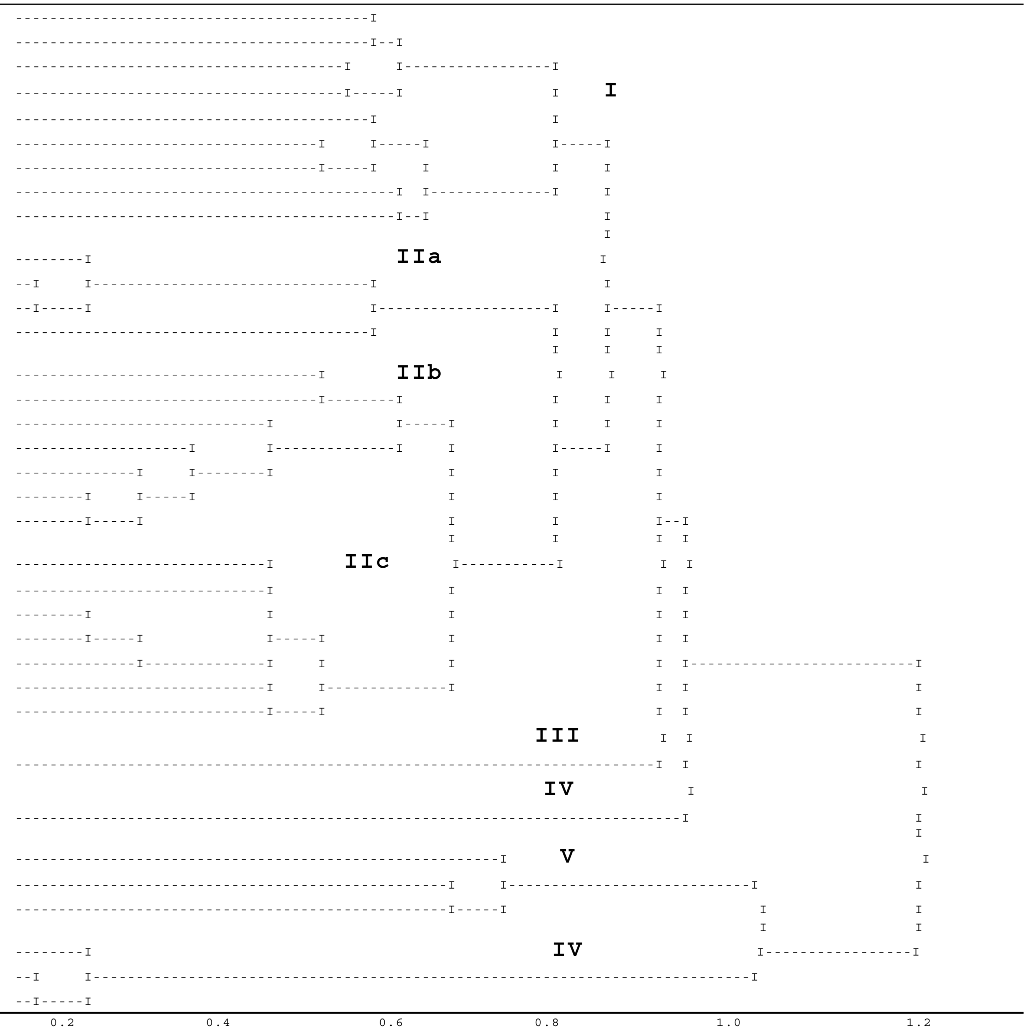


Figure 5-3. Station dendrogram of 1999 Nearfield infauna data includes all replicates (Gallagher's CNESS dissimilarity and UMPGA sorting).

Stat	Abund	Spp	Gravel %	Fines %	Mean phi	TOC %	Clostridium #/gdw
FF10	2966	96	21	19	3.0	0.5	1200
NF14	3186	85	13	10	1.9	1.0	700
NF18	3170	90	51	11	0.6	0.6	900
FF13	1239	47	3	55	4.9	1.2	4900
FF12	2480	59	5	25	3.8	0.5	3200
NF15	2781	60	4	12	2.5	0.9	800
NF07	2692	82	2	33	3.9	0.8	2000
NF19	4746	87	2	16	3.1	0.5	500
NF09	1506	75	0	38	4.0	0.5	1600
NF10	3415	78	0	41	4.5	0.9	1900
NF12	1781	65	0	74	5.8	1.5	3200
NF08	2050	60	2	72	5.5	1.1	3700
NF16	2399	67	1	32	3.6	0.7	2300
NF20	2771	69	11	22	2.8	0.7	2300
NF24	3329	57	0	62	5.2	1.1	2100
NF21	2883	75	0	61	5.3	1.5	2500
NF22	1622	61	4	43	4.3	0.9	2700
NF05	1282	70	1	17	3.2	0.4	900
NF02	3813	77	1	5	1.8	0.2	500
NF04	1528	73	0	5	2.6	0.1	200
NF13	2162	69	0	6	2.4	0.2	200
NF23	2324	75	21	2	1.4	0.2	300
NF17	1968	59	0	1	2.2	0.1	100

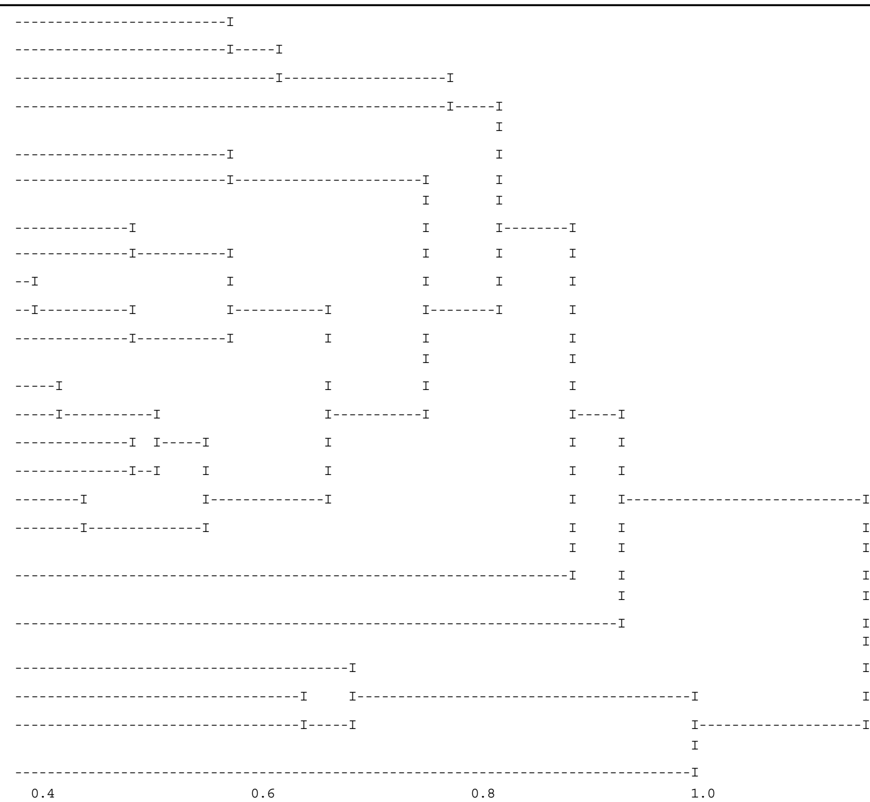


Figure 5-4. Dendrogram of 1999 Nearfield data including only the first replicate from each station (Gallagher's CNESS dissimilarity and UMPGA sorting).

The data from sediment samples (grain-size, hydrocarbons, heavy metals) and SPI supported the basic pattern of stations produced by the station cluster groups. Based on discriminant analysis using a condensed version of the six station groups derived from the cluster analysis (Figure 5-3) (with groups III and IV, and V and VI combined because at least two stations are needed per discriminant group) the distribution of heavy metals best matched the cluster groups. Using ten heavy metals, 20 of the 23 stations best classified with their original cluster group. For each of the other data sets (seven sediment, five SPI, and six hydrocarbon variables) 16 of the 23 stations classified with their original group (Table 5-8). There was no pattern among the misclassified stations. Station FF10 misclassified in three of the four discriminant analyses and FF12, NF19, and NF20 misclassified in two analyses (Table 5-8). When all four data sets were combined for one discriminant analysis none of the stations misclassified.

Table 5-7. Nearfield physical and biological parameters averaged by station cluster groups. See Figure 5-4 for relationship between groups. Values are average and SD underneath. Sediment parameters are from Sections 3 and 4.

Cluster Group	Abundance (/0.04 m^2)	Species	RPD (cm)	Gravel (%)	Sand (%)	Fines (%)	Mean phi	Predominant Sediment	Pen[a] (cm)	Surface Process
I	2640 940	80 22	2.4 0.8	22 21	54 18	24 21	2.6 1.8	Cobble to Fine	5 3	Biogenic/Physical
IIa	2630 210	60 1	2.0 0.5	5 1	77 11	18 10	3.2 0.9	Pebble to Fine	5 0	Biogenic/Physical
IIb	2830 1310	77 8	1.8 0.2	1 1	59 20	40 21	4.3 1.0	Fine	12 6	Biogenic/tube mats
IIc	2510 620	65 7	1.9 0.5	3 4	48 16	49 19	4.5 1.1	Pebble to Fine	13 6	Biogenic/tube mats
III	1280	70	2.7	1	82	17	3.2	Sand over Fine	5	Biogenic
IV	3810	77	2.1	1	94	5	1.8	Cobble to Fine	1	Physical
V	2000 420	72 3	3.2 0.4	7 12	89 10	4 2	2.1 0.6	Pebble to FS	3 1	Biogenic/Physical
VI	1970	59	>4.0	0	99	1	2.2	Gravel to Sand	4	Physical

[a]Penetration depth of SPI camera prism.

Nearfield Species Patterns—Species cluster analysis was based on 214 included species in the reduced data set, which consisted of only first replicate at a station. The 13 species that occurred only in the second and third replicates were not included. At about the 0.2 CNESS dissimilarity level 18 species groups were formed (Figure 5-5 Table 5-9). The 18 species groups were divided into three distinct sets of groups A to G, H to M, and N to R (Figure 5-5). The first two contained most of the dominant species and the third was mostly rarer species. Many of the taxa in species group set N to R corresponded to those comprising a sand-dwelling fauna identified in previous years (Kropp *et al.* 2000). Group set H to M were mostly taxa associated with finer sediment and higher TOC levels. Overall, group set A to G did not appear to be associated with physical sediment parameters.

The inclusion of rarer species in the analysis was instructive in forming intergroup associations but tended to complicate interpretation of species groups by lowering nodal analysis coefficients. Membership of species within most species groups was divided between high abundance or occurrence species and rarer species. For example, group A was composed of 13 species, 7 of which were abundance and occurrence dominants and 6 of which were low abundance and occurrence, rarer species. Nodal constancy and fidelity indicated that many of the species groups were associated with specific station groups. Species groups A and H, composed of the top dominant species (Table 5-9, Appendix D-4), had high constancy (≥0.5) with all station groups (Figure 5-6). Groups A and H were broadly distributed among the station groups with little preference or fidelity (0.8–1.4) for any station group.

Table 5-8. Summary of discriminant analyses to evaluate strength of cluster analysis groups for 1999 Nearfield data. Cluster groups are from Figure 5-3. Sediment data are from Section 4, SPI data are from Section 3. Station groups III and IV, and V and VI were combined because at least two stations are needed per discriminant group. D^2 is the squared distance between groups.

Sediment variables: Depth, TOC, *C. perfringens* spores, % Gravel, % Fines, %SAND, Mean Phi 16 of 23 stations (70%) correctly classified.

Station	Original Group	Predicted Group	D^2	Prob.
NF09	IIb	III	3.92	0.53
NF12	IIb	IIc	3.21	0.81
NF20	IIc	IIa	3.53	0.60
NF24	IIc	IIb	4.05	0.62
NF05	III	V	3.88	0.36
NF13	V	III	0.63	0.62
NF17	VI	III	1.28	0.56

Heavy Metals: Al, Cd, Cr, Cu, Fe, Pb, Hg, Ni, Ag, Zn 20 of 23 stations (87%) correctly classified.

Station	Original Group	Predicted Group	D^2	Prob.
FF10	I	IIb	9.31	0.48
FF12	IIa	IIb	5.24	0.36
NF20	IIc	I	4.96	0.59

SPI variables: Penetration, Surface Relief, Apparent Color RPD, Surface Processes, Worm Tubes16 of 23 stations (70%) correctly classified.

Station	Original Group	Predicted Group	D^2	Prob.
FF10	I	III	0.35	0.74
FF13	I	IIa	5.04	0.50
NF14	I	V	0.47	0.84
NF12	IIb	IIc	3.15	0.71
NF19	IIc	IIa	1.26	0.94
NF21	IIc	IIb	1.30	0.51
NF24	IIc	IIa	4.89	0.57

Hydrocarbons: Total PAH, Total PCB, Total Pesticides, Total DDT, Total Chlordane, Total LAB 16 of 23 stations (70%) correctly classified.

Station	Original Group	Predicted Group	D^2	Prob.
FF10	I	V	1.46	0.41
NF18	I	III	0.34	0.47
FF12	IIa	III	1.44	0.43
NF10	IIb	III	1.79	0.29
NF19	IIb	III	0.98	0.41
NF16	IIc	IIb	2.34	0.64
NF22	IIc	I	1.74	0.44

```
A ----------I
            I--------I
B ----------I        I
                     I--I
C -------------------I  I
                        I
D -------------------I  I------I
                     I  I      I
E ----------I        I--I      I
            I-----I  I         I
F ----------I     I  I         I
                  I--I         I
G ----------------I            I
                               I-I
H -------I                     I I
         I-----------I         I I
I -------I           I         I I
                     I------I  I I
J -------------------I      I  I I
                            I  I I
K ----I                     I--I I
      I--------------I      I    I
L ----I              I------I    I
                     I           I
M -------------------I           I
                                 I
N ----I                          I
      I-----------I              I
O ----I           I              I
                  I--------I     I
P ----------------I        I     I
                           I-----I
Q -------------I           I
               I-----------I
R -------------I
0.2           0.0
```

Figure 5-5. Species group dendrogram of 1999 Nearfield infaunal data including only the first replicate from each station (Gallagher's CNESS dissimilarity and UMPGA sorting). See Table 5-9 for the species in each group.

Groups B, D, E, F, and G were primarily composed of rarer species with low constancy and little fidelity with any of the station groups. The exception was group G that was strongly associated with station group IV, composed of only station NF02. Groups C and D contained subdominant species broadly distributed among the station groups. Groups I, J, K, L, M, and Q contained species with many occurrences, but that were not abundance dominants, that exhibited some preference for stations groups I, II, and III. Groups N, O, P, and R included occurrence but not abundance dominants with little preference for any station group.

Table 5-9. Species included in each of the species cluster groups from Figure 5-5. "Abund." is total individuals and "occur." is the total number of occurrences for replicate one of 1999 Nearfield stations.

Cluster Group	Species	Total abund.	Total occur.
A	*Prionospio steenstrupi*	22783	23
	Ninoe nigripes	1388	20
	Parougia caeca	413	23
	Monticellina dorsobranchialis	161	17
	Argissa hamatipes	113	19
	Actiniaria sp. 2	68	18
	Sphaerodoridium sp. A	66	15
	Carinomella lactea	36	9
	Lyonsia arenosa	24	10
	Euclymeninae sp. 1	16	6
	Flabelligera spp.	7	4
	Propebela turricula	4	3
	Aphrodita spp.	1	1
B	Tubificidae sp. 2	100	6
	Leptocheirus pinguis	90	10
	Enipo torelli	14	10
	Heteromastus filiformis	3	2
	Diastylis cornuifer	1	1
C	*Aricidea catherinae*	2165	22
	Scoletoma hebes	172	6
	Pleurogonium rubicundum	83	17
	Nephtys cornuta	19	1
	Ampelisca abdita	15	1
	Pleurogonium inerme	9	5
	Crangon septemspinosa	5	5
	Turbellaria *spp.*	1	1
D	*Tharyx acutus*	1240	22
	Hiatella arctica	973	20
	Molgula manhattensis	27	4
	Musculus niger	12	6
	Nemertea sp. 2	6	1
	Sthenelais limicola	1	1
	Gitanopsis arctica	1	1
	Paramphinome jeffreysii	1	1
E	*Protomedeia fasciata*	971	13
	Gattyana amondseni	36	12
	Dulichia tuberculata	22	10
	Casco bigelowi	11	3
	Parapleustes gracilis	4	1
	Melita nr. *dentata*	3	2
	Harmothoe imbricata	2	1
	Terebellides stroemii	2	2
	Moelleria costulata	1	1
	Boonea impressa	1	1
	Baeonectes muticus	1	1
F	*Ericthonius fasciatus*	243	9
	Tubificoides apectinatus	54	9
	Polydora aggregata	38	3
	Pleurogonium spinosissimum	17	6
	Gattyana cirrosa	12	5
	Crenella glandula	10	2
	Deflexilodes tuberculatus	9	4
	Anomia simplex	4	3
	Microphthalmus aberrans	3	3
	Melita sp. 1	2	1
	Drilonereis magna	1	1
	Oenopota harpularia	1	1
G	*Asabellides oculata*	139	13
	Ilyanassa trivittata	46	12
	Pionosyllis sp. A	13	5
	Pitar morrhuana	9	5
	Ceriantheopsis americanus	7	3
	Exogone longicirris	6	4
	Cancer borealis	4	3
	Nephtys ciliata	3	3
	Dipolydora caulleryi	1	1
	Axius serratus	1	1
H	*Mediomastus californiensis*	3868	23
	Euchone incolor	2032	20
	Spio limicola	1351	20
	Levinsenia gracilis	737	20
	Monticellina baptisteae	456	18
	Leitoscoloplos acutus	225	17
	Micrura spp.	223	20
	Mya arenaria	76	17
	Mayerella limicola	52	9
	Aricidea quadrilobata	34	7
	Cerebratulus lacteus	20	6
	Yoldia sapotilla	18	6
	Cossura longocirrata	18	7
	Terebellides atlantis	5	5
	Praxillella gracilis	2	2
	Ancistrosyllis groenlandica	1	1
	Lanassa venusta venusta	1	1
I	*Dipolydora socialis*	2372	18
	Capitella capitata complex	133	16
	Nephtys incisa	79	16
	Amphiporus angulatus	68	16
	Laonome kroeyeri	12	8
	Deflexilodes tesselatus	3	3
	Diaphana minuta	2	2
	Trochochaeta multisetosa	1	1
	Sternaspis scutata	1	1
J	*Pholoe minuta*	440	23
	Scoloplos armiger	90	18
	Eteone longa	67	13
	Goniada maculata	66	17
	Orchomenella minuta	33	7
	Apistobranchus typicus	28	11
	Paradulichia typica	22	7
	Nemertea sp. 14	21	7
	Arcteobia anticostiensis	18	13
	Dyopedos monacanthus	17	6
	Pectinaria granulata	9	4
	Hippomedon propinquus	8	3
	Sphaerosyllis brevifrons	7	2
	Stereobalanus canadensis	3	3
	Cephalothricidae sp. 1	2	1
	Harmothoe extenuata	2	1
	Aphelochaeta sp. 1	1	1

Table 5–9. Species included in each of the species cluster groups from Figure 5-5. "Abund." is total individuals and "occur." is the total number of occurrences for replicate one of 1999 Nearfield stations (continued).

K	*Aphelochaeta marioni*	588	18
	Nucula delphinodonta	662	19
	Thracia conradi	109	10
	Maldane sarsi	123	6
	Clymenella torquata	53	7
	Ampharete acutifrons	44	12
	Onoba pelagica	18	5
	Placopecten magellanicus	8	6
	Campylaspis rubicunda	1	1
L	*Crenella decussata*	349	20
	Haploops fundiensis	146	5
	Harpinia propinqua	127	13
	Thyasira flexuosa	80	9
	Aeginina longicornis	73	7
	Anobothrus gracilis	37	9
	Edwardsia elegans	21	9
	Diastylis quadrispinosa	21	9
	Scoletoma fragilis	16	7
	Anonyx liljeborgi	11	8
	Eudorella pusilla	8	4
	Sphaerodoropsis minuta	6	5
	Ischyrocerus anguipes	5	3
	Rhodine loveni	5	3
	Hartmania moorei	2	2
	Nemertea sp. 12	1	1
	Eudorella hispida	1	1
M	*Photis pollex*	328	22
	Edotia montosa	200	19
	Petalosarsia declivis	8	5
	Dipolydora concharum	1	1
	Ophiura sarsi	1	1
	Eulalia bilineata	1	1
N	*Crassicorophium crassicorne*	961	12
	Phyllodoce mucosa	1011	23
	Polygordius sp. A	921	20
	Cerastoderma pinnulatum	798	20
	Pseudunciola obliquua	400	3
	Echinarachnius parma	96	4
	Dipolydora quadrilobata	95	5
	Phyllodoce maculata	54	9
	Solariella obscura	42	3
	Spio thulini	38	10
	Tetrastemma vittatum	20	7
	Chone duneri	20	12
	Chaetozone setosa MB	16	6
	Chiridotea tuftsi	14	2
	Phoxocephalus holbolli	12	5
	Hippomedon serratus	8	3
	Acanthohaustorius millsi	7	1
	Politolana polita	5	4
	Rhepoxynius hudsoni	5	1
	Eudorellopsis deformis	3	1
	Ampelisca vadorum	1	1
O	*Unciola inermis*	1244	8
	Exogone hebes	1140	21
	Exogone verugera	744	20
	Grania postclitello longiducta	262	3
	Ampharete finmarchica	134	13
	Unciola irrorata	87	7
	Euclymene collaris	63	6
	Tanaissus psammophilus	78	5
	Ptilanthura tenuis	63	12
	Aglaophamus circinata	47	9
	Ampelisca macrocephala	49	11
	Sphaerosyllis longicauda	36	8
	Polycirrus phosphoreus	36	9
	Adelodrilus sp. 1	33	2
	Cyclocardia borealis	20	7
	Diastylis sculpta	18	9
	Galathowenia oculata	13	8
	Clymenura sp. A	9	2
	Glycera capitata	5	3
	Cylichna gouldi	8	3
	Colus parvus	3	2
	Ameroculodes sp. 1	3	3
	Orbinia swani	1	1
	Chaetozone sp. 4	1	1
	Scolelepis texana	1	1
	Proclea graffii	1	1
	Oenopota incisula	1	1
	Pleustes panoplus	1	1
P	*Astarte undata*	210	19
	Adelodrilus sp. 2	187	4
	Arctica islandica	62	17
	Axiothella catenata	40	6
	Euchone elegans	31	6
	Munna sp. 1	21	7
	Syrrhoe sp. 1	15	7
	Scalibregma inflatum	12	9
	Phascolion strombi	3	2
	Pontogeneia inermis	1	1
Q	*Owenia fusiformis*	590	11
	Stenopleustes inermis	200	21
	Phoronis architecta	142	14
	Metopella angusta	109	19
	Ophelina acuminata	13	8
	Deflexilodes intermedius	2	2
	Neanthes virens	1	1
R	*Spiophanes bombyx*	420	21
	Exogone sp. A	15	1
	Pherusa affinis	8	4
	Nereis procera	6	3
	Nephtys caeca	3	3
	Syllides longocirrata	1	1

Constancy

Species Groups	I	II	III	IV	V	VI	IIa	IIb	IIc
	Station groups						*Group II Subgroups*		
A	0.6	0.5	0.6	0.6	0.6	0.5	0.4	0.6	0.5
B	0.2	0.3	0	0.4	0.1	0	0.3	0.4	0.3
C	0.6	0.3	0.1	0.5	0.3	0.3	0.1	0.3	0.3
D	0.4	0.3	0.4	0.3	0.3	0.3	0.4	0.3	0.3
E	0.1	0.2	0.1	0.3	0.2	0.2	0.2	0.1	0.3
F	0.2	0.2	0.3	0.3	0.1	0	0.2	0.1	0.3
G	0.3	0.2	0.4	0.7	0.2	0	0.2	0.1	0.2
H	0.5	0.5	0.5	0.6	0.6	0.7	0.3	0.6	0.4
I	0.4	0.4	0.6	0.3	0.4	0.4	0.3	0.5	0.3
J	0.3	0.4	0.5	0.2	0.2	0.5	0.3	0.5	0.4
K	0.4	0.4	0.4	0.2	0.5	0.2	0.3	0.6	0.3
L	0.2	0.3	0.5	0.1	0.2	0.2	0.6	0.4	0.2
M	0.4	0.3	1.0	0.3	0.3	0.3	0.3	0.3	0.3
N	0.3	0.3	0.2	0.4	0.2	0.2	0.4	0.3	0.4
O	0.2	0.3	0.3	0.1	0.3	0.1	0.5	0.2	0.3
P	0.3	0.3	0.5	0.2	0.6	0.3	0.3	0.2	0.4
Q	0.7	0.4	0.6	0.4	0.4	0.3	0.1	0.5	0.5
R	0.3	0.2	0.5	0.2	0.2	0.2	0.1	0.2	0.3

Fidelity

Species Groups	I	II	III	IV	V	VI	IIa	IIb	IIc
	Station groups						*Group II Subgroups*		
A	1.1	0.9	1.1	1.1	1.1	0.8	0.7	1.1	0.9
B	0.8	1.3	0	1.6	0.3	0	1.2	1.6	1.2
C	1.8	0.8	0.4	1.6	0.8	0.8	0.4	1.0	0.9
D	1.4	0.9	1.2	0.8	0.8	0.8	1.2	0.9	0.8
E	0.7	1.1	0.5	1.5	1.0	1.0	1.2	0.5	1.5
F	1.0	1.1	2.0	1.5	0.5	0	1.0	0.3	1.8
G	1.5	0.7	1.8	3.2	0.8	0	0.7	0.5	1.0
H	1.0	0.9	1.0	1.2	1.2	1.4	0.6	1.2	0.8
I	1.0	1.0	1.4	0.9	1.0	1.1	0.7	1.4	0.7
J	0.8	1.1	1.5	0.5	0.7	1.5	0.8	1.3	1.1
K	1.0	1.0	1.1	0.5	1.2	0.5	0.8	1.5	0.7
L	0.7	1.2	1.8	0.4	0.8	0.8	2.1	1.2	0.8
M	1.1	0.9	2.8	0.9	0.8	0.9	0.9	0.8	0.9
N	1.1	1.1	0.8	1.2	0.8	0.6	1.1	0.8	1.3
O	0.6	1.1	0.9	0.5	1.3	0.3	1.9	0.8	1.1
P	0.8	0.9	1.5	0.6	1.8	0.9	0.9	0.6	1.1
Q	1.4	0.9	1.2	0.9	0.8	0.6	0.3	1.2	1.0
R	1.0	1.0	2.1	0.7	0.9	0.7	0.3	0.7	1.4

Figure 5-6. Nodal constancy and fidelity between 1999 Nearfield stations and species groups derived from cluster analysis of infaunal data.

5.2.4 1999 Farfield Multivariate Analysis

Farfield Station Patterns—The basic pattern in the station cluster analysis of the 1999 Farfield data was similar to that found in previous years (see Blake *et al*. 1998 and Kropp *et al*. 2000). Station cluster analysis of the 1999 Farfield data with eight stations and three replicates per station indicated that similarity within a station was stronger than between stations. All three replicates from each of the eight stations clustered together (Figure 5-7a). At the eight group level, one group for each station, the CNESS dissimilarity was approximately 0.55. A similar station pattern was produced when the three station replicates were summed (Figure 5-7b). At the four and three station group levels respectively, both analyses indicated that while there was high within station similarity, between station similarity was low and appeared related to a station's geographic position, sediment grain-size, and depth. The most similar station pairs were FF01A and FF09, the northern most and shallow (35–50 m) stations (group I), and FF05 and FF14, primarily eastern stations with 50–65 m water depth (group II in part). The other group II stations were FF04 and FF11, both about 85–90 m deep.

Cape Cod Bay stations (FF06 and FF07), the shallowest (30–40 m), formed group III in the summed replicate analysis, but in the individual replicate analysis they chained onto the dendrogram as the last two stations (Figure 5-7). Group I stations were fine-sand with highest taxa richness within the Farfield. Groups II and III were both composed of fine sediment (5–7 Phi) stations with group III having lower taxa richness.

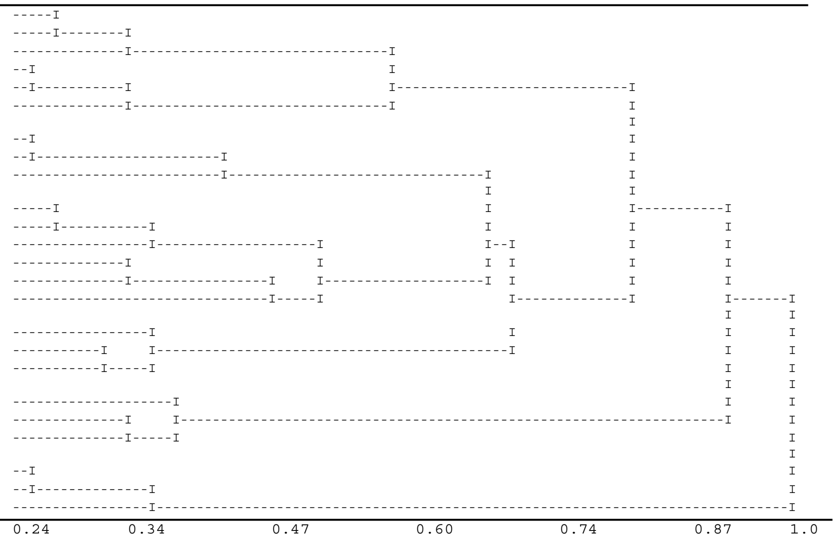
The water depth and data from sediment samples (grain-size, hydrocarbons, heavy metals) supported the basic pattern of stations produced by the station cluster groups. Discriminant analysis using the summed replicate, three cluster station groups (Figure 5-7) indicated very strong correspondence between biological and sediment data. Patterns of depth, grain-size, metals, and hydrocarbons matched the cluster groups almost perfectly. Discrimination with only depth produced only one misclassification (Table 5-10). Station FF01A from cluster group I that had a depth of about 35 m was placed in group III with the other 30-m stations. Based on only grain-size data, station FF04 was reclassified from group II to III (Table 5-10).

Farfield Species Patterns—Species cluster analysis was based on 198 species and at about the 0.13 CNESS dissimilarity 13 species groups were formed (Figure 5-8, Table 5-11). The 13 species groups were divided into three distinct sets of groups A to F, G to K, and L to M (Figure 5-8). The first and last groups contained most of the dominant species and the third was primarily subdominant species. Groups A to K were primarily composed of sandy species and groups L and M mostly finer sediment species.

The inclusion of rarer species in the Farfield analysis had a similar effect as in the Nearfield analysis. Membership of species within most species groups was divided between high abundance or occurrence species and rarer species. Nodal constancy and fidelity indicated that many of the species groups were associated with specific stations groups. Species groups A to F were composed of the top dominant species (Table 5-11, Appendix D-4) that had consistently high constancy (≥ 0.5) with station group II and to a lesser degree with group I (Figure 5-9). Overall, station group I had moderate to high constancy with all of the species groups. Species groups L and M were most strongly associated with station group III. Patterns of Fidelity support the constancy patterns. Groups F to K showed moderate to strong avoidance of station group III. Only groups L and M showed preference for station group III (Figure 5-9). Groups A to F showed moderate preference for group II. Highest fidelity (> 1.7) was between species groups G to K with station group I. Groups F and H to K were primarily composed of rarer taxa but with both high constancy and fidelity with station group I.

A – All replicates separate:

Station	Abund Ind/m²	Spp Total	Sand %	Fines %	Mean Phi	TOC %	*Clostridium.* #/gdw
FF01A 1	4230	84	87	13	3.28	0.42	645
FF01A 2	3430	80					
FF01A 3	4220	93					
FF09 1	2090	96	82	17	3.64	0.33	415
FF09 2	2410	90					
FF09 3	1210	64					
FF04 1	920	58	5	95	6.98	2.35	1905
FF04 3	860	67					
FF04 2	1080	54					
FF05 1	2320	73	46	54	4.97	0.63	630
FF05 2	1680	66					
FF05 3	2310	77					
FF14 1	2420	82	23	75	5.49	1.31	1125
FF14 2	1530	67					
FF14 3	1150	63					
FF11 1	4520	72	21	79	5.61	1.73	1285
FF11 2	7790	78					
FF11 3	3290	68					
FF07 1	2520	57	8	92	6.72	2.43	980
FF07 2	2560	53					
FF07 3	1660	50					
FF06 1	1140	52	34	66	5.77	0.85	995
FF06 2	1160	50					
FF06 3	980	49					



B - Replicates from each station summed:

Station	Abund Ind/m²	Spp Total	Sand %	Fines %	Mean Phi	TOC %	*Clostridium* #/gdw
FF01A	11879	117	87	13	3.3	0.4	645
FF09	5710	120	82	17	3.6	0.3	415
FF04	2871	86	5	95	7.0	2.4	1905
FF05	6312	98	46	54	5.0	0.6	630
FF14	5096	99	24	75	5.5	1.3	1125
FF11	15602	100	20	79	5.6	1.7	1285
FF06	6734	75	8	92	6.7	2.4	980
FF07	3286	69	34	66	5.8	0.9	995

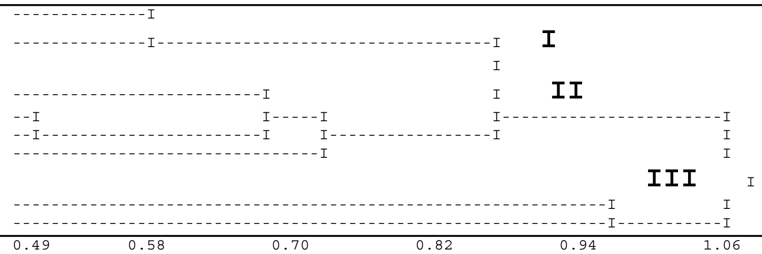


Figure 5-7. Dendrogram of 1999 Farfield station groups with all replicates from each station (A) and replicates summed for each station (B). Both analyses are with Gallagher's CNESS dissimilarity and UMPGA sorting.

Table 5-10. Summary of discriminant analyses to evaluate strength of cluster analysis groups for 1999 Farfield data. Cluster groups are from Figure 5-7. Sediment data are from Section 4.

Only Depth:
7 of 8 stations (88%) correctly classified.

Station	Original Group	Predicted Group	D^2	Prob.
FF01A	I	III	0.01	0.55

Sediment variables: TOC, % Gravel, % Fines, Mean Phi 7 of 8 stations (88%) correctly classified.

Station	Original Group	Predicted Group	D^2	Prob.
FF04	II	III	1.13	0.76

Hydrocarbons: Total PAH, Total PCB, Total Pesticides, Total DDT, Total Chlordane
8 of 8 stations (100%) correctly classified.

Heavy Metals: Al, Cd, Cr, Cu, Fe
8 of 8 stations (100%) correctly classified

Sediment variables: Depth, TOC, % Fines, Mean Phi, *C. perfringens* spores
8 of 8 stations (100%) correctly classified.

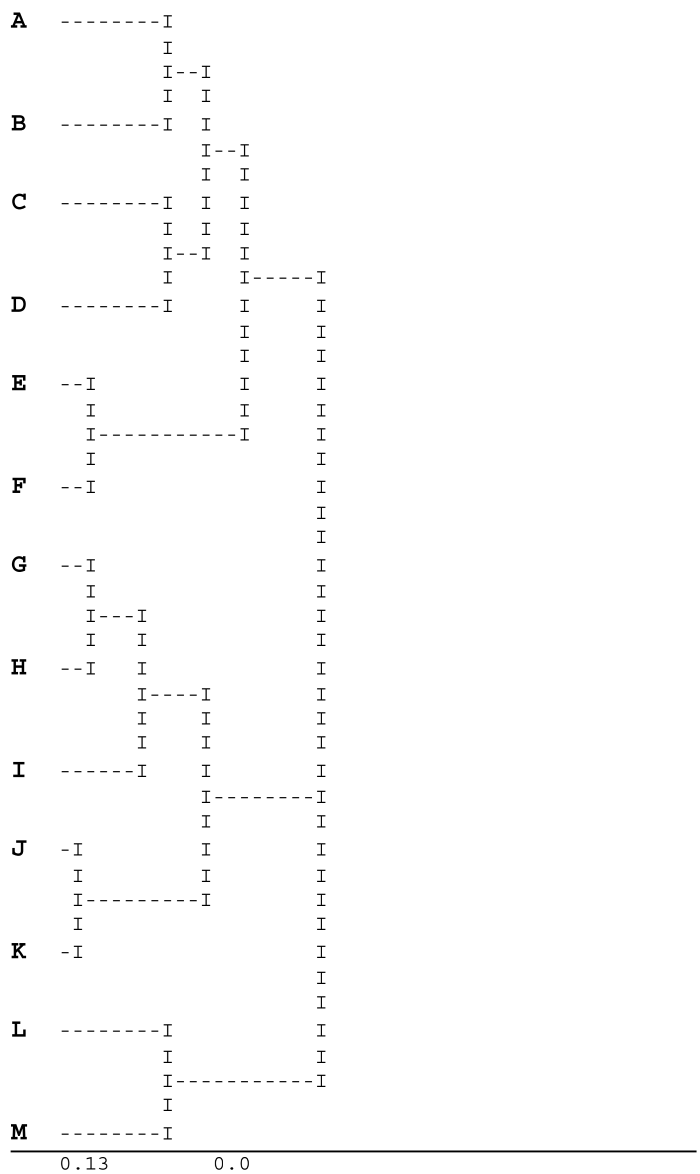


Figure 5-8. Species group dendrogram of 1999 Farfield infaunal data with replicates from each station summed (Gallagher's CNESS dissimilarity and UMPGA sorting). See Table 5-11 for the species in each group.

Table 5-11. Species included in each of the species cluster groups from Figure 5-7. "Abund." is total individuals and "occur." is the total number of station occurrences for summed replicates of 1999 Farfield data.

Cluster Group	Species	Total abund.	Total occur.
A	*Prionospio steenstrupi*	17945	8
	Dentalium entale	611	7
	Tubificoides apectinatus	587	6
	Metopella angusta	159	7
	Aphelochaeta marioni	129	8
	Diplocirrus hirsutus	90	8
	Goniada maculata	83	6
	Leitoscoloplos acutus	65	5
	Scalibregma inflatum	39	5
	Leucon acutirostris	32	2
	Crenella decussata	22	3
	Sphaerodoropsis minuta	19	2
	Molgula manhattensis	15	5
	Monoculodes packardi	8	2
	Leucon fulvus	5	3
	Retusa obtusa	4	1
	Euchone elegans	3	2
	Deflexilodes intermedius	3	3
	Priapulus caudatus	3	2
	Trochochaeta multisetosa	2	1
B	*Euchone incolor*	7051	8
	Aricidea quadrilobata	2503	8
	Anobothrus gracilis	1921	8
	Parougia caeca	764	8
	Sternaspis scutata	441	7
	Galathowenia oculata	330	8
	Spiophanes kroeyeri	168	6
	Amphiporus cruentatus	81	4
	Axiothella catenata	49	6
	Nuculana messanensis	27	3
	Macoma balthica	2	1
C	*Spio limicola*	1538	7
	Thyasira flexuosa	688	8
	Thracia conradi	202	6
	Eteone longa	117	7
	Cylichna gouldi	49	6
	Chaetozone sp. 4	34	4
	Ctenodiscus crispatus	27	4
	Diaphana minuta	21	5
	Trichobranchus roseus	5	3
	Prionospio cirrifera	4	2
	Hartmania moorei	3	3
	Dysponetus pygmaeus	3	2
	Drilonereis longa	1	1
	Chone cf. magna	1	1
	Onoba pelagica	511	8
D	*Mayerella limicola*	87	4
	Nephtys incisa	78	8
	Pleurogonium rubicundum	64	5
	Stenopleustes inermis	56	8
	Mystides borealis	28	7
	Leptostylis longimana	20	5
	Campylaspis rubicunda	7	2
	Deflexilodes tesselatus	7	3
E	*Levinsenia gracilis*	1603	8
	Chaetozone setosa MB	499	6
	Micrura spp.	341	8
	Photis pollex	271	8
	Apistobranchus typicus	176	7
	Paramphinome jeffreysii	155	5
	Heteromastus filiformis	114	6
	Carinomella lactea	42	8
	Sphaerosyllis longicauda	29	5
	Tubulanus pellucidus	25	2
	Spiochaetopterus oculatus	14	4
	Terebellides stroemii	10	3
	Streptosyllis cf. *pettiboneae*	9	1
	Chaetoderma nitidulum canadense	7	4
	Enipo torelli	6	5
	Crassicorophium crassicorne	6	2
	Cerebratulus lacteus	5	4
	Pseudunciola obliquus	4	2
	Byblis cf. *gaimardi*	2	1
	Aphelochaeta sp. 1	1	1
F	*Eudorella hispida*	152	7
	Yoldia sapotilla	130	7
	Bathymedon obtusifrons	30	4
	Phascolion strombi	26	4
	Melinna cristata	11	4
	Hippomedon propinquus	6	4
	Flabelligera spp.	3	2
	Praxillella gracilis	3	2
	Nuculana pernula	3	2
	Turbellaria spp.	2	2
G	*Dipolydora socialis*	3999	8
	Nucula delphinodonta	882	8
	Pholoe minuta	342	8
	Phyllodoce mucosa	290	8
	Maldane sarsi	90	5
	Exogone verugera	89	5
	Exogone hebes	71	3
	Haploops fundiensis	69	7
	Capitella capitata complex	58	6
	Praxillura ornata	57	2
	Laonome kroeyeri	52	5
	Phoronis architecta	38	3
	Rhodine loveni	36	1
	Propebela turricula	16	2
	Unciola irrorata	13	3
	Casco bigelowi	10	3
	Ericthonius fasciatus	9	2
	Arcteobia anticostiensis	8	4
	Chone duneri	8	4
	Munna sp. 1	4	1
	Exogone longicirris	1	1
	Byblis gaimardi	1	1

Table 5–11. Species included in each of the species cluster groups from Figure 5-7. "Abund." is total individuals and "occur." is the total number of station occurrences for summed replicates of 1999 Farfield data (continued).

H	*Astarte undata*	88	5
	Eudorella pusilla	38	5
	Oenopota incisula	27	5
	Pionosyllis sp. A	5	1
	Gattyana cirrosa	2	1
	Nephtys ciliata	1	1
	Scolelepis texana	1	1
	Paradulichia typica	1	1
I	*Diastylis cornuifer*	31	7
	Lyonsia arenosa	17	3
	Argissa hamatipes	17	4
	Ischyrocerus anguipes	9	3
	Scoloplos armiger	5	2
	Proboloides holmesi	5	3
	Trochochaeta carica	3	2
	Euclymeninae sp. 1	3	2
	Aphrodita hastata	2	2
	Myxicola infundibulum	1	1
	Diastylis quadrispinosa	1	1
	Dulichia tuberculata	1	1
J	*Spiophanes bombyx*	373	4
	Cerastoderma pinnulatum	367	2
	Edotia montosa	151	5
	Arctica islandica	106	4
	Edwardsia elegans	70	4
	Aeginina longicornis	41	2
	Monticellina baptisteae	40	5
	Euclymene collaris	27	4
	Spio thulini	26	2
	Ptilanthura tenuis	25	3
	Crenella glandula	21	1
	Ampelisca macrocephala	16	2
	Protomedeia fasciata	12	1
	Ilyanassa trivittata	3	1
	Laonice sp. 1	2	1
	Pectinaria granulata	2	2
	Placopecten magellanicus	2	1
	Ceriantheopsis americanus	1	1
	Phyllodoce maculata	1	1
	Glycera dibranchiata	1	1
	Laonice cirrata	1	1
	Pitar morrhuana	1	1
	Tanaissus psammophilus	1	1
K	*Hiatella arctica*	255	6
	Owenia fusiformis	34	4
	Siliqua costata	14	4
	Ameroculodes sp. 1	11	2
	Ophelina acuminata	7	4
	Amphiporus groenlandicus	6	4
	Petalosarsia declivis	5	1
	Syrrhoe sp. 1	3	1
	Nemertea sp. 14	2	1
	Monticellina dorsobranchialis	2	1
	Clymenella torquata	2	1
	Aglaophamus circinata	1	1
	Ampharete finmarchica	1	1
	Colus parvus	1	1
L	*Cossura longocirrata*	2706	7
	Mediomastus californiensis	2037	8
	Tubificidae sp. 2	546	4
	Ninoe nigripes	432	8
	Aricidea catherinae	398	4
	Tharyx acutus	332	7
	Polygordius sp. A	100	6
	Syllides longocirrata	93	6
	Scoletoma fragilis	51	7
	Proclea graffii	49	4
	Sphaerodoridium sp. A	37	5
	Stereobalanus canadensis	22	6
	Nephtys cornuta	2	1
	Crangon septemspinosa	2	1
M	*Leptocheirus pinguis*	892	5
	Harpinia propinqua	685	7
	Orchomenella minuta	145	5
	Terebellides atlantis	112	5
	Ophiura sarsi	91	8
	Gattyana amondseni	58	6
	Nucula annulata	43	2
	Pleusymtes glaber	37	1
	Amphiporus angulatus	33	6
	Mya arenaria	33	7
	Pleurogonium spinosissimum	23	2
	Tetrastemma vittatum	19	5
	Aricidea minuta	17	1
	Melita nr. *dentata*	16	1
	Anonyx liljeborgi	16	5
	Pleurogonium inerme	13	3
	Brada villosa	9	2
	Dyopedos monacanthus	5	2
	Scoletoma hebes	2	1
	Chaetozone sp. 5 (Phillips 1999)	1	1
	Lanassa venusta venusta	1	1

Constancy

	Station Group		
	I	**II**	**III**
A	0.5	0.7	0.3
B	0.7	0.9	0.6
C	0.4	0.7	0.4
D	0.7	0.8	0.6
E	0.6	0.7	0.4
F	0.4	0.7	0.2
G	0.9	0.4	0.3
H	0.6	0.2	0.2
I	0.7	0.2	0.2
J	0.6	0.2	0.1
K	0.6	0.2	0.1
L	0.6	0.6	0.9
M	0.5	0.3	0.7

Fidelity

	0	**II**	**III**
A		1.3	0.6
B	0.9	1.1	0.8
C	0.8	1.3	0.7
D	1.0	1.1	0.8
E	1.0	1.2	0.7
F	0.8	1.4	0.3
G	1.7	0.8	0.6
H	2.0	0.7	0.6
I	2.2	0.6	0.5
J	2.3	0.7	0.3
K	2.3	0.8	0.3
L	0.9	0.9	1.3
M	1.0	0.7	1.5

Figure 5-9. Nodal constancy and fidelity between 1999 Farfield stations and species groups derived from cluster analysis of infaunal data.

5.2.5 Comparison of 1999 Descriptive Community Measures to Previous Years

Nearfield— Comparison of the mean 1999 Nearfield descriptive community measures to the 1992–1998 Nearfield data showed that abundance continued to be among the highest found since the program started (Figure 5-10a). Since dropping to a very low value in 1993, abundance in the Nearfield has increased in a step-wise fashion, increasing to about 2,000 individuals per grab sample in 1994–1996 and to about 2,600 individuals per grab sample in 1997–1999. As mentioned previously by Blake *et al.* (1998) and Kropp *et al.* (2000), the low values describing the infaunal communities in 1993 were probably attributable to a strong storm that swept the area in late 1992. The storm significantly affected sediments in western Massachusetts Bay (Bothner *et al.* 1994). As shown below, mean overall Nearfield values for 1999 were similar to those found for 1997 and 1998. Mean 1999 values for Shannon diversity and Pielou's evenness continued the downward trend that started in 1997 (Figure 5-10a). Both values in 1999 were among the lowest measured during the program. Species richness (*i.e.*, numbers of species) and log-series alpha showed strikingly similar trends, slightly decreasing in 1999 (Figure 5-10a).

Farfield—Mean infaunal abundances within the Farfield have shown a steady increase since 1994 (Figure 5-10b) such that the mean value for 1999 (~2,653/0.04 m^2) was more than 3 times greater than that estimated for 1994 (~801/0.04 m^2). The mean number of species per Farfield station found in 1997–1999 (~68–70) was about 1.5 times greater than that found in 1994 (~47; Figure 5-10b). Other than in 1993 and 1994 (when abundance was low), evenness among Farfield stations has been fairly similar throughout the baseline period. However, diversity as measured by log-series alpha has increased substantially in the later baseline years (1996–1999), although there has been somewhat of a decrease since 1997 (Figure 5-10b).

5.2.6 Comparison of 1999 Multivariate Community Analysis to Previous Years—Nearfield

Nearfield Station Patterns—Station cluster analysis of the 1992 to 1999 Nearfield data was done on a reduced set of data. Only the first replicate at a station was used. The second and third replicates were removed to give equal weight to each station in defining patterns and associations through time. Included were 173 station/year combinations and 365 species. Fifty-one station/year combinations had three replicated grab samples with a total of 96 species that occurred only in replicates two and three, which were not used in this analysis.

Station clusters from the 1992 to 1999 years analysis exhibited patterns related to both strong and weak within station similarity through time. At the 12 group level (Figure 5-11) five stations formed exclusive groups [FF10 (IIIc), FF13 (VIII), NF02 (IX), NF05 (VI), and NF17 (XII)]. Station FF12 also formed a near exclusive subgroup (IIa) within group II. Overall, these six stations tended to be physically dominated through time with heterogeneous sediments. Time in itself did not turn out to be a strong determinant of group formation with only two groups forming around specific years. Group I was a mixture of stations from 1992 and 1994, with one 1993 station (NF14). About half of 1992 stations and about a fourth of the 1994 stations were in group I (Figure 5-11). The stations in group I were primarily those with finer sediments. Group X was composed of four stations from 1994 that were also primarily finer sediments and were missing many of the numerically dominant species. Other groups that exhibited some temporal affinities were IIb, primarily early years 1992 to 1995, groups IIId, V, and VII from 1995 to 1999, and group IV primarily 1998 and 1999 (Figure 5-11). Other multistation groups were a combination of years, such as IIIb and XI, and reflected a strong within station similarity through time.

