MACROFAUNA DISTRIBUTIONS AND SEDIMENT ANALYSES FROM THE BRUNSWICK, GEORGIA OCEAN DREDGED MATERIAL DISPOSAL SITE AND ENVIRONS

Technical Report 89-1

by

D. M. Gillespie

J.L. Harding

R. A. Culp[1]

J. E. Noakes[1]

and

A. L. Edwards[2]

The University of Georgia
Marine Extension Service
P. O. Box 13687
Savannah, Georgia 31416-0687

The Technical Report Series of the Georgia Marine Science Center is issued by the Georgia Sea Grant College Program and the Marine Extension Service of the University of Georgia on Skidaway Island (P. O. Box 13687, Savannah, Georgia 31416). It was established to provide dissemination of technical information and progress reports resulting from marine studies and investigations mainly by staff and faculty of the University System of Georgia. In addition, it is intended for the presentation of techniques and methods, reduced data, and general information of interest to industry, local, regional, and state governments and the public. Information contained in these reports is in the public domain. If this pre-publication copy is cited, it should be cited as an unpublished manuscript. (Sea Grant College Program, Grant #NA84AA-D-00072). 1989.

1. Center for Applied Isotope Studies, Athens

2. Museum of Natural History, Athens

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

Abstract

Sediment samples were obtained from the proposed Ocean Dredged Material Disposal Site and from nearby areas and subjected to chemical and biological analyses. Water samples and trawl tows were also taken over and near the disposal site. Sediment samples were analyzed for grain size distribution, human debris, total organic carbon, oil and grease, high molecular weight hydrocarbons, pesticides, halogenated hydrocarbons, and heavy metals. Trawl macrofauna were also subsampled and analyzed for tissue organics and metals. Sediment was sieved to 0.5 mm, and the macrofauna preserved, identified, and counted. Data were statistically analyzed for possible treatment effects related to the use of the site for disposal of dredged material.

Statistical results are presented, along with tables of physical and chemical data. Macrofauna densities are tabulated by station, relative to position over or near the disposal site.

No consistent pattern of treatment effect could be discerned from analysis of the data using our sampling regime and analytical techniques. Although ocean dredge spoil dumping undoubtedly disturbs the environment, this study suggests that effects are transient in this area.

KEYWORDS

Benthos	Invertebrate
Dredgespoil	Macrofauna
Ecology	Pesticide
Hydrocarbon	Sediment

Acknowledgements

We thank the staff of the Marine Extension Service, Skidaway Island and Brunswick, and the Center for Applied Isotope Studies, Athens, for their support and assistance. In particular Carol Morrill, Keith Gates, Sim Graves, Randy Walker, and Lisa Creasman contributed to field and laboratory work essential to the project. Jeanette Haley typed, corrected, and organized the manuscript and Karen Roeder provided the graphics. Tom Yourk, Savannah District, U.S. Army Corps of Engineers, provided invaluable assistance and advice throughout the project. Reginald Rogers, Water Management Division, USEPA, Region IV, reviewed the original report, which formed part of the basis for draft and final Environmental Impact Statements. George Davidson, Reita Rivers and two anonymous reviewers contributed substantially to final corrections and clarification. The Georgia Department of Natural Resources, Coastal Resources Division, provided dock space during two weeks of field work.

The work was supported by Contract No. DACW21-84-C-0055 with the Savannah District, U.S. Army Corps of Engineers.

INTRODUCTION

This report covers the results of field and laboratory investigations conducted by the University of Georgia Marine Extension Service and Center for Applied Isotope Studies for the U.S. Army Corps of Engineers, Savannah District, as part of an environmental study to support the permanent designation of the Brunswick Ocean Dredged Materials Disposal Site (BODMDS), off Jekyll Island, Georgia (Fig 1). The area is currently approved by USEPA on an interim basis, and has been in use since 1964 as the primary disposal site for sediment dredged from Brunswick Harbor approaches. The BODMDS is located about two miles south of the buoy at mile 8 of the Brunswick bar channel, 6.6 nautical miles (nmi) offshore (at the NW corner). The site is 1 nmi wide (E-W) by 2 nmi long (N-S), and is bounded by a line beginning at 31½02'35"N, 80½17'40"W; thence due east to 31½02'35"N, 81½16'30"W; thence due south to 31½ 00'30"N, 81½16'30"W; thence due west to 31½00'30", 81½17'42"; thence north to the point of origin (Federal Register, Vol 42, No 7, 11 January 1977). Water depth is 9 to 14 meters, with the deeper areas generally east-southeast. The gently rolling bottom is generally firm, composed of fine sand with an admixture of shell fragments, and is inhabited by a diverse but rather sparse community of small macroinvertebrates. The study included analysis of macrofauna as collected by beam trawl and box cores, turbidity as determined by transmissometer profiles, human debris and grain size analysis of sediments, and chemical analyses of water, sediments and macrofauna tissues.

Field sampling was accomplished twice, once in mid-October, 1984 and again in mid-April, 1985. The six-month hiatus was chosen in order to ascertain if any seasonality could be detected in the faunal assemblages. Both of the field excursions utilized the R/V *Sea Dawg*, a 43-foot diesel-powered vessel based at the Skidaway Island facility of the Marine Extension Service. Prior to the commencement of each survey, the vessel was dispatched to the Georgia Department of Natural Resources dock facility in Brunswick for mobilization.

PERSONNEL

The following personnel were involved in the collection of the listed data.

<u>October 15, 16, 1984</u>

Dr. David Gillespie, Marine Ecologist
Dr. James Harding, Marine Geologist
Dr. John Noakes, Chemical Oceanographer
Mr. Randy Culp, Chemist
Mr. Randy Walker, Biologist
Ms. Lisa Creasman, Recorder
Mr. Sim Graves, Boat Captain

<u>April 15, 16, 1985</u>

The personnel were the same as in October except that Ms. Carol Morrill replaced Ms. Creasman as recorder.

METHODS AND PROCEDURES

FIELD EQUIPMENT AND TECHNIQUES

All horizontal positioning was accomplished using LORAN-C. The "C" readings were converted to latitude-longitude coordinates for purposes of this report.

Nine sample sites were selected in and adjacent to the Brunswick Ocean Dredge Material Disposal Site. The nine stations consisted of six on a north-south transect through the middle of the disposal area and three on an east-west transect. This pattern resulted in three stations being located within the boundaries of the disposal area, with two to the north, two to the south and two to the east of the boundary lines (see Figure 1). Additionally, the macroepifauna was sampled by six tows with a 3-meter beam trawl, two each within the disposal area and to the north and south, respectively. Each trawl tow was approximately 14-15 minutes in duration at a tow speed of two knots. Tows were logged to the nearest 0.01 nautical mile, and the distance covered converted to meters. The result was multiplied by the 3-meter width of the trawl to obtain the sample area in square meters.

All sample sites were designated by a letter indicating transect location (N, S, or E, for North, South or East) and a number indicating location relative to the disposal site (1 for on-site, 2 for immediately adjacent to the site, 3 for farthest off-site). Additionally, trawl stations were indicated by a "T" preceding the sample designation. This convention facilitated statistical analyses using three treatment levels (1,2 or3), and two (for trawls) or three transect directions (N,S and/or E), to determine the impacts of dredge spoil disposal. (See Figure 1).

The nine sample stations and six trawl tows were occupied during each of the two seasonal surveys. The October locations were reproduced on the April survey within the accuracy of pre-plotted LORAN-C coordinates. Navigational error was estimated to be less than one hundred feet.

Beam Trawl

A beam trawl was used to collect the macroepifauna. The mouth of the net was held open by a steel beam 3.0 meters long. The net was 1.5-inch stretch mesh with an inner liner at the throat of 0.5-inch stretch mesh. The trawl was towed from the stern of the vessel by a three-point bridle. Upon retrieval, net contents were drained and transferred to a bucket for field weight, then subsampled for tissue chemical analyses, and the remaining sample preserved in buffered formaldehyde.

Box Corer

The sediment sampler used was a box corer of all stainless steel construction. The boxes employed sampled a surface area of 175 square centimeters. A total of six box cores were obtained at each sample station during each of the surveys for a total of one hundred eight (108) cores. One core per station was subsampled for sediment analyses. Samples for sediment size analysis were taken with a 2-inch O.D. coring tube from the center of each box core. The other five were washed through a series of sieves with screen sizes grading down to 0.5 mm, and the retrieved organisms preserved in buffered 5% Formalin.

Transmissometer

A Hydro Products transmissometer was used to determine water clarity or turbidity. This instrument was deployed at all of the anchor stations during each of the survey periods.

Water Sampler

Water samples were obtained with a Van-Dorn type (close-open-close) water sampler, constructed entirely of non-contaminating material. The sampler was activated by a messenger, which closed the open-ended tube upon impact. Water samples were obtained at all anchor stations.

Bathymetry

Bathymetric measurements were made with a Raytheon DE-719C Survey Fathometer with its transducer mounted on a rigid rod attached to the railing of the survey vessel. The transducer was fixed at 1.0 foot below the water surface.

Sample Handling and Preservation

All sample handling and subsequent sample storage procedures were conducted according to the recommendations given by Pequegnat, et al (1981), pp. 148-158.

LABORATORY ANALYSES

Oil and Grease

Oil and grease in the sediment samples were analyzed by the Soxhlet Extraction Method wherein soluble metallic soaps are hydrolyzed by acidification. After extraction in a Soxhlet apparatus with trichlorotrifluoroethane, the residue remaining after solvent evaporation is weighed to determine the oil and grease content. Reference: American Public Health Association, (1981).

Suspended Solids

The total non-filterable residue was the retained material on a standard glass-fiber filter after the filtration of a well-mixed sample. The residue was dried at 103 to 105~C. Each filter was weighed three times on successive days and the three weighings were averaged.

Sediment Analysis

The sand samples were returned to the laboratory, split with a mechanical splitter, washed with distilled water to remove the salts and placed in a drying oven at 100~C for 24 hours. Each sample was then weighed and placed in nested 8-inch stainless steel sieves with mesh sizes of 2.0, 1.0, 0.5, 0.25, 0.125, 0.0625 and the collecting pan. The stack of sieves was ro-tapped in a sieve shaker for 15 minutes, size fractions removed, weighed and calculations done to obtain fraction percents of total sample weight and phi sizes.

Sediment Total Organic Carbon

The wet combustion method was utilized to obtain the TOC values in the sediment samples.

Sediment Chlorinated Hydrocarbons

The sediment chlorinated hydrocarbons were extracted by column elution with a mixture of 1:1 acetone/hexane and analyzed by gas chromatography according to the procedures stated in Pequegnat, et al (1981).

Sediment High Molecular Weight Hydrocarbons

The sediment HMW hydrocarbons were also analyzed by gas chromatography as according to Pequegnat, et al, 1981, pp. 182-183.

Sediment Trace Metals

The mercury, lead, copper and cadmium contents of the sediments were determined by AAS (atomic absorption spectrophotometry) with the mercury analyzed by the cold vapor method.

Tissue Trace Metals

The tissue samples were freeze-dried prior to analysis. Following thawing, they were processed according to specimen type. Analyses were accomplished by flameless AAS, and values composed to NBS standards.

Chlorinated Hydrocarbons in Tissue

The chlorinated hydrocarbons in faunal tissue were analyzed by gas chromatography with sample preparation and extraction procedures conducted according to Pequegnat, et al (1981).

High Molecular Weight Hydrocarbons in Tissue

The faunal tissue was homogenized and extracts prepared by the methods given in Pequegnat, et al. (1981), pp. 167, 168. Silica-alumina column chromatography was then performed.

High Molecular Weight Hydrocarbons in Water Samples

The HMW hydrocarbons were extracted from the water by liquid-liquid partition and then analyzed by gas chromatography.

Beam Trawl Macrofauna Samples

Biological samples from the beam trawls were weighed in the field, and specimens removed for chemical analysis of tissue were identified and logged. The remainder of each sample was preserved and returned to the laboratory for identification to species and counting. Results are shown in this report as numbers per 1000 square meters.

Box Core Macroinfauna Samples

Organisms retained by the 0.5 mm screen were preserved in 5% formalin, and returned to the laboratory where they were transferred to 70% ethanol for permanent preservation. Samples were wet-weighed, then sorted, identified to species (or to the lowest possible taxonomic level), and the taxa were counted. Several species new to the area were tentatively identified, and some unidentified species may be undescribed. Expert assistance is being sought, and any additional information will be included in later supplements to this report. All specimens have been logged and are being retained by the University of Georgia Museum of Natural History in Athens, where they will be permanently stored at the completion of this project (except for some to be deposited in the Smithsonian Institution or other major museum). Taxonomic references are listed separately at the end of this report.

STATISTICAL ANALYSES

Analysis of Variance

Analysis of variance (ANOVA) was applied to all species from trawl samples and box core samples for each sample date. A fully nested multiple ANOVA model (samples nested within stations within location relative to the site) was tried, but would not work with the full data sets because of singularities in the sparse data matrices. This model was used with reduced data sets obtained by eliminating all species which occurred in only one sample, and multivariate indicators (Box's M, Rao's Test, Pillai's Trace, Hotelling's Trace, and Wilks' Lambda) were used to test the null hypothesis that all samples were drawn from a common randomly distributed set. Such manipulation of the data, while necessary, reduces the usefulness of the tests, and detailed results were not tabulated, although general results are reported. A univariate nested model was applied to each species in the box core macroinfauna stations, and results were included (Table 19a,b), although we do not consider these as reliable as the oneway ANOVAs. Oneway ANOVA using three treatment levels (corresponding to on-site, adjacent and off-site sample locations) was applied in each case. Oneway ANOVA was also used to test for differences associated with transect direction (N, S and E). The F-ratios were calculated and the probabilities of treatment effects being important determined. A significance level of Á=0.05 was chosen as a threshold (See Tables 14a,b; 19a,b).

Correlation Analysis

Among-station matrices of Pearson product-moment correlations were constructed for species distributions in trawl and box core samples for both sample dates (Tables 15a,b; 20a,b). If significant faunal distribution effects occur, highest correlations are expected among those samples from similar locations.

Principal Components Analysis

As an additional test of association among sample sites, the correlation matrices were subjected to a standardized Principal Components Analysis (PCA). PCA is a form of eigen analysis (or factor analysis) which seeks to reveal any underlying structure in a data set while retaining as much information content as possible (Gauch, 1982; Pielou, 1984). Tables of components and eigen values are reported here (Tables 16a,b; 21a,b) along with plots of points along the two most significant PCA axes (Figures IIIa,b; Va,b). Although only the first two components are plotted, all components were considered in the analyses. Any environmental gradient (such as that created by dredge spoil disposal) should, if significant, result in clustering of similar points along the PCA axes.

Hierarchical Cluster Analysis

As an independent measure of possible association among sample stations, Hierarchical Cluster Analysis (HCA) was applied to all trawl macrofauna and box core macroinfauna data. This approach uses some measure of dissimilarity based on the original data, and thus is largely independent of correlation analysis (although one would expect similar results). HCA should reveal significant treatment effects by clustering similarly treated stations or samples first. Several dissimilarity measures (Euclidean, squared Euclidean, city-block) were tried, as well as a number of clustering methods (centroid, nearest-neighbor, farthest neighbor, within- and between-group averages). The method chosen for reporting, between-group average clustering using city-block distances, was that which showed maximum effects using our data. The results are shown as dendrograms or "tree" diagrams (Figures IVa,b; VIa,b), along with cluster sequence tables (Tables 17a,b; 22a,b).

RESULTS

BATHYMETRY

During both survey periods, all bathymetric measurements were made using a Raytheon DE-719C Survey Fathometer. Bathymetric profiles surveyed in April, 1985 were used for correlation purposes with the soundings done by the Corps of Engineers in May, 1984 (Drawing No. DBH 232/227, Sheet 3).

Soundings of several lines obtained in the Corps survey were plotted on cross-section paper, as were corresponding lines done by the Marine Extension Service in the April, 1985 survey. The latter soundings were corrected to MLW, the same datum that the Corps employed. Figure II, (Appendix) displays the cross-sectional plot and spatial distribution of the two sets of data.

As can be noted on Figure II, close correlation exists between all line numbers. Considering that two different horizontal positioning systems were employed, all lines are felt to be a representative match.

The close correlation between the soundings taken approximately one year apart illustrate the overall stability of the material within the disposal area. No evidence of wave-base induced scour was noted. This is especially important as during the interval of time between the two surveys, the area was subjected to numerous northeasters which were capable of producing scour.

Transmissometer Profiles

The water clarity in the disposal area was determined using a Hydro Products transmissometer. The water was much more turbid during the October, 1984 survey than it was in April, 1985. In October (see Table 2a) the percentage light transmission at the sea surface ranged from 72 to 80% and at the bottom from 69 to 87%. The measurements made in April (Table 2b) showed a greater degree of consistency within the entire water column with light transmission ranging from 93 to 97% on the surface and from 92 to 97% at the seafloor. The differences between the two sets of measurements reflects prevailing sea states, fresh-water runoff volumes, etc. more than seasonal changes.

Sediment Characteristics

The bottom sediments in and adjacent to the disposal area were sampled by box coring at all nine sample stations during each of the two survey periods. The statistical breakdown of the coarse fraction size analysis for each is given in Tables 3. The contents of the pan (+230 mesh or the silt plus the clay fractions) were then added to 1000 ml volumetric cylinders for pipette analysis.

The majority of the bottom sediments both within and without the disposal area can be described as unimodal, meaning that the majority of a given sample is in one size class. The only exception to this trend was the material at Sample Station N-2, just outside the northern boundary of the disposal area. At this site, the bottom material exhibits a bimodal distribution, wherein over 50% of the sediments occur in two size classes. This apparent anomaly may be explained in part by the high concentration of shell debris in the samples taken at this site.

