Boston Harbor soft-bottom benthic monitoring program: 1996 and 1997 results

Massachusetts Water Resources Authority

Environmental Quality Department

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BOSTON HARBOR SOFT-BOTTOM BENTHIC MONITORING PROGRAM

1996 and 1997 results

submitted to

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EXECUTIVE SUMMARY

The present report presents benthic biology and sedimentology data collected in 1996 and 1997 as part of a long-term monitoring program designed to document the recovery of the Boston Harbor ecosystem as a result of MWRA's treatment improvements, among them sludge abatement in December 1991. This data set constitutes the fifth and sixth years of post-abatement monitoring and includes traditional benthic biology (quantitative analysis of replicated grab samples), sediment profile image analysis, and ancillary sedimentary characteristics such as grain size, total organic carbon and total organic nitrogen concentrations, and *Clostridium perfringens* spore counts. In addition, the levels of several metals and organic constituents of the sediments were measured in August 1997. Finally, the 1991-1997 benthic infaunal database was examined for long-term trends in community structure and recovery.

The cessation in December 1991 of dumping sludge into Boston Harbor was perhaps the single most significant change in the input of pollutants into the Harbor environment since sewage disposal began about 100 years ago. Additional changes have included the cessation of scum discharge from both Deer Island and Nut island (1989) and upgrading the treatment of wastewater to enhanced primary (1995), then to secondary (1997). In addition to the reduced pollutant input, a severe storm in late October 1991 affected the bottom sediments, leaving traces of wave scour and resulting in a coarsening of sediment texture.

Boston Harbor and the interconnecting bay systems have shown a marked improvement in benthic conditions from 1991 to 1997 as inferred from sediment-profile imaging data, by which the spread of amphipod tube mats in the harbor has been documented. The best indicator of the overall improvement in the benthic condition of the Harbor is the spread of these dense populations of *Ampelisca abdita*, an amphipod species that builds tubes which promote the settlement and retention of organic muds (Rhoads and Boyer, 1982). Tube irrigation serves to transport oxygenated water into the bottom, thereby deepening the apparent RPD depth. Tubicolous amphipods such as *Ampelisca* tend to dominate the ecological ecotone between very high organic loading and low or ambient loading (Valente *et al.*, 1992). As organic loading decreases, the amphipod mats may contract in spatial coverage and tube density. Prior to sludge abatement, less than 20 percent of the profile camera monitoring stations showed the presence of amphipod tube mats. In 1996, over 60 percent of the monitoring stations showed well-developed tube mats. In 1997, this coverage appeared to have decreased slightly, perhaps due to poor image resolution in the August 1997 photographs, but mats still covered more than 50 percent of the area surveyed.

The tube mats are effective in trapping fine-grained sediment and have had a significant impact on enhancing sedimentation rates of silt-clay and very fine sand. Reduced muds associated with the mats are gradually oxidized, thereby lowering the concentration of reduced metabolites. This is probably a significant diagenetic process which will ultimately prepare these sediments for other colonizing benthic species (Rice and Rhoads, 1989). Because benthic infaunal succession is prograding and mixing depths are increasing, organism-sediment indices have shown improvement over time. As the area covered by the tube mats decreases, the low density of tubes serves to increase bottom roughness and fluid form drag. Muddy sediment bound within the tube mats can be expected to be resuspended and redistributed.

Data from infaunal grab samples indicate that the greatest change in benthic infaunal community structure took place between September 1991 (before cessation of sludge discharge) and August 1993. Since that time, infaunal communities have shown seasonal differences, but have not changed substantially in terms of species composition or diversity. Multivariate analyses of the 1991-1997 data indicate that at many stations

the communities sampled in late 1991 were most similar to the community at the same station the following May, with subsequent samples generally somewhat dissimilar to these early samples. Recent samples (1996 and 1997) are very similar to samples taken in 1993/1994, indicating a relative stability in community structure since 1993.

The major source of variation in the infaunal benthic communities in Boston Harbor appears to be related to differences among the sampling sites. Each station has a distinct faunal community and appears to have responded differently over time. In previous years, the discussion of similarity or differences among the benthic infaunal stations has focused on a north/south dichotomy, with the northern stations (i.e., those north of Long Island), which are closer to the original sewage discharges from Deer Island as well as to the sludge discharges from both Deer and Nut Island, being those that were considered to have received the greatest impact and therefore showed the greatest degradation. The southern part of the Harbor, especially Hingham and Hull Bays, and occasionally Quincy Bay, was, from the earliest studies in 1978 and continuing through 1997, apparently cleaner, perhaps because those areas received less sewage input, no sludge, and were in areas of better or greater tidal flow. Those stations (T6, T7, T8) have always exhibited higher species richness and diversity and have been considered healthier than the northern stations. There is also a dichotomy between the nearshore stations (T1, T2, T4) and those that are farther from shore and therefore subject to a different physicochemical regime (T3, T6, and T8).

Seasonal changes are obvious in several community parameters, with some stations showing high diversity in April when larvae and juveniles may be settling to the bottom, followed by lower diversity in August when many of these juveniles may have failed to survive at these stations (e.g., T4, Figure 61; T5A, Figure 62). Multivariate analyses also suggest a seasonal component to the community structure, however, this seasonal component is secondary to the differences among the stations.

Four major faunal groups have been elucidated from the 1991-1997 data set. These groups include the *Streblospio benedicti* assemblage, found in stressed environments such as Station T4 in Savin Hill Cove; the amphipod assemblage, primarily dominated by *Ampelisca abdita* but also including the polychaete *Polydora cornuta*; the *Aricidea catherinae* assemblage, and the *Tubificoides* nr. *pseudogaster* assemblage, the latter two groups being found at the more diverse outer Harbor stations such as T3, T6, and T8.

The parameters of TOC and *C. perfringens* spore counts are more conservative than organism-sediment relationships in terms of showing change in the system related to sludge abatement. These parameters can be expected to show change but on a longer time span than macrobenthic responses. It may take several more years for the organically loaded stations to reflect reduced sedimentation rates of labile organic matter and for the *Ampelisca* mats to be replaced by the next stage in the succession of benthic communities.

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1.0 INTRODUCTION

1.1 History of Discharges to Boston Harbor

Boston Harbor has a long history of anthropogenic impacts dating back at least to colonial times. In addition to the damming of rivers and the filling of salt marshes and shallow embayments, the direct discharge of waste products has had a profound impact on the health and composition of the biological communities in the Harbor. Prior to the 1950's, raw sewage was discharged into Boston Harbor primarily from three locations: Moon Island, Nut Island, and Deer Island. In 1952, the Nut Island treatment plant became operational and began treating sewage from the southern part of Boston's Metropolitan area. The Deer Island treatment plant was completed in 1968, thus providing treatment for sewage from the northern part of the area. (The third location, Moon Island, was relegated to emergency status at that time and not used routinely thereafter.) At both plants, the effluent was discharged continuously; an annual average of 120 million gallons per day (MGD) from Nut Island and 240 MGD from Deer Island. During storm events, up to 3.8 billion gallons per year (BGY) of additional material was occasionally discharged to the Harbor through the system of combined sewer overflows (CSOs).

Sludge, which was separated from the effluent, was held for later discharge. Sludge from Nut Island was pumped across Quincy Bay and discharged through an outfall near Long Island on the southeastern side of Presidents Roads. Sludge from Deer Island was discharged though a separate outfall on the northern side of Presidents Roads. Sludge discharges were timed to coincide with the outgoing tide, under the assumption that the tide would carry the discharges out of the Harbor and away offshore. Unfortunately, studies have shown that the material often was trapped near the tip of Long Island and carried back into the Harbor on incoming tides.

In 1972, the Federal Clean Water Act (CWA) mandated secondary treatment for all sewage discharges to coastal waters, but an amendment allowed communities to apply for waivers from this requirement. Boston's application for such a waiver was denied on the basis of the observed degradation of the benthic communities in Boston Harbor. In 1985, in response to the EPA mandate to institute secondary treatment, the Massachusetts Water Resources Authority (MWRA) was created and instituted a multifaceted approach to upgrading the sewage treatment system: both an upgrade in the treatment facility itself and construction of a new outfall pipe that would carry the treated effluent to a diffuser system located in deep water in Massachusetts Bay.

In 1989, both the Deer Island and Nut Island treatment plants stopped the discharge of more than 10,000 gallons per day (GPD) of scum, or floatable pollutants comprising grease, oil, and plastics. Sludge discharge ceased in December 1991, marking the end of one of the most significant inputs of pollutants to the Harbor. In 1995, a new primary treatment plant at Deer Island was completed, increasing the system's overall capacity and the effectiveness of the treatment. In 1997, the first phase of secondary treatment was completed, increasing the level of solids removal to 80%. For the first time, the MWRA's discharge met the requirements of the Clean Water Act. As of October 1998, an average of 45 tons per day (TPD) of solids is discharged to the Harbor, reduced from the 138 TPD discharged in the 1980's.

In July 1998, a new screening facility became operational at Nut Island, with sand, gravel, and large objects being removed from the wastewater flow prior to transport via pipe to Deer Island for further processing. In

October 1998, the old Nut Island plant was officially decommissioned, ending more than 100 years of wastewater discharges to the shallow waters of Quincy Bay.

The future goals of the MWRA upgrade include diverting all wastewater discharges to the new outfall in Massachusetts Bay by July 1999, with a third battery for secondary treatment operational by November 1999. In addition, the number of CSOs will be reduced from the current number of 81, with an associated discharge of 1 BGY, to 51, with an estimated discharge of 0.4 BGY, of which 95% will be treated by screening and disinfection.

1.2 History of Benthic Studies in Boston Harbor

Prior to the initiation of MWRA's ongoing monitoring in 1991, the most extensive studies of the infaunal benthos of Boston Harbor were associated with the application in the late 1970's and early 1980's for a waiver from the CWA requirement to implement secondary treatment. Surveys were conducted in the summers of 1978, 1979, and 1982 in support of the waiver application. The results of those surveys were reviewed by Blake *et al.* (1989), who identified some year-to-year patterns at those few stations that were resampled in subsequent years.

It was found that the benthic communities of Boston Harbor fell into two groups based on their proximity either to the more oceanic conditions of Massachusetts Bay or to known sources of pollution or stress. The southern region of the outer Harbor was found to be relatively healthy, with species richness and faunal composition similar to that found in offshore locations. In the northern part of the Harbor, periodic population explosions of ampeliscid amphipods alternated with assemblages dominated by spionid and capitellid polychaetes. These results suggested to Blake *et al.* (1989) that benthic communities in Boston Harbor were continuously shifting between the Stage I and II successional seres of Rhoads and Germano (1982). There was little evidence for the development of communities that included deep-burrowing deposit feeders (Stage III).

Studies initiated in 1991 by the MWRA were intended to characterize the infauna of Boston Harbor so that changes following the sludge abatement in December 1991 could be documented. Stations were positioned near the major sludge discharges and in key control locations. Pre-abatement baseline surveys using sediment profile imaging were conducted in 1989, 1990, and 1991; this technique provides information on the depth of the apparent redox potential discontinuity (RPD), an estimation of grain size composition, the successional stage of the infauna, and the presence of any biogenic features such as burrows and tubes. Benthic infaunal communities and correlated sediment parameters were sampled in September 1991, approximately three months prior to the cessation of sludge discharge.

Post-abatement surveys were conducted in April-May and August 1992 to 1995. Reports on the results of these surveys have been prepared (SAIC, 1989, 1990, 1992; Kelly and Kropp, 1992; Blake *et al.* 1993; Kropp and Diaz, 1994; 1995; Hilbig *et al.*, 1996). The present report includes a detailed analysis of the quantitative benthic infaunal data and sediment profile images collected in April and August 1996 and 1997 as well as a review of the data collected from 1991 through 1997. This analysis considers natural temporal patterns as well as possible changes due to sludge abatement.

1.3 Overview of the Present Study

Sixty stations were sampled with the sediment profile camera in August 1996 and again in 1997. Because of problems encountered in August 1997, several stations were reoccupied in October 1997. Eight of these stations were also sampled in April and August each year using grabs for biology, sediment grain-size, total organic carbon (TOC), and spores of *Clostridium perfringens*; two other stations were sampled as part of a parallel program to assess benthic nutrient flux.

The station design has been the same since May 1992, when it was modified from the earlier design used in 1989 and 1990; also, several sediment profile stations were relocated or added in 1995. The sediment profile stations provide the means to assess benthic conditions over most of the outer Boston Harbor and Dorchester, Quincy, Hingham, and Hull Bays. The so-called "Traditional" stations (those sampled with grabs and subjected to a complete taxonomic analysis) cover the same areas, but are much more limited in scope. The actual station selection was originally based on an assessment of water circulation in the Harbor and location of historical sampling sites. At least five of the eight traditional stations correspond to stations that were sampled during the waiver application surveys (see Blake *et al.*, 1989). Although the coordinates of those early survey stations are not exactly the same as those occupied in the present study, it is possible to compare current results with those obtained in the late 1970's and early 1980's as well as those obtained since 1991.

2.0 METHODS

2.1 Field Operations

2.1.1 Sampling Design and Location of Stations

Benthic grab samples were collected in April and August 1996 and in April and August 1997 at eight stations referred to as Harbor Traditional Stations T1- T8 (Appendix A1, Figure 1). During the first three surveys, three replicate grabs were taken for analysis of macroinfauna and one grab for analysis of sediment characteristics. In August 1997, in addition to the three infauna replicates taken at each station, three replicate grabs were taken for sediment analyses, which also included polychlorinated biphenyls (PCBs) pesticides, polynuclear aromatic hydrocarbons (PAHs), and linear alkyl benzenes (LABs), and 10 inorganic metals.

Sediment profile images were taken at 60 stations in August 1996 and August 1997(some were repeated in October 1997, see below) (Appendix A2, Figure 2). These stations were the same as in 1995 and included the 8 Harbor Traditional stations; 42 Reconnaissance stations that had also been sampled in 1993-1994; the Benthic Flux stations BH02, BH03A, BH08A and QB; and 6 stations sampled in 1990 and 1991.

2.1.2 Navigation

Navigational positioning was accomplished with a Northstar 41X Differential GPS system with an accuracy of 5 to 15 m. If the vessel drifted more than 0.01 nmi (ca. 18 m) away from the reference coordinates, it was repositioned between replicate samples. The ship's position was logged every minute while underway and marked at the time of each touchdown of the grab or camera with the Maptech software.

2.1.3 Grab Sampling

A 0.04-m^2 Ted Young-modified Van Veen grab was used to collect biology (benthic infaunal) and chemistry samples. At each station (T1-T8, see Figure 1 and Appendix A1), three replicate grabs for benthic infauna and one (or three) grab(s) for sediment chemistry were taken. The benthic infaunal samples were checked for depth of the apparent RPD layer, sediment color and texture, and penetration depth of the grab with a resulting rough estimate of the sample volume. The samples were then washed into a bucket, sieved through 300-μm mesh screens, and fixed in 10% buffered formalin.

The sediment chemistry grab was inspected for an undisturbed surface and acceptable penetration depth of the grab (i.e., grab at least half full). The top 2 cm of sediment were then removed with a scoop, homogenized in a stainless steel bowl, and subsampled for sediment grain size, TOC, and *Clostridium perfringens*. The samples were kept cool on ice and blue ice packs. In August 1997, additional grabs were collected for analysis of organic contaminants and metals. Subsamples were collected with a Teflon spatula and homogenized in a Teflon bowl. The samples were kept cool on ice or frozen on dry ice as required by the CW/QAPP (Blake and Hilbig, 1995).

2.1.4 Sediment Profile Imaging

At each of the 60 Harbor sediment profiling stations (see Figure 2 and Appendix A2), the sediment profiling camera was lowered to the seafloor; the camera was allowed to stay on the bottom for 12 sec (measured with a stop watch on board ship starting at the point at which the wire went slack), during which the

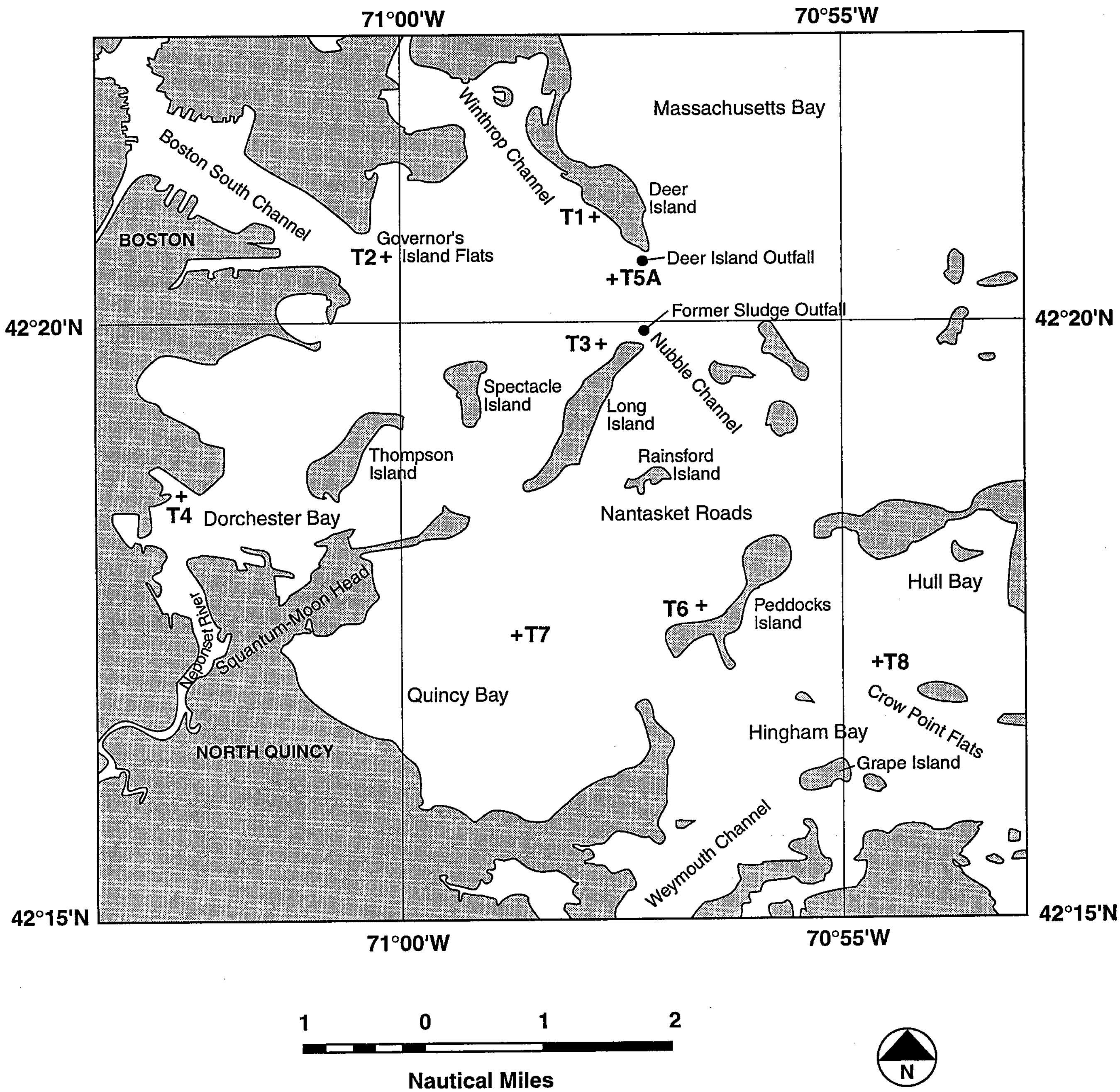


Figure 1. Boston Harbor Traditional Stations.

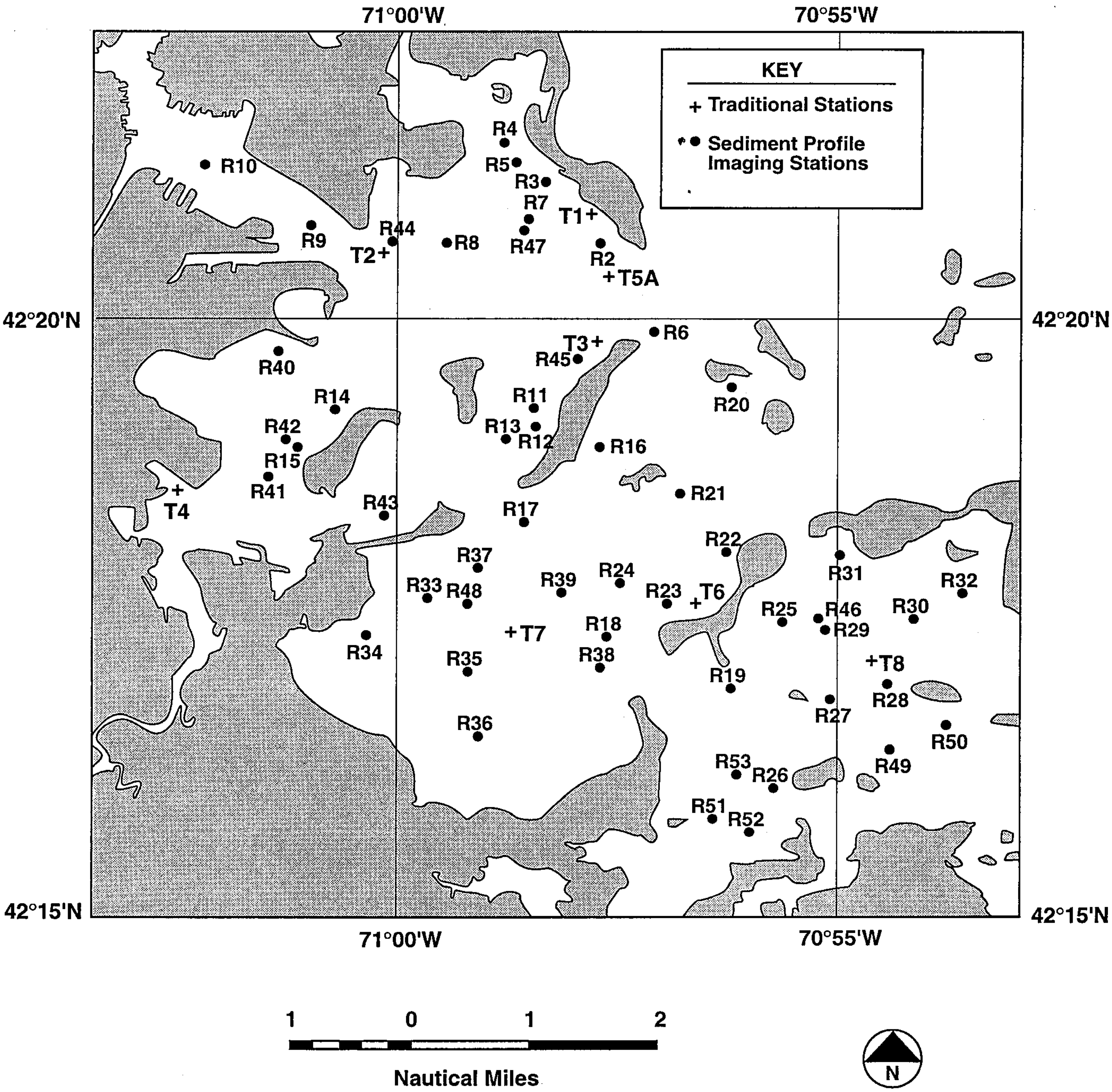


Figure 2. Boston Harbor Sediment Profile Imaging Stations.

camera's prism penetrated the sediment. Two photographs were taken each time: the first one was taken 2 sec after the frame settled on the bottom and the second one 10 sec later.

This protocol ensures that at least one useable photograph is produced during each lowering. If the bottom is very soft, the prism will overpenetrate after 12 sec (no sediment-water interface on the photograph), but the first exposure, taken after 2 sec, will usually show the interface and will be suitable for a full analysis. If the sediment is compacted or mixed with rocks, the second exposure can be used for analysis because the prism will usually penetrate deep enough to allow for measurement of all required parameters.

After 12 sec, the camera was lifted off the bottom, returned to the surface for a quick visual inspection, and lowered again for the next replicate set of two exposures. A total of four replicate sets (eight exposures) was taken at each station. At the end of a station, the camera was hauled back on deck for transit to the next station.

2.1.5 Sample Documentation, Custody, and Quality Assurance/Quality Control
Standard ENSR procedures for sample tracking and custody were followed. Prior to each field survey, preprinted labels were produced that were linked to ENSR's MWRA HOM database. All sample containers were labeled on the outside, and the macrofauna containers were also labeled on the inside. Information on the labels included the survey number, date, station and replicate, sample type, and the laboratory to which the sample was to be delivered for analysis.

All pertinent information on field activities and sampling efforts was recorded into a bound, numbered logbook. The number of the logbook was entered into the MWRA HOM database. Entries were recorded in indelible ink and included, at a minimum:

- Date and time of starting work
- Names of ship's crew and scientific party
- Sampling sites and activities and references to ship's navigation system
- Deviations from survey plan, if any
- Field observations such as weather and sea state

Chain-of-custody forms were created either electronically or by hand when samples left the ship or the custody of the scientist responsible for shipping. All coolers and boxes used for shipping were sealed with numbered chain-of-custody tape; the number on the tape was recorded on the chain-of-custody form. For additional information see ENSR's CW/QAPP for Benthic Monitoring (Blake and Hilbig, 1995).

2.2 Laboratory Methods: Sample Processing and Analysis

2.2.1 Benthic Infauna
About 48 h after the samples had been fixed in formalin, they were resieved on a 300-μm screen with fresh water and transferred to 70% alcohol for preservation. Before sorting, the samples were stained with a saturated alcoholic solution of Rose Bengal, a stain for proteins that enhances the visibility of organisms in the sediment. All animals, including fragments, were then removed from the sediment and sorted into major

taxa, such as polychaetes, oligochaetes, mollusks, crustaceans, and echinoderms. Taxonomists then identified each taxon to the lowest practical level (usually to species) and enumerated each taxon. Sorting and identification of the benthic infauna was performed by Cove Corporation; the second replicates of each station sampled in April 1996 were sent to ENSR taxonomists for identification to ensure consistency and accuracy in the identifications.

In order to assure consistency in the identifications of species of the amphipod genus *Ampelisca* made over the several years of this program, several samples collected prior to 1995 were reexamined. The often very numerous juveniles of this genus were sometimes identified only as *Ampelisca* spp. juv., resulting in a large number (sometimes several thousand) of individuals excluded from statistical analyses. It was determined that the exclusion of so many individuals would introduce a larger error into the database than would the assumption that the juveniles occur in densities proportional to those of the identified specimens. In order to assign juveniles to either *A. abdita* or *A. vadorum,* the ratio of adults of each species was determined for each sample and the mean was calculated for each station. The juveniles were then assigned to either species at the same ratio as the adults had occurred.

In order to reassign specimens of *Ampelisca* spp. juv collected from 1991-1994, 10% of the individuals from selected replicates were reexamined. From those identifications, studied assumptions based on sampling history at the station under consideration or proportional calculations (where feasible) were made, and individuals were reassigned to either *A. abdita* or *A. vadorum.* For August 1995 and 1996, individuals were reassigned by proportion. For the August 1997 samples, all individuals were examined and identified. The April 1995-1997 samples contained mostly large individuals which were easily identified.

2.2.2 Sediment Profile Image (SPI) Analysis

Three out of eight replicate images (see Section 2.1.4) from each station were analyzed with the ImagePro Plus software package. Each slide was digitized and then analyzed for parameters including penetration depth, surface roughness, apparent redox potential discontinuity (RPD), grain size major mode, successional stage of the infauna, the presence of methane bubbles, and biogenic features such as burrows and tubes. Any additional observations were entered into a comment field. The data were compiled on separate data sheets for each image and the organism-sediment index (OSI) was calculated (Rhoads and Germano, 1982).

A detailed account of the SPI parameters can be found in SAIC (1992); the following paragraph provides a brief characterization of these parameters. *Penetration depth* is measured from the bottom of the image to the sediment-water interface (maximally 20 cm) and is a measure for softness of the substratum, which depends on characteristics such as water content and grain size. *Surface roughness* is the difference between the least and greatest penetration depth across the sediment-water interface depicted on a slide (the width is 15 cm). It may be a measure for physical disturbance—natural or anthropogenic—or biological activity such as burrowing. The *apparent RPD depth* is measured from the sediment-water interface to the depth in the sediment at which there is a change in sediment color caused by the lack or absence of oxygen at depth; the color commonly changes from tan or brownish (ferric hydroxides) in the well-oxygenated surface layer to greyish (ferric hydroxides being reduced) or black (presence of sulfide, anoxic conditions) at a few mm to several cm depth. The RPD depth depends on a variety of physical and biological factors, such as currents, organic loading, and bioturbation by infaunal organisms, and is commonly used as a first-approximation measure for the health of a habitat. *Methane bubbles*, discernable by their strong reflectance (silvery color), form only under severely oxygen-depleted sediment conditions as a result of anaerobic bacterial metabolism. The *grain size major mode* is the dominant particle size in an image, measured visually by comparing the slide with a photograph of phi size classes. The *infaunal successional stages* are derived from a paradigm describing recolonization of disturbed habitats. Stage I organisms are those that live very close to the sediment-water interface, and they are pioneers because they do not require much oxidized sediment. By their feeding and burrowing activities these stage I organisms, often small annelids, deepen the RPD, preparing the sediment for somewhat larger animals to colonize, such as certain amphipods (stage II). Stage III organisms are large, deep-burrowing, head-down deposit feeders, such as large polychaetes and echinoderms, that aerate the sediment to several cm depth. Their presence indicates an equilibrium community and healthy environment.

2.2.3 Sediment Chemistry: Organic Contaminants

Sediment samples were analyzed by Arthur D. Little, Inc. (ADL) for an extended list of 43 polycyclic aromatic hydrocarbons (PAH), C_{10} to C_{14} linear alkyl benzenes (LAB), 17 chlorinated pesticides, and 20 polychlorinated biphenyl (PCB) congeners. Determinations of total organic carbon (TOC) were also made in order to normalize the data to TOC.

The organic analyses targeted the same analytes as those measured in previous years. Sediment samples were extracted for PAH, LAB, chlorinated pesticides and PCB following methods developed for NOAA's National Status & Trends Mussel Watch Project (NOAA, 1993). Briefly, approximately 30 g of sediment was serially extracted with a 1:1 mixture of dichloromethane (DCM):acetone and sodium sulfate using shaker table techniques. A 10-g aliquot of the original sample was taken for dry weight determinations. The samples were weighed into Teflon extraction jars and spiked with the appropriate surrogate internal standards, solvent added, the jars shaken for the appropriate amount of time and the samples filtered. The extracts were decanted into Erlenmeyer flasks. After extraction (a total of 3 solvent additions) the filtered solvent was combined in the flasks. The combined extracts were processed through alumina column and concentrated to 900 μl under nitrogen. The concentrated extracts were further cleaned using size-exclusion high-performance liquid chromatography (HPLC). This procedure removed common contaminants, including elemental sulfur, which interfere with instrumental analysis. The post-HPLC extracts were concentrated to approximately 1 ml under nitrogen and the recovery internal standards were added to quantify extraction efficiencies. The final extracts were split for analysis, one half remaining in DCM for PAH and LAB analysis and the other half solvent-exchanged with isooctane for PCB and pesticide analysis.

Sample extracts were analyzed for PAH and LAB compounds by gas chromatography /mass spectrometry (GC/MS) operating in the selected-ion-monitoring (SIM) mode. Concentrations of LAB compounds were determined as five separate LAB groups (those with alkyl chains containing 10, 11, 12, 13, and 14 carbon atoms, primary ion-m/z 91). LAB were quantified versus the surrogate internal standard 1-phenyl nonane. Pesticides and PCB congeners were analyzed by gas chromatography electron capture detection (GC/ECD). All analytes were determined by the method of internal standards using surrogate internal standards for quantitation and results were reported on a dry weight basis. Additional details on sample processing methods can be found in the CW/QAPP for Benthic Monitoring (Blake and Hilbig, 1995).

2.2.4 Sediment Chemistry: Metals

Sediment samples were analyzed for metals by Envitec as described in the CW/QAPP for Benthic Monitoring (Blake and Hilbig, 1995). At each of two stations, one grab sample was analyzed in duplicate: the analytical differences in values between these duplicates were generally quite small (<10%). Analysis of separate grab samples taken from the same station were, however, often substantial. The source of these differences is not analytical and most probably reflects real differences in sample composition among replicates taken at the same location. The greatest source of uncertainty in sediment concentrations reported for a given station is most likely due to heterogeneity in surface sediment composition at individual stations.

2.2.5 Sediment Grain Size

Grain size was determined by GeoPlan Associates, Inc. using a combination of wet and dry sieve and pipette analyses (NOAA, 1993). The sediment was processed through a sieve series based on the Wentworth grade scale, including mesh sizes of 2 mm (-1 phi), 1 mm (0 phi), 0.5 mm (1 phi), 0.25 mm (2 phi), 0.125 mm (3 phi), and 0.063 mm (4 phi). The sediment fraction retained on each sieve was weighed and reported as percent gravel (grain size >2 mm) and percent sand (grain size 2 mm to 0.063 mm). Sediment passing through the 0.063-mm sieve was further analyzed by pipette analysis to obtain percent silt (grain size 0.063 mm to 0.004 mm) and percent clay (grain size <0.004 mm). For the sand fraction, the weight percent for each phi size was also recorded.

2.2.6 Total Organic Carbon (TOC) and Total Organic Nitrogen (TON)

TOC analysis followed NOAA's procedures developed for the Mussel Watch program (NOAA, 1993). The sediment samples were dried to constant mass, exposed to HCl fumes to eliminate inorganic carbon, and TOC and TON were measured with a CHN analyzer. A detailed description of the procedure can be found in the CW/QAPP for Benthic Monitoring (Blake and Hilbig, 1995).

2.2.7 Clostridium Spores

The enumeration of *Clostridium perfringens* spores was performed using methods developed by Emerson and Cabelli (1982) and modified by Saad (personal communication). The data were recorded as units of spores per gram dry weight of sediment. Details of the laboratory procedure can be found in the CW/QAPP for Benthic Monitoring (Blake and Hilbig, 1995).

2.3 Data Management and Analysis

2.3.1 Benthic Infauna

Data from infaunal indentifications were either entered directly into a QuattroPro spreadsheet or a compatible electronic format, or they were first documented manually on data sheets and then entered into a spreadsheet. NODC codes and ENSR's alphanumeric codes were added, and the data were converted into a database format suitable for statistical analyses. Electronic spreadsheets of the raw data recorded in this program are available upon request from the MWRA.

Juvenile and indeterminable organisms were included in calculations of density, but were excluded from similarity and diversity measures. A suite of benthic community parameters was calculated and several multivariate cluster and ordination analyses were performed to identify patterns and trends in the data. Diversity was calculated as the Shannon-Wiener index H′, Pileou's evenness J′, Brillouin's Index H and its evenness value V and with the rarefaction method (Sanders, 1968) as modified by Hurlbert (1971). The Shannon-Wiener index was calculated using the base $\log_2$; the Brillouin index H approximates Shannon-Wiener H′ at base $\log_e$. For rarefaction, the number of individuals was set at defined points between 50 and 500.

May's log-series alpha was calculated to approximate a perfect log-series curve for each sample. This curve was then compared with the one generated by the Hurlbert rarefaction method; the deviation of each sample from the log-series curve serves as an approximation of the degree of disturbance in the samples. Deviation values of 0.7 or more indicate a disturbed environment.

shared, is a metric version of Grassle & Smith's (1976) NESS faunal similarity index. Principal components analysis for hypergeometric probabilities (PCA-H) is an ordination method for visualizing CNESS distances among samples. The PCA-H method produces two types of plots, both based on Gabriel (1971). The Euclidean distance biplot provides a two-dimensional projection of the major sources of CNESS variation. The species that contribute to CNESS variation can be determined using matrix methods adapted from Greenacre's correspondence analysis. These species are plotted as vectors in the Euclidean distance biplot. To show the association among species, the Gabriel covariance biplot is used. Species which co-occur plot with species vectors with very acute angles. Species which have discordant distributions plot with angles approaching 180 °. The cosine of the angles among species vectors in the covariance biplot can be clustered, as described in Trueblood *et al.* (1994).

Most benthic parameters and multivariate analyses were performed with MATLAB™. The methods used for performing PCA-H analysis and cluster analysis are described in Trueblood *et al.* (1994). Cluster analysis was performed using COMPAH96, a program originally written by Dr. Donald Boesch (Boesch, 1977). This program is available on Dr. Eugene Gallagher's web page (*http://www.es.umb.edu/edgwebp.htm*).

2.3.2 Sediment Profile Image Analysis

A spreadsheet of the raw data from each year was generated and several parameters were mapped and contoured by hand. Due to the heterogeneity of the Harbor bottom (see Knebel and Circé, 1995), some contour lines may cross over small areas of very coarse sediment or hardground unsuitable for sampling.

2.3.3 Sedimentology Data

Data on sediment grain size, TOC, TON, *Clostridium* spores and chemistry data were all entered into separate computerized spreadsheets. Summary statistics were performed on the data, which were then reported to MWRA in various data reports. The data were submitted electronically to the MWRA.

3.0 Results

3.1 Sedimentology: the 1996 Survey

3.1.1 Sediment Grain Size and the Distribution of Sediment Types

Most stations within Boston Harbor and Dorchester, Quincy, Hingham, and Hull Bays consist of silt-clay (>4 phi) sediments (Figures 3 and 4, Appendix C96-1). These fine-grained muds accumulate in low kinetic energy environments along with labile organic matter. Anaerobic decomposition of this organic matter can result in the formation of methane gas at depth within the bottom after sulphate becomes limiting (Stations R9, R47, R11, R12, T4, R17, R25). Other stations may also be methanogenic but these 7 stations have sufficiently large methane gas bubbles to be clearly identifiable as gas in the sediment profile images. High rates of fine-grained sediment accumulation (or resuspension) also result in the formation of fluid muds (> 70% water content) which is manifested by deep penetration of the camera prism into the bottom. Fluid muds are present in South Boston Channel (R10, R9, and T2), at organically enriched station T4 in Dorchester Bay, and at Hingham Bay stations R43 and R17. Sands dominate shallow water areas adjacent to the shore, form apron deposits around the bay and harbor islands, and the floors of tidal/navigation channels. These sands show evidence of periodic current scouring (shell lag deposits) and lateral bed transport (rippling and sand-over-mud stratigraphy).

3.1.2 Total Organic Carbon and Total Organic Nitrogen

The distribution of total organic carbon (TOC) at the Traditional stations is shown in Figures 5A and 6 and presented in Appendix C96-2. Total organic carbon (TOC) values of ca.≥2% tend to result in sulfidic/methanogenic sediments with high potential sediment oxygen demand. These sediments are found at Stations T3, T4, T6, and T7. Figure 5B and Appendix C96-2 also include data for total organic nitrogen measured at these stations. The C/N ratios, reported as molar fractions, were highest at Stations T3 (10.04) and T4 (12.39) in April 1996 and at Stations T1 (15.68) and T2, T4, and T5A (10.38, 10.84, and 10.96, respectively) in August. The remaining C/N ratios ranged from 7.23 (T5A, April) to 9.83 (T3, August). Fresh algal material has a C/N of about 6; this ratio increases as the material decomposes because nitrogen is recycled faster than carbon. A C/N >15 is indicative of land plants or well-processed marine material.

3.1.3 Clostridium perfringens

The concentration of colony-forming units (CFUs) of the enteric bacterium *Clostridium perfringens* is shown in Figure 6 (the exponent of concentration, log base 10 is shown within the circles). These concentrations are 10^4 at five of the eight Traditional stations. Station T8 in Hull Bay, Station T1 on the Deer Island flats, and Station T5A in the adjacent channel have an order-of-magnitude fewer spores (10^3). The lower spore counts are associated with sandy sediments rather than silt-clays (see Figure 4). A complete analysis of *C. perfringens* spores in sediment samples collected in 1996 is included in Appendix C96-3.

3.1.4 Mean Apparent RPD Depths

Figure 7 shows the mapped distribution of mean apparent RPD depths and frequency distribution of these values (inset). Values <2 cm tend to be concentrated along the shoreline in shallow-water sandy deposits and form the largest frequency class (1.00 to 1.99 cm). Mean apparent RPD values generally increase away from the shore producing local highs in Boston Harbor (Stas. R8, T3, R45, and R11). Peak values are associated with Station R24 in Hingham Bay and Stations R25, R46, R29, R28, and R50 in Hull Bay. These peak values (all above 4 cm in depth) form the right skewed tail of the frequency distribution. All of the

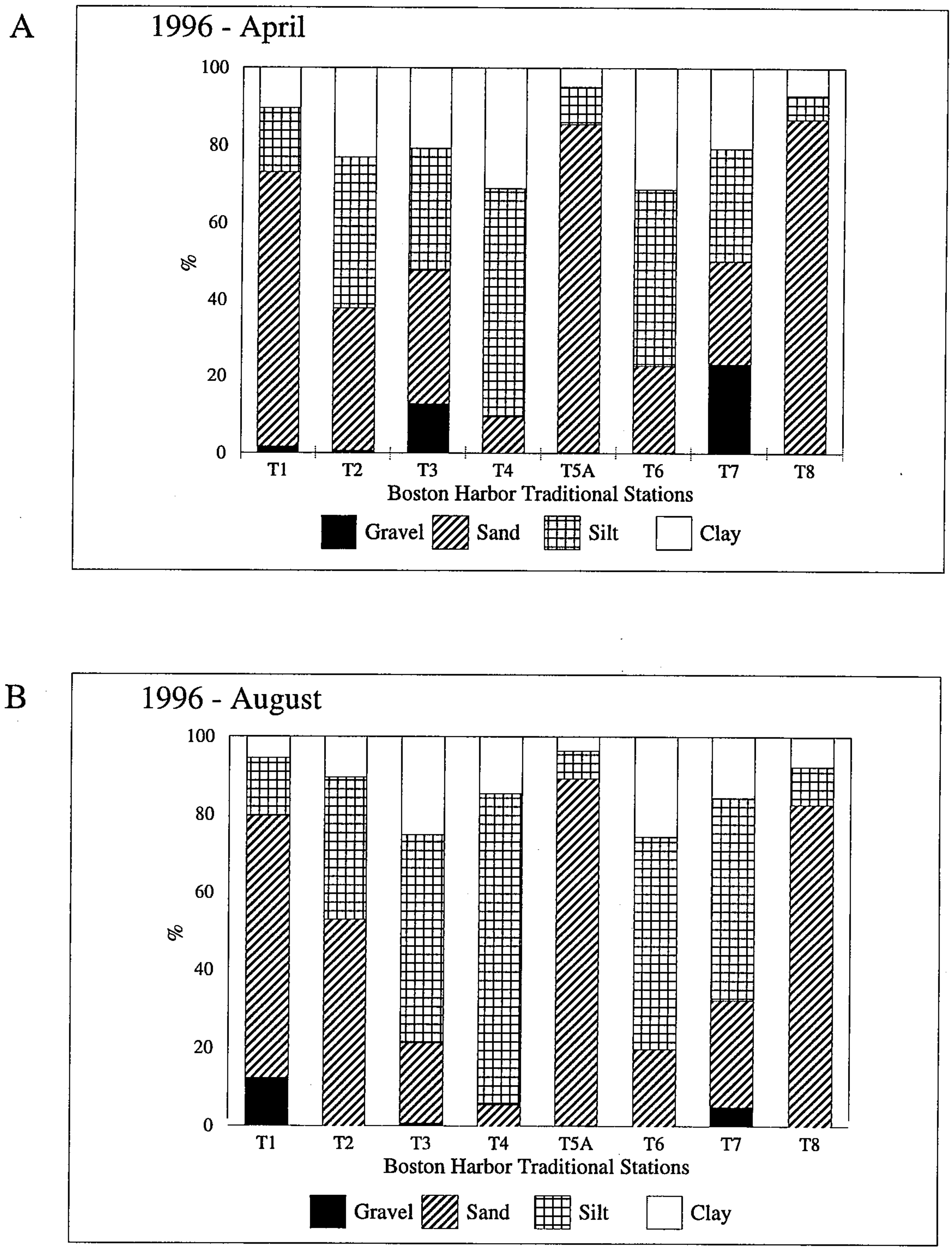


Figure 3. Percentages of gravel, sand, silt and clay for the Boston Harbor Traditional Stations determined from sieving and gravimetric analysis of sediments collected in (A) April and (B) August 1996.

