# 6.0 BIOLOGICAL FIELD SURVEYS

## 6.1 BACKGROUND

Two biological field surveys provided environmental data in and around eight sand resource areas offshore New Jersey. The surveys were conducted in May and September 1998. Infaunal, epifaunal, demersal fish, and sediment grain size samples, sediment profile images, and water column data were collected. The following sections provide the methods, results, and discussion for the biological field surveys; information pertaining to the sediment profiling camera element is provided in Appendix D1.

## 6.2 METHODS

### 6.2.1 Survey Design

The primary objective of the New Jersey field surveys in May and September 1998 was to characterize benthic ecological conditions (i.e., infauna, epifauna, demersal fishes, and sediment grain size) in eight sand resource areas (Figure 6-1). Supporting data collected in the areas consisted of water column profiles. A secondary objective was to obtain descriptive data on infauna and sediment grain size at three adjacent stations (Figure 6-1).

For the original proposal in 1997, the NJGS identified six potential sand resource areas. The total numbers of samples by type that were originally proposed for the six sand resource areas during Surveys 1 and 2 were as follows:

| Sample Type | Survey 1 (May 1998) | Survey 2 (Sep 1998) |
|---|---|---|
| Infauna | | |
| Sediment Profiling Camera | 90 stations<br>(2 images/station) | 30 stations<br>(2 images/station) |
| Smith-McIntyre Grab | 30 stations<br>(1 grab/station) | 60 stations<br>(1 grab/station) |
| Sediment Grain Size | | |
| Smith-McIntyre Grab | 90 stations<br>(1 grab/station) | 60 stations<br>(1 grab/station) |
| Epifauna | | |
| Mongoose Trawl | 6 transects | 6 transects |
| Water Column | | |
| Hydrolab Profile | 6 stations | 6 stations |

After the original proposal in 1997, the NJGS changed the number of sand resource areas from six to eight. The change necessitated modifications to the original sampling plan in 1998.

The following sampling rationale pertains to Survey 1 in May 1998 and Survey 2 in September 1998. The sampling plan for Surveys 1 and 2 is summarized in Table 6-1.

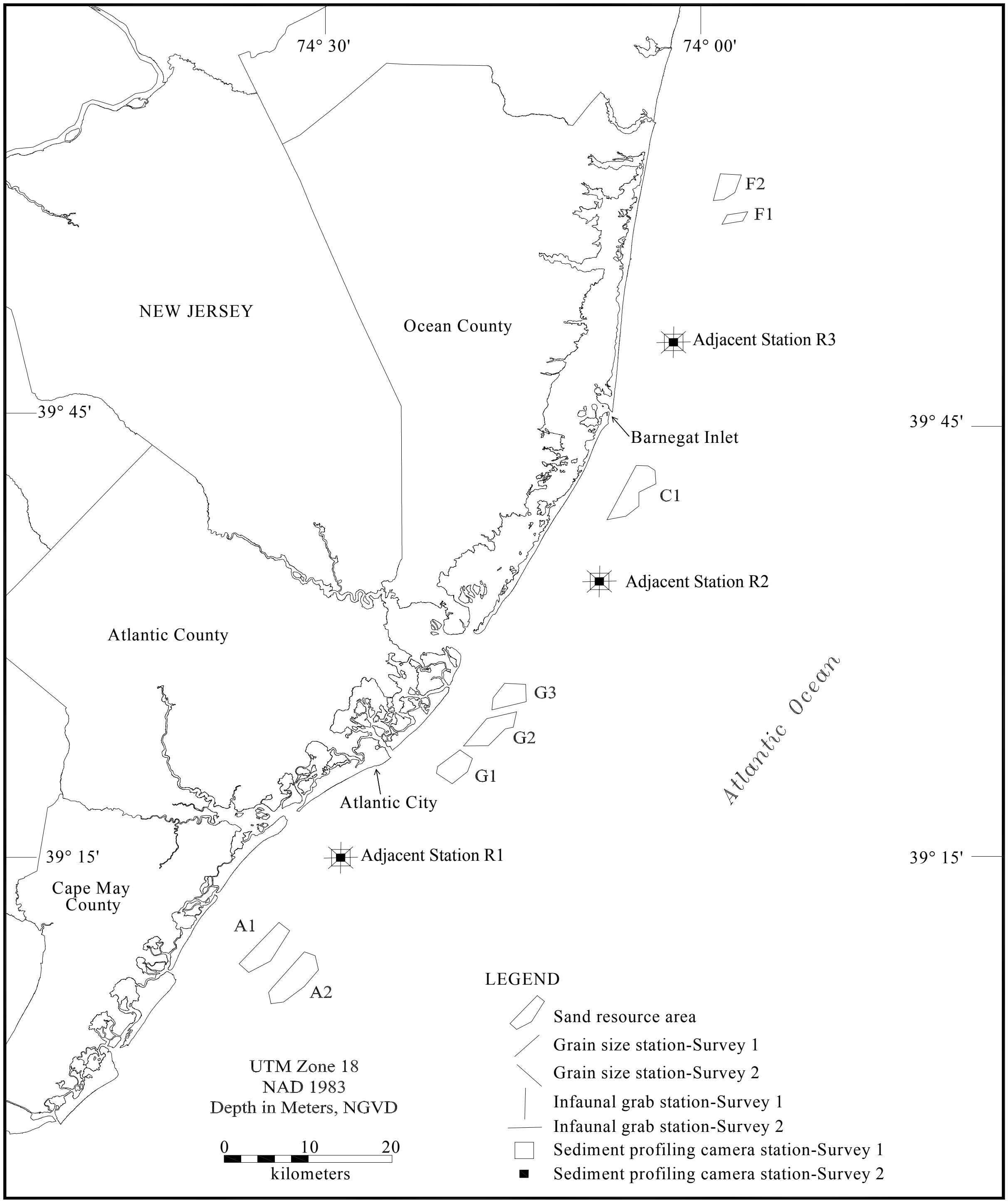


Figure 6-1. Adjacent stations relative to the eight sand resource areas and the New Jersey coast.

Table 6-1. Sampling for the New Jersey May 1998 Survey 1 and September 1998 Survey 2. Where number of samples planned differ from number of samples collected, number of samples collected are given in parentheses.

| Area | Surface Area (million sq ft) and Percent of Total | Water Depth (m) | Number of Stations | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Sediment Profiling Camera | | Smith-McIntyre Grab | | | | Epifaunal Trawls | | Hydrolab | |
| | | | | | Infauna | | Grain Size | | | | | |
| | | | Survey 1 | Survey 2 | Survey 1 | Survey 2 | Survey 1 | Survey 2 | Survey 1 | Survey 2 | Survey 1 | Survey 2 |
| A1 | 164<br>16% | 8-20 | 13 | 4 | 4 | 9 | 13 | 9 | 1 | 1 | 1 | 1 |
| A2 | 204<br>20% | 8-21 | 19 | 4 | 4 | 8 | 19 (18) | 8 | 1 | 1 | 1 | 1 |
| C1 | 190<br>18% | 12-21 | 16 | 5 | 5 | 11 | 16 | 11 | 1 | 1 | 1 | 1 |
| F1 | 29<br>3% | 16-22 | 4 (2) | 2 | 2 | 3 | 4 | 3 | 0 | 0 | 0 | 0 |
| F2 | 79<br>8% | 15-22 | 6 (2) | 2 | 2 | 5 | 6 | 5 | 1 | 1 (2) | 1 | 1 (2) |
| G1 | 113<br>11% | 8-20 | 8 | 3 | 3 | 6 | 8 | 6 | 1 (0) | 1 | 1 (0) | 1 |
| G2 | 142<br>14% | 9-19 | 12 | 4 | 4 | 8 | 12 | 8 | 0 (1) | 0 (1) | 0 (1) | 0 (1) |
| G3 | 107<br>10% | 9-20 | 9 | 3 | 3 | 7 | 9 | 7 | 1 | 1 | 1 | 1 |
| R1 | -- | -- | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| R2 | -- | -- | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| R3 | -- | -- | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| Total Number of Stations | | | 90 (84) | 30 | 30 | 60 | 90 (89) | 60 | 6 | 6 (8) | 6 | 6 (8) |

Table 6-1 lists surface area information, water depth ranges, and number of stations by sample type for each of the eight sand resource areas and three adjacent stations. Sampling locations are shown in Figures 6-2 to 6-9. Sample types, sample codes, coordinates, and water depths are tabulated in Appendix D2**.**

#### 6.2.1.1 Infauna and Sediment Grain Size

Survey 1 (May 1998)

To determine the number of infaunal and sediment grain size samples to collect at each of the eight sand resource areas during the May 1998 Survey 1, surface area and percent of total surface area for each area were calculated (Table 6-1). The percent of the total surface area for each of the sand resource areas then was multiplied by the total number of stations originally proposed for the project minus three for the adjacent stations, resulting in the number of samples per area.

The next step was to determine the placement of the infaunal (sediment profiling camera and Smith-McIntyre grab) and sediment grain size stations within each area to characterize existing assemblages. The goal in placement of the sediment profiling camera and sediment grain size stations was to provide broad spatial and depth coverage within the sand resource areas and, at the same time, ensure that the samples would be independent of one another to satisfy statistical assumptions. To accomplish this goal, a systematic sampling approach was used to provide broad spatial and depth coverage of the target populations. This approach can, in many cases, yield more accurate estimates of the mean than simple random sampling (Gilbert, 1987). Grids were placed over figures of each sand resource area. The number of grid cells was determined by the number of samples per area. One sampling station then was randomly placed within each grid cell of each sand resource area. Randomizing within grid cells eliminates biases that could be introduced by unknown spatial periodicities in the sampling area.

This systematic sampling approach resulted in designation of 90 locations for the sediment profiling camera and sediment grain size stations. These 90 stations were used for both the sediment profiling camera and sediment grain size sampling to maximize comparisons of grain size data from the two types of sampling equipment. All station locations then were pre-plotted on geodetically corrected maps.

Attention then was directed to selection of areas to be sampled for infauna with a Smith-McIntyre grab. Whereas 90 stations were proposed for sediment profiling camera and sediment grain size sampling, 30 stations were proposed for infaunal sampling using a Smith-McIntyre grab. Because the purpose of the grab samples was to maximize interpretation of the sediment profiling camera and sediment grain size data, it was desirable to collect the grab samples at the sediment profiling camera stations. Maps of the 90 sediment profiling camera and sediment grain size stations were analyzed and 30 stations were selected. Due to the limited number of grabs per area, grab stations were manually selected to maximize spatial, depth, and habitat considerations.

Some samples that were planned for Survey 1 were not collected due to bad weather. Sediment profiling camera images were not collected at Stations 3 and 4 in Area F1 and Stations 1 through 4 in Area F2. In addition, a grain size sample was not taken at Station 15 in Area A2.

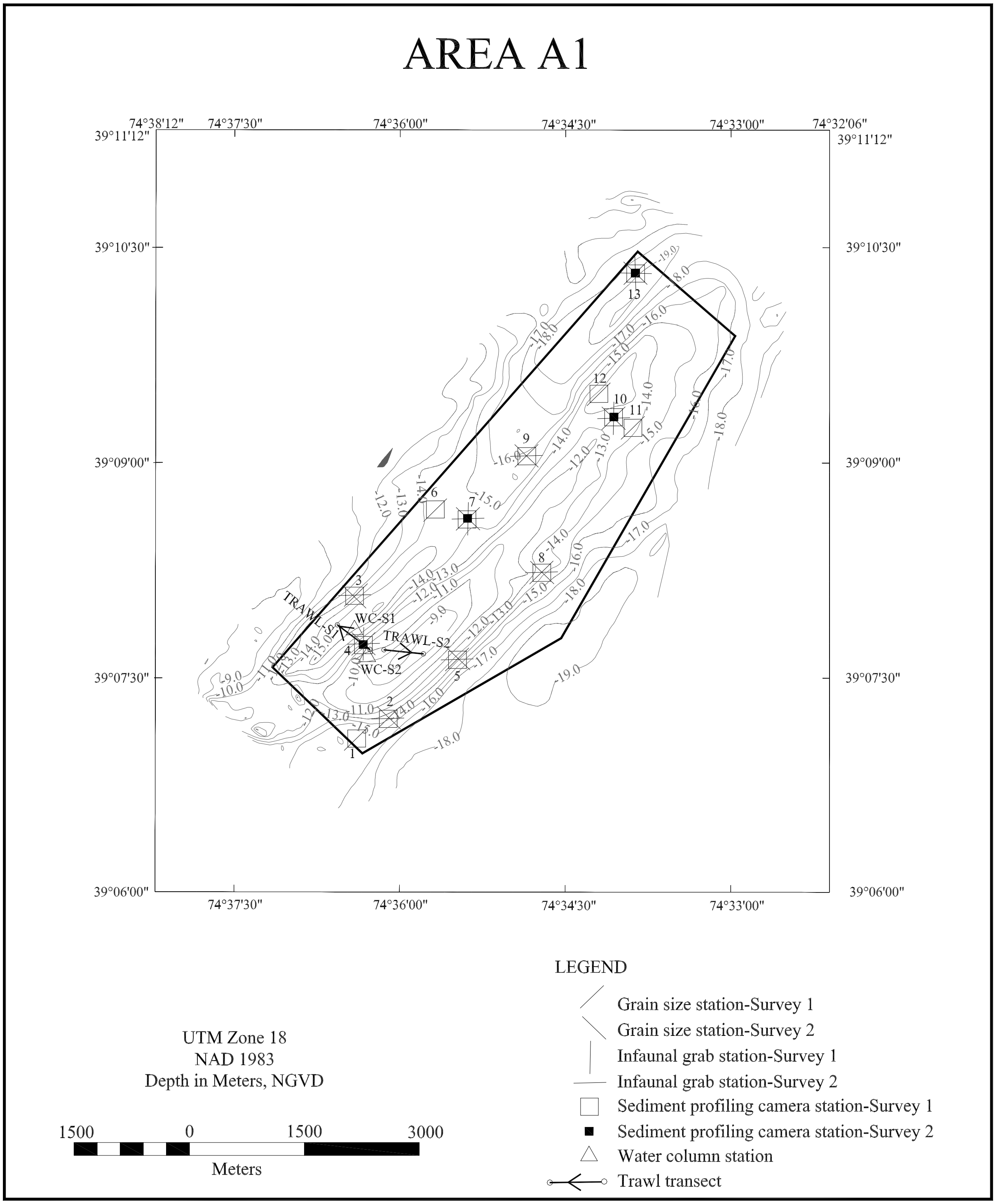


Figure 6-2. Sampling locations for New Jersey Sand Resource Area A1.

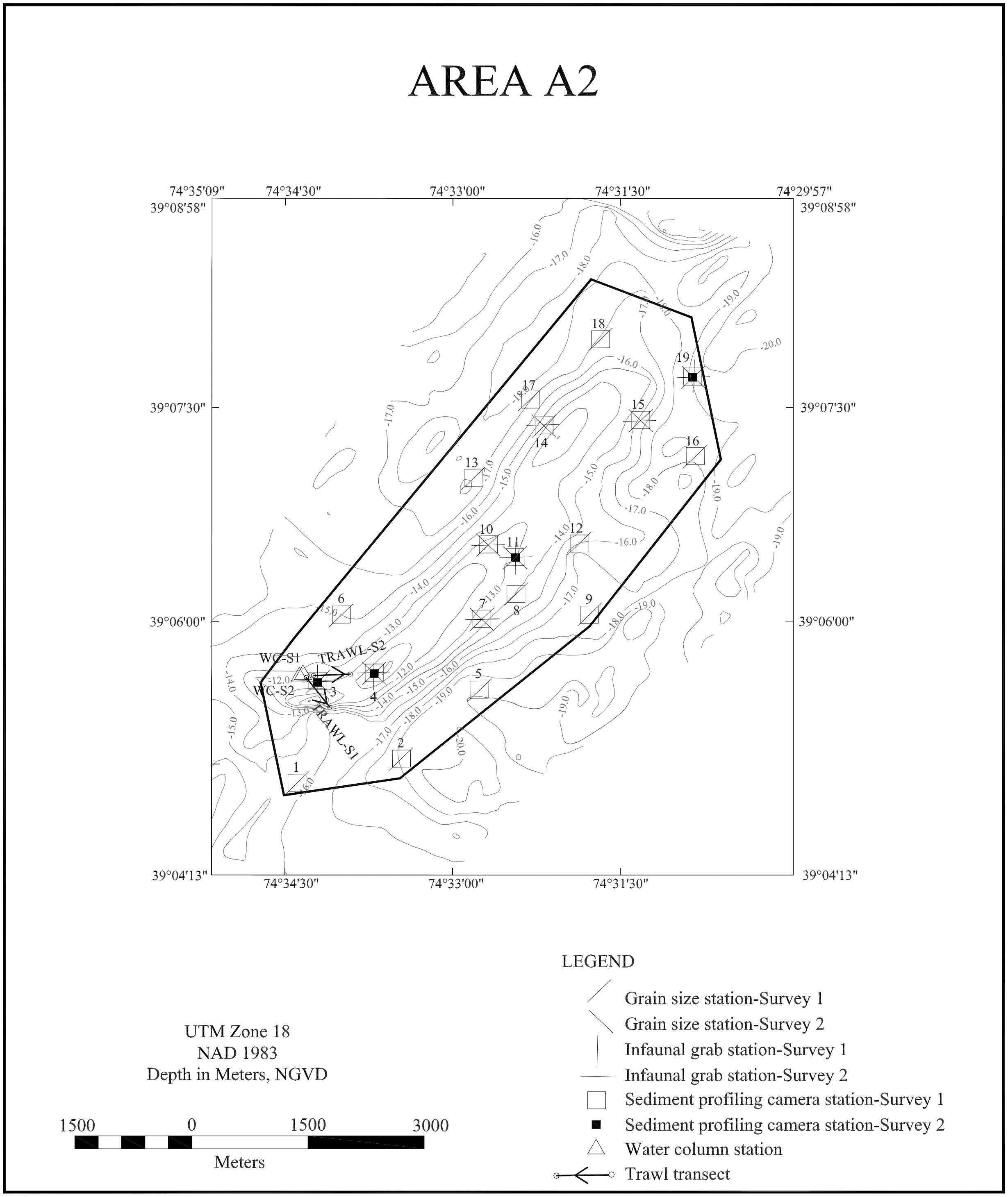


Figure 6-3. Sampling locations for New Jersey Sand Resource Area A2.

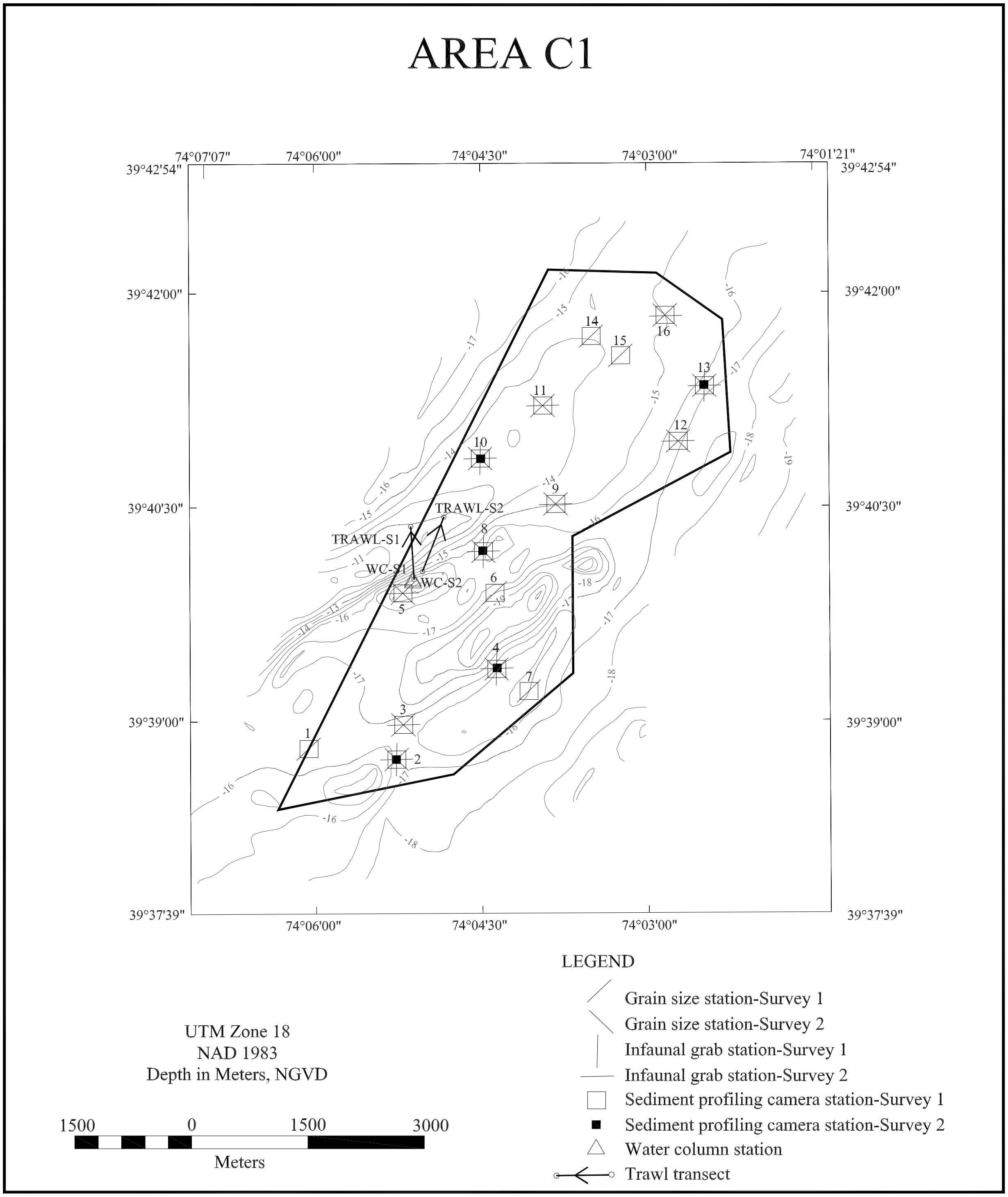


Figure 6-4. Sampling locations for New Jersey Sand Resource Area C1.

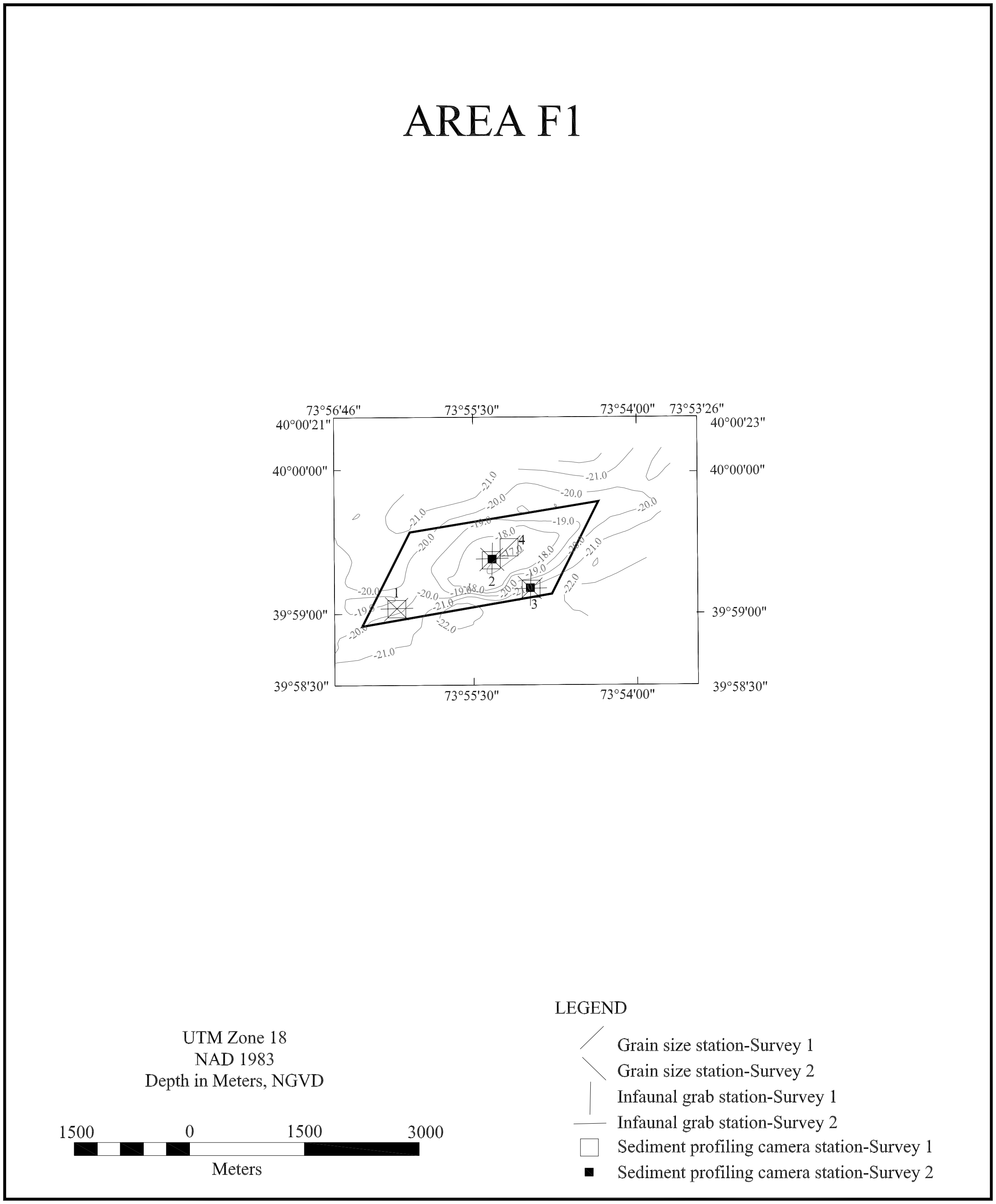


Figure 6-5. Sampling locations for New Jersey Sand Resource Area F1.