The bottom sediments of the entire surveyed area can be cataloged as fine to very fine-grained sand with some silt and almost no clay. The sand fraction consists of shell fragments, most of which are recognizable portions of molluscs, lithic fragments, quartz and feldspar grains, mica and unidentified opaque mineral grains. No evidence of human debris was seen in any of the sediments analyzed. There is no discernable difference between the bottom material within the disposal area and that sampled outside the boundaries of the prescribed area.

WATER ANALYSES

Total Suspended Solids

The highest content of suspended solids was 50 mg/l at sample station S-2 taken in the April survey (Table 4b). Although somewhat anomalous when compared to the other samples, it should be pointed out that even this concentration is very low (50 parts per million).

No definite trends can be seen in the amounts of suspended material and there is no significant difference between the suspended solids in the water column samples within the disposal area versus those taken outside its boundaries.

High Molecular Weight Hydrocarbons

The concentration of high molecular weight hydrocarbons were at or below detection limits in all samples. Trace amounts (approximating detection limits) of C-25 (pentacosane) and C-26 (hexacosane) were present in the samples taken at station S-3 (outside the disposal area) during both surveys.

However, even these were less that 0.10 parts per billion. The amounts of aliphatic and aromatic hydrocarbons in the water samples (see Tables 5a and 5b) are extremely minute both inside and outside the boundaries of the disposal area, with no detectable differences other than that discussed above.

SEDIMENT ANALYSES

Oil and Grease

Sediment oil and grease was found in low but detectable levels in all sediment samples analyzed (Table 6). No detectable trends were found with regard to location of samples relative to the disposal site. Oil and grease levels were slightly higher in October, 1984, than in April, 1985, but the data are not adequate to show a significant seasonal trend.

High Molecular Weight Hydrocarbons

Sediment high molecular weight hydrocarbons were below detection limits (0.1 ppb for aliphatic compounds: 0.50 ppb for aromatic compounds) on both sample dates for all samples at all sites (Table 7a,b).

Chlorinated Hydrocarbons and Related Compounds

Sediment chlorinated hydrocarbons for both sample dates were all below limits of detectability (Tables 8a, 8b). In addition to the samples shown in table 8, all samples were analyzed for PCB's (Aroclor 1254 standard) and were found to be below limits of detectability. Samples were also tested for the following related compounds, and all were below detectable limits: Carbophenolthion, Diazinon, Ethion, Malathion, Methoxychlor, Parathion, Methyl Parathion, Mirex and Rabon.

Total Organic Carbon and Heavy Metals

Organic carbon was present in all samples from all sites on both surveys. In the October survey, the highest concentration was in the sediments at station S-1, which is inside the disposal area, whereas in the April, 1985 survey, the highest concentration was at station S-3, outside the disposal area. No significant trends and/or differences with respect to sample location can be delineated from the analyses presented in Table 9.

Mercury was detected in all samples from all sites on both surveys, and ranged from 37 to 85 parts per billion (Tables 9a and 9b).

The other heavy metals (lead, copper and cadmium) which were present in all samples (see Table 9) showed no discernable trend with respect to sample location or season, either inside or outside of the disposal area.

TISSUE ANALYSES

Due to the sparsity of faunal samples, both vertebrate and invertebrate, in some of the trawl hauls, insufficient biomass precluded the analysis of tissue material from all of the trawl sets.

High Molecular Weight Hydrocarbons

In the majority of the trawl samples, the aliphatic compounds were below detectable limits (Table 10a,b). In the October samples, the striped drum from trawl S2 had trace amounts of C-21 and C-22, whereas the same species from trawl N1 contained trace amounts of C-19, C-20 and C-21. The aromatic compounds in the October samples were all below limits of detectability, with the exception of the lizard fish from trawl N2, which contained 1.00 part per billion pyrene.

In the April samples, all tissues analyzed were below detectable limits for the aliphatic compounds, as were the aromatics with the exception of the squid in trawl N3, which contained 1.21 ppb phenanthrene.

Chlorinated Hydrocarbons and Related Compounds

Chlorinated hydrocarbons were below limits of detectability in all faunal tissue samples collected on both dates. In addition to the data presented in Tables 11a and 11b, all samples were also analyzed for PCB's (Aroclor 1254 standard) and were found to be below detectable limits. Similar results were obtained on all samples analyzed for the same related compounds listed above under the sediment analyses.

Heavy Metals - Macrofauna

Heavy metals (mercury, lead, copper and cadmium) were detected in all of the tissue samples from the macrofauna on both sample dates (Table 12a,b). In the October samples, mercury was rather high in the croaker from trawl S2, and copper was high in the blue crab from trawl N1 and the portunid crab from trawl S3 (99 and 165 ppm, respectively). In the April samples, mercury was again high in the anchovies (242 ppb) and the flounder (701 ppb) from trawl N2.

FAUNAL DISTRIBUTION AND ANALYSES

Trawl Macroepifauna

Beam trawl samples included 25 species in samples taken October 16, 1984, and 15 species in samples taken April 17, 1985. (Tables 13a, 13b). Although species richness was fairly high, numbers and biomass were very low. More than one third of the species were represented in single samples, and several by single individuals. The resulting data matrices are very sparse (with mostly zero entries) and therefore somewhat difficult to interpret.

Multivariate analysis of variance (MANOVA) was performed on the samples for both dates using three treatment levels. Levels were on-site (samples TS-1 and TN-1), adjacent (samples TS-2 and TN-2), and off-site (samples TS-3 and TN-3). Box's test for equality of dispersions and Rao's test for equality of population centroids were calculated, in addition to Pillai's, Hotelling's and Wilk's tests. None of these showed any specific treatment effect, although the hypotheses of common means and variances for all species were rejected. The univariate F-Ratios for all species were calculated (Tables 14a, 14b) and the probabilities of calculated ratios relating to treatment effects were determined, with 2 +3 degrees of freedom and significance level of 1-Á=0.90. The data for October, 1984, show only one species (of 25) with significant treatment response, while the April, 1985 data show two species (of 15) responding significantly. In both cases, the number of species showing treatment effects is less than that expected to as a result of random sampling effects (Harris, 1985), and is interpreted as showing no significant impacts from dredge spoil disposal. The data were also tested for differences associated with transect direction, and no significant differences could be detected.

The among-station correlations were calculated for each sample date (Tables 15a, 15b). If significant treatment effects due to dredge spoil disposal occur, correlations are expected to be highest between pairs of stations receiving similar treatments (those with common numerical indices). This does not appear in either correlation matrix. The October, 1984, results show apparently random dispersal, while those for April, 1985 show highly significant correlation among all stations except station TS-2, which is poorly correlated with other stations. Examination of table 13b shows that this result is due to the effects of a single species (Mnemiopsis leidyi). If M. leidyi is dropped from the data, the results are approximately random.

In order to examine the correlation matrices for additional, possibly hidden, patterns, they were subjected to principal components analysis (PCA) using a varimax rotation procedure to emphasize existing differences. The resulting factor tables and PCA plots (Tables 16a, 16b; Figures IIIa, IIIb) show no additional significant patterns. The April, 1985 plot shows the expected clustering of all stations except TS-2 (#4), while the October, 1984 plot shows apparently random scatter with no particular gradient.

As an additional test, independent of the correlation matrix, hierarchical cluster analysis (HCA), based on the raw numerical data by station, was applied to the data (Tables 17a, 17b; Figures IVa, IVb). Here again, if treatment effects due to location were evident in the species distribution data, the samples would be expected to cluster first in pairs from similarly treated location (i,e., with the same numerical index) before forming larger clusters. No such effects were found in the tables or dendrograms.

Box Core Macroinfauna

Macroinfauna sampling was accomplished on October 15, 1984 and April 16, 1985. Forty-four species were found in the first set of samples and sixty-two species in the second set (Tables 18a, 18b). Most of the taxonomic work, sorting, and counting was done by Ms. Amy L. Edwards, who is associated with the University of Georgia Museum of Natural History in Athens. As with the trawl samples, species richness was moderate but numbers and biomass very low. The data matrices are very sparse, with many species represented in single samples.

Three-level nested MANOVA was performed on the samples for both dates. Levels corresponded to station location, and, as stated before, are indicated by numerical indices (1 for on-site; 2 for immediately adjacent to the site; 3 for farthest off-site). Multivariate measures of significance showed no treatment effects and did not permit rejection of the null hypothesis that all sample came from a common pool. Univariate results of nested and oneway

ANOVAs (Tables 19a, 19b) showed no significant treatment effects due to location relative to the dredge spoil disposal site, or to transect direction. Box's test for equality of dispersions and Rao's test for equality of population centroids were calculated. The hypotheses of common means and common variances were rejected, but no overall treatment effects were found. Calculation of F-ratios and associated probabilities for each species resulted in two species (of 43) from the October, 1984 sampling and five (of 62) from the April, 1985 sampling showing significant treatment effects (Á=0.05). These are fewer than would be expected from chance alone in sampling a randomly distributed set of species. The overall conclusion is that one cannot reject the null hypothesis of no treatment effect due to dredge spoil disposal.

Samples were grouped by station for among-station correlation analyses. The resulting matrices (Tables 20a, 20b) show no obvious pattern for either sampling date. Only one pairwise correlation (N-1 vs E-2, Table 20b) came very close to the critical value for significance (approximately 0.75 in this case), and no evidence of association by location appeared.

As an additional test, PCA's were performed (Tables 21a, 21b; Figures Va, Vb) on the correlation matrices to emphasize any obscure patterns. Five significant factors' axes were found for the October, 1984 samples and four for the April, 1985 samples. In each case, only the two most significant axes are plotted, although all significant axes were considered in the analyses. No significant treatment-related trends appeared in either set of data. The apparent association of the off-site stations for October, 1984 (points 7,8 and 9 in Figure Va) is an artifact, and disappears as other axes are examined.

Hierarchical cluster analysis (HCA) was also applied to the data matrices. The results of HCA by station are presented here (Tables 22a, 22b; Figures VIa, VIb). HCA was also done on a sample-by-sample basis, but no additional information was revealed except for a slight tendency to cluster by station. The clustering sequences and resulting dendrograms show no significant patterns related to sample location. Clusters and distance coefficient relationships appear essentially random.

CONCLUSIONS AND RECOMMENDATIONS

Aside from expected differences in faunal make-up and distribution between the two sampling dates, with the Spring survey resulting in a greater number of species, no significant differences were detected in the parameters studied.

The data were analyzed statistically based on the null hypothesis that no significant differences would be ascertainable that could be attributed to the effects of dredge spoil disposal. The sampling permitted a three-level analysis consisting of coded samples within the site, immediately adjacent to the site and further from the site. With this approach, any consistent gradient relative to sample location would have resulted in the rejection of the null hypothesis. In fact, no such gradients occurred in any of the data with the result that the null hypothesis could not be rejected. The distribution of samples in transects radiating from the center of the site to the north, south, and for the box cores, east, allowed analyses for transect effects to test the assumption of isotropy of dispersion. No significant differences were found which could be attributed to transect direction. The overall conclusion must be that no effects attributed to dredge spoil disposal were identified in these studies.

We recommend that similar surveys be continued to monitor the site in the future, and further suggest that a winter/summer schedule be selected. In view of the lack of detectable effects, every other year should suffice for monitoring to maintain the quality of the site.

The only significant procedural changes that we would recommend are (1) that either larger or longer trawls be employed to obtain larger macrofauna samples; and (2) that because of the unexpectedly sparse macroinfauna found in the box cores, that some sampling of at least the larger meiofauna (using a sieve with mesh no larger than 0.10 mm) be included. Other work (Gillespie and Harding, 1987; Gillespie and Hodges, 1982) in nearby areas has shown relatively larger and more diverse populations and higher productivity of large meiofauna, compared to the macrofauna sampled in this study using a 0.5 mm mesh sieve. The use of a smaller mesh would add to the cost of the monitoring, and a compromise might be chosen that would combine adequate sampling with reasonable cost (e.g., a mesh size of 0.20 mm might be acceptable).

REFERENCES

Methods

Gauch, H.G., Jr. 1982. Multivariate Analysis in Community Ecology. Cambridge University Press, Cambridge. pp.298.

Gillespie, D.M. and J.L. Harding. 1987. An environmental study of the Savannah Harbor Ocean Disposal Site. Report submitted to the Savannah District, U. S. Army Corps of Engineers. Contract #DACW 21-86-C-0030.

Gillespie, D.M. and J.C. Hodges, Jr. 1982. Production of Invertebrates in the Tidewater Zone of a Coastal River and Adjacent Estuary. ERC 04-82, Georgia Institute of Technology, Atlanta, Georgia. pp. 57.

Green, R.H., 1979. Sampling Design and Statistical Methods for Environmental Biologists. Wiley-Interscience, New York. pp. 257.

Legendre, L. and P. Legendre. 1983. Numerical Ecology. Elservier Scientific Publications, New York. pp. xvi + 419.

Harris, R.J., 1985. A Primer of Multivariate Statistics, 2nd Edition. Academic Press. 576 pp + xii.

Pielou, E.C. 1984. The Interpretation of Ecological Data - a primer on classification and ordination. J. Wiley and Sons, New York.

Pequegnat, W.E.; Pequegnat, L.H.; James, B.U.; Kennedy, E.A.; Fay, T. and Fredericks, A.D. (1981). Procedural Guide for Designation Surveys of Ocean Dredged Material Disposal Sites, Tech Report EL-81-1, TerEco Corp., College Station, Texas, for Chief of Engineers, U.S. Army, Washington, D.C. 20314.

U.S. Environmental Protection Agency. 1986. Draft Environmental Impact Statement, Brunswick Harbor, Georgia Ocean Dredged Material Disposal Site Designation. Cooperating agency, U.S. Army Corps of Engineers, Savannah District. pp. 1-48; A1-A52.

U.S. Environmental Protection Agency. 1988. Final Environmental Impact Statement, Brunswick Harbor, Georgia Ocean Dredged Material Disposal Site Designation. Cooperating agency, U.S. Army Corps of Engineers, Savannah District. pp. 1-65 + vi.

Taxonomic - General

Fox, R.S. and E.E. Ruppert, 1985. Shallow-Water Marine Benthic Macroinvertebrates of South Carolina. University of South Carolina Press. pp. 330.

Gosner, K.L., 1971. Guide to Identification of Marine and Estuarine Invertebrates, Cape Hatteras to the Bay of Fundy. Wiley-Interscience, New York. pp. 693.

Miner, R.W., 1950. Field book of seashore life. G.P. Putnam's Sons, New York. pp. 888.

Sterrer, W. (ed.). 1986. Marine Fauna and Flora of Bermuda: A Systematic Guide to the Identification of Marine Organisms. John Wiley and Sons. New York. pp. 742.

Annelids

Day, J.H., 1973. New Polychaeta from Beaufort, with a key to all species recorded from North Carolina. NOAA Tech. Report, NMFS CIRC-375. pp. 141.

Fauchald, K., 1977. The Polychaete worms. Natural History Museum of Los Angeles County and the Allen Hancock Foundation Univ. California Science Series no. 28.

Fauchald, K., 1982. Some species of *Onuphis* from the Atlantic Ocean. Proceedings of the Biological Society of Washington. 95(2): 238-250.

Gardiner, S.L., 1975. Errant polychaete Annelids from North Carolina. Journal of the Elisha Mitchell Science Society. 91(3): 77-220.

Mikkelsen, P.S. and R.W. Virnstein, 1982. An Illustrated Glossary of Polychaete Terms. HBF, Inc. Tech. Report #46. pp. 92.

Uebelacker, J.M. and P.G. Johnson (Ed.), 1984. Taxonomic guide to the polychaetes of the Northern Gulf of Mexico. Final Report to the Minerals Management Service, Contract 14-12-001-27091. Barry A. Vittor and Assoc., Inc., Mobile, Alabama. 7 Vol.

Arthropods

Barnard, J.L., 1969B. The families and genera of marine Gammaridean Amphipoda. USNM Bulletin no. 271. pp. 535.

Bousfield, E.L., 1965. Haustoriidae of New England. Proceedings of the USNM no. 3512, vol. 117. pp. 159-240.

Menzies, R.J. and D. Frankenberg. 1966. Handbook on the common marine Isopod Crustacea of Georgia. University of Georgia Press. Athens, Georgia. pp. 93.

Schultz, G.A., 1969. The marine Isopod Crustaceans. Wm. C. Brown Co., Dubuque, Iowa. pp. 359.

Thomas, J.D. and J.L. Barnard. 1984. *Acanthohaustorius pansus*, a new species sand-burrowing Amphipod from Looe Key Reef, Florida Keys, with redescription and distribution data of *Acanthohaustorius bousfieldi* Frame, 1980. Proceedings of the Biological Society of Washington 97(4). pp. 909-926.

Williams, A.B. 1965. Marine Decapod Crustaceans of the Carolinas. Fishery Bulletin Vol. 65, No. 1. pp. 995.

Williams, A.B. 1984. Shrimps, Lobsters, and Crabs of the Atlantic Coast of the Eastern United States, Maine to Florida. Smithsonian Inst. Press. pp. 550.

Mollusca

Abbott, R.T. 1974. American Seashells 2nd ed. VanNostrand, New York. pp. 663.

Morris, P.A. 1975. A field guide to shells. Houghton Mifflin Co., Boston. pp. 330.

Echinoderms

Thomas, L.P. 1962. The shallow water Amphiurid Brittlestars of Florida. Bulletin Mar. Sci. of Gulf and Caribbean. pp. 663-695.