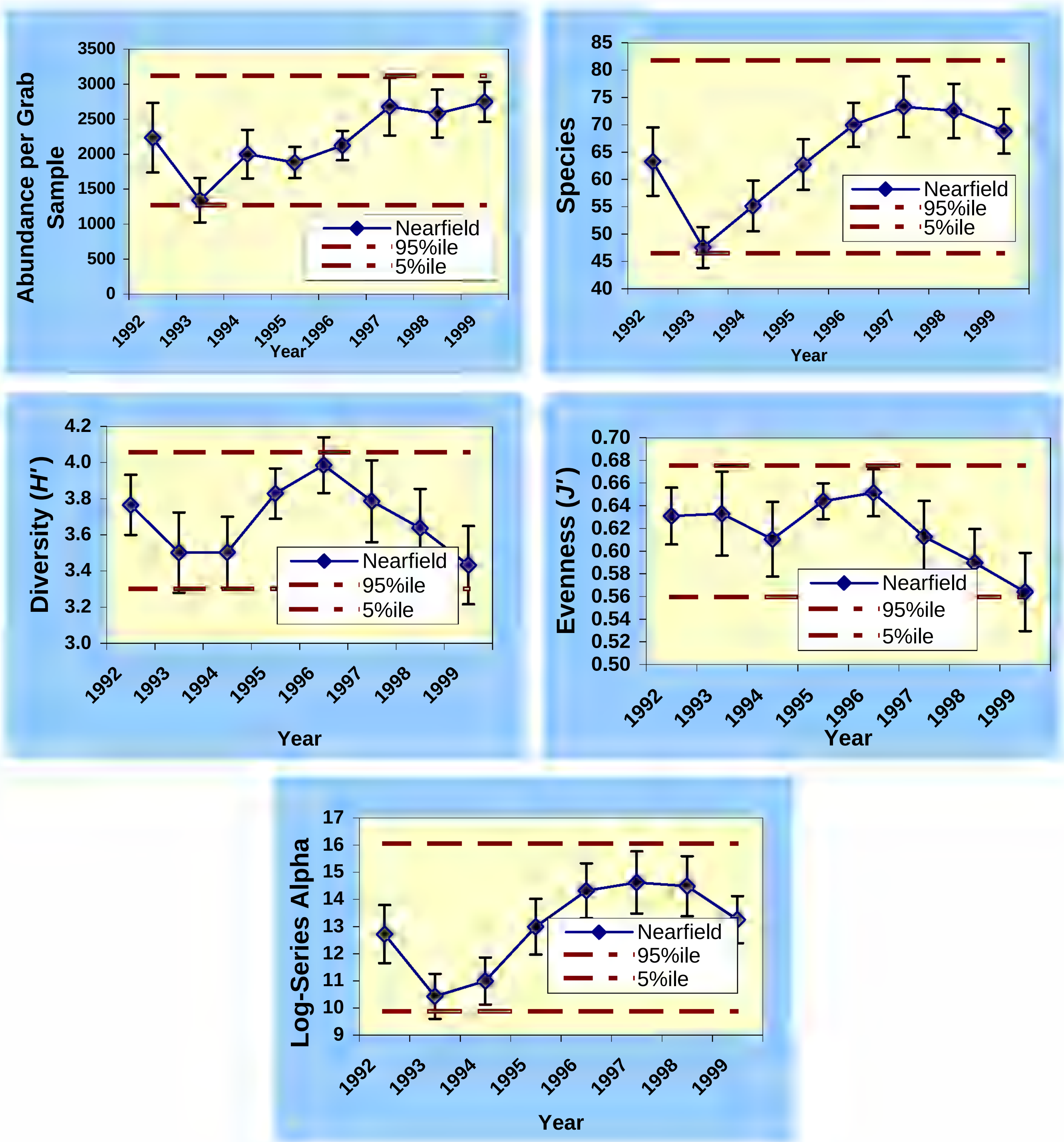


Figure 5-10a. Annual mean (± 95 % confidence intervals) infaunal numbers of species, Shannon diversity (*H'*), evenness (*J'*), and log-series alpha for Nearfield stations sampled from 1992 to 1999. Possible threshold limits are shown as horizontal dashed lines.

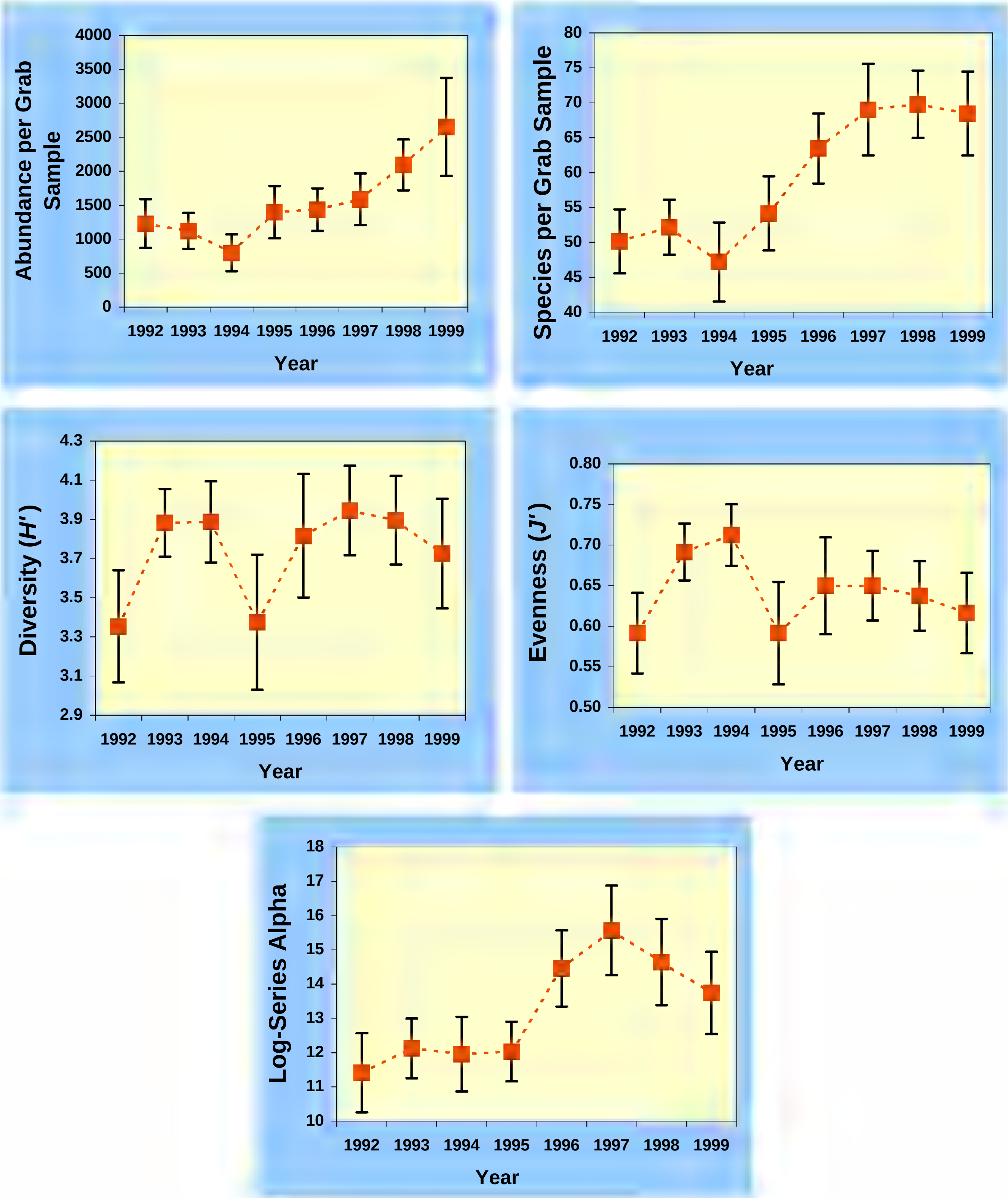


Figure 5-10b. Annual mean (± 95 % confidence intervals) infaunal abundance, numbers of species, Shannon diversity (*H'*), evenness (*J'*), and log-series alpha for Farfield stations sampled from 1992 to 1999.

Group	Station	Year							
I	FF10	92							
I	NF03	92							
I	NF05	92							
I	NF06	92							
I	NF07	92		94					
I	NF09	92							
I	NF10	92							
I	NF13	92							
I	NF14	92	93	94					
I	NF15	92		94					
I	NF18	92							
I	NF19	92		94					
I	NF22			94					
I	NF24			94					
IIa	FF12	92	93		95	96	97	98	99
IIa	NF15							98	
IIb	FF13		93	94					
IIb	NF02	92		94	95				
IIb	NF08	92	93	94	95				
IIIa	NF10					96			
IIIa	NF11	92							
IIIa	NF12	92	93	94					
IIIa	NF16	92	93						
IIIa	NF20	92			95	96			
IIIb	NF09		93	94	95	96	97	98	99
IIIb	NF10		93	94	95		97	98	99
IIIb	NF12				95	96	97	98	99
IIIb	NF21			94	95	96	97	98	
IIIc	FF10		93	94	95	96	97		
IIId	NF07				95				
IIId	NF16				95	96	97		
IIId	NF22				95	96	97	98	99
IIId	NF24				95		97		
IV	FF13								99
IV	NF08					96	97	98	99
IV	NF15					96			
IV	NF16							98	99
IV	NF20						97	98	99
IV	NF21								99
IV	NF24							98	99
V	NF02					96			
V	NF04						97		
V	NF07					96		98	99
V	NF15				95		97		99
V	NF19				95	96	97	98	99
V	NF24					96			
VI	NF05				95	96	97	98	99
VII	FF10								99
VII	NF04							98	
VII	NF14				95	96		98	99
VII	NF18			94	95	96	97	98	99
VIII	FF13	92			95	96	97	98	
IX	NF02		93				97	98	99
X	FF12			94					
X	NF05			94					
X	NF16			94					
X	NF20			94					
XI	NF01	92							
XI	NF04	92	93	94	95	96			99
XI	NF07						97		
XI	NF13			94	95	96	97	98	99
XI	NF14						97		
XI	NF17	92		94		96			
XI	NF23			94	95	96	97	98	99
XII	NF17		93		95		97	98	99

Similarity

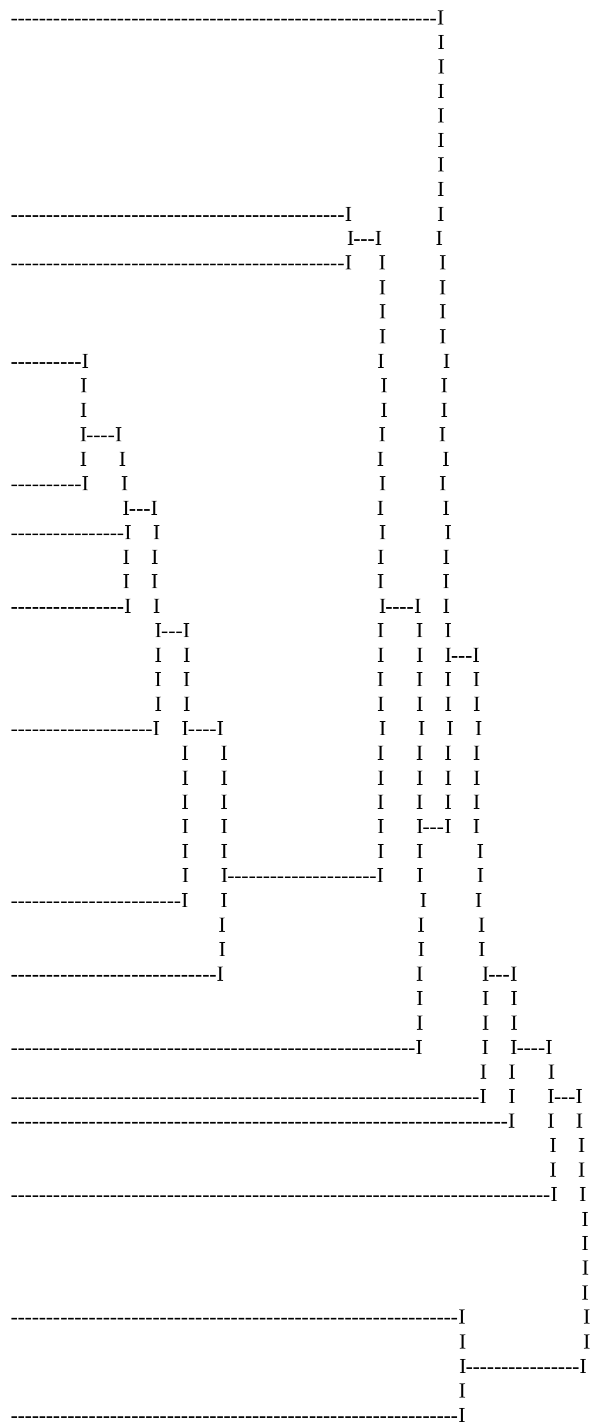


Figure 5-11. Station group dendrogram for 1992–1999 Nearfield infaunal data including only the first replicate from each station (Gallagher's CNESS dissimilarity and UMPGA sorting).

In addition to the six stations that formed exclusive or near exclusive groups, within station similarity over the 1992 to 1999 period for multistation groups was strongest (5 or more year/station occurrences within a cluster group) for stations NF18 (VII), NF19 (V), NF22 (IIId), NF09, NF10, and NF21. The latter three stations all being in subcluster group IIIb.

Overall, the analyses failed to document strong temporal variability in nearfield community composition. Temporal trends were weakly represented within station group III with subgroup IIIa being earlier years and IIId later. Within-station similarity was the primary feature structuring the 1992 to 1999 data. This lack of temporal variability in composition is of particular interest given the temporal trends observed in species richness and species abundance described in section 7.5 of Kropp *et al.* (1999).

Nearfield Species Patterns—While approximately 460 species were collected from 1992 to 1999 in the Nearfield area the species cluster analysis was based on the top 132 numerical (total abundance > 1,000 individuals) or occurrence (> 24 year/station occurrences) dominants. Over the years these species were found to be primary contributors to community structure (Blake *et al*. 1998, Kropp *et al.* 2000). At the nine group level species were formed into three distinct groups, about 0.1 CNESS dissimilarity (Figure 5-12, Table 5-12). Groups A, B and C contained many of the broadly distributed species. Group A included only one dominant species, *Prionospio steenstrupi* the overall most abundant species in the Nearfield (grand total 78,080 individuals). The other species in Group A had two order of magnitude lower total abundance. Nodal analysis indicated group A tended to have higher constancy and fidelity with station groups IV to VII, composed mostly of stations from 1995 to 1999 (Figure 5-13). Groups B and C were composed of species with a preference for sandy sediments, such as *Aricidea catherinae*. Groups B and C had moderate to high constancy and exhibited little fidelity with all station groups except station groups X and XI. Groups D to H were primarily species with a preference for muddy sediment. Groups D, E and F contained most of the muddy dominants and groups G and H subdominants (Table 5-12). Constancy and fidelity of groups D, F, and G was moderate at station groups I to VII and low at groups VII to XI. Group E had low constancy and fidelity with all station groups except IIIb, IIIc, and IX. Group H had low constancy exhibited little fidelity to any station group. . Group I was composed of subdominants with high constancy and moderate fidelity for station groups X and XI (Figure 5-13).

5.2.7 Comparison of 1999 Multivariate Community Analysis to Previous Years—Farfield

Farfield Station patterns—Since the Farfield stations consistently had high within station similarity, cluster analysis of the combined 1992 to 1999 Farfield data was preformed on the sum of the three replicates. A total of 64 station/year combinations and 338 species were included.

Station clusters from the combined 1992 to 1999 analysis primarily exhibited patterns related to strong within station similarity through time and secondarily to temporal trends at some stations. The Farfield stations were completely separated at the three group level (Figure 5-14). Group I was composed of subdominants with one that represented station FF01 in its original location for 1992 and 1993 (subgroup Ia), after which it was moved to FF01A. Subgroups Ib, Ic, and Id almost perfectly tracked time at stations FF04, FF05, FF11, and FF14, which were the deepest of the Farfield stations, with subgroup Ib being 1992 to 1994, Ic 1995 to 1997, and Id 1998 and 1999 (Figure 5-14). Groups II and III emphasized both the strong within station similarity and between station dissimilarity. Group II was exclusively stations FF01A and FF09, northern stations. Within Group II these stations formed exclusive subgroups except in 1999 when both stations were grouped together. Group III was the Cape Cod Bay stations FF06 and FF07 that through the eight years (1992 to 1999) exhibited weak temporal pattern.

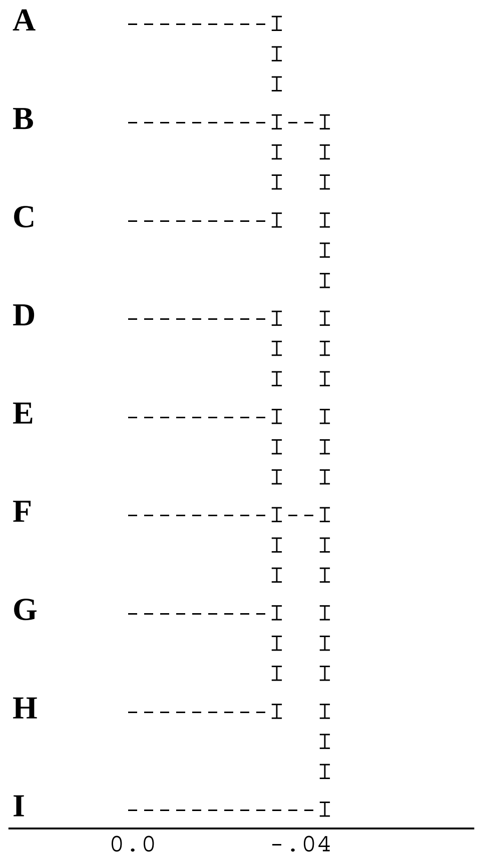


Figure 5-12. Species group dendrogram of 1992–1999 Nearfield data including only the first replicate from each station (Gallagher's CNESS dissimilarity and UMPGA sorting). See Table 5-12 for the species in each group.

Table 5-12. Species included in each of the species cluster groups from Figure 5-12. "Abund." is total individuals and "occur." is total number of occurrences for replicate one of 1992–1999 Nearfield stations. Total year/station occurrences was 173 grabs.

Cluster Group	Species	Total abund.	Total occur.
A	*Prionospio steenstrupi*	78080	168
	Lyonsia arenosa	277	58
	Edwardsia elegans	245	83
	Ceriantheopsis americanus	226	50
	Sphaerodoridium sp. A	215	63
	Dulichia tuberculata	105	33
	Pherusa affinis	66	37
B	*Aricidea catherinae*	17252	167
	Tharyx acutus	14156	161
	Owenia fusiformis	3779	84
	Phoronis architecta	2020	130
	Tubificidae sp. *2*	1683	79
	Nephtys cornuta	1316	52
	Capitella capitata Ccomplex	1221	133
	Heteromastus filiformis	66	34
C	*Hiatella arctica*	4444	140
	Photis pollex	2081	142
	Dyopedos monacanthus	1382	84
	Scoletoma hebes	1118	54
	Arctica islandica	930	128
	Nephtys incisa	765	110
	Pleurogonium rubicundum	724	100
	Argissa hamatipes	558	125
	Spio thulini	175	37
	Diastylis sculpta	175	58
	Actiniaria sp. 2	173	56
	Ensis directus	169	31
	Pleurogonium inerme	139	43
	Nemertea sp. 2	134	41
	Orchomenella minuta	105	35
	Crangon septemspinosa	37	28
D	*Mediomastus californiensis*	33833	167
	Ninoe nigripes	10994	149
	Aphelochaeta marioni	8136	133
	Monticellina baptisteae	7165	125
	Euchone incolor	6787	139
	Levinsenia gracilis	5330	142
	Leitoscoloplos acutus	3589	138
	Parougia caeca	1901	144

Table 5-12. Species included in each of the species cluster groups from Figure 5-12. "Abund." is total individuals and "occur." is total number of occurrences for replicate one of 1992–1999 Nearfield stations. Total year/station occurrences was 173 grabs (continued).

	Micrura spp.	1318	146
	Monticellina dorsobranchialis	1262	125
	Metopella angusta	1155	126
	Amphiporus angulatus	513	101
	Clymenella torquata	382	35
	Carinomella lactea	362	65
	Yoldia sapotilla	284	63
	Thracia conradi	257	51
	Periploma papyratium	253	52
	Ilyanassa trivittata	249	67
	Mya arenaria	239	81
	Aricidea quadrilobata	220	63
	Mayerella limicola	211	28
	Gattyana amondseni	148	68
	Cossura longocirrata	80	39
	Pitar morrhuana	57	31
	Deflexilodes intermedius	54	26
	Campylaspis rubicunda	50	33
E	*Nucula delphinodonta*	4894	140
	Crenella decussata	3197	113
	Maldane sarsi	1658	50
	Astarte undata	1367	118
	Thyasira gouldi	513	68
	Haploops fundiensis	419	32
	Leptocheirus pinguis	386	44
	Apistobranchus typicus	381	82
	Harpinia propinqua	339	51
	Trochochaeta multisetosa	324	50
	Galathowenia oculata	231	90
	Anobothrus gracilis	176	52
	Onoba pelagica	173	28
	Cyclocardia borealis	109	33
	Goniada maculata	103	46
	Cancer borealis	91	47
	Sphaerodoropsis minuta	85	30
	Rhodine loveni	83	26
	Eudorella pusilla	73	36
	Enipo torelli	68	40
	Arcteobia anticostiensis	44	32
F	*Spio limicola*	32966	152
	Dipolydora socialis	17995	128
	Ampharete acutifrons	2346	110
	Asabellides oculata	1449	89
	Tubificoides apectinatus	612	89
	Scalibregma inflatum	599	75
	Laonome kroeyeri	326	76
	Flabelligera spp.	69	27
G	*Dipolydora quadrilobata*	2364	71
	Pholoe minuta	2241	162
	Edotia montosa	1289	138
	Eteone longa	1081	133
	Stenopleustes inermis	724	116
	Scoloplos armiger	305	76
	Cerebratulus lacteus	300	80
	Anonyx liljeborgi	71	40
	Diastylis quadrispinosa	53	33
H	*Crenella glandula*	662	46
	Nemertea sp. 5	335	43
	Sphaerosyllis longicauda	272	79
	Pionosyllis sp. A	253	38
	Leitoscoloplos sp. B	212	48
	Nereis grayi	201	52
	Scoletoma fragilis	183	69
	Spio filicornis	125	43
	Exogone longicirris	116	29
	Chone duneri	74	45
	Ameroculodes sp. 1	59	38
I	*Exogone hebes*	12117	161
	Exogone verugera	8110	149
	Crassicorophium crassicorne	6118	63
	Spiophanes bombyx	3635	136
	Unciola inermis	3374	36
	Phyllodoce mucosa	3304	148
	Polygordius sp. A	3181	91
	Cerastoderma pinnulatum	2984	112
	Protomedeia fasciata	2195	62
	Euclymene collaris	845	61
	Ericthonius fasciatus	770	44
	Aglaophamus circinata	754	52
	Euchone elegans	528	34
	Ptilanthura tenuis	489	72
	Echinarachnius parma	374	34
	Unciola irrorata	355	38
	Ampharete finmarchica	350	59
	Tanaissus psammophilus	330	29
	Chaetozone setosa MB	327	52
	Cephalothricidae sp. 1	291	69
	Phyllodoce maculata	250	46
	Ampelisca macrocephala	238	76
	Petalosarsia declivis	186	62
	Syrrhoe sp. 1 (Kropp 1998)	94	38
	Phoxocephalus holbolli	75	25
	Hippomedon serratus	65	27

Constancy

Species Group	I	IIa	IIb	IIIa	IIIb	IIIc	IIId	IV	V	VI	VII	VIII	IX	X	XI	XII
A	0.3	0.5	0.3	0.3	0.4	0.4	0.4	0.5	0.6	0.5	0.6	0.4	0.5	0.1	0.4	0.3
B	0.6	0.7	0.7	0.7	0.7	0.7	0.5	0.6	0.6	0.5	0.6	0.8	0.7	0.4	0.4	0.3
C	0.4	0.6	0.5	0.3	0.4	0.6	0.4	0.5	0.5	0.4	0.5	0.6	0.5	0.5	0.4	0.2
D	0.5	0.6	0.4	0.6	0.7	0.7	0.7	0.6	0.6	0.5	0.5	0.3	0.3	0.3	0.2	0.1
E	0.4	0.2	0.1	0.2	0.5	0.5	0.3	0.3	0.4	0.8	0.4	0.1	0.2	0.2	0.3	0.1
F	0.7	0.5	0.6	0.6	0.6	0.7	0.5	0.5	0.6	0.7	0.6	0.5	0.6	0.2	0.4	0.1
G	0.8	0.6	0.5	0.5	0.6	0.7	0.5	0.5	0.6	0.5	0.6	0.4	0.4	0.6	0.4	0.2
H	0.3	0.1	0.1	0.3	0.3	0.3	0.3	0.2	0.4	0.3	0.6	0.1	0.2	0.1	0.2	0.1
I	0.3	0.3	0.2	0.2	0.3	0.3	0.2	0.3	0.5	0.4	0.6	0.2	0.5	0.1	0.7	0.7

Fidelity

Species Group	I	IIa	IIb	IIIa	IIIb	IIIc	IIId	IV	V	VI	VII	VIII	IX	X	XI	XII
A	0.8	1.3	0.7	0.8	0.9	1.0	1.0	1.2	1.4	1.3	1.6	1.0	1.1	0.3	0.9	0.7
B	1.1	1.2	1.2	1.2	1.2	1.1	0.8	1.0	1.1	0.9	1.0	1.3	1.1	0.7	0.7	0.5
C	0.9	1.4	1.1	0.8	0.9	1.3	0.8	1.1	1.1	0.9	1.1	1.5	1.2	1.1	0.9	0.5
D	1.0	1.2	0.8	1.1	1.4	1.3	1.3	1.2	1.2	1.0	1.0	0.6	0.6	0.6	0.4	0.2
E	1.1	0.7	0.3	0.7	1.4	1.5	1.0	0.9	1.3	2.3	1.3	0.2	0.5	0.6	0.8	0.3
F	1.3	1.0	1.0	1.1	1.0	1.3	1.0	0.8	1.2	1.3	1.2	0.8	1.0	0.3	0.7	0.2
G	1.4	1.1	1.0	0.9	1.0	1.3	0.9	1.0	1.1	0.9	1.0	0.7	0.7	1.1	0.8	0.4
H	1.0	0.5	0.5	1.1	1.0	1.2	1.1	0.8	0.9	0.8	1.3	0.2	0.4	0.3	0.6	0.1
I	0.8	0.8	0.5	0.5	0.7	0.7	0.6	0.9	1.2	1.1	1.4	0.5	1.2	0.4	1.9	1.7

Figure 5-13. Nodal constancy and fidelity between 1992–1999 Nearfield stations and species groups derived from cluster analysis of infaunal data.

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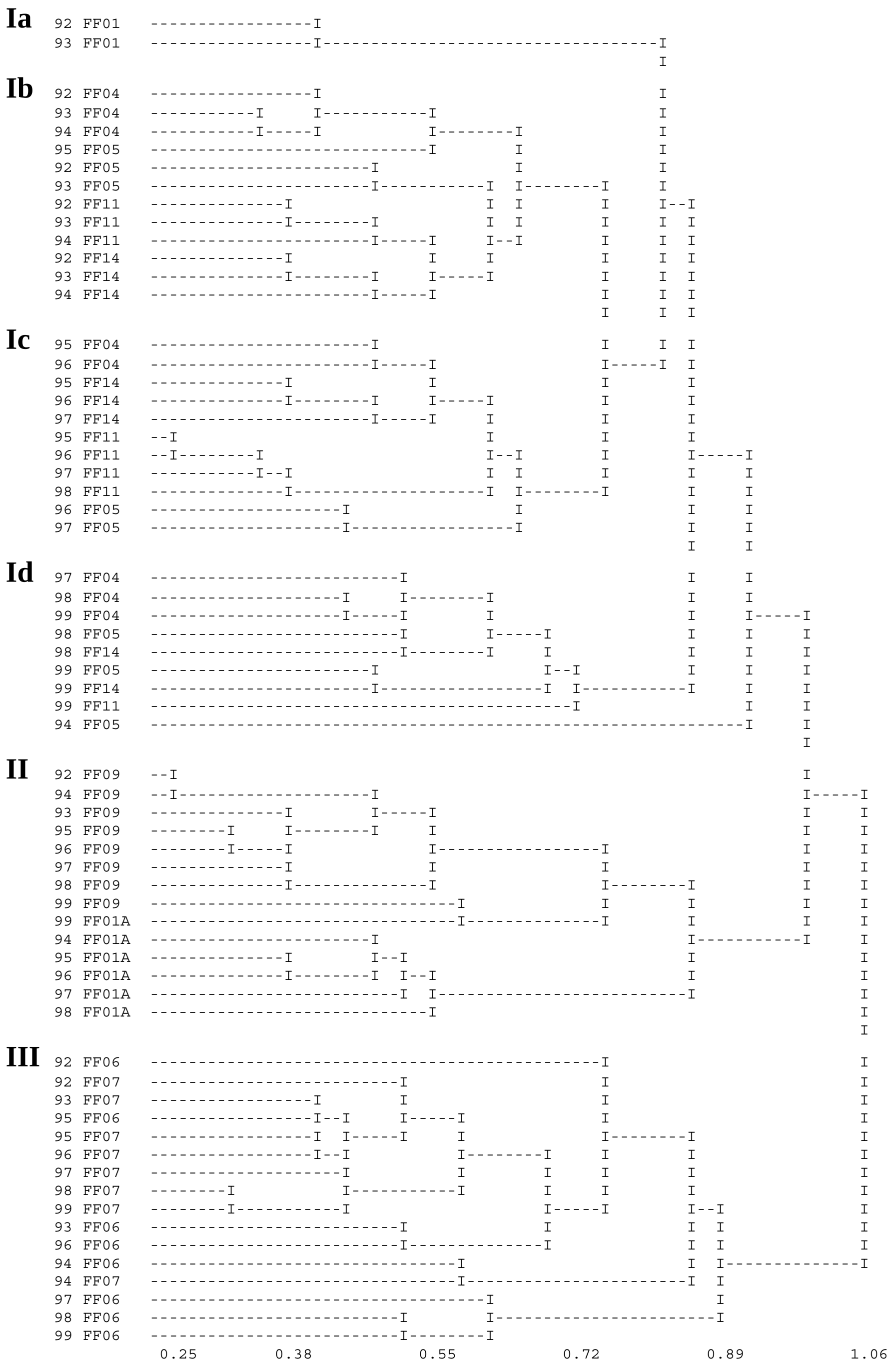

Figure 5-14. Station dendrogram of 1992–1999 Farfield station groups with replicates summed for each station (Gallagher's CNESS dissimilarity and UMPGA sorting). All species included.

Overall, the 1992 to 1999 Farfield infaunal data was dominated by both strong spatial differences between stations and temporal trends. Temporal trends were more pronounced at the deepest stations (FF04, FF05, FF11, and FF14) than spatial differences between these stations. The reverse was the case at shallower stations located to the north (FF01A and FF09) and in Cape Cod Bay (FF06 and FF07) (Figure 5-14).

Farfield Species Patterns—While approximately 340 species were collected from 1992 to 1999 in the Farfield area the species cluster analysis was based on the top 148 numerical (total abundance > 1,000 individuals) or occurrence (> 10 year/station occurrences) dominants. Over the years these species were found to be primary contributors to community structure (Blake *et al.* 1998, Kropp *et al.* 2000). At the six group level species formed into three distinct clusters, about 0.0 CNESS dissimilarity, each composed of two groups (Figure 5-15, Table 5-13). Groups A and B contained species with high constancy and fidelity to stations FF01A and FF09 (group II). Group A also contained the top numerical dominant, *Prionospio steenstrupi*, which was also the top dominant at the Nearfield. Many of the A group species were more abundant at FF01A and B group species more abundant at FF09. Groups C and D had many of the numerical dominants with moderate constancy at all station groups and slightly higher fidelity with the Cape Cod Bay station group III. Groups E and F had moderate constancy and higher fidelity with Group I stations. Group E was composed of the species that were dominant through time in all of Group I subgroups. Group F species were more abundant within subgroups Ic and Id and represented 1995 to 1999 conditions (Figure 5-16).

```
A      -------I
              I
              I--------I
              I        I
B      -------I        I
                       I
C      ----------I     I
                 I     I
                 I-----I
                 I     I
D      ----------I     I
                       I
E      -------------I  I
                    I  I
                    I--I
                    I
F      -------------I
       0.13             -.06
```

Figure 5-15. Species group dendrogram of 1992–1999 Farfield data with replicates summed for each station (Gallagher's CNESS dissimilarity and UMPGA sorting). Only species with > 10 occurrences were included. See Table 5-13 for the species in each group.

Table 5-13. Species included in each of the 1992–1999 Farfield species cluster groups from Figure 5-15. Abund. is total individuals and occur. total number of occurrences for replicate one of 1992–1999 Nearfield stations. Total year/station occurrences was 64 (replicates were summed).

Cluster Group	Species	Total abund.	Total occur.
A	*Prionospio steenstrupi*	67061	58
	Dipolydora socialis	10482	48
	Exogone verugera	819	26
	Exogone hebes	586	24
	Ampharete acutifrons	566	24
	Phyllodoce mucosa	448	35
	Phoronis architecta	434	31
	Astarte undata	374	24
	Haploops fundiensis	372	46
	Praxillura ornata	220	13
	Rhodine loveni	156	12
	Laonome kroeyeri	144	29
	Nereis grayi	143	19
	Phascolion strombi	111	29
	Sphaerodoropsis minuta	97	21
	Unciola irrorata	74	15
	Ophelina acuminata	70	26
	Dipolydora quadrilobata	63	11
	Arcteobia anticostiensis	32	12
	Gattyana cirrosa	28	10
	Casco bigelowi	26	11
	Diastylis quadrispinosa	26	13
B	*Nucula delphinodonta*	4937	55
	Pholoe minuta	1250	57
	Photis pollex	1085	55
	Cerastoderma pinnulatum	948	22
	Spiophanes bombyx	692	17
	Edotia montosa	458	32
	Crenella decussata	449	24
	Hiatella arctica	425	23
	Arctica islandica	367	21
	Edwardsia elegans	367	22
	Owenia fusiformis	360	22
	Asabellides oculata	335	19
	Praxillella praetermissa	300	25
	Ptilanthura tenuis	227	16
	Goniada maculata	172	34
	Ampelisca macrocephala	139	14
	Argissa hamatipes	128	24
	Lyonsia arenosa	119	11
	Ameroculodes sp. 1 (Kropp 1998)	89	18
	Paradulichia typica	73	12
	Campylaspis rubicunda	36	17
C	*Euchone incolor*	17910	56
	Mediomastus californiensis	16632	59
	Cossura longocirrata	16436	54
	Tubificidae sp. 2 (Blake 1992)	3344	18
	Apistobranchus typicus	2242	50
	Syllides longocirrata	926	40
	Polygordius sp. A	256	22
	Sphaerodoridium sp. A	144	18
	Stereobalanus canadensis	119	27
	Proclea graffii	83	11
D	*Tharyx acutus*	4874	36
	Ninoe nigripes	3433	59
	Aricidea catherinae	3221	25
	Onoba pelagica	1810	46
	Harpinia propinqua	1806	52
	Terebellides atlantis	1346	43
	Metopella angusta	1249	48
	Nephtys incisa	828	50
	Eteone longa	677	55
	Capitella capitata Complex	439	50
	Eudorella pusilla	395	47
	Periploma papyratium	387	33
	Nucula annulata	374	13
	Stenopleustes inermis	355	32
	Pleurogonium rubicundum	315	41
	Ophiura sarsi	247	31
	Scoletoma fragilis	230	45
	Leucon acutirostris	184	27
	Mayerella limicola	154	18
	Pleurogonium inerme	144	22
	Leptostylis longimana	104	29
	Gattyana amondseni	96	30
	Leptocheirus pinguis	94	15
	Mya arenaria	82	32
	Diastylis cornuifer	79	22
	Mystides borealis	69	23
	Orchomenella minuta	65	21
	Oenopota incisula	56	23
	Nemertea sp. 2	55	14
	Cerebratulus lacteus	53	24
	Anonyx liljeborgi	51	21
	Flabelligera spp.	45	14
	Dyopedos monacanthus	40	14
E	*Spio limicola*	27192	58
	Aricidea quadrilobata	9639	59
	Levinsenia gracilis	9308	59
	Chaetozone setosa	4581	52
	Tubificoides apectinatus	3953	45
	Thyasira gouldi	2636	52
	Scalibregma inflatum	2153	51
	Yoldia sapotilla	1645	56
	Sternaspis scutata	1533	44
	Leitoscoloplos acutus	1303	53
	Micrura spp.	1138	59
	Aphelochaeta marioni	1083	57
	Maldane sarsi	874	41
	Heteromastus filiformis	596	36
	Nemertea Sp. 5	532	22
	Nuculoma tenuis	401	34
	Carinomella lactea	223	46
	Paramphinome jeffreysii	213	18
	Monticellina baptisteae	154	26
	Megayoldia thraciaeformis	144	20
	Tubulanus pellucidus	143	22
	Enipo torelli	131	36
	Trochochaeta carica	128	26
	Ophiura robusta	112	16
	Syllides japonica	103	27
	Sphaerosyllis longicauda	79	20
	Tetrastemma vittatum	67	19
	Deflexilodes intermedius	64	22
	Ctenodiscus crispatus	64	23
	Praxillella gracilis	55	20
	Aphelochaeta monilaris	55	12
	Chaetoderma nitidulum canadense	45	28

Table 5-13 Species included in each of the 1992–1999 Farfield species cluster groups from Figure 5-15 (continued).

	Priapulus caudatus	40	12
	Melinna cristata	37	17
	Byblis gaimardi	29	16
	Hippomedon propinquus	28	15
	Hartmania moorei	19	12
F	*Anobothrus gracilis*	5261	59
	Parougia caeca	1860	58
	Dentalium entale	1474	37
	Galathowenia oculata	1155	48
	Thracia conradi	497	19
	Cephalothricidae sp. 1	457	27
	Trochochaeta multisetosa	366	27
	Eudorella hispida	338	24
	Cylichna gouldi	274	36
	Amphiporus angulatus	228	39
	Spiophanes kroeyeri	189	21
	Pythinella cuneata	189	13
	Diplocirrus hirsutus	145	18
	Nephtys cornuta	126	18
	Bathymedon obtusifrons	123	17
	Axiothella catenata	78	17
	Amphiporus groenlandicus	54	11
	Diaphana minuta	43	14
	Terebellides stroemii	43	14
	Leucon fulvus	41	13

Constancy

Station Groups

	Ia	Ib	Ic	Id	II	III
A	0.4	0.3	0.3	0.3	0.8	0.2
B	0.3	0.2	0.4	0.4	0.8	0.3
C	0.6	0.5	0.5	0.7	0.6	0.8
D	0.4	0.4	0.5	0.5	0.6	0.7
E	0.7	0.7	0.6	0.6	0.5	0.4
F	0.4	0.3	0.5	0.6	0.4	0.4

Fidelity

	Ia	Ib	Ic	Id	II	III
A	1.0	0.8	0.7	0.8	2.0	0.6
B	0.7	0.5	0.9	0.9	1.8	0.8
C	0.9	0.8	0.9	1.1	0.9	1.3
D	0.8	0.7	0.9	1.1	1.0	1.2
E	1.3	1.2	1.1	1.1	0.9	0.8
F	1.0	0.8	1.3	1.4	0.9	0.9

Figure 5-16. Nodal constancy and fidelity between 1992–1999 Farfield stations and species groups derived from cluster analysis of infaunal data.

5.3 Nearfield Threshold Comparisons

Thresholds to allow the early detection of potentially unacceptable changes in the benthic community have been under development for several years. Narrative threshold statements were developed (MWRA 1997) relying on measures of species diversity and the proportion of opportunistic species in the Nearfield community. The goals of the benthic community thresholds are twofold. The first goal is to rapidly identify a change in infaunal communities large enough to warrant a more detailed evaluation and notification of regulators, even if the change is not related to the outfall discharge. The second goal of the benthic thresholds is to detect changes indicative of outfall-induced degradation in benthic communities.

This section summarizes MWRA benthic threshold development since 1997 and summarizes recommendations made to the Outfall Monitoring Science Advisory Panel at its June 2000 meeting. It complements an information briefing prepared for that meeting, which is available online at http://www.mwra.state.ma.us/harbor/html/cppmodb1.pdf. The minutes of that meeting, which include OMSAP's approval of those recommendations, are available available online at http://www.mwra.state.ma.us/harbor/html/cppmodb1.pdf.

A series of decision steps was necessary to arrive at a quantitative set of threshold statements. The project team identified precise station and species sets for the calculations, the parameters to be used, the data aggregation to be used in the calculations, and the test statistic to be used.

Station/Sample set. In its Supplemental Environmental Impact Statement (SEIS) (EPA 1988) approving the offshore outfall location, the U. S. Environmental Protection Agency (EPA) projected impacts to the benthos based on modeled organic carbon deposition to the sediments. For the approved outfall location, EPA determined that under worst case conditions (stratified water column, primary discharge), the benthos would be changed, but not degraded, over an area of approximately 12 km^2. Model projections for a secondary effluent discharge predicted a substantially smaller area (~3 km^2) of changed communities (EPA 1988, Table 5.1.3.a). Based on these projections and a construction schedule suggesting that only partial secondary treatment would be available at outfall startup, MWRA and its project team (Coats 1995, Blake *et al*. 1998, MWRA 1997b) suggested that modest changes within approximately 2 km of the outfall were to be expected and should not trigger threshold exceedences, while appreciable change at the remainder of western Massachusetts Bay stations (the "midfield") might indicate an impact of the outfall beyond our expectations.

Two of three batteries of the secondary treatment plant were online when outfall discharge began in September 2000, and the third was nearly complete. This substantially cleaner effluent is more similar to the secondary effluent projections run in the SEIS than to the primary effluent projections, and suggested that the Nearfield/midfield sample splits may not be appropriate. Projections from the Bays Eutrophication Model suggest that whether effluent is discharged in Boston Harbor or at the offshore outfall site, summertime maxima in the particulate organic carbon (POC) flux to the sediments will occur to the west of the diffuser alignment. Lower maxima are predicted over a smaller area for outfall secondary discharges than for harbor primary discharges (Figure 5-17). Therefore, the maximal POC deposition may not be centered on the outfall.

Based on this reevaluation, the project team decided that the exclusion of samples collected within 2 km of the discharge from threshold testing was not warranted. The western offset to the projected deposition maxima led MWRA to recommend retaining the western Massachusetts Bay Farfield stations in the bin of samples included in the calculation of baseline and in threshold testing. MWRA made this

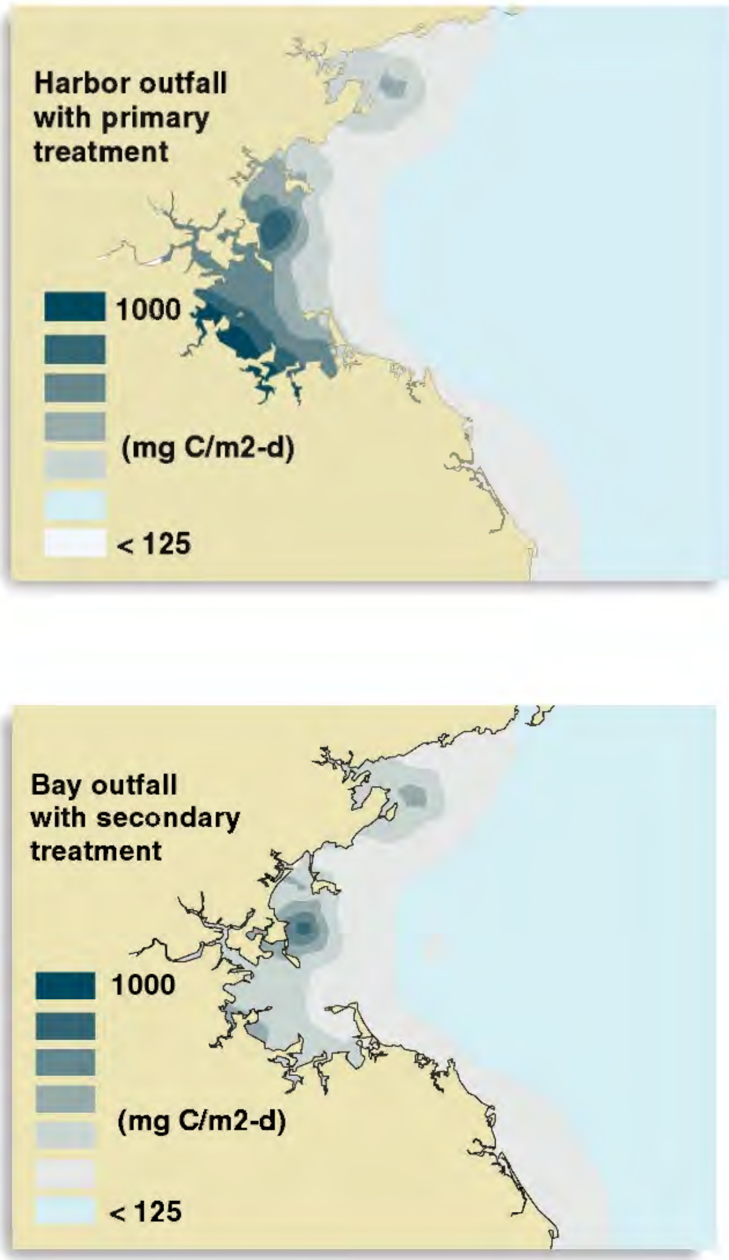

Figure 5-17. Modeled August particular organic carbon deposition for primary effluent discharged into Boston Harbor (a) and secondary effluent discharged at the Bay outfall (b).

recommendation to Outfall Monitoring Science Advisory Panel (OMSAP) in June 2000, which concurred. This recommended station set (Figure 2-1) has been used throughout this report for the evaluation of the monitoring data. All baseline samples collected between August 1992 and August 2000 will be included in the computation of the final threshold values.

Species set. The species set included in the threshold calculations needs to be consistent. As of August 1999, more than 460 species or higher-level taxa (for example, Turbellaria spp.) have been identified during outfall monitoring. Rules for merging or dropping taxa from the analyses have developed along with our understanding of the benthic communities in the region. Every year new information has come to light causing revision to one or more merge/drop rule used in a previous year's report. For example, in 1999 the identification of a species of Glycera not previously found caused the rule merging Glyceridae and *Glycera capitata* to be dropped. Although these rules have been clearly indicated and justified in reports, once thresholds have been established, the rules must be relatively invariant. For the analyses presented here, the merge/drop rules used for the 1999 analyses were invoked. These are indicated in Appendix D-2, and the "good species list" is presented in Appendix D-5. The merge-drop rules will be reviewed when results from outfall monitoring in 2000 are available, and will then be finalized for the purposes of threshold testing.

Parameters. MWRA (1997b) contained only a narrative diversity threshold and identified several potential metrics. Baseline trends through 1998 for four diversity metrics, log-series alpha, Pielou's evenness (*J'*), Shannon's diversity (*H'*), and total number of species per grab sample were subsequently evaluated by Gallagher and Keay (Section 7.5 in Kropp *et al.* 2000), but specific threshold values were not proposed. In the following section we consider all four measures further and propose testable threshold statements.

MWRA (1997b) proposed caution and warning level thresholds based on the relative abundance of opportunistic taxa and set these levels at 25% and 50% of the Nearfield fauna, respectively. Based on discussions with members of the project teams, review of the Boston Harbor and Massachusetts Bay infaunal databases, and other similar databases for adjacent waters (*e.g.*, EMAP), seven taxa were selected as the most likely opportunists to increase in abundance in response to potential organic enrichment created by discharges from the outfall. These taxa are *Ampelisca abdita*, *Ampelisca vadorum*, *Ampelisca macrocephela*, *Capitella capitata* complex, *Polydora cornuta*, *Mulinia lateralis*, and *Streblospio benedicti*. The relative abundance of these taxa in western Massachusetts Bay is evaluated here.

Data aggregation. The benthic monitoring design underwent substantial modification between 1992 and 1994, when the nearfield station set and sampling design stabilized (*e.g.*, Blake *et al*. 1993, Coats 1995). This resulted in changes in the numbers of stations sampled and the number of replicate samples obtained at a station. After determining that the baseline trends in species richness mentioned below are essentially unchanged if all samples collected in a year are averaged in one step or if replicates within a station are averaged first, the project team decided on the former approach. Annual means are then averaged to compute a baseline mean.

Baseline trends. As presented at the September 1999 OMSAP workshop and detailed further in Chapter 7 of Kropp *et al*. (2000), the baseline for the species diversity and evenness indices to be used for threshold testing show substantial natural, and possibly non-random, interannual variability in the Nearfield and Farfield. For example, in 1993 nearfield mean species richness decreased by approximately one quarter, probably in response to the effects of the December 1992 "no-name" storm (Kropp *et al*. 2000).

As seen in Figure 5-10a, 1999 mean Nearfield and Farfield total species and log-series alpha add to the appearance of non-random interannual variability in species richness in the Massachusetts Bay/Cape Cod Bay system. Shannon-Wiener *H'*, sensitive to both richness and evenness in the fauna, does not show a consistent trend in baseline to date, while Pielou's *J'* evenness index shows a minor decrease during the past three years. Infaunal abundance in the Nearfield, which is not a threshold parameter, was higher in 1997–1999 than in previous years (Fig. 5-10a). These scientifically exciting findings, whose possible causes are the focus of active investigation, form a critical backdrop to the computation and interpretation of Contingency Plan Thresholds. If there is a natural 6-8 year cycle in species richness in Bay sediments (several more years would be required to confidently conclude that), outfall startup in late 2000 could coincide with a period of naturally decreasing species richness. This emphasizes the possibility that thresholds could be triggered in the absence of a substantial impact from the outfall discharge.