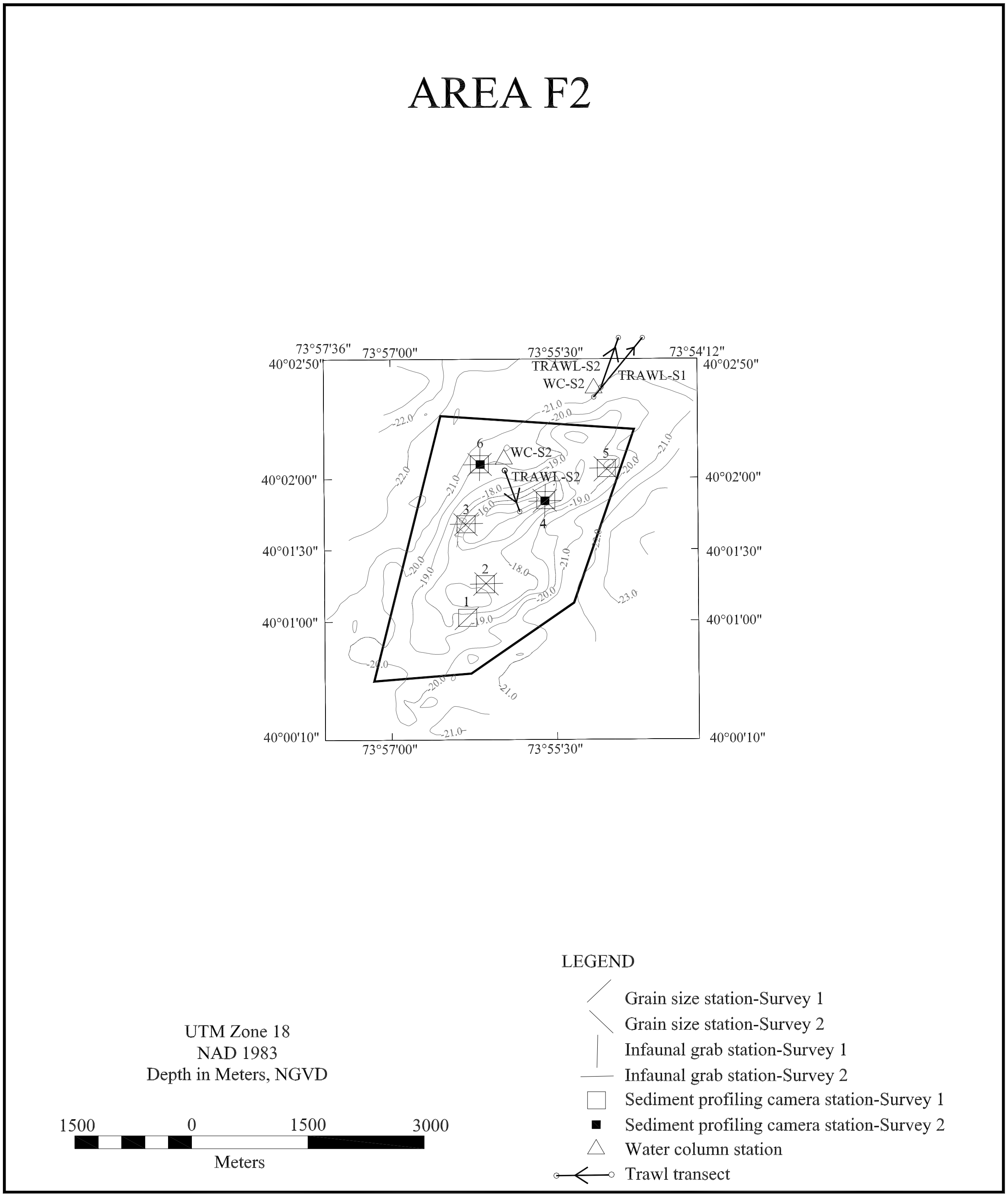


Figure 6-6. Sampling locations for New Jersey Sand Resource Area F2.

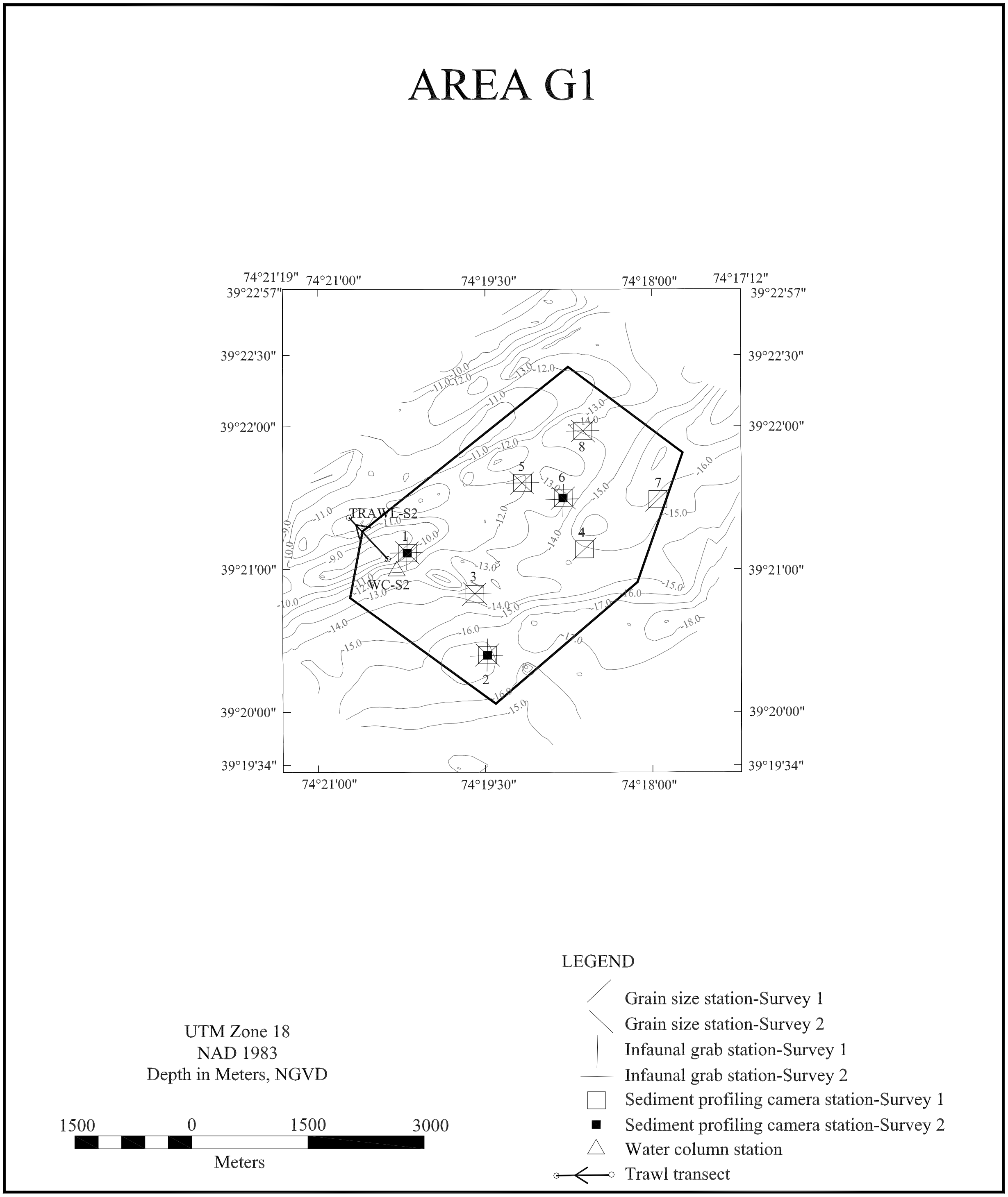


Figure 6-7. Sampling locations for New Jersey Sand Resource Area G1.

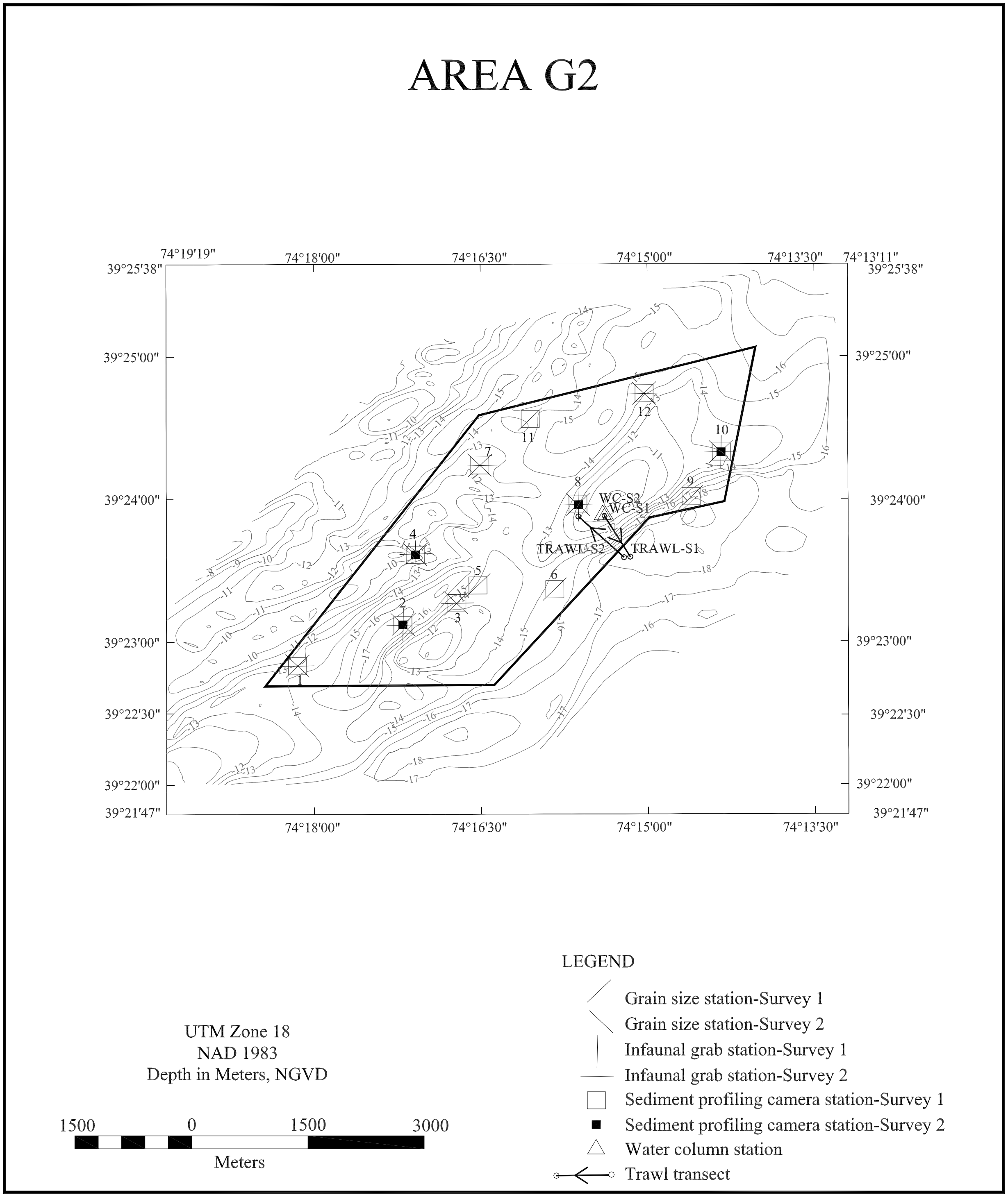


Figure 6-8. Sampling locations for New Jersey Sand Resource Area G2.

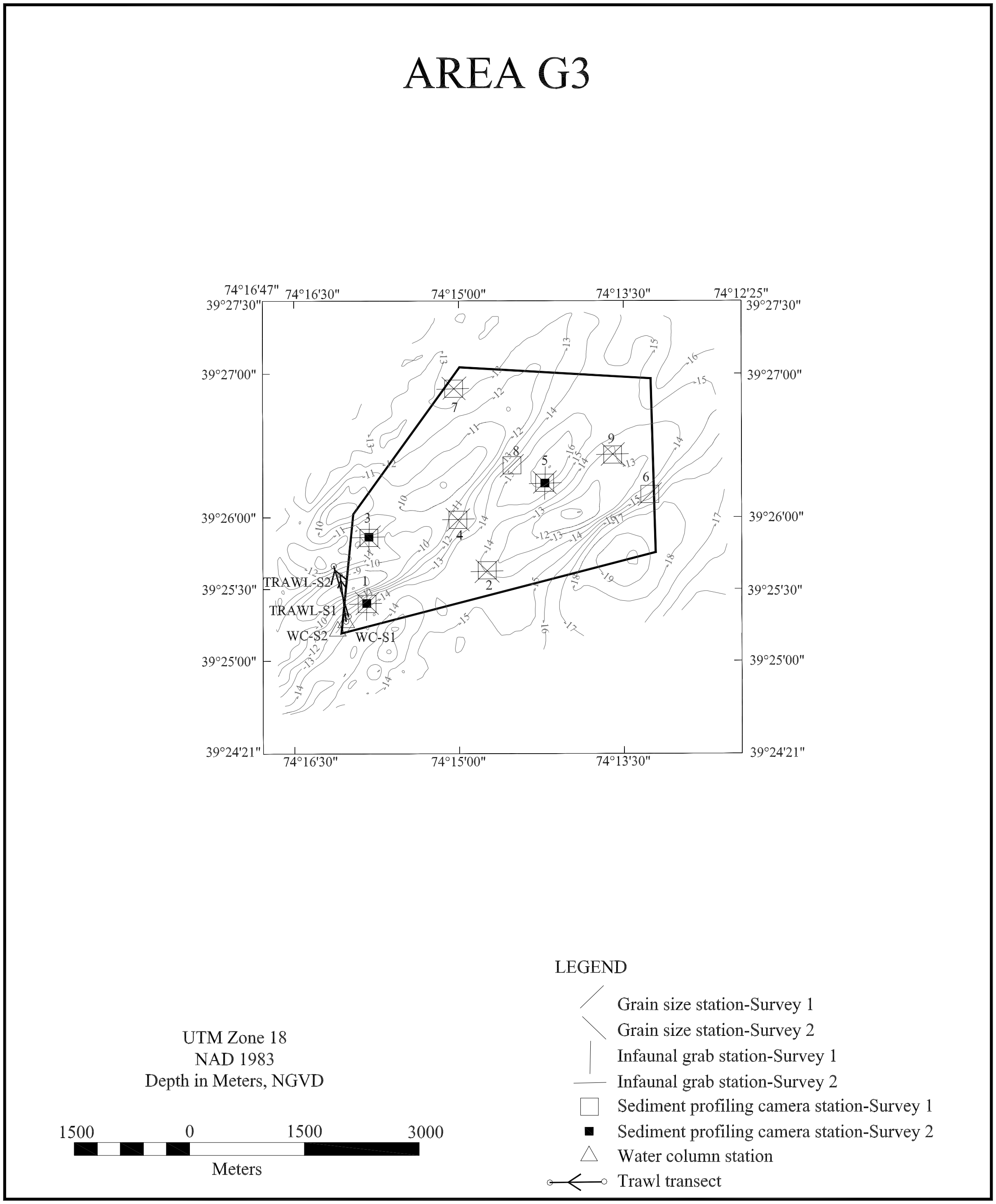


Figure 6-9. Sampling locations for New Jersey Sand Resource Area G3.

Survey 2 (September 1998)

Placement of infaunal and sediment grain size stations for the September 1998 Survey 2 was determined based on post-plots and results of the analyses of samples collected from infaunal and sediment grain size stations during the May 1998 Survey 1. The Survey 2 rationale was to sample previously sampled stations for temporal comparisons and further investigate areas of heterogeneity.

The 30 sediment profiling camera stations for Survey 2 occupied the same locations as the 30 Smith-McIntyre infaunal stations for Survey 1 because these stations were originally selected to maximize spatial, depth, and habitat considerations. This also would enable comparisons of temporal effects because the sediment profiling camera also was used at these 30 stations during Survey 1.

During Survey 2, 60 Smith-McIntyre infaunal stations and 60 Smith-McIntyre sediment grain size stations were sampled. The locations of the 60 Smith-McIntyre infaunal stations and 60 Smith-McIntyre sediment grain size stations were identical to each other so that resulting grain size data could be used to interpret the infaunal data. The first 30 of these 60 stations were in the same locations as the 30 sediment profiling camera stations for Survey 2 and the 30 Smith-McIntyre infaunal stations during Survey 1 which 1) enabled comparison of grain size data from the Smith-McIntyre and sediment profiling camera equipment during Survey 2; 2) maximized interpretation of the sediment profiling camera infaunal images based on Smith-McIntyre infaunal identifications from Survey 2; and 3) allowed comparisons of temporal effects by comparing the Smith-McIntyre data from Surveys 1 and 2.

Based on the results of the Survey 1 sample analyses, there was an interest in furthering the investigation of the abundance and distribution of juvenile Atlantic surfclams and infauna during Survey 2. The remaining 30 of the 60 Smith-McIntyre stations for Survey 2 were located at some stations where Smith-McIntyre sampling for infauna did not occur during Survey 1 to broaden the geographic coverage for juvenile Atlantic surfclams and infauna within the sand resource areas. These other 30 stations where Smith-McIntyre samples were taken for infauna and grain size during Survey 2 were as follows:

| Area | Stations |
|---|---|
| A1 | 2, 3, 5, 8, 9 |
| A2 | 7, 10, 14, 15 |
| C1 | 3, 5, 9, 11, 12, 16 |
| F1 | 1 |
| F2 | 2, 3, 5 |
| G1 | 3, 5, 8 |
| G2 | 1, 3, 7, 12 |
| G3 | 2, 4, 7, 9 |

**6.2.1.2 Epifauna and Demersal Fishes**

The original proposal for sampling epifauna and demersal fishes was to tow a trawl along one transect in each sand resource area. The original proposal included six areas and six trawl transects. During the sampling design stage for Survey 1, the six trawl transects were assigned to the eight new areas such that a trawl transect was to be made in all of the potential sand resource areas except Areas F1 and G2. Area F1 was eliminated during the original sampling design stage because it was the smallest of the eight areas and was adjacent to Area F2, which has a similar depth range. Area G2 was eliminated during the sampling design stage because it was located between and had approximately the same depth range as Areas G1 and G3.

Trawls were towed to cover as wide a depth range within a potential sand resource area as possible within the limits of the length of a trawl tow. During Survey 1, Area G2 was trawled inadvertently rather than Area G1 and the trawl for Area F2 was taken outside of the boundary for Area F2. The trawl for Area F2 was designated F2-Out. During Survey 2, trawls were made in Areas G1 and G2, and inside and outside the boundary of Area F2 (designated F2-In and F2-Out, respectively). Trawls also were made inside the boundaries of Areas A1, A2, C1, and G3, as was done during Survey 1. Trawl transects for Survey 2 were made along lines that were close to those used during Survey 1.

#### 6.2.1.3 Water Column

For Surveys 1 and 2, a water column profile was made at the beginning point of each trawl transect prior to actual trawling. Parameters measured were temperature, salinity, dissolved oxygen, and depth. A water column profile was taken in all of the potential sand resource areas except Area F1 for reasons explained in the previous epifauna and demersal fishes section.

### 6.2.2 Field Methods

#### 6.2.2.1 Vessel

The May field survey was conducted aboard the R/V LIONEL WALFORD based in Sandy Hook, New Jersey. Field sampling occurred from 3 to 8 May 1998. The September field survey was conducted aboard the R/V WEATHERBIRD based in Beaufort, North Carolina. This survey took place from 18 to 21 September 1998.

#### 6.2.2.2 Navigation

A differential global positioning system (DGPS) was used to navigate the survey vessels to all sampling stations. The DGPS was connected to an on-board computer equipped with Hypack Navigation Software Version 6.4 (Coastal Oceanographics, 1996). With this system, the ship's position was displayed in real-time on a monitor affixed to a counter top in the wheel house. All sampling stations were pre-plotted and stored in the Hypack program. While in the field, the actual positions of all samples collected were recorded and stored by the program.

#### 6.2.2.3 Water Column

Temperature, salinity, dissolved oxygen, and depth were measured with a portable Hydrolab unit. The Hydrolab was calibrated as needed each working day. Hydrolab measurements of temperature (ºC), salinity (ppt), and dissolved oxygen (mg/L) were taken at 1.5-m intervals from the surface to bottom. The Hydrolab was fastened to a weighted line then lowered to depth by hand. All measurements were recorded on standard data sheets.

#### 6.2.2.4 Sediment Grain Size

One grab sample was taken with a Smith-McIntyre grab at each pre-plotted sediment sampling station. Once a sample was deemed acceptable (i.e., adequate penetration and undisturbed surface layer), a subsample of sediment (about 250 g) was removed with a 5-cm diameter acrylic core tube and placed in a labeled plastic bag for grain size analyses. This sample was stored at 4ºC (i.e., on ice).

### 6.2.2.5 Infauna

The same Smith-McIntyre grab samples collected at each pre-plotted sediment sampling station (see Section 6.2.2.4) were used for infauna. After a subsample of sediment was removed for grain size analyses, the remainder of the grab sample was sieved through 0.5-mm sieve for infaunal analyses. The infaunal sample was placed in a container and preserved in 10% formalin with rose bengal stain.

### 6.2.2.6 Epifauna and Demersal Fishes

A 25-ft mongoose trawl was towed for 10 min (bottom time) along the pre-plotted transects. The path of each trawl tow was logged into the Hypack navigation system. Once the trawl was on deck, the contents of the catch bag were sorted then identified to the lowest practical taxon. All organisms were identified and returned to the sea. Identifications were recorded on standard trawl data sheets.

### 6.2.3 Laboratory Methods

### 6.2.3.1 Sediment Grain Size

Sediment grain size analyses were conducted using combined sieve and hydrometer analyses according to recommended American Society for Testing Materials (ASTM) procedures. Grain-size samples were washed in demineralized water, dried, and weighed. Coarse and fine fractions (sand/silt) were separated by sieving through a U.S. Standard Sieve Mesh No. 230 (62.5 μm). Sediment texture of the coarse fraction was determined at half-phi intervals by passing the sediment through nested sieves. The weight of the materials collected in each particle size class was recorded. Boyocouse hydrometer analyses were used to analyze the fine fraction (<62.5 μm).

### 6.2.3.2 Infauna

Formalin-preserved infaunal samples were rinsed on a U.S. Standard No. 30 (0.59-mm) sieve and transferred to 70% isopropanol. Before sorting, samples were passed through a series of sieves (0.3, 0.5, 0.6, 1, and 2 mm) to separate the organisms into size classes. Samples were sorted by hand under dissecting microscopes. All sediment in each sample was examined by a technician who removed all infauna observed. Organisms were identified to the lowest practical taxon and counted. A minimum of 10% of all samples were resorted by different technicians as a quality control measure. Voucher specimens of each taxon were archived at the Barry A. Vittor & Associates, Inc. laboratory.