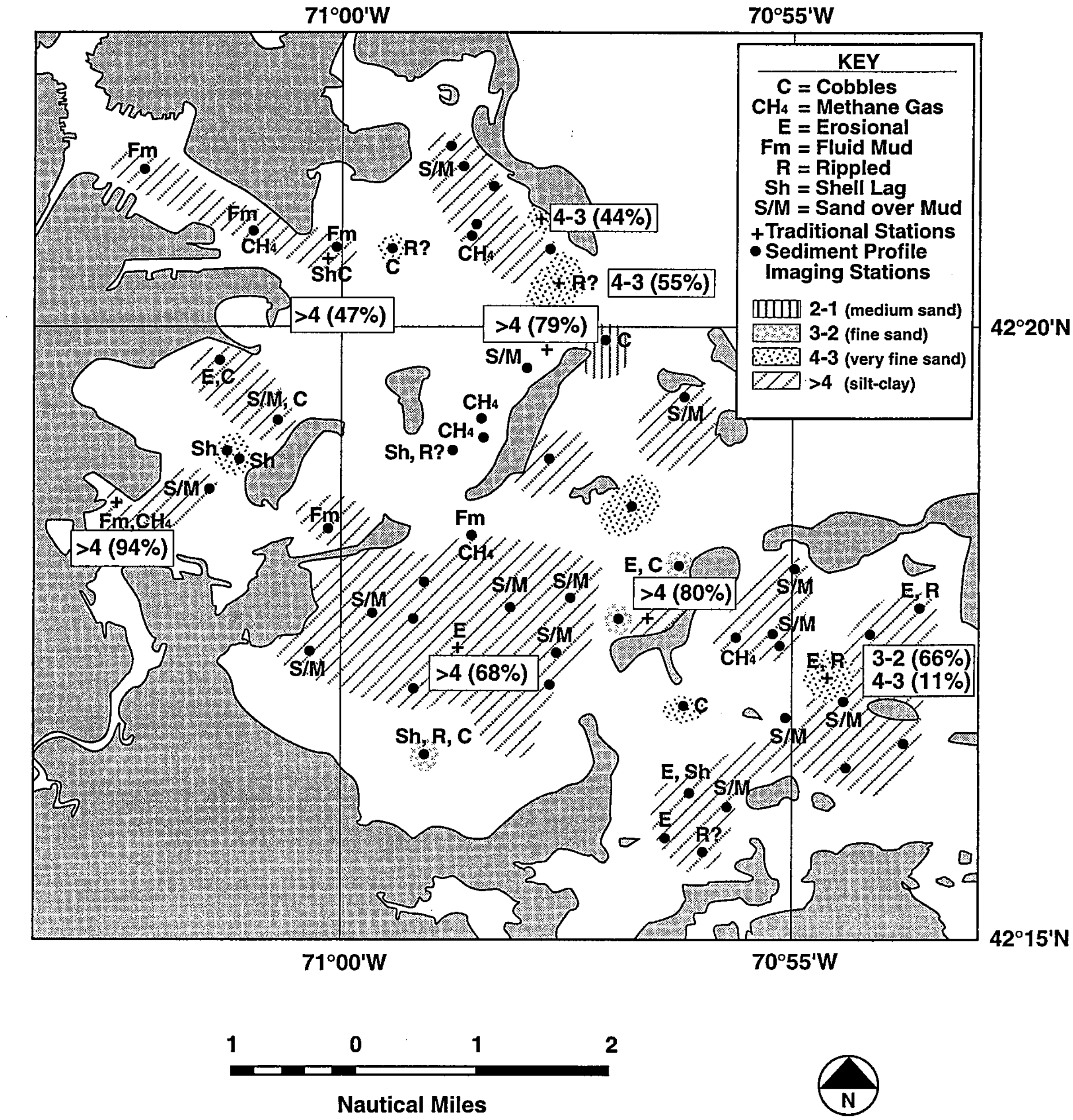
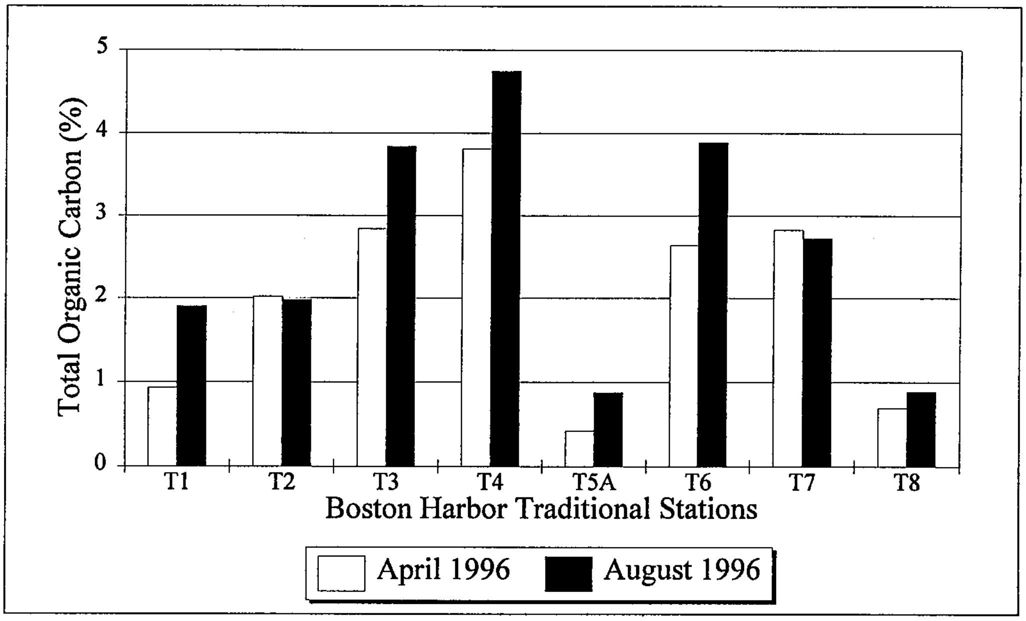


Figure 4. Major modal grain-size (phi classes) and other sedimentary features at stations sampled in 1996. Values in boxes are from Traditional Stations (+'s). The major modal grain size given in the box (e.g., 4-3 phi) is based on sediment profile imaging. The percentage value following the major modal grain size is weight percent of this dominant class based on traditional sieve analysis. Traditional textural analysis and estimates from sediment profile images show general agreement. Sedimentary features are represented by letters and symbols (see key).

A



B

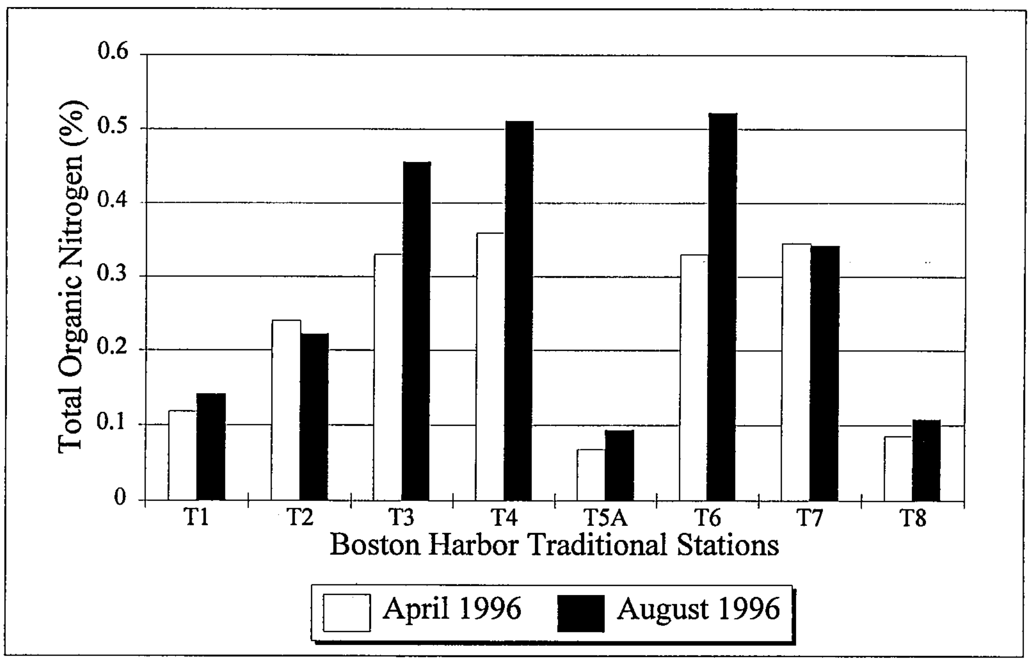


Figure 5. Total Organic Carbon (A) and Total Organic Nitrogen (B) in sediments from Boston Harbor Traditional Stations sampled in April and August 1996.

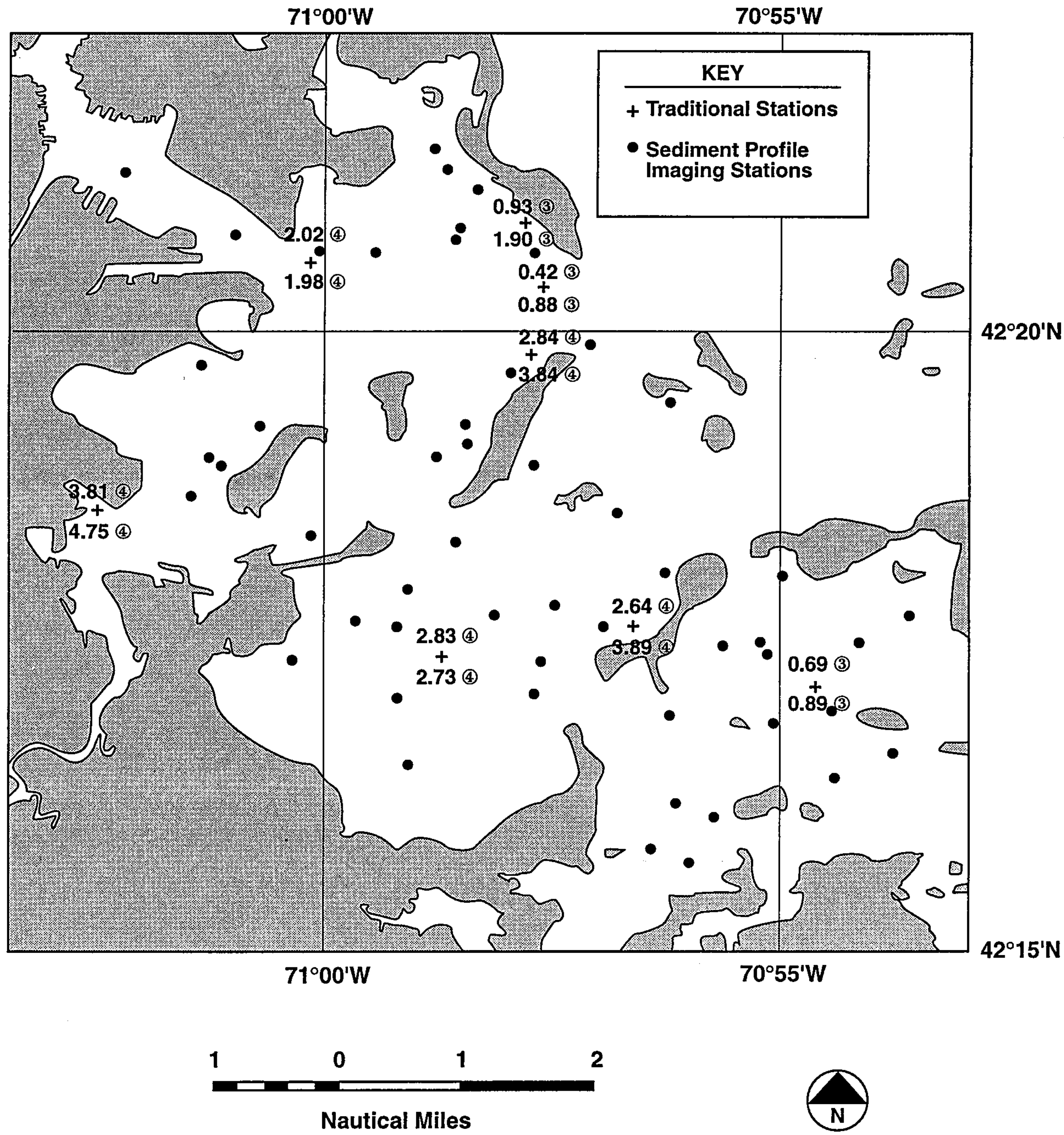


Figure 6. Sediment total organic carbon (TOC) by weight percent and density of the enteric bacterium *Clostridium perfringens* in 1996. The value in the circles represents the exponent of concentrations, (log base 10) of spores/gm of sediment. Upper pair of numbers at each station are April TOC and *Clostridium* values (n=1); the lower pairs of numbers are August values (n=1).

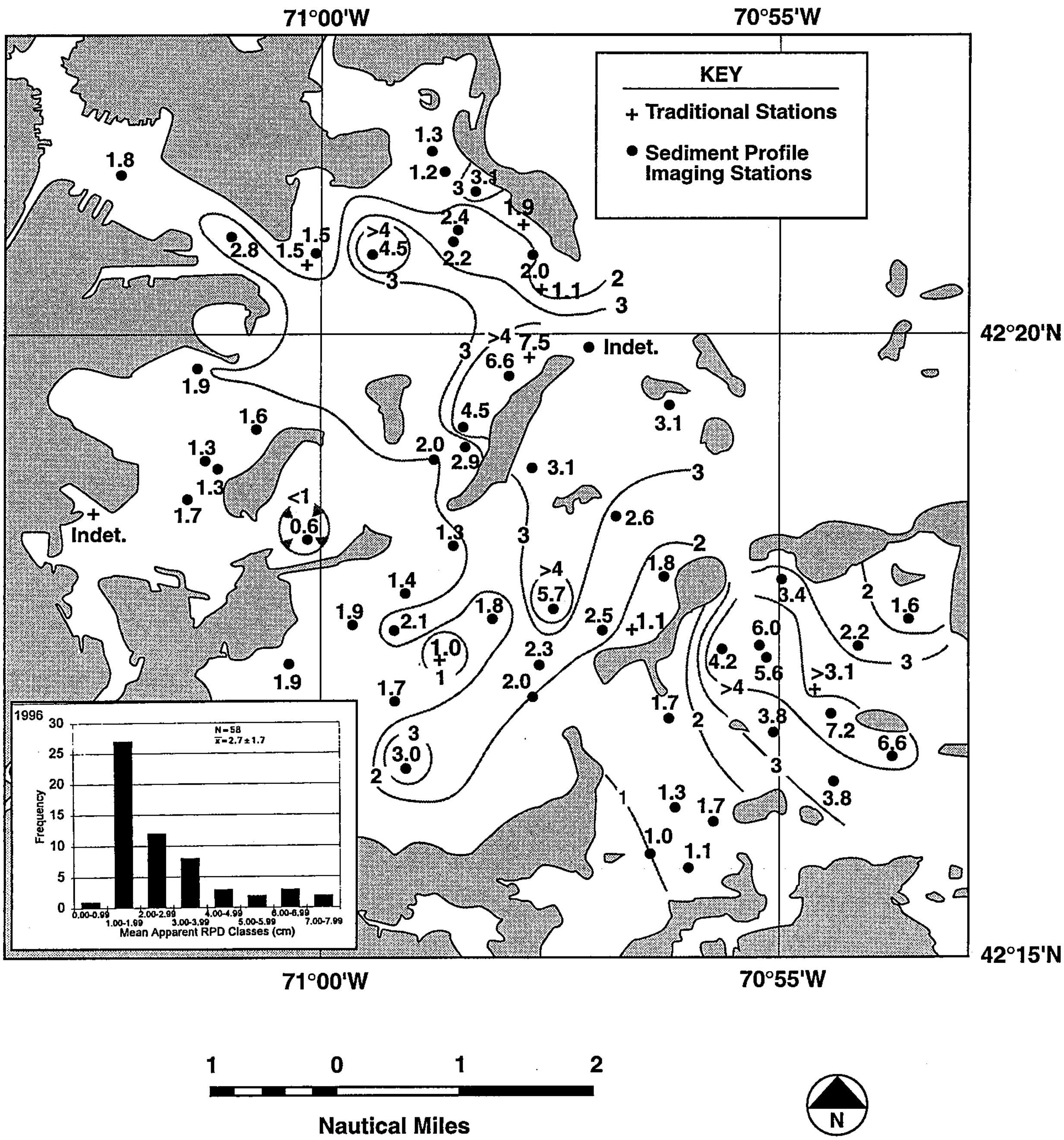


Figure 7. Contoured depth (cm) of the apparent redox potential discontinuity (RPD) at stations sampled in August 1996. Note that the deepest apparent RPD depths tend to be located near the center of the bay system. The RPD frequency histogram is given in the inset.

deep apparent RPD depths are associated with partial (Station R8) or fully developed amphipod tube mats (see section 3.1.5).

3.1.5 Infaunal Successional Stages

The central and outer regions of Boston Harbor, Dorchester, Hingham, and Hull Bays are dominated by Stage II seres (Figure 8). These areas are dominated by dense tube fields (mats) of the amphipod genus *Ampelisca* sp. Tube irrigation activities of these densely aggregated crustaceans account for the relatively deep mean apparent RPDs mapped in Figure 7. Stage I or Stage I on III seres dominate nearshore stations: South Boston Channel (Station R10), Dorchester Bay (Station R42), and Hingham Bay (Stations R37, R46, R33, R48, and R35). All of these stations are located outside of the Stage II amphipod tube mat or are marginal to patchy amphipod mats.

3.1.6 Organism-Sediment Indices (OSIs)

The distribution of OSIs is mapped in Figure 9 along with the OSI frequency distribution (inset). There is a gradient of increasing OSIs away from shore into the central and outer regions of Boston Harbor and Dorchester, Hingham, and Hull Bays. Our experience in mapping OSI values for a number of nearshore habitats around the world indicates that values ≥+6 are associated with relatively high habitat quality (intermediate to advanced successional seres with relatively deep RPDs). In Figure 9, all stations with OSI values ≥+6 are indicated by cross-hatching. Fully developed mats are found at more than 60% of the stations and more than 80% of the stations show some evidence of fully or partially developed amphipod mats. The mapped distribution of Stage II amphipod mats represents the largest areal distribution since these mats were noted and mapped in 1991 (refer also to Discussion Section 4.0).

3.2 Sedimentology: the 1997 Survey

3.2.1 Sediment Grain Size and the Distribution of Sediment Types

The distribution of sediment textures (major modal grain-size) shown in Figures 10 and 11 reflects the patchy and heterogeneous nature of the bottom in Boston Harbor and Dorchester, Quincy, Hingham, and Hull Bays. Estimates of the major modal grain-size distributions (from sediment profile images) can be compared with the results of the sieve analysis at Traditional stations. These two methods yield comparable results. Details of the sediment grain-size analyses for 1997 are included in Appendix C97-1.

Sediment profile imagery also continues to confirm conclusions regarding the wide range of sedimentary processes described for the Harbor and bays by Knebel and Circe (1995). Figure 11 shows that most stations located in the center of the harbor and interconnecting bays consist of silt/clays (≥4 phi). While the major modal grain-size is fine-grained, the upper centimeter of surface sediment of these muds is composed of sand-sized fecal pellets. The source of these pellets may be from zooplankton and/or from benthic species. It is likely that most pellets are produced by the dense populations of tube-dwelling amphipods that have been mapped throughout the Harbor and bays. The pellets consist of silt-clay grains compacted into fecal aggregates of sand size. The association of amphipod tube mats and pelletal sediment has been noted in earlier surveys. Stations located near Harbor and bay islands and within channels are dominated by sand and coarser-grained sediment (mineral sand rather than pelletal sand). These coarser-grained sediments often show evidence of active bed-load transport (ripples) or other physical evidence of erosion such as high boundary roughness and/or shell scour lag deposits. At sand-mud facies boundaries, sediment profiles show intercalation of sands lying over muds. This small-scale stratigraphy reflects temporal and spatial change in sedimentation. Sands may invade muddy areas during near-shore turbulent mixing of the bottom (waves) or

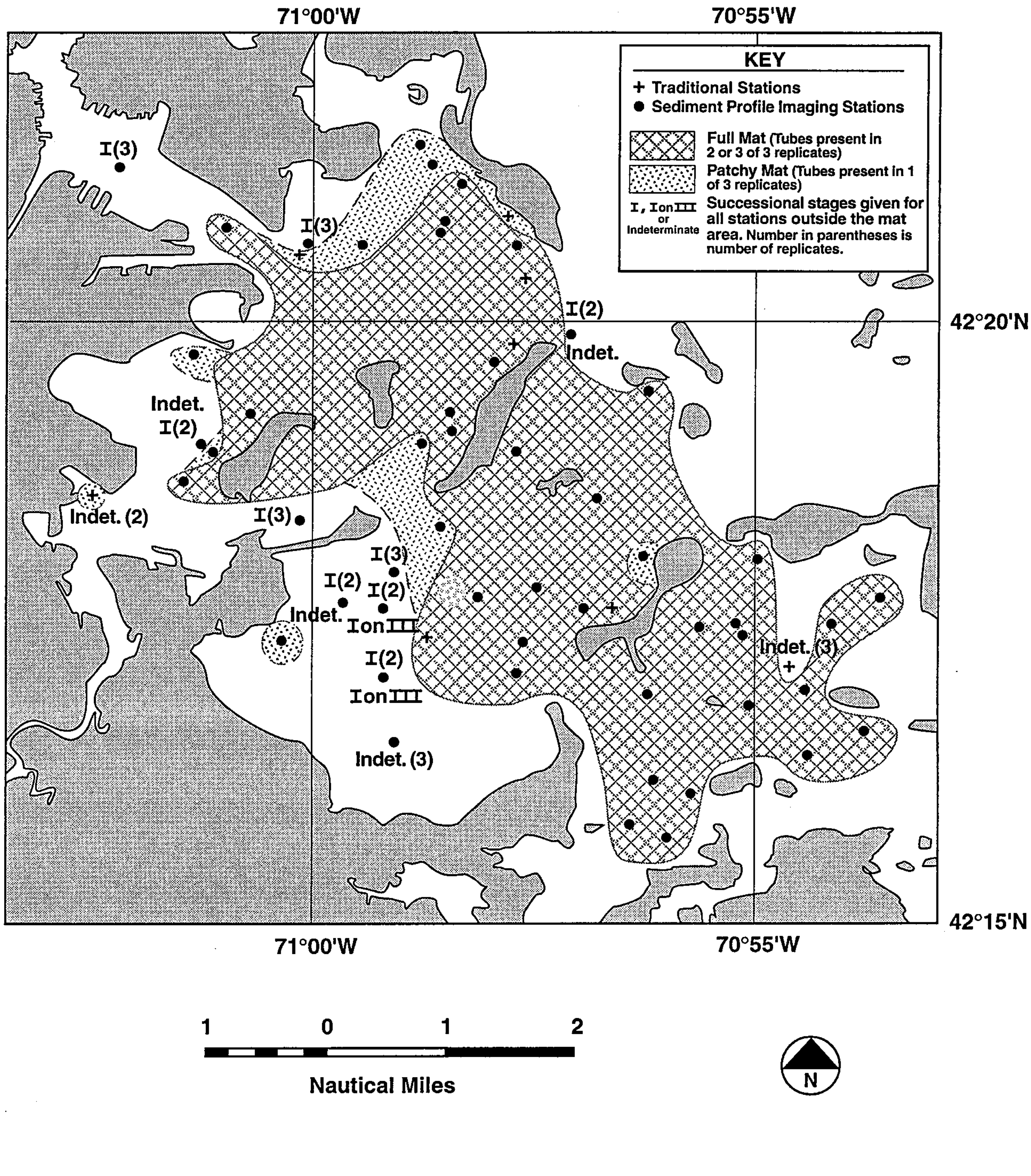


Figure 8. Mapped successional stages in 1996. More than half of the sampled stations are dominated by Stage II amphipods (*Ampelisca* sp.). Stage I and I on III seres dominate nearshore.

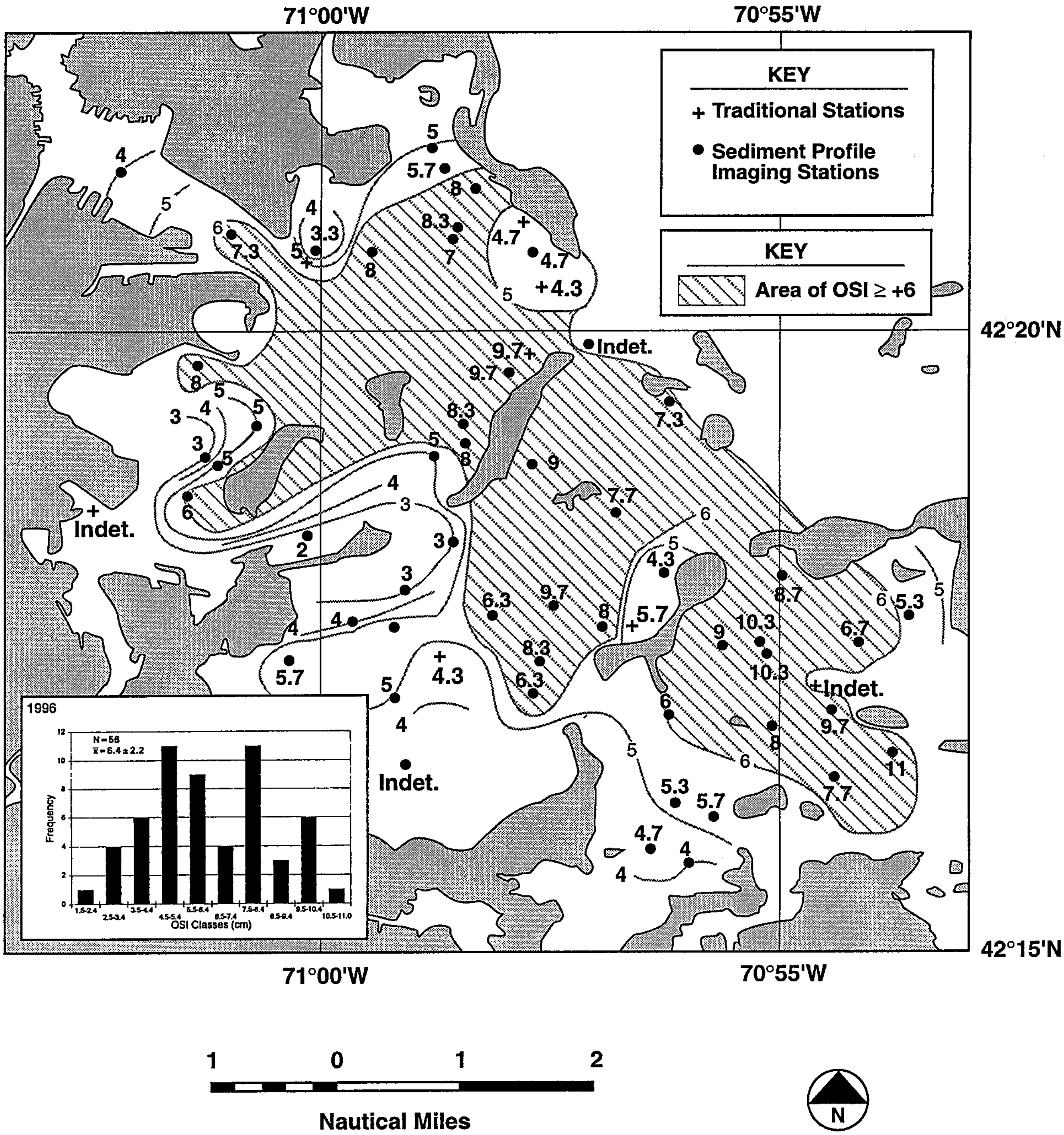


Figure 9. Distribution of organism-sediment indices (OSIs) in 1996. Note that the distribution of OSIs ≥+6 closely corresponds to the outer edge of these mats. Values < +6 tend to characterize the nearshore areas of Dorchester and Hingham Bays.

A

B

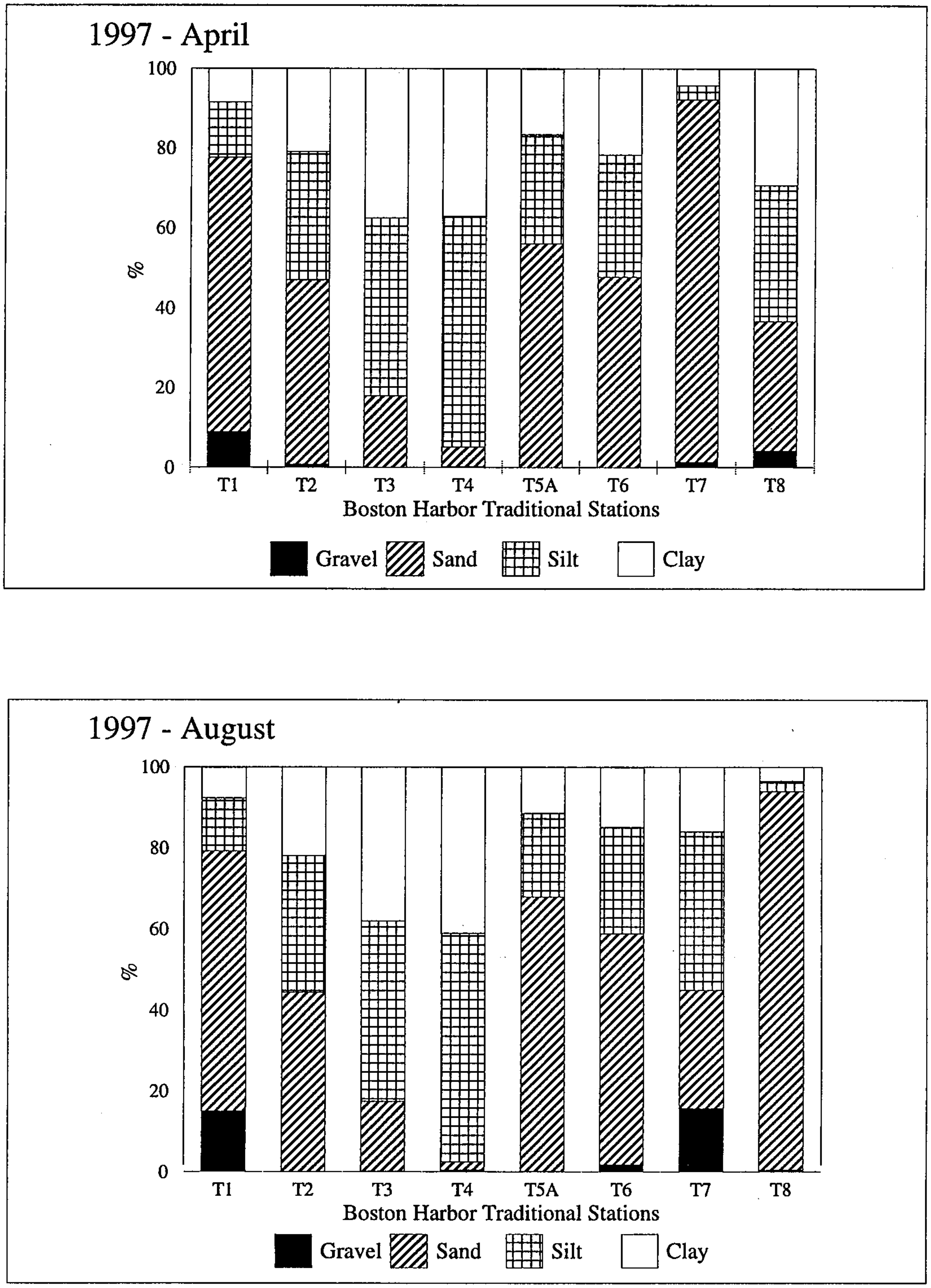


Figure 10. Percentages of gravel, sand, silt and clay for the Boston Harbor Traditional Stations determined from sieving and gravimetric analysis of sediments collected in (A) April and (B) August 1997.

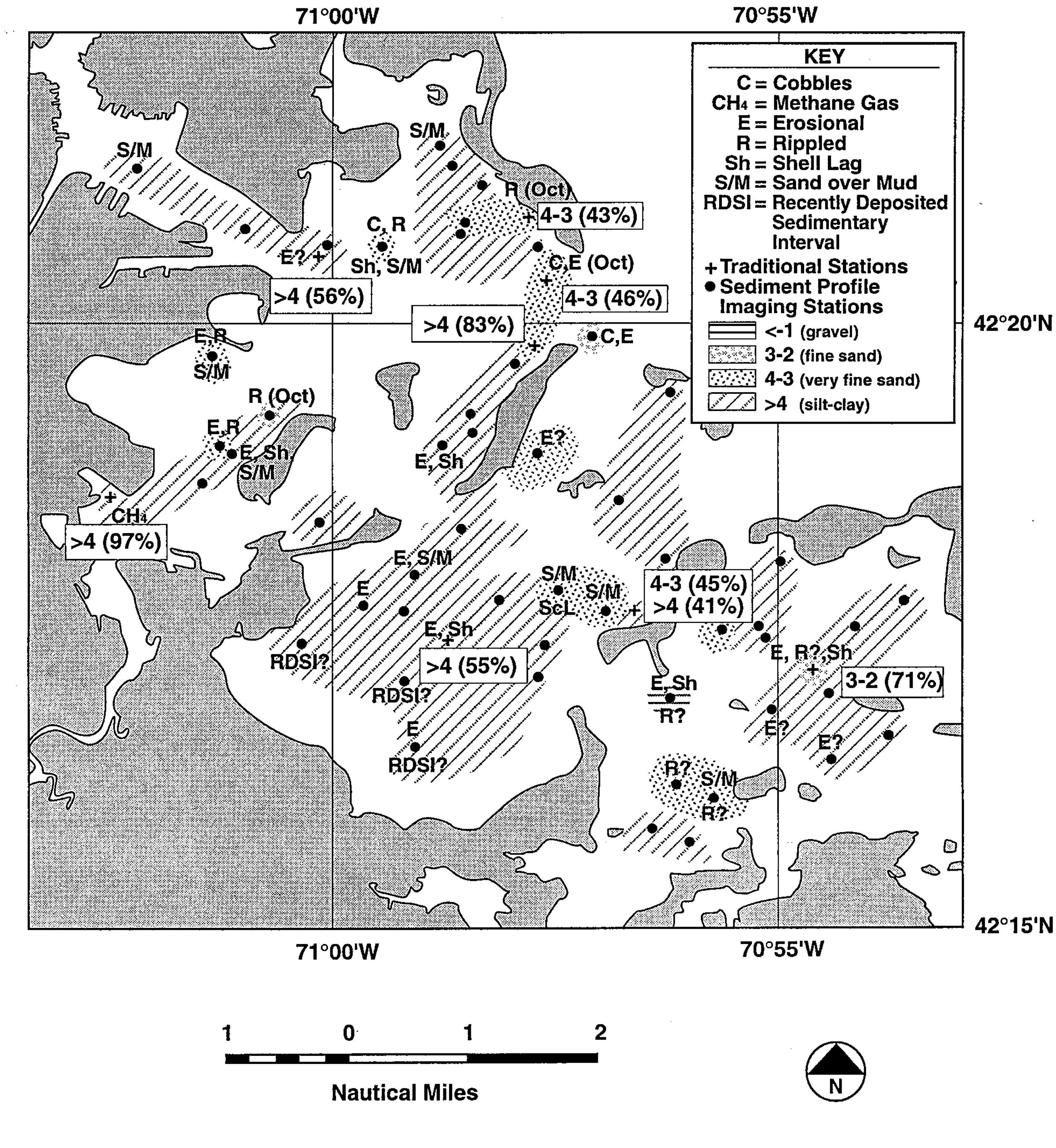


Figure 11. Major modal grain-size (phi classes) and other sedimentary features at stations sampled in 1997. The major modal grain size given in the box (e.g., 4-3 phi) is based on sediment profile imaging at Traditional stations. The percentage value following the major modal grain size is based on the weight percentage of this dominant class based on traditional sieve analysis. Both analyses show general agreement. Notable sedimentary features also are represented by letters and symbols (see key).

during high runoff periods. Muddy silt-clay sediments represent a lower kinetic energy depositional environment. Unlike the survey in 1996, no fluid muds were mapped in the 1997 survey and methane (CH_4) was imaged in sediments at only one station (T4). The relatively poor quality of the 1997 August images may have compromised our ability to identify gas bubbles within the sediment.

3.2.2 Total Organic Carbon, Total Organic Nitrogen, and Sediment Chemistry

As expected, the total organic carbon (TOC) content of the Harbor and bays sediments is highest in the silt-clay facies (n=8, ranging from 4.08-1.46% by weight, with a mean of ca. 3%). Station T4 had the highest TOC (4.08%) is located in Dorchester Bay (Figures 12 and 13). This station consists of 97% (by weight) silt-clay and the high inventory of reduced TOC is generating methane gas at depth (Figures 11 and 13). Very fine sands (4-3 phi) have lower TOC values (n=6, ranging from 3.38-1.05%, with a mean of 1.69%). Fine sands (3-2 phi) in Hull Bay (T8) have the lowest TOC (n=2 with values less than 0.5% TOC).

Details of both the TOC and TON analyses are presented in Appendix C97-2. The results of the organic and metal analyses of the August 1997 sediment samples are given in Appendix D, but are not discussed further in this report. The C/N ratios were highest at Stations T3 (10.00) and T4 (11.39) in April and at Station T1 (12.84) in August.

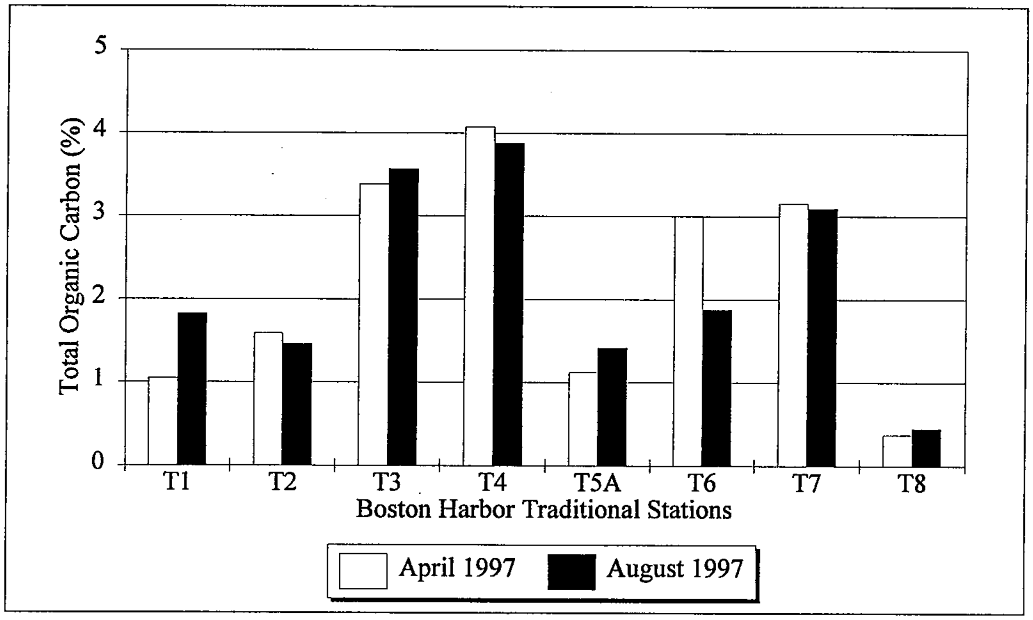
3.2.3 Clostridium perfringens

Figure 13 also shows the exponent of concentration of *Clostridium perfringens* spores in a gram of sediment (circled values are the log base 10 exponent of concentration). *Clostridium perfringens* produces long-lived resting spores that accumulate in sediments. This enteric bacterium is associated with the feces of warm-blooded animals including man, other mammals, and birds. As such, it is a good time-integrator of fecal and/or sewage contributions to the organic fraction of sediments. Therefore, this microbiological measure helps to identify depositional hot spots for sewage waste. Spore counts range from 10^3 to 10^4 spores per gm of sediment (Figure 13). The highest spore counts are found near the entrance to Boston South Channel (Station T2), in the proximity of the main Nut Island outfall (Station T3), the highly organic and methanogenic Dorchester station (T4), and Peddocks Island and Quincy Bay muds located near the Nut Island effluent outfalls (T6 and T7). Stations located on the Deer Island mud flats have generally low *C. perfringens* counts (T1 and T5A). Sandy sediments from Station T8 in Hull Bay also have relatively low spore counts. Overall, the highest spore counts occur in fine-grained and organic-rich sediments located in depositional sites of low kinetic energy. High spore counts also are associated with proximity of stations to effluent sources with the notable exception of Station T1 near the Deer Island mud flats. Details of the counts are presented in Appendix C97-3.

3.2.4 Mean Apparent RPD Depths

Contoured RPD data for August 1997 are shown in Figure 14. As observed in the past, values ≤2.0 cm dominate nearshore. Values increase toward the centers of the harbor and bay systems. The major modal RPD class frequency distribution is bimodal, reflecting thin apparent RPD depths nearshore and deeper mixing depths within the region of the amphipod tube mats (Figure 14, inset). The subordinate modal RPD classes reflect the influence of biological irrigation of the sediment by dense mats of tubiculous amphipods (see Section 3.25 below). Most stations populated by amphipods have mean RPD values ≥2 cm with many (n = 12 or 27%) showing RPD depths of ≥4 cm.

A



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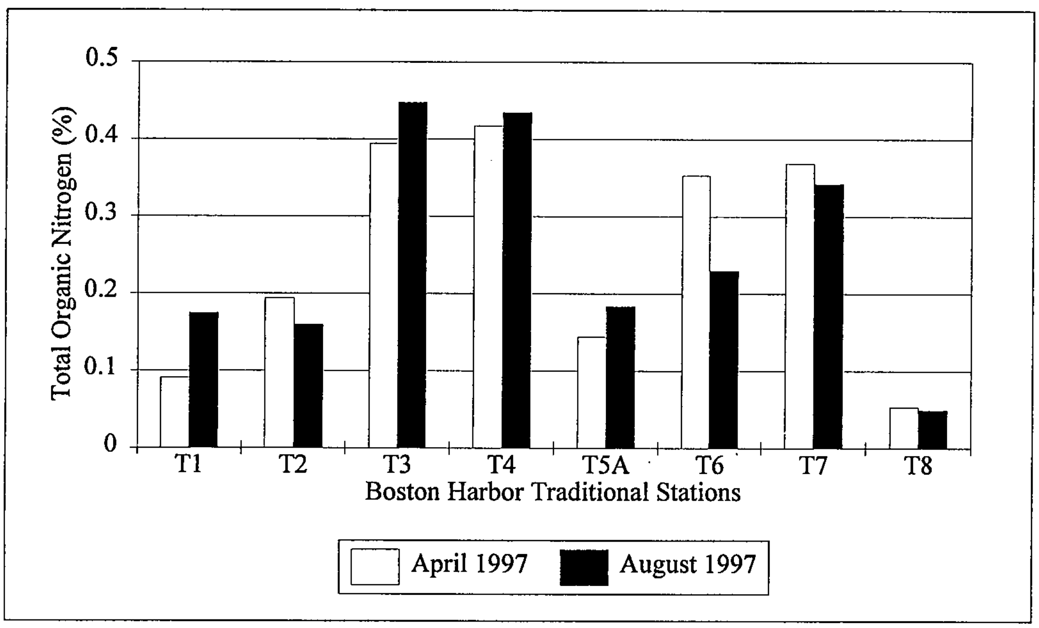


Figure 12. Total Organic Carbon (A) and Total Organic Nitrogen (B) in sediments from Boston Harbor Traditional Stations sampled in April and August 1997.