5.3.1 Diversity Threshold Computation

Recommended diversity thresholds were calculated as the baseline period mean ± (1.96 × standard deviation). This calculation yields the 2.5^{th} and 97.5^{th} percentiles of a normal distribution fitted to the baseline annual means, and will be updated to include the results for 2000 when those are available. The data through 1999 showed that all baseline yearly mean values for each of the four diversity measures were within the suggested threshold boundaries (Figure 5-10a). However, two of the measures, H' and J', have shown consistent decreases since 1996. If this trend, based on the data through 1999, continues in the future there likely would be a crossing of the threshold boundary for one (J') or the other (H'), or both. Log-series alpha and total species per sample have approached a threshold boundary only once, in 1993 (Figure 5-17). Both parameters have shown strikingly similar patterns over the baseline period. The two were very highly correlated during this period ($r = 0.978$, $p < 0.01$, $n = 8$). Both also were correlated with infaunal abundance (species, $r = 0.878$, $p < 0.01$; alpha, $r = 0.765$, $p < 0.05$).

The high correlation between total species and log-series alpha suggests that having both as threshold parameters may be redundant, since both would be likely to trigger simultaneously. As the project team carried out these evaluations we considered whether to drop one or the other from consideration. Log-series alpha is a clearly preferable species richness measure on theoretical grounds (summarized in Kropp *et al.* 2000). However, its true meaning is difficult to convey, especially to the general public. The total number of species per sample, on the other hand, is easy to understand and present to a lay audience. Changes in this metric are also relatively easy to understand. Both, therefore, were retained as threshold parameters.

5.3.2 Opportunists

The total percent composition of the selected opportunist taxa in the Nearfield and Farfield infaunal communities throughout the baseline period has been < 2 % (Table 5-14). Year-to-year variability during the baseline period, as indicated by the range of yearly values, was small. The maximum percent composition of the seven opportunist taxa occurred in 1992 (1.83 %) and the minimum value occurred in 1999 (0.34 %). Significant change in the contribution of these taxa to overall infaunal abundances in western Massachusetts Bay would be easy to detect long before the extant thresholds were approached.

The opportunistic species thresholds were initially set (MWRA 1997b) to represent levels the project team considered would indicate an appreciable change outside our expectations of the impact the outfall discharge might have (caution) and a level of change that would clearly indicate degradation (warning). Based on the 1992–1999 data, these opportunistic taxa are consistently present at such low abundances in the offshore fauna that the project team no longer believes the extant thresholds adequately protective. Consequently, in MWRA's June 2000 presentations, we recommended that the caution and warning levels be changed to 10% and 25% of the Nearfield fauna, respectively.

Table 5-14. Percent opportunist taxa[a] by year for Nearfield and Farfield samples collected 1992–1999. The maximum values for individual samples are provided; the minimum value was 0.00% for every year.

	Nearfield		Farfield	
Year	Percent Opportunist Taxa	Maximum Percent Opportunist Taxa	Percent Opportunist Taxa	Maximum Percent Opportunist Taxa
1992	1.83	25.51	0.14	0.54
1993	0.72	5.20	0.39	1.50
1994	0.91	3.31	1.00	3.28
1995	0.73	6.72	0.16	1.17
1996	0.75	8.86	0.10	0.46
1997	0.43	2.78	1.23	13.99
1998	0.42	2.37	0.11	0.48
1999	0.34	1.47	0.10	0.56

[a]Taxa are *Ampelisca abdita*, *Ampelisca vadorum*, *Ampelisca macrocephela*, *Capitella capitata* complex, *Polydora cornuta*, *Mulinia lateralis*, and *Streblospio benedicti*.

6. 1999 HARD-BOTTOM STUDIES

by Barbara Hecker

6.1 Methods

This section contains the results of an analysis of still photographs and videotapes obtained during the Nearfield hard-bottom survey conducted in June 1999. Twenty-one of the 23 waypoints were surveyed (Table 6-1). The photographic coverage ranged from 18-27 minutes of video footage and 26-33 still photographs (35-mm slides) at each waypoint. A total of 608 still photographs were used for the following data analysis. The two waypoints located within a 1000-m zone of the outfall (T2-5 and Diffuser #44) were not surveyed in 1999, because of work in the outfall tunnel. However, video footage collected during inspection of the diffuser heads in the summer of 1999 was reviewed.

Table 6-1. Photographic coverage at locations surveyed during the 1999 Nearfield hard-bottom survey.

Transect	Waypoint	Location on drumlin	Depth (ft)	Depth (m)	Video (min)	Stills (# frames)
1	1	Top	84	26	24	26
1	2	Top	92	28	22	28
1	3	Top	76	23	21	33
1	4	Top	82	25	21	30
1	5	Flank	97	30	22	28
2	1	Top	88	27	21	30
2	2	Top	86	26	22	28
2	3	Top	85	26	21	29
2	4	Flank	100	30	22	30
4	1	Flank	114	35	24	29
4	2	Flank	110	34	18	28
4	3	Flank	105	32	21	28
4&6	4	Top	75	23	21	26
6	1	Flank	105	32	23	30
6	2	Flank	98	30	22	29
7	1	Top	80	24	23	28
7	2	Top	78	24	22	30
8	1	Top	74	23	24	28
8	2	Top	84	26	25	30
9	1	Top	80	24	21	29
10	1	Top	80	24	27	31

6.1.1 Visual Analysis

Each 35-mm slide was projected and analyzed for sea-floor characteristics (*i.e.,* substratum type and size class, and amount of sediment drape) and biota. Most recognizable taxa were counted and recorded. Several very abundant taxa (for which accurate counts were impossible to obtain) were assessed in terms of percent cover or relative abundance. The abundance of the encrusting coralline alga *Lithothamnion* was assessed as rough estimates of percent cover. Several other taxa, *Asparagopsis hamifera* (a filamentous red alga), 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 of the local flora and fauna (Martinez and Harlow 1994, Weiss 1995). Many of the encrusting species could not be identified to species. Most of these were assigned to descriptive categories (*e.g*., "orange-tan encrusting"); however, each of these descriptive categories possibly included several species. Additionally, some species might be split between two similar descriptive categories (*e.g*., "orange encrusting" and "orange lumpy encrusting"), as a result of differences in viewing angles and lighting. Because of high relief in many of the habitats surveyed, all reported abundances should be considered to be extremely conservative. In many areas, only part of the surfaces of large boulders were visible; thus, actual faunal abundances in these areas were undoubtedly much higher than the counts indicated. A summary of the 1999 slide analysis is included in Appendix E-1.

The videotapes were viewed to provide additional information about uniformity of the habitat at each of the sites. Notes on habitat relief, substrate size classes, and relative amount of sediment drape were recorded. Rare, large, and clearly identifiable organisms were enumerated. All fish, except the cunner *Tautogolabrus adspersus* (which was frequently very abundant), were enumerated. Counts of abundant motile organisms, cryptic organisms, and all encrusting organisms were not attempted because of the large amount of time accurate counts would require and the general lack of resolution of the video footage. A summary of the 1999 video analyses is included in Appendix E-2. Notes on habitat relief, substrate size classes, and relative amount of sediment drape were recorded.

6.1.2 Data analysis

Data for the analyses from all slides taken at each waypoint were pooled. To facilitate comparisons among waypoints, species counts were normalized to mean number of individuals per slide to account for differences in the number of slides collected at each site. Hydroids and small barnacles and/or spirorbids were omitted from the data analysis because they consisted of several species, could not be accurately assessed, and it was impossible to tell if they were alive. General taxonomic categories (*i.e.,* fish, sponge, etc.) were included in estimates of total faunal abundances, but were omitted from community analysis. Only taxa with an abundance of ten or more individuals in the entire data set were retained for community analysis. This process resulted in 35 of the original 76 taxa being retained for community analysis. Juvenile and adult *Asterias vulgaris* (northern sea stars) and white and pink color-morphs of *Halocynthia pyriformis* (sea peach tunicates) were pooled.

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. This coefficient was chosen because it relies on the relative proportion that each species contributes to the faunal composition, and as a result is 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.

6.2 Results and Discussion

Habitat characterizations and dominant taxa that were determined separately from video images and still photographs were 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 videotapes, and the higher occurrence of encrusting taxa afforded by the superior resolution of the still photographs.

6.2.1 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 categories. These areas frequently consisted of numerous boulders interspersed with cobbles, and were generally characterized by moderate to high relief. Several exceptions to this pattern of moderate to high relief on the tops of drumlins were noted. The sea floor at three sites in the middle of the drumlin directly north of the diffuser (T1-1, T1-2, and T2-1) had low to moderate relief, and consisted mainly of a mix of cobbles, small boulders, and gravel. Two of the reference sites southwest of the diffuser (T8-1 and T8-2) also had moderately low relief, consisting of a cobble pavement occasionally interrupted by smaller boulders. In contrast, the sea floor at the other southwestern reference site (T10-1) consisted mostly of large boulders and was characterized by high relief. Sediment drape on the tops of drumlins was variable. Some areas had mostly clean rock surfaces (T1-3, T1-4, T4-4, and T8-1), while other areas had a moderate (T2-1, T2-2, T2-3, T8-2, and T9-1) or heavy (T10-1) sediment drape. The sea floor on the flanks of the drumlins frequently consisted of a low-relief cobble pavement, occasionally interrupted by patches of boulders or gravel. Sediment drape in these regions ranged from a moderately light drape (T6-2) to a moderately heavy mat-like cover (T4-2 and T6-1). Habitat relief and sediment drape frequently were quite variable within many of the sites. Most moderate to high relief areas had small patches of low relief cobbles and gravel, and some of the low relief areas had occasional small patches of boulders. Additionally, in areas of moderate to heavy sediment drape, occasional bare rock surfaces neighbored heavily draped ones. An example of this habitat heterogeneity can be seen in photographs from T9-1 (Appendix F, Plates 1 and 2), where boulders several meters apart show dramatic differences in degree of sediment drape.

6.2.2 Distribution and Abundance of Epibenthic Biota

Seventy-eight taxa were seen during the visual analyses of the 1999 Nearfield hard-bottom survey still photographs and videotapes (Table 6-2). Seventy-six of these taxa were seen on the still photographs. Taxonomic counts or estimates of abundances included 6,707 algae, 12,120 invertebrates, and 843 fish (Table 6-3). The three most abundant taxa observed were three algae, the coralline red alga *Lithothamnion* spp., the dulse alga *Rhodymenia palmata*, and a red filamentous alga *Asparagopsis hamifera*, with abundances of 3,842, 1,581, and 1,179 individuals, respectively. The abundances of *Lithothamnion* and *A. hamifera* were estimated and therefore were very conservative. Another alga, the shotgun kelp *Agarum cribosum*, also was seen during this survey. The most abundant invertebrates observed on the still photographs were juveniles and adults of the northern sea star *Asterias vulgaris* (2,201 and 212 individuals, respectively), the horse mussel *Modiolus modiolus* (1,506 individuals), large barnacles *Balanus* spp. (867 individuals), the brachiopod *Terebratulina septentrionalis* (701 individuals), the sea pork tunicate *Aplidium* spp. (695 individuals), the blood sea star *Henricia sanguinolenta* (559 individuals), and the northern white crust tunicate *Didemnum albidum* (547 individuals). Other common invertebrate inhabitants of the drumlins included the frilled anemone *Metridium senile* (365 individuals), the green sea urchin *Strongylocentrotus droebachiensis* (315 individuals), the slime worm *Myxicola infundibulum* (291 individuals), the red soft coral *Gersemia rubiformis* (189 individuals), the fig sponge *Suberites* spp. (165 individuals), and many sponges and encrusting organisms. The most abundant fish observed in the still photographs was the cunner *Tautogolabrus adspersus* (818 individuals).

Table 6-2. Taxa observed during the 1999 Nearfield hard-bottom survey.

	Taxon	Common Name		Taxon	Common Name
	Algae			nudibranch	
	Lithothamnion spp.	coralline algae	*	bivalve	
	Asparagopsis hamifera	filamentous red algae		*Modiolus modiolus*	horse mussel
	Rhodymenia palmata	dulse		*Placopecten magellanicus*	sea scallop
	Agarum cribosum	shotgun kelp	*	*Arctica islandica*	ocean quahog
	Fauna			Crustaceans	
	Sponges			*Balanus* spp.	acorn barnacle
	sponge			*Cancer* spp.	Jonah or rock crab
*	*Aplysilla sulfurea*	yellow encrust sponge		*Homarus americanus*	American lobster
	Halichondria panicea	crumb-of-bread sponge		Hermit crab	
	Haliclona spp.	finger sponge		Echinoderms	
	Melonanchora elliptica	warty sponge		*Strongylocentrotus droebachiensis*	green sea urchin
	Suberites spp.	fig sponge	*	starfish	
	sponge? (*Polymastia?*)			juvenile *Asterias*	small white starfish
	white divided	sponge on brachiopod		*Asterias vulgaris*	northern sea star
*	orange/tan encrusting			*Crossaster papposus*	spiny sunstar
*	orange encrusting			*Henricia sanguinolenta*	blood sea star
*	gold encrusting		*	*Porania insignis*	badge star
*	tan encrusting		*	*Pteraster militaris*	winged sea star
*	pink fuzzy encrusting			*Psolus fabricii*	scarlet holothurian
*	white translucent			Tunicates	
*	cream encrusting			*Aplidium* spp.	sea pork tunicate
	white chalice			*Boltenia ovifera*	stalked tunicate
*	filamentous white encrusting		*	*Dendrodoa carnea*	drop of blood tunicate
*	General encrusting organism		*	*Didemnum albidum*	northern white crust
	Cnidarians			*Halocynthia pyriformis*	sea peach tunicate
	hydroid		*	clear globular tunicate	
**	*Corymorpha pendula*	stalked hydroid	*	white globular tunicate	
	Obelia geniculata		*	white *Halocynthia pyriformis*	
	anemone			Bryozoans	
	Metridium senile	frilly anemone		bryozoan	
	Urticina felina	northern red anemone	*	red crust bryozoan	
*	*Fagesia lineata*	lined anemone		Miscellaneous	
	Cerianthus borealis	northern ceriantid		*Myxicola infundibulum*	slime worm
	Gersemia rubiformis	red soft coral		spirorbid	
*	*Alcyonium digitatum*	dead man's fingers		*Terebratulina septentrionalis*	northern lamp shell
	Mollusks			Fish	
*	gastropod			fish	
*	*Tonicella marmorea*	mottled red chiton		*Gadus morhua*	cod
*	*Crepidula plana*	flat slipper limpet		*Hemitripterus americanus*	sea raven
*	*Notoacmea testudinalis*	tortoiseshell limpet		*Myoxocephalus* spp.	sculpin
	Buccinum undatum	waved whelk		*Macrozoarces americanus*	ocean pout
**	*Busycotypus canaliculatus*	channeled whelk		*Pseudopleuronectes americanus*	winter flounder
*	*Ilyanassa trivittata*	New England dog whelk		*Tautogolabrus adspersus*	cunner
	Neptunea decemcostata	ten-ridged whelk			

* Only seen on still photographs ** Only seen on video tapes

Table 6-3. List of taxa seen on still photographs taken during the 1999 Nearfield hard-bottom survey, arranged in order of abundance.

Taxon	Count	Taxon	Count
Algae		*Alcyonium digitatum*	9
Lithothamnion spp.	3842[1]	*Melonanchora elliptica*	8
Rhodymenia palmata	1581	white chalice type sponge	7
Asparagopsis hamifera	1179[1]	*Arctica islandica*	7
Agarum cribosum	105	sponge? (*Polymastia*?)	7
Total algae	**6707**	*Boltenia ovifera*	7
		Cancer spp.	6
Invertebrates		starfish	5
juvenile *Asterias*	2201	*Cerianthus borealis*	4
Modiolus modiolus	1506	clear globular tunicate	4
Balanus spp.	867	*Haliclona* spp.	3
Terebratulina septentrionalis	701	nudibranch	3
Aplidium spp.	695	*Homarus americanus*	3
Henricia sanguinolenta	559	Hermit crab	3
orange encrusting sponge	556	gold encrusting sponge	2
Didemnum albidum	549	*Fagesia lineata*	2
general encrusting organism	413	gastropod	2
orange/tan encrusting sponge	396	*Neptunea decemcostata*	2
Metridium senile	365	*Crossaster papposus*	2
white translucent sponge	331	*Pteraster militaris*	2
Strongylocentrotus droebachiensis	315	bryozoan	2
Myxicola infundibulum	291	filamentous white encrusting sponge	1
tan encrusting sponge	271	*Notoacmea testudinalis*	1
cream encrusting sponge	251	*Ilyanassa trivittata*	1
Asterias vulgaris	212	bivalve	1
Gersemia rubiformis	189	*Porania insignis*	1
Suberites spp.	165	white globular tunicate	1
Aplysilla sulfurea	142	sponge	3
white divided sponge on brachiopod	141	hydroids	*
Dendrodoa carnea	138	Spirorbid/barnacle complex	*
pink fuzzy encrusting sponge	99	**Total invertebrates**	**12120**
Psolus fabricii	98		
Tonicella marmorea	83		
Obelia geniculata	67	**Fish**	
Halichondria panicea	65	*Tautogolabrus adspersus*	818
Halocynthia pyriformis	65	*Myoxocephalus* spp.	11
red crust bryozoan	45	*Pseudopleuronectes americanus*	8
white *Halocynthia pyriformis*	33	*Gadus morhua*	3
Crepidula plana	29	*Macrozoarces americanus*	1
Placopecten magellanicus	28	*Hemitripterus americanus*	1
anemone	24	fish	1
Buccinum undatum	12	**Total fish**	**843**
Urticina felina	9		

*Not counted [1] Estimated

Lithothamnion spp. was the most abundant and widely distributed taxa encountered during the survey. This encrusting coralline alga was seen at all waypoints except T4-1. Its mean areal coverage ranged from < 2 % at T10-1 to 83 % at T1-3. *Lithothamnion* was the dominant inhabitant in drumlin top areas that had minimal sediment drape on the rock surfaces. An example of high *Lithothamnion* cover can be seen in photographs from T1-3 and T4-4 (Appendix F, Plates 3 and 4). In contrast, two upright algae, *Asparagopsis hamifera* and dulse frequently dominated areas that had high relief and a moderate to heavy sediment drape (Plates 5, 6, and 7, Appendix F). The reduced percent cover of *Lithothamnion* in areas supporting high abundances of upright algae appeared to be related to fine particles being trapped by the holdfasts of the upright algae and blanketing the rock surfaces. In areas with heterogeneous substrate characteristics, *Asparagopsis* and dulse frequently dominated on the tops of boulders, while *Lithothamnion* dominated on the cobbles and smaller boulders in between.

Several of the commonly seen invertebrates also exhibited wide distribution patterns. The northern sea star *Asterias vulgaris* was found at all of the sites. Juvenile *Asterias* were usually much more abundant than adults and were most abundant on the top of drumlins. In contrast, adult *Asterias* were most abundant on the flank of drumlins. The highest abundances of juvenile *A. vulgaris* were found at T1-3 and T4-4, and the lowest abundances were found at T4-1, T8-1 and T8-2. The horse mussel *Modiolus modiolus* was also very widely distributed, being found at all but one site (T4-1). This mussel was most abundant on the top of drumlins, where large numbers frequently were observed nestled among cobbles and at the bases of boulders (T7-1, T1-3, and T4-4). Because of the mussel's cryptic nature of being nestled in among rocks and frequently being almost totally buried, the observed abundances therefore were very conservative. The number of mussels definitely would be underestimated in areas of high relief, because the bases of larger boulders frequently were not visible in the images. The sea pork tunicate *Aplidium* spp. also was found at all but four of the sites and was most abundant at T6-2, T1-1, T8-1, and T1-5 (Appendix F, Plate 8). The blood sea star *Henricia sanguinolenta* was observed at all of the sites, and was most abundant on boulders in areas of high relief (T10-1 and T4-4).

Several other abundant invertebrates exhibited much more restricted distributions. Three of these species appeared to be primarily restricted to large boulders. The brachiopod *Terebratulina septentrionalis* was found at seven of the sites, but was only seen in high abundances at two of them (T7-2 and T2-4). This species appeared to be restricted to the sides of large boulders where it might be protected from heavy sediment loading (Appendix F, Plate 6). Another species that was markedly more abundant on large boulders was the frilled anemone *Metridium senile*. This anemone was found at 18 sites, but was abundant at only 3 of them (T1-3, T4-4, and T1-1). This anemone usually was seen on the tops of large boulders. The third species that appeared to be restricted to large boulders was the soft coral *Gersemia rubiformis*, which had a very restricted distribution. It was seen only at T10-1, where it dominated the fauna attached to the large boulders characteristic of this site (Appendix F, Plate 9).

The distribution of the green sea urchin *Strongylocentrotus droebachiensis* appeared to be related to food availability rather than specific substrate characteristics. This urchin was widely distributed, but was only found in high abundances in regions that had high cover of *Lithothamnion* (T1-3, T2-1, T1-4, T4-4, T1-2, and T8-2), on which it grazes (Sebens 1986). The red holothurian *Psolus fabricii* also was widely distributed. This holothurian was found at 16 sites, but was abundant at only 4 of them (T1-3, T4-4, T6-2 and T1-5). Reasons for its high abundance at some sites, and not at others, were not readily apparent. The sea scallop *Placopecten magellanicus* was seen at eight of the sites and was only abundant at one of the (T4-1). This scallop was only seen in areas of low relief (Appendix F, Plate 10).

Encrusting invertebrate taxa generally were most abundant in moderate to high relief areas that had light to moderate sediment drape on the rock surfaces. This is not surprising because most juveniles of attached taxa require sediment-free surfaces for settlement. Additionally, clean rock surfaces are indicative of strong currents that could provide adequate food supplies for suspension-feeding organisms.

Boulders and large cobbles also provide a physically more stable environment than smaller cobbles as they are more resistant to mechanical disturbance.

The fish fauna was dominated by the cunner *Tautogolabrus adspersus*, which was observed at all 21 waypoints. This fish was most abundant in high-relief areas, where it tended to congregate among large boulders (T2-2, T1-3, T2-1, T7-2, and T10-1). In areas of heterogeneous relief, *T. adspersus* frequently was seen only in the vicinity of boulders. Three other fish species, sculpin (*Myoxocephalus* spp.), winter flounder (*Pseudopleuronectes americanus*), and cod (*Gadus morhua*) also were seen. The sculpin and flounder were usually seen in areas of low relief, whereas cod were only observed in the vicinity of large boulders.

6.2.3 Community Structure

Classification of the 21 waypoints and 35 taxa (which were retained for analysis) defined three clusters of stations and two outlier areas (Figure 6-1). The first two clusters further divided into slightly more cohesive subgroups. The first cluster consisted of moderate to high-relief drumlin top areas that had relatively heavy sediment drape. These included the three northern reference sites (T7 and T9) and three areas on the drumlin north of the outfall (T2-2, T2-3, and T1-1). The second cluster consisted of drumlin top and flank areas that had variable relief and light to moderate sediment drape. These included the two southernmost reference sites (T8), and sites on the drumlins north and south of the outfall. The third cluster consisted of three drumlin flank areas that had moderately low relief and heavy sediment drape. These flank sites were located near the outfall (T2-4, T4-2, and T6-1). The two outlier areas were opposite extremes in terms of habitat characteristics. T10-1, one of the southern reference sites, had very high relief and heavy sediment drape, while T4-1, southeast of the outfall, had very low relief and heavy sediment drape. The clustering structure appeared to be determined by a combination of drumlin topography, habitat relief, sediment drape, and geographic location. Neighboring waypoints with similar habitat characteristics tended to cluster together. Habitat characteristics and range of abundances of dominant taxa for each of the cluster groups are presented in Table 6-4.

The encrusting coralline alga *Lithothamnion* was a common inhabitant of most of the areas comprising the first two cluster groups. Differences among the areas in these two cluster groups were mainly related to the relative proportion of encrusting and upright algae at each of the sites. The areas in Cluster 1 were dominated by upright algae, *Asparagopsis hamifera* and *Rhodymenia palmata*, whereas the areas in Cluster 2 were dominated by *Lithothamnion*. This is not surprising because the sea floor of all areas in Cluster 1 had moderate to high relief, and upright algae appeared to be more common on the tops of boulders. Cluster 1 divided into two subgroups that reflected slight shifts in the composition of the communities inhabiting these areas, as well as differences in biotic abundances. The areas in Subgroup 1a (the three northern reference sites) supported more algae (particularly *Asparagopsis hamifera*) and *Modiolus modiolus*, and the areas in Subgroup 1b (three sites on the drumlin north of the outfall) supported more dulse (*Rhodymenia palmata*) and *Aplidium*. The northern reference sites (Subgroup 1a) supported more algae and invertebrates, than the sites on the drumlin north of the outfall (Subgroup 1b). Fish were relatively abundant in all of the areas in Cluster 1. Representative photographs of the northern reference sites can be seen in Appendix F, Plates 2, 5, 6, and 7.

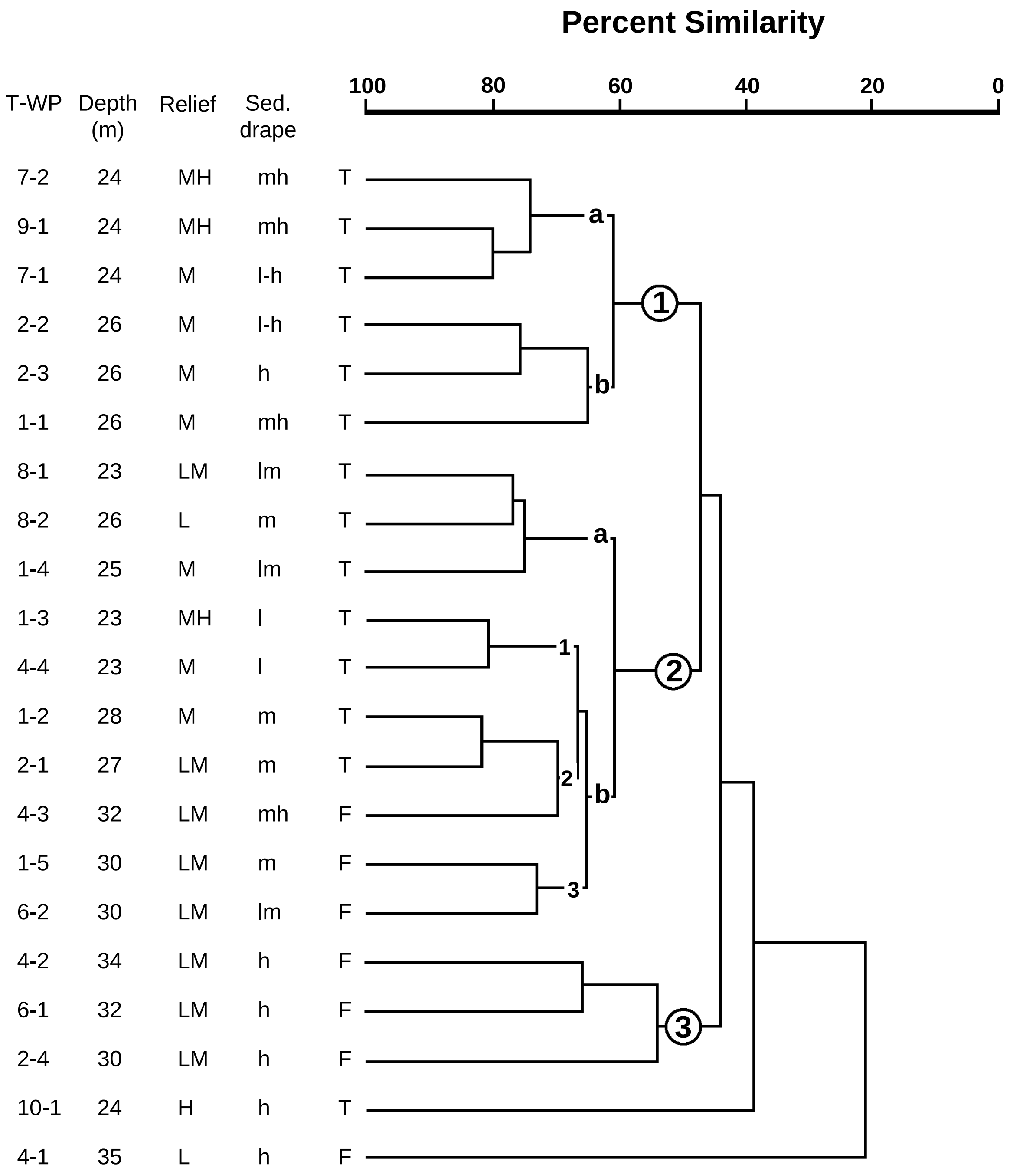

Figure 6-1. Cluster analysis of data collected from still photographs taken during the 1999 Nearfield hard-bottom survey.

Table 6-4. Habitat characteristics and range of abundance (number per picture) of selected taxa in the clusters defined by classification analysis. Numbers in bold highlight major differences among clusters and subgroups.

Cluster	1		2				3		
	a	b	a	b_1	b_2	b_3		10-1	4-1
Depth (meters)	24	26	23-26	23	27-32	30	30-34	24	35
Habitat relief[a]	M-MH	M	L-M	M-MH	LM-M	LM	LM	H	L
Sediment drape[b]	l-mh	l-h	lm-m	l	m-mh	lm-m	h	h	h
Location[c]	T	T	T	T	T&F	F	F	T	F
Asparagopsis hamifera	**8.0-12.1**	0.6-4.0	-	0.1-0.5	<0.1	<0.1	-	0.5	-
Rhodymenia palmata	**8.0-8.8**	**5.7-9.0**	<0.1	0.0-0.9	0.0-2.0	<0.1	0.0-0.7	4.8	-
Lithothamnion spp.	5.4-8.2	2.4-5.2	**9.7-13.8**	**14.5-15.7**	**4.6-6.7**	**4.9-6.8**	0.9-2.0	0.4	-
Lithothamnion spp. (percent cover)	28-47	13-26	51-70	72-83	25-36	29-37	2-8	2	-
Asterias vulgaris	3.2-5.2	3.9-5.8	1.2-2.2	**7.0-8.9**	2.2-4.3	3.3-6.2	2.9-4.8	4.0	1.4
Modiolus modiolus	**3.0-8.4**	1.3-2.4	1.4-3.7	**5.9-6.5**	0.4-1.8	1.6-2.3	0.3-1.3	1.0	-
Aplidium spp.	<0.1	**1.2-5.0**	0.0-3.0	0.0-0.6	0.2-1.1	**2.6-6.3**	0.5-1.2	0.2	-
Strongylocentrotus droebachiensis	0.1-0.3	0.2-0.7	0.8-1.0	**1.2-1.3**	0.6-1.2	0.2-0.4	<0.1	0.3	-
Placopecten magellanicus	-	-	-	-	-	-	<0.1	-	**0.7**
Metridium senile	0.1-1.1	0.1-2.2	-	**2.3-3.9**	0.0-0.4	-	0.0-0.2	0.3	-
Gersemia rubiformis	-	-	-	-	-	-	-	**6.1**	-
Terebratulina septentrionalis	0.3-12.1	0.0-0.3	-	-	-	0.0-0.4	0.0-7.5	-	-
Tautogolabrus adspersus	**1.4-2.3**	**1.2-3.5**	0.1-1.5	**1.0-2.8**	0.4-2.4	0.3-0.7	0.3-1.1	**2.0**	0.1
Algae	**22.2-29.3**	11.9-15.7	9.7-14.3	**15.8-15.9**	4.6-8.8	5.1-6.8	0.9-2.0	6.0	-
Invertebrates	**18.8-36.0**	17.4-21.4	7.8-16.2	**24.5-32.3**	11.6-17.1	17.0-29.1	12.9-26.8	**33.2**	3.0
Fish	1.4-2.3	1.3-3.5	0.1-1.5	1.0-2.9	0.4-2.5	0.3-0.7	0.4-1.2	**2.0**	0.1
Total	**43.3-67.4**	32.9-36.5	17.6-31.6	**43.1-49.2**	16.6-28.0	24.1-34.9	14.3-29.8	**41.2**	3.1

Key

[a]Habitat relief: L = low, LM = moderately low, M = moderate, MH = moderately high, H = high

[b]Sediment drape: l = light, lm = moderately light, m = moderate, mh = moderately heavy, h = heavy

[c]Location: T = drumlin top, F = drumlin flank

The ten areas in Cluster 2 were characterized by either less, or more variable, habitat relief and much less sediment drape than the areas in Cluster 1. The benthic communities at all of the areas in Cluster 2 were dominated by *Lithothamnion* and included few other algae. The areas in this cluster further divided into four subgroups. Subgroup 2a consisted of the two southernmost reference sites (T8) and one site on the drumlin north of the outfall (T1-4). The benthic communities in these three areas were dominated by *Lithothamnion*. The composition of the communities inhabiting the remaining areas in this cluster (Subgroup 2b) varied considerably. The two drumlin-top areas in Subgroup $2b_1$ were located on either side of the outfall (T1-3 and T4-4). These sites supported more *Lithothamnion*, *Asterias vulgaris*, *Modiolus modiolus*, *Metridium senile*, and *Tautogolabrus adspersus* than the other sites in this subgroup. The drumlin top and flank sites in the remaining two subgroups ($2b_2$ and $2b_3$) supported fewer *Lithothamnion* than the other areas in this cluster, and the two drumlin flank sites in Subgroup $2b_3$ supported more *Aplidium* spp. The areas in Subgroup $2b_1$ supported the most algae, invertebrates and fish in this cluster. Representative photographs of three of the sites in this cluster can be seen in Appendix F, Plates 3, 4, and 8.

Cluster 3 consisted of three drumlin flank areas near the outfall that had moderately low relief and heavy sediment drape. All of these areas supported a moderate abundance of invertebrates, and few algae and fish. The benthic communities at these three sites were not dominated by any one taxon. However, many northern lamp shells *Terebratulina septentrionalis* were seen attached to occasional boulders at T2-4.

The two outlier areas supported markedly different communities. The large boulders at the T10-1 southern reference site supported numerous invertebrates and fish, some dulse, and few other algae. The most abundant invertebrates seen at this site were the soft coral *Gersemia rubiformis* (which was not seen anywhere else), *Asterias vulgaris*, and barnacles *Balanus* spp. The high relief of this area also provided suitable habitat for numerous cunner. In contrast, the low-relief cobble and gravel pavement at the T4-1 flank site was quite depauperate. Occasional adult *Asterias vulgaris* and the sea scallop *Placopecten magellanicus* were the main inhabitants of this area. Representative photographs of these two outlier sites can be seen in Appendix F, Plates 9 and 10.

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

Baseline studies of the Nearfield hard-bottom communities in the vicinity of the outfall have been conducted for the last six years. These studies have provided a database that has allowed characterization of the habitats and benthic communities on the hard-bottom drumlins in the vicinity of the outfall. During this time period the sampling design and approach have evolved to maximize the probability of detecting potential impacts of future outfall operations. The original survey conducted in 1994 consisted of videotapes taken along a series of transects of hard-bottom areas adjacent to the outfall (Coats *et al.* 1995). Starting in 1995 the sampling protocol was changed to surveying discrete stations (waypoints) on the drumlins immediately north and south of the outfall, and at several reference sites on drumlins further away (Figure 6-2). The 1995 sampling plan consisted of 19 waypoints, 17 near the outfall (on Transects 1, 2, 4 and 6) and 1 at each of 2 reference sites (Transects 7 and 8). In 1996, one additional waypoint was added at each of the reference sites and T6-3 was dropped because it was found to be exceptionally depauperate. Two new reference sites (Transects 9 and 10), and the head of Diffuser #44, were added during the 1997 survey. Diffuser #44 was added to the survey protocol because it is not scheduled to go online. Because it is less than 40m from adjacent diffusers that are to be activated, and it like other diffusers, has been densely colonized, it represents a worst case scenario of potential impact. This sampling protocol was repeated in 1998. The two waypoints on or near the diffuser (T2-5 and Diffuser #44) were omitted from the 1999 survey, because of concurrent work being conducted in the outfall tunnel. However, videotapes were collected at both of these sites during diffuser inspections conducted late in the summer of 1999.

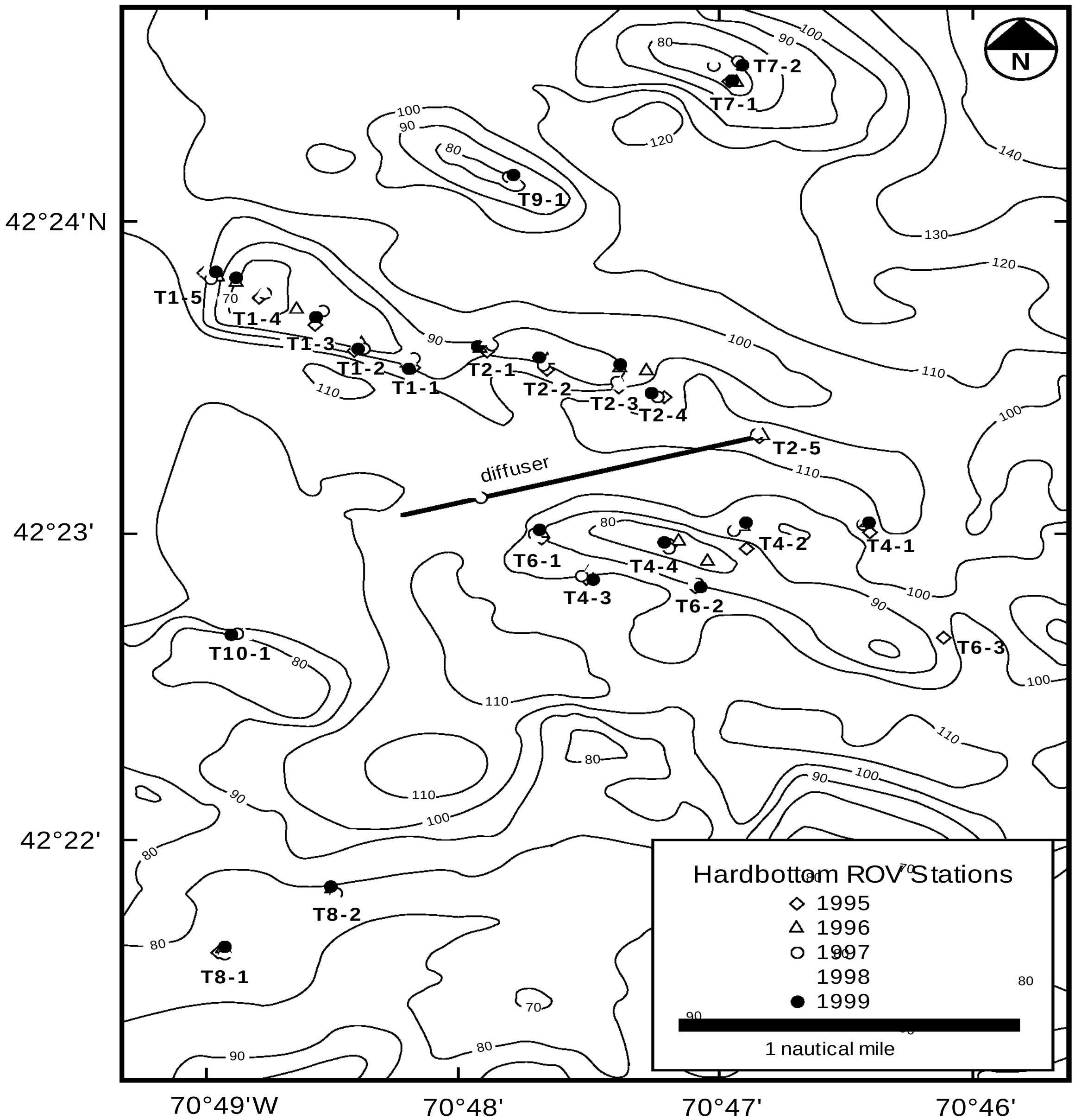

Figure 6-2. Nearfield hard-bottom stations surveyed from 1995 to 1999.

A review of the video footage collected during inspection of the diffusers revealed that the fauna colonizing the diffuser heads was similar to that observed in previous years. The frilly anemone *Metridium senile* was by far the dominant inhabitant on Diffusers #1 and #2. Additionally, numerous northern sea stars *Asterias vulgaris* and hydroids, as well as several sea peach tunicates *Halocynthia pyriformis* were also observed. The fauna colonizing Diffuser #44 differed slightly from that colonizing other diffusers. In previous years, the fauna on Diffuser #44 consisted of fewer *M. senile* and more *H. pyriformis*. In 1999 more *M. senile* were observed, but they are still not present in the high densities seen on the other diffusers. In addition, Diffuser #44 still supported numerous *H. pyriformis*, *A. vulgaris*, and hydroids. A large finger sponge *Haliclona oculata* which had been seen on previous surveys was also still present during the 1999 inspection.

In addition to a sampling plan that evolved to address specific issues, the emphasis on data products also has evolved during this time period. The 1994 and 1995 data sets relied mainly on an analysis of video footage. During the 1995 survey a few still photographs also were taken at each of the sites. Analysis of these photographs showed that the resolution afforded by the still photographs was far superior to that of the video images, and hence subsequent emphasis has been shifted to analysis of still photographs. The video images cover a much broader area than the still photographs, and are primarily used to assess habitat relief and heterogeneity and the occurrence of rarer fauna. The still photographs are used to provide detailed data on habitat characteristics (substrate size classes and amount of sediment drape), estimated percent cover of encrusting algae, estimated relative abundances of upright algae, and faunal composition of the benthic communities.

Analysis of the last five years of video and 35-mm still photographs showed a temporally stable pattern in the structure of benthic communities inhabiting the hard-bottom areas in the vicinity of the outfall. The hard-bottom habitats are spatially quite variable, but have shown several consistent trends during the study period. Figure 6-3 shows the habitat characteristics observed during the 1995 to 1999 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 on the tops of drumlins varied from moderately high to high in areas dominated by boulders (T1-2, T1-3, T2-2, T2-3, T4-4, T7, T9, and T10) to moderate to low in areas that consisted of a mix of cobbles and boulders (T1-4 and T8). Sediment drape on the tops of drumlins ranged from light (T1-3, T1-4, T4-4, and T8) to moderate (T2-3 and T7) at most locations, to moderately heavy or heavy at others (T2-2, and T9, T10). The sea floor on the flanks of drumlins was quite variable, but usually consisted of a cobble pavement interspersed with patches of sand, gravel and occasional boulders. Habitat relief on the flanks ranged from low to moderate, depending on how many boulders were present. Sediment drape in the flank areas usually ranged from moderate to heavy. The tops of the drumlins frequently were relatively homogeneous (T1-3, T1-4, T4-4, T8, T9, and T10), so lateral shifts in position frequently did not result in different habitat characteristics. In contrast, small lateral shifts in position near the edges of the drumlin tops frequently resulted in substantially different habitat characteristics (*i.e.*, T1-1, T1-2, T2-2, and T2-3).

The benthic communities inhabiting the hard-bottom areas showed a temporally consistent trend during the 1995 to 1999 time period. Algae usually dominated on the tops of drumlins, while invertebrates (mostly encrusting or attached forms) were increasingly dominant on the flanks. The encrusting coralline alga *Lithothamnion* spp. was the most abundant and widely distributed alga encountered during this study. The distribution and areal coverage of *Lithothamnion* were temporally quite stable during the five years of this study. Figure 6-4 shows the percent cover of *Lithothamnion* estimated from the 35-mm images taken during the 1995 to 1999 surveys. This coralline alga was most abundant on the top of drumlins (40 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). Table 6-5 shows the percent cover of *Lithothamnion* estimated for the four years (1996–1999) in which comparable data was collected. The

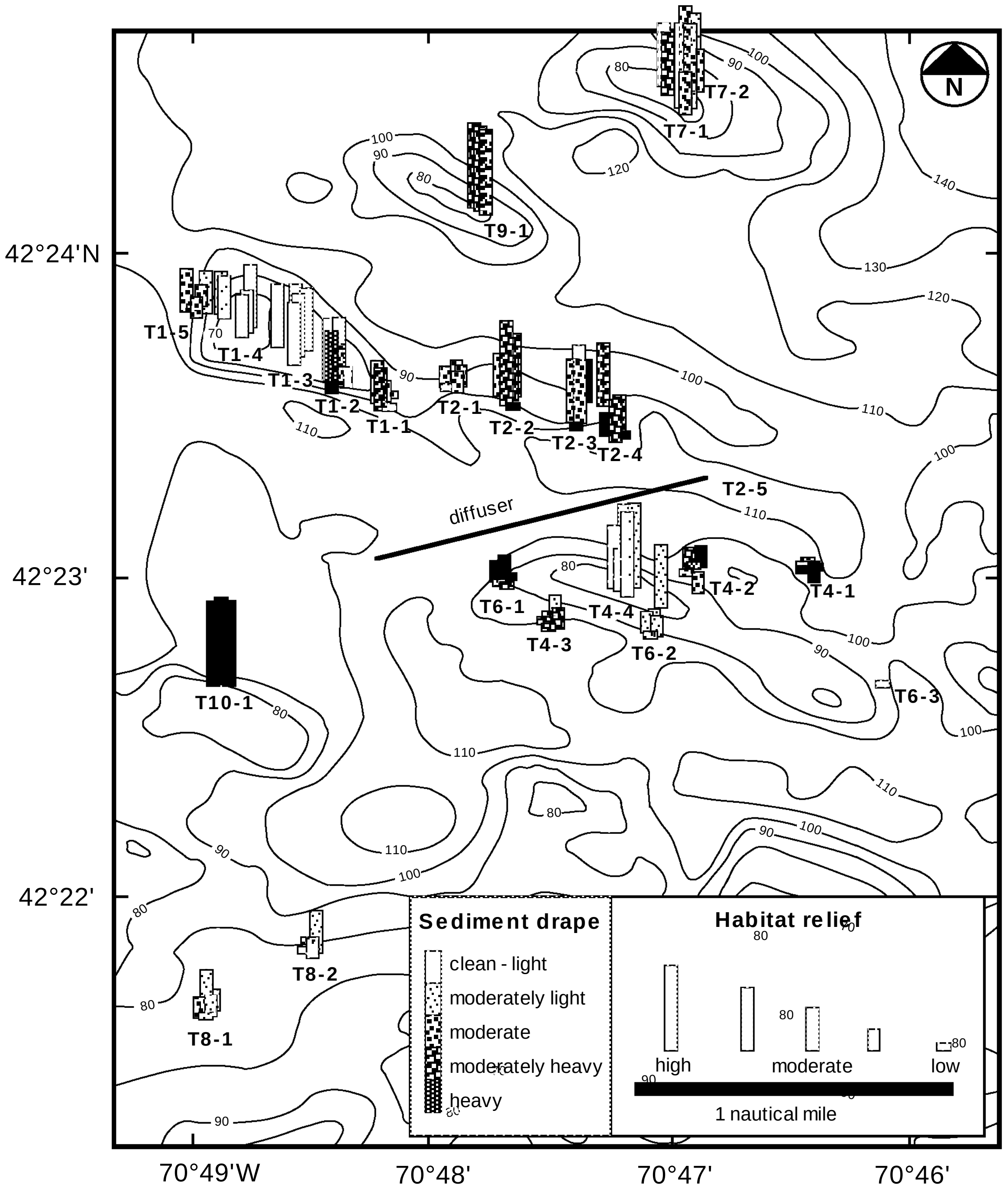

Figure 6-3. Sea floor characteristics, habitat relief, and sediment drape determined from the 1995 to 1999 Nearfield hard-bottom surveys.

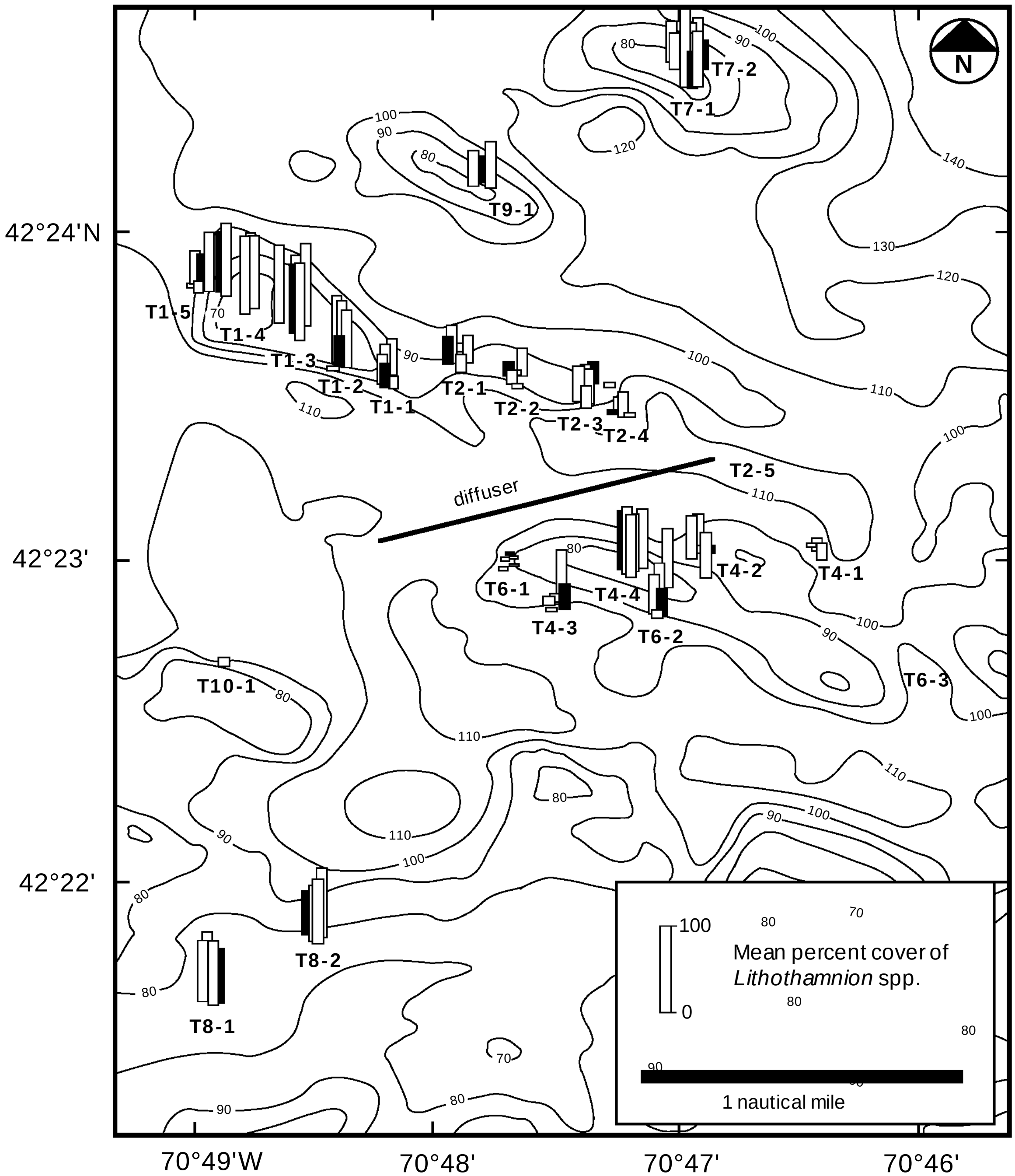

Figure 6-4. Mean percent cover of the encrusting coralline alga *Lithothamnion* spp. Determined from the 1995 to 1999 Nearfield hard-bottom surveys. Black bars are values from the 1999 survey.