### 6.2.4 Data Analysis

### 6.2.4.1 Water Column

Temperature, salinity, dissolved oxygen, and depth values were entered into an electronic spreadsheet and tabulated. Depth profiles were plotted for temperature-salinity and temperature-dissolved oxygen.

### 6.2.4.2 Sediment Grain Size

A computer algorithm was used to determine size distribution and provide interpolated size information for the fine fraction at 0.25-phi intervals. Percentages of gravel, sand, silt, and clay were calculated and recorded along with a Folk's description for each sample.

### 6.2.4.3 Infauna

Summary statistics including number of taxa, number of individuals, density, diversity (*H′*), evenness (*J′*), and species richness (*D*) were calculated for each sampling station. Diversity (*H′*), also known as Shannon's Index (Pielou, 1966), was calculated as follows:

$$H' = -\sum_{S}^{i=1} p_i \ln(p_i)$$

where *S* is the number of taxa in the sample, *i* is the *i*th taxa in the sample, and $p_i$ is the number of individuals of the *i*th taxa divided by (N) the total number of individuals in the sample.

Evenness (*J′*) was calculated with Pielou's (1966) index of evenness:

$$J' = \frac{H'}{\ln(S)}$$

where *H′* is Shannon's index as calculated above and *S* is the total number of taxa in a sample.

Species richness (D) was calculated by Margalef's index:

$$D = \frac{(S - 1)}{\ln(N)}$$

where *S* is the total number of taxa in the sample, and N is the number of individuals in the sample.

Spatial and temporal patterns in infaunal assemblages were examined with cluster analysis. Cluster analyses were performed on similarity matrices constructed from raw data matrices consisting of taxa and samples (station – survey). Only species-level taxa, with the exception of two species complexes that can be only reliably identified to genus, were included in the analysis. Of these taxa, only those contributing at least 0.1% of the total abundance of species level taxa were included. Raw counts of infaunal taxa were transformed with the $\log_{10}(n+1)$ transformation prior to similarity analysis. Both normal (stations) and inverse (taxa) similarity matrices were generated using the Bray-Curtis index that was calculated using the following formula:

$$B_{jk} = \frac{2\sum_{i} \min(x_{ij}, x_{ik})}{\sum_{i} (x_{ij} + x_{ik})}$$

where $B_{jk}$ (for normal analysis) is the similarity between samples *j* and *k*; $x_{ij}$ and $x_{ik}$ are the abundances of species *i* in samples *j* and *k*. *B* ranges from 0.0 when two samples have no species in common to 1.0 when the distribution of individuals among species is identical between samples. For inverse analysis, the $B_{jk}$ is the similarity between species *j* and *k*; $x_{ij}$ and $x_{ik}$ are the abundances of species *j* and *k* in sample *i*.

Normal similarity matrices were clustered using the group averaging method of clustering, and inverse similarity matrices were clustered using the flexible sorting method of clustering (Boesch, 1973). Flexible sorting was performed with $\beta = -0.25$, a widely accepted value for this analysis (Boesch, 1973).

The extent to which sample groups formed by normal cluster analysis of the entire data set could be explained by environmental variables such as sediment grain size parameters was examined by canonical discriminant analysis (SAS Institute Inc., 1989). Canonical discriminant analysis identifies the degree of separation among predefined groups of variables in multivariate space. This analysis examined the relationships among the environmental variables and the station groups as indicated by the normal cluster analysis.

#### 6.2.4.4 Epifauna and Demersal Fishes

Data on epifauna and demersal fishes were summarized by numbers of taxa and number of individuals per tow in each sand resource area. Normal and inverse cluster analyses as described previously (Section 6.2.4.3) were used to examine patterns in the epifaunal/demersal fish data set. Both normal and inverse clustering were performed with the group averaging algorithm.

## 6.3 RESULTS

### 6.3.1 Water Column

Raw data for water column profiles made during Survey 1 are provided in Appendix D3, Table D3-1. Depth profiles of temperature-salinity and temperature-dissolved oxygen for the May 1998 Survey 1 are shown in Figures 6-10 and 6-11. Temperature profiles varied little from surface to bottom in Resource Areas A1, C1, and G3. For Areas F2 and G2, the profiles showed a slight discontinuity at about 5 m below the surface. Surface temperatures ranged from 11.9°C at Area F2 to 12.9°C in Areas A1 and G3. Bottom temperatures ranged from 8.2°C at Area F2 to 11.2°C in Area A1. Salinity profiles were fairly uniform from surface to bottom in Areas A1, A2, C1, and G3. For Areas F2 and G2, the profiles shifted to higher values at about 10 m water depths. Surface salinity values ranged from 26.0 ppt in Area C1 to 31.5 ppt in Areas A1 and A2. Bottom salinity values ranged from 28.5 ppt in Area C1 to 33.8 ppt at Area F2. Figure 6-11 gives the dissolved oxygen profiles recorded during the May 1998 Survey 1. With the exception of Area F2, these profiles did not vary appreciably from surface to bottom. Surface dissolved oxygen values ranged from 6.98 mg/L in Area G3 to 8.70 mg/L at Area F2. Bottom measurements ranged from 6.41 mg/L in Area G2 to 9.60 mg/L at Area F2.

Raw data for water column profiles made during Survey 2 are given in Appendix D3, Table D3-2. Temperature, salinity, and dissolved oxygen profiles made during the September 1998 Survey 2 are shown in Figures 6-12 and 6-13. Temperature profiles changed little or just slightly from surface to bottom in Resource Areas A1, A2, G1, G2, and G3. Temperature profiles for Area F2 exhibited a definite discontinuity at about 15 m below the surface. Surface temperatures during Survey 2 ranged from 22.4°C in Area A2 to 23.6°C in Area G2. Bottom temperatures ranged from 12.5°C for Area F2 (F2-Out) to 22.2°C in Area G1. Salinity profiles were uniform from surface to bottom in all resource areas during the September 1998 Survey 2. Surface salinity values ranged from 27.5 ppt in Areas G1, G2, and G3 to 33.1 ppt in Area A1. Bottom salinity values ranged from 27.6 ppt in Areas G1 and G2 to 33.4 in Area A2. Dissolved oxygen profiles were uniform from surface to bottom in Areas A2, G1, and G2, whereas dissolved oxygen profiles from Areas A1, C1, F2, and G3 decreased with depth (Figure 6-13). Surface dissolved oxygen values ranged from 6.96 mg/L in Area F2 (F2-Out) to 8.03 mg/L in Area G1. Bottom dissolved oxygen values ranged from 2.94 mg/L in Area G3 to 6.48 mg/L in Area G2. Hypoxic conditions were not found during either Surveys 1 or 2.

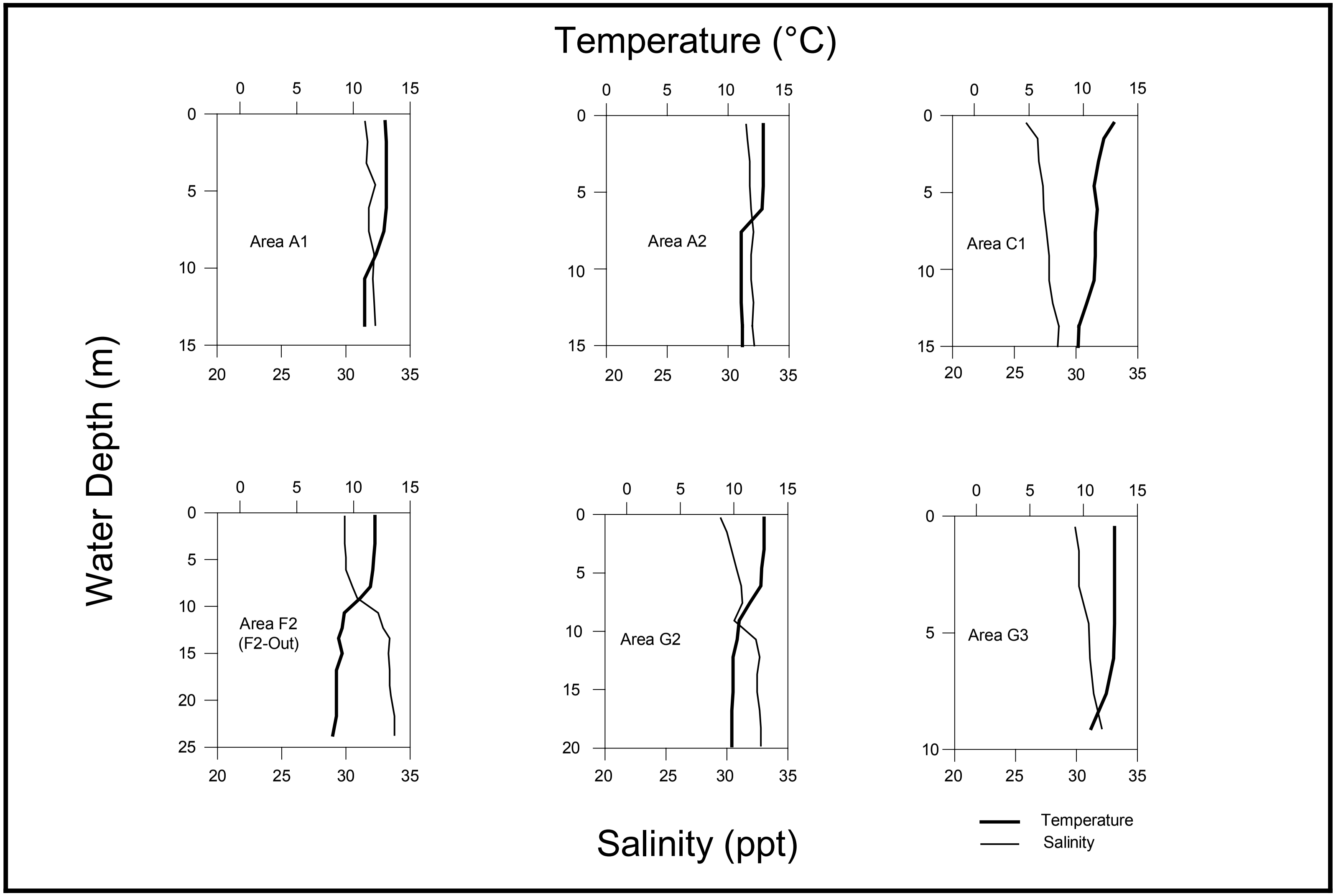


Figure 6-10. Temperature and salinity water column profiles from Resource Areas A1, A2, C1, F2, G2, and G3 during the May 1998 Survey 1 offshore New Jersey.

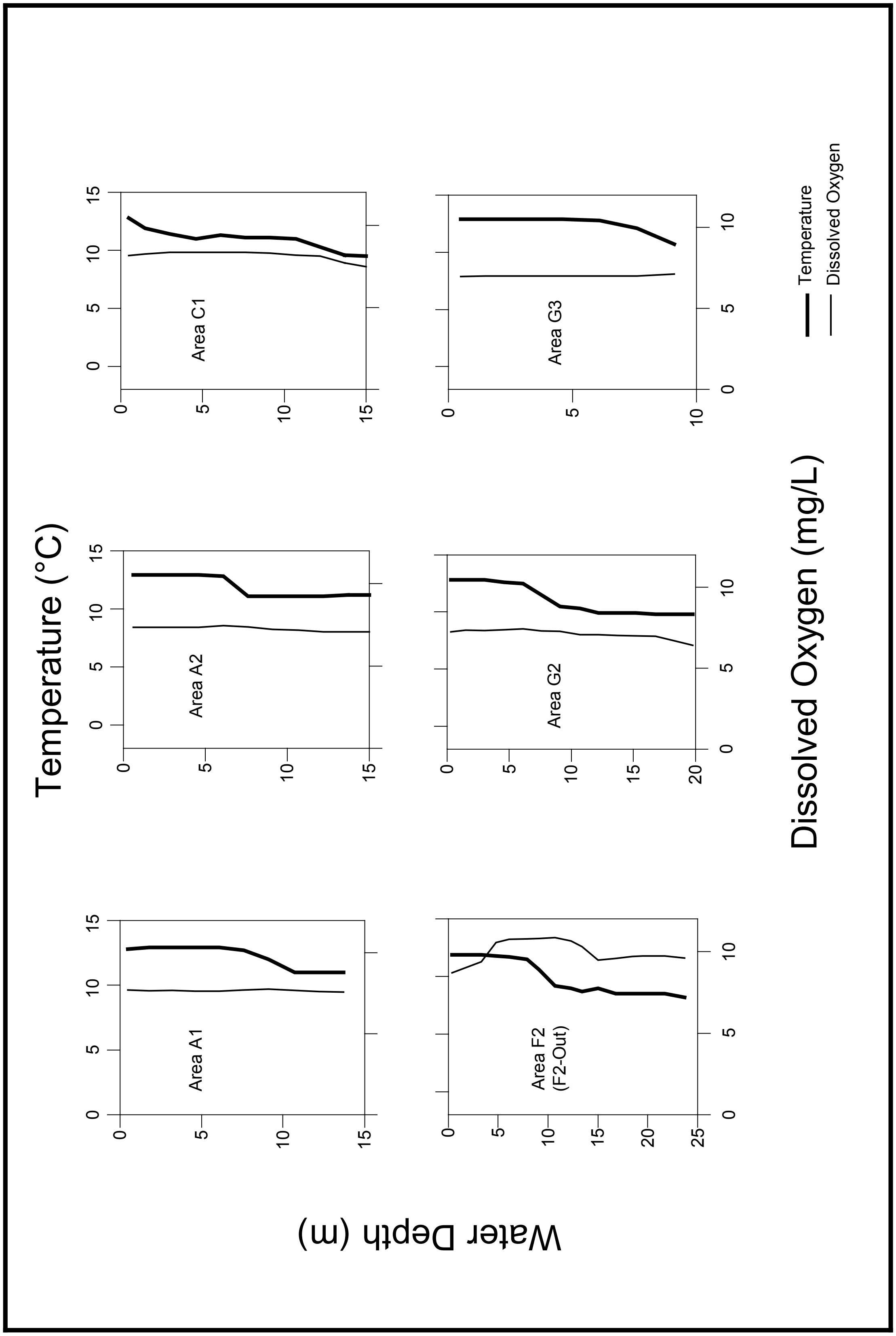


Figure 6-11. Temperature and dissolved oxygen water column profiles from Resource Areas A1, A2, C1, F2, G2, and G3 during the May 1998 Survey 1 offshore New Jersey.

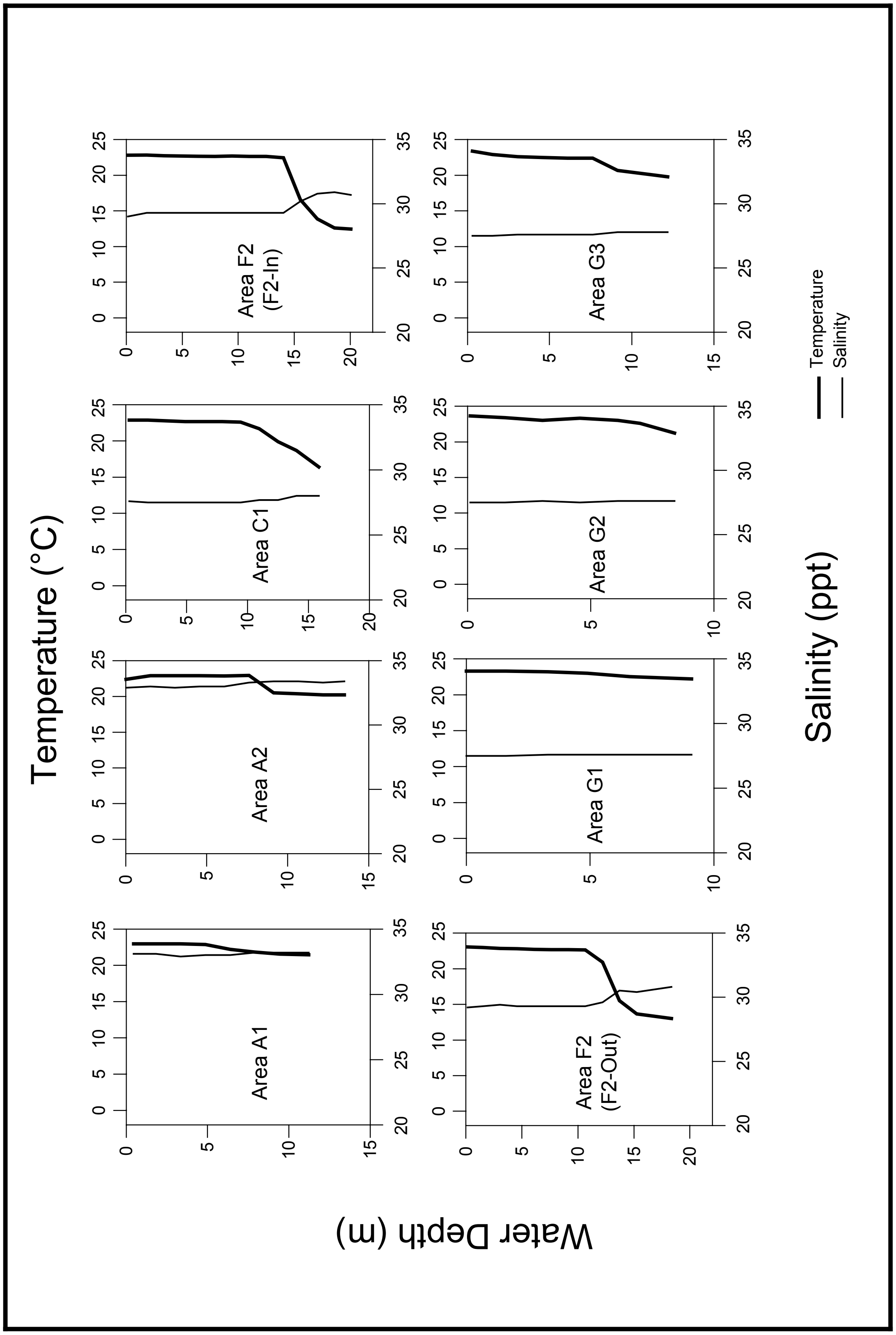


Figure 6-12. Temperature and salinity water column profiles from Resource Areas A1, A2, C1, F2, G1, G2 and G3 during the September 1998 Survey 2 offshore New Jersey.

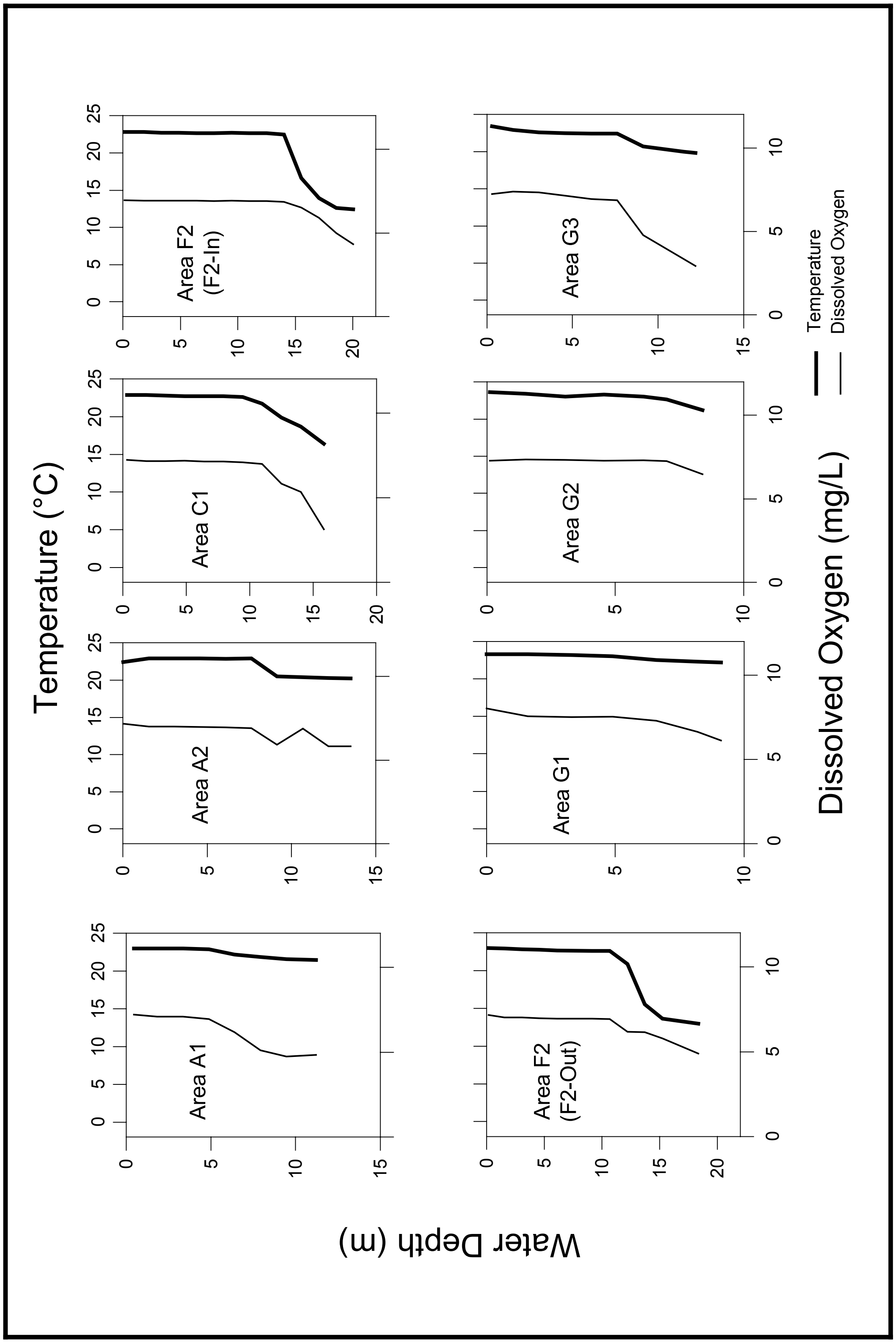


Figure 6-13. Temperature and dissolved oxygen water column profiles from Resource Areas A1, A2, C1, F2, G1, G2, and G3 during the September 1998 Survey 2 offshore New Jersey.

### 6.3.2 Sediment Grain Size

Sediment grain size composition of Smith-McIntyre grab samples taken in the resource areas during the May 1998 Survey 1 ranged from gravel to sandy mud (Appendix D4, Table D4-1). Proportions of gravel, sand, and fine sediment in the samples varied within and among resource areas. Samples with high sand fractions (>95%) were most common, followed by samples with high gravel fractions (>10%). In Area A1, 9 of 13 grab samples collected during Survey 1 contained >96% sand. The remaining samples were gravelly sand or sandy gravel. Area A2 yielded 8 of 19 samples with >95% sand. The remaining samples contained sandy gravel and gravelly sand. Eight of 16 samples from Area C1 contained >97% sand. The proportion of gravel in the remaining samples ranged from 0 to 81.3%. Area F1 produced two of four samples with >95% sand. The other two samples were distinguished by high gravel fractions with sand. In Area F2, two of six samples had >99% sand; the other four samples contained varying proportions of gravel with sand. In Areas G1, G2, and G3, the samples contained high sand fractions. In Area G1, 5 of 8 samples were >96% sand. In Area G2, 11 of 12 samples were represented by >97% sand. In Area G3, 8 of 9 samples were >98% sand.

General patterns of grain size composition of the grab samples taken during the September 1998 Survey 2 were similar to the patterns seen during the May 1998 Survey 1 (Appendix D4, Table D4-2). Six of nine grab samples collected during the September 1998 Survey 2 from Resource Area A1 contained >98% sand. In Resource Area A2, three of eight samples contained >99% sand, five samples contained gravelly sand, and one sample was sandy gravel. In Resource Area C1, 7 of 11 samples contained >98% sand; the other four samples contained gravel fractions ranging from 19.6 to 79.5%. The three samples from Resource Area F1 were composed of varying fractions of sand and gravel; only one of the three samples exhibited >91% sand. Resource Area F2 yielded two of five samples with >99% sand; the other three samples consisted of gravelly sand and sandy gravel. In Resource Area G1, grab samples yielded mostly sand, with five of six samples containing >98% sand. Resource Area G2 had seven of eight samples with >96% sand. In Resource Area G3, all seven samples contained >98% sand.