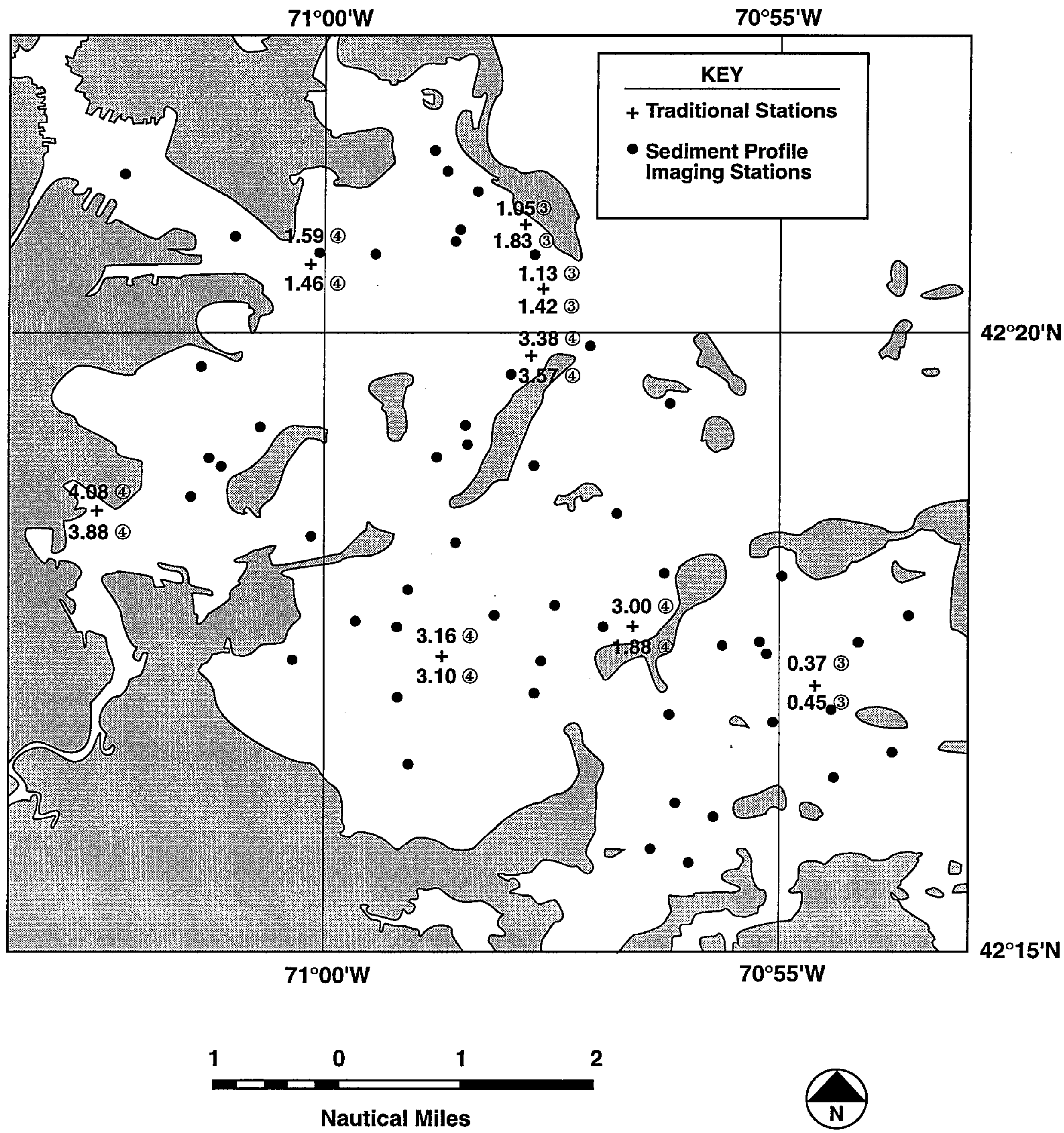


Figure 13. Sediment total organic carbon (TOC) by weight percent and density of the enteric bacterium *Clostridium perfringens* in 1997. The value in the circles represents the exponent of concentrations, (log base 10) of spores/gm of sediment. The upper pair of numbers at each station are April TOC and *Clostridium* values (n=1); the lower pair are mean August values (n=3).

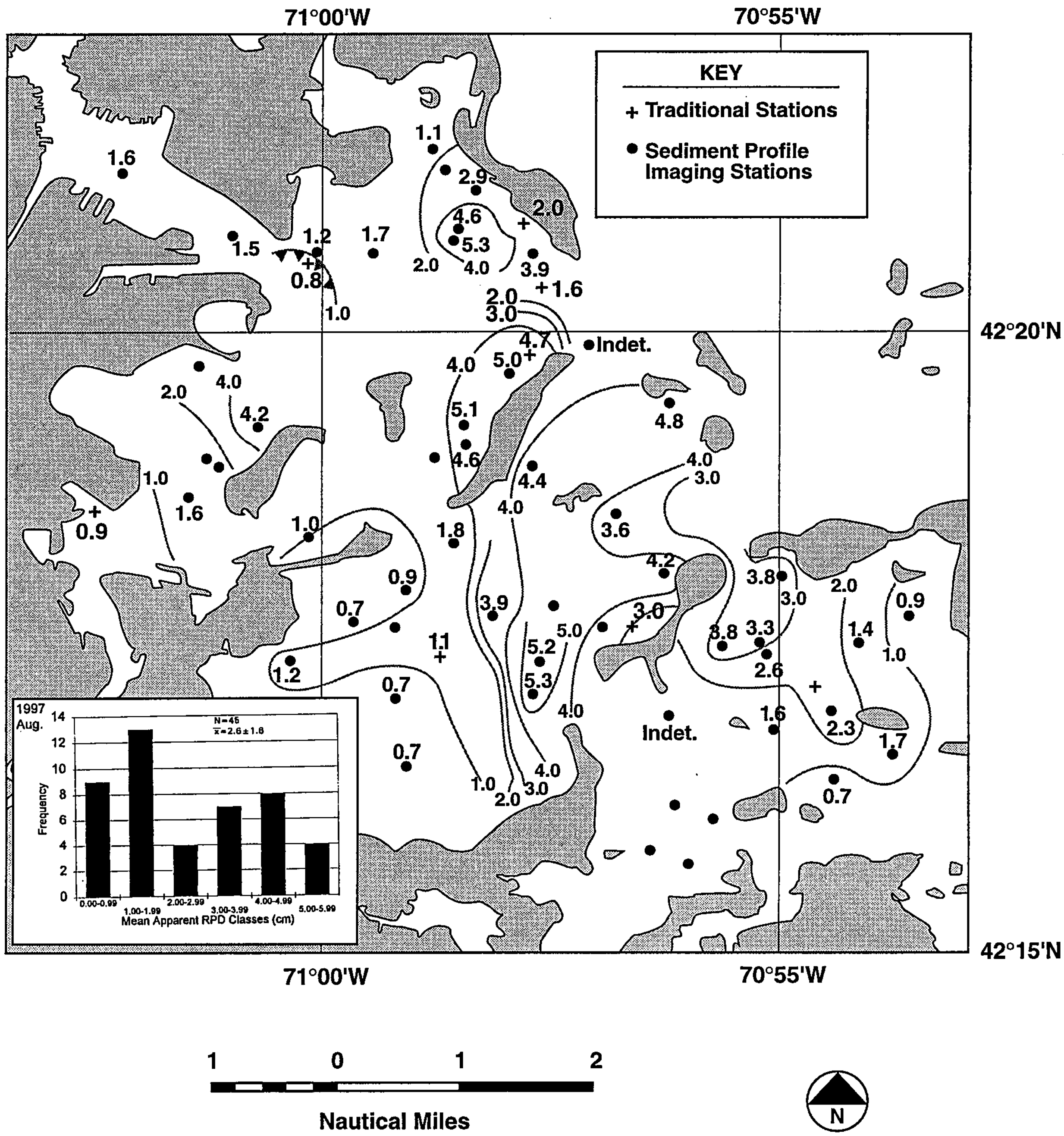


Figure 14. Contoured depth (cm) of the apparent redox potential discontinuity (RPD) at stations sampled in August, 1997. Note that the deepest apparent RPD depths tend to be located near the center of the bay system. The RPD frequency histogram is given in the inset.

Contoured RPD data for October 1997 are shown in Figure 15. The October data set has fewer stations and gradients are therefore more difficult to contour with confidence. Nevertheless, most values are < 2 cm. The apparent RPD depth frequency distribution in October shows the major mode to be within the 1.00 to 1.99 frequency class mode (Figure 15). The difference between the August and October data sets is sufficiently great that the RPD data must be mapped separately for each sampling period (insert). The apparent rebound in the RPD depth in October may be related to mortality and/or senescence of amphipod tube mats. In both August and October, tube mats were found that showed evidence of decomposition and disintegration (compare Figure 16A showing living mats seen in October with Figure 16B showing decomposing tube mats seen in August). The apparent change in RPD depths between August and October underscores the importance of obtaining apparent RPD depth data in the same month, and at the same stations, in order to make valid comparisons with earlier baseline data.

3.2.5 Infaunal Successional Stages

More than half of the area and stations sampled in August in Boston Harbor, Dorchester, Quincy, Hingham, and Hull Bays are populated by tube mats of *Ampelisca* sp. (Figure 17). This distribution is comparable to distributions mapped in 1996. *Ampelisca* sp. populations represent Stage II seres that replace opportunistic polychaete assemblages (Stage I seres) and are often found at the edge of organically enriched areas (i.e., the enrichment ecotone). The densely packed tubes (several per linear cm in sediment-profile images) physically bind sediment to the bottom between the tubes; dense tube mats promote sedimentation between the tubes (see Figure 16A). Tube irrigation by the small amphipod crustaceans also serves to depress the apparent RPD into the bottom.

Nearshore stations in Dorchester Bay, Quincy Bay, the mouth of Weymouth Channel, and Crow Point Flats are populated by patchy amphipod mats or apparently lack these mats. Stage I seres continue to dominate these areas as they have in the past (Figures 17 and 18). The dominance of amphipod tube mats in the surveyed area represents a major change in benthic faunal structure since the earliest baseline surveys in 1989 and 1990. This change is strong ecological evidence of improved water/sediment quality within these harbors and embayments.

3.2.6 Organism-Sediment Indices (OSIs)

The areal distribution of OSI values for stations sampled in August 1997 is shown in Figure 19 and for stations sampled in October in Figure 20. The highest values (≥+6) are generally located within the centers of the bays away from shore with the notable exception of Boston Harbor where high values were mapped on Deer Island Flats and Boston South Channel. The OSI ≥+6 contour corresponds closely to the edge of the amphipod mats. The OSI frequency distribution plot (Figure 21) is polymodal for August with a major mode falling within OSI class interval 9.5 to 10.4, a subordinate mode within the 2.5 to 3.4 class and a minor mode within the 5.5 to 6.4 class. The major mode represents stations located well within the amphipod tube mat. The subordinate mode represents stations located well outside of the amphipod mat. The minor mode represents stations located near the edge of the amphipod mat.

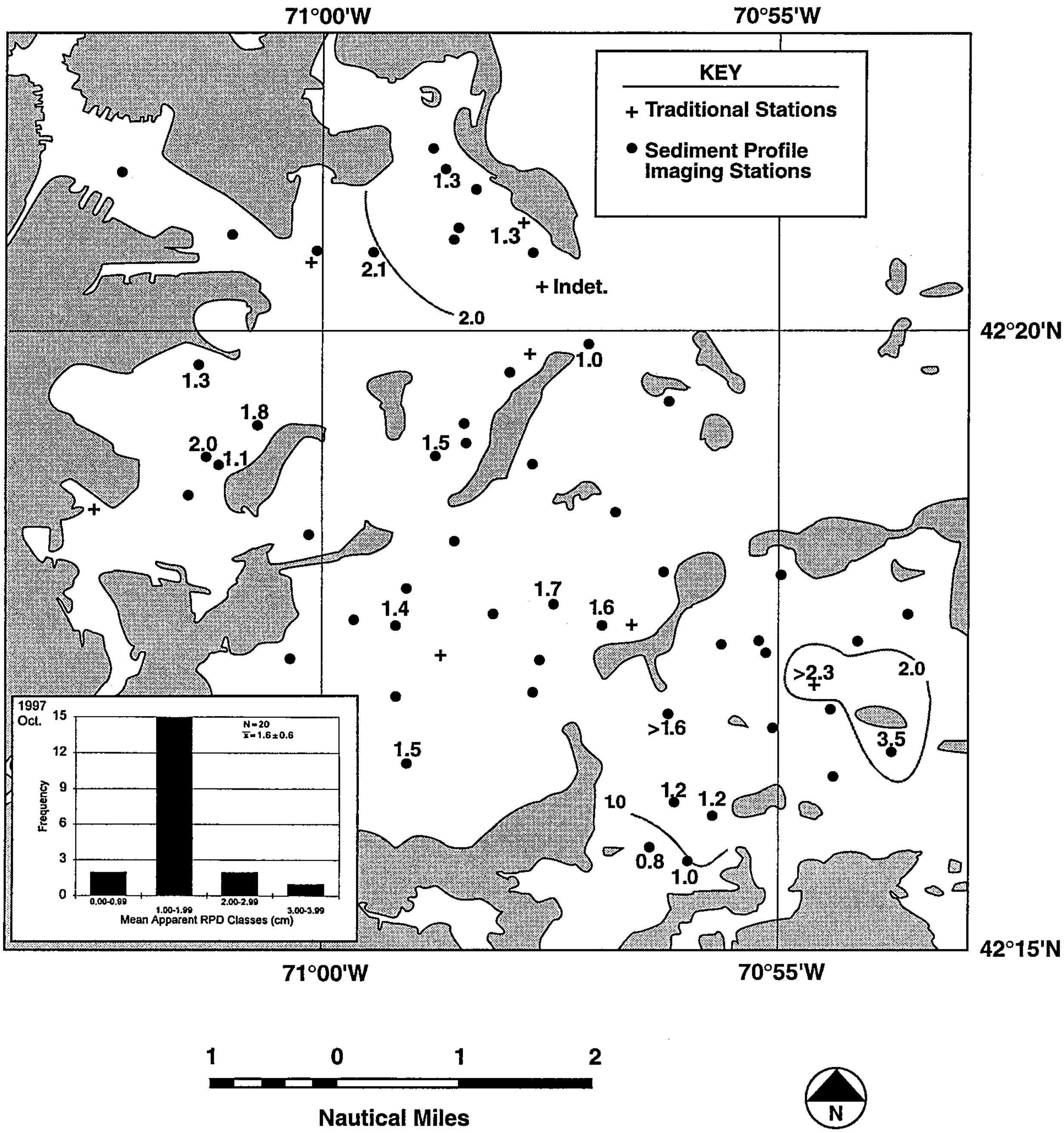


Figure 15. Contoured depth (cm) of the apparent redox potential discontinuity (RPD) at stations sampled in October 1997. None of the station values are above 3.53.

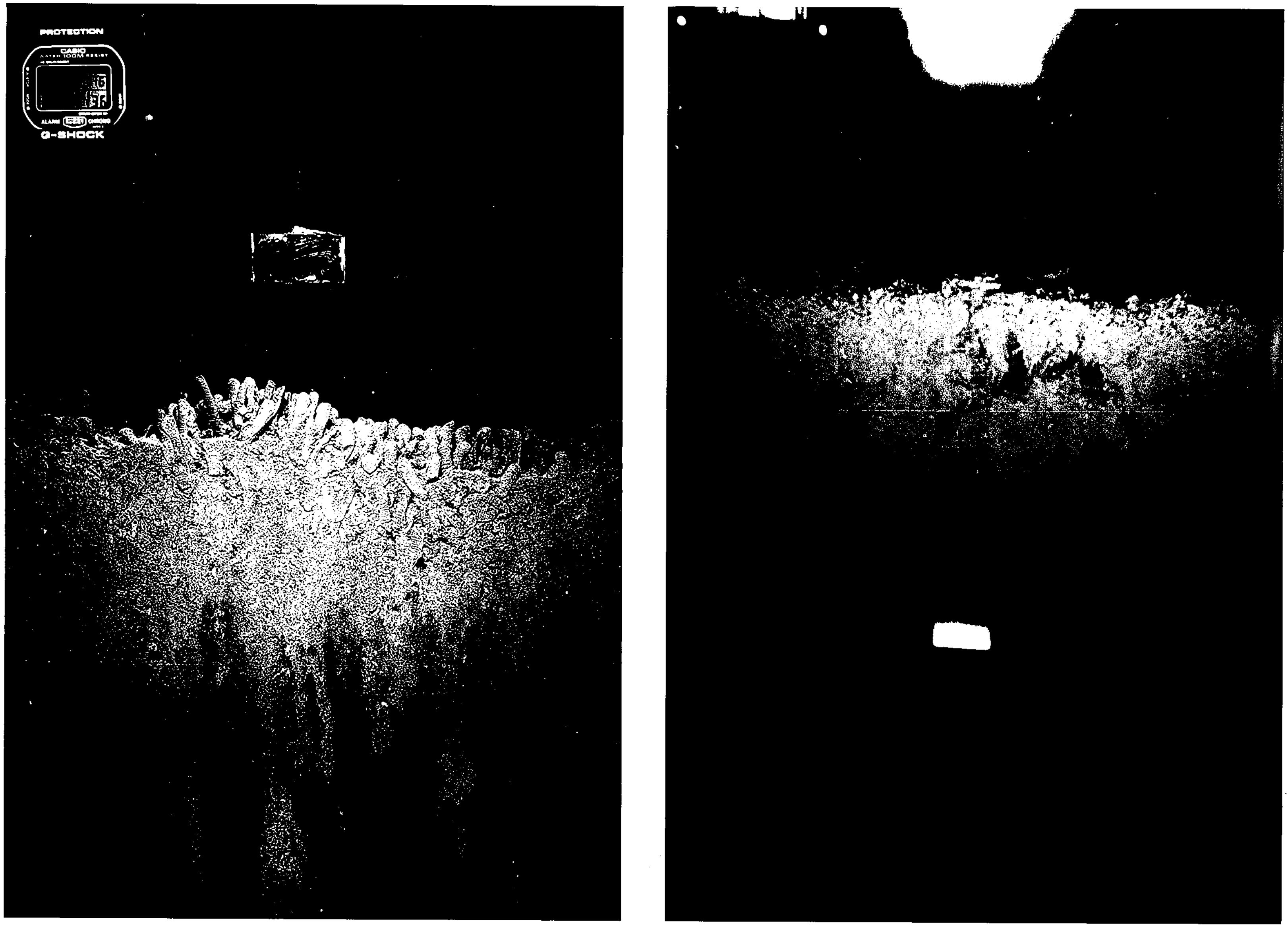


Figure 16. Sediment profile images of amphipod tube mats. (A, left) A well-developed healthy tube mat (Sta. R50, rep. A, Oct. 1997). Note vertically oriented tubes with sharp margins, relatively deep RPD, and pelletal sand between tubes. (B, right) A decomposing and disintegrating tube mat representing a senescent population (retrograde succession) of amphipods (Sta. R11, rep. C; August 1997). Note recumbent tubes with irregular margins due to decomposition and disintegration of tubes and the relatively thin apparent RPD.

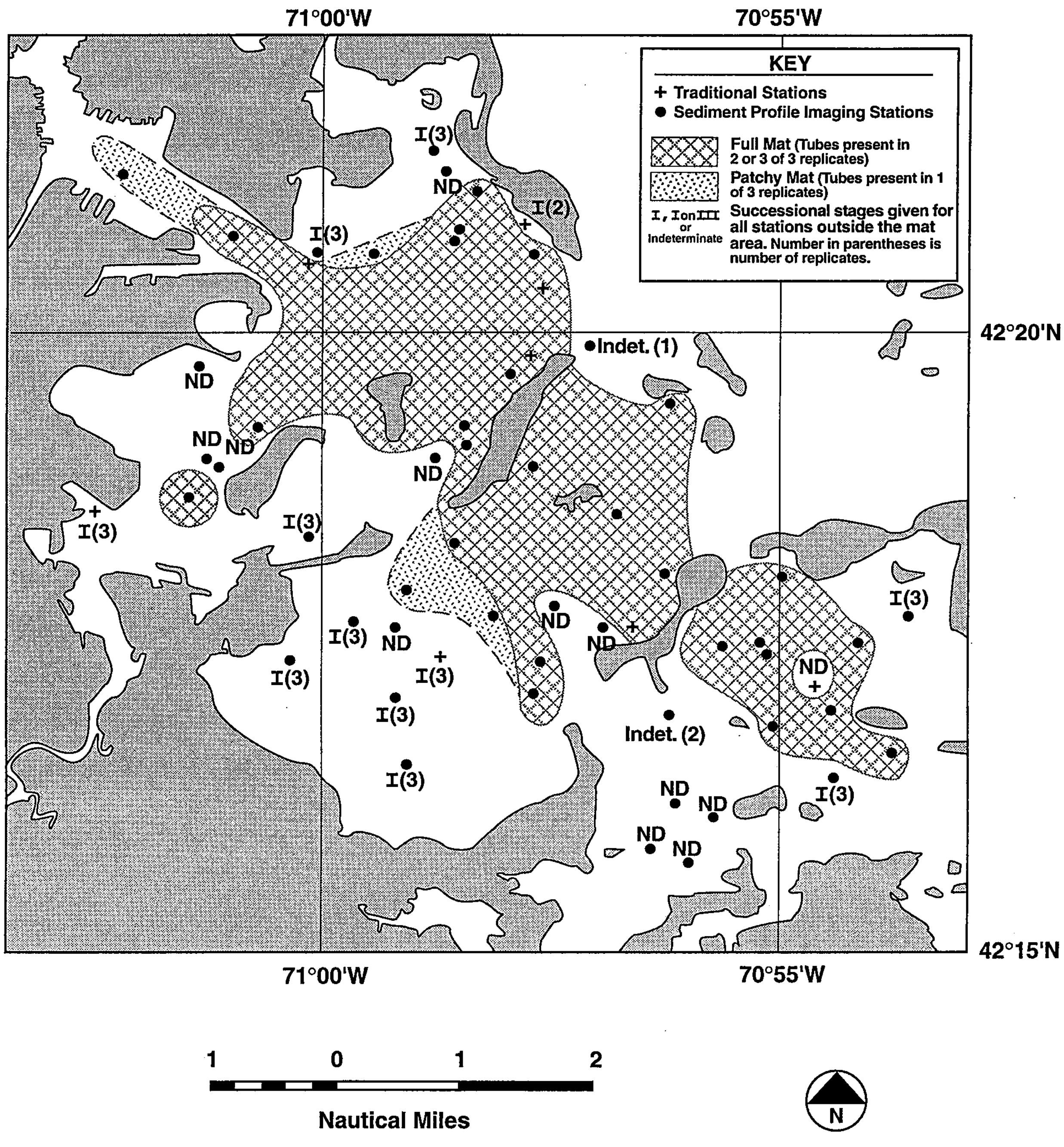


Figure 17. Mapped successional stages in August 1997. More than half of the sampled stations are dominated by Stage II amphipods (*Ampelisca* sp.). Stage I and I on III seres dominate nearshore.

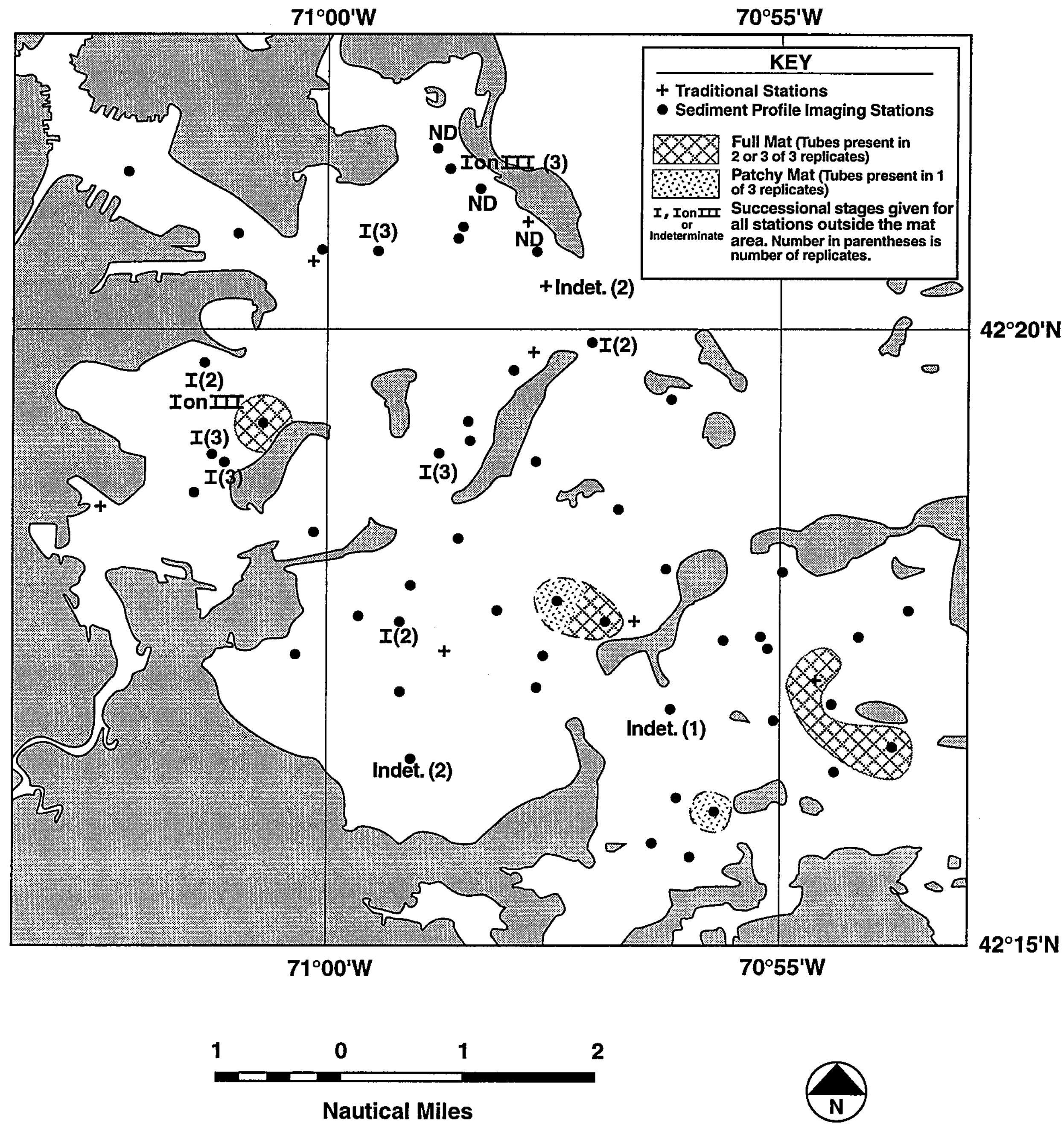


Figure 18. Mapped successional stages in October 1997. Most of these stations are located nearshore and are populated by Stage I assemblages.

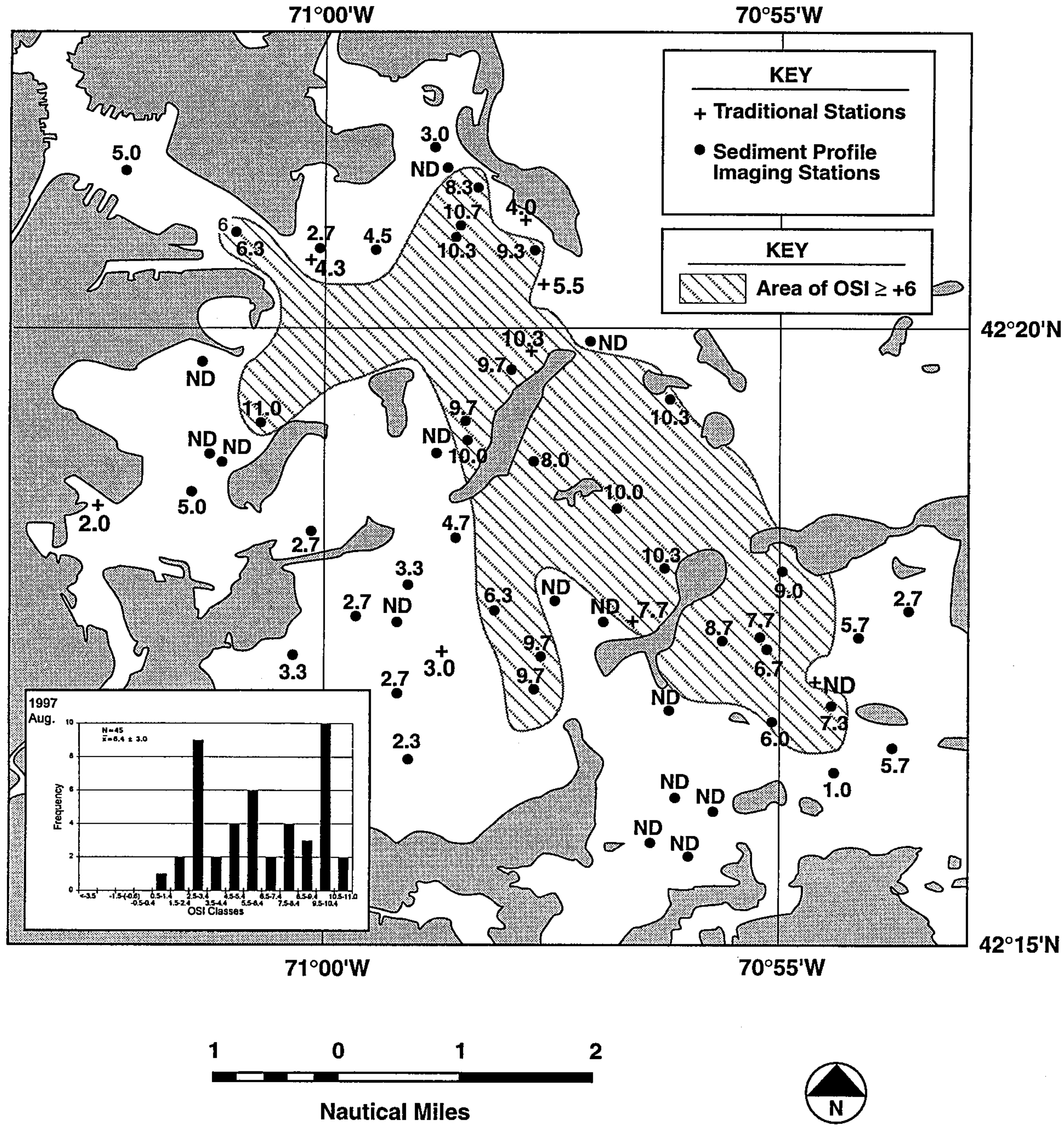


Figure 19. Contoured Organism-Sediment Indices (OSIs) for August, 1997. Values ≥+6 are shown by cross-hatching. The polymodal OSI frequency histogram is shown in the inset.

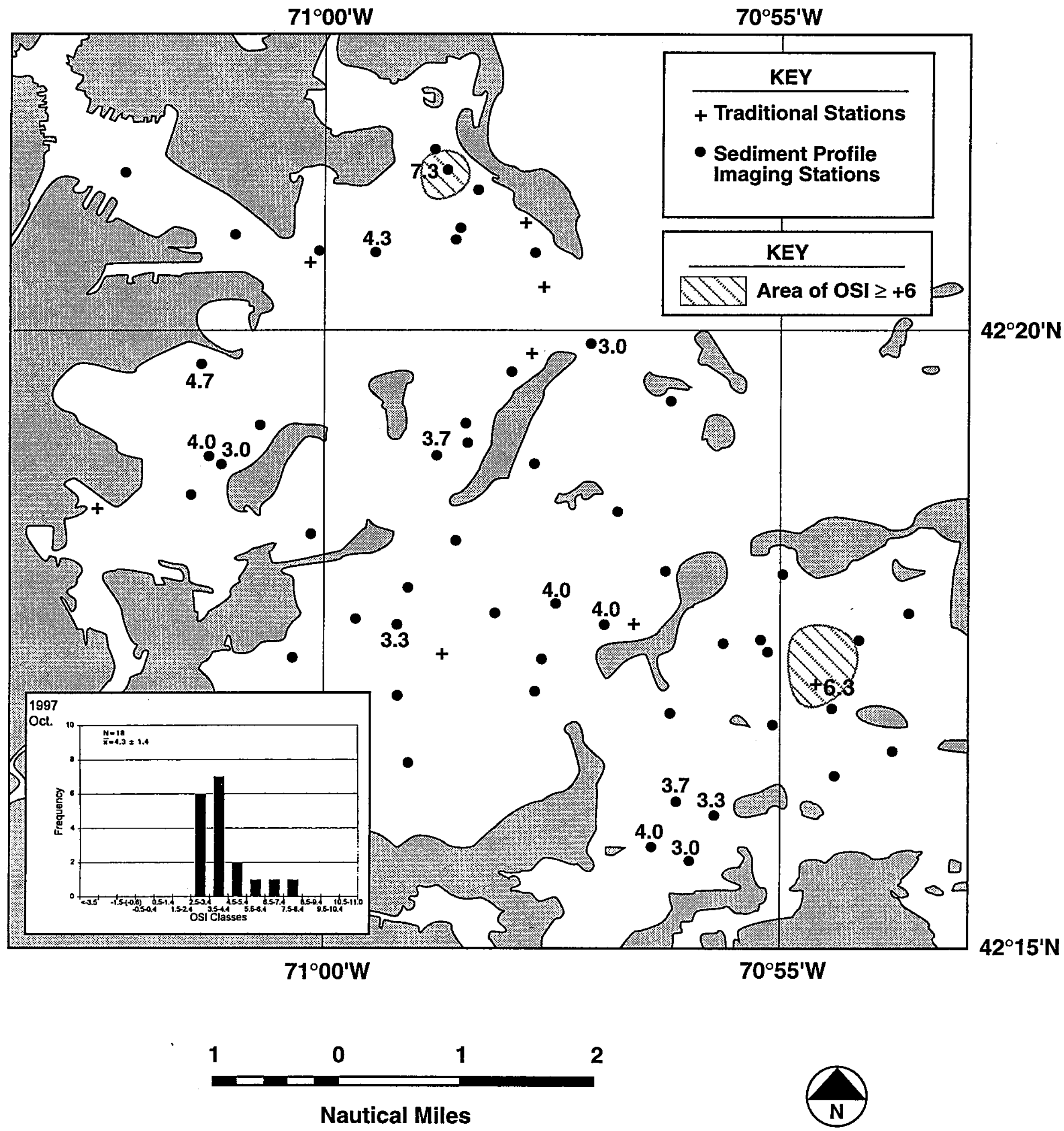


Figure 20. Contoured Organism-Sediment Indices (OSIs) for October 1997. Values ≥+6 are shown by cross-hatching. The OSI frequency distribution is shown in the inset.

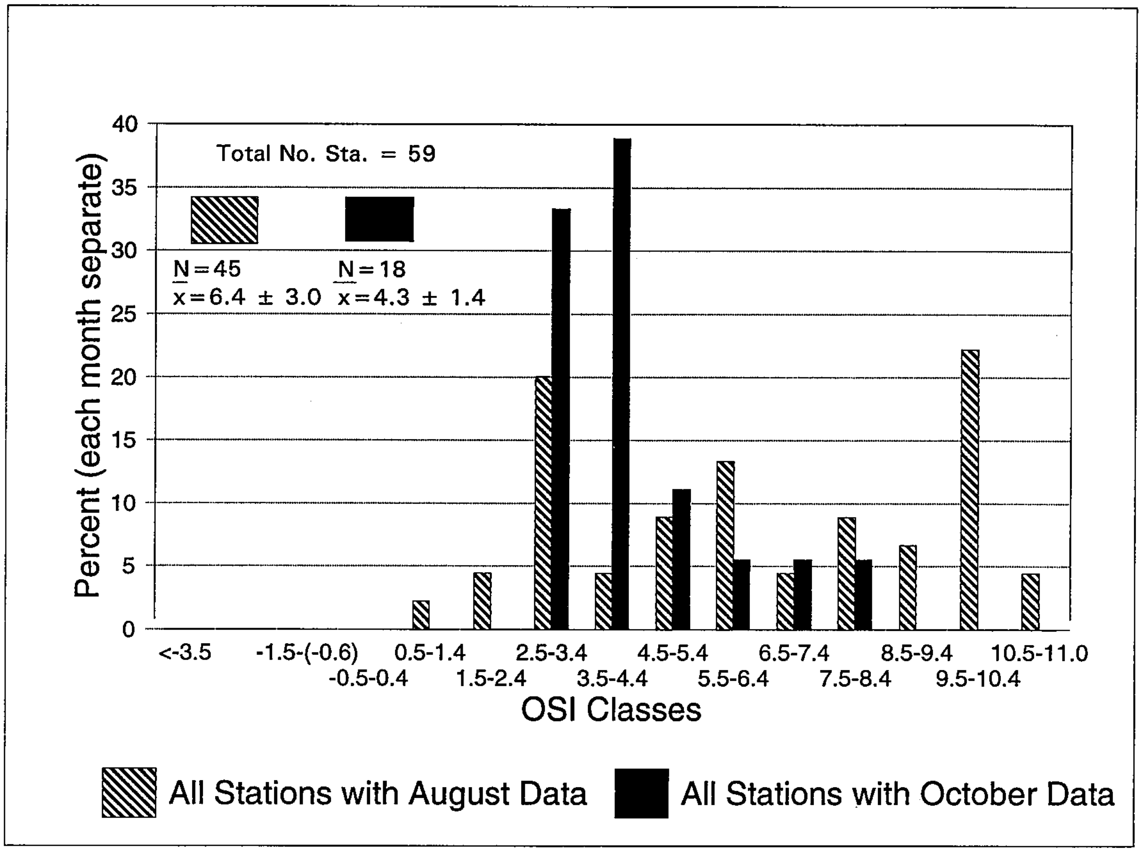


Figure 21. Frequency histogram of OSI classes plotted separately for August 1997 data (cross-hatched bars) and October 1997 data (solid bars). The y-axis is the percentage of stations falling within each OSI class interval. Note difference in sample size (N) between these two data sets.

3.3 Benthic Infauna: the 1996 Survey

3.3.1 Taxonomic Composition

In 1996, the benthic infauna of Boston Harbor included 150 species of which 116 species occurred in April and 102 species in August (Appendix E). Annelids comprised the largest segment of the infauna with 69 species (60%) in the spring and 56 species (55%) in the summer; the second largest group was the arthropods with 27 species (23%) and 24 species (24%), respectively. Mollusks contributed 14 and 19 species (12 and 19%), respectively, to the benthic infauna, and the remaining fauna was composed of a small number of platyhelminths, nemerteans, sipunculans, phoronids, echinoderms, and tunicates. During both seasons, spionids were the most species-rich polychaete family, contributing roughly 25-30% to the polychaete fauna; amphipods were the predominant crustacean group, comprising 67 and 75% of all crustacean species in spring and summer, respectively.

3.3.2 Distribution and Density of Dominant Species

Infaunal densities, based on all the organisms collected in each sample, were lowest at Station T4 in April (3100 individuals/m^2) and at Station T5A in August (6658 individuals/ m^2) and highest at Station T8 in the spring (177,467 individuals/m^2) and Station T6 in the summer (192,333 individuals/m^2). Stations T3 and T6 had the greatest increases between the April and August samplings, due principally to increases in the population densities of several amphipod species. In contrast to 1995, there was no *Ampelisca* mat sampled at Station T5A in August 1996; consequently the large increase observed in 1995 was not repeated in 1996. Sharp declines in total densities between April and August 1996 were observed at Stations T2 and T4, due to much lower numbers of *Streblospio benedicti* at those stations.

The most abundant species and their contribution to the infauna at each station are listed in Appendices F1 and F2. In April 1996, the infauna in the Harbor showed a composition similar to that documented over the last few years. Tubificid oligochaetes were widespread and abundant (Figure 22A); amphipod mats were especially common at Stations T3, T6, and T8 (Figure 22B); and the spionid polychaete *Streblospio benedicti* had a relatively high abundance at inshore Stations T1, T2, and T4 (Figure 22C). In addition, the blue mussel *Mytilus edulis* was found to be widespread at generally moderate densities of about 600 to 800 individuals/m^2 throughout the Harbor (densities were lower at Station T4 and higher at Station T8). High densities of the clay borer *Petricola pholadiformis* (2500 individuals/m^2) and *Nucula delphinodonta* (14,100 individuals/m^2) were found at Stations T6 and T8, respectively.

In August 1996, tubificid oligochaetes were still widespread, but in many cases not as abundant as in the spring, especially in the southern Harbor where the populations decreased sharply. For example, at Station T8 in Hull Bay, tubificid densities declined from more than 50,000 individuals/m^2 in April to just over 2000/m^2 in August (see Figure 22A). The *Ampelisca* mats at Stations T3, T6, and T8 were still present in the summer, with a 3- to 4-fold increase in density at Stations T3 and T6 and a slight increase at T8 (Figure 22B). Stations T1 and T2 had moderate abundances of *Tubificoides* nr. *pseudogaster* and *Streblospio benedicti* during both seasons. *Streblospio* was also present in relatively high densities at Station T4 (both spring and summer) where it has been the dominant species for several years (Figure 22C). Station T5A near Deer Island Flats mirrored somewhat the seasonal changes at T6, where the very abundant tubificids were replaced by highly abundant amphipods in the summer. At T5A, a similar shift in the top dominant occurred: the top ranking species in the spring was the snail *Ilyanassa trivittata*, and in the summer the opportunistic bivalve *Tellina agilis*. At Station T7, the infauna was somewhat similar to that at Stations T1 and T2, with tubificids and *Streblospio* predominating; however, a different oligochaete, *T. apectinatus*, was the most abundant species at this station.