Table 6-5. Estimated percent cover of *Lithothamnion* spp. from 1996 to 1999. Large differences are highlighted in bold. Asterisks mark differences that appear to be related to shifts in position of the areas surveyed.

Transect	Waypoint	1996	1997	1998	1999
1	1	35	42	37	**26***
	2	71	72	79	**36***
	3	90	96	80	83
	4	87	83	82	70
	5	**68***	**12**	39	37
2	1	45	33	**9***	35
	2	5	13	**33***	13
	3	27	41	39	**21***
	4	**7***	27	18	**4**
	5	<1	<1	<1	
4	1		**16***	<1	0
	2	41	53	**9***	**8***
	3	12	12	**56***	25
	4	72	67	77	72
6	1	2	4	5	2
	2	**69***	55	45	**29***
7	1	**65**	43	49	47
	2	53	54	45	**36***
8	1		73	74	69
	2	82	75	65	**51***
9	1		40	54	**28**
10	1		**12**	<1	2
Diff	44		<1	<1	

percent cover of *Lithothamnion* was most variable near the edges of the tops or on the flanks of drumlins, where small lateral shifts in location frequently resulted in a very different habitat.

Figure 6-5 shows the relationship between percent cover of *Lithothamnion* and depth at the sites covered during the surveys. Even though *Lithothamnion* cover was highly variable within many of the depth strata surveyed (usually ranging from 5 to 90 %), there was a general trend of lower cover with increasing depth. It is unlikely that this observed decrease in *Lithothamnion* cover with distance from the top of drumlins is related to the attenuation of light with depth. Depth *per se* does not appear to be a limiting factor for *Lithothamnion* within the depths covered during this survey. Vadas and Steneck (1988) reported coralline algal cover of up to 80 % at depths >50 m on Ammen Rock Pinnacle in the Gulf of Maine and Sears and Cooper (1978) reported finding coralline algae at depths of 47 m on offshore ledges in the Gulf of Maine. Additionally, high *Lithothamnion* cover has been observed at a depth of 34 m at a hard-bottom site in Massachusetts Bay near Scituate (B. Hecker, personal observation). Sediment drape on the rock surfaces also tended to increase with depth. A plot of mean percent cover of *Lithothamnion* versus sediment drape shows that its abundance appears to be mainly related to sediment drape; percent

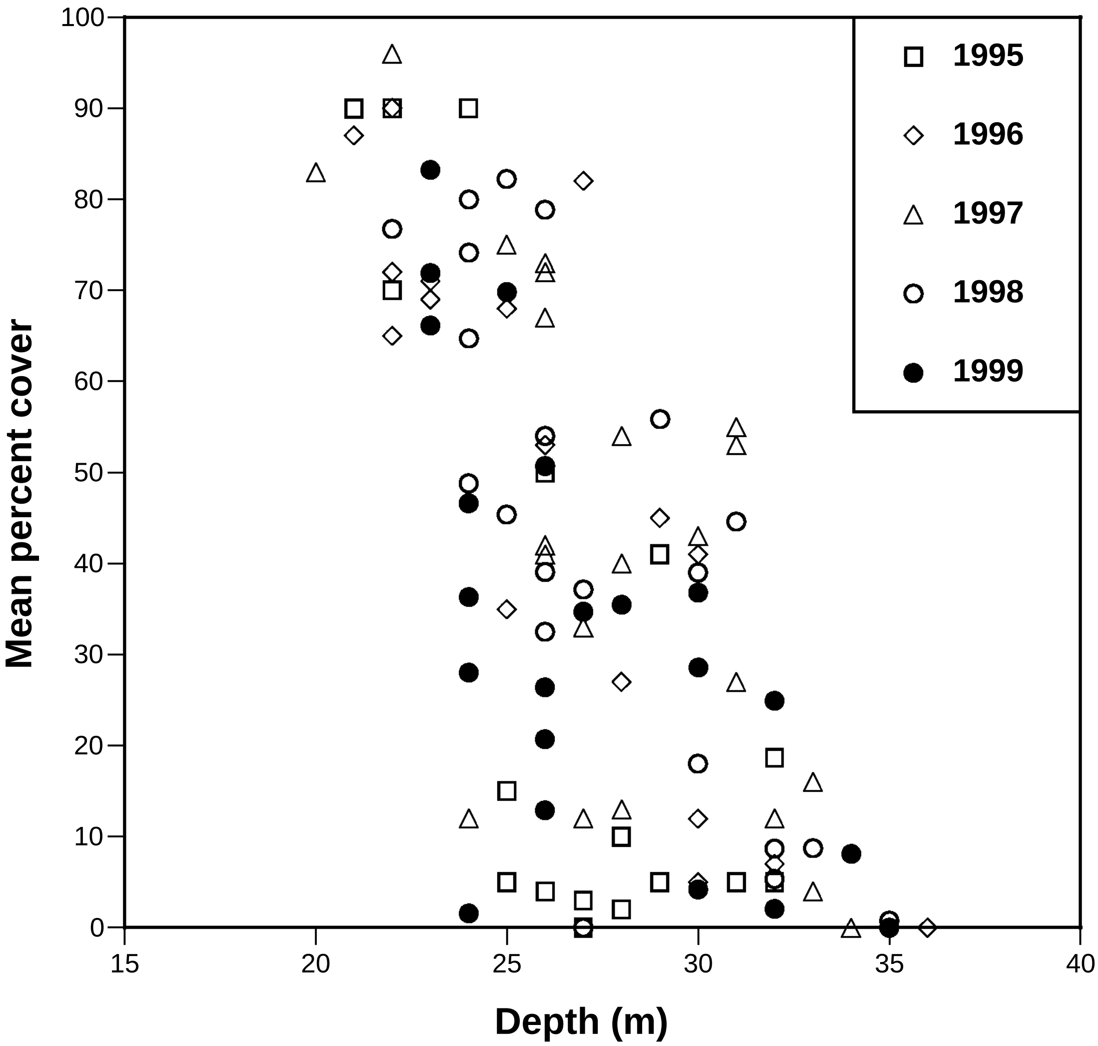

Figure 6-5. Mean percent cover of *Lithothamnion* spp. versus depth from the 35-mm images taken at each waypoint during the 1995 to 1999 Nearfield hard-bottom surveys.

cover was highest in areas that had little drape and lowest in areas with moderate to heavy drape (Figure 6-6). This is not surprising, because the encrusting growth form of *Lithothamnion* would make 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 to be mainly controlled by habitat relief. These algae were patchily distributed and only abundant on the top of boulders in areas of moderate to high relief. Figure 6-7 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 numerous holdfasts of the algae appeared to actively trap sediment, thereby possibly excluding the encrusting *Lithothamnion*. Additionally, invertebrates and fish (mainly the cunner, *Tautogolabrus adspersus*) generally were more abundant in areas of moderate to high relief and less abundant in areas of low relief.

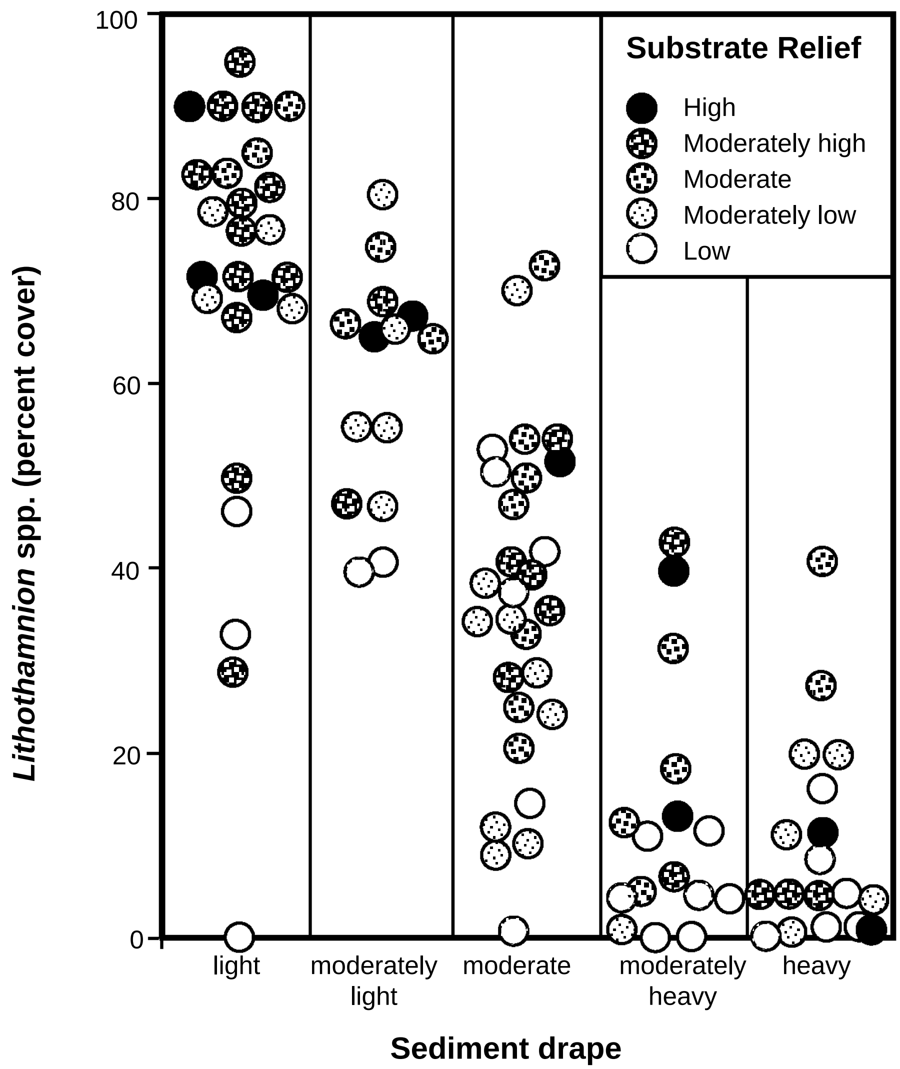

Figure 6-6. Mean percent cover of *Lithothamnion* spp. in relation to sediment drape and habitat relief. Based on yearly averages of 35-mm images taken at each waypoint during the 1995 to 1999 Nearfield hard-bottom surveys.

The pattern of benthic community structure in the hard-bottom areas was remarkably consistent during the 1996–1999 time period. Figure 6-8 shows the distribution of benthic communities defined by hierarchical classification analysis. The dendrograms were remarkably similar among the four years (see Blake *et al.* 1997, Blake *et al.* 1998, Kropp *et al.* 2000 for the 1996, 1997, and 1998 dendrograms). The communities at many of the sites remained the same during the four-year period. Good examples of this can be seen at the northern reference sites (T7 and T9), the southernmost reference sites (T8), and the top of the drumlin north of the outfall (T1-3, T1-4, T1-1, T2-2, and T2-3). Of 15 instances of waypoints differing in their cluster designation among the years, 11 appeared to reflect slight lateral shifts in relation to drumlin topography (Table 6-6). This was quite noticeable at T1-5 where in 1996 and 1999 the community was dominated by *Lithothamnion* (Cluster 1) and in 1997 and 1998 it was not (Cluster 3). A close examination of the map reveals that the areas surveyed at this site in 1996 and 1999 were nearer to the top of the drumlin. Another example of this can be seen at T2-1 where the community surveyed in 1998 (Cluster 3) differed from that found in the other three years (Cluster 2). The area surveyed at this site in 1998 was located slightly down the flank of the drumlin and was not dominated by algae. The

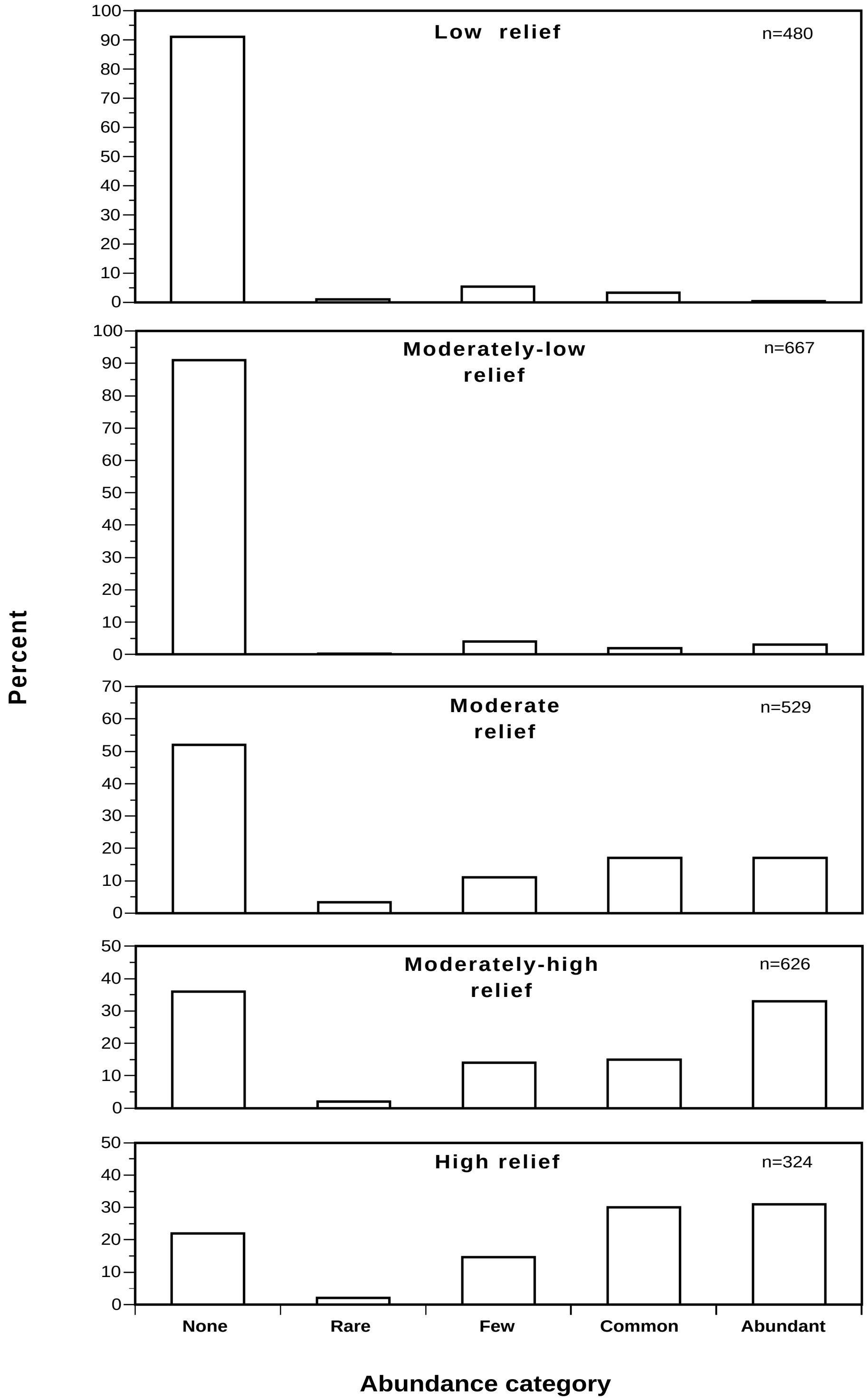

Figure 6-7. Relative abundance of the filamentous red alga *Asparagopsis hamifera* in relation to habitat relief. Based on individual 35-mm images taken during the 1995 to 1999 Nearfield hard-bottom surveys. *n* = number of slides taken within each habitat relief category.

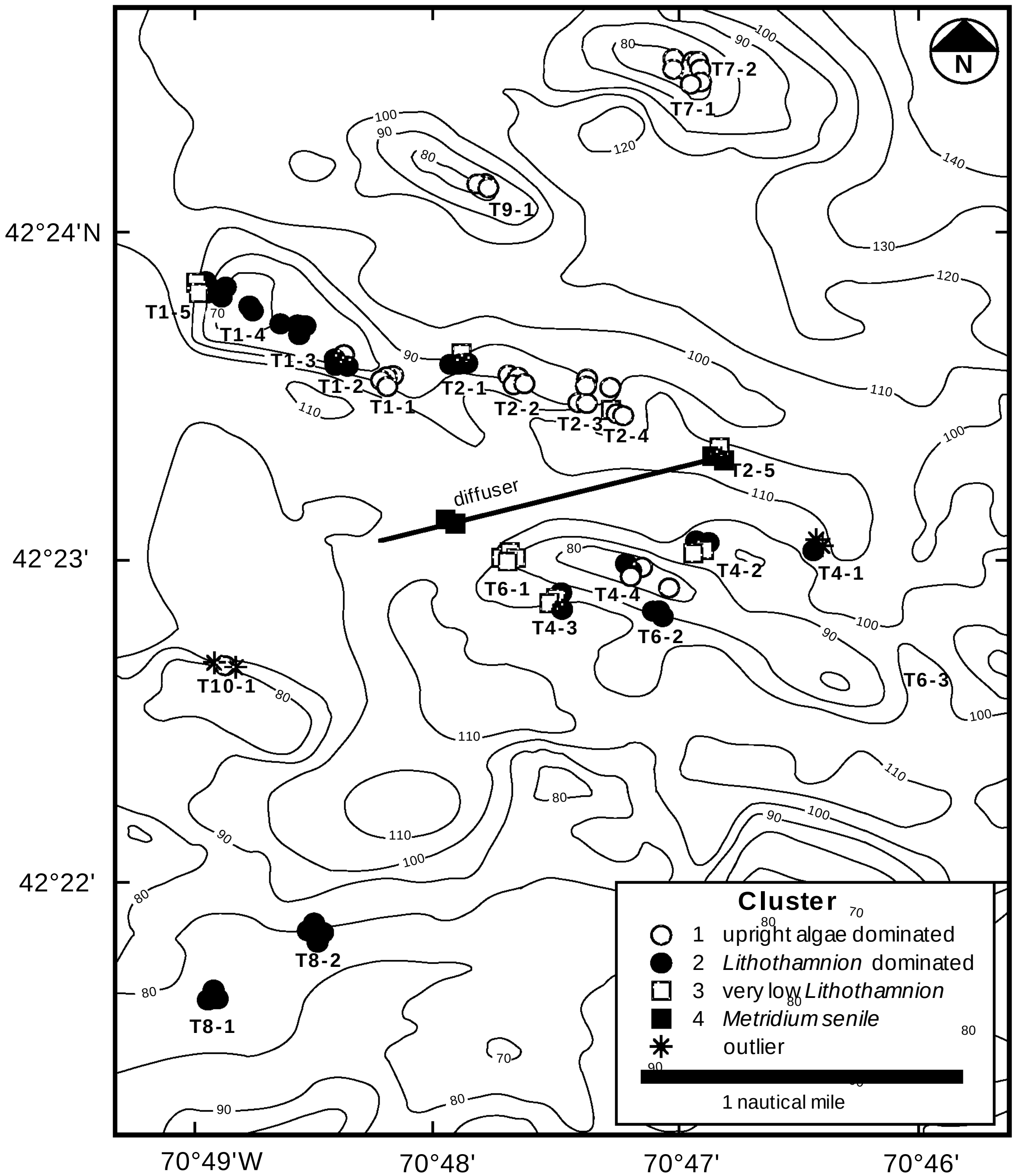

Figure 6-8. Map of benthic communities defined from classification of the 35-mm images taken during the 1995 to 1999 Nearfield hard-bottom surveys.

Table 6-6. Cluster group designations defined by classification analysis of the waypoints surveyed from 1996 to 1999. Differences are highlighted in bold. Asterisks show differences explained by shifts in location.

Transect	Waypoint	1996	1997	1998	1999
1	1	1	1	1	1
	2	1*	2	2	2
	3	2	2	2	2
	4	2	2	2	2
	5	2*	3	3	2*
2	1	2	2	3*	2
	2	1	1	1	1
	3	1	1	1	1
	4	1	1	1	3
	5	4	4	3*	
4	1		2*	outlier	outlier
	2	2	2	3*	3*
	3	3	3	2	2
	4	1	1	2*	2*
6	1	3	3	3	3
	2	1*	2	2	2
7	1	1	1	1	1
	2	1	1	1	1
8	1		2	2	2
	2	2	2	2	2
9	1		1	1	1
10	1		1	outlier	outlier
Diff	44		4	4	

other four instances of differences in cluster group designation among years appeared to be related to the generally patchy nature of the hard-bottom habitats.

Communities dominated by upright algae were found on the tops of drumlins on either side of the diffuser (T1-1, T2-2, T2-3, T2-4, and T4-4) and at all three of the northern reference sites (T7-1, T7-2, and T9-1). In contrast, *Lithothamnion* dominated the benthic communities on top of a drumlin located northwest of the diffuser (T1-2, T1-3, and T1-4), at two of the southwestern reference sites (T8-1 and T8-2), and at some of the drumlin flank sites. Two of the flank sites located just south of the diffuser (T4-3 and T6-1) had exceptionally low abundances of *Lithothamnion* and were relatively depauperate when compared to the other sites. The diffuser heads that were surveyed were colonized by *Metridium senile* and *Asterias vulgaris* (T2-5 and Diffuser #44). The outlier areas represented the most extreme habitats that were surveyed, flat sand and cobble pavement at T4-1 and very large boulders with heavy sediment drape at T10-1. These patterns also generally agreed with the results obtained in 1995. No attempt at a direct community analysis comparison with the 1995 data was made, because of the limited number and non-random collection of the 35-mm images taken during that year.

Our results are generally similar to those reported by Coats *et al.* (1995) from the 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 near continuous video coverage along the transects, while the present design focuses on topographically selected points (waypoints) along the transects that include representative drumlin top and flank locations. The 1995–1999 surveys respectively identified 76, 72, 100, 84, and 78 taxa, compared to 37 identified from the 1994 survey. Rather than indicating changes in the benthic communities, the greater number of taxa identified from the post-1994 surveys appear to be related to the enhanced visual resolution of the still photographs. Many of the additional taxa identified in the last five surveys are encrusting forms that would be difficult to resolve on video images. Additionally, the ROV has been kept much closer to the sea floor in the post-1994 surveys (right on the bottom as opposed to an altitude of 1 to 3 m). Differences in taxonomic designations also exist between the 1994 and post-1994 surveys. Coats *et al.* 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 outfall identified 23 taxa (Etter *et al.* 1987). The lower number of species seen in that survey was probably related to habitat differences between the areas surveyed. The 1987 survey mostly covered depositional sediment areas, whereas the present study concentrated 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, personal observation). This may be related to the generally more limited availability of hard substrates in subtidal environments. Even in much deeper water, occasional hard surfaces (*i.e*., boulders, shipwrecks, airplane wrecks, and nuclear-waste drums) are almost always heavily colonized by a variety of attached taxa (B. Hecker, personal observation).

General faunal distribution patterns were similar among the 1994–1999 surveys. All surveys found algae to be most abundant on the tops of drumlins. Coats *et al.* reported that *Rhodymenia palmata*, *Rhodymenia* sp. A (a pinnate red alga), and *Agarum cribosum* were found together on hard substrata at shallower depths. In the later surveys (1995–1999), *Lithothamnion* was found to dominate on cobbles and smaller boulders, while *Asparagopsis hamifera* was found to dominate on the tops of larger boulders. While Coats *et al.* estimated percent cover of *Lithothamnion* they did not discuss its distribution. All three sets of surveys (1987, 1994, and 1995–1999) also found that the anemone *Metridium senile* and the cunner *Tautogolabrus adspersus* were most abundant near large boulders. Coats *et al.* reported that the distribution of the green sea urchin *Strongylocentrotus droebachiensis* was depth related, with the urchins being most abundant at shallower depths. A similar pattern was found in the 1995–1999 surveys, with the highest abundance of urchins being found on the top of drumlins, but the distribution of the urchin was attributed to availability of their primary food source, the coralline alga *Lithothamnion* (Sebens 1986). Because of the different overall focus of the Coats *et al.* (1995) report, more detailed comparisons of community structure and factors that control it cannot be made.

The baseline surveys show that the hard-bottom benthic communities near the outfall were relatively stable over the 1995 to 1999 time period, and apparently back to 1994 as well. The remarkable similarities among the 1996 to 1999 surveys indicate that substantial departures from baseline conditions should be detectable. The expanded emphasis on 35-mm images has enabled better resolution of factors controlling the distribution of several of the dominant taxa. Larger boulders appeared to be the predominant substrate for upright algae and a number of attached invertebrate taxa. This is not surprising since larger rocks would be less susceptible to mechanical disturbance. Boulders were frequently the dominant size class observed on the top of drumlins. In contrast, the distribution of the encrusting coralline alga *Lithothamnion* appeared to be primarily related to degree of sediment drape. Not surprisingly, sediment loading also appeared to restrict many other encrusting and sessile taxa, which frequently were restricted to the sides and underhangs of boulders. Sediment drape was frequently heaviest 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 substantial small-scale within-site heterogeneity in the distribution of many of the taxa. *Lithothamnion* appears to hold the greatest promise as an indicator species for detecting habitat degradation as a result of the outfall coming on line. This species was the most predictable taxon encountered in terms of abundance, distributional pattern, and habitat requirements. It was the least patchily distributed taxon, and appeared to dominate in all areas that were shallower than 33 m and had little sediment drape. Additionally, it was common in areas of high and low relief. By focusing on *Lithothamnion* as an indicator, it is likely that major changes in the benthic communities inhabiting the hard-bottom areas near the outfall could be detected.

Potential outfall related impacts might include changes in the amount of particulate material reaching the sea floor. A marked decrease in the percent coverage of *Lithothamnion* likely would result if materials discharged from the outfall were to accumulate in the vicinity of the drumlins. Changes might be expected in the depth distribution of *Lithothamnion* if discharges from the outfall alter properties of the water column that affect light penetration. 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.

7. CONCLUSIONS

7.1 Sediment Profile Image (SPI) Analyses

- Quick Look analysis of sediment redox potential discontinuity (RPD) depth was highly comparable to that resulting from the detailed image analysis.
  - The difference between the two analyses averaged 0.3 cm; only one station-replicate (NF22-2) showed a difference of > 1 cm.
  - The Quick Look analysis has sufficient resolution to evaluate the MWRA RPD trigger.
- Detailed analyses showed that the average RPD value for 1999 (2.3 cm) was slightly deeper than it was for 1998.
  - Statistical comparison of RPD values for the seven stations that were measured for all for years (1992, 1995, 1997, 1998, 1999) showed strong differences among years.
  - Values for 1992, 1995, and 1999 differed from those for 1997 and 1998. Values for 1992 differed from those for all other years.
- Stage II communities dominated in the Nearfield in 1998 and 1999, whereas pioneering successional Stage I communities prevailed in 1992 to 1997.
- The overall 1999 Nearfield average Organism-Sediment Index was statistically the same as those calculated in 1992, 1995, and 1998, but was higher (as was 1998) than the 1997 value. The low 1997 values might have reflected a seasonal change stress as SPI sampling was done in October rather than August.
- The 1999 SPI data showed that biological processes continued to increase in importance as a structuring mechanism of the Nearfield communities, a trend that likely began in 1995.

7.2 Sediment Geochemistry

7.2.1 Ancillary Parameters

- The spatial distribution and temporal response of grain size and total organic carbon (TOC) in 1999 were not substantially different from previous years (1992–1998).
- Total organic carbon content of the Nearfield sediments continued to be low as none contained > 1.5 % TOC by dry weight.
- *Clostridium perfringens* showed decreasing abundance in 1998 and 1999 from earlier years. This suggested that a "cleaner effluent" with less particulates is being discharged, possibly as a result of secondary treatment coming on-line in 1997.
- The abundance of *Clostridium perfringens* appeared to decrease with distance from Boston Harbor.
  - Yearly means values of *Clostridium perfringens* (normalized to percent fines) for near-in stations (< 20 km) showed a decrease in abundance in 1998 and 1999 relative to earlier years.
  - Values at stations further away from Deer Island Point (> 20 km) were on average relatively constant from 1992–1999.
  - The constancy in results within distance classifications after normalization to fine grained sediments suggests the *Clostridium perfringens* abundance is strongly related to grain size.

7.2.2 Contaminants

- The spatial distribution and temporal response of contaminant parameters in the 1999 Nearfield and Farfield generally were not substantially different from earlier years (1992–1998).
- Concentrations of organic and metal contaminants were generally low and the system was spatially variable. Variability was primarily controlled by grain size and TOC.
- Baseline mean values in the Nearfield have been relatively consistent since 1992 and were well below MWRA thresholds.
- Baseline mean values in the Farfield were also relatively constant since 1992 and were generally less than Nearfield values.
- The temporal response of the baseline was similar for Special Contaminant Study and Nearfield stations, suggesting that the Special Contaminant Study stations are reasonably representative of the Nearfield.
- The 95^{th} percentile upper confidence limit (based on the *t* distribution) of the mean of the annual means was used to determine when significant increases above the baseline would be detected. These values are well within the analytical detection range.
- MWRA thresholds are at least 2.4 times higher than the level of significant increase, suggesting that the ability to detect changes in contaminant concentrations prior to exceeding thresholds is high.

7.3 Infaunal Communities

- Values for infaunal abundance, species numbers, diversity, and evenness generally were similar to those estimated for the previous two years
- The most abundant species also were generally the same as found in 1997–1998. However, the polychaete *Dipolydora socialis* was much more abundant in 1999 than it was in 1998. The abundance and overall importance of crustaceans also appeared to be greater in 1999 than in 1998.
- Station grouping based on cluster analysis of the 1999 data reflected the strong influence of sediment type and biogenic activity in structuring Nearfield communities. Two main sets of stations were distinguished.
  - The larger group consisted of many stations occurring in regions of heterogeneous sediments.
  - The smaller consisted of stations in sandy sediments where the RPD layers were deep and biogenic and physical activity was present.
- Cluster analysis of the 1999 Farfield data showed that between-station similarity was low and appeared related to station geographic location, sediment grain size, and depth. The general patterns were similar to those seen during previous analyses.
- A set of diversity measures (numbers of species, Shannon diversity, Pielou's evenness, and log-series alpha) and the proportion of seven opportunistic taxa (*Ampelisca abdita*, *Ampelisca vadorum*, *Ampelisca macrocephela*, *Capitella capitata* complex, *Polydora cornuta*, *Mulinia lateralis*, and *Streblospio benedicti*) were evaluated as potential Nearfield thresholds.

- Analysis of Nearfield data through 1999 showed that all yearly mean values were within the estimated threshold values (the 5th and 95th percentiles of a normal distribution fitted to the data).
- The total percent composition of the selected opportunist taxa in the Nearfield and Farfield infaunal communities throughout the baseline period has been < 2 % and the year-to-year variability during the baseline period, as indicated by the range of yearly values, has been small.

7.4 Hard-bottom Communities

- The hard-bottom communities near the outfall have been studied consistently for the past six years. During this time, especially from 1996 to 1999, the communities, although spatially variable, have shown reasonable temporal stability.
- Classification analysis of the 1999 hard-bottom data showed that the community could be separated into three clusters of stations and two outlier areas.
  - The first cluster consisted of moderate to high-relief drumlin top areas that had relatively heavy sediment drape. These included the three northern reference sites (T7 and T9) and three areas on the drumlin north of the outfall (T2-2, T2-3, and T1-1). Areas comprising Cluster 1 were dominated by upright algae, *Asparagopsis hamifera* and *Rhodymenia palmata*.
  - The second cluster consisted of drumlin top and flank areas that had variable relief and light to moderate sediment drape. These included the two southernmost reference sites (T8), and sites on the drumlins north and south of the outfall. *Lithothamnion* was the dominant taxon in this group.
  - The third cluster consisted of 3 drumlin flank areas that had moderately low relief and heavy sediment drape. These flank sites were located near the outfall (T2-4, T4-2, and T6-1). Areas in this group were characterized by a moderate abundance of invertebrates, and few algae and fish. The benthic communities at these three sites were not dominated by any one taxon.
  - The two outlier areas were opposite extremes in terms of habitat characteristics. T10-1, one of the southern reference sites, had very high relief and heavy sediment drape. The most abundant invertebrates seen at this site were the soft coral *Gersemia rubiformis* (which was not seen anywhere else), *Asterias vulgaris*, and barnacles *Balanus* spp. T4-1, southeast of the outfall, had very low relief and heavy sediment drape. Occasional adult *Asterias vulgaris* and the sea scallop *Placopecten magellanicus* were the main inhabitants of this area.
- *Lithothamnion* shows promise as an indicator species for detecting habitat degradation as a result of the outfall coming on line. This species was the most predictable taxon encountered in terms of abundance, distributional pattern, and habitat requirements. It was the least patchily distributed taxon, and appeared to dominate in all areas that were shallower than 33 m and had little sediment drape. Additionally, it was common in areas of high and low relief. By focusing on *Lithothamnion* as an indicator, it is likely that major changes in the benthic communities inhabiting the hard-bottom areas near the outfall could be detected.

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APPENDIX A-1

Actual Locations of Grab Samples Collected in 1999

StationID	SampleID	Latitude	Longitude	Depth (m)	SampleDateTime[a]	Protocol
FF01A	BF991163	42.56370	70.67566	35.7	8/11/99 14:40	FA
FF01A	BF991164	42.56407	70.67567	35.7	8/11/99 14:48	FA
FF01A	BF991165	42.56413	70.67585	35.7	8/11/99 14:56	FA
FF01A	BF991166	42.56400	70.67582	35.7	8/11/99 15:13	CH
FF01A	BF991168	42.56396	70.67577	35.7	8/11/99 15:30	CH
FF04	BF991214	42.28831	70.42494	89.3	8/13/99 11:55	CH
FF04	BF991215	42.28826	70.42515	89.3	8/13/99 12:09	CH
FF04	BF991218	42.28825	70.42510	89.3	8/13/99 12:52	FA
FF04	BF99121A	42.28830	70.42494	89.3	8/13/99 13:11	FA
FF04	BF99121B	42.28837	70.42495	89.3	8/13/99 13:22	FA
FF05	BF991222	42.13326	70.42235	63.9	8/13/99 14:21	CH
FF05	BF991223	42.13346	70.42236	63.9	8/13/99 14:33	CH
FF05	BF991224	42.13349	70.42233	63.9	8/13/99 14:43	FA
FF05	BF991225	42.13340	70.42243	63.9	8/13/99 14:52	FA
FF05	BF991226	42.13346	70.42240	63.9	8/13/99 15:02	FA
FF06	BF99123A	41.89841	70.40337	33.3	8/13/99 17:52	CH
FF06	BF99123B	41.89842	70.40334	33.3	8/13/99 17:59	CH
FF06	BF99123C	41.89847	70.40334	33.3	8/13/99 18:03	FA
FF06	BF99123D	41.89840	70.40334	33.3	8/13/99 18:11	FA
FF06	BF99123E	41.89837	70.40337	33.3	8/13/99 18:17	FA
FF07	BF99122E	41.95835	70.26660	38.6	8/13/99 16:27	CH
FF07	BF99122F	41.95844	70.26670	38.6	8/13/99 16:36	CH
FF07	BF991231	41.95845	70.26649	38.6	8/13/99 16:48	FA
FF07	BF991232	41.95835	70.26656	38.6	8/13/99 16:56	FA
FF07	BF991235	41.95835	70.26667	38.6	8/13/99 17:04	FA
FF09	BF99120C	42.31254	70.65668	49.3	8/13/99 10:08	CH
FF09	BF99120D	42.31249	70.65668	49.3	8/13/99 10:19	CH
FF09	BF99120E	42.31267	70.65663	49.3	8/13/99 10:25	FA
FF09	BF99120F	42.31256	70.65685	49.3	8/13/99 10:33	FA
FF09	BF991210	42.31255	70.65665	49.3	8/13/99 10:44	FA
FF10	BF9911AB	42.41397	70.87876	28.9	8/12/99 9:52	FA
FF10	BF9911AD	42.41407	70.87862	28.9	8/12/99 10:04	FA
FF10	BF9911B0	42.41397	70.87872	28.9	8/12/99 10:11	FA
FF10	BF9911B2	42.41408	70.87852	28.9	8/12/99 10:20	CH
FF10	BF9911B7	42.41387	70.87891	28.9	8/12/99 10:40	CH
FF10	BF9911BA	42.41408	70.87877	28.9	8/12/99 10:56	CH
FF11	BF991157	42.65800	70.50018	89.3	8/11/99 12:19	CH
FF11	BF991159	42.65821	70.50020	89.3	8/11/99 12:33	CH
FF11	BF99115A	42.65842	70.49989	89.3	8/11/99 12:48	FA
FF11	BF99115B	42.65847	70.49987	89.3	8/11/99 12:58	FA
FF11	BF99115F	42.65808	70.49997	89.3	8/11/99 13:25	FA
FF12	BF991196	42.38997	70.89968	22.7	8/12/99 8:30	FA
FF12	BF991197	42.39009	70.89960	22.7	8/12/99 8:38	FA
FF12	BF99119A	42.39005	70.89965	22.7	8/12/99 8:51	FA
FF12	BF99119F	42.38997	70.89979	22.7	8/12/99 8:58	CH
FF12	BF9911A5	42.39008	70.89970	22.7	8/12/99 9:20	CH
FF13	BF991013	42.31973	70.82263	22.9	8/10/99 11:25	FA

StationID	SampleID	Latitude	Longitude	Depth (m)	SampleDateTime[a]	Protocol
FF13	BF99101E	42.31980	70.82291	22.9	8/10/99 11:59	FA
FF13	BF991023	42.31990	70.82287	22.9	8/10/99 12:09	FA
FF13	BF991026	42.31988	70.82296	22.9	8/10/99 12:18	CH
FF13	BF991029	42.31978	70.82294	22.9	8/10/99 12:39	CH
FF14	BF991144	42.41662	70.65490	75.0	8/11/99 9:10	FA
FF14	BF991145	42.41690	70.65479	75.0	8/11/99 9:24	FA
FF14	BF991146	42.41668	70.65490	75.0	8/11/99 9:36	FA
FF14	BF99114A	42.41662	70.65483	75.0	8/11/99 9:57	CH
FF14	BF99114B	42.41678	70.65488	75.0	8/11/99 10:10	CH
NF02	BF9911FA	42.33852	70.82825	26.8	8/13/99 8:30	FA
NF02	BF9911FD	42.33848	70.82815	26.8	8/13/99 8:42	CH
NF04	BF991172	42.41545	70.80645	34.0	8/11/99 17:10	FA
NF04	BF991176	42.41547	70.80652	34.0	8/11/99 17:21	CH
NF05	BF99116E	42.42702	70.83394	35.2	8/11/99 16:43	FA
NF05	BF99116F	42.42693	70.83376	35.2	8/11/99 16:50	CH
NF07	BF9911BD	42.41012	70.81515	35.6	8/12/99 11:24	FA
NF07	BF9911BE	42.40993	70.81503	35.6	8/12/99 11:30	CH
NF08	BF991037	42.40001	70.86359	30.5	8/10/99 13:48	FA
NF08	BF99103C	42.40002	70.86359	30.5	8/10/99 14:00	CH
NF08	BF99103D	42.40019	70.86346	30.5	8/10/99 14:11	CH
NF08	BF99103E	42.40010	70.86343	30.5	8/10/99 14:24	CH
NF09	BF9911C6	42.39988	70.84485	32.5	8/12/99 12:20	FA
NF09	BF9911C7	42.39979	70.84476	32.5	8/12/99 12:30	CH
NF10	BF99104B	42.39302	70.83828	31.5	8/10/99 15:41	FA
NF10	BF99104C	42.39293	70.83829	31.5	8/10/99 15:49	CH
NF12	BF9911CA	42.39001	70.83047	35.6	8/12/99 12:51	FA
NF12	BF9911CE	42.38998	70.83035	35.6	8/12/99 13:04	FA
NF12	BF9911CF	42.38998	70.83063	35.6	8/12/99 13:12	FA
NF12	BF9911D0	42.38997	70.83051	35.6	8/12/99 13:20	CH
NF12	BF9911D1	42.38997	70.83055	35.6	8/12/99 13:29	CH
NF13	BF991183	42.39008	70.82240	31.6	8/11/99 18:16	FA
NF13	BF991184	42.39000	70.82246	31.6	8/11/99 18:25	CH
NF14	BF9911D5	42.38663	70.82240	34.6	8/12/99 13:46	FA
NF14	BF9911D9	42.38670	70.82253	34.6	8/12/99 14:05	CH
NF15	BF991057	42.38223	70.82787	31.3	8/10/99 17:09	FA
NF15	BF99105C	42.38227	70.82807	31.3	8/10/99 17:32	CH
NF16	BF99104F	42.37835	70.83767	29.5	8/10/99 16:09	FA
NF16	BF991052	42.37842	70.83778	29.5	8/10/99 16:31	CH
NF17	BF9911DC	42.38142	70.81465	31.1	8/12/99 14:21	FA
NF17	BF9911DD	42.38135	70.81482	31.1	8/12/99 14:29	FA
NF17	BF9911DE	42.38145	70.81473	31.1	8/12/99 14:38	FA
NF17	BF9911DF	42.38133	70.81482	31.1	8/12/99 14:51	CH
NF17	BF9911E0	42.38143	70.81483	31.1	8/12/99 15:00	CH
NF18	BF991046	42.39678	70.82169	33.5	8/10/99 15:15	FA
NF18	BF991047	42.39685	70.82183	33.5	8/10/99 15:21	CH
NF19	BF9911E5	42.37163	70.80493	34.9	8/12/99 15:22	FA
NF19	BF9911E7	42.37170	70.80513	34.9	8/12/99 15:36	CH

StationID	SampleID	Latitude	Longitude	Depth (m)	SampleDateTime[a]	Protocol
NF20	BF99102E	42.37835	70.84475	30.3	8/10/99 13:16	FA
NF20	BF991034	42.37844	70.84495	30.3	8/10/99 13:25	CH
NF21	BF991041	42.40284	70.83652	32.2	8/10/99 14:45	FA
NF21	BF991042	42.40282	70.83663	32.2	8/10/99 14:53	CH
NF22	BF991202	42.34782	70.81493	33.3	8/13/99 8:57	FA
NF22	BF991203	42.34782	70.81496	33.3	8/13/99 9:02	CH
NF22	BF991206	42.34779	70.81503	33.3	8/13/99 9:13	CH
NF22	BF991207	42.34784	70.81502	33.3	8/13/99 9:23	CH
NF23	BF99117C	42.39760	70.80156	33.2	8/11/99 17:44	FA
NF23	BF99117E	42.39764	70.80167	33.2	8/11/99 17:56	CH
NF23	BF9911C2	42.39743	70.80220	34.8	8/12/99 11:48	FA
NF23	BF9911C3	42.39748	70.80182	34.8	8/12/99 11:55	CH
NF24	BF9911EC	42.38057	70.80182	35.8	8/12/99 16:08	CH
NF24	BF9911ED	42.38071	70.80160	35.8	8/12/99 16:17	CH
NF24	BF9911EF	42.38054	70.80157	35.8	8/12/99 16:31	CH
NF24	BF9911F2	42.38052	70.80167	35.8	8/12/99 16:56	FA
NF24	BF9911F3	42.38058	70.80178	35.8	8/12/99 17:03	FA
NF24	BF9911F5	42.38049	70.80164	35.8	8/12/99 17:18	FA

[a] Eastern Daylight Time

APPENDIX A-2

Actual Locations of Sediment Profile Camera Drops in 1999

SurveyID	StationID	SampleID	Latitude	Longitude	SampleDateTime[a]	Depth (m)
HR991	FF13	HR991032	42.3193	-70.8230	08/24/1999 8:29:45	20.5
HR991	FF13	HR991033	42.3192	-70.8230	08/24/1999 8:31:15	20.5
HR991	FF13	HR991034	42.3197	-70.8227	08/24/1999 8:33:15	20.5
HR991	FF13	HR991035	42.3197	-70.8227	08/24/1999 8:38:15	20.5
HR991	FF13	HR991036	42.3195	-70.8227	08/24/1999 8:39:04	20.5
HR991	FF13	HR991037	42.3195	-70.8227	08/24/1999 8:40:06	20.5
HR991	NF02	HR991038	42.3390	-70.8280	08/24/1999 8:55:41	28.0
HR991	NF02	HR991039	42.3388	-70.8280	08/24/1999 8:56:55	28.0
HR991	NF02	HR99103A	42.3387	-70.8280	08/24/1999 8:58:45	28.0
HR991	NF02	HR99103B	42.3387	-70.8280	08/24/1999 9:01:00	28.0
HR991	NF22	HR99103C	42.3485	-70.8148	08/24/1999 9:15:02	38.1
HR991	NF22	HR99103D	42.3481	-70.8152	08/24/1999 9:17:52	38.1
HR991	NF22	HR991040	42.3480	-70.8153	08/24/1999 9:27:57	38.1
HR991	NF19	HR991041	42.3719	-70.8048	08/24/1999 9:47:10	34.8
HR991	NF19	HR991042	42.3718	-70.8048	08/24/1999 9:48:23	34.8
HR991	NF19	HR991043	42.3718	-70.8049	08/24/1999 9:49:16	34.8
HR991	NF24	HR991044	42.3804	-70.8018	08/24/1999 10:02:43	36.0
HR991	NF24	HR991045	42.3802	-70.8020	08/24/1999 10:05:39	36.0
HR991	NF24	HR991046	42.3800	-70.8022	08/24/1999 10:08:47	36.0
HR991	NF24	HR991047	42.3799	-70.8022	08/24/1999 10:10:54	36.0
HR991	NF17	HR991049	42.3816	-70.8141	08/24/1999 10:27:25	30.4
HR991	NF17	HR99104A	42.3815	-70.8143	08/24/1999 10:28:36	30.4
HR991	NF17	HR99104B	42.3815	-70.8145	08/24/1999 10:30:05	30.4
HR991	NF15	HR99104C	42.3827	-70.8276	08/24/1999 10:40:11	33.0
HR991	NF15	HR99104D	42.3826	-70.8278	08/24/1999 10:41:27	33.0
HR991	NF15	HR99104E	42.3827	-70.8279	08/24/1999 10:42:42	33.0
HR991	NF16	HR99104F	42.3792	-70.8382	08/24/1999 10:51:26	31.5
HR991	NF16	HR991050	42.3787	-70.8379	08/24/1999 10:59:20	31.5
HR991	NF16	HR991051	42.3787	-70.8382	08/24/1999 11:02:42	31.5
HR991	NF20	HR991052	42.3785	-70.8445	08/24/1999 11:10:03	29.4
HR991	NF20	HR991053	42.3785	-70.8447	08/24/1999 11:11:29	29.4
HR991	NF20	HR991054	42.3785	-70.8446	08/24/1999 11:12:52	29.4
HR991	NF14	HR991057	42.3868	-70.8225	08/24/1999 11:29:12	33.3
HR991	NF14	HR991058	42.3867	-70.8225	08/24/1999 11:30:24	33.3
HR991	NF14	HR991059	42.3867	-70.8226	08/24/1999 11:32:05	33.3
HR991	NF13	HR99105A	42.3900	-70.8223	08/24/1999 11:41:34	33.0
HR991	NF13	HR99105B	42.3900	-70.8224	08/24/1999 11:42:58	33.0
HR991	NF13	HR99105C	42.3900	-70.8225	08/24/1999 11:44:19	33.0
HR991	NF12	HR99105F	42.3898	-70.8301	08/24/1999 12:10:31	34.1
HR991	NF12	HR991060	42.3899	-70.8303	08/24/1999 12:14:16	34.1
HR991	NF12	HR991061	42.3899	-70.8303	08/24/1999 12:17:56	34.1
HR991	NF10	HR991064	42.3935	-70.8380	08/24/1999 12:28:34	32.7
HR991	NF10	HR991065	42.3936	-70.8382	08/24/1999 12:31:55	32.7
HR991	NF10	HR991066	42.3937	-70.8382	08/24/1999 12:33:16	32.7
HR991	NF09	HR991067	42.3999	-70.8445	08/24/1999 12:43:30	30.4
HR991	NF09	HR991068	42.4001	-70.8447	08/24/1999 12:46:21	30.4

SurveyID	StationID	SampleID	Latitude	Longitude	SampleDateTime[a]	Depth (m)
HR991	NF09	HR991069	42.4001	-70.8448	08/24/1999 12:47:49	30.4
HR991	NF21	HR99106C	42.4028	-70.8365	08/24/1999 12:56:26	32.3
HR991	NF21	HR99106D	42.4030	-70.8366	08/24/1999 12:59:46	32.3
HR991	NF21	HR99106E	42.4032	-70.8369	08/24/1999 13:03:15	32.3
HR991	NF18	HR99106F	42.3969	-70.8217	08/24/1999 13:16:56	33.5
HR991	NF18	HR991070	42.3970	-70.8217	08/24/1999 13:18:16	33.5
HR991	NF18	HR991071	42.3971	-70.8220	08/24/1999 13:21:55	33.5
HR991	NF23	HR991074	42.3978	-70.8005	08/24/1999 13:35:32	32.7
HR991	NF23	HR991075	42.3972	-70.8020	08/24/1999 13:40:48	32.7
HR991	NF23	HR991076	42.3971	-70.8021	08/24/1999 13:42:14	32.7
HR991	NF23	HR991077	42.3977	-70.8016	08/24/1999 13:46:44	32.7
HR991	NF07	HR991078	42.4107	-70.8146	08/24/1999 14:02:12	33.0
HR991	NF07	HR991079	42.4099	-70.8151	08/24/1999 14:08:49	33.0
HR991	NF07	HR99107A	42.4102	-70.8153	08/24/1999 14:13:31	33.0
HR991	NF04	HR99107B	42.4151	-70.8058	08/24/1999 14:24:10	33.7
HR991	NF04	HR99107C	42.4152	-70.8060	08/24/1999 14:25:55	33.7
HR991	NF04	HR99107D	42.4152	-70.8061	08/24/1999 14:28:04	33.7
HR991	NF05	HR991080	42.4266	-70.8336	08/24/1999 14:50:56	35.1
HR991	NF05	HR991081	42.4268	42.4268	08/24/1999 14:52:25	35.1
HR991	NF05	HR991082	42.4269	42.4269	08/24/1999 14:53:40	35.1
HR991	NF08	HR991085	42.4003	42.4003	08/24/1999 15:16:37	28.2
HR991	NF08	HR991086	42.4004	42.4004	08/24/1999 15:18:32	28.2
HR991	NF08	HR991087	42.4006	42.4006	08/24/1999 15:20:09	28.2
HR991	FF10	HR99108A	42.4141	42.4141	08/24/1999 15:33:40	26.7
HR991	FF10	HR99108B	42.4142	42.4142	08/24/1999 15:35:00	26.7
HR991	FF10	HR99108C	42.4143	42.4143	08/24/1999 15:36:24	26.7
HR991	FF12	HR99108F	42.3899	42.3899	08/24/1999 15:58:33	22.0
HR991	FF12	HR991090	42.3900	42.3900	08/24/1999 15:59:41	22.0
HR991	FF12	HR991091	42.3902	42.3902	08/24/1999 16:01:01	22.0
HR991	FF12	HR991092	42.3903	42.3903	08/24/1999 16:02:31	22.0

