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Eversource Energy

Seacoast Reliability Project
Benthic Community Preconstruction Baseline Report

Prepared For:
Eversource Energy
13 Legends Drive
Hooksett, NH 03106

Submitted On:
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Prepared By:
Normandeau Associates, Inc.
25 Nashua Road
Bedford, NH 03110

www.normandeau.com

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1.0 Introduction

Eversource's Seacoast Reliability Project (SRP) included burying three cables in the sediments crossing Little Bay north of Adams Point within a corridor previously identified as a "Cable Area" on navigation charts. The installation methods, primarily jet plow and hand burial, released sediments into the water column creating a minor turbidity plume that was controlled by both the tides and the progress of installation along the route. Results of water quality monitoring are being provided in a separate document. The jet plow created an ephemeral "trench" about a 0.3 meter wide for each cable that was expected to be substantially backfilled as the installation progressed across the bay. Skids for the jet plow depressed the sediments to the sides of each cable to a width of approximately 15 feet. The majority of the sediments suspended into the water column were predicted to settle near each cable so that the total footprint for substrate affected by jet plowing was predicted to be about 6.3 acres. Cable installation in nearshore areas was achieved using diver assisted hand jets. In areas where burial depth could not be achieved due to bedrock, concrete mattresses were used to protect the cables. The concrete mattresses are considered permanent impacts, and affect approximately 0.2 acres of intertidal flats.

As a result of the installation of these cables, Eversource expected temporary changes to benthic habitat conditions (localized changes in bathymetry) and the benthic infaunal community (direct losses from disturbance). These temporary changes were predicted to recover, at least partially, within a year of the installation.

NH DES's requirements related to benthic recovery monitoring are addressed in two conditions:

- Condition 42 – Benthic Habitat Monitoring
- Condition 43 – Benthic Infaunal Community Monitoring

The Benthic Community Monitoring Plan (Normandeau 2019) addresses each of these conditions and specifies the monitoring and recovery evaluation protocols to be followed during the jet plow trial run, jet plow installation of cables, and hand jetting.

Condition 42, Benthic Habitat Monitoring, addresses monitoring the recovery of the substrate following cable installation by surveying topography and grain size distribution. This will be accomplished using a combination of multibeam sonar to measure bay floor topography and near-surface sediment grain size collection in the shallow intertidal zone. The purpose of Condition 43, Benthic Infaunal Community Monitoring, is to assess the impact of the project on the benthic infaunal community by sampling it before and after cable installation. Grain size samples collected in conjunction with infaunal samples will be used for habitat recovery evaluation.

A jet plow trial was conducted on September 9, 2019. The cable installation via jet plowing took place from October 16 through November 7 2019, with three cable laying events taking place at about one-week intervals. Because the jet plow could not be used near-shore, these sections of cable were buried using diver-operated hand jets from November 11 through December 18, 2019. Finally, where burial sufficient to meet the 3.5-foot depth requirement was not feasible, concrete mattresses were placed over the cables. The final concrete mattresses were installed in early January 2020.

This report provides the results of the baseline benthic infaunal community survey conducted in July-August 2019. The baseline bathymetry survey was conducted in early September 2019, prior to the jet plow trial, and has been incorporated into the As-Built Cable plan that will be submitted to NHDES. A post-construction bathymetric survey is scheduled to take place in March 2020. Results of the two surveys will be provided separately.

2.0 Anticipated Effects to Benthos

Jet plowing was expected to have two primary types of direct impacts on benthic resources: loss of sediment and infauna along the three cable routes and deposition of suspended sediments on adjacent substrate. As reported in the Revised Little Bay Impact Assessment (Normandeau 2017a) the total footprint of the plow along the three routes is approximately 6.3 acres. All of those impacts are temporary with the exception of approximately 0.2 acres, where the use of concrete mattresses were required. Industry experience has found that most sediments fluidized by the jet plow remain in the narrow trench. Based on the grain size distribution observed along the project route, RPS (2016, 2017) predicted that sediments that are suspended and dispersed away from the jet plow would tend to redeposit close to the route. Sediment deposition greater than 1 mm was estimated to have the potential to adversely affect the benthic community. These predictions are shown in Figure 1, representing the slowest advance rate (100 m/hour or 13 hours to cross; RPS 2015) and the fastest advance rate (183 m/hour or 7 hours to cross; RPS 2017). The extent of deposition resulting from hand jetting where no turbidity barrier is feasible on the east side is also shown in Figure 1 (RPS 2017).

3.0 Benthic Infaunal Community Monitoring (Condition 43)

NHDES Condition 43 states: *"To assess the impact of work associated with laying cable in Little Bay on the benthic infaunal community, the Applicant shall conduct pre and post-construction monitoring of the benthic infaunal community in the Little Bay estuary. At least ninety (90) days prior to the scheduled date for conducting the pre-construction monitoring, the Applicant shall submit a plan to NH DES describing:*

- how, when and where the monitoring will be conducted;
- how results will be assessed to determine impact on the benthic infaunal community;
- how and when results will be reported to NHDES;
- mitigation measures that will be implemented based on benthic infaunal community impacts and recovery; and
- when the data will be input electronically into the NHDES Environmental Monitoring Database.

The Applicant shall then implement the approved plan. Results of the pre-construction monitoring shall be submitted to NH DES for approval no less than thirty (30) days prior to the scheduled cable installation date. A report comparing the pre to post- construction monitoring results shall be submitted to NH DES for approval no more than ninety (90) days after the post-construction monitoring is completed."

A Benthic Habitat Monitoring Plan was approved by NH DES (Normandeau 2019). This monitoring plan has been followed for siting, collection and analysis of the pre-construction benthic community, and will be similarly followed for post-construction monitoring.

Installation of the three cables across Little Bay will unavoidably disturb the estuarine substrate in approximately 6.3 acres through a combination of displacement into the water column, compression by the jet plow skids, and redeposition of suspended sediments back on to the bay floor. As described in the SRP Natural Resource Impact Report (Normandeau 2016a), the benthic infaunal community in this footprint will be impacted. It is expected that the substrate will be restored to its approximate pre-construction condition, including grain size distribution and bathymetry, by natural processes within several months. Because the in-water cable installation is planned to take place during the fall, recruitment of infaunal organisms into the disturbed area is likely to be limited until the following spring through summer when benthic reproduction is typically at its peak. As described in the monitoring plan (Normandeau 2019), Eversource proposes to document the recovery of the infaunal community to demonstrate that there is no long term degradation of this resource in the project footprint and that the benthic community within the area of disturbance is functioning similarly to that outside the disturbance.

Baseline sampling was conducted in early fall 2014 along three transects running perpendicular to the charted Cable Area in different depth strata with stations located evenly north and south of the originally proposed route as shown in the SRP Natural Resources Existing Conditions Report (Normandeau 2016b). This design was selected to enable a characterization of the benthic infaunal community in the project area. It also provides an indication of spatial variability, although a single year does not capture the full range of natural temporal variability that occurs in a system like Little Bay and does not account for events such as storms that affect large areas. In general, the baseline collections showed that within a depth stratum, the transects represented a single, fairly consistent community across the proposed construction zone indicating that a similar gradient-type design for post-installation monitoring should be effective in documenting recovery. For that reason, Eversource proposed the same study design for the 2019 pre-construction monitoring and the 2020 post-construction monitoring, locating stations along transects so that they fall both within and well outside the predicted area of disturbance. The transects were aligned so that the mid-point stations are located at the centerline of the three cables (Figure 2).

This report provides the results of the baseline (pre-construction) benthic infaunal community survey conducted in summer 2019 and includes the results of sediment grain size and TOC sampling conducted along with benthic collections.

4.0 Methods

4.1 Benthic Infaunal Community Monitoring Methods

Eversource demonstrated in their filings to the SEC that installation of cables in Little Bay substrate was unlikely to have an unreasonable long term adverse effect on the natural environment of the bay. Because installation directly disturbed the substrate and associated benthic infauna there will be unavoidable temporary changes in these resources. The purpose of the benthic infauna monitoring program is to demonstrate recovery of the benthic community to a similar functional level as nearby areas in the bay. The primary value of the baseline survey is to demonstrate the similarity or dissimilarity of the infaunal community within each depth zone across the route within the baseline timeframe.

4.1.1 Sampling Locations and Timing

Benthic infauna samples were collected from 5 locations from each of four transects: three crossing the cable route to assess recovery from jet plow installation of the cables as well as a fourth 5-station transect east of the jet plowed section where currents are too fast to allow use of turbidity barriers around hand jetting (Figure 3). Each transect was oriented so that the central station is on the centerline of the cable route, two stations (one each north and south of the centerline) are located within areas where the sediment plume model predicted that suspended sediments would be redeposited, and two reference stations (one north and one south) where no sediment effects are expected (Figure 3). Transects are located in different depth regimes. This design allows the evaluation of whether there is a gradient of community parameters with distance from the impact area within a given depth zone. Note that originally the transects within each depth zone were expected to fall along relatively straight lines. During baseline sampling in July 2019, however, substrate at the original locations for channel stations B09 and B10 was gravelly or rocky such that suitable soft substrate samples could not be collected and the habitat conditions were visually different than at Stations B06 through B08. Stations were relocated to be as close to the originally planned location as possible while remaining either in (B09) or outside (B10) the anticipated impact area. Grain size and total organic carbon (TOC) data from the monitoring stations are used to define habitat conditions at each station along a transect. Coordinates for each station are shown on Table 1.

Baseline benthic surveys were conducted in mid-summer (July-August) 2019 prior to any in-water work on the project, and consistent with EPA's National Coastal Condition Assessment (NCCA) program (USEPA 2014a) recommendation for sampling benthic infauna from June through September. Post-installation collections will be made during the same time frame in 2020. Scheduling the sampling for July-August captures overwintering populations and spring-early summer recruitment. Benthic samples supporting the project application to the SEC were collected in September 2014.

4.1.2 Sampling Methods

Field methods adhered to the protocols established by EPA's NCCA program (USEPA 2014a). By following these established methods, the NCCA results are directly comparable to the samples collected in the Project Area during permitting (Normandeau 2016a) and the samples collected in the Great Bay system during multiple years under the NCCA program.

Normandeau's survey vessel navigated to each station using dGPS that has sub-meter accuracy and the vessel was either anchored or held in position with the engine. The vessel was oriented so that the davit supporting the grab sampler was located on the station's GPS coordinates. Triplicate benthic infauna samples were collected at each station using a 0.04 m^2 Young-modified van Veen grab. This grab typically obtains a sample of the upper 7 cm of the substrate where macroinvertebrates are concentrated. Care was taken to move the sampler between grabs to ensure that undisturbed sediments are collected each time following the initial deployment. A fourth grab was collected at each station to be analyzed for sediment grain size and total organic carbon (TOC), both measures of habitat conditions. This grab was subsampled using small cores to collect sufficient material for laboratory analysis.

Once retrieved the top of the grab was opened to confirm that the grab was acceptable as defined in Figure 4 (source: USEPA 2014a). Material from acceptable grabs was washed through a 0.5 mm-mesh sieve to prepare the benthic infauna sample. Sieved material was placed in a jar with buffered formaldehyde to preserve the organisms. Material from the fourth grab for sediment analysis was not sieved.

Samples collected are summarized in Table 2.

4.1.3 Laboratory Analysis

Benthic infauna samples were analyzed in Normandeau's Bedford NH taxonomy laboratory following NCCA protocols for sample handling and taxonomy (USEPA 2015) and Quality Assurance (USEPA 2014b).

Sediment grain size and TOC were analyzed following NCCA protocols (USEPA 2015) by Enthalpy Laboratories.

4.2 Data Analysis

Evaluation of recovery of benthic infaunal resources focuses primarily on comparison of a series of parameters and measures across the stations within a depth zone. Primary parameters include sediment grain size (percent silt-clay and median phi size), TOC, total infaunal abundance, taxa richness, and community structure as well as derived metrics (Shannon Weiner Diversity H' and Pielou's Evenness J') (Table 3). Statistical analyses were designed for the primary parameters to evaluate whether benthic conditions within the footprint disturbed by installation of the cables are similar to those in the reference area and/or to pre-construction conditions. Those analyses are described below.

Additional secondary biological parameters (Table 4) were also examined because they are useful in describing the marine benthic community. Although they will not be used to answer the question of whether the benthos has recovered from the physical disturbances of cable installation directly, the secondary parameters will help provide insight into the potential ecological effect of any changes. These secondary parameters include groupings of organisms (opportunistic taxa; dominant taxa; and feeding guilds) that provide indications of ecological function.

4.2.1 Physicochemical Factors

Sediment grain size is one of the primary factors affecting infaunal community structure. Some benthic species are highly associated with certain grain size categories, particularly in sandy substrates, although this relationship is not absolute and occurs over a sediment gradient. Grain size data are presented using the Wentworth scale (based on particle diameters expressed in millimeters) and converted to the phi scale (the negative logarithm to the base 2 of the Wentworth value). The phi classification provides greater resolution at the smaller grain sizes where differences in infaunal benthic communities are more likely to be observed. A change in grain size (e.g., from predominantly silty such as occurs on the western tidal flat) to predominantly sandy (such as occurs in the channel), or vice versa, or a change within a major class (silt/clay or sand)) could potentially result in an altered community and should be considered as an indication that the installation of the cable had sorted and redistributed sediments more than was predicted by the model. A comparison of grain size data collected from the same locations in Little Bay months apart (September 2016 versus May 2017) showed that there is temporal variability in this characteristic (Normandeau 2017b) in terms of relative proportions of fines (silt + clay) and sands but those stations that were predominantly sandy in 2016 were still predominantly sandy in 2017 and the same held true for silty stations. Because of this temporal variability, it is likely that only a large change in grain size would affect the benthic infauna; therefore, the criterion for detecting a difference potentially related to the project focuses on changes in silt/clay and sand textures (Table 3). Combined with grain size distribution, TOC reflects organic enrichment of the sediments (Pelletier et al. 2010) and provides an indicator of the expected feeding structure of the benthic infaunal community (e.g., deposit feeders versus filter feeders). However, physicochemical factors should not stand alone as an indication of project-related change in the benthos. If the criteria based directly on infauna parameters show no or limited differences between the impact station and non-impact stations, then the change in sediment grain size distribution or TOC would be considered to be inconsequential.