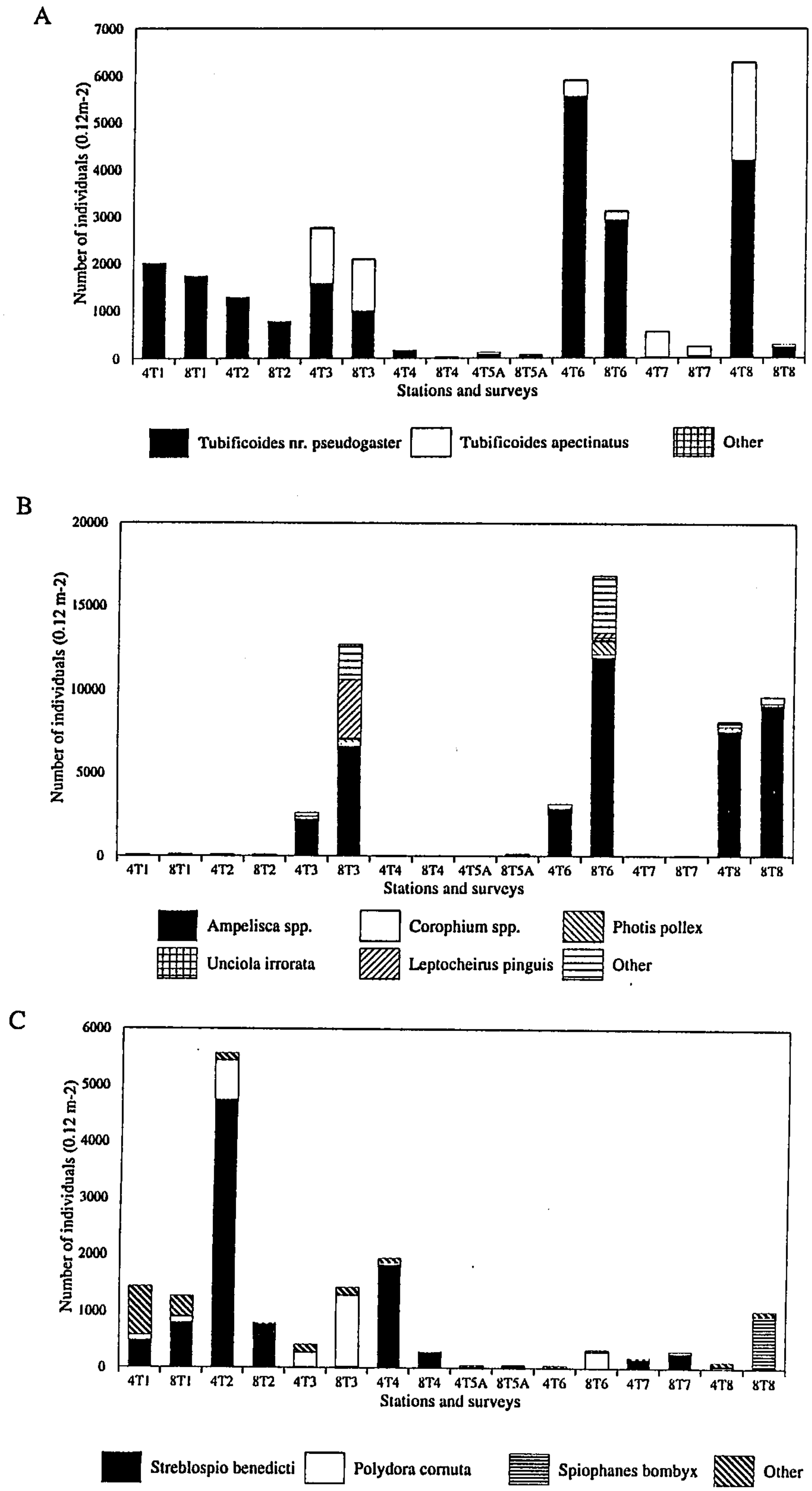


Figure 22. Densities of (A) oligochaetes, (B) amphipods, and (C) spionid polychaetes at the Boston Harbor Traditional Stations in April and August 1996. The number in front of the station designation indicates the month of sampling (e.g., 4T1 = April 1996, Station T1).

3.3.3 Species Richness and Diversity

In 1996, species richness ranged from 21 (T4) to 70 (T8) in April and from 10 (T4) to 64(T8) in August (Tables 1 and 2; taxa not identified to species excluded). Seasonal changes were different at individual stations; at Stations T1, T5A and T7 the number of species was nearly the same during both seasons; whereas at Stations T2, T4, T6 and T8 it was lower in the summer than in the spring, and at Station T3 it was higher in the summer. The increase in species richness at the latter station is probably related to the development of a very dense amphipod mat in the summer, which, when fully developed, seems to attract a wide variety of species, perhaps because it provides microhabitat. The high number of species in the spring and subsequent decrease between spring and summer at three other stations may be the result of die-off or emigration of juveniles that had recently settled around the time of the spring sampling.

Diversity as measured with the Shannon-Wiener index (H′) was highest at Station T5A in both April and August (Tables 1 and 2) and at Station T1 as measured with the Hurlbert rarefaction method (Figure 23, Tables 1 and 2). Diversity was lowest at Station T4 during both seasons and as measured with both the Hurlbert rarefaction method (Figure 23) and the Shannon-Wiener index (H′) (Tables 1 and 2). The seasonal trend was toward higher diversity in the summer except at Stations T4 and T8. The oxygen concentration in the sediment is very low at Station T4 and the benthic community at this station is apparently sensitive to even small changes that may be related to warmer temperatures and other parameters such as increased organic loading either from runoff or the large number of boats in the nearby yacht club. In August, abundances of the two most important species at Station T4, *Streblospio benedicti* and *Tubificoides* nr. *pseudogaster*, declined to one-sixth the spring values. Diversity values at Station T8 stayed essentially the same between April and August.

3.3.4 Community Analysis

April 1996. The 1996 data were analyzed using both the Bray-Curtis similarity index and CNESS; each season was analyzed separately and replicates were analyzed both separately and pooled. For April 1996, these approaches gave similar results. Both the Bray Curtis and CNESS analyses of separate replicates produced similar groupings of stations (Figure 24). Both dendrograms indicate four station clusters, grouping the stations roughly by geography and species composition/diversity. The groups can be described as (1) northern/lower diversity (T1, T2, and sometimes T4); (2) high diversity T5A; (3) outer Harbor stations (T3, T6, T8), and (4) Quincy Bay station (T7) (which sometimes clusters with T4).

PCA-H (at m=18) was used to further examine the community structure of the April 1996 data. The Gabriel Euclidean distance biplot, which provides a two-dimensional projection of the major sources of the CNESS variation, is shown in Figure 25 for PCA-H axis 1, which accounted for 40% of the variation, versus axis 2, which accounted for 15% of the variation. Seven species in particular were identified as important to the station groupings. The polychaetes *Streblospio benedicti* and *Polydora cornuta,* which were dominant at Stations T1, T2, and T3; the molluscs *Ilyanassa trivittata* and *Mytilus edulis*, which were dominant at Station T5A; the amphipod *Ampelisca abdita* and the polychaete *Aricidea catherinae*, which were important at Stations T3, T6 and T8; and the oligochaete *Tubificoides apectinatus*, which along with *Aricidea catherinae*, dominated Station T7.

Figure 26 presents the Bray-Curtis and CNESS dendrograms produced by an analysis of the April replicates pooled for each station. The groupings are essentially those seen in the separate-replicates analysis, with Station T4 grouping with Stations T1 and T2 rather than being split between that grouping and Station T7. The Gabriel Euclidean distance biplot for pooled replicates (Figure 27) is also essentially identical to that

Table 1. Community parameters (replicates averaged) for the Boston Harbor Traditional stations, April 1996.

Station	# spp ($0.12 m^2$)	# indiv. ($0.04 m^2$)	spp./ 50 ind.	spp./100 ind.	spp./500 ind.	H′	J′
T1	54	1190	9.3	13.1	27.2	2.4	0.5
T2	53	2445	7.0	9.5	18.9	1.9	0.4
T3	47	3174	8.9	11.4	20.5	2.8	0.5
T4	21	731	5.7	7.3	n/a	1.4	0.4
T5A	37	160	14.4	19.3	n/a	3.2	0.7
T6	48	3650	7.1	9.6	18.6	2.1	0.4
T7	31	476	8.9	11.2	n/a	2.6	0.6
T8	70	6830	10.0	13.3	24.7	2.9	0.5

Table 2. Community parameters (replicates averaged) for the Boston Harbor Traditional stations, August 1996.

Station	# spp ($0.12 m^2$)	# indiv. ($0.04 m^2$)	spp./ 50 ind.	spp./100 ind.	spp./500 ind.	H′	J′
T1	54	1365	11.3	15.2	27.4	2.9	0.6
T2	34	651	7.0	9.5	19.7	2.1	0.5
T3	57	6820	10.4	12.7	21.5	3.1	0.6
T4	10	111	4.3	n/a	n/a	0.8	0.3
T5A	34	212	15.2	19.8	n/a	3.6	0.8
T6	42	7394	8.3	10.8	18.1	2.3	0.5
T7	32	439	10.8	14.0	n/a	2.9	0.7
T8	64	4589	10.7	14.3	25.2	2.6	0.5

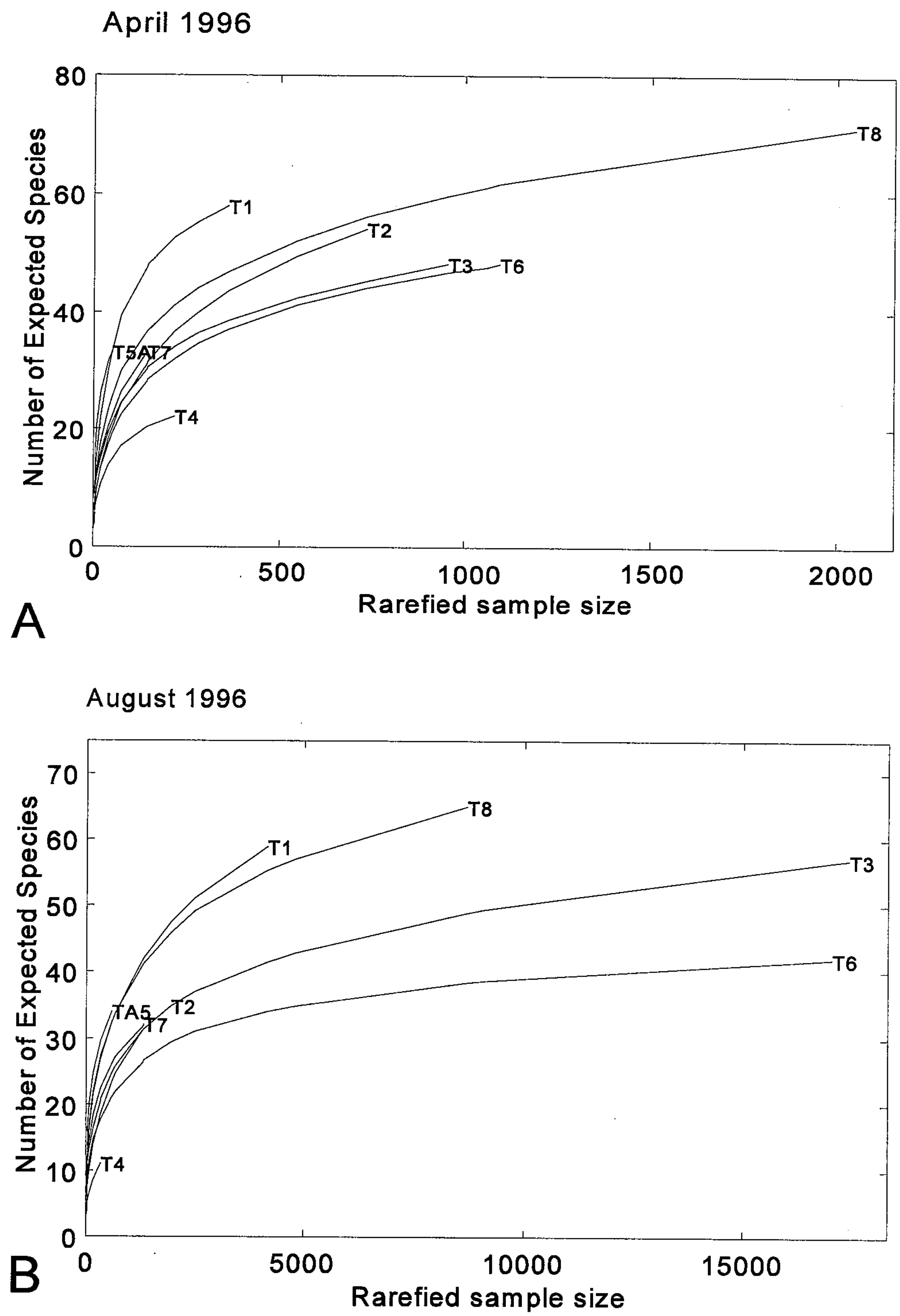


Figure 23. Rarefaction curves for samples taken in April (A) and August (B) 1996 at Boston Harbor traditional stations. Values plotted are for pooled replicates.

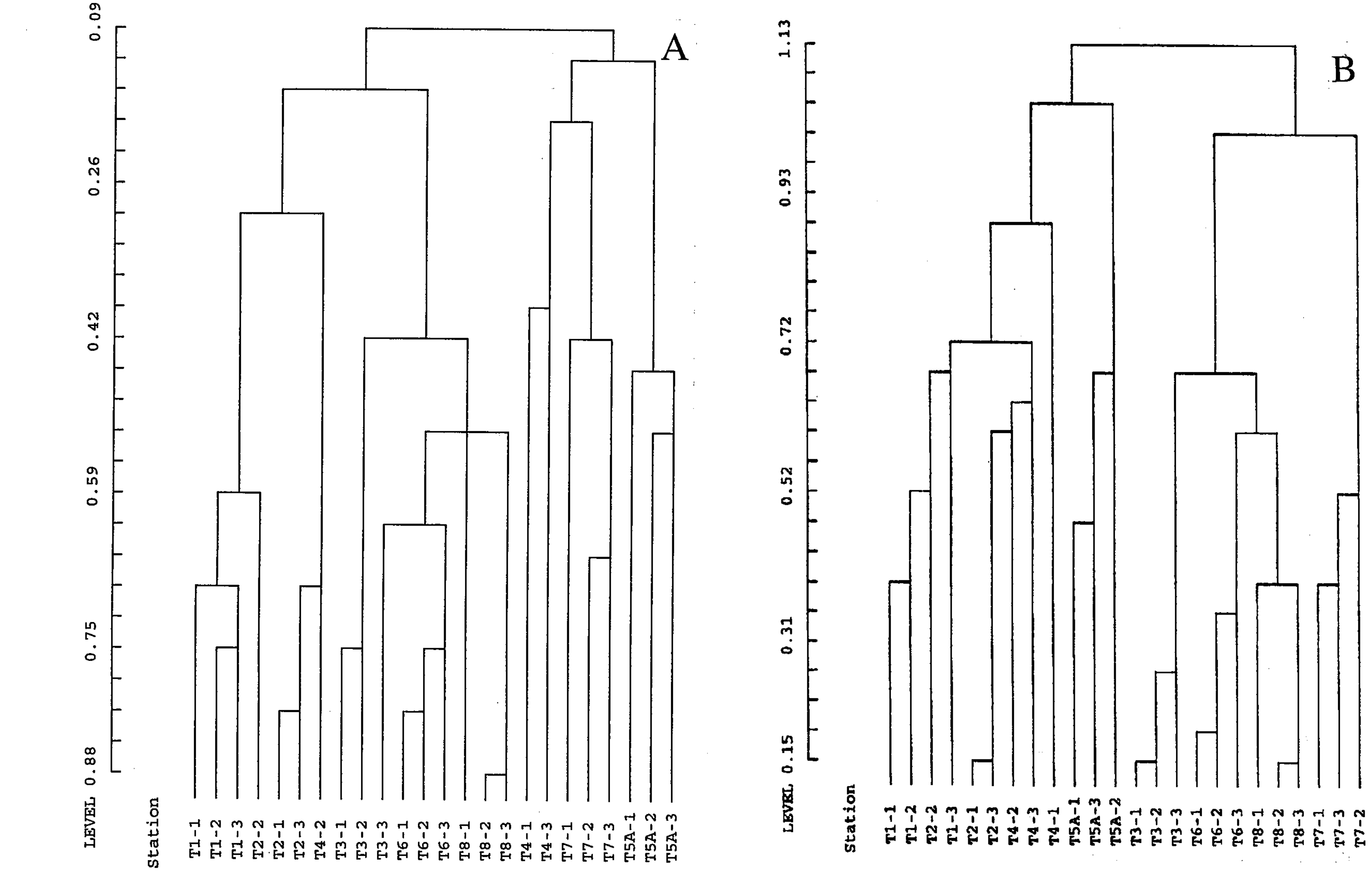


Figure 24. Similarity among replicates taken in April 1996 at Boston Harbor Traditional stations as measured with the Bray-Curtis similarity measure (A) and CNESS (m=18) dissimilarity measure (B).

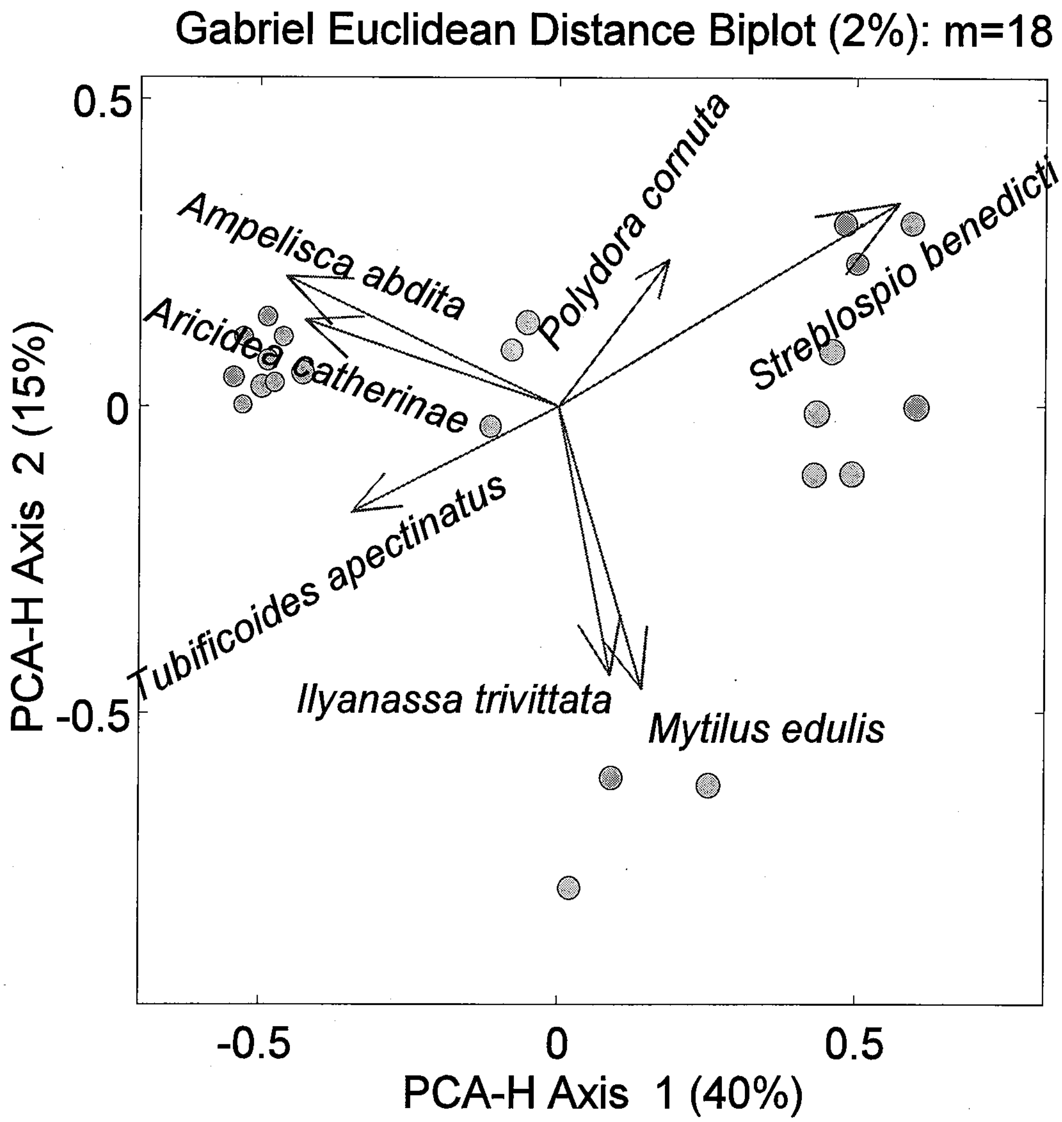


Figure 25. Gabriel Euclidean distance biplot based on individual replicates taken at Boston Harbor traditional stations in April 1996.

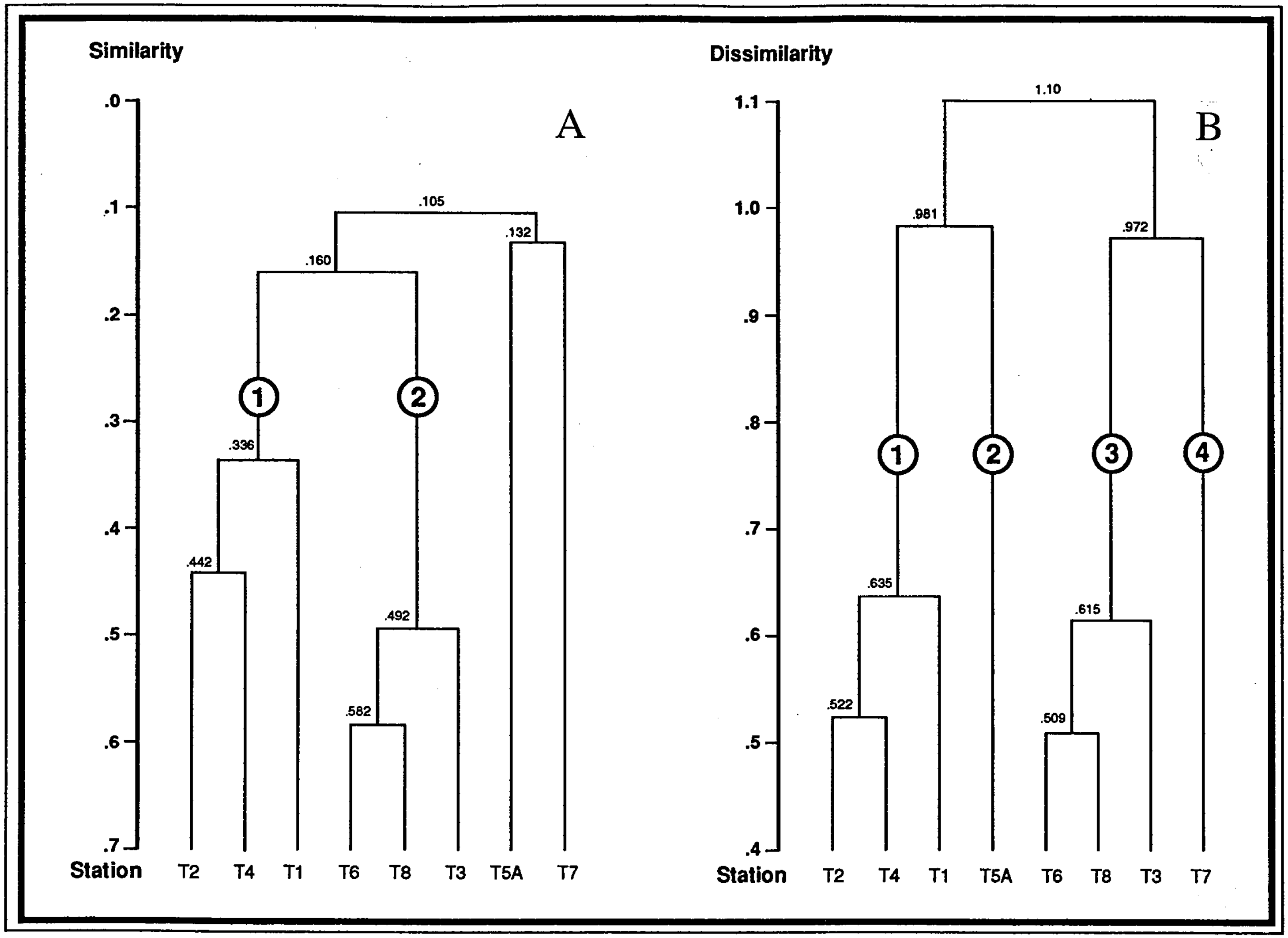


Figure 26. Relationships among the Boston Harbor Traditional stations (replicates pooled) in April 1996 as measured with the Bray-Curtis similarity measure (A) and the CNESS (m=18) dissimilarity measure (B).

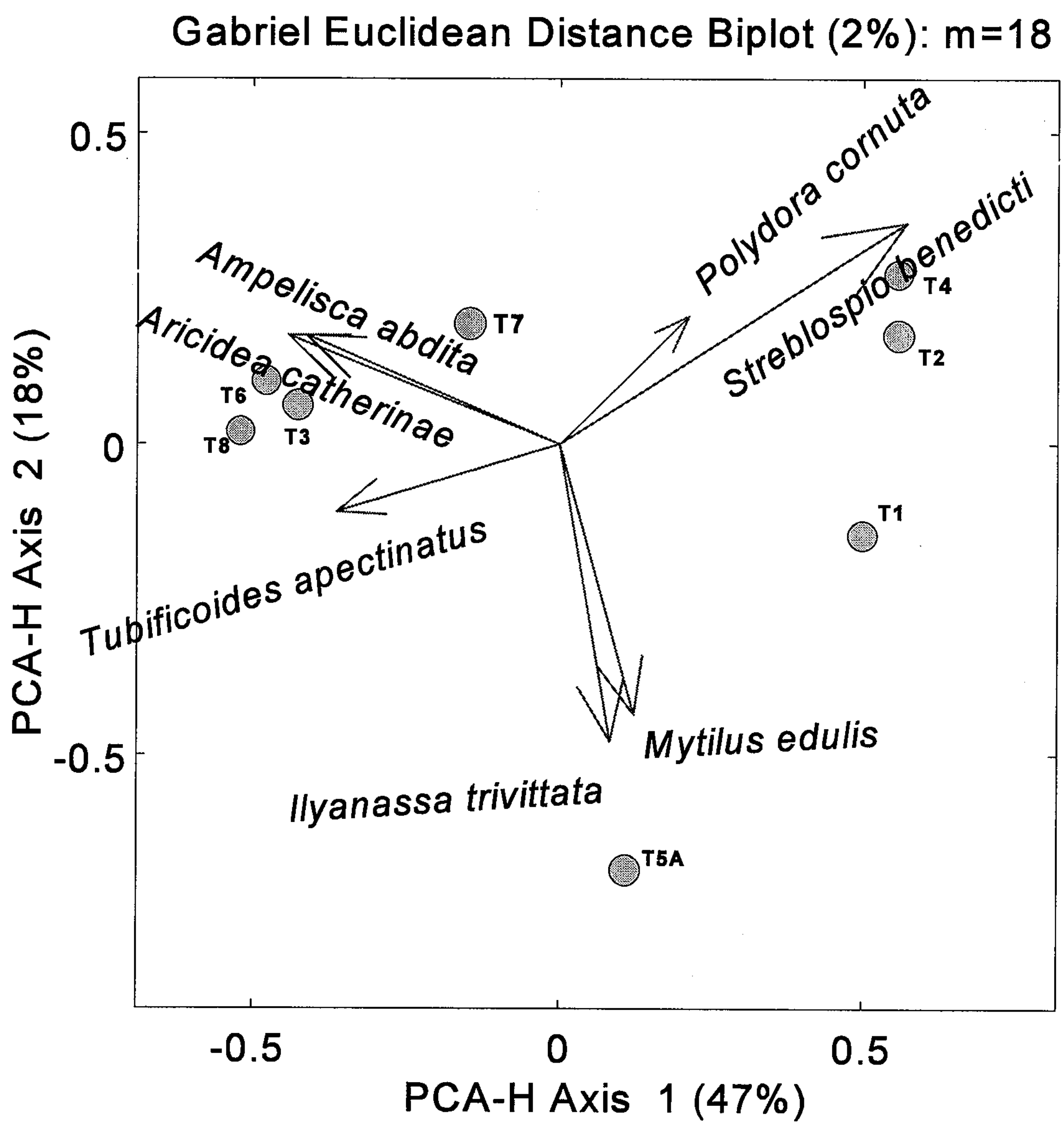


Figure 27. Gabriel Euclidean distance biplot based on pooled samples taken at Boston Harbor traditional stations in April 1996.

produced for separate replicates, but with axis 1 accounting for 47% of the variation. Figure 28 shows the position of stations (a) and dominant species (b) in the space defined by the first three axes of the PCA-H analysis. The first three axes account for 82% of the total variance in the CNESS distances among stations: 47% on axis 1, 18% on axis 2, and 17% on axis 3. Axis 1 reflects the separation of the northern/inshore stations (T1, T2, T4 and T5A) from the outer/southern harbor stations (T3, T6, T7, and T8). Axis 2 reflects the separation of T5A and, to a lesser extent, Station T1, from the remaining stations, and axis 3 reflects the separation of Quincy Bay Station T7 from the rest. Ten species account for 76% of the total variation in the infaunal community structure as defined by the CNESS distances (Table 3). Five of these species account for 87% of the variation on axis 1; three species account for 55% of the variation on axis 2, and five species account for 80% of the variation on axis 3.

August 1996. The Bray-Curtis and CNESS dendrograms for the August 1996 samples show the same major station groupings as seen in April, although with differences in levels of similarity at which stations join (or, conversely, levels of dissimilarity) (Figure 29). The Bray-Curtis analysis shows successive linkages of a group comprised of samples from Stations T1 and T2 with Stations T7, T4, and finally T5A. This pattern is comparable to that seen with the CNESS analysis for April samples. In August, Stations T3, T6, and T8 form a grouping that is distinct from that formed by the other stations; in the April analysis, this grouping was most similar to Stations T1 and T2. The CNESS analysis is similar to the Bray-Curtis results in that Stations T1 and T2, then T7 and T4 group to form a major cluster; unlike the Bray-Curtis analysis, this major group does not include Station T5A. Stations T3, T5A, T6 and T8 form four distinct station groupings that comprises second major, albeit dissimilar cluster. Although the major groupings can still be elucidated, it is noteworthy that each station appears to have a distinct identity. Station T7 in Quincy Bay is not quite as distinctive in August as it was in April 1996.

Principal components analysis of metrically scaled CNESS (m=18) distances (PCA-H) was used to further examine the community structure of the August 1996 data. Figure 30 is the Gabriel Euclidean distance biplot of PCA-H axis 1, which accounted for 38% of the variation, versus axis 2, which accounted for 15% of the variation. Species identified as important to the station groupings included the polychaete *Streblospio benedicti,* a top dominant at Stations T1, T2, T4 and T7. *Spiophanes bombyx*, another polychaete, along with the bivalve *Tellina agilis* and the mysid *Neomysis americana* account for the distinctiveness of Station T5A. The amphipod *Phoxocephalus holbolli* was important at Stations T3 and T6, as was *Ampelisca abdita*, which was also dominant at Stations T5A and T8.

Figure 31 presents the Bray-Curtis and CNESS dendrograms produced by an analysis of the August replicates pooled. The groupings are essentially those seen in the separate-replicates analysis. The Gabriel Euclidean distance biplot for pooled replicates (Figure 32) is also very similar to that produced for separate replicates, but with axis 1 accounting for 42% of the variation (the presentation in Figure 32 is similar but rotated from that shown in Figure 30). Figure 33 shows the position of stations (a) and dominant species (b) in the space defined by the first three axes of the PCA-H analysis. The first three axes account for 72% of the total variance in the CNESS distances among stations: 42% on axis 1, 17% on axis 2, and 13% on axis 3. Axis 1 separates the inshore stations T1, T2, T4 and T7 from the remaining stations. Axis 2 separates T5A, and axis 3 separates Stations T4 and T7 from T1 and T2 and further separates the stations in cluster 2. Ten species account for 62% of the total variation in the infaunal community structure as defined by the CNESS distances (Table 4). Two of these species account for 52% of the variation on axis 1; four species account for 55% of the variation on axis 2, and four species account for 61% of the variation on axis 3.

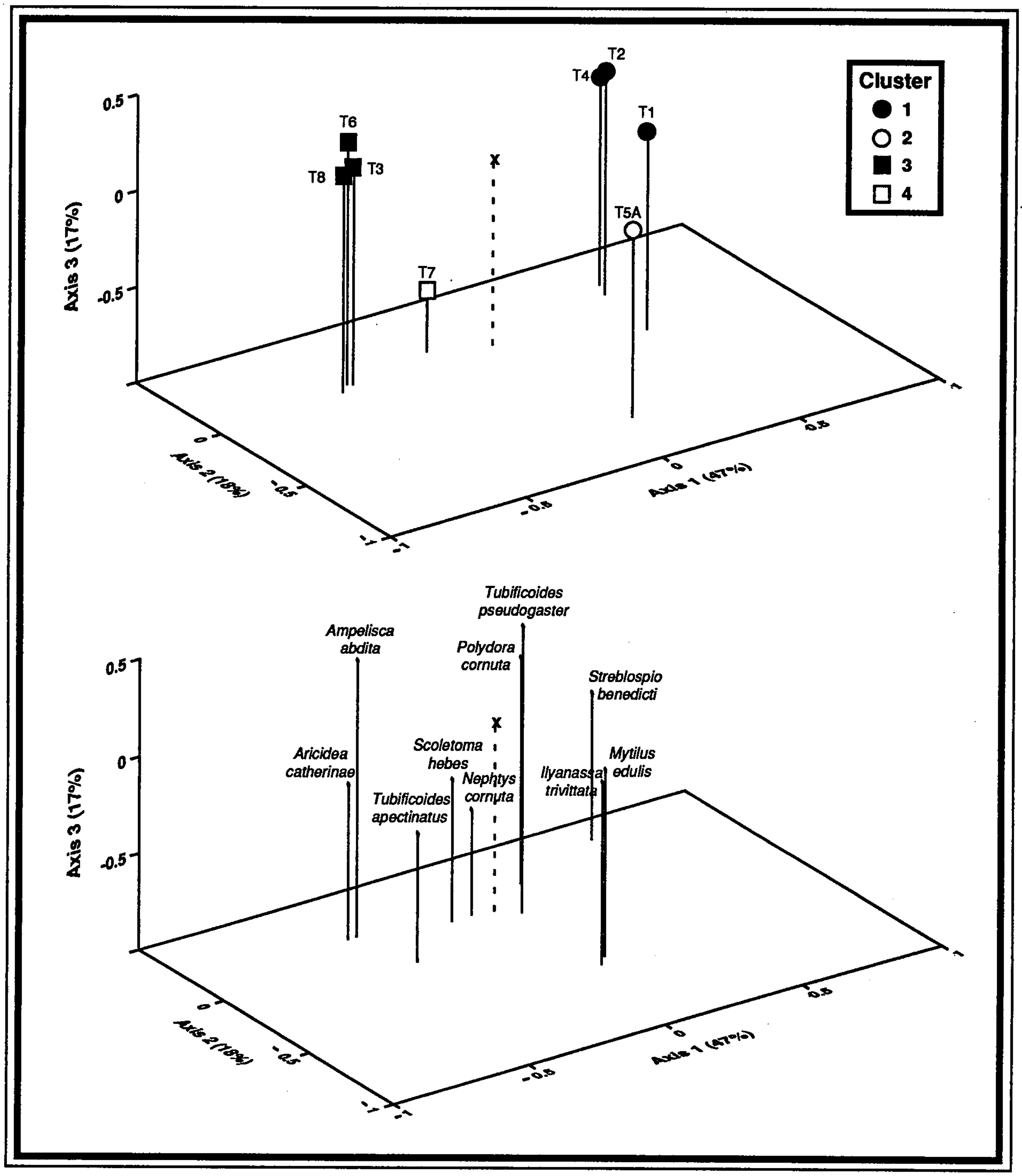


Figure 28. PCA-H analysis of CNESS distances for samples taken at the Boston Harbor Traditional stations in April 1996. The first three axes account for 82% of the total variation.

Table 3. Species and their contribution to CNESS distances, April 1996, replicates pooled.

Species	% Contribution to Total CNESS Distances		% Contribution to Relative (Axes) CNESS Distances		
	% Contrib.	Cumul. %	Axis 1	Axis 2	Axis 3
Streblospio benedicti	19	19	32	13	6
Aricidea catherinae	11	30	20	3	4
Ampelisca abdita	11	41	17	3	18
Tubificoides apectinatus	9	50	13	1	11
Polydora cornuta	6	56	5	4	3
Ilyanassa trivittata	5	61	1	23	0
Mytilus edulis	5	66	2	19	0
Tubificoides nr. pseudogaster	4	70	1	0	23
Nephtys cornuta	4	74	0	1	21
Scoletoma hebes	2	76	1	1	7

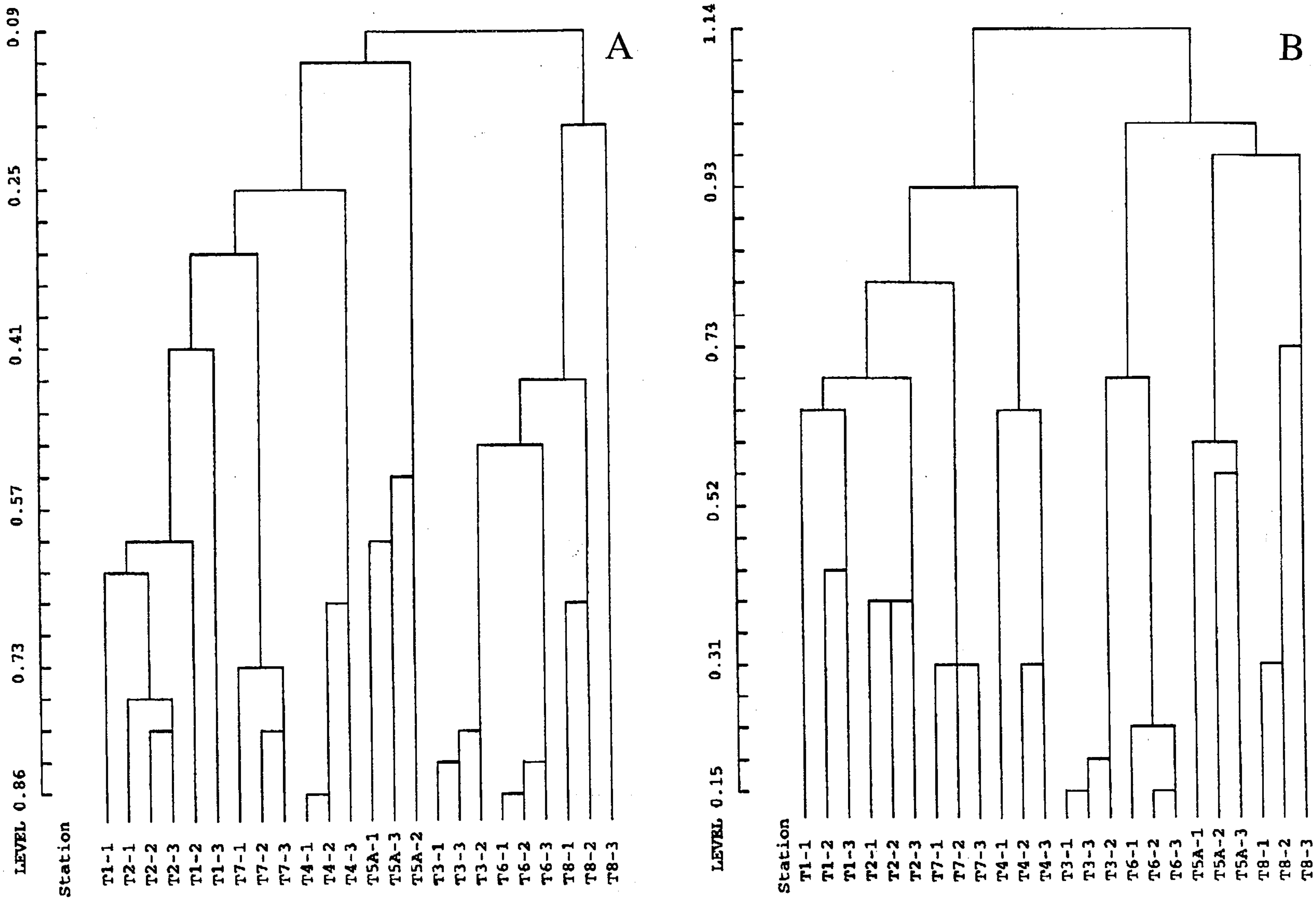


Figure 29. Similarity among replicates taken in August 1996 at Boston Harbor Traditional stations as measured with the Bray-Curtis similarity measure (A) and CNESS (m=18) dissimilarity measure (B).

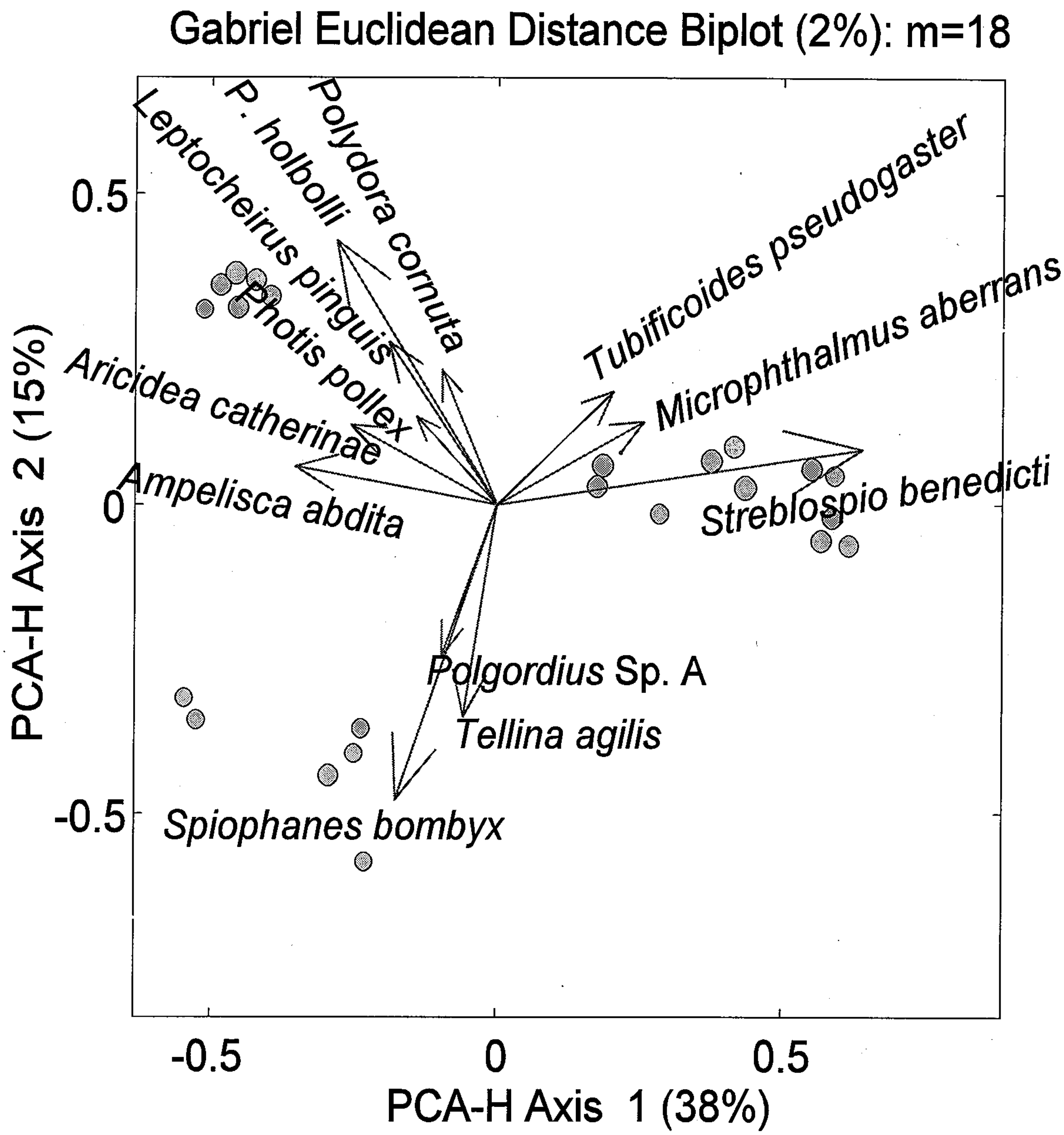


Figure 30. Gabriel Euclidean distance biplot based on individual replicates taken at Boston Harbor traditional stations in 1996.

