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FALL 2001 INFAUNA CHARACTERIZATION REPORT

**RHODE ISLAND REGION LONG-TERM DREDGE
MATERIAL DISPOSAL SITE EVALUATION PROJECT**

FINAL

Fall 2001 Infauna Characterization Report

**Rhode Island Region
Long-Term Dredge Material Disposal Site Evaluation Project**

**Contract Number DACW33-01-D-004
Project Number Delivery Order 0002**

to

**U.S. Army Corps of Engineers
North Atlantic Division
New England District
696 Virginia Rd.
Concord, MA 01742-2751**

By:

**Battelle
397 Washington Street
Duxbury, MA 02332
(781) 934-0571**

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INTRODUCTION

In August of 2001, the Army Corps of Engineers New England Division (the Corps) issued a final environmental impact statement (EIS) for maintenance dredging of the federal navigation channel in the Providence River and upper Narragansett Bay. Based on that EIS, a Record of Decision (ROD) was issued in March 2002 that identified a site in Rhode Island Sound (Site 69B, Separation Zone) for use by the Providence River dredging project and other applicants. The ROD allows material to be disposed for five years, with a possible five-year extension period. However, the Rhode Island region needs a long-term disposal site to permit the considerable dredging of federal and private ports and marinas that will be needed in the future, therefore, the state of Rhode Island and the U.S. Congress asked the Corps and the U.S. Environmental Protection Agency (EPA Region 1) to evaluate the designation of one or more additional sites in the Rhode Island region for long-term dredged material disposal. The Marine Protection, Research and Sanctuaries Act authorized EPA Region 1 to designate ocean disposal sites for long-term use and gave the Corps shared authority with EPA Region 1 for the management and regulation of dredged material disposal in open water. To designate a long-term site, the Corps and EPA Region 1 are cooperating in the preparation of a new site-designation EIS. The purpose of this study is to provide data that will be used in support of the EIS and its analyses.

Site characterization goals for the EIS include documentation of existing physical, chemical, and biological conditions at the site to (a) provide a basis for comparison of the biological value of the sites (habitat characterizations); (b) assess the suitability of each site for dredged material disposal (bathymetry, sediment type, hydrodynamics); and (c) assess potential short- and long-term impacts from dredged material disposal at each site. This report summarizes the results of an evaluation of the benthic infauna at the potential candidate sites, summarizing the communities now present at the site. The evaluation also investigated conditions at the historic disposal site at Site 16 (Brenton Reef), the only site in Rhode Island Sound extensively used for the disposal of dredged materials. The last disposal there occurred in the 1970s (Federal Register 2001). Other potential disposal sites in Rhode Island Sound were identified during the 1980s, but were never used (Federal Register 2001). Samples were collected at Site 16 using a technique that would allow a sediment triad evaluation (chemistry, infauna community, and toxicology) of the conditions at Site 16, with the intent of determining whether or not the Site has recovered from the disposal activities.

METHODS

This section provides an overview of the methods used to collect and analyze benthic infauna samples. A more detailed description of the methods are contained in the sedimentation characterization survey report (Short and Albro, 2002).

Field Sampling

Field sampling in Rhode Island Sound took place from September 7-13; 27-28, 2001 and October 3 and 12-13, 2001 at the historic disposal site and three candidate disposal sites (Figure 1):

- Site 16 (Brenton Reef – BR), located about 6 nm south of Newport (Figure 2).
- Site 18 (Brenton A – BA), located about 10 nm south-southeast of Newport, Rhode Island (Figure 3)

- Site 69A (Jamestown Bridge Reef – JB), located about 10 nm east-northeast of Block Island (Figure 4), and
- Site 69B (Separation Zone – SZ) located about 8 nm east-northeast of Block Island, and at the former dredged material disposal site (Figure 5).

A summary of the samples collected during the survey is provided in Appendix A. The sampling strategy was designed to provide an overall characterization of the infaunal community and sedimentary regimes. To that end, individual samples from 15 to 18 discrete stations in and around each site were collected.

At each of the study sites (i.e., Site 18, Site 69A, Site 69B), benthic infauna samples were collected from individual stations by using an 0.04-m²-Young-modified van Veen grab sampler. In addition, an 0.1-m²-Young-modified van Veen grab sampler was used to collect a co-located sediment sample at each location for chemical analyses.

At Site 16 (Brenton Reef), sediment samples for chemistry and infauna analyses were collected by using a 0.25-m²-Mark III Sandia box corer. This sampler provided enough surface area, in one or two drops, to collect 1 to 2 gallons of sediment from the top 2 cm of the sample for analysis of the targeted physical and chemical analytes, benthic infauna, and for toxicity testing. To make the infaunal samples collected from Site 16 more comparable to the grab samples collected at the other sites, a 5-by 5-segmented grid, with each segment having a surface area of 0.01 m², was placed over the surface of the sample. Four of the 25 segments, yielding a total area sampled of 0.04 m², were removed to a depth of 10 cm and prepared for infaunal analysis. At the request of the Corps, grab sampling (using the 0.04-m²-Young-modified van Veen grab sampler) was also conducted at the Site 16 reference station which provided the opportunity to compare samples from devices normally considered to have quite different sampling properties.

Separate subsamples for total organic carbon (TOC) and grain-size analysis were removed from each sample designated for chemistry analysis and frozen (TOC) or kept chilled at 4 °C (grain size) until analyses. Samples for benthic infaunal analyses were rinsed over a 0.5-mm-mesh sieve (except on September 7, 2001 as noted below), placed in a properly labeled jar and fixed to a final concentration of 10% buffered formalin.

During the field sampling, a few deviations from the project Quality Assurance Project Plan (QAPP; Battelle 2001) occurred. These are noted below and their potential impacts evaluated during the data analyses.

Infaunal samples processed on the first day of sampling (September 7) were rinsed over a 0.3-mm-mesh sieve rather than the intended 0.5-mm-mesh sieve. Samples were fixed with formalin as described above and sent to the sorting laboratory for processing. At the sorting laboratory, the fixed samples were rinsed over a 0.5-mm-mesh sieve. Therefore, the samples were ultimately rinsed over the correct mesh sieve. However, Ohwada (1988) found substantial differences between fixed and unfixed samples rinsed over the same mesh sieve. The process of fixation causes a certain degree of rigidity in soft-bodied animals that could lead to greater retention of fixed animals on a sieve. For example, some species of polychaetes were more abundant (by as much as 13 times) in samples that were fixed prior to rinsing as compared to samples that were rinsed before being fixed (Ohwada, 1988). Hard-bodied animals such as clams were not affected. Samples that were fixed prior to being rinsed over a 0.5-mm-mesh sieve were Site 69B samples SZ1 (RIS1S039), SZ2 (RIS1S01F), SZ6 (RIS1S027), SZ7 (RIS1S023), SZ8 (RIS1S04F), SZ9 (RIS1S048), and SZR2 (RIS1S030). These samples might have abundances of polychaetes that differ from those processed according to the QAPP. The potential effects of this difference in sample processing will be evaluated.

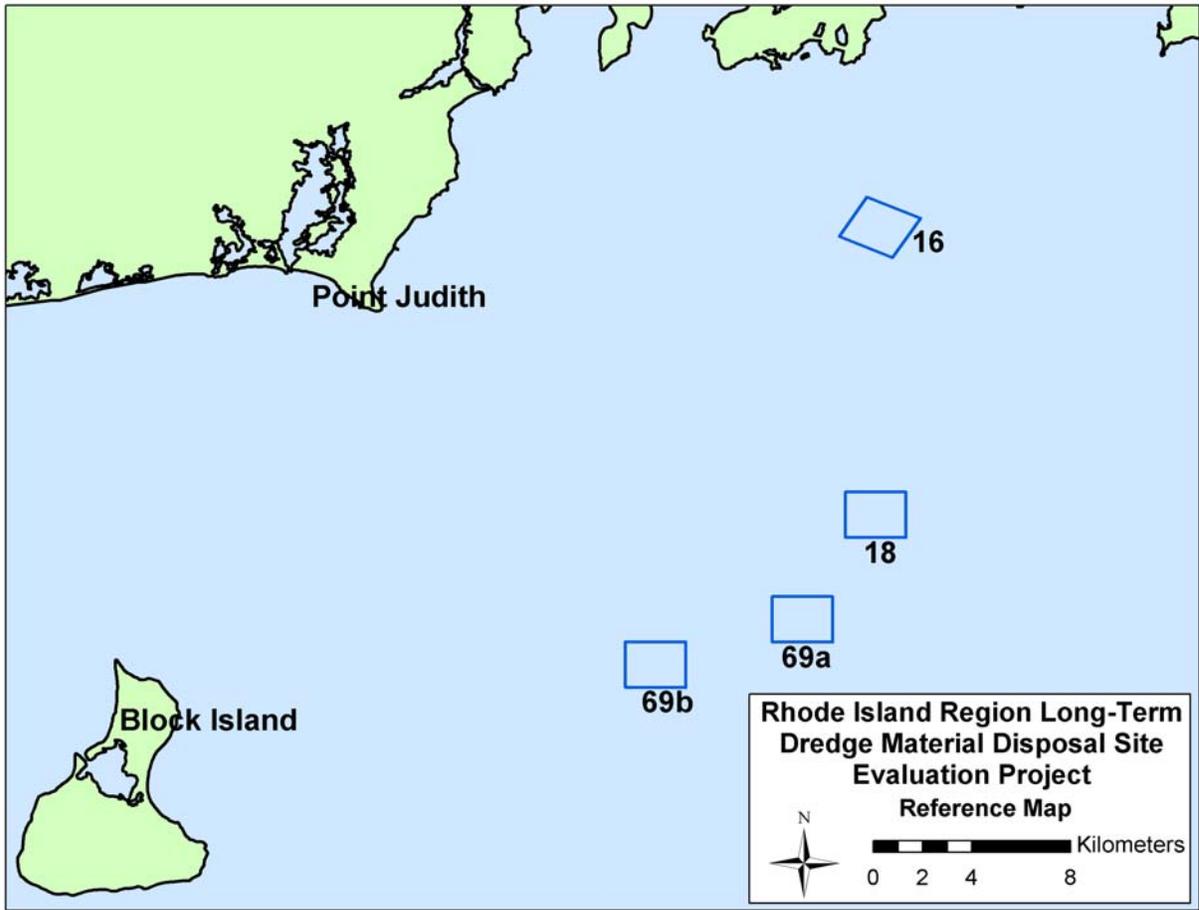


Figure 1. Locations of Rhode Island Sound sites sampled in 2001.

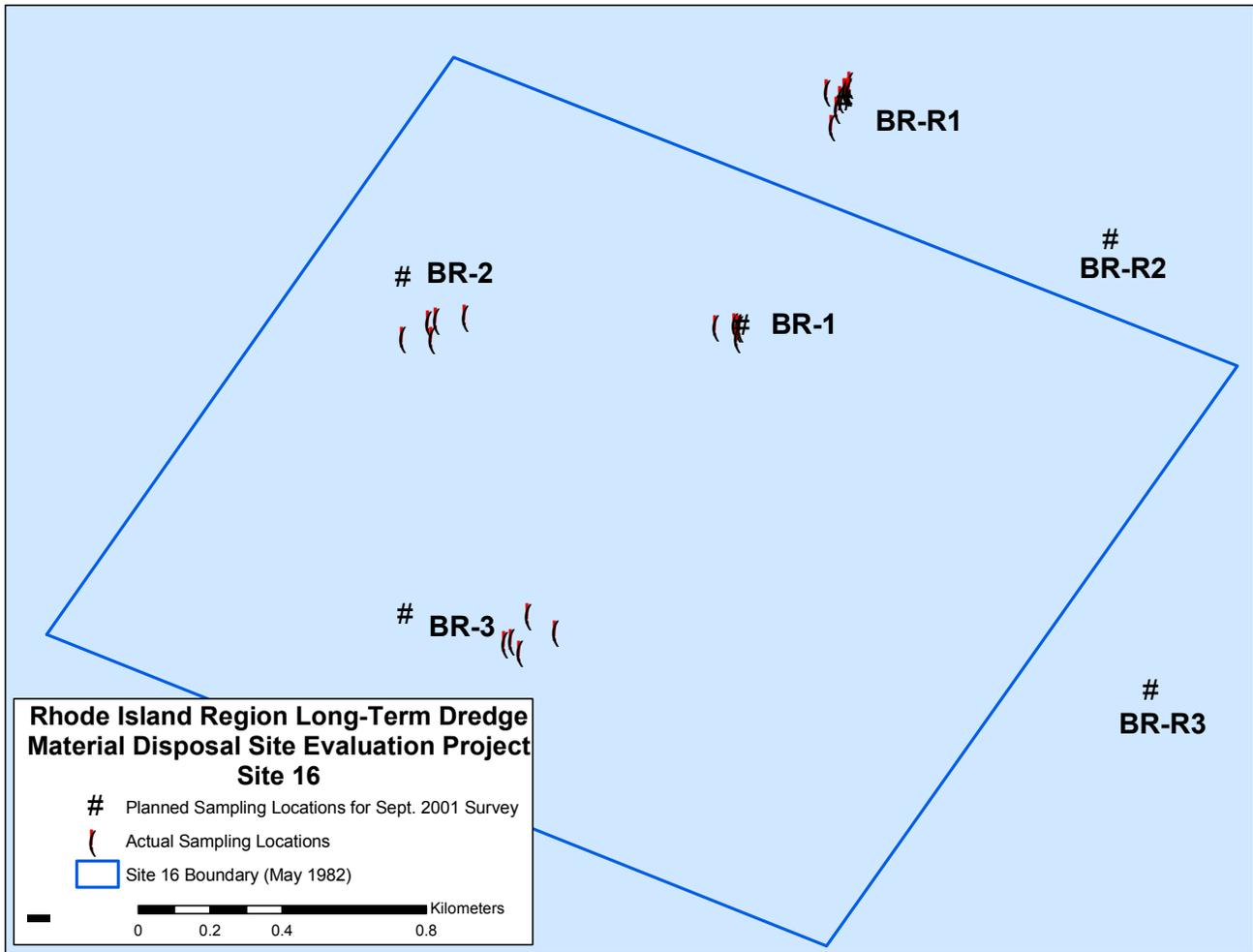


Figure 2. Locations of samples collected at Site 16 (Brenton Reef - Historic Disposal Site), September–October 2001.

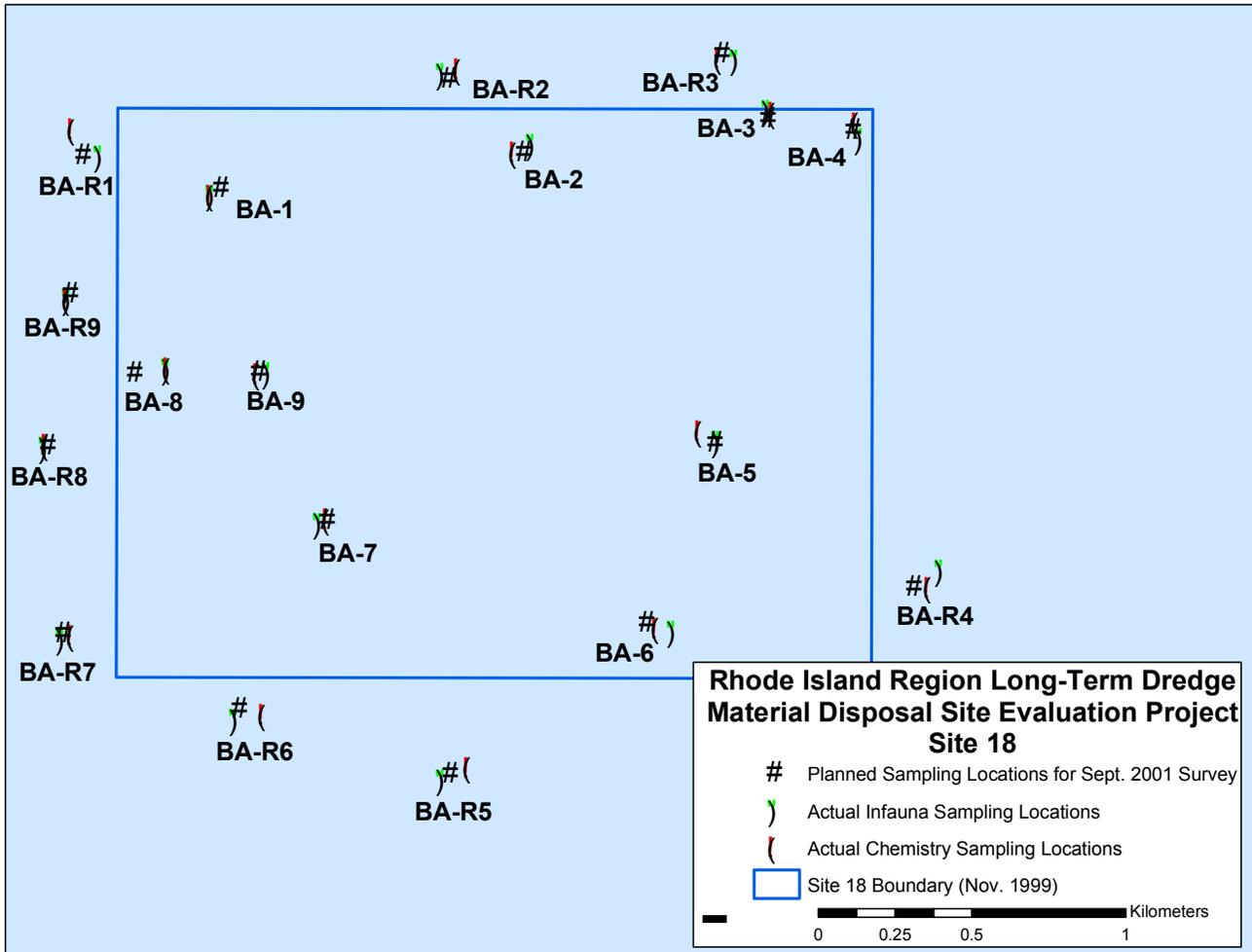


Figure 3. Locations of samples collected at Site 18 (Brenton A), September 2001.

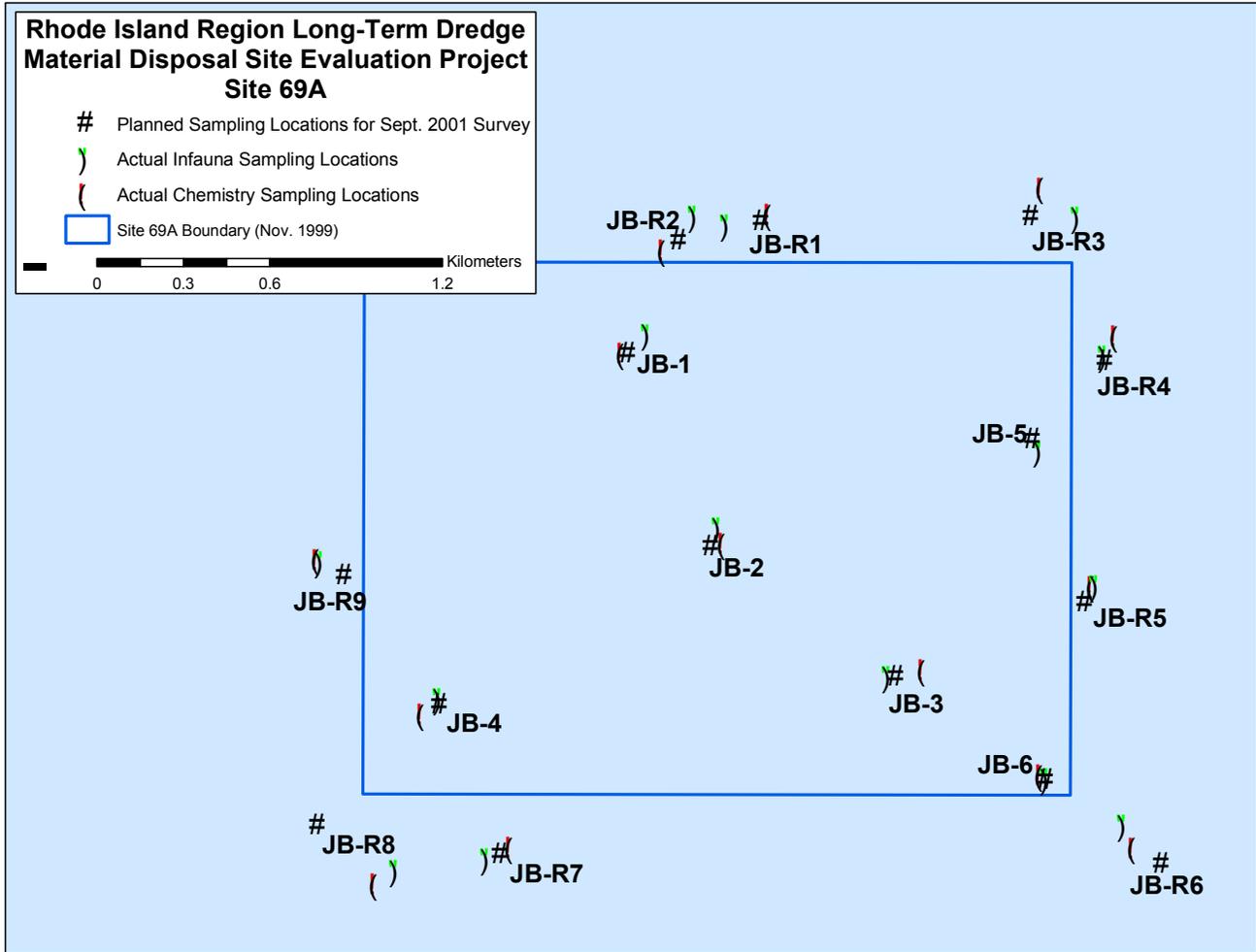


Figure 4. Locations of samples collected at Site 69A (Jamestown Bridge), September 2001.

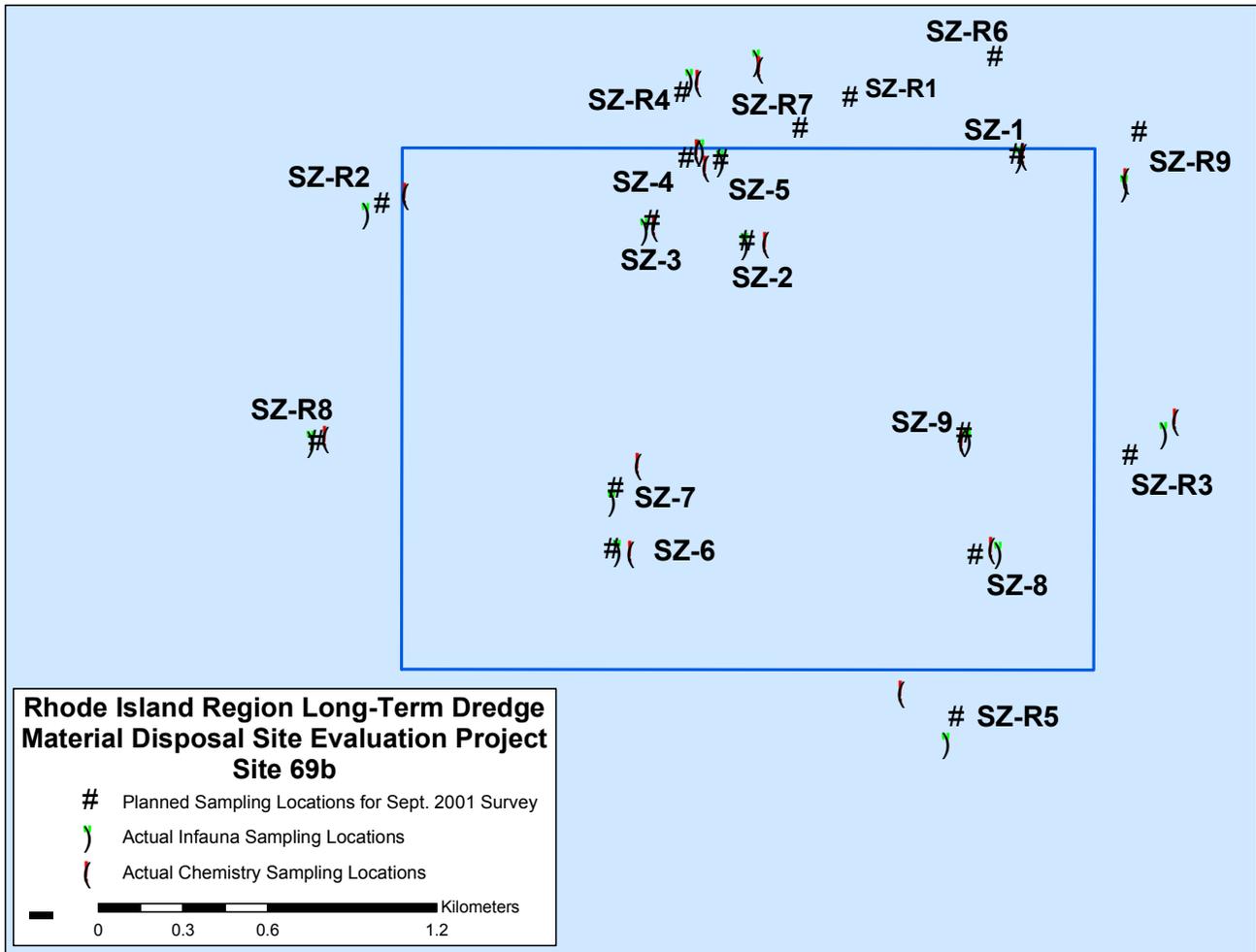


Figure 5. Locations of samples collected Site 69B (Separation Zone), September 2001.