APPENDIX

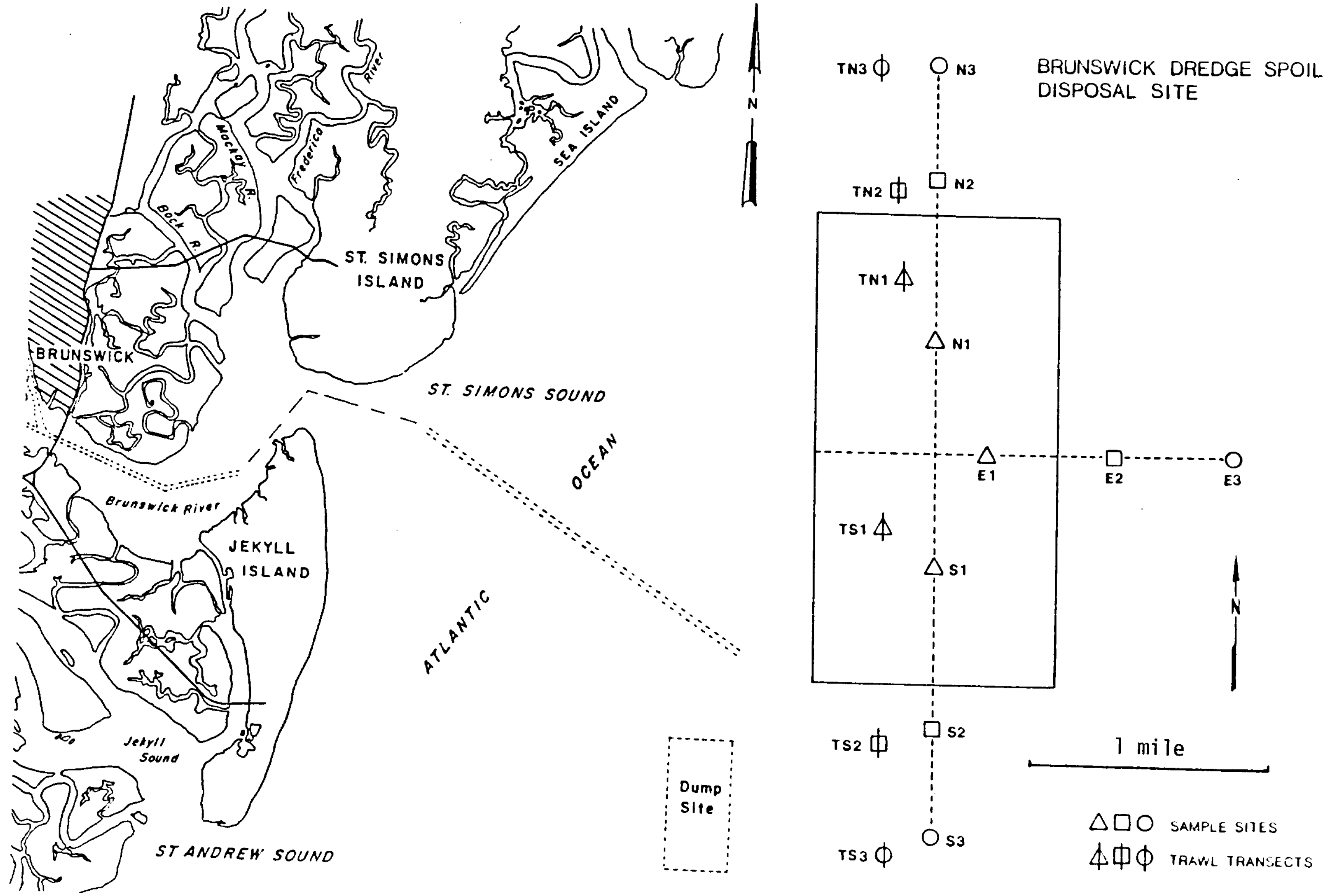


Figure I. Sample locations in the Brunswick, Georgia dredge spoil ocean disposal site. Locations are approximate.

Table 1. Station Locations, October, 1984, as determined by Loran-C (to nearest 0.01 minute), with area covered by trawl tows (to nearest square meter).

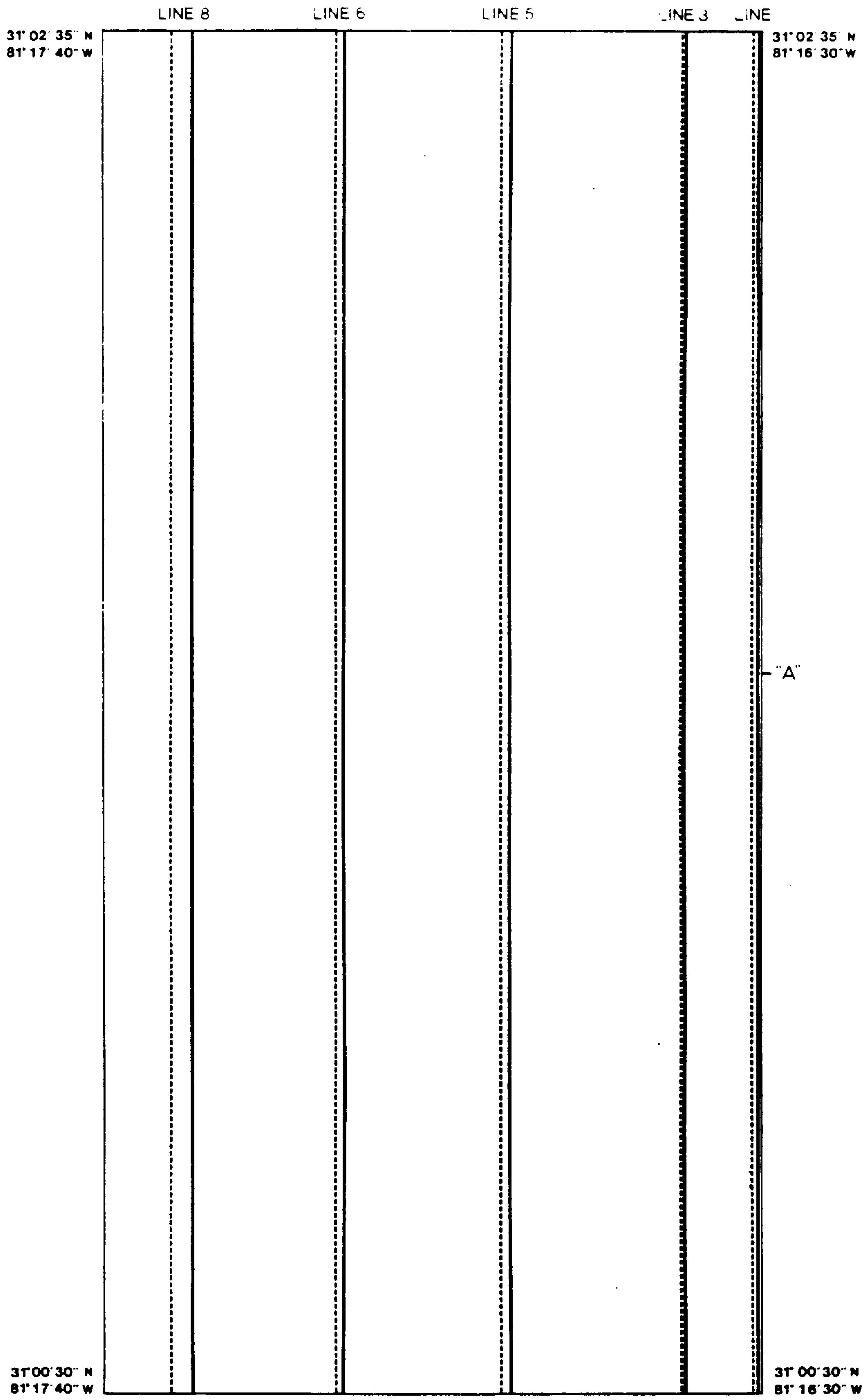
ANCHOR STATIONS

Station	Longitude (N)	Latitude (W)
N1	31° 02.14'	81° 16.90'
N2	31° 03.22'	81° 16.90'
N3	31° 03.75'	81° 16.89'
E1	31° 01.68'	81° 16.72'
E2	31° 01.66'	81° 15.68'
E3	31° 01.66'	81° 15.16'
S1	31° 01.16'	81° 16.93'
S2	31° 00.11'	81° 16.89'
S3	30° 59.13'	81° 16.92'

Beam Trawl Transects

	Start			End		
Station	Latitude(N)	Longitude(W)		Latitude(N)	Longitude(W)	Area(m^2)
TN1	31° 01.74'	81° 17.20'	to	31° 02.28'	81° 17.20'	3002
TN2	31° 02.84'	81° 17.18'	to	31° 03.36'	81° 17.21'	2899
TN3	31° 03.69'	81° 17.30'	to	31° 04.04'	81° 17.77'	3258
TS1	31° 00.70'	81° 17.22'	to	31° 01.32'	81° 17.23'	3447
TS2	31° 00.36'	81° 17.32'	to	30° 59.89'	81° 17.32'	2613
TS3	30° 59.65'	81° 17.24'	to	31° 00.03'	81° 17.26'	2115

FIGURE II.

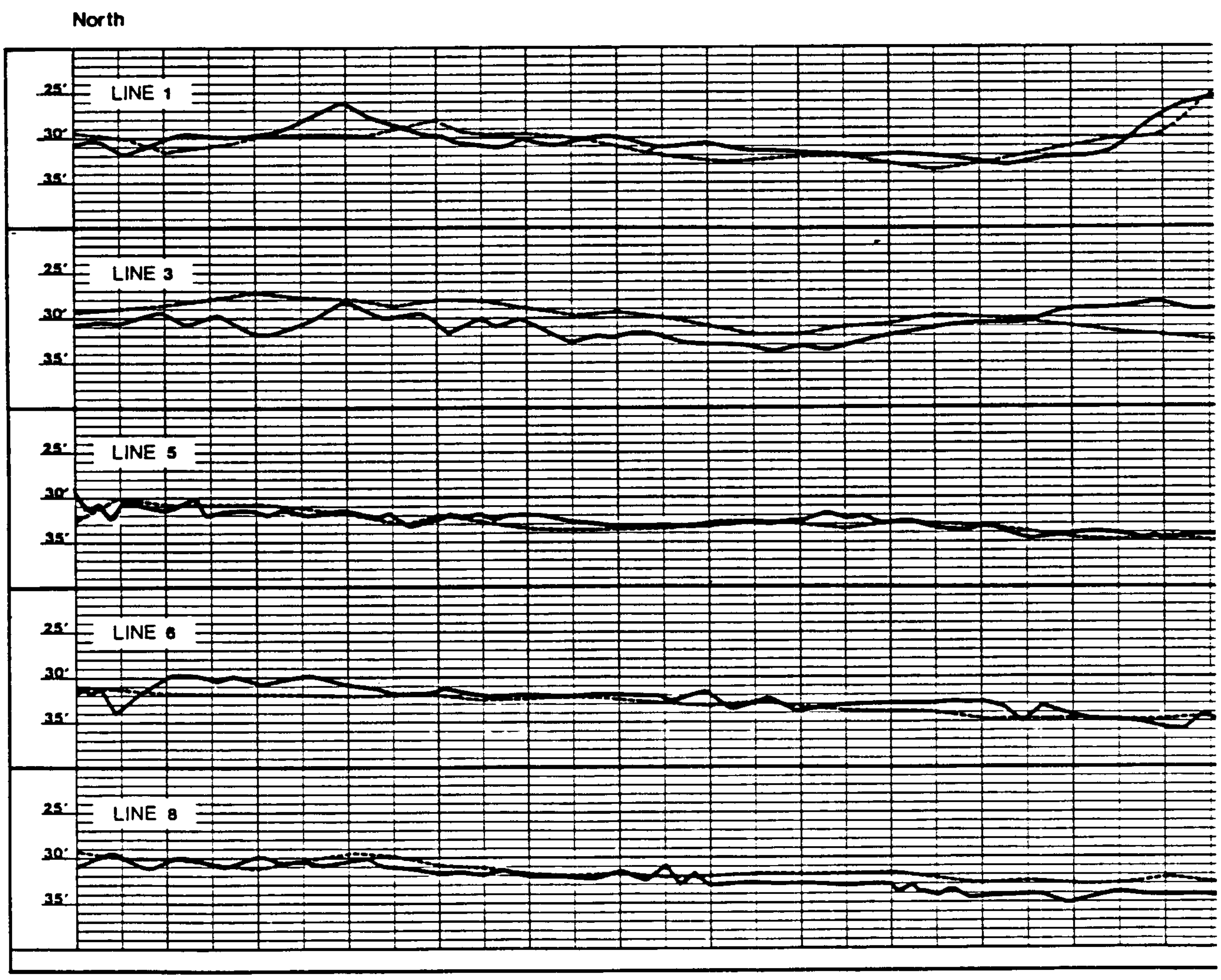


LINE 8
LINE 6
LINE 5
LINE 3
LINE
31° 02' 35" N
81° 17' 40" W
31° 02' 35" N
81° 16' 30" W
"A"
31° 00' 30" N
81° 17' 40" W
31° 00' 30" N
81° 16' 30" W

FIGURE II.

BATHYMETRIC CROSS - SECTIONS

BRUNSWICK HARBOR
OFFSHORE DISPOSAL AREA



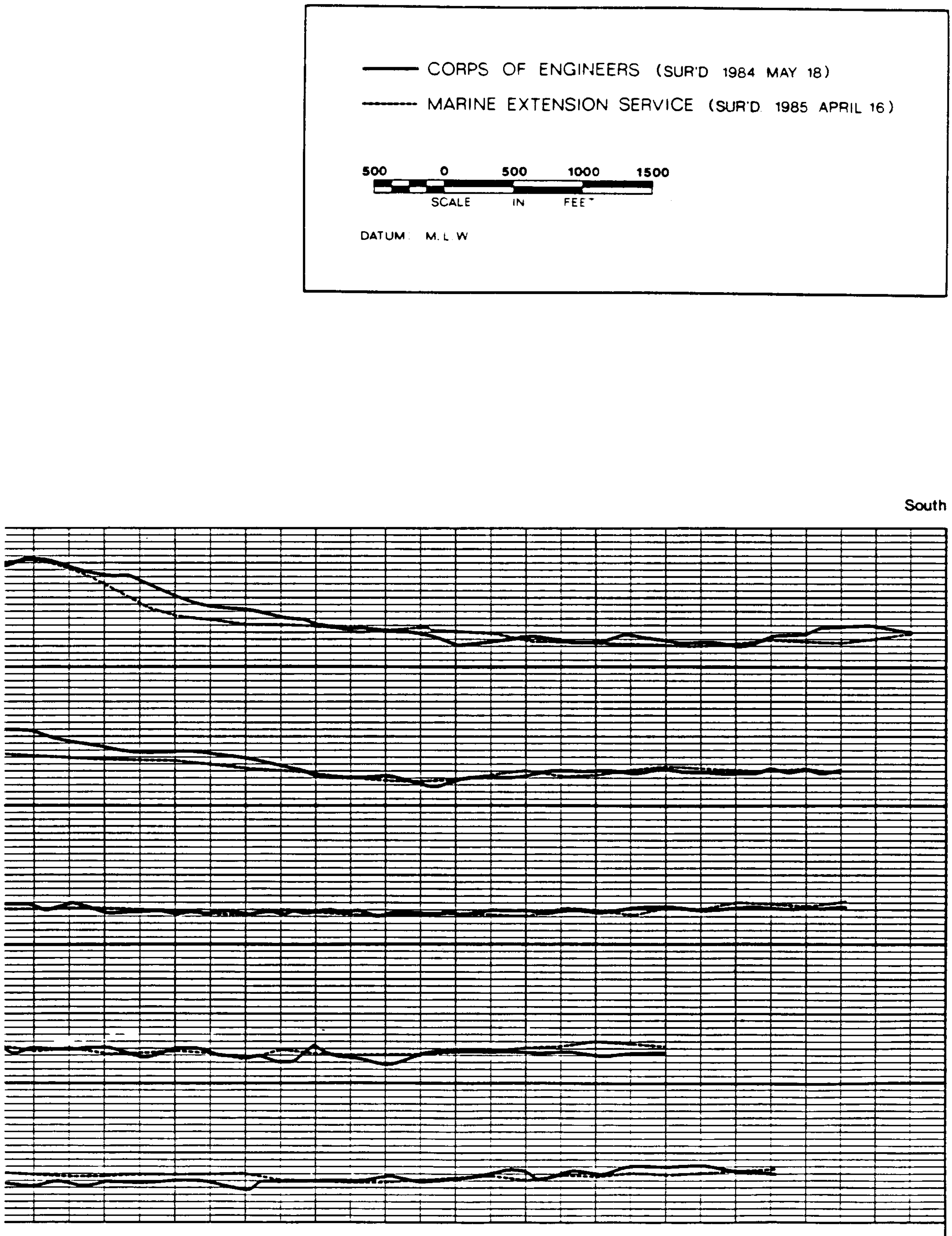

CORPS OF ENGINEERS (SUR'D 1984 MAY 18)
MARINE EXTENSION SERVICE (SUR'D 1985 APRIL 16)
500 0 500 1000 1500
SCALE IN FEET
DATUM: M.L.W.
South

Table 2a. Transmissometer Profiles
(Percent Transmittance) for October, 1984

Depth	N1	N2	N3	E1	E2	E3	S1	S2	S3
Surface	80	80	78	72	75	76	80	79	77
2m	80	80	78	74	76	78	80	79	78
4m	80	82	79	70	81	86	82	84	80
6m	85	81	76	80	88	88	89	88	86
8m	86	78	69	83	87	88	87	87	85
10m	*82	*78	*69 (9m)	*84	87	87	86	85	85
12m					86	*87	*81	*82 (11m)	*82
					*84 (13m)				

*Bottom (to nearest meter)

Table 2b. Transmissometer Profiles
(Percent Transmittance) for April, 1985

Depth	N1	N2	N3	E1	E2	E3	S1	S2	S3
Surface	94	94	96	97	97	93	95	97	95
2m	94	95	94	96	96	93	95	96	97
4m	93	95	94	95	96	92	92	96	96
6m	93	95	93	95	96	93	92	96	97
8m	93	94	93	95	95	93	92	96	97
10m	93	94	93	94	96	93	92	96	97

Table 3.
GRAIN SIZE ANALYSIS
October, 1984
Total Sample Weight: 23.54 grms
N-1 #2

MESH	SW	%	PHI
+ 10	0.46	1.95	-1.0
+ 18	0.55	2.33	0.0
+ 35	1.13	4.80	+1.0
+ 60	2.95	12.53	+2.0
+120	12.76	54.20	+3.0
+230	5.00	21.24	+4.0
PAN	0.33	1.40	+5.0
		98.45	

No human debris

No clay content

Coarse fraction high in molluscan debris

Table 3 (Cont'd)
GRAIN SIZE ANALYSIS
October, 1984
Total Sample Weight: 18.08 grms
N-2 #2

MESH	SW	%	PHI
+ 10	1.95	10.78	-1.0
+ 18	1.24	6.85	0.0
+ 35	3.45	19.08	+1.0
+ 60	5.46	30.19	+2.0
+120	5.50	30.42	+3.0
+230	0.45	2.48	+4.0
PAN	T		
		99.80	

No human debris

Trace of silt and clay

Coarse fraction had molluscan debris, coral and rock fragments, quartz and feldspar grains.