[a] Eastern Daylight Time

APPENDIX A-3

Actual Locations of Hard-Bottom Stations Sampled in 1999

SurveyID	StationID	SampleID	SampleDate	Latitude	Longitude	Depth (m)
BH991	T1-1	BH991026	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991034	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH99104D	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH99104E	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH99104F	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991050	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991051	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991052	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991053	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991054	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991055	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991056	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991057	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991058	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991059	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH99105A	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH99105B	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH99105C	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH99105D	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH99105E	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH99105F	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991060	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991061	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991062	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991063	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991064	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991065	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991066	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991067	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991068	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991069	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH99106A	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH99106B	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH99106C	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH99106D	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH99106E	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH99106F	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991070	22-Jun-99	42.3926	70.80309	29
BH991	T1-1	BH991071	22-Jun-99	42.3926	70.80309	29
BH991	T1-2	BH99109C	22-Jun-99	42.3941	70.80517	27
BH991	T1-2	BH9911BD	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911BF	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911C3	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911C5	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911C7	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911C9	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911CB	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911CA	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911DC	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911DB	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911DA	23-Jun-99	42.3939	70.80583	27

SurveyID	StationID	SampleID	SampleDate	Latitude	Longitude	Depth (m)
BH991	T1-2	BH9911D9	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911D8	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911D7	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911D6	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911D5	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911E3	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911E2	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911E1	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911E0	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911DF	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911DE	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911DD	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911D4	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911D3	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911D2	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911D1	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911D0	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911CF	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911CE	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911CD	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911CC	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911C8	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911C6	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911C2	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911C0	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911BE	23-Jun-99	42.3939	70.80583	27
BH991	T1-2	BH9911C4	23-Jun-99	42.3939	70.80583	27
BH991	T1-3	BH99118B	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH991192	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH99118D	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH99118C	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH991193	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH991195	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH991198	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH991197	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911A1	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911A0	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH99119F	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH99119E	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH99119D	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH99119C	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH99119B	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH99119A	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911AA	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911A8	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911A7	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911A6	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911A5	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911A4	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911A3	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911A2	23-Jun-99	42.3957	70.80907	24

SurveyID	StationID	SampleID	SampleDate	Latitude	Longitude	Depth (m)
BH991	T1-3	BH9911B2	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911B1	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911B0	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911AF	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911AE	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911AD	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911AC	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911AB	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911B6	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911B5	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911B4	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH9911B3	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH991199	23-Jun-99	42.3957	70.80907	24
BH991	T1-3	BH991194	23-Jun-99	42.3957	70.80907	24
BH991	T1-4	BH9910FB	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH9910FC	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH9910FD	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH9910FE	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH9910FF	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991100	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991101	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991102	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991103	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991104	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991105	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991106	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991107	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991108	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991109	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH99110A	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH99110B	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH99110C	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH99110D	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH99110E	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH99110F	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991110	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991111	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991112	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991113	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991114	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991116	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991117	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991118	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991119	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH99111A	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH99111B	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH99111C	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH99111D	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH99111E	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH99111F	22-Jun-99	42.3976	70.81435	25
BH991	T1-4	BH991120	22-Jun-99	42.3976	70.81435	25

SurveyID	StationID	SampleID	SampleDate	Latitude	Longitude	Depth (m)
BH991	T1-4	BH991121	22-Jun-99	42.3976	70.81435	25
BH991	T1-5	BH991128	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991129	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH99112A	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH99112B	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH99112C	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH99112D	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH99112E	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH99112F	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991130	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991131	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991132	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991133	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991134	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991135	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991136	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991137	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991139	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH99113A	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH99113B	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH99113C	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH99113D	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH99113E	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH99113F	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991140	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991141	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991142	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991143	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991144	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991145	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991146	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991147	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991148	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH991149	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH99114A	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH99114B	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH99114C	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH99114D	22-Jun-99	42.3978	70.81528	29
BH991	T1-5	BH99114E	22-Jun-99	42.3978	70.81528	29
BH991	T10-1	BH991323	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991324	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991325	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991327	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991329	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH99132B	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH99132A	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991344	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991343	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991342	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991341	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991340	23-Jun-99	42.3779	70.81535	27

SurveyID	StationID	SampleID	SampleDate	Latitude	Longitude	Depth (m)
BH991	T10-1	BH99133F	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH99133E	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH99133D	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991348	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991347	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991346	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991345	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH99133C	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH99133B	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH99133A	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991339	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991338	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991337	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991336	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991335	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991334	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991333	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991332	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991331	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991330	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH99132F	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH99132E	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH99132D	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH99132C	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991328	23-Jun-99	42.3779	70.81535	27
BH991	T10-1	BH991326	23-Jun-99	42.3779	70.81535	27
BH991	T2-1	BH9911EA	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911EB	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911EC	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911ED	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911EE	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911EF	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911F0	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911F1	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911F2	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911F3	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911F4	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911F5	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911F6	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911F7	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911F8	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911F9	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911FA	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911FB	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911FC	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911FD	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911FE	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH9911FF	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH991200	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH991201	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH991202	23-Jun-99	42.3936	70.79851	28

SurveyID	StationID	SampleID	SampleDate	Latitude	Longitude	Depth (m)
BH991	T2-1	BH991203	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH991204	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH991205	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH991207	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH991208	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH991209	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH99120A	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH99120B	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH99120C	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH99120D	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH99120E	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH99120F	23-Jun-99	42.3936	70.79851	28
BH991	T2-1	BH991210	23-Jun-99	42.3936	70.79851	28
BH991	T2-2	BH991213	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991214	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991215	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991216	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991217	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991218	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991219	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH99121A	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH99121B	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH99121C	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH99121D	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH99121E	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH99121F	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991220	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991221	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991222	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991223	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991224	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991225	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991226	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991227	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991228	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991229	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH99122A	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH99122B	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH99122C	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH99122D	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH99122E	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH99122F	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991230	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991231	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991232	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991233	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991234	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991235	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991236	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991237	23-Jun-99	42.3934	70.79501	28
BH991	T2-2	BH991238	23-Jun-99	42.3934	70.79501	28

SurveyID	StationID	SampleID	SampleDate	Latitude	Longitude	Depth (m)
BH991	T2-3	BH991243	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991244	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991245	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991246	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991247	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991248	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991249	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH99124A	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH99124B	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH99124C	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH99124D	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH99124E	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH99124F	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991250	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991251	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991252	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991253	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991254	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991255	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991256	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991257	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991258	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991259	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH99125A	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH99125B	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH99125C	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH99125D	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH99125E	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH99125F	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991260	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991261	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991262	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991263	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991265	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991266	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991267	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991268	23-Jun-99	42.3929	70.79025	29
BH991	T2-3	BH991269	23-Jun-99	42.3929	70.79025	29
BH991	T2-4	BH991270	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991271	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991272	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991273	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991274	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991275	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991276	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991277	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991278	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991279	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH99127A	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH99127B	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH99127C	23-Jun-99	42.3911	70.7883	31

SurveyID	StationID	SampleID	SampleDate	Latitude	Longitude	Depth (m)
BH991	T2-4	BH99127D	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH99127E	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH99127F	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991280	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991281	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991282	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991283	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991284	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991285	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991286	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991287	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991288	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991289	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH99128A	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH99128B	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH99128C	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH99128D	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH99128E	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH99128F	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991290	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991291	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991292	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991293	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991294	23-Jun-99	42.3911	70.7883	31
BH991	T2-4	BH991295	23-Jun-99	42.3911	70.7883	31
BH991	T4-1	BH99135C	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991360	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991362	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991364	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991363	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991382	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991381	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991380	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH99137F	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH99137E	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH99137D	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH99137C	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH99137B	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH99137A	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991379	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991378	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991377	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991376	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991375	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991374	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991373	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991372	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991371	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991370	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH99136F	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH99136E	24-Jun-99	42.3843	70.77478	35

SurveyID	StationID	SampleID	SampleDate	Latitude	Longitude	Depth (m)
BH991	T4-1	BH99136D	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH99136C	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH99136B	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH99136A	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991369	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991367	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991366	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991365	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH991361	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH99135F	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH99135D	24-Jun-99	42.3843	70.77478	35
BH991	T4-1	BH99135E	24-Jun-99	42.3843	70.77478	35
BH991	T4-2	BH991387	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH99138C	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH99138E	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH99138D	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH99139F	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH99139E	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH99139D	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH99139C	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH99139B	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH99139A	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH991399	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH991398	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH9913AC	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH9913AB	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH9913AA	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH9913A9	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH9913A8	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH9913A7	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH9913A6	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH9913A5	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH9913A4	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH9913A3	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH9913A2	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH9913A1	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH9913A0	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH991397	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH991396	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH991395	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH991394	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH991393	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH991392	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH991391	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH991390	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH99138F	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH99138B	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH991388	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH991389	24-Jun-99	42.3837	70.78184	34
BH991	T4-2	BH99138A	24-Jun-99	42.3837	70.78184	34
BH991	T4-3	BH9913B1	24-Jun-99	42.3808	70.79307	35

SurveyID	StationID	SampleID	SampleDate	Latitude	Longitude	Depth (m)
BH991	T4-3	BH9913B6	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913B8	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913B7	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913D6	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913D5	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913D4	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913D3	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913D2	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913D1	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913D0	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913CF	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913CE	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913CD	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913CC	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913CB	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913CA	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913C1	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913C0	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913BF	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913BE	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913BD	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913BC	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913BB	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913BA	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913C9	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913C8	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913C7	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913C6	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913C5	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913C4	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913C3	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913C2	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913B9	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913B5	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913B2	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913B3	24-Jun-99	42.3808	70.79307	35
BH991	T4-3	BH9913B4	24-Jun-99	42.3808	70.79307	35
BH991	T4/T6-1	BH991433	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991437	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991439	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991438	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH99144B	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991449	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991448	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991447	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991446	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991445	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991444	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991443	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991459	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991458	24-Jun-99	42.3829	70.78703	34

SurveyID	StationID	SampleID	SampleDate	Latitude	Longitude	Depth (m)
BH991	T4/T6-1	BH991457	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991456	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991455	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991454	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991453	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991452	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991451	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991450	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH99144F	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH99144E	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH99144D	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH99144C	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991442	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991441	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991440	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH99143F	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH99143E	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH99143D	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH99143C	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH99143B	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH99143A	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991436	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991434	24-Jun-99	42.3829	70.78703	34
BH991	T4/T6-1	BH991435	24-Jun-99	42.3829	70.78703	34
BH991	T6-1	BH991408	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH99140C	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH99140E	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH99140D	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH99142E	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH99142D	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH99142C	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH99142B	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH99142A	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991429	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991428	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991427	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991426	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991425	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991424	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991423	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991422	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991421	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991417	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991416	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991415	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991414	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991413	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991412	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991411	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991410	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991420	24-Jun-99	42.3834	70.79459	34

SurveyID	StationID	SampleID	SampleDate	Latitude	Longitude	Depth (m)
BH991	T6-1	BH99141F	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH99141E	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH99141C	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH99141B	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH99141A	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991419	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991418	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH99140F	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH99140B	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH991409	24-Jun-99	42.3834	70.79459	34
BH991	T6-1	BH99140A	24-Jun-99	42.3834	70.79459	34
BH991	T6-2	BH9913DB	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913E0	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913E2	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913E1	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913F3	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913F2	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913F1	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913F0	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913EF	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913EE	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913ED	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913EC	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH991401	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH991400	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913FF	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913FE	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913FD	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913FC	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913FB	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913FA	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913F8	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913F7	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913F6	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913F5	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913F4	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913EB	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913EA	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913E9	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913E8	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913E7	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913E6	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913E5	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913E4	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913E3	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913DF	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913DC	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913DD	24-Jun-99	42.3807	70.78481	33
BH991	T6-2	BH9913DE	24-Jun-99	42.3807	70.78481	33
BH991	T7-1	BH99129C	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH99129D	23-Jun-99	42.4084	70.78201	24

SurveyID	StationID	SampleID	SampleDate	Latitude	Longitude	Depth (m)
BH991	T7-1	BH99129E	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912A0	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912A1	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912A2	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912A3	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912A4	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912A5	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912A6	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912A7	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912A8	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912A9	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912AA	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912AB	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912AC	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912AD	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912AE	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912AF	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912B0	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912B1	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912B2	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912B3	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912B4	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912B5	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912B6	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912B7	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912B8	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912B9	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912BA	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912BB	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912BC	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912BD	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912BE	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912BF	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912C0	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912C1	23-Jun-99	42.4084	70.78201	24
BH991	T7-1	BH9912C2	23-Jun-99	42.4084	70.78201	24
BH991	T7-2	BH9912CB	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912CC	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912CD	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912CE	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912CF	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912D0	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912D1	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912D2	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912D3	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912D4	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912D5	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912D6	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912D7	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912D8	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912D9	23-Jun-99	42.4094	70.78198	26

SurveyID	StationID	SampleID	SampleDate	Latitude	Longitude	Depth (m)
BH991	T7-2	BH9912DA	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912DB	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912DC	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912DD	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912DE	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912DF	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912E0	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912E1	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912E2	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912E3	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912E4	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912E5	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912E6	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912E7	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912E8	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912E9	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912EA	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912EB	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912EC	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912ED	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912EE	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912EF	23-Jun-99	42.4094	70.78198	26
BH991	T7-2	BH9912F0	23-Jun-99	42.4094	70.78198	26
BH991	T8-1	BH99145E	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991464	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991467	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991466	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991480	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH99147F	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH99147E	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH99147D	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH99147C	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH99147B	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH99147A	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991479	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991484	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991483	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991482	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991481	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991478	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991477	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991476	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991475	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991474	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991473	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991472	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991471	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991470	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH99146F	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH99146E	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH99146D	24-Jun-99	42.3607	70.81537	24

SurveyID	StationID	SampleID	SampleDate	Latitude	Longitude	Depth (m)
BH991	T8-1	BH99146C	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH99146B	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH99146A	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991469	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991468	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991463	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH99145F	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991460	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991462	24-Jun-99	42.3607	70.81537	24
BH991	T8-1	BH991461	24-Jun-99	42.3607	70.81537	24
BH991	T8-2	BH991489	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH991491	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH991490	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH9914A3	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH9914A2	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH9914A1	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH9914A0	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH99149E	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH99149D	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH99149C	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH99149B	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH99149A	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH991499	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH991498	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH991497	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH991496	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH991495	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH991494	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH991493	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH9914AB	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH9914AA	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH9914A9	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH9914A8	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH9914A7	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH9914A6	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH9914A5	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH9914A4	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH9914B0	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH9914AF	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH9914AE	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH9914AD	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH9914AC	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH991492	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH99148A	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH99148C	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH99148E	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH99148F	24-Jun-99	42.3642	70.80849	26
BH991	T8-2	BH99148B	24-Jun-99	42.3642	70.80849	26
BH991	T9-1	BH9912F5	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH9912F6	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH9912F7	23-Jun-99	42.4028	70.79604	27

SurveyID	StationID	SampleID	SampleDate	Latitude	Longitude	Depth (m)
BH991	T9-1	BH9912F8	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH9912F9	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH9912FA	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH9912FB	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH9912FC	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH9912FD	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH9912FE	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH9912FF	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH991300	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH991301	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH991302	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH991303	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH991304	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH991305	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH991306	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH991307	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH991308	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH991309	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH99130A	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH99130B	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH99130C	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH99130D	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH99130E	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH99130F	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH991310	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH991311	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH991312	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH991313	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH991314	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH991315	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH991317	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH991318	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH991319	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH99131A	23-Jun-99	42.4028	70.79604	27
BH991	T9-1	BH99131B	23-Jun-99	42.4028	70.79604	27

APPENDIX B-1

Complete Listing of Sediment Profile Image Data

Station	Rep	Day	Time	Pen. Min (Cm)	Pen. Max (Cm)	Pen. Ave. (Cm)	Sur. Rel. (Cm)	Rpd Min (Cm)	Rpd Max (Cm)	Rpd Qualifyer	Rpd Ave. (Cm)	Sediment Grain Size	Surface Features	Sedi. Layer	Amphipod Tubes	Worm Tubes	Worms	Burrows	Oxic Voids	Anaerobic Voids	Succ. Stage	Osi	Other
FF10	1	08/24/1999	15:39	0.0	9.5	0.0	9.5	.	.	IND	.	RK	BIO/PHY	NONE	NONE	MANY	.	.	.	.	.	IND	Hydroid like organism, Tubes on rocks
FF10	2	08/24/1999	15:40	4.7	5.6	5.2	0.9	1.0	4.6		2.2	FSMS,GR,PB,SH	BIO/PHY,SH	NONE	NONE	MANY	1	0	0	0	II	6	Hydroid like organism
FF10	3	08/24/1999	15:41	6.2	7.9	7.1	1.8	1.1	5.3		2.2	SIFS,GR,PB	BIO/PHY	NONE	NONE	MANY	7	3	0	0	II	6	Hydroid like organism
FF12	1	08/24/1999	16:03	4.4	4.8	4.6	0.3	1.0	3.9		1.3	FS	BIO/PHY	NONE	NONE	MANY	1	5	0	0	II/III	6	
FF12	2	08/24/1999	16:06	4.6	5.0	4.8	0.5	0.4	4.4		1.7	FS	BIO/PHY	NONE	NONE	MANY	9	9	0	0	II/III	7	
FF12	3	08/24/1999	16:07	4.0	4.6	4.3	0.7	0.9	3.4		1.9	FS	BIO/PHY	NONE	NONE	MANY	14	6	0	0	II/III	7	Hermit crab
FF13	1	08/24/1999	8:34	0.0	3.3	0.0	3.3	.	.	IND	.	PB	PHY,SH	NONE	NONE	MANY	.	.	.	.	.	IND	Hydroid like organism
FF13	2	08/24/1999	8:36	0.0	8.0	0.0	8.0	.	.	IND	.	RK	PHY	NONE	NONE	NONE	.	.	.	.	.	IND	Barnacles
FF13	3	08/24/1999	8:43	3.1	3.5	3.3	0.3	0.4	2.7		1.0	FS	BIO	NONE	NONE	MANY	10	5	0	0	II	5	Worm out of tube
FF13	4	08/24/1999	8:44	2.2	3.2	2.7	1.0	0.9	1.7		1.2	FSSI,GR	BIO/PHY	NONE	NONE	SOME	0	0	0	0	II	5	Hydroid like organism
FF13	5	08/24/1999	8:45	1.3	3.2	2.3	1.9	0.8	2.2		2.4	FSSI,GR	BIO/PHY	NONE	NONE	SOME	0	0	0	0	II	7	
NF02	1	08/24/1999	9:01	0.0	13.4	0.0	13.4	.	.	IND	.	RK	PHY,SH	NONE	NONE	MANY	.	.	.	.	.	IND	Red Sponge, Hydroids, Calcarious tubes, Mussel?
NF02	2	08/24/1999	9:02	0.0	3.4	0.0	3.4	.	.	IND	.	PB	PHY,SH	NONE	NONE	NONE	.	.	.	.	.	IND	
NF02	3	08/24/1999	9:04	0.0	6.5	0.0	6.5	.	.	IND	.	PB,RK	PHY	NONE	NONE	MANY	.	.	.	.	.	IND	Red Sponge, Hydroids, Calcarious tubes
NF02	4	08/24/1999	9:06	0.0	3.8	1.9	3.8	0.3	3.3		2.1	FSSI,GR	PHY,SH	NONE	NONE	NONE	.	.	.	.	.	IND	Only small section of image fine sediment
NF04	1	08/24/1999	14:29	2.9	3.5	3.2	0.6	.	.	>	3.2	FS	BIO/PHY,BF?,SH	NONE	NONE	MANY	0	0	0	0	II	8	
NF04	2	08/24/1999	14:31	2.4	3.7	3.1	1.4	.	.	>	3.1	FS,GR	BIO/PHY,SH	NONE	NONE	SOME	0	0	0	0	II	8	White palps?
NF04	3	08/24/1999	14:33	3.9	4.5	4.2	0.6	.	.	>	4.2	FS,GR	BIO/PHY,SH	NONE	NONE	MANY	1	0	0	0	II	9	Worm out of tube
NF05	1	08/24/1999	14:56	4.2	5.7	4.9	1.4	1.2	4.0		2.3	FS/SICL	BIO	FEW	FEW	SOME	4	5	0	0	II	7	Ampelisca tubes?, Sand over silty sediment
NF05	2	08/24/1999	14:57	6.2	7.1	6.7	0.9	1.1	4.4		2.2	FS/SICL	BIO	FEW	NONE	MANY	5	6	0	0	II	6	Stick amphipod, Worm out of tube, Sand over silty sedi.
NF05	3	08/24/1999	14:59	3.8	4.6	4.2	0.8	1.2	3.6		3.5	FS/SICL	BIO	FEW	NONE	MANY	3	2	0	0	II	8	Sand over silty sediment
NF07	1	08/24/1999	14:07	11.6	12.7	12.2	1.2	0.3	8.5		1.6	SIFS	BIO	NONE	NONE	MAT	7	8	2	0	II	6	
NF07	2	08/24/1999	14:14	14.7	15.0	14.9	0.3	0.9	8.4		2.1	SIFS	BIO,SH	NONE	NONE	MAT	3	8	1	0	II/III	7	Stick amphipod, worm in void, White organism
NF07	3	08/24/1999	14:18	13.9	15.5	14.7	1.6	0.5	7.2		1.0	SIFS	BIO	NONE	NONE	MAT	11	12	1	1	II/III	6	White organism near void
NF08	1	08/24/1999	15:21	21.4	21.9	23.7	0.5	0.3	7.0		1.9	SIFS	BIO	FEW	NONE	MAT	7	5	0	0	II	6	Gray silt over darker silt
NF08	2	08/24/1999	15:23	20.9	21.7	23.3	0.8	0.2	3.8		1.5	SIFS	BIO	FEW	NONE	SOME	9	8	0	1	II	5	Gray silt over darker silt
NF08	3	08/24/1999	15:25	17.3	18.1	17.7	0.8	0.2	5.9		1.7	SIFS	BIO	FEW	NONE	MAT	6	7	0	0	II	6	Gray silt over darker silt, Cerianthid in burrow
NF09	1	08/24/1999	12:48	12.4	14.1	13.2	1.7	0.1	6.3		2.3	FSSI	BIO	NONE	NONE	MAT	14	6	4	0	III	9	

Station	Rep	Day	Time	Pen. Min (Cm)	Pen. Max (Cm)	Pen. Ave. (Cm)	Sur. Rel. (Cm)	Rpd Min (Cm)	Rpd Max (Cm)	Rpd Qualifyer	Rpd Ave. (Cm)	Sediment Grain Size	Surface Features	Sedi. Layer	Amphipod Tubes	Worm Tubes	Worms	Burrows	Oxic Voids	Anaerobic Voids	Succ. Stage	Osi	Other
NF09	2	08/24/1999	12:53	10.2	11.5	10.9	1.3	0.1	7.3		1.4	FSSI	BIO	NONE	NONE	MAT	7	5	2	0	III	7	Stick Amphipod
NF09	3	08/24/1999	12:53	9.7	11.9	10.8	2.2	0.3	9.1		2.0	FSSI	BIO	NONE	NONE	MAT	4	5	2	0	III	8	2 large worms
NF10	1	08/24/1999	12:33	13.4	14.6	14.0	1.1	0.3	9.9		1.6	FSSICL	BIO	NONE	NONE	MAT	7	8	4	0	III	8	Worm in void, Cerianthid in burrow
NF10	2	08/24/1999	12:37	11.3	12.9	12.1	1.6	0.8	10.9		2.5	FSSICL	BIO	NONE	NONE	MAT	14	8	1	1	III	9	
NF10	3	08/24/1999	12:38	10.1	10.7	10.4	0.6	0.5	8.1		1.6	FSSICL	BIO	NONE	NONE	MAT	10	8	2	0	III	8	
NF12	1	08/24/1999	12:15	20.2	21.5	20.9	1.3	0.2	9.1		1.8	FSSICL	BIO	NONE	NONE	MAT	8	7	5	1	III	8	
NF12	2	08/24/1999	12:19	20.7	22.0	22.3	1.2	0.1	10.8		1.3	FSSICL	BIO	NONE	NONE	MAT	8	4	4	0	III	7	
NF12	3	08/24/1999	12:23	18.5	21.0	19.8	2.5	0.9	9.4		2.5	FSSICL	BIO	NONE	NONE	MAT	8	6	5	0	III	9	Worm in void
NF13	1	08/24/1999	11:46	1.7	3.9	2.8	2.2	.	.	>	2.8	FSMS	BIO/PHY,SH	NONE	NONE	MANY	0	0	0	0	II	7	
NF13	2	08/24/1999	11:48	2.5	3.1	2.8	0.6	.	.	>	2.8	FSMS	BIO/PHY	NONE	NONE	SOME	0	0	0	0	II	7	
NF13	3	08/24/1999	11:49	2.0	3.1	2.5	1.1	.	.	>	2.5	FSMS	BIO/PHY,SH	NONE	NONE	SOME	0	0	0	0	II	7	
NF14	1	08/24/1999	11:34	5.9	7.9	6.9	2.0	2.5	6.3		4.6	SIFS,SH,PB	BIO/PHY,SH	NONE	NONE	SOME	0	1	0	0	II/III	10	Large burrow opening
NF14	2	08/24/1999	11:35	5.1	5.8	5.5	0.7	0.2	5.0		3.0	SIFS,SH,PB	BIO/PHY,SH	NONE	NONE	MANY	2	0	0	0	II	7	
NF14	3	08/24/1999	11:37	4.5	5.3	4.9	0.8	0.7	4.3		2.1	SIFS,SH,PB	BIO/PHY	NONE	NONE	MANY	1	2	0	0	II/III	7	Large burrow opening
NF15	1	08/24/1999	10:45	2.6	4.7	3.7	2.1	0.7	3.7		2.3	FS,PB,GR,SH	BIO/PHY,SH	NONE	NONE	SOME	0	0	0	0	II	7	Sand Dollars
NF15	2	08/24/1999	10:46	6.9	7.5	7.2	0.7	0.3	6.2		2.5	FSSI,PB,GR,SH	BIO/PHY,SH	NONE	NONE	SOME	1	6	1	0	II	7	
NF15	3	08/24/1999	10:48	2.8	3.8	3.3	1.0	0.9	3.3		2.1	FSSI,PB,GR,SH	BIO/PHY,SH	NONE	NONE	MANY	4	0	0	0	II	6	Large Cancer Crab
NF16	1	08/24/1999	10:56	12.4	15.3	13.8	2.9	0.1	4.8		2.2	FSSICL	BIO,SH	NONE	NONE	MAT	8	5	1	0	III	8	Cerianthid in burrow
NF16	2	08/24/1999	11:04	14.9	19.2	17.0	4.3	0.1	7.7		1.2	FSSICL	BIO	NONE	NONE	FEW	6	3	0	0	II	5	
NF16	3	08/24/1999	11:08	17.5	18.2	17.8	0.7	0.3	5.9		1.9	FSSICL	BIO	NONE	NONE	MAT	12	8	4	3	III	8	
NF17	1	08/24/1999	10:32	2.4	4.4	3.4	2.0	.	.	>	3.4	MS,GR	PHY,SH	NONE	NONE	NONE	0	0	0	0	IND	IND	
NF17	2	08/24/1999	10:33	4.7	5.6	5.2	0.9	.	.	>	5.2	FSMS	PHY,SH	NONE	NONE	SOME	0	0	0	0	II	9	
NF17	3	08/24/1999	10:35	2.9	3.8	3.3	0.9	.	.	>	3.3	FSMS	BIO/PHY,SH	NONE	NONE	SOME	0	0	0	0	II	8	Sand Dollars
NF18	1	08/24/1999	13:22	9.7	10.9	10.3	1.2	1.2	7.4		2.6	SIFS,GR,SH	BIO	NONE	NONE	MAT	4	5	0	0	II	7	
NF18	2	08/24/1999	13:23	8.1	9.9	9.0	1.7	0.4	5.1		2.5	SIFS,GR,PB,SH	BIO/PHY	NONE	NONE	SOME	1	1	2	0	II	7	
NF18	3	08/24/1999	13:27	6.8	8.1	7.4	4.6	0.5	8.2		2.9	SIFS,GR,PB,SH	BIO/PHY,SH	NONE	NONE	SOME	2	2	3	0	I/II	6	Calcarious tubes
NF19	1	08/24/1999	9:52	2.2	4.0	3.1	1.8	0.7	3.7		1.5	FSSICL	BIO,SH	NONE	NONE	MANY	3	4	0	0	II	5	
NF19	2	08/24/1999	9:53	3.0	4.0	3.5	1.0	0.4	2.9		1.6	FSSICL	BIO/PHY	NONE	NONE	SOME	2	6	0	0	II	6	
NF19	3	08/24/1999	9:54	3.0	3.5	3.2	0.6	0.2	2.7		1.3	FSSICL	BIO/PHY,SH	NONE	NONE	SOME	7	9	0	0	II	5	

Station	Rep	Day	Time	Pen. Min (Cm)	Pen. Max (Cm)	Pen. Ave. (Cm)	Sur. Rel. (Cm)	Rpd Min (Cm)	Rpd Max (Cm)	Rpd Qualifyer	Rpd Ave. (Cm)	Sediment Grain Size	Surface Features	Sedi. Layer	Amphipod Tubes	Worm Tubes	Worms	Burrows	Oxic Voids	Anaerobic Voids	Succ. Stage	Osi	Other
NF20	1	08/24/1999	11:15	4.3	6.1	5.2	1.8	1.5	5.4		3.4	SIFS,PB	BIO	NONE	NONE	MAT	0	0	0	0	II	8	
NF20	2	08/24/1999	11:16	3.6	5.0	4.3	1.4	0.3	4.3		2.0	SIFS,PB	BIO/PHY,SH	NONE	NONE	MAT	4	3	0	0	II	6	
NF20	3	08/24/1999	11:18	7.7	9.1	8.4	3.2	0.6	7.3		2.9	SIFS,PB	BIO/PHY	NONE	NONE	MAT	2	1	0	0	II	7	Worm on surface
NF21	1	08/24/1999	13:01	20.3	20.9	20.6	0.6	0.7	11.6		2.3	SIFS	BIO	NONE	NONE	MAT	4	8	3	2	III	9	
NF21	2	08/24/1999	13:05	18.3	18.9	18.6	0.6	0.5	5.8		2.0	SIFS	BIO	NONE	NONE	MAT	8	9	5	1	III	8	Cut large burrow
NF21	3	08/24/1999	13:08	11.7	14.3	13.0	2.6	0.1	2.6		0.9	SIFS	BIO	NONE	NONE	MAT	9	8	0	0	II/III	6	
NF22	1	08/24/1999	9:20	14.7	17.4	16.0	2.7	0.3	2.9		1.9	SIFS	BIO	NONE	NONE	MAT	15	7	2	1	II/III	7	
NF22	2	08/24/1999	9:23	13.9	14.8	14.3	0.9	0.3	6.8		2.4	SIFS	BIO	NONE	NONE	MAT	5	5	2	0	III	9	Large burrow cut
NF22	3	08/24/1999	9:33	8.6	9.7	9.2	1.1	0.4	5.9		1.9	SIFS	BIO	NONE	NONE	MAT	5	4	1	0	II/III	7	Large burrow opening, Cerianthid in burrow
NF23	1	08/24/1999	13:40	3.2	4.3	3.7	1.1	.	.	>	3.7	FSMS,PB	BIO/PHY,BF ?	NONE	NONE	SOME	0	0	0	0	II	8	
NF23	2	08/24/1999	13:46	1.6	3.8	2.7	2.2	.	.	>	2.7	PB,GR,FS	BIO/PHY,SH	NONE	NONE	MANY	0	0	0	0	I/II	6	Calcarious tubes
NF23	3	08/24/1999	13:47	6.9	8.0	7.5	3.8	0.9	6.1		4.4	PB,FSSICL	BIO/PHY,SH	NONE	NONE	MANY	2	0	0	0	I/II	8	Caprellid amphipod
NF23	4	08/24/1999	13:52	1.5	3.6	2.6	2.0	.	.	>	2.6	GR,FS,SH	BIO/PHY,SH	NONE	NONE	SOME	0	0	0	0	I/II	6	
NF24	1	08/24/1999	10:08	14.5	15.4	14.9	0.9	0.2	4.4		1.1	SIFS	BIO	NONE	NONE	MAT	7	7	4	2	II/III	6	
NF24	2	08/24/1999	10:11	6.5	7.0	6.7	0.5	0.2	4.8		1.6	FSSICL	BIO	NONE	NONE	MANY	14	8	0	0	II	6	
NF24	3	08/24/1999	10:14	0.0	6.7	0.0	6.7	.	.	IND	.	PB,FSSI	PHY	NONE	NONE	MANY	.	.	.	.	.	IND	Hydroid like organism, Tubes on pebbles
NF24	4	08/24/1999	10:16	0.0	3.8	0.0	3.8	.	.	IND	.	PB	PHY	NONE	NONE	MANY	.	.	.	.	.	IND	Tubes on pebbles

APPENDIX B-2

Summary of quantitative SPI parameters for the August 1999 Nearfield stations.

Prism Penetration									
Station	**N**	**Mean (cm)**	**Median (cm)**	**Min. (cm)**	**Max. (cm)**	**SD (cm)**	**SE (cm)**	**CV (%)**	**Max-Min/Md (%)**
FF10	3	4.1	5.2	0.0	7.1	3.7	2.1	89.8	136.5
FF12	3	4.6	4.6	4.3	4.8	0.3	0.1	5.5	10.9
FF13	5	1.7	2.3	0.0	3.3	1.6	0.7	93.8	143.5
NF02	4	0.5	0.0	0.0	1.9	1.0	0.5	200.0	.
NF04	3	3.5	3.2	3.1	4.2	0.6	0.4	17.4	34.4
NF05	3	5.3	4.9	4.2	6.7	1.3	0.7	24.5	51.0
NF07	3	13.9	14.7	12.2	14.9	1.5	0.9	10.8	18.4
NF08	3	21.6	23.3	17.7	23.7	3.4	1.9	15.5	25.8
NF09	3	11.6	10.9	10.8	13.2	1.4	0.8	11.7	22.0
NF10	3	12.2	12.1	10.4	14.0	1.8	1.0	14.8	29.8
NF12	3	21.0	20.9	19.8	22.3	1.3	0.7	6.0	12.0
NF13	3	2.7	2.8	2.5	2.8	0.2	0.1	6.4	10.7
NF14	3	5.8	5.5	4.9	6.9	1.0	0.6	17.8	36.4
NF15	3	4.7	3.7	3.3	7.2	2.2	1.2	45.5	105.4
NF16	3	16.2	17.0	13.8	17.8	2.1	1.2	13.1	23.5
NF17	3	4.0	3.4	3.3	5.2	1.1	0.6	26.9	55.9
NF18	3	8.9	9.0	7.4	10.3	1.5	0.8	16.3	32.2
NF19	3	3.3	3.2	3.1	3.5	0.2	0.1	6.4	12.5
NF20	3	6.0	5.2	4.3	8.4	2.2	1.2	36.0	78.8
NF21	3	17.4	18.6	13.0	20.6	3.9	2.3	22.6	40.9
NF22	3	13.2	14.3	9.2	16.0	3.5	2.0	26.9	47.6
NF23	4	4.1	3.2	2.6	7.5	2.3	1.2	55.7	153.1
NF24	4	5.4	3.4	0.0	14.9	7.1	3.5	131.1	444.8

Surface Relief									
Station	**N**	**Mean (cm)**	**Median (cm)**	**Min. (cm)**	**Max. (cm)**	**SD (cm)**	**SE (cm)**	**CV (%)**	**Max-Min/Md (%)**
FF10	3	4.1	1.8	0.9	9.5	4.7	2.7	116.2	477.8
FF12	3	0.5	0.5	0.3	0.7	0.2	0.1	40.0	80.0
FF13	5	2.9	1.9	0.3	8.0	3.1	1.4	105.5	405.3
NF02	4	6.8	5.2	3.4	13.4	4.6	2.3	68.3	194.2
NF04	3	0.9	0.6	0.6	1.4	0.5	0.3	53.3	133.3
NF05	3	1.0	0.9	0.8	1.4	0.3	0.2	31.1	66.7
NF07	3	1.0	1.2	0.3	1.6	0.7	0.4	64.5	108.3
NF08	3	0.7	0.8	0.5	0.8	0.2	0.1	24.7	37.5
NF09	3	1.7	1.7	1.3	2.2	0.5	0.3	26.0	52.9
NF10	3	1.1	1.1	0.6	1.6	0.5	0.3	45.5	90.9
NF12	3	1.7	1.3	1.2	2.5	0.7	0.4	43.4	100.0
NF13	3	1.3	1.1	0.6	2.2	0.8	0.5	63.0	145.5
NF14	3	1.2	0.8	0.7	2.0	0.7	0.4	62.0	162.5
NF15	3	1.3	1.0	0.7	2.1	0.7	0.4	58.2	140.0
NF16	3	2.6	2.9	0.7	4.3	1.8	1.1	68.8	124.1
NF17	3	1.3	0.9	0.9	2.0	0.6	0.4	50.1	122.2
NF18	3	2.5	1.7	1.2	4.6	1.8	1.1	73.6	200.0
NF19	3	1.1	1.0	0.6	1.8	0.6	0.4	53.9	120.0
NF20	3	2.1	1.8	1.4	3.2	0.9	0.5	44.3	100.0
NF21	3	1.3	0.6	0.6	2.6	1.2	0.7	91.2	333.3
NF22	3	1.6	1.1	0.9	2.7	1.0	0.6	63.0	163.6
NF23	4	2.3	2.1	1.1	3.8	1.1	0.6	49.4	128.6
NF24	4	3.0	2.4	0.5	6.7	2.9	1.4	97.3	263.8

Apparent Color RPD Layer Depth									
Station	**N**	**Mean (cm)**	**Median (cm)**	**Min. (cm)**	**Max. (cm)**	**SD (cm)**	**SE (cm)**	**CV (%)**	**Max-Min/Md (%)**
FF10	2	2.2	2.2	2.2	2.2	0.0	0.0	0.0	0.0
FF12	3	1.6	1.7	1.3	1.9	0.3	0.2	18.7	35.3
FF13	3	1.5	1.2	1.0	2.4	0.8	0.4	49.4	116.7
NF02	1	2.1	2.1	2.1	2.1	.	.	.	.
NF04	3	>3.5	>3.2	>3.1	>4.2	0.6	0.4	17.4	34.4
NF05	3	2.7	2.3	2.2	3.5	0.7	0.4	27.1	56.5
NF07	3	1.6	1.6	1.0	2.1	0.6	0.3	35.2	68.8
NF08	3	1.7	1.7	1.5	1.9	0.2	0.1	11.8	23.5
NF09	3	1.9	2.0	1.4	2.3	0.5	0.3	24.1	45.0
NF10	3	1.9	1.6	1.6	2.5	0.5	0.3	27.4	56.3
NF12	3	1.9	1.8	1.3	2.5	0.6	0.3	32.3	66.7
NF13	3	>2.7	>2.8	>2.5	>2.8	0.2	0.1	6.4	10.7
NF14	3	3.2	3.0	2.1	4.6	1.3	0.7	39.2	83.3
NF15	3	2.3	2.3	2.1	2.5	0.2	0.1	8.7	17.4
NF16	3	1.8	1.9	1.2	2.2	0.5	0.3	29.0	52.6
NF17	3	>4.0	>3.4	>3.3	>5.2	1.1	0.6	26.9	55.9
NF18	3	2.7	2.6	2.5	2.9	0.2	0.1	7.8	15.4
NF19	3	1.5	1.5	1.3	1.6	0.2	0.1	10.4	20.0
NF20	3	2.8	2.9	2.0	3.4	0.7	0.4	25.6	48.3
NF21	3	1.7	2.0	0.9	2.3	0.7	0.4	42.5	70.0
NF22	3	2.1	1.9	1.9	2.4	0.3	0.2	14.0	26.3
NF23	4	>3.4	>3.2	>2.6	>4.4	0.9	0.4	25.6	56.3
NF24	2	1.4	1.4	1.1	1.6	0.4	0.3	26.2	37.0

Infaunal Worms									
Station	**N**	**Mean (cm)**	**Median (cm)**	**Min. (cm)**	**Max. (cm)**	**SD (cm)**	**SE (cm)**	**CV (%)**	**Max-Min/Md (%)**
FF10	2	4.0	4.0	1.0	7.0	4.2	3.0	106.0	150.0
FF12	3	8.0	9.0	1.0	14.0	6.6	3.8	82.0	144.4
FF13	3	3.3	0.0	0.0	10.0	5.8	3.3	173.3	.
NF02	0	.	.	.	.	.	.	.	.
NF04	3	0.3	0.0	0.0	1.0	0.6	0.3	173.3	.
NF05	3	4.0	4.0	3.0	5.0	1.0	0.6	25.0	50.0
NF07	3	7.0	7.0	3.0	11.0	4.0	2.3	57.1	114.3
NF08	3	7.3	7.0	6.0	9.0	1.5	0.9	20.8	42.9
NF09	3	8.3	7.0	4.0	14.0	5.1	3.0	61.6	142.9
NF10	3	10.3	10.0	7.0	14.0	3.5	2.0	34.0	70.0
NF12	3	8.0	8.0	8.0	8.0	0.0	0.0	0.0	0.0
NF13	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF14	3	1.0	1.0	0.0	2.0	1.0	0.6	100.0	200.0
NF15	3	1.7	1.0	0.0	4.0	2.1	1.2	124.6	400.0
NF16	3	8.7	8.0	6.0	12.0	3.1	1.8	35.3	75.0
NF17	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF18	3	2.3	2.0	1.0	4.0	1.5	0.9	65.5	150.0
NF19	3	4.0	3.0	2.0	7.0	2.7	1.5	66.3	166.7
NF20	3	2.0	2.0	0.0	4.0	2.0	1.2	100.0	200.0
NF21	3	7.0	8.0	4.0	9.0	2.7	1.5	37.9	62.5
NF22	3	8.3	5.0	5.0	15.0	5.8	3.3	69.3	200.0
NF23	4	0.5	0.0	0.0	2.0	1.0	0.5	200.0	.
NF24	2	10.5	10.5	7.0	14.0	5.0	3.5	47.1	66.7

Infaunal Burrows									
Station	**N**	**Mean** (cm)	**Median** (cm)	**Min.** (cm)	**Max.** (cm)	**SD** (cm)	**SE** (cm)	**CV** (%)	**Max-Min/Md** (%)
FF10	2	1.5	1.5	0.0	3.0	2.1	1.5	141.3	200.0
FF12	3	6.7	6.0	5.0	9.0	2.1	1.2	31.2	66.7
FF13	3	1.7	0.0	0.0	5.0	2.9	1.7	173.1	.
NF02	0	*	*	*	*	*	*	.	.
NF04	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF05	3	4.3	5.0	2.0	6.0	2.1	1.2	48.0	80.0
NF07	3	9.3	8.0	8.0	12.0	2.3	1.3	24.8	50.0
NF08	3	6.7	7.0	5.0	8.0	1.5	0.9	22.9	42.9
NF09	3	5.3	5.0	5.0	6.0	0.6	0.3	10.8	20.0
NF10	3	8.0	8.0	8.0	8.0	0.0	0.0	0.0	0.0
NF12	3	5.7	6.0	4.0	7.0	1.5	0.9	27.0	50.0
NF13	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF14	3	1.0	1.0	0.0	2.0	1.0	0.6	100.0	200.0
NF15	3	2.0	0.0	0.0	6.0	3.5	2.0	173.0	.
NF16	3	5.3	5.0	3.0	8.0	2.5	1.5	47.3	100.0
NF17	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF18	3	2.7	2.0	1.0	5.0	2.1	1.2	77.9	200.0
NF19	3	6.3	6.0	4.0	9.0	2.5	1.5	39.8	83.3
NF20	3	1.3	1.0	0.0	3.0	1.5	0.9	114.6	300.0
NF21	3	8.3	8.0	8.0	9.0	0.6	0.3	6.9	12.5
NF22	3	5.3	5.0	4.0	7.0	1.5	0.9	28.7	60.0
NF23	4	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF24	2	7.5	7.5	7.0	8.0	0.7	0.5	9.4	13.3

Oxic Voids									
Station	**N**	**Mean (cm)**	**Median (cm)**	**Min. (cm)**	**Max. (cm)**	**SD (cm)**	**SE (cm)**	**CV (%)**	**Max-Min/Md (%)**
FF10	2	0.0	0.0	0.0	0.0	0.0	0.0	.	.
FF12	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
FF13	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF02	0	.	.	.	.	.	.	.	.
NF04	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF05	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF07	3	1.3	1.0	1.0	2.0	0.6	0.3	43.3	100.0
NF08	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF09	3	2.7	2.0	2.0	4.0	1.2	0.7	43.3	100.0
NF10	3	2.3	2.0	1.0	4.0	1.5	0.9	65.5	150.0
NF12	3	4.7	5.0	4.0	5.0	0.6	0.3	12.4	20.0
NF13	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF14	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF15	3	0.3	0.0	0.0	1.0	0.6	0.3	173.3	.
NF16	3	1.7	1.0	0.0	4.0	2.1	1.2	124.6	400.0
NF17	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF18	3	1.7	2.0	0.0	3.0	1.5	0.9	91.7	150.0
NF19	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF20	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF21	3	2.7	3.0	0.0	5.0	2.5	1.5	94.4	166.7
NF22	3	1.7	2.0	1.0	2.0	0.6	0.3	34.6	50.0
NF23	4	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF24	2	2.0	2.0	0.0	4.0	2.8	2.0	141.5	200.0

Anaerobic Voids									
Station	**N**	**Mean (cm)**	**Median (cm)**	**Min. (cm)**	**Max. (cm)**	**SD (cm)**	**SE (cm)**	**CV (%)**	**Max-Min/Md (%)**
FF10	2	0.0	0.0	0.0	0.0	0.0	0.0	.	.
FF12	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
FF13	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF02	0	.	.	.	.	.	.	.	.
NF04	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF05	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF07	3	0.3	0.0	0.0	1.0	0.6	0.3	173.3	.
NF08	3	0.3	0.0	0.0	1.0	0.6	0.3	173.3	.
NF09	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF10	3	0.3	0.0	0.0	1.0	0.6	0.3	173.3	.
NF12	3	0.3	0.0	0.0	1.0	0.6	0.3	173.3	.
NF13	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF14	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF15	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF16	3	1.0	0.0	0.0	3.0	1.7	1.0	173.0	.
NF17	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF18	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF19	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF20	3	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF21	3	1.0	1.0	0.0	2.0	1.0	0.6	100.0	200.0
NF22	3	0.3	0.0	0.0	1.0	0.6	0.3	173.3	.
NF23	4	0.0	0.0	0.0	0.0	0.0	0.0	.	.
NF24	2	1.0	1.0	0.0	2.0	1.4	1.0	141.0	200.0

Organism Sediment Index									
Station	**N**	**Mean (cm)**	**Median (cm)**	**Min. (cm)**	**Max. (cm)**	**SD (cm)**	**SE (cm)**	**CV (%)**	**Max-Min/Md (%)**
FF10	2	6.0	6.0	6.0	6.0	0.0	0.0	0.0	0.0
FF12	3	6.7	7.0	6.0	7.0	0.6	0.3	8.7	14.3
FF13	3	5.7	5.0	5.0	7.0	1.2	0.7	20.4	40.0
NF02	0	.	.	.	.	.	.	.	.
NF04	3	8.3	8.0	8.0	9.0	0.6	0.3	6.9	12.5
NF05	3	7.0	7.0	6.0	8.0	1.0	0.6	14.3	28.6
NF07	3	6.3	6.0	6.0	7.0	0.6	0.3	9.1	16.7
NF08	3	5.7	6.0	5.0	6.0	0.6	0.3	10.2	16.7
NF09	3	8.0	8.0	7.0	9.0	1.0	0.6	12.5	25.0
NF10	3	8.3	8.0	8.0	9.0	0.6	0.3	6.9	12.5
NF12	3	8.0	8.0	7.0	9.0	1.0	0.6	12.5	25.0
NF13	3	7.0	7.0	7.0	7.0	0.0	0.0	0.0	0.0
NF14	3	8.0	7.0	7.0	10.0	1.7	1.0	21.6	42.9
NF15	3	6.7	7.0	6.0	7.0	0.6	0.3	8.7	14.3
NF16	3	7.0	8.0	5.0	8.0	1.7	1.0	24.7	37.5
NF17	2	8.5	8.5	8.0	9.0	0.7	0.5	8.3	11.8
NF18	3	6.7	7.0	6.0	7.0	0.6	0.3	8.7	14.3
NF19	3	5.3	5.0	5.0	6.0	0.6	0.3	10.8	20.0
NF20	3	7.0	7.0	6.0	8.0	1.0	0.6	14.3	28.6
NF21	3	7.7	8.0	6.0	9.0	1.5	0.9	19.9	37.5
NF22	3	7.7	7.0	7.0	9.0	1.2	0.7	15.1	28.6
NF23	4	7.0	7.0	6.0	8.0	1.2	0.6	16.5	28.6
NF24	2	6.0	6.0	6.0	6.0	0.0	0.0	0.0	0.0

APPENDIX C-1

Station Mean Values (dry weight basis) for Bulk Sediment Properties and *Clostridium perfringens* Determined in 1999.