4.2.2 Biological Factors

Most of the factors to be considered for evaluating recovery of the disturbed habitats relate to biological attributes. The primary factors guiding assessment of infaunal recovery are all direct measures of community structure (species richness, abundance, and taxonomic composition). These three factors are commonly used to describe marine and estuarine benthic communities and were used for the NCCA program. These factors will be evaluated across stations within each transect and between the pre-construction and post-construction events using statistical tools for conducting a BACI (Before-After-Control-Impact) comparison (Table 4). Use of statistics provides a bias-free method of determining change. Analysis of variance (ANOVA) and numerical classification have been widely accepted for impact analysis having been used for numerous other monitoring programs in New England, including the long-running Seabrook Station monitoring program. The appropriateness of using ANOVA or a nonparametric equivalent for comparing between pre- and post-construction data sets will be based on the results of the post-construction survey. In addition to the direct parameters, two derived measures describing diversity (Shannon Weiner diversity and Pielou's evenness) are included as primary factors. The Shannon Weiner diversity index has no upper bound so provides no universal threshold for defining "good" or "bad" benthic conditions. However, within a given dataset, samples or stations can be categorized as more or less diverse. Pielou's evenness ranges from 0 to 1 with lower values indicating that fewer taxa have higher abundances than others and higher numbers indicating that abundances are more uniformly distributed among the taxa.

Community structure was compared across all stations using numerical classification. Bray-Curtis similarity indices were computed for the square-root transformed abundances (no./0.04 m^2) using all replicates to evaluate variability of species composition within stations. As the results of this analysis show relatively low variability within stations, numerical classification was also conducted using mean values for stations. Bray-Curtis similarities were used to classify the samples into groups using the group average method (Boesch 1977) using the computer program PRIMER-E.

Statistics don't necessarily provide insight into biological function however. Therefore Eversource uses a number of secondary factors qualitatively to help interpret differences that are observed via statistics. These secondary factors, including relative abundance of opportunistic species, comparison of numerical dominants, and feeding guild structure, reflect how robust the community is and were included in this assessment because of the patterns observed in the 2014 collections. Several opportunistic species (*Polydora cornuta*, *Streblospio benedicti* and *Capitella capitata*) were found in benthic samples collected in the project area in 2014 (Normandeau 2016b). These pioneering species have high fecundity rates, multiple reproductive periods per year and short life spans. While they contribute to the forage base for some benthic consumers, their presence tends to be ephemeral so they are not necessarily a good indicator of the full function and stability of the infaunal community. Assessment of the populations of opportunists can provide insight into differences in total abundance. Benthic collections from the project area in 2014 also showed that there were several species that were numerical dominants regardless of station within each depth zone (Normandeau 2016b). The 2014 survey also described the predominant feeding patterns of the benthic infauna, finding that stations within depth zones supported similar feeding types. Such patterns point to similarity in habitat conditions. Marked changes in either of these factors restricted only to either impact stations or reference stations could indicate changes in the substrate related to cable installation.

Both diversity indices proposed for inclusion in this assessment (Shannon Weiner diversity and Pielou's evenness) are suitable for comparisons within a particular dataset. Shannon Weiner diversity takes into account both numbers of species and their abundances while Pielou's evenness evaluates the extent to which some species are more abundant than others. Combined they can provide an indication of resilience of the community to perturbations based on the premise that the more species in the community the greater likelihood that at least some of them are more tolerant of disturbance than others. In general, higher evenness and diversity values are considered to be positive community attributes but there are no well-defined thresholds for these measures. Thus, comparisons will only be made within the project-specific dataset.

All data obtained during the benthic infaunal community monitoring program will be uploaded to NHDES' EMD upon completion of the study.

Data manipulations

Several data manipulations were conducted prior to calculating community parameters, particularly the diversity indices of species richness, Shannon Weiner $\log_e$ diversity and Pielou's evenness. In each of these cases, only unique taxa were included. For example, when an individual was only identifiable to genus and there were individuals identifiable to a species within that genus, only the species-level individuals were included the calculations. These exclusions were applied to the entire dataset and involved only a small number of individuals. Doing so enhances comparability across the samples. Specifically, these changes were made to the data set for calculations of species richness, diversity and evenness:

- individuals identified only to family Syllidae, Maldanidae, Sabellidae or Tellinidae were eliminated because there were individuals identifiable to a greater degree of precision
- counts of *Leitoscoloplos robustus* and *Leitoscoloplos* sp. were combined; counts of Cirratulidae and *Tharyx acutus* were combined; counts of Terebellidae, *Polycirrus phophoreus* and *Polycirrus* sp. were combined.
- For numerical classification, the count data (number per 0.04 m^2 or number per sample) were normalized by using a square root transformation. This reduces the effect of extremely high or extremely low abundances in the analysis.
- Nematodes were counted but excluded from any analyses as they are typically considered to be meiofauna, rather than macrofauna, and were likely to have been underrepresented in the sieved samples.

Calculations of station means and standard deviations were based on the three replicates collected from each station. Calculations of transect means and standard deviations were based on the means from each of the five stations.

5.0 Results

5.1 Physicochemical Factors

Sediment grain size varied substantially among transects (Table 5). Finest sediments occurred on the western tidal flat where percent silt-clay (fines) ranged from 43 (B5) to 78 (B1) percent with the extremes occurring at the reference stations. Sediments along the eastern shallow subtidal transect ranged from 7 (B16) to 35 (B19) percent silt-clay. The two middle transects exhibited low levels of fines with sediments in the channel ranging from 2 (B7) to 10 (B9) percent and sediments along the channel slope ranging from 4 (B11) to 17 (B15) percent silt-clay. Grain size results are generally consistent with the patterns observed in sediment samples collected along the route from vibracores collected as part of previous sediment quality characterization investigations (Normandeau 2016c; 2017b) conducted for the project although the earlier collections were made at different locations than the benthic survey stations.

Median phi sizes reflected the fact that throughout the survey area predominant grain sizes ranged from silts to medium sands (Table 5). Stations along the western intertidal transect were classified as silt (median phi size of 6) except for the southernmost station B5 which was very fine sand. Stations along the eastern shallow subtidal transect were classified as very fine sand (median phi size of 3.5) except for the northernmost station B16 which was fine sand (median phi size of 2.5). The channel transect stations B6-B10 ranged between fine and medium sand (median phi size of 2.5 or 1.5). Stations along the channel slope were the most consistent and were classified as fine sand (median phi size of 2.5). These results suggest that the greatest differences in the benthic infaunal community are likely to be observed between the western transect stations and the channel and slope stations, and that intra-transect differences are minimal.

Total organic carbon (TOC) was uniformly low across all samples (Table 5), exceeding 1% at only one station (B15). There was a tendency for the shallower stations to have slightly higher TOC than the deeper stations with the exception of B15. As observed in 2016 (Normandeau 2016c), TOC values tended to be higher in the western stations, consistent with higher levels of fines although TOC values were typically lower in 2019 than the earlier sampling.

5.2 Primary Biological Factors

As described in Section 4.2.2, benthic infaunal community attributes can be characterized in a number of different ways. Taken alone, each of these factors can provide a somewhat skewed picture of the community ecology such that statistically significant changes in one or more of the factors may or may not represent an ecosystem level change directly relatable to the SRP construction activities. For this reason, the results of all attributes must be taken in total. Results of the baseline survey are presented for each of two directly measured parameters (total faunal abundance and taxa richness), two derived parameters (Shannon-Weiner diversity and Pielou's evenness), and one overarching community assessment (numerical classification of community structure).

For the baseline investigation, data were examined within individual stations as well as among the five stations that compose a depth-related transect. As the transects were located to represent expected differences in sediment characteristics and water depth, results for each of the direct and derived parameters are presented by transect.

Among the stations located on the western tidal flat transect (Stations B01-B05), total mean infaunal abundance ranged from 357-1338 organisms/0.04 m^2 and averaged 788 organisms/0.04 m^2 (Table 6). Lowest abundances occurred at Station B03 and this was consistent among replicates (Figure 5). In most cases, standard deviations overlapped suggesting that differences in mean abundances among stations were unlikely to be statistically significant. Mean species richness ranged from 14.7 to 19.7 unique taxa per sample and averaged 17.1 across the transect. Variability in species richness was low both within and among stations (Figure 5). Both abundance and number of taxa are taken into account for Shannon –Weiner's diversity and Pielou's evenness. On this transect, diversity ranged from 1.77 to 1.97, averaging 1.89; evenness ranged from 0.61 to 0.74 and averaged 0.67. As with species richness, variability in diversity was low within stations and among most stations (Figure 5). Within stations, variability of evenness was generally low with the exception of B02. Evenness in the three stations within the predicted impact zone (B02-B04) appeared to be higher than in the reference stations (B01 and B05) as there was less overlap in standard deviations than in other parameters (Figure 5). This is an indication that even in pre-construction the reference stations had one to several taxa that were higher in abundance than the remaining taxa. As all evenness values were greater than 0.6, however, there was no indication of a greatly unbalanced community.

Stations B06-B10 were located in the channel where total mean abundance ranged from 636-1477 organism/0.04 m^2 and averaged 888 organism/0.04 m^2. Variability in abundance was relatively high within stations although station means were similar with the exception of reference station B06 (Figure 6). Mean species richness ranged from 14.7-24.7 taxa per sample, averaging 21.2 taxa per sample. Within station variability in species richness was generally low but there were distinct differences among stations (Figure 6). Diversity ranged from 1.75-2.20, averaging 2.02. Evenness ranged from 0.57-0.74 with a transect average of 0.67. Both diversity and evenness exhibited apparent differences among stations and these differences reflect the fact that both Stations B06 and B08 included one or two taxa with relatively high abundances compared to other taxa (see Section 5.3, Dominant Taxa).

Along the eastern channel slope (Stations B11-B15), total mean abundance ranged from 822-1810 organisms/0.04 m^2 and averaged 1180 organisms per 0.04 m^2. Several stations (B12, B13 and B15) exhibited high variability among replicates although means of all stations except B15 were within the variability of all other stations (Figure 7). Mean species richness ranged from 26.3-30.7 per sample and averaged 27.3 unique taxa along the entire transect. Station B11 exhibited the lowest species richness along this transect (Figure 7). Shannon-Wiener diversity ranged from 1.98-2.40 among the stations and averaged 2.27 along the entire transect. Evenness ranged from 0.60-0.75 among the stations, averaging 0.69 along the transect. Diversity and evenness were lowest at Station B15 reflecting overwhelmingly higher abundances of two amphipod species that, while present at other stations, were not among the dominants.

On the eastern shallow subtidal, total mean abundance ranged from 518-1125 individuals/0.04 m^2 among stations B16-B20 and averaged 701 individuals/0.04 m^2. Mean abundance at B17 was about double that at other stations, but variability was high enough at B17 that differences among stations are unlikely to be statistically significant except Station B16 that had very low variability among replicates (Figure 8). Mean species richness ranged from 17.7-24.3 unique taxa per sample, with a transect mean of 21.1. Species richness was lowest at B16 (Figure 8). Diversity ranged from 2.02-2.27, averaging 2.14 along the transect and was similar among all stations (Figure 8). Evenness ranged from 0.69-0.74 and averaged 0.71 along the transect and exhibited only small differences among stations.

With few exceptions, it appears that these baseline community measures exhibited good consistency along transects suggesting that changes related to lack of recovery after construction impacts will be identifiable.

Community structure based on replicates

The univariate parameters reported above do not take into account the actual species composition of the infaunal community when making comparisons among stations. Bray-Curtis similarity does assess this. In order to evaluate the variability within each station, numerical classification based on Bray-Curtis similarity was conducted using the individual replicates for each station. Figure 9 shows that comparisons of station/replicates formed five distinct groups that were primarily separated by transect.

The shallowest stations (all the stations from the western tidal flat and 4 out of 5 stations from the eastern shallow subtidal) were grouped together at a within group similarity of nearly 60%. The fifth station from the eastern shallows (B16) was more closely grouped with the majority of the stations from the channel slope as well as one station (B6) from the channel. Two channel stations (B7 and B9, along with one replicate from B10) grouped together. The remaining stations formed two smaller groups (B10; B15).

Dominant species (ten most abundant taxa within a group) in each of these groups is shown in Table 7. Groups 1, 3, 4 and 5 encompassed the stations located along the channel and slope transects as well as samples from Station 16 (eastern shallow subtidal). Group 1, primarily Stations B7 and B8, was dominated by the tanaid arthropod Tanaissus sp. a and the polychaete *Pygospio elegans*. Also relatively abundant (in descending order) were the amphipod *Acanthohaustorius millsi*, oligochaetes, and the polychaetes *Streblopsio benedicti*, *Aricidea (Acmira) catherinae* and *Scolelepis (Parascolelepis) texana*. Group 3 included Stations B06, B11-B14 and B16 as well as one replicate from B09 and B17. This group was dominated by polychaetes *Tharyx acutus*, *S. benedicti*, *S. (Parascolelepis) texana*, and *A. (Acmira) catherinae* as well as oligochaetes. Dominants in group 4 (one replicate from B09 and two from B10) were similar to Group 3 with the exception that the polychaete *Paraonis fulgens* replaced *S. benedicti* among the numerical dominants. Station B15 was unique and formed Group 5 which was dominated by the amphipods *Melita nitida* and *Microdeutopus gryllotalpa* and the polychaetes *Polydora cornuta* and *A. (Acmira) catherinae.*

All of the samples collected on the western tidal flat and all but one sample collected along the eastern shallow subtidal clustered together to form Group 2. Because replicates from a particular station typically clustered together, it is reasonable to conduct further analysis of community structure based on means of replicates. Group 2 was dominated by polychaetes including *Streblospio benedicti, Streptosyllis arenae, Heteromastus filiformis, Scoletoma tenuis* and *Tharyx acutus*.