- The 0.5-mm-mesh screens were missing from the doors of the 0.04-m² -Young-modified van Veen grab sampler used to collect infaunal samples. These screens, which reduce the bow wave (aka shock wave) pushed ahead of the descending grab sampler, are important for minimizing the loss of infauna when the grab penetrates the sediment surface. Andersin and Sandler (1981) compared samples collected by van Veen grab samplers that had different size door screens, but that were otherwise identical. They found that the sampler with the smaller screens, thus generating a larger bow wave, was about 50% less efficient than the sampler with the larger screens. They also found that the bow wave affected the collection of some taxa, especially those living in the uppermost layers of the sediment, more than others. It is important to note that in the current evaluation, all grab samples were collected with the same grab sampler. Therefore, the expected differences among samples directly related to the lack of door screens should be minimal.
- The relatively long duration of the overall sampling program (about 5 weeks) and the hiatus between samples collected on September 13 and October 12, was the result of rough sea conditions that occurred as a series of weather fronts and tropical storms passed off the northeast coast of the U.S. (e.g., Hurricanes Erin, Felix, Gabriel). Some infaunal animals may have relatively short generation times, therefore extended sampling periods may introduce differences among samples that are related to small scale temporal variation rather than spatial variation (Morrisey et al. 1992). This is important to keep in mind when comparing samples collected at Site 16, where replicates 1–3 at Station BR1 were collected on September 13 and replicates 4 and 5 were collected on October 12.
- Some planned samples could not be collected. For example, at station JB-5, an infaunal sample was collected but a chemistry sample could not be collected because of cobbles lying beneath the overlying sand and mud. No samples were collected at stations SZ-R1 and SZ-R6 because of the hard-bottom conditions there. No samples were collected at station BR-R2 because the sediments there were too unconsolidated. Only grab samples were collected at station BR-R3 because of the coarse sediment there. However, the project management team agreed to drop this station from the analyses.

In addition to the deviation from the QAPP summarized above, other factors potentially affecting correlation of the sediment and infaunal data should be considered. For example, the use of small grab samplers at the candidate disposal sites did not provide enough material to permit chemistry and infaunal data to be derived from the same grab sample. Therefore, these data were obtained from separate grab samples as described above. Additionally, sea state and wind conditions resulted in a relatively large separation between the collection locations of the chemistry and infaunal samples at a few stations. For example, the two samples were approximately 200 m or more apart at stations SZR5 and SZ7. This spatial separation of the two sample types means that measured sediment parameters and the infaunal community may not be strongly linked.

Laboratory Processing

TOC and Grain Size

TOC and grain-size analyses were performed by Applied Marine Sciences, League City, Texas according to protocols described in the project QAPP (Battelle 2001).

Infaunal Analyses

Infaunal samples were processed by Cove Corporation in Lusby, Maryland. When received by the laboratory, samples were rinsed with freshwater to remove the formalin and transferred to 70% isopropyl alcohol for sorting and storage. Animals removed from the samples were identified to the lowest possible level, usually species, and counted by Cove Corporation taxonomists. Species identities and counts were entered onto project-specific data sheets and transferred to a project data-loading application for loading into the project database.

Data Analyses

Physical Characteristics

Physical parameters determined for the Rhode Island Sound sediments were TOC, water content, total solids, and the percent gravel, coarse sand, medium sand, fine sand, silt, and clay. Water content and total solids were not included in subsequent data analyses. Descriptive statistics for the other parameters, including the number of samples, mean, median, standard deviation, extreme observations, and quartiles, were used to characterize each site (Appendix B). Multiple samples taken from the four sampling stations at Site 16 (i.e., BR-1, BR-2, BR-3, and BR-R1) can be considered a measure of small-scale variability, while samples taken from Site 18 (Brenton A), Site 69A (Jamestown Bridge Reef), and Site 69B (Separation Zone) should be considered measures of larger-scale variability. Thus, in general, the variability normally would be expected to be greater among samples taken at BA, JB, and SZ than among samples within stations at BR-1, BR-2, BR-3, and BR-R1. However, the past use of Site 16 as a disposal site no doubt introduces within-site variability that likely does not occur at the other sites.

Box plots (Appendix B) showing the quartiles and extreme observations and a nonparametric Kruskal-Wallis test of equal median values were used to provide a coarse characterization of each station and its reference station (i.e., samples from outside of the proposed disposal site). These analyses were also used to suggest variables for cluster analysis. Parameters with a wide range and greater variability from the larger-scale measurements would be expected to provide the best separation of stations. The site-specific parameters used for the analyses are described in the Results and Discussion section. Cluster analysis based on these physical parameters was used to link stations having relatively similar physical features within sites and among sites. Clusters were determined from joining tree (or hierarchical) clustering based on Euclidian distance (Hand 1981). All variables used in the clustering analysis were standardized by subtracting the mean value and dividing by the standard deviation. K-means clustering with $k = 5$ was then used to finalize cluster membership. The resulting joining tree dendrograms depict the relationship of increasing compactness (similarity) with an increasing number of clusters until each observation is its own cluster. Minitab™ statistical software (Minitab, Inc, Release 13.32, 2000) and Statistica™ statistical software (StatSoft, Inc., Release 5.1, 1997) were used to conduct the analyses.

Infauna

Prior to performing the infaunal data analyses, the overall data set was scanned for noninfaunal taxa, which were excluded from all analyses, and name errors, which were corrected. Data for several taxa were pooled. This involved pooling data for a taxon identified to a level higher than species (e.g., genus) with those data for a species within that higher taxon. This pooling was done only when one species of the higher taxon was identified. For example, *Crenella glandula* (a small clam) was the only species of the genus found, so that any clams identified only to the genus *Crenella* spp. were treated as if they were *C. glandula*. Calculations of abundance included all taxa occurring in each sample whether identified to species level or not. Calculations based on species (diversity, evenness, number of species, and cluster

analyses) included only those taxa identified to species level. All such preliminary data manipulations are listed in the Appendix C.

The software package BioDiversity Professional, Version 2 (© 1997 The Natural History Museum / Scottish Association for Marine Science; <http://www.sams.ac.uk/dml/projects/benthic/bdpro/index.htm>) was used to calculate total species, log-series alpha, Shannon's Diversity Index (H'), and Pielou's Evenness (J'). Shannon's H' was calculated by using \log_2 because that is closest to Shannon's original intent (personal communication, E. Gallagher, U. Massachusetts Boston, 1998). Pielou's (1996) J' , which is the observed H' divided by H_{max} , is a measure of the evenness component of diversity, Magurran (1988) describes all of the diversity indices used here. BioDiversity Pro is available at <http://www.sams.ac.uk/dml/projects/benthic/bdpro/index.htm>. R-mode cluster analyses (Boesch 1977) of the Rhode Island Sound infaunal abundance data was performed using data or taxa identified to species level only. Bray-Curtis similarity (Bray and Curtis 1957) was the clustering algorithm and cluster groups were generated by using group average sorting. BioDiversity Pro was used to perform the cluster analyses.

Additionally, to determine the distribution of the benthic taxa collected during the study, the infaunal data set was modified to form a presence/absence matrix. The matrix consisted of ones or zeros that represented the presence or absence of taxa at each replicate for all stations, respectively. This matrix was used to evaluate species associations across stations. Individual station matrices were created from the presence/absence matrix using only the samples associated with a given station. This matrix was used to evaluate the species associations by station.

Cluster analyses using Euclidean distance as a measure of the difference between observations (*i.e.*, the square root of the sum of squared differences between two observations for all variables measured) and a complete linkage rule for combining clusters (*i.e.* clusters are combined based on the Euclidean distance between the points furthest apart) were performed on the presence/absence matrix to determine the similarity in species associations among stations. Horizontal, hierarchical dendrograms were used to provide a visual diagram of the linkage distance between replicates (or stations) and clusters of replicates. Clusters combined at greater linkage distance are more dissimilar than those combined at smaller linkage distances. Presence/absence cluster analyses were performed by using the statistical software package Statistica™.

RESULTS AND DISCUSSION

Rhode Island Sound Study Regional Characteristics

Physical Characteristics

Sixty-eight samples were analyzed for TOC, water content, total solids, and grain-size particle distribution. Descriptive statistics for 10 stations with at least 5 observations each are presented in Appendix B.

TOC ranged from 0.06 to 0.92% with station BR-R1 having the greatest median value (0.78%) and BR-2 having the smallest median value (0.14%). Even though stations had statistically different median values ($p < 0.001$), this range of values was not expected to produce biologically important differences. Thus, TOC was not used in the clustering analysis.

Water content ranged from 9 to 81% with station BR-R1 having the greatest median value (63%) and BR2 and BR3 having the smallest median values (24%). Total solids (generally 100% - water content %; $r = -0.99$) ranged from 55 to 92% with stations BR2 and BR3 having the greatest median value (81%) and BR-R1 having the smallest median value (61%). Stations had statistically different median values for both water content and total solids ($p < 0.001$).

Gravel ranged from 0 to 49.3%. Station BR3 had the greatest median value (15%) and stations BA and BR-R1 had the smallest (0%). Coarse, medium, and fine sand ranged from 0 to 19%, 1 to 70%, and 7 to 88% respectively. Silt ranged from 0.13 to 45.5%, and clay ranged from 1.8 to 24%. Station BR-3 had the greatest median value of coarse sand (12.4%) and BA had the smallest (0.07%). Station BR-3 also had the greatest median value of medium sand (29%) and BR-R1 had the smallest (3.8%). The greatest and smallest median value of fine sand was found at stations JB (77%) and BR-3 (22%) respectively. The greatest median value of silt was at station BR-R1 (40%) and the smallest at SZR (1.5%). The median value of clay was also greatest at station BR-R1 (17.5%) and smallest at BR-2 (3.5%). Percent gravel, silt, and clay was highly significantly different between stations ($p < 0.01$). Percent coarse and medium sand were significantly different between stations ($p < 0.05$). Fine sand was not found to be significantly different between stations ($p > 0.10$). However, stations BA and SZ and their references exhibited large variability. Percent clay was highly correlated with percent silt ($r = 0.9$).

Cluster analysis of all stations sampled during the study using gravel, coarse sand, medium sand, fine sand, and silt resulted in five main cluster groups (Appendix B). BAR9 stands out because of its amount of coarse sand (19%). SZ1 and SZ3 have the greatest amounts of gravel (39 and 46% respectively). The remainder of the clusters are composed of a mixture of stations across the region.

Biological Characteristics

Seventy-four samples were collected and analyzed for infauna. Represented among the samples were 199 species-level taxa. Infaunal abundance varied widely, ranging from 174 individuals per sample ($\sim 4,350/\text{m}^2$; station JB5) to 3,198 individuals per sample ($\sim 79,950/\text{m}^2$; station BR1, replicate 1). Species numbers ranged from 22 per sample (station JB5) to 69 per sample (station SZ1). Shannon diversity (H') was low to moderate, ranging from 1.70 (station BA4) to 4.60 (station BA6). Pielou's evenness (J') varied from 0.30 (station BA4) to 0.85 (stations JB5 and JBR3). Infaunal species data by station are in Appendix C. Boxplots summarizing these ecological parameters for each study site are in Appendix D. The fauna was numerically dominated by an amphipod, *Ampelisca agassizi*, and a small clam, *Nucula annulata* (which is sometimes considered a variety of *Nucula proxima*). Both are usually characteristic of silty-fine sands (Pratt 1973, Schaffner and Boesch 1982). The former species has been termed pollution sensitive, whereas the latter species was characterized as pollution tolerant (Chang et al. 1992). These two species accounted for about 54% of the total infaunal abundance (29% and 25%, respectively) found during the study. No other species contributed more than 5% of the total abundance. Other relatively prominent species were the annelid worms, *Polygordius* sp. A, *Tharyx acutus*, *Oligochaeta* spp., *Ninoe nigripes*, *Levinsenia gracilis*, and *Exogone hebes*; the crustaceans *Byblis serrata* (Amphipoda) and *Eudorella pusilla* (Cumacea); and the clam *Nucula delphinodonta*.

Bray Curtis and presence/absence cluster analyses were performed on the entire Rhode Island Sound data set (Appendix D, Figures D-1, D-2). Both types of analyses separated the samples into two distinct groups. In each case one group was primarily characterized by containing all of the samples collected at stations BR1 and BRR1. In both analyses, these 15 samples formed two subgroups that did not include samples from any other site, although the analyses measured different facets of the communities. Each analysis also included a few samples from the candidate disposal sites. The second group delineated by

each analysis consisted of samples from stations BR2, BR3, and most of the candidate site samples. These samples clustered in mixed subgroups that did not show strong site-related alignment.

Individual Site Characterizations

Site 16 (Brenton Reef)

Physical Characteristics

Water depth among the Site 16 samples ranged from 28 m to 43 m. However, only one sample (station BR1, replicate 3) was collected at a depth greater than 31 m. Classification analysis for this site was based on gravel, coarse sand, medium sand, fine sand, and silt. At a linkage distance of 3, the cluster analysis defined four station groups (Figure 6). Group I consisted of all five samples collected at station BR1. These were characterized primarily by percent fines (silt + clay) ranging from 32% to 47% and by TOC content (0.6–0.8%) that was higher than that at stations BR2 and BR3. Group II was comprised of all five box corer samples collected from station BRR1 (the grab sampler was not used to collect grain size samples at station BRR1). These samples contained the highest percent fines (56–65%) and TOC content (0.7–0.9%) found at any of the Site 16 stations. Group III consisted of three samples from station BR2 (replicates 1, 3, and 5) and two samples from station BR3 (replicates 1 and 2). These were generally characterized by having moderate to high total sand content (77–96%) and low TOC content (0.1–0.4%). Group IV included two samples from station BR2 (replicates 2 and 4) and three samples from station BR3 (replicates 3, 4, and 5). These samples were very coarse, consisting of 5–26% gravel, low percent fines (silt + clay <8%), and low TOC content (0.1–0.3%).

Biological Characteristics

Infaunal abundance within the Site 16 study area ranged from 392 individuals/sample (~9,800/m²) to 3,198 individuals/sample (~79,950/m²). Total species ranged from 31 per sample to 63 per sample. Shannon diversity (H') was low to moderately high, ranging from 1.91 to 4.03. Pielou's evenness (J') varied from 0.35 to 0.72. Numerically, the infauna was dominated by the amphipods *Ampelisca agassizi* and *Byblis serrata*, the nut clams *Nucula annulata*, the annelid worms *Polygordius* sp. A, *Tharyx acutus*, *Ninoe nigripes*, and *Mediomastus ambiseta*, all of which accounted for about 77% of the infaunal abundance at Site 16.

Bray-Curtis cluster analysis separated the Site 16 samples into two very distinct groups (Figure 7). Group I consisted of samples from stations BR2 and BR3. Average infaunal abundance was low among these samples (~880 individuals/sample), numbers of species were moderate (~45), diversity was moderate ($H' = 3.22$), and evenness was moderate ($J' = 0.59$). Primary taxa characterizing the cluster group were *Byblis serrata* and *Polygordius* sp. A. The polychaetes *Aricidea catherinae* and *Goniadella gracilis*, and the amphipod *Leptocheirus pinguis* were also numerically important at some stations within the group. Cluster Group II was comprised of samples from station BR1 and both sets of samples (Box corer and van Veen grab) collected at station BRR1. Average infaunal abundance among these stations was high (~2,181 individuals/sample), species numbers were moderately high (~51/sample), diversity was moderate ($H' = 2.76$), and evenness was moderately low ($J' = 0.49$). Predominant taxa included *Ampelisca agassizi*, *Nucula annulata*, *Tharyx acutus*, *Ninoe nigripes*, *Mediomastus ambiseta*, and several other polychaete worms.

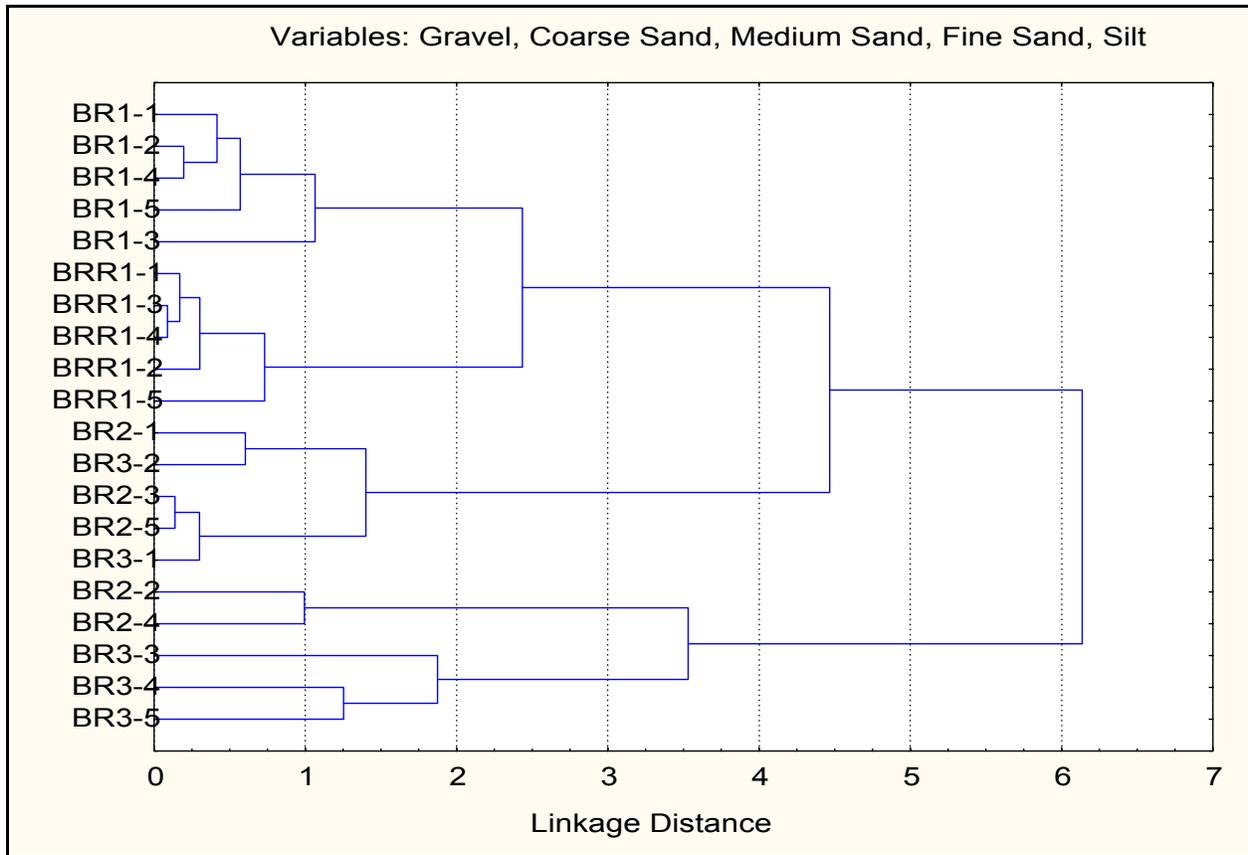


Figure 6. Dendrogram resulting from classification analysis of physical factors at Site 16 (Brenton Reef).

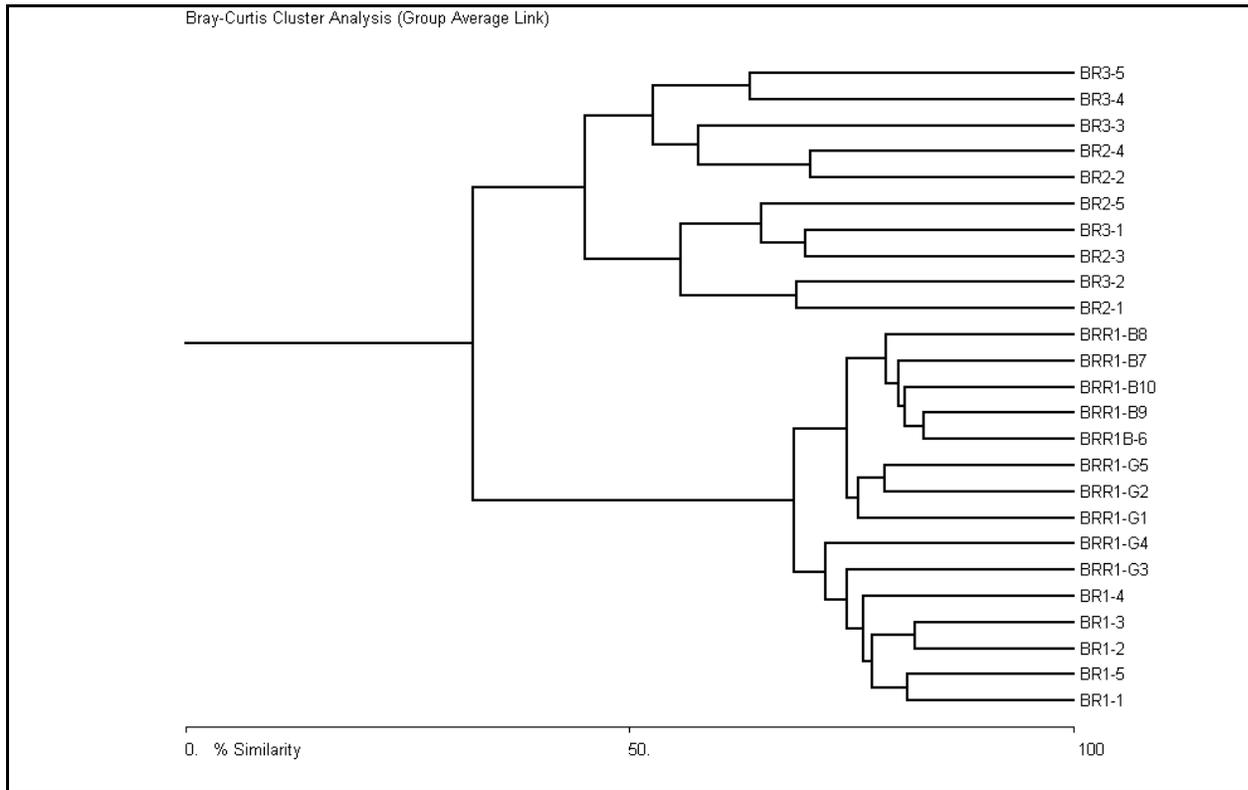


Figure 7. Dendrogram resulting from Bray-Curtis analysis of samples collected from Site 16 (Brenton Reef). Samples BRR1 (G1–G5) were collected with the grab sampler, samples BRR1 (B6–B10) were collected with the box corer.

Clustering based on the presence/absence data matrix (Figure 8) resulted in separation of the same two major groups of stations as shown by the Bray-Curtis cluster analysis. Both of the biological cluster analyses defined groups that accurately mirrored the groups defined by the grain-size cluster analysis.

As previously mentioned, there was approximately a one-month delay between the collection of replicates 1–3 and replicates 4–5 at station BR1 because of adverse weather conditions. However, Bray-Curtis cluster analysis showed that the five replicates from this station were more similar to each other than to any other samples and that the replicates did not separate by collection date. The presence/absence clustering showed that replicates 4–5 classified separately from, although very similar to, replicates 1–3. The ranges of the values for the various ecological metrics calculated for the five replicates overlapped (Appendix C). Therefore, it is not likely that the length of time between sample collection had any important impact on the data interpretation.

The samples collected at the Site 16 reference station (BRR1) provided the opportunity to make an interesting comparison between those collected by the box corer and those collected by the van Veen grab sampler. The Bray-Curtis cluster analysis (Figure 7) showed that the box corer samples were classified together and were most similar to the three grab samples that classified together. The presence/absence clustering showed some mixing of the two types of samples, but that again they were more similar to each other than to samples from other stations. The Boxplots of the calculated ecological parameters (Appendix C) showed that values for the two sample types were very comparable although the grab samples tended to have higher abundance values and perhaps slightly higher species numbers. Therefore, conclusions regarding the nature of the infaunal community at station BRR1 were not affected by the type of sampling gear used to collect the samples.

Site 18 (Brenton A)

Physical Characteristics

Water depth at Site 18 stations ranged from 34 m to 40 m. Classification analysis for this site was based on medium sand, fine sand, silt, and clay. The analysis resulted in the separation of two main station groups (Figure 9). Group I consisted of stations BA1, BAR4, and BAR9 and was characterized primarily as having high medium sand content (>58%). Group II consisted of the remaining Site 18 stations and could be further divided into three subgroups of stations that separated primarily on total percent sand (>84%; BA5, BA6, BAR1, BAR2, BAR5, BAR7, BAR8), moderate percent fines (silt + clay = 21–39%; BA2, BA3, BA7, BA9, BAR3, BAR6), and relatively high percent fines (silt + clay >56%; BA4). The latter two groups (moderate to high percent fines) were located from the NE corner through the middle of the Site and to the SW corner. Coarser sediment were found around the NW and SE corners of the Site and off the Site's western boundary.