### 6.3.3 Infauna

The phylogenetic list of infauna collected in bottom grabs during the May and September 1998 surveys is presented in Appendix D5 along with other infaunal data from the surveys. For both surveys combined, 57,098 individuals were collected, representing 202 taxa in 10 separate phyla. As a group, infauna were more abundant during the May survey when overall density averaged 772 individuals/grab as compared to 566 individuals/grab during the September survey. Eighty-seven taxa (43% of total) were common to both surveys. Of those taxa found in just one of the two surveys, 68% (78 taxa) were sampled during the September cruise. The archiannelid *Polygordius* (lowest practical identification level [LPIL]) was numerically dominant in the grabs, representing 18% of all infauna censused over both surveys. Other than *Polygordius*, taxa that were among the top 10 numerical dominants during both the May and September surveys included the bivalve *Nucula proxima*, oligochaetous annelids, and rhynchocoels.

Table 6-2 lists the numerically dominant taxa sampled from each of the resource areas and adjacent stations during the May survey. Numerically dominant taxa sampled during the May survey included *Spiophanes bombyx* (polychaete; 16.4% of all collected individuals), Ascidiacea (tunicate; 16.1%), *Polygordius* (archiannelid; 16.1%), *Mytilus edulis* (bivalve; 11.6%),

Table 6-2. Ten most abundant infaunal taxa from samples collected during the May 1998 Survey 1 in the eight resource areas (A1, A2, C1, F1, F2, G1, G2, and G3) and three adjacent stations (R1, R2, and R3) offshore New Jersey.

| Area | Taxonomic Name | Count | Area | Taxonomic Name | Count |
|---|---|---|---|---|---|
| A1 | *Mytilus edulis* | 795 | G2 | *Spiophanes bombyx* | 1,732 |
| | *Turbonilla interrupta* | 354 | | *Polygordius* (LPIL) | 367 |
| | *Ampelisca macrocephala* | 288 | | *Mytilus edulis* | 107 |
| | Ascidiacea (LPIL) | 247 | | Oligochaeta (LPIL) | 77 |
| | *Pisione remota* | 182 | | Rhynchocoela (LPIL) | 74 |
| | *Mercenaria mercenaria* | 166 | | *Nucula proxima* | 74 |
| | *Ampelisca* (LPIL) | 140 | | *Tanaissus psammophilus* | 63 |
| | *Spiophanes bombyx* | 127 | | *Spisula solidissima* | 53 |
| | Oligochaeta (LPIL) | 115 | | Cirratulidae (LPIL) | 49 |
| | *Polygordius* (LPIL) | 104 | | *Protohaustorius wigleyi* | 44 |
| A2 | *Polygordius* (LPIL) | 232 | G3 | *Spiophanes bombyx* | 1,883 |
| | Oligochaeta (LPIL) | 109 | | *Caulleriella* sp.J | 162 |
| | *Astarte castanea* | 59 | | *Polygordius* (LPIL) | 93 |
| | *Tanaissus psammophilus* | 53 | | *Chiridotea tuftsi* | 55 |
| | *Chiridotea tuftsi* | 48 | | *Spisula solidissima* | 52 |
| | *Spio setosa* | 47 | | Oligochaeta (LPIL) | 35 |
| | Rhynchocoela (LPIL) | 43 | | *Echinarachnius parma* | 32 |
| | *Crenella decussata* | 25 | | *Unciola irrorata* | 31 |
| | *Hesionura elongata* | 22 | | Rhynchocoela (LPIL) | 22 |
| | Ascidiacea (LPIL) | 21 | | *Protohaustorius wigleyi* | 19 |
| C1 | *Mytilus edulis* | 1,122 | R1 | *Nucula proxima* | 390 |
| | Ascidiacea (LPIL) | 480 | | *Spiophanes bombyx* | 45 |
| | *Polygordius (LPIL)* | 438 | | *Ampelisca macrocephala* | 36 |
| | Oligochaeta (LPIL) | 141 | | *Spisula solidissima* | 33 |
| | *Tanaissus psammophilus* | 124 | | *Mytilus edulis* | 32 |
| | Rhynchocoela (LPIL) | 122 | | *Ampelisca* (LPIL) | 29 |
| | *Pisione remota* | 100 | | *Nephtys picta* | 24 |
| | *Echinarachnius parma* | 97 | | *Tellina* (LPIL) | 22 |
| | *Spisula solidissima* | 83 | | Cirratulidae (LPIL) | 14 |
| | Echinoidea (LPIL) | 39 | | *Caulleriella* sp. J | 13 |
| F1 | Oligochaeta (LPIL) | 694 | R2 | Ascidiacea (LPIL) | 2,816 |
| | *Polygordius* (LPIL) | 156 | | *Mytilus edulis* | 562 |
| | *Lumbrinerides acuta* | 88 | | Rhynchocoela (LPIL) | 248 |
| | *Tanaissus psammophilus* | 54 | | Oligochaeta (LPIL) | 184 |
| | *Cirrophorus* (LPIL) | 27 | | *Spisula solidissima* | 82 |
| | Sigalionidae (LPIL) | 26 | | *Pisione remota* | 59 |
| | Rhynchocoela (LPIL) | 17 | | *Astarte castanea* | 53 |
| | *Pisione remota* | 15 | | *Polygordius (LPIL)* | 39 |
| | *Exogone hebes* | 15 | | *Crenella decussata* | 30 |
| | Echinoidea (LPIL) | 14 | | Bivalvia (LPIL) | 25 |
| F2 | Ascidiacea (LPIL) | 157 | R3 | *Polygordius* (LPIL) | 1,014 |
| | *Polygordius* (LPIL) | 120 | | Rhynchocoela (LPIL) | 43 |
| | *Spisula solidissima* | 85 | | *Spisula solidissima* | 42 |
| | Rhynchocoela (LPIL) | 65 | | Cirratulidae (LPIL) | 19 |
| | *Pisione remota* | 47 | | *Echinarachnius parma* | 18 |
| | Oligochaeta (LPIL) | 34 | | *Hemipodus roseus* | 17 |
| | *Hemipodus roseus* | 32 | | Oligochaeta (LPIL) | 16 |
| | *Astarte castanea* | 32 | | Ascidiacea (LPIL) | 14 |
| | *Tanaissus psammophilus* | 26 | | *Tanaissus psammophilus* | 9 |
| | *Exogone hebes* | 22 | | Sigalionidae (LPIL) | 8 |
| G1 | *Polygordius* (LPIL) | 1,166 | MAY TOTAL | *Spiophanes bombyx* | 3,806 |
| | *Nucula proxima* | 92 | | Ascidiacea (LPIL) | 3,739 |
| | *Capitella capitata* | 91 | | *Polygordius* (LPIL) | 3,732 |
| | Oligochaeta (LPIL) | 68 | | *Mytilus edulis* | 2,696 |
| | *Mytilus edulis* | 51 | | Oligochaeta (LPIL) | 1,475 |
| | Capitellidae (LPIL) | 44 | | Rhynchocoela (LPIL) | 749 |
| | Rhynchocoela (LPIL) | 38 | | *Nucula proxima* | 623 |
| | *Tellina (LPIL)* | 30 | | *Spisula solidissima* | 507 |
| | Ampharetidae (LPIL) | 24 | | *Pisione remota* | 418 |
| | *Caulleriella* sp.J | 10 | | *Turbonilla interrupta* | 354 |

LPIL = Lowest practical identification level and unidentified oligochaetous annelids (6.4%). Together, these taxa comprised 66% of infaunal individuals collected in May. During the May survey, Atlantic surfclam (*Spisula solidissima*) was among the top 10 numerically dominant taxa in several of the resource areas (C1, F2, G2, G3), each of the adjacent stations (R1, R2, and R3), and in the overall May total (Table 6-2). Juvenile *S. solidissima* represented 2.2% of all censused infauna during the May survey.

Numerically dominant taxa collected during the September survey (Table 6-3) were the archiannelid *Polygordius* (19.5% of all collected individuals), the polychaete *Asabellides oculata* (6.4%), unidentified rhynchocoels (5.9%), the tanaid *Tanaissus psammophilus* (5.9%), and the amphipod *Pseudunciola obliquua* (4.5%). Other than *Polygordius*, numerical dominance during September was more evenly distributed among infaunal taxa than was the case during the first survey, with the remaining numerically dominant taxa comprising between 6.4 and 3.9% of collected individuals from all areas combined. Atlantic surfclam was among the top 10 numerically dominant taxa collected in September grab samples only in Areas F1 and F2 (Table 6-3).

Table 6-4 summarizes the number of taxa, number of individuals, density, species diversity, evenness, and richness for each of the sand resource areas and adjacent stations during the May and September surveys. During the May survey, the mean number of taxa sampled per station was greatest in Area A1 (37 taxa), while Area G1 stations averaged the greatest number of taxa (43) in September (Table 6-4). The highest number of infaunal taxa collected from a single station was collected at Station 1 in Area A1 (67 individuals) during the May survey and at Station 2 in Area G1 (61) during the September survey. During the May survey, the mean number of taxa per station was lowest in Areas A2 and G1 (21 taxa), while Area F2 stations averaged the lowest number of taxa (26) in September (Table 6-4). The fewest number of infaunal taxa collected from a single station was collected at Station 4 in Area A2 (14) during May and at Station 13 in Area C1 (18) in September.

The greatest number of infauna collected in a single grab was at Adjacent Station 2 during the May survey (4,296 individuals), due mostly to a high density of the tunicate Ascidiacea (LPIL) (Table 6-2). Excluding adjacent stations, greatest infaunal abundances were sampled from Area A1 (station average = 898 individuals) during the May survey, while Area G2 yielded the greatest mean abundances (800) in September (Table 6-4). The greatest number of individuals collected from a single station was sampled from Station 3 in Area G3 (2,373 individuals) during the May survey and from Station 2 in Area G2 (3,613) in September. Area A2 yielded the lowest mean abundance during the May survey (217), while Area F2 yielded the lowest mean abundance in September (339) (Table 6-4). The fewest number of individuals sampled from a single station during the May survey was collected at Station 1 in Area G1 (41 individuals), while the September survey yielded its lowest count from Station 16 in Area C1 (42).

Mean values of species diversity (H') and species richness (D) were generally higher in September as compared to May, while species evenness (J') was similar during both surveys, although this index was less variable across the study area during September (Table 6-4). Stations in Area A1 yielded the highest mean values of species diversity (2.37) and richness (5.67) during May. During the May survey, the highest measure of mean species evenness was from Area A2 stations (0.73). The lowest mean values of species diversity and richness (1.64 and 3.71, respectively) during the May survey were from Area G1. Species evenness was lowest in Area F1 (0.51) during the May survey. Highest mean values of species diversity and evenness during September were from Area G2 stations (2.48 and 0.71, respectively), while the

Table 6-3. Ten most abundant infaunal taxa from samples collected during the September 1998 Survey 2 in the eight sand resource areas (A1, A2, C1, F1, F2, G1, G2, and G3) and three adjacent stations (R1, R2, and R3) offshore New Jersey.

| Area | Taxonomic Name | Count | Area | Taxonomic Name | Count |
|---|---|---|---|---|---|
| A1 | *Polygordius* (LPIL) | 1,555 | G2 | *Asabellides oculata* | 1,121 |
| | *Ampelisca* sp.X | 818 | | *Nucula proxima* | 1,043 |
| | *Pseudunciola obliquua* | 563 | | Ampharetidae (LPIL) | 1,009 |
| | Oligochaeta (LPIL) | 296 | | *Apoprionospio pygmaea* | 526 |
| | Rhepoxynius *hudsoni* | 295 | | *Polygordius* (LPIL) | 469 |
| | *Protohaustorius wigleyi* | 268 | | Oligochaeta (LPIL) | 276 |
| | *Aricidea catherinae* | 194 | | Cirratulidae (LPIL) | 225 |
| | *Ampelisca abdita* | 185 | | *Tanaissus psammophilus* | 144 |
| | *Spiophanes bombyx* | 148 | | *Spiophanes bombyx* | 125 |
| | *Donax variabilis* | 119 | | *Tellina agilis* | 115 |
| A2 | *Polygordius* (LPIL) | 543 | G3 | *Polygordius* (LPIL) | 1,071 |
| | Oligochaeta (LPIL) | 393 | | *Asabellides oculata* | 628 |
| | *Ampelisca abdita* | 286 | | Ampharetidae (LPIL) | 416 |
| | *Donax variabilis* | 270 | | *Tanaissus psammophilus* | 200 |
| | *Aricidea cerrutii* | 263 | | *Tellina agilis* | 89 |
| | *Tanaissus psammophilus* | 215 | | *Pseudunciola obliquua* | 87 |
| | *Rhepoxynius hudsoni* | 135 | | Oligochaeta (LPIL) | 84 |
| | *Protodorvillea kefersteini* | 102 | | *Branchiostoma* (LPIL) | 79 |
| | *Protohaustorius wigleyi* | 100 | | Rhynchocoela (LPIL) | 65 |
| | *Unciola irrorata* | 98 | | *Apoprionospio pygmaea* | 60 |
| C1 | Rhynchocoela (LPIL) | 1,562 | R1 | *Ampelisca* sp. X | 606 |
| | *Polygordius* (LPIL) | 767 | | *Nucula proxima* | 258 |
| | *Tanaissus psammophilus* | 492 | | *Apoprionospio pygmaea* | 126 |
| | *Pseudunciola obliquua* | 218 | | *Tellina agilis* | 67 |
| | Oligochaeta (LPIL) | 158 | | *Polygordius* (LPIL) | 38 |
| | Actiniaria (LPIL) | 125 | | *Ilyanassa trivittata* | 23 |
| | *Exogone hebes* | 101 | | *Caulleriella* sp. J | 22 |
| | *Unciola irrorata* | 52 | | *Aricidea wassi* | 20 |
| | *Parapionosyllis longicirrata* | 41 | | *Spiophanes bombyx* | 20 |
| | Ampharetidae (LPIL) | 37 | | Oligochaeta (LPIL) | 16 |
| F1 | *Pseudunciola obliquua* | 380 | R2 | Oligochaeta (LPIL) | 153 |
| | *Tanaissus psammophilus* | 377 | | Rhynochocoela (LPIL) | 85 |
| | *Polygordius* (LPIL) | 350 | | *Cirriformia grandis* | 54 |
| | *Lumbrinerides acuta* | 52 | | *Brania wellfleetensis* | 29 |
| | *Echinarachnius parma* | 36 | | *Polygordius* (LPIL) | 22 |
| | Oligochaeta (LPIL) | 34 | | *Pisone remota* | 14 |
| | *Aricidea* (LPIL) | 31 | | Actiniaria (LPIL) | 13 |
| | *Spisula solidissima* | 26 | | *Astarte castanea* | 8 |
| | *Sigalion arenicola* | 18 | | Cirratulidae (LPIL) | 8 |
| | *Protohaustorius wigleyi* | 16 | | *Travisia parva* | 8 |
| F2 | *Polygordius* (LPIL) | 440 | R3 | *Polygordjius* (LPIL) | 295 |
| | *Tanaissus psammophilus* | 397 | | *Echinarachnius parma* | 40 |
| | *Pseudunciola obliquua* | 134 | | *Tanaissus psammophilus* | 25 |
| | *Astarte castanea* | 102 | | *Pseudunciola obliquua* | 19 |
| | *Echinarachnius parma* | 92 | | *Hemipodus roseus* | 13 |
| | Nephtyidae (LPIL) | 65 | | Oligochaeta (LPIL) | 13 |
| | *Pisione remota* | 52 | | Cirratulidae (LPIL) | 9 |
| | Rhynchocoela (LPIL) | 39 | | Actiniaria (LPIL) | 7 |
| | *Spisula solidissima* | 36 | | *Sigalion arenicola* | 6 |
| | *Microphthalmus* (LPIL) | 31 | | *Politolana polita* | 4 |
| G1 | *Polygordius* (LPIL) | 1,081 | SEPT TOTAL | *Polygordius* (LPIL) | 6,631 |
| | *Apoprionospio pygmaea* | 613 | | *Asabellides oculata* | 2,186 |
| | *Asabellides oculata* | 412 | | Rhynchocoela (LPIL) | 2,007 |
| | *Spiophanes bombyx* | 279 | | *Tanaissus psammophilus* | 1,990 |
| | *Nucula proxima* | 119 | | *Pseudunciola obliquua* | 1,536 |
| | *Protohaustorius wigleyi* | 81 | | Oligochaeta (LPIL) | 1,527 |
| | Oligochaeta (LPIL) | 77 | | *Nucula proxima* | 1,498 |
| | *Glycera dibranchiata* | 64 | | Ampharetidae (LPIL) | 1,481 |
| | Cirratulidae (LPIL) | 62 | | *Ampelisca* sp.X | 1,445 |
| | *Spiochaetopterus oculatus* | 62 | | *Apoprionospio pygmaea* | 1,326 |

LPIL = Lowest practical identification level.

Table 6-4. Summary of infaunal statistics by survey for sand resource areas (A1, A2, C1, F1, F2, G1, G2, and G3) and adjacent stations (R1, R2, and R3) offshore New Jersey.

May 1998 (Survey 1)

| Area | No. of Taxa | | No. of Individuals | | Density (Individuals/$m^2$) | | H' Diversity | | J' Evenness | | D Richness | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean Per Station | Standard Deviation | Mean Per Station | Standard Deviation | Mean Per Station | Standard Deviation | Mean Per Station | Standard Deviation | Mean Per Station | Standard Deviation | Mean Per Station | Standard Deviation |
| A1 | 37 | 20 | 898 | 846 | 8,975 | 8,463 | 2.37 | 0.61 | 0.67 | 0.16 | 5.67 | 2.28 |
| A2 | 21 | 7 | 217 | 181 | 2,173 | 1,814 | 2.20 | 0.69 | 0.73 | 0.20 | 3.85 | 1.01 |
| C1 | 28 | 9 | 625 | 616 | 6,254 | 6,158 | 2.01 | 0.52 | 0.63 | 0.20 | 4.49 | 0.72 |
| F1 | 31 | 1 | 609 | 441 | 6,090 | 4,412 | 1.74 | 0.46 | 0.51 | 0.14 | 4.75 | 0.49 |
| F2 | 26 | 13 | 351 | 343 | 3,505 | 3,429 | 2.25 | 0.24 | 0.72 | 0.05 | 4.26 | 1.50 |
| G1 | 21 | 5 | 565 | 612 | 5,647 | 6,124 | 1.64 | 1.10 | 0.54 | 0.37 | 3.71 | 0.90 |
| G2 | 27 | 8 | 757 | 866 | 7,570 | 8,658 | 1.91 | 0.76 | 0.59 | 0.26 | 4.26 | 0.77 |
| G3 | 33 | 18 | 878 | 1,296 | 8,783 | 12,960 | 2.10 | 0.80 | 0.64 | 0.30 | 5.35 | 1.41 |
| R1 | 39 | | 748 | | 7,480 | | 2.13 | | 0.58 | | 5.74 | |
| R2 | 44 | | 4,296 | | 42,960 | | 1.42 | | 0.38 | | 5.14 | |
| R3 | 34 | | 1,252 | | 12,520 | | 1.01 | | 0.29 | | 4.63 | |

September 1998 (Survey 2)

| Area | No. of Taxa | | No. of Individuals | | Density (Individuals/$m^2$) | | H' Diversity | | J' Evenness | | D Richness | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean Per Station | Standard Deviation | Mean Per Station | Standard Deviation | Mean Per Station | Standard Deviation | Mean Per Station | Standard Deviation | Mean Per Station | Standard Deviation | Mean Per Station | Standard Deviation |
| A1 | 41 | 11 | 734 | 625 | 7,339 | 6,245 | 2.41 | 0.37 | 0.66 | 0.11 | 6.24 | 1.26 |
| A2 | 33 | 8 | 447 | 366 | 4,468 | 3,660 | 2.40 | 0.31 | 0.69 | 0.08 | 5.53 | 1.19 |
| C1 | 28 | 6 | 384 | 447 | 3,842 | 4,473 | 2.15 | 0.76 | 0.65 | 0.23 | 5.10 | 1.15 |
| F1 | 36 | 4 | 507 | 393 | 5,073 | 3,933 | 2.14 | 0.39 | 0.60 | 0.13 | 5.85 | 0.12 |
| F2 | 26 | 5 | 339 | 109 | 3,392 | 1,092 | 2.08 | 0.34 | 0.64 | 0.11 | 4.30 | 0.83 |
| G1 | 43 | 10 | 644 | 351 | 6,438 | 3,512 | 2.33 | 0.51 | 0.62 | 0.13 | 6.68 | 1.52 |
| G2 | 35 | 7 | 800 | 1,207 | 8,000 | 12,067 | 2.48 | 0.41 | 0.71 | 0.12 | 5.70 | 1.14 |
| G3 | 40 | 7 | 547 | 392 | 5,470 | 3,920 | 2.42 | 0.52 | 0.66 | 0.16 | 6.44 | 0.93 |
| R1 | 40 | | 1,320 | | 13,200 | | 1.98 | | 0.54 | | 5.43 | |
| R2 | 31 | | 446 | | 4,460 | | 2.26 | | 0.66 | | 4.92 | |
| R3 | 27 | | 459 | | 4,590 | | 1.56 | | 0.47 | | 4.24 | |

highest measure of mean species richness was from Area G1 (6.68). During the September survey, the lowest mean values of species diversity and richness were from Area F2 (2.08 and 4.30, respectively). The lowest mean value of species evenness during the September survey was from Area F1 stations (0.60).

#### 6.3.3.1 Juvenile Atlantic Surfclam

Each of the sand resource areas yielded juvenile Atlantic surfclam (*S. solidissima*) during both surveys. Table 6-5 presents mean densities of juvenile *S. solidissima* from each of the eight sand resource areas and three adjacent stations. Juvenile Atlantic surfclam mean densities were much greater during the May survey than in September at all areas except Areas F1 and G1. Greatest surfclam mean densities occurred at adjacent stations during both the May (Station R2) and September (Station R1) surveys. Within sand resource areas, mean densities in May ranged from 425 clams/$m^2$ at Area F2 stations to 20 clams/$m^2$ in Area F1. Mean juvenile Atlantic surfclam densities in September ranged from 87 clams/$m^2$ at Area F1 stations to 8 clams/$m^2$ in Area A2. The distribution of juvenile Atlantic surfclams during the surveys was very heterogeneous, as indicated by large standard deviations (Table 6-5). Juvenile surfclams were not associated with any single type of sedimentary habitat, although stations with at least some gravel content tended to yield greater numbers than stations with pure sand.

#### 6.3.3.2 Cluster Analysis

Patterns of infaunal similarity among stations were examined with cluster analysis. The cluster analysis excluded those taxa that were rare in the samples or had an LPIL designation, except for the polychaete *Mediomastus* (LPIL) and the archiannelid *Polygordius*. When examined over both surveys, normal cluster analysis produced six groups (Groups A through F) of stations (samples) that were similar with respect to species composition and relative abundance (Figure 6-14). Several stations that were not included within any of these six station groupings, yet were dissimilar enough not to be grouped together, were placed into outlier groups (X and Y). Station Groups X and Y contained 13 of the 90 stations sampled during the project and included samples collected during both surveys. Station Groups B and E included samples taken only during the September survey, while Group D contained stations sampled in May. Three of the six station groups (Groups A, C, and F) included samples collected during both surveys. Four of the six station groups (Groups A, C, D, and E) each were represented by relatively few stations, while Groups B (21 stations) and F (31 stations) together contained most of the total project samples (Figure 6-14). Group B stations were distinguished from other stations primarily by the presence of relatively high numbers of the polychaetes *Apoprionospio pygmaea*, *Dispio uncinata*, and *Spiochaetopterus oculatus* and amphipods *Protohaustorius wigleyi* and *Rhepoxynius hudsoni*. Group F stations were depauperate with respect to these taxa, and were further distinguished from other station groupings primarily by exhibiting high numbers of the archiannelid *Polygordius*, the amphipod *Pseudunciola obliquua*, and the tanaid *T. psammophilus*.

Figure 6-14 shows the geographic distribution of infaunal stations grouped by normal analysis. Group F stations were distributed across all resource areas and both surveys, and included all stations in Areas F1 and F2, as well as Adjacent Station 3. Group B stations were located in Areas A1, A2, G1, G2, and G3. Station Group A (seven stations) primarily was associated with Area C1 and Adjacent Station 2. Group C (nine stations) included Adjacent Station 1 and stations in Areas A1, G2, and G3. Group D included one station in each of Areas A1, A2, C1, G2, and G3, while Group E was composed of two stations each in Areas A2 and G2.

