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Final Report

BENTHIC INFAUNA DATA REPORT FOR AREA E AND AREA W, JULY 2003

RHODE ISLAND REGION LONG-TERM DREDGED MATERIAL DISPOSAL SITE EVALUATION PROJECT

FINAL

Benthic Infauna Data for Area E and Area W, July 2003

Rhode Island Region
Long-Term Dredged Material Disposal Site Evaluation Project

Contract Number DACW33-01-D-0004
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to

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1.0 INTRODUCTION

In response to requests from former Governor Almond and Senator Reed, the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (Corps) initiated an evaluation project to determine the feasibility of designation of a long-term disposal site in the Rhode Island Region (RIR) and adjacent waters under section 102(c) of the MPRSA in a forthcoming EIS. The EIS will evaluate other possible alternatives including other open water disposal sites, other disposal and management options, and the no action alternative.

A survey was completed in July 2003 to obtain sediment samples for infaunal community analysis to enable the characterization of two areas within the RIR (Alternative Area E and Alternative Area W) (Figure 1) in which future dredged material disposal sites are being considered. This survey also provided sediment physical and chemical data that will be used to evaluate and compare the two potential locations.

During the processing of the infaunal samples and the related data analysis, the location of two alternative disposal sites (Site E and Site W) (Figure 2 and Figure 3) were identified within the alternative areas. The benthic infauna community data presented in this report are discussed by site and the surrounding area.

2.0 MATERIALS AND METHODS

2.1 Field Methods

The benthic infauna survey was conducted July 29–30, 2003. Eighteen and 10 stations were sampled in Area E and Area W, respectively (Figure 2 and Figure 3). Details of the survey are discussed in a survey report prepared for the program (Battelle, 2003).

At each of the 28 grab sample stations, one sediment sample was collected for biological (infauna) analysis and one sediment sample was collected for chemical (grain size, total organic carbon, PAH, and metals contaminant) analysis. Stations were selected from the list of SPI stations, based on the video analysis described in Battelle (2003). All samples were collected with a Kynar-coated 0.04 m^2 Young-modified Van Veen grab sampler. Several visual measurements for all grabs, including apparent RPD, penetration depth, and sediment type, were recorded in the field log.

Grain Size/Total Organic Carbon (TOC): After the sample was deemed acceptable and the appropriate measurements were collected, subsamples for grain size and TOC were taken. Portions of the top two centimeters of sediment were removed with a Kynar-coated scoop and homogenized in a clean, glass bowl. In between stations, the grab sampler and all associated homogenizing equipment was washed with soapy water and rinsed with acetone and dichloromethane (DCM). The TOC/grain size samples were placed in 16 ounce glass jars and kept cold. Samples were sent to Applied Marine Sciences, League City, Texas for analyses.

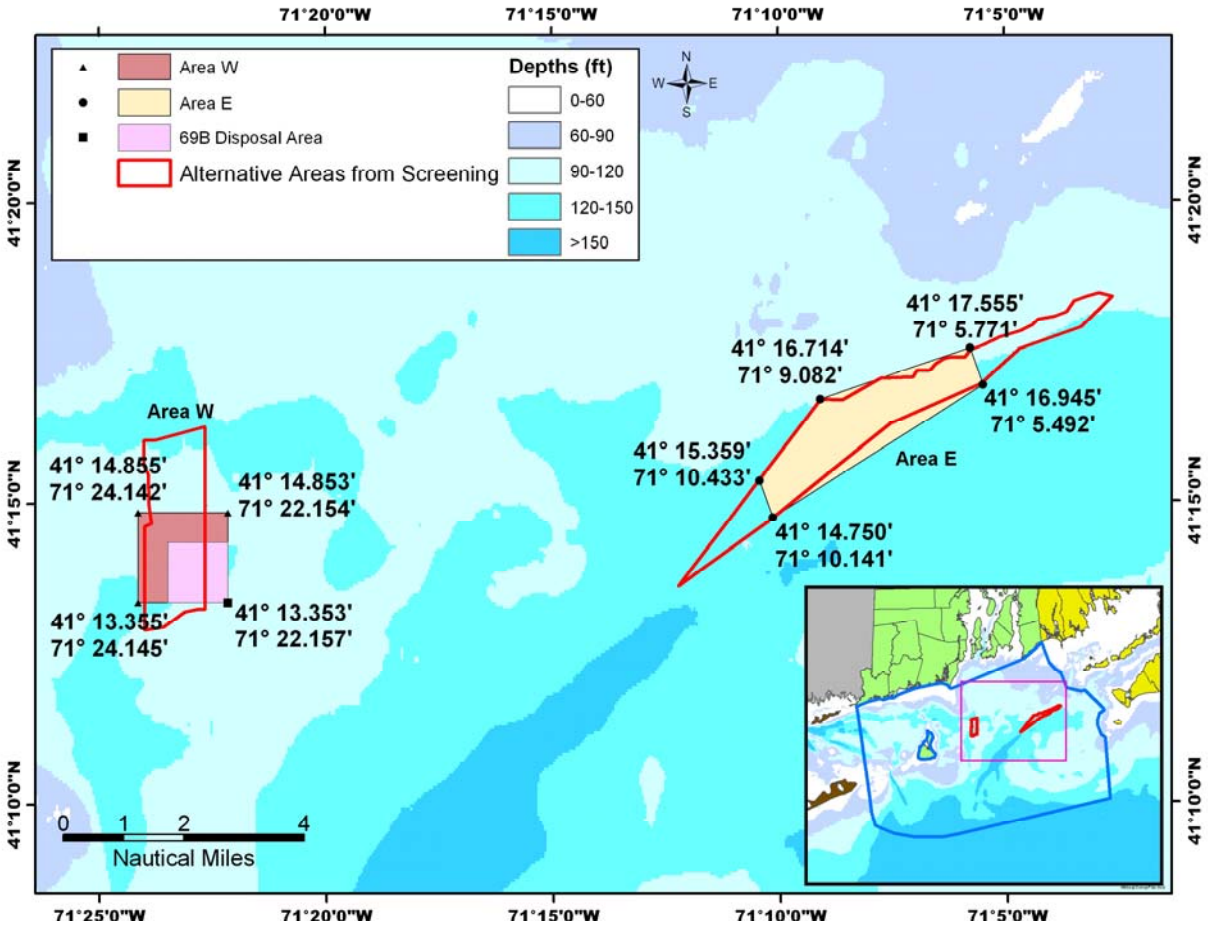

Figure 1. Location of Alternate Areas E and W in Rhode Island Sound.