Biological Characteristics

Infaunal abundance within the Site 18 study area ranged from 305 individuals/sample (~7,625/m²) to 2,701 individuals/sample (~67,525/m²). Total species ranged from 29 per sample to 57 per sample. Shannon diversity (H') was low to moderately high, ranging from 1.70 to 4.60. Pielou's evenness (J') varied from 0.30 to 0.83. Numerically, the infauna was dominated by the nut clams *Nucula annulata* and *N. delphinodonta*, the amphipods *Ampelisca agassizi* and *Byblis serrata*, the annelid worms *Polygordius* sp. A and *Tharyx acutus*, and the cumacean *Eudorella pusilla*.

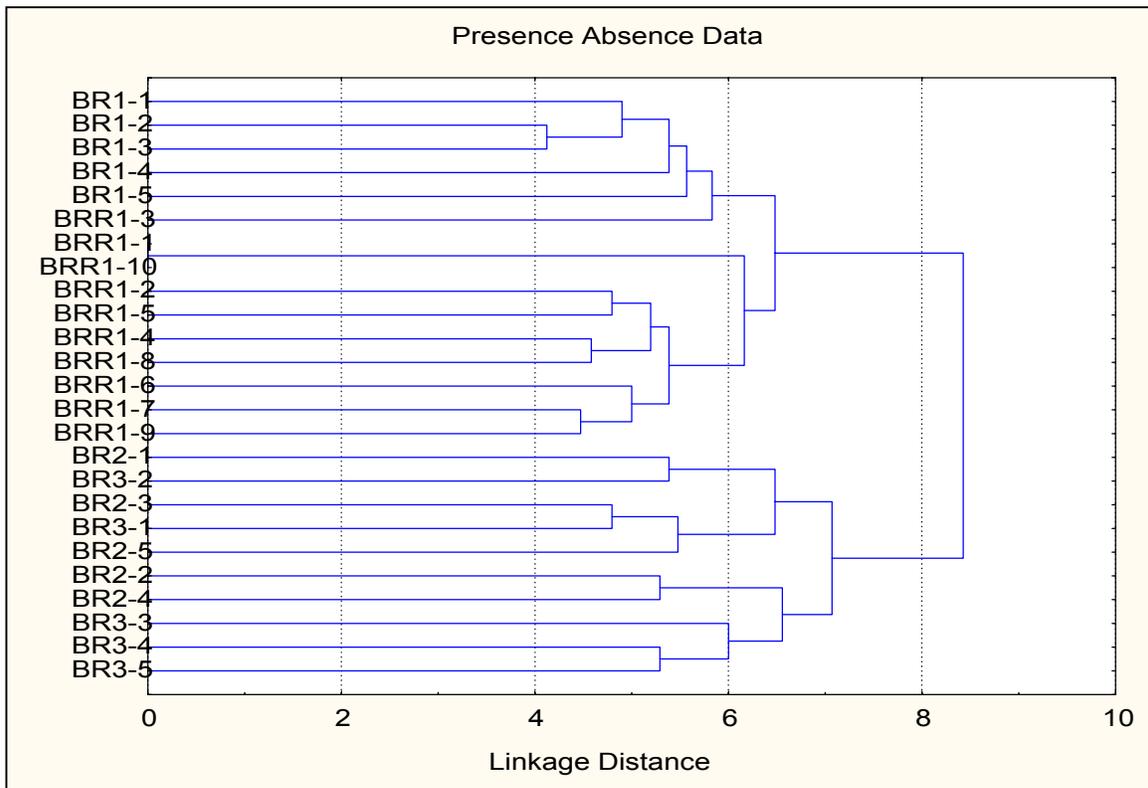


Figure 8. Dendrogram resulting from classification analysis of presence/absence data from Site 16 (Brenton Reef). Samples BRR1 (1–5) were collected with the grab sampler, samples BRR1 (6–10) were collected with the box corer.

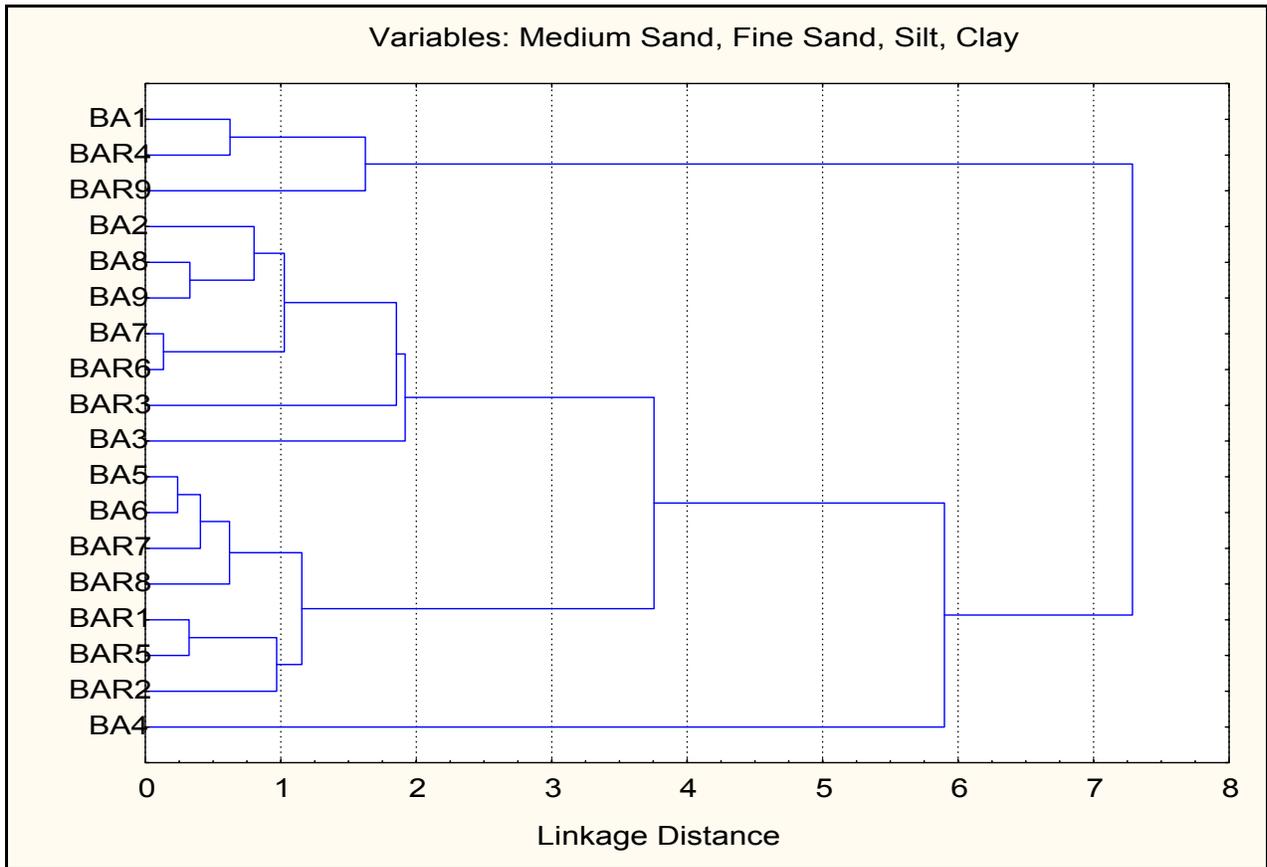


Figure 9. Dendrogram resulting from classification analysis of physical factors at Site 18 (Brenton A).

Bray-Curtis cluster analysis (Figure 10) separated the Site 18 stations into two primary groups. Group I consisted of 14 stations, which included reference and within-site stations. This cluster group was characterized by moderate infaunal abundance (~1,500 individuals/sample), numbers of species (~47/sample), and moderate diversity ($H' = 2.95$) and evenness ($J' = 0.53$). Numerically dominant taxa included *Nucula annulata*, *Ampelisca agassizi*, *Eudorella pusilla*, *Nucula delphinodonta*, and *Tharyx acutus*. Four stations, representing the northwest (BAR1, BA1) and southeast (BAR4, BAR5) corners of the study area, comprised Group II. Abundance (~699 individuals/sample) and species numbers (~33/sample) among these stations were low; diversity ($H' = 2.41$) and evenness ($J' = 0.48$) were moderate. Key taxa were the annelid worm *Polygordius* sp. A and the ampeliscid amphipod *Byblis serrata*.

Clustering based on the presence/absence data matrix (Figure 11) resulted in separation of the same two major groups of stations as shown by the Bray-Curtis cluster analysis.

None of the physical or biological analyses revealed major distinctions among the stations located within the candidate disposal site and those located immediately outside the site boundaries.

Site 69A (Jamestown Bridge)

Physical Characteristics

Water depth at Site 69A stations ranged from 35 m to 38 m. Classification analysis for this site was based on gravel, medium sand, fine sand, silt, and clay. The analysis resulted in the separation of two main station groups (Figure 12). Group I consisted of all stations except stations JB3, JB6, and JBR2, and was characterized by high total sand content (total sand >84%). Group II consisted of stations JB3, JB6, and JBR2, and was defined by high percent fines (silt + clay >22%). Two of the stations (JB3, JB6) with higher percent fines were located inside the Site at its SE corner, the third (JBR2) along the northern boundary.

Biological Characteristics

Infaunal abundance within the Site 69A study area ranged from 174 individuals/sample (~4,350/m²) to 2,475 individuals/sample (~61,875/m²). Total species ranged from 22 per sample to 60 per sample. Shannon diversity (H') was low to moderately high, ranging from 2.39 to 4.58. Pielou's evenness (J') varied from 0.46 to 0.85. Numerically, the infauna was dominated by the amphipod *Ampelisca agassizi*, the nut clams *Nucula annulata* and *N. delphinodonta*, the annelid worms *Polygordius* sp. A and *Exogone hebes*, and the cumacean *Eudorella pusilla*.

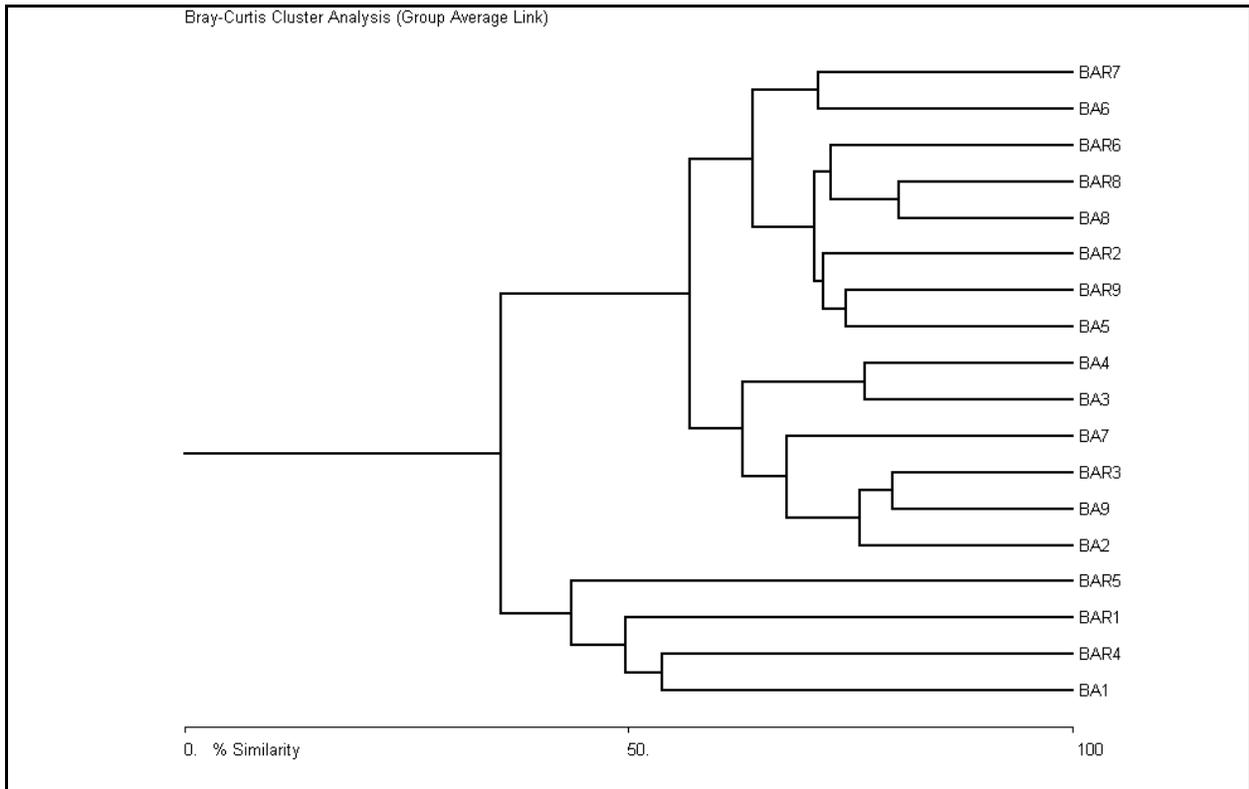


Figure 10. Dendrogram resulting from Bray-Curtis analysis of samples collected from Site 18 (Brenton A).

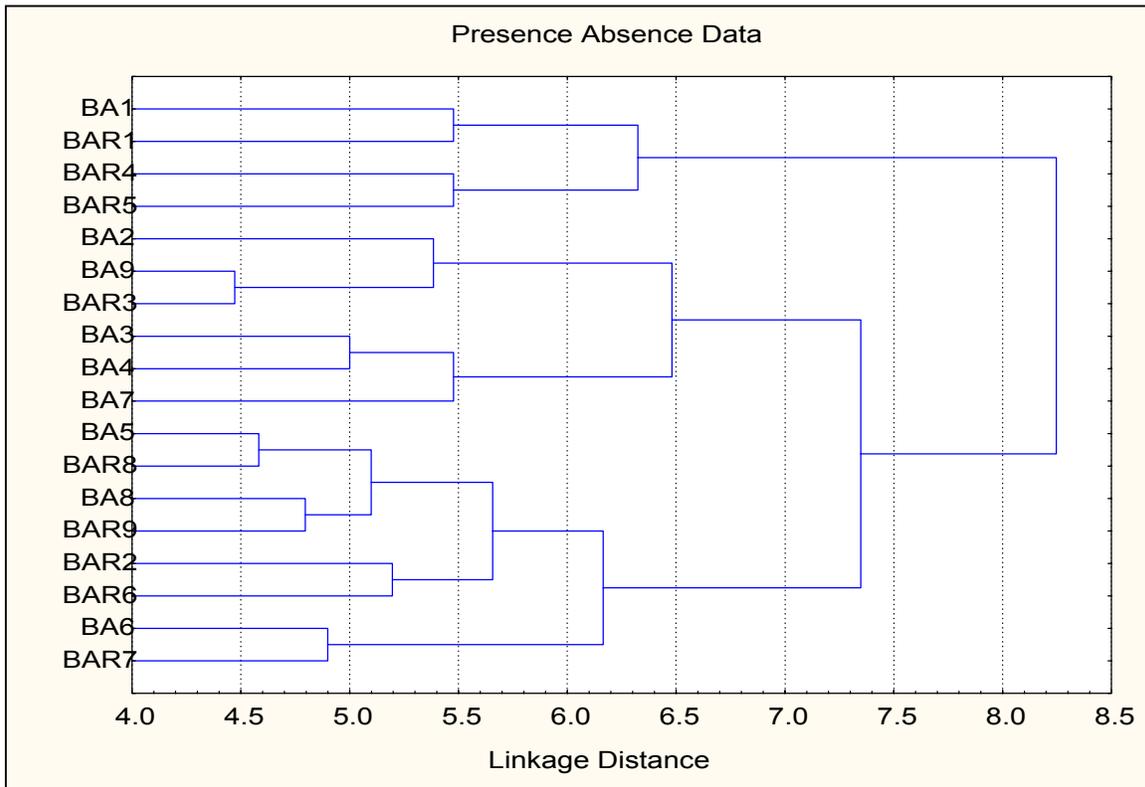


Figure 11. Dendrogram resulting from classification analysis of presence/absence data from Site 18 (Brenton A).

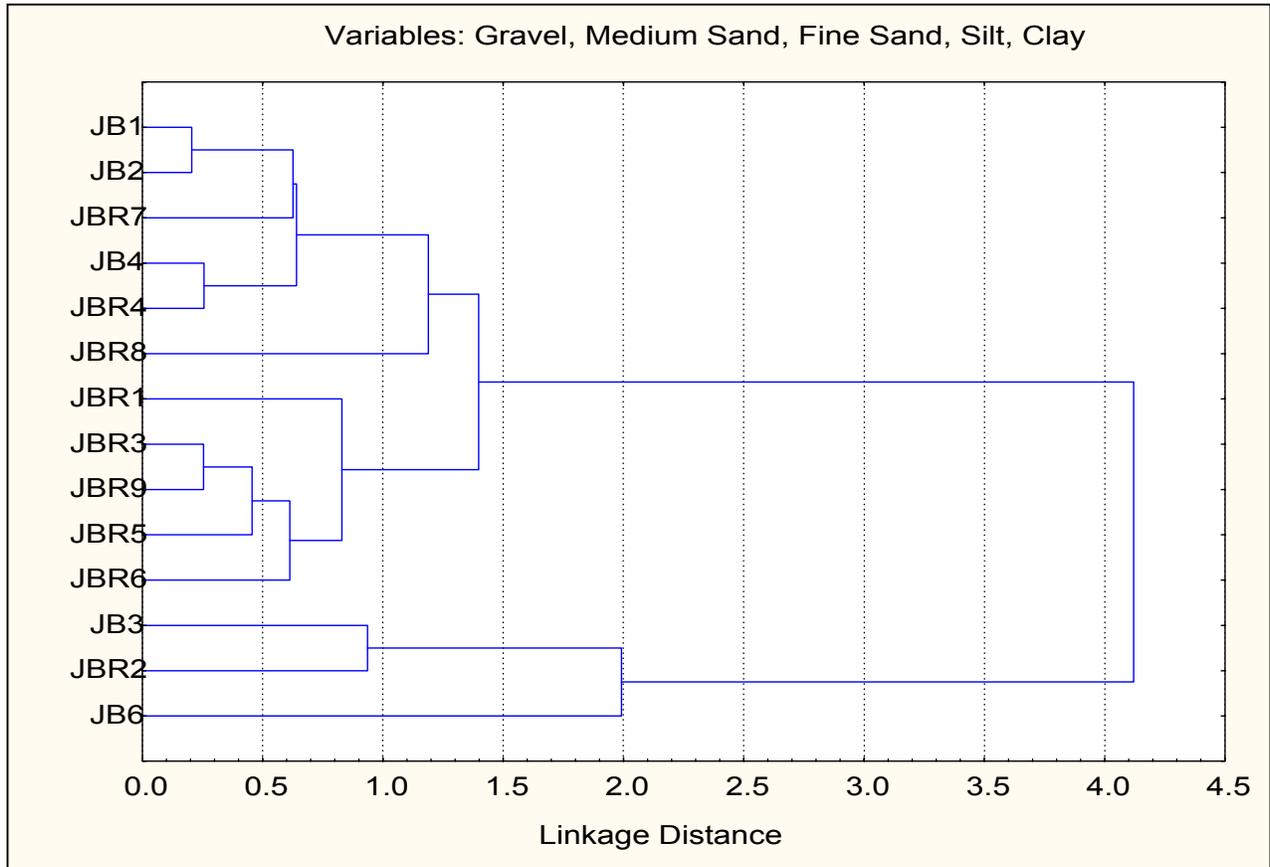


Figure 12. Dendrogram resulting from classification analysis of physical factors at Site 69A (Jamestown Bridge).

Bray-Curtis cluster analysis (Figure 13) separated the Site 69A stations into two primary groups. Group I was comprised of three stations, JBR7, JBR3, and JB5. This cluster group was characterized by low infaunal abundance (~292 individuals/sample), numbers of species (~28/sample), and moderately high diversity ($H' = 3.91$) and high evenness ($J' = 0.82$). Characteristic taxa included the annelid worms *Aricidea catherinae*, *Scoletoma hebes*, and *Prionospio steenstrupi*, although abundances of each varied considerably among the stations comprising the group. Group II consisted of the remaining Site 69A stations and could be further subdivided into two subgroups. Subgroup IIa consisted of stations JBR8, JBR5, JBR9, and JB4. This subgroup was characterized by low infaunal abundance (~517 individuals/sample), high numbers of species (~49/sample), and moderately high diversity ($H' = 4.27$) and high evenness ($J' = 0.76$). Four annelid worm species (*Exogone hebes*, *Polygordius* sp. A, *Scoletoma hebes*, and *Tharyx acutus*) and one species of amphipod (*Ampelisca agassizi*) were the characteristic fauna. The remaining eight stations formed subgroup IIb. Among these stations infaunal abundance was moderate (~1,119 individuals/sample), numbers of species were high (~49/sample), and diversity ($H' = 3.40$) and evenness ($J' = 0.61$) were moderate. *Ampelisca agassizi*, *Nucula annulata* and *N. delphinodonta*, *Exogone hebes*, *Polygordius* sp. A, and *Eudorella pusilla* were among the key taxa characterizing the community at these stations.

Clustering based on the presence/absence data matrix (Figure 14) resulted in separation of two major groups of stations that were essentially the same as those shown by the Bray-Curtis cluster analysis. However, the Group I stations as defined by the Bray-Curtis cluster analysis were joined by station JBR2 to form one group in the presence/absence analysis. The remaining stations comprised Group II in the presence/absence analysis as they did in the Bray-Curtis cluster analysis, although the subgroup composition differed between the two analyses.

None of the physical or biological analyses revealed major distinctions among the stations located within the candidate disposal site and those located immediately outside the site boundaries.

Site 69B (Separation Zone)

Physical Characteristics

Water depth at Site 69B stations ranged from 35 m to 39 m. Classification analysis for this site was based on gravel, medium sand, fine sand, silt, and clay. The analysis resulted in the separation of two main station groups (Figure 15). Group I consisted of only stations SZ1 and SZ3, which were distinguished from the other Site 69B stations by having a very high gravel content (>36%). Group II was comprised of the remaining Site 69B stations and could be further divided into four subgroups of stations that separated primarily on gravel content (>6%; SZ2, SZ4, SZR4, SZR7, SZR9), percent fine sand (>74%; SZ5, SZ6, SZ7, SZ8, SZR2, SZR8), percent medium sand (>41%; SZR3, SZR5), or percent fines (>38%; SZ9). High gravel stations were found along the NE portion of the Site [note that because of hard-bottom conditions (Short and Albro 2002) no grain size samples were taken from SZR1 and SZR6, which were located in this general area].

Biological Characteristics

Infaunal abundance within Site 69B study area ranged from 191 individuals/sample (~4,775/m²) to 2,294 individuals/sample (~57,350/m²). Total species ranged from 34 per sample to 69 per sample. Shannon diversity (H') was low to moderately high, ranging from 1.96 to 4.26. Pielou's evenness (J') varied from 0.36 to 0.78. Numerically, the infauna was dominated by *Ampelisca agassizi*, *Nucula annulata*, *Exogone hebes*, *Polygordius* sp. A, *Tharyx acutus*, *Oligochaeta* spp., *Byblis serrata*, and *Eudorella pusilla*. Additionally, the polychaete worm *Goniadella gracilis* was relatively abundant at one station (217 individuals/sample, SZR5).

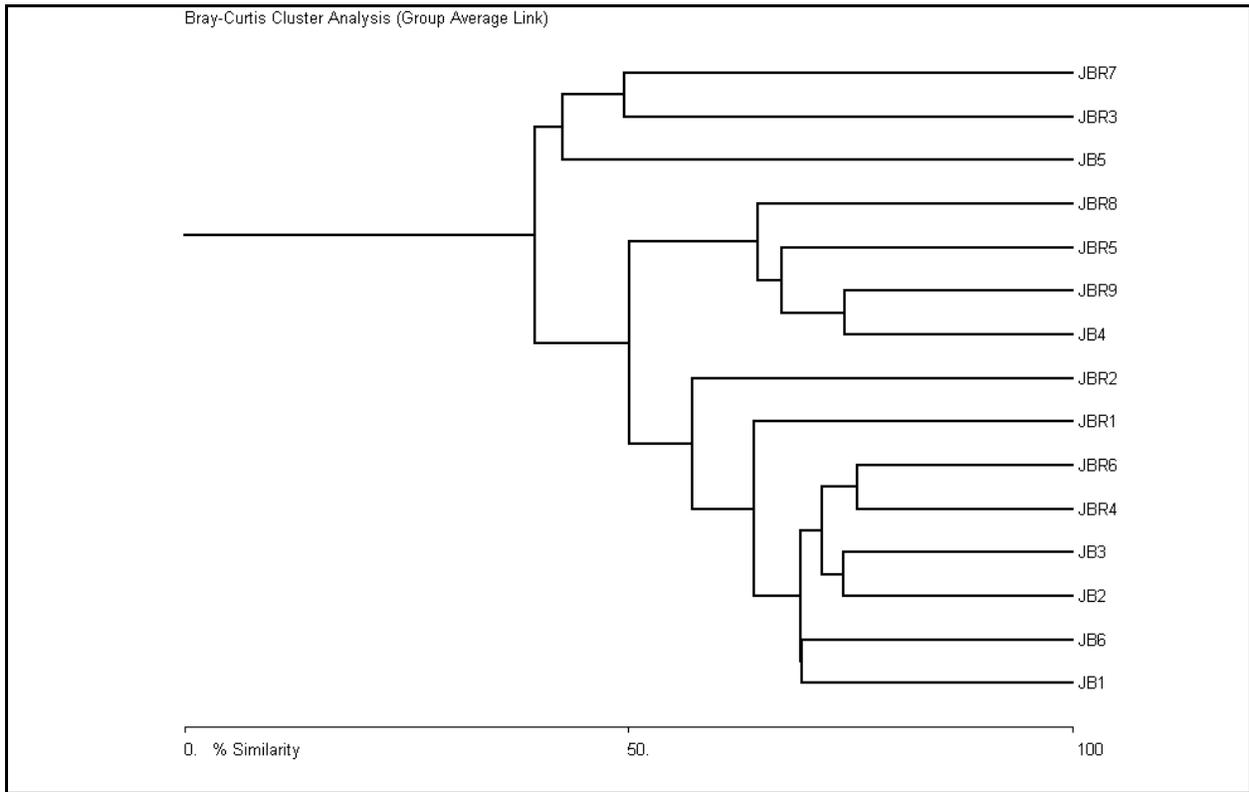


Figure 13. Dendrogram resulting from Bray-Curtis analysis of samples collected from Site 69A (Jamestown Bridge).