Table 6-5. Occurrence and density of juvenile Atlantic surfclam, *Spisula solidissima*, in Smith-McIntyre grab samples taken in the eight sand resource areas and three adjacent stations during the May 1998 Survey 1 and September 1998 Survey 2 offshore New Jersey.

| May 1998 | | | |
|---|---|---|---|
| Area | Number of Samples | Mean Density (clams/m$^2$) | Standard Deviation |
| A1 | 4 | 228 | 151.3 |
| A2 | 4 | 43 | 56.8 |
| C1 | 5 | 166 | 140.1 |
| F1 | 2 | 20 | 14.1 |
| F2 | 2 | 425 | 558.6 |
| G1 | 3 | 23 | 23.1 |
| G2 | 4 | 133 | 63.4 |
| G3 | 3 | 173 | 161.7 |
| R1 | 1 | 330 | |
| R2 | 1 | 820 | |
| R3 | 1 | 0 | |
| | | | |
| September 1998 | | | |
| Area | Number of Samples | Mean Density (clams/m$^2$) | Standard Deviation |
| A1 | 9 | 14 | 21.3 |
| A2 | 8 | 8 | 8.9 |
| C1 | 11 | 25 | 41.3 |
| F1 | 3 | 87 | 106.9 |
| F2 | 5 | 72 | 86.4 |
| G1 | 6 | 37 | 35.0 |
| G2 | 8 | 25 | 27.8 |
| G3 | 7 | 11 | 9.0 |
| R1 | 1 | 100 | |
| R2 | 1 | 0 | |
| R3 | 1 | 0 | |

Inverse cluster analysis examining both the May and September surveys resulted in five groups of taxa (Groups 1 through 5) that reflected their co-occurrence in sand resource area samples (Table 6-6). Most taxa included in the cluster analysis were polychaetes (32 taxa), followed by crustaceans (18), bivalve (9) and gastropod mollusks (7), and a single echinoid (*Echinarachnius parma*). Species Group 1 included the most homogeneously distributed taxa found during the study, both among the various sand resource areas and among surveys. This group included the polychaetes *Caulleriella* sp. J and *S. bombyx*, the archiannelid *Polygordius*, the bivalves *S. solidissima* and *Tellina agilis*, amphipods *Acanthohaustorius millsi*, *Protohaustorius wigleyi, Pseudunciola obliquua,* and *R. hudsoni*, and tanaid *T. psammophilus*.

Species Group 1 was particularly associated with Station Group B; all stations in this group included a majority of the taxa comprising Group 1. These taxa generally inhabit areas of sandy sediments, especially the polychaete *S. bombyx* and archiannelid *Polygordius*. Station Group B was, in fact, the most homogeneous station group with respect to sediment composition, as 20 of the 21 stations were characterized by a sand substratum (Figure 6-15). Taxa in Species Groups 2, 3, 4, and 5 were heterogeneously distributed.

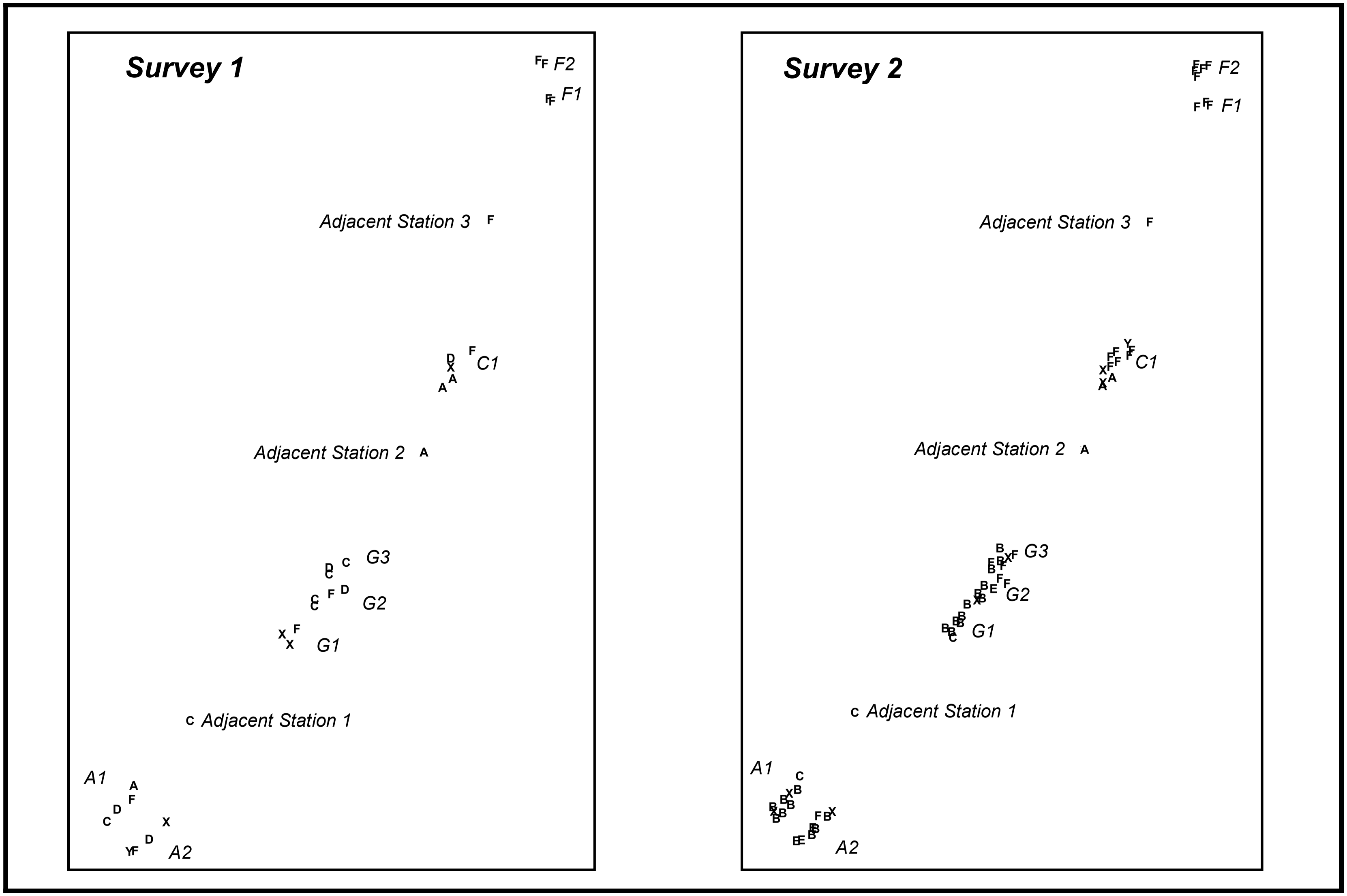


Figure 6-14. Station groups (A to F; X and Y) based on normal cluster analysis of infaunal samples collected during the May 1998 Survey 1 and September 1998 Survey 2 in the eight sand resource areas (A1, A2, C1, F1, F2, G1, G2, and G3) and three adjacent stations offshore New Jersey.

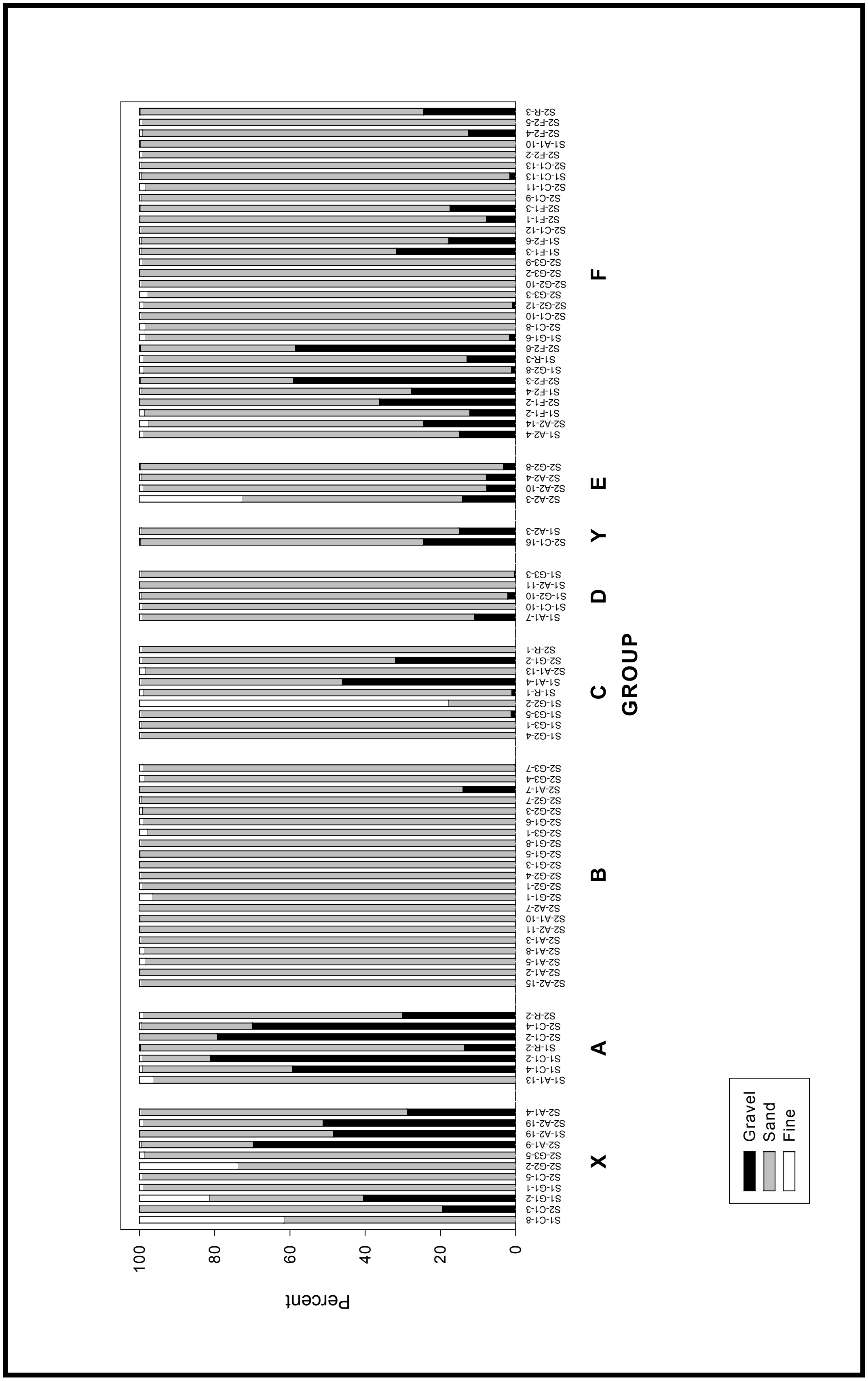


Figure 6-15. Grain size composition of infaunal samples collected during the May 1998 Survey 1 (S1) and September 1998 Survey 2 (S2) in the eight sand resource areas offshore New Jersey. Sample order and groups (A to F; X and Y) are based on normal cluster analysis.

Station Group A was characterized by Group 2 taxa (Table 6-6). Group C was characterized by taxa from Species Groups 1, 3, and 4. Group D was depauperate of common taxa (Table 6-6), while Group E was characterized by taxa from Species Groups 1, 2, and 3.

Table 6-6. Infaunal species groups resolved from inverse cluster analysis of all samples collected during the May 1998 Survey 1 and September 1998 Survey 2 in the eight sand resource areas and three adjacent stations offshore New Jersey.

**GROUP 1**

*Polygordius* (LPIL)
*Tanaissus psammophilus*
*Pseudunciola obliquua*
*Spiophanes bombyx*
*Spisula solidissima*
*Tellina agilis*
*Caulleriella* sp. J
*Protohaustorius wigleyi*
*Rhepoxynius hudsoni*
*Acanthohaustorius millsi*

**GROUP 2**

*Pisione remota*
*Astarte castanea*
*Hemipodus roseus*
*Mytilus edulis*
*Crenella decussata*
*Lumbrinerides acuta*
*Aricidea cerrutii*
*Hesionura elongata*
*Protodorvillea kefersteini*
*Parougia caeca*
*Spio setosa*

**GROUP 3**

*Petricola pholadiformis*
*Nereis succinea*
*Anachis lafresnayi*
*Brania wellfleetensis*
*Cirriformia grandis*
*Chiridotea tuftsi*
*Sigalion arenicola*
*Politolana polita*
*Donax variabilis*
*Bathyporeia parkeri*
*Oxyurostylis smithi*
*Tectonatica pusilla*
*Echinarachnius parma*
*Exogone hebes*
*Parapionosyllis longicirrata*
*Streptosyllis arenae*
*Capitella capitata*
*Diastylis polita*
*Ampelisca abdita*
*Unciola irrorata*
*Aricidea catherinae*
*Ampelisca* sp. X
*Apoprionospio dayi*
*Mediomastus* (LPIL)
*Ampelisca macrocephala*
*Mercenaria mercenaria*
*Odostomia gibbosa*

**GROUP 4**

*Tharyx acutus*
*Asabellides oculata*
*Nucula proxima*
*Edotia triloba*
*Nephtys picta*
*Phyllodoce arenae*
*Ilyanassa trivittata*
*Apoprionospio pygmaea*
*Dispio uncinata*
*Spiochaetopterus oculatus*
*Magelna papillicornis*
*Euspira heros*
*Acanthohaustorius shoemakeri*
*Microprotopus raneyi*
*Turbonilla interrupta*
*Americamysis bigelowi*

**GROUP 5**

*Glycera dibranchiata*
*Mitrella lunata*
*Harmothoe imbricata*

LPIL = Lowest practical identification level.

### 6.3.3.3 Canonical Discriminant Analysis

Data collected during the two surveys were analyzed using canonical discriminant analysis to determine which environmental factors most affected the distribution of infaunal assemblages. The first two canonical discriminant variates were used to analyze variability among those station groups identified by normal cluster analysis as being similar with respect to species composition and relative abundance. The first canonical variate correlated best with percent gravel (0.6978) and percent sand (-0.6814), and to a lesser degree with survey (-0.5489) and station water depth (0.4859). The second canonical variate best correlated with latitude (Northing [0.8371]) and longitude (Easting [0.7659]).

Patterns of infaunal similarity among stations (normal cluster analysis) and the co-occurrence of taxa within samples (inverse cluster analysis) were examined for each sand resource area. The following describes the results of this area-by-area analysis for each survey, as well as the affinities of the station groups and species groups identified by cluster analyses. Due to the heterogeneity of most taxa distributions, generally low abundances, and relatively limited sampling, only well-defined species groups generated from the inverse analyses are included in the discussion.

**Area A1**

Normal cluster analysis resulted in four station groups in Area A1 (Station Groups A through D) that were similar with respect to assemblage composition and abundance of infaunal taxa (Table 6-7). Group A consisted of two stations that were characterized by the polychaetes *Hemipodus roseus*, *Hesionura elongata,* and *Parougia caeca* and bivalves *Crenella decussata* and *M*. *edulis*. Station Group B included eight stations sampled primarily during the September survey that were distinguished from other groups by yielding high numbers of the amphipods *A*. *millsi*, *Protohaustorius wigleyi*, and *Pseudunciola obliquua* and tanaid *T*. *psammophilus*. Juvenile Atlantic surfclam (*S. solidissima*) was associated primarily with Group B stations. Group C consisted of two stations that were characterized by the exclusive or near exclusive presence of the polychaete *Mediomastus*, bivalve *N*. *proxima*, gastropod *Turbonilla interrupta*, and amphipod *Unciola irrorata*. Group D was represented by a single station from the September survey that was generally depauperate but did yield taxa that were rare at other stations, including the polychaete *Harmothoe imbricata* and gastropods *Crepidula fornicata* and *M. lunata* (Table 6-7).

Inverse cluster analysis resulted in three groups of taxa (Species Groups 1 through 3) that reflected their co-occurrence in samples collected in Area A1 (Table 6-7). Species Group 1 had the most homogeneously distributed taxa in Area A1 and included the polychaetes *Caulleriella* sp. J and *S*. *bombyx*, archiannelid *Polygordius*, bivalve *Donax variabilis*, gastropod *Tectonatica pusilla,* amphipods *A. millsi*, *Bathyporeia parkeri*, *Protohaustorius wigleyi*, *Pseudunciola obliquua*, and *R. hudsoni,* cumacean *Oxyurostylis smithi*, and tanaid *T*. *psammophilus.* Group 2 consisted of taxa collected primarily from two stations, including the polychaetes *Hemipodus roseus*, *Hesionura elongata*, *Parougia caeca*, and *Pisione remota,* bivalves *C*. *decussata* and *M*. *edulis*, and isopod *Chiridotea tuftsi*. Species Group 3 also contained taxa collected primarily from two stations. Group 3 taxa included the polychaetes *Aricidea catherinae*, *Asabellides oculata*, *Mediomastus*, *Nephtys picta*, *Phyllodoce arenae*, and *Tharyx acutus,* bivalve *N*. *proxima*, gastropods *Ilyanassa trivittata* and *T*. *interrupta*, and amphipods *Ampelisca abdita* and *U*. *irrorata* (Table 6-7).

Sediments in Area A1 were fairly homogeneous, as all but two sampled stations were characterized by sand substrata. Those stations that had high gravel content yielded taxa that were rare or absent at other stations, including the polychaete *H*. *imbricata*, bivalves *Astarte castanea* and *Mercenaria mercenaria*, gastropods *C*. *fornicata, Mitrella lunata,* and *Odostomia gibbosa*, and amphipod *Ampelisca macrocephala*. Species Group 1 was primarily associated with Station Group B, Species Group 2 was associated with Station Group A, and Species Group 3 was associated with Station Group C. Station 13 yielded high abundances of certain taxa and supported distinct assemblages during both the May (e.g., polychaete *P*. *remota* and bivalve *M. edulis*) and September (e.g., polychaete *Apoprionospio dayi* and amphipod *Ampelisca* sp. X) surveys, despite having sediments similar to other stations in Area A1. Station 13 was situated in a trough feature and was the deepest (20 m) station in Area A1.

Table 6-7. Two-way table from normal (Station Groups A-D) and inverse (Species Groups 1-3[a]) cluster analysis of infaunal samples collected during the May 1998 Survey 1 (S1) and September 1998 Survey 2 (S2) in Sand Resource Area A1 offshore New Jersey. Data are presented as total counts for individual taxa.

| Taxon | A | | B | | | | | | | | C | | D | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | S1-A1-13 | S2-A1-4 | S1-A1-7 | S1-A1-10 | S2-A1-7 | S2-A1-10 | S2-A1-3 | S2-A1-2 | S2-A1-5 | S2-A1-8 | S1-A1-4 | S2-A1-13 | S2-A1-9 | |
| *Polygordius* (LPIL[b]) | 75 | 561 | 6 | 17 | 530 | 1 | 5 | 97 | 13 | 32 | 6 | 20 | 170 | |
| *Protohaustorius wigleyi* | | 1 | 21 | 11 | 5 | 37 | 78 | 51 | 62 | 33 | | 1 | | |
| *Rhepoxynius hudsoni* | | 85 | 4 | 1 | 19 | 47 | 32 | 55 | 28 | 28 | | | 1 | |
| *Spiophanes bombyx* | | | | 80 | 15 | 14 | 23 | 26 | 26 | 17 | 47 | 22 | 5 | |
| *Pseudunciola obliquua* | | 1 | | 7 | 525 | 1 | 11 | 9 | 16 | | | | | |
| *Tanaissus psammophilus* | 1 | | | 5 | 25 | 4 | 12 | 7 | 35 | 2 | | | | |
| *Caulleriella* sp.J | | 4 | 3 | 6 | 17 | 3 | 7 | 1 | 17 | 5 | 2 | | 2 | 1 |
| *Donax variabilis* | | 8 | | | 1 | 52 | 33 | | 25 | | | | | |
| *Bathyporeia parkeri* | | 2 | | | | 6 | 21 | 46 | 20 | 5 | | | | |
| *Acanthohaustorius millsi* | | | 1 | | 1 | 12 | | 36 | 11 | 1 | | | | |
| *Tectonatica pusilla* | | 4 | 2 | 1 | 2 | 5 | 13 | 18 | 6 | 8 | | 4 | | |
| *Oxyurostylis smithi* | | 3 | | | 12 | 7 | 7 | 5 | 2 | 8 | | 7 | | |
| *Bathyporeia quoddyensis* | | | | 17 | | | | | | | | | | |
| *Spisula solidissima* | 5 | | 22 | 22 | 6 | 1 | 1 | | 4 | | | 1 | | |
| *Exogone hebes* | | | 2 | 4 | 6 | | 1 | | | 1 | | | | |
| *Sigalion arenicola* | | | | 3 | 3 | | 6 | | | | | | | |
| *Dissodactylus mellitae* | | | | | 8 | | | | 13 | | | | | |
| *Magelona papillicornis* | | | | | 2 | | | 6 | 3 | | | | | |
| *Mytilus edulis* | 791 | 48 | | | | | | | | | 4 | | | |
| *Pisione remota* | 182 | 47 | | | | | | 1 | | | | | | |
| *Parougia caeca* | 28 | 32 | | | | | | | | | | | | |
| *Hesionura elongata* | 7 | 36 | | | | | | | | | | | | 2 |
| *Crenella decussata* | 17 | 5 | | | | | | | | | | | | |
| *Hemipodus roseus* | 9 | 11 | | | | | | | | | | | | |
| *Chiridotea tuftsi* | 2 | 3 | | | | 1 | 2 | 3 | | | | | | |
| *Ampelisca macrocephala* | | | | | | | | | | | 288 | | | |
| *Mercenaria mercenaria* | | | | | | | | | | | 166 | | | |
| *Odostomia gibbosa* | | | | | | | | | | | 37 | | | |
| *Astarte castanea* | | | | | | | | | | | 10 | | | |
| *Glycera dibranchiata* | | | | 2 | | | | | | | | 3 | 7 | |
| *Mitrella lunata* | | | | | | | 1 | | | | | 1 | 35 | |
| *Crepidula fornicata* | | 1 | | | | | | | | | | | 22 | |
| *Harmothoe imbricata* | | | | | | | | | | 1 | | | 8 | |
| *Aricidea cerrutii* | | 13 | | | | | | | | | | | | |
| *Brania wellfleetensis* | | 10 | | | | | | | | | | | | |
| *Paraeupolymnia* sp.A | | 9 | | | | | | | | | | | | |
| *Lumbrinerides acuta* | | 9 | | | | | | | | | | | | |
| *Ampelisca* sp.X | | | | | | | | | | | | 816 | 2 | |
| *Apoprionospio dayi* | | | | | | | | | | | | 115 | | |
| *Ampelisca abdita* | | 19 | | | | 11 | 1 | | 2 | 1 | 69 | 125 | 26 | |
| *Aricidea catherinae* | | 57 | | | | | | | | | 54 | 137 | | |
| *Unciola irrorata* | | 6 | | | | 1 | | 1 | | 1 | 52 | 85 | 2 | |
| *Tellina agilis* | | | 5 | 5 | | | | 18 | | 42 | 51 | 49 | | |
| *Turbonilla interrupta* | | | | | | | | | | | 354 | 82 | | |
| *Nucula proxima* | | | | 1 | | | | | | | 44 | 50 | 2 | 3 |
| *Mediomastus* (LPIL) | | | 1 | | | | | | | | 36 | 9 | | |
| *Phyllodoce arenae* | | | | | 1 | 1 | 6 | | | | 4 | 9 | 1 | |
| *Asabellides oculata* | | | | | 5 | | | | | | 3 | 6 | 5 | |
| *Nephtys picta* | | 8 | | | 5 | 3 | 1 | | | 1 | 21 | 8 | | |
| *Ilyanassa trivittata* | | 4 | | | | 1 | 2 | | | 1 | 10 | 2 | | |
| *Tharyx acutus* | | 3 | | | | | | | | | 5 | 1 | | |

[a] Due to the heterogeneity of most taxa distributions, generally low abundances, and relatively limited sampling, only well-defined species groups generated from the inverse analyses are numbered.

[b] LPIL = Lowest practical identification level.