Two of the primary groups exhibited subgroups. In particular, Subgroup 2B was composed of two replicates from both B01 and B02 and all three replicates from B04 and B05; Subgroup 2C was composed of two replicates from both B17 and B20 and all three replicates from B18 and B19. All replicates from B03 clustered with one replicate from B01 and B02 in Subgroup 2A and one replicate from B20 was loosely allied with Subgroup 2C. As evident on Table 7, while the numerically dominant taxa were the same in these subgroups, the relative abundances and total abundances varied. Similarly, Group 3 could be divided into two subgroups that differed in the relative abundance of numerical dominants. Subgroup 3A encompassed four samples including all replicates from B06 and one from B17. Subgroup 3B was made up of all replicates from stations B11, B12, B13, B14 and B16 as well as one replicate from both B09 and B10. Total abundances and abundances of numerical dominants were higher in Subgroup 3A than in 3B.

Despite differences in relative abundances among the groups, many of the same taxa were present throughout the site. Eleven taxa were common to all of the five primary groups (although not always among the dominants) and six additional taxa were common to four of the five groups (Table 7). This is an indication that despite differences in sediment texture and water depth, these taxa are ubiquitous in the project area.

Community structure based on station means

Examining community structure using Bray-Curtis Similarity for station means provides a similar picture of the relationship among the stations. As shown in Figure 10, all of the shallow stations, except B16 were grouped together at greater than 60% similarity (Group 2). The majority of the channel and slope stations grouped together at about 60% similarity although channel stations B07 and B08 were similar (80%) but markedly different than other stations (less than 40%) and eastern shallow station B15 differed from all other stations.

Numerically dominant species composition of the four apparent station groups illustrates why the stations were clustered (Table 8). In group 2, encompassing the shallow stations, the infaunal community was dominated by the polychaetes *Streblospio benedicti*, *Tharyx acutus*, *Heteromastus filiformis* and *Scoletoma tenuis*. Both *T. acutus* and *S. benedicti* were among the top dominants in channel/slope group 3 but polychaetes *Scolelepis (Parascolelepis) texana* and *Aricidea (Acmira) catherinae* and oligochaetes were also numerically important in this group while less so in Group 2. Group 1 shared many of the same taxa as the other groups, but the most abundant species differed from Groups 2 and 3. In Group 1, the most abundant taxon was the tanaid arthropod *Tanaissus* sp. a, followed by the polychaete *Pygospio elegans*, oligochaete and the amphipod *Acanthohaustorius millsi*. Community composition at slope station B15 (Group 4) was quite different with high numbers of the amphipods *Microdeutopus gryllotalpa* and *Melita nitida* and the polychaete *Polydora cornuta*.

5.3 Secondary Biological Factors

Opportunistic Species

Opportunistic species are important early recruits, or pioneers, to disturbed habitats. In the marine and estuarine benthic infaunal community these species typically have high fecundity, frequent reproduction, and short lives. They reside at the surface and are often surface deposit feeders. In New England estuaries, opportunistic species are often polychaetes, in particular *Polydora cornuta*, *Streblospio benedicti* and *Capitella capitata*. Numerical domination of the community by these species can be an indication of either recent or frequent disturbance and that the habitat is in early stages of colonization. When they are found in combination with deeper dwelling or longer lived species, or species with varied feeding habits, it is more likely that they are simply a component of a dynamic but healthy community.

As evident in Table 9, opportunistic polychaetes were present throughout the survey area. In particular, *Streblospio benedicti* occurred at all stations. Relative abundances of opportunists was highest along the shallow transects, not unexpected given the higher stresses (potential drying; wider temperature fluctuations) associated with greater exposure in these areas compared the deeper portions of the bay.

Dominant Taxa

Consistency of dominant taxa along a transect provides insight into ecological function of the infaunal community. Table 10 lists relative abundances of taxa making up at least 10% of the total abundances at each station. Across Transect 1, there were four dominants at each station. Of these, two species (*Streblospio benedicti* and *Tharyx acutus*) were dominants at all stations, *Scoletoma tenuis* was dominant at four stations (B01-B04) but present at B05 and *Heteromastus filiformis* was dominant at three stations and present at the remaining two stations. Transect 4 exhibited similar dominants, reflective of the similar shallow water and substrate conditions along the two transects.

The channel transect (2) exhibited greater variability among stations in terms of dominant taxa. Although four taxa (*Aricidea (Acmira) catherinae, Streblopsio benedicti, Scolelelpis (Parascolelepis) texana*, and Oligochaeta) occurred at all stations, none of these species was a numerical dominant at every station. In neither transect was a single species a numerical dominant at all stations.

Channel slope transect (3) supported the highest number of taxa that were a dominant at one or more stations and occurred at all stations. These taxa included *Tharyx acutus* (dominant at four stations); *Streblospio benedicti, Scolelepis (Parascolelepis) texana,* and Oligochaeta (dominant at three stations); *Aricidea catherinae* (dominant at two stations); and, *Polydora cornuta, Microdeutopus gryllotalpa* and *Melita nitida* (dominant at one station).

Use of dominant taxa to identify changes in the benthic community related to the cable installation may be more feasible for the shallow transects than the channel and channel slope transects because of the higher consistency of species composition in the shallow transects.

Feeding Guilds

Feeding strategies are known for some benthic organisms in the project area although many species may utilize more than one strategy (e.g., surface deposit feeding and filter feeding). Primary feeding types for the dominant taxa are listed on Table 10. The majority of the stations are dominated by surface deposit feeders, generally an indication of exposure to frequent stresses. Subsurface feeders were prevalent at Stations B03, B08, B10 and B11. This suggests a more stable benthic community than at other stations. Stations B07 and B08 were unique in having *Tanaissus*, a filter-feeding carnivore dominating and Station B15 was unique in have the herbivorous amphipods dominating.

Prevalence of surface deposit feeders suggests that assessment of feeding guilds would provide clarity in terms of changes to the functioning of the benthic community only if changes are large.

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Figures

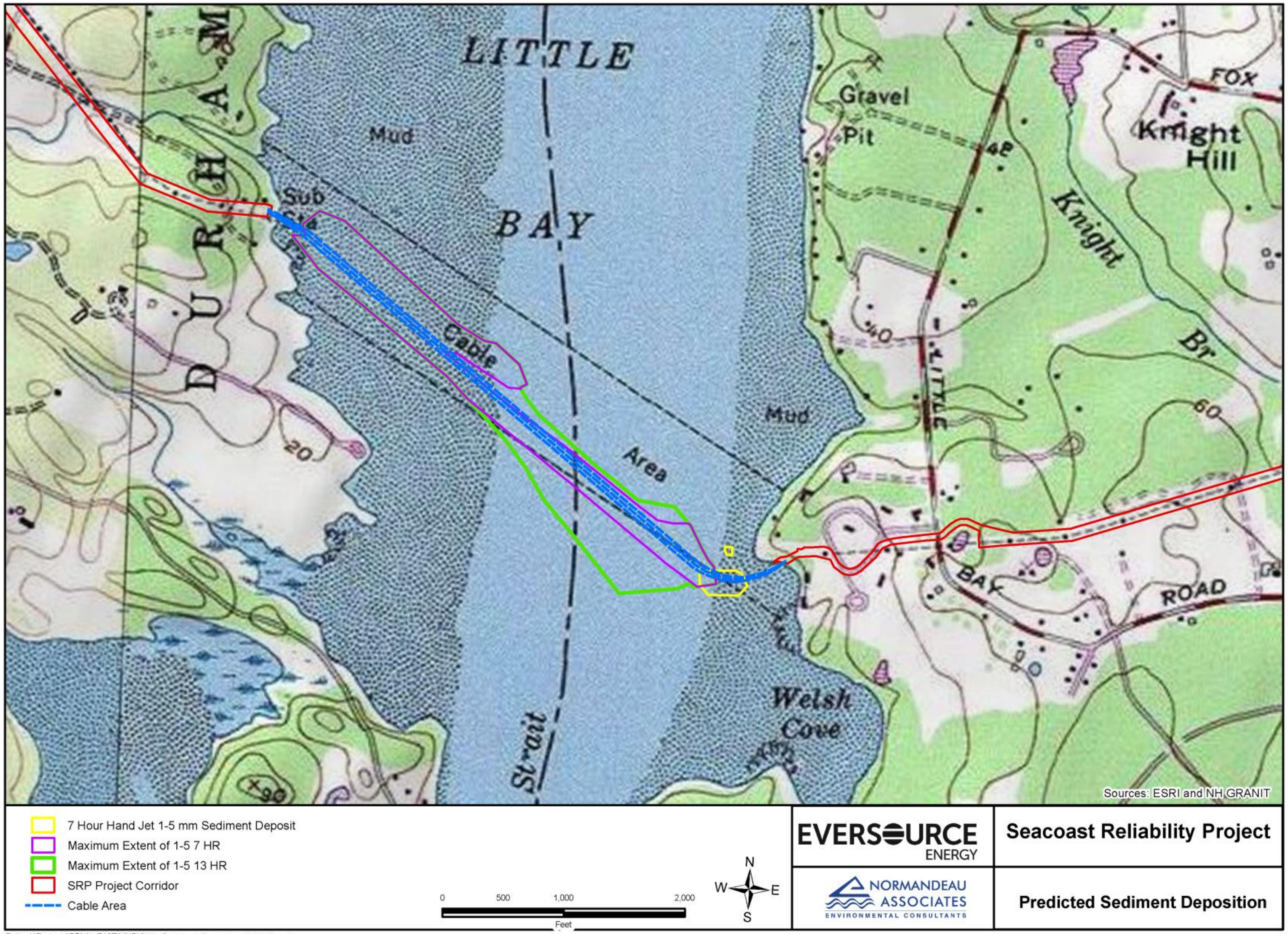

Figure 1. Area predicted to experience redeposition of sediments suspended during jet plowing or hand jetting.

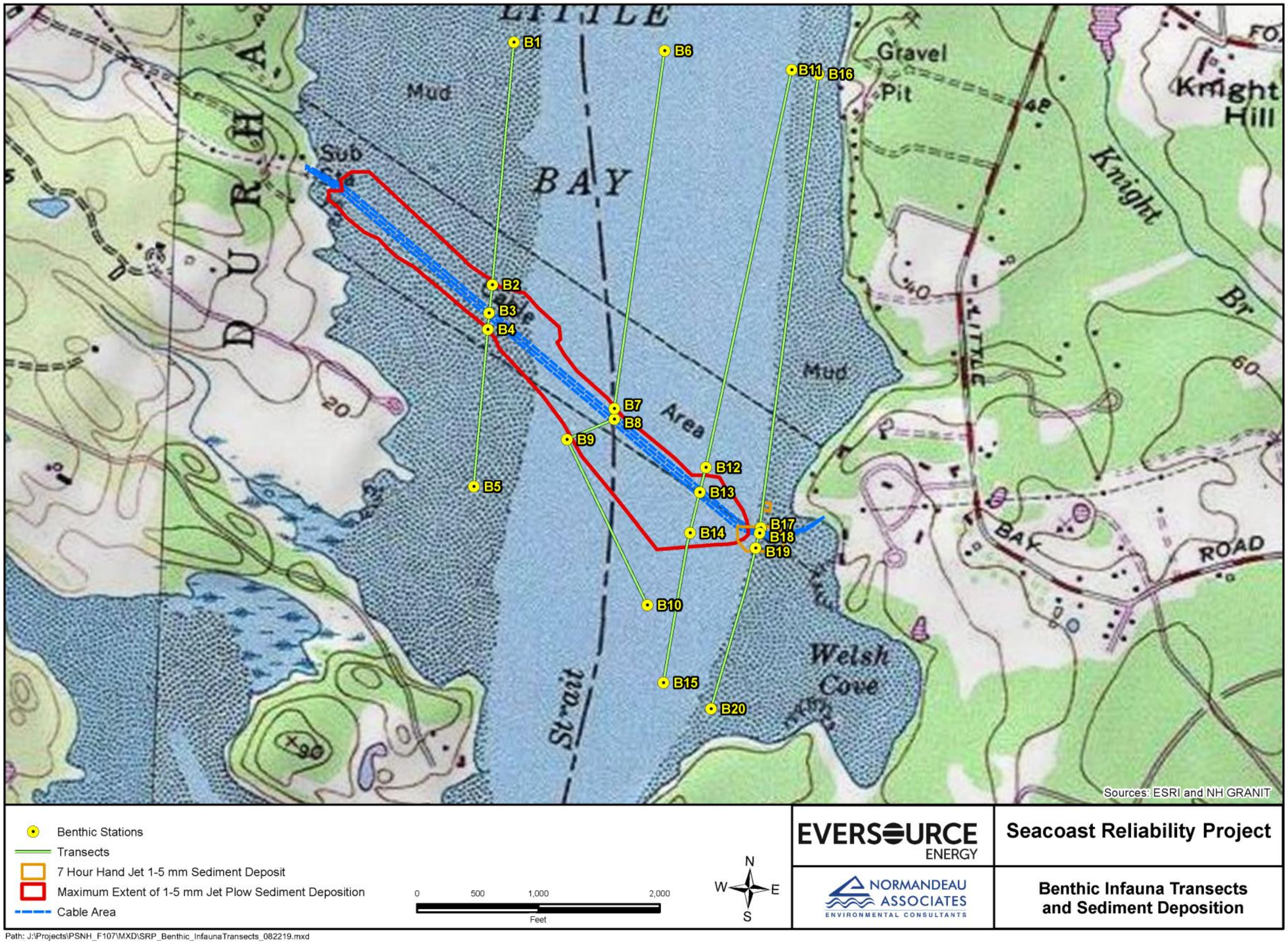

Figure 2. Location of benthic infauna monitoring stations relative to predicted deposition.