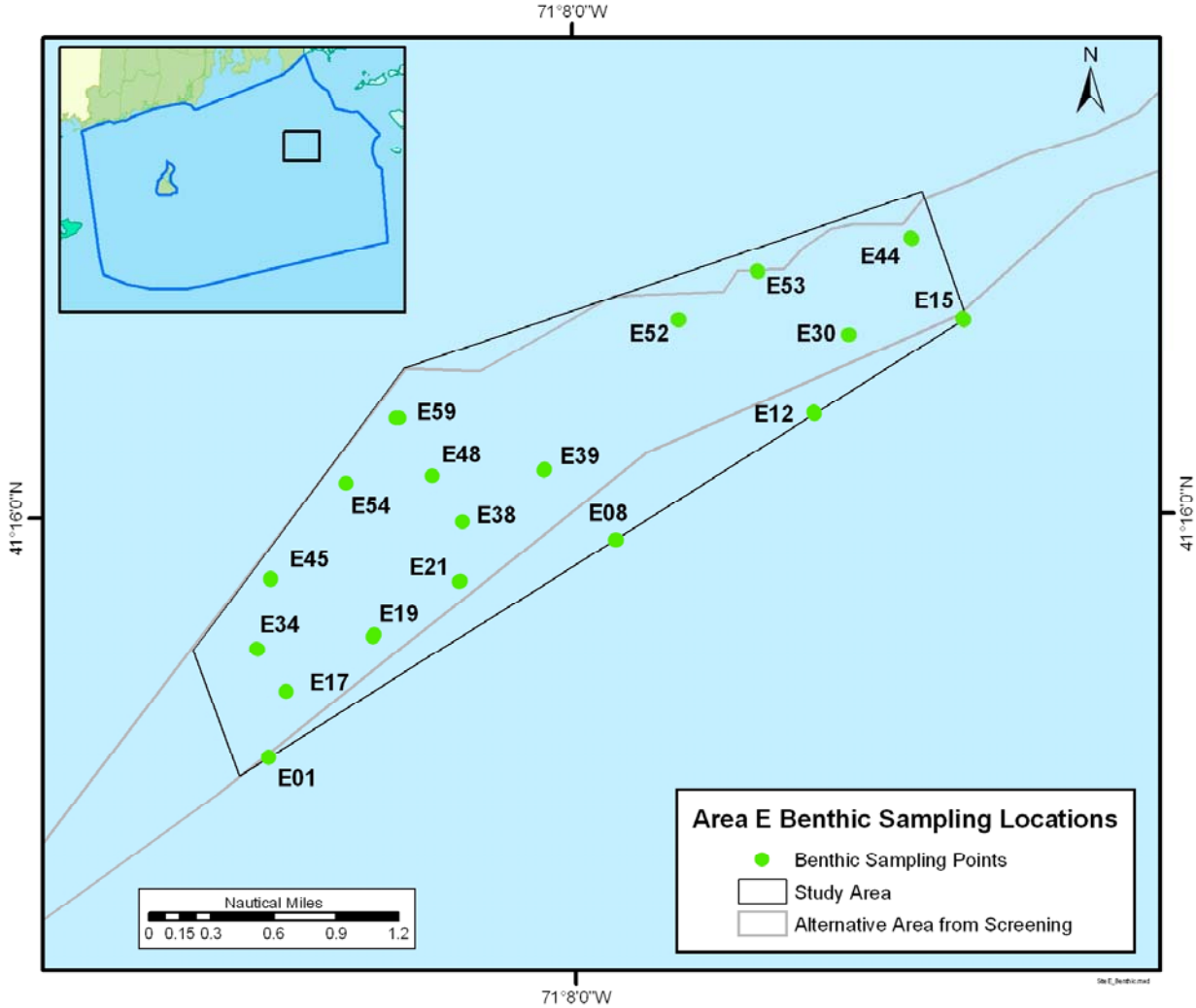

Figure 2. Benthic Sediment Stations from Rhode Island Sound, Area E, July 2003.

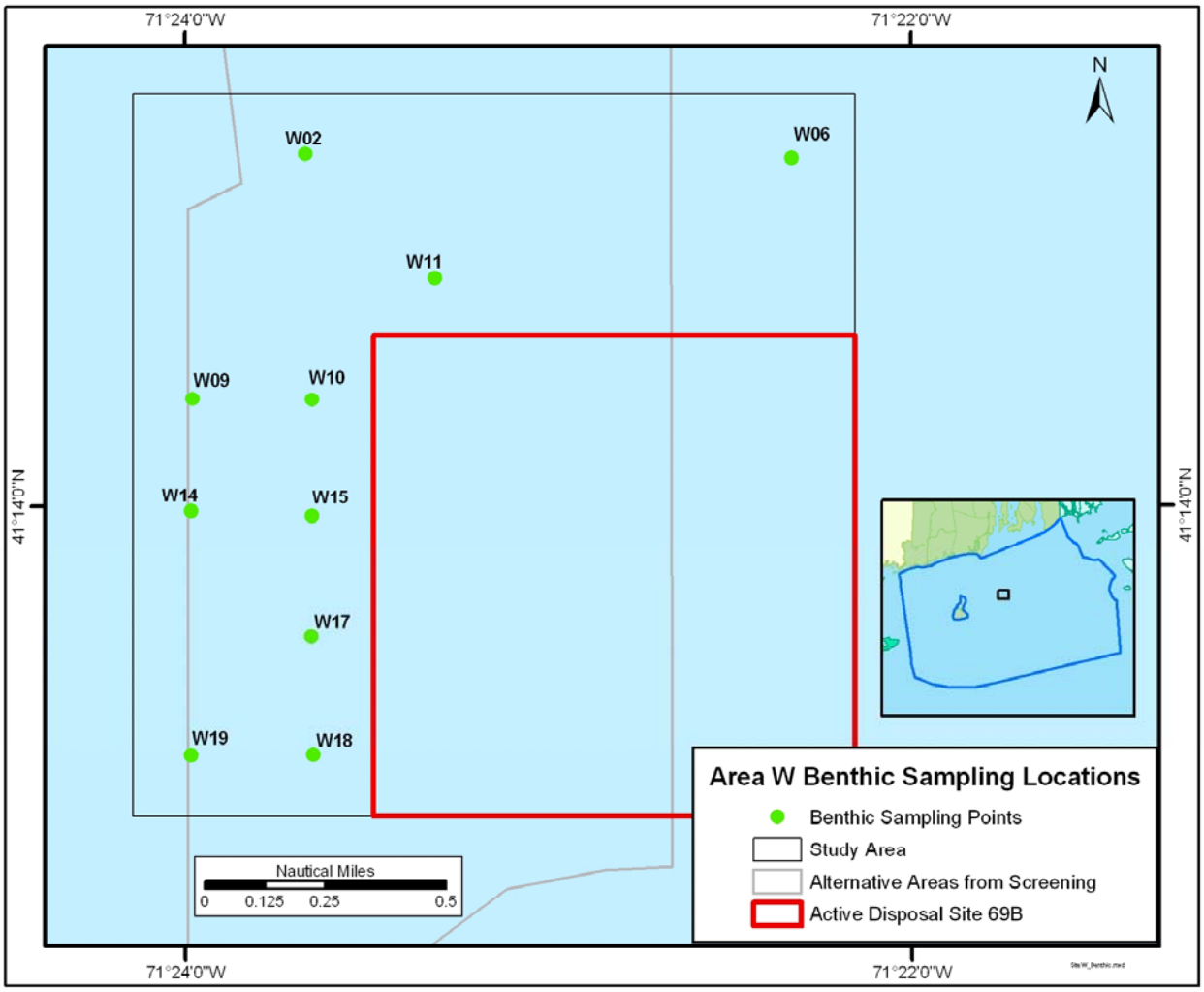

Figure 3. Benthic Sediment Stations from Rhode Island Sound, Area W, July 2003.