**Area A2**

Normal cluster analysis resulted in three station groups in Area A2 (Groups A through C). Group A included the same station (Station 19) sampled during both the May and September surveys and was depauperate with respect to most of the numerically dominant taxa found in Area A2 (Table 6-8). Group A did yield taxa that were absent at all other stations in Area A2 (the polychaete *Spio setosa* and amphipod *U. irrorata*). Group A also yielded high numbers of the archiannelid *Polygordius* and amphipod *A. abdita*. Station Group B included six stations, two of which (Stations 3 and 4) were sampled during both surveys. Group B was distinguished from other station groups primarily by the presence of the polychaetes *Aricidea cerutii*, *H. elongata*, *Pisione remota*, and *Protodorvillea kefersteini* and bivalves *A. castanea* and *C. decussata*. The archiannelid *Polygordius*, isopod *C. tuftsi*, and tanaid *T. psammophilus* were found at all Group B stations. Station Group C consisted of four stations and yielded an abundance of the amphipods *A. millsi*, *P. wigleyi*, and *R. hudsoni*. The echinoid *E. parma* was found only at Group C stations.

Inverse cluster analysis resulted in four groups of co-occurring taxa (Groups 1 through 4) in Area A2 (Table 6-8). Group 1 included the polychaetes *Aricidea cerutii*, *H. elongata, Pisione remota,* and *Protodorvillea kefersteini* and bivalves *Astarte castanea* and *C. decussata*. Taxa in Species Group 2 were collected mostly from a single station (Station 19) during both the May and September surveys, and included the polychaete *S. setosa* and amphipods *A. abdita* and *U. irrorata*. Group 3 contained the most homogeneously distributed taxa in Area A2 and included the polychaete *Sigalion arenicola*, archiannelid *Polygordius*, bivalve *D. variabilis*, isopods *C. tuftsi* and *Politolana polita*, amphipod *R. hudsoni,* and tanaid *T. psammophilus*. Species Group 4 included the polychaetes *Phyllodoce arenae* and *S. bombyx,* amphipods *A. millsi* and *P. wigleyi*, cumacean *O. smithi*, and echinoid *E. parma.*

Station groupings in Area A2 were separated by sediment type. Station Group A was represented by Station 19 during both surveys and was characterized by a sandy gravel substratum. Group B stations all were characterized by gravelly sand, while Group C stations were characterized by a sand substratum. Species Group 1 was associated with Station Group B, Group 2 taxa were associated with Group A stations, Group 3 taxa were associated with stations in Groups B and C, and Group 4 taxa were associated primarily with Station Group C.

**Area C1**

Normal cluster analysis resulted in five station groups in Area C1 (Groups A through E). Three station groups (Groups A, B, and D) each included a single station that was generally depauperate (Table 6-9). Groups A and D consisted of stations sampled during September, while the Group B station was sampled during the May survey. Group A did yield polychaete taxa (*Cirriformia grandis* and *Glycera dibranchiata*) that were rare at other stations. Station Group C included two stations (2 and 4) that were sampled during both the May and September surveys and were distinguished from other station groups by yielding high numbers of the polychaete *P. remota* and bivalves *C. decussata* and *M. edulis*. Group E was represented by five stations sampled primarily during the September survey, and yielded high abundances of the archiannelid *Polygordius*, amphipod *Pseudunciola obliquua*, tanaid *T. psammophilus,* and echinoid *E. parma*.

Inverse cluster analysis resulted in two groups of co-occurring taxa (Groups 1 and 2) in Area C1 (Table 6-9). Species Group 1 included several polychaetes, including *Caulleriella* sp. J, *E. hebes*, *N. picta*, *Parapionosyllis longicirrata*, *Sigalion arenicola*, *and Streptosyllis arenae*. Group 1 also included the archiannelid *Polygordius*, bivalve *S. solidissima*, amphipod

Table 6-8. Two-way table from normal (Station Groups A-C) and inverse (Species Groups 1-4[a]) cluster analysis of infaunal samples collected during the May 1998 Survey 1 (S1) and September 1998 Survey 2 (S2) in Sand Resource Area A2 offshore New Jersey. Data are presented as total counts for individual taxa.

| | A | | B | | | | | | C | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Taxon | S1-A2-19 | S2-A2-19 | S1-A2-3 | S1-A2-4 | S2-A2-14 | S2-A2-3 | S2-A2-10 | S2-A2-4 | S1-A2-11 | S2-A2-15 | S2-A2-11 | S2-A2-7 | |
| *Protodorvillea kefersteini* | | | | | 102 | | | | | | | | |
| *Aricidea cerrutii* | | | | 7 | 258 | | 2 | 3 | | | | | |
| *Astarte castanea* | | | 2 | 57 | 78 | | | 15 | | | | | 1 |
| *Crenella decussata* | | | | 25 | 51 | 1 | 1 | 38 | | | | | |
| *Hesionura elongata* | | | 12 | 10 | 54 | | 2 | | | | | | |
| *Pisione remota* | | | 1 | 9 | 27 | 1 | | | | | | | |
| *Ampelisca abdita* | 4 | 283 | | | 1 | | | | 4 | 1 | | 1 | |
| *Unciola irrorata* | 16 | 98 | | | | | | | | | | | 2 |
| *Spio setosa* | 47 | 11 | | | | | | | | | | | |
| *Hemipodus roseus* | | 18 | | | | | 2 | 3 | | | | | |
| *Brania wellfleetensis* | | 3 | | | 2 | 2 | 6 | 7 | | | | | |
| *Bathyporeia parkeri* | | | | | | | 15 | | | | 6 | 5 | |
| *Ampelisca* sp.X | | 5 | | | | | 14 | | | | 2 | | |
| *Tectonatica pusilla* | | | | | | | 3 | 4 | | | 3 | 1 | |
| *Acanthohaustorius shoemakeri* | | | | | | | 3 | | | | 2 | 1 | |
| *Polygordius* (LPIL[b]) | 147 | 311 | 16 | 63 | 143 | 7 | 37 | 18 | 6 | | | 27 | |
| *Tanaissus psammophilus* | | 1 | 6 | 47 | 40 | 9 | 8 | 149 | | 1 | 2 | 5 | |
| *Chiridotea tuftsi* | | | 1 | 45 | 8 | 16 | 48 | 9 | 2 | | 1 | 6 | |
| *Donax variabilis* | | | | | 9 | 56 | 49 | 31 | | 4 | 54 | 67 | 3 |
| *Rhepoxynius hudsoni* | | | | | 2 | | 11 | 2 | | 56 | 22 | 42 | |
| *Politolana polita* | | | | | 2 | 5 | 13 | 15 | | | 2 | 2 | |
| *Sigalion arenicola* | | | | 1 | 2 | 7 | 2 | 10 | | 3 | 4 | 2 | |
| *Protohaustorius wigleyi* | 1 | | 1 | 2 | | | 2 | 2 | 13 | 5 | 49 | 42 | |
| *Acanthohaustorius millsi* | 1 | | | | | | | 1 | 10 | | 27 | 22 | |
| *Echinarachnius parma* | | | | | | | | | 2 | 13 | 2 | 2 | |
| *Spiophanes bombyx* | | | | | | 4 | 1 | 2 | | 5 | 2 | 27 | 4 |
| *Oxyurostylis smithi* | | 1 | | | 1 | | | 2 | | 6 | 5 | 6 | |
| *Phyllodoce arenae* | | 1 | | | | | | 1 | | 3 | 1 | 3 | |
| *Synchelidium americanum* | | | | | | 1 | 1 | | 3 | 1 | | | |
| *Nephtys picta* | | 2 | | | | | | | | 1 | 1 | | |
| *Ilyanassa trivittata* | | 1 | 1 | | | | | | | 1 | | 1 | |
| *Mytilus edulis* | | | | 5 | | 2 | | 10 | 2 | | | | |
| *Lumbrinerides acuta* | | | | 1 | | | | 9 | | | | | |
| *Caecum johnsoni* | | | | 4 | | | | 2 | | | | | |
| *Streptosyllis arenae* | | | | 3 | | | | 1 | | | 1 | | |
| *Spisula solidissima* | | | | 5 | 2 | | 1 | 1 | 12 | | | 2 | |
| *Tellina agilis* | | | 6 | 3 | | | | | 10 | | | 1 | |
| *Dispio uncinata* | | | 1 | 2 | | | | | | | | 6 | |
| *Parapionosyllis longicirrata* | | | 1 | 3 | | | | | | | | | |

[a] Due to the heterogeneity of most taxa distributions, generally low abundances, and relatively limited sampling, only well-defined species groups generated from the inverse analyses are numbered.

[b] LPIL = Lowest practical identification level.

Table 6-9. Two-way table from normal (Station Groups A-E) and inverse (Species Groups 1 and 2[a]) cluster analysis of infaunal samples collected during the May 1998 Survey 1 (S1) and September 1998 Survey 2 (S2) in Sand Resource Area C1 offshore New Jersey. Data are presented as total counts for individual taxa

| Taxon | A | B | C | | | | D | E | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | S2-C1-3 | S1-C1-8 | S1-C1-4 | S1-C1-2 | S2-C1-2 | S2-C1-4 | S2-C1-5 | S1-C1-10 | S2-C1-16 | S2-C1-8 | S2-C1-10 | S2-C1-11 | |
| *Microphthalmus similis* | | | 8 | 1 | | | | | | | | | |
| *Glycera americana* | | | 8 | | | | | | | | | | |
| *Glycera dibranchiata* | 10 | | | | | | | | | | | | |
| *Cirriformia grandis* | 10 | | | | | | | | | | | | |
| *Chiridotea tuftsi* | 7 | | 1 | | | | | | | | 1 | | |
| *Scoletoma acicularum* | 3 | | | | | 2 | | | | | | | |
| *Polygordius* (LPIL[b]) | | | 10 | 43 | 2 | 33 | 1 | 6 | 2 | 44 | 24 | 172 | |
| *Tanaissus psammophilus* | 1 | | | | 1 | | | 2 | | 2 | 17 | 16 | |
| *Pseudunciola obliquua* | | | | | | | 1 | | 1 | 27 | 22 | 44 | |
| *Echinarachnius parma* | | | | | | | | 14 | 4 | | 3 | 7 | |
| *Spisula solidissima* | | | 33 | 13 | | 1 | | 8 | 1 | 9 | | 3 | |
| *Parapionosyllis longicirrata* | | | 2 | 8 | 8 | | | | 2 | | 1 | | 1 |
| *Exogone hebes* | | | | | | | | | | | 1 | 4 | |
| *Streptosyllis arenae* | | | | | | | | 1 | 1 | | 3 | 1 | |
| *Caulleriella* sp.J | | | | | | | | 2 | 2 | 7 | 1 | 5 | |
| *Nephtys picta* | 1 | | | | | | 4 | | | 2 | 1 | 4 | |
| *Sigalion arenicola* | | | | | | | | 2 | 6 | 2 | | | |
| *Spiophanes bombyx* | | 1 | | 2 | 1 | 1 | 4 | 1 | | | | | |
| *Nucula proxima* | | | 2 | 3 | | | 8 | | | 1 | | | |
| *Harmothoe imbricata* | | | 1 | 22 | | | | | | | | | |
| *Asabellides oculata* | | 6 | 2 | 5 | | | | | | | | | |
| *Hemipodus roseus* | | | | 7 | 8 | 4 | | | 1 | 3 | | | |
| *Astarte castanea* | | 1 | | 8 | 6 | | | | | | | 2 | |
| *Mytilus edulis* | 1 | 6 | 10 | 65 | 4 | 5 | | | | | | | 2 |
| *Pisione remota* | | 1 | 81 | 18 | 16 | 19 | | | | | | | |
| *Unciola irrorata* | 3 | | 2 | 25 | 31 | 7 | 1 | | | | | | |
| *Crenella decussata* | 2 | | 12 | 5 | 2 | 1 | | | | | | | |
| *Ophelia denticulata* | 2 | | 2 | 1 | 1 | 3 | | | 2 | | | | |
| *Ampharete acutifrons* | | | | | 6 | | | | | 1 | | | |
| *Phyllodoce arenae* | | | | | | | | | | 1 | | | |
| *Brania wellfleetensis* | | | | | | | | | 1 | | | | |
| *Edotia triloba* | | | | | 1 | | 1 | | | 3 | | | |
| *Tellina agilis* | | | | | | | 1 | | 1 | 4 | | | |
| *Politolana polita* | | | | | | | | | 1 | | 4 | | |
| *Rhepoxynius hudsoni* | | | | | | | | 5 | | 1 | 13 | 10 | |
| *Protohaustorius wigleyi* | | | | | | | | 9 | 2 | | | 9 | |
| *Dispio uncinata* | | | | | | | | | | | 1 | 2 | |

[a] Due to the heterogeneity of most taxa distributions, generally low abundances, and relatively limited sampling, only well-defined species groups generated from the inverse analyses are numbered.

[b] LPIL = Lowest practical identification level.

*Pseudunciola obliquua*, tanaid *T. psammophilus,* and echinoid *E. parma*. Group 2 included the polychaetes *A. oculata*, *H. imbricata*, *H. roseus*, *Ophelia denticulata*, and *P. remota,* bivalves *A. castanea*, *C. decussata*, and *M. edulis*, and amphipod *U. irrorata*.

The two primary station groups in Area C1 (Groups C and E) were characterized by different substratum types. Group C stations had gravel bottoms and Group E stations had sand bottoms. Species Group 1 was associated primarily with Station Group E, and Species Group 2 was associated primarily with Station Group C (Table 6-9).

**Area F1**

Normal cluster analysis resulted in two station groups in Area F1 (Groups A and B). Station Group A consisted of three stations that yielded relatively high numbers of the polychaetes *Goniadella gracilis*, *H. roseus*, and *P. remota* (Table 6-10). Group B included two stations during the September survey that yielded relatively high numbers of the polychaetes *N. picta* and *S. bombyx*, amphipods *Protohaustorius wigleyi* and *Pseudunciola obliquua*, tanaid *T. psammophilus,* and echinoid *E. parma*. Juvenile Atlantic surfclams were collected at all Area F1 stations.

Inverse cluster analysis resulted in two groups of co-occurring taxa (Groups 1 and 2) (Table 6-10). Species Group 1 included mostly polychaetes (*E. hebes*, *Lumbrinerides acuta*, *N. picta*, *Sigalion arenicola*, and *Spiophanes bombyx*) and crustaceans (*C. tuftsi*, *Protohaustorius wigleyi*, *Pseudunciola obliquua*, and *T. psammophilus*), and also included the archiannelid *Polygordius*, bivalve *S. solidissima,* and echinoid *E. parma*. Group 2 consisted entirely of polychaetes, including *Aricidea cerrutii*, *G. gracilis*, *H. roseus*, *Parapionosyllis longicirrata*, *Pisione remota*, and *Scolelepis squamata*.

Area F1 is characterized by a centrally located, elevated ridge feature and assemblage composition was different across station locations. Station 2 was situated on top of the ridge, while Stations 1 and 3 were located in deeper water adjacent to the ridge. Species Group 1 was associated with both station groups and Species Group 2 was associated primarily with Station Group A, which included stations that had gravelly substrata.

**Area F2**

Normal cluster analysis resulted in two station groups in Area F2 (Groups A and B). Station Group A consisted of two stations that yielded high numbers of the polychaetes *Asabellides oculata*, *Capitella jonesi*, *Notomastus hemipodus*, and *T. acutus* (Table 6-11). Group B consisted of five stations sampled primarily during the September survey. Group B stations were characterized by the exclusive or near exclusive presence of the polychaetes *Ampharete finmarchica*, *Aphelochaeta marioni*, and *Mediomastus*.

Inverse cluster analysis resulted in two groups of co-occurring taxa (Groups 1 and 2), with both groups represented entirely by polychaetes (Table 6-11). Species Group 1 contained the most homogeneously distributed taxa, including *Ampharete acutifrons*, *A. americana*, *A. finmarchica*, *Aphelochaeta marioni*, *C. capitata*, *Mediomastus*, and *S. oculatus*. Group 2 contained co-occurring taxa primarily from two stations, and included *Asabellides oculata*, *C. jonesi*, *N. hemipodus*, *P. kefersteini*, and *T. acutus*.

Species Group 1 was distributed across both station groups, while Species Group 2 was associated primarily with Station Group A. Group A stations were situated on top of a ridge feature at depths of 18 m, while some of the Group B stations were located in deeper water (19 to 22 m) at the base of the ridge. Sediments at Group A stations were sandy gravel or gravelly sand, while Group B stations mostly had sand or gravelly sand.

Table 6-10. Two-way table from normal (Station Groups A and B) and inverse (Species Groups 1 and 2[a]) cluster analysis of infaunal samples collected during the May 1998 Survey 1 (S1) and September 1998 Survey 2 (S2) in Sand Resource Area F1 offshore New Jersey. Data are presented as total counts for individual taxa.

| Taxon | A | | | B | | |
|---|---|---|---|---|---|---|
| | S1-F1-3 | S1-F1-2 | S2-F1-2 | S2-F1-1 | S2-F1-3 | |
| *Polygordius* (LPIL[b]) | 126 | 30 | 77 | 271 | 2 | 1 |
| *Tanaissus psammophilus* | 37 | 17 | 45 | 210 | 122 | |
| *Lumbrinerides acuta* | 1 | 87 | 43 | 8 | 1 | |
| *Spisula solidissima* | 3 | 1 | 21 | 3 | 2 | |
| *Chiridotea tuftsi* | | | 13 | 2 | | |
| *Pseudunciola obliquua* | | | 2 | 340 | 38 | |
| *Echinarachnius parma* | 2 | 1 | 2 | 12 | 22 | |
| *Sigalion arenicola* | 1 | 1 | 4 | 5 | 9 | |
| *Exogone hebes* | 10 | 5 | | 11 | 2 | |
| *Protohaustorius wigleyi* | | 1 | | 15 | 1 | |
| *Spiophanes bombyx* | | | | 6 | 8 | |
| *Nephtys picta* | | | 1 | 10 | 3 | |
| *Unciola irrorata* | | | 1 | 1 | 3 | |
| *Aricidea catherinae* | | | | 2 | 3 | |
| *Dipolydora socialis* | | | | | 3 | |
| *Edotia triloba* | 2 | | | 1 | 1 | |
| *Politolana polita* | 1 | | | 1 | 1 | |
| *Dispio uncinata* | | | | 1 | 1 | |
| *Ilyanassa trivittata* | 1 | | | | 1 | |
| *Parapionosyllis longicirrata* | | 9 | 1 | 3 | | 2 |
| *Hemipodus roseus* | 1 | 10 | 14 | 1 | | |
| *Goniadella gracilis* | 2 | 5 | 3 | | | |
| *Pisione remota* | | 15 | 6 | | | |
| *Aricidea cerrutii* | | 3 | 6 | | | |
| *Scolelepis squamata* | | 4 | | | | |
| *Astarte castanea* | 3 | 3 | 1 | 1 | 1 | |
| *Caulleriella* sp.J | 3 | 1 | 2 | | 1 | |
| *Cirrophorus ilvana* | 8 | 1 | | | | |
| *Mytilus edulis* | 2 | | | | | |
| *Cancer irroratus* | | | 2 | | 2 | |
| *Harmothoe imbricata* | | | 2 | | | |
| *Pseudoleptocuma minor* | | | 1 | 3 | | |
| *Hippomedon serratus* | | | 1 | 1 | | |
| *Asabellides oculata* | | | | 3 | | |
| *Aricidea wassi* | | | | 2 | | |

[a] Due to the heterogeneity of most taxa distributions, generally low abundances, and relatively limited sampling, only well-defined species groups generated from the inverse analyses are numbered.

[b]LPIL = Lowest practical identification level.

Table 6-11. Two-way table from normal (Station Groups A and B) and inverse (Species Groups 1 and 2[a]) cluster analysis of infaunal samples collected during the May 1998 Survey 1 (S1) and September 1998 Survey 2 (S2) in Sand Resource Area F2 offshore New Jersey. Data are presented as total counts for individual taxa.

| Taxon | A | | B | | | | | |
|---|---|---|---|---|---|---|---|---|
| | S1-F2-4 | S2-F2-3 | S1-F2-6 | S2-F2-2 | S2-F2-4 | S2-F2-5 | S2-F2-6 | |
| *Ampharete americana* | 86 | 69 | 34 | 75 | 18 | 41 | 237 | 1 |
| *Ampharete acutifrons* | 20 | 7 | 6 | 145 | 47 | 134 | 64 | |
| *Capitella capitata* | 82 | | 3 | | 15 | 18 | 3 | |
| *Ampharete finmarchica* | | 1 | 1 | 94 | 4 | 32 | 3 | |
| *Mediomastus* (LPIL[b]) | | | 5 | 61 | 3 | 24 | 4 | |
| *Spiochaetopterus oculatus* | 1 | 1 | | | 4 | 20 | 4 | |
| *Aphelochaeta marioni* | | | 1 | 2 | 3 | 9 | 4 | |
| *Asabellides oculata* | 32 | 100 | | | | 1 | 1 | 2 |
| *Capitella jonesi* | 47 | 49 | | | | | 3 | |
| *Notomastus hemipodus* | 32 | 11 | | 1 | 4 | | | |
| *Tharyx acutus* | 7 | 11 | | | | | 2 | |
| *Protodorvillea kefersteini* | 3 | 4 | 1 | | | | 3 | |
| *Schistomeringos pectinata* | | | | 9 | 2 | 4 | | |
| *Glycera capitata* | | | | | 2 | 3 | | |
| *Hemipodus roseus* | | | | | | 5 | | |
| *Glycera dibranchiata* | | | | 1 | 1 | 2 | 1 | |
| *Nephtys incisa* | | | | 1 | | 2 | | |
| *Cirriformia grandis* | | | 22 | 2 | | 1 | | |
| *Nephtys picta* | | | | 3 | | | | |
| *Travisia parva* | | | | 2 | | | | |
| *Owenia fusiformis* | | | | | 2 | | | |
| *Caulleriella* sp.J | | 19 | | | | | | |
| *Glycera americana* | | 5 | 1 | | | | | |
| *Microphthalmus similis* | | 4 | | | | | | |
| *Nereis succinea* | | 2 | | | | | | |
| *Onuphis eremita* | | 2 | | | | | | |
| *Leitoscoloplos robustus* | | 2 | | | | | | |
| *Goniadella gracilis* | | | 1 | | | | 4 | |
| *Pherusa plumosa* | | | | | | | 8 | |
| *Microphthalmus hartmanae* | | | | | | | 5 | |
| *Magelona papillicornis* | | | | | | | 3 | |
| *Nephtys bucera* | | | | | | | 3 | |
| *Leitoscoloplos fragilis* | | | | | | | 2 | |
| *Orbinia americana* | | | | | | | 2 | |
| *Aricidea catherinae* | | | | | | | 2 | |
| *Nereis acuminata* | 1 | | | | | | 1 | |
| *Ophelia denticulata* | | 1 | | | | | 1 | |
| *Axiothella mucosa* | 2 | 1 | | | | | | |
| *Diopatra cuprea* | 1 | 1 | | | | | | |
| *Parougia caeca* | 9 | | | | | | | |
| *Lumbrinerides acuta* | 4 | | | | | | | |
| *Scoletoma acicularum* | 3 | | | | | | | |
| *Scoletoma fragilis* | 3 | | | | | | | |
| *Scoletoma verrilli* | 3 | | | | | | | |
| *Aricidea wassi* | 2 | | | | | | | |

[a] Due to the heterogeneity of most taxa distributions, generally low abundances, and relatively limited sampling, only well-defined species groups generated from the inverse analyses are numbered.

[b] LPIL = Lowest practical identification level.

**Area G1**

Normal cluster analysis resulted in five station groups in Area G1 (Groups A through E). Four of the five station groups in Area G1 each contained a single station (Table 6-12). Station Group A was depauperate with respect to the numerically dominant taxa sampled from Area G1. Group B yielded high numbers of the polychaete *C. capitata* and bivalve *M. edulis*. Group C yielded high numbers of the archiannelid *Polygordius* but was otherwise depauperate. Group D was distinguished from other station groups by yielding high numbers of the polychaete *A. oculata* and by the near exclusive presence of the polychaetes *G. dibranchiata* and *Pectinaria gouldii,* bivalve *Petricola pholadiformis*, and gastropod *M. lunulata*. Station Group E included five stations sampled during the September survey. Several taxa were found only in this group, including the polychaete *S. oculatus*, gastropod *T. interrupta*, amphipod *P. obliquua,* and mysid *Americamysis bigelowi*. Station Group E also yielded high numbers of the polychaetes *A. pygmaea* and *S. bombyx* and tanaid *T. psammophilus*. All station groups in Area G1 yielded juveniles of the bivalve *S. solidissima*.