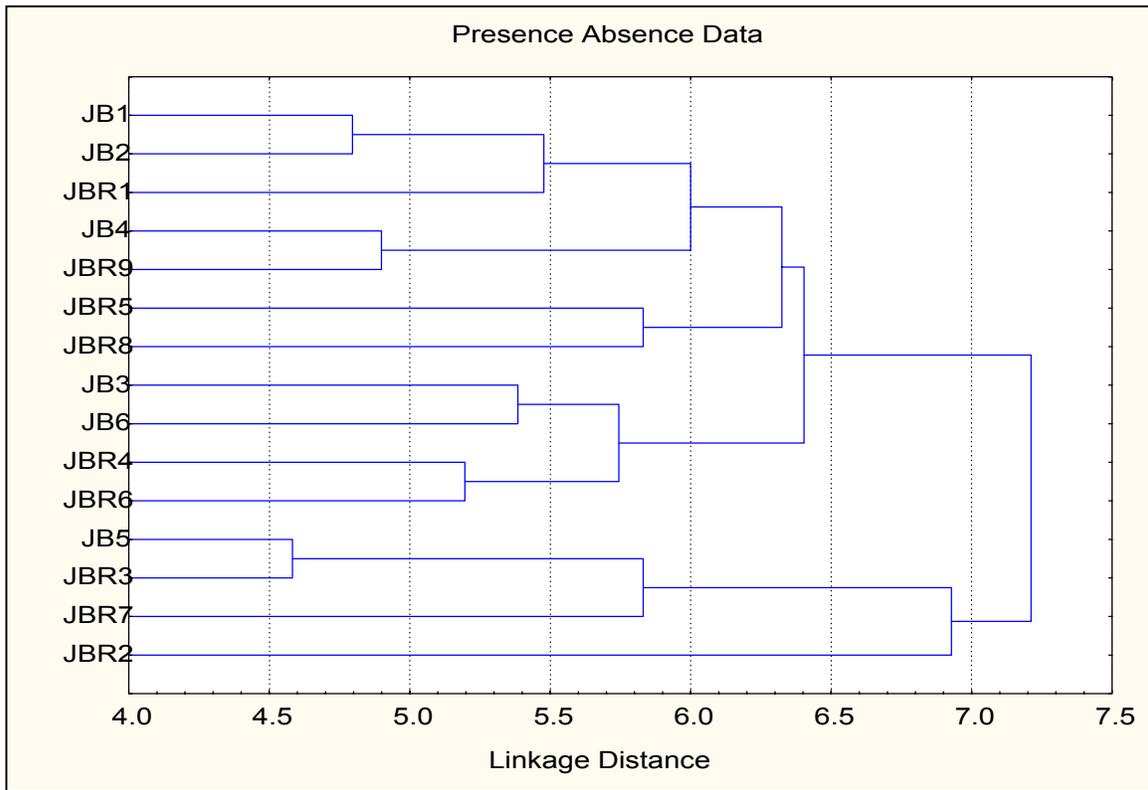


Figure 14. Dendrogram resulting from classification analysis of presence/absence data from Site 69A (Jamestown Bridge).

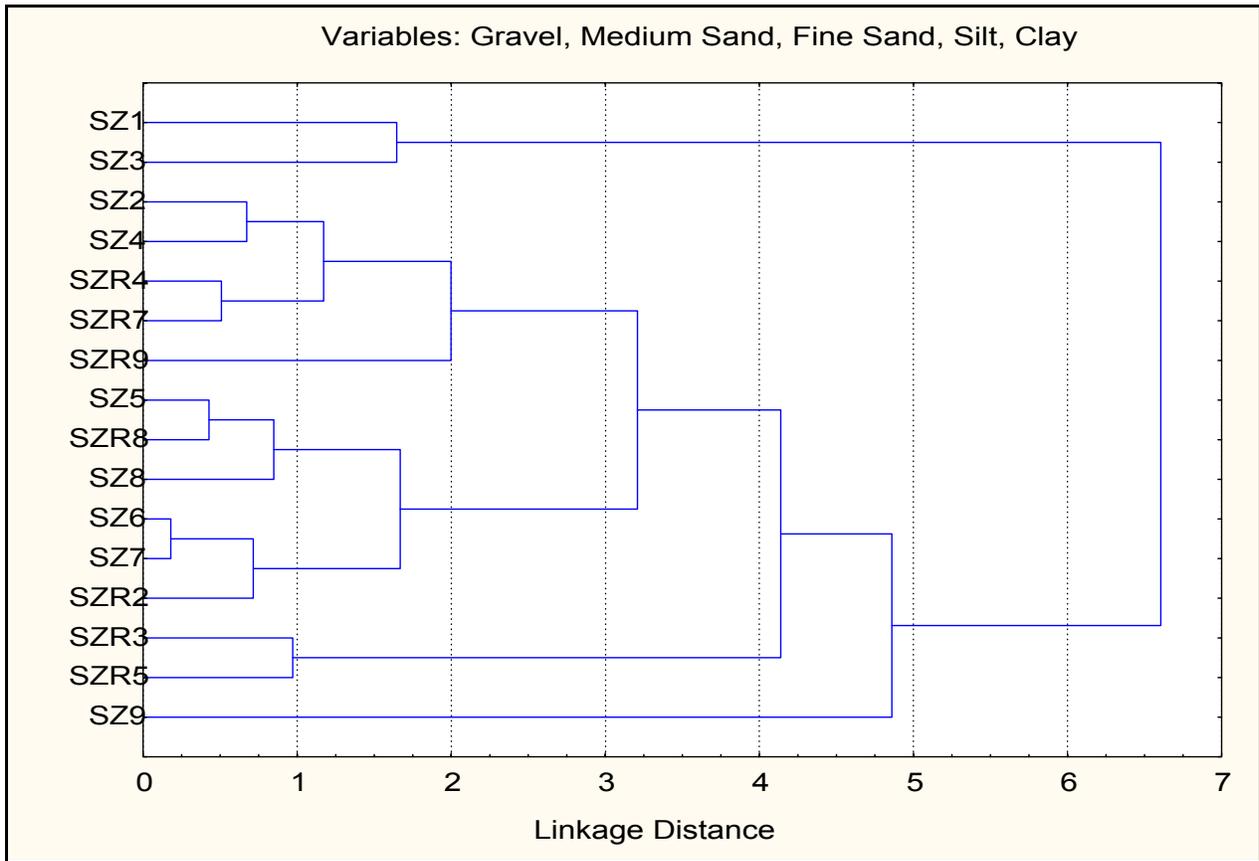


Figure 15. Dendrogram resulting from classification analysis of physical factors at Site 69B (Separation Zone).

Bray-Curtis cluster analysis (Figure 16) separated Site 69B stations into two primary groups. Group I was comprised of three stations, SZR5, SZR3, and SZ8. Among these stations infaunal abundance was low (~609 individuals/sample), numbers of species were moderate (~38/sample), and diversity ($H' = 3.09$) and evenness ($J' = 0.59$) were moderate. The taxa that primarily defined the group were *Polygordius* sp. A, and *Byblis serrata*. The polychaetes *Goniadella gracilis* and *Lumbrinerides acuta* also helped to distinguish these stations from the others although neither was present at station SZ8. Group II consisted of the remaining 13 Site 69B stations. Infaunal abundance among these stations was high (~1,327 individuals/sample), numbers of species were high (~53/sample), and diversity ($H' = 3.44$) and evenness ($J' = 0.60$) were moderate. Two stations in this cluster group were not very similar to the remaining stations. Station SZR7 was characterized by low infaunal abundance (191 individuals), most of which (~56%) was accounted for by *Polygordius* sp. A, the polychaete *Ninoe nigripes*, *Ampelisca agassizi*, and *Scoletoma hebes*. Station SZ9 was numerically dominated by *Nucula annulata*, which accounted for 71% (1,322 individuals) of the total infaunal abundance at the station. The remaining 11 stations separated into two subgroups. Subgroup IIa was characterized by *Ampelisca agassizi*, *Nucula annulata*, *Tharyx acutus*, and *Eudorella pusilla*. Subgroup IIb was characterized by *Ampelisca agassizi*, *Polygordius* sp. A, *Tharyx acutus*, *Eudorella pusilla*, and *Exogone hebes*.

Clustering based on the presence/absence data matrix (Figure 17) resulted in separation of the same two major groups of stations as shown by the Bray-Curtis cluster analysis. However, there was no distinct separation of stations SZR7 and SZ9 from the remaining Group II stations.

None of the physical or biological analyses revealed major distinctions among the stations located within the candidate disposal site and those located immediately outside the site boundaries.

Some of the Site 69B samples (those collected on 09/07/2001) were rinsed over a 0.3-mm-mesh sieve in the field, fixed in formalin, and then resieved over a 0.5-mm-mesh sieve in the laboratory. Based on the findings of Ohwada (1988), the samples that were fixed prior to rinsing over the larger mesh sieve might have been expected to have greater numbers of polychaetes than samples rinsed prior to being fixed (those collected on 09/08/2001). The Bray-Curtis cluster analysis (Figure 16) showed that most of the samples collected at Site 69B did not sort by the date on which they were collected. One group of five stations collected on September 7 did cluster together. However, cluster group affinities in Site 69B were defined primarily by taxa (e.g., *Byblis serrata*, *Nucula annulata*, *Ampelisca agassizi*) not expected to be affected by the difference in field processing. Some polychaetes helped to define cluster groups. However, these either did not differ appreciably among samples collected on the two days (*Ninoe nigripes*, *Goniadella gracilis*), or were more abundant when collected on September 8 than on September 7 (*Polygordius* sp. A, *Exogone hebes*). The species that were much more abundant in samples collected on September 7 than in those collected a day later (*Nucula annulata*, *Parvilucina multilineata*, *Onoba pelagica*,) were not expected to be affected by the difference in field procedures because they are hard-shelled molluscs. Therefore, it seems unlikely that the difference in field processing between the two days had any important impact on the data interpretation.

Tissue Collections

Future analyses to be done in support of the Rhode Island Sound EIS program include the collection of invertebrates for the determination of baseline tissue contaminant levels. The taxa to be sampled include the lobster (*Homarus americanus*), a filter feeder (e.g., Mahogany quahog), and a deposit feeder (e.g., polychaete). The intent of this section is to recommend taxa that exist in sufficient quantity in Rhode Island Sound to be sampled for tissue analyses.

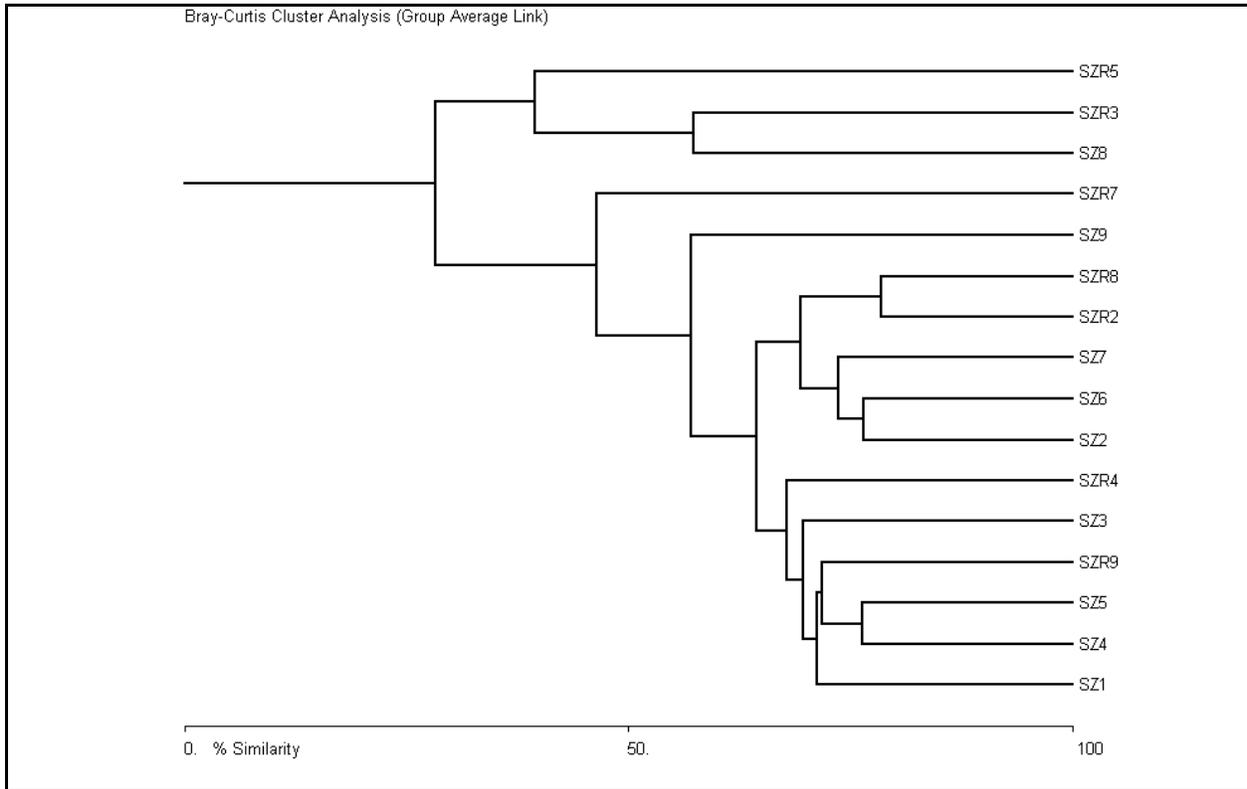


Figure 16. Dendrogram resulting from Bray-Curtis analysis of samples collected from Separation Zone (Site 69B).

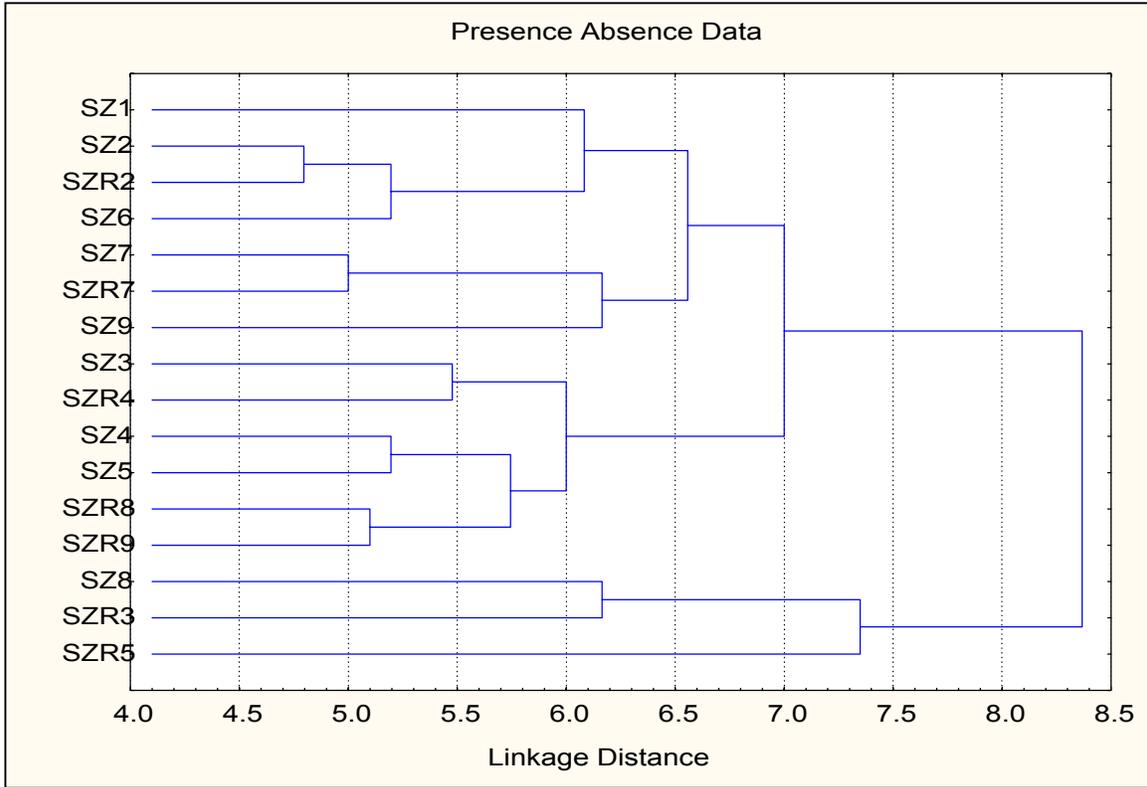


Figure 17. Dendrogram resulting from classification analysis of presence/absence data from Separation Zone (Site 69B).

Determining the abundance of the lobster is beyond the scope of this report because lobsters were not collected during the infaunal sampling. However, lobster abundances have previously been documented for the Rhode Island Sound sites (USACE 2001). The Mahogany quahog, which is more appropriately known in Rhode Island Sound waters as the ocean quahog (*Arctica islandica*), is a long-lived clam (Thompson et al. 1980, Jones 1983) that reaches an average shell length of more than 90 mm in Rhode Island Sound (Battelle 1998). *Arctica islandica* occurred in the samples collected in Rhode Island Sound during the September 2001 infaunal survey, but were not abundant (120 individuals collected in all samples, ~1.6 clams/sample). Clams collected by the sampling methods employed for this investigation were most likely small and it would be difficult to collect enough individuals from each site to obtain sufficient tissue for analyses. If this species is to be tested for baseline tissue contaminant levels, a more appropriate sampling method (e.g., trawling) should be used. Site-specific density and size information are presented in Battelle (1998), which can be used to suggest appropriate collection sites for this species.

The selection of ideal deposit feeders, especially polychaetes, is difficult. As summarized in this report, the infaunal communities present in the candidate disposal sites in Rhode Island Sound were not numerically dominated by polychaetes, and those polychaetes that do appear to be abundant are typically small species, or are not deposit feeders. Polychaete biomass in Rhode Island Sound is most likely very low. Steimle (1990) reported a maximum total polychaete wet weight biomass of 100 g/m² from a station that was located very close to Site 16. To estimate the feasibility of using the most common annelid species for tissue analyses an assumed wet weight of 2 mg for each species [wet weights could only be found for *Aricidea catherinae* (<1 mg) and *Clymenella torquata* (~10 mg), both from Shull and Gallagher (1998) and for *Nephtys incisa* (~45 mg average; estimated from Reid et al. (1991))] was multiplied by the maximum abundance of the species found within a Site to yield the maximum total predicted wet weight obtainable in one grab sample (0.04 m²). To estimate the number of grab samples required to obtain enough tissue for analyses, the minimum weight needed (75 g wet weight) was divided by the total wet weight for a species in one sample (Table 1). Also provided in Table 1 are the number of occurrences of a species in a Site and the mean abundance per occurrence. In addition to the most common species, the table also includes some species (*Nephtys incisa*, *Pherusa affinis*, *Pitar morrhuanus*) that have been used for, or considered for, tissue evaluations in Long Island Sound. It is apparent that none of the common polychaetes that occurred in Rhode Island Sound were found in sufficient numbers to provide enough tissue for analyses without requiring the collection of more grab samples than is practical. Therefore, it may be necessary to pool polychaete species to obtain sufficient tissue for the desired analysis. However, it should be noted that many grab samples may still be required to obtain enough material [~25 small (0.04 m²) grab samples, if Steimle's data still approximate present conditions].

Estimates of the number of grab samples required to collect sufficient tissue of clam or crustacean species were limited to the two most common species, *Nucula annulata* and *Ampelisca agassizi*, because wet weight data were not available for other species. Wet weight biomass estimates for *Nucula annulata* (~4 mg wet weight, but likely includes the shell) and *Ampelisca agassizi* (~2 mg wet weight) were derived using data presented by Reid et al. (1991). Based on these estimates, it is not likely that either species can be sampled efficiently enough to provide adequate amounts of tissue for contaminant analyses.

Table 1. Estimated grabs required to obtain sufficient tissue for chemical analyses.

Descr	Site 16					Site 18					Site 69A					Separation Zone				
	# Occur ⁶	Mean /occur ⁷	StDev /occur ⁸	Max ⁹	# grabs ¹⁰	# Occur ⁶	Mean /occur ⁷	StDev /occur ⁸	Max ⁹	# grabs ¹⁰	# Occur ⁶	Mean /occur ⁷	StDev /occur ⁸	Max ⁹	# grabs ¹⁰	# Occur ⁶	Mean /occur ⁷	StDev /occur ⁸	Max ⁹	# grabs ¹⁰
Polychaetes																				
Polygordius sp. A	15	129	148.6	511	73	15	91	136.5	370	101	13	28	24.7	74	507	16	60	67.9	220	170
Tharyx acutus	25	81	65.0	248	151	18	30	41.8	139	270	15	21	15.2	51	735	16	56	65.5	257	146
Oligochaeta spp.	25	34	20.9	80	469	16	15	22.9	94	399	14	19	24.9	91	412	16	51	58.8	182	206
Ninoe nigripes	22	48	32.9	143	262	17	27	21.5	82	457	15	18	9.0	35	1071	13	23	11.3	47	798
Exogone hebes	13	9	12.1	41	915	14	19	30.8	104	361	13	42	37.8	123	305	14	44	35.4	142	264
Scoletoma hebes	25	15	11.4	47	798	16	13	8.3	31	1210	15	21	24.0	101	371	14	19	11.0	39	962
Aricidea catherinae ¹	24	27	35.0	125	600	15	7	4.1	18	4167	13	16	20.8	73	1027	13	9	5.9	18	4167
Clymenella torquata ²	16	17	23.6	91	82	11	12	8.1	24	313	13	19	15.5	52	144	14	22	16.7	50	150
Prionospio steenstrupi	22	14	15.2	66	568	14	9	7.2	23	1630	14	12	7.9	33	1136	15	19	13.2	50	750
Owenia fusiformis	21	21	16.9	59	636	10	8	8.1	25	1500	6	2	0.8	3	12500	10	3	4.4	15	2500
Goniadella gracilis	7	26	31.0	88	426	3	17	25.2	46	815	4	5	6.4	14	2679	6	52	86.4	217	173
Monticellina baptistae	23	19	13.1	53	708	10	2	2.6	9	4167	5	5	4.7	13	2885	10	2	1.4	6	6250
Spiophanes bombyx	13	2	3.1	12	3125	10	7	6.3	17	2206	11	7	5.3	19	1974	14	22	35.9	141	266
Nephtys incisa ³	14	3	2.1	8	208	12	4	2.1	9	185	10	3	2.4	9	185	11	4	2.9	11	152
Pherusa affinis	13	3	1.3	5	7500	8	2	0.8	3	12500	3	1	0.0	1	37500	2	3	2.1	4	9375
Bivalves																				
Nucula annulata ⁴	24	450	416.8	1,393	13	18	459	617.6	2,088	9	14	125	181.5	640	29	14	254	388.1	1,322	14
Nucula delphinodonta	22	9	10.0	41	--	16	36	29.9	99	--	13	47	41.4	134	--	14	20	21.7	84	--
Periploma papyratium	20	24	13.1	43	--	15	27	22.5	68	--	13	13	6.8	26	--	12	15	11.7	40	--
Pitar morrhuanus	18	7	6.2	23	--	6	3	2.7	8	--	7	4	3.8	11	--	5	3	1.7	5	--
Crustaceans																				
Ampelisca agassizi ⁵	19	655	604.1	1,878	20	14	441	403.9	1,371	27	13	285	376.8	1,381	27	13	426	381.7	1,258	30
Byblis serrata	14	140	228.6	608	--	8	99	165.5	416	--	8	6	8.3	26	--	11	41	77.1	255	--
Eudorella pusilla	23	27	20.1	80	--	18	42	32.8	97	--	14	31	32.8	110	--	15	55	63.7	185	--

¹ Assuming a wet weight of 1 mg; calculated from Shull and Gallagher (1998).
² Assuming a wet weight of 10 mg; from Shull and Gallagher (1998).
³ Assuming a wet weight of 45 mg, mean value (n = 12 samples) calculated from Reid et al. (1991).
⁴ Assuming a wet weight of 4 mg, Mean value (n = 6 samples) calculated from Reid et al. (1991).
⁵ Assuming a wet weight of 2 mg, Mean value (n = 7 samples) calculated from Reid et al. (1991).
⁶ Number of occurrences
⁷ Mean abundance per occurrence
⁸ Standard deviation abundance per occurrence
⁹ Maximum abundance per occurrence
¹⁰ Equals the minimum wet weight needed divided by the total wet weight in a sample

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Appendix A
Sample Collection Data

Table A-1. Benthic Infauna Sample Collection Data.