Infauna: After the sample was determined to be acceptable (the surface is undisturbed, the jaws are fully closed, the grab at least half full but not over-penetrated) and the visual measurements recorded, the entire sample was washed from the sampler into a plastic bucket positioned beneath the grab. At an on-board sieve table, the sediment was rinsed from the bucket through a 0.5-mm-mesh sieve. The sample retained on the screen was transferred to a labeled jar and fixed in 10% formalin. In addition, one teaspoon of borax was added to each sample to buffer the formalin. Jars were sent to the sorting laboratory, Cove Corporation, Lusby, Maryland for processing.

2.2 Laboratory Methods

Grain size/total organic carbon (TOC): TOC and grain-size analyses were performed by Applied Marine Sciences according to protocols described in the project QAPP (Battelle, 2001). Grain size was reported as percent gravel, sand, silt, and clay. TOC was reported as percent dry weight.

Infauna: Samples were processed by Cove Corporation in accordance with protocols described in the project QAPP (Battelle, 2001). Briefly, 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. Species identities and counts were entered into excel spreadsheets for analyses.

2.3 Data Analyses

Grain size/total organic carbon (TOC): Grain size and TOC data were summarized in tabular form. *R*-mode cluster analyses was performed on arc-sin-transformed data 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). 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 perform the cluster 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, *Lyonsia hyalina* (a small clam) was the only species of the genus found, so that any clams identified only to the genus *Lyonsia* spp. were treated as if they were *L. hyalina*. 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.

The diversity indices used in this evaluation are described in detail by Magurran (1988). BioDiversity Professional, Version 2 was used to perform calculations of total species, log-series alpha, Shannon's Diversity Index (H'), and Pielou's Evenness (J'); and the cluster analyses. Shannon's H' was calculated using $\log_2$. *R*-mode cluster analyses (Boesch, 1977) of the infaunal abundance data was performed using data or taxa identified to species level only. Data were log transformed prior to the analyses. Bray-Curtis similarity (Bray and Curtis, 1957) was used as the clustering algorithm and cluster groups were generated by using group average sorting.

3.0 RESULTS AND DISCUSSION

3.1 Area E

3.1.1 Grain Size/Total Organic Carbon

Sediment grain size varied considerably within Area E. Sediments at most stations were relatively coarse, as only six stations had a fine sediment fraction (silt + clay) greater than 20% (Table 1). Within Site E, sediments were primarily sandy (mean % sand = 90.1), although sediments from station E54 were only 79% sand (fines = 21%). The percent sand fraction of sediments collected outside the Site E boundaries were less sandy (77%), but generally contained a higher proportion of gravel (10%).

Table 1. Sediment Grain Size and TOC Content From Samples Collected in Rhode Island Sound, Area E, July 2003.

Station	Gravel %	Sand %	Silt %	Clay %	Fines [1] %	TOC %
In-site Stations						
E17	1.1	89.5	3.0	6.4	9.4	0.22
E19	0.0	98.0	0.8	1.2	2.0	0.07
E34	0.0	97.1	0.9	2.1	2.9	0.15
E45	7.2	86.7	0.7	5.5	6.1	0.26
E54	0.3	79.1	10.4	10.3	20.6	0.38
Mean	1.7	90.1	3.1	5.1	8.2	0.22
sd	3.1	7.8	4.2	3.6	7.5	0.12
Reference Stations						
E01	0.6	97.6	1.4	0.5	1.8	0.08
E08	0.0	75.2	11.8	13.0	24.8	0.47
E12	0.0	62.6	21.5	16.0	37.5	0.58
E15	4.5	73.8	10.4	11.3	21.7	0.45
E21	0.0	97.4	1.6	1.0	2.6	0.10
E30	0.0	73.6	14.4	12.0	26.4	0.55
E38	13.8	81.2	2.0	3.0	5.0	0.20
E39	0.3	77.0	10.8	12.0	22.8	0.46
E44	2.5	84.5	4.8	8.3	13.1	0.38
E48	16.0	74.9	2.6	6.5	9.1	0.29
E52	24.2	73.3	0.1	2.5	2.6	0.21
E53	61.9	35.4	0.2	2.5	2.7	0.51
E59	4.6	92.2	0.6	2.7	3.3	0.16
Mean	9.9	76.8	6.3	7.0	13.3	0.34
sd	17.4	16.1	6.8	5.3	11.9	0.18

[1] Fines = silt + clay
sd = standard deviation

The TOC content of sediments among stations within Area E was very low, ranging from 0.07% to 0.58%. Mean TOC content among the five stations located within the boundaries of Site E was 0.22% (standard deviation = 0.12%).

Cluster analyses of the combined grain size and TOC data resulted in two primary groups of stations and one outlier station (Figure 4). Sediment at the outlier station, station E53, was comprised of 62% gravel. The cluster groups defined by the analysis were organized primarily by differences in grain size, not TOC. Group A consisted of the six stations, stations E12–E54 in Figure 4, having sediments containing >20% fines. These stations were located along the southeastern boundary of Area E and included station E54 from the northeast corner of Site E (Figure 2). Group B consisted primarily of stations with high sand and/or high gravel content. The high gravel stations (E38, E48, E52, E53) were located in a band reaching from the central part to the northeastern boundary of Area E. Four stations having >97% sand clustered together. These were found in the southwestern portion of Area E with two of the stations (E19, E34) being located within Site E. The final cluster was comprised of sandy (85–92% sand) stations scattered throughout Area E.