Inverse cluster analysis resulted in four groups of co-occurring taxa (Groups 1 through 4) in Area G1 (Table 6-12). A pair of taxa sampled mostly from a single station (polychaete *C. capitata* and bivalve *M. edulis*) represented Group 1. Species Group 2 included primarily polychaetes (*Asabellides oculata*, *Apoprionospio pygmaea*, *D. uncinata*, *Magelona papillicornis*, *N. picta*, *Owenia fusiformis*, *P. arenae*, *Spiochaetopterus oculatus*, *Sphiophanes bombyx*, and *T. acutus*), the gastropod *T. interrupta*, and crustaceans (*Acanthohaustorius shoemakeri*, *Americamysis bigelowi*, *Pseudunciola obliquua*, *Protohaustorius wigleyi*, *R. hudsoni*, and *T. psammophilus*). Group 3 contained sparsely distributed taxa that were sampled primarily from a single station during the September survey, and included polychaetes (*Caulleriella* sp. J, *G. dibranchiata*, *Nereis succinea*, and *P. gouldii*), bivalves (*N. proxima*, *P. pholadiformis*, and *T. agilis*), the gastropod *M. lunulata*, and cumacean *Diastylis polita*. Species Group 4 included bivalve (*D. variabilis* and *S. solidissima*) and gastropod (*E. heros* and *I. trivittata*) mollusks, as well as crustaceans (*A. millsi*, *C. tuftsi*, *O. smithi*, and *Parahaustorius attenuatus*).

Species Group 1 (polychaete *C. capitata* and bivalve *M. edulis*) was associated with Station Group B (muddy sandy gravel), Species Group 2 was associated with Station Group E (sand), and Group 3 taxa were associated primarily with Station Group D (sandy gravel). Species Group 4 was distributed across station groups. Station 2 was isolated as a station group during both surveys (Groups B and D) and, in addition to having a distinct sedimentary regime relative to other stations, was the deepest infaunal station in Area G1.

**Area G2**

Normal cluster analysis resulted in three station groups in Area G2 (Groups A through C). Station Group A included a single station sampled during the September survey that yielded high numbers of the polychaete *A. oculata* and bivalve *N. proxima* (Table 6-13). The presence of the polychaete *N. succinea*, bivalve *P. pholadiformis*, and gastropod *Anachis lafresnayi* also characterized Group A stations. Group B consisted of four stations from both surveys that yielded high numbers of the polychaetes *A. pygmaea* and *S. bombyx*. The bivalve *M. edulis* was collected only from Group B stations. Group C consisted of seven stations that yielded taxa not found in Station Groups A or B, primarily during the September survey, including the isopod *Politolana polita*, amphipod *P. obliquua*, and tanaid *T. psammophilus*.

Inverse cluster analysis resulted in three groups of co-occurring taxa (Groups 1 through 3) (Table 6-13). Species Group 1 contained primarily polychaetes, including *Asabellides oculata*, *Apoprionospio pygmaea*, *Loimia medusa*, *N. picta*, *P. arenae*, and *T. acutus*, and also included

Table 6-12. Two-way table from normal (Station Groups A-E) and inverse (Species Groups 1-4[a]) cluster analysis of infaunal samples collected during the May 1998 Survey 1 (S1) and September 1998 Survey 2 (S2) in Resource Area G1 offshore New Jersey. Data are presented as total counts for individual taxa.

| Taxon | A | B | C | D | E | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | S1-G1-1 | S1-G1-2 | S1-G1-6 | S2-G1-2 | S2-G1-1 | S2-G1-6 | S2-G1-3 | S2-G1-5 | S2-G1-8 | |
| *Capitella capitata* | | 91 | | | | | | | | 1 |
| *Mytilus edulis* | 2 | 48 | 1 | | | | | | | |
| *Polygordius* (LPIL[b]) | | 7 | 1,159 | 96 | 45 | 4 | 100 | 282 | 554 | 2 |
| *Apoprionospio pygmaea* | | | | 7 | | 7 | 341 | 213 | 45 | |
| *Spiophanes bombyx* | 1 | 1 | 3 | 2 | 49 | 45 | 30 | 79 | 74 | |
| *Protohaustorius wigleyi* | 3 | 1 | 2 | 1 | 6 | 5 | 58 | 3 | 8 | |
| *Asabellides oculata* | | | | 393 | 3 | 3 | 1 | 7 | 5 | |
| *Phyllodoce arenae* | | | | 7 | | 6 | 2 | 3 | 5 | |
| *Nephtys picta* | | | | 5 | 1 | 6 | 3 | 5 | 3 | |
| *Tanaissus psammophilus* | | 1 | 1 | 1 | 1 | 24 | 10 | 17 | 2 | |
| *Pseudunciola obliquua* | | | | | | 30 | 3 | 4 | 2 | |
| *Americamysis bigelowi* | | | | | | 18 | 9 | 3 | 8 | |
| *Spiochaetopterus oculatus* | | | | | 4 | 6 | 9 | 30 | 13 | |
| *Dispio uncinata* | | | | 1 | 15 | 4 | 5 | 14 | 13 | |
| *Magelona papillicornis* | | | | | | 1 | 8 | 4 | 11 | |
| *Rhepoxynius hudsoni* | | | 1 | 1 | 1 | 2 | 3 | 3 | 9 | |
| *Turbonilla interrupta* | | | | | | | 34 | 8 | 3 | |
| *Acanthohaustorius shoemakeri* | | | | | | | | 7 | 1 | |
| *Owenia fusiformis* | | | | | | 5 | 2 | 2 | 1 | |
| *Tharyx acutus* | | | | | | 1 | 2 | 4 | | |
| *Glycera dibranchiata* | | | | 64 | | | | | | 3 |
| *Mitrella lunata* | | | | 34 | | 1 | | | | |
| *Pectinaria gouldii* | | | | 14 | | | | | | |
| *Nereis succinea* | | | | 11 | | | | 1 | | |
| *Petricola pholadiformis* | | | | 9 | | | | | 1 | |
| *Nucula proxima* | 2 | 89 | 1 | 114 | | 1 | 1 | 3 | | |
| *Tellina agilis* | 2 | 1 | 4 | 40 | | | 9 | | | |
| *Caulleriella* sp.J | | 2 | 8 | 14 | | 2 | | | 1 | |
| *Unciola irrorata* | | | | 5 | | 5 | 1 | | | |
| *Diastylis polita* | | 4 | | 1 | | 4 | | | | |
| *Acanthohaustorius millsi* | 2 | | | 3 | 1 | | 30 | 1 | | 4 |
| *Euspira heros* | 2 | | | 9 | 3 | 1 | 5 | 1 | 2 | |
| *Ilyanassa trivittata* | 1 | | | 11 | 3 | | 1 | | | |
| *Parahaustorius attenuatus* | | 1 | | | 6 | 1 | | | | |
| *Spisula solidissima* | 1 | 5 | 1 | 1 | 4 | | 3 | 10 | 4 | |
| *Donax variabilis* | | | | | 6 | | | 4 | 4 | |
| *Chiridotea tuftsi* | 2 | | | | 6 | 1 | | | 4 | |
| *Oxyurostylis smithi* | | | | 1 | 1 | | | 1 | 2 | |

[a] Due to the heterogeneity of most taxa distributions, generally low abundances, and relatively limited sampling, only well-defined species groups generated from the inverse analyses are numbered.

[b] LPIL = Lowest practical identification level.

Table 6-13. Two-way table from normal (Station Groups A-C) and inverse (Species Groups 1-3[a]) cluster analysis of infaunal samples collected during the May 1998 Survey 1 (S1) and September 1998 Survey 2 (S2) in Sand Resource Area G2 offshore New Jersey. Data are presented as total counts for individual taxa.

| Taxon | A | B | | | | C | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | S2-G2-2 | S1-G2-2 | S1-G2-4 | S2-G2-1 | S2-G2-4 | S1-G2-10 | S2-G2-10 | S2-G2-12 | S2-G2-3 | S2-G2-7 | S1-G2-8 | S2-G2-8 | |
| *Mytilus edulis* | | 39 | 67 | | | | | | | | 1 | | |
| *Diastylis polita* | | 38 | | | 1 | | | | | | | | |
| *Nereis succinea* | 73 | | | | 1 | | | | | | | | |
| *Petricola pholadiformis* | 54 | | | | 1 | | | | | | | | |
| *Anachis lafresnayi* | 33 | | | | | | | | | | | | |
| *Brania wellfleetensis* | | | | | | | | | | | | 22 | |
| *Asabellides oculata* | 1,045 | 4 | 8 | 72 | 2 | | | | 1 | 1 | | | |
| *Nucula proxima* | 1,026 | 74 | | 14 | 1 | | | | 1 | 1 | | | |
| *Edotia triloba* | 28 | 19 | 2 | 5 | | | | 3 | | | | | |
| *Nephtys picta* | 3 | 4 | 3 | 13 | 7 | | | 1 | 1 | 1 | | | |
| *Ilyanassa trivittata* | | 9 | | 8 | 4 | | | 1 | 1 | | | | |
| *Spiochaetopterus oculatus* | | 1 | | 12 | 1 | | 1 | 1 | 4 | 6 | | | 1 |
| *Phyllodoce arenae* | 1 | | | 7 | 2 | | 2 | 1 | 4 | 4 | | | |
| *Euspira heros* | 5 | | 2 | 4 | 4 | | 1 | | 1 | 4 | | | |
| *Apoprionospio pygmaea* | | | | 359 | 163 | | | | 2 | | | 2 | |
| *Tharyx acutus* | 7 | | | 65 | | | 1 | | | | | | |
| *Loimia medusa* | | | | 13 | | | | | | | | | |
| *Spiophanes bombyx* | | 1,652 | 75 | 32 | 18 | 2 | 2 | | 37 | 32 | 3 | 4 | |
| *Polygordius* (LPIL[b]) | | 20 | 44 | 358 | 13 | 8 | 30 | 7 | 4 | 8 | 295 | 49 | |
| *Tellina agilis* | 4 | 12 | 27 | 38 | 5 | | 42 | 7 | 2 | 13 | 2 | 4 | |
| *Protohaustorius wigleyi* | 2 | | 36 | 5 | 16 | 7 | 12 | | 5 | 9 | 1 | | |
| *Spisula solidissima* | | 11 | 7 | 5 | 8 | 22 | 3 | | 1 | 2 | 13 | 1 | 2 |
| *Chiridotea tuftsi* | | | 27 | 1 | | | | | 1 | 2 | 1 | 4 | |
| *Acanthohaustorius millsi* | | | 26 | | 7 | | | | 15 | 1 | 2 | | |
| *Magelona papillicornis* | | | 6 | 3 | 1 | | | | 11 | 4 | | | |
| *Unciola irrorata* | | | 12 | 6 | 1 | | 2 | | | | | | |
| *Sigalion arenicola* | | | 1 | 3 | | | 2 | 2 | 1 | | | 2 | |
| *Dispio uncinata* | | | | | 6 | | | | 7 | 29 | | | |
| *Parahaustorius attenuatus* | | | | | | 1 | | | 1 | 8 | | | |
| *Pseudunciola obliquua* | | | | | | | 8 | 25 | 46 | 12 | | | |
| *Rhepoxynius hudsoni* | | | 3 | | 2 | 7 | 7 | 12 | 23 | 7 | | | |
| *Oxyurostylis smithi* | | | | 1 | | | 4 | 18 | 6 | 2 | | 1 | |
| *Tanaissus psammophilus* | | | | | | 2 | 42 | 15 | 1 | 7 | 61 | 79 | 3 |
| *Politolana polita* | | | | | | | 10 | 2 | 1 | 6 | | 11 | |
| *Caulleriella* sp.J | | 1 | 1 | 2 | | 2 | 6 | | 4 | 1 | 1 | 1 | |
| *Echinarachnius parma* | | 4 | | | | 6 | 6 | | 2 | | | | |
| *Exogone hebes* | | | | | | 2 | 5 | | | 1 | | | |
| *Aricidea cerrutii* | | | | | | | | | | | 21 | 1 | |
| *Hemipodus roseus* | | | | | | | | 4 | | | 5 | | |
| *Streptosyllis arenae* | | | | | | 1 | 1 | 1 | | | 4 | 1 | |

[a] Due to the heterogeneity of most taxa distributions, generally low abundances, and relatively limited sampling, only well-defined species groups generated from the inverse analyses are numbered.

[b] LPIL = Lowest practical identification level.

bivalve (*N. proxima*) and gastropod (*E. heros* and *I. Trivittata*) mollusks and the isopod *Edotia triloba*. Species Group 2 included the most homogeneously distributed taxa in Area G2. Numerically dominant taxa in Group 2 included the polychaete *S. bombyx*, archiannelid *Polygordius*, and bivalve *T. agilis*. Other Group 2 taxa included the polychaetes *M. papillicornis* and *Sigalion arenicola*, bivalve *Spisula solidissima*, isopod *C. tuftsi*, and amphipods *A. millsi, P. wigleyi,* and *U. irrorata.* Species Group 3 contained mostly crustaceans, including *O. smithi*, *Parahaustorius attenuatus*, *Politolana polita*, *Pseudunciola obliquua*, *R. hudsoni*, and *T. psammophilus*. Other Group 3 taxa included the polychaetes *Caulleriella* sp. J and *E. hebes* and echinoid *E. parma*.

Species Group 1 was associated primarily with Station Groups A and B, Species Group 2 was associated with stations in Groups B and C, and Group 3 taxa were associated primarily with Station Group C (Table 6-13). Group B stations were located in the southwestern corner of Area G2, while Group C stations were located primarily in the northeastern corner of this sand resource area. Station 2 was located in a trough feature that apparently is an area of fine sediment deposition; sediments at this station were classified as sandy mud (May) or silty sand (September). Station 2 yielded very high abundances of the polychaetes *A. oculata* and *S. bombyx* and bivalve *N. proxima.*

**Area G3**

Normal cluster analysis resulted in three station groups in Area G3 (Groups A through C) that were separated by survey (Table 6-14). Group A contained a single station sampled during the September survey that yielded high numbers of the polychaetes *A. oculata* and *N. succinea*, bivalve *P. pholadiformis*, and gastropod *Anachis lafresnayi*. Station Group B consisted of three stations from the May survey that yielded high numbers of the polychaete *S. bombyx*, bivalve *S. solidissima,* isopod *C. tuftsi*, and echinoid *E. parma*. The bivalve *M. edulis* and amphipod *Americhelidium americanum* were found only at Group B stations. Group C included six stations from the September survey that yielded high numbers of the polychaete *Spiochaetopterus oculatus,* archiannelid *Polygordius*, amphipods *Pseudunciola obliquua* and *R. hudsoni*, and tanaid *T. psammophilus*. Several taxa were found only at Group C stations, including the polychaetes *D. uncinata* and *Nephtys bucera*, isopod *Ancinus depressus,* and amphipod *Acanthohaustorius shoemakeri*.

Inverse cluster analysis resulted in four groups of co-occurring taxa (Groups 1 through 4) (Table 6-14). Species Groups 1 and 2 contained heterogeneously distributed taxa, while Groups 3 and 4 were distributed more evenly across Area G3 stations. Group 1 included the bivalve *M. edulis*, gastropod *Odostomia gibbosa*, the crustaceans *A. americanum* and *U. irrorata* (amphipoda), *C. tuftsi* (isopoda), and *Pseudoleptocuma minor* (cumacea), and echinoid *E. parma*. Group 2 included the polychaetes *Apoprionospio pygmaea*, *D. uncinata*, and *S. oculatus*, gastropod *T. interrupta,* and crustaceans *Ancinus depressus* (isopod), *Acanthohaustorius shoemakeri* and *Microprotopus raneyi* (amphipods), and *Americamysis bigelowi* (mysid). Species Group 3 was the most homogeneously distributed group, and included polychaetes (*Caulleriella* sp. J and *S. bombyx*), the archiannelid *Polygordius*, bivalves (*S. solidissima* and *T. agilis*), amphipods (*Protohaustorius wigleyi*, *Pseudunciola obliquua*, and *R. hudsoni*), and the tanaid *T. psammophilus*. Group 4 contained mostly polychaetes, including *A. oculata*, *Diopatra cuprea*, *Nephtys picta*, *Nereis succinea*, and *P. arenae*, and also included the bivalves *N. proxima* and *P. pholadiformis,* gastropod *Anachis lafresnayi*, and isopod *E. triloba*.

Species Group 1 was associated with Station Group B, while Species Group 2 was associated with Station Group C. Species Groups 3 and 4 were distributed across all station

Table 6-14. Two-way table from normal (Station Groups A-C) and inverse (Species Groups 1-4[a]) cluster analysis of infaunal samples collected during the May 1998 Survey 1 (S1) and September 1998 Survey 2 (S2) in Sand Resource Area G3 offshore New Jersey. Data are presented as total counts for individual taxa.

| | A | B | | | C | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Taxon | S2-G3-5 | S1-G3-3 | S1-G3-1 | S1-G3-5 | S2-G3-1 | S2-G3-4 | S2-G3-7 | S2-G3-3 | S2-G3-2 | S2-G3-9 | |
| *Odostomia gibbosa* | | | | 17 | | | | | | | |
| *Chiridotea tuftsi* | | 1 | 16 | 38 | 2 | | | 1 | | 1 | |
| *Echinarachnius parma* | | | 12 | 20 | | | | | 3 | 4 | |
| *Unciola irrorata* | | | 5 | 26 | | | 2 | | | | 1 |
| *Pseudoleptocuma minor* | | | 8 | 4 | | | | | 1 | | |
| *Mytilus edulis* | | 1 | 3 | 9 | | | | | | | |
| *Amerinchelidium americanum* | | 1 | 6 | 2 | | | | | | | |
| *Apoprionospio pygmaea* | 1 | | | | 55 | | 4 | | | | |
| *Microprotopus raneyi* | 14 | | | | 16 | | 4 | 1 | | | |
| *Spiochaetopterus oculatus* | 1 | | | | 17 | 4 | 1 | 6 | 2 | | |
| *Ancinus depressus* | | | | | 11 | 1 | 6 | 4 | | | |
| *Dispio uncinata* | | | | | 11 | 7 | 3 | | | | 2 |
| *Acanthohaustorius shoemakeri* | | | | | 27 | | | | 1 | 1 | |
| *Turbonilla interrupta* | | | | | 11 | | | | | | |
| *Americamysis bigelowi* | | | | | 7 | | | | | | |
| *Spiophanes bombyx* | 1 | 8 | 42 | 1,833 | 6 | 6 | | 2 | 5 | | |
| *Spisula solidissima* | 2 | 8 | 8 | 36 | 2 | 1 | 1 | | 2 | | |
| *Caulleriella* sp.J | 12 | | 2 | 160 | | 21 | 6 | | 8 | 5 | |
| *Polygordius* (LPIL[b]) | 1 | 18 | 37 | 38 | 263 | 600 | 93 | 64 | 34 | 16 | |
| *Pseudunciola obliquua* | | | | 3 | 20 | 26 | 12 | 3 | 12 | 14 | 3 |
| *Rhepoxynius hudsoni* | | | 3 | 2 | 16 | 21 | 5 | 4 | 10 | 2 | |
| *Tellina agilis* | 17 | 1 | 3 | 11 | 8 | 8 | 4 | 22 | 18 | 12 | |
| *Tanaissus psammophilus* | | 4 | 2 | 4 | 4 | 44 | 11 | 8 | 50 | 83 | |
| *Protohaustorius wigleyi* | | 8 | 7 | 4 | 3 | 8 | 6 | 4 | 10 | 8 | |
| *Asabellides oculata* | 553 | | 3 | 2 | 37 | 3 | 31 | 4 | | | |
| *Nephtys picta* | 20 | 1 | 3 | 12 | 7 | 1 | 9 | | | | |
| *Nucula proxima* | 11 | | 1 | 10 | 1 | 1 | | | | | |
| *Petricola pholadiformis* | 48 | | | | 2 | 1 | | | 1 | | |
| *Anachis lafresnayi* | 25 | | | 1 | 1 | | | | | | 4 |
| *Edotia triloba* | 12 | | | 2 | 1 | | 12 | | | 1 | |
| *Phyllodoce arenae* | 7 | | | | 2 | 2 | 6 | 1 | 1 | 1 | |
| *Nereis succinea* | 11 | | | | | 1 | 2 | | | | |
| *Diopatra cuprea* | 6 | | | | | | 1 | | | 1 | |
| *Acanthohaustorius millsi* | | 3 | 6 | | | 2 | 4 | 3 | | | |
| *Magelona papillicornis* | | | | 5 | 1 | 3 | 2 | | | | |
| *Ilyanassa trivittata* | | | 1 | | | 2 | 6 | | | | |
| *Euspira heros* | 1 | | 1 | 1 | | 2 | 2 | | | | |
| *Hesionura elongata* | | | 1 | | | | | | | 20 | |
| *Aricidea cerrutii* | | | | | | | | | 1 | 9 | |
| *Tectonatica pusilla* | 4 | | | | 2 | 1 | | 5 | 2 | 4 | |
| *Politolana polita* | | 2 | | | | | | 11 | 9 | 7 | |
| *Streptosyllis arenae* | | 2 | | | | | | 2 | 2 | 4 | |
| *Nephtys bucera* | | | | | | 2 | 1 | 2 | | 1 | |
| *Oxyurostylis smithi* | 1 | | | | | | 7 | 2 | | 4 | |
| *Hemipodus roseus* | | | | | | | 1 | 1 | | 4 | |
| *Brania wellfleetensis* | | | | | | | | | 11 | | |
| *Diastylis polita* | | | | | | 2 | | | 4 | | |

[a] Due to the heterogeneity of most taxa distributions, generally low abundances, and relatively limited sampling, only well-defined species groups generated from the inverse analyses are numbered.

[b] LPIL = Lowest practical identification level.

groups, although Group 4 taxa were most abundant in Station Group A (Table 6-14). Sediments were homogeneous in Area G3, consisting primarily of sand. Station groups were separated by survey, and water depth also may have been a factor influencing assemblage composition. Station 5 was situated in a trough feature, was the deepest station in Area G3, and yielded relatively high abundances of certain taxa, including polychaetes *A. oculata*, *Caulleriella* sp. J, and *S. bombyx*.

### 6.3.4 Epifauna and Demersal Fishes

During the May 1998 Survey 1, a total of 17,474 individuals in 29 taxa was collected by trawl at six of the eight sand resource areas (Table 6-15). An extremely large catch of the sand dollar *E. parma* at Area F2 contributed 17,005 individuals to this total. In addition to the sand dollar, 469 specimens of epifauna and demersal fishes were collected in 28 taxa. Trawls yielded 107 individuals in 15 fish taxa and were numerically dominated by hakes (*Urophycis* spp.), clearnose skate (*Raja eglanteria*), windowpane (*Scophthalmus aquosus*), scup (*Stenotomus chrysops*), and summer flounder (*Paralichthys dentatus*). Invertebrates excluding the sand dollar contributed 13 taxa and 362 specimens to the trawl catches. The sea star *Asterias forbesi*, hermit crab *Pagurus* sp., sand shrimp *Crangon septemspinosa*, and rock crab *Cancer irroratus* were the top ranking species in terms of abundance. A single adult Atlantic surfclam (*S. solidissima*) specimen was collected in Area A1 and two adult specimens were collected at Area F2 during the May survey.

The highest number (19) of taxa (fishes and invertebrates combined) was recorded for Area C1 during May 1998; the lowest number (5) of fish and invertebrate taxa was recorded for Area A1. The number of invertebrate and fish taxa collected per haul averaged 12.3. Area G2 yielded the most fish taxa (10), followed by Areas C1 and G3 (8 taxa each). The number of fish taxa per haul ranged from 1 to 10 and averaged 5.8. Area C1 produced the highest number (11) of invertebrate taxa, followed by Area F2 (9). The number of invertebrate taxa per haul ranged from 4 to 11 and averaged 6.5.

The most specimens of fishes and invertebrates combined were recorded from Areas F2 (17,095) and C1 (169) during the May 1998 survey. The numbers of fish and invertebrate individuals collected per haul ranged from 14 to 17,095 and averaged 2,912.3. Fishes were not abundant; highest catches came from Areas G2 (36) and C1 (34). The number of fish individuals collected per haul ranged from 1 to 36 and averaged 17.8. A huge catch of sand dollars in Area F2 overwhelmed invertebrate abundance estimates. Without considering Area F2, Area C1 yielded the highest number of invertebrate specimens (135) and Area A2 the lowest (12). The number of invertebrate individuals collected per haul ranged from 12 to 17,084 and averaged 2,894 (including sand dollars). Excluding sand dollars, the numbers of invertebrate individuals ranged from 10 to 132 and averaged 60.3.