Station	Gravel PCT	Sand PCT	Gravel + Sand PCT	Silt PCT	Clay PCT	Fines PCT	Mean phi PCT	TOC PCT	*Clostridium perfringens* #/GDW
Farfield									
FF01A	0.05	86.9	86.9	11.3	1.8	13.1	3.28	0.42	645
FF04	0	5.05	5.05	56.9	38.1	95	6.98	2.35	1910
FF05	0.3	46.2	46.5	39.3	14.3	53.6	4.97	0.625	630
FF06	0	33.9	33.9	44	22.2	66.1	5.77	0.85	995
FF07	0	8	8	59.6	32.5	92.1	6.72	2.43	980
FF09	0.3	82.3	82.6	9.6	7.8	17.4	3.64	0.33	415
FF11	0.1	20.5	20.6	73.6	5.85	79.4	5.61	1.73	1290
FF14	1.3	23.5	24.8	65.4	9.9	75.3	5.49	1.31	1130
Nearfield									
NF02	1.4	93.9	95.3	2.5	2.3	4.8	1.79	0.15	480
NF04	0.1	94.6	94.7	3	2.2	5.2	2.62	0.14	165
NF05	1	82	83	14.6	2.43	17	3.19	0.4	930
NF07	1.8	64.8	66.6	23.4	9.93	33.3	3.85	0.84	1980
NF08	2.03	26.3	28.4	59.6	12	71.6	5.48	1.11	3660
NF09	0.4	61.2	61.6	27.3	11.1	38.4	3.96	0.5	1600
NF10	0.2	58.7	58.9	34.3	6.8	41.1	4.54	0.87	1870
NF12	0	26.5	26.5	55.2	18.4	73.5	5.77	1.47	3250
NF13	0.1	94.4	94.5	2.3	3.2	5.5	2.45	0.23	210
NF14	13.1	76.6	89.7	8.4	1.9	10.3	1.86	1.03	700
NF15	4	84.6	88.6	11.1	0.4	11.5	2.49	0.88	750
NF16	1.2	66.5	67.7	26	6.3	32.3	3.59	0.74	2320
NF17	0.05	98.7	98.8	0.65	0.6	1.25	2.19	0.085	140
NF18	51.2	38.2	89.4	8.9	1.8	10.7	0.623	0.59	930
NF19	2.3	82.2	84.5	9.5	6	15.5	3.06	0.5	480
NF20	11.4	66.4	77.8	14.7	7.5	22.2	2.82	0.74	2280
NF21	0	39.4	39.4	50.4	10.3	60.7	5.27	1.5	2470
NF22	3.97	52.8	56.7	32.2	11.1	43.3	4.32	0.88	2660
NF23	21.1	77.4	98.5	0.8	0.8	1.6	1.35	0.24	290
NF24	0.167	37.5	37.6	47.7	14.7	62.4	5.19	1.15	2140
FF10	21.1	59.6	80.7	15	4.33	19.3	2.97	0.54	1190
FF12	5	69.7	74.7	17.3	8	25.3	3.82	0.485	3230
FF13	2.7	42.7	45.4	36.1	18.6	54.7	4.88	1.16	4930

APPENDIX C-2

Station Mean Values (dry weight basis) for Organic Contaminant Parameters Determined in 1999.

Station	Total PAH ng/g	*Total PCB* ng/g	Total Pesticide ng/g	Total DDT ng/g	Total Chlordane ng/g	Total LAB ng/g
Farfield						
FF01A	1770	6.69	0.0652	1.75	0.0995	15.4
FF04	2190	6.92	0.482	4.06	0.154	31.5
FF05	696	3.57	0.174	1.59	0	22.4
FF06	1340	7.38	0.493	3.11	0.144	33
FF07	1780	10.1	0.44	4.98	0.314	44.8
FF09	652	2.56	0.177	0.709	0.051	15.3
FF11	3300	7.46	0.169	3.17	0.115	29.4
FF14	2310	29.1	0.134	2.41	0.158	28.4
Nearfield						
NF02	362	2.95	0	0.766	0.118	25.3
NF04	305	1.37	0	0.394	0.127	9.54
NF05	2360	6.62	0	1.45	0.124	27.5
NF07	17800	24.4	0	2.5	0	58.1
NF08	7400	18.7	0.0824	6.32	0.378	128
NF09	4780	9.42	0	1.44	0.0538	49.8
NF10	5530	7.64	0	3.03	0.166	46.6
NF12	14800	16.5	0	5.26	0.283	95.8
NF13	549	0.872	0	0.065	0	10.4
NF14	14700	3.59	0	3.42	0.0197	52.9
NF15	4350	5.44	0	1.48	0.759	35.4
NF16	5960	13.1	0.0566	1.56	0.221	88.4
NF17	159	0.721	0	0	0	7.78
NF18	1480	4.09	0	1.4	0.0939	20.1
NF19	1450	3.94	0	0.792	0	27.7
NF20	3270	9.97	0.115	3.03	0.122	68.4
NF21	17200	39.3	0.412	4.12	0.369	103
NF22	4430	12.1	0.176	2.56	0.238	91.3
NF23	578	2.06	0.0291	1.89	0	10.1
NF24	7260	12.6	0	6.28	0.127	72.7
FF10	3230	2.62	0	0.587	0.0281	25.6
FF12	2630	8.05	0	1.42	0.0929	50.5
FF13	2480	22.5	0.468	3.25	0.438	242

APPENDIX C-3

Station Mean Values (dry weight basis) for Metal Contaminant Parameters Determined in 1999.

Station	Al %	*Cd* µg/g	Cr µg/g	Cu µg/g	Fe %	Pb µg/g	Hg µg/g	Ni µg/g	Ag µg/g	Zn µg/g
Farfield										
FF01A	4.44	0.0658	19.8	9	1.34	26.1	0.0437	8.6	0.214	35.9
FF04	7.88	0.0915	107	27.2	3.85	53.1	0.212	31.3	0.344	105
FF05	5.7	0.056	45.1	14.3	1.9	28.4	0.0904	13.9	0.219	47.8
FF06	5.14	0.0366	55.2	16.6	2.54	38.4	0.166	18.4	0.395	72.8
FF07	6.58	0.148	88.9	25.8	3.67	45.1	0.201	31.7	0.492	97.8
FF09	5.31	0.0544	39.4	9.85	1.77	27.6	0.0765	14.3	0.21	36.7
FF11	5.13	0.138	66	20.3	2.95	36.2	0.132	23.2	0.256	78.4
FF14	5.5	0.0675	71.5	19.7	2.67	40.2	0.13	23.3	0.242	72
Nearfield										
NF02	5.21	0.00639	49.1	17.4	2.89	31.8	0.113	19.4	0.341	62.9
NF04	3.08	0.0451	28.5	10.4	1.54	25.6	0.0402	8.4	0.199	27.3
NF05	4.03	0.0967	62.6	17	2.08	28	0.099	14.3	0.228	42.7
NF07	6.42	0.104	56	32.1	2.27	51.3	0.261	16.9	0.298	70.5
NF08	5.52	0.221	95.4	32.4	2.61	50.9	0.311	19.1	0.918	79.4
NF09	5.12	0.105	61	27.2	2.18	40.5	0.207	19	0.392	62.5
NF10	5.19	0.0319	76	25.5	2.38	39.1	0.213	15.2	0.416	66.3
NF12	5.81	0.132	95.7	35.9	2.96	64.5	0.445	27.1	0.622	86.2
NF13	3.15	0.0845	28.3	10.1	1.58	30	0.0606	7.9	0.153	32.3
NF14	4.04	0	38.6	18.4	1.57	60	0.17	10.8	0.304	32.8
NF15	4.13	0	31.8	31.5	1.46	54.5	0.138	9.4	0.254	37.3
NF16	5.16	0.0471	65.5	29.7	2.54	44.6	0.254	21.5	0.692	67.9
NF17	3.77	0.0347	30.4	9.15	1.92	34.4	0.0464	6.6	0.193	29
NF18	4.43	0.0286	41.7	17	1.99	55.9	0.156	7.3	0.328	44.1
NF19	4.35	0.0498	47.6	9.9	1.93	29.9	0.121	12.2	0.278	37.5
NF20	4.84	0.0363	51.5	21.1	2.54	44.2	0.206	19	0.643	57.8
NF21	5.77	0.126	93.5	28.5	2.66	55.8	0.382	19.8	0.616	79.1
NF22	6.01	0.109	74	25.4	2.66	45.9	0.381	23.2	0.66	65.6
NF23	4.26	0.0205	33.7	10.4	2.14	27.4	0.0588	10.4	0.166	39.9
NF24	5.74	0.103	83	32.9	2.73	68.3	0.362	24.2	0.488	79.1
FF10	5.07	0.0713	56.9	20.6	2.05	28.5	0.107	17.7	0.269	55.9
FF12	4.79	0.0981	52.1	19.2	2.17	36.9	0.18	17.1	0.478	53.5
FF13	5.1	0.192	72.6	28.8	2.91	46.6	0.365	23.2	1.34	76

APPENDIX D-1

List of 1999 Taxonomists

Taxonomic Responsibilities for the Massachusetts Bay Nearfield Samples, August 1999

Taxonomist	Groups Identified
Suzanne L. Arcuri (Cove Corporation)	• Polychaeta: Amphinomidae, Capitellidae, Cossuridae, Lumbrineridae, Nephtyidae, Opheliidae, Pectinariidae, Pholoidae, Polygordiidae, Scalibregmatidae, Sphaerodoridae, Sternaspidae, and Trochochaetidae
Lawrence L. Lovell (Scripps Institution of Oceanography)	• Polychaeta: Maldanidae and Paraonidae
C. Timothy Morris (Cove Corporation)	• Arthropoda (all stations with one replicate) • Polychaeta: Aphroditidae, Chrysopetalidae, Dorvilleidae, Glyceridae, Hesionidae, Nereididae, Oenonidae, Orbiniidae, and Spionidae
Nancy K. Mountford (Cove Corporation)	• Mollusca • Polychaeta: Ampharetidae, Apistobranchidae, Flabelligeridae, Goniadidae, Oweniidae, Phyllodocidae, and Syllidae
C. Anthony Phillips (Environmental Monitoring Division)	• Polychaeta: Cirratulidae
R. Eugene Ruff (Ruff Systematics)	• Polychaeta: Polynoidae, Sabellidae, Terebellidae, and Trichobranchidae
Isabelle P. Williams (ENSR)	• Arthropoda (all stations with three replicates)
Paula Winchell (ENSR)	• Anthozoa • Ascidiacea • Echinodermata • Echiura • Enteropneusta • Nemertea • Phoronida • Sipuncula • Turbellaria
Russell D. Winchell (Ocean's Taxonomic Services)	• Oligochaeta

Taxonomic Responsibilities for the Massachusetts Bay Farfield Samples, August 1999

Taxonomist	Groups Identified
Suzanne L. Arcuri (Cove Corporation)	• Polychaeta: Amphinomidae, Capitellidae, Cossuridae, Goniadidae, Lumbrineridae, Nephtyidae, Opheliidae, Pectinariidae, Pholoidae, Polygordiidae, Scalibregmatidae, Sphaerodoridae, Sternaspidae, and Trochochaetidae
Lawrence L. Lovell (Scripps Institution of Oceanography)	• Polychaeta: Maldanidae and Paraonidae
C. Timothy Morris (Cove Corporation)	• Arthropoda (stations FF07, FF09, FF11, & FF14) • Polychaeta: Aphroditidae, Chaetopteridae, Chrysopetalidae, Dorvilleidae, Glyceridae, Hesionidae, Nereididae, Oenonidae, Orbiniidae, and Spionidae
Nancy K. Mountford (Cove Corporation)	• Mollusca • Polychaeta: Ampharetidae, Apistobranchidae, Flabelligeridae, Oweniidae, Phyllodocidae, and Syllidae
C. Anthony Phillips (Environmental Monitoring Division)	• Polychaeta: Cirratulidae
R. Eugene Ruff (Ruff Systematics)	• Polychaeta: Polynoidae, Sabellidae, Terebellidae, and Trichobranchidae
Isabelle P. Williams (ENSR)	• Arthropoda (stations FF01A, FF04, FF05, & FF06)
Paula Winchell (ENSR)	• Anthozoa • Ascidiacea • Echinodermata • Echiura • Enteropneusta • Nemertinea • Phoronida • Sipuncula • Turbellaria
Russell D. Winchell (Ocean's Taxonomic Services)	• Oligochaeta

APPENDIX D-2

Preliminary Data Treatments

1. The May 1992 (S9202) data were excluded from the analyses.
2. Station FF08 data were excluded from the analyses.
3. Stations FF10, FF12, and FF13 were included in the Nearfield analyses; but not included in the Farfield analyses.
4. The following taxa were excluded from the analyses:

CODE	DESCR
36SPP	PORIFERA SPP.
3701SPP	HYDROZOA SPP.
3703250104	CORYMORPHA PENDULA
5103640204	CREPIDULA FORNICATA
51036402SPP	CREPIDULA SPP.
53SPP	POLYPLACOPHORA SPP.
5507010101	MYTILUS EDULIS
55070101SPP	MYTILUS SPP.
5507010601	MODIOLUS MODIOLUS
6134020104	BALANUS CRENATUS
61340201SPP	BALANUS SPP.
6151SPP	MYSIDACEA SPP.
6153011401	MYSIS MIXTA
6153011508	NEOMYSIS AMERICANA
6153012301	ERYTHROPS ERYTHROPHTHALMA
6161050101	LIMNORIA LIGNORUM
6183060226	PAGURUS ACADIANUS
61830602SPP	PAGURUS SPP.

5. The following taxa were merged for these analyses

Merge This		With This	
CODE	DESCR	CODE	DESCR
3901SP01	Turbellaria sp. 1	3901SPP	Turbellaria spp.
3901SP02	Turbellaria sp. 2	3901SPP	Turbellaria spp.
43060602SPP	Tetrastemma spp.	4306060216	Tetrastemma vittatum
50010601SPP	Pholoe spp.	5001060101	Pholoe minuta
50010601TECT	Pholoe tecta	5001060101	Pholoe minuta
50013614SP01	Parougia sp. 1	50013614CAEC	Parougia caeca
50013614SP02	Parougia sp. 2	50013614CAEC	Parougia caeca
50014108SPP	Levinsenia spp.	5001410801	Levinsenia gracilis
50014201SPP	Apistobranchus spp.	5001420103	Apistobranchus typicus
5001420101	Apistobranchus tullbergi	5001420103	Apistobranchus typicus
500152SPP	Cossuridae spp.	5001520101	Cossura longocirrata
5001540202	Flabelligera affinis	50015402 SPP	Flabelligera spp.
500157SPP	Scalibregmatidae spp.	5001570101	Scalibregma inflatum
50016303SPP	Maldane spp.	5001630301	Maldane sarsi
5001630302	Maldane glebifex	5001630301	Maldane sarsi
5001631102CF	Euclymene cf. collaris	5001631102	Euclymene collaris
50016312SPP	Clymenura spp.	50016312SP01	Clymenura sp. A
5001631202	Clymenura polaris	50016312SP01	Clymenura sp. A
50016402SPP	Myriochele spp.	5001640201	Myriochele heeri
50016817SP01	Proclea sp. 1	5001681702	Proclea graffii
51021004SPP	Solariella spp.	5102100402	Solariella obscura
5103760402CF	Polinices cf. pallidus	5103760402	Polinices pallidus
5502040220CF	Nuculana nr. messanensis	5502040220	Nuculana messanensis
55152903SPP	Ensis spp.	5515290301	Ensis directus
55200502SPP	Lyonsia spp.	5520050201	Lyonsia arenosa
61692107SPP	Gammarus	6169210602	Gammarus angulosus
74SPP	Priapulida spp.	7400010101	Priapulus caudatus

6. The following taxa were treated as species-level taxa for these analyses:

CODE	DESCR
3901SPP	Turbellaria spp.
43030205SPP	Micrura spp.
50010101SPP	Aphrodita spp.
50015402 SPP	Flabelligera spp.
51050103SPP	Urosalpinx spp.
51050508SPP	Neptunea spp.

7. Total abundance for each 1999 and 1992–1999 sample was calculated including all taxa
8. Dominance per station was calculated for 1999 data only. All taxa were included. The mean and standard deviation abundance per sample was calculated for replicated stations.
9. The abundance (all taxa) and number of species (good species) of major taxa for 1999 data only — Annelida (MWRA codes 50*), Arthropoda (MWRA codes 60* and 61*), Mollusca (MWRA codes 51*, 54*, 55*, and 56*), Other (MWRA codes 37*, 39*, 43*, 72*, 73*, 74*, 77*, 81*, 82*, and 84*) were calculated.

APPENDIX D-3

BioDiversity Pro Validation Data

Gallagher Calculations							BioDiversity Pro Calculations				
Site	**Rep**	**Total Ind**	**Total Spp**	***H'***	***J'***	**Log Series alpha**	**Log Series alpha**	**Total Ind**	**Total Spp**	***H'***	***J'***
FF10	1	3155	96	4.09	0.62	18.70	18.72	3155	96	4.09	0.62
FF10	2	1918	87	3.94	0.61	18.76	18.78	1918	87	3.94	0.61
FF10	3	2996	91	4.23	0.65	17.72	17.74	2996	91	4.23	0.65
FF12	1	2801	65	3.32	0.55	11.89	11.91	2801	65	3.33	0.55
FF12	2	2540	61	3.21	0.54	11.25	11.26	2540	61	3.22	0.54
FF12	3	1743	53	3.17	0.55	10.32	10.33	1743	53	3.17	0.55
FF13	1	2760	55	2.55	0.44	9.73	9.74	2760	55	2.55	0.44
FF13	2	4351	54	2.58	0.45	8.68	8.70	4351	54	2.59	0.45
FF13	3	2418	62	3.11	0.52	11.60	11.61	2418	62	3.11	0.52
NF02	1	1053	53	3.61	0.63	11.76	11.77	1053	53	3.61	0.63
NF04	1	1891	90	4.60	0.71	19.67	19.68	1891	90	4.6	0.71
NF05	1	1220	81	4.84	0.76	19.51	19.52	1220	81	4.84	0.76
NF07	1	2817	91	3.68	0.57	17.98	18.00	2817	91	3.68	0.57
NF08	1	2399	68	3.03	0.50	13.02	13.04	2399	68	3.03	0.50
NF09	1	1573	80	4.29	0.68	17.81	17.82	1573	80	4.29	0.68
NF10	1	2218	79	4.28	0.68	15.99	16.01	2218	79	4.28	0.68
NF12	1	3115	90	4.38	0.68	17.31	17.33	3115	90	4.38	0.68
NF12	2	2440	85	4.23	0.66	17.11	17.13	2440	85	4.23	0.66
NF12	3	2505	79	4.39	0.70	15.52	15.54	2505	79	4.39	0.70
NF16	1	2148	64	3.39	0.56	12.40	18.03	1785	83	4.11	0.65

APPENDIX D-4

Twelve Most Abundant Taxa, 1999

Station	Taxon	Mean	StDev	%	Cum %	98 Rank
FF01A	PRIONOSPIO STEENSTRUPI	2278.7	287.83	57.55%	57.55%	1
	DIPOLYDORA SOCIALIS	369.0	116.92	9.32%	66.87%	
	SPIOPHANES BOMBYX	123.3	6.43	3.11%	69.98%	3
	CERASTODERMA PINNULATUM	119.3	59.48	3.01%	72.99%	
	EUCHONE INCOLOR	84.0	37.59	2.12%	75.12%	
	NUCULA DELPHINODONTA	82.0	22.61	2.07%	77.19%	2
	HIATELLA ARCTICA	75.3	65.96	1.90%	79.09%	
	LEVINSENIA GRACILIS	74.3	22.48	1.88%	80.97%	6
	PHYLLODOCE MUCOSA	53.7	34.96	1.36%	82.32%	
	THARYX ACUTUS	51.0	8.72	1.29%	83.61%	4
	PHOLOE MINUTA	44.7	15.50	1.13%	84.74%	
	MEDIOMASTUS CALIFORNIENSIS	40.7	17.01	1.03%	85.76%	5
FF04	EUCHONE INCOLOR	189.3	44.56	19.78%	19.78%	1
	COSSURA LONGOCIRRATA	90.3	34.02	9.44%	29.22%	3
	ARICIDEA QUADRILOBATA	73.7	6.66	7.70%	36.92%	2
	CHAETOZONE SETOSA MB	62.0	44.58	6.48%	43.40%	11
	LEVINSENIA GRACILIS	50.3	21.22	5.26%	48.66%	10
	ANOBOTHRUS GRACILIS	50.3	23.80	5.26%	53.92%	4
	MEDIOMASTUS CALIFORNIENSIS	47.0	31.05	4.91%	58.83%	5
	PARAMPHINOME JEFFREYSII	43.7	10.97	4.56%	63.39%	
	PRIONOSPIO STEENSTRUPI	36.7	14.84	3.83%	67.22%	7
	DENTALIUM ENTALE	31.7	7.02	3.31%	70.53%	6
	HETEROMASTUS FILIFORMIS	31.0	8.89	3.24%	73.77%	
	MICRURA SPP.	23.7	7.02	2.47%	76.25%	
FF05	EUCHONE INCOLOR	441.3	153.38	20.98%	20.98%	1
	DIPOLYDORA SOCIALIS	278.7	46.32	13.24%	34.22%	
	PRIONOSPIO STEENSTRUPI	178.7	66.37	8.49%	42.71%	4
	SPIO LIMICOLA	146.3	51.54	6.96%	49.67%	11
	ANOBOTHRUS GRACILIS	127.0	48.12	6.04%	55.70%	3
	ARICIDEA QUADRILOBATA	101.3	38.08	4.82%	60.52%	6
	MEDIOMASTUS CALIFORNIENSIS	100.0	10.15	4.75%	65.27%	2
	THYASIRA FLEXUOSA	82.7	12.58	3.93%	69.20%	8
	LEVINSENIA GRACILIS	65.3	13.61	3.11%	72.31%	5
	COSSURA LONGOCIRRATA	59.3	12.22	2.82%	75.13%	7
	DENTALIUM ENTALE	54.3	29.28	2.58%	77.71%	
	ONOBA PELAGICA	49.3	49.10	2.34%	80.05%	9
FF06	LEPTOCHEIRUS PINGUIS	296.0	2.00	27.02%	27.02%	1
	COSSURA LONGOCIRRATA	155.0	11.14	14.15%	41.17%	2
	HARPINIA PROPINQUA	101.3	13.32	9.25%	50.43%	5
	MEDIOMASTUS CALIFORNIENSIS	100.7	19.55	9.19%	59.62%	3
	DIPOLYDORA SOCIALIS	46.3	27.10	4.23%	63.85%	
	ORCHOMENELLA MINUTA	44.7	19.40	4.08%	67.92%	
	NINOE NIGRIPES	33.3	8.14	3.04%	70.97%	8
	ARICIDEA CATHERINAE	31.3	2.89	2.86%	73.83%	9
	ONOBA PELAGICA	29.0	20.30	2.65%	76.48%	7
	LEVINSENIA GRACILIS	26.3	5.03	2.40%	78.88%	10
	NUCULA DELPHINODONTA	22.3	6.81	2.04%	80.92%	4
	TEREBELLIDES ATLANTIS	21.0	11.79	1.92%	82.84%	11

Station	Taxon	Mean	StDev	%	Cum %	98 Rank
FF07	EUCHONE INCOLOR	801.7	253.39	35.71%	35.71%	1
	COSSURA LONGOCIRRATA	491.0	238.00	21.87%	57.59%	2
	MEDIOMASTUS CALIFORNIENSIS	238.0	102.50	10.60%	68.19%	3
	TUBIFICIDAE SP. 2 (BLAKE 1992)	166.0	179.94	7.40%	75.59%	4
	ARICIDEA QUADRILOBATA	65.0	26.29	2.90%	78.48%	8
	ARICIDEA CATHERINAE	60.7	58.88	2.70%	81.19%	10
	NINOE NIGRIPES	52.3	8.62	2.33%	83.52%	
	PRIONOSPIO STEENSTRUPI	50.3	10.26	2.24%	85.76%	8
	THARYX ACUTUS	40.0	3.00	1.78%	87.54%	
	SPIO LIMICOLA	28.0	2.65	1.25%	88.79%	
	POLYGORDIUS SP. A	22.0	13.53	0.98%	89.77%	
	SYLLIDES LONGOCIRRATA	21.0	10.58	0.94%	90.70%	
FF09	DIPOLYDORA SOCIALIS	577.7	214.86	30.35%	30.35%	2
	PRIONOSPIO STEENSTRUPI	427.7	190.55	22.47%	52.82%	1
	EUCHONE INCOLOR	159.7	79.69	8.39%	61.21%	12
	LEVINSENIA GRACILIS	68.7	18.18	3.61%	64.82%	6
	THYASIRA FLEXUOSA	47.7	6.51	2.50%	67.32%	11
	SPIO LIMICOLA	47.3	7.51	2.49%	69.81%	3
	MEDIOMASTUS CALIFORNIENSIS	45.3	11.72	2.38%	72.19%	5
	ANOBOTHRUS GRACILIS	44.0	24.98	2.31%	74.50%	8
	NUCULA DELPHINODONTA	43.0	29.51	2.26%	76.76%	4
	HARPINIA PROPINQUA	34.3	13.43	1.80%	78.56%	9
	EXOGONE VERUGERA	27.7	12.06	1.45%	80.02%	
	PHYLLODOCE MUCOSA	26.3	16.65	1.38%	81.40%	
FF11	PRIONOSPIO STEENSTRUPI	2807.0	912.25	53.97%	53.97%	1
	ARICIDEA QUADRILOBATA	450.7	341.30	8.67%	62.64%	3
	EUCHONE INCOLOR	442.7	346.72	8.51%	71.15%	10
	ANOBOTHRUS GRACILIS	345.0	392.70	6.63%	77.78%	
	LEVINSENIA GRACILIS	173.0	100.53	3.33%	81.11%	2
	PAROUGIA CAECA	150.7	72.22	2.90%	84.01%	
	STERNASPIS SCUTATA	70.3	32.52	1.35%	85.36%	10
	TUBIFICOIDES APECTINATUS	68.0	46.68	1.31%	86.67%	4
	NUCULA DELPHINODONTA	66.7	32.32	1.28%	87.95%	8
	GALATHOWENIA OCULATA	57.0	55.07	1.10%	89.05%	5
	DENTALIUM ENTALE	56.3	29.74	1.08%	90.13%	
	SPIOPHANES KROEYERI	52.0	34.77	1.00%	91.13%	
FF14	EUCHONE INCOLOR	227.7	48.50	13.40%	13.40%	4
	SPIO LIMICOLA	218.0	38.94	12.83%	26.24%	3
	PRIONOSPIO STEENSTRUPI	189.7	87.18	11.17%	37.40%	2
	ARICIDEA QUADRILOBATA	121.7	103.00	7.16%	44.56%	5
	MEDIOMASTUS CALIFORNIENSIS	96.3	58.65	5.67%	50.24%	7
	TUBIFICOIDES APECTINATUS	94.7	54.37	5.57%	55.81%	
	COSSURA LONGOCIRRATA	73.7	45.79	4.34%	60.15%	6
	LEVINSENIA GRACILIS	63.7	46.46	3.75%	63.89%	8
	STERNASPIS SCUTATA	63.3	53.78	3.73%	67.62%	1
	ANOBOTHRUS GRACILIS	63.3	66.91	3.73%	71.35%	
	DIPOLYDORA SOCIALIS	47.0	18.25	2.77%	74.12%	12
	CHAETOZONE SETOSA MB	45.7	34.20	2.69%	76.81%	

Station	Taxon	Mean	StDev	%	Cum %	98 Rank
FF10	PRIONOSPIO STEENSTRUPI	1142.0	401.83	43.55%	43.55%	1
	ARICIDEA CATHERINAE	167.7	47.06	6.39%	49.94%	2
	CERASTODERMA PINNULATUM	131.3	90.40	5.01%	54.95%	
	MEDIOMASTUS CALIFORNIENSIS	124.7	19.73	4.75%	59.71%	3
	PROTOMEDEIA FASCIATA	111.3	151.45	4.25%	63.95%	
	EXOGONE VERUGERA	97.7	80.13	3.72%	67.68%	12
	EXOGONE HEBES	85.0	58.40	3.24%	70.92%	
	NINOE NIGRIPES	48.3	34.43	1.84%	72.76%	6
	NUCULA DELPHINODONTA	43.7	35.92	1.67%	74.42%	4
	UNCIOLA INERMIS	42.7	73.90	1.63%	76.05%	
	CRASSICOROPHIUM CRASSICORNE	41.7	51.60	1.59%	77.64%	
	MONTICELLINA BAPTISTEAE	38.7	31.79	1.47%	79.12%	5
FF12	PRIONOSPIO STEENSTRUPI	1578.0	165.68	54.40%	54.40%	1
	OWENIA FUSIFORMIS	354.7	33.62	12.23%	66.63%	2
	MEDIOMASTUS CALIFORNIENSIS	165.3	44.52	5.70%	72.33%	3
	THARYX ACUTUS	106.7	18.77	3.68%	76.01%	6
	EUCHONE INCOLOR	79.3	33.47	2.74%	78.74%	
	NINOE NIGRIPES	72.3	4.73	2.49%	81.23%	5
	SCOLETOMA HEBES	71.0	12.53	2.45%	83.68%	8
	SPIOPHANES BOMBYX	61.3	18.48	2.11%	85.80%	7
	MONTICELLINA BAPTISTEAE	40.7	26.27	1.40%	87.20%	4
	PHORONIS ARCHITECTA	34.7	3.21	1.20%	88.39%	9
	STENOPLEUSTES INERMIS	30.0	10.15	1.03%	89.43%	
	PHYLLODOCE MUCOSA	27.7	21.55	0.95%	90.38%	
FF13	PRIONOSPIO STEENSTRUPI	1120.3	527.50	53.49%	53.49%	1
	ARICIDEA CATHERINAE	160.0	36.17	7.64%	61.13%	2
	MEDIOMASTUS CALIFORNIENSIS	151.3	76.00	7.23%	68.36%	5
	PHOTIS POLLEX	93.0	126.46	4.44%	72.80%	11
	SCOLETOMA HEBES	55.3	18.01	2.64%	75.44%	8
	PLEUROGONIUM RUBICUNDUM	52.7	28.29	2.51%	77.96%	
	THARYX ACUTUS	50.0	33.60	2.39%	80.34%	4
	NINOE NIGRIPES	47.3	43.11	2.26%	82.60%	
	ASABELLIDES OCULATA	35.7	47.65	1.70%	84.31%	
	HIATELLA ARCTICA	31.7	34.43	1.51%	85.82%	
	MICRURA SPP.	26.0	13.45	1.24%	87.06%	
	PLEUROGONIUM INERME	21.3	17.21	1.02%	88.08%	
NF02	PRIONOSPIO STEENSTRUPI	930.0	0.00	24.39%	24.39%	1
	HIATELLA ARCTICA	620.0	0.00	16.26%	40.65%	5
	THARYX ACUTUS	467.0	0.00	12.25%	52.90%	2
	ARICIDEA CATHERINAE	400.0	0.00	10.49%	63.39%	4
	POLYGORDIUS SP. A	263.0	0.00	6.90%	70.29%	
	PHYLLODOCE MUCOSA	191.0	0.00	5.01%	75.30%	8
	DIPOLYDORA SOCIALIS	150.0	0.00	3.93%	79.23%	
	SPIOPHANES BOMBYX	90.0	0.00	2.36%	81.59%	6
	MEDIOMASTUS CALIFORNIENSIS	80.0	0.00	2.10%	83.69%	10
	CERASTODERMA PINNULATUM	77.0	0.00	2.02%	85.71%	
	PROTOMEDEIA FASCIATA	53.0	0.00	1.39%	87.10%	

Station	Taxon	Mean	StDev	%	Cum %	98 Rank
	EUCHONE INCOLOR	40.0	0.00	1.05%	88.15%	
NF04	DIPOLYDORA SOCIALIS	369.0	0.00	24.15%	0.24149	10
	EXOGONE HEBES	232.0	0.00	15.18%	39.33%	1
	GRANIA POSTCLITELLO LONGIDUCTA	164.0	0.00	10.73%	50.07%	
	UNCIOLA INERMIS	104.0	0.00	6.81%	56.87%	
	CERASTODERMA PINNULATUM	60.0	0.00	3.93%	60.80%	
	TANAISSUS PSAMMOPHILUS	57.0	0.00	3.73%	64.53%	
	CRASSICOROPHIUM CRASSICORNE	51.0	0.00	3.34%	67.87%	
	EXOGONE VERUGERA	50.0	0.00	3.27%	71.14%	3
	OWENIA FUSIFORMIS	31.0	0.00	2.03%	73.17%	
	PRIONOSPIO STEENSTRUPI	30.0	0.00	1.96%	75.13%	2
	PROTOMEDEIA FASCIATA	29.0	0.00	1.90%	77.03%	
	PHYLLODOCE MUCOSA	28.0	0.00	1.83%	78.86%	
NF05	DIPOLYDORA SOCIALIS	274.0	0.00	21.37%	21.37%	
	PRIONOSPIO STEENSTRUPI	174.0	0.00	13.57%	34.95%	1
	HAPLOOPS FUNDIENSIS	131.0	0.00	10.22%	45.16%	7
	MEDIOMASTUS CALIFORNIENSIS	78.0	0.00	6.08%	51.25%	2
	APHELOCHAETA MARIONI	70.0	0.00	5.46%	56.71%	3
	AEGININA LONGICORNIS	57.0	0.00	4.45%	61.15%	
	LEVINSENIA GRACILIS	55.0	0.00	4.29%	65.44%	7
	NUCULA DELPHINODONTA	49.0	0.00	3.82%	69.27%	4
	THARYX ACUTUS	40.0	0.00	3.12%	72.39%	6
	HARPINIA PROPINQUA	33.0	0.00	2.57%	74.96%	
	THYASIRA FLEXUOSA	31.0	0.00	2.42%	77.38%	11
	NINOE NIGRIPES	29.0	0.00	2.26%	79.64%	12
NF07	PRIONOSPIO STEENSTRUPI	1101.0	0.00	40.90%	40.90%	1
	DIPOLYDORA SOCIALIS	319.0	0.00	11.85%	52.75%	4
	SPIO LIMICOLA	253.0	0.00	9.40%	62.15%	3
	MEDIOMASTUS CALIFORNIENSIS	133.0	0.00	4.94%	67.09%	2
	EUCHONE INCOLOR	89.0	0.00	3.31%	70.39%	5
	PHYLLODOCE MUCOSA	73.0	0.00	2.71%	73.11%	6
	CRENELLA DECUSSATA	60.0	0.00	2.23%	75.33%	
	PHOLOE MINUTA	56.0	0.00	2.08%	77.41%	12
	HARPINIA PROPINQUA	42.0	0.00	1.56%	78.97%	
	NUCULA DELPHINODONTA	40.0	0.00	1.49%	80.46%	11
	EXOGONE VERUGERA	36.0	0.00	1.34%	81.80%	
	PHOTIS POLLEX	32.0	0.00	1.19%	82.99%	
NF08	PRIONOSPIO STEENSTRUPI	1106.0	0.00	53.95%	53.95%	1
	MEDIOMASTUS CALIFORNIENSIS	250.0	0.00	12.20%	66.15%	2
	EUCHONE INCOLOR	174.0	0.00	8.49%	74.63%	9
	NINOE NIGRIPES	83.0	0.00	4.05%	78.68%	3
	LEVINSENIA GRACILIS	48.0	0.00	2.34%	81.02%	4
	LEPTOCHEIRUS PINGUIS	42.0	0.00	2.05%	83.07%	
	MONTICELLINA BAPTISTEAE	31.0	0.00	1.51%	84.59%	5
	THARYX ACUTUS	29.0	0.00	1.41%	86.00%	
	TUBIFICIDAE SP. 2 (BLAKE 1992)	29.0	0.00	1.41%	87.41%	11
	LEITOSCOLOPLOS ACUTUS	28.0	0.00	1.37%	88.78%	8

Station	Taxon	Mean	StDev	%	Cum %	98 Rank
	MICRURA SPP.	24.0	0.00	1.17%	89.95%	12
	PHOLOE MINUTA	21.0	0.00	1.02%	90.98%	
NF09	PRIONOSPIO STEENSTRUPI	347.0	0.00	23.04%	23.04%	1
	MEDIOMASTUS CALIFORNIENSIS	120.0	0.00	7.97%	31.01%	2
	NINOE NIGRIPES	107.0	0.00	7.10%	38.11%	5
	SPIO LIMICOLA	99.0	0.00	6.57%	44.69%	4
	ARICIDEA CATHERINAE	85.0	0.00	5.64%	50.33%	3
	NUCULA DELPHINODONTA	85.0	0.00	5.64%	55.98%	6
	MALDANE SARSI	71.0	0.00	4.71%	60.69%	8
	APHELOCHAETA MARIONI	57.0	0.00	3.78%	64.48%	9
	EUCHONE INCOLOR	57.0	0.00	3.78%	68.26%	12
	DIPOLYDORA SOCIALIS	55.0	0.00	3.65%	71.91%	
	LEVINSENIA GRACILIS	53.0	0.00	3.52%	75.43%	10
	PHYLLODOCE MUCOSA	37.0	0.00	2.46%	77.89%	
	MONTICELLINA BAPTISTEAE	37.0	0.00	2.46%	80.35%	7
NF10	PRIONOSPIO STEENSTRUPI	870.0	0.00	25.48%	25.48%	1
	DIPOLYDORA SOCIALIS	421.0	0.00	12.33%	37.80%	
	MEDIOMASTUS CALIFORNIENSIS	389.0	0.00	11.39%	49.19%	2
	SPIO LIMICOLA	310.0	0.00	9.08%	58.27%	3
	ARICIDEA CATHERINAE	215.0	0.00	6.30%	64.57%	4
	NINOE NIGRIPES	135.0	0.00	3.95%	68.52%	6
	APHELOCHAETA MARIONI	119.0	0.00	3.48%	72.01%	9
	NUCULA DELPHINODONTA	99.0	0.00	2.90%	74.90%	
	MONTICELLINA BAPTISTEAE	90.0	0.00	2.64%	77.54%	5
	PHYLLODOCE MUCOSA	88.0	0.00	2.58%	80.12%	
	EUCHONE INCOLOR	75.0	0.00	2.20%	82.31%	7
	THARYX ACUTUS	66.0	0.00	1.93%	84.25%	8
NF12	PRIONOSPIO STEENSTRUPI	335.3	57.57	18.98%	18.98%	2
	MEDIOMASTUS CALIFORNIENSIS	258.3	68.73	14.62%	33.60%	1
	DIPOLYDORA SOCIALIS	196.3	44.46	11.11%	44.71%	10
	EUCHONE INCOLOR	133.3	48.23	7.55%	52.25%	3
	SPIO LIMICOLA	102.3	25.40	5.79%	58.05%	5
	ARICIDEA CATHERINAE	80.3	19.09	4.55%	62.59%	6
	NINOE NIGRIPES	76.3	11.85	4.32%	66.91%	7
	APHELOCHAETA MARIONI	66.3	16.29	3.75%	70.67%	4
	MONTICELLINA BAPTISTEAE	60.3	11.24	3.41%	74.08%	8
	LEVINSENIA GRACILIS	57.7	11.93	3.26%	77.34%	9
	NUCULA DELPHINODONTA	43.0	19.16	2.43%	79.78%	12
	THARYX ACUTUS	40.0	19.16	2.26%	82.04%	11
NF13	UNCIOLA INERMIS	545.0	0.00	25.21%	25.21%	7
	POLYGORDIUS SP. A	219.0	0.00	10.13%	35.34%	3
	CRASSICOROPHIUM CRASSICORNE	189.0	0.00	8.74%	44.08%	9
	PRIONOSPIO STEENSTRUPI	140.0	0.00	6.48%	50.56%	4
	DIPOLYDORA SOCIALIS	99.0	0.00	4.58%	55.13%	
	CERASTODERMA PINNULATUM	97.0	0.00	4.49%	59.62%	
	GRANIA POSTCLITELLO LONGIDUCTA	91.0	0.00	4.21%	63.83%	1
	PHYLLODOCE MUCOSA	89.0	0.00	4.12%	67.95%	9

Station	Taxon	Mean	StDev	%	Cum %	98 Rank
	EXOGONE HEBES	83.0	0.00	3.84%	71.79%	6
	EXOGONE VERUGERA	65.0	0.00	3.01%	74.79%	8
	ERICTHONIUS FASCIATUS	63.0	0.00	2.91%	77.71%	
	UNCIOLA IRRORATA	51.0	0.00	2.36%	80.06%	
NF14	PRIONOSPIO STEENSTRUPI	1589.0	0.00	49.87%	49.87%	1
	MEDIOMASTUS CALIFORNIENSIS	195.0	0.00	6.12%	55.99%	5
	THARYX ACUTUS	162.0	0.00	5.08%	61.08%	
	CERASTODERMA PINNULATUM	139.0	0.00	4.36%	65.44%	8
	ARICIDEA CATHERINAE	122.0	0.00	3.83%	69.27%	4
	EXOGONE VERUGERA	102.0	0.00	3.20%	72.47%	11
	ERICTHONIUS FASCIATUS	94.0	0.00	2.95%	75.42%	6
	UNCIOLA INERMIS	87.0	0.00	2.73%	78.15%	3
	PROTOMEDEIA FASCIATA	86.0	0.00	2.70%	80.85%	2
	EXOGONE HEBES	68.0	0.00	2.13%	82.99%	
	TUBIFICIDAE SP. 2 (BLAKE 1992)	46.0	0.00	1.44%	84.43%	7
	CRENELLA DECUSSATA	45.0	0.00	1.41%	85.84%	
NF15	PRIONOSPIO STEENSTRUPI	1484.0	0.00	53.36%	53.36%	1
	MEDIOMASTUS CALIFORNIENSIS	211.0	0.00	7.59%	60.95%	3
	OWENIA FUSIFORMIS	197.0	0.00	7.08%	68.03%	9
	ARICIDEA CATHERINAE	136.0	0.00	4.89%	72.92%	2
	EUCHONE INCOLOR	106.0	0.00	3.81%	76.73%	6
	EXOGONE HEBES	78.0	0.00	2.80%	79.54%	
	NINOE NIGRIPES	73.0	0.00	2.62%	82.16%	
	SPIOPHANES BOMBYX	42.0	0.00	1.51%	83.67%	4
	SPIO LIMICOLA	41.0	0.00	1.47%	85.15%	
	MONTICELLINA BAPTISTEAE	36.0	0.00	1.29%	86.44%	
	PAROUGIA CAECA	32.0	0.00	1.15%	87.59%	
	PHYLLODOCE MUCOSA	31.0	0.00	1.11%	88.71%	5
NF16	PRIONOSPIO STEENSTRUPI	1356.0	0.00	56.52%	56.52%	1
	MEDIOMASTUS CALIFORNIENSIS	149.0	0.00	6.21%	62.73%	2
	NINOE NIGRIPES	137.0	0.00	5.71%	68.45%	4
	EUCHONE INCOLOR	132.0	0.00	5.50%	73.95%	11
	LEVINSENIA GRACILIS	115.0	0.00	4.79%	78.74%	3
	PAROUGIA CAECA	55.0	0.00	2.29%	81.03%	
	ARICIDEA CATHERINAE	50.0	0.00	2.08%	83.12%	
	EXOGONE HEBES	24.0	0.00	1.00%	84.12%	
	MONTICELLINA DORSOBRANCHIALIS	24.0	0.00	1.00%	85.12%	9
	THARYX ACUTUS	21.0	0.00	0.88%	85.99%	6
	POLYGORDIUS SP. A	20.0	0.00	0.83%	86.83%	
	PHOTIS POLLEX	18.0	0.00	0.75%	87.58%	
NF17	CRASSICOROPHIUM CRASSICORNE	508.7	55.73	27.73%	27.73%	4
	PSEUDUNCIOLA OBLIQUUA	345.7	74.39	18.84%	46.57%	3
	POLYGORDIUS SP. A	184.3	20.55	10.05%	56.62%	2
	PHYLLODOCE MUCOSA	151.7	49.65	8.27%	64.89%	5
	DIPOLYDORA QUADRILOBATA	114.0	27.22	6.21%	71.11%	
	CERASTODERMA PINNULATUM	111.3	38.53	6.07%	77.18%	
	ECHINARACHNIUS PARMA	61.0	4.58	3.33%	80.50%	7

Station	Taxon	Mean	StDev	%	Cum %	98 Rank
	UNCIOLA INERMIS	55.7	13.32	3.03%	83.54%	
	PRIONOSPIO STEENSTRUPI	31.3	10.41	1.71%	85.24%	8
	SPIOPHANES BOMBYX	27.3	5.13	1.49%	86.73%	1
	EXOGONE HEBES	25.0	2.65	1.36%	88.10%	6
	ARICIDEA CATHERINAE	20.7	21.13	1.13%	89.22%	
NF18	PRIONOSPIO STEENSTRUPI	1271.0	0.00	40.09%	40.09%	1
	PROTOMEDEIA FASCIATA	634.0	0.00	20.00%	60.09%	6
	MEDIOMASTUS CALIFORNIENSIS	218.0	0.00	6.88%	66.97%	5
	ARICIDEA CATHERINAE	112.0	0.00	3.53%	70.50%	
	NINOE NIGRIPES	82.0	0.00	2.59%	73.09%	12
	EXOGONE HEBES	77.0	0.00	2.43%	75.52%	3
	EXOGONE VERUGERA	49.0	0.00	1.55%	77.07%	2
	EUCHONE INCOLOR	41.0	0.00	1.29%	78.36%	
	APHELOCHAETA MARIONI	38.0	0.00	1.20%	79.56%	
	PHOLOE MINUTA	37.0	0.00	1.17%	80.73%	12
	ASABELLIDES OCULATA	35.0	0.00	1.10%	81.83%	
	LEPTOCHEIRUS PINGUIS	35.0	0.00	1.10%	82.93%	
NF19	PRIONOSPIO STEENSTRUPI	2973.0	0.00	62.64%	62.64%	1
	MEDIOMASTUS CALIFORNIENSIS	266.0	0.00	5.60%	68.25%	2
	DIPOLYDORA SOCIALIS	197.0	0.00	4.15%	72.40%	9
	EUCHONE INCOLOR	164.0	0.00	3.46%	75.85%	7
	PHYLLODOCE MUCOSA	109.0	0.00	2.30%	78.15%	
	NUCULA DELPHINODONTA	85.0	0.00	1.79%	79.94%	4
	EXOGONE HEBES	76.0	0.00	1.60%	81.54%	8
	EDOTIA MONTOSA	71.0	0.00	1.50%	83.04%	
	NINOE NIGRIPES	63.0	0.00	1.33%	84.37%	10
	PHOTIS POLLEX	57.0	0.00	1.20%	85.57%	
	APHELOCHAETA MARIONI	53.0	0.00	1.12%	86.68%	3
	EXOGONE VERUGERA	49.0	0.00	1.03%	87.72%	
NF20	PRIONOSPIO STEENSTRUPI	1623.0	0.00	58.57%	58.57%	1
	ARICIDEA CATHERINAE	246.0	0.00	8.88%	67.45%	2
	MEDIOMASTUS CALIFORNIENSIS	167.0	0.00	6.03%	73.48%	3
	NINOE NIGRIPES	125.0	0.00	4.51%	77.99%	4
	EUCHONE INCOLOR	80.0	0.00	2.89%	80.87%	
	LEVINSENIA GRACILIS	50.0	0.00	1.80%	82.68%	7
	MONTICELLINA BAPTISTEAE	47.0	0.00	1.70%	84.37%	4
	PAROUGIA CAECA	44.0	0.00	1.59%	85.96%	
	THARYX ACUTUS	39.0	0.00	1.41%	87.37%	9
	ASABELLIDES OCULATA	35.0	0.00	1.26%	88.63%	
	EXOGONE HEBES	32.0	0.00	1.15%	89.79%	10
	MONTICELLINA DORSOBRANCHIALIS	28.0	0.00	1.01%	90.80%	
NF21	PRIONOSPIO STEENSTRUPI	1426.0	0.00	49.46%	49.46%	1
	SPIO LIMICOLA	286.0	0.00	9.92%	59.38%	3
	MEDIOMASTUS CALIFORNIENSIS	276.0	0.00	9.57%	68.96%	2
	EUCHONE INCOLOR	253.0	0.00	8.78%	77.73%	12
	NINOE NIGRIPES	91.0	0.00	3.16%	80.89%	5
	MONTICELLINA BAPTISTEAE	78.0	0.00	2.71%	83.59%	6