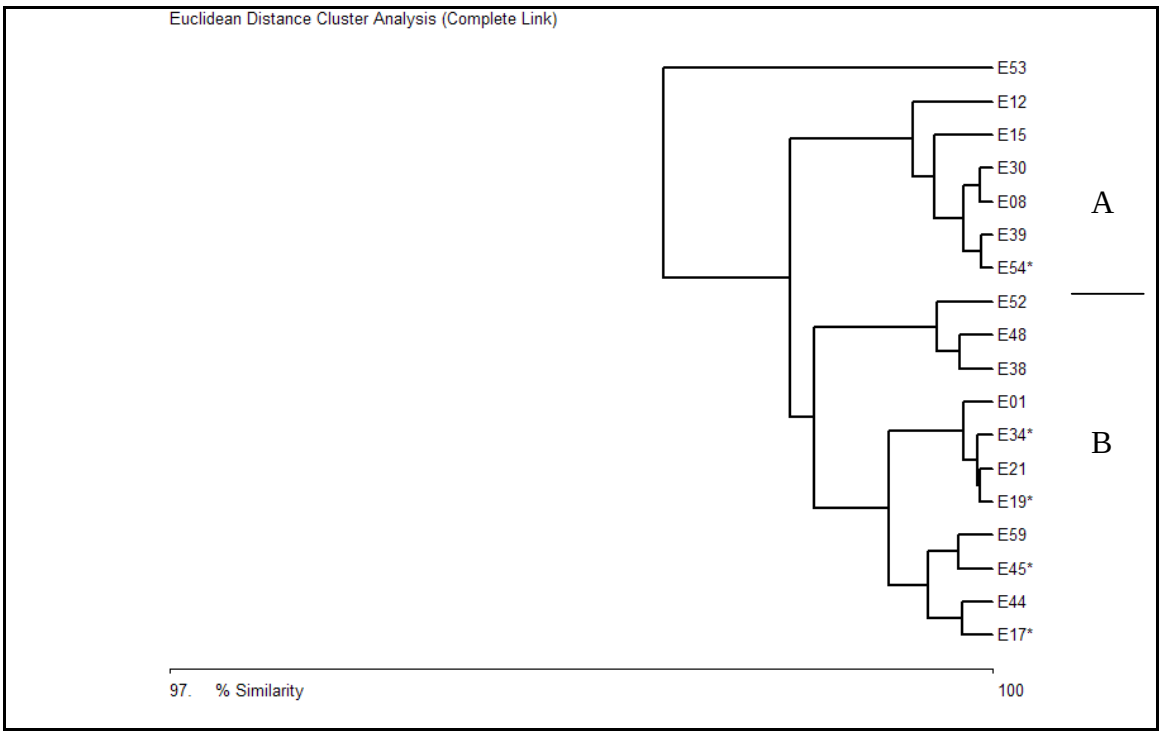

Figure 4. Dendogram Resulting from Euclidean Distance Analysis of Grain Size and TOC Samples Collected from Rhode Island Sound, Area E, July 2003.

3.1.2 Infauna

Among the 18 samples collected from Area E and analyzed for infauna, 178 species-level taxa were identified. Infaunal abundance varied widely (Table 2), ranging from 510 individuals per sample (~12,750/m^2; station E48) to 3,084 individuals per sample (~77,100/m^2; station E54). Species numbers ranged from 40 per sample (station E01) to 75 per sample (station E53). Diversity within the Area was relatively high as indicated by Shannon diversity (*H'*) that was moderate to relatively high, ranging from 2.9 (station E30) to 5.0 (station E53) and log-series alpha ranging from 10.0 (station E01) to 18.5 (station E53). Pielou's evenness (*J'*) varied from 0.47 (station E30) to 0.83 (station E48).

Mean values for the various ecological parameters for stations from within Site E were generally similar to mean values calculated for stations outside the alternative site boundaries (Table 2).

Table 2. Ecological Parameters for Samples Collected in Rhode Island Sound, Area E, July 2003.

Station	Total Individuals	Total Species	*H'*	*J'*	Log-series Alpha
In-site Stations					
E17	1057	59	4.4	0.74	13.7
E19	1180	53	3.3	0.57	11.5
E34	571	52	4.1	0.72	14.1
E45	1070	61	4.6	0.77	14.1
E54	3084	74	3.0	0.48	13.7
Mean	1392.4	59.8	3.9	0.7	13.4
sd	974.4	8.8	0.7	0.1	1.1
Reference Stations					
E01	568	40	3.4	0.64	10.0
E08	2243	62	3.5	0.59	11.9
E12	2223	68	3.1	0.50	13.3
E15	1875	58	3.4	0.59	11.4
E21	1275	55	3.5	0.60	11.8
E30	2549	72	2.9	0.47	13.8
E38	1208	62	4.5	0.76	13.9
E39	2251	65	3.2	0.53	12.6
E44	1649	54	3.4	0.58	10.8
E48	510	56	4.8	0.83	16.3
E52	1048	66	4.2	0.69	15.7
E53	1067	75	5.0	0.80	18.5
E59	1198	71	4.6	0.76	16.6
Mean	1512.6	61.8	3.8	0.6	13.6
sd	668.8	9.4	0.7	0.1	2.6

sd = standard deviation

The small nut clam, *Nucula annulata*, was the predominant species collected within Area E, accounting for 27% of the infauna that were identified to species level (Table 3). Other characteristic taxa were several species of polychaete worms (*e.g.*, *Polygordius* sp. A, *Tharyx acutus*, and *Exogone hebes*) and small crustaceans (including the ampeliscid amphipods *Byblis serrata* and *Ampelisca agassizi*). The ten most abundant species accounted for 71% of the infauna that were identified to species level (Table 3). The abundance of some of the species varied considerably among the stations as indicated by the high calculated standard deviation values. For example, the abundance of *N. annulata* varied from 3 individuals per sample (station E01) to 1,778 individuals per sample (station E54). The predominant species were generally similar for stations within Site E and those located outside the site boundaries.

Table 3. Ten Most Abundant Species Among In-site Stations in Rhode Island Sound, Area E, July 2003.

Species	Mean (#/ sample)	Standard Deviation	%	Cumulative %
Nucula annulata	365.0	789.9	27%	27%
Polygordius sp. A	169.8	220.0	12%	39%
Tharyx acutus	92.8	86.2	7%	46%
Exogone hebes	59.8	39.5	4%	50%
Nucula delphinodonta	56.6	46.2	4%	54%
Byblis serrata	69.5	51.2	4%	59%
Eudorella pusilla	52.2	56.1	4%	62%
Euchone incolor	46.4	44.8	3%	66%
Ericthonius fasciatus	41.2	29.9	3%	69%
Ampelisca agassizi	40.3	37.8	2%	71%

Bray-Curtis cluster analysis of the infaunal data from Area E yielded two main groups of stations (Figure 5). Overall similarity between the two groups was about 43%. Group A was comprised of the six silty stations located along southeastern boundary of Area E, but also included station E54 located in the northeast corner of Site E (Figure 2). Species characterizing Group A stations were the nut clam *N. annulata* (~1,095/sample) and three small crustacean species *A. agassizi* (~164/sample), *Ericthonius fasciatus* (~132/sample), and *Eudorella pusilla* (~113/sample). Among the ten most abundant species at Group A stations, only three were polychaete worms. Group B stations typically were comprised of sand and/or gravel sediments. Characteristic species included eight species of polychaete worms (e.g., *Polygordius* sp. A, *Exogone hebes*, *Tharyx acutus*, *Aricidea catherinae*, *Ampharete lindstroemi*, and *Scoletoma hebes*). The nut clam *N. annulata*, which was the most abundant taxon among Group A stations, was not very abundant among Group B stations (~18/sample).