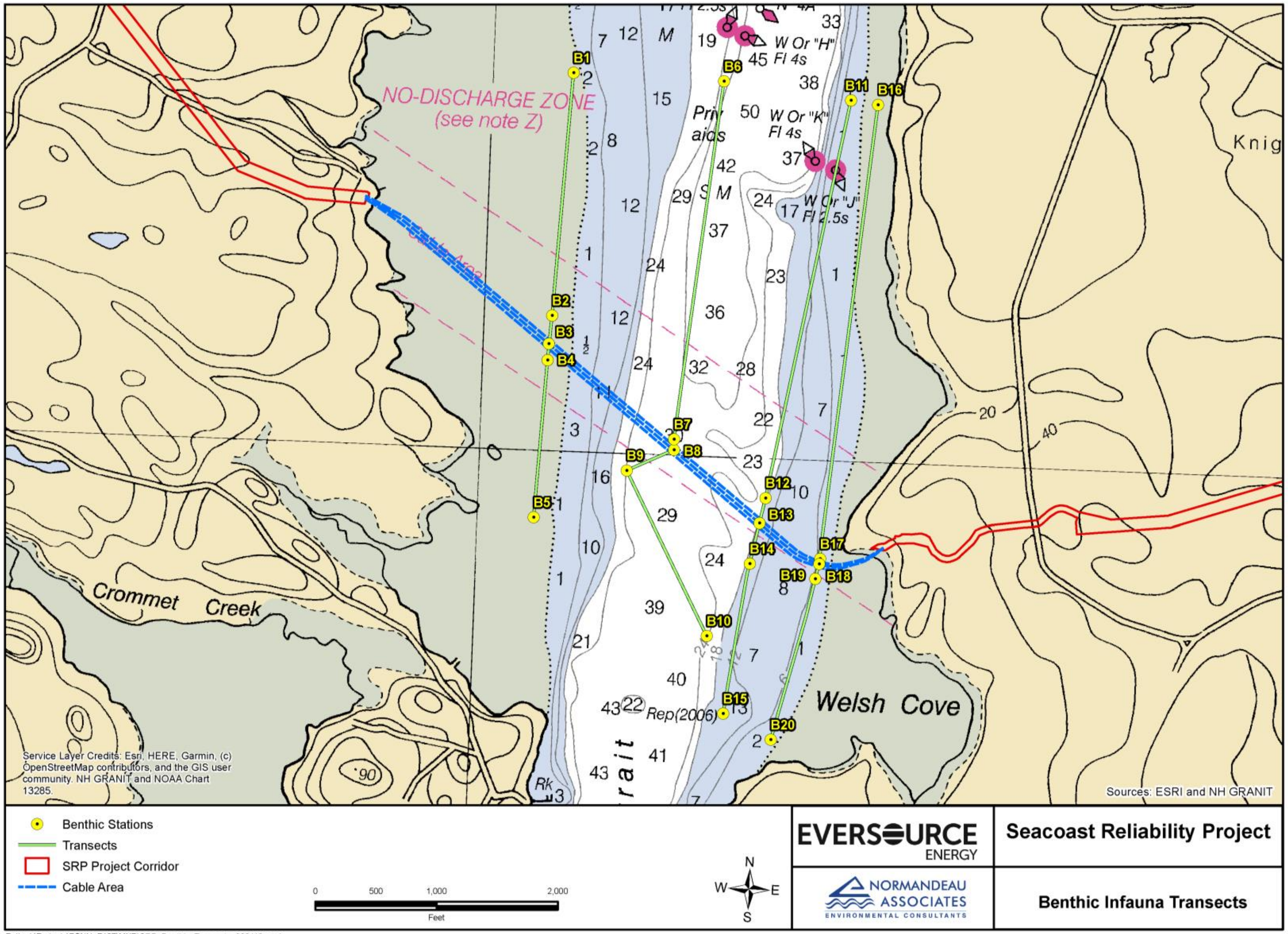

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Figure 3. Location of benthic infauna monitoring stations relative to existing bathymetry.

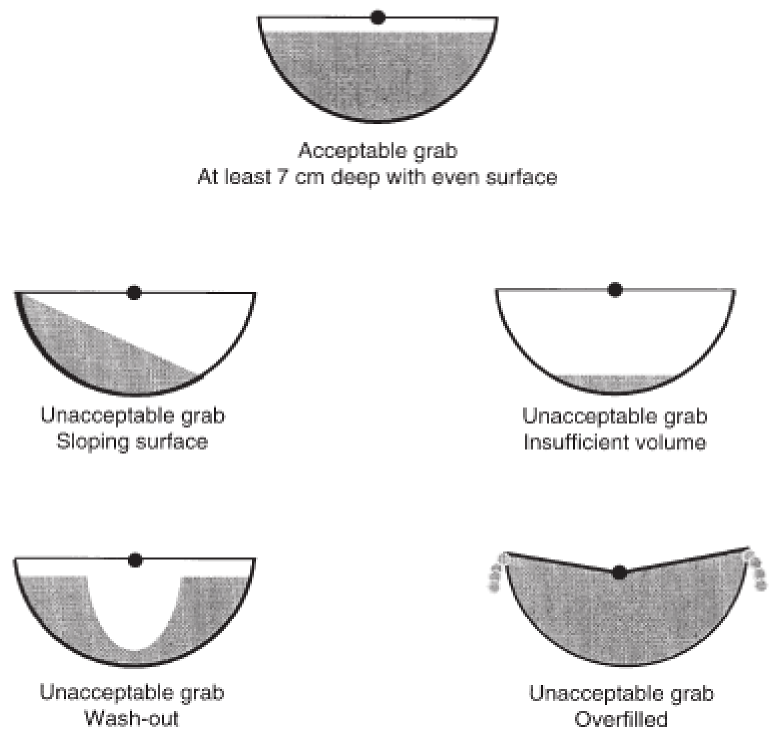

Figure 4. Illustration of acceptable & unacceptable grabs for benthic community analysis. An acceptable grab is at least 7 cm in depth (using a 0.04m2 Van Veen sampler), but not oozing out of the top of the grab, and has a relatively level surface. (Source: USEPA 2014a).

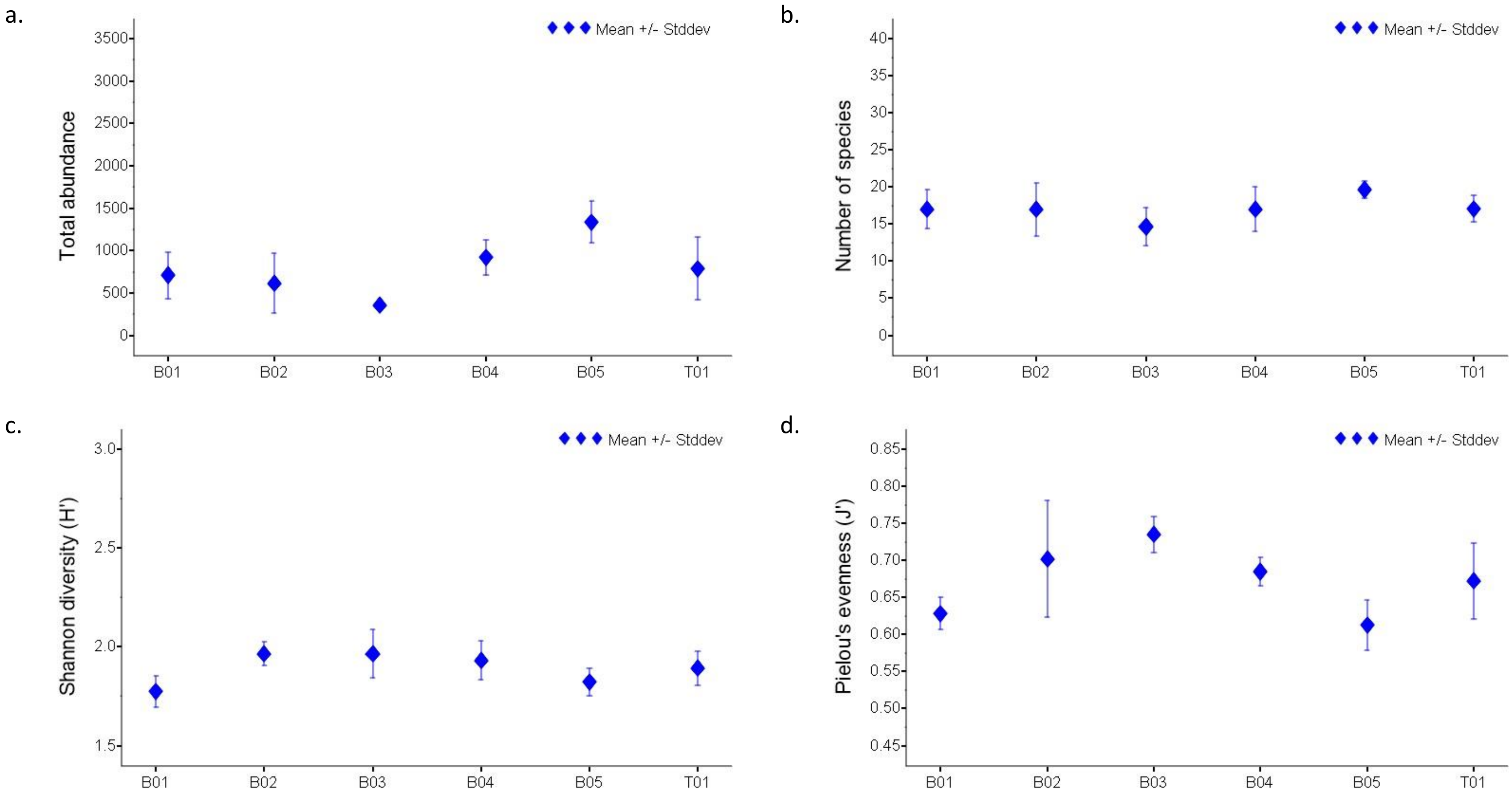

Figure 5. Biological parameters for Transect 1, Western Tidal Flat, during baseline survey, July-August 2019.

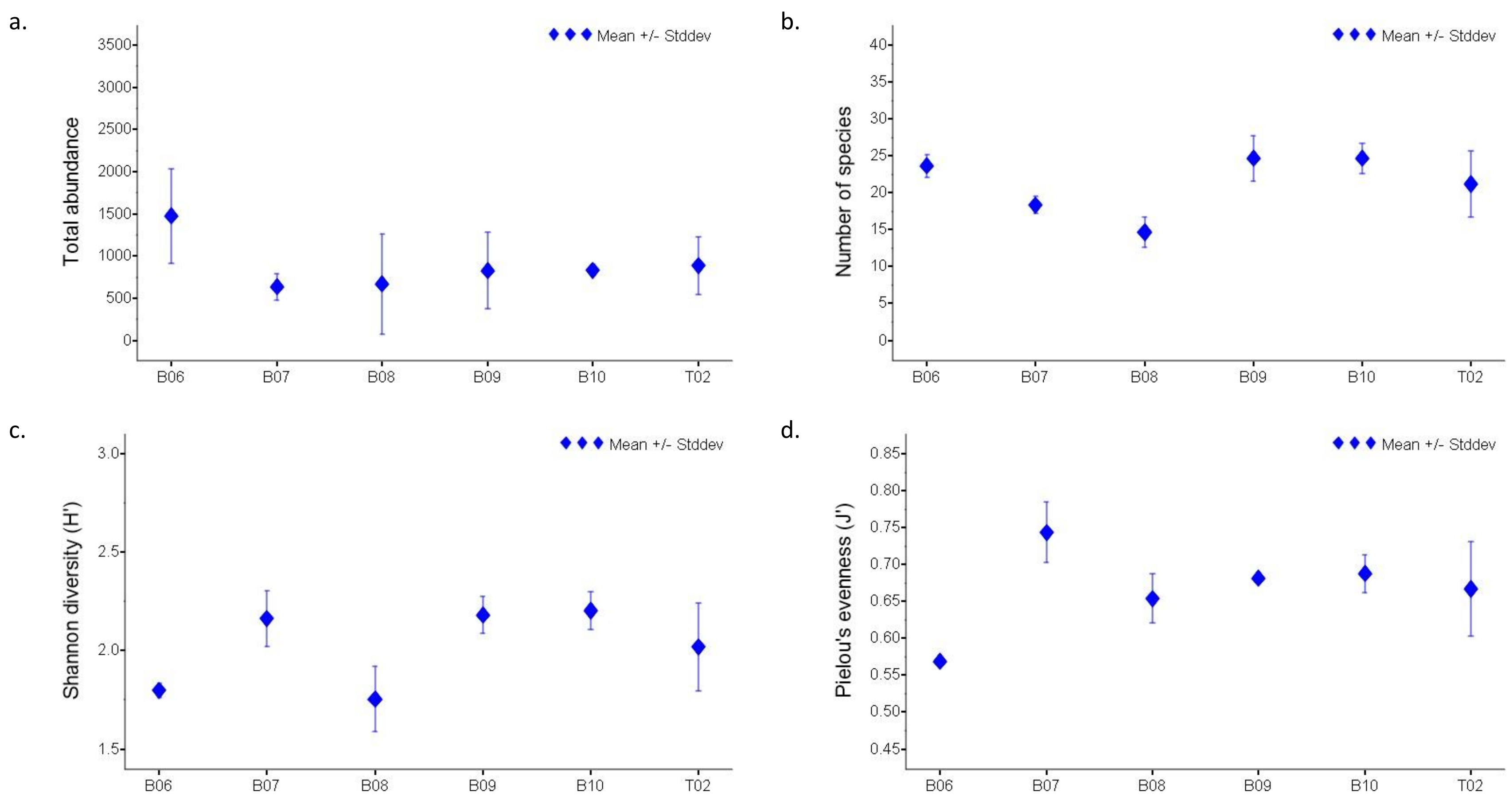

Figure 6. Biological parameters for Transect 2, Channel, during baseline survey, July-August 2019.