Table 3 (Cont'd)
GRAIN SIZE ANALYSIS
October, 1984
Total Sample Weight: 33.80 grms
N-3 #1

MESH	SW	%	PHI
+ 10	4.08	12.07	-1.0
+ 18	4.19	12.39	0.0
+ 35	12.61	37.30	+1.0
+ 60	6.48	19.17	+2.0
+120	5.95	17.60	+3.0
+230	0.21	.62	+4.0
PAN	0.28	.82	+5.0
		99.97	

No human debris

No clay content - contents of pan all silt

Coarse fraction contains molluscan debris, rock fragments, quartz and feldspar grains

Table 3 (Cont'd)
GRAIN SIZE ANALYSIS
October, 1984
Total Sample Weight: 25.07 grms
E-1 #1

MESH	SW	%	PHI
+ 10	1.35	5.38	-1.0
+ 18	3.30	13.16	0.0
+ 35	12.83	51.17	+1.0
+ 60	3.50	13.96	+2.0
+120	2.94	11.72	+3.0
+230	1.03	4.10	+4.0
PAN	0	0	
		99.49	

No human debris

No silt or clay

Coarse fraction consists of molluscan debris, quartz and feldspar grains, and rock fragments

Table 3 (Cont'd)
GRAIN SIZE ANALYSIS
October, 1984
Total Sample Weight: 35.95 grms
E-2 #1

MESH	SW	%	PHI
+ 10	1.75	4.86	-1.0
+ 18	1.60	4.45	0.0
+ 35	3.68	10.23	+1.0
+ 60	7.51	20.89	+2.0
+120	20.04	55.74	+3.0
+230	1.11	3.08	+4.0
PAN	T		+5.0
		99.25	

No human debris

Trace of silt and clay

Coarse fraction had molluscan debris, rock fragments and mica

Table 3 (Cont'd)
GRAIN SIZE ANALYSIS
October, 1984
Total Sample Weight: 45.72 grms
E-3 #2

MESH	SW	%	PHI
+ 10	0.34	.74	-1.0
+ 18	2.36	5.16	0.0
+ 35	23.90	52.27	+1.0
+ 60	8.85	19.35	+2.0
+120	8.99	19.66	+3.0
+230	1.07	2.34	+4.0
PAN	T		+5.0
		99.52	

No human debris

No clay content; trace of silt

Coarse fraction had shell fragments, rock fragments, quartz, feldspar and mica

Table 3 (Cont'd)
GRAIN SIZE ANALYSIS
October, 1984
Total Sample Weight: 36.76 grms
S-1 #2

MESH	SW	%	PHI
+ 10	0.54	1.46	-1.0
+ 18	1.26	3.42	0.0
+ 35	3.71	10.09	+1.0
+ 60	3.70	10.06	+2.0
+120	20.91	56.88	+3.0
+230	6.15	16.73	+4.0
PAN	.32	.87	+5.0
		99.51	

No human debris

No clay content

Coarse fraction had molluscan fragments, quartz, feldspar, rock fragments and had a high mica content

Table 3 (Cont'd)
GRAIN SIZE ANALYSIS
October, 1984
Total Sample Weight: 45.95 grms
S-2 #1

MESH	SW	%	PHI
+ 10	0.66	1.43	-1.0
+ 18	1.29	2.80	0.0
+ 35	3.74	8.13	+1.0
+ 60	11.04	24.02	+2.0
+120	28.00	60.93	+3.0
+230	1.11	2.41	+4.0
PAN	.06	.13	+5.0
		99.85	

No human debris

No clay content

Coarse fraction had molluscan debris, quartz and feldspar grains

Table 3 (Cont'd)
GRAIN SIZE ANALYSIS
October, 1984
Total Sample Weight: 37.92 grms
S-3 #1

MESH	SW	%	PHI
+ 10	0.20	.52	-1.0
+ 18	0.83	2.18	0.0
+ 35	1.48	3.90	+1.0
+ 60	3.92	10.33	+2.0
+120	28.78	75.89	+3.0
+230	2.31	6.09	+4.0
PAN	T		+5.0
		99.91	

No human debris

Trace of silt and clay

Coarse fraction had shell fragments, quartz, feldspar and mica

Table 3 (Cont'd)
GRAIN SIZE ANALYSIS
April, 1985
Total Sample Weight: 62.76 grms
N-1 #2

MESH	SW	%	PHI
+ 10	0.59	0.94	-1.0
+ 18	1.34	2.13	0.0
+ 35	3.39	5.40	+1.0
+ 60	6.82	10.86	+2.0
+120	46.11	73.47	+3.0
+230	4.31	6.86	+4.0
PAN	0.21	0.33	+5.0
		99.99	

No human debris

No clay content

Very fine-grained sand; molluscan debris

Table 3 (Cont'd)
GRAIN SIZE ANALYSIS
April, 1985
Total Sample Weight: 60.12 grms
N-2 #2

MESH	SW	%	PHI
+ 10	21.02	34.96	-1.0
+ 18	8.65	14.38	0.0
+ 35	11.93	19.84	+1.0
+ 60	9.54	15.86	+2.0
+120	7.48	12.44	+3.0
+230	1.54	2.56	+4.0
PAN	Trace		+5.0
		100.04	

No human debris

Trace of silt; no clay

Large shell fragments, lithic fragments, sand mostly quartz and feldspar, some mica

Table 3 (Cont'd)
GRAIN SIZE ANALYSIS
April, 1985
Total Sample Weight: 62.02 grms
N-3 #1

MESH	SW	%	PHI
+ 10	0.32	0.51	-1.0
+ 18	1.35	2.18	0.0
+ 35	3.65	5.88	+1.0
+ 60	2.53	4.07	+2.0
+120	37.70	60.78	+3.0
+230	15.75	25.39	+4.0
PAN	0.72	1.16	+5.0
		99.97	

No human debris

No clay - contents of pan all silt

Molluscan debris, quartz and feldspar, 1-2% opaque minerals, rock fragments

Table 3 (Cont'd)
GRAIN SIZE ANALYSIS
April, 1985
Total Sample Weight: 77.85 grms
E-1 #1

MESH	SW	%	PHI
+ 10	2.75	3.53	-1.0
+ 18	6.87	8.82	0.0
+ 35	29.15	37.44	+1.0
+ 60	22.33	28.68	+2.0
+120	15.93	20.46	+3.0
+230	0.82	1.05	+4.0
PAN	Trace		+5.0
		99.98	

No human debris

Trace of silt; no clay

Clear quartz grains; feldspar, 1-2% opaque minerals; molluscan fragments and whole valves; some bryzoan fragments

Table 3 (Cont'd)
GRAIN SIZE ANALYSIS
April, 1985
Total Sample Weight: 57.61 grms
E-2 #1

MESH	SW	%	PHI
+ 10	1.35	2.34	-1.0
+ 18	3.17	5.50	0.0
+ 35	6.84	11.87	+1.0
+ 60	7.80	13.53	+2.0
+120	33.44	58.04	+3.0
+230	4.89	8.48	+4.0
PAN	0.13	0.22	+5.0
		99.98	

No human debris

Abundant small shell fragments; quartz and feldspar; minor opaque minerals

No clay

Table 3 (Cont'd)
GRAIN SIZE ANALYSIS
April, 1985
Total Sample Weight: 61.84 grms
E-3 #2

MESH	SW	%	PHI
+ 10	3.77	6.09	-1.0
+ 18	4.22	6.82	0.0
+ 35	7.28	11.77	+1.0
+ 60	8.13	13.15	+2.0
+120	35.59	57.56	+3.0
+230	2.77	4.47	+4.0
PAN	.07	.11	+5.0
		99.97	

No human debris

Small shell (molluscan) fragments; quartz and feldspar grains

No clay

Table 3 (Cont'd)
GRAIN SIZE ANALYSIS
April, 1985
Total Sample Weight: 59.76 grms
S-1 #2

MESH	SW	%	PHI
+ 10	.23	.38	-1.0
+ 18	.62	1.04	0.0
+ 35	1.88	3.14	+1.0
+ 60	4.38	7.32	+2.0
+120	45.02	75.32	+3.0
+230	7.49	12.53	+4.0
PAN	.64	.23	+5.0
		99.96	

No human debris

Molluscan fragments; quartz, feldspar, mica; rock fragments

No clay

Table 3 (Cont'd)
GRAIN SIZE ANALYSIS
April, 1985
Total Sample Weight: 50.27 grms
S-2 #1

MESH	SW	%	PHI
+ 10	2.51	4.99	-1.0
+ 18	1.99	3.95	0.0
+ 35	5.36	10.66	+1.0
+ 60	5.08	10.11	+2.0
+120	29.86	59.39	+3.0
+230	4.88	9.70	+4.0
PAN	.59	1.17	+5.0
		99.97	

No human debris

Quartz, feldspar and mica with small shell fragments

No clay

Table 3 (Cont'd)
GRAIN SIZE ANALYSIS
April, 1985
Total Sample Weight: 67.84 grms
S-3 #1

MESH	SW	%	PHI
+ 10	.39	.57	-1.0
+ 18	.82	1.20	0.0
+ 35	1.75	2.58	+1.0
+ 60	5.34	7.87	+2.0
+120	55.10	81.22	+3.0
+230	4.19	6.17	+4.0
PAN	.26	.38	+5.0
		99.99	

No human debris

Small shell fragments; quartz and feldspar

No clay

Table 4a. Water column suspended solids found at anchor stations, October 15, 1984 (in mg/liter).

Station	Suspended Solids #1	Suspended Solids #2
N1	2.80	3.60
N2	4.60	4.04
N3	13.65	23.60
E1	14.40	15.05
E2	3.92	5.10
E3	2.40	2.60
S1	8.40	7.40
S2	4.02	4.10
S3	5.50	3.98

Table 4b. Water column suspended solids found at anchor stations, April, 1985 (in mg/liter).

Station	Suspended Solids #1	Suspended Solids #2
N1	12.13	13.67
N2	18.23	19.47
N3	14.93	14.63
E1	9.43	9.53
E2	23.53	23.97
E3	7.13	7.30
S1	2.84	3.60
S2	50.76	50.32
S3	11.53	11.90

Table 5a. Water Column high molecular weight hydrocarbons for October, 1984 samples Aliphatic Compounds (data in parts per billion).

Station	n-nonadecane C-19	n-eicosane C-20	n-heneicosane C-21	n-docosane C-22	n-tetracosane C-24	n-pentacosane C-25	n-hexacosane C-26
N1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
N2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
N3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
E1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
E2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
E3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10
S1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

Table 5a (Cont'd). Water column high molecular weight hydrocarbons for October 15, 1984. Aliphatic Compounds (data in parts per billion).

Station	n-heptacosane C-27	n-octacosane C-28	n-nonacosane C-29	n-triacontane C-30	n-hentriacontane C-31	n-dotriacontane C-32
N1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
N2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
N3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
E1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
E2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
E3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
S1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
S2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
S3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Table 5a (Cont'd). Water column high molecular weight hydrocarbons for October, 1984 samples. Aromatic Compounds (data in parts per billion).

Station	Phenanthrene	1-Phenyl0 Naphthalene	3-Methyl Phenanthrene	Fluoranthene	Pyrene	Chrysene	Benzo-a-Pyrene
N1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
N2	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
N3	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
E1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
E2	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
E3	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
S1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
S2	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
S3	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

Table 5b. Water Column high molecular weight hydrocarbons for April 16, 1985 samples Aliphatic Compounds (data in parts per billion).

Station	n-nonadecane C-19	n-eicosane C-20	n-heneicosane C-21	n-docosane C-22	n-tetracosane C-24	n-pentacosane C-25	n-hexacosane C-26
N1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
N2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
N3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
E1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
E2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
E3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.10	<0.10
S1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

Table 5b (Cont'd). Water column high molecular weight hydrocarbons for April 16, 1985 samples Aliphatic Compounds (data in parts per billion).

Station	n-heptacosane C-27	n-octacosane C-28	n-nonacosane C-29	n-triacontane C-30	n-hentriacontane C-31	n-dotriacontane C-32
N1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
N2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
N3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
E1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
E2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
E3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
S1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
S2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
S3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Table 5b (Cont'd). Water column high molecular weight hydrocarbons for April 16, 1985 samples. Aromatic Compounds (data in parts per billion).

Station	Phenanthrene	1-Phenyl Naphthalene	3-Methyl Phenanthrene	Fluoranthene	Pyrene	Chrysene	Benzo-a-Pyrene
N1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
N2	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
N3	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
E1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
E2	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
E3	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
S1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
S2	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
S3	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

Table 6a. Sediment oil and grease analyses by station for October, 1984, as percent wet and dry weight. (2 replicates).

STATION	% OIL AND GREASE WET BASIS		% OIL AND GREASE DRY BASIS	
N1	0.106	0.114	0.142	0.153
N2	0.047	0.025	0.061	0.032
N3	0.044	0.071	0.057	0.090
E1	0.036	0.054	0.040	0.060
E2	0.063	0.071	0.086	0.097
E3	0.043	0.044	0.059	0.061
S1	0.065	0.061	0.088	0.083
S2	0.109	0.110	0.143	0.150
S3	0.043	0.037	0.058	0.050

Table 6b. Sediment oil and grease analyses by station for April, 1985, as percent wet and dry weight. (2 replicates).

STATION	% OIL AND GREASE WET BASIS		% OIL AND GREASE DRY BASIS	
N1	0.017	0.040	0.023	0.054
N2	0.024	0.042	0.031	0.055
N3	0.029	0.035	0.042	0.051
E1	0.033	0.049	0.043	0.064
E2	0.039	0.032	0.054	0.044
E3	0.023	0.020	0.031	0.027
S1	0.037	0.032	0.049	0.043
S2	0.029	0.032	0.038	0.042
S3	0.039	0.034	0.050	0.044

Table 7a. Sediment high molecular weight hydrocarbons for October, 1984 samples Aliphatic Compounds (data in parts per billion or ng/g).

Station	n-nonadecane C-19	n-eicosane C-20	n-heneicosane C-21	n-docosane C-22	n-tetracosane C-24	n-pentacosane C-25	n-hexacosane C-26
N1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
N2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
N3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
E1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
E2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
E3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

Table 7a (Cont'd). Sediment high molecular weight hydrocarbons for October, 1984 samples Aliphatic Compounds (data in parts per billion or ng/g).

Station	n-heptacosane C-27	n-octacosane C-28	n-nonacosane C-29	n-triacontane C-30	n-hentriacontane C-31	n-dotriacontane C-32
N1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
N2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
N3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
E1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
E2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
E3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

Table 7a (Cont'd). Sediment high molecular weight hydrocarbons for October, 1984 samples. Aromatic Compounds (data in parts per billion or ng/g).

Station	Phenanthrene	1-Phenyl Naphthalene	3-Methyl Phenanthrene	Fluoranthene	Pyrene	Chrysene	Benzo-a-Pyrene
N1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
N2	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
N3	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
E1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
E2	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
E3	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
S1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
S2	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
S3	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

Table 7b. Sediment high molecular weight hydrocarbons for April, 1985 samples. Aliphatic Compounds (data in parts per billion or ng/g).

Station	n-nonadecane C-19	n-eicosane C-20	n-heneicosane C-21	n-docosane C-22	n-tetracosane C-24	n-pentacosane C-25	n-hexacosane C-26
N1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
N2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
N3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
E1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
E2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
E3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

Table 7b (Cont'd). Sediment high molecular weight hydrocarbons for April, 1985 samples. Aliphatic Compounds (data in parts per billion or ng/g).

Station	n-heptacosane C-27	n-octacosane C-28	n-nonacosane C-29	n-triacontane C-30	n-hentriacontane C-31	n-dotriacontane C-32
N1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
N2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
N3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
E1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
E2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
E3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S2	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
S3	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

Table 7b (Cont'd). Sediment high molecular weight hydrocarbons for April, 1985 samples. Aromatic Compounds (data in parts per billion or ng/g).

Station	Phenanthrene	1-Phenyl Naphthalene	3-Methyl Phenanthrene	Fluoranthene	Pyrene	Chrysene	Benzo-a-Pyrene
N1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
N2	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
N3	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
E1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
E2	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
E3	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
S1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
S2	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
S3	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

Table 8a. Sediment chlorinated hydrocarbons, October 15, 1984 (mg/kg).

Station	Endrin	Dieldrin	Chlordane	A. BHC	B. BHC
N1	<0.01	<0.01	<0.01	<0.01	<0.01
N2	<0.01	<0.01	<0.01	<0.01	<0.01
N3	<0.01	<0.01	<0.01	<0.01	<0.01
E1	<0.01	<0.01	<0.01	<0.01	<0.01
E2	<0.01	<0.01	<0.01	<0.01	<0.01
E3	<0.01	<0.01	<0.01	<0.01	<0.01
S1	<0.01	<0.01	<0.01	<0.01	<0.01
S2	<0.01	<0.01	<0.01	<0.01	<0.01
S3	<0.01	<0.01	<0.01	<0.01	<0.01

All values are less than detectability limits which are as follows:

0.01 ppm 0.01 ppm 0.01 ppm 0.01 ppm 0.01 pp

Table 8a (Cont'd). Sediment chlorinated hydrocarbons, October 15, 1984 (mg/kg).