Sample ID	Station ID	Sample Type	Latitude ° N	Longitude ° W	Collection Date	Depth (m)
RIS1S153	BA1	Biol	41.29160	71.30817	9/9/2001	34.7
RIS1S154	BA1	Chem	41.29160	71.30817	9/9/2001	34.7
RIS1S182	BA2	Biol	41.29308	71.29878	9/10/2001	37.3
RIS1S183	BA2	Chem	41.29285	71.29929	9/10/2001	37.3
RIS1S178	BA3	Biol	41.29408	71.29190	9/10/2001	38.4
RIS1S17B	BA3	Chem	41.29402	71.29172	9/10/2001	38.4
RIS1S174	BA4	Biol	41.29325	71.28918	9/10/2001	38.5
RIS1S175	BA4	Chem	41.29372	71.28928	9/10/2001	39.5
RIS1S16F	BA5	Chem	41.28470	71.29387	9/10/2001	37.6
RIS1S170	BA5	Biol	41.28438	71.29337	9/10/2001	37.6
RIS1S164	BA6	Biol	41.27882	71.29467	9/10/2001	36.2
RIS1S166	BA6	Chem	41.27892	71.29512	9/10/2001	36.2
RIS1S137	BA7	Biol	41.28198	71.30503	9/9/2001	37.6
RIS1S138	BA7	Chem	41.28210	71.30476	9/9/2001	38.0
RIS1S147	BA8	Biol	41.28650	71.30946	9/9/2001	35.8
RIS1S148	BA8	Chem	41.28653	71.30943	9/9/2001	36.2
RIS1S142	BA9	Biol	41.28638	71.30652	9/9/2001	36.5
RIS1S143	BA9	Chem	41.28635	71.30680	9/9/2001	36.7
RIS1S18D	BAR1	Biol	41.29273	71.31145	9/10/2001	34.4
RIS1S18E	BAR1	Chem	41.29353	71.31222	9/10/2001	34.4
RIS1S188	BAR2	Biol	41.29515	71.30143	9/10/2001	37.6
RIS1S189	BAR2	Chem	41.29528	71.30092	9/10/2001	37.6
RIS1S17E	BAR3	Biol	41.29557	71.29283	9/10/2001	37.5
RIS1S17F	BAR3	Chem	41.29560	71.29328	9/10/2001	37.5
RIS1S16A	BAR4	Biol	41.28060	71.28683	9/10/2001	36.0
RIS1S16B	BAR4	Chem	41.28012	71.28715	9/10/2001	36.0
RIS1S12B	BAR5	Biol	41.27447	71.30143	9/9/2001	34.2
RIS1S12C	BAR5	Chem	41.27483	71.30064	9/9/2001	34.4
RIS1S12F	BAR6	Biol	41.27623	71.30748	9/9/2001	37.6
RIS1S130	BAR6	Chem	41.27638	71.30663	9/9/2001	38.4
RIS1S133	BAR7	Biol	41.27858	71.31255	9/9/2001	34.7
RIS1S134	BAR7	Chem	41.27870	71.31223	9/9/2001	34.9
RIS1S13B	BAR8	Biol	41.28420	71.31305	9/9/2001	36.0
RIS1S13C	BAR8	Chem	41.28428	71.31300	9/9/2001	36.2
RIS1S14F	BAR9	Biol	41.28855	71.31237	9/9/2001	34.9
RIS1S150	BAR9	Chem	41.28855	71.31237	9/9/2001	34.9
RIS1S1A1	BR1	Biol/Chem	41.39542	71.29598	9/13/2001	31.1
RIS1S1A6	BR1	Biol/Chem	41.39535	71.29585	9/13/2001	30.5
RIS1S1A9	BR1	Biol/Chem	41.39535	71.29591	9/13/2001	42.6
RIS1S23D	BR1	Biol/Chem	41.39537	71.29646	10/12/2001	30.5
RIS1S241	BR1	Biol/Chem	41.39510	71.29594	10/12/2001	30.7
RIS1S1B7	BR2	Biol/Chem	41.39548	71.30363	9/27/2001	29.5

Sample ID	Station ID	Sample Type	Latitude ° N	Longitude ° W	Collection Date	Depth (m)
RIS1S1ED	BR2	Biol/Chem	41.39562	71.30272	9/28/2001	29.5
RIS1S1F0	BR2	Biol/Chem	41.39507	71.30355	9/28/2001	29.5
RIS1S1F7	BR2	Biol/Chem	41.39508	71.30428	9/28/2001	28.5
RIS1S1FB	BR2	Biol/Chem	41.39555	71.30344	9/28/2001	28.3
RIS1S1FE	BR3	Biol/Chem	41.38815	71.30115	9/28/2001	29.6
RIS1S206	BR3	Biol/Chem	41.38752	71.30157	9/28/2001	29.5
RIS1S20A	BR3	Biol/Chem	41.38745	71.30173	9/28/2001	29.5
RIS1S20F	BR3	Biol/Chem	41.38723	71.30135	9/28/2001	29.6
RIS1S212	BR3	Biol/Chem	41.38773	71.30047	9/28/2001	30.0
RIS1S220	BRR1	Biol	41.40108	71.29335	10/3/2001	29.3
RIS1S223	BRR1	Biol	41.40083	71.29343	10/3/2001	30.8
RIS1S228	BRR1	Biol	41.40145	71.29311	10/3/2001	30.5
RIS1S22C	BRR1	Biol	41.40127	71.29369	10/3/2001	29.9
RIS1S233	BRR1	Biol	41.40038	71.29356	10/3/2001	30.5
RIS1S249	BRR1	Biol/Chem	41.40127	71.29320	10/12/2001	30.4
RIS1S260	BRR1	Biol/Chem	41.40128	71.29321	10/12/2001	30.2
RIS1S263	BRR1	Biol/Chem	41.40130	71.29324	10/12/2001	31.3
RIS1S266	BRR1	Biol/Chem	41.40132	71.29314	10/12/2001	31.3
RIS1S269	BRR1	Biol/Chem	41.40127	71.29315	10/12/2001	31.1
RIS1S125	JB1	Chem	41.25297	71.32954	9/9/2001	36.9
RIS1S126	JB1	Biol	41.25357	71.32878	9/9/2001	36.5
RIS1S0DF	JB2	Chem	41.24702	71.32639	9/9/2001	37.5
RIS1S0E0	JB2	Biol	41.24750	71.32657	9/9/2001	37.8
RIS1S0D9	JB3	Chem	41.24305	71.32014	9/9/2001	38.3
RIS1S0DB	JB3	Biol	41.24283	71.32125	9/9/2001	37.5
RIS1S0E6	JB4	Chem	41.24166	71.33578	9/9/2001	35.3
RIS1S0E7	JB4	Biol	41.24215	71.33528	9/9/2001	35.7
RIS1S101	JB5	Biol	41.24990	71.31654	9/9/2001	36.5
RIS1S0D4	JB6	Biol	41.23963	71.31631	9/9/2001	37.3
RIS1S0D5	JB6	Chem	41.23977	71.31647	9/9/2001	37.8
RIS1S117	JBR1	Chem	41.25732	71.32494	9/9/2001	37.3
RIS1S11B	JBR1	Biol	41.25698	71.32630	9/9/2001	36.3
RIS1S11E	JBR2	Chem	41.25622	71.32825	9/9/2001	38.4
RIS1S122	JBR2	Biol	41.25727	71.32730	9/9/2001	38.2
RIS1S111	JBR3	Chem	41.25815	71.31644	9/9/2001	36.2
RIS1S113	JBR3	Biol	41.25723	71.31535	9/9/2001	36.2
RIS1S10B	JBR4	Biol	41.25288	71.31450	9/9/2001	36.2
RIS1S10C	JBR4	Chem	41.25350	71.31412	9/9/2001	36.1
RIS1S0F4	JBR5	Chem	41.24567	71.31487	9/9/2001	36.9
RIS1S0FC	JBR5	Biol	41.24570	71.31477	9/9/2001	37.0
RIS1S0CB	JBR6	Chem	41.23748	71.31357	9/9/2001	37.9
RIS1S0CC	JBR6	Biol	41.23818	71.31390	9/9/2001	37.8
RIS1S0C0	JBR7	Biol	41.23712	71.33380	9/8/2001	36.7
RIS1S0C1	JBR7	Chem	41.23750	71.33302	9/8/2001	36.6

Sample ID	Station ID	Sample Type	Latitude ° N	Longitude ° W	Collection Date	Depth (m)
RIS1S0B6	JBR8	Biol	41.23678	71.33665	9/8/2001	35.3
RIS1S0BC	JBR8	Chem	41.23635	71.33725	9/8/2001	35.1
RIS1S0EA	JBR9	Biol	41.24643	71.33898	9/9/2001	36.0
RIS1S0ED	JBR9	Chem	41.24652	71.33907	9/9/2001	36.2
RIS1S039	SZ1	Biol	41.23895	71.37151	9/7/2001	37.5
RIS1S03A	SZ1	Chem	41.23905	71.37135	9/7/2001	37.1
RIS1S01F	SZ2	Biol	41.23618	71.38025	9/7/2001	38.7
RIS1S020	SZ2	Chem	41.23622	71.37959	9/7/2001	38.5
RIS1S081	SZ3	Biol	41.23663	71.38347	9/8/2001	36.3
RIS1S085	SZ3	Chem	41.23675	71.38312	9/8/2001	38.0
RIS1S095	SZ4	Biol	41.23917	71.38167	9/8/2001	37.1
RIS1S096	SZ4	Chem	41.23917	71.38175	9/8/2001	37.2
RIS1S088	SZ5	Biol	41.23882	71.38103	9/8/2001	37.3
RIS1S08E	SZ5	Chem	41.23865	71.38148	9/8/2001	37.6
RIS1S027	SZ6	Biol	41.22635	71.38432	9/7/2001	38.4
RIS1S029	SZ6	Chem	41.22633	71.38388	9/7/2001	38.5
RIS1S023	SZ7	Biol	41.22797	71.38450	9/7/2001	38.4
RIS1S024	SZ7	Chem	41.22913	71.38365	9/7/2001	38.0
RIS1S04F	SZ8	Biol	41.22630	71.37217	9/7/2001	36.5
RIS1S050	SZ8	Chem	41.22647	71.37237	9/7/2001	36.5
RIS1S048	SZ9	Biol	41.22992	71.37315	9/7/2001	38.5
RIS1S049	SZ9	Chem	41.22985	71.37331	9/7/2001	38.5
RIS1S030	SZR2	Biol	41.23715	71.39233	9/7/2001	36.9
RIS1S031	SZR2	Chem	41.23777	71.39107	9/7/2001	37.2
RIS1S07D	SZR3	Biol	41.23013	71.36690	9/8/2001	36.9
RIS1S07E	SZR3	Chem	41.23057	71.36650	9/8/2001	36.4
RIS1S034	SZR4	Biol	41.24143	71.38202	9/7/2001	36.2
RIS1S036	SZR4	Chem	41.24138	71.38174	9/7/2001	36.0
RIS1S056	SZR5	Biol	41.22020	71.37383	9/7/2001	34.9
RIS1S05E	SZR5	Chem	41.22185	71.37525	9/7/2001	34.9
RIS1S0A1	SZR7	Biol	41.24203	71.37988	9/8/2001	35.6
RIS1S0A7	SZR7	Chem	41.24182	71.37977	9/8/2001	35.5
RIS1S02C	SZR8	Biol	41.22983	71.39410	9/7/2001	37.5
RIS1S02D	SZR8	Chem	41.23000	71.39362	9/7/2001	37.5
RIS1S044	SZR9	Biol	41.23802	71.36815	9/7/2001	37.3
RIS1S045	SZR9	Chem	41.23825	71.36808	9/7/2001	36.8

Appendix B

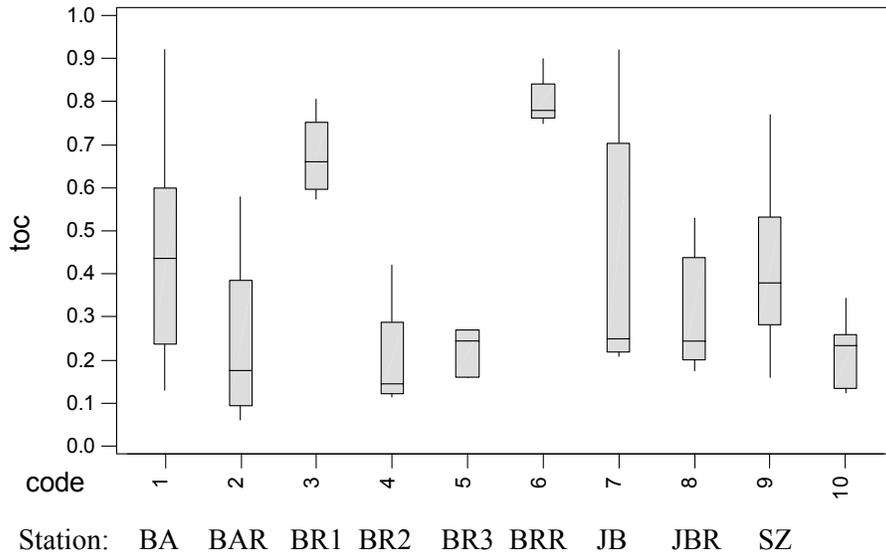
Physical Characteristics

**Table B-1. Descriptive Statistics for Benthic Infauna Samples
 (TOC, Water Content, Total Solids, Grain Size)**

Variable	Station		Mean	Median	Standard Deviation	Minimum	Maximum	Quartile 1	Quartile 3
TOC	BA	9	0.4467	0.435	0.2409	0.13	0.92	0.2375	0.6
	BAR	9	0.2411	0.175	0.1788	0.06	0.58	0.095	0.385
	BR1	5	0.672	0.66	0.0876	0.575	0.805	0.5975	0.7525
	BR2	5	0.193	0.145	0.1278	0.115	0.42	0.1225	0.2875
	BR3	5	0.221	0.245	0.0566	0.16	0.27	0.16	0.27
	BRR	5	0.798	0.78	0.0586	0.75	0.9	0.7625	0.8425
	JB	5	0.42	0.25	0.302	0.21	0.92	0.22	0.705
	JBR	9	0.3022	0.245	0.1331	0.175	0.53	0.2025	0.44
	SZ	9	0.4167	0.38	0.1839	0.16	0.77	0.2825	0.5325
	SZR	7	0.22	0.235	0.0758	0.125	0.345	0.135	0.26
Water Content	BA	9	45.44	43	16.52	24	81	33.5	53.5
	BAR	9	31	31	12.63	9	53	22.5	38.5
	BR1	5	48	46	8.8	37	60	40.5	56.5
	BR2	5	27.4	24	7.13	23	40	23.5	33
	BR3	5	23.2	24	8.04	15	32	15	31
	BRR	5	64.3	63	6.36	58	75	60	69.25
	JB	5	42	33	16.7	31	70	31	57.5
	JBR	9	33.22	31	7.12	28	50	28.5	35.5
	SZ	9	32.56	33	8.53	20	50	26	36
	SZR	7	28.57	26	5.06	25	39	25	31
Total Solids	BA	9	69.44	70	7.52	55	81	65	75
	BAR	9	77	76	7.63	65	92	72.5	81.5
	BR1	5	67.6	69	4.22	62	73	63.5	71
	BR2	5	78.6	81	4.34	71	81	75	81
	BR3	5	81.6	81	5.27	76	87	76.5	87
	BRR	5	60.8	61	2.28	57	63	59	62.5
	JB	5	71.2	75	7.5	59	77	64	76.5
	JBR	9	75.22	77	3.9	66	78	74	77.5
	SZ	9	75.78	75	4.89	67	84	73.5	79.5
	SZR	7	77.71	79	2.87	72	80	76	80
Gravel	BA	9	0.496	0	0.909	0	2.1	0	1.18
	BAR	9	0.329	0.18	0.404	0	0.99	0	0.75
	BR1	5	0.448	0.3	0.491	0	1.29	0.145	0.825
	BR2	5	1.96	0.34	2.54	0	4.74	0	4.74
	BR3	5	13.28	15.37	11.94	0.32	25.59	0.9	24.62
	BRR	5	0.048	0	0.1073	0	0.24	0	0.12
	JB	5	1.348	0.78	1.579	0	3.7	0.04	2.94
	JBR	9	3.651	4.05	2.483	0	6.98	0.97	5.58
	SZ	9	11.81	4.41	18.16	0	49.3	0.36	22.4
	SZR	7	7.04	1.35	8.24	0	19.08	0	14.85
Coarse Sand	BA	9	0.35	0.07	0.458	0.02	1.14	0.035	0.75
	BAR	9	2.91	0.65	6.21	0.1	19.21	0.16	2.38
	BR1	5	0.574	0.64	0.306	0.24	0.94	0.26	0.855
	BR2	5	3.68	0.49	4.75	0.1	9.66	0.12	8.84
	BR3	5	9.42	12.43	8.2	0.55	17.71	0.68	16.67
	BRR	5	0.896	0.78	0.343	0.57	1.46	0.645	1.205

Variable	Station	N	Mean	Median	Standard Deviation	Minimum	Maximum	Quartile 1	Quartile 3	
Coarse Sand	JB	5	1.232	0.55	1.184	0.42	3.19	0.45	2.355	
	JBR	9	1.563	1.81	0.757	0.13	2.4	0.885	2.135	
	SZ	9	4.49	4.82	4.85	0.36	15.24	0.43	6.38	
	SZR	7	2.727	2.69	2.604	0.07	6.85	0.14	5.24	
Medium Sand	BA	9	10.32	4.06	20.48	0.8	64.61	1.25	6.58	
	BAR	9	19.98	8.15	26.14	1.1	69.84	1.58	40.28	
	BR1	5	5.13	4.6	2.32	3.31	9.16	3.6	6.94	
	BR2	5	28.5	8.6	28.6	6.8	65.7	7.6	59.5	
	BR3	5	26.18	29.06	19.45	7.29	53.68	7.49	43.43	
	BRR	5	3.824	3.8	0.974	2.32	4.86	2.99	4.67	
	JB	5	5.706	6.14	1.355	4.16	7.28	4.295	6.9	
	JBR	9	9.19	8.42	5.07	1.94	15.97	5.06	14.6	
	SZ	9	8.19	6.18	4.7	4.14	18.01	4.8	11.43	
	SZR	7	20.66	9.11	20.2	1.97	55.04	7.7	41.85	
	Fine Sand	BA	9	63.83	68.45	19.36	25.35	84.62	51.17	79.13
		BAR	9	64.15	74.95	28.69	6.65	88.28	40.74	86.82
BR1		5	54.8	55	4.51	49.07	61.28	50.84	58.66	
BR2		5	57.5	68.2	33.2	15.9	87.4	22.4	87.1	
BR3		5	42.9	22.2	34.1	11.2	83.3	16.3	79.9	
BRR		5	36.6	37.65	2.83	31.72	38.6	34.2	38.48	
JB		5	74.3	77.37	13.02	53.72	85.95	62.09	84.99	
JBR		9	74.07	72.91	5.95	66.33	83.64	69	79.77	
SZ		9	61.97	70.15	21.27	23.11	82.09	43.65	76.82	
SZR		7	62.7	63.44	16.15	41.8	84.37	49.33	80.83	
Silt		BA	9	12.72	10.96	10.4	1.3	32.51	2.65	19.4
		BAR	9	4.89	3.01	5.57	0.13	14.45	0.42	9.4
	BR1	5	26	25.24	3.9	21.19	31.87	22.95	29.44	
	BR2	5	4.06	1.48	5.94	0.55	14.63	0.92	8.49	
	BR3	5	3.95	3.03	3.02	1.15	9.08	1.96	6.39	
	BRR	5	40.74	39.62	2.88	37.96	45.5	38.74	43.3	
	JB	5	7.86	2.87	8.17	1.95	20.42	2.04	16.18	
	JBR	9	4.78	3.12	5.19	1.21	18.1	1.94	5.11	
	SZ	9	6.72	3.65	7.02	0.27	23.31	2.1	9.24	
	SZR	7	2.651	1.45	1.973	0.59	5.52	1.07	4.49	
	Clay	BA	9	12.28	12	5.58	5.5	24	7.5	15.25
		BAR	9	7.73	6.5	3.92	3.5	15	4.79	11
BR1		5	13.05	12.5	1.736	11	15.5	11.625	14.75	
BR2		5	4.286	3.5	2.082	3.11	8	3.215	5.75	
BR3		5	4.272	4	1.101	3.03	6	3.43	5.25	
BRR		5	17.9	17.5	1.257	16.5	19.75	16.875	19.125	
JB		5	9.55	6.5	5.16	6	18	6.13	14.5	
JBR		9	6.75	6	2.88	3.25	13.5	5.125	7.5	
SZ		9	6.82	5.11	3.68	3.5	15	4.14	9	
SZR		7	4.226	3.77	2.013	1.82	8	2.5	5	

Boxplots of TOC by Station



Kruskal-Wallis Test: TOC versus Station

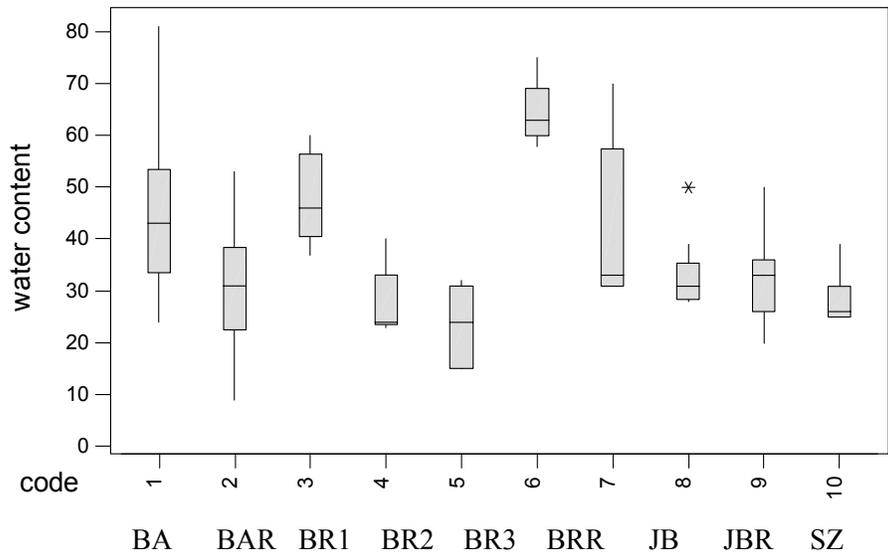
Kruskal-Wallis Test on TOC

Station	N	Median	Ave Rank	Z
1	9	0.4350	40.9	1.04
2	9	0.1750	21.7	-2.09
3	5	0.6600	58.2	2.78
4	5	0.1450	15.1	-2.28
5	5	0.2450	23.9	-1.25
6	5	0.7800	63.0	3.35
7	5	0.2500	37.4	0.34
8	9	0.2450	30.4	-0.66
9	9	0.3800	41.2	1.09
10	7	0.2350	21.5	-1.84
Overall	68		34.5	

H = 33.08 DF = 9 P = 0.000

H = 33.10 DF = 9 P = 0.000 (adjusted for ties)

Boxplots of water content by Station



Kruskal-Wallis Test: Water Content versus Station

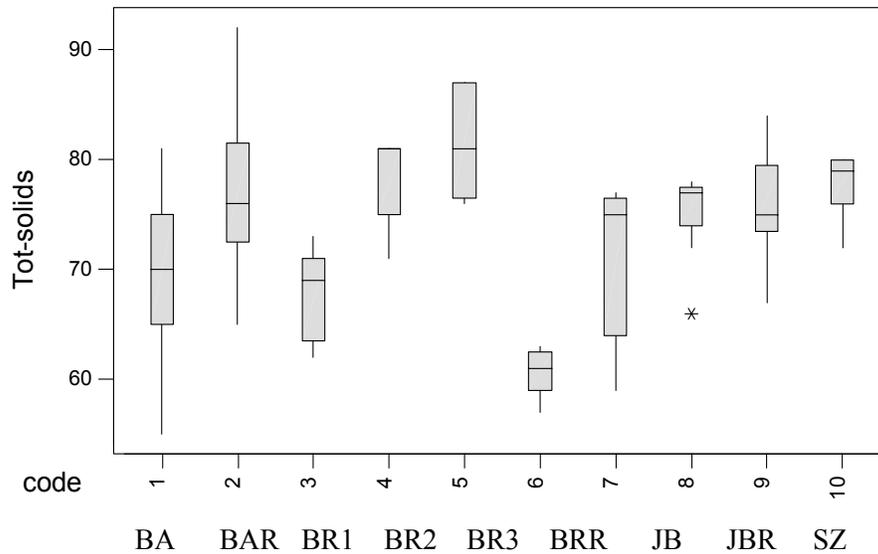
Kruskal-Wallis Test on Water Content

Station	N	Median	Ave Rank	Z
1	9	43.00	46.2	1.90
2	9	31.00	28.6	-0.97
3	5	46.00	53.7	2.26
4	5	24.00	17.5	-2.00
5	5	24.00	14.4	-2.36
6	5	63.00	64.0	3.47
7	5	33.00	42.3	0.92
8	9	31.00	31.6	-0.48
9	9	33.00	30.9	-0.59
10	7	26.00	21.7	-1.81
Overall	68		34.5	