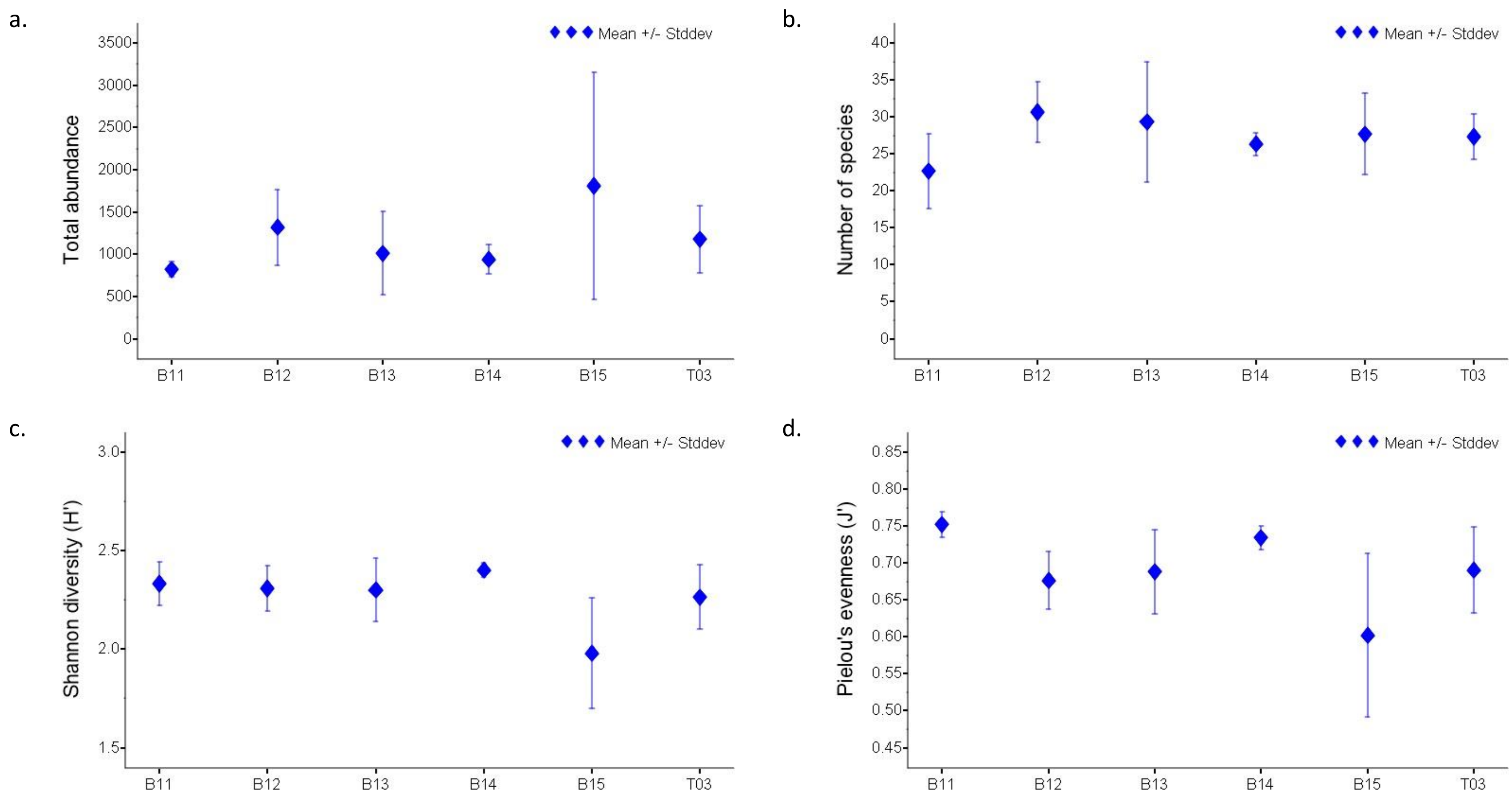

Figure 7. Biological parameters for Transect 3, Channel slope, during baseline survey, July-August 2019.

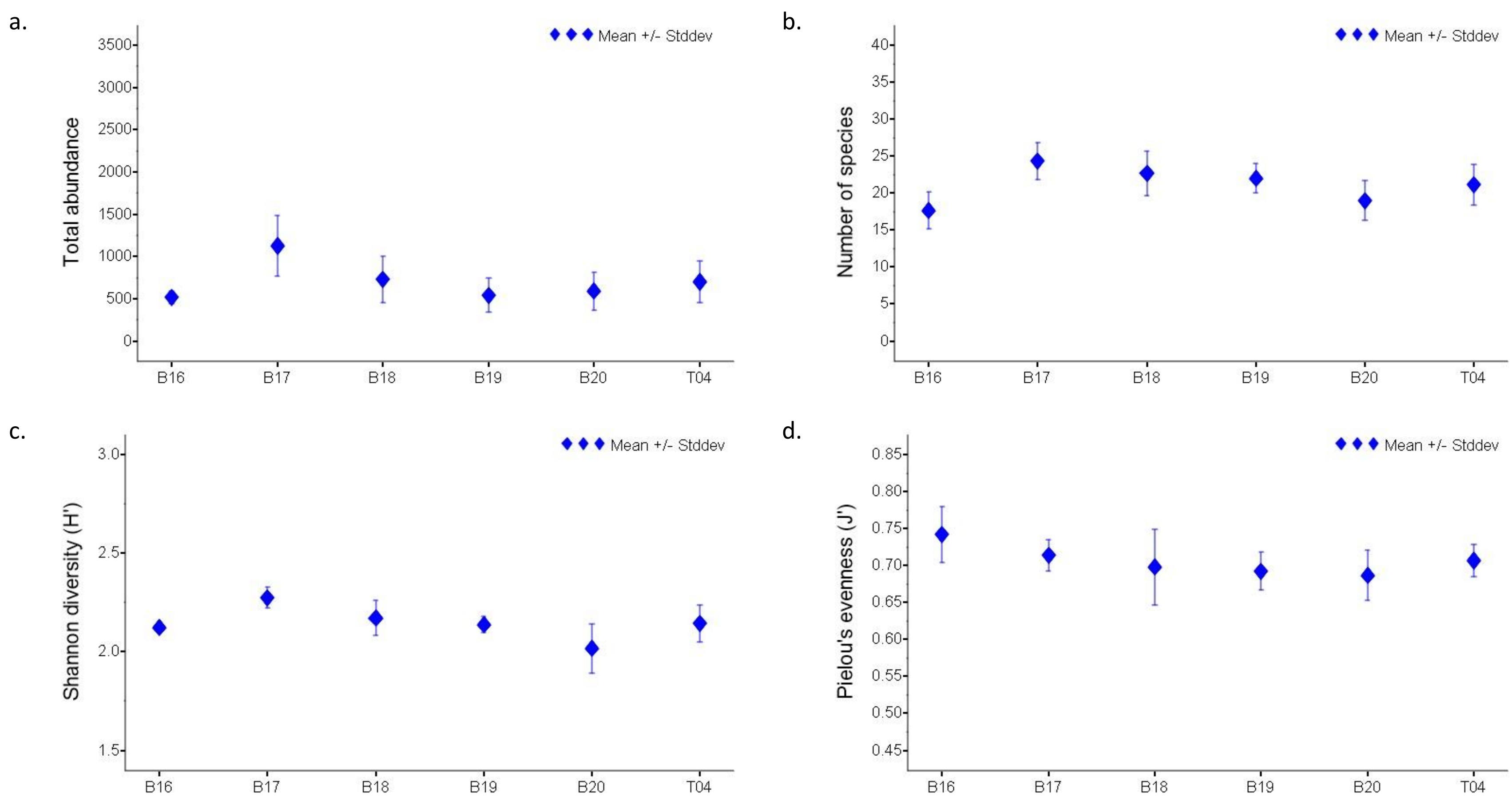

Figure 8. Biological parameters for Transect 4, Eastern Shallow Subtidal, during baseline survey, July-August 2019.

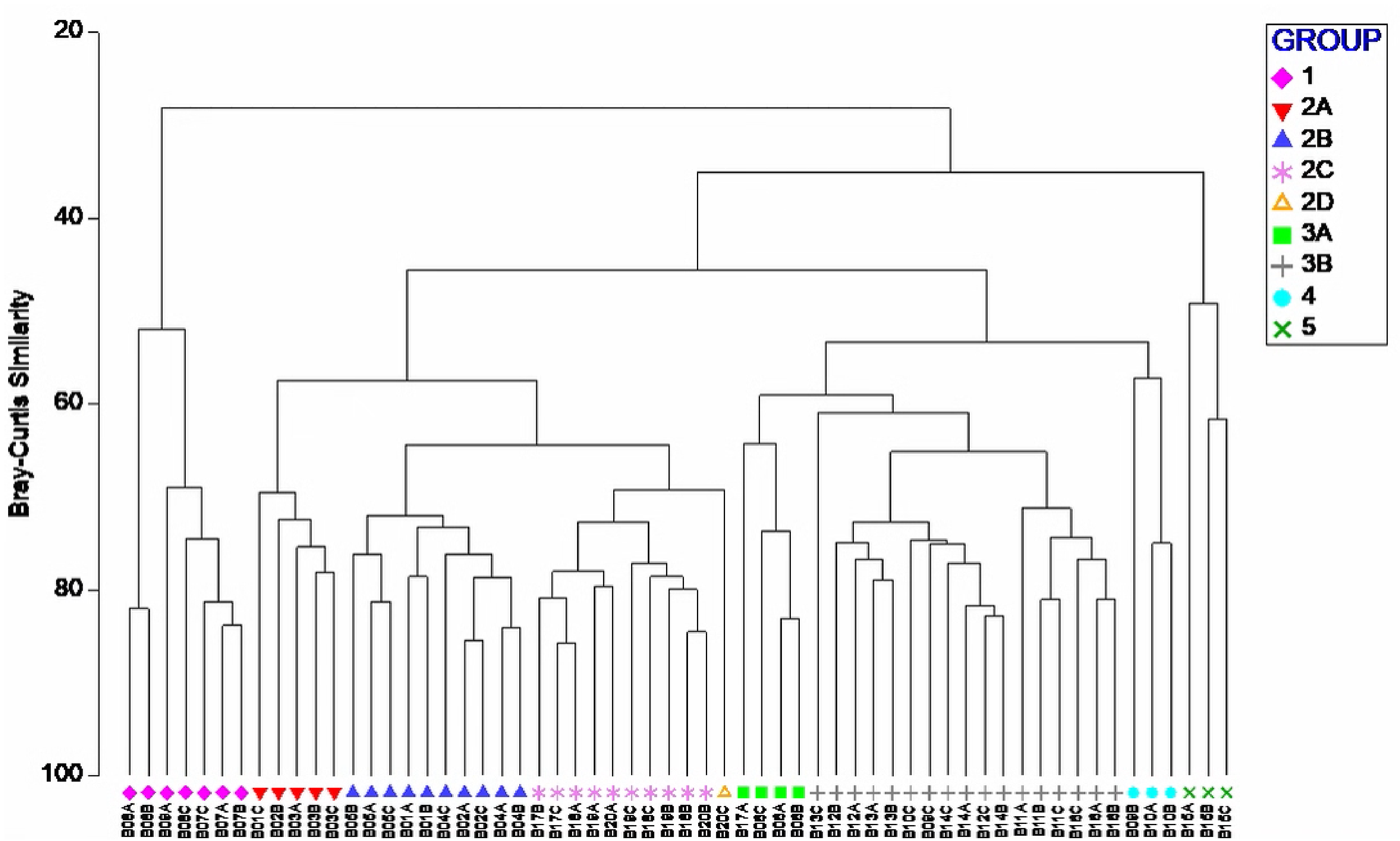

Figure 9. Dendrogram formed from numerical classification of replicate samples collected along transects in the SRP project area during baseline survey, July-August 2019.