Station	Taxon	Mean	StDev	%	Cum %	98 Rank
	PAROUGIA CAECA	53.0	0.00	1.84%	85.43%	
	LEVINSENIA GRACILIS	44.0	0.00	1.53%	86.96%	8
	NUCULA DELPHINODONTA	35.0	0.00	1.21%	88.17%	7
	MAYERELLA LIMICOLA	33.0	0.00	1.14%	89.32%	
	PHOLOE MINUTA	22.0	0.00	0.76%	90.08%	
	MICRURA SPP.	20.0	0.00	0.69%	90.77%	
NF22	EUCHONE INCOLOR	328.0	0.00	20.22%	20.22%	4
	MEDIOMASTUS CALIFORNIENSIS	312.0	0.00	19.24%	39.46%	1
	PRIONOSPIO STEENSTRUPI	271.0	0.00	16.71%	56.17%	3
	LEVINSENIA GRACILIS	103.0	0.00	6.35%	62.52%	6
	NINOE NIGRIPES	77.0	0.00	4.75%	67.26%	5
	SPIO LIMICOLA	75.0	0.00	4.62%	71.89%	9
	APHELOCHAETA MARIONI	59.0	0.00	3.64%	75.52%	7
	THARYX ACUTUS	51.0	0.00	3.14%	78.67%	2
	NUCULA DELPHINODONTA	50.0	0.00	3.08%	81.75%	
	MONTICELLINA BAPTISTEAE	27.0	0.00	1.66%	83.42%	8
	PAROUGIA CAECA	26.0	0.00	1.60%	85.02%	11
	MICRURA SPP.	19.0	0.00	1.17%	86.19%	
	LEITOSCOLOPLOS ACUTUS	19.0	0.00	1.17%	87.36%	
NF23	UNCIOLA INERMIS	438.0	0.00	18.85%	18.85%	2
	DIPOLYDORA SOCIALIS	285.0	0.00	12.26%	31.11%	
	PRIONOSPIO STEENSTRUPI	272.0	0.00	11.70%	42.81%	4
	EXOGONE HEBES	215.0	0.00	9.25%	52.07%	5
	ADELODRILUS SP. 2 (BLAKE 1996)	166.0	0.00	7.14%	59.21%	
	EXOGONE VERUGERA	123.0	0.00	5.29%	64.50%	
	CERASTODERMA PINNULATUM	78.0	0.00	3.36%	67.86%	
	CRASSICOROPHIUM CRASSICORNE	67.0	0.00	2.88%	70.74%	
	ARICIDEA CATHERINAE	60.0	0.00	2.58%	73.32%	11
	HIATELLA ARCTICA	58.0	0.00	2.50%	75.82%	8
	NUCULA DELPHINODONTA	47.0	0.00	2.02%	77.84%	
	SPIOPHANES BOMBYX	46.0	0.00	1.98%	79.82%	1
NF24	PRIONOSPIO STEENSTRUPI	2193.3	228.62	62.25%	62.25%	1
	MEDIOMASTUS CALIFORNIENSIS	331.3	98.66	9.40%	71.66%	2
	EUCHONE INCOLOR	177.3	8.50	5.03%	76.69%	3
	ARICIDEA CATHERINAE	107.7	54.63	3.06%	79.74%	7
	LEVINSENIA GRACILIS	95.3	28.31	2.71%	82.45%	5
	THARYX ACUTUS	83.0	46.00	2.36%	84.81%	4
	PHOLOE MINUTA	76.7	28.59	2.18%	86.98%	9
	NINOE NIGRIPES	66.3	8.08	1.88%	88.86%	6
	SPIO LIMICOLA	64.0	17.35	1.82%	90.68%	10
	PHYLLODOCE MUCOSA	32.7	21.73	0.93%	91.61%	
	LEITOSCOLOPLOS ACUTUS	28.0	12.53	0.79%	92.40%	
	APHELOCHAETA MARIONI	26.7	35.92	0.76%	93.16%	8

APPENDIX D-5

MB SPP LIST 1999

MWRA Code	Taxon Name	Higher Taxon	Family	Species?
3740SPP	ANTHOZOA SPP.	CNI		No
374301SPP	CERIANTHIDAE SPP.	CNI	Cerianthidae	No
3743010201	CERIANTHEOPSIS AMERICANUS	CNI	Cerianthidae	Yes
3743010102	CERIANTHUS BOREALIS	CNI	Cerianthidae	Yes
3758SPP	ACTINIARIA SPP.	CNI		No
3758SP01	ACTINIARIA SP. 1 (BLAKE 1992)	CNI		Yes
3758SP02	ACTINIARIA SP. 2 (BLAKE 1992)	CNI		Yes
3758SP03	ACTINIARIA SP. 3 (BLAKE 1992)	CNI		Yes
3758SP06	ACTINIARIA SP. 6 (KROPP 1995)	CNI		Yes
3759010101	EDWARDSIA ELEGANS	CNI	Edwardsiidae	Yes
3759040102	HALCAMPA DUODECIMCIRRATA	CNI	Halcampidae	Yes
3901SPP	TURBELLARIA SPP.	PLA		Yes
4302010104	TUBULANUS PELLUCIDUS	NEM	Tubulanidae	Yes
4302010201	CARINOMELLA LACTEA	NEM	Carinomidae	Yes
430203SP01	CEPHALOTHRICIDAE SP. 1	NEM	Cephalothricidae	Yes
4303020209	CEREBRATULUS LACTEUS	NEM	Lineidae	Yes
4303020405	LINEUS PALLIDUS	NEM	Lineidae	No
43030205SPP	MICRURA SPP.	NEM	Lineidae	Yes
43060501SPP	AMPHIPORUS SPP.	NEM	Amphiporidae	No
4306050101	AMPHIPORUS ANGULATUS	NEM	Amphiporidae	Yes
4306050115	AMPHIPORUS CRUENTATUS	NEM	Amphiporidae	Yes
4306050124	AMPHIPORUS GROENLANDICUS	NEM	Amphiporidae	Yes
4306060216	TETRASTEMMA VITTATUM	NEM	Tetrastemmatidae	Yes
43SPP	NEMERTEA SPP.	NEM		No
43SP02	NEMERTEA SP. 2	NEM		Yes
43SP04	NEMERTEA SP. D	NEM		Yes
43SP05	NEMERTEA SP. 5	NEM		Yes
43SP07	NEMERTEA SP. 7	NEM		Yes
43SP12	NEMERTEA SP. 12 (KROPP 1998)	NEM		Yes
43SP13	NEMERTEA SP. 13 (KROPP 1998)	NEM		Yes
43SP14	NEMERTEA SP. 14 (KROPP 1998)	NEM		Yes
50010101SPP	APHRODITA SPP.	POL	Aphroditidae	No
5001010104	APHRODITA HASTATA	POL	Aphroditidae	Yes
500102SPP	POLYNOIDAE SPP.	POL	Polynoidae	No
500102HARSPP	HARMOTHOINAE SPP.	POL	Polynoidae	No
5001020301	ARCTEOBIA ANTICOSTIENSIS	POL	Polynoidae	Yes
5001022401	AUSTROLAENILLA MOLLIS	POL	Polynoidae	Yes
5001025501	BYLGIDES ELEGANS	POL	Polynoidae	Yes
50010255GROE	BYLGIDES GROENLANDICUS	POL	Polynoidae	Yes
50010255SARS	BYLGIDES SARSI	POL	Polynoidae	Yes
50010255SPP	BYLGIDES SPP.	POL	Polynoidae	No
5001021502	ENIPO GRACILIS	POL	Polynoidae	Yes
5001022103	ENIPO TORELLI	POL	Polynoidae	Yes
50010206SPP	GATTYANA SPP.	POL	Polynoidae	No
5001020601	GATTYANA AMONDSENI	POL	Polynoidae	Yes
5001020603	GATTYANA CIRROSA	POL	Polynoidae	Yes
50010208SPP	HARMOTHOE SPP.	POL	Polynoidae	No

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5001020803	HARMOTHOE EXTENUATA	POL	Polynoidae	Yes
5001020806	HARMOTHOE IMBRICATA	POL	Polynoidae	Yes
5001022001	HARTMANIA MOOREI	POL	Polynoidae	Yes
5001060101	PHOLOE MINUTA	POL	Pholoidae	Yes
50010603SPP	STHENELAIS SPP.	POL	Sigalionidae	No
5001060303	STHENELAIS LIMICOLA	POL	Sigalionidae	Yes
5001080201	DYSPONETUS PYGMAEUS	POL	Chrysopetalidae	Yes
5001100401	PARAMPHINOME JEFFREYSII	POL	Amphinomidae	Yes
500113SPP	PHYLLODOCIDAE SPP.	POL	Phyllodocidae	No
50011302SPP	ETEONE SPP.	POL	Phyllodocidae	No
5001130204	ETEONE FLAVA	POL	Phyllodocidae	Yes
5001130207	ETEONE HETEROPODA	POL	Phyllodocidae	Yes
5001130205	ETEONE LONGA	POL	Phyllodocidae	Yes
5001130202	ETEONE SPETSBERGENSIS	POL	Phyllodocidae	Yes
5001130304	EULALIA BILINEATA	POL	Phyllodocidae	Yes
5001130301	EULALIA VIRIDIS	POL	Phyllodocidae	Yes
5001131101	EUMIDA SANGUINEA	POL	Phyllodocidae	Yes
5001130501	MYSTIDES BOREALIS	POL	Phyllodocidae	Yes
5001130801	PARANAITIS SPECIOSA	POL	Phyllodocidae	Yes
50011314SPP	PHYLLODOCE SPP.	POL	Phyllodocidae	No
5001131410	PHYLLODOCE ARENAE	POL	Phyllodocidae	Yes
5001130102	PHYLLODOCE GROENLANDICA	POL	Phyllodocidae	Yes
5001130106	PHYLLODOCE MACULATA	POL	Phyllodocidae	Yes
5001130104	PHYLLODOCE MUCOSA	POL	Phyllodocidae	Yes
5001210103	GYPTIS CF. VITTATA	POL	Hesionidae	Yes
50012102SPP	MICROPHTHALMUS SPP.	POL	Hesionidae	No
5001210202	MICROPHTHALMUS ABERRANS	POL	Hesionidae	Yes
5001210203	MICROPHTHALMUS LISTENSIS	POL	Hesionidae	Yes
5001220104	Ancistrosyllis groenlandica	POL	Pilargiidae	Yes
5001220501	SYNELMIS KLATTI	POL	Pilargiidae	Yes
500123SPP	SYLLIDAE SPP.	POL	Syllidae	No
500123AUSPP	AUTOLYTINAE SPP.	POL	Syllidae	No
50012307SPP	EXOGONE SPP.	POL	Syllidae	No
5001230707	EXOGONE HEBES	POL	Syllidae	Yes
5001230711	EXOGONE LONGICIRRIS	POL	Syllidae	Yes
50012307SP01	EXOGONE SP. A	POL	Syllidae	Yes
5001230706	EXOGONE VERUGERA	POL	Syllidae	Yes
5001231701	PARAPIONOSYLLIS LONGICIRRATA	POL	Syllidae	Yes
50012302SP01	PIONOSYLLIS SP. A	POL	Syllidae	Yes
50012308SPP	SPHAEROSYLLIS SPP.	POL	Syllidae	No
5001230801	SPHAEROSYLLIS BREVIFRONS	POL	Syllidae	Yes
5001230817	SPHAEROSYLLIS LONGICAUDA	POL	Syllidae	Yes
5001231605CF	STREPTOSYLLIS CF. PETTIBONEAE	POL	Syllidae	Yes
50012315SPP	SYLLIDES SPP.	POL	Syllidae	No
5001231503CON	SYLLIDES CONVOLUTA	POL	Syllidae	Yes
5001231501	SYLLIDES JAPONICA	POL	Syllidae	Yes
5001231503	SYLLIDES LONGOCIRRATA	POL	Syllidae	Yes

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50012303SPP	SYLLIS SPP.	POL	Syllidae	No
5001230306	SYLLIS CORNUTA	POL	Syllidae	Yes
50012305SPP	TYPOSYLLIS SPP.	POL	Syllidae	No
5001230501	TYPOSYLLIS ALTERNATA	POL	Syllidae	Yes
50012305SP01	TYPOSYLLIS SP. 1 (BLAKE 1992)	POL	Syllidae	Yes
500124SPP	NEREIDIDAE SPP.	POL	Nereidae	No
5001240302	NEANTHES VIRENS	POL	Nereidae	Yes
50012404SPP	NEREIS SPP.	POL	Nereidae	No
5001240409	NEREIS GRAYI	POL	Nereidae	Yes
5001240404	NEREIS PROCERA	POL	Nereidae	Yes
5001240406	NEREIS ZONATA	POL	Nereidae	Yes
5001241001	WEBSTERINEREIS TRIDENTATA	POL	Nereidae	Yes
500125SPP	NEPHTYIDAE SPP.	POL	Nephtyidae	No
5001250304	AGLAOPHAMUS CIRCINATA	POL	Nephtyidae	Yes
50012501SPP	NEPHTYS SPP.	POL	Nephtyidae	No
5001250103	NEPHTYS CAECA	POL	Nephtyidae	Yes
5001250102	NEPHTYS CILIATA	POL	Nephtyidae	Yes
5001250104	NEPHTYS CORNUTA	POL	Nephtyidae	Yes
5001250108	NEPHTYS DISCORS	POL	Nephtyidae	Yes
5001250115	NEPHTYS INCISA	POL	Nephtyidae	Yes
5001250110	NEPHTYS PARADOXA	POL	Nephtyidae	Yes
500126SPP	SPHAERODORIDAE SPP.	POL	Sphaerodoridae	No
5001260401	SPHAERODORIDIUM CLAPAREDII	POL	Sphaerodoridae	Yes
50012604SP01	SPHAERODORIDIUM SP. A	POL	Sphaerodoridae	Yes
5001260201	SPHAERODOROPSIS MINUTA	POL	Sphaerodoridae	Yes
5001270101	GLYCERA CAPITATA	POL	Glyceridae	Yes
5001280202	GONIADA MACULATA	POL	Goniadidae	Yes
5001290108	ONUPHIS OPALINA	POL	Onuphidae	Yes
500131SPP	LUMBRINERIDAE SPP.	POL	Lumbrineridae	No
500131WINS	ABYSSONINOE WINSNESAE	POL	Lumbrineridae	Yes
500131ERASPP	ERANNO SPP.	POL	Lumbrineridae	No
5001310113	LUMBRINERIS TENUIS	POL	Lumbrineridae	Yes
5001310204	NINOE NIGRIPES	POL	Lumbrineridae	Yes
5001310203	PARANINOE BREVIPES	POL	Lumbrineridae	Yes
50013101SPP	SCOLETOMA SPP.	POL	Lumbrineridae	No
5001310102	SCOLETOMA FRAGILIS	POL	Lumbrineridae	Yes
5001310140	SCOLETOMA HEBES	POL	Lumbrineridae	Yes
5001310115	SCOLETOMA IMPATIENS	POL	Lumbrineridae	Yes
500133SPP	ARABELLIDAE SPP.	POL	Arabellidae	No
50013301SPP	DRILONEREIS SPP.	POL	Arabellidae	No
5001330101	DRILONEREIS FILUM	POL	Arabellidae	Yes
5001330103	DRILONEREIS LONGA	POL	Arabellidae	Yes
5001330105	DRILONEREIS MAGNA	POL	Arabellidae	Yes
5001330901	LABROROSTRATUS PARASITICUS	POL	Arabellidae	Yes
500136SPP	DORVILLEIDAE SPP.	POL	Dorvilleidae	No
5001360108	DORVILLEA SOCIABILIS	POL	Dorvilleidae	Yes
5001360601	MEIODORVILLEA MINUTA	POL	Dorvilleidae	Yes

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50013604SPP	OPHRYOTROCHA SPP.	POL	Dorvilleidae	No
5001360413	OPHRYOTROCHA BIFIDA	POL	Dorvilleidae	Yes
5001360402CF	OPHRYOTROCHA CF. LABRONICA	POL	Dorvilleidae	Yes
50013604SP01	OPHRYOTROCHA SP. 1	POL	Dorvilleidae	Yes
50013604SP02	OPHRYOTROCHA SP. 2	POL	Dorvilleidae	Yes
50013614CAEC	PAROUGIA CAECA	POL	Dorvilleidae	Yes
500140SPP	ORBINIIDAE SPP.	POL	Orbiniidae	No
50014016SPP	LEITOSCOLOPLOS SPP.	POL	Orbiniidae	No
5001400305	LEITOSCOLOPLOS ACUTUS	POL	Orbiniidae	Yes
50014016SP01	LEITOSCOLOPLOS SP. B	POL	Orbiniidae	Yes
50014005SPP	ORBINIA SPP.	POL	Orbiniidae	No
5001400502	ORBINIA SWANI	POL	Orbiniidae	Yes
5001400307CF	SCOLOPLOS (LEODAMAS) ?RUBRA	POL	Orbiniidae	Yes
50014003SPP	SCOLOPLOS SPP.	POL	Orbiniidae	No
5001400311	SCOLOPLOS ACMECEPS	POL	Orbiniidae	Yes
5001400301	SCOLOPLOS ARMIGER	POL	Orbiniidae	Yes
500141SPP	PARAONIDAE SPP.	POL	Paraonidae	No
50014102SPP	ARICIDEA SPP.	POL	Paraonidae	No
5001410208	ARICIDEA CATHERINAE	POL	Paraonidae	Yes
50014102CERR	ARICIDEA CERRUTII	POL	Paraonidae	Yes
5001410220	ARICIDEA MINUTA	POL	Paraonidae	Yes
5001410217	ARICIDEA QUADRILOBATA	POL	Paraonidae	Yes
5001410606	CIRROPHORUS FURCATUS	POL	Paraonidae	Yes
5001410801	LEVINSENIA GRACILIS	POL	Paraonidae	Yes
5001411205	PARADONEIS ELIASONI	POL	Paraonidae	Yes
5001411201	PARADONEIS LYRA	POL	Paraonidae	Yes
5001420103	APISTOBRANCHUS TYPICUS	POL	Apistobranchidae	Yes
500143SPP	SPIONIDAE SPP.	POL	Spionidae	No
500143DISPP	DIPOLYDORA SPP.	POL	Spionidae	No
5001430404	DIPOLYDORA CAULLERYI	POL	Spionidae	Yes
5001430414	DIPOLYDORA CONCHARUM	POL	Spionidae	Yes
5001430408	DIPOLYDORA QUADRILOBATA	POL	Spionidae	Yes
5001430402	DIPOLYDORA SOCIALIS	POL	Spionidae	Yes
50014302SPP	LAONICE SPP.	POL	Spionidae	No
5001430201	LAONICE CIRRATA	POL	Spionidae	Yes
50014302SP01	LAONICE SP. I (BLAKE 1992)	POL	Spionidae	Yes
50014304SPP	POLYDORA SPP.	POL	Spionidae	No
5001430438	POLYDORA AGGREGATA	POL	Spionidae	Yes
5001430448	POLYDORA CORNUTA	POL	Spionidae	Yes
5001430412	POLYDORA WEBSTERI	POL	Spionidae	Yes
50014305CIRR	PRIONOSPIO CIRRIFERA	POL	Spionidae	Yes
5001430506	PRIONOSPIO STEENSTRUPI	POL	Spionidae	Yes
5001431302	PYGOSPIO ELEGANS	POL	Spionidae	Yes
5001432007	SCOLELEPIS FOLIOSA	POL	Spionidae	Yes
5001432001	SCOLELEPIS SQUAMATA	POL	Spionidae	Yes
5001432006	SCOLELEPIS TEXANA	POL	Spionidae	Yes
50014307SPP	SPIO SPP.	POL	Spionidae	No

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5001430701	SPIO FILICORNIS	POL	Spionidae	Yes
5001430707	SPIO LIMICOLA	POL	Spionidae	Yes
5001430704	SPIO SETOSA	POL	Spionidae	Yes
5001430709	SPIO THULINI	POL	Spionidae	Yes
500143SP01	SPIONID SP. A	POL	Spionidae	Yes
5001431001	SPIOPHANES BOMBYX	POL	Spionidae	Yes
5001431002	SPIOPHANES KROEYERI	POL	Spionidae	Yes
5001431801	STREBLOSPIO BENEDICTI	POL	Spionidae	Yes
50014502SPP	TROCHOCHAETA SPP.	POL	Trochochaetidae	No
5001450201	TROCHOCHAETA CARICA	POL	Trochochaetidae	Yes
5001450203	TROCHOCHAETA MULTISETOSA	POL	Trochochaetidae	Yes
5001450202	TROCHOCHAETA WATSONI	POL	Trochochaetidae	Yes
5001480101	PSAMMODRILUS BALANOGLOSSOIDES	POL	Psammodrilidae	Yes
5001490303	SPIOCHAETOPTERUS OCULATUS	POL	Chaetopteridae	Yes
500150SPP	CIRRATULIDAE SPP.	POL	Cirratulidae	No
50015003ASPP	APHELOCHAETA SPP.	POL	Cirratulidae	No
5001500307	APHELOCHAETA MARIONI	POL	Cirratulidae	Yes
5001500301	APHELOCHAETA MONILARIS	POL	Cirratulidae	Yes
50015003ASP01	APHELOCHAETA SP. 1	POL	Cirratulidae	Yes
50015002SP02	CAULLERIELLA SP. B (WILLIAMS 1998)	POL	Cirratulidae	Yes
50015002SP03	CAULLERIELLA SP. C (KROPP 1999)	POL	Cirratulidae	Yes
50015004SPP	CHAETOZONE SPP.	POL	Cirratulidae	No
50015004MB	CHAETOZONE SETOSA MB	POL	Cirratulidae	Yes
500150043SP04	CHAETOZONE SP. 4 (KROPP 1998)	POL	Cirratulidae	Yes
50015004SP05	CHAETOZONE SP. 5 [PHILLIPS 1999]	POL	Cirratulidae	Yes
50015004VIVI	CHAETOZONE VIVIPARA	POL	Cirratulidae	Yes
5001500101	CIRRATULUS CIRRATUS	POL	Cirratulidae	Yes
50015003MSPP	MONTICELLINA SPP.	POL	Cirratulidae	No
50015003BAPT	MONTICELLINA BAPTISTEAE	POL	Cirratulidae	Yes
5001500310	MONTICELLINA DORSOBRANCHIALIS	POL	Cirratulidae	Yes
50015003SPP	THARYX SPP.	POL	Cirratulidae	No
5001500305	THARYX ACUTUS	POL	Cirratulidae	Yes
50015003KIRK	THARYX KIRKEGAARDI	POL	Cirratulidae	Yes
50015003SP02	THARYX SP. A (KROPP 1993)	POL	Cirratulidae	Yes
5001520101	COSSURA LONGOCIRRATA	POL	Cossuridae	Yes
50015401SPP	BRADA SPP.	POL	Flabelligeridae	No
5001540107	BRADA INCRUSTATA	POL	Flabelligeridae	Yes
5001540102	BRADA VILLOSA	POL	Flabelligeridae	Yes
50015404SPP	DIPLOCIRRUS SPP.	POL	Flabelligeridae	No
5001540402	DIPLOCIRRUS HIRSUTUS	POL	Flabelligeridae	Yes
5001540401	DIPLOCIRRUS LONGISETOSUS	POL	Flabelligeridae	Yes
5001540202	FLABELLIGERA AFFINIS	POL	Flabelligeridae	Yes
50015403SPP	PHERUSA SPP.	POL	Flabelligeridae	No
5001540304	PHERUSA AFFINIS	POL	Flabelligeridae	Yes
5001540302	PHERUSA PLUMOSA	POL	Flabelligeridae	Yes
5001570101	SCALIBREGMA INFLATUM	POL	Scalibregmatidae	Yes
500158SPP	OPHELIIDAE SPP.	POL	Ophellidae	No

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5001580601	OPHELINA ABRANCHIATA	POL	Ophellidae	Yes
5001580607	OPHELINA ACUMINATA	POL	Ophellidae	Yes
5001590101	STERNASPIS SCUTATA	POL	Sternaspidae	Yes
500160SPP	CAPITELLIDAE SPP.	POL	Capitellidae	No
5001600601	BARANTOLLA AMERICANA	POL	Capitellidae	Yes
50016006SP01	BARANTOLLA SP. A (BLAKE 1992)	POL	Capitellidae	Yes
5001600101	CAPITELLA CAPITATA COMPLEX	POL	Capitellidae	Yes
5001600201	HETEROMASTUS FILIFORMIS	POL	Capitellidae	Yes
5001600402	MEDIOMASTUS CALIFORNIENSIS	POL	Capitellidae	Yes
500163SPP	MALDANIDAE SPP.	POL	Maldanidae	No
5001630801	AXIOTHELLA CATENATA	POL	Maldanidae	Yes
5001630202	CLYMENELLA TORQUATA	POL	Maldanidae	Yes
50016312SP01	CLYMENURA SP. A (BLAKE 1992)	POL	Maldanidae	Yes
5001631102	EUCLYMENE COLLARIS	POL	Maldanidae	Yes
500163EUSPP	EUCLYMENINAE SPP.	POL	Maldanidae	No
500163EUSP01	EUCLYMENINAE SP. 1 (KROPP 1998)	POL	Maldanidae	Yes
5001630301	MALDANE SARSI	POL	Maldanidae	Yes
5001630701	PETALOPROCTUS TENUIS	POL	Maldanidae	Yes
50016309SPP	PRAXILLELLA SPP.	POL	Maldanidae	No
5001630903	PRAXILLELLA AFFINIS	POL	Maldanidae	Yes
5001630901	PRAXILLELLA GRACILIS	POL	Maldanidae	Yes
5001630902	PRAXILLELLA PRAETERMISSA	POL	Maldanidae	Yes
5001631803	PRAXILLURA ORNATA	POL	Maldanidae	Yes
5001631001	RHODINE BITORQUATA	POL	Maldanidae	Yes
5001631003	RHODINE LOVENI	POL	Maldanidae	Yes
500164SPP	OWENIIDAE SPP.	POL	Oweniidae	No
5001640402	GALATHOWENIA OCULATA	POL	Oweniidae	Yes
5001640201	MYRIOCHELE HEERI	POL	Oweniidae	Yes
5001640102	OWENIA FUSIFORMIS	POL	Oweniidae	Yes
50016603SPP	PECTINARIA SPP.	POL	Pectinariidae	No
5001660302	PECTINARIA GOULDI	POL	Pectinariidae	Yes
5001660303	PECTINARIA GRANULATA	POL	Pectinariidae	Yes
500167SPP	AMPHARETIDAE SPP.	POL	Ampharetidae	No
50016702SPP	AMPHARETE SPP.	POL	Ampharetidae	No
5001670208	AMPHARETE ACUTIFRONS	POL	Ampharetidae	Yes
5001670214	AMPHARETE FINMARCHICA	POL	Ampharetidae	Yes
5001670213	AMPHARETE LINDSTROEMI	POL	Ampharetidae	Yes
5001670303	AMPHICTEIS GUNNERI	POL	Ampharetidae	Yes
5001670701	ANOBOTHRUS GRACILIS	POL	Ampharetidae	Yes
5001670802	ASABELLIDES OCULATA	POL	Ampharetidae	Yes
5001670501	MELINNA CRISTATA	POL	Ampharetidae	Yes
500168SPP	TEREBELLIDAE SPP.	POL	Terebellidae	No
50016801SPP	AMPHITRITINAE SPP.	POL	Terebellidae	No
5001680101	AMPHITRITE CIRRATA	POL	Terebellidae	Yes
500168130201	LANASSA VENUSTA VENUSTA	POL	Terebellidae	Yes
5001680602	NICOLEA ZOSTERICOLA	POL	Terebellidae	Yes
5001680701	PISTA CRISTATA	POL	Terebellidae	Yes

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50016808SPP	POLYCIRRUS SPP.	POL	Terebellidae	No
5001680805	POLYCIRRUS CF. HAEMATODES	POL	Terebellidae	Yes
5001680804	POLYCIRRUS EXIMIUS	POL	Terebellidae	Yes
5001680802	POLYCIRRUS MEDUSA	POL	Terebellidae	Yes
5001680807	POLYCIRRUS PHOSPHOREUS	POL	Terebellidae	Yes
5001681702	PROCLEA GRAFFII	POL	Terebellidae	Yes
50016901SPP	TEREBELLIDES SPP.	POL	Trichobranchidae	No
5001690105	TEREBELLIDES ATLANTIS	POL	Trichobranchidae	Yes
5001690101	TEREBELLIDES STROEMII	POL	Trichobranchidae	Yes
5001690201	TRICHOBRANCHUS GLACIALIS	POL	Trichobranchidae	Yes
5001690202	TRICHOBRANCHUS ROSEUS	POL	Trichobranchidae	Yes
500170SPP	SABELLIDAE SPP.	POL	Sabellidae	No
50017001SPP	CHONE SPP.	POL	Sabellidae	No
5001700106	CHONE CF. MAGNA	POL	Sabellidae	Yes
5001700104	CHONE DUNERI	POL	Sabellidae	Yes
5001700102	CHONE INFUNDIBULIFORMIS	POL	Sabellidae	Yes
5001700205	EUCHONE ELEGANS	POL	Sabellidae	Yes
5001700204	EUCHONE INCOLOR	POL	Sabellidae	Yes
5001700202	EUCHONE PAPILLOSA	POL	Sabellidae	Yes
5001701401	LAONOME KROEYERI	POL	Sabellidae	Yes
5001700502	MYXICOLA INFUNDIBULUM	POL	Sabellidae	Yes
50017022SP01	POTAMETHUS SP. 1 (BLAKE 1992)	POL	Sabellidae	Yes
5001700601	POTAMILLA NEGLECTA	POL	Sabellidae	Yes
5001700609	POTAMILLA RENIFORMIS	POL	Sabellidae	Yes
50020501SP01	POLYGORDIUS SP. A	POL	Polygordiidae	Yes
5003SPP	OLIGOCHAETA SPP.	OLI		No
500901SP02	ENCHYTRAEIDAE SP. 2 (KROPP 1995)	OLI	Enchytraeidae	Yes
500901SP03	ENCHYTRAEIDAE SP. 3 (KROPP 1995)	OLI	Enchytraeidae	Yes
50090103PAST	GRANIA POSTCLITELLO LONGIDUCTA	OLI	Enchytraeidae	Yes
500902SPP	TUBIFICIDAE SPP.	OLI	Tubificidae	No
50090210SP01	ADELODRILUS SP. 1	OLI	Tubificidae	Yes
50090210SP02	ADELODRILUS SP. 2 (BLAKE 1996)	OLI	Tubificidae	Yes
500902SP02	TUBIFICIDAE SP. 2 (BLAKE 1992)	OLI	Tubificidae	Yes
500902SP04	TUBIFICIDAE SP. 4 (BLAKE 1996)	OLI	Tubificidae	Yes
50090209SPP	TUBIFICOIDES SPP.	OLI	Tubificidae	No
5009020906	TUBIFICOIDES APECTINATUS	OLI	Tubificidae	Yes
5009020403	TUBIFICOIDES NR. PSEUDOGASTER	OLI	Tubificidae	Yes
50090209SP01	TUBIFICOIDES SP. 1	OLI	Tubificidae	Yes
50090209SP03	TUBIFICOIDES SP. 3	OLI	Tubificidae	Yes
51SPP	GASTROPODA SPP.	GAS		No
51SP01	GASTROPODA SP. A	GAS		Yes
51SP02	GASTROPODA SP.2 (KROPP 1995)	GAS		Yes
510210SPP	TROCHIDAE SPP.	GAS	Trochidae	No
51021003SPP	MARGARITES SPP.	GAS	Trochidae	No
5102100402	SOLARIELLA OBSCURA	GAS	Trochidae	Yes
5102120202	MOELLERIA COSTULATA	GAS	Turbinidae	Yes
5103090305	LACUNA VINCTA	GAS	Lacunidae	Yes

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5103200108	ALVANIA CASTANEA	GAS	Rissoidae	Yes
51032001SP02	ALVANIA SP. 2 (BLAKE 1996)	GAS	Rissoidae	Yes
5103202115	ONOBA MIGHELSI	GAS	Rissoidae	Yes
5103202113	ONOBA PELAGICA	GAS	Rissoidae	Yes
5103200127	PUSILLINA HARPA	GAS	Rissoidae	Yes
5103202301	PUSILLINA PSEUDOAREOLATA	GAS	Rissoidae	Yes
510320SP01	RISSOIDAE SP. A (KROPP 1995)	GAS	Rissoidae	Yes
5103240102	SKENEOPSIS PLANORBIS	GAS	Skeneopsidae	Yes
5103500102GR	EPITONIUM GREENLANDICUM	GAS	Epitoniidae	Yes
510376SPP	NATICIDAE SPP.	GAS	Naticidae	No
5103761201	EUSPIRA HEROS	GAS	Naticidae	Yes
5103760408	EUSPIRA IMMACULATA	GAS	Naticidae	Yes
5103760402	POLINICES PALLIDUS	GAS	Naticidae	Yes
51050103SPP	UROSALPINX SPP.	GAS	Muricidae	Yes
510504SPP	BUCCINIDAE SPP.	GAS	Buccinidae	No
51050503SPP	COLUS SPP.	GAS	Buccinidae	No
5105050335	COLUS PARVUS	GAS	Buccinidae	Yes
5105050326	COLUS PUBESCENS	GAS	Buccinidae	Yes
5105050328	COLUS PYGMAEUS	GAS	Buccinidae	Yes
51050503SP01	COLUS SP. A (KROPP 1995)	GAS	Buccinidae	Yes
51050508SPP	NEPTUNEA SPP.	GAS	Buccinidae	Yes
5105080202	ILYANASSA TRIVITTATA	GAS	Nassariidae	Yes
51060204SPP	OENOPOTA SPP.	GAS	Turridae	No
5106020443CF	OENOPOTA CF. CANCELLATUS	GAS	Turridae	Yes
5106020409	OENOPOTA HARPULARIA	GAS	Turridae	Yes
5106020426	OENOPOTA INCISULA	GAS	Turridae	Yes
5106020410	OENOPOTA PYRIMIDALIS	GAS	Turridae	Yes
5106020603	PROPEBELA EXARATA	GAS	Turridae	Yes
5106020601	PROPEBELA TURRICULA	GAS	Turridae	Yes
510602SP01	TURRIDAE SP. A (KROPP 1995)	GAS	Turridae	Yes
5108011402	BOONEA IMPRESSA	GAS	Pyramidellidae	Yes
5108011504	ODOSTOMIA GIBBOSA	GAS	Pyramidellidae	Yes
5108010133	ODOSTOMIA SULCOSA	GAS	Pyramidellidae	Yes
5181SPP	OPISTHOBRANCHIA SPP.	GAS		No
5110SPP	CEPHALASPIDEA SPP.	GAS		No
5110040103	ACTEOCINA CANALICULATA	GAS	Acteocinidae	Yes
51100402SPP	CYLICHNA SPP.	GAS	Cylichnidae	No
5110040203	CYLICHNA ALBA	GAS	Cylichnidae	Yes
5110040206	CYLICHNA GOULDI	GAS	Cylichnidae	Yes
5110090101	DIAPHANA MINUTA	GAS	Diaphanidae	Yes
5110130101	RETUSA OBTUSA	GAS	Retusidae	Yes
5127SPP	NUDIBRANCHIA SPP.	GAS		No
5131070201	DORIDELLA OBSCURA	GAS	Corambidae	Yes
54SPP	APLACOPHORA SPP.	APL		No
5402010102	CHAETODERMA NITIDULUM CANADENSE	APL	Chaetodermatidae	Yes
55SPP	BIVALVIA SPP.	BIV		No
55SP02	BIVALVIA SP. A (KROPP 1995)	BIV		Yes

MWRA Code	Taxon Name	Higher Taxon	Family	Species?
550202SPP	NUCULIDAE SPP.	BIV	Nuculidae	No
55020202SPP	NUCULA SPP.	BIV	Nuculidae	No
5502020205	NUCULA ANNULATA	BIV	Nuculidae	Yes
5502020206	NUCULA DELPHINODONTA	BIV	Nuculidae	Yes
5502020216	NUCULOMA GRANULOSA	BIV	Nuculidae	Yes
5502020201	NUCULOMA TENUIS	BIV	Nuculidae	Yes
550204SPP	NUCULANIDAE SPP.	BIV	Nuculanidae	No
5502040507	MEGAYOLDIA THRACIAEFORMIS	BIV	Nuculanidae	Yes
55020402SPP	NUCULANA SPP.	BIV	Nuculanidae	No
5502040220	NUCULANA MESSANENSIS	BIV	Nuculanidae	Yes
5502040201	NUCULANA PERNULA	BIV	Nuculanidae	Yes
55020402SP01	NUCULANA SP. 1 (BLAKE 1992)	BIV	Nuculanidae	Yes
5502040513	YOLDIA SAPOTILLA	BIV	Nuculanidae	Yes
5502040611	YOLDIELLA LUCIDA	BIV	Nuculanidae	Yes
550601SPP	ARCIDAE SPP.	BIV	Arcidae	No
550701SPP	MYTILIDAE SPP.	BIV	Mytilidae	No
55070102SPP	CRENELLA SPP.	BIV	Mytilidae	No
5507010201	CRENELLA DECUSSATA	BIV	Mytilidae	Yes
5507010203	CRENELLA GLANDULA	BIV	Mytilidae	Yes
55070104SPP	MUSCULUS SPP.	BIV	Mytilidae	No
5507010402	MUSCULUS DISCORS	BIV	Mytilidae	Yes
5507010401	MUSCULUS NIGER	BIV	Mytilidae	Yes
5509050901	PLACOPECTEN MAGELLANICUS	BIV	Pectinidae	Yes
5509090202	ANOMIA SIMPLEX	BIV	Anomiidae	Yes
5509090203	ANOMIA SQUAMULA	BIV	Anomiidae	Yes
551502SPP	THYASIRIDAE SPP.	BIV	Thyasiridae	No
55150203SPP	THYASIRA SPP.	BIV	Thyasiridae	No
5515020325	THYASIRA GOULDI	BIV	Thyasiridae	Yes
5515090301	PYTHINELLA CUNEATA	BIV	Montacutidae	Yes
5515170106	CYCLOCARDIA BOREALIS	BIV	Carditidae	Yes
55151901SPP	ASTARTE SPP.	BIV	Astartidae	No
5515190101	ASTARTE BOREALIS	BIV	Astartidae	Yes
5515190113	ASTARTE UNDATA	BIV	Astartidae	Yes
5515220601	CERASTODERMA PINNULATUM	BIV	Cardiidae	Yes
5515250301	MULINIA LATERALIS	BIV	Mactridae	Yes
5515250102	SPISULA SOLIDISSIMA	BIV	Mactridae	Yes
5515290301	ENSIS DIRECTUS	BIV	Solenidae	Yes
5515290105	SILIQUA COSTATA	BIV	Solenidae	Yes
5515310116	MACOMA BALTHICA	BIV	Tellinidae	Yes
5515310205	TELLINA AGILIS	BIV	Tellinidae	Yes
5515390101	ARCTICA ISLANDICA	BIV	Arcticidae	Yes
5515471201	PITAR MORRHUANA	BIV	Veneridae	Yes
5517010201	MYA ARENARIA	BIV	Myidae	Yes
5517060102	Crytodaria siliqua	BIV	Hiatellidae	Yes
5517060201	HIATELLA ARCTICA	BIV	Hiatellidae	Yes
55200201SPP	PANDORA SPP.	BIV	Pandoridae	No
5520020101	PANDORA GLACIALIS	BIV	Pandoridae	Yes

MWRA Code	Taxon Name	Higher Taxon	Family	Species?
5520020107	PANDORA GOULDIANA	BIV	Pandoridae	Yes
5520020109CF	PANDORA NR. INFLATA	BIV	Pandoridae	Yes
5520050201	LYONSIA ARENOSA	BIV	Lyonsiidae	Yes
5520070102	PERIPLOMA FRAGILE	BIV	Periplomatidae	Yes
5520070104	PERIPLOMA PAPYRATIUM	BIV	Periplomatidae	Yes
552008SPP	THRACIIDAE SPP.	BIV	Thraciidae	No
5520080102	ASTHENOTHAERUS HEMPHILLI	BIV	Thraciidae	Yes
5520080209	THRACIA CONRADI	BIV	Thraciidae	Yes
5601010201	DENTALIUM ENTALE	SCA	Dentaliidae	Yes
60SPP	PYCNOGONIDA SPP.	PYC		No
6001010101	NYMPHON GROSSIPES	PYC	Nymphonidae	Yes
6154SPP	CUMACEAN SPP.	CUM		No
6154010105	LAMPROPS QUADRIPLICATA	CUM	Lampropidae	Yes
61540402SPP	EUDORELLA SPP.	CUM	Leuconidae	No
61540402HIRS	EUDORELLA HIRSUTA	CUM	Leuconidae	Yes
6154040208	EUDORELLA HISPIDA	CUM	Leuconidae	Yes
6154040211	EUDORELLA PUSILLA	CUM	Leuconidae	Yes
6154040304	EUDORELLOPSIS DEFORMIS	CUM	Leuconidae	Yes
61540401SPP	LEUCON SPP.	CUM	Leuconidae	No
6154040106	LEUCON ACUTIROSTRIS	CUM	Leuconidae	Yes
6154040104	LEUCON FULVUS	CUM	Leuconidae	Yes
61540401SP01	LEUCON SP. 1 (BLAKE 1992)	CUM	Leuconidae	Yes
615405SPP	DIASTYLIDAE SPP.	CUM	Diastylidae	No
61540501SPP	DIASTYLIS SPP.	CUM	Diastylidae	No
6154050129	DIASTYLIS ABBREVIATA	CUM	Diastylidae	Yes
6154050130	DIASTYLIS CORNUIFER	CUM	Diastylidae	Yes
6154050121	DIASTYLIS POLITA	CUM	Diastylidae	Yes
6154050126	DIASTYLIS QUADRISPINOSA	CUM	Diastylidae	Yes
6154050127	DIASTYLIS SCULPTA	CUM	Diastylidae	Yes
61540504SPP	LEPTOSTYLIS SPP.	CUM	Diastylidae	No
6154050403CF	LEPTOSTYLIS CF. AMPULLACEA	CUM	Diastylidae	Yes
6154050404	LEPTOSTYLIS LONGIMANA	CUM	Diastylidae	Yes
6154060101	PETALOSARSIA DECLIVIS	CUM	Pseudocumidae	Yes
61540701SPP	CAMPYLASPIS SPP.	CUM	Nannastacidae	No
61540701SUCF	CAMPYLASPIS NR. SULCATA	CUM	Nannastacidae	Yes
6154070103	CAMPYLASPIS RUBICUNDA	CUM	Nannastacidae	Yes
6154090301	PSEUDOLEPTOCUMA MINOR	CUM	Bodotriidae	Yes
6157000101	ANARTHRURA CF. SIMPLEX	TAN	Anarthruridae	Yes
6157020402	TANAISSUS PSAMMOPHILUS	TAN	Nototanaidae	Yes
6159010111	GNATHIA CERINA	ISO	Gnathiidae	Yes
6160010301	PTILANTHURA TENUIS	ISO	Anthuridae	Yes
6161011203	POLITOLANA POLITA	ISO	Cirolanidae	Yes
6162020503	CHIRIDOTEA TUFTSI	ISO	Chaetiliidae	Yes
6162020701	EDOTIA MONTOSA	ISO	Idoteidae	Yes
6162020703	EDOTIA TRILOBA	ISO	Idoteidae	Yes
6162020308	IDOTEA BALTHICA	ISO	Idoteidae	Yes
616312SPP	MUNNIDAE SPP.	ISO	Munnidae	No

MWRA Code	Taxon Name	Higher Taxon	Family	Species?
61631201SPP	MUNNA SPP.	ISO	Munnidae	No
61631201SP01	MUNNA SP. 1	ISO	Munnidae	Yes
61631201SP02	MUNNA SP. 2 (BLAKE 1992)	ISO	Munnidae	Yes
61631202SPP	PLEUROGONIUM SPP.	ISO	Paramunnidae	No
6163120204	PLEUROGONIUM INERME	ISO	Paramunnidae	Yes
6163120202	PLEUROGONIUM RUBICUNDUM	ISO	Paramunnidae	Yes
6163120201	PLEUROGONIUM SPINOSISSIMUM	ISO	Paramunnidae	Yes
6163170702	BAEONECTES MUTICUS	ISO	Eurycopidae	Yes
6168SPP	AMPHIPODA SPP.	AMP		No
616902SPP	AMPELISCIDAE SPP.	AMP	Ampeliscidae	No
61690201SPP	AMPELISCA SPP.	AMP	Ampeliscidae	No
6169020108	AMPELISCA ABDITA	AMP	Ampeliscidae	Yes
6169020101	AMPELISCA MACROCEPHALA	AMP	Ampeliscidae	Yes
6169020109	AMPELISCA VADORUM	AMP	Ampeliscidae	Yes
6169020202	BYBLIS GAIMARDI	AMP	Ampeliscidae	Yes
6169020306	HAPLOOPS FUNDIENSIS	AMP	Ampeliscidae	Yes
6169040101	AMPITHOE RUBRICATA	AMP	Amphilochidae	Yes
6169030403	GITANOPSIS ARCTICA	AMP	Amphilocidae	Yes
6169060702	LEPTOCHEIRUS PINGUIS	AMP	Aoridae	Yes
6169060402	MICRODEUTOPUS ANOMALUS	AMP	Aoridae	Yes
6169070101	ARGISSA HAMATIPES	AMP	Argissidae	Yes
616915SPP	COROPHIIDAE SPP.	AMP	Corophiidae	No
6169150203	CRASSICOROPHIUM CRASSICORNE	AMP	Corophiidae	Yes
6169150308	ERICTHONIUS FASCIATUS	AMP	Corophiidae	Yes
6169150201	MONOCOROPHIUM ACHERUSICUM	AMP	Corophiidae	Yes
6169150211	MONOCOROPHIUM INSIDIOSUM	AMP	Corophiidae	Yes
6169150207	MONOCOROPHIUM TUBERCULATUM	AMP	Corophiidae	Yes
6169150801	PSEUDUNCIOLA OBLIQUUA	AMP	Corophiidae	Yes
61691507SPP	UNCIOLA SPP.	AMP	Corophiidae	No
6169150702	UNCIOLA INERMIS	AMP	Corophiidae	Yes
6169150703	UNCIOLA IRRORATA	AMP	Corophiidae	Yes
6169201203	PONTOGENEIA INERMIS	AMP	Eusiridae	Yes
6169210602	GAMMARELLUS ANGULOSUS	AMP	Gammaridae	Yes
616921MESPP	MELITIDAE SPP.	AMP	Melitidae	No
6169211601	CASCO BIGELOWI	AMP	Melitidae	Yes
6169210802	MAERA LOVENI	AMP	Melitidae	Yes
6169211003CF	MELITA NR. DENTATA	AMP	Melitidae	Yes
61692110SP01	MELITA SP. 1	AMP	Melitidae	Yes
6169220602	ACANTHOHAUSTORIUS MILLSI	AMP	Haustoriidae	Yes
6169220603	ACANTHOHAUSTORIUS SPINOSUS	AMP	Haustoriidae	Yes
6169221301	PSEUDOHAUSTORIUS BOREALIS	AMP	Haustoriidae	Yes
6169260217	PHOTIS POLLEX	AMP	Isaeidae	Yes
6169260202	PHOTIS REINHARDI	AMP	Isaeidae	Yes
6169260301	PROTOMEDEIA FASCIATA	AMP	Isaeidae	Yes
6169270202	ISCHYROCERUS ANGUIPES	AMP	Ischyroceridae	Yes
6169270303	JASSA MARMORATA	AMP	Ischyroceridae	Yes
616934SPP	LYSIANASSIDAE SPP.	AMP	Lysianassidae	No

MWRA Code	Taxon Name	Higher Taxon	Family	Species?
6169340303	ANONYX LILJEBORGI	AMP	Lysianassidae	Yes
61693414SPP	HIPPOMEDON SPP.	AMP	Lysianassidae	No
6169341405	HIPPOMEDON PROPINQUUS	AMP	Lysianassidae	Yes
6169341408	HIPPOMEDON SERRATUS	AMP	Lysianassidae	Yes
61693452SPP	ORCHOMENELLA SPP.	AMP	Lysianassidae	No
6169345201	ORCHOMENELLA MINUTA	AMP	Lysianassidae	Yes
616937SPP	OEDICEROTIDAE SPP.	AMP	Oedicerotidae	No
616937AMSP01	AMEROCULODES SP. 1 (KROPP 1998)	AMP	Oedicerotidae	Yes
6169370505	BATHYMEDON OBTUSIFRONS	AMP	Oedicerotidae	Yes
61693708DESPP	DEFLEXILODES SPP.	AMP	Oedicerotidae	No
6169370817	DEFLEXILODES INTERMEDIUS	AMP	Oedicerotidae	Yes
6169370821	DEFLEXILODES TESSELATUS	AMP	Oedicerotidae	Yes
6169370815	DEFLEXILODES TUBERCULATUS	AMP	Oedicerotidae	Yes
61693708SPP	MONOCULODES SPP.	AMP	Oedicerotidae	No
6169370810	MONOCULODES PACKARDI	AMP	Oedicerotidae	Yes
616937SP03	OEDICEROTIDAE SP. A (KROPP 1995)	AMP	Oedicerotidae	Yes
6169371505	WESTWOODILLA BREVICALCAR	AMP	Oedicerotidae	Yes
616942SPP	PHOXOCEPHALIDAE SPP.	AMP	Phoxocephalidae	No
6169421901	EOBROLGUS SPINOSUS	AMP	Phoxocephalidae	Yes
6169420116	HARPINIA PROPINQUA	AMP	Phoxocephalidae	Yes
61694202SP01	HARPINIOPSIS SP. 1	AMP	Phoxocephalidae	Yes
6169420702	PHOXOCEPHALUS HOLBOLLI	AMP	Phoxocephalidae	Yes
6169421502	RHEPOXYNIUS HUDSONI	AMP	Phoxocephalidae	Yes
616943SPP	PLEUSTIDAE SPP.	AMP	Pleustidae	No
6169430305	PARAPLEUSTES GRACILIS	AMP	Pleustidae	Yes
6169430405	PLEUSTES PANOPLUS	AMP	Pleustidae	Yes
6169430503	PLEUSYMTES GLABER	AMP	Pleustidae	Yes
6169430610	STENOPLEUSTES INERMIS	AMP	Pleustidae	Yes
616944SPP	PODOCERIDAE SPP.	AMP	Podoceridae	No
6169440110	DULICHIA TUBERCULATA	AMP	Podoceridae	Yes
6169440104	DYOPEDOS MONACANTHUS	AMP	Podoceridae	Yes
6169440302	PARADULICHIA TYPICA	AMP	Podoceridae	Yes
616948SPP	STENOTHOIDAE SPP.	AMP	Stenothoidae	No
6169480306	METOPELLA ANGUSTA	AMP	Stenothoidae	Yes
6169480801	PROBOLOIDES HOLMESI	AMP	Stenothoidae	Yes
61695003SP01	SYRRHOE SP. 1 (KROPP 1998)	AMP	Synopiidae	Yes
617101SPP	CAPRELLIDAE SPP.	AMP	Caprellidae	No
6171010801	AEGININA LONGICORNIS	AMP	Caprellidae	Yes
6171010703	CAPRELLA LINEARIS	AMP	Caprellidae	Yes
6171010302	MAYERELLA LIMICOLA	AMP	Caprellidae	Yes
6171010901	PARACAPRELLA TENUIS	AMP	Caprellidae	Yes
6175SPP	DECAPODA SPP.	DEC		No
6175SP01	DECAPODA SP. 1 (BLAKE 1992)	DEC		Yes
6179SPP	CARIDEA SPP.	DEC		No
6179160408	EUALUS PUSIOLUS	DEC	Hippolytidae	Yes
6179220103	CRANGON SEPTEMSPINOSA	DEC	Crangonidae	Yes
6183020301	AXIUS SERRATUS	DEC	Axiidae	Yes