Station	Toxaphene	Heptachlor	Hept. Epoxide	Lindane	Aldrin
N1	<0.05	<0.05	<0.01	<0.01	<0.01
N2	<0.05	<0.05	<0.01	<0.01	<0.01
N3	<0.05	<0.05	<0.01	<0.01	<0.01
E1	<0.05	<0.05	<0.01	<0.01	<0.01
E2	<0.05	<0.05	<0.01	<0.01	<0.01
E3	<0.05	<0.05	<0.01	<0.01	<0.01
S1	<0.05	<0.05	<0.01	<0.01	<0.01
S2	<0.05	<0.05	<0.01	<0.01	<0.01
S3	<0.05	<0.05	<0.01	<0.01	<0.01

All values are less than detectability limits which are as follows:

	Toxaphene	Heptachlor	Hept. Epoxide	Lindane	Aldrin
	0.05 ppm	0.05 ppm	0.01 ppm	0.01 ppm	0.01 ppm

Table 8a (Cont'd). Sediment chlorinated hydrocarbons, October 15, 1984 (mg/kg).

Station	p,p'-DDD	o,p'-DDD	p,p'-DDE	p,p'-DDT	o,p'-DDT
N1	<0.005	<0.005	<0.005	<0.005	<0.005
N2	<0.005	<0.005	<0.005	<0.005	<0.005
N3	<0.005	<0.005	<0.005	<0.005	<0.005
E1	<0.005	<0.005	<0.005	<0.005	<0.005
E2	<0.005	<0.005	<0.005	<0.005	<0.005
E3	<0.005	<0.005	<0.005	<0.005	<0.005
S1	<0.005	<0.005	<0.005	<0.005	<0.005
S2	<0.005	<0.005	<0.005	<0.005	<0.005
S3	<0.005	<0.005	<0.005	<0.005	<0.005

All values are less than detectability limits which are as follows:

	p,p'-DDD	o,p'-DDD	p,p'-DDE	p,p'-DDT	o,p'-DDT
	0.005 ppm	0.005 ppm	0.005 ppm	0.005 ppm	0.005 ppm

Table 8b. Sediment chlorinated hydrocarbons, April 16, 1985 (mg/kg).

Station	Endrin	Dieldrin	Chlordane	A. BHC	B. BHC
N1	<0.01	<0.01	<0.01	<0.01	<0.01
N2	<0.01	<0.01	<0.01	<0.01	<0.01
N3	<0.01	<0.01	<0.01	<0.01	<0.01
E1	<0.01	<0.01	<0.01	<0.01	<0.01
E2	<0.01	<0.01	<0.01	<0.01	<0.01
E3	<0.01	<0.01	<0.01	<0.01	<0.01
S1	<0.01	<0.01	<0.01	<0.01	<0.01
S2	<0.01	<0.01	<0.01	<0.01	<0.01
S3	<0.01	<0.01	<0.01	<0.01	<0.01

All values are less than detectability limits which are as follows:

	Endrin	Dieldrin	Chlordane	A. BHC	B. BHC
	0.01 ppm	0.01 ppm	0.01 ppm	0.01 ppm	0.01 ppm

Table 8b (Cont'd). Sediment chlorinated hydrocarbons, April 16, 1985 (mg/kg).

Station	Toxaphene	Heptachlor	Hept. Epoxide	Lindane	Aldrin
N1	<0.05	<0.05	<0.01	<0.01	<0.01
N2	<0.05	<0.05	<0.01	<0.01	<0.01
N3	<0.05	<0.05	<0.01	<0.01	<0.01
E1	<0.05	<0.05	<0.01	<0.01	<0.01
E2	<0.05	<0.05	<0.01	<0.01	<0.01
E3	<0.05	<0.05	<0.01	<0.01	<0.01
S1	<0.05	<0.05	<0.01	<0.01	<0.01
S2	<0.05	<0.05	<0.01	<0.01	<0.01
S3	<0.05	<0.05	<0.01	<0.01	<0.01

All values are less than detectability limits which are as follows:

	Toxaphene	Heptachlor	Hept. Epoxide	Lindane	Aldrin
	0.05 ppm	0.05 ppm	0.01 ppm	0.01 ppm	0.01 ppm

Table 8b (Cont'd). Sediment chlorinated hydrocarbons, April 16, 1985 (mg/kg).

Station	p,p'-DDD	o,p'-DDD	p,p'-DDE	p,p'-DDT	o,p'-DDT
N1	<0.005	<0.005	<0.005	<0.005	<0.005
N2	<0.005	<0.005	<0.005	<0.005	<0.005
N3	<0.005	<0.005	<0.005	<0.005	<0.005
E1	<0.005	<0.005	<0.005	<0.005	<0.005
E2	<0.005	<0.005	<0.005	<0.005	<0.005
E3	<0.005	<0.005	<0.005	<0.005	<0.005
S1	<0.005	<0.005	<0.005	<0.005	<0.005
S2	<0.005	<0.005	<0.005	<0.005	<0.005
S3	<0.005	<0.005	<0.005	<0.005	<0.005

All values are less than detectability limits which are as follows:

	0.005 ppm	0.005 ppm	0.005 ppm	0.005 ppm	0.005 p

Table 9a. Total organic carbon and heavy metal analyses in sediments, October, 1984.

Station	T.O.C. (%)	Mercury (ng/g)	Lead (ug/g)	Copper (ug/g)	Cadmium (ug/g)
N1	1.43	52	3.72	1.58	1.08
N2	0.87	52	2.80	0.87	0.73
N3	1.06	64	3.85	0.60	0.65
E1	0.67	42	2.58	1.33	0.63
E2	1.34	72	3.00	0.33	0.50
E3	1.21	48	2.67	1.55	0.35
S1	2.21	60	3.07	1.48	0.38
S2	0.75	52	2.33	1.47	0.37
S3	0.81	52	2.47	1.48	0.85

Table 9b. Total organic carbon and heavy metal analyses in sediments, April, 1985.

Station	T.O.C. (%)	Mercury (ng/g)	Lead (ug/g)	Copper (ug/g)	Cadmium (ug/g)
N1	1.84	74	3.83	1.85	0.19
N2	0.85	37	4.02	1.43	0.12
N3	0.93	49	4.27	1.39	0.15
E1	1.01	37	1.82	1.37	0.13
E2	1.53	85	2.97	1.57	0.14
E3	1.46	74	3.96	2.07	0.19
S1	1.35	37	4.05	1.47	0.17
S2	1.34	37	2.40	1.37	0.14
S3	2.09	37	1.99	1.33	0.15

Table 10a. Tissue high molecular weight hydrocarbons for trawl macrofauna, October 15, 1984 (ng/g). Aliphatic compounds. (Some stations missing because inadequate sample recovered.)

Trawl	Species	n-nonadecane	n-eicosane	n-heneicosane	n-docosane	n-tetracosane	n-pentacosane	n-hexacosane
		C-19	C-20	C-21	C-22	C-24	C-25	C-26
TS2	Larimus fasciatus	<0.50	<0.50	0.60	0.71	<0.50	<0.50	<0.50
TN1	Larimus fasciatus	1.76	0.68	1.73	<0.50	<0.50	<0.50	<0.50
TN2	Synodus faetens	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
TN3	Chloroscombrus chrysurus	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

Table 10a (Cont'd). Tissue high molecular weight hydrocarbons for trawl macrofauna, October 15, 1984. (ng/g) Aliphatic Compounds (Some stations missing because inadequate sample recovered.)

Trawl	Species	n-heptacosane	n-octacosane	n-nonacosane	n-triacontane	n-hentriacontane	n-dotriacontane
		C-27	C-28	C-29	C-30	C-31	C-32
TS2	Larimus fasciatus	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
TN1	Larimus fasciatus	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
TN2	Synodus faetens	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
TN3	Chlòroscombrus chrysurus	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

Table 10a (Cont'd). Tissue high molecular weight hydrocarbons for trawl macrofauna, October 15, 1984. (ng/g). Aromatic Compounds (Some stations missing because inadequate sample recovered.)

Trawl	Species	Phenanthrene	1-Phenyl Naphthalene	3-Methyl Phenanthrene	Fluoranthene	Pyrene	Chrysene	Benzo-a-Pyrene
TS2	*Larimus fasciatus*	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
TN1	*Larimus fasciatus*	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
TN2	*Synodus faetens*	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
TN3	*Chloroscombrus chrysurus*	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

Table 10b. Tissue high molecular weight hydrocarbons for trawl macrofauna, April 16, 1985 (ng/g). Aliphatic compounds. (Some stations missing because inadequate sample recovered.)

Trawl	Species	n-nonadecane	n-eicosane	n-heneicosane	n-docosane	n-tetracosane	n-pentacosane	n-hexacosane
		C-19	C-20	C-21	C-22	C-24	C-25	C-26
TN3	<u>Loliguncula brevis</u>	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
TS1	<u>Loliguncula brevis</u>	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

Table 10b (Cont'd). Tissue high molecular weight hydrocarbons for trawl macrofauna, April 16, 1985. (ng/g) Aliphatic Compounds (Some stations missing because inadequate sample recovered.)

Trawl	Species	n-heptacosane	n-octacosane	n-nonacosane	n-triacontane	n-hentriacontane	n-dotriacontane
		C-27	C-28	C-29	C-30	C-31	C-32
TN3	*Loliguncula brevis*	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
TS1	*Loliguncula brevis*	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

Table 10b (Cont'd). Tissue high molecular weight hydrocarbons for trawl macrofauna, April, 16, 1985. (ng/g). Aromatic Compounds (Some stations missing because inadequate sample recovered.)

Trawl	Species	Phenanthrene	1-Phenyl Naphthalene	3-Methyl Phenanthrene	Fluoranthene	Pyrene	Chrysene	Benzo-a-Pyrene
TN3	<u>Loliguncula brevis</u>	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
TS1	<u>Loliguncula brevis</u>	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

Table 11a. Tissue chlorinated hydrocarbons from trawl macrofauna, October 15, 1984 (mg/kg). (Some stations missing because inadequate sample recovered.)

Trawl	Species	Endrin	Dieldrin	Chlordane	BHC	Malathion
TS2	Larimus fasciatus	<0.02	<0.02	<0.10	<0.01	<0.10
TN1	Larimus fasciatus	<0.02	<0.02	<0.10	<0.01	<0.10
TN2	Synodus faetens	<0.02	<0.02	<0.10	<0.01	<0.10
TN3	Penaeus setiferus	<0.02	<0.02	<0.10	<0.01	<0.10
TN3	Chloroscombrus chrysurus	<0.02	<0.02	<0.10	<0.01	<0.10

Table 11a (Cont'd). Tissue chlorinated hydrocarbons from trawl macrofauna, October 15,1984 (mg/kg). (Some stations missing because inadequate sample recovered.)

Trawl	Species	Toxaphene	Heptachlor	Hept.Epoxide	Lindane	Aldrin
TS2	Larimus fasciatus	<0.10	<0.01	<0.02	<0.01	<0.01
TN1	Larimus fasciatus	<0.10	<0.01	<0.02	<0.01	<0.01
TN2	Synodus faetens	<0.10	<0.01	<0.02	<0.01	<0.01
TN3	Penaeus setiferus	<0.10	<0.01	<0.02	<0.01	<0.01
TN3	Chloroscombrus chrysurus	<0.10	<0.01	<0.02	<0.01	<0.01

Table 11a (Cont'd). Tissue chlorinated hydrocarbons from trawl macrofauna, October 15,1984 (mg/kg). (Some stations missing because inadequate sample recovered.)

Trawl	Species	DDD	DDE	DDT	Diazinon	Methoxychlor
TS2	Larimus fasciatus	<0.01	<0.01	<0.01	<0.10	<0.05
TN1	Larimus fasciatus	<0.01	<0.01	<0.01	<0.10	<0.05
TN2	Synodus faetens	<0.01	<0.01	<0.01	<0.10	<0.05
TN3	Penaeus setiferus	<0.01	<0.01	<0.01	<0.10	<0.05
TN3	Chloroscombrus chrysurus	<0.01	<0.01	<0.01	<0.10	<0.05

Table 11b. Tissue chlorinated hydrocarbons from trawl macrofauna, April 16, 1985 (mg/kg). (Some stations missing because inadequate sample recovered.)

Trawl	Species	Endrin	Dieldrin	Chlordane	BHC	Malathion
TN1	*Loliguncula brevis*	<0.02	<0.02	<0.10	<0.01	<0.10
TN1	*Prionotus evolans*	<0.02	<0.02	<0.10	<0.01	<0.10
TN2	*Loliguncula brevis*	<0.02	<0.02	<0.10	<0.01	<0.10
TN2	*Prionotus evolans*	<0.02	<0.02	<0.10	<0.01	<0.10
TN3	*Thyone* sp.	<0.02	<0.02	<0.10	<0.01	<0.10
TS1	*Loliguncula brevis*	<0.02	<0.02	<0.10	<0.01	<0.10
TS2	*Loliguncula brevis*	<0.02	<0.02	<0.10	<0.01	<0.10
TS2	*Prionotus evolans*	<0.02	<0.02	<0.10	<0.01	<0.10

Table 11b (Cont'd). Tissue chlorinated hydrocarbons from trawl macrofauna, April 16, 1985 (mg/kg). (Some stations missing because inadequate sample recovered.)

Trawl	Species	Toxaphene	Heptachlor	Hept.Epoxide	Lindane	Aldrin
TN1	Loliguncula brevis	<0.10	<0.01	<0.02	<0.01	<0.01
TN1	Prionotus evolans	<0.10	<0.01	<0.02	<0.01	<0.01
TN2	Loliguncula brevis	<0.10	<0.01	<0.02	<0.01	<0.01
TN2	Prionotus evolans	<0.10	<0.01	<0.02	<0.01	<0.01
TN3	Thyone sp.	<0.10	<0.01	<0.02	<0.01	<0.01
TS1	Loliguncula brevis	<0.10	<0.01	<0.02	<0.01	<0.01
TS2	Loliguncula brevis	<0.10	<0.01	<0.02	<0.01	<0.01
TS2	Prionotus evolans	<0.10	<0.01	<0.02	<0.01	<0.01

Table 11b (Cont'd). Tissue chlorinated hydrocarbons from trawl macrofauna, April 16, 1985 (mg/kg). (Some stations missing because inadequate sample recovered.)

Trawl	Species	DDD	DDE	DDT	Diazanon	Methoxychlor
TN1	*Lolliguncula brevis*	<0.01	<0.01	<0.01	<0.10	<0.05
TN1	*Prionotus evolans*	<0.01	<0.01	<0.01	<0.10	<0.05
TN2	*Lolliguncula brevis*	<0.01	<0.01	<0.01	<0.10	<0.05
TN2	*Prionotus evolans*	<0.01	<0.01	<0.01	<0.10	<0.05
TN3	*Thyone* sp.	<0.01	<0.01	<0.01	<0.10	<0.05
TS1	*Lolliguncula brevis*	<0.01	<0.01	<0.01	<0.10	<0.05
TS2	*Lolliguncula brevis*	<0.01	<0.01	<0.01	<0.10	<0.05
TS2	*Prionotus evolans*	<0.01	<0.01	<0.01	<0.10	<0.05

Table 12a. Trawl Heavy Metal Analyses, Macrofauna October, 1984

Trawl	Species	Mercury (ng/g)	Lead (ug/g)	Copper (ug/g)	Cadmium (ug/g)
TS3	Synodus faetens	94	1.17	0.84	<0.01
	Portunus sp.	38	1.49	165.00	0.33
TS2	Leiostomus xanthurus	248	0.86	4.03	0.13
	no invert				
TS1	Larimus fasciatus	52	0.86	2.11	0.33
	no invert				
TN1	Chloroscombrus chrysurus	64	1.09	<0.01	<0.01
	Callinectes sapidus	34	1.49	99.70	0.59
TN2	Anchoa hepsetus	90	1.09	1.62	0.03
	no invert				
TN3	Anchoa hepsetus	102	1.16	2.24	0.07
	no invert				

All analyses are in weight to weight ratios either percent, parts per million (ug/g) or parts per billion (ng/g). The sediment and macrofauna are relative to their dry weights. Detection limits for all the metals are 10 ng/g or 0.01 ug/g.

Table 12b. Trawl Heavy Metal Analyses, Macrofauna April, 1985

Trawl	Species	Mercury (ng/g)	Lead (ug/g)	Copper (ug/g)	Cadmium (ug/g)
TS3	no vert				
	no invert				
TS2	<u>Ancyclopsetta quadrocellata</u>	701	1.94	1.76	0.41
	<u>Loliguncula brevis</u>	61	19.90	5.30	1.14
TS1	<u>Prionotus evolans</u>	157	4.25	3.31	0.52
	<u>Thyone</u> sp.	109	10.99	2.97	0.96
TN1	no vert				
	<u>Luwidia</u> sp.	2.4	16.78	4.76	1.20
TN2	<u>Anchoa hepsetus</u>	242	0.48	1.86	0.23
	<u>Libinica dubia</u>	24	4.34	11.75	1.77
TN3	<u>Prionotus evolans</u>	79	4.85	3.04	0.49
	<u>Loliguncula brevis</u>	91	2.42	14.19	1.19

All analyses are in weight to weight ratios either percent, parts per million (ug/g) or parts per billion (ng/g). The sediment and macrofauna are relative to their dry weights. Detection limits for all the metals are 10 ng/g or 0.01 ug/g.

Table 13a. Species distribution by sampling station for trawl macrofauna, October, 1984 (no. per 1000 m^2).