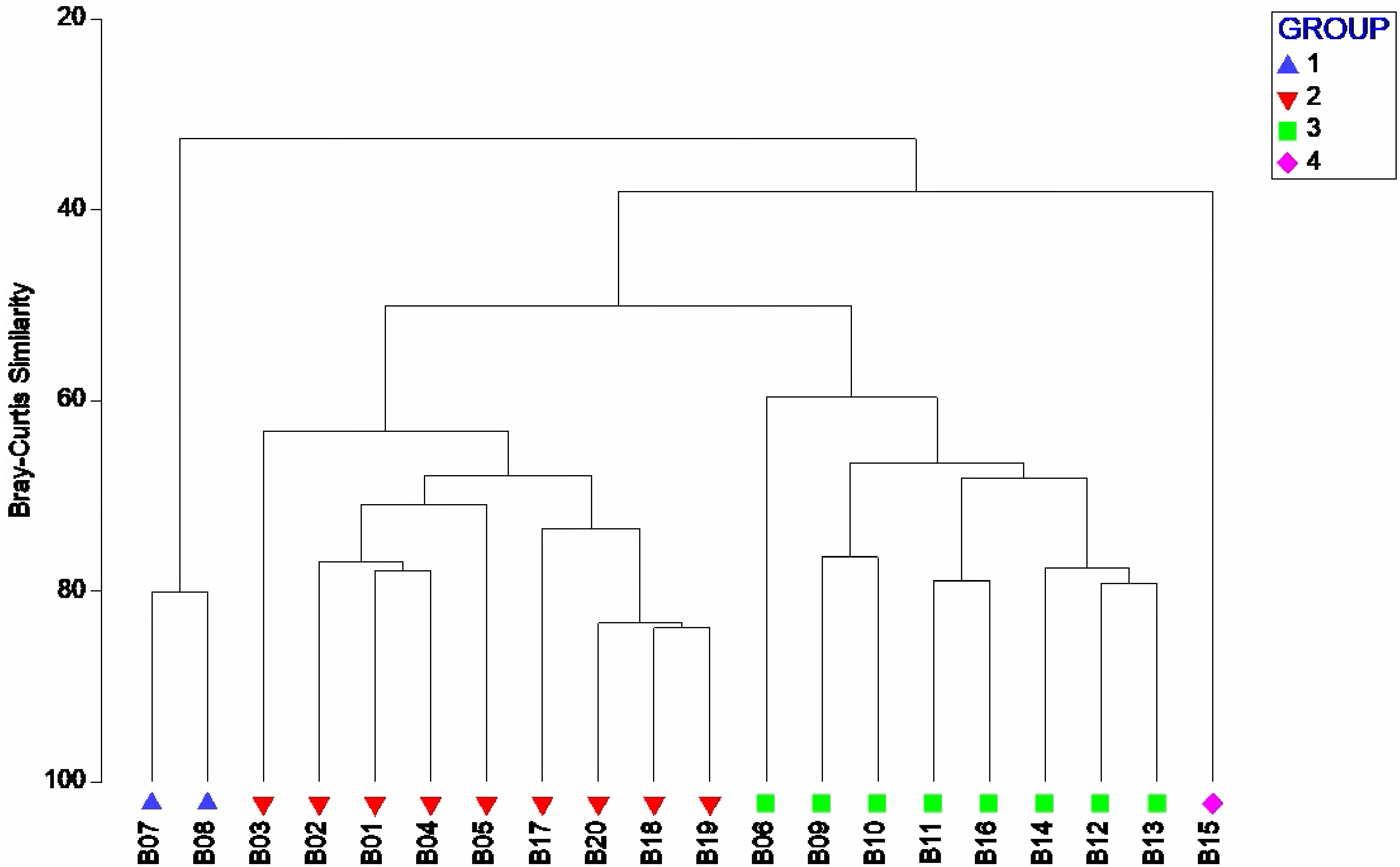

Figure 10. Dendrogram formed from numerical classification of mean of replicates collected along transects in the SRP project area during baseline survey, July-August 2019.

Tables

Table 1. Coordinates of Benthic Infauna Monitoring Stations

Transect	Purpose	Station	Latitude	Longitude	Transect	Purpose	Station	Latitude	Longitude
Intertidal (West)	Reference	B1	43.10856	-70.8642	Slope	Reference	B11	43.10817	-70.85577
	Impact	B2	43.10305	-70.8646		Impact	B12	43.09911	-70.8578
		B3	43.10241	-70.8646			B13	43.09854	-70.8579
		B4	43.10204	-70.8647			B14	43.09762	-70.8582
	Reference	B5	43.09848	-70.8649		Reference	B15	43.09421	-70.8588
Channel	Reference	B6	43.10850	-70.8595	Shallow Subtidal	Reference	B16	43.10817	-70.8553
	Impact	B7	43.10036	-70.8607		Impact	B17	43.09779	-70.856
		B8	43.10012	-70.8606			B18	43.09767	-70.856
		B9	43.0986	-70.8623			B19	43.09733	-70.8561
	Reference	B10	43.09563	-70.85902		Reference	B20	43.09366	-70.8573

Table 2. Summary of Benthic Grab Collections

Station	Purpose	Baseline		Post-Construction	
		No. of Infauna Samples	No. of Sediment Samples[a]	No. of Infauna Samples	No. of Sediment Samples[a]
B1	Tidal flat reference	3	1	3	1
B2	Tidal flat deposition	3	1	3	1
B3	Tidal flat jet plow	3	1	3	1
B4	Tidal flat deposition	3	1	3	1
B5	Tidal flat reference	3	1	3	1
B6	Channel reference	3	1	3	1
B7	Channel deposition	3	1	3	1
B8	Channel jet plow	3	1	3	1
B9	Channel deposition	3	1	3	1
B10	Channel reference	3	1	3	1
B11	Slope reference	3	1	3	1
B12	Slope deposition	3	1	3	1
B13	Slope jet plow	3	1	3	1
B14	Slope deposition	3	1	3	1
B15	Slope reference	3	1	3	1
B16	Hand jet reference	3	1	3	1
B17	Hand jet deposition	3	1	3	1
B18	Hand jet centerline	3	1	3	1
B19	Hand jet deposition	3	1	3	1
B20	Hand jet reference	3	1	3	1
Total		**60**	**20**	**60**	**20**

[a] grain size and TOC analysis

Table 3. Primary Parameters for Measuring Successful Restoration of Benthic Habitat and Community

Parameter	Rationale for Including	Criterion for Acceptance (Comparison of BACI and Impact to Non-impact Stations within same depth zone)
	Physicochemical Factors	
Grain size distribution	Important factor influencing benthic infaunal community composition, particularly for species associated with sand (Sanders 1958; Snelgrove and Butman 1994); the phi scale is an expression of the grain size distribution reflecting all size components.	Comparison of the median phi value for pre- and post-construction at each station shows no change of median phi size from sand (phi between -1.0 and 4.0) to silt (phi between 4.0 and 8.0) or vice versa unless also observed in one or more reference stations along a specific transect, then it will be concluded that changes in grain size are not significant
TOC	Indicator of eutrophication level and factor influencing infaunal community structure; was generally low in NCCA Little Bay data and site specific samples. Sediment testing along the cable route in 2016 showed TOC levels below 2%. Examining benthic communities throughout the world, Hyland et al. (2005) found changes in benthic infaunal communities occurred at TOC >3%.	Post-construction TOC not to exceed 3% unless also observed in one or more reference stations along same transect
	Biological Factors	
Total Infauna Abundance	Abundance of benthic infauna is an indicator of food resources for secondary consumers such as demersal fishes. However, taken alone absolute abundance can be deceptive because it does not reflect the “quality” of this forage base since numerous small infauna do not provide the same food value as fewer more robust organisms.	Normality of the data will be determined using SAS univariate procedures; based on this data transformation may be required before running a one-way ANOVA comparing stations within a transect and sampling periods. Significance will be based on $p \leq 0.1$. If data cannot be normalized, comparisons will be made using a nonparametric equivalent to ANOVA
Taxa Richness	Taxa richness is an indication of the diversity of the infaunal community and provides an indication of the resilience of the benthos to environmental perturbations.	Normality of the data will be determined using SAS univariate procedures; based on this data transformation may be required before running a one-way ANOVA comparing stations within a transect and sampling periods. Significance will be based on $p \leq 0.10$. If data cannot be normalized, comparisons will be made using a nonparametric equivalent to ANOVA

Parameter	Rationale for Including	Criterion for Acceptance (Comparison of BACI and Impact to Non-impact Stations within same depth zone)
Species Diversity (Shannon Weiner H')	Diversity provides a measure of the resilience of a community. A community with a wide variety of species is better able to withstand ecological perturbations than a community based on few species. Higher diversity is considered a positive community attribute; no upper limit.	Means and standard deviations within each station along a transect will be presented graphically for baseline and post-construction results. If the means of the impact area stations fall within the range of the standard deviations of the reference stations, results will be considered similar. If there are differences among stations along a transect in baseline collections, but the post-construction results exhibit the same pattern as the baseline, it will be concluded that there are no substantial differences over time.
Evenness (Pielou's J')	Evenness indicates whether the community is dominated by a few species or if the abundance is more equally distributed across the majority of species. Evenness values can range from 0 to 1 with higher values considered to be a positive community attribute.	Means and standard deviations within each station along a transect will be presented graphically for baseline and post-construction results. If the means of the impact area stations fall within the range of the standard deviations of the reference stations, results will be considered similar. If there are differences among stations along a transect in baseline collections, but the post-construction results exhibit the same pattern as the baseline, it will be concluded that there are no substantial differences over time.
Similarity of Community Structure	Numerical classification measures the similarity of species composition and abundances among groups of samples. For marine benthos, a similarity of 60% is typically considered to indicate comparable communities (Boesch 1977). This is a powerful tool for handling complex datasets with numerous species.	Because project specific data reported in Normandeau (2016b) indicated community structure varied between the depth-oriented transects, this analysis will be conducted on a transect-by-transect basis, using both pre-construction and post-construction data. Based on Bray-Curtis similarity, impact station clusters must show a similarity value of 60% or higher to at least one non-impact station within a given transect

Table 4. Secondary, Descriptive Parameters for Interpreting Temporal or Spatial Differences in Benthic Community

Parameter	Rationale for Including[a]
Abundance of Opportunistic Species (e.g., *Polydora cornuta, Streblospio benedicti and Capitella capitata*)	Opportunistic species are small bodied species with high reproductive rates that are able to rapidly populate disturbed sediments. They are typically surface deposit feeders and represent early stages of community development but are often present in a community of a mixed successional stage. They can reflect a habitat that undergoes frequent low level disturbances. The species included in this factor were all observed in the 2014 collections in the project area. Because these species can be quite ephemeral, it is often valuable to exclude them from statistical analyses to examine the key attributes of the rest of the community members of which reflect the more stable component of the community (Nestler, et al. 2013).
Similarity of Dominant Species	Benthic infauna in estuaries frequently exhibit a relatively high degree of small scale variability among the less abundant species. Dominant species generally occur over wider area and, therefore, may be more readily available for recruitment to disturbed substrates. Thus if dominant taxa differ between impacted and non-impacted stations or their relative abundances vary substantially this could be an indication that recovery has not occurred completely.
Feeding Guilds	Feeding guilds provide an indication of the successional stage of the benthic community. Surface deposit feeders are early settlers (potentially within days to weeks of disturbance because of their ability to reproduce frequently) whereas subsurface deposit feeders typically take longer to populate a disturbed area and have longer reproductive cycles (Wilber and Clarke 2007).

Table 5. Sediment grain size (percent) and total organic carbon (percent) at benthic infaunal stations during baseline sampling, July-August 2019.

Parameter		Station																			
		Western Tidal Flat					Channel					Channel Slope					Eastern Shallow Subtidal				
		B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20
Gravel	**Coarse**	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
	Med.	0	0	0	0	4	0	0	0	1	0	0	4	0	11	0	0	0	0	0	2
	Fine	0	0	0	0	1	1	2	0	1	0	1	0	1	0	1	1	2	2	0	1
	V. Fine	0	0	1	0	1	1	0	0	1	0	1	2	0	1	2	0	1	1	1	1
Sand	**Very Coarse**	1	0	0	0	0	1	3	1	0	0	2	1	1	1	1	1	2	1	1	0
	Coarse	0	1	0	1	1	0	2	16	2	2	6	1	1	1	1	7	2	3	2	2
	Med.	1	1	1	0	0	1	60	70	3	60	19	6	11	13	5	23	11	10	5	6
	Fine	1	3	3	3	4	48	11	8	58	32	56	66	74	63	42	45	28	31	17	16
	V. Fine	19	44	39	42	46	39	1	1	24	1	11	10	6	6	31	16	29	30	39	39
Silt		55	33	37	35	25	4	1	3	7	3	2	2	2	4	7	3	14	13	21	21
Clay		23	18	19	19	18	5	1	1	3	2	2	5	4	0	10	4	11	9	14	12
% Fines		***78***	***51***	***56***	***54***	***43***	***9***	***2***	***4***	***10***	***5***	***4***	***7***	***6***	***4***	***17***	***7***	***25***	***22***	***35***	***33***
Median Phi Size[a]		***6***	***6***	***6***	***6***	***3.5***	***2.5***	***1.5***	***1.5***	***2.5***	***1.5***	***1.5***	***1.5***	***1.5***	***1.5***	***1.5***	***1.5***	***3.5***	***3.5***	***3.5***	***3.5***
Total Organic Carbon		0.865	0.565	0.64	0.57	0.59	0.40	<0.2	<0.2	0.315	<0.2	<0.2	<0.2	0.10	0.235	1.38	<0.2	0.275	0.265	0.44	0.325

[a] Phi categories:
clay = 8 to 10
silt = 4 to 8
very fine sand = 3 to 4
fine sand = 2 to 3
medium sand = 1 to 2
coarse sand = 0 to 1
very coarse sand = -1 to 0
very fine gravel = -1 to -2
fine gravel = -2 to -3
medium gravel = -4 to -3
coarse gravel = -4 to -5

Table 6. Species richness, Abundance (no./0.04 m^2), Shannon Weiner Diversity (H') and Pielou's Evenness (J') of replicate samples collected during baseline survey with the SRP area, July-August 2019.