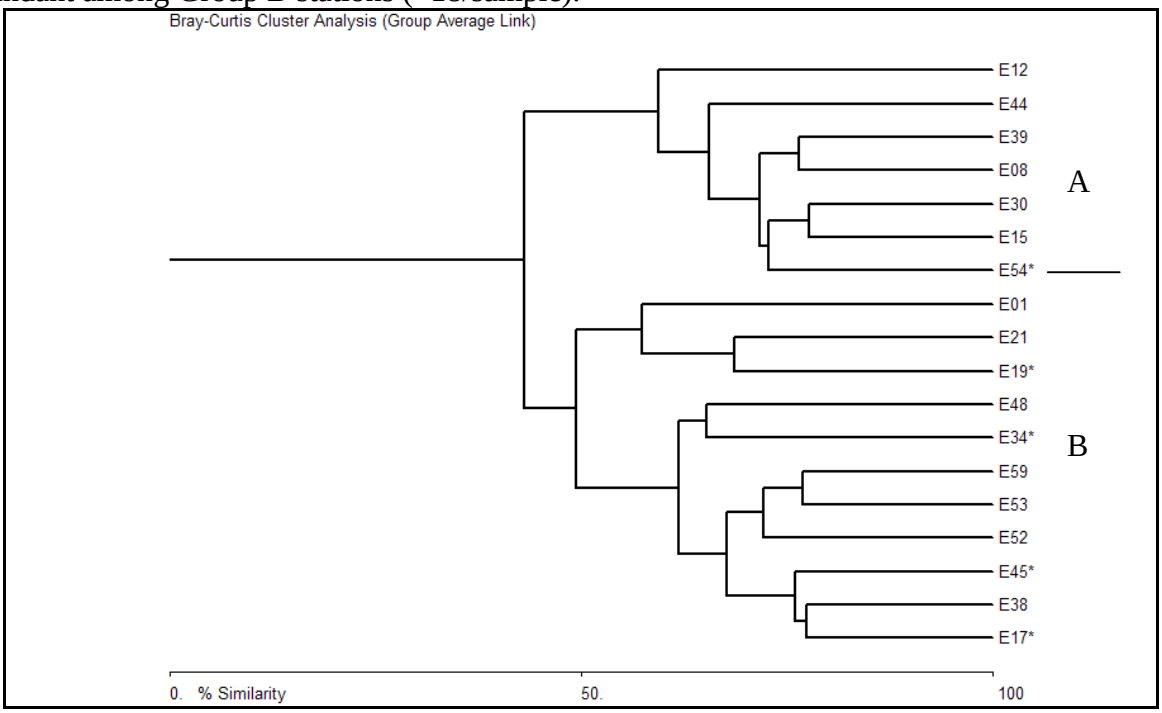

Figure 5. Dendogram Resulting from Bray-Curtis Analysis of Infaunal Samples Collected from Rhode Island Sound, Area E, July 2003.

3.2 Area W

3.2.1 Grain Size/Total Organic Carbon

Sediment grain size varied somewhat within Area W. Sediments at most stations were relatively fine, as six stations had a fine sediment fraction (silt + clay) greater than 20% (Table 4). One station (W02) had a large gravel component (57%). The TOC content among stations within Area W was low, ranging from 0.29% to 0.79%. Mean TOC content among the 10 stations within Area W was 0.49% (standard deviation = 0.17%).

Table 4. Sediment Grain Size and TOC Content for Samples Collected in Rhode Island Sound, Area W, July 2003.

Station	Gravel %	Sand %	Silt %	Clay %	Fines [1] %	TOC %
W02	56.7	39.2	1.2	2.9	4.1	0.43
W06	12.3	78.0	4.5	5.3	9.7	0.29
W09	1.9	81.6	7.5	9.0	16.5	0.36
W10	0.0	58.4	29.1	12.5	41.6	0.65
W11	0.2	77.8	12.0	10.0	22.0	0.42
W14	2.9	80.6	6.6	10.0	16.6	0.36
W15	0.0	37.7	47.3	15.0	62.3	0.79
W17	0.5	46.1	39.5	14.0	53.5	0.67
W18	1.4	48.5	35.1	15.0	50.1	0.59
W19	0.6	80.8	9.3	9.3	18.6	0.34
Mean	7.6	62.9	19.2	10.3	29.5	0.49
sd	17.6	18.7	16.8	4.0	20.5	0.17

[1] Fines = silt + clay
sd = standard deviation

Cluster analyses of the combined grain size and TOC data resulted in two primary groups of stations and one outlier station (Figure 6). The outlier station, station W02, was comprised of 57% gravel. Group A was comprised of four stations having silty sediments (>40% fines). These were located along the western boundary of Site W (Figure 3). The remaining stations comprised Group B and were primarily sandy (78–81% sand).