OCT 1984 STATION	TN1	TS1	TN2	TS2	TN3	TS3
FIELD WEIGHTS(kg)	1.8	0.1	1.1	4.2	5.7	1.0
AREA COVERED(1000m^2)	3.002	3.447	2.899	2.613	3.258	2.115
CNIDARIA						
Aurelia aurita	0.00	0.00	0.00	0.38	0.31	0.00
Chiropsalmus quadrimanus	1.00	0.00	1.72	5.36	9.52	1.42
Stomalophus meleagrus	0.00	0.00	0.00	0.38	0.00	0.47
Tamoya haplonema	6.66	0.00	2.41	12.25	12.28	3.78
MOLLUSCA						
Loliguncula brevis	21.65	0.00	1.38	1.15	0.00	1.42
ARTHROPODA						
Callinectes sapidus	0.33	0.00	0.00	0.00	0.00	0.00
Penaeus setiferus	0.00	0.00	0.00	0.38	0.31	0.00
Portunus sayi	0.00	0.00	0.00	0.00	0.61	0.47
Trachypenaeus constrictus	0.00	0.00	0.00	0.00	0.31	0.00
CHONDRICHTHYES						
Raja eglanteria	0.00	0.00	0.00	0.38	0.00	0.00
OSTEICHTHYES						
Anchoa hepsetus	0.33	0.00	2.07	0.00	4.91	0.00
Anchoa mitchelli	104.93	0.29	0.69	21.81	64.46	0.00
Chloroscombrus chrysurus	3.33	0.00	1.03	9.57	4.60	2.84
Citharichthys macrops	0.33	0.00	0.00	0.00	0.00	0.00
Eucinostomus argenteus	0.00	0.00	0.00	0.00	0.00	0.47
Hippocampus erectus	0.67	0.00	0.00	0.00	0.00	0.00
Larimus fasciatus	0.33	0.29	0.00	4.59	0.00	0.00
Leiostomus xanthurus	0.00	0.00	0.00	0.00	0.31	0.00
Menticirrhus americanus	0.00	0.00	0.34	0.00	0.00	0.00
Micropogon undulatus	0.00	0.00	0.00	0.38	0.00	0.00
Monacanthus hispidus	0.00	0.00	0.00	0.38	0.00	0.00
Peprilus triancanthus	0.00	0.00	0.34	0.00	0.00	0.00
Prionotus evolans	0.00	0.00	0.34	0.00	0.00	0.00
Symphurus plagiosa	0.00	0.00	0.00	0.38	0.00	0.00
Synodus foetens	0.00	0.00	0.34	0.38	0.00	0.47

Table 13b. Species distribution by sampling station for trawl macrofauna, April, 1985 (No. per 1000 m^2).

APR 1985 STATION	TN1	TS1	TN2	TS2	TN3	TS3
FIELD WEIGHTS(kg)	2	8.5	6.4	0.6	2.9	2.3
AREA COVERED(1000m^2)	2.835	2.835	2.78	2.841	2.502	2.5
CNIDARIA						
Stomalophus meleagrus	0.35	0.00	1.08	0.00	0.00	0.00
CTNOPHORA						
Mnemiopsis (leidyi)	12.70	123.81	38.49	1.06	20.78	17.60
MOLLUSCA						
Loliguncula brevis	0.00	2.47	1.08	0.70	4.00	0.00
Polinices duplicatus	0.00	0.00	0.00	0.00	0.40	0.00
ARTHROPODA						
Libinia dubia	0.00	0.35	0.72	0.00	0.00	0.00
Penaeus setiferus	0.00	0.00	0.00	0.35	0.40	0.00
Portunus (sayi)	0.00	0.00	0.00	1.41	0.40	0.00
ECHINODERMATA						
Astropectin sp.	0.00	0.00	0.00	0.35	0.00	0.00
Luidia clathrata	0.35	0.00	0.00	0.00	0.00	0.00
Thyone (briareus)	0.35	0.35	0.00	0.00	0.00	0.00
OSTEICHTHYES						
Anchoa mitchelli	0.00	0.35	1.08	0.70	0.00	0.00
Ancyclopsetta quadrocellata	0.00	0.00	0.00	1.41	0.40	0.00
Centropristis (striata)	0.00	0.00	0.00	0.00	0.40	0.00
Prionotus evolans	0.00	0.35	0.36	0.35	1.60	0.00
Scophthalmus aquosus	0.00	0.00	0.36	0.00	0.00	0.00

Table 14a. Three-level ANOVA for trawl macrofauna data, October, 1984, showing F-ratios by species and associated probabilities. Significant treatment effect indicated by (*).

	F Ratio	Probability	
CNIDARIA			
Aurelia aurita	.5000	.3505	
Chiropsalmus quadrimanus	.8249	.4818	
Stomalophus meleagrus	.5000	.3505	
Tamoya haplonema	.2992	.2387	
MOLLUSCA			
Loliguncula brevis	.8529	.4910	
ARTHROPODA			
Callinectes sapidus	1.0000	.5352	
Penaeus setiferus	.5000	.3505	
Portunus sayi	9.0000	.9460	*
Trachypenaeus constrictus	1.0000	.5352	
CHONDRICHTHYES			
Raja eglanteria	1.0000	.5352	
OSTEICHTHYES			
Anchoa hepsetus	.5973	.3951	
Anchoa mitchelli	.3434	.2660	
Chloroscombrus chrysurus	.3714	.2824	
Citharichthys macrops	1.0000	.5352	
Eucinostomus argenteus	1.0000	.5352	
Hippocampus erectus	1.0000	.5352	
Larimus fasciatus	.8611	.4936	
Leiostomus xanthurus	1.0000	.5352	
Menticirrhus americanus	1.0000	.5352	
Micropogon undulatus	1.0000	.5352	
Monacanthus hispidus	1.0000	.5352	
Peprilus triancanthus	1.0000	.5352	
Prionotus evolans	1.0000	.5352	
Symphurus plagiosa	1.0000	.5352	
Synodus foetens	3.0000	.8075	

Table 14b. Three-level ANOVA for trawl macrofauna data, April, 1985, showing F-ratios by species and associated probabilities. Significant treatment effect indicated by (*).

	F Ratio	Probability	
CNIDARIA			
Stomalophus meleagrus	.7000	.4370	
CTNOPHORA			
Mnemiopsis (leidyi)	.7339	.4498	
MOLLUSCA			
Loliguncula brevis	.1267	.1145	
Polinices duplicatus	1.0000	.5352	
ARTHROPODA			
Libinia dubia	.6000	.3963	
Penaeus setiferus	.5000	.3505	
Portunus (sayi)	.7647	.4610	
ECHINODERMATA			
Astropectin sp.	1.0000	.5352	
Luidia clathrata	1.0000	.5352	
Thyone (briareus)	INF	1.0000	*
OSTEICHTHYES			
Anchoa mitchelli	10.5000	.9558	*
Ancyclopsetta quadrocellata	.7647	.4610	
Centropristis (striata)	1.0000	.5352	
Prionotus evolans	.4118	.3050	
Scophthalmus aquosus	1.0000	.5352	

Table 15a. Correlation Matrix for Trawl Macrofauna Stations October 16, 1984

Station	TN1	TS1	TN2	TS2	TN3	TS3
TN1	1.000					
TS1	0.669	1.000				
TN2	0.176	-0.035	1.000			
TS2	0.807	0.637	0.458	1.000		
TN3	0.957	0.655	0.283	0.887	1.000	
TS3	0.007	-0.142	0.710	0.479	0.097	1.000

Table 16a. Principal Component Analysis factor table for Trawl macrofauna data for October, 1984.

A. Significant* eigenvalues with percent of variance accounted for by each factor, and cummulative percents.

B. Final varimax-rotated factor matrix used to construct PCA plot for stations (Figure IIIa).

*(Eigenvalues $\geq$ 1, or a minimum of 2 factors.)

A. Factor	Eigenvalue	Percent of Variance	Cummulative Percent
1	3.47287	57.9	57.9
2	1.77092	29.5	87.4

B. Station	Factor 1	Factor 2
TN1	.95125	.05351
TS1	.84099	-.18934
TN2	.12884	.89714
TS2	.85496	.47081
TN3	.95329	.16705
TS3	-.01718	.93908

Table 15b. Correlation Matrix for Trawl Macrofauna Stations April 12, 1985

Station	TN1	TS1	TN2	TS2	TN3	TS3
TN1	1.000					
TS1	0.999	1.000				
TN2	0.998	0.999	1.000			
TS2	0.321	0.341	0.336	1.000		
TN3	0.977	0.984	0.983	0.377	1.000	
TS3	0.999	0.999	0.999	0.338	0.981	1.000

Table 16b. Principal Component Analysis factor table for Trawl macrofauna data for April, 1985.

A. Significant *eigenvalues with percent of variance accounted for by each factor, and cummulative percents.

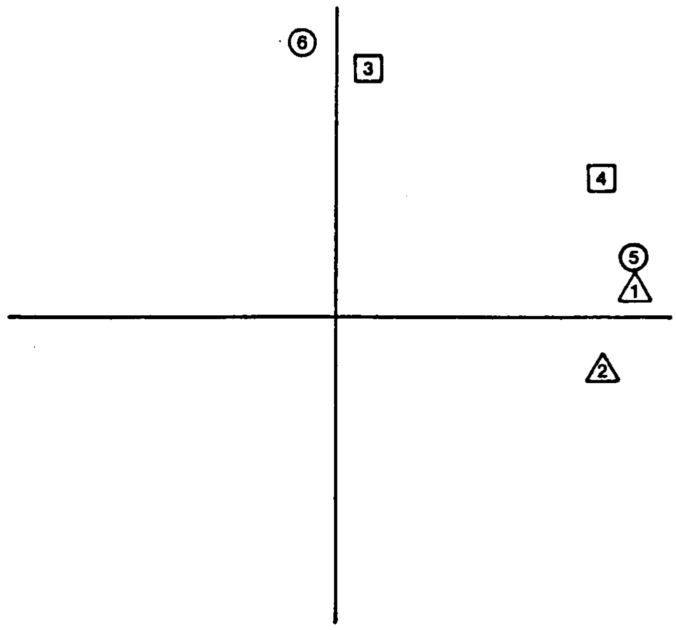
B. Final varimax-rotated factor matrix used to construct PCA plot for stations (Figure IIIb).

*(Eigenvalues ≥ 1, or a minimum of 2 factors.)

A. Factor	Eigenvalue	Percent of Variance	Cummulative Percent
1	5.11031	85.2	85.2
2	.85968	14.3	99.5

B. Station	Factor 1	Factor 2
TN1	.98673	.15102
TS1	.98476	.17184
TN2	.98511	.16698
TS2	.17389	.98473
TN3	.96551	.21399
TS3	.98462	.16895

HORIZONTAL FACTOR 1 VERTICAL FACTOR 2



SYMBOL	STATION	COORDINATES 1	COORDINATES 2
1	TN1	.951	.054
2	TS1	.841	-.189
3	TN2	.129	.897
4	TS2	.855	.417
5	TN3	.953	.167
6	TS3	-.017	.939

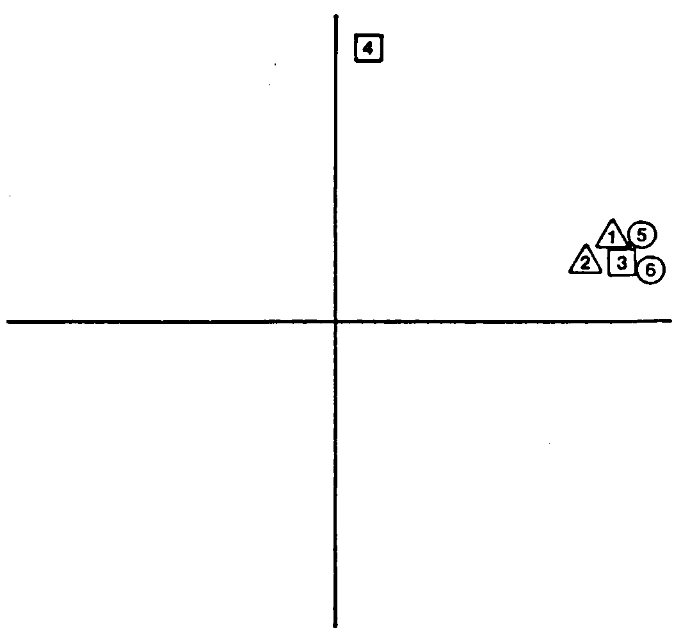
△ = ON-SITE

□ = ADJACENT

○ = OFF-SITE

Figure IIIa. PCA plot for October, 1984 trawl macrofauna stations. Shapes associated with symbols indicate location relative to the dredge spoil disposal site.

HORIZONTAL FACTOR 1 VERTICAL FACTOR 2



SYMBOL	STATION	COORDINATES 1	COORDINATES 2
1	TN1	.987	.151
2	TS1	.985	.172
3	TN2	.985	.167
4	TS2	.174	.985
5	TN3	.966	.214
6	TS3	.985	.169

△ = ON-SITE

□ = ADJACENT

○ = OFF-SITE

Figure IIIb. PCA plot for April, 1985 trawl macrofauna stations. Shapes and symbols as in Fig. IIIa.

Table 17a. Agglomeration schedule for HCA of trawl macrofauna stations for October, 1984. Station numbers are in dendrogram plot (Figure IVa), with clusters denoted by the lowest numbered station contained therein.

Stage	Stations Combined: Cluster 1	Stations Combined: Cluster 2	Coefficient
1	3	6	21.000000
2	2	3	28.500000
3	2	4	140.000000
4	1	5	249.000000
5	1	2	346.000000

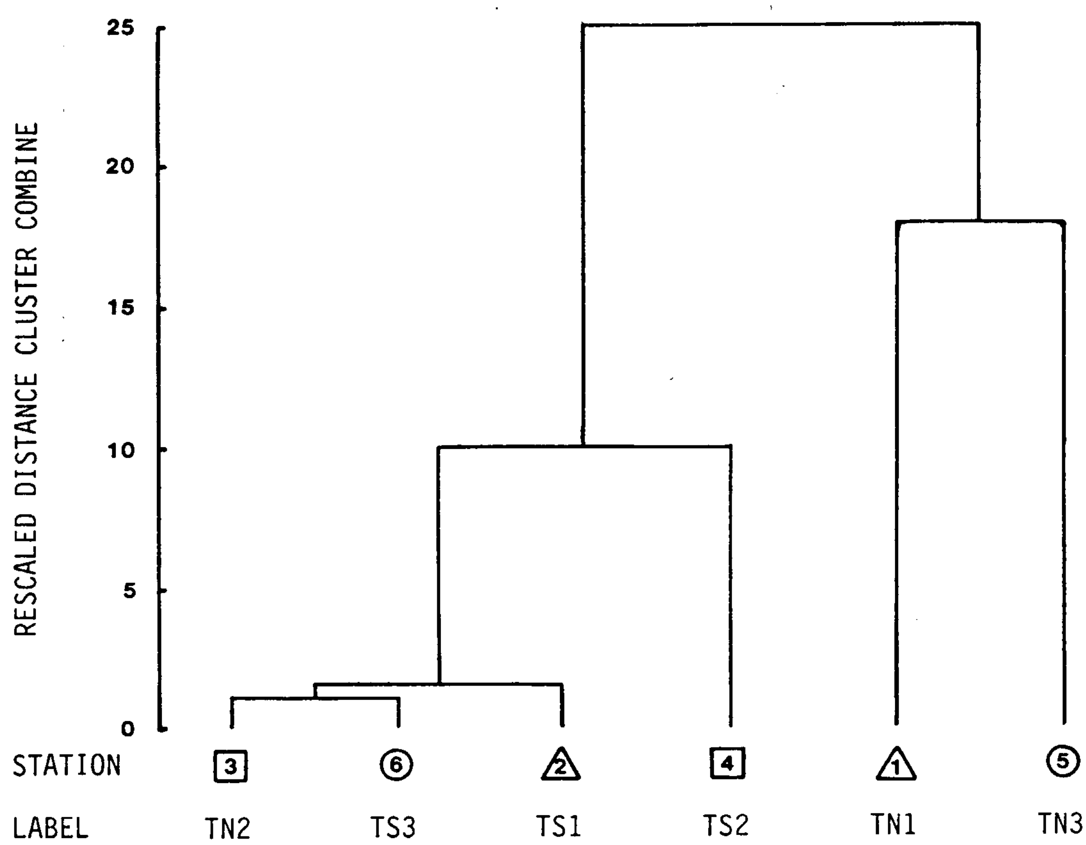


Figure IVa. HCA dendrogram plot of trawl macrofauna stations based on coefficients in Table 17a. Symbols as in Fig. III.

Table 17b. Agglomeration schedule for HCA of trawl macrofauna stations for April, 1985. Station numbers are in dendrogram plot (Figure IVb), with clusters denoted by the lowest numbered station contained therein.