Station_Rep	#Species	Abundance	H'(Loge)	J'
B01A	20	821	1.86	0.62
B01B	15	912	1.77	0.65
B01C	16	399	1.70	0.61
B02A	18	846	1.92	0.66
B02B	13	204	2.03	0.79
B02C	20	795	1.94	0.65
B03A	17	422	2.10	0.74
B03B	15	323	1.92	0.71
B03C	12	326	1.88	0.75
B04A	20	1083	2.05	0.68
B04B	14	994	1.86	0.70
B04C	17	690	1.89	0.67
B05A	19	1596	1.82	0.62
B05B	21	1304	1.75	0.58
B05C	19	1113	1.89	0.64
B06A	25	2036	1.84	0.57
B06B	24	1477	1.79	0.56
B06C	22	919	1.77	0.57
B07A	19	515	2.33	0.79
B07B	19	583	2.10	0.71
B07C	17	810	2.06	0.73
B08A	14	350	1.63	0.62
B08B	13	304	1.68	0.66
B08C	17	1351	1.94	0.69
B09A	24	931	2.16	0.68
B09B	22	328	2.10	0.68
B09C	28	1227	2.28	0.69
B10A	23	858	2.23	0.71
B10B	27	755	2.29	0.69
B10C	24	879	2.10	0.66
B11A	28	899	2.45	0.73
B11B	18	844	2.23	0.77
B11C	22	724	2.33	0.75
B12A	30	1770	2.18	0.64
B12B	35	1312	2.39	0.67
B12C	27	877	2.36	0.72
B13A	38	1418	2.45	0.67
B13B	28	1152	2.13	0.64
B13C	22	464	2.32	0.75
B14A	28	1135	2.39	0.72
B14B	26	870	2.44	0.75
B14C	25	811	2.37	0.74

Station_Rep	#Species	Abundance	H'(Loge)	J'
B15A	34	3244	1.72	0.49
B15B	25	569	2.28	0.71
B15C	24	1618	1.94	0.61
B16A	15	596	2.12	0.78
B16B	20	503	2.12	0.71
B16C	18	457	2.13	0.74
B17A	22	1525	2.28	0.74
B17B	27	818	2.33	0.71
B17C	24	1033	2.22	0.70
B18A	20	1042	2.17	0.73
B18B	22	547	2.26	0.73
B18C	26	598	2.08	0.64
B19A	24	774	2.16	0.68
B19B	22	445	2.09	0.68
B19C	20	404	2.16	0.72
B20A	20	843	1.94	0.65
B20B	21	517	2.16	0.71
B20C	16	410	1.95	0.70

Table 7. Dominant taxa (top ten taxa within any group) within groups (1-5) and subgroups (2a-2d and 3a-3b) from numerical classification of replicate samples collected along transects in the SRP project area during baseline survey, July-August 2019.

Major Taxon	Species	_1	2.0	_2a	_2b	_2c	_2d	3.0	_3a	_3b	_4	_5
Polychaeta	*Aricidea (Acmira) catherinae*	43.4	0.5	0.4	-	1.0	-	92.2	127.0	84.0	192.0	84.7
	Scolelepis (Parascolelepis) texana	38.0	17.5	4.8	11.2	30.2	16.0	133.0	189.0	119.8	124.7	9.3
	Cirratulidae	0.9	10.7	2.4	20.2	6.4	-	28.2	29.0	28.0	2.7	-
	Heteromastus filiformis	0.3	99.4	54.0	128.0	96.4	70.0	18.5	32.5	15.2	2.0	7.3
	Hypereteone heteropoda	4.3	17.2	1.6	19.2	24.2	4.0	31.1	40.0	29.1	18.7	28.0
	Leitoscoloplos robustus	-	11.8	8.4	9.4	16.4	6.0	8.4	30.0	3.3	0.7	0.7
	Leitoscoloplos sp.	-		0.8	3.2	12.4	-		8.5	0.6	-	-
	Manayunkia speciosa	-		-	-	-	-	0.2	0.5	0.1	2.0	41.3
	Microphthalmus sczelkowii	-		0.4	23.4	-	-		-	0.1	-	-
	Paraonis fulgens	6.3		-	-	-	-	0.1	-	0.1	49.3	-
	Polycirrus sp.	0.3		-	-	-	-	1.0	-	1.3	0.7	29.3
	Polydora cornuta	-	5.5	0.8	3.8	8.6	14.0	17.4	4.0	20.6	5.3	219.3
	Pygospio elegans	107.1	6.5	-	3.0	13.2	8.0	17.9	34.5	14.0	12.0	1.3
	Scoletoma tenuis	-	97.8	115.8	107.2	81.0	82.0	10.7	11.5	10.5	-	20.0
	Spio filicornis	4.3		4.0	1.6	11.6	-		52.0	8.5	2.7	8.0
	Streblospio benedicti	62.3	219.0	45.6	302.6	230.9	130.0	133.6	236.0	109.5	14.0	36.7
	Streptosyllis arenae	12.6		-	-	-	-		-	-	-	-
	Tharyx acutus	1.1	137.2	46.8	224.6	102.8	58.0	268.3	560.0	199.6	62.7	40.7
Oligochaeta	Oligochaeta	72.0	47.2	3.2	111.6	9.2	4.0	128.1	41.0	148.6	58.7	29.3
Gastropoda	*Haminoea solitaria*	-		6.8	3.4	0.2	-		-	-	-	-
	Tritia obsoleta	-	12.7	21.2	16.2	6.2	-	0.5	-	0.6	-	-
Bivalvia	*Ameritella agilis*	13.1	1.9	1.2	1.8	2.6	-	12.5	25.5	9.4	4.7	0.7
	Mulinia lateralis	-		9.2	8.0	1.4	4.0		-	-	-	-
Arthropoda	*Acanthohaustorius millsi*	77.0		-	-	-	-	0.2	-	0.2	6.7	-
	Grandidierella japonica	1.1	3.2	0.8	0.8	7.0	-	38.6	6.3	46.2	8.0	25.0
	Melita nitida	-	0.4	-	0.8	0.2	-	18.8	-	23.2	0.7	579.0
	Microdeutopus gryllotalpa	0.3	1.0	-	1.6	0.8	2.0	22.3	2.0	27.1	2.0	555.3
	Oxyurostylis smithi	9.1		0.4	0.8	9.3	4.0		0.5	5.6	7.3	0.7
	Protohaustorius cf. deichmannae	-		-	-	-	-	0.1	-	0.1	14.7	-
	Rhepoxynius hudsoni	15.7		-	-	-	-	0.2	-	0.2	4.7	-
	Tanaissus sp. a	206.4	0.1	-	0.2	-	-	0.4	-	0.5	19.7	-
Misc. Phyla	*Stereobalanus canadensis*	0.1		-	-	-	-	4.3	-	5.4	16.3	-

Table 8. Dominant taxa (top ten taxa within any group) in groups formed by numerical classification of mean abundances at stations in the SRP project area during baseline survey, July-August 2019.

Major Taxon	Species	_1	_2	_3	_4
Polychaeta	*Aricidea (Acmira) catherinae*	20.7	2.6	109.8	84.7
	Scolelepis (Parascolelepis) texana	33.3	26.1	124.2	9.3
	Cirratulidae	0.3	10.7	24.7	-
	Heteromastus filiformis	-	99.9	11.8	7.3
	Hypereteone heteropoda	3.7	18.1	28.1	28.0
	Leitoscoloplos robustus	-	12.8	5.8	0.7
	Manayunkia speciosa	-	-	0.4	41.3
	Polycirrus sp.	0.3	-	1.0	29.3
	Polydora cornuta	-	5.9	15.3	219.3
	Pygospio elegans	111.3	10.2	16.2	1.3
	Scoletoma tenuis	-	94.3	9.2	20.0
	Streblospio benedicti	45.3	226.8	107.6	36.7
	Streptosyllis arenae	14.3	-	0.1	-
	Tharyx acutus	0.7	138.3	235.8	40.7
Oligochaeta	Oligochaeta	80.3	49.0	116.3	29.3
Gastropoda	*Tritia obsoleta*	-	12.2	0.4	-
Bivalvia	*Ameritella agilis*	11.7	2.1	12.2	0.7
Arthropoda	*Acanthohaustorius millsi*	86.3	-	1.9	-
	Grandidierella japonica	-	3.4	34.7	25.0
	Melita nitida	-	0.4	16.5	579.0
	Microdeutopus gryllotalpa	-	1.1	19.7	555.3
	Rhepoxynius hudsoni	16.7	-	1.2	-
	Tanaissus sp. a	196.5	0.1	13.9	-

Table 9. Occurrence of opportunistic species in baseline samples

Transect	Station	Opportunistic Species Present	Relative abundance of all opportunists
Western tidal flat (Transect 1)	BO1	*Polydora cornuta, Streblospio benedicti*	27.3
	B02	*Streblospio benedicti*	27.9
	B03	*Polydora cornuta, Streblospio benedicti*	14.2
	B04	*Polydora cornuta, Streblospio benedicti*	28.0
	B05	*Polydora cornuta, Streblospio benedicti, Capitella capitata* complex	29.7
Channel (Transect 2)	B06	*Streblospio benedicti*	11.4
	B07	*Streblospio benedicti*	10.2
	B08	*Streblospio benedicti*	3.5
	B09	*Polydora cornuta, Streblospio benedicti, Capitella capitata* complex	9.9
	B10	*Polydora cornuta, Streblospio benedicti, Capitella capitata* complex	5.1
Slope (Transect 3)	B11	*Polydora cornuta, Streblospio benedicti, Capitella capitata* complex	13.0
	B12	*Polydora cornuta, Streblospio benedicti, Capitella capitata* complex	16.3
	B13	*Polydora cornuta, Streblospio benedicti, Capitella capitata* complex	16.0
	B14	*Polydora cornuta, Streblospio benedicti, Capitella capitata* complex	14.8
	B15	*Polydora cornuta, Streblospio benedicti, Capitella capitata* complex	14.8
Eastern Shallow Subtidal (Transect 4)	B16	*Polydora cornuta, Streblospio benedicti, Capitella capitata* complex	14.9
	B17	*Polydora cornuta, Streblospio benedicti, Capitella capitata* complex	31.1
	B18	*Polydora cornuta, Streblospio benedicti, Capitella capitata* complex	32.6
	B19	*Polydora cornuta, Streblospio benedicti*	30.5
	B20	*Polydora cornuta, Streblospio benedicti*	34.0

Table 10. Relative abundance and feeding type of dominant taxa by station during baseline collections along the SRP survey area, July-August 2019.

Taxon	Feeding type	Relative abundance (% of mean no. of individuals per 0.04 m²)																			
		B01	B02	B03	B04	B05	B06	B07	B08	B09	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20
Scoletoma tenuis	C (s)	16.2	20.8	27.6	13.7	*	*					*	*	*		*	*	*	12.6	9.9	14.1
Aricidea (Acmira) catherinae	SSD			*			10.0	*	*	16.5	19.9	10.9	*	*	12.0	*	*	*	*	*	*
Polydora cornuta	SD/F	*		*	*	*				*	*	*	*	*	*	11.6	*	*	*	*	*
Pygospio elegans	SD/F		*			*	*			*	*	*	*	*	*	*	*	*	*	*	*
Streblospio benedicti	SD	26.7	27.9	13.6	27.3	28.9	11.4	10.2	*	*	*	12.0	14.0	11.5	*		13.4	30.1	31.3	29.2	31.9
Scolelepis (Parascolelepis) texana	SD	*	*	*	*	*	11.2	*	*	*	16.5	12.4	18.2	*	13.3	*	14.5	10.1	*	*	*
Cirratulidae	SD	*	*	*	*	*	*	*		*	*	*	*	*	*		11.1	*	*	*	
Tharyx acutus	SD	23.2	16.2	15.4	13.6	26.4	45.9	*		15.5	10.6	15.4	20.0	22.9	21.7	*	16.0	12.1	13.2	15.5	14.1
Heteromastus filiformis	SSD	*	12.3	15.7	20.7	*	*			*	*	*	*	*	*	*	*	*	11.6	15.8	15.9
Oligochaeta	SSD	10.5	*		*	14.5	*	11.9	11.8	*	16.6	14.3	13.8	21.4	*	*	16.2	*	*	*	*
Tanaissus sp. A	C/F	*	*					26.6	31.0	13.3	*		*	*							
Microdeutopus gryllotalpa	H	*					*			*	*	*	*	*	*	29.3	*	*			*
Melita nitida	H	*								*	*		*	*	*	30.5		*			
Acanthohaustorius millsi	SSD							*	17.9	*	*		*	*							
Total %		**76.6**	**77.1**	**72.4**	**75.4**	**69.7**	**67.3**	**56.4**	**74.2**	**45.3**	**63.6**	**53.0**	**65.9**	**55.8**	**43.5**	**71.4**	**71.3**	**52.3**	**56.1**	**70.5**	**76.1**
% by feeding type	**C(s)**	16.2	20.8	27.6	13.7	0	0	0	0	0	0	0	0	0	0	0	0	0	12.6	9.9	14.1
	SSD	10.5	12.3	15.7	20.7	14.5	10	11.9	29.7	16.5	36.5	25.2	13.8	21.4	12	0	16.2	0	11.6	15.8	15.9
	SD/F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11.6	0	0	0	0	0
	SD	49.9	44.1	29	40.9	55.3	68.5	10.2	0	15.5	27.1	39.8	52.2	34.4	35	0	55	52.3	44.5	44.7	46
	C/F	0	0	0	0	0	0	26.6	31	13.3	0	0	0	0	0	0	0	0	0	0	0
	H	0	0	0	0	0	0	0	0	0	0	0	0	0	0	59.8	0	0	0	0	0

*present but <10%

Feeding types: C(s) = subsurface carnivore; SSD = subsurface deposit feeder; SD/F = surface deposit feeder; F = filter feeder; H = herbivore (grazer)

In % by feeding type = shading reflects feeding type represents more than 25% of the community abundance