During the September 1998 Survey 2, eight trawl samples at seven of the eight sand resource areas produced 31 taxa (19 fishes and 12 invertebrates) represented by 2,541 individuals (761 fishes and 1,780 invertebrates) (Table 6-16). As with Survey 1, the most abundant species was the sand dollar represented by 864 individuals. This was followed by squid (*Loligo* sp.) and bay anchovy (*Anchoa mitchilli*) contributing 637 and 630 individuals, respectively. Other abundant fish species in the catches included clearnose skate, northern searobin (*Prionotus carolinus*), and scup. Other numerically important invertebtrates caught during Survey 2 were sea star, hermit crab (*Pagurus longicarpus*), common northern moon-shell (*Euspira* [*Lunatia*] *heros*), and squid (*Loligo pealei*).

Table 6-15. Epifauna and demersal fishes collected by mongoose trawl and ranked by numerical abundance from the May 1998 Survey 1 at six potential sand resource areas offshore New Jersey.

| Species | Area | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | A1 | A2 | C1 | F2 (F2-Out) | G2 | G3 | |
| FISHES | | | | | | | |
| *Urophycis* sp. | | | 11 | 4 | 8 | 3 | 26 |
| *Raja eglanteria* | | | 5 | 2 | 13 | 5 | 25 |
| *Scophthalmus aquosus* | 1 | 2 | 5 | 1 | | 7 | 16 |
| *Paralichthys dentatus* | | | | 1 | 7 | | 8 |
| *Stenotomus chrysops* | | | 6 | | 1 | 1 | 8 |
| *Pleuronectes americanus* | | | 1 | 1 | 1 | 3 | 6 |
| *Raja egg case* | | | 4 | 1 | | 1 | 6 |
| *Merluccius bilinearis* | | | 1 | | 1 | | 2 |
| *Prionotus carolinus* | | | | 1 | 1 | | 2 |
| *Prionotus evolans* | | | | | 2 | | 2 |
| *Syacium* sp. | | | | | | 2 | 2 |
| *Ammodytes americanus* | | | | | 1 | | 1 |
| *Anchoa mitchilli* | | | | | | 1 | 1 |
| *Lophius americanus* | | | 1 | | | | 1 |
| *Peprilus triacanthus* | | | | | 1 | | 1 |
| INVERTEBRATES | | | | | | | |
| *Echinarachnius parma* | | 2 | 3 | 17,000 | | | 17,005 |
| *Asterias forbesi* | | 1 | 88 | 33 | | | 122 |
| *Pagurus* sp. | 1 | 5 | 22 | 5 | 20 | 6 | 59 |
| *Crangon septemspinosa* | | 2 | 4 | 11 | 29 | 7 | 53 |
| *Cancer irroratus* | | | 9 | 13 | 26 | | 48 |
| *Loligo pealei* | 28 | 2 | 2 | 6 | 2 | 1 | 41 |
| *Euspira heros* | 2 | | | 13 | 6 | 4 | 25 |
| *Ilyanassa trivittata* | | | | 1 | | 3 | 4 |
| *Spisula solidissima* | 1 | | | 2 | | | 3 |
| *Ensis directus* | | | 2 | | | | 2 |
| *Pagurus pollicarus* | | | 2 | | | | 2 |
| *Libinia dubia* | | | 1 | | | | 1 |
| Nudibranch sp. | | | 1 | | | | 1 |
| *Pandalus sp.* | | | 1 | | | | 1 |
| FISH TOTALS | | | | | | | |
| Total Individuals | 1 | 2 | 34 | 11 | 36 | 23 | 107 |
| Total Taxa | 1 | 1 | 8 | 7 | 10 | 8 | 15 |
| INVERTEBRATE TOTALS | | | | | | | |
| Total Individuals | 32 | 12 | 135 | 17,084 | 83 | 21 | 17,367 |
| Total Taxa | 4 | 5 | 11 | 9 | 5 | 5 | 14 |
| FISH AND INVERTEBRATE TOTALS COMBINED | | | | | | | |
| Total Individuals | 33 | 14 | 169 | 17,095 | 119 | 44 | 17,474 |
| Total Taxa | 5 | 6 | 19 | 16 | 15 | 13 | 29 |

Table 6-16. Epifauna and demersal fishes collected by mongoose trawl and ranked by numerical abundance form the September 1998 Survey 2 at seven potential sand resource areas offshore New Jersey

| Species | Area | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | A1 | A2 | C1 | F2 (F2-In) | F2 (F2-Out) | G1 | G2 | G3 | |
| FISHES | | | | | | | | | |
| *Anchoa mitchilli* | | | | | | 630 | | | 630 |
| *Raja eglanteria* | 8 | 32 | | | | | | 1 | 41 |
| *Prionotus carolinus* | 4 | 4 | 3 | | 2 | 1 | | 7 | 21 |
| *Stenotomus chrysops* | | | 1 | | | 13 | | 1 | 15 |
| *Paralichthys* sp. | | 9 | | | | | | | 9 |
| *Peprilus triacanthus* | | | 2 | | | 1 | 5 | | 8 |
| *Raja* egg case | | | 1 | | 7 | | | | 8 |
| *Raja ocellata* | | | | 2 | 6 | | | | 8 |
| *Paralichthys dentatus* | | 1 | 2 | | 2 | | | | 5 |
| *Centropristis striata* | 2 | 1 | | | | | | | 3 |
| *Trachinocephalus myops* | | 2 | 1 | | | | | | 3 |
| *Cynoscion regalis* | | | | | | | | 2 | 2 |
| *Micropogonias undulatus* | | | | | | 1 | | 1 | 2 |
| *Chilomycterus schoepfi* | | | | | | 1 | | | 1 |
| *Fistualria tabacaria* | | | | | | 1 | | | 1 |
| *Pleuronectes ferrugineus* | | | | | 1 | | | | 1 |
| *Raja* sp. | | | | 1 | | | | | 1 |
| *Scophthalmus aquosus* | | | 1 | | | | | | 1 |
| *Sphoeroides dorsalis* | | | | | | | | 1 | 1 |
| INVERTEBRATES | | | | | | | | | |
| *Echinarachnius parma* | 3 | 11 | 8 | 707 | 135 | | | | 864 |
| *Loligo* sp. | | 22 | 80 | 157 | 84 | 120 | 144 | 30 | 637 |
| *Asterias forbesi* | 8 | 27 | 97 | 1 | | 3 | 4 | 2 | 142 |
| *Pagurus longicarpus* | 6 | 16 | 10 | 4 | 8 | 8 | 7 | 2 | 61 |
| *Euspira heros* | | | | 2 | 27 | | | | 29 |
| *Loligo pealei* | 16 | | | | | | | | 16 |
| *Cancer irroratus* | | 1 | 1 | 3 | 5 | | | | 10 |
| *Ilyanassa trivittata* | | | | 2 | 6 | | 1 | | 9 |
| *Pagurus pollicarus* | 2 | 3 | | | | | | 2 | 7 |
| *Libinia dubia* | | | 2 | | 1 | | | | 3 |
| *Astarte castenea* | | | | | 1 | | | | 1 |
| *Homarus americanus* | | | | | 1 | | | | 1 |
| FISH TOTALS | | | | | | | | | |
| Total Individuals | 14 | 49 | 11 | 3 | 18 | 648 | 5 | 13 | 761 |
| Total Taxa | 3 | 6 | 7 | 2 | 5 | 7 | 1 | 6 | 19 |
| INVERTEBRATE TOTALS | | | | | | | | | |
| Total Individuals | 35 | 80 | 198 | 876 | 268 | 131 | 156 | 36 | 1,780 |
| Total Taxa | 5 | 6 | 6 | 7 | 9 | 3 | 4 | 4 | 12 |
| FISH AND INVERTEBRATE TOTALS COMBINED | | | | | | | | | |
| Total Individuals | 49 | 129 | 209 | 879 | 286 | 779 | 161 | 49 | 2,541 |
| Total Taxa | 8 | 12 | 13 | 9 | 14 | 10 | 5 | 10 | 31 |

A trawl haul (F2-Out) at Area F2 produced the highest number (14) of total taxa during September 1998, followed by the haul in Area C1 which produced 13 taxa. The fewest total taxa (5) were collected in Area G2. On average, the total number of combined taxa per haul was 10.1. The greatest number of fish taxa (7) was collected in Areas C1 and G1. The number of fish taxa per haul ranged from 1 to 7 and averaged 4.6. The number of invertebrate taxa per haul ranged from 3 in Sand Resource Area G1 to 9 at Sand Resource Area F2 (F2-Out). The average number of invertebrate taxa per trawl haul was 5.5.

Total catches during September 1998 varied among sand resource areas, ranging from 49 individuals in Areas A1 and G3 to 879 individuals in Area F2 (F2-In). The average catch was 317.6 individuals per haul for all eight areas. Fish catches ranged from 3 individuals in Area F2 (F2-In) to 648 individuals in Area G1 and averaged 95.1 individuals per haul. Invertebrate catches ranged from 35 in Area A1 to 876 individuals per haul in Area F2 (F2-In). The average invertebrate catch per haul was 222.5 individuals per haul.

Normal cluster analysis of the trawl samples revealed two major station groups, A and B, that separated the samples by survey (Table 6-17). The first, Group A, consisted of all samples from the May 1998 Survey 1, whereas Group B included the eight samples from September 1998 Survey 2. Within Group B, the samples were arranged in a north-south fashion suggesting a gradient of species composition.

The inverse analysis formed six species groups (Table 6-17). Two of these groups consisted of single species. Group 1 was composed of taxa collected frequently during both surveys. Group 2 consisted of taxa collected mostly during the May 1998 Survey 1.

## 6.4 DISCUSSION

Benthic assemblages surveyed from the sand resource areas offshore New Jersey consisted of members of the major invertebrate and vertebrate groups commonly found in the study area. Numerically dominant infaunal groups included numerous crustaceans, echinoderms, molluscans, and polychaetes, while epifaunal taxa consisted primarily of decapods, sand dollars, gastropods, and squids. The numerically dominant infaunal and epifaunal groups collected during the 1998 sand resource areas surveys are typical components of benthic assemblages in the study area. Similarly, the numerically dominant demersal fishes collected in trawls within the resource areas revealed consistency with previous surveys. Fishes such as bay anchovy (*Anchoa mitchilli*), clearnose skate (*Raja eglanteria*), northern searobin (*Prionotus carolinus*), scup (*Stenotomus chrysops*), and windowpane (*Scophthalmus aquosus*) were numerical dominants during the surveys and these species consistently are among the most ubiquitous and abundant demersal taxa in the region (Able and Hagen, 1995; Barry A. Vittor & Associates, Inc., 1999a).

Results of the 1998 sand resource area surveys support the findings of other investigations that have found strong associations of infaunal taxa with particular sedimentary habitats (Pearce et al., 1981; Chang et al., 1992; Theroux and Wigley, 1998). Canonical correlation analysis indicated that the composition of benthic assemblages inhabiting New Jersey resource areas was affected primarily by relative percentages of gravel and sand comprising surficial sediments at area stations. Surficial sediments were mixtures of sand and gravel at most stations in the northernmost resource areas (Areas F1 and F2), as compared to more varied habitat types in the other more southern resource areas (Areas A1, A2, C1, G1, G2, and G3). The southernmost resource areas included several stations with relatively high gravel content, but most other stations in these areas were characterized by sand bottoms (Figure 6-15). Infaunal assemblage distributions reflected these sediment type distributions. Station groupings based on normal cluster analysis of infaunal samples from the resource area

Table 6-17. Two-way table from normal (Station Groups A and B) and inverse (Species Groups 1-4) cluster analysis of trawl samples collected during the May 1998 Survey 1 (S1) and September 1998 Survey 2 (S2) from sand resource areas (A1, A2, C1, F2, G1, G2, and G3) offshore New Jersey. Data are presented as total counts for individual taxa.

| Taxa | A | | | | | | B | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | S1-A1 | S1-A2 | S1-C1 | S1-G2 | S1-F2 (Out) | S1-G3 | S2-A1 | S2-A2 | S2-C1 | S2-G1 | S2-G2 | S2-G3 | S2-F2 (In) | S2-F2 (Out) | |
| *Echinarachnius parma* | | 2 | 3 | | 17,000 | | 3 | 11 | 8 | | | | 707 | 135 | |
| *Loligo* sp. | | | | | | | | 22 | 80 | 120 | 144 | 30 | 157 | 84 | |
| *Pagurus longicarpus* | | | | | | | 6 | 16 | 10 | 8 | 7 | 2 | 4 | 8 | |
| *Asterias forbesi* | | 1 | 88 | | 33 | | 8 | 27 | 97 | 3 | 4 | 2 | 1 | | |
| *Prionotus carolinus* | | | | 1 | 1 | | 4 | 4 | 3 | 1 | | 7 | | 2 | 1 |
| *Paralichthys dentatus* | | | | 7 | 1 | | | 1 | 2 | | | | | 2 | |
| *Libinia dubia* | | | 1 | | | | | | 2 | | | | | 1 | |
| *Peprilus triacanthus* | | | | 1 | | | | | 2 | 1 | 5 | | | | |
| *Ilyanassa trivittata* | | | | | 1 | 3 | | | | | 1 | | 2 | 6 | |
| *Raja ocellata* | | | | | | | | | | | | | 2 | 6 | |
| *Anchoa mitchilli* | | | | | | 1 | | | | 630 | | | | | |
| *Stenotomus chrysops* | | | 6 | 1 | | 1 | | | 1 | 13 | | 1 | | | |
| *Raja eglanteria* | | | 5 | 13 | 2 | 5 | 8 | 32 | | | | 1 | | | |
| *Pagurus* sp. | 1 | 5 | 22 | 20 | 5 | 6 | | | | | | | | | |
| *Crangon septemspinosa* | | 2 | 4 | 29 | 11 | 7 | | | | | | | | | |
| *Urophycis* sp. | | | 11 | 8 | 4 | 3 | | | | | | | | | |
| *Scophthalmus aquosus* | 1 | 2 | 5 | | 1 | 7 | | | 1 | | | | | | 2 |
| *Loligo pealei* | 28 | 2 | 2 | 2 | 6 | 1 | 16 | | | | | | | | |
| *Cancer irroratus* | | | 9 | 26 | 13 | | | 1 | 1 | | | | 3 | 5 | |
| *Euspira heros* | 2 | | | 6 | 13 | 4 | | | | | | | 2 | 27 | |
| *Pleuronectes americanus* | | | 1 | 1 | 1 | 3 | | | | | | | | | |
| *Merluccius bilinearis* | | | 1 | 1 | | | | | | | | | | | |
| *Ensis directus* | | | 2 | | | | | | | | | | | | |
| *Prionotus evolans* | | | | 2 | | | | | | | | | | | |
| *Spisula solidissima* | 1 | | | | 2 | | | | | | | | | | 3 |
| *Pagurus pollicaris* | | | 2 | | | | 2 | 3 | | | | 2 | | | |
| *Centropristis striata* | | | | | | | 2 | 1 | | | | | | | 4 |
| *Paralichthys* sp. | | | | | | | | 9 | | | | | | | |
| *Trachinocephalus myops* | | | | | | | | 2 | 1 | | | | | | |
| *Syacium* sp. | | | | | | 2 | | | | | | | | | 5 |
| *Cynoscion regalis* | | | | | | | | | | | | 2 | | | 6 |
| *Micropogonias undulatus* | | | | | | | | | | 1 | | 1 | | | |

surveys indicated homogeneity of infaunal assemblage types in the northern resource areas and varied assemblage types in the southernmost resource areas (Figure 6-14). Each of the adjacent stations (R1, R2, and R3) were included in the same Station Group (Group C, A, and F, respectively) for both the May and September surveys. The latitudinal difference in infaunal assemblage and sediment-type distributions was reflected by the second canonical variate, which correlated best with relative geographic location (northing and easting) of resource areas and adjacent stations.

Resource area stations with surficial sediments containing a relatively high percentage of gravel supported a number of taxa that were rare at stations characterized by a sand substratum. These gravel-inhabiting taxa included bivalves, such as *Astarte castanea*, *Crenella decussata* and *Mytilus edulis*, suspension-feeding invertebrates that feed efficiently when buried in coarse sediments. The gastropods *Crepidula fornicata* and *Mitrella lunata* and the polychaetes *Harmothoe imbricata*, *Hemipodus roseus*, and *Pisione remota* also were positively associated with gravel-sized sediments, habitat which provides interstitial space for these types of foraging carnivores (Pettibone, 1963; Young and Rhoads, 1971).

The most ubiquitous infauna collected during the surveys tended to exhibit greatest population densities at stations characterized by sand. Infaunal taxa that were abundant in sand included the polychaetes *Caulleriella* sp. J (= *C*. cf. *killariensis*) and *Spiophanes bombyx*, archiannelid *Polygordius*, bivalve *Tellina agilis*, amphipods *Acanthohaustorius millsi*, *Pseudunciola obliquua*, *Protohaustorius wigleyi,* and *Rhepoxynius hudsoni*, and tanaid *Tanaissus psammophilus*. Numerical dominance by these taxa in sand habitats reaffirms results from previous investigations in the study area (Pearce et al., 1981; Chang et al., 1992). Certain of the numerically dominant infaunal taxa were distributed across a range of sedimentary habitats (i.e., sand and gravel), especially the annelids *Polygordius* and *S. bombyx*. The free-living, burrowing amphipods *A. millsi*, *Pseudunciola obliquua*, *Protohaustorius wigleyi,* and *R. hudsoni* comprised a group that were positively associated with sand and negatively associated with gravel during the resource areas surveys, the only example of such an association clearly defined from the 1998 data.

Juvenile surf clam (*Spisula solidissima*) distribution in relation to sedimentary habitat agreed with previous investigations of Mid-Atlantic shelf waters (Parker, 1967; Parker and Fahlen, 1968). Stations with substantial gravel content tended to yield greater abundance than areas with high percentages of sand. Juvenile surf clam abundance was greatest in Areas F1 (September 1998 Survey 2) and F2 (May 1998 Survey 1), where gravel content of surficial sediments was consistently higher than in other resource areas. Juvenile surf clams also were common in sand bottom habitats, as has been observed by other investigations (Pearce et al., 1981), indicating no selective settlement of surf clam spat. Reasons for higher surf clam abundance in areas with measurable gravel, therefore, likely are post-settlement ecological factors, such as possibly higher rates of clam survivorship in gravel habitats relative to sand.

Stations that had a relatively high percentage of mud or silt yielded high numbers of deposit feeding taxa such as the polychaetes *Asabellides oculata* and *Capitella capitata* and the nut clam *Nucula proxima*. These species typically are strongly associated with fine sediments (Pearce et al., 1981; Chang et al., 1992).

In addition to sedimentary habitat, canonical discriminant analysis indicated that the composition of benthic assemblages inhabiting New Jersey sand resource area stations was somewhat affected by water depth. Within areas, station water depths varied primarily due to patchy bathymetric features (i.e., ridges and troughs). Depths of shallower stations in most areas generally ranged between 10 and 12 m, while the deepest stations had depths of 17 to 19 m; however, depth-related variability in benthic assemblage composition likely is due more to environmental parameters that are correlated with water depth. In other words, absolute water depth may be an ultimate factor influencing benthic assemblages, but hydrology and sedimentary regime are proximate factors that are influenced to some degree by water depth.

Bathymetric features can affect environmental variables that determine the suitability of infaunal habitats. Trough features, especially those that are spatially abrupt, tend to dissipate current flow and promote deposition of fine materials that are suspended in the water column. An example of this was evident in Area G2, where Station 2 was located in a trough feature that apparently is an area of fine sediment deposition; sediments at this station were classified as sandy mud (May) and silty sand (September). This station yielded very high abundances of the polychaetes *A. oculata* and *S. bombyx* and the nut clam *N. proxima*. These organisms, along with spionid polychaetes (*Apoprionospio dayi* and *Spio setosa*) and certain amphipods (*Ampelisca* spp. and *Unciola irrorata*), are trough-inhabiting taxa and deposit feeders that are adapted to living in fine sediments. Some stations located in trough features adjacent to ridges supported relatively high numbers of the polychaete *A. oculata* during the September survey. In Area A2, Station 19 was the deepest infaunal station and supported an assemblage distinct from other Area A2 stations during both the May and September surveys, including an abundance of the polychaete *S. setosa* and amphipods *Ampelisca abdita* and *U. irrorata*.

Depth-related variability in benthic assemblage composition during the surveys may be discerned by comparing stations that were in proximity to one another, yet supported different infaunal assemblages even if they were characterized by a similar sedimentary regime. In Area A1, for example, Station 13 was situated in a trough feature (20 m depth), while other A1 stations had an average depth of about 14 m. Despite having sediments similar to other stations in Area A1, this station supported distinct assemblages during both the May (e.g., polychaete *Pisione remota* and bivalve *M. edulis*) and September (e.g., polychaete *A. dayi* and amphipod *Ampelisca* sp. X) surveys.

In addition to sediment-based and bathymetry-based spatial variability in the southern resource areas, there were temporal differences in the composition of infaunal assemblages. Canonical discriminant analysis indicated that the composition of benthic assemblages inhabiting stations was affected to a substantial degree by survey. In the southern resource areas, Station Groups B and E included samples collected during the September survey, while Group D contained stations sampled in May. Temporal changes in infaunal assemblages were not observed among northern resource areas (F1 and F2). In the northern areas, temporal effects on the composition of infaunal assemblages may have been overridden by local sedimentary habitats.

Temporal variability in infaunal assemblage composition was evidenced by both qualitative and quantitative community measures. Nearly half of the infaunal taxa sampled over the entire project were included in both the May and September surveys; however, most (68%) of the remainder of censused taxa were collected only during the September cruise, resulting in higher mean values of species richness compared to the May survey (Table 6-4). It is unknown whether higher measurements of infaunal taxa richness in September were due primarily to temporal recruitment patterns or were an artifact of an expanded September sampling effort, when twice the number of samples were collected as were collected during the May survey. Also, overall infaunal abundance was greater during the May survey than was observed during September. Temporal variation of infaunal density is typical of the study area, although consistent patterns of variability are difficult to identify (Pearce et al., 1976), and may not exist for many infaunal taxa. Both the number of epifaunal taxa and overall epifaunal abundance were greater in September as compared to the May survey, as well, and this temporal abundance pattern also is characteristic of the study area (Hales et al., 1995; Viscidio et al., 1997).

Offshore New Jersey, there is considerable variation in the abundance and distribution of demersal taxa, both spatially and seasonally (Able and Hagen, 1995; Barry A. Vittor & Associates, Inc., 1999a), and this dynamic may have been manifest in the results of the sand resource area surveys. Ultimately, low fish densities and relatively limited sampling preclude any definitive statements about causes of variability in fish abundance and distribution, based on the results of the surveys. However, some variability between areas was apparent in the composition of trawls. In particular, during the May survey, both overall fish abundance and the number of fish taxa were markedly lower in Areas A1 and A2 compared to other resource areas. Reasons for this distributional variability are not apparent; hydrological parameters measured concurrently with trawls did not differ between Areas A1 and A2 and the more northern areas. Neither was infaunal and epifaunal (potential prey) abundance lower in Areas A1 and A2 than in the more northerly stations. Given that there were no apparent habitat differences between areas, low fish abundance in Areas A1 and A2 simply may have been a matter of natural variability, perhaps due to seasonality. The various areas yielded comparable fish abundance and species richness measurements during the September survey.

Some patterns of fish distribution and abundance that are comparable to historic data were found during the surveys. Overall, fish abundance was higher in September than in May, due primarily to a large number of bay anchovy sampled from Area G1. This abundance pattern agrees with the results of previous long-term sampling efforts that found peak fish abundance occurs in offshore New Jersey waters during the months September through November, largely due to an abundance of bay anchovy (Able and Hagen, 1995). Windowpane was much more common in September trawls than those taken during the May survey, a temporal abundance pattern observed previously for this species (Able and Hagen, 1995; Barry A. Vittor & Associates, Inc., 1999a).

The results of the sand resource area surveys agree well with previous descriptions of benthic assemblages residing in shallow shelf waters offshore New Jersey. Overall, canonical discriminant analysis indicated that sedimentary regime most affected the composition of infaunal assemblages. Trough and sand ridge features further contributed to the prominent spatial variability exhibited by infaunal assemblages. Bathymetric features contribute to a multi-dimensional heterogeneity of benthic habitats that vary temporally as well as spatially. Despite inherent spatial and temporal heterogeneity in the distribution and abundance of demersal taxa, results of the 1998 surveys of the sand resource areas generally are consistent with historical demersal survey results in the region.