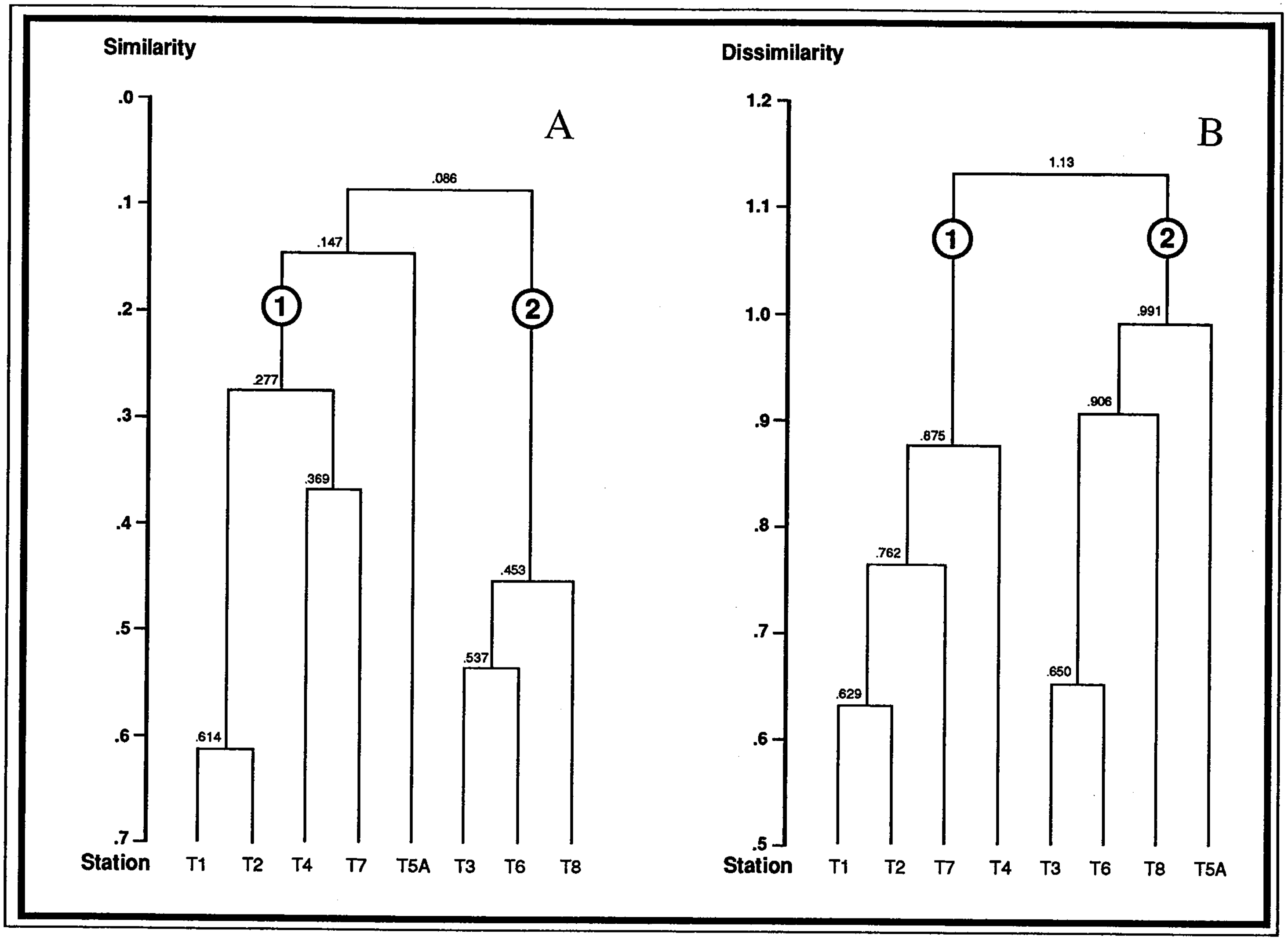


Figure 31. Relationships among the Boston Harbor Traditional stations (replicates pooled) in August 1996 as measured with the Bray-Curtis similarity measure (A) and the CNESS (m=18) dissimilarity measure (B).

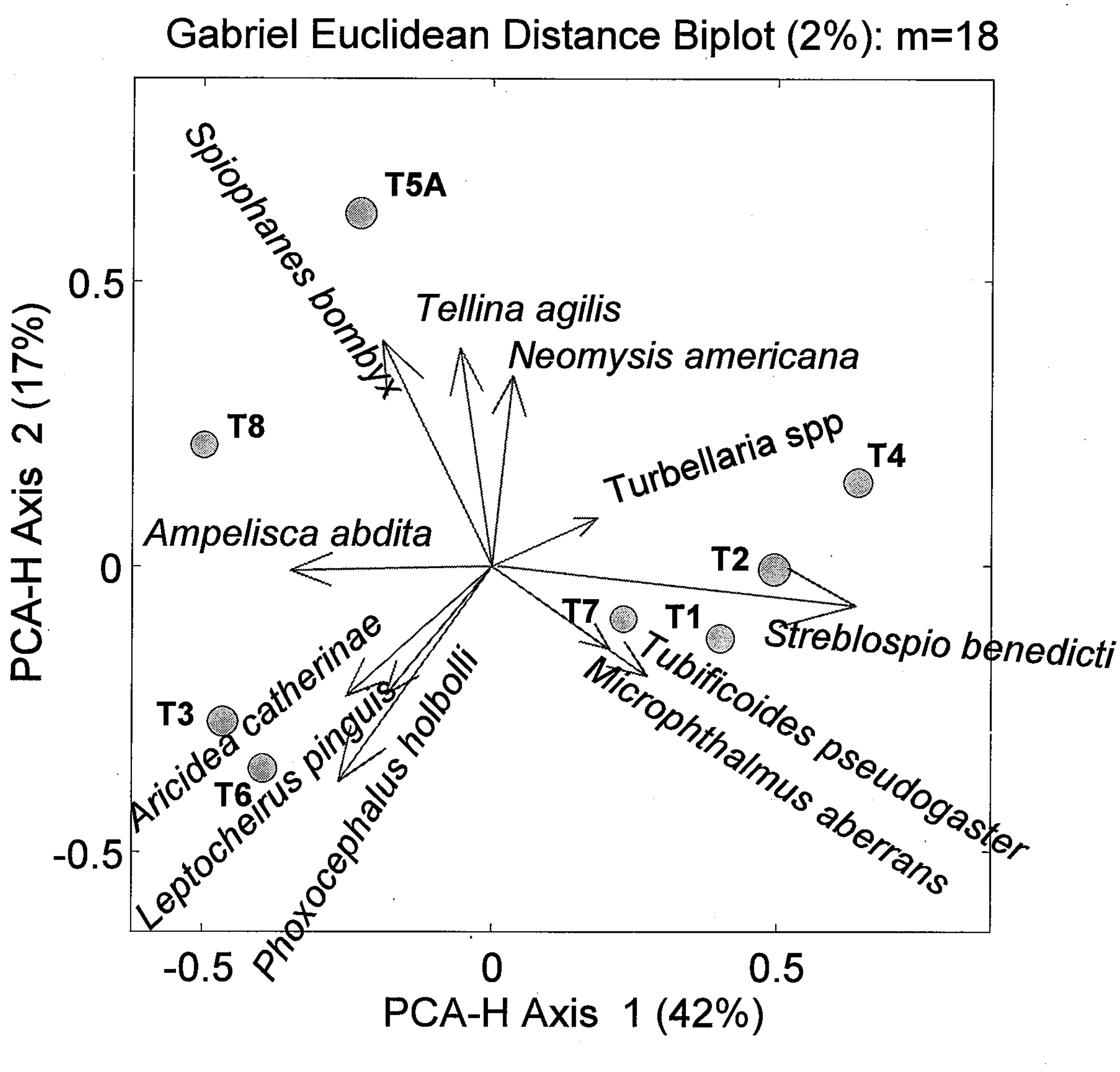


Figure 32. Gabriel Euclidean distance biplot based on pooled samples taken at Boston Harbor traditional stations in August 1996.

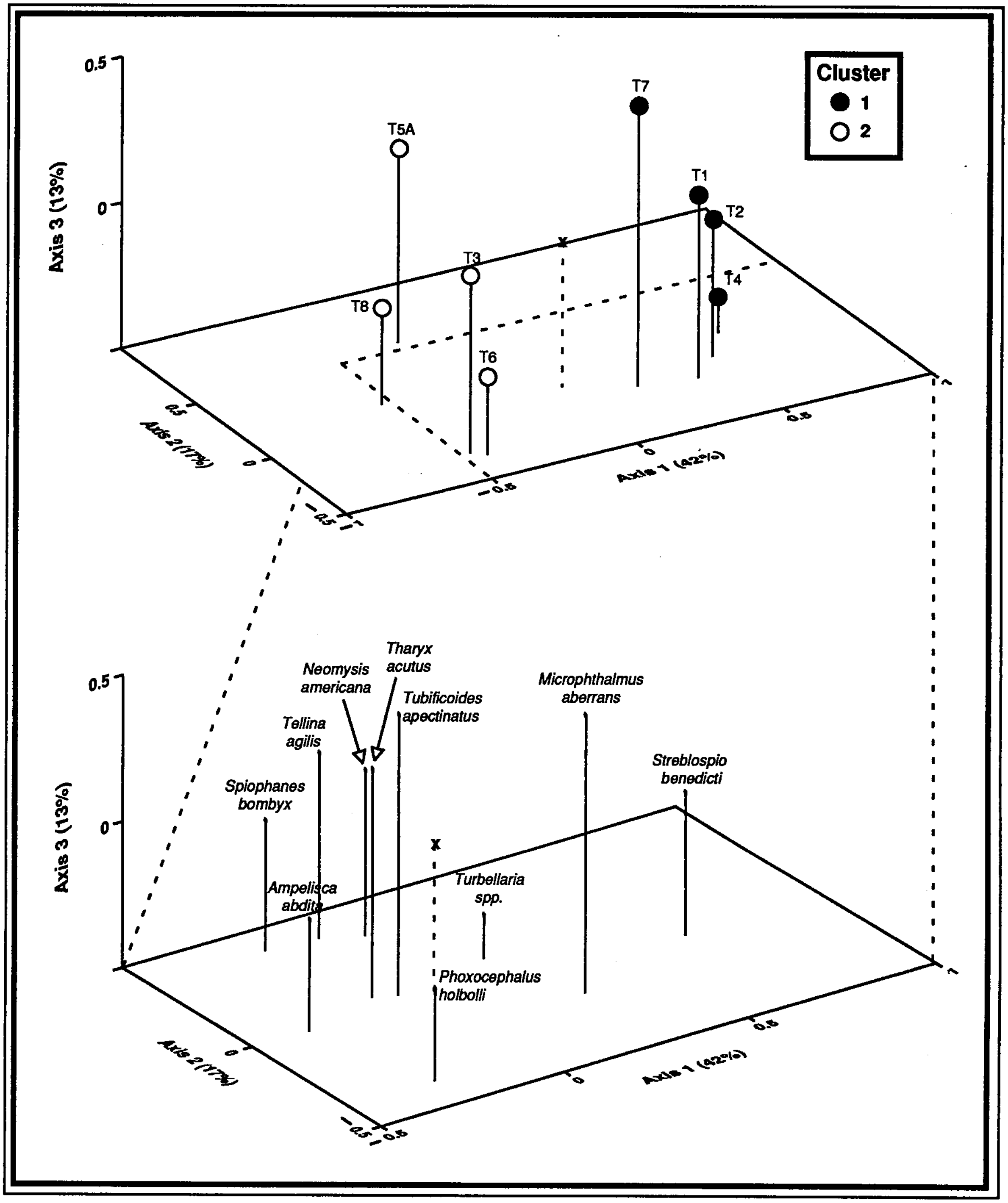


Figure 33. PCA-H analysis of CNESS distances for samples taken at the Boston Harbor Traditional stations in August 1996. The first three axes account for 72% of the total variation.

Table 4. Species and their contribution to CNESS distances, August 1996, replicates pooled.

Species	% Contribution to Total CNESS Distances		% Contribution to Relative (Axes) CNESS Distances		
	% Contrib.	Cumul. %	Axis 1	Axis 2	Axis 3
Streblospio benedicti	17	17	40	0	0
Ampelisca abdita	6	23	12	0	2
Spiophanes bombyx	5	28	4	16	0
Tellina agilis	3	31	0	14	2
Neomysis americanus	3	34	0	11	0
Phoxocephalus holbolli	6	40	7	14	4
Microphthalmus aberrans	8	48	7	4	20
Tubificoides apectinatus	5	53	1	0	21
Turbellaria spp	5	58	4	1	12
Tharyx acutus	4	62	2	0	8

3.4 Benthic Infauna: the 1997 Survey

3.4.1 Taxonomic Composition

In 1997, the benthic infauna included 152 species of which 112 species occurred in April and 100 in August (Appendix E). Annelids comprised the largest segment of the infauna with 62 species (55%) in the spring and 54 species (54%) in the summer; the second largest group was the arthropods with 28 species (25%) and 26 species (26%), respectively. Mollusks contributed 17 and 18 species (15 and 18%), respectively, to the benthic infauna, and the remaining fauna was composed of a small number of platyhelminths, nemerteans, phoronids, echinoderms, and tunicates. During both seasons, spionids were the most species-rich polychaete family, contributing roughly 21% of the polychaete fauna; amphipods were the predominant crustacean group, comprising 64 and 73% of all crustacean species in spring and summer, respectively.

A summary of the entire benthic infauna identified from the Boston Harbor benthos for 1995-1997 is presented in Appendix E. A total of 200 species were identified including: 93 annelids (46.5%), 52 crustaceans (26%), 36 molluscs (18%), and 19 species from lesser groups (9.5%). Within these major categories, there were 86 polychaetes (43%), 33 amphipods (16.5%), and 24 bivalves (12%). At the species level, the Spionidae (16), Phyllodocidae (11), and Cirratulidae (9) were the best represented polychaete families and the Corophiidae (7) had the most amphipod species.

3.4.2 Distribution and Density of Dominant Species

Infaunal densities, based on all the organisms collected in each sample, were lowest at Station T4 in both April (9917 individuals/m^2) and August (2667 individuals/m^2). The highest densities were recorded at Station T3 in both April (145,375 individuals/m^2) and August (551,650 individuals/m^2). Infaunal densities were lower in April 1996 compared to April 1997, but significantly higher in August due to the extraordinarily high abundances at Stations T3 and T5A, where over 540,000 individuals/m^2 were estimated. Although the general patterns seen in 1996 were documented again in 1997, the patchy and seasonal nature of the fauna was again evident.

The most abundant species and their contribution to the infauna at each station are listed in Appendices F3 and F4. Figure 34 shows the relative abundances of some of the top dominants in both April and August 1997. The oligochaete *Tubificoides* nr. *pseudogaster* was consistently among the top 10 dominant species at all eight Harbor stations, and ranked as the top dominant at Station T6 for the past four sampling seasons. As in 1996, the August 1997 densities of this widespread species were lower than the April 1997 densities, resulting in a lower ranking at the majority of stations. In some cases, *T.* nr. *pseudogaster* was replaced by another species, *T. pectinatus*, as at Station T2; while at other stations it maintained its April densities but was overshadowed by other species. For example, at Station T1 *T.* nr. *pseudogaster* was the top dominant in April 1997 with a density of over 20,000 individuals /m^2 (21,208); in August, the density of this species was 16,800 individuals/m^2, but it was outranked by the spionid polychaete *Polydora cornuta*, which had a density of over 30,000 individuals/m^2. At Station T5A in April 1997, the bivalve *Mytilus edulis* ranked first with a density of 6367 individuals/m^2 and *T.* nr. *pseudogaster* had 1542 individuals/ m^2. In August, *T.* nr. *pseudogaster* had increased to 3375 individuals/m^2 but was overshadowed by the population explosions of *Ampelisca* to nearly 220,000 individuals/m^2 and *Polydora cornuta* to over 210,000 individuals/m^2.

Ampelisca abdita, a species of particular interest because of its reputation as indicative of improving water quality in organically enriched areas and its ability to alter sediment texture by virtue of its tube-building activities, was again primarily dominant at Stations T3, T6 and T8 in April and August but also at Stations T2 and T5A in August. In some instances the absolute abundances of this species were essentially similar to

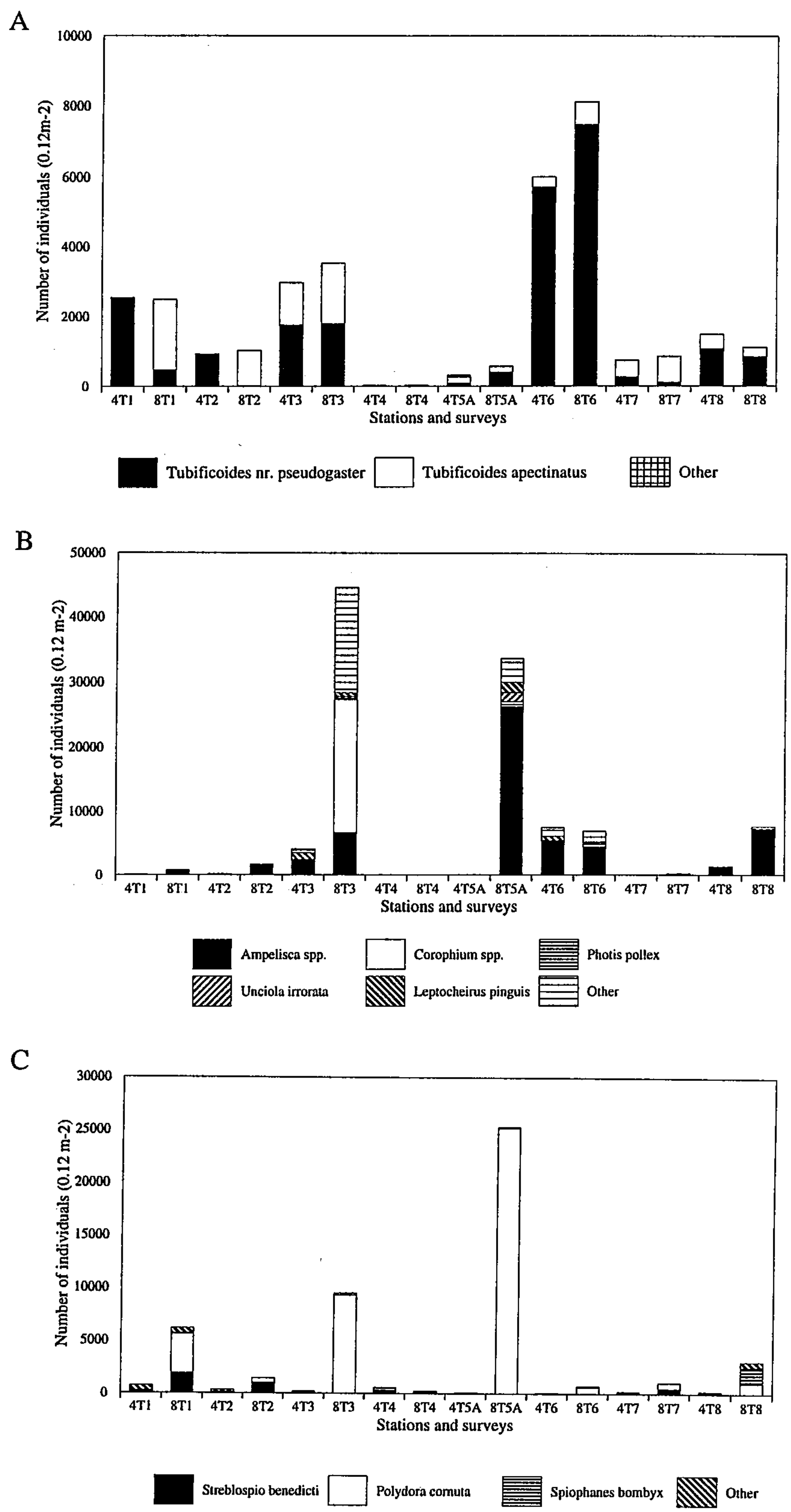


Figure 34. Densities of (A) oligochaetes, (B) amphipods, and (C) spionid polychaetes at the Boston Harbor Traditional Stations in April and August 1997.

those recorded in 1996, but its percent contribution to the total fauna was very different due to the fluctuations in abundance of other species. For example, at Station T3 in April 1996, *A. abdita* represented 21.4% of the total fauna, while a year later at the same station, although the density of this species was actually slightly higher, it represented only 14% of the total fauna. In April 1997, the polychaetes *Tharyx acutus* and *Aricidea catherinae* occurred in densities twice those recorded in April 1996, accounting for the lesser importance of *A. abdita* at that station.

3.4.3 Species Richness and Diversity

In 1997, species richness ranged from 18 (T4) to 60 (T8) in April and from 11 (T4) to 67(T8) in August (Tables 5 and 6; taxa not identified to species excluded). Compared to April 1996, the number of species was approximately 10% lower in 1997 at Stations T1, T2, T4 and T8 and 10% higher at the remaining stations (see Tables 1 and 2). For August 1997 compared to August 1996, the number of species recorded was higher at all stations except Station T3; Station T5A showed a significant increase from 34 species in 1996 to 71 species in 1997. Seasonal changes in 1997 varied at individual stations: at Station T3 the number of species was nearly the same during both seasons; whereas at Stations T2, T4, T6 and T7 it was lower in the summer than in the spring, and at Stations T1, T5A and T8 it was higher in the summer.

As in 1996, diversity was lowest at Station T4 during both seasons and as measured with both the Hurlbert rarefaction method (Figure 35) and the Shannon-Wiener index (H′) (Tables 5 and 6). (N.B. The rarefaction curves are carried out only to 500 individuals). The highest H′ diversity was seen at Station T8 in April and Station T1 in August 1997. The high species richness at Station T5A in August did not translate into a high diversity value because only two species, *Ampelisca abdita* and *Polydora cornuta*, together accounted for 84% of the fauna.

3.4.4 Community Analysis

For 1997, the analyses performed were slightly different than those performed on the 1996 data: (1) the similarity measure Bray-Curtis was not used, (2) all replicates were kept separate and no analyses were performed on pooled samples, and (3) both seasons (April and August) were analyzed together rather than separately. CNESS was used to analyze individual replicates from each of the two seasons. Results are shown in Figure 36 and essentially represent four large clusters. Stations T1, T2, T4, and T5A are seasonally distinct with those from the April survey forming a separate cluster (1) and the August samples distributed in clusters 2 and 3. Replicates from each of those stations form a distinct grouping within each of those larger clusters. April and August samples from Stations T3 and T6 and two of six replicates from Station T8 are in Cluster 2. All six of the samples from Station T6 cluster together before joining with samples from any other station, indicating a distinct identity for that station. Cluster 3 includes August replicates from Stations T1, T2, T4 and T7, as well as the April replicates from T7. Cluster 4 is comprised of four replicates from Station T8, two each from April and August.

The PCA-H metric scaling of the 1997 data, shown in Figure 37, shows four distinct groups of stations. There is some evidence of seasonality in the majority of the stations (T1, T2, T3, T5A, T7), but not others (T6, T8). The species that contribute to the CNESS distances among stations are shown in the Gabriel Euclidean distance biplot (Figure 38). The major species associations for 1997 are indicated in the Gabriel covariance plot (Figure 39). Species which tend to co-occur in the same samples are shown as arrows pointed in the same direction. Twenty-five species account for over 95% of the variance in CNESS. The most important species, in rank order with their contributions to CNESS are: *Streblospio benedicti* (12%), *Polydora cornuta* (10%), *Ampelisca abdita* (9%), *Aricidea catherinae* (8%), *Tubificoides apectinatus* (7%) and *T.* nr. *pseudogaster* (7%). Figure 39 shows three relatively distinct faunal assemblages: (1) the

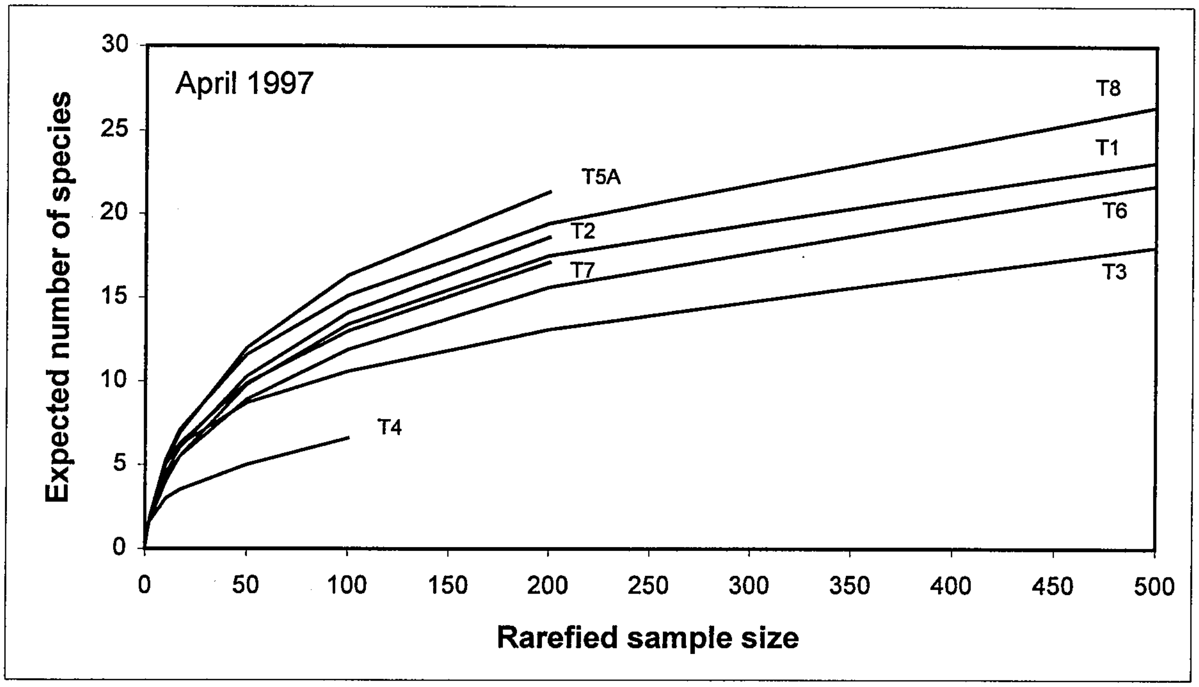
Table 5. Community parameters (replicates averaged) for the Boston Harbor Traditional stations, April 1997.

Station	# spp (0.12m²)	# indiv. (0.04 m²)	spp./ 50 ind.	spp./100 ind.	spp./500 ind.	H′	J′
T1	47	1367	9.8	13.4	23.1	2.3	0.5
T2	47	680	10.3	14.1	18.2	2.6	0.6
T3	55	5069	8.7	10.6	18.0	2.8	0.5
T4	18	328	5.0	6.6	n/a	1.6	0.5
T5A	41	532	12.0	16.3	17.3	2.9	0.6
T6	55	5254	8.9	11.9	21.7	2.5	0.5
T7	39	605	9.9	13.0	15.4	2.8	0.6
T8	60	2482	11.6	15.1	26.4	3.1	0.6

Table 6. Community parameters (replicates averaged) for the Boston Harbor Traditional stations, August 1997.

Station	# spp (0.12m²)	# indiv. (0.04 m²)	spp./ 50 ind.	spp./100 ind.	spp./500 ind.	H′	J′
T1	59	3919	12.3	16.2	28.2	3.2	0.6
T2	36	1530	7.4	9.4	17.7	2.4	0.5
T3	54	13,818	9.8	12.2	20.1	2.8	0.5
T4	11	100	5.5	n/a	n/a	1.0	0.4
T5A	71	20,468	7.5	10.6	19.6	2.1	0.4
T6	47	5768	8.5	11.2	20.1	2.5	0.5
T7	34	1228	9.5	11.7	19.0	2.9	0.6
T8	67	2455	11.7	15.7	28.0	2.9	0.5

A



B

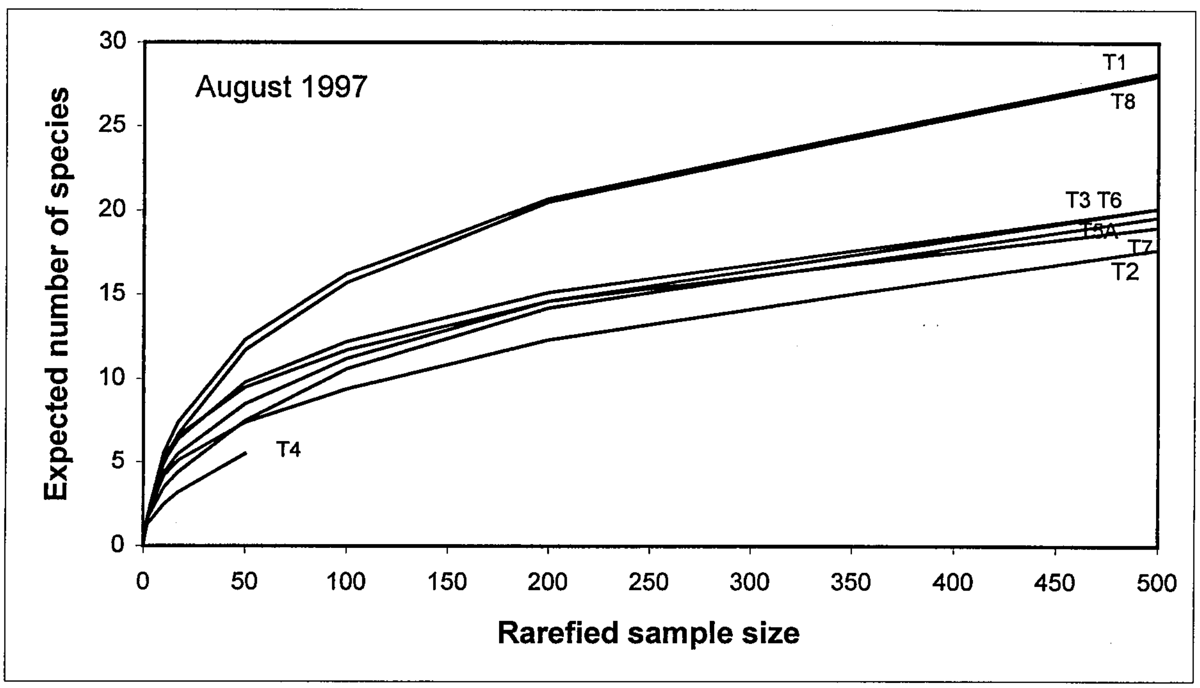


Figure 35. Rarefaction curves for samples taken in April (A) and August (B) 1997 at Boston Harbor Traditional stations. Values plotted are means of individual replicates.

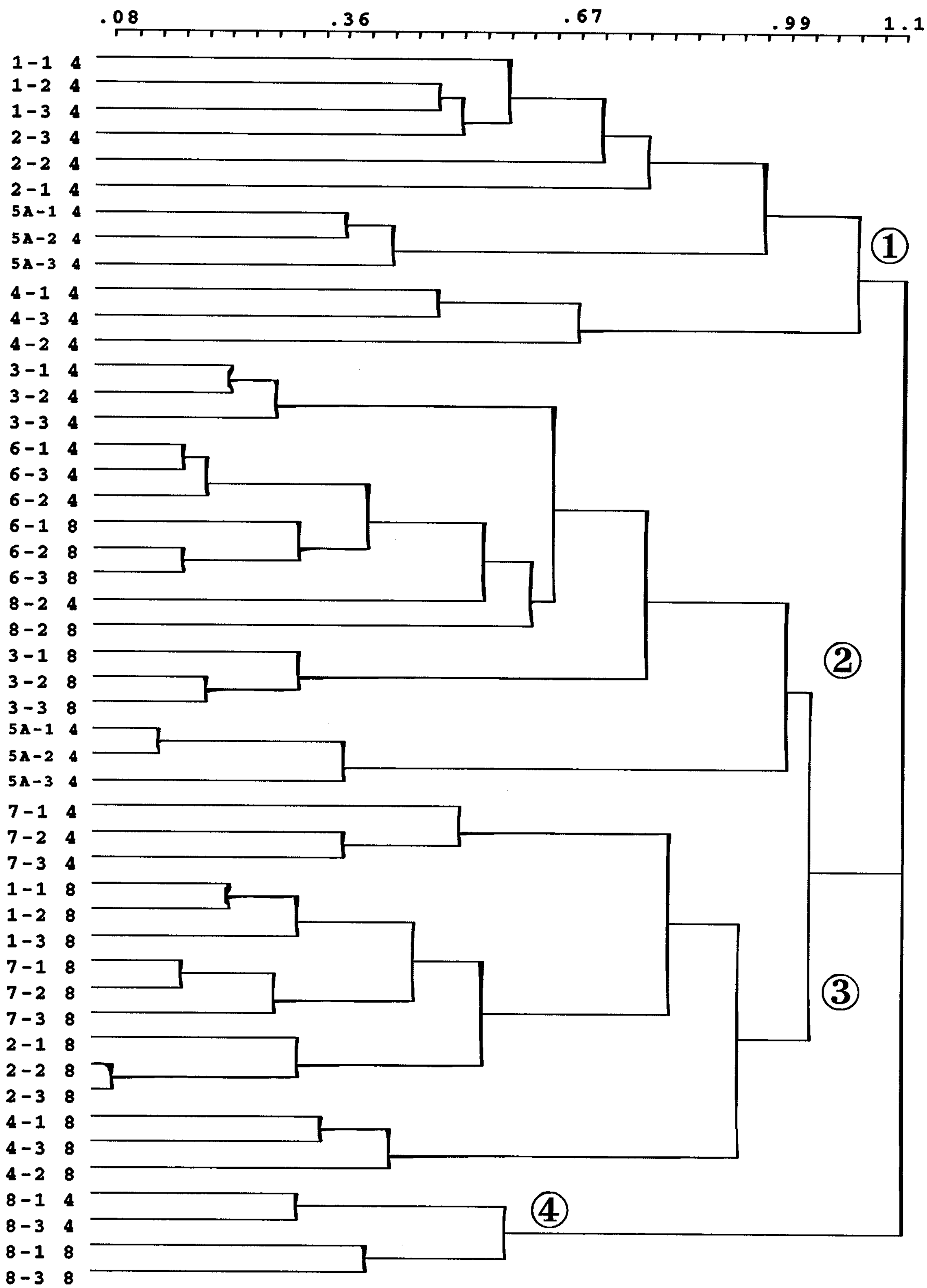


Figure 36. Similarity among replicates taken in April and August 1971 at Boston Harbor traditional stations as measured with CNESS (m=17). Labels indicate station/ replicate/month of sampling.

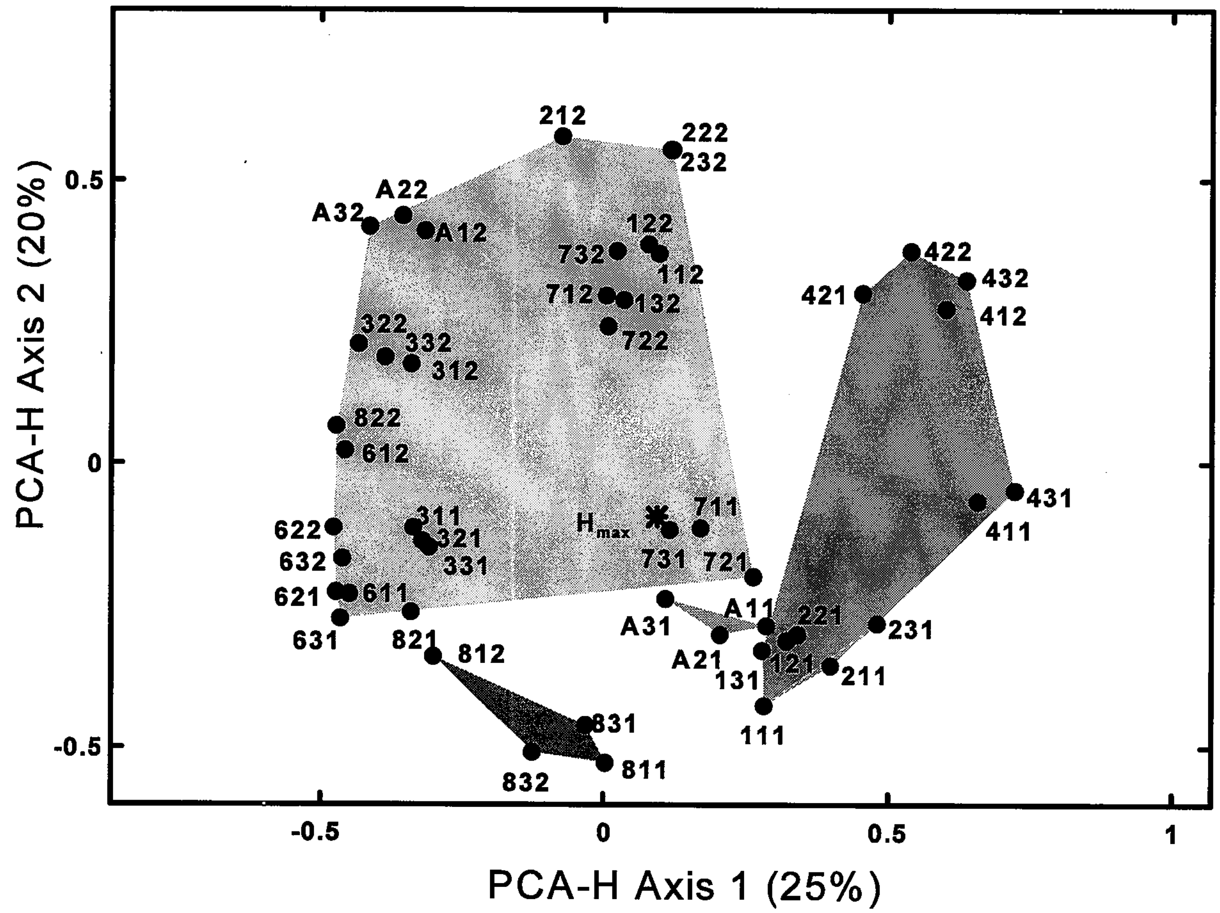


Figure 37. PCA-H metric scaling of the 1997 Boston Harbor data. Stations are labeled with number (A = T5A), replicate, and season (April = 1). H_{max} indicates the point of maximum diversity, a sample with equal abundances of all species.

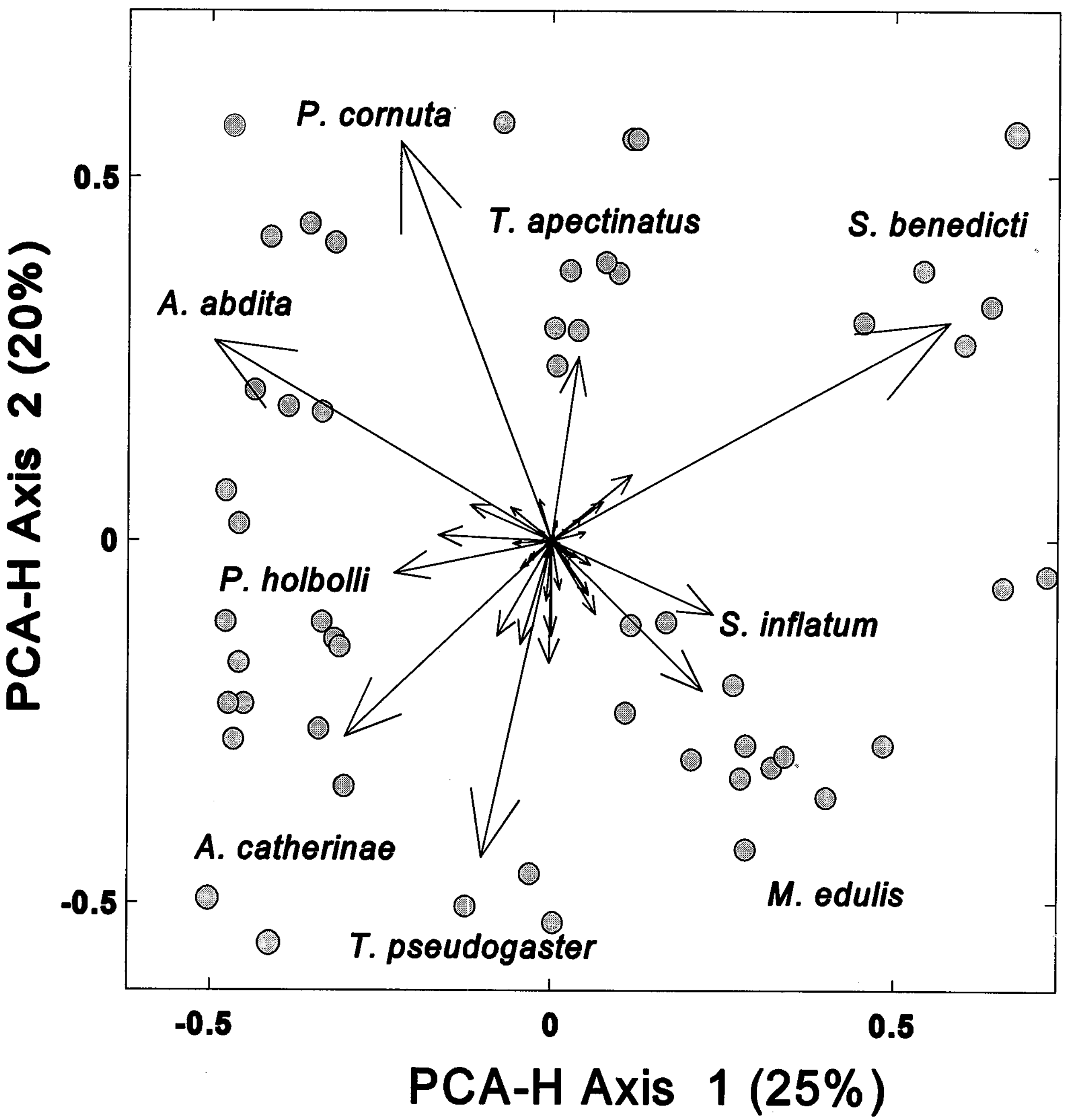


Figure 38. Gabriel Euclidean distance biplot for 1997 Boston Harbor data. The length of the species vectors indicates the relative importance of species to CNESS distances. Filled circles indicate specific samples.