H = 32.86 DF = 9 P = 0.000

H = 32.93 DF = 9 P = 0.000 (adjusted for ties)

Boxplots of Total Solids by Station



Kruskal-Wallis Test: Total Solids versus Station

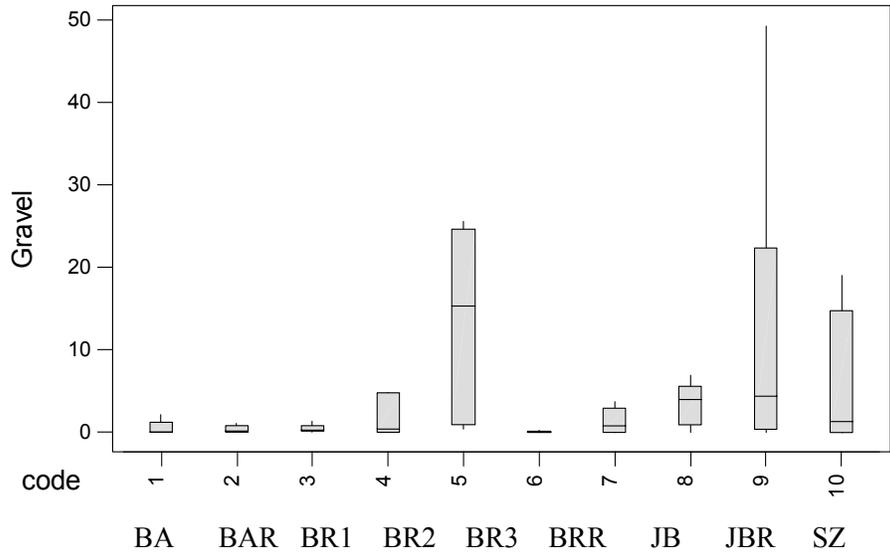
Kruskal-Wallis Test on Total Solids

Station	N	Median	Ave Rank	Z
1	9	70.00	22.7	-1.92
2	9	76.00	40.4	0.96
3	5	69.00	15.4	-2.24
4	5	81.00	51.0	1.94
5	5	81.00	55.0	2.41
6	5	61.00	5.1	-3.45
7	5	75.00	26.8	-0.90
8	9	77.00	37.8	0.54
9	9	75.00	38.2	0.60
10	7	79.00	46.8	1.74
Overall	68		34.5	

H = 32.59 DF = 9 P = 0.000

H = 32.71 DF = 9 P = 0.000 (adjusted for ties)

Boxplots of Gravel by Station



Kruskal-Wallis Test: Gravel versus Station

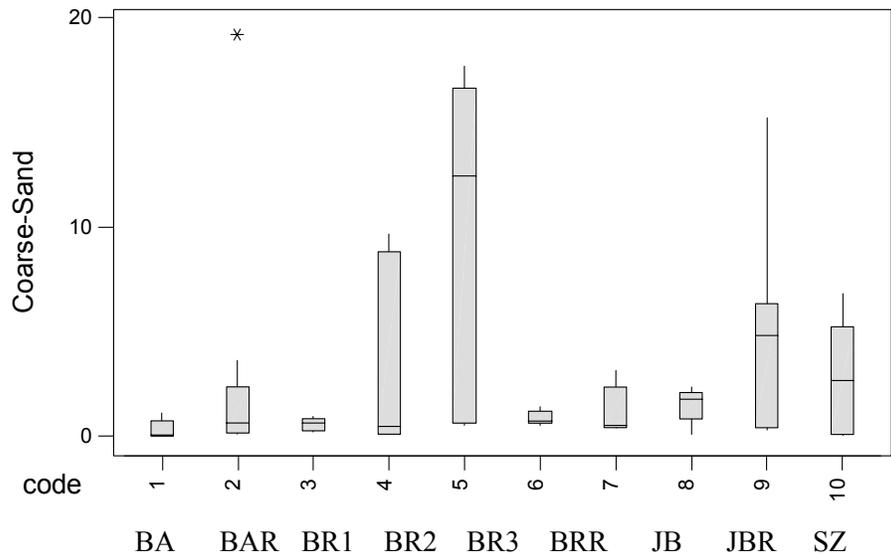
Kruskal-Wallis Test on Gravel

Station	N	Median	Ave Rank	Z
1	9	0.00E+00	20.8	-2.24
2	9	1.80E-01	24.3	-1.66
3	5	3.00E-01	29.0	-0.65
4	5	3.40E-01	32.2	-0.27
5	5	1.54E+01	54.0	2.29
6	5	0.00E+00	14.2	-2.38
7	5	7.80E-01	34.0	-0.06
8	9	4.05E+00	46.3	1.93
9	9	4.41E+00	45.9	1.85
10	7	1.35E+00	41.9	1.04
Overall	68		34.5	

H = 24.48 DF = 9 P = 0.004

H = 25.22 DF = 9 P = 0.003 (adjusted for ties)

Boxplots of Coarse-Sand by Station



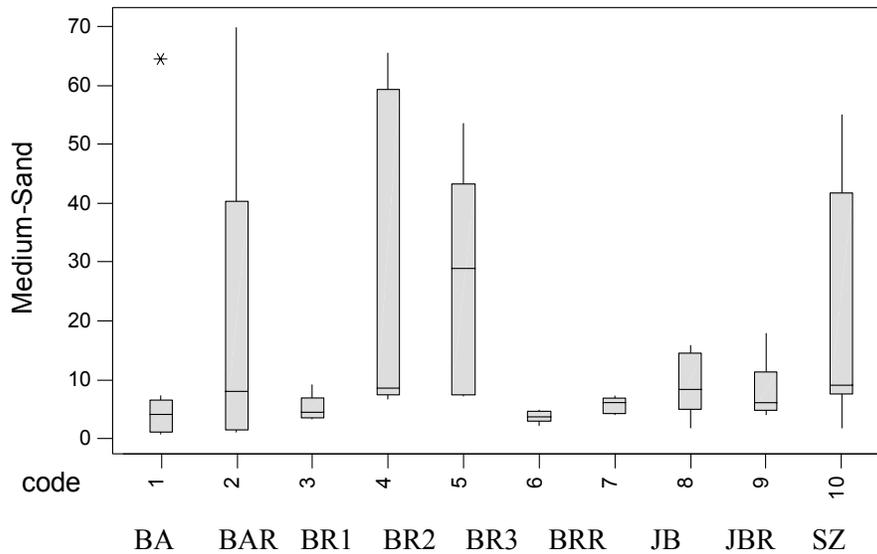
Kruskal-Wallis Test: Coarse-Sand versus Station

Kruskal-Wallis Test on Coarse Sand

Station	N	Median	Ave Rank	Z
1	9	0.07000	15.1	-3.16
2	9	0.65000	30.9	-0.59
3	5	0.64000	25.6	-1.05
4	5	0.49000	33.3	-0.14
5	5	12.43000	51.1	1.95
6	5	0.78000	34.4	-0.01
7	5	0.55000	33.5	-0.12
8	9	1.81000	41.4	1.12
9	9	4.82000	43.7	1.49
10	7	2.69000	39.6	0.72
Overall	68		34.5	

H = 17.01 DF = 9 P = 0.049
H = 17.01 DF = 9 P = 0.049 (adjusted for ties)

Boxplots of Medium-Sand by Station



Kruskal-Wallis Test: Medium-Sand versus Station

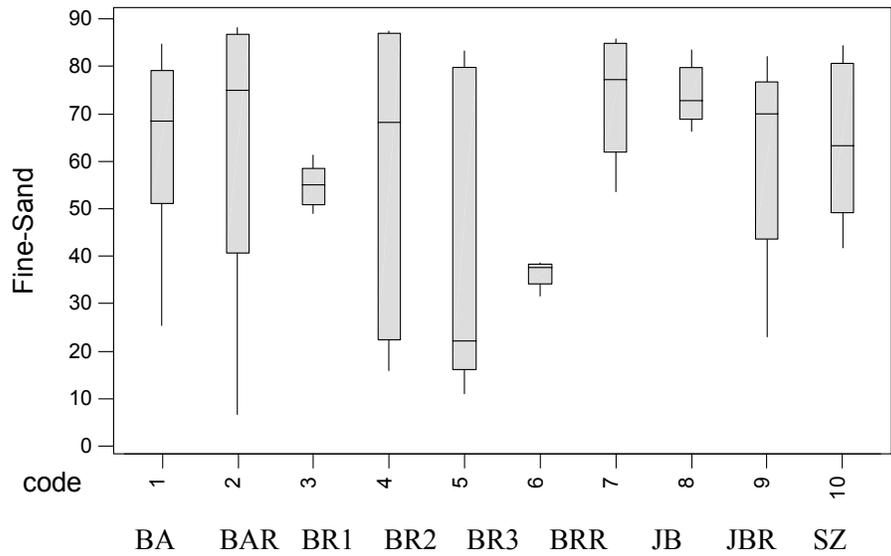
Kruskal-Wallis Test on Medium Sand

Station	N	Median	Ave Rank	Z
1	9	4.060	20.6	-2.26
2	9	8.150	35.9	0.24
3	5	4.600	23.8	-1.26
4	5	8.620	50.8	1.91
5	5	29.060	51.9	2.04
6	5	3.800	16.0	-2.17
7	5	6.140	27.4	-0.83
8	9	8.420	38.3	0.62
9	9	6.180	35.9	0.24
10	7	9.110	45.6	1.56
Overall	68		34.5	

H = 20.82 DF = 9 P = 0.013

H = 20.82 DF = 9 P = 0.013 (adjusted for ties)

Boxplots of Fine-Sand by Station



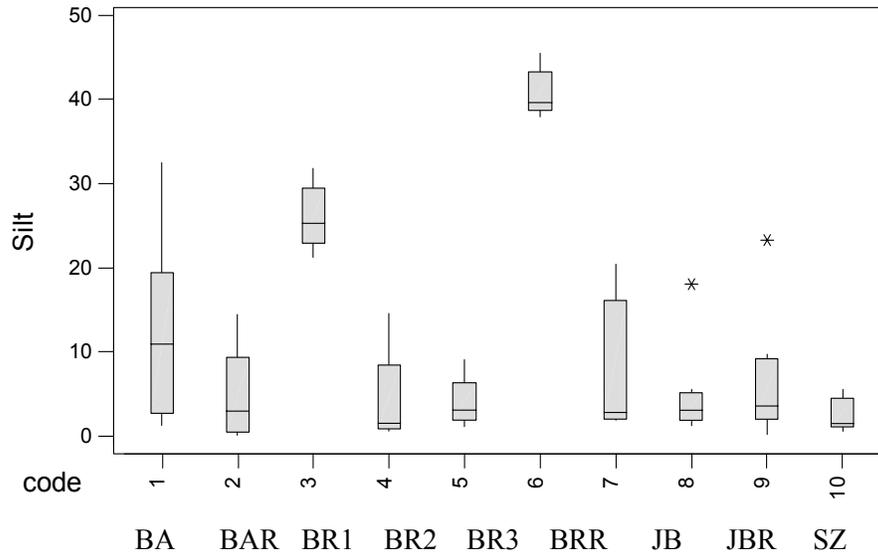
Kruskal-Wallis Test: Fine-Sand versus Station

Kruskal-Wallis Test on Fine Sand

Station	N	Median	Ave Rank	Z
1	9	68.45	36.1	0.26
2	9	74.95	40.9	1.04
3	5	55.00	23.6	-1.28
4	5	68.21	35.4	0.11
5	5	22.21	23.4	-1.30
6	5	37.65	12.8	-2.55
7	5	77.37	47.0	1.47
8	9	72.91	43.8	1.51
9	9	70.15	34.7	0.03
10	7	63.44	33.7	-0.11
Overall	68		34.5	

H = 14.12 DF = 9 P = 0.118

Boxplots of Silt by Station



Kruskal-Wallis Test: Silt versus Station

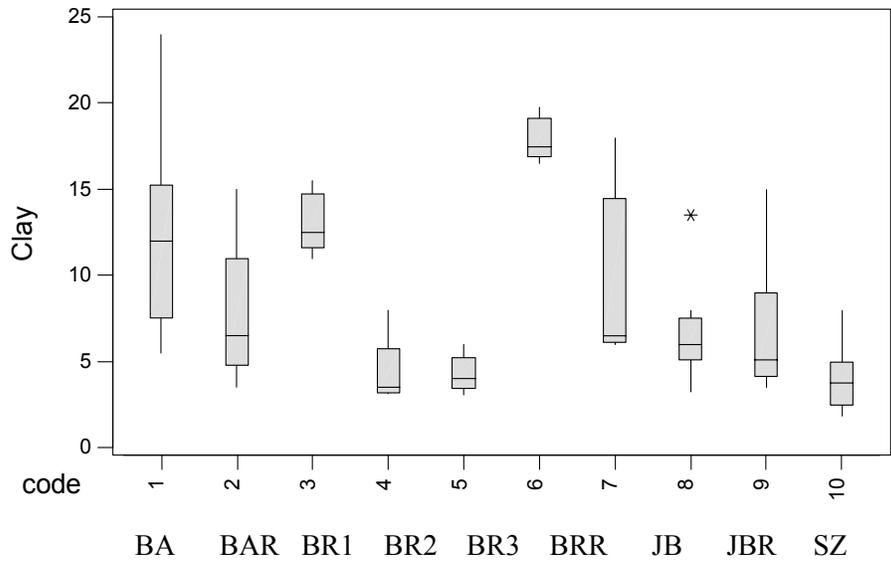
Kruskal-Wallis Test on Silt

Station	N	Median	Ave Rank	Z
1	9	10.960	42.0	1.22
2	9	3.010	25.5	-1.47
3	5	25.240	59.6	2.95
4	5	1.480	20.2	-1.68
5	5	3.030	27.6	-0.81
6	5	39.620	66.0	3.70
7	5	2.870	32.6	-0.22
8	9	3.120	29.7	-0.79
9	9	3.650	32.3	-0.35
10	7	1.450	21.5	-1.84
Overall	68		34.5	

H = 30.85 DF = 9 P = 0.000

H = 30.85 DF = 9 P = 0.000 (adjusted for ties)

Boxplots of Clay by Station



Kruskal-Wallis Test: Clay versus Station

Kruskal-Wallis Test on Clay

Station	N	Median	Ave Rank	Z
1	9	12.000	49.2	2.39
2	9	6.500	33.6	-0.15
3	5	12.500	53.7	2.26
4	5	3.500	13.6	-2.46
5	5	4.000	15.7	-2.21
6	5	17.500	64.4	3.51
7	5	6.500	41.8	0.86
8	9	6.000	31.3	-0.52
9	9	5.110	29.6	-0.80
10	7	3.770	15.4	-2.70
Overall	68		34.5	

H = 39.25 DF = 9 P = 0.000

H = 39.31 DF = 9 P = 0.000 (adjusted for ties)

Correlations: Gravel, Coarse Sand, Medium Sand, Fine Sand, Silt, Clay

	Gravel	Coarse-S	Medium-S	Fine-San	Silt
Coarse-S	0.639 0.000				
Medium-S	0.157 0.202	0.571 0.000			
Fine-San	-0.414 0.000	-0.653 0.000	-0.655 0.000		
Silt	-0.284 0.019	-0.305 0.012	-0.387 0.001	-0.274 0.024	
Clay	-0.355 0.003	-0.395 0.001	-0.473 0.000	-0.129 0.294	0.906 0.000

Cell Contents: Pearson correlation
P-Value

Coarse-S = Coarse Sand
Medium-S = Medium Sand
Fine-San = Fine Sand

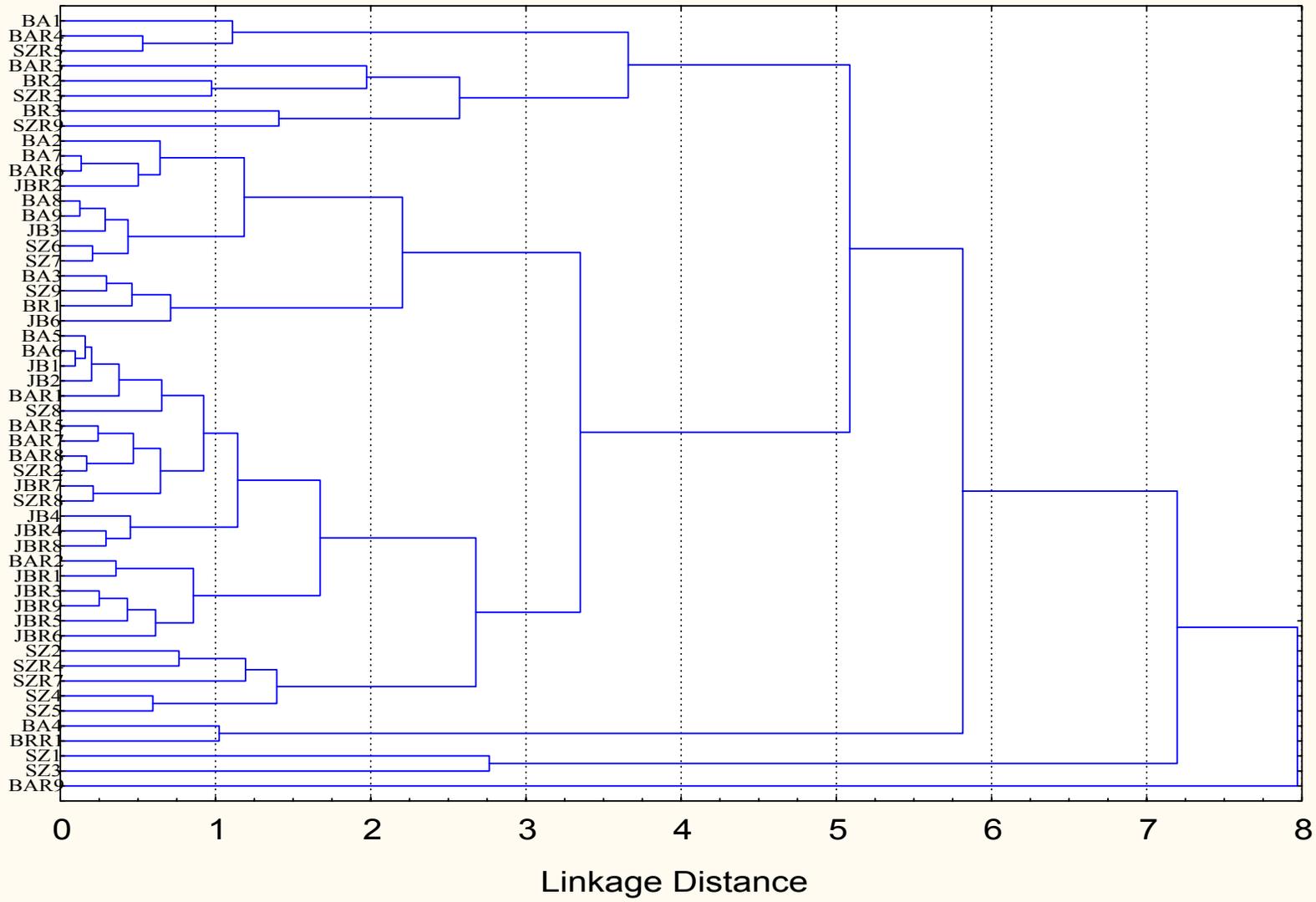


Figure B-1. Dendrogram resulting from classification analysis of physical factors of all samples collected from the Rhode Island Sound sites during September–October, 2001.

Appendix C

Species Data by Station

See Separate Appendix C File

Appendix D
Biological Characteristics

Table D-1. Percent occurrence of species in samples collected in Rhode Island Sound.

Taxa very common everywhere

Major Taxon Code	Name	Family	BA-all	BRR	JB-all	SZ-all	Candidate Sites	Historic Site	Region
POL	Tharyx acutus	Cirratulidae	100%	100%	100%	100%	100%	100%	100%
OLI	Oligochaeta spp.	Oligochaeta spp.	89%	100%	93%	100%	94%	100%	96%
POL	Scoletoma hebes	Lumbrineridae	89%	100%	100%	88%	92%	100%	95%
BIV	Nucula annulata	Nuculidae	100%	100%	93%	88%	94%	93%	95%
CUM	Eudorella pusilla	Leuconidae	100%	100%	93%	94%	96%	87%	95%
POL	Ninoe nigripes	Lumbrineridae	94%	100%	100%	81%	92%	80%	91%
POL	Aricidea catherinae	Paraonidae	83%	90%	87%	81%	84%	100%	88%
POL	Prionospio steenstrupi	Spionidae	78%	100%	93%	94%	88%	80%	88%
BIV	Nucula delphinodonta	Nuculidae	89%	100%	87%	88%	88%	80%	88%
POL	Levinsenia gracilis	Paraonidae	83%	100%	87%	75%	82%	80%	84%

Taxa common regionally

Major Taxon Code	Name	Family	BA-all	BRR	JB-all	SZ-all	Candidate Sites	Historic Site	Region
NEM	Micrura spp.	Lineidae	83%	100%	93%	69%	82%	87%	85%
BIV	Cerastoderma pinnulatum	Cardiidae	56%	90%	80%	69%	67%	73%	72%
POL	Scalibregma inflatum	Scalibregmatidae	78%	50%	73%	100%	84%	100%	82%
AMP	Unciola irrorata	Corophiidae	61%	50%	80%	88%	76%	73%	72%
POL	Polygordius sp. A	Polygordiidae	83%	40%	87%	100%	90%	80%	81%
POL	Exogone hebes	Syllidae	78%	20%	87%	88%	84%	73%	73%
BIV	Periploma papyratium	Periplomatidae	83%	100%	87%	75%	82%	67%	81%
AMP	Ameplisca agassizi	Ampeliscidae	78%	100%	87%	81%	82%	60%	80%
POL	Euchone incolor	Sabellidae	72%	100%	60%	81%	71%	60%	73%
POL	Clymenella torquata	Maldanidae	61%	70%	87%	88%	78%	60%	73%
ECH	Echinarachnius parma	Echinarachniidae	100%	20%	67%	88%	86%	53%	70%

Green = 70-100%
 Yellow = 33-69%
 Light Blue = 0-32%

Table D-1. Percent occurrence of species in samples collected in Rhode Island Sound. (continued)

Taxa common at the historic disposal site

Major Taxon Code	Name	Family	BA-all	BRR	JB-all	SZ-all	Candidate Sites	Historic Site	Region
POL	Owenia fusiformis	Oweniidae	56%	100%	40%	63%	53%	73%	64%
POL	Monticellina baptistae	Cirratulidae	56%	100%	33%	63%	51%	87%	65%
POL	Polycirrus haematodes	Terebellidae	50%	100%	33%	56%	47%	73%	59%
POL	Spiochaetopterus oculatus	Chaetopteridae	50%	60%	20%	31%	35%	80%	47%
POL	Cirrophorus furcatus	Paraonidae	33%	50%	53%	56%	47%	73%	53%
AMP	Leptocheirus pinguis	Aoridae	28%	40%	7%	63%	33%	73%	42%
CUM	Diastylis sculpta	Diastylidae	22%	40%	20%	38%	27%	93%	42%
POL	Parougia sp. 1	Dorvilleidae	67%	30%	73%	69%	69%	93%	69%
AMP	Byblis serrata	Ampeliscidae	44%	10%	53%	69%	55%	87%	55%

Taxa less common regionally and at the historic disposal site

Major Taxon Code	Name	Family	BA-all	BRR	JB-all	SZ-all	Candidate Sites	Historic Site	Region
GAS	Onoba pelagica	Rissoidae	39%	100%	33%	38%	37%	33%	45%
POL	Cossura longocirrata	Cossuridae	33%	100%	20%	25%	27%	40%	39%
POL	Nephtys incisa	Nephtyidae	67%	90%	67%	69%	67%	33%	64%
BIV	Pitar morrhuanus	Veneridae	33%	90%	47%	31%	37%	60%	49%
POL	Terebellides atlantis	Trichobranchidae	67%	80%	60%	75%	67%	33%	62%
AMP	Photis pollex	Isaeidae	6%	80%	7%	38%	16%	60%	34%
POL	Pherusa affinis	Flabelligeridae	44%	70%	20%	13%	27%	40%	35%
POL	Spiophanes bombyx	Spionidae	56%	60%	73%	88%	71%	53%	66%
POL	Drilonereis longa	Arabellidae	50%	60%	27%	31%	37%	60%	45%
AMP	Erichthonius fasciatus	Corophiidae	61%	50%	73%	75%	69%	40%	61%
BIV	Arctica islandica	Arcticidae	39%	50%	33%	31%	35%	53%	41%
POL	Syllis cornuta	Syllidae	33%	30%	40%	56%	43%	53%	43%
BIV	Astarte undata	Astartidae	61%	10%	100%	81%	80%	53%	65%
ISO	Ptilanthura tenuis	Anthuridae	44%	10%	87%	75%	67%	47%	55%
AMP	Crassikorophium crassicorne	Corophiidae	22%	0%	33%	63%	39%	40%	34%