MWRA Code	Taxon Name	Higher Taxon	Family	Species?
6188030107	CANCER BOREALIS	DEC	Cancridae	Yes
72SPP	SIPUNCULA SPP.	SIP		No
7200020305	NEPHASOMA DIAPHANES	SIP	Golfingiidae	Yes
7200020401	PHASCOLION STROMBI	SIP	Golfingiidae	Yes
7301020201	ECHIURUS ECHIURUS	ECI	Echiuridae	Yes
7400010101	PRIAPULUS CAUDATUS	PRI	Priapulidae	Yes
7700010203	PHORONIS ARCHITECTA	PHO	Phoronidae	Yes
8104SPP	ASTEROIDEA SPP.	ECH		No
8107020101	CTENODISCUS CRISPATUS	ECH	Porcellanasteridae	Yes
8114040111	HENRICIA SANGUINOLENTA	ECH	Echinasteridae	Yes
8120SPP	OPHIUROIDEA SPP.	ECH		No
8129030202	AXIOGNATHUS SQUAMATUS	ECH	Amphiuridae	Yes
8127010401	OPHIOCTEN SERICEUM	ECH	Ophiuridae	Yes
8129040102	OPHIOTHRIX ANGULATA	ECH	Ophiotrichidae	Yes
81270106SPP	OPHIURA SPP.	ECH		No
8127010611	OPHIURA ROBUSTA	ECH	Ophiuridae	Yes
8127010610	OPHIURA SARSI	ECH	Ophiuridae	Yes
81270106SP02	OPHIURA SP. A	ECH	Ophiuridae	Yes
8136SPP	ECHINOIDEA SPP.	ECH		No
8155020101	ECHINARACHNIUS PARMA	ECH	Echinarachniidae	Yes
8170SPP	HOLOTHUROIDEA SPP.	ECH		No
8179010102	MOLPADIA OOLITICA	ECH	Molpadiidae	Yes
8201SPP	ENTEROPNEUSTA SPP.	HEM		No
8201010201	STEREOBALANUS CANADENSIS	HEM	Harrimaniidae	Yes
8401SPP	ASCIDIACEA SPP.	URO		No
8406010303	CNEMIDOCARPA MOLLIS	URO	Molgulidae	Yes
8406030108	MOLGULA MANHATTENSIS	URO	Molgulidae	Yes
8406030501	BOSTRICHOBRANCHUS PILULARIS	URO	Molgulidae	Yes
Key:				
AMP	Amphipoda			
APL	Aplacophora			
BIV	Bivalvia			
CNI	Cnidaria			
CUM	Cumacea			
DEC	Decapoda			
ECH	Echinodermata			
ECI	Echiura			
GAS	Gastropoda			
HEM	Hemichordata			
ISO	Isopoda			
NEM	Nemertea			
OLI	Oligochaeta			
PHO	Phoronida			
PLA	Platyhelminthes			
POL	Polychaeta			
PRI	Priapulida			

MWRA Code	Taxon Name	Higher Taxon	Family	Species?
PYC	Pycnogonida			
SCA	Scaphopoda			
SIP	Sipuncula			
TAN	Tanaidacea			
URO	Urochordata			

APPENDIX E-1

Hard-bottom 99 - Stills Summary

Transect	1	1	1	1	1	2	2	2	2	4	4	4	4	6	6	7	7	8	8	9	10	Total
Waypoint	1	2	3	4	5	1	2	3	4	1	2	3	4	1	2	1	2	1	2	1	1	
Roll	1+2	10	9+4	6	7	11	12	13	14	19	20	21	24	23	22	15	16	25	26	17	18	
Frames	26	28	33	30	28	30	28	29	30	29	28	28	26	30	29	28	30	28	30	29	31	608
Depth (ft)	84	92	76	82	97	88	86	85	100	114	110	105	75	105	98	80	78	74	84	80	80	
Substrate	mix	mix	b+c	b+c	mix	b+mix	b+mix	b+mix	b+mix	gp+c	mix	mix	b+mix	c+mix	mix+b	b+mix	b+c	mix	mix	b+c	b+c	
Seddrape	l-h	m	l	l-lm	m	l-h	mh	m	mh	h	h	lm-m	l	mh	m	l-mh	l-mh	lm	lm	lm-mh	h	
Lithothamnion spp.	26.4	35.5	83.2	69.8	36.8	34.7	12.9	20.7	4.2		8.1	24.9	71.9	2.1	28.6	46.6	36.3	68.8	50.7	28.0	1.6	
Asparagopsis hamifera	r		r			r	c	f-c					r			a	a			a	r	
hydroids	f-c	c	r-c	f-c	f-c	f-c	c	c	f-a	r-f	f	f	f	f	f-c	r	f-a	f-c	f	f-c	c	
spir/barn comp	f	f-c	r	f-c	f	f	f	f	f-c	r-f	f-c	f-c	f-a	f	c	f	c	f	f	f-c	a	
Rhodymenia palmata	157	29	0	4	0	60	252	164	21	0	0	0	24	0	3	245	240	0	0	233	149	1581
Agarum cribrosum	1						9									12	50			22	11	105
sponge	1																	1			1	3
Aplysilla sulfurea		4				27	10	17	14		14	10	4	1	10		4			13	14	142
Halichondria panicea	1	8		1	1	1	2					1	1		8	3	16			7	15	65
Haliclona spp.		1					1										1					3
sponge? (*Polymastia*?)																			7			7
Suberites spp.	3	7	2		8	20	8	14	27	1	23	6		22	22			2				165
white divided sponge on brachiopod									94		25						21			1		141
orange/tan encrusting sponge	31	16	10	16	28	28	18	23	30		40	9	10	20	52	7	11	9	6	15	17	396
orange encrusting sponge	10	26	13	28	29	27	24	21	14		5	31	42	1	28	34	66	47	18	58	34	556
gold encrusting sponge					2																	2
tan encrusting sponge	3	11	2	12	3	11	3	4	3		2	68	22	27	34	20	21	5	1	13	6	271
pink fuzzy encrusting sponge			17	32	17	4	6		3			4	14	2								99
white translucent sponge	44	8	2	10	16	10	25	15	22		8	3	15	16	17	4	32	3		14	67	331
cream encrusting sponge	1	19	3	5	5	31	29	14	40	1	20	12	3	9	12	1		29	8	8	1	251
white chalice type sponge							2	1	2		1					1						7
filamentous white encrusting sponge																					1	1

Transect	1	1	1	1	1	2	2	2	2	4	4	4	4	6	6	7	7	8	8	9	10	Total
Waypoint	1	2	3	4	5	1	2	3	4	1	2	3	4	1	2	1	2	1	2	1	1	
Melonanchora elliptica	1	1				1		1	1		1						1			1		8
general encrusting organism	8	31	6	3	26	6	6	17	29	14	11	11	9	35	37	20	11	19	8	29	77	413
Obelia geniculata	1						6									5	40			10	5	67
anemone				1	3	1		1		1	3	1	3	1		1	1	1	4	1	1	24
Metridium senile	57	11	128		1	4	2	36	4		5		59	1		4	33		1	9	10	365
Urticina felina						4	1				1	1		2								9
Fagesia lineata			1		1																	2
Cerianthus borealis										2	2											4
Gersemia rubiformis																					189	189
Alcyonium digitatum									9													9
gastropod										1				1								2
Tonicella marmorea	1		28	3	2	6	1	5				1	10		3	7	5	6	3	2		83
Crepidula plana											17			12								29
Notoacmea testudinalis																1						1
Buccinum undatum			1	1		3		1	2	1			1						2			12
Ilyanassa trivittata												1										1
Neptunea decemcostata	1	1																				2
nudibranch				1					1			1										3
bivalve														1								1
Modiolus modiolus	61	51	193	111	45	43	37	42	38		29	10	169	8	68	235	121	85	43	87	30	1506
Placopecten magellanicus					1					20	2	1		3					1			28
Arctica islandica									1			1		3	1		1					7
Balanus spp.	14	18	50	62	25	54	13	43	18		40	39	59	33	33	27	11	10	52	12	254	867
Homarus americanus		1									1							1				3
Cancer spp.		1				1								1				1	2			6
Hermit crab					1													1	1			3
Strongylocentrotus droebachiensis	6	30	43	31	12	36	19	8	1		3	16	30		5	9	2	21	29	6	8	315
starfish																1				4		5
juvenile *Asterias*	95	115	226	63	86	90	134	167	84	18	104	50	224	94	170	86	155	32	32	92	84	2201
Asterias vulgaris	6	5	5	2	1	4	9	1	3	23	30	12	8	37	10	4	2	4	3	3	40	212
Henricia sanguinolenta	8	23	29	35	34	29	42	22	24	1	6	14	50	11	38	23	27	15	4	32	92	559

Transect	1	1	1	1	1	2	2	2	2	4	4	4	4	6	6	7	7	8	8	9	10	Total
Waypoint	1	2	3	4	5	1	2	3	4	1	2	3	4	1	2	1	2	1	2	1	1	
Porania insignis							1															1
Crossaster papposus																	2					2
Pteraster militaris								1												1		2
Psolus fabricii	1	2	26	8	14		1	1	2		1	2	18		15		2	1	1		3	98
Aplidium spp.	129	20	2	1	73	34	44	35	35		13	5		31	182	2		83		1	5	695
Dendrodoa carnea	6	1	4	8	22	6	3						5		8	2	7	2	9	14	41	138
Didemnum albidum		28	11	33	7	21	12	51	46		22	8	68	7	54	51	67	10		53		549
Halocynthia pyriformis	8		6	2			3						2	1	5	1	11			23	3	65
white globular tunicate					1																	1
Boltenia ovifera	1						1							1	1		2			1		7
clear globular tunicate								1						1	2							4
white *Halocynthia pyriformis*							1		4				2			1	22			3		33
bryozoan																2						2
red crust bryozoan						1		14	9			3		3							15	45
Myxicola infundibulum	15	30	1	18	12	11	23	55	17	3	18	5	12	3	18	1	23	2		9	15	291
Terebratulina septentrionalis								9	226		62				12	8	362			22		701
fish												1										1
Tautogolabrus adspersus	32	67	91	45	8	61	97	64	33	2	11	10	25	10	19	38	66	6	4	66	63	818
Myoxocephalus spp.		3	1		1	1		1						3				1				11
Macrozoarces americanus				1																		1
Hemitripterus americanus																	1					1
Pseudopleuronectes americanus		1	1						2	1	1			2								8
Gadus morhua	1		1														1					3

APPENDIX E-2

Hard-bottom 99 - Video

Transect	1	1	1	1	1	2	2	2	2	4
Waypoint	1	2	3	4	5	1	2	3	4	1
Start time	9:39,11:46,12:07	10:00,10:18	9:12,9:17	16:29	18:06	11:00,11:12	11:48	12:36,12:55	13:41	8:40,8:58
End time	9:43,12:03,12:10	10:09,10:31	9:13,9:37	16:50	18:28	11:07,11:26	12:10	12:51,13:01	14:03	8:44,9:18
Minutes	24	22	21	21	22	21	22	21	22	24
Start depth (ft)	98	88,97	77,78	82	97	93,88	95	90,85	97	117,115
End depth (ft)	88	102,87	75,80	87	104	90,100	86	86,87	106	114,114
Primary substrate	mix	b+c	b+c	b+c	mix	c+b,b+c	b+c	b+mix	mix	gp+c
Sediment drape	mh	m	c-l	lm	m	l-mh,l-m	l-h	h	h	h
Relief	m	lm-m	mh-h	lm-m	l-lm	l-ml,ml-m	m	m	l-lm	l
Lithothamnion spp.	c	c	va	a	c	c	r-c	c	f	
Asparagopsis hamifera							c	f-c		
hydroids	f-c	c	f	f	f-c	f-c	c-a	c	c	r-f
spirorbids/small barnacles	f-c	f-c	f	f-c		f	f	f-c	f-c	r-f
Rhodymenia palmata	c	f				f	c	c	r	
Agarum cribrosum			1			1	c	1		
Sponge		1								
Halichondria panicea	1	6		1	3	4	3		1	
Haliclona spp.		1					2			
sponge? (*Polymastia*?)										
Suberites spp.	c	c	f		c	c	c	c	c	r
Melonanchora elliptica	1	1				2		1		
white chalice-type sponge							2	1	3	
white divided sponge									c	
Obelia geniculata							c			
anemone										5
Metridium senile	c	f-c	c	f	r	f	c	c	f	
Urticina felina	3				2	9	3		1	
Cerianthus borealis										12
Gersemia rubiformis										

Transect	1	1	1	1	1	2	2	2	2	4
Waypoint	1	2	3	4	5	1	2	3	4	1
Corymorpha pendula										f
Buccinum undatum				1						
Neptunea decemcostata		1								1
Busycotypus canaliculatus										
nudibranch					1					
Modiolus modiolus	c	c	a	a	c	c	c	c	c	
Placopecten magellanicus		1			7					79
Balanus spp.	f	f	c	c	f	c	f	c	f	
Homarus americanus				1						
Cancer spp.	1	2			2	1				
hermit crab										
Strongylocentrotus droebachiensis	f	c	a	c-a	c	c	c	f-c	r	
juvenile *Asterias*	c	c	a	c	c	c	a	a	c	f
Asterias vulgaris	f	f	f	r	f	f	c	f	f	c
Henricia sanguinolenta	f	f	f	c	c	f	c	f	f	r
Crossaster papposus										1
Psolus fabricii		r	c	f	f		r	r	f	
Aplidium spp.	a	f-c	f	f	c	c	c	c	c	
Halocynthia pyriformis	f		f	r			r		f	
Boltenia ovifera	2						2	2	3	
encrusting bryozoans										
Myxicola infundibulum	c	c		c	c	c	c	c	c	f
Terebratulina septentrionalis									a	
fish		1								
Tautogolabrus adspersus	c	c	va	c	f	f-c	a	c	f-c	r
Myoxocephalus spp.		1	1		1	3	1	1	3	4
Macrozoarces americanus			1	1						
Pseudopleuronectes americanus	4	2	1		1			2	2	3
Hemitripterus americanus										
Gadus morhua	1		7						1	

APPENDIX F

Hardbottom Stills

Plate 1. Transect 9 – Waypoint 1, Frame #29; Boulder with light sediment drape, 70% *Lithothamnion* cover, filamentous red algae *Asparagopsis hamifera*, *Asterias* (juveniles and one adult), a shot-gun kelp *Agarum cribosum* encrusted with the hydroid *Obelia geniculata*, and cunner *Tautogolabrus adspersus.*

Plate 2. Transect 9 – Waypoint 1, Frame #30; Boulder with moderately heavy sediment drape, numerous hydroids, a few northern white crust *Didemnum albidum*, juvenile *Asterias*, and the sponge *Aplysilla sulfurea.*

Plate 3. Transect 1 – Waypoint 3, Frame #18; Boulders and large cobbles with no sediment drape, 90% *Lithothamnion* cover, mussels *Modiolus modiolus* at base of rocks, juvenile *Asterias*, green sea urchins *Strongylocentrotus droebachiensis*, and cunner *Tautogolabrus adspersus.*

Plate 4. Transect 4 – Waypoint 4, Frame #17; Boulders with light sediment drape, 80% *Lithothamnion* cover, green sea urchins *Strongylocentrotus droebachiensis*, juvenile *Asterias*, an unidentified anemone, and cunner *Tautogolabrus adspersus.*

Plate 5. Transect 7 – Waypoint 2, Frame #27; Boulder with moderately heavy sediment drape, 5% *Lithothamnion* cover, abundant filamentous red algae *Asparagopsis hamifera*, dulse *Rhodymenia palmata*, shot-gun kelp *Agarum cribosum*, a frilled anemone *Metridium senile*, juvenile *Asterias*, and cunner *Tautogolabrus adspersus.*

Plate 6. Transect 7 – Waypoint 2, Frame #30; Boulder with moderate sediment drape, abundant filamentous red algae *Asparagopsis hamifera*, numerous sea peach tunicates *Halocynthia pyriformis* and northern lamp shells *Terebratulina septentrionalis*, juvenile *Asterias*, blood stars *Henrecia sanguinolenta*, crumb-of-bread sponges *Halichondria panecia*, and cunner *Tautogolabrus adspersus.*

Plate 7. Transect 9 – Waypoint 1, Frame #3; Boulders with moderate sediment drape, 30% *Lithothamnion* cover, abundant filamentous red algae *Asparagopsis hamifera*, dulse *Rhodymenia palmata*, shot-gun kelp *Agarum cribosum* encrusted with the hydroid *Obelia geniculata*, mussels *Modiolus modiolus*, the sponge *Aplysilla sulfurea*, and cunner *Tautogolabrus adspersus.*

Plate 8. Transect 1 – Waypoint 5, Frame #18; Large cobbles with moderately light sediment drape, 40% *Lithothamnion* cover, sea pork *Aplidium* spp. and juvenile *Asterias.*

Plate 9. Transect 10 – Waypoint 1, Frame #20; Boulders and cobbles with heavy sediment drape, several dulse *Rhodymenia palmata*, the soft red coral *Gersemia rubiformis*, numerous hydroids, encrusting sponges, *Asterias* (juveniles and one adult), some live barnacles *Balanus* spp. and the bases of numerous dead ones, and cunner *Tautogolabrus adspersus.*

Plate 10. Transect 4 – Waypoint, 1 Frame #9; Gravel pavement with small cobbles, heavy sediment drape, sea scallops *Placopecten magellanicus*, and an unidentified encrusting organism.

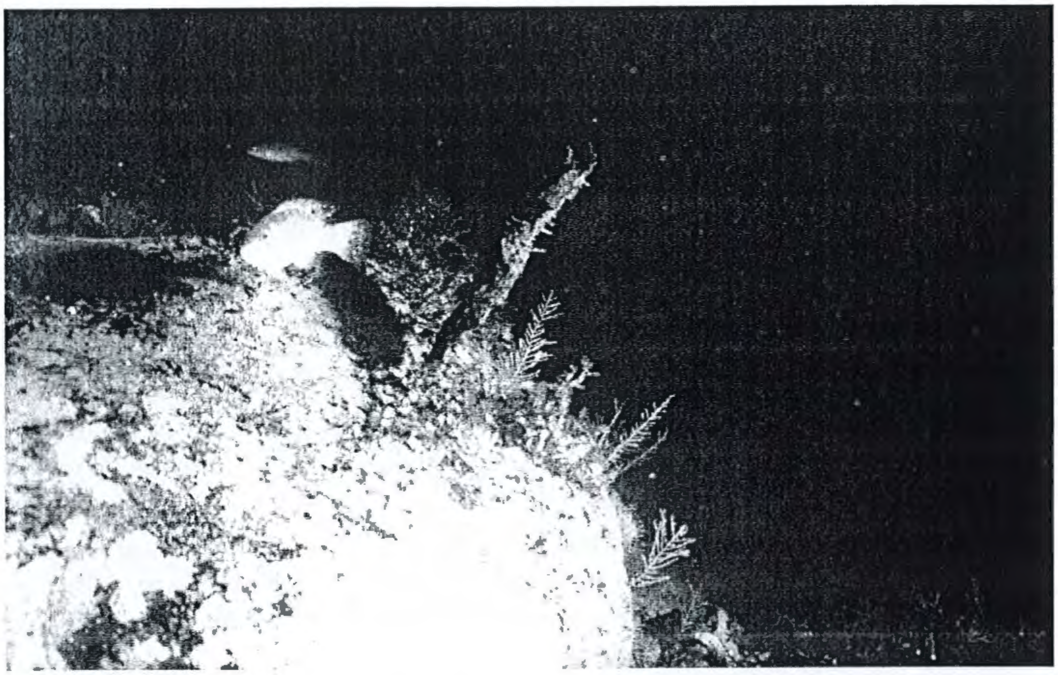

Plate 1

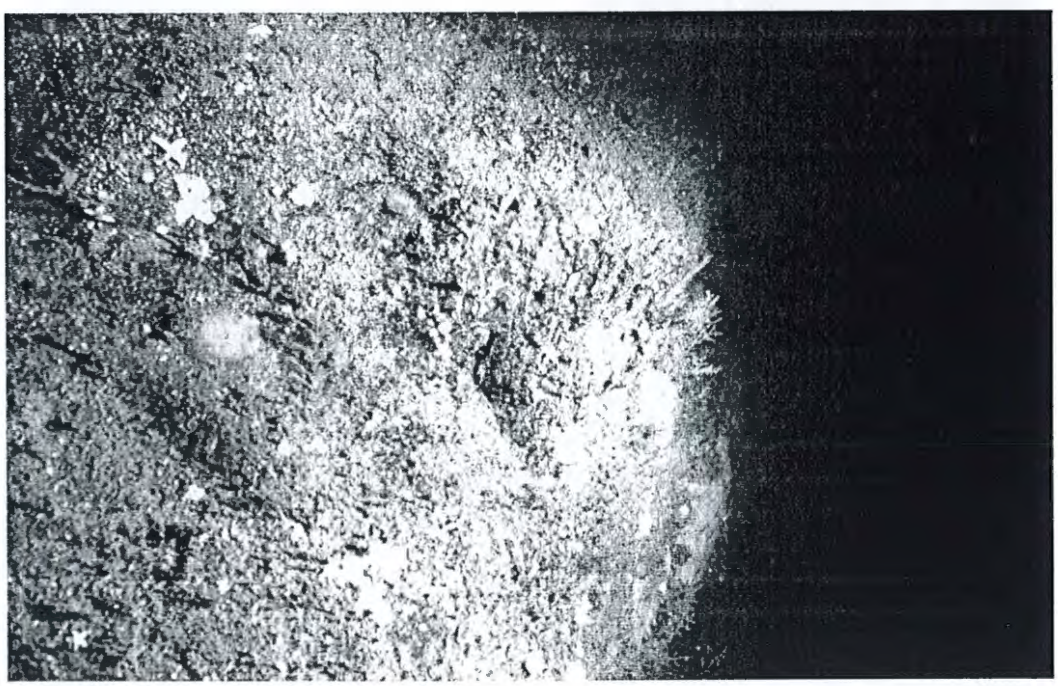

Plate 2

Plate 3

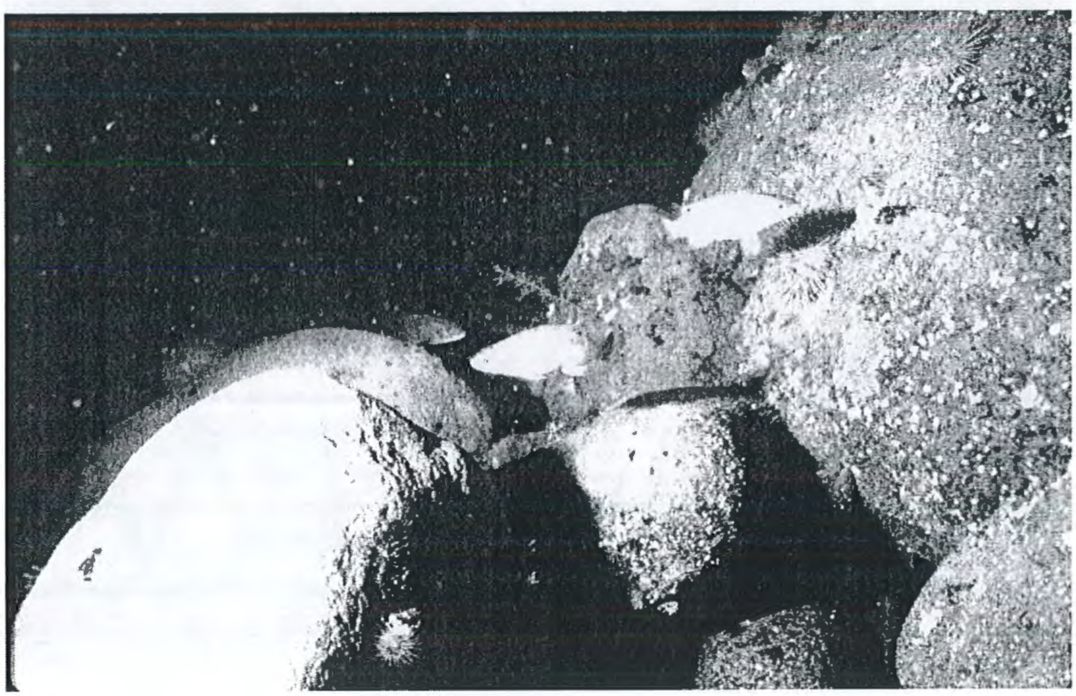

Plate 4

Plate 5

Plate 6

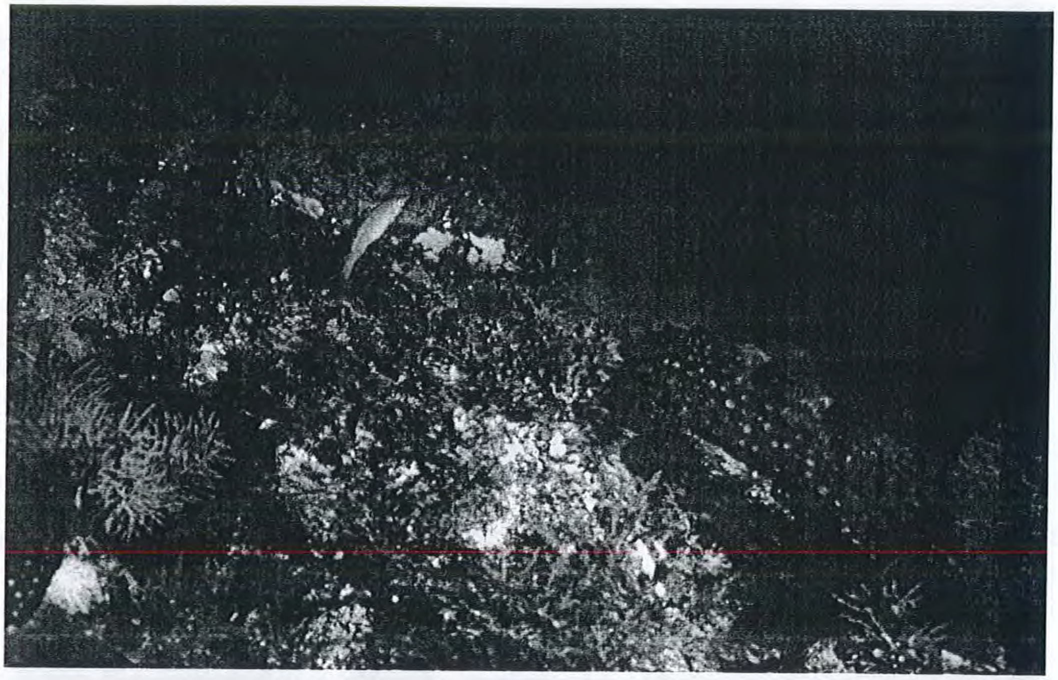

Plate 7

Plate 8

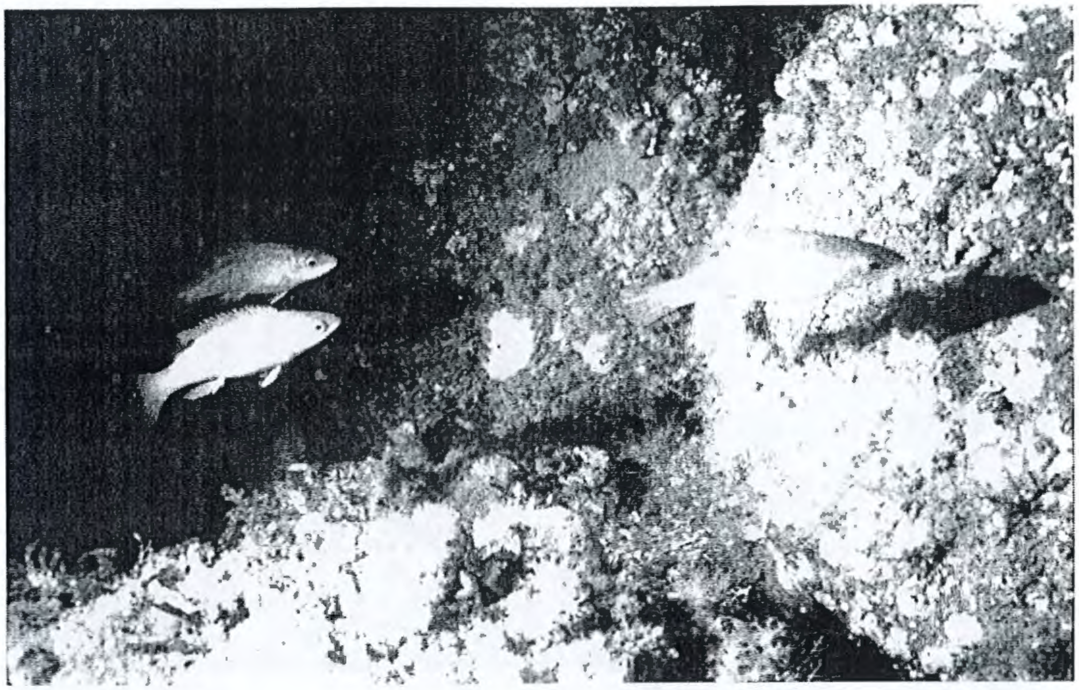

Plate 9

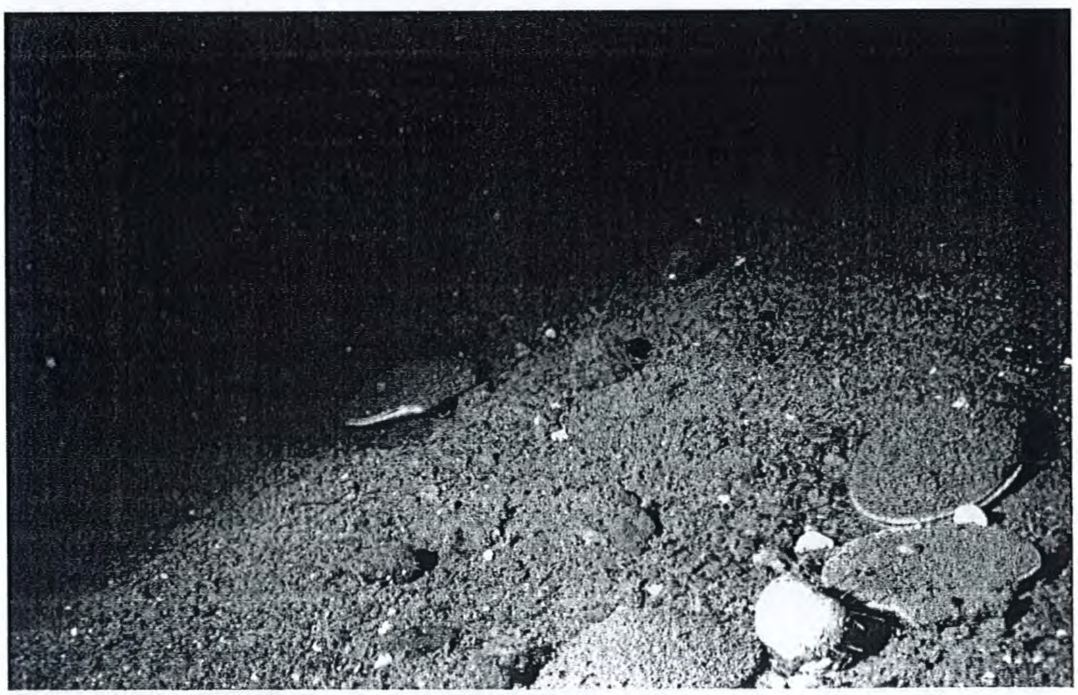

Plate 10

Supplement to Appendix F

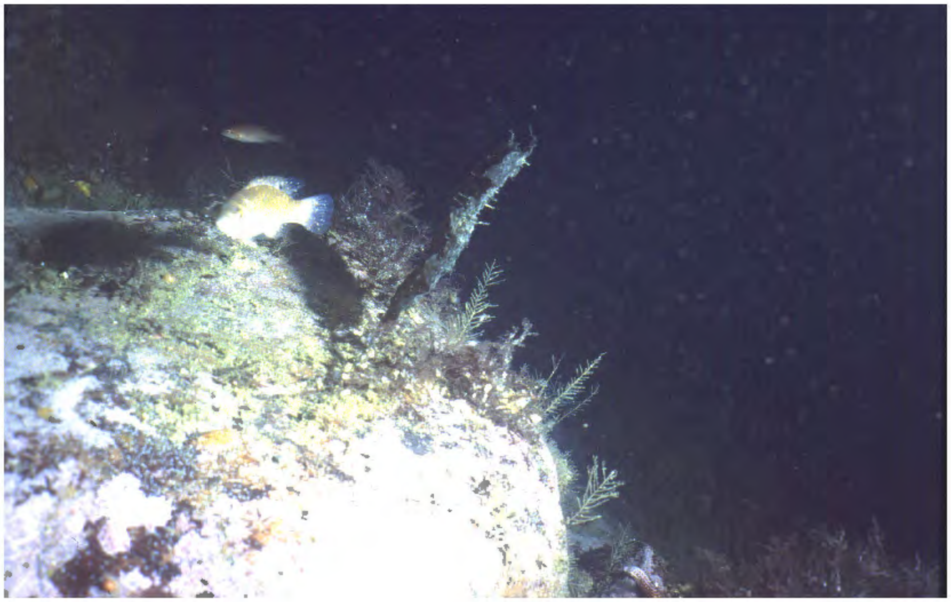

Plate 1. Boulder with light sediment drape, 70% Lithothamnion cover, filamentous red algae Asparagopsis hamifera, Asterias (juveniles and one adult), a shotgun kelp Agarum cribosum encrusted with the hydroid Obelia geniculata, and cunner Tautogolabrus adspersus.

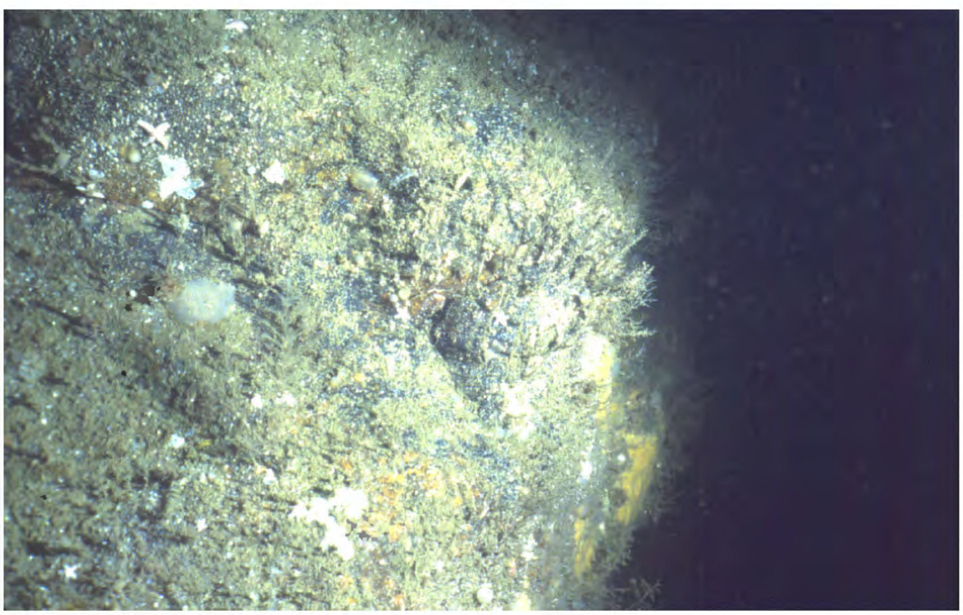

Plate 2. Boulder with moderately heavy sediment drape, numerous hydroids, a few northern white crust Didemnum albidum, juvenile Asterias, and the sponge Aplysilla sulfurea.

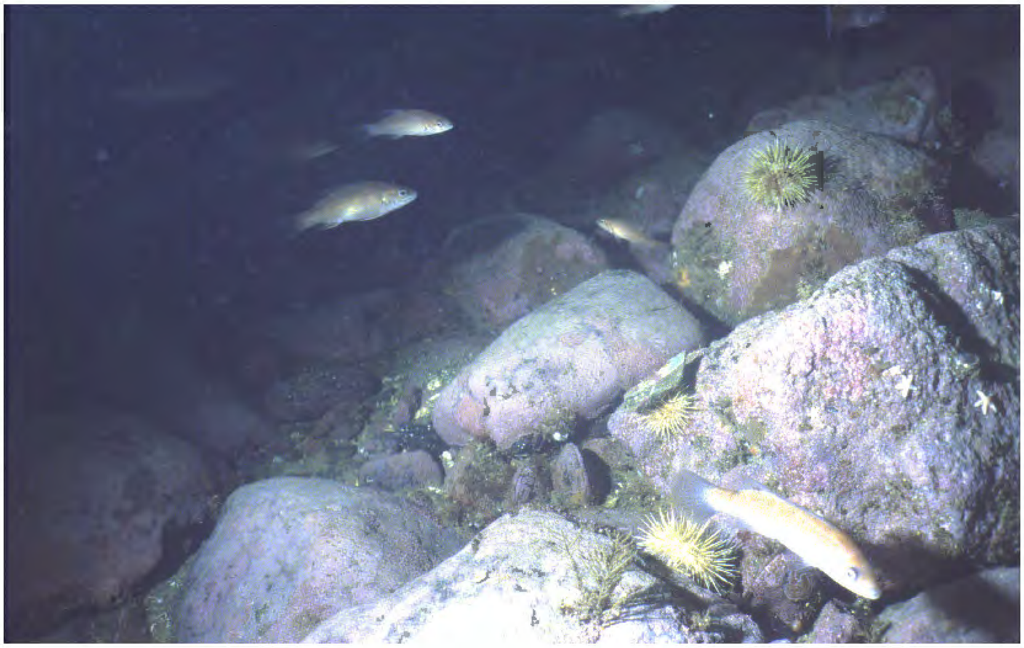

Plate 3. Boulders and large cobbles with no sediment drape, 90% Lithothamnion cover, mussels Modiolus modiolus at base of rocks, juvenile Asterias, green sea urchins Strongylocentrotus droebachiis, juvenile Asterias, an unidentified anemone, and cunner Tautogolabrus adspersus.

Plate 4. Boulders with light sediment drape, 80% Lithothamnion cover, green sea urchins Strongylocentrotus droebachiis, juvenile Asterias, an unidentified anemone, and cunner Tautogolabrus adspersus.

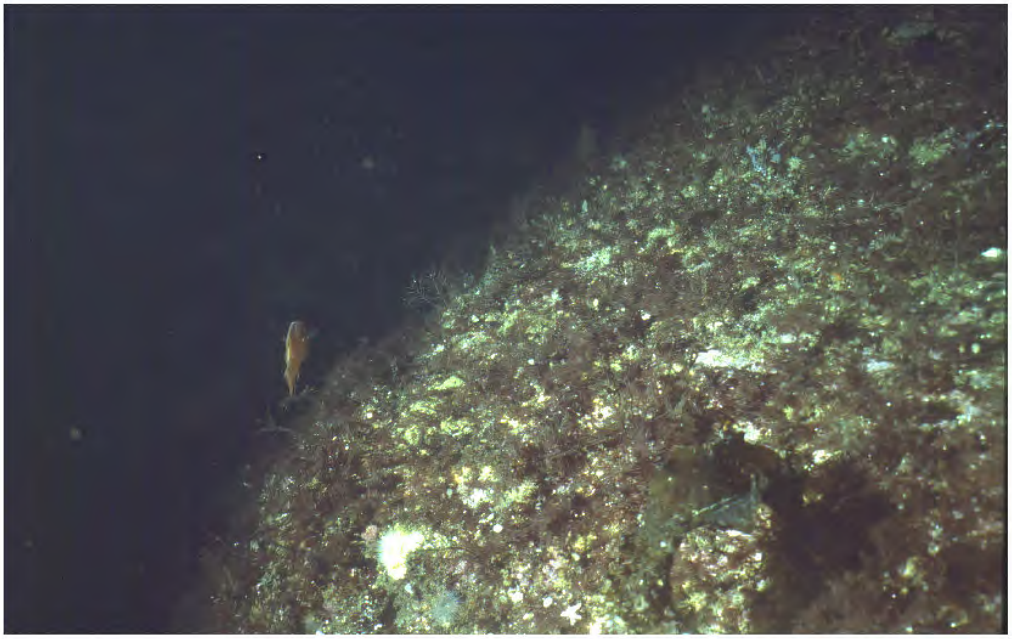

Plate 5. Boulder with moderately heavy sediment drape, 5% Lithothamnion cover, abundant filamentous red algae Asparagopsis hamifera, dulse Rhodymenia palmata, shot-gun kelp Agarum cribosum, a frilled anemone Metridium senile, juvenile Asterias, and cunner Tautogolabrus adspersus.

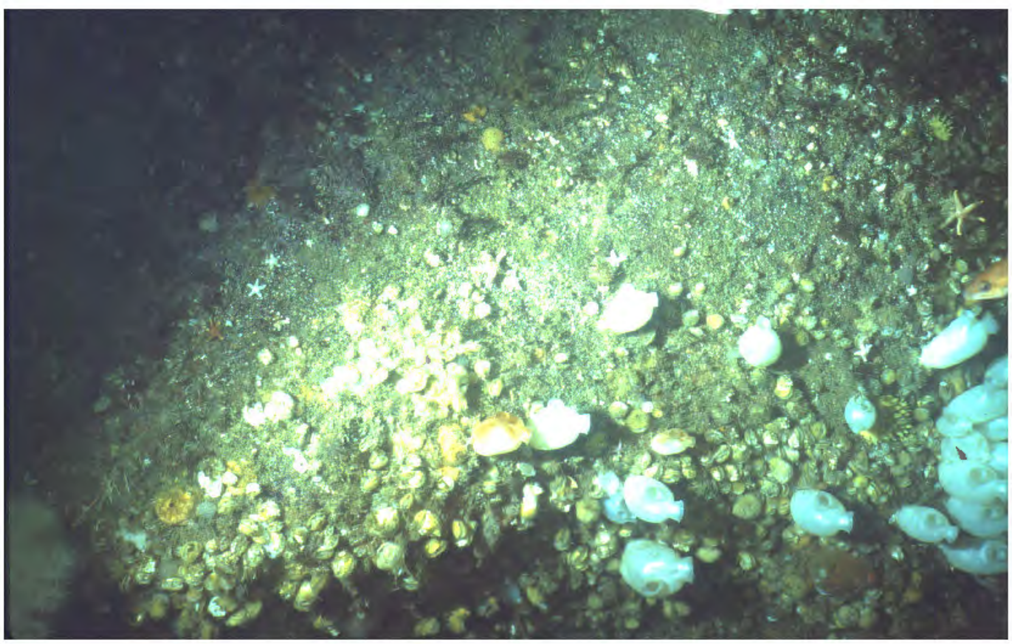

Plate 6. Boulder with moderate sediment drape, abundant filamentous red algae Asparagopsis hamifera, numerous sea peach tunicates Halocynthia pyriformis and northern lamp shells Terebratulina septentrionali, juvenile Asterias, blood stars Henrecia sanguinolenta, crumb-of-bread sponges Halichondria panecia, and cunner Tautogolabrus adspersus.

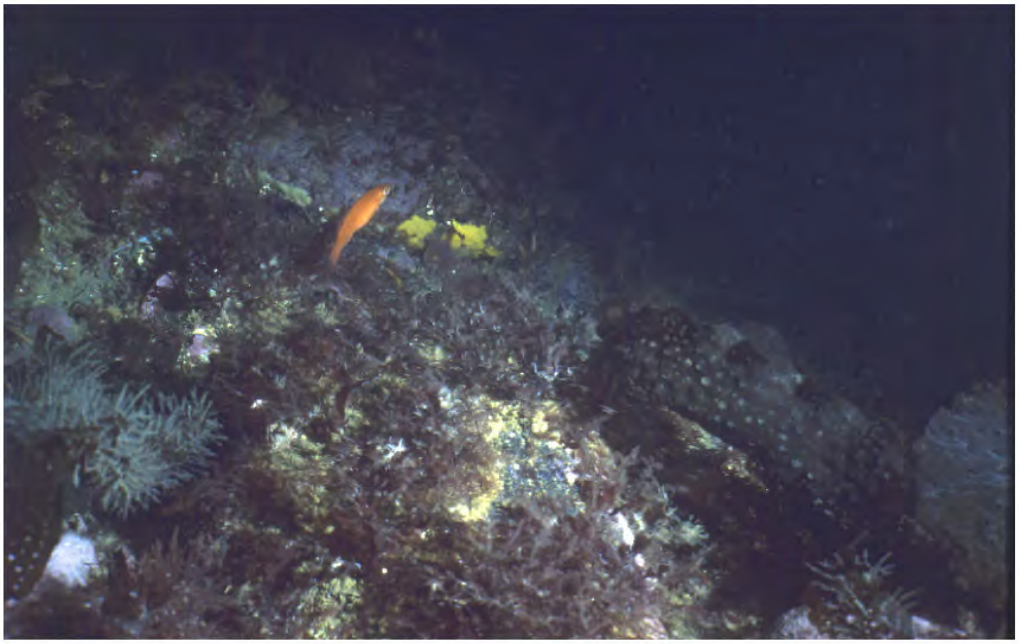

Plate 7. Boulders with moderate sediment drape, 30% Lithothamnion cover, abundant filamentous red algae Asparagopsis hamifera, dulse Rhodymenia palmata, shot-gun kelp Agarum cribosum encrusted with hydroid Obelia geniculata, mussels Modiolus modiolus, the sponge Aplysilla sulfurea, and cunner Tautogolabrus adspersus.

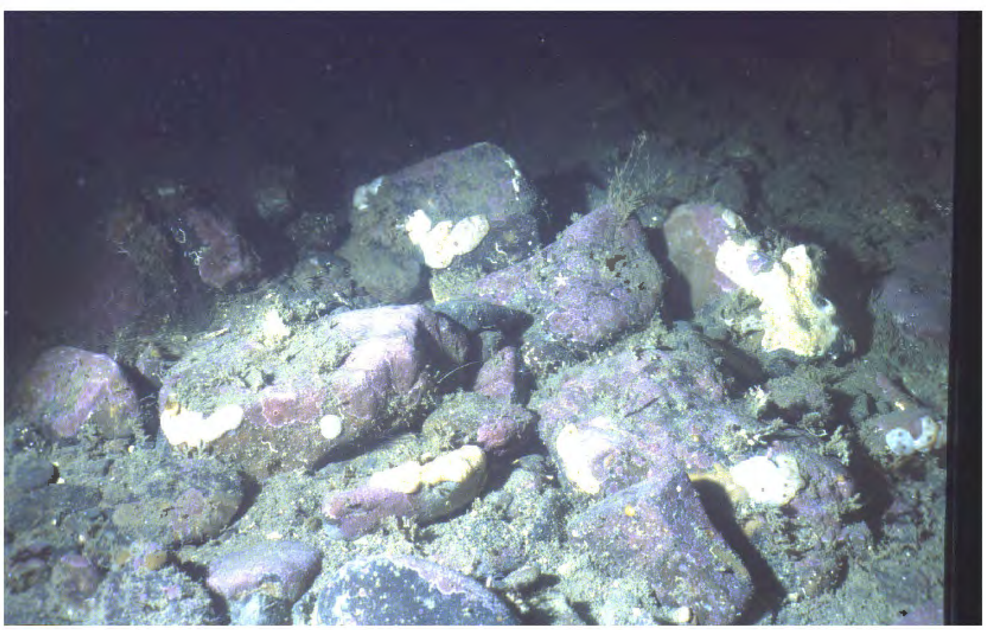

Plate 8. Large cobbles with moderately light sediment drape, 40% Lithothamnion cover, sea pork Aplidium spp. and juvenile Asterias.

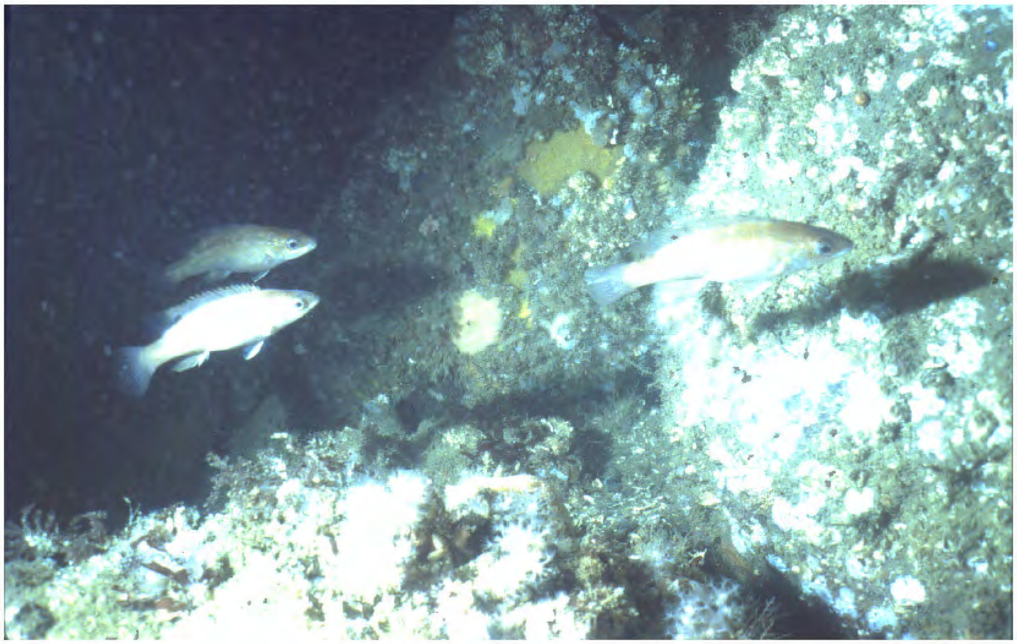

Plate 9. Boulders and cobbles with heavy sediment drape, several dulse Rhodymenia palmata, the soft red coral Gersemia rubiformis, numerous hydroids, encrusting sponges, Asterias (juveniles and one adult), some live barnacles Balanus spp. and the bases of numerous dead ones, and cunner Tautogolabrus adspersus.

Plate 10. Gravel pavement with small cobbles, heavy sediment drape, sea scallops Placopecten magellanicus, and an unidentified encrusting organism

Massachusetts Water Resources Authority
100 First Avenue • Boston, MA 02129
www.mwra.com
617-242-6000