Appendix Table Mean abundance (no. of individuals/0.04 m^2 averaged over three reps) on transects along SRP route

Major Group	Species	STATION									
		B01	B02	B03	B04	B05	B06	B07	B08	B09	B10
Cnidaria (anemone)	*Diadumene leucolena*										
Platyhelminthes	*Platyhelminthes* sp. 5 NAI						1			1	
	Platyhelminthes sp. 17 NAI										
Turbellaria	*Stylochus ellipticus*						1				
	Euplana gracilis										
Nemertea	*Carinoma tremaphoros*										
	Lineidae									1	
	Amphiporus bioculatus	4	1	1	1.67	1.5	2				
	Amphiporus ochraceus		1							1	
Nematoda	Nematoda	44	318	18	2497.33	1344	78.67	19.33	80	51.33	36
Polychaeta	*Harmothoe imbricata*										
	Pholoe tecta							2			
	Eteone longa										
	Hypereteone heteropoda	7	6	4	29.33	25.33	38.67	3.33	12	13.33	26
	Eteone lactea		2							2	2
	Eumida sanguinea										
	Microphthalmus sczelkowii	8	5		12	58				2	
	Syllidae										2

(continued)

Continued

Major Group	Species	STATION									
		B01	B02	B03	B04	B05	B06	B07	B08	B09	B10
Polychaeta (cont'd)	*Streptosyllis arenae*							11.33	17.33	2	
	Exogone hebes						9.33			2	
	Streptosyllis varians							6	26	2	2
	Neanthes arenaceodentata						8.67	4		6	2
	Hediste diversicolor										
	Glycera dibranchiata			2			2				
	Scoletoma tenuis	121.67	135.33	105.33	130.67	57.33	14				
	Leitoscoloplos robustus	8.67	7.33	8	12	9.33	26.67			16	2
	Leitoscoloplos sp.	2	4	2	7	4	9				
	Aricidea (Acmira) catherinae			2			150.33	13.33	28	169.33	180.67
	Paraonis fulgens							8	7	8	74
	Polydora cornuta	4		2	6	8.67				11	13
	Spio filicornis		2.67	5.33		6	54.67	8	2	4	3
	Spiophanes bombyx						2	2			
	Pygospio elegans		3			8	10.67	128.33	95	32.67	12
	Streblospio benedicti	201.33	181.33	52	260	390	171.33	66.33	24.67	78.67	28.67
	Scolelepis (Parascolelepis) texana	4	12.67	6	7.33	15.33	168	41.67	26.33	65.33	149.33
	Dipolydora quadrilobata			2		2					
	Cirratulidae	4	5	4	18	46	34.67	2		5.33	5.33
	Tharyx acutus	174.67	105.33	58.67	129.33	358.67	690.67	4		158.67	96
	Ophelina acuminata								7		
	Capitella capitata complex					4				12	4.67
	Heteromastus filiformis	67.33	80	60	196.67	112.67	5.33			5	6

(continued)

Continued

Major Group	Species	STATION									
		B01	B02	B03	B04	B05	B06	B07	B08	B09	B10
Polychaeta (cont'd)	Maldanidae										
	Clymenella torquata		4		4	2	6			16	2
	Euclymene collaris						2				
	Pectinaria gouldii										
	Ampharete oculata	2			4		2				
	Terebellidae										
	Polycirrus phosphoreus										
	Polycirrus sp.								2	8	2
	Sabellidae										
	Manayunkia speciosa						2			2	4
	Parasabella microphthalma										2
	Polygordius jouinae							2.67	4	4	
Oligochaeta	Oligochaeta	78.67	26		84.67	196.67	22.67	78	83.33	63.33	150
Gastropoda	*Crepidula plana*										
	Astyris lunata										
	Tritia obsoleta	16	26	25.33	10	12					
	Tritia trivittata										2
	Odostomia eburnea		2	8	4	13.33	4			4	4
	Asmunda elegantula									2	
	Boonea bisuturalis	2			2						
	Haminella solitaria		8	11.33	6	4					
Nudibranchia	*Corambe obscura*										

(continued)

Continued

Major Group	Species	STATION									
		B01	B02	B03	B04	B05	B06	B07	B08	B09	B10
Bivalvia	Mytilidae				2						
	Mysella planulata						2				
	Mulinia lateralis	2.67	17.33	10	5.33	6.67					
	Ensis leei		2	2	4		2	2		2	2
	Tellinidae				4						
	Macoma sp.		2		4						
	Limecola balthica	2	2								
	Ameritella agilis	2	3	2	3	2	32	17.33	6	13.33	8
	Mercenaria mercenaria				2	2					
	Gemma gemma					2					2
	Mya arenaria	2		2							
Arthropoda; Merostomata	*Limulus polyphemus*						2				
Arthropoda Crustacea (Mysida)	*Heteromysis formosa*										
	Neomysis americana						12	2		2	2
(Cumacea)	*Leucon americanus*	2			2		2		2		
	Oxyurostylis smithi		2	2		3		5	6	18	8
(Tanaida)	*Tanaissus* sp. A NAI	1	1					174	219	136	26.5
(Isopoda)	*Edotia triloba*										
	Chiridotea tuftsii								2.67		
(Amphipoda)	*Ampelisca abdita*	2	2	2		2	3			10	
	Ampelisca vadorum										

(continued)

Continued

Major Group	Species	STATION									
		B01	**B02**	**B03**	**B04**	**B05**	**B06**	**B07**	**B08**	**B09**	**B10**
Amphipoda (cont'd)	*Ampithoe valida*										
	Microdeutopus gryllotalpa	16					4			17	13
	Unciola irrorata										
	Grandidierella japonica	3.33	2				4.67			15.33	13.33
	Monocorophium acherusicum									6	4
	Gammarus mucronatus										
	Melita nitida	8								66	7
	Acanthohaustorius millsi							46	126.67	21	10
	Protohaustorius cf. deichmannae [In Bynum and Fox, 1977]									2	14.67
	Phoxocephalus holbolli										
	Rhepoxynius hudsoni							24	9.33	10	5.33
	Hardametopa carinata	2									
(Caprellida)	*Paracaprella tenuis*										
(Decapoda)	*Crangon septemspinosa*	2									
	Pagurus longicarpus	2		2		4	2	2			
	Dyspanopeus sayi										
Hemichordata, Enteropneusta	*Stereobalanus canadensis*									4	14.67
	Saccoglossus bromophenolosus										
Chordata, Tunicata	*Molgula* sp.									4	1
	Mean Total Abundance	796.34	968.99	398.99	3448.33	2700.5	1583	672.65	786.33	1075.7	942.17
	(excluding nematodes)	752.34	650.99	380.99	951	1356.5	1504.4	653.32	706.33	1024.3	906.17

(continued)

Continued

Major Group	Species	STATION									
		B11	B12	B13	B14	B15	B16	B17	B18	B19	B20
Cnidaria	*Diadumene leucolena*					2					
Platyhelminthes	*Platyhelminthes* sp. 5 NAI		2			3.5					
	Platyhelminthes sp. 17 NAI									1	
Turbellaria	*Stylochus ellipticus*										
	Euplana gracilis					4					
Nemertea	*Carinoma tremaphoros*					1					
	Lineidae		2			2					
	Amphiporus bioculatus	2	1	2		2		3	3.5	2	1
	Amphiporus ochraceus		2	1.5	1	4.33		3	2	.	2
Nematoda	Nematoda	198.67	126.67	169.33	56.67	86.67	644	128	80	20	5.33
Polychaeta	*Harmothoe imbricata*					2					
	Pholoe tecta		2			2					
	Eteone longa		2								
	Hypereteone heteropoda	24	47.33	32.67	17.33	28	25.33	44.67	28.67	11.33	12
	Eteone lactea	2			4	2	2		2	2	
	Eumida sanguinea		2		2	4.67					
	Microphthalmus sczelkowii										
	Syllidae					4					
	Exogone hebes	4		2							

(continued)

Continued

Major Group	Species	STATION									
		B11	B12	B13	B14	B15	B16	B17	B18	B19	B20
Polychaeta (cont'd)	*Streptosyllis arenae*										
	Streptosyllis varians		2								
	Neanthes arenaceodentata	6	3	4	2	2	4				
	Hediste diversicolor			4		2		2	2		3
	Glycera dibranchiata					2		2	2	2	
	Scoletoma tenuis	35.33	12	3		15	10.33	57.33	96	57.33	88
	Leitoscoloplos robustus	4	3	4	5	2	4	24.67	16.67	16	12.67
	Leitoscoloplos sp.	2	2.67					30	14	2	9
	Aricidea (Acmira) catherinae	92	94.67	54.67	116.67	84.67	20	30	2	2	2
	Paraonis fulgens	2									
	Polydora cornuta	5	24	32.33	44.67	220.33	3	9.33	9.33	7.33	12.67
	Spio filicornis	5.33	18	8.67	14	8		23.33	18	9.33	8
	Spiophanes bombyx							2			
	Pygospio elegans	28	21.33	6	9.33	4	9.33	49.33	14.67	11.33	6.67
	Streblospio benedicti	102	190	122	95.33	37.33	72.67	349.33	239.33	168.67	199
	Scolelepis (Parascolelepis) texana	104.67	246	52.67	130	14	77.33	116.67	32	23	26
	Dipolydora quadrilobata										
	Cirratulidae	34.67	36	17.33	4.67		59.33	8.67	14	7.33	
	Tharyx acutus	130.67	269.33	243.33	212	40.67	85.33	140	100.67	89.33	88
	Ophelina acuminata										
	Capitella capitata complex	3	6	15.33	4.67	24	4	2			
	Heteromastus filiformis	28.67	16	18	4.67	11	18	103.33	88.67	91.33	99.33
	Maldanidae	2									

(continued)

Continued

Major Group	Species	STATION									
		B11	B12	B13	B14	B15	B16	B17	B18	B19	B20
	Clymenella torquata		2		4			40	8	8	4
	Euclymene collaris			2							
	Pectinaria gouldii							1			
	Ampharete oculata			2	2	2		2	2	4	
	Terebellidae		3			18					
	Polycirrus phosphoreus		3	2	2	7.33					
	Polycirrus sp.			3	2.67	29.33					
	Sabellidae					4					
	Manayunkia speciosa			2		41.33					
	Parasabella microphthalma			2		4					
	Polygordius jouinae										
Oligochaeta	Oligochaeta	121.33	186.67	228	72.33	29.33	86.67	51.33	12	2	6
Gastropoda	*Crepidula plana*			2							
	Astyris lunata			2	2						
	Tritia obsoleta						3.33	4	6.67	10.67	3
	Tritia trivittata			4						2	
	Odostomia eburnea		2	2	10				2	2	2
	Asmunda elegantula										
	Boonea bisuturalis		2	2							
	Haminella solitaria									2	
Nudibranchia	*Corambe obscura*	2									
Bivalvia	Mytilidae										
	Mysella planulata										

(continued)

Continued

Major Group	Species	STATION									
		B11	B12	B13	B14	B15	B16	B17	B18	B19	B20
Bivalvia (cont'd)	*Mulinia lateralis*							3	4	2	4
	Ensis leei		4		3	.	2	2		2	
	Tellinidae										
	Macoma sp.									2	2
	Limecola balthica								2		
	Ameritella agilis	13.33	5.33	4.67	10	2	13.33	4	5	2.67	3
	Mercenaria mercenaria									2	4
	Gemma gemma	2	2			2	2	.	3	2	2
	Mya arenaria	2				2	2	2	2		
Arthropoda; Merostomata	*Limulus polyphemus*							2			
Arthropoda Crustacea (Mysida)	*Heteromysis formosa*				4	26.67					
	Neomysis americana										
(Cumacea)	*Leucon americanus*		3	2						2	
	Oxyurostylis smithi	5.33	4.67	6	6	2	8	15	7.33	6.67	4
(Tanaida)	*Tanaissus* sp. A NAI		1	8							
(Isopoda)	*Edotia triloba*		2					2			
	Chiridotea tuftsii										
(Amphipoda)	*Ampelisca abdita*	2	3	2	2			8	12.67	11	6
	Ampelisca vadorum		4		2						
	Ampithoe valida				2						
	Microdeutopus gryllotalpa	16	30.67	40	47.33	555.33	3	4			2

(continued)

Continued

Major Group	Species	STATION									
		B11	B12	B13	B14	B15	B16	B17	B18	B19	B20
(Amphipoda) (cont'd)	*Unciola irrorata*					2					
	Grandidierella japonica	42.33	54	59.67	71.33	37.5	16.67	10.33	5.33	4.67	10
	Monocorophium acherusicum		4	2		2			2		
	Gammarus mucronatus					2					2
	Melita nitida		22	36.33	47.33	579		2			
	Acanthohaustorius millsi		2	2							
	Protohaustorius cf. deichmannae [In Bynum and Fox, 1977]										
	Phoxocephalus holbolli		2	7	2						
	Rhepoxynius hudsoni			2							
	Hardametopa carinata										
(Caprellida)	*Paracaprella tenuis*				2	6		4			
(Decapoda)	*Crangon septemspinosa*	2	2	2	2						
	Pagurus longicarpus	2		2	4					6	
	Dyspanopeus sayi		2	3	2	6			2		
Hemichordata, Enteropneusta	*Stereobalanus canadensis*	17	2.33	2.33	3.33		3.33				
	Saccoglossus bromophenolosus	1			2						
Chordata, Tunicata	*Molgula* sp.	1		6	1	10		2	2		
	Mean Total Abundance	1045.3	1479.7	1232.8	1032.3	1985	1179	1287.3	843.51	596.99	628.7
	(excluding nematodes)	846.66	1353	1063.5	975.66	1898.3	535	1159.3	763.51	576.99	623.3