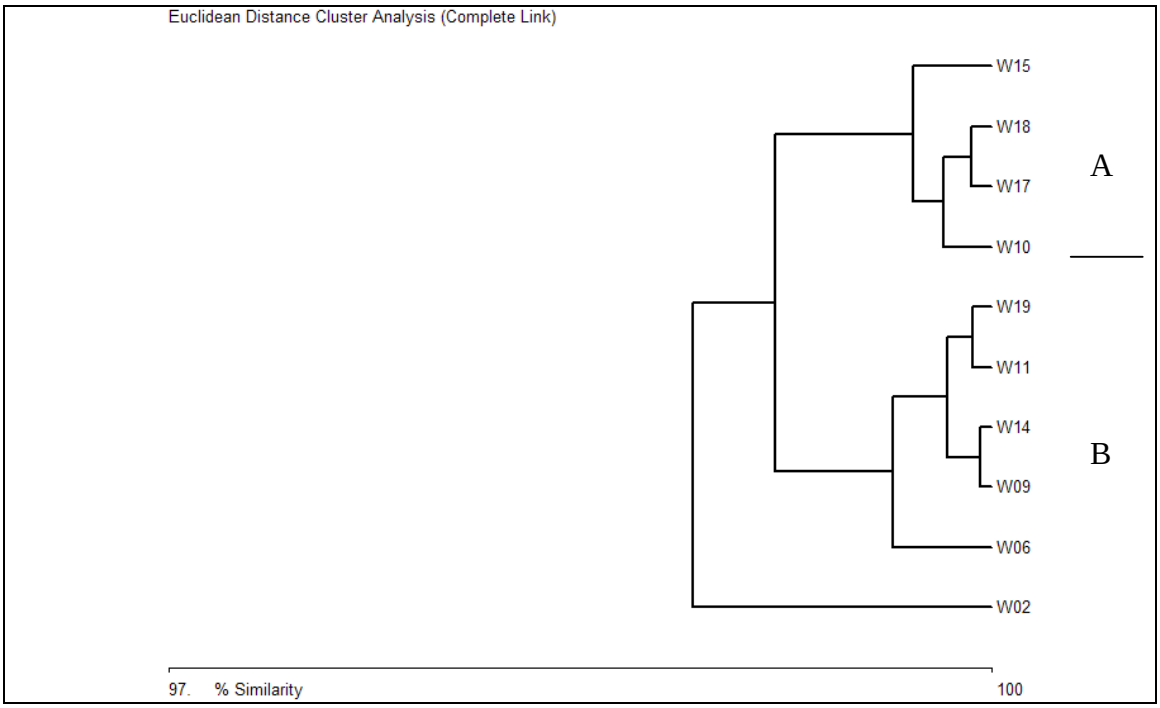

Figure 6. Dendogram Resulting from Euclidean Distance Analysis of Grain Size and TOC Samples Collected from Rhode Island Sound, Area W, July 2003.

3.2.2 Infauna

Among the 10 samples collected from Area W and analyzed for infauna, 124 species-level taxa were identified. Infaunal abundance varied moderately (Table 5), ranging from 514 individuals per sample (~12,850/m^2; station W06) to 1,658 individuals per sample (~41,450/m^2; station W10). Species numbers ranged from 44 per sample (stations W17, W18) to 68 per sample (station W09). Diversity within the Area was moderately high as indicated by Shannon diversity (*H'*) that was moderate to moderately high, ranging from 2.8 (station W15) to 4.9 (station W06) and log-series alpha ranging from 8.7 (station W17) to 18.2 (station W06). Pielou's evenness (*J'*) varied from 0.51 (stations W10, W15) to 0.82 (station W06).

Table 5. Ecological Parameters for Samples Collected in Rhode Island Sound, Area W, July 2003.

Station	Total Individuals	Total Species	*H'*	*J'*	Log-series Alpha
W02	752	66	4.7	0.78	17.5
W06	514	61	4.9	0.82	18.2
W09	1339	68	4.4	0.73	15.3
W10	1657	59	3.0	0.51	12.0
W11	1471	55	3.3	0.57	11.3
W14	1204	64	4.2	0.70	14.5
W15	1197	48	2.8	0.51	10.1
W17	1438	44	2.9	0.52	8.7
W18	750	44	3.1	0.57	10.2
W19	1425	59	4.0	0.68	12.5
Mean	1174.7	56.8	3.7	0.6	13.0
sd	376.6	8.8	0.8	0.1	3.2

sd = standard deviation

The small nut clam, *Nucula annulata*, was the predominant species collected within Area W, accounting for 29% of the infauna that were identified to species level (Table 6). Five species of small crustaceans (including *Ampelisca agassizi*, *Crassicorophium crassicorne*, and *Eudorella pusilla*). Only two polychaete worm species occurred among the 10 most abundant taxa. The abundance of some of the species varied considerably among the stations as indicated by the high calculated standard deviation values. For example, the abundance of *N. annulata* varied from 3 individuals per sample (station W06) to 809 individuals per sample (station W10).

Table 6. Ten Most Abundant Species Among In-site Stations in Rhode Island Sound, Area W, July 2003.

Species	Mean (#/ Sample)	Standard Deviation	%	Cumulative %
Nucula annulata	338.3	320.3	29%	29%
Ampelisca agassizi	216.6	112.2	19%	48%
Crassicorophium crassicorne	63.7	66.6	5%	53%
Eudorella pusilla	53.8	37.6	5%	58%
Exogone hebes	49.9	32.6	4%	62%
Unciola irrorata	47.5	20.2	4%	66%
Crenella decussata	35.3	28.0	3%	70%
Nucula delphinodonta	23.6	18.1	2%	72%
Tharyx acutus	22.2	11.5	2%	74%
Ericthonius fasciatus	23.8	28.0	2%	75%

Bray-Curtis cluster analysis of the infaunal data from Area W yielded two main groups of stations (Figure 7). Overall similarity between the two groups was about 59%. Group A was comprised of the five stations located just west and north of the boundary for Site W. All five stations were primarily silty (~22–62% fines). Species characterizing Group A stations were the nut clam *N. annulata* (~608/sample) and three small crustacean species *A. agassizi* (~213/sample), *Eudorella pusilla* (~62/sample), and *Unciola irrorata* (~55/sample). Among the ten most abundant species at Group A stations, only two were polychaete worms. Group B stations typically were comprised of sand and/or gravel sediments with <20% fines. Characteristic species included five species of crustaceans [including *Ampelisca agassizi* (220/sample), *Crassicorophium crassicorne* (~97/sample), and *Eudorella pusilla* (~45/sample)] and three species of polychaete worms (*Exogone hebes*, *Aricidea catherinae*, and *Tharyx acutus*).