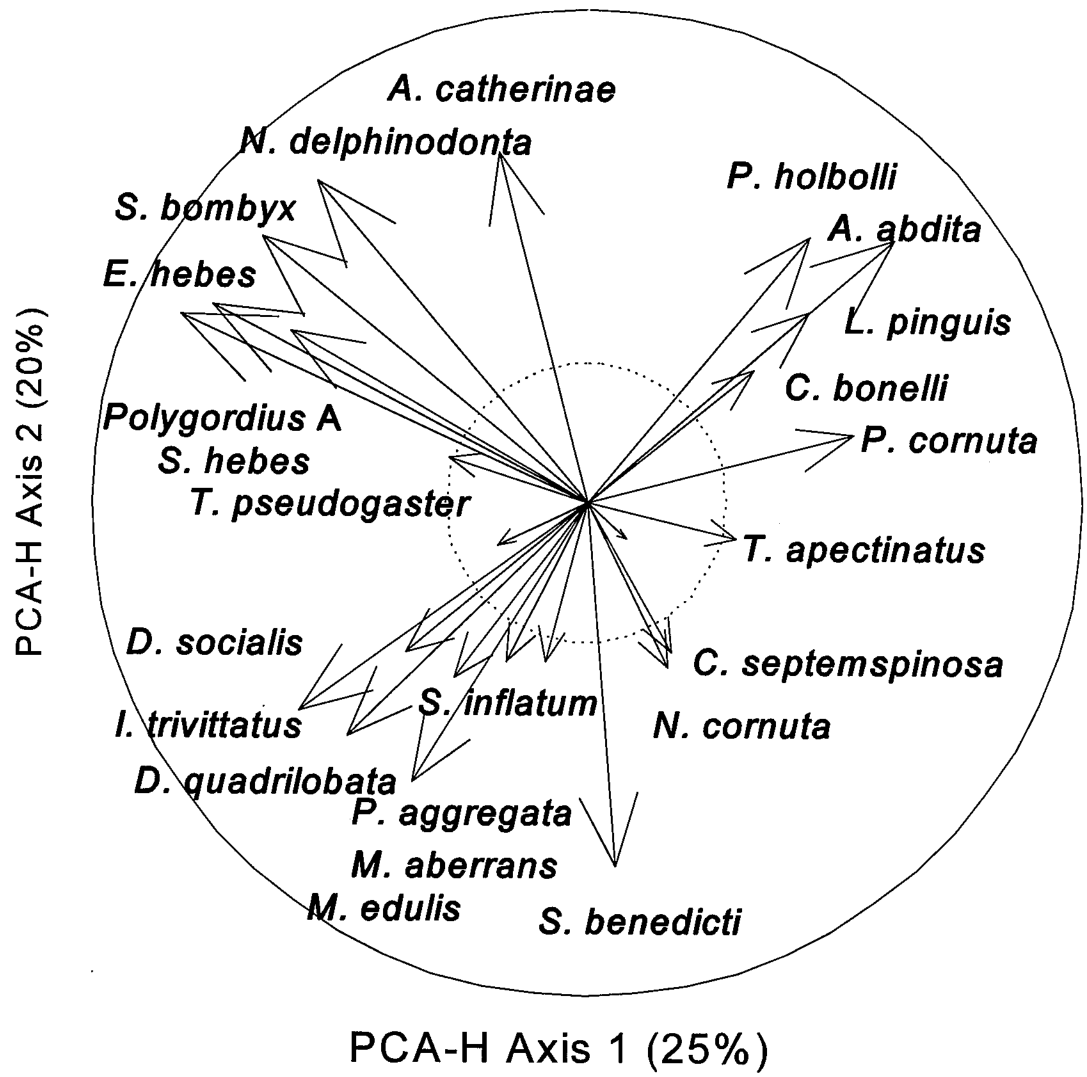


Figure 39. Gabriel covariance biplot for 1997 Boston Harbor data. Only the 25 most important contributors to CNESS distances are shown.

amphipod assemblage, dominated by *A. abdita* and including *P. cornuta*; (2) the *S. benedicti* assemblage, including the polychaete *Nephthys cornuta*, the shrimp *Crangon septemspinosa*, and the oligochaete *T. apectinatus*; and (3) the *A. catherinae* assemblage, including the polychaete *Spiophanes bombyx* and the bivalve *Nucula delphinodonta*. A fourth assemblage, dominated by *T.* nr. *pseudogaster*, *Mytilus edulis*, *Scolotema inflatum*, and *Tharyx acutus*, is shown more clearly in the cluster diagram (Figure 40), which is based on the cosine of the angle among species vectors in Figure 39.

3.5 Benthic Infauna: 1991 - 1997

Multivariate analyses similar to those performed on the 1997 data set were applied to a database consisting of all 311 samples collected at Boston Harbor stations from September 1991 through August 1997. Appendix G includes the diversity measures calculated for each sample collected during this time period. A cluster analysis using CNESS (m = 17) was performed on all 311 samples, resulting in several major cluster groups. The dendrogram resulting from this analysis is given in Appendix H1.

The major patterns in this ordination are controlled by intersite variation; that is, faunal samples from any station are generally most similar to other samples from the same station, suggesting a unique identity for each station. In the majority of cases, the three replicates taken at each station on each sampling date cluster together (i.e., are most similar to each other) before joining with replicates from other sampling dates, and the majority of replicates taken at each station generally cluster together (Appendix H1). Within this predominant pattern, a seasonal pattern can be detected within many of the station clusters. One major pattern of station similarity that can be seen in this dendrogram is the dichotomy between the northern/nearshore Stations T1, T2 and T4 and the southern/outer Harbor Stations T3, T5A-T8.

The first cluster in the 311-sample dendrogram includes samples taken in September 1991 at Stations T1, T3, and T7; these samples are most similar to those taken the following spring (April 1992). The majority of samples from Station T4 are in the second cluster; within this grouping, the spring samples tend to separate from the summer samples. The April 1996 and 1997 samples from Station T4 join the major portion of this cluster at a somewhat lower level of similarity. The next large group consists of samples from Stations T1 and T2, which are nearshore stations in the northern part of the harbor. Within this large cluster, there are two groupings that, as seen for Station T4, essentially reflect a seasonal pattern, with the majority of April samples in one subcluster and the August samples in another. A few outliers from Stations T2 and T4 complete the first major portion of the dendrogram.

The next major portion of the dendrogram starts with a cluster of samples from Station T6 taken in the early period of the program, i.e., September 1991 and April 1992. These combine with a few replicates from Station T8, also from early years in the sampling program, but all from the August/September sampling dates. Within the large cluster of samples from Station T6, there are occasionally additional replicates from Station T8, but essentially Station T6 replicates form a coherent cluster, which then joins with April samples from Station T3. August replicates from Station T3 cluster with August replicates from Station T5A to form another distinct grouping. Replicates from Stations T5A, T7 and T8 each form separate clusters, with April samples generally separated from August samples.

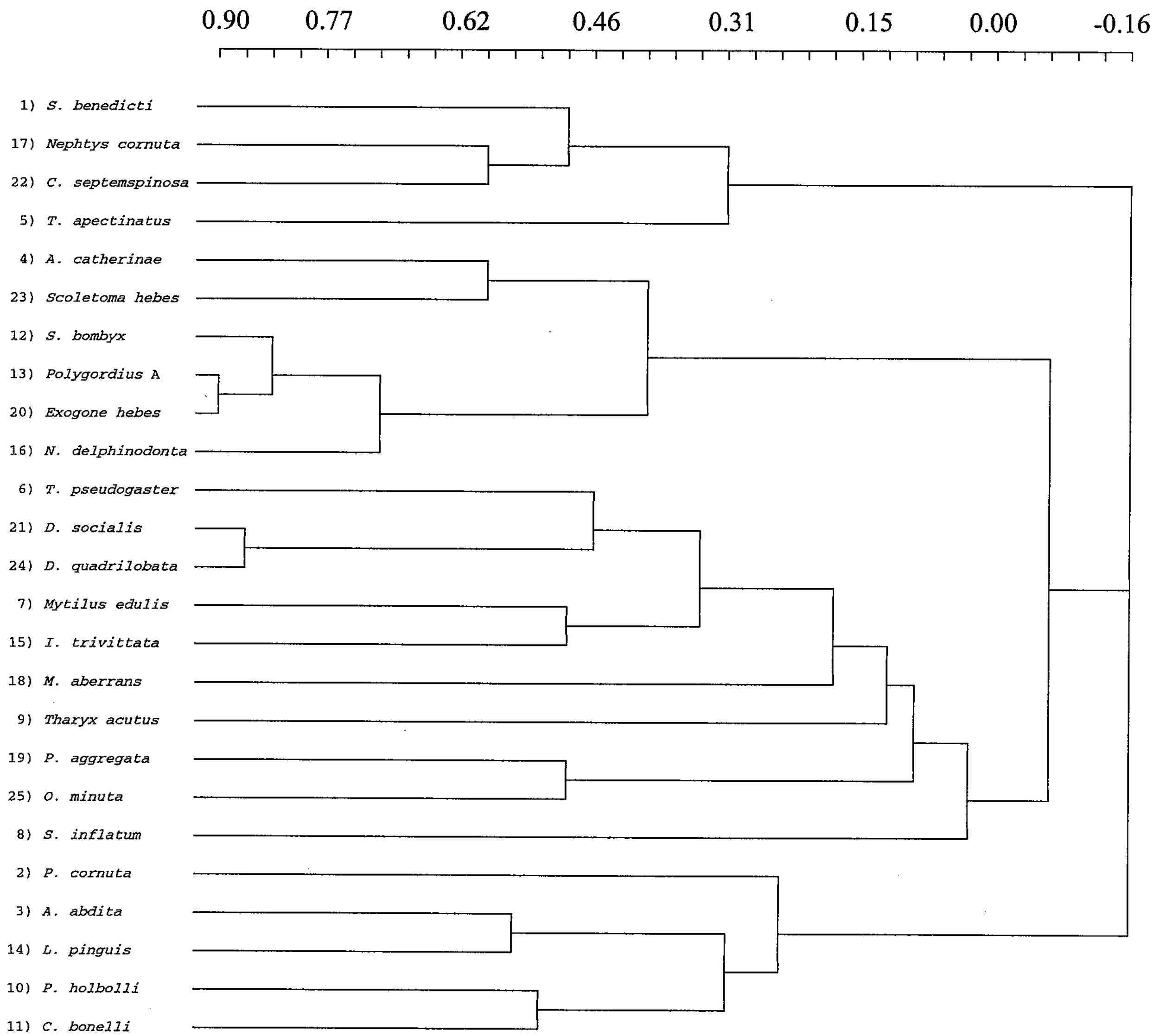


Figure 40. Cluster analysis of the 25 species that contribute most to CNESS variation for the 1997 Boston Harbor data (ranks indicated). The similarity measure was the cosine of the angles among species vectors, shown in Fig. 39.

These major groups were then superimposed on the PCA-H metric scaling shown in Figure 41. The species that control the position of the samples in Figure 41 are shown in the Gabriel Euclidean distance biplot (Figure 42). The major gradient in community structure evident in this figure is the transition from the *S. benedicti* assemblage (characteristic of Station T4, all years) to the *A. abdita* assemblage (characteristic of Stations T3, T6, and T8 in some years). The Gabriel covariance biplot (Figure 43) shows the associations among species, with three major species assemblages evident: the *S. benedicti* assemblage, the *A. catherinae* assemblage, and the *A. abdita* assemblage.

The cosine of the angle among species vectors was clustered to show the major species associations (Figure 44). The top eight species account for more than 59% of the variation in CNESS. These species include *S. benedicti* (14%), *A. abdita* (9%), *A. catherinae* (8%), *T.* nr. *pseudogaster* (7%), *P. cornuta* (7%), *T. apectinatus* (5%), *T. acutus* (5%), and *Capitella* spp. (4%). There are four major species groups, the most important being the *S. benedicti - C. septemspinosa* community, the amphipod community dominated by *A. abdita* and including *P. cornuta*, the *A. catherinae-T. pectinatus* assemblage, and finally the *T.* nr. *pseudogaster - T. acutus-Capitella* assemblage.

Spring Samples. Cluster analysis was performed separately on the 143 samples taken in April of each year from 1992-1997. The dendrogram resulting from this analysis is given in Appendix H2. The major pattern seen in this dendrogram is identical to that presented for all 311 samples; that is, the northern/inner Stations T1, T2, and T4 form a major group that is distinct from the southern/outer Stations T3 and T5A-T8. Samples from Stations T5A, T6, T7 and T8, with a few exceptions, form cohesive station groupings. Samples from Stations T1, T2 and T4 tend to mix with each other, and those stations do not show as identifiable a signature.

At many stations, the spring samples from 1992 appear to be very different from replicates collected in later years. In particular, the April 1992 replicates from Stations T2, T4, and T5A form a distinct cluster. At Station T7, the 1992 replicates are clustered with a group of T2 and T4 replicates. The replicates taken in April 1992 at Stations T3 and T5A also occur in the group of northern/inner station replicates.

Replicates from Station T2 are similar to others from that station on most given sampling dates, but only 1994 and 1995 samples are most similar to each other; samples from other years tend to be similar to replicates from other stations. For example, 1996 Station T2 replicates are most similar to 1996 replicates from Station T4; and 1993 Station T2 replicates are most similar to 1993 replicates from Station T3. At Station T3, replicates from 1992 are most similar to replicates from Station T1; replicates from years 1994-1997 form a grouping that then joins with 1993.

Two replicates from Station T4, both from 1995, form a singular, highly dissimilar cluster. A laboratory mishap with the three replicates from this station is most likely the explanation for this result. The other spring replicates from Station T4 sometimes cluster with replicates from Station T2 and T5A and sometimes with replicates from Station T7 before joining with other T4 replicates.

Of particular note is the high level of similarity between replicates taken in 1993 and those taken in 1997 at Stations T6 and T7. This result implies that there has been little change in the benthic infauna (at least at those stations) over that 4-year period. In general, the early samples from 1992 and sometimes 1993 have a low similarity to samples from later years, but the later years (1994-1997) tend to be fairly similar to each other.

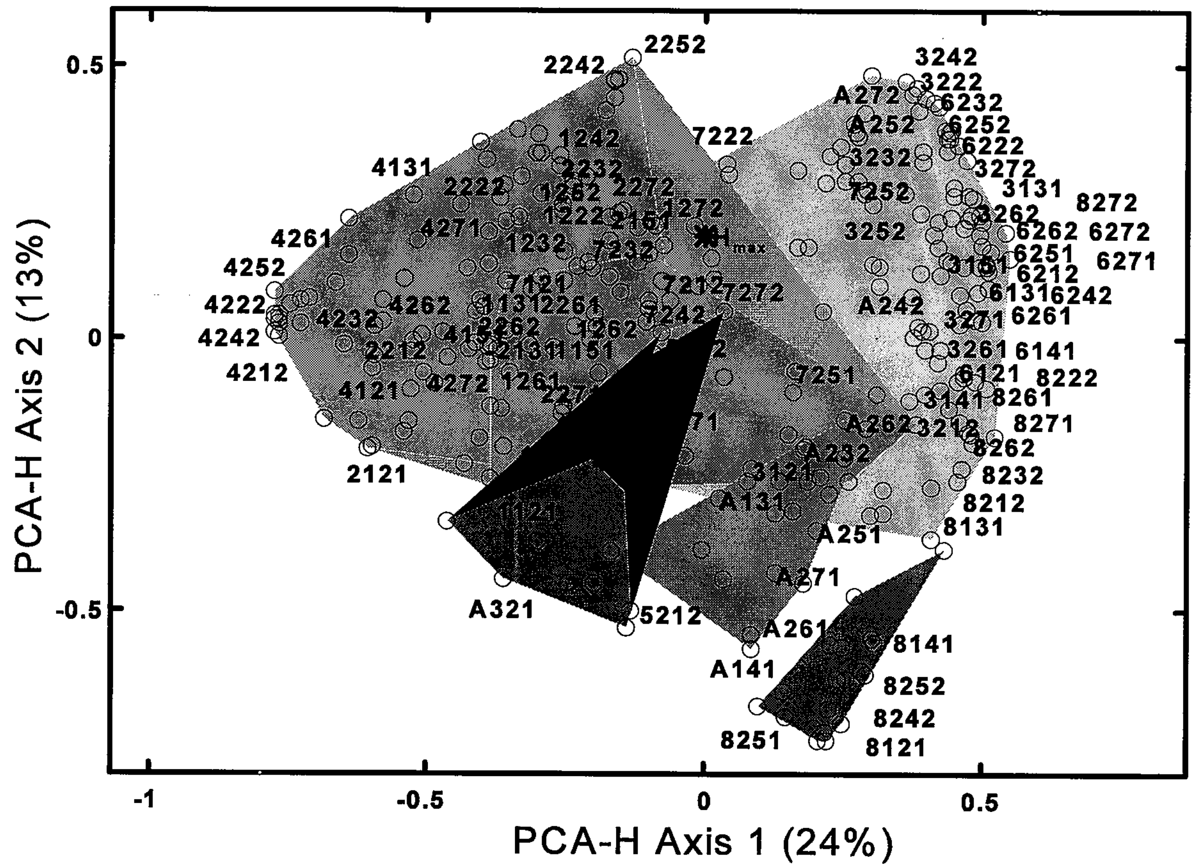


Figure 41. Metric scaling of CNESS (m=17) of all 311 Boston Harbor benthic samples, with 10 major cluster groups superimposed as convex hulls. One-third of the stations are labeled: station (A = T5A)/replicate/year (e.g., 4 = 1994)/season (spring = 1).

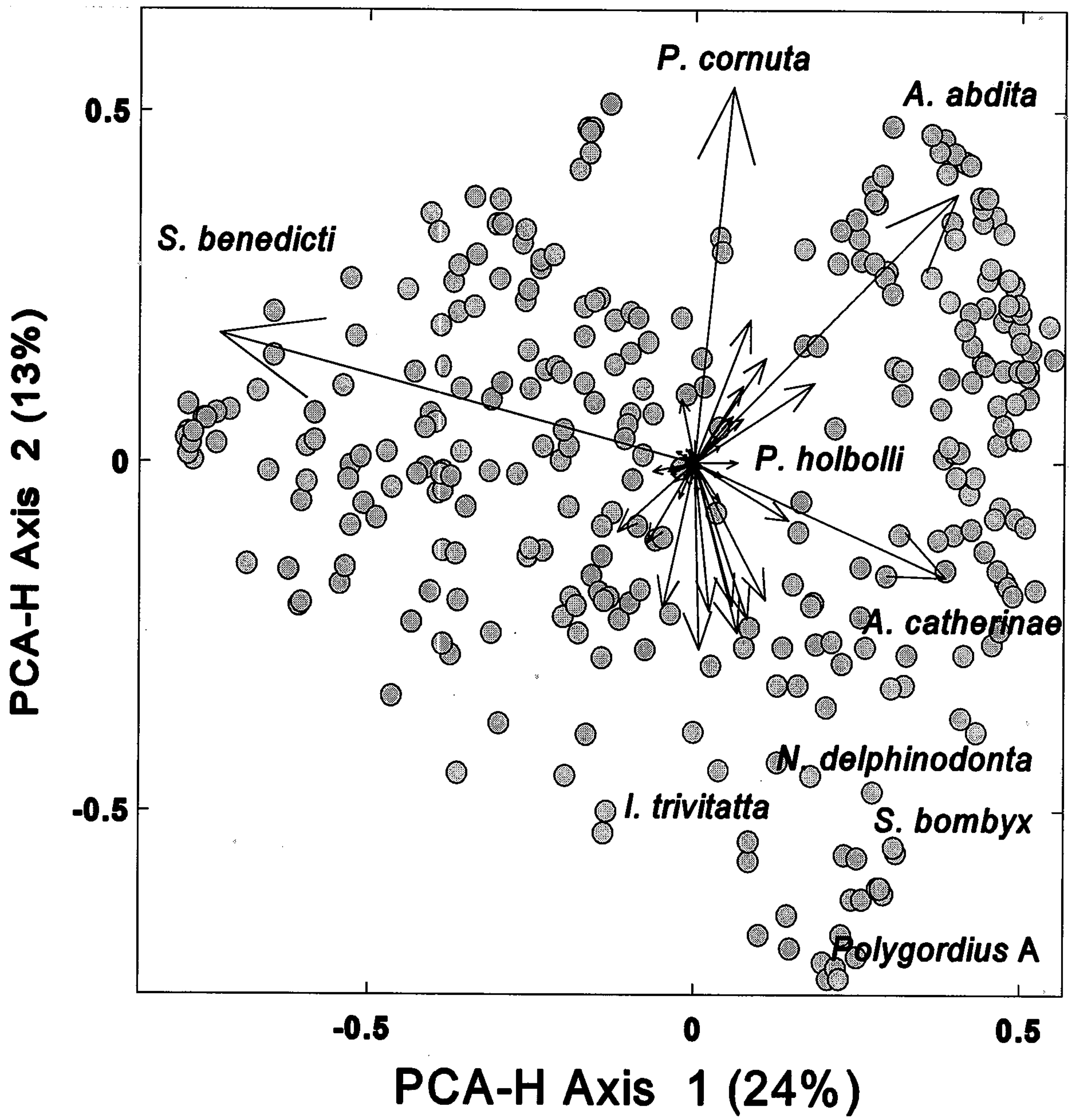


Figure 42. Gabriel Euclidean distance biplot corresponding to the metric scaling shown in Figure 41. The length of the species vectors indicates their contribution to CNESS variance. Filled circles represent specific samples.

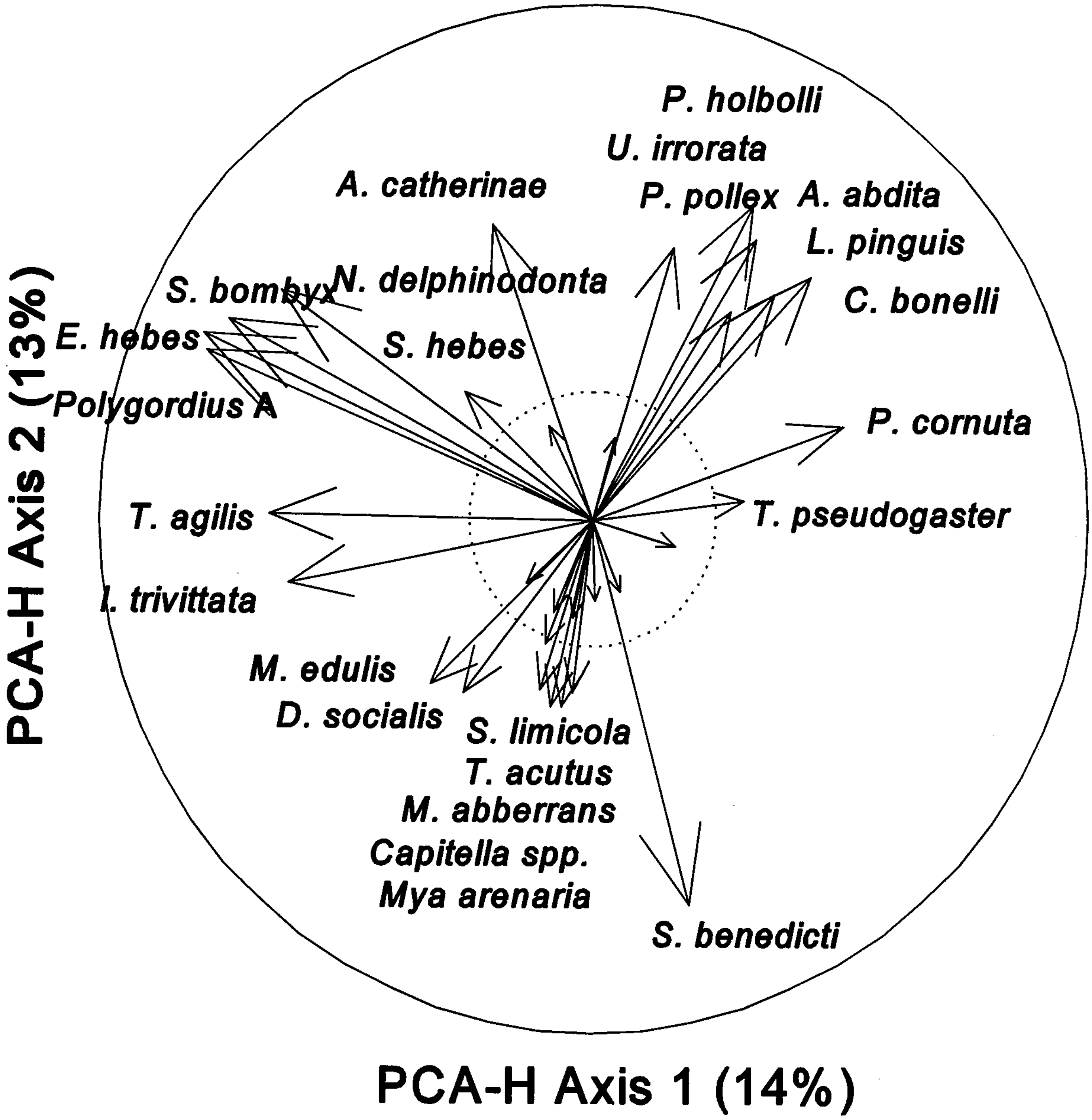


Figure 43. Gabriel Covariance biplot for the 311 Boston Harbor benthic samples. Only the 32 most important species contributing to the CNESS variance are shown.

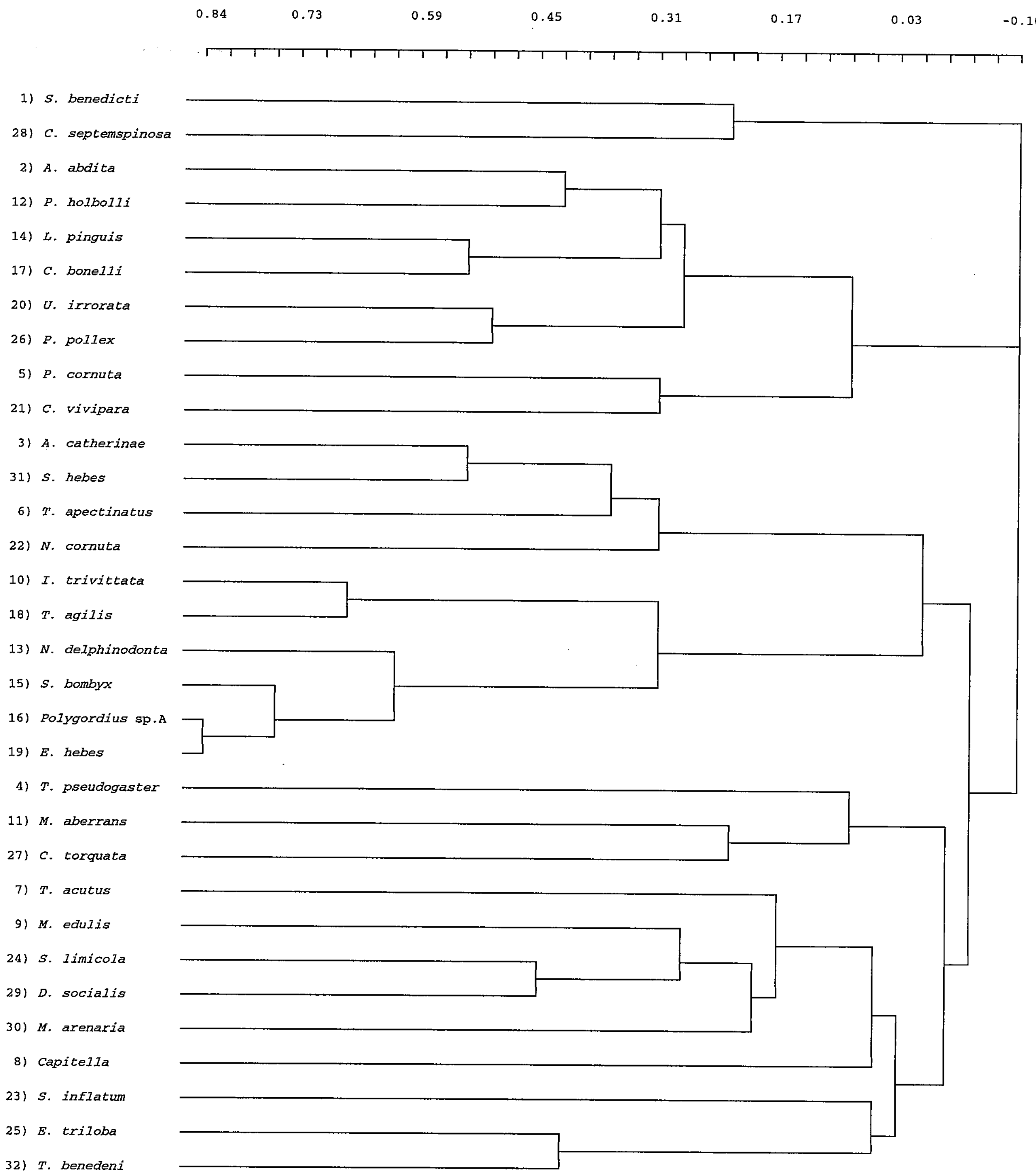


Figure 44. The species clusters for the 32 most important contributors to CNESS distances for all 311 Boston Harbor samples from 1991-1997 (ranks indicated). Clustering was performed with Pearson's r similarity using the normalized hypergeometric probability matrix with m=17 and UPGMA sorting.

The major clusters elucidated among the spring samples were superimposed on the PCA-H metric scaling shown in Figure 45. The Gabriel Euclidean distance biplot, shown in Figure 46, reveals the species that control the variation in community structure. The Gabriel covariance biplot (Figure 47) displays the faunal associations among spring samples. There were 33 species (of the total 185) that contributed the most to the variation in CNESS distances among the spring samples. Figure 48 shows a cluster dendrogram of these 33 species, revealing five major community types. The first is the *Streblospio-Polydora-Capitella* assemblage. The second assemblage is dominated by *Tharyx acutus*. The third assemblage is dominated by *Mytilus edulis* and *Ilyanassa trivitatta*. The fourth assemblage is composed mainly of amphipods, especially *A. abdita*, and includes the oligochaete *T.* nr. *pseudogaster*. The fifth assemblage is dominated by the paraonid *A. catherinae* and the oligochaete *T. apectinatus*.

Summer Samples. The 168 samples collected in September 1991 and August 1992-1997 were analyzed separately. The dendrogram resulting from that analysis is shown in Appendix H3. Many clusters include all replicates (or the majority of replicates) from individual stations. This dendrogram differs from the two-season and spring dendrograms (Appendices H1 and H2, respectively) primarily in the position of replicates from Station T7, which have a greater similarity with Stations T1 and T2 than to Station T3. Although the three replicates from Station T7 taken in 1991 cluster with replicates from Station T3, as seen for previous analyses, the 1997 replicates are most similar to those from Stations T1 and T2 and the remaining Station T7 replicates form a cluster that then joins with the remaining replicates from T1 and T2. The large group containing Stations T1, T2 and T7 then joins with a group comprised primarily of all replicates from Station T4. Like Stations T4 and T7, replicates from Station T8 form a distinct cluster, as do replicates from Station T5, which was sampled only in September 1991 and August 1992. Station T5A also forms two fairly distinct units, with replicates from 1993/96 by themselves and a group of 1994/95/97 replicates similar to those from Stations T3 and T6.

Metric scaling of the summer samples is shown in Figure 49. The Gabriel Euclidean distance biplot, shown in Figure 50, shows the species that explain the CNESS distances. The Gabriel covariance biplot (Figure 51) shows the faunal associations of the most important species that control variation in community structure. Figure 52 is the cluster dendrogram based on the 29 most important species in the summer samples. There are three major communities identified: the *Streblospio benedicti* assemblage, the *Ampelisca abdita-Polydora cornuta* assemblage, and the *Aricidea catherinae-Spiophanes bombyx* assemblage. There is little strong seasonality in community structure. One exception is *Polydora cornuta*, which was associated with *Streblospio benedicti* in the spring, but with the amphipod assemblage in the summer.

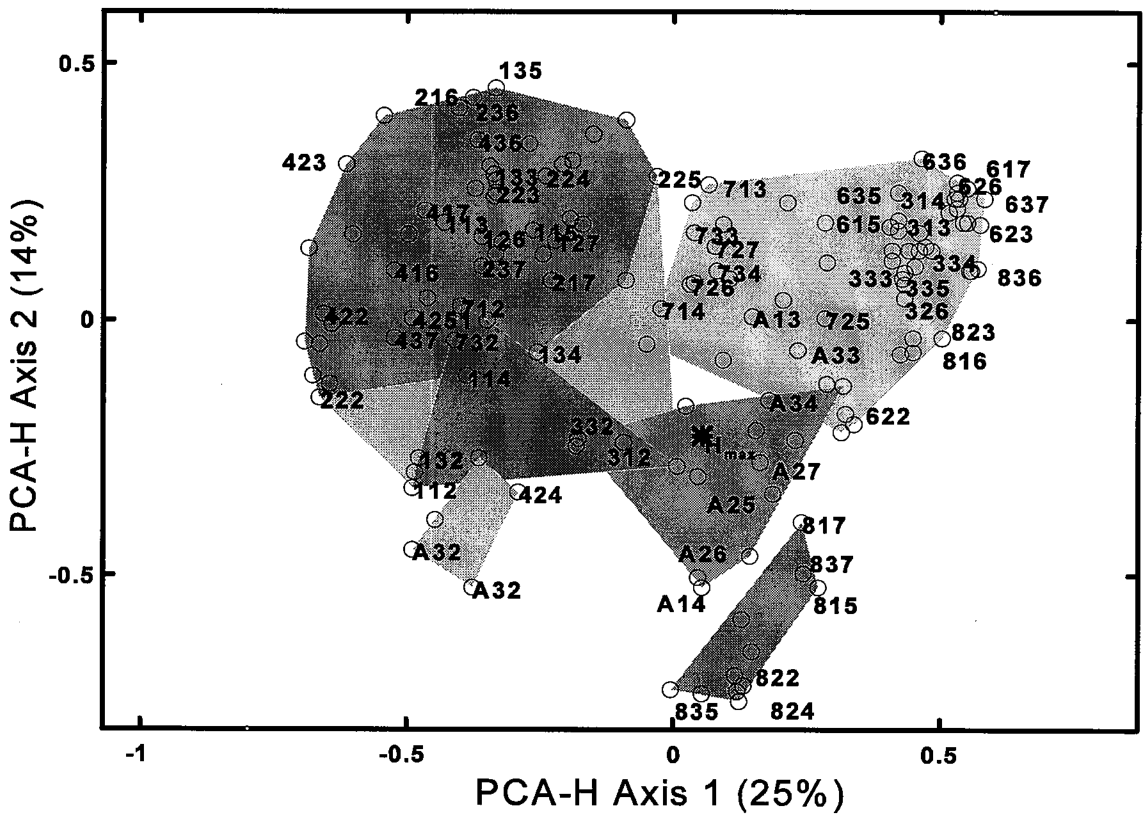


Figure 45. Metric scaling of CNESS (m=17) distances of Spring 1991-1997 Boston Harbor benthic samples. The clusters from the 311-sample analysis (all seasons) are superimposed as convex hulls.

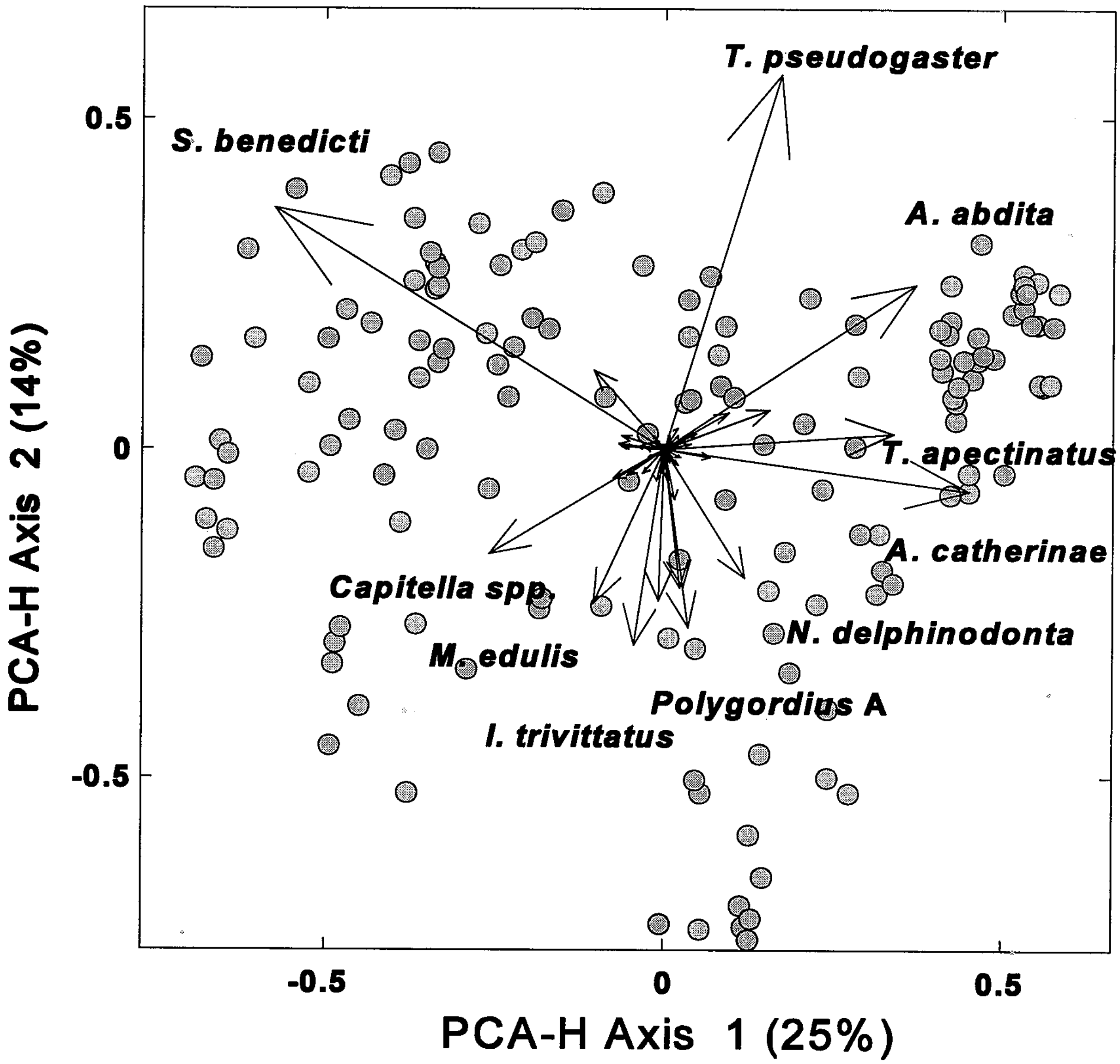


Figure 46. Gabriel Euclidean distance biplot for the Spring 1991-1997 Boston Harbor benthic samples. Filled circles indicate specific samples.

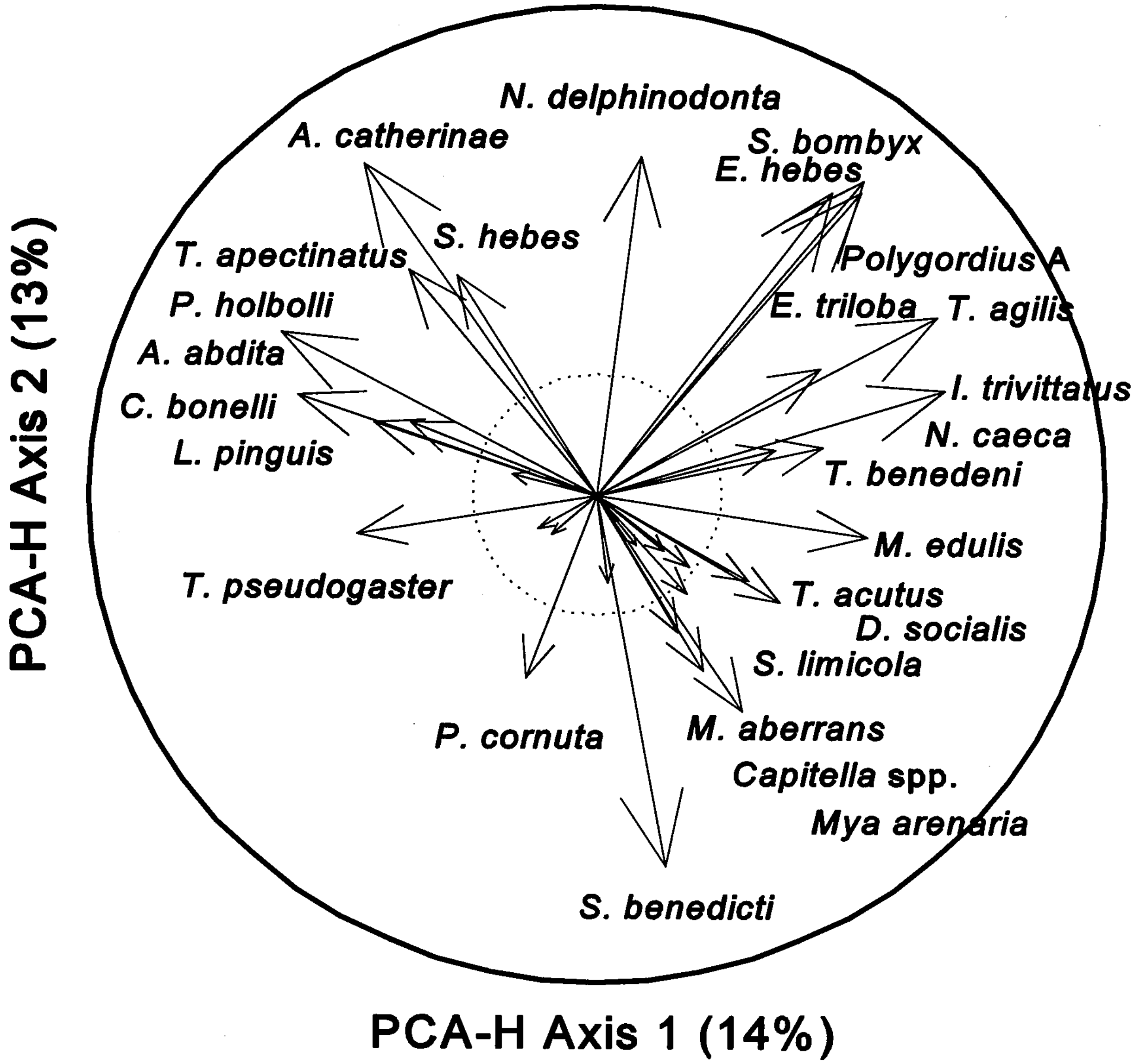


Figure 47. Gabriel covariance biplot for the Spring 1991-1997 Boston Harbor benthic samples. The 33 species shown in this figure were clustered in Figure 45.