Green = 70-100%
 Yellow = 33-69%
 Light Blue = 0-32%

Table D-1. Percent occurrence of species in samples collected in Rhode Island Sound. (continued)

Taxa less common regionally and rare at the historic disposal site

Major Taxon Code	Name	Family	BA-all	BRR	JB-all	SZ-all	Candidate Sites	Historic Site	Region
BIV	Parvilucina multilineata	Lucinidae	44%	90%	40%	50%	45%	20%	46%
POL	Anobothrus gracilis	Ampharetidae	83%	40%	100%	81%	88%	7%	65%
POL	Ophelina acuminata	Ophellidae	67%	20%	73%	75%	71%	20%	54%
AMP	Harpinia propinqua	Phoxocephalidae	67%	0%	67%	63%	65%	27%	49%
BIV	Crenella glandula	Mytilidae	67%	0%	73%	56%	65%	13%	46%
POL	Phyllodoce mucosa	Phyllodocidae	56%	0%	53%	63%	57%	20%	42%
CUM	Diastylis quadrispinosa	Diastylidae	67%	0%	47%	44%	53%	20%	39%

Taxa rare regionally and less common at the historic disposal site

Major Taxon Code	Name	Family	BA-all	BRR	JB-all	SZ-all	Candidate Sites	Historic Site	Region
POL	Mediomastus ambiseta	Capitellidae	17%	100%	7%	0%	8%	60%	31%
GAS	Turbonilla interrupta	Pyramidellidae	33%	90%	13%	0%	16%	47%	32%
POL	Laonome kroeyeri	Sabellidae	22%	90%	7%	13%	14%	33%	28%
CNI	Ceriantheopsis americanus	Cerianthidae	17%	90%	7%	6%	10%	40%	27%
AMP	Ampelisca abdita	Ampeliscidae	17%	70%	0%	6%	8%	33%	22%
POL	Sternaspis scutata	Sternaspidae	33%	60%	7%	6%	16%	33%	26%
AMP	Orchomenella minuta	Lysianassidae	11%	40%	7%	31%	16%	60%	28%
POL	Galathowenia oculata	Oweniidae	28%	30%	27%	31%	29%	33%	30%
BIV	Ensis directus	Solenidae	6%	30%	7%	6%	6%	60%	20%
URO	Molgula manhattensis	Molgulidae	22%	10%	33%	31%	29%	53%	31%
ISO	Edotia montosa	Idoteidae	28%	0%	47%	38%	37%	33%	31%
POL	Aglaophamus circinata	Nephtyidae	28%	0%	27%	50%	35%	40%	31%
POL	Goniadella gracilis	Goniadidae	17%	0%	27%	38%	27%	47%	27%
POL	Scoletoma acicularum	Lumbrineridae	11%	0%	13%	31%	18%	53%	23%
POL	Brada villosa	Flabelligeridae	17%	0%	20%	19%	18%	33%	19%
AMP	Ampelisca vadorum	Ampeliscidae	6%	0%	0%	25%	10%	60%	19%
POL	Aphelochaeta sp. 2	Cirratulidae	6%	0%	0%	6%	4%	33%	9%
DEC	Axius serratus	Axiidae	0%	0%	7%	0%	2%	33%	8%
CUM	Oxyurostylis smithi	Diastylidae	0%	0%	0%	0%	0%	47%	9%

Green = 70-100%
 Yellow = 33-69%
 Light Blue = 0-32%

Table D-1. Percent occurrence of species in samples collected in Rhode Island Sound. (continued)

Taxa rare regionally and at the historic disposal site

Major Taxon Code	Name	Family	BA-all	BRR	JB-all	SZ-all	Candidate Sites	Historic Site	Region
PHO	Phoronis architecta	Phoronidae	11%	100%	7%	19%	12%	20%	26%
POL	Scolecipis bousfieldi	Spionidae	0%	90%	0%	0%	0%	13%	15%
BIV	Thyasira gouldi	Thyasiridae	22%	60%	20%	13%	18%	13%	23%
NEM	Carinomella lactea	Carinomidae	11%	60%	13%	13%	12%	20%	20%
POL	Dipolydora socialis	Spionidae	11%	60%	0%	0%	4%	20%	15%
CNI	Edwardsia elegans	Edwardsiidae	11%	60%	0%	0%	4%	0%	11%
POL	Pholoe minuta	Pholoidae	11%	50%	13%	13%	12%	20%	19%
POL	Paranaitis speciosa	Phyllodocidae	0%	40%	13%	31%	14%	13%	18%
BIV	Tellina agilis	Tellinidae	28%	40%	7%	0%	12%	20%	18%
POL	Euchone elegans	Sabellidae	28%	0%	40%	69%	45%	7%	31%
DEC	Cancer irroratus	Cancridae	39%	20%	33%	44%	39%	13%	31%
GAS	Mitrella rosacea	Columbellidae	0%	0%	53%	56%	35%	0%	23%
POL	Exogone verugera	Syllidae	6%	10%	40%	56%	33%	7%	24%
AMP	Rhepoxynius hudsoni	Phoxocephalidae	22%	0%	27%	50%	33%	20%	26%
GAS	Cylichna gouldi	Cylichnidae	33%	30%	33%	13%	27%	20%	26%
POL	Chone cf. magna	Sabellidae	28%	30%	13%	38%	27%	13%	24%
AMP	Phoxocephalus holbolli	Phoxocephalidae	11%	0%	40%	31%	27%	27%	23%
AMP	Hippomedon propinquus	Lysianassidae	33%	0%	20%	25%	27%	0%	18%
AMP	Casco bigelowi	Melitidae	6%	10%	33%	38%	24%	0%	18%
POL	Nereis procera	Nereidae	0%	0%	40%	38%	24%	13%	19%
POL	Spio limicola	Spionidae	33%	30%	13%	19%	22%	7%	20%
POL	Sphaerodoridium sp. A	Sphaerodoridae	17%	0%	27%	25%	22%	0%	15%
POL	Ampharete finmarchica	Ampharetidae	17%	10%	33%	13%	20%	20%	19%

Green = 70-100%
 Yellow = 33-69%
 Light Blue = 0-32%

Table D-1. Percent occurrence of species in samples collected in Rhode Island Sound. (continued)

Taxa Rare at all Sites

Major Taxon Code	Name	Family	BA-all	BRR	JB-all	SZ-all	Candidate Sites	Historic Site	Region
POL	Glycera robusta	Glyceridae	17%	0%	13%	31%	20%	27%	19%
NEM	Amphiporus angulatus	Amphiporidae	6%	20%	20%	25%	16%	0%	14%
ECH	Henricia sanguinolenta	Echinasteridae	11%	0%	27%	13%	16%	0%	11%
POL	Laonice sp. 1	Spionidae	28%	0%	7%	0%	12%	0%	8%
BIV	Cyclocardia borealis	Carditidae	6%	0%	13%	19%	12%	0%	8%
SIP	Phascolion strombi	Golfingiidae	0%	0%	13%	25%	12%	0%	8%
BIV	Yoldia sapotilla	Nuculanidae	22%	20%	0%	6%	10%	7%	11%
POL	Harmothoe extenuata	Polynoidae	6%	0%	13%	13%	10%	27%	12%
AMP	Unciola inermis	Corophiidae	11%	0%	7%	13%	10%	27%	12%
AMP	Hippomedon serratus	Lysianassidae	17%	0%	0%	13%	10%	13%	9%
POL	Clymenura sp. A	Maldanidae	17%	0%	0%	13%	10%	7%	8%
NEM	Zygeupolia rubens	Lineidae	11%	0%	7%	13%	10%	0%	7%
CUM	Leptostylis longimana	Diastylidae	28%	0%	0%	0%	10%	0%	7%
CUM	Diastylis cornuifer	Diastylidae	17%	20%	0%	6%	8%	0%	8%
GAS	Ilyanassa trivittata	Nassariidae	6%	10%	13%	6%	8%	13%	9%
POL	Goniada sp. 1	Goniadidae	0%	10%	13%	13%	8%	0%	7%
POL	Sthenelais limicola	Sigalionidae	6%	0%	7%	13%	8%	27%	11%
POL	Lumbrinerides acuta	Lumbrineridae	11%	0%	0%	13%	8%	20%	9%
TAN	Tanaissus psammophilus	Nototanaiidae	11%	0%	0%	13%	8%	13%	8%
POL	Parapionosyllis longicirrata	Syllidae	11%	0%	0%	13%	8%	7%	7%
GAS	Retusa obtusa	Retusidae	11%	0%	0%	13%	8%	7%	7%
AMP	Ameroculodes sp. 1	Oedicerotidae	6%	0%	13%	6%	8%	7%	7%
BIV	Astarte castanea	Astartidae	11%	0%	7%	6%	8%	0%	5%
POL	Trochochaeta multisetosa	Trochochaetidae	11%	20%	0%	6%	6%	0%	7%
AMP	Argissa hamatipes	Argissidae	6%	10%	7%	6%	6%	7%	7%
BIV	Lyonsia arenosa	Lyonsiidae	11%	0%	7%	0%	6%	13%	7%
POL	Aberranta enigmatica	Aberrantidae	0%	0%	7%	13%	6%	0%	4%

Major Taxon Code	Name	Family	BA-all	BRR	JB-all	SZ-all	Candidate Sites	Historic Site	Region
POL	Phyllodoce maculata	Phyllodocidae	6%	0%	7%	6%	6%	0%	4%
POL	Phyllodoce pettiboneae	Phyllodocidae	0%	0%	7%	13%	6%	0%	4%
POL	Syllides convoluta	Syllidae	6%	0%	7%	6%	6%	0%	4%
GAS	Margarites costalis	Trochidae	6%	0%	7%	6%	6%	0%	4%
CUM	Petalosarsia declivis	Pseudocumidae	0%	0%	0%	19%	6%	0%	4%
ISO	Politolana polita	Cirolanidae	0%	0%	7%	13%	6%	0%	4%
POL	Aphelochaeta sp. 1	Cirratulidae	0%	10%	13%	0%	4%	20%	8%
POL	Spio filicornis	Spionidae	0%	0%	7%	6%	4%	27%	8%
ISO	Chiridotea tuftsi	Chaetiliidae	6%	0%	0%	6%	4%	13%	5%
POL	Pisione remota	Pisionidae	0%	0%	7%	6%	4%	7%	4%
POL	Sphaerosyllis brevifrons	Syllidae	6%	0%	0%	6%	4%	7%	4%
POL	Paradoneis lyra	Paraonidae	0%	0%	0%	13%	4%	7%	4%
HEM	Stereobalanus canadensis	Harrimaniidae	6%	0%	7%	0%	4%	7%	4%
POL	Gattyana amondseni	Polynoidae	0%	0%	13%	0%	4%	0%	3%
POL	Eteone foliosa	Phyllodocidae	6%	0%	7%	0%	4%	0%	3%
POL	Glycera dibranchiata	Glyceridae	6%	0%	0%	6%	4%	0%	3%
POL	Eunicidae sp.	Eunicidae	6%	0%	0%	6%	4%	0%	3%
POL	Paraonis pygoenigmatica	Paraonidae	6%	0%	0%	6%	4%	0%	3%
POL	Aricidea wassi	Paraonidae	6%	0%	0%	6%	4%	0%	3%
POL	Laonice cirrata	Spionidae	6%	0%	0%	6%	4%	0%	3%
POL	Caulleriella sp. B	Cirratulidae	11%	0%	0%	0%	4%	0%	3%
POL	Capitella jonesi	Capitellidae	11%	0%	0%	0%	4%	0%	3%
POL	Mediomastus californiensis	Capitellidae	6%	0%	7%	0%	4%	0%	3%
GAS	Colus pygmaeus	Buccinidae	6%	0%	7%	0%	4%	0%	3%
BIV	Yoldia limatula	Nuculanidae	6%	0%	0%	6%	4%	0%	3%
BIV	Pandora spp.	Pandoridae	0%	0%	7%	6%	4%	0%	3%
AMP	Melitidae sp. 1	Melitidae	0%	0%	0%	13%	4%	0%	3%
AMP	Stenopleustes inermis	Pleustidae	0%	10%	0%	6%	2%	20%	7%
NEM	Cerebratulus lacteus	Lineidae	0%	10%	0%	6%	2%	13%	5%
POL	Euclymene collaris	Maldanidae	6%	10%	0%	0%	2%	13%	5%
POL	Hartmania moorei	Polynoidae	0%	10%	0%	6%	2%	0%	3%

Major Taxon Code	Name	Family	BA-all	BRR	JB-all	SZ-all	Candidate Sites	Historic Site	Region
NEM	Tetrastemma vittatum	Tetrastemmatidae	0%	0%	0%	6%	2%	7%	3%
NEM	Cephalothricidae sp. 1	Cephalothricidae	0%	0%	0%	6%	2%	0%	1%
POL	Aphrodita spp.	Aphroditidae	0%	0%	7%	0%	2%	0%	1%
POL	Exogone longicirris	Syllidae	0%	0%	0%	6%	2%	0%	1%
POL	Nephtys caeca	Nephtyidae	6%	0%	0%	0%	2%	0%	1%
POL	Drilonereis magna	Arabellidae	0%	0%	7%	0%	2%	0%	1%
POL	Scoloplos armiger	Orbiniidae	6%	0%	0%	0%	2%	0%	1%
POL	Leitoscoloplos robustus	Orbiniidae	0%	0%	0%	6%	2%	0%	1%
POL	Leitoscoloplos acutus	Orbiniidae	6%	0%	0%	0%	2%	0%	1%
POL	Aricidea minuta	Paraonidae	6%	0%	0%	0%	2%	0%	1%
POL	Aricidea cerrutti	Paraonidae	0%	0%	0%	6%	2%	0%	1%
POL	Aricidea sp. 1	Paraonidae	6%	0%	0%	0%	2%	0%	1%
POL	Dipolydora caulleryi	Spionidae	0%	0%	7%	0%	2%	0%	1%
POL	Spio setosa	Spionidae	0%	0%	0%	6%	2%	0%	1%
POL	Streblospio benedicti	Spionidae	0%	0%	7%	0%	2%	0%	1%
POL	Aphelochaeta marioni	Cirratulidae	6%	0%	0%	0%	2%	0%	1%
POL	Travisia carnea	Ophellidae	0%	0%	0%	6%	2%	0%	1%
POL	Chone infundibuliformis	Sabellidae	0%	0%	7%	0%	2%	0%	1%
POL	Pseudopototamilla reniformis	Sabellidae	0%	0%	7%	0%	2%	0%	1%
GAS	Alvania castanea	Rissoidae	0%	0%	7%	0%	2%	0%	1%
GAS	Euspira immaculata	Naticidae	0%	0%	0%	6%	2%	0%	1%
GAS	Odostomia engonia	Pyramidellidae	0%	0%	0%	6%	2%	0%	1%
BIV	Nuculoma tenuis	Nuculidae	6%	0%	0%	0%	2%	0%	1%
CEP	Hutchinsoniella macracantha	Hutchinsoniellidae	6%	0%	0%	0%	2%	0%	1%
CUM	Campylaspis rubicunda	Nannastacidae	6%	0%	0%	0%	2%	0%	1%
AMP	Ampelisca macrocephala	Ampeliscidae	0%	0%	0%	6%	2%	0%	1%
AMP	Megamoera dentata	Melitididae	0%	0%	7%	0%	2%	0%	1%
AMP	Anonyx sarsi	Lysianassidae	0%	0%	7%	0%	2%	0%	1%

Major Taxon Code	Name	Family	BA-all	BRR	JB-all	SZ-all	Candidate Sites	Historic Site	Region
AMP	Aeginina longicornis	Caprellidae	0%	0%	7%	0%	2%	0%	1%
DEC	Cancer borealis	Cancridae	6%	0%	0%	0%	2%	0%	1%
POL	Pectinaria gouldi	Pectinariidae	0%	30%	0%	0%	0%	13%	7%
ECH	Cucumaria frondosa	Cucumariidae	0%	30%	0%	0%	0%	7%	5%
POL	Chaetozone spp.	Cirratulidae	0%	20%	0%	0%	0%	7%	4%
POL	Flabelligera affinis	Flabelligeridae	0%	20%	0%	0%	0%	7%	4%
AMP	Photis dentata	Isaeidae	0%	20%	0%	0%	0%	7%	4%
POL	Sigambra tentaculata	Pilargiidae	0%	20%	0%	0%	0%	0%	3%
POL	Dipolydora commensalis	Spionidae	0%	20%	0%	0%	0%	0%	3%
AMP	Dyopedos monacanthus	Podoceridae	0%	20%	0%	0%	0%	0%	3%
POL	Carazziella hobsonae	Spionidae	0%	10%	0%	0%	0%	20%	5%
GAS	Astyris lunata	Columbellidae	0%	10%	0%	0%	0%	13%	4%
FLA	Turbellaria spp.	Turbellaria spp.	0%	10%	0%	0%	0%	0%	1%
POL	Sabaco elongatus	Maldanidae	0%	10%	0%	0%	0%	0%	1%
GAS	Acteocina oryza	Acteocinidae	0%	10%	0%	0%	0%	0%	1%
POL	Hesperonoe sp. 1	Polynoidae	0%	0%	0%	0%	0%	13%	3%
BIV	Aligena elevata	Keliidae	0%	0%	0%	0%	0%	13%	3%
CUM	Pseudoleptocuma minor	Bodotriidae	0%	0%	0%	0%	0%	7%	1%
GAS	Rictaxis punctostriatus	Acteonidae	0%	0%	0%	0%	0%	0%	0%

Green = 70-100%
Yellow = 33-69%
Light Blue = 0-32%

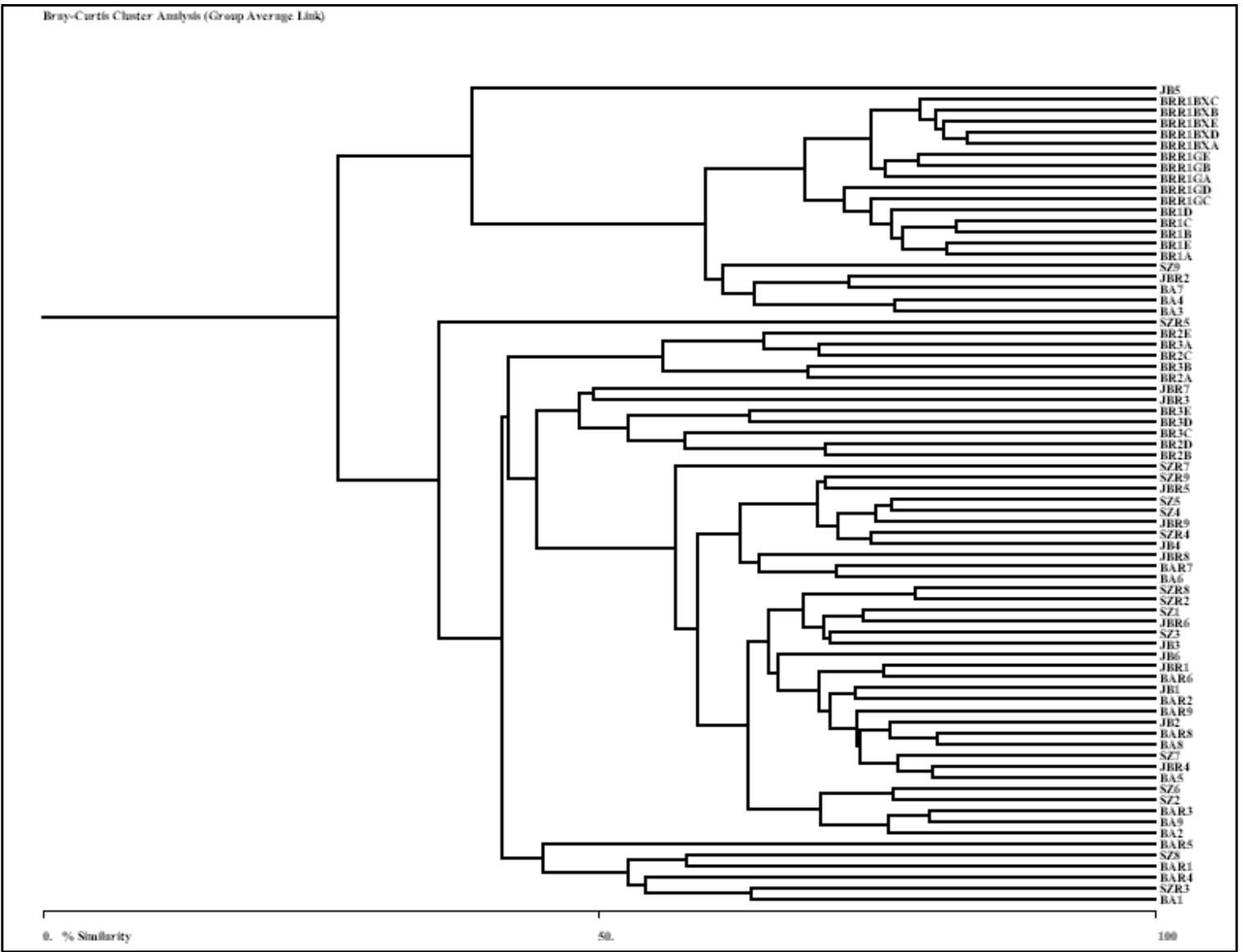


Figure D-1. Dendrogram resulting from Bray-Curtis analysis of all samples collected from the Rhode Island Sound sites.

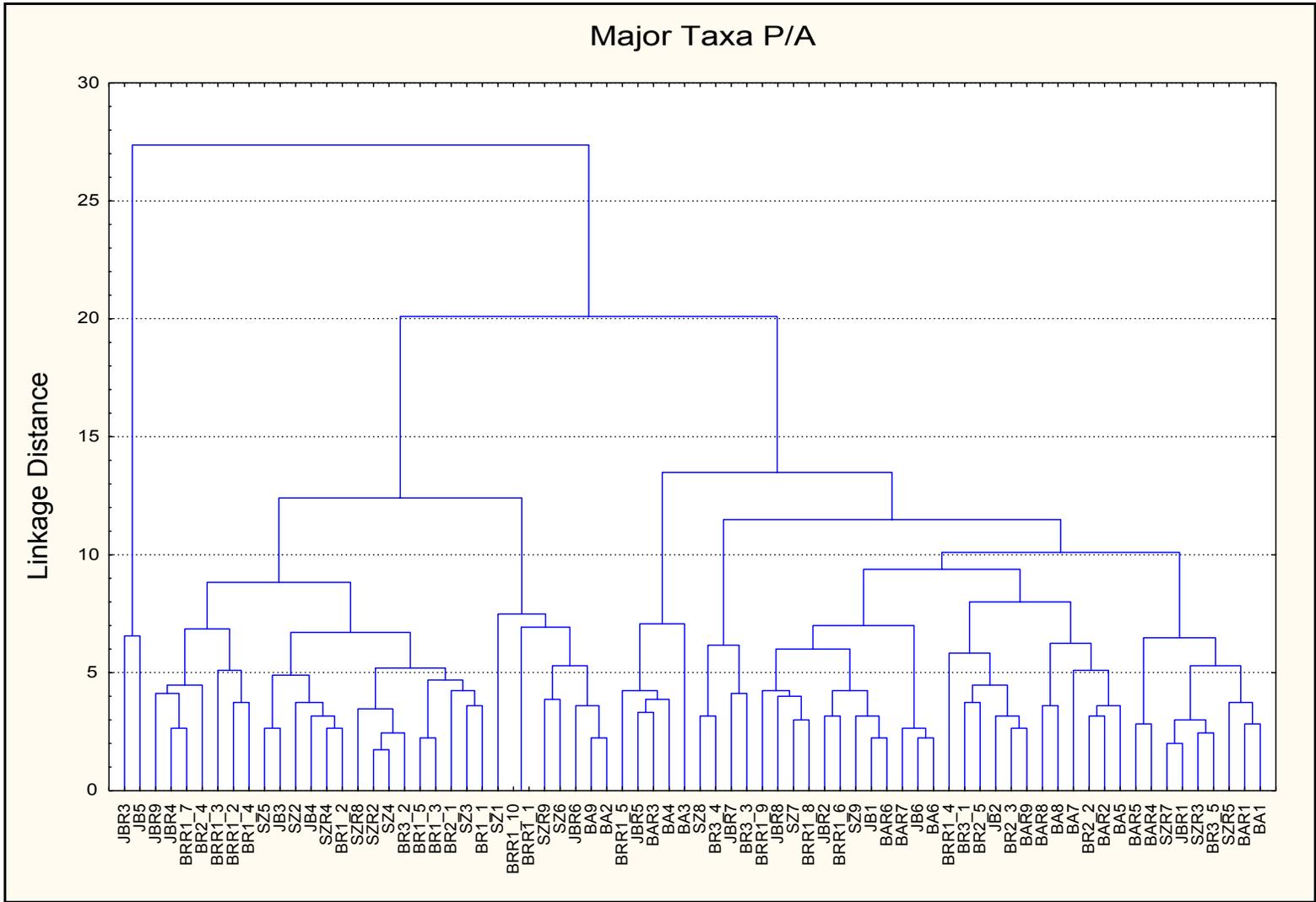


Figure D-2. Dendrogram resulting from classification analysis of presence/absence data from all Rhode Island Sound sites.