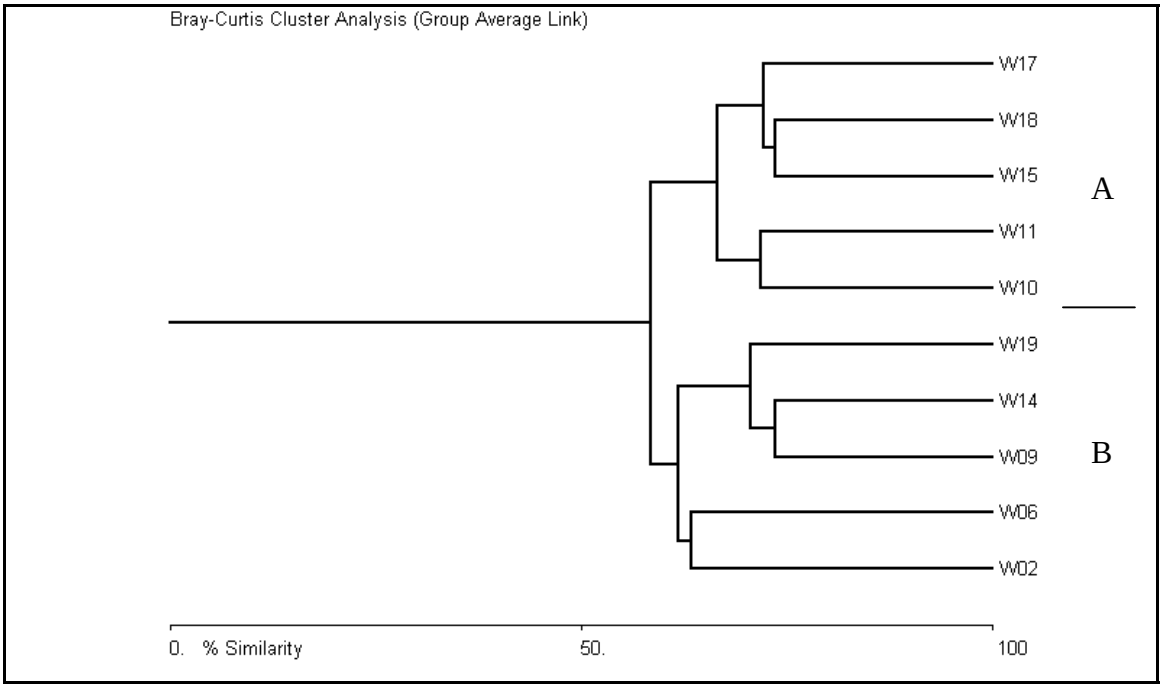

Figure 7. Dendrogram Resulting from Bray-Curtis Analysis of Infaunal Samples Collected from Rhode Island Sound, Area W, July 2003.

3.2.3 Comparison of Area W to Site W

Stations within and near Site W were sampled in September 2001 during an earlier study of benthic communities in the central ZSF (Battelle, 2002). Benthic grab sampling stations from each survey are presented in Figure 8. Because the sampling methods for that survey and the present one were the same, and the taxonomic identifications were performed by the same laboratory (Cove Corporation), some direct comparisons between the two studies can be made. However, the comparisons must be tempered by the nearly two-year separation between the studies and that the 2003 study was conducted in late July, whereas the 2001 survey occurred in late September/October. These caveats may introduce unknown seasonal and/or temporal differences. Before the comparative analysis, minor taxonomic differences between the two data sets were corrected via conversations with the lead Cove taxonomist, Mr. Tim Morris.

The main analysis for this exercise was a similarity analysis using the Bray-Curtis algorithm as the similarity measure. The analysis was restricted only to individuals identified to species level. The three station sets were Area W (designated by W#, 2003), Site W (designated SZ#, 2001), and Site W Reference (designated SZR#, 2001).

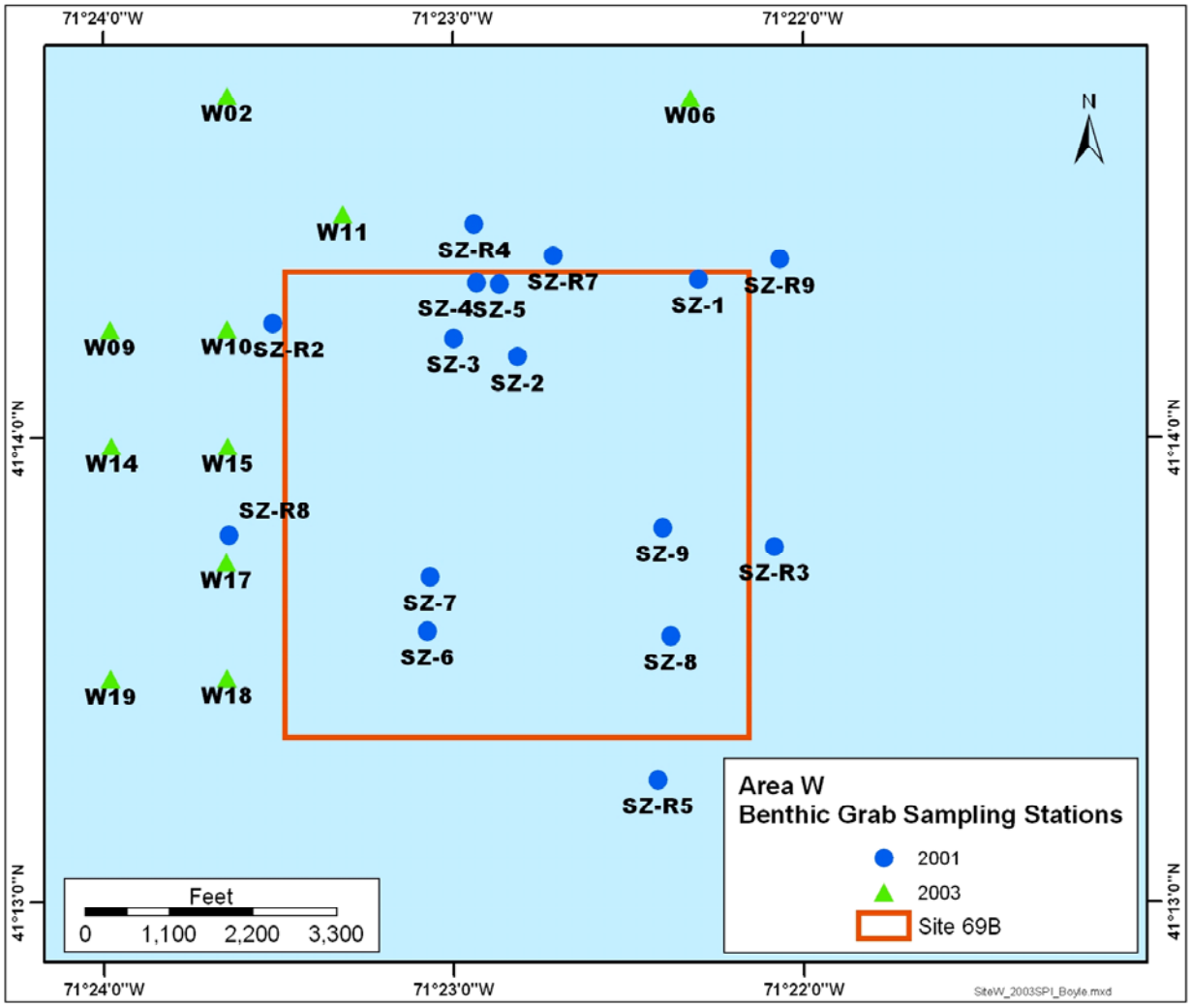

Figure 8. Area W Grab Sampling Locations from 2001 and 2003.