	Stations Combined		
Stage	Cluster 1	Cluster 2	Coefficient
1	1	6	13.000000
2	1	5	33.500000
3	1	4	60.333332
4	1	3	91.250000
5	1	2	317.200012

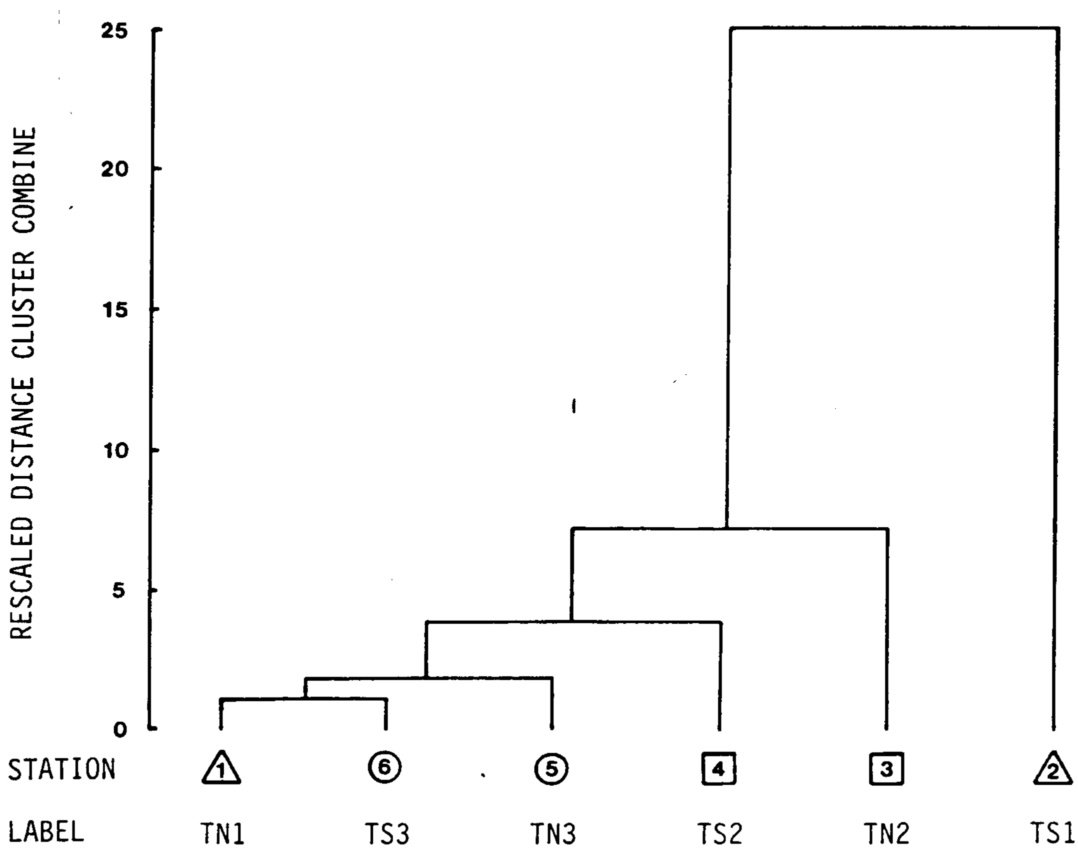


Figure IVb. HCA dendrogram plot of trawl macrofauna stations based on coefficients in Table 17b. Symbols as in Fig. III.

Table 18a. Species distribution by station for October, 1984, box core macroinfauna. Data in mean numbers per square meter.

Stations	N1	E1	S1	N2	E2	S2	N3	E3	S3
NEMERTINA									
Hoplonemertea sp.	0.00	0.00	0.00	0.00	11.43	0.00	0.00	11.43	0.00
Cerebratulus sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.86	0.00
MOLLUSCA									
Ervilia concentrica	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.43
Eulima bifasciata	11.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kellia suborbicularis	11.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Natica pusilla	0.00	0.00	0.00	0.00	11.43	0.00	0.00	22.86	0.00
Olivella minuta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.43	0.00
Parvilucina multilineata	11.43	0.00	0.00	0.00	11.43	0.00	0.00	0.00	57.14
SIPUNCULIDA									
Golfingiidae sp.	0.00	0.00	57.14	0.00	0.00	11.43	22.86	11.43	0.00
Aspidosiphonidae sp.	0.00	0.00	0.00	0.00	11.43	0.00	0.00	0.00	0.00
ANNELIDA									
Aglaophamus circinata	0.00	0.00	11.43	11.43	0.00	0.00	0.00	0.00	11.43
Aglaophamus verrilli	11.43	0.00	0.00	0.00	11.43	0.00	0.00	0.00	0.00
Anaitides groenlandica	0.00	0.00	0.00	0.00	11.43	0.00	0.00	0.00	0.00
Armandia agilis	0.00	0.00	0.00	0.00	11.43	0.00	0.00	11.43	45.71
Ceratonereis irritabilis	0.00	0.00	11.43	0.00	0.00	0.00	45.71	0.00	0.00
Chaetopteridae sp.	0.00	0.00	0.00	0.00	0.00	0.00	11.43	0.00	0.00
Glycera papillosa	0.00	22.86	22.86	0.00	0.00	0.00	0.00	0.00	0.00
Glycera robusta	0.00	0.00	11.43	0.00	0.00	0.00	0.00	0.00	0.00
Glyceridae sp.	0.00	0.00	0.00	0.00	0.00	11.43	11.43	0.00	0.00
Goniada littorea	22.86	0.00	0.00	11.43	34.29	0.00	0.00	11.43	11.43
Magelona papillicornis	11.43	0.00	22.86	11.43	34.29	11.43	0.00	0.00	0.00
Marphysa sp.	0.00	0.00	11.43	0.00	0.00	0.00	0.00	0.00	0.00
Prionospio dayi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.43
Prionospio pygmaea	0.00	0.00	0.00	0.00	0.00	0.00	11.43	0.00	0.00
Leitoscoloplos fragilis	0.00	0.00	0.00	0.00	137.14	0.00	0.00	0.00	0.00

Table 18a. (Cont'd)

Stations	N1	E1	S1	N2	E2	S2	N3	E3	S3
Polychaete sp. UK	0.00	0.00	0.00	0.00	0.00	11.43	11.43	11.43	0.00
Sthenelais limicola	11.43	0.00	0.00	11.43	0.00	0.00	0.00	0.00	0.00
Scionopsis sp.	0.00	11.43	205.71	0.00	11.43	0.00	11.43	0.00	0.00
Tharyx cf. annulosus	0.00	0.00	0.00	0.00	0.00	0.00	34.29	0.00	0.00
ARTHROPODA									
Acanthohaustorius pansus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.43
Albunea paretii	11.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Apanthura magnifica	0.00	0.00	0.00	11.43	0.00	0.00	0.00	0.00	0.00
Balanus sp.	217.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bowmaniella dissimilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.43
Ebalia cariosa	0.00	0.00	0.00	11.43	0.00	0.00	0.00	0.00	0.00
Hepatus pudibundus	0.00	0.00	0.00	0.00	0.00	0.00	11.43	0.00	0.00
Oxyurostylis smithi	11.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pagurus brevidactylus	0.00	34.29	0.00	11.43	0.00	0.00	11.43	0.00	0.00
Pinnixia cariosa	0.00	0.00	22.86	0.00	0.00	0.00	0.00	0.00	0.00
Pinnixia sayana	0.00	0.00	0.00	0.00	0.00	0.00	11.43	0.00	0.00
ECHINODERMATA									
Amphiodia pulchella	11.43	0.00	0.00	11.43	22.86	0.00	57.14	0.00	0.00
CHORDATA									
Branchiostoma sp.	0.00	0.00	0.00	11.43	0.00	22.86	0.00	0.00	0.00
Ophidiidae sp.	0.00	0.00	11.43	11.43	0.00	0.00	0.00	11.43	0.00

Table 18b. Species distribution by station for April, 1985, box core macroinfauna. Data in mean numbers per square meter.

Station	N1	E1	S1	N2	E2	S2	N3	E3	S3
CNIDARIA									
Anemone sp.	22.86	0.00	0.00	0.00	22.86	11.43	0.00	0.00	11.43
NEMERTINEA									
Hoplonemertea sp.	0.00	0.00	0.00	0.00	34.29	0.00	0.00	0.00	0.00
Cerebratulus sp.	11.43	11.43	0.00	0.00	11.43	0.00	42.86	11.43	11.43
Nemertea sp. AA	11.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MOLLUSCA									
Strigilla mirabilis	0.00	0.00	0.00	0.00	0.00	45.71	0.00	0.00	0.00
Ensis (directus)	0.00	0.00	0.00	0.00	11.43	0.00	0.00	0.00	11.43
Ervilia concentrica	0.00	0.00	0.00	0.00	11.43	11.43	14.29	0.00	11.43
Eulima bifasciata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.43
Oliva cf. *sayana* juv.	11.43	0.00	11.43	0.00	22.86	0.00	22.86	11.43	0.00
Olivella minuta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.86
Diplodonta punctata	0.00	0.00	11.43	0.00	0.00	0.00	0.00	0.00	0.00
Parvilucina multilineata	0.00	0.00	0.00	0.00	11.43	0.00	0.00	0.00	0.00
Polinices duplicatus	0.00	0.00	0.00	0.00	11.43	0.00	0.00	0.00	0.00
Tellina agilis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.43
Terebra dislocata	11.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dentalium texasianum	0.00	0.00	0.00	0.00	0.00	0.00	14.29	0.00	0.00
SIPUNCULIDA									
Golfingiidae sp.	22.86	0.00	11.43	0.00	0.00	0.00	14.29	0.00	0.00
ANNELIDA									
Aglaophamus circinata	0.00	0.00	0.00	0.00	11.43	0.00	0.00	0.00	0.00
Lumbrineris sp.	11.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aglaophamus vervilli	22.86	0.00	0.00	11.43	11.43	0.00	28.57	11.43	0.00
Sabellides sp.	354.29	0.00	400.00	0.00	0.00	0.00	0.00	0.00	445.71
Anaitides groenlandica	45.71	0.00	0.00	0.00	0.00	0.00	28.57	0.00	0.00
Armandia agilis	11.43	0.00	11.43	0.00	11.43	0.00	0.00	11.43	11.43

Table 18b. (Cont'd)

Station	N1	E1	S1	N2	E2	S2	N3	E3	S3
Cistenides gouldii	80.00	0.00	0.00	0.00	0.00	0.00	14.29	0.00	0.00
Glycera papillosa	0.00	0.00	11.43	22.86	0.00	11.43	0.00	0.00	0.00
Glyceridae sp.	34.29	0.00	0.00	11.43	0.00	0.00	0.00	0.00	0.00
Goniada littorea	11.43	0.00	0.00	0.00	11.43	11.43	0.00	11.43	11.43
Magelona papillicornis	80.00	0.00	11.43	0.00	22.86	0.00	14.29	0.00	11.43
Nephtys sp.	22.86	0.00	0.00	0.00	171.43	0.00	14.29	0.00	0.00
Owenia fusiformis	582.86	34.29	160.00	0.00	34.29	57.14	100.00	0.00	0.00
Phyllodoce arenae	34.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Prionospio dayi	11.43	0.00	0.00	0.00	125.71	11.43	0.00	0.00	11.43
Prionospio pygmaea	34.29	0.00	0.00	0.00	22.86	0.00	14.29	0.00	0.00
Leitoscoloplos fragilis	11.43	0.00	0.00	0.00	0.00	0.00	14.29	0.00	0.00
Onuphis texana	0.00	0.00	11.43	11.43	0.00	0.00	0.00	0.00	11.43
Polychaete sp. JJ	0.00	0.00	0.00	0.00	11.43	0.00	0.00	0.00	11.43
Sigambra bassi	0.00	0.00	0.00	11.43	0.00	0.00	0.00	0.00	0.00
Myriowenia sp.	0.00	0.00	0.00	11.43	0.00	0.00	0.00	0.00	0.00
Polychaete sp. PP	0.00	0.00	0.00	11.43	0.00	0.00	0.00	0.00	0.00
Sabellaria cf. floridensis	0.00	0.00	22.86	0.00	0.00	0.00	0.00	0.00	0.00
Polychaete sp. UK	11.43	0.00	0.00	0.00	11.43	0.00	14.29	0.00	0.00
Sabellaridae sp.	68.57	0.00	68.57	0.00	91.43	0.00	0.00	11.43	0.00
Spionidae sp.	34.29	0.00	0.00	0.00	0.00	22.86	0.00	0.00	0.00
Spiophanes bombyx	22.86	0.00	0.00	0.00	45.71	0.00	14.29	0.00	22.86
Prionospio cirrifera	34.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ARTHROPODA									
Albunea paretii	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.43
Erichthonius sp.	57.14	0.00	11.43	0.00	0.00	0.00	0.00	0.00	0.00
Haustorius sp.	11.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iodleidae sp. CC	125.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Iodleidae sp DD	228.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	57.14
Ischyrocerus sp.	22.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Amphipod sp. FF	34.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dogielinotus sp.	0.00	0.00	0.00	22.86	11.43	0.00	0.00	0.00	0.00
Wandelia sp.	0.00	0.00	0.00	22.86	11.43	0.00	0.00	0.00	0.00
Portunidae sp. juv.	0.00	11.43	0.00	0.00	0.00	0.00	0.00	0.00	34.29
Edotea montosa	11.43	0.00	0.00	0.00	11.43	0.00	0.00	0.00	11.43

Table 18b. (Cont'd)

Station	N1	E1	S1	N2	E2	S2	N3	E3	S3
Oxyurostylis smithi	1200.00	0.00	0.00	11.43	320.00	0.00	42.86	0.00	11.43
Shrimp sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.43
ECHINODERMATA									
Amphiodia pulchella	22.86	11.43	0.00	0.00	11.43	0.00	0.00	0.00	0.00
Encope emarginata	0.00	11.43	0.00	0.00	0.00	0.00	0.00	0.00	34.29
Thyone sp.	11.43	0.00	0.00	0.00	11.43	0.00	0.00	11.43	0.00
CHORDATA									
Ophidiidae sp.	0.00	0.00	0.00	0.00	0.00	11.43	0.00	0.00	0.00

Table 19a. Three-level oneway and nested ANOVAs for boxcore macroinfauna data, October, 1984, showing F-ratios by species and associated probabilities. Significant treatment effect indicated by (*).

	Oneway		Nested	
	F Ratio	Probability	F Ratio	Probability
NEMERTINEA				
Hoplonemertea sp.	0.526	0.595	1.032	0.445
Cerebratulus sp.	2.286	0.115	0.706	0.734
MOLLUSCA				
Ervilia concentrica	1.000	0.377	1.000	0.471
Eulima bifasciata	1.000	0.377	1.000	0.471
Kellia suborbicularis	1.000	0.377	1.000	0.471
Natica pusilla	0.625	0.540	1.026	0.450
Olivella minuta	1.675	0.200	0.619	0.810
Parvilucina multilineata	1.096	0.344	0.580	0.842
SIPUNCULIDA				
Golfingiidae sp.	1.000	0.377	1.000	0.471
Aspidosiphonidae sp.	0.000	1.000	1.067	0.418
ANNELIDA				
Aglaophamus circinata	0.488	0.618	1.032	0.445
Aglaophamus verrilli	1.000	0.377	1.000	0.471
Anaitides groenlandica	1.918	0.160	0.677	0.761
Armandia agilis	3.514	0.039*	0.364	0.967
Ceratonereis irritabilis	1.000	0.377	1.000	0.471
Chaetopteridae sp.	2.105	0.135	0.706	0.734
Glycera papillosa	1.000	0.377	1.000	0.471
Glycera robusta	0.488	0.618	1.032	0.445
Glyceridae sp.	0.440	0.647	1.484	0.181
Goniada littorea	1.743	0.188	1.089	0.401
Magelona papillicornis	1.000	0.377	1.000	0.471
Marphysa sp.	1.000	0.377	1.000	0.471
Prionospio dayi	1.000	0.377	1.000	0.471
Prionospio pygmaea	1.000	0.377	1.000	0.471
Leitoscoloplos fragilis	1.000	0.377	1.000	0.471
Polychaete sp. UK	0.526	0.595	1.032	0.445
Stenelais limicola	2.000	0.149	0.119	1.000
Scionopsis	7.448	0.002*	0.762	0.683
Tharyx cf. annulosus	1.000	0.377	1.000	0.471
ARTHROPODA				
Acanthohaustorius pansus	1.000	0.377	1.000	0.471
Albunea paretii	1.000	0.377	1.000	0.471
Apanthura magnifica	1.126	0.334	0.966	0.500
Balanus sp.	1.000	0.377	1.000	0.471
Bowmaniella dissimilis	1.000	0.377	1.000	0.471
Ebalia cariosa	1.000	0.377	1.000	0.471
Hepatus pudibundus	1.000	0.377	1.000	0.471
Oxyurostylis smithi	0.357	0.702	1.041	0.438

	Oneway		Nested	
	F Ratio	Probability	F Ratio	Probability
Pagurus brevidactylus	1.000	0.377	1.000	0.471
Pinnixia cariosa	1.000	0.377	1.000	0.471
Pinnixia sayana	2.162	0.128	0.272	0.990
ECHINODERMATA				
Amphiodia pulchella	2.059	0.141	0.597	0.828
CHORDATA				
Branchiostoma sp.	0.488	0.618	1.032	0.445
Ophidiidae sp.	1.000	0.377	1.000	0.471

Table 19b. Three-level oneway and nested ANOVAs for boxcore macroinfauna data, April, 1985, showing F-ratios by species and associated probabilities. Significant treatment effect indicated by (*).