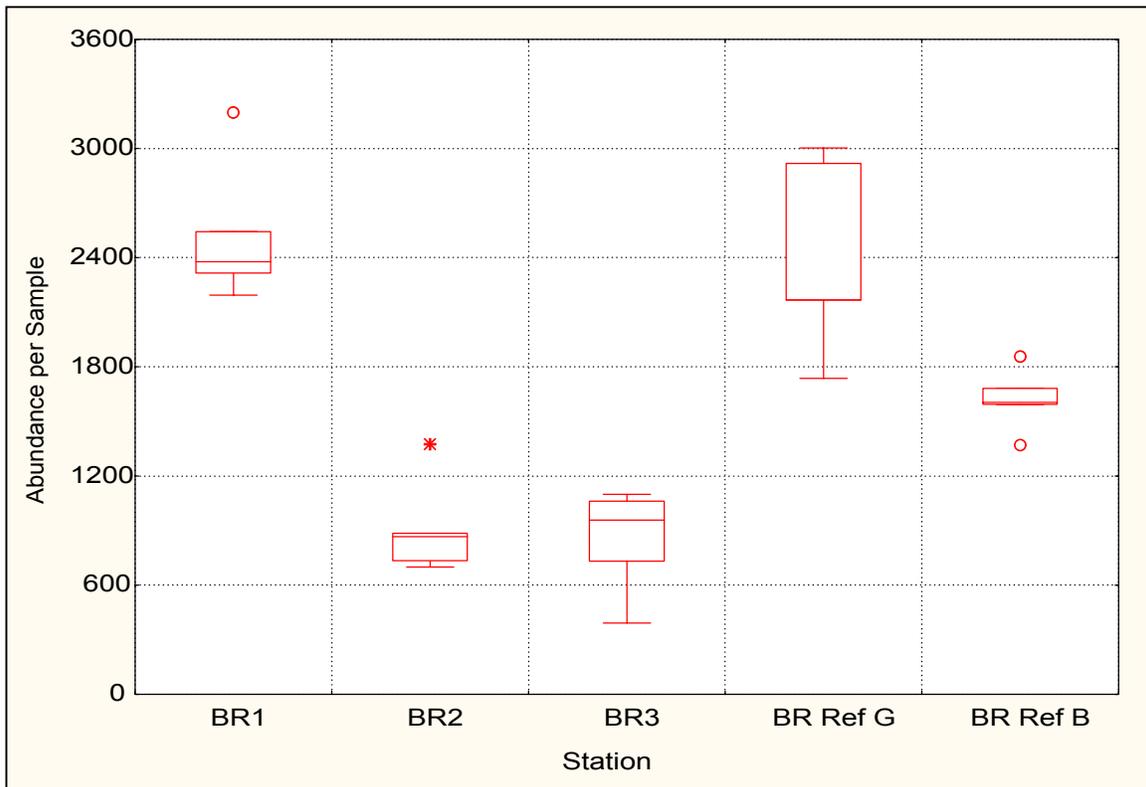


Figure D-3. Boxplots of total infaunal abundance at Site 16 (Brenton Reef) stations. BR Ref G denotes the grab samples collected at station BRR1; BR Ref B denotes the samples collected with the box corer at station BRR1.

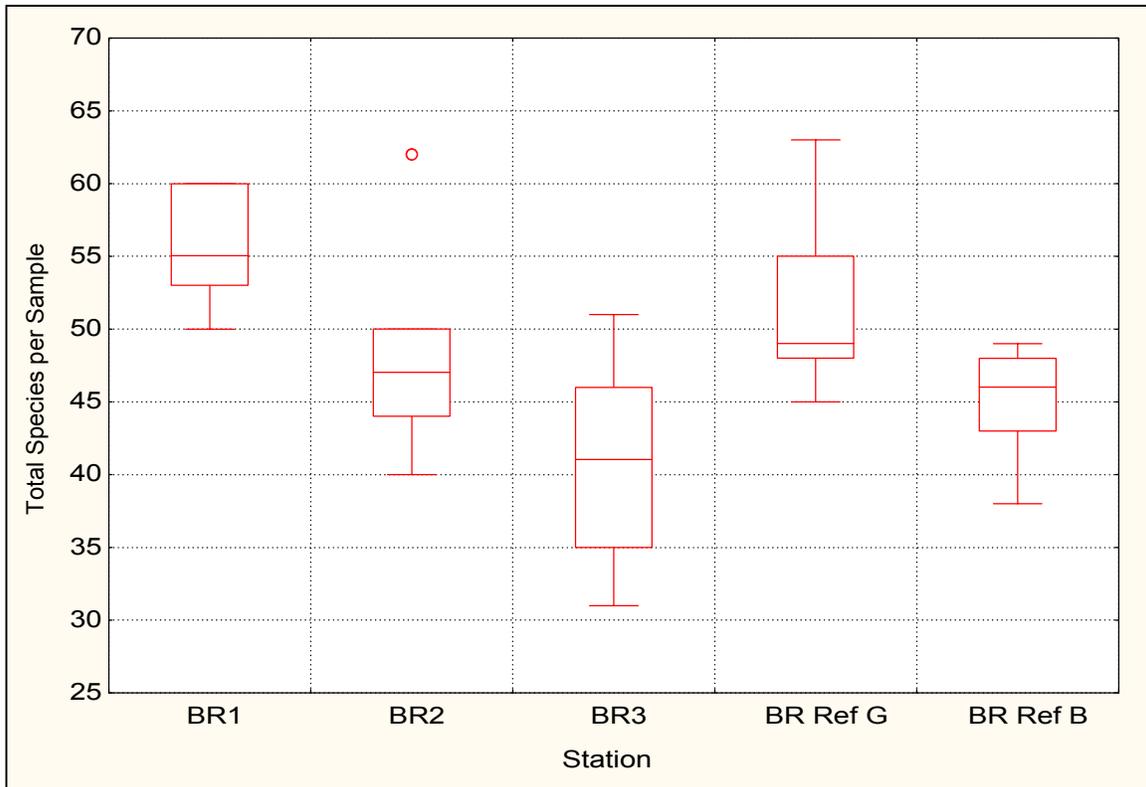


Figure D-4. Boxplots of total numbers of infaunal species at Site 16 (Brenton Reef) stations. BR Ref G denotes the grab samples collected at station BRR1; BR Ref B denotes the samples collected with the box corer at station BRR1.

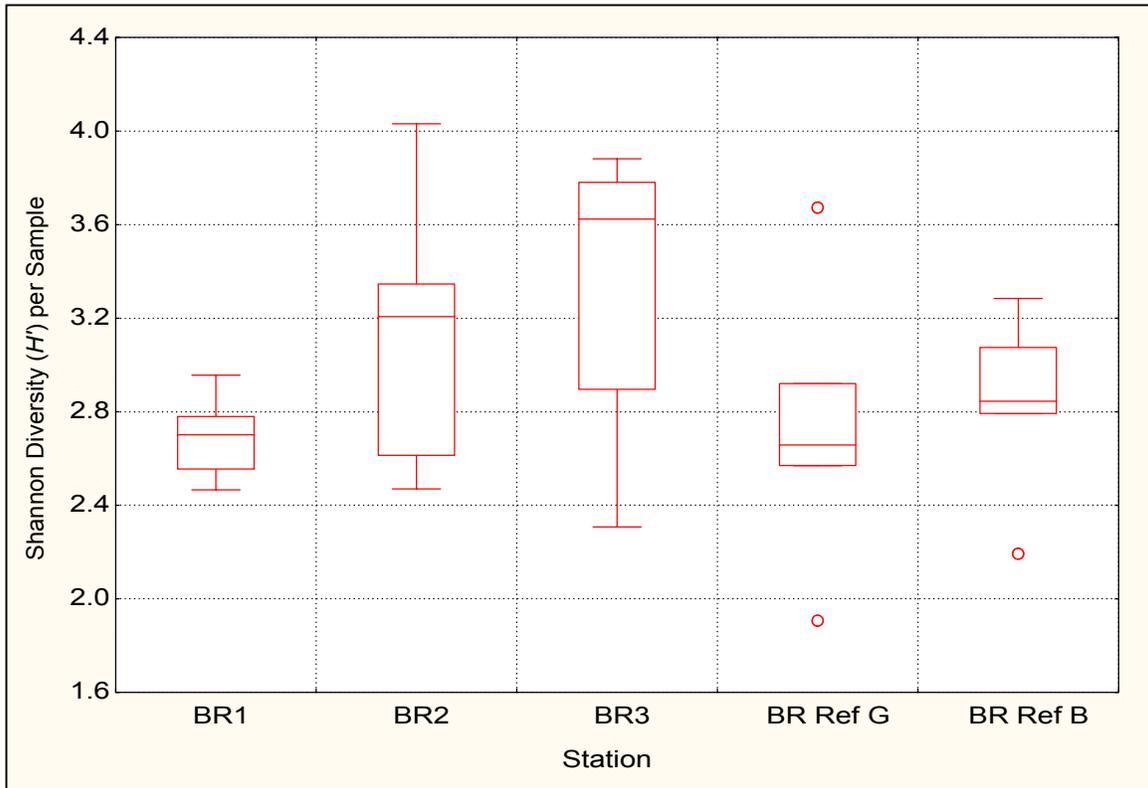


Figure D-5. Boxplots of Shannon diversity (H') at Site 16 (Brenton Reef) stations. BR Ref G denotes the grab samples collected at station BRR1; BR Ref B denotes the samples collected with the box corer at station BRR1.

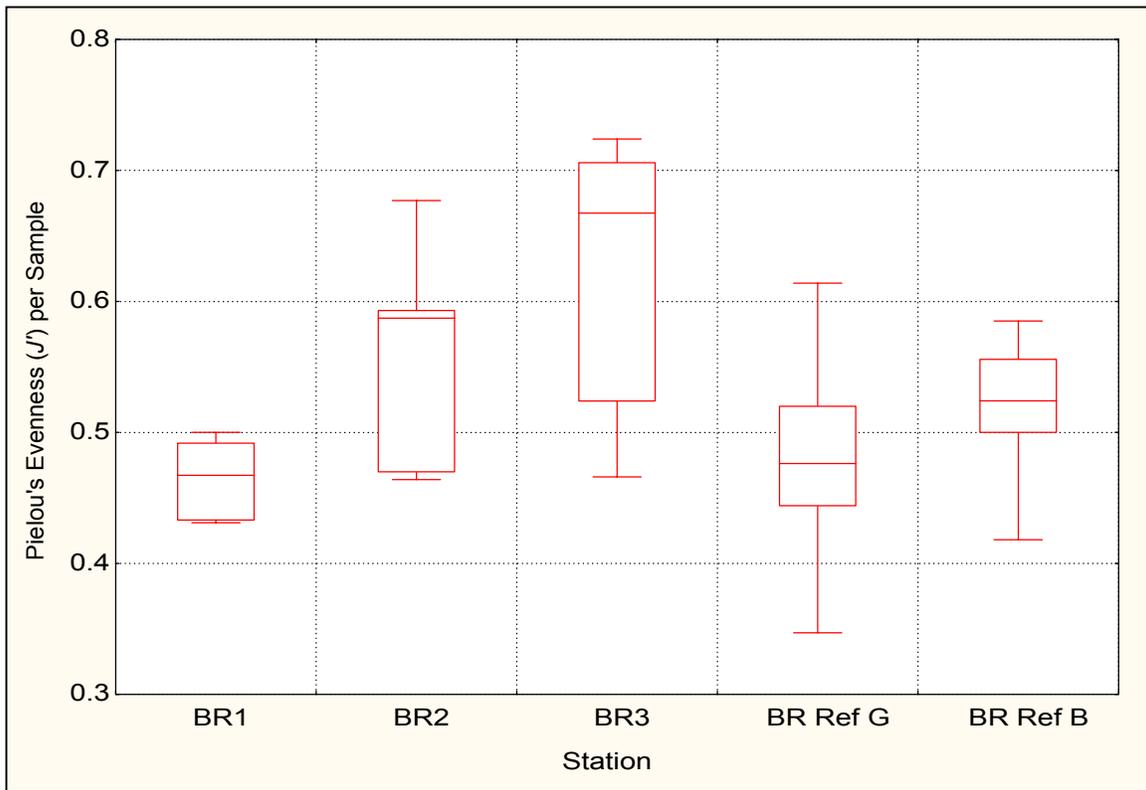


Figure D-6. Boxplots of Pielou's evenness (J') at Site 16 (Brenton Reef) stations. BR Ref G denotes the grab samples collected at station BRR1; BR Ref B denotes the samples collected with the box corer at station BRR1.

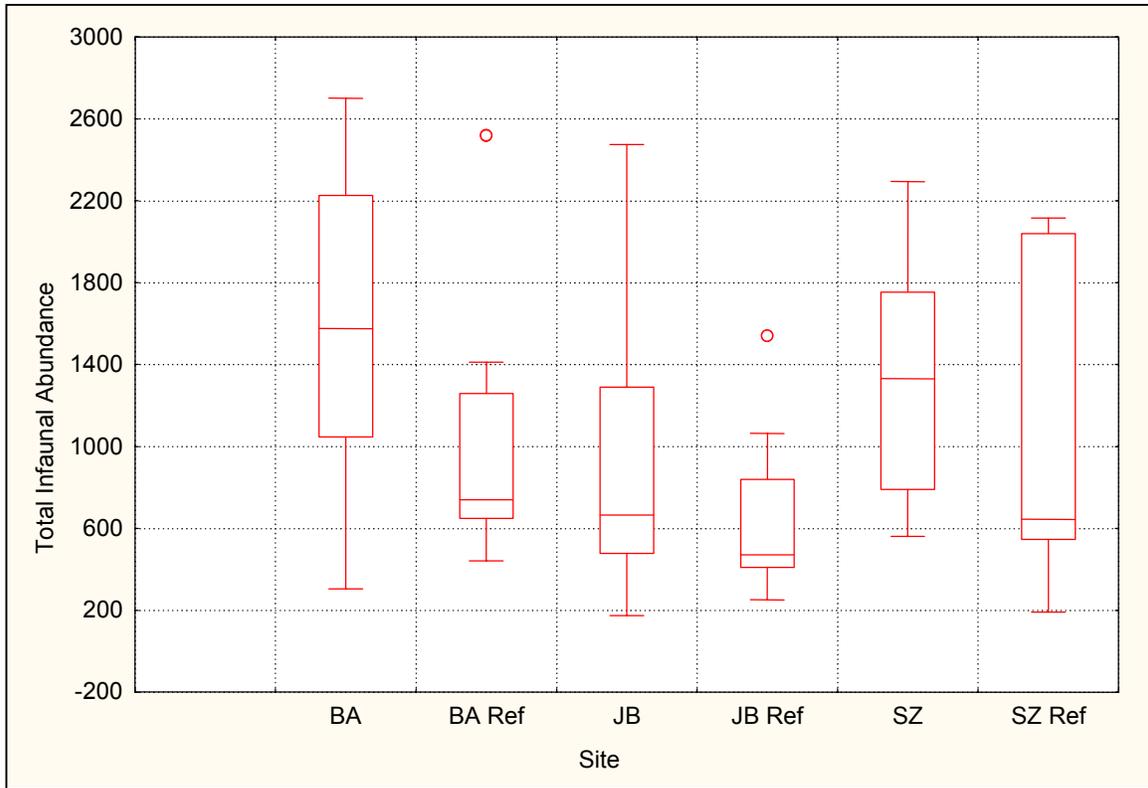


Figure D-7. Boxplots of total infaunal abundance at Sites 18 (BA), 69A (JB), and 69B (SZ).

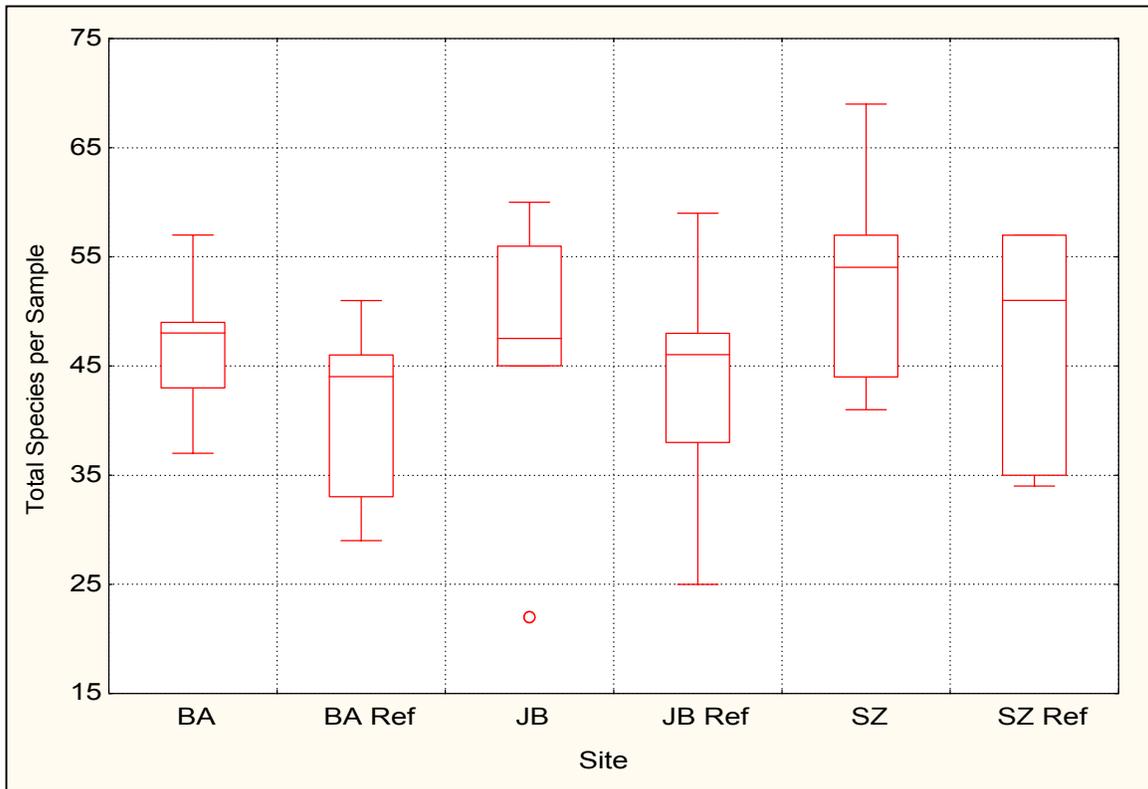


Figure D-8. Boxplots of total infaunal species at Sites 18 (BA), 69A (JB) and 69B (SZ).

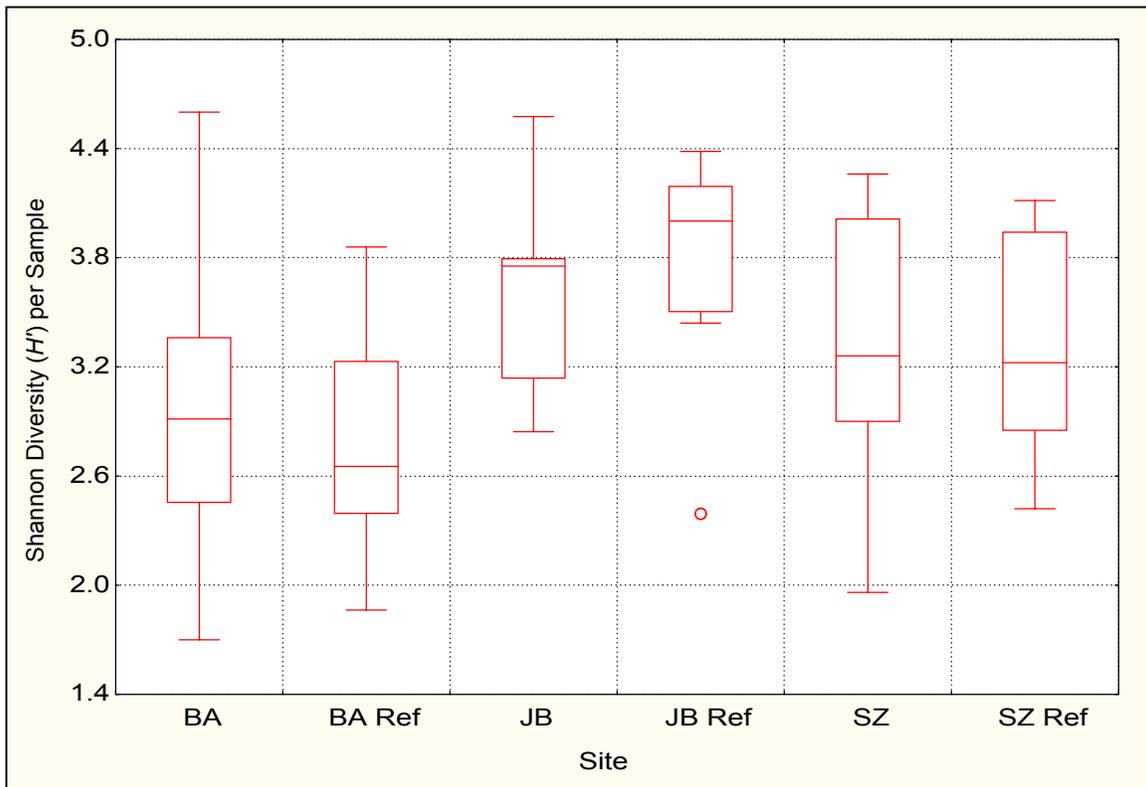


Figure D-9. Boxplots of Shannon diversity (H') at Sites 18 (BA), 69A (JB), and 69B (SZ).

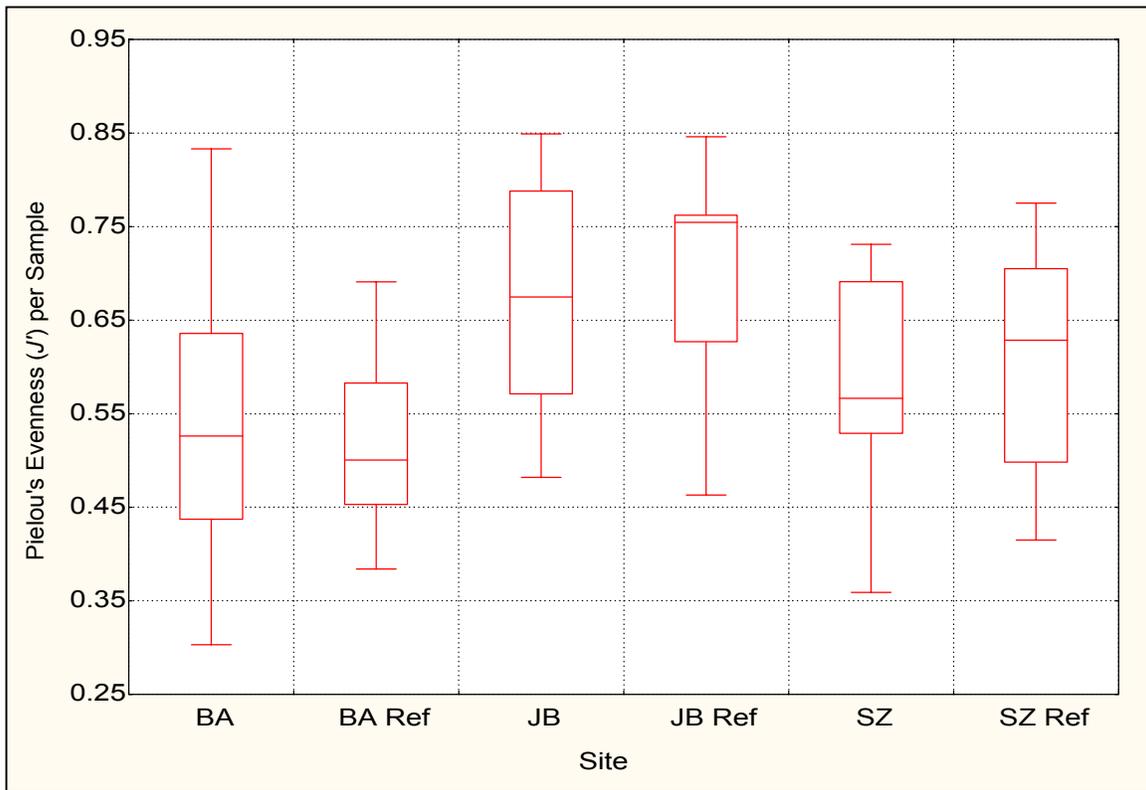


Figure D-10. Boxplots of Pielou's evenness (J') at Sites 18 (BA), 69A (JB), and 69B (SZ).