The dendrogram resulting from this analysis was complex, showing two disparate groups of stations; one small group of three 2001 stations and another group of the remaining 2001 and 2003 stations (Figure 9). The interesting points revealed by the analysis were the lack of distinct separation of the Site W (SZ#) and the Site W Reference (SZR#) stations and the clustering together of most of the Area W (W#) stations. Eight of the Area W stations cluster as a group within a larger cluster of 2001 stations. These eight Area W stations separate as they did in the analysis conducted for only Area W. The five stations immediately west and north of Site W for one station group and the three stations (W09, W14, W19) farther west form another group (identified by a vertical line in Figure 9). The two northernmost Area W stations (W02, W06) cluster among several 2001 stations. Three stations sampled in 2001 were in the same general area as stations sampled in 2003. Because the Bray-Curtis similarity algorithm is strongly influenced by species abundances, it is useful to look for changes in the numerical dominance structure of these stations to explain differences in the resulting classification. The stations sampled in 2001 (SZ-R2, SZ-R4, SZ-R8) were numerically dominated by the filter-feeding

amphipod *Ampelisca agassizi*, which was about two to ten times more abundant than the second most abundant species, the nut clam *Nucula annulata*. In 2003, Nucula annulata was the numerical dominant at these stations. It was two to three and one-half times more abundant than *Ampelisca agassizi*, the second most abundant taxon. A similar shift in dominance structure occurred in the area just northwest of Site W (Station W11 compared to Stations SZ-R2 and SZ-R4). Other changes in these areas from 2001 to 2003 included decreased numbers of the polychaetes *Tharyx acutus* and *Polygordius* sp. A and increased abundances of the clams *Nucula delphinodonta* and *Crenella* spp. Such community changes likely did not occur well north of the site because the stations sampled there in 2003 (stations W02, W06) were more similar to stations sampled in 2001 than they were to those sampled in 2003. The separation of the eight Area W stations from the Site W stations, and the associated changes in dominance structure at those stations, may indicate that changes in the infaunal community related to the recent disposal of dredged material occurred, although it is not possible to completely discount natural, cyclic community variation as an explanation for them.

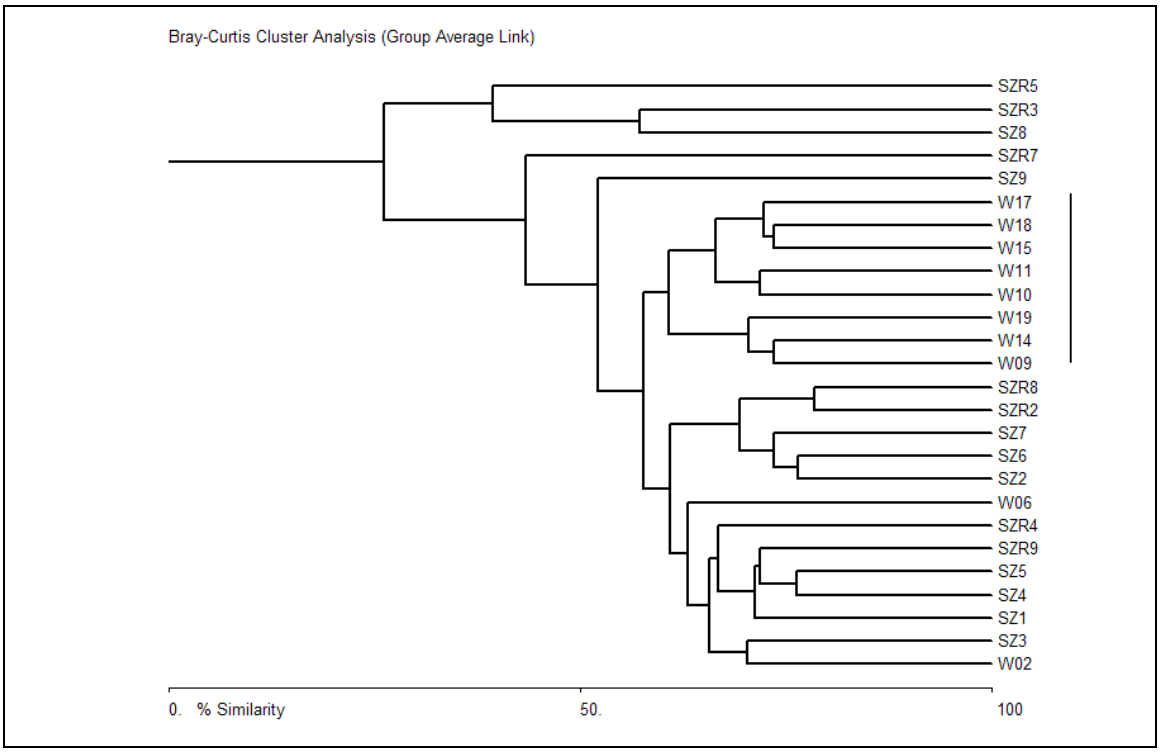

Figure 9. Dendrogram Resulting from Bray-Curtis Analysis of Infaunal Samples Collected from Within and Near Rhode Island Sound, Site W, September/October 2001 (labeled SZ#, SZR#) and July 2003 (labeled W#).

4.0 CONCLUSIONS

4.1.1 Area E

Area E contained two infaunal communities that are typical of open water sediments in Rhode Island Sound. One community (Group A) occurred primarily among relatively silty sediments, the other (Group B) among sandier sediments. The range of infaunal abundance at Area E was similar (up to ~80,000 individuals/m^2) to that reported for stations sampled during an earlier study in the central ZSF (Battelle, 2002), although species numbers and diversity were slightly higher for Area E than for the central ZSF locations.

4.1.2 Area W

Area W contained two infaunal communities that are typical of open water sediments in Rhode Island Sound. One community (Group A) occurred primarily among relatively silty sediments, the other (Group B) among sandier sediments. Infaunal abundances were somewhat less than those reported previously for the central portion of the ZSF (Battelle, 2002). Eight of the stations sampled during 2003 may have been affected by recent dredged material disposal activities.

5.0 REFERENCES

Battelle. 2001. Final Quality Assurance Project Plan Rhode Island Sound Disposal Site Study. Task 1 QAPP: Field Sampling, Chemical, and Toxicity Testing. Prepared under Contract No. DACW33-01-D-0004, Delivery Order No. 02. September 2001.

Battelle. 2002. Fall 2001 Infauna Characterization Report. Rhode Island Region Long-Term Dredged Material Disposal Site Evaluation Project. Contract Number DACW33-01-D-004, Delivery Order 0002.

Battelle. 2003. Draft Summer 2003 SPI and Benthic Survey Report. Rhode Island Region Long-Term Dredged Material Disposal Site Evaluation Project. Contract Number DACW33-01-D-004, Delivery Order 0002.

Boesch, D.F. 1977. Application of Numerical Classification in Ecological Investigations of Water Pollution. Environmental Research laboratory, Office of Research and Development, U.S. Environmental Protection Agency. Corvallis, Oregon. EPA-600/3-77-033. 115 p.

Bray, J.R. and C.T. Curtis. 1957. An ordination of the upland forest communities of southern Wisconsin. Ecological Monographs 27:325-349.

Magurran, A.E. 1988. Ecological Diversity and its Measurement. Princeton University Press, Princeton.