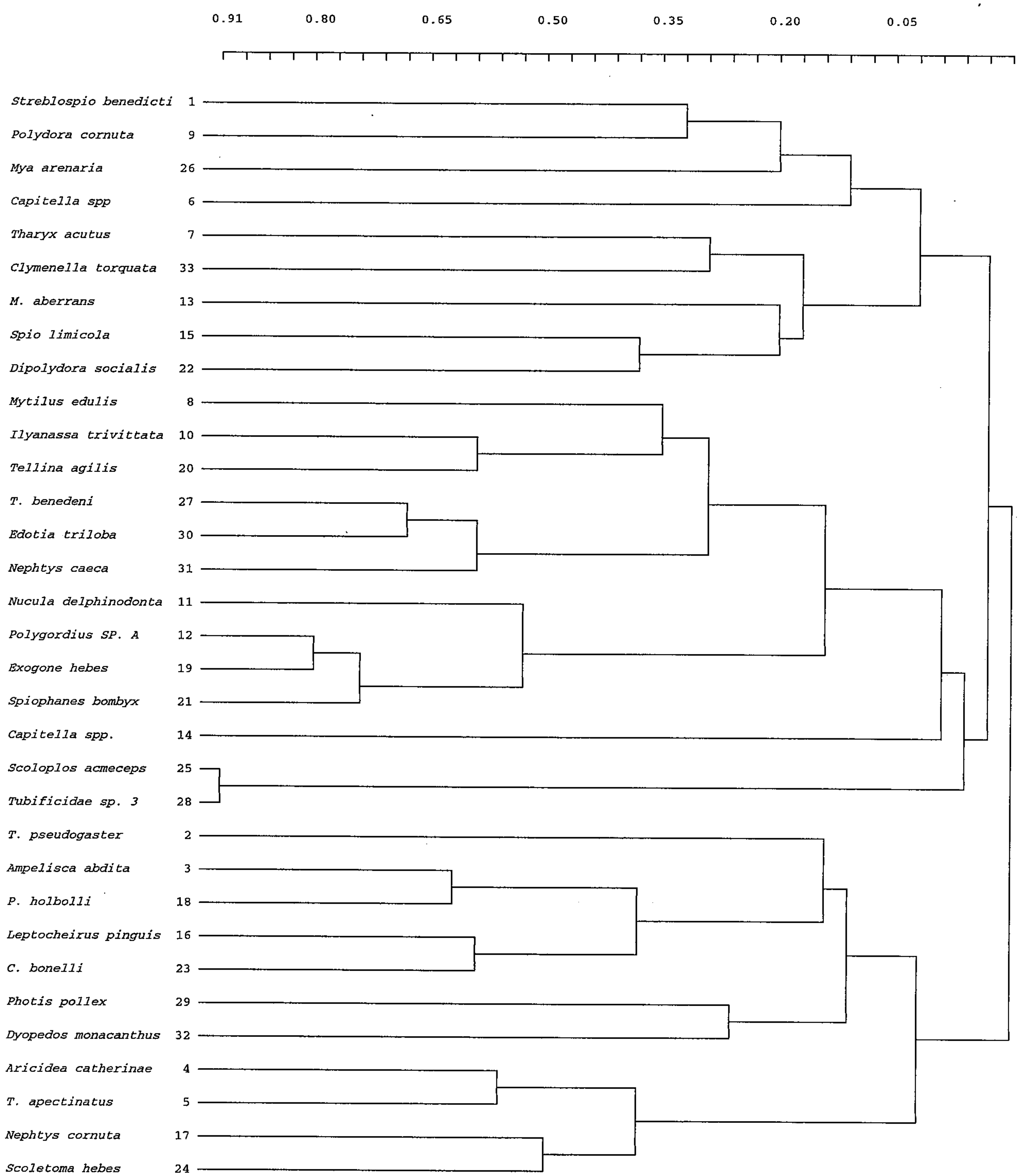


Figure 48. Species clusters for the 33 most important contributors to CNESS distances for the Spring 1991-1997 Boston Harbor benthic samples. Clustering was performed with Pearson's r similarity using the normalized hypergeometric probability matrix with m=17 (as described in Trueblood *et al.* 1994). Clustering was performed with UPGMA sorting.

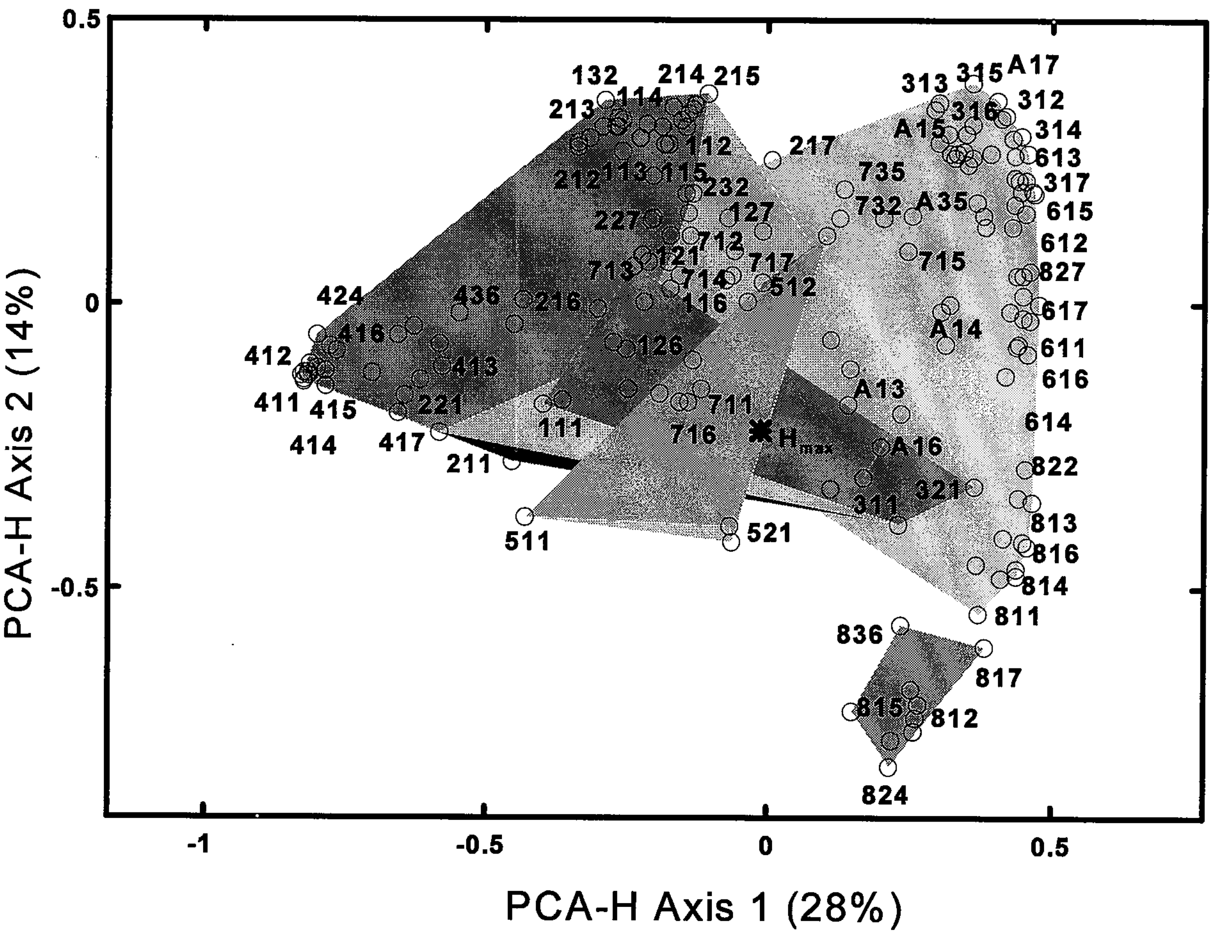


Figure 49. Metric scaling of CNESS (m=17) distances of Summer 1991-1997 Boston Harbor benthic samples.

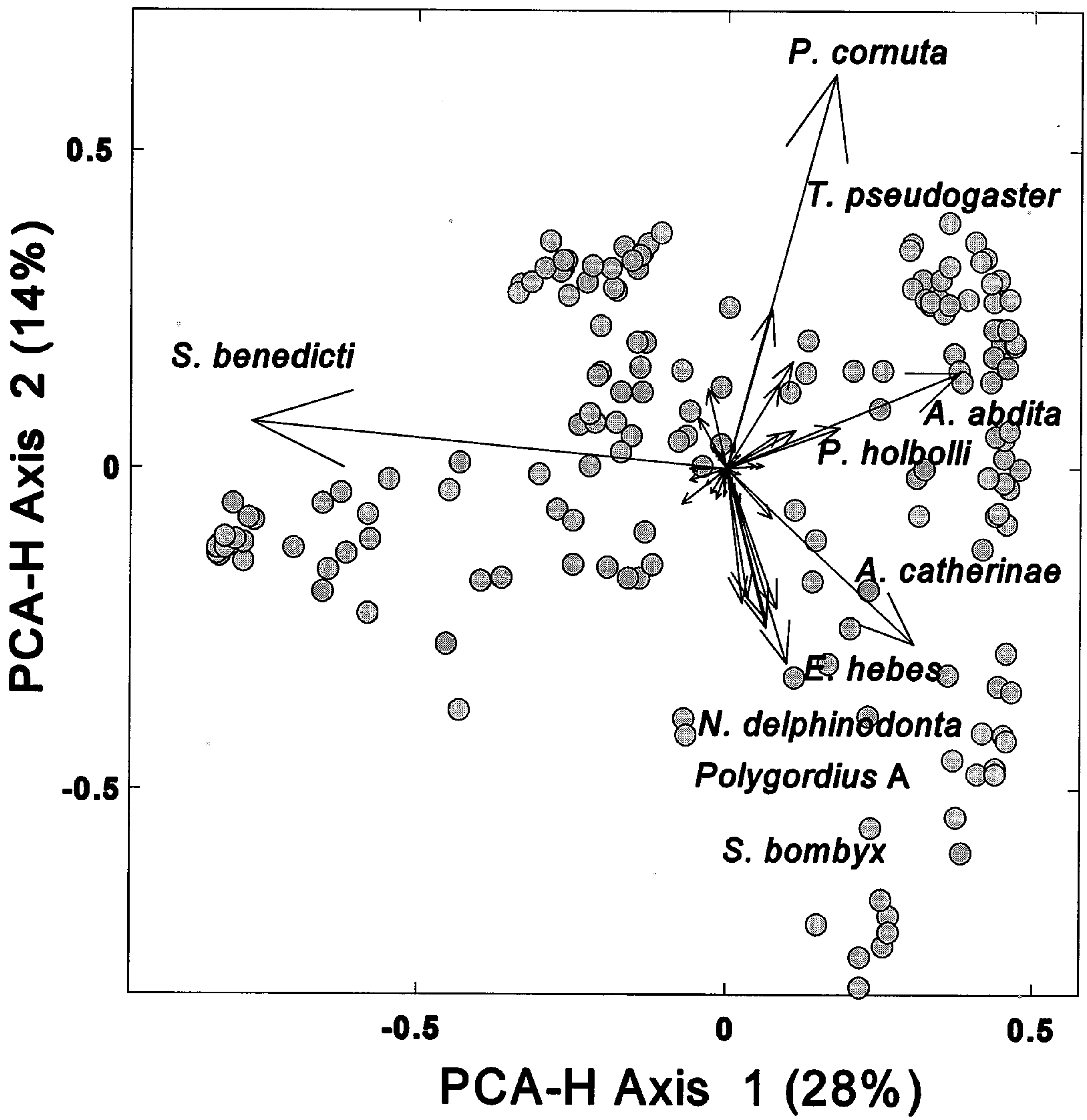


Figure 50. Gabriel Euclidean distance biplot for Summer 1991-1997 Boston Harbor benthic samples. Filled circles represent specific samples.

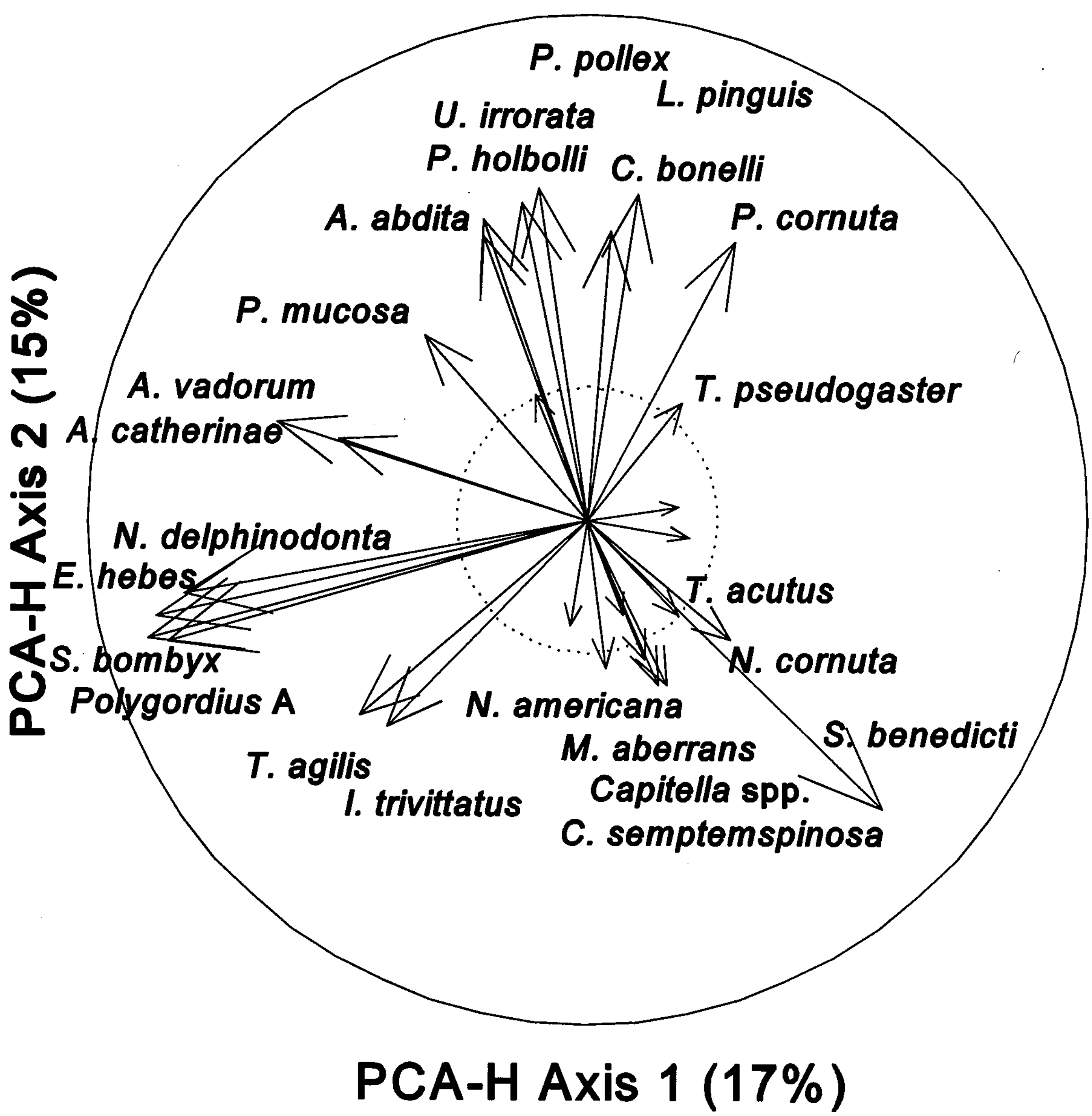


Figure 51. Gabriel covariance biplot for the Summer 1991-1997 Boston Harbor benthic samples.

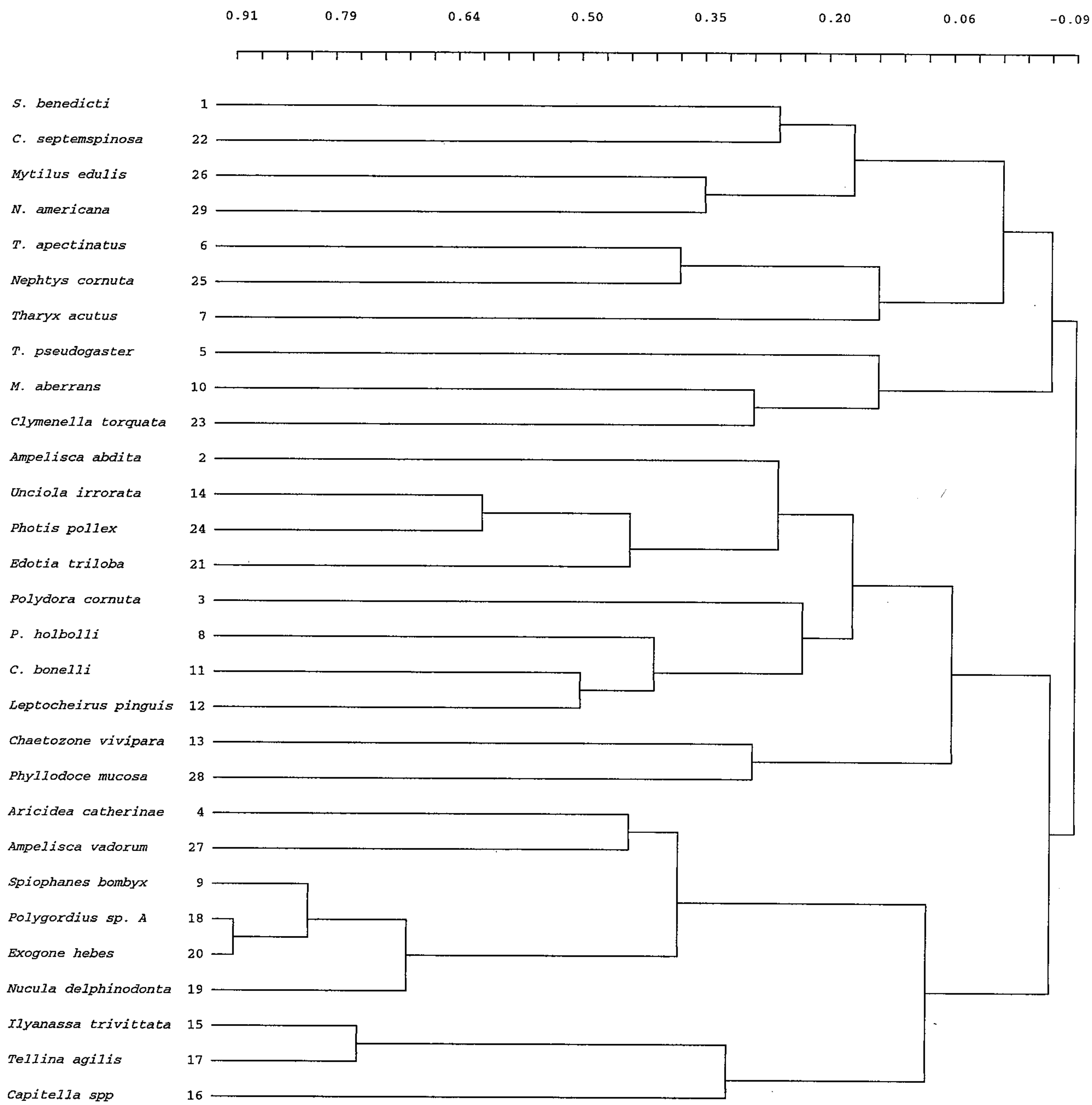


Figure 52. Species clusters for the 29 most important contributors to CNESS distances for the Summer 1991-1997 Boston Harbor benthic samples. Clustering was performed with Pearson's r similarity using the normalized hypergeometric probability matrix with m=17 and UPGMA sorting.

4.0 DISCUSSION

4.1 Spatial/Temporal Patterns in Sedimentological Parameters

4.1.1 Sediments

The distribution of sediment grain size has changed little over the period of baseline monitoring. Sandy (and coarser) bottom facies dominate nearshore, in tidal and navigation channels, and adjacent to islands located within the bay system. Sandy deposits show imaged evidence of physical instability such as shell (SH) scour lag deposits, ripples (R), high boundary roughness from erosion (E), and recently deposited sedimentary intervals (RDSIs). These shallow-water deposits apparently experience wave and current scour. In 1996, deep penetration of the camera prism at several nearshore muddy stations indicated that the mud was of high water content. High resuspension rates (or net accumulation rates) tend to produce fluid muds. Fluid muds were not noted in 1997. The presence or absence of high-water-content muds in a particular survey year depends on the kinetic energy of the water column just before the survey. Eight stations in 1996 showed evidence of methane gas bubbles within the imaged sediment column. Only one station (T4) showed methanogenic sediments in the 1997 data set. In general, the 1997 August images were of poor quality and this may have compromised our ability to identify small gas bubbles in the sediment.

Silt-clay texture dominates the center and outer region of the bay system. Evidence of physical reworking of the bottom is less common except adjacent to shoal areas. More mud accumulates in a lower kinetic energy environment than do sandy sediments. Nearshore muds may show (mineral) sand over mud reflecting nearshore resuspension of sands that are then transported into deeper water and form a thin blanket of sand over otherwise muddy deposits. The sand-over-mud stratigraphy in the central and outer bay muds is unrelated to mineral sand transport. Rather, the sand is of biogenic origin (fecal pellets; e.g., see Figure 16). Densely packed amphipod tubes are known to promote rapid sediment accumulation of fine-grained sediment (Rhoads and Boyer, 1982). If these mats are thinned out or amphipod populations experience high mortality due to major events such as severe storms, the mud formerly trapped between tubes would be resuspended and redistributed. A massive release of bound sediment could increase water column turbidity, attenuate light penetration, and inhibit primary production.

4.1.2 Organic Carbon Content

In addition to gradients in kinetic energy (i.e., physical reworking), organic carbon loading is a significant ecological stress factor for benthic populations. The total organic carbon content (TOC) at Traditional stations is compared between 1993 and 1997 for both April (Figure 53) and August (Figure 54). The April values represent natural loading sources such as the spring plankton bloom as well as additions from spring run-off and anthropogenic contributions. The August inventories largely represent the net inventory of organic matter following respiration of the spring input of carbon substrates. In theory, April inventories should be higher than August inventories. At some stations this is true (e.g., T1) but at the majority of stations the relationship does not hold. Differences in TOC between April and August also can change over time (e.g., compare Station T4 1996 with 1997). However, stations can often be consistently ranked between survey years based on their relative TOC inventories. For example, Stations T3, T4, T6 and T7 showed higher inventories in both April and August compared to the other Traditional stations (T1, T2, T5A, and T8). Values approaching or exceeding 3% TOC were found at these four stations in several years. Inventories $\geq$3% TOC tend to inhibit some benthic groups (especially molluscs), probably because of the high sulphide flux and low dissolved oxygen associated with high TOC muds (Purdy, 1964). Values were generally lowest at Station T8.

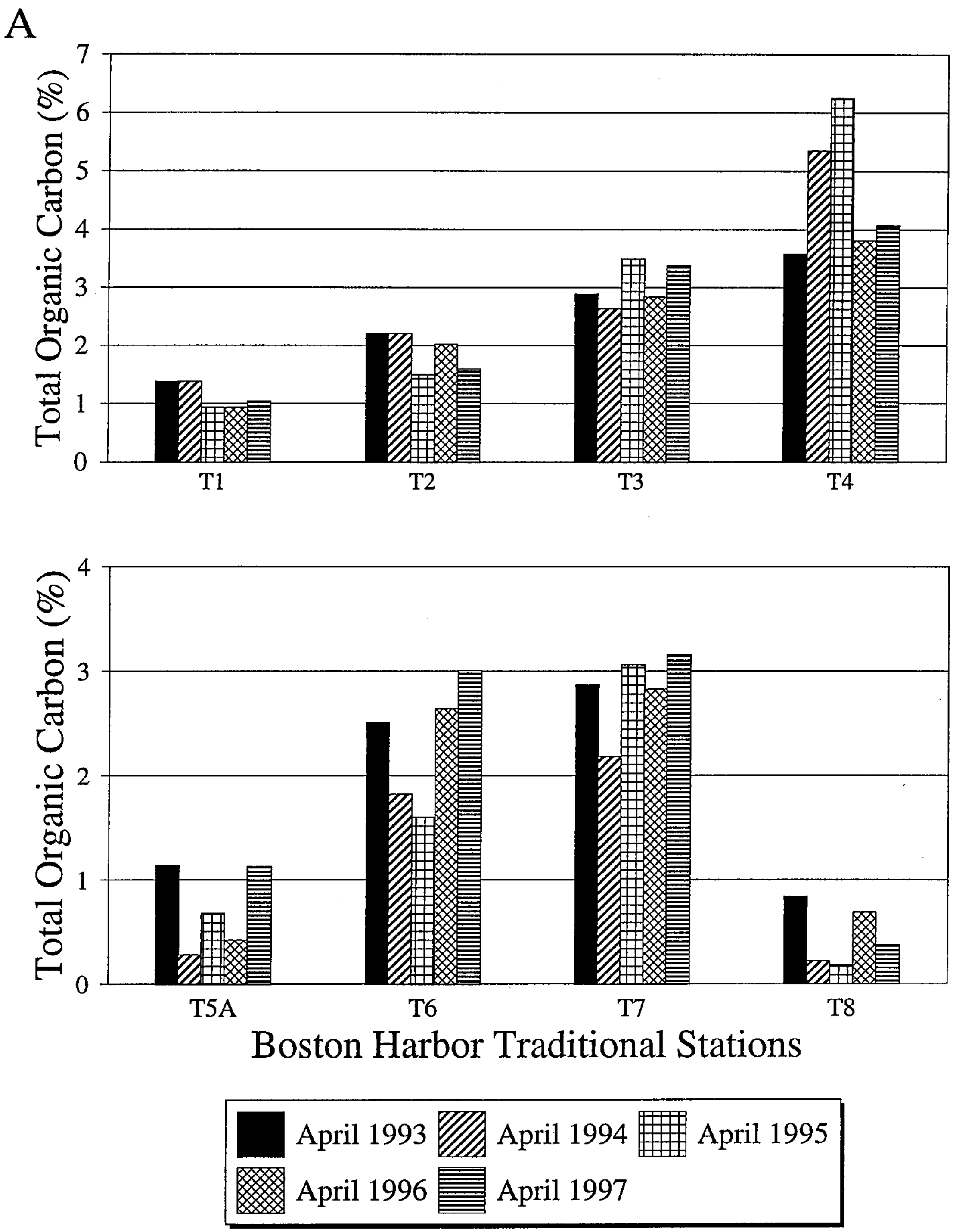


Figure 53. Total organic carbon (dry weight percent) at Boston Harbor Traditional stations in April 1993-1997.

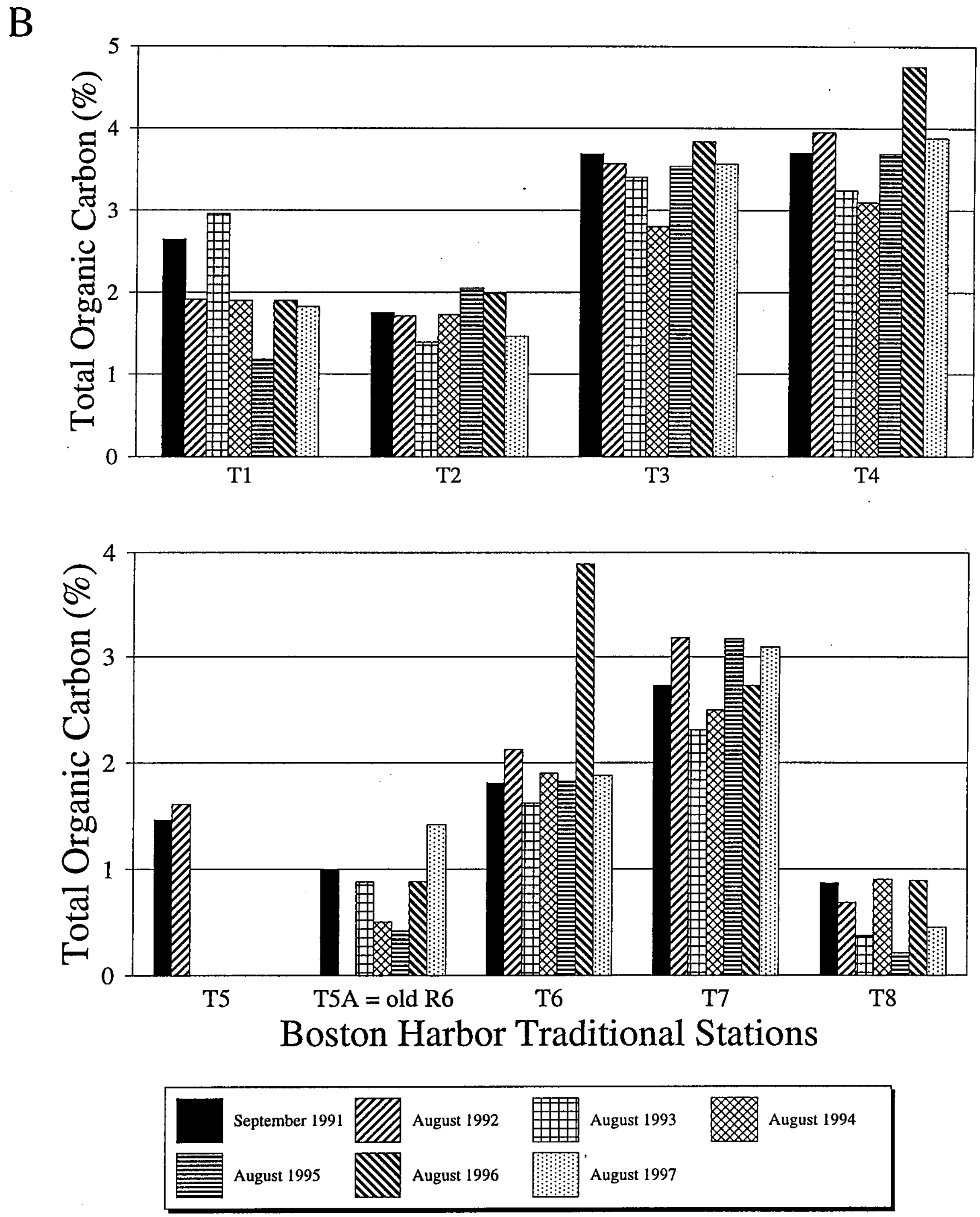


Figure 54. Total organic carbon (dry weight percent) at Boston Harbor Traditional stations in September 1991 and August 1992-1997.

4.1.3 Concentrations of Clostridium perfringens Spores

The concentration of *C. perfringens* spores at Traditional stations from 1991 to 1997 is shown in Figures 55 and 56. If a high-spore-count station is defined as having spore densities ≥ 15,000 per gram (dry weight) of sediment, six stations consistently fall within this category: Stations T2, T3, T4, T6 and T7. Station T5, located in the President Roads/Boston North Channel near the Deer Island Outfall, also falls within the high spore count category but was only sampled in 1991 and 1992. Those stations that have high spore counts also have the highest total organic carbon (TOC) inventories (Figures 53 and 54). The TOC and spore count data are complementary. The qualitative correlation between high TOC and spore counts helps to identify sediment focusing sites for organic-rich sewage. Over time, the inventory of *C. perfringens* spores has shown several maxima separated by intervals of relatively low inventories (Figures 55 and 56). There appears to be no consistent year-to-year pattern in the seasonality of spore counts. For example, in 1996, spore counts were mostly higher in August relative to April. In 1997, April spore counts were higher than August counts. Because of the high spatial and temporal variance in spore counts, the long term effect of sludge and waste water abatement will require monitoring these parameters for several years.

4.2 Spatial/Temporal Patterns in Organism/Sediment Relationships

4.2.1 Depth of the Mean Apparent RPD Depth

The mean apparent RPD depth, expressed as a percentage of stations represented by different RPD depth classes, is shown over the baseline period 1992 to 1997 in Figure 57. These percentage distributions are skewed to the left with the major RPD class for all years being 1.00-1.99 cm. This RPD class generally represents the shallow bioturbation depth associated with Stage I seres that dominate nearshore stations. The major difference in the distribution of mean RPDs over the 6-year period is the increase in RPD depths in the right-hand tail of the distribution (i.e., ≥ 4.00 cm). Station values ≥ 4 cm are located in silt-clay sediments populated by dense tube mats of amphipods in the central to outer parts of the bay system. Aerated water is pumped into the bottom from the overlying water, thus depressing the apparent RPD into the sediments. The pumping activity is related to tube irrigation (fluid bioturbation) of amphipods (*Ampelisca* sp). Amphipod tube mats reached an acme in 1995-1996 (see Figure 58). In 1997, the distribution is contracted slightly from that mapped in 1996 (Figures 58 and 59), resulting in fewer stations showing RPD depths ≥ 4.00 cm.

The RPD histograms are sensitive to the success of *Ampelisca* in exploiting space. As seen in Figures 57 and 58, increasing population size (area) results in deeper fluid bioturbation. Conversely, Stage II amphipod populations tend to be short-lived and may be expected to decline in the future. If this decline retrogrades to a Stage I sere, RPD depths will be dominated by RPD classes < 4.00 cm. If, however, amphipods are replaced by Stage III seres, RPD depths can be expected to be maintained or deepened.

4.2.2 Successional Status

Amphipod tube mats have been mapped in the survey area since 1989 (Figures 58 and 59). In late October 1991, a severe storm left evidence of wave scour on the bottom sediments and caused a harbor-wide shift in sediment texture from mud to mostly fine sand, which is the substrate preferred by settling ampeliscid larvae (SAIC, 1992; Hilbig *et al.*, 1997). The first survey with the sediment profile camera following both the storm and the December 1991 cessation of sewage sludge disposal was made in May 1992. Podocerid amphipods were noted at only a few (n=9) stations in outer Quincy Bay (Nantasket Roads area between Long and Peddocks Islands) and at four stations in Hull Bay. Amphipods were absent from Dorchester Bay and Boston Harbor except at Station R9 located on the west side of Long Island across the channel from the Deer Island outfall and south of the Long Island outfall (SAIC, 1992). *Ampelisca* mats have subsequently

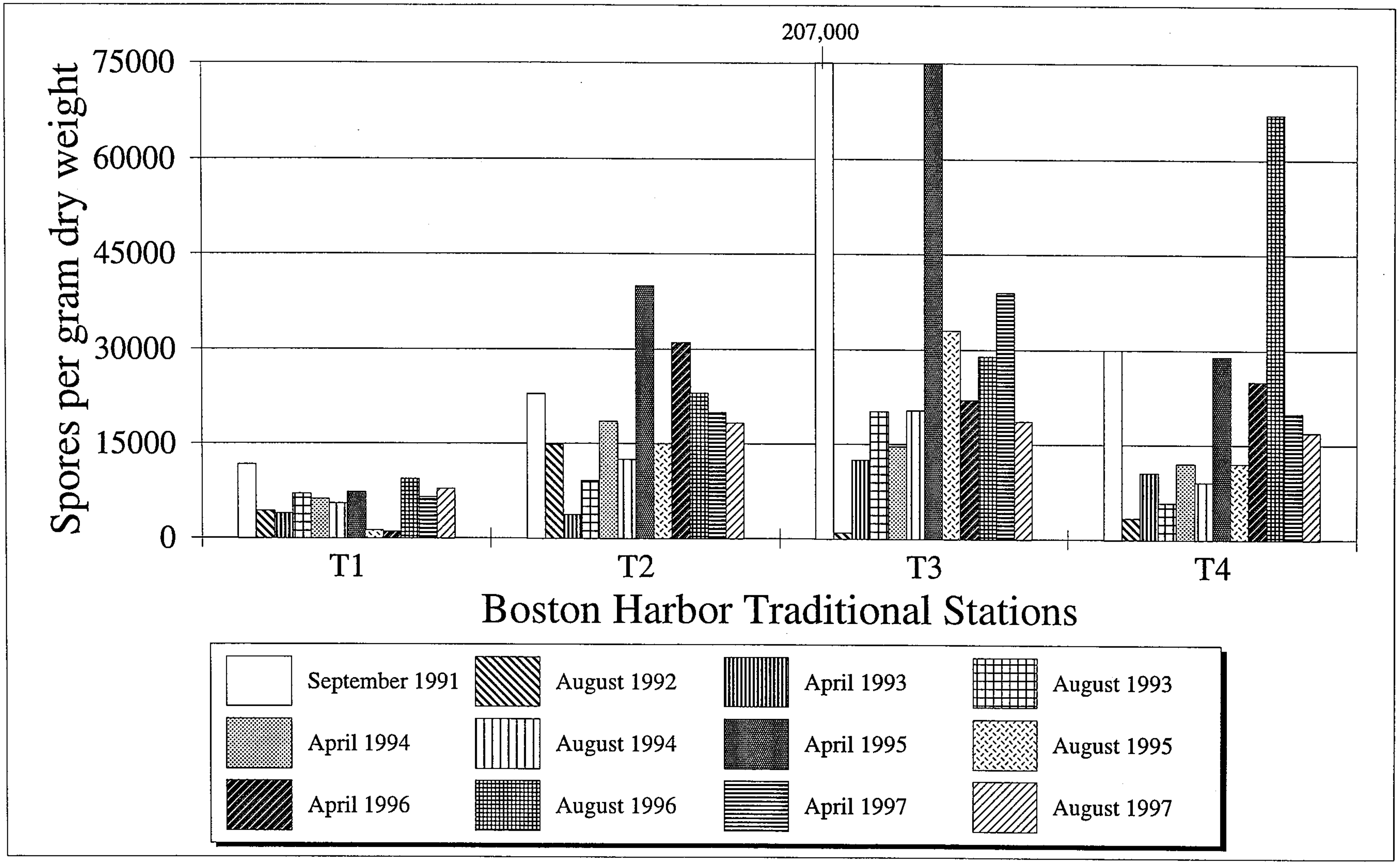


Figure 55. ***Clostridium perfringens*** **spore counts at Boston Harbor Traditional stations T1-T4 from September 1991 through August 1997.**

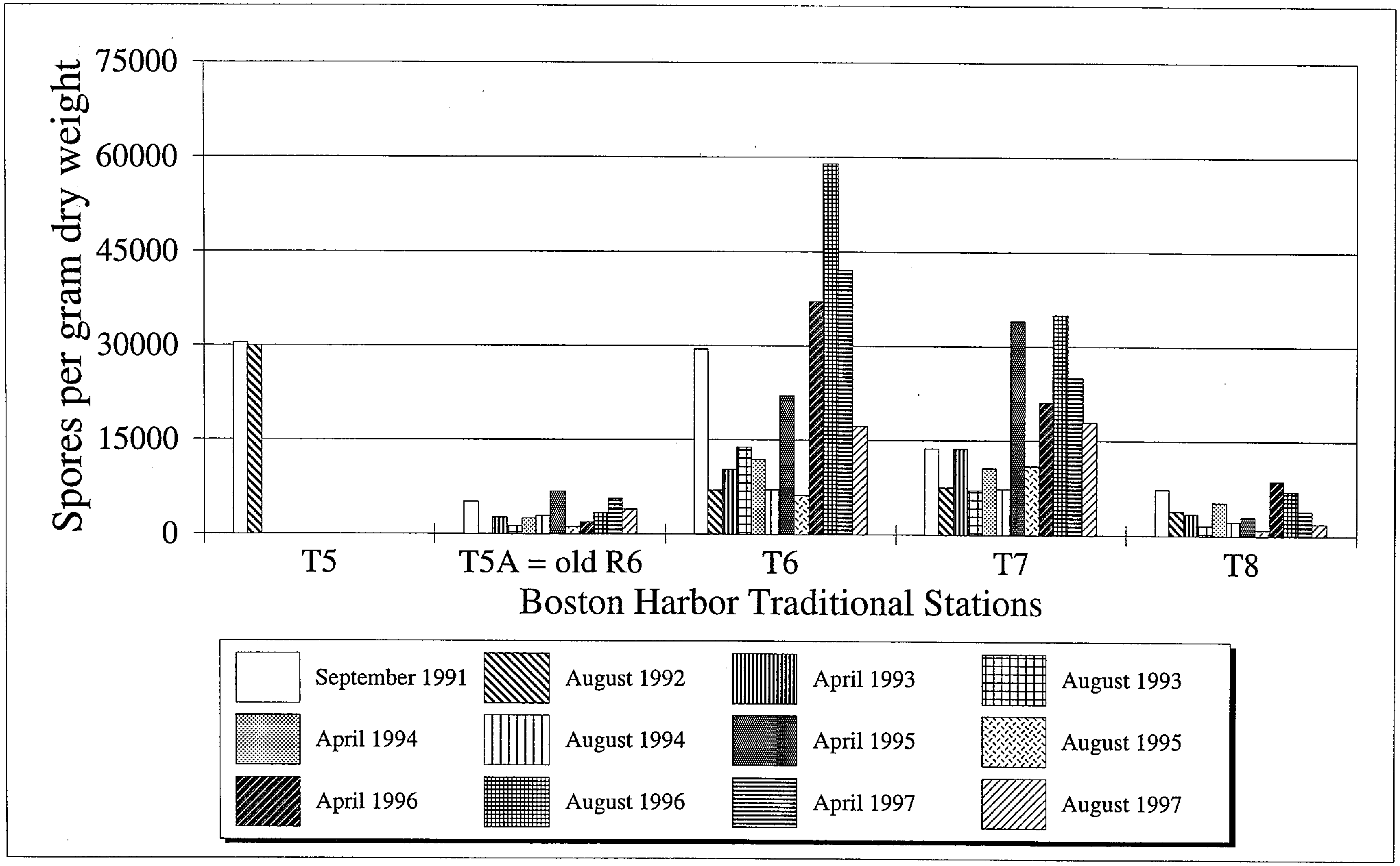


Figure 56. ***Clostridium perfringens*** **spore counts at Boston Harbor Traditional stations T5 - T8 from September 1991 through August 1997.**

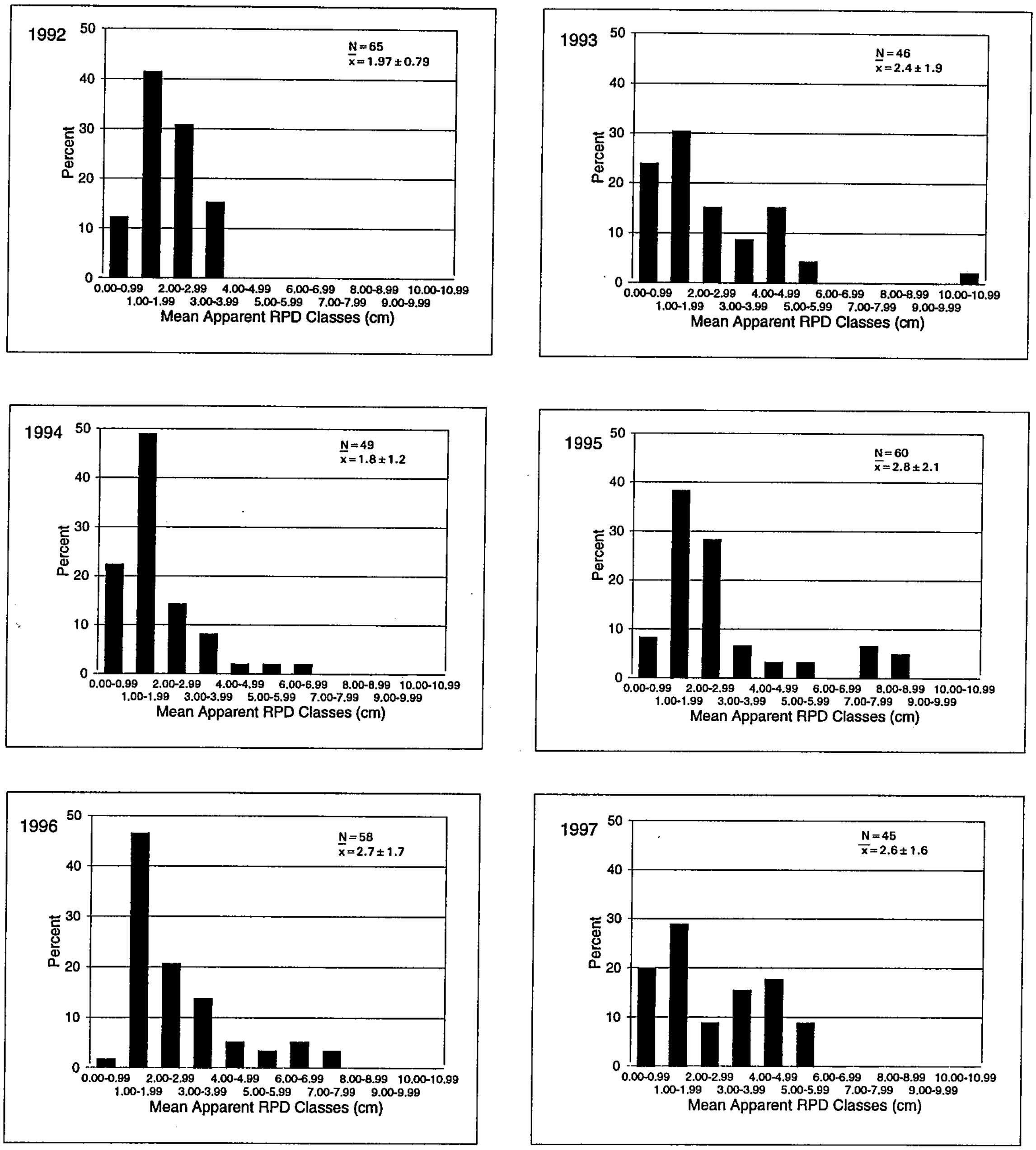


Figure 57. Comparison of apparent redox potential discontinuity (RPD) depths (cm) over the period 1992-1997.