	Oneway		Nested	
	F Ratio	Probability	F Ratio	Probability
CNIDARIA				
Anemone sp.	0.396	0.675	1.333	0.249
NEMERTINEA				
Hoplonemartea	1.909	0.161	0.762	0.683
Cerebratulus sp.	1.517	0.231	0.811	0.638
Nemertea sp. AA	1.000	0.377	1.000	0.471
MOLLUSCA				
Strigilla mirabilis	1.000	0.377	1.000	0.471
Ensis (directus)	1.000	0.377	1.000	0.471
Ervilia concentrica	1.077	0.350	0.750	0.694
Eulima bifasciata	1.000	0.377	1.000	0.471
Oliva sayana juv.	0.359	0.701	1.899	0.073
Olivella minuta	1.000	0.377	1.000	0.471
Diplodonta punctata	1.000	0.377	1.000	0.471
Parvilucina multilineata	1.000	0.377	1.000	0.471
Polinices duplicatus	1.000	0.377	1.000	0.471
Tellina agilis	1.000	0.377	1.000	0.471
Terebra dislocata	1.000	0.377	1.000	0.471
Dentalium texasianum	1.000	0.377	1.000	0.471
SIPUNCULIDA				
Golfingiidae sp.	1.225	0.304	2.388	0.025*
ANNELIDA				
Aglaophamus circinata	1.000	0.377	1.000	0.471
Lumbriceris sp.	1.000	0.377	1.000	0.471
Aglaophamus vervilli	0.159	0.853	1.231	0.306
Sabellides sp.	0.949	0.395	2.173	0.040*
Anaitides groenlandica	0.672	0.516	0.993	0.477
Armandia agilis	0.212	0.810	0.842	0.609
Cistenides gouldii	2.150	0.129	0.643	0.790
Glycera papillosa	1.960	0.154	1.538	0.161
Glyceridae sp.	0.700	0.502	1.019	0.455
Goniada littorea	0.212	0.810	0.842	0.609
Magelona papillicornis	1.750	0.186	1.048	0.433
Nephtys sp.	2.036	0.143	0.593	0.831
Owenia fusiformis	5.031	0.011*	0.522	0.884
Phyllodoce arenae	1.909	0.161	0.762	0.683
Prionospio dayi	1.397	0.259	0.823	0.627
Prionospio pygmaea	0.253	0.778	1.005	0.466
Leitoscoloplos fragilis	0.500	0.610	1.032	0.445

Table 19b. (Cont'd)

	Oneway		Nested	
	F Ratio	Probability	F Ratio	Probability
Onuphis texana	0.000	1.000	1.067	0.418
Polychaete sp. JJ	0.500	0.610	1.032	0.445
Sigambra bassi	1.000	0.377	1.000	0.471
Myriowenia sp.	1.000	0.377	1.000	0.471
Polychaete sp. PP	1.000	0.377	1.000	0.471
Sabellaria cf. *floridensis*	1.000	0.377	1.000	0.471
Polychaete sp. UK	0.000	1.000	1.067	0.418
Sabellaridae sp.	0.935	0.401	0.892	0.564
Spionidae sp.	1.000	0.377	1.000	0.471
Spiophanes bombyx	0.253	0.778	1.005	0.466
Prionospio cirrifera	1.000	0.377	1.000	0.471
ARTHROPODA				
Albunea paretii	1.000	0.377	1.000	0.471
Erichthonius sp.	1.424	0.252	1.641	0.129
Haustorius sp.	1.000	0.377	1.000	0.471
Iodleidae sp. CC	1.000	0.377	1.000	0.471
Iodleidae sp. DD	0.765	0.472	1.015	0.459
Ischyrocerus sp.	1.000	0.377	1.000	0.471
Amphipod sp. FF	1.000	0.377	1.000	0.471
Dogielinotus sp.	3.500	0.039*	1.641	0.129
Wandelia sp.	3.500	0.039*	1.641	0.129
Portunidae sp. juv.	0.700	0.502	1.019	0.455
Edotea montosa	0.000	1.000	1.067	0.418
Oxyurostylis smithi	1.257	0.295	0.817	0.632
Shrimp sp.	1.000	0.377	1.000	0.471
ECHINODERMATA				
Amphiodia pulchella	1.960	0.154	1.538	0.161
Encope emarginata	1.225	0.304	0.825	0.625
Thyone sp.	0.000	1.000	1.067	0.418
CHORDATA				
Ophidiidae sp.	1.000	0.377	1.000	0.471

Table 20a. Correlation Matrix for Box Core Macroinfauna Stations October 15, 1984

Station	N1	E1	S1	N2	E2	S2	N3	E3	S3
N1	1.000								
E1	-0.060	1.000							
S1	-0.061	0.260	1.000						
N2	-0.035	0.162	-0.073	1.000					
E2	-0.026	-0.062	0.010	0.047	1.000				
S2	-0.061	-0.084	0.048	0.220	-0.024	1.000			
N3	-0.074	0.039	0.114	0.050	-0.034	-0.000	1.000		
E3	-0.084	-0.118	-0.039	-0.051	0.000	0.053	-0.100	1.000	
S3	-0.027	-0.087	-0.089	-0.078	0.030	-0.118	-0.162	0.055	1.000

Table 21a. Principal Component Analysis factor table for Boxcore macroinfauna data for October, 1984.

A. Significant *eigenvalues with percent of variance accounted for by each factor, and cummulative percents.

B. Final varimax-rotated factor matrix used to construct PCA plot for stations (Figure Va).

*(Eigenvalues $\geq$ 1, or a minimum of 2 factors.)

A. Factor	Eigenvalue	Percent of Variance	Cummulative Percent
1	1.49399	16.6	16.6
2	1.24374	13.8	30.4
3	1.11024	12.3	42.8
4	1.05137	11.7	54.4
5	1.00488	11.2	65.6

B. Station	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
N1	-.26120	-.05969	-.07038	-.67863	-.23444
E1	.84388	.14782	-.09271	-.15940	-.06854
S1	.65231	-.15525	.25525	.20966	-.02278
N2	.14058	.82445	-.04833	-.14774	.15043
E2	-.08371	.02805	-.02605	.01908	.92070
S2	-.16571	.67728	.19042	.29530	-.15420
N3	.07127	-.09396	.78003	.00181	.11126
E3	-.20867	-.01280	-.20032	.68804	-.17425
S3	-.02335	-.22163	-.65936	.10755	.15973

Table 20b. Correlation Matrix for Box Core Macroinfauna Stations April 17, 1985

Station	N1	E1	S1	N2	E2	S2	N3	E3	S3
N1	1.000								
E1	0.297	1.000							
S1	0.348	0.264	1.000						
N2	0.101	-0.106	-0.073	1.000					
E2	0.701	-0.003	-0.010	0.096	1.000				
S2	0.242	0.578	0.223	-0.045	-0.024	1.000			
N3	0.512	0.617	0.196	-0.060	0.331	0.450	1.000		
E3	-0.067	0.009	-0.007	-0.066	0.034	-0.056	0.185	1.000	
S3	0.238	-0.008	0.889	-0.083	-0.044	-0.056	-0.077	-0.051	1.000

Table 21b. Principal Component Analysis factor table for Boxcore macroinfauna data for April, 1985.

A. Significant *eigenvalues with percent of variance accounted for by each factor, and cummulative percents.

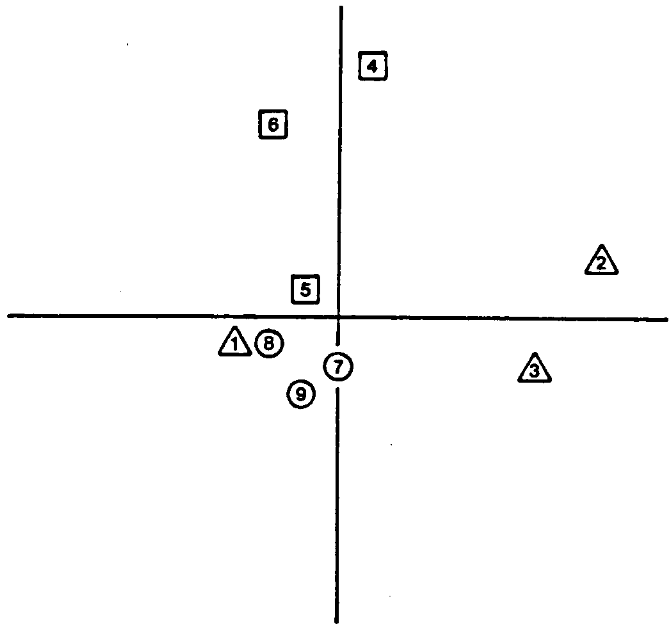
B. Final varimax-rotated factor matrix used to construct PCA plot for stations (Figure Vb).

*(Eigenvalues $\geq$ 1, or a minimum of 2 factors.)

A. Factor	Eigenvalue	Percent of Variance	Cummulative Percent
1	2.73648	30.4	30.4
2	1.80596	20.1	50.5
3	1.50770	16.8	67.2
4	1.09283	12.1	79.4

B. Station	Factor 1	Factor 2	Factor 3	Factor 4
N1	.28913	.27402	.84153	-.11930
E1	.88101	.08003	.04811	.07070
S1	.21585	.94747	.08101	.03955
N2	-.14037	-.14389	.25424	-.53655
E2	-.04945	-.06812	.92597	-.01341
S2	.84589	.03485	-.03127	-.10170
N3	.70977	-.02349	.47206	.25485
E3	-.06985	-.08901	.12542	.86116
S3	-.10924	.97935	.02285	.00680

HORIZONTAL FACTOR 1 VERTICAL FACTOR 2



SYMBOL	STATION	COORDINATES 1	COORDINATES 2
1	N1	-.261	-.060
2	E1	.844	.148
3	S1	.652	-.155
4	N2	.141	.824
5	E2	-.084	.028
6	S2	-.166	.677
7	N2	.071	-.094
8	E3	-.209	-.013
9	S3	-.023	-.222

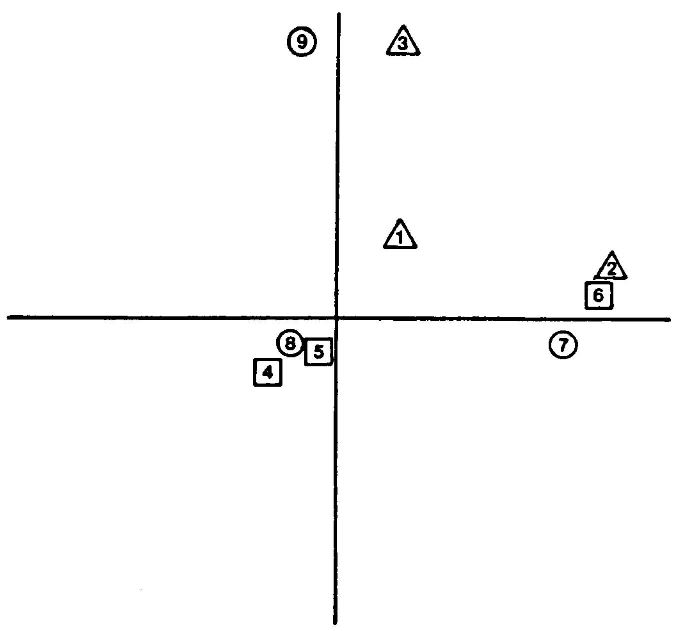
△ = ON-SITE

□ = ADJACENT

○ = OFF-SITE

Figure Va. PCA plot for October, 1984 box core macroinfauna stations. Shapes associated with symbols indicate location relative to the dredge spoil disposal site.

HORIZONTAL FACTOR 1 VERTICAL FACTOR 2



SYMBOL	STATION	COORDINATES 1	COORDINATES 2
1	N1	.289	.274
2	E1	.881	.080
3	S1	.216	.947
4	N2	-.140	-.144
5	E2	-.049	-.068
6	S2	.846	.035
7	N3	.710	-.023
8	E3	-.070	-.089
9	S3	-.109	.979

△ = ON-SITE

□ = ADJACENT

○ = OFF-SITE

Figure Vb. PCA plot for April, 1985 box core macroinfauna stations. Shapes and symbols as in Fig. Va.

Table 22a. Agglomeration schedule for HCA of box core macroinfauna stations for October, 1984. Station numbers are in dendrogram plot (Figure VIa), with clusters denoted by the lowest numbered station contained therein.

Stage	Stations Combined Cluster 1	Cluster 2	Coefficient
1	4	6	12.000000
2	2	4	13.000000
3	2	8	15.666667
4	2	9	21.250000
5	2	7	28.400000
6	2	5	34.666668
7	1	2	39.714287
8	1	3	45.250000

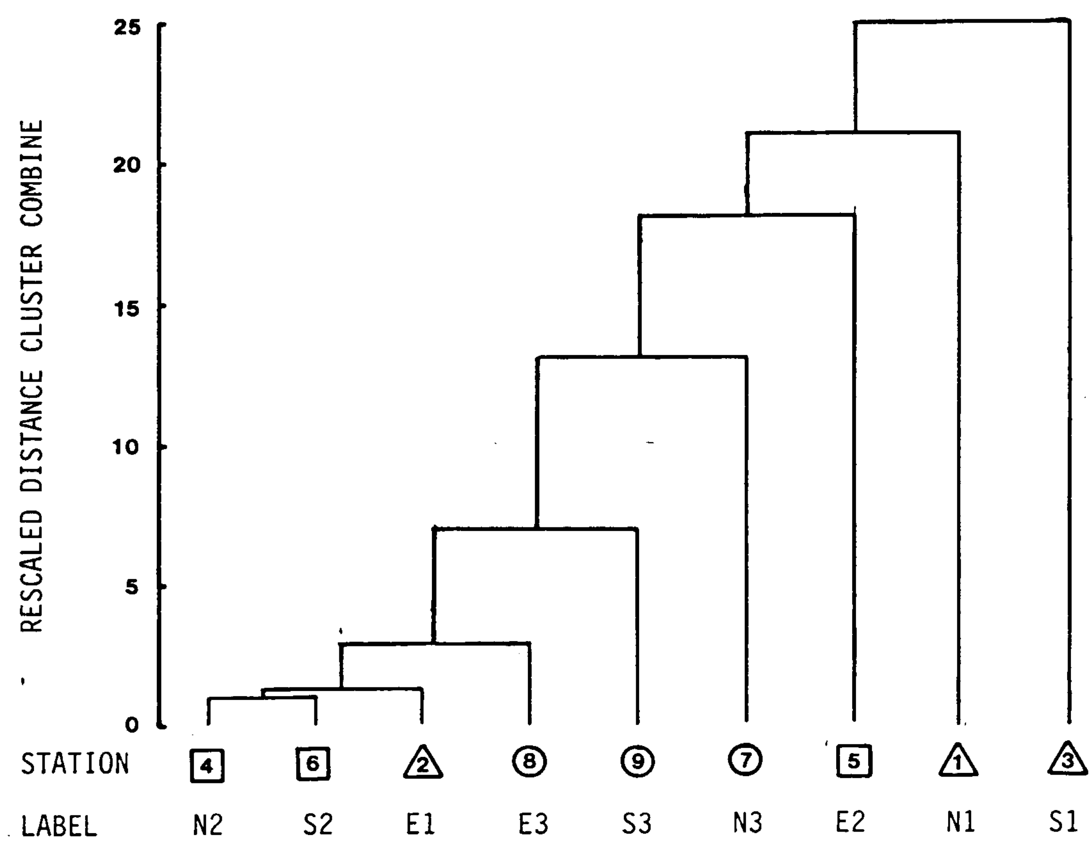


Figure VIa. HCA dendrogram plot of box core macroinfauna stations based on coefficients in Table 22a. Symbols as in Fig. III.

Table 22b. Agglomeration schedule for HCA of box core macroinfauna stations for April, 1985. Station numbers are in dendrogram plot (Figure VIb), with clusters denoted by the lowest numbered station contained therein.

Stage	Stations Combined Cluster 1	Cluster 2	Coefficient
1	2	8	13.000000
2	2	6	18.500000
3	2	4	21.666666
4	2	7	36.750000
5	3	9	62.000000
6	2	3	75.000000
7	2	5	110.285713
8	1	2	275.500000

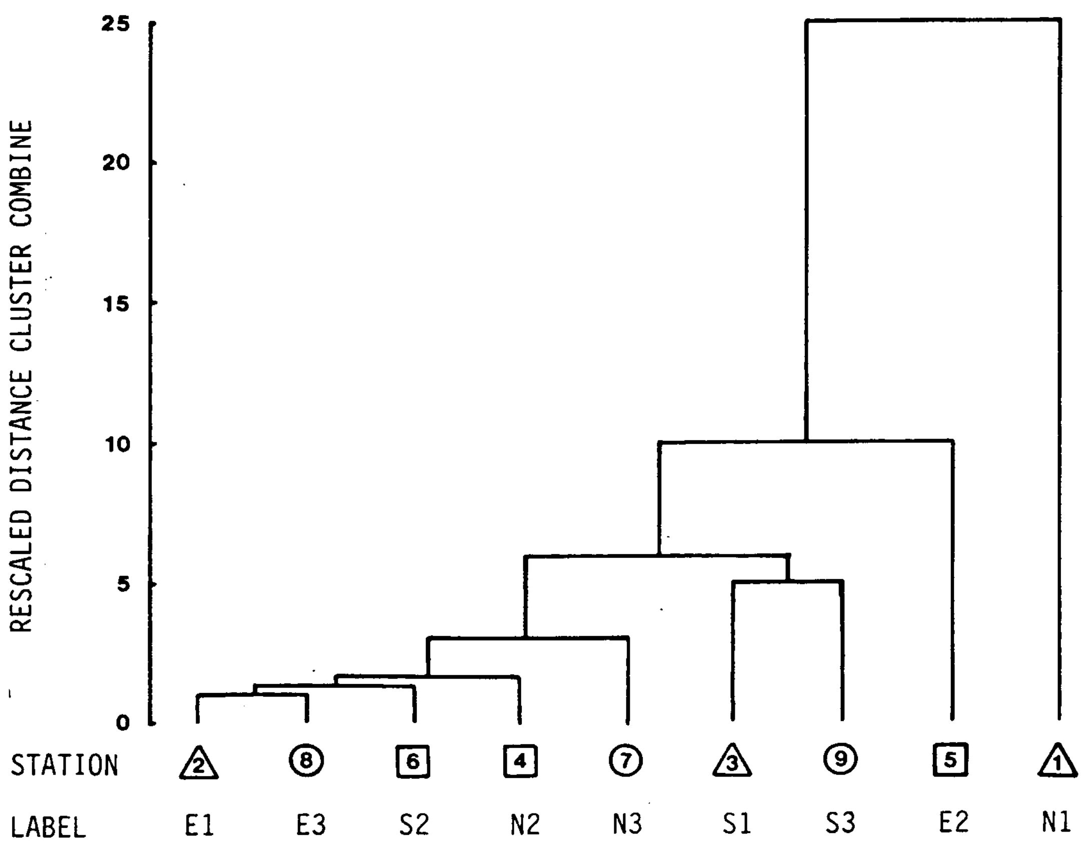


Figure VIb. HCA dendrogram plot of box core macroinfauna stations based on coefficients in Table 22b. Symbols as in Fig. III.