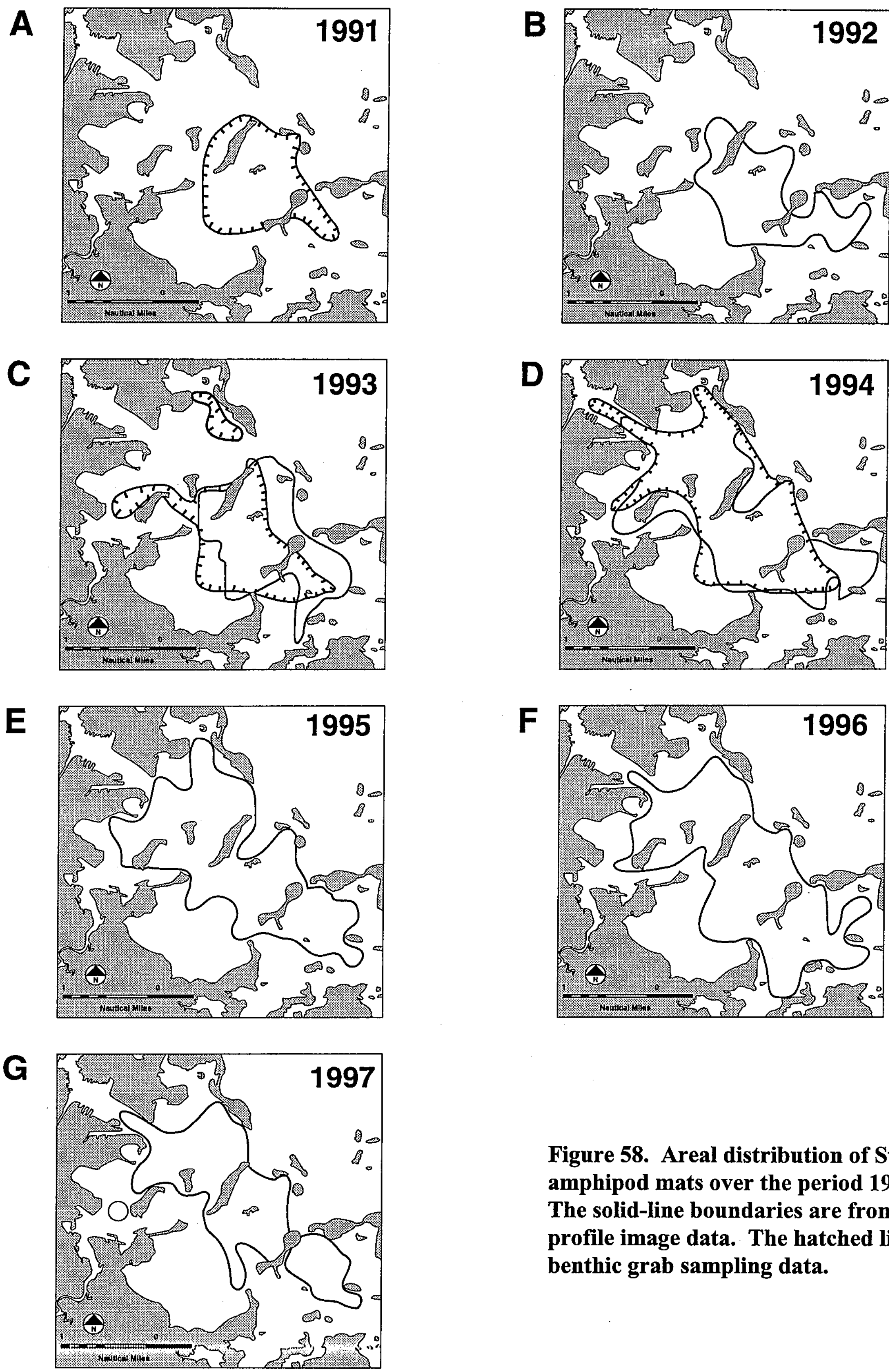


Figure 58. Areal distribution of Stage II amphipod mats over the period 1991 to 1997. The solid-line boundaries are from sediment-profile image data. The hatched lines are from benthic grab sampling data.

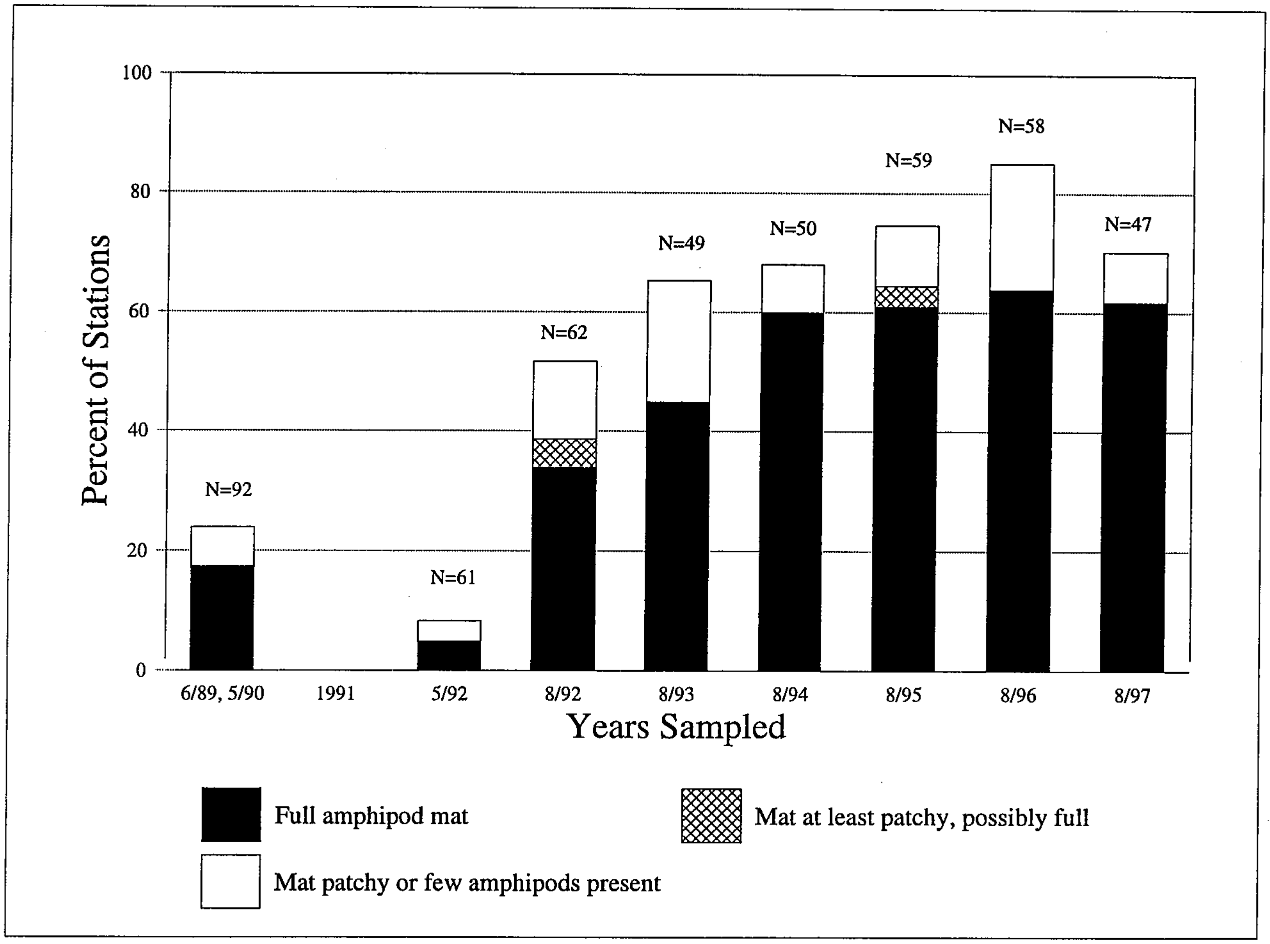


Figure 59. Frequency (percentage) of stations showing well-developed amphipod tube mats (solid bars), patchy mats (open bars), and transitional mats (shaded bars) over the period 1989 to 1997.

spread into Boston Harbor including Boston South Channel, Deer Island Flats, President Roads/Boston North Channel, Spectacle Island and Thompson's Island (Figure 58). Well-developed amphipod tube mats increased dramatically from 1992 (< 10% of sampled stations) to a peak of more than 60% of the stations sampled in 1996 (Figure 59). In 1997, well-developed tube mats are still present at over 50% of the stations (Figure 59). The apparent slight decline in area covered by the amphipod mats between the 1996 and 1997 surveys may be due to the poor quality of the images from the August 1997 survey rather than to a real decline in spatial extent of the mats.

The importance of these amphipods in aerating and mixing the bottom has been noted above (Section 4.4). Extensive mats of amphipods tend to be transient in space and time and may experience retrograde succession (back to Azoic or Stage I conditions) or, alternatively, prograde to Stage III. It is uncertain what the long-term benthic equilibrium assemblage will be in Boston Harbor and environs. It is likely that the Harbor and inter-connected bays will consist of smaller scale disturbance mosaics, each one representing different frequencies and intensities of local chemical and/or physical disturbance (Johnson, 1972).

4.2.3 Organism-Sediment Indices (OSI)

The distribution of OSIs among stations over the period 1992 through 1997 is shown in Figure 60. This period represents one of major change in infaunal dominance as described above. In 1992, amphipod tube mats were not widespread. The distribution of OSI values had a central tendency with most values falling within the 6.5 to 8.4 OSI classes. As Stage II amphipod mats increased in area from 1993 through 1997, the histograms showed bimodality or polymodality in OSI distributions. Inspection of the mapped OSI data indicates that OSI values within these mats generally increased over time and space reaching an acme in 1997 (major modal OSI= 9.5 to 10.4 at over 20% of the stations). Stations dominated by Stage I seres located well outside of the amphipod tube mats (especially nearshore) form the left-hand tail of the OSI distributions. Most of these values fall below 3.5. Stations located near, but outside of the amphipod tube mat boundary, yield intermediate OSI values. This trimodality was best developed in 1997 (Figure 60).

4.3 Spatial/Temporal Trends in Benthic Infauna

The cessation in December 1991 of dumping sludge into Boston Harbor was perhaps the single most significant change in the input of pollutants into the Harbor environment since sewage disposal began about 100 years ago. Additional changes have included the cessation of scum discharge from both Deer Island and Nut Island (1989) and upgrading the treatment of wastewater to enhanced primary (1995), then to secondary (1997). In addition to the reduced pollutant input, the severe storm of late October 1991 affected the bottom sediments of the Harbor, leaving traces of wave scour and resulting in a coarsening of sediment texture.

At all stations, the biggest change in benthic community parameters was seen between the pre-abatement September 1991 samples and the April and August samples taken the following year (1992). Species richness increased at the majority of stations during this interval(Figures 61 and 62). However, the following April (1993) saw a reversal of this trend to a greater (e.g., Stations T1 and T2, Figure 61) or lesser (e.g., T3 and T4, Figure 61) extent. Multivariate analyses of the 1991-1997 data set (see Section 3.5) indicate that at many stations, the communities sampled in late 1991 were most similar to the community at the same station the following May; generally followed by lower similarity to samples taken in subsequent years. However, recent samples (1996 and 1997) are very similar to samples taken in 1993/1994, indicating a relative stability in community structure since 1993.

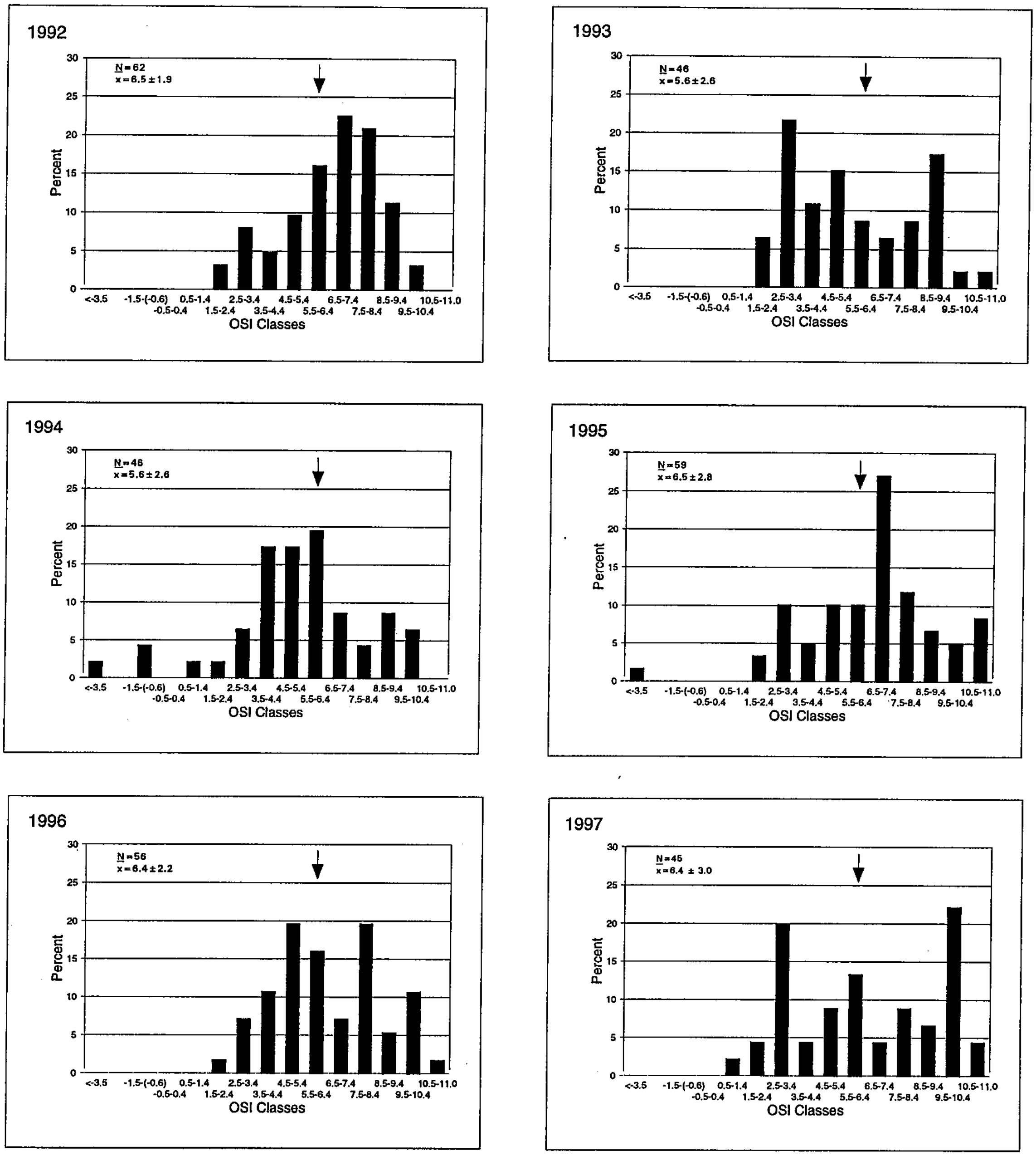


Figure 60. Comparison of the Organism-Sediment Index (OSI) frequency distributions over the period 1992 to 1997. Values ≥ +6 (to right of arrows) represent the highest benthic habitat quality.

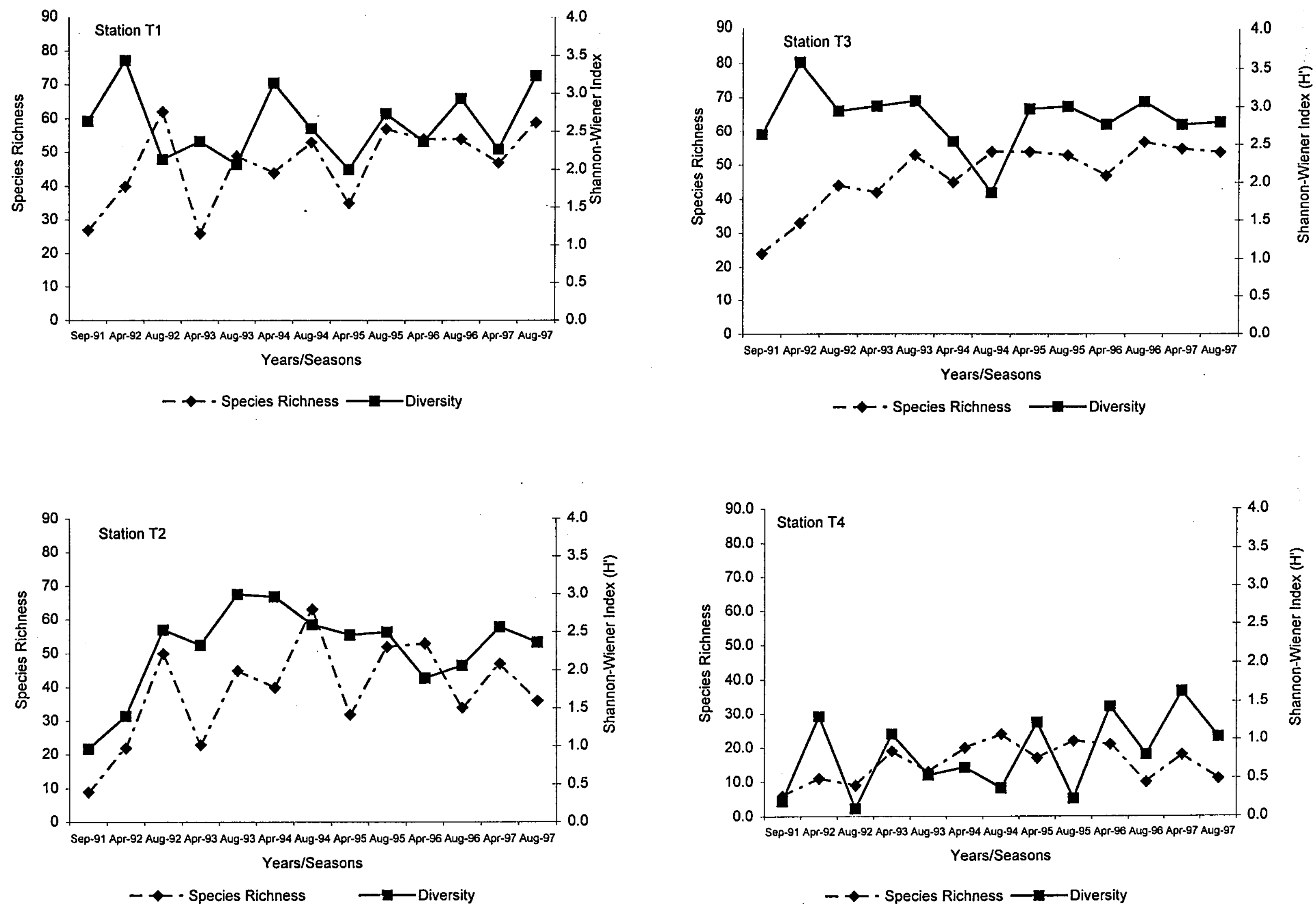


Figure 61. Species richness and diversity over the period September 1991 through August 1997 at Boston Harbor Traditional stations T1, T2, T3, and T4.

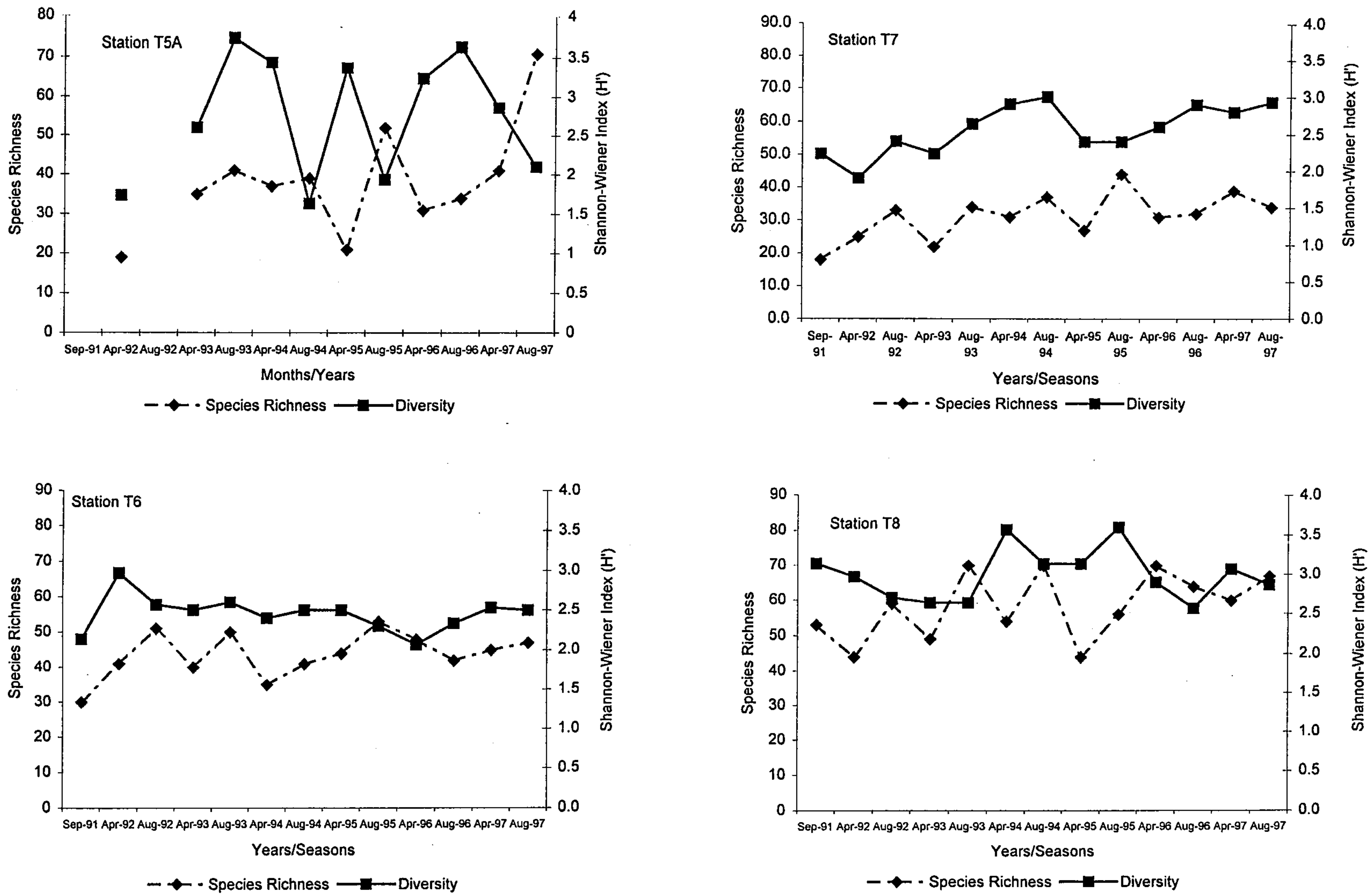


Figure 62. Species richness and diversity over the period September 1991 through August 1997 at Boston Harbor Traditional stations T5A, T6, T7, and T8.

Seasonal changes are obvious in several community parameters, with some stations showing high diversity in April when larvae and juveniles may be settling to the bottom, followed by lower diversity in August when many of these juveniles may have failed to survive at these stations (e.g., T4, Figure 61; T5A, Figure 62). Multivariate analyses also suggest a seasonal component to the community structure.

In previous years, the discussion of similarity or differences among the benthic infaunal stations has focused on a north/south dichotomy, with the northern stations (i.e., those north of Long Island), which are closer to the original sewage discharges from Deer Island as well as to the sludge discharges from both Deer and Nut Island, being those that were considered to have received the greatest impact and therefore showed the greatest degradation. The southern part of the Harbor, especially Hingham and Hull Bays, and occasionally Quincy Bay, was, from the earliest studies in 1978 and continuing through 1997, apparently cleaner, perhaps because those areas received less sewage input, no sludge, and were in areas of better or greater tidal flow. Those stations (T6, T7, T8) have always exhibited higher species richness and diversity and have been considered healthier than the northern stations. There is also a dichotomy between the nearshore stations (T1, T2, T4) and those that are farther from shore and therefore subject to a different physicochemical regime (T3, T6, and T8).

One of the consistent features of all the analyses is the presence of fairly well-characterized faunal assemblages in the Harbor. The most characteristic is the amphipod assemblage, dominated by *Ampelisca abdita*. *Polydora cornuta*, an opportunistic polychaete, is a consistent member of this assemblage in the summer (August) samples, but is associated with the *Streblospio* assemblage in the spring (April). A second important community type is the *Streblospio benedicti* assemblage, as seen at Station T4 in Savin Hill Cove. The third major community type is the *Aricidea catherinae* assemblage. Station T8, one of the most diverse stations, was dominated by the *Ampelisca* assemblage in 1993, 1996, and 1997, but by *Aricidea catherinae* in 1991-1992 and 1994-1995. A fourth assemblage is dominated by oligochaetes, in particular *Tubificoides* nr. *pseudogaster*, and includes *Mytilus edulis* and *Tharyx acutus*.

Although the benthic infaunal database has not in itself suggested notable changes in the benthic biology of the Harbor since August 1993, the spread of ampeliscid tube mats, as determined by the sediment profile camera, does suggest a significant improvement in the overall health of the Harbor. Amphipod mats covered less than 10% of the area surveyed in 1992 and increased to a peak of 60% in 1996. The modest decline in the areal extent of the mats between the 1996 and 1997 surveys may be due more to the poor quality of the images taken in the August 1997 survey than to a real decline in the extent of the mat; however, it is not expected that these mats will persist over the monitored area indefinitely. Tubicolous amphipods tend to dominate the ecological ecotone between very high organic loading and low or ambient loading (Valente *et al.*, 1992). As organic loading decreases, the amphipod mats may contract in spatial coverage and tube density. As this takes place, the low density of tubes serves to increase bottom roughness and fluid form drag. Muddy sediment bound within the tube mats can be expected to be resuspended and redistributed. This event can be expected to result in a major reorganization of the benthic community before a mosaic of new assemblages is established over the long term. It remains to be seen whether the removal of the wastewater that is currently still discharged to the Harbor will result in a progression of the benthic communities to a more highly developed stage, or whether the remaining physico-chemical stresses will keep the Harbor at its present level of community structure.

5.0 CONCLUSIONS

- Boston Harbor and the interconnecting bay systems has shown a marked improvement in benthic conditions from 1991 to 1997 as inferred from sediment-profile imaging data.

- Data from infaunal grabs indicate that the greatest change took place between September 1991 (before cessation of sludge discharge) and August 1993. Since that time, infaunal communities have shown seasonal differences, but have not changed substantially in terms of species composition or diversity.

- Four faunal groups have been elucidated from the 1991-1997 data set. These groups include the *Streblospio benedicti* assemblage, found in stressed environments such as Station T4 in Savin Hill Cove; the amphipod assemblage, primarily dominated by *Ampelisca abdita* but in August also including the polychaete *Polydora cornuta*; the *Aricidea catherinae* assemblage, and the *Tubificoides* nr. *pseudogaster* assemblage, the latter two groups being found at the more diverse outer Harbor stations such as T3, T6, and T8.

- The major source of variation in Boston Harbor benthic community structure is among the sampling sites. There are seasonal differences in community structure, but these differences are small compared to the among-site differences.

- The best time-integrator of the overall improvement in the benthic condition of the Harbor is the spread of dense populations of *Ampelisca abdita*, an amphipod species that builds tubes which promote the settlement and retention of organic muds (Rhoads and Boyer, 1982). Tube irrigation serves to transport oxygenated water into the bottom, thereby deepening the apparent RPD depth.

- Tubicolous amphipods such as *Ampelisca* tend to dominate the ecological ecotone between very high organic loading and low or ambient loading (Valente *et al.*, 1992). As organic loading decreases, the amphipod mats may contract in spatial coverage and tube density. Prior to sludge abatement, less than 20 percent of the profile camera monitoring stations showed the presence of amphipod tube mats. In 1996, over 60 percent of the monitoring stations showed well-developed tube mats. In 1997, this coverage had decreased slightly, but mats still cover about 50% of the area surveyed.

- The tube mats are effective in trapping fine-grained sediment and have had a significant impact on enhancing sedimentation rates of silt-clay and very fine sand. Reduced muds are gradually oxidized, lowering the concentration of reduced metabolites. This is probably a significant diagenetic process which will ultimately prepare these sediments for other colonizing benthic species (Rice and Rhoads, 1989). Because benthic infaunal succession is prograding and mixing depths are increasing, organism-sediment indices have shown improvement over time

- As the area covered by the tube mats decreases, the low density of tubes serves to increase bottom roughness and fluid form drag. Muddy sediment bound within the tube mats can be expected to be resuspended and redistributed.

- The parameters of TOC and *C. perfringens* spore counts are more conservative than organism-sediment relationships in terms of showing change in the system related to sludge abatement. These parameters can be expected to show change but on a longer time span than macrobenthic responses. It may take several more years for the organically loaded stations to reflect reduced sedimentation rates of labile organic matter.

6.0 ACKNOWLEDGMENTS

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Appendix A

Station Locations

Appendix A1. Target locations for the Boston Harbor Traditional stations.

Station	Latitude	Longitude	Depth (m)
T1	42°20.95′N	70°57.81′W	4.0
T2	42°20.57′N	71°00.12′W	6.0
T3	42°19.81′N	70°57.72′W	9.0
T4	42°18.60′N	71°02.49′W	3.5
T5a	42°20.38′N	70°57.64′W	18.0
T6	42°17.61′N	70°56.66′W	6.0
T7	42°17.36′N	70°58.71′W	7.0
T8	42°17.12′N	70°54.75′W	11.0

Appendix A2. Target locations for the Boston Harbor Reconnaissance stations.

Station	Latitude	Longitude	Depth (m)
T1	42°20.95′N	70°57.81′W	4.0
T2	42°20.57′N	71°00.12′W	6.0
T3	42°19.81′N	70°57.72′W	9.0
T4	42°18.60′N	71°02.49′W	3.5
T5a	42°20.38′N	70°57.64′W	18.0
T6	42°17.61′N	70°56.66′W	6.0
T7	42°17.36′N	70°58.71′W	7.0
T8	42°17.12′N	70°54.75′W	11.0
R2	42°20.66′N	70°57.69′W	12.0
R3	42°21.18′N	70°58.37′W	5.5
R4	42°21.52′N	70°58.78′W	8.5
R5	42°21.38′N	70°58.68′W	7.1
R6	42°19.91′N	70°57.12′W	6.8
R7	42°20.85′N	70°58.53′W	5.9
R8	42°20.66′N	70°59.50′W	2.8
R9	42°20.80′N	71°00.98′W	11.8
R10	42°21.32′N	71°02.20′W	13.5
R11	42°19.28′N	70°58.48′W	7.0
R12	42°19.10′N	70°58.47′W	6.3
R13	42°19.03′N	70°58.84′W	7.2
R14	42°19.25′N	71°00.77′W	7.9
R15	42°18.92′N	71°01.15′W	3.6
R16	42°18.95′N	70°57.68′W	6.9
R17	42°18.29′N	70°58.63′W	8.2
R18	42°17.33′N	70°57.67′W	7.9
R19	42°16.92′N	70°56.27′W	9.7
R20	42°19.49′N	70°56.10′W	9.7
R21	42°18.53′N	70°56.78′W	7.0
R22	42°18.02′N	70°56.37′W	8.3
R23	42°17.63′N	70°57.00′W	10.5
R24	42°17.78′N	70°57.51′W	8.3
R25	42°17.48′N	70°55.72′W	6.8
R26	42°16.13′N	70°55.80′W	5.8
R27	42°16.83′N	70°54.98′W	3.7
R28	42°16.90′N	70°54.52′W	8.2

Appendix A2 (Continued)

Station	Latitude	Longitude	Depth (m)
R29	42°17.38′N	70°55.25′W	8.8
R30	42°17.43′N	70°54.25′W	5.2
R31	42°18.05′N	70°55.03′W	9.8
R32	42°17.68′N	70°53.82′W	5.5
R33	42°17.65′N	70°59.67′W	4.0
R34	42°17.33′N	71°00.42′W	3.4
R35	42°17.05′N	70°59.28′W	4.3
R36	42°16.53′N	70°59.20′W	2.7
R37	42°17.93′N	70°59.08′W	4.0
R38	42°17.08′N	70°57.83′W	4.6
R39	42°17.73′N	70°58.22′W	6.4
R40	42°19.73′N	71°01.45′W	4.6
R41	42°18.67′N	71°01.50′W	5.5
R42	42°19.18′N	71°01.50′W	3.7
R43	42°18.40′N	71°00.13′W	4.0
R44	42°20.62′N	71°00.13′W	6.1
R45	42°19.70′N	70°58.05′W	6.7
R46	42°17.46′N	70°55.33′W	9.5
R47	42°20.67′N	70°58.72′W	8.3
R48	42°17.61′N	70°59.27′W	3.1
R49	42°16.39′N	70°54.49′W	8.4
R50	42°16.50′N	70°53.92′W	7.6
R51	42°15.80′N	70°56.53 ′W	2.4
R52	42°15.71′N	70°56.09′W	2.1
R53	42°16.15′N	70°56.27′W	3.0

Appendix B

Sediment Profile Survey Results

HOM - 1996 BOSTON HARBOR SEDIMENT PROFILE SURVEY RESULTS

Stat_ID	Replicate	Penetration Depth (cm)			Boundary Roughness		Grain Size (phi)			Redox Potential Discontinuity (RPD) Depth (cm)			
					Thickness (cm)	Type			Major Mode	Replicates			Station
		Minimum	Maximum	Mean			Minimum	Maximum		Minimum	Maximum	Mean	Mean
BHR02	A	17.76	18.90	18.36	1.14	Biological	>4	3 to 2	>4	0.90	7.08	1.8	
BHR02	B	18.81	19.77	19.23	0.96	Biological	>4	3 to 2	>4	0.39	7.05	2.0	2.0
BHR02	C	18.93	19.86	19.36	0.93	Biological	>4	3 to 2	>4	1.32	6.63	2.1	
BHR03	A	14.40	15.15	14.74	0.75	Biological	>4	4 to 3	>4	1.80	7.02	3.0	
BHR03	B	13.17	13.95	13.51	0.78	Biological	>4	3 to 2	>4	0.81	11.16	3.5	3.1
BHR03	C	18.00	20.28	19.08	2.28	Biological	>4	4 to 3	>4	0.00	6.39	2.9	
BHR04	A	20.64	21.15	20.91	0.51	Biological	>4	4 to 3	>4	0.15	2.67	1.6	
BHR04	B	11.88	12.87	12.40	0.99	Biological	>4	4 to 3	>4	0.09	3.12	0.9	1.3
BHR04	C	19.41	20.07	19.73	0.66	Biological	>4	4 to 3	>4	0.00	3.27	1.5	
BHR05	A	16.86	17.82	17.42	0.96	Biological	>4	4 to 3	>4	0.12	3.48	1.1	
BHR05	B	16.98	17.76	17.39	0.78	Biological	>4	4 to 3	>4	0.39	4.95	1.9	1.2
BHR05	C	18.12	19.38	18.59	1.26	Biological	>4	4 to 3	>4	0.00	3.15	0.7	
BHR06	A	0.00	0.00	0.00	Indeterminate	Indeterminate	2 to 1	<-1	<-1	0.00	0.00	Indeterminate	
BHR06	C	0.00	0.00	0.00	Indeterminate	Physical	2 to 1	<-1	<-1	0.00	0.00	Indeterminate	Indeterminate
BHR06	D	3.42	6.27	4.41	2.85	Physical	>4	<-1	<-1	1.05	4.70	Indeterminate	
BHR07	A	19.56	21.69	20.59	2.13	Biological	>4	3 to 2	>4	0.78	7.65	4.8	
BHR07	B	20.04	21.57	20.99	1.53	Biological	>4	4 to 3	>4	0.19	5.07	1.1	2.4
BHR07	C	20.04	21.87	20.73	1.83	Biological	>4	4 to 3	>4	0.75	4.32	1.4	
BHR08	A	5.52	6.51	6.00	0.99	Physical	>4	<-1	4 to 3	0.99	6.03	4.0	
BHR08	B	6.33	7.50	6.87	1.17	Physical	>4	<-1	4 to 3	1.26	7.50	6.0	4.5
BHR08	C	7.89	9.21	8.56	1.32	Biological	>4	4 to 3	4 to 3	1.83	6.12	3.5	
BHR09	A	21.30	22.02	21.66	0.72	Biological	>4	4 to 3	>4	1.41	6.09	3.4	
BHR09	B	20.97	21.30	21.12	0.33	Biological	>4	3 to 2	>4	0.96	4.92	2.4	2.8
BHR09	C	21.30	22.59	22.25	1.29	Biological	>4	4 to 3	>4	1.38	6.36	2.5	
BHR10	B	21.09	22.74	22.00	1.65	Biological	>4	4 to 3	>4	0.15	3.90	1.6	
BHR10	C	22.71	23.16	22.93	0.45	Biological	>4	4 to 3	>4	1.89	4.23	2.6	1.8
BHR10	D	21.69	22.08	21.89	0.39	Biological	>4	4 to 3	>4	0.99	4.26	1.1	
BHR11	A	20.82	21.72	21.35	0.90	Biological	>4	4 to 3	>4	2.31	8.07	4.0	
BHR11	C	20.79	21.45	21.09	0.66	Biological	>4	4 to 3	>4	2.58	8.97	4.5	4.5
BHR11	D	20.04	21.39	20.58	1.35	Biological	>4	4 to 3	>4	2.22	8.64	5.0	
BHR12	A	20.67	21.21	21.00	0.54	Biological	>4	4 to 3	>4	2.46	11.28	3.5	
BHR12	B	20.40	21.03	20.81	0.63	Biological	>4	4 to 3	>4	0.00	5.13	2.6	2.9
BHR12	C	20.79	21.96	21.59	1.17	Biological	>4	4 to 3	>4	1.35	6.75	2.5	
BHR13	A	15.12	15.84	15.55	0.72	Biological	>4	3 to 2	>4	0.00	4.50	1.5	
BHR13	B	16.77	17.97	17.27	1.20	Indeterminate	>4	3 to 2	4 to 3	0.12	6.30	2.1	2.0
BHR13	C	15.42	15.93	15.71	0.51	Biological	>4	3 to 2	4 to 3	0.00	7.10	2.4	
BHR14	A	9.72	10.38	10.02	0.66	Biological	>4	<-1	>4	0.69	4.26	1.8	
BHR14	B	1.08	15.45	11.32	14.37	Indeterminate	>4	0 to -1	>4	0.15	2.88	1.2	1.6
BHR14	C	11.91	12.78	12.48	0.87	Biological	>4	3 to 2	>4	1.17	5.46	1.9	
BHR15	A	14.10	15.75	14.67	1.65	Physical	>4	<-1	>4	0.00	8.31	1.8	
BHR15	B'	15.15	16.23	15.82	1.08	Biological	>4	3 to 2	>4	0.93	5.70	1.6	1.3
BHR15	D	14.52	17.85	16.96	3.33	Physical	>4	<-1	>4	0.12	11.16	0.6	
BHR16	A	13.71	14.37	14.04	0.66	Physical	>4	3 to 2	>4	0.39	4.32	2.3	
BHR16	C	15.21	15.96	15.65	0.75	Biological	>4	4 to 3	>4	2.88	8.16	3.5	3.1
BHR16	D	16.05	17.31	16.73	1.26	Biological	>4	3 to 2	>4	2.76	8.25	3.6	

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Stat_ID	Replicate	Penetration Depth (cm)			Boundary Roughness		Grain Size (phi)			Redox Potential Discontinuity (RPD) Depth (cm)			
					Thickness	Type			Major	Replicates			Station
		Minimum	Maximum	Mean	(cm)		Minimum	Maximum	Mode	Minimum	Maximum	Mean	Mean
BHR17	A'	21.81	23.04	22.40	1.23	Biological	>4	3 to 2	>4	1.53	4.02	1.6	
BHR17	B	19.47	21.75	20.87	2.28	Biological	>4	4 to 3	>4	0.12	2.61	0.5	1.3
BHR17	D'	23.10	23.30	23.20	0.20	Biological	>4	4 to 3	>4	1.65	3.27	1.7	
BHR18	A	17.37	18.18	17.83	0.81	Biological	>4	3 to 2	>4	0.90	4.14	2.8	
BHR18	B	18.24	19.77	18.96	1.53	Biological	>4	4 to 3	>4	0.00	5.52	1.9	2.3
BHR18	C	21.09	22.65	21.80	1.56	Biological	>4	3 to 2	>4	1.14	6.72	2.1	
BHR19	A	4.05	6.12	5.02	2.07	Biological	>4	3 to 2	4 to 3	0.51	>4.05	2.5	
BHR19	B	0.93	6.42	4.51	5.49	Biological	>4	<-1	4 to 3	1.05	3.54	1.8	1.7
BHR19	C	3.78	4.98	4.48	1.20	Physical	>4	<-1	4 to 3	0.00	1.98	0.9	
BHR20	A	19.14	20.40	19.91	1.26	Biological	>4	3 to 2	>4	0.60	8.79	2.8	
BHR20	B	21.60	22.23	21.98	0.63	Biological	>4	3 to 2	>4	2.28	10.38	2.9	3.1
BHR20	C	19.53	20.70	19.89	1.17	Biological	>4	3 to 2	>4	1.92	5.82	3.5	
BHR21	A	12.75	13.32	13.01	0.57	Biological	>4	3 to 2	4 to 3	0.99	8.16	3.5	
BHR21	B	9.81	10.95	10.43	1.14	Biological	>4	3 to 2	4 to 3	1.71	7.29	2.4	2.6
BHR21	C	10.29	12.03	11.30	1.74	Biological	>4	3 to 2	4 to 3	1.53	9.15	2.0	
BHR22	A	5.73	6.42	6.06	0.69	Biological	>4	3 to 2	4 to 3	0.63	4.98	2.1	
BHR22	B	4.35	5.64	5.00	1.29	Physical	4 to 3	<-1	3 to 2	0.12	>5.64	2.0	1.8
BHR22	C	0.60	4.11	2.86	3.51	Physical	>4	<-1	3 to 2	1.38	3.06	1.2	
BHR23	A	4.95	6.84	6.05	1.89	Biological	>4	2 to 1	3 to 2	1.14	5.61	2.5	
BHR23	B	9.81	10.98	10.54	1.17	Biological	>4	3 to 2	3 to 2	4.20	9.24	5.0	2.5
BHR23	C	6.51	8.04	7.43	1.53	Biological	>4	3 to 2	4 to 3	0.22	7.02	3.1	
BHR24	A	20.13	21.33	21.07	1.20	Biological	>4	3 to 2	>4	3.54	10.80	5.0	
BHR24	B	20.76	21.69	21.21	0.93	Biological	>4	3 to 2	>4	3.60	10.08	5.2	5.7
BHR24	C	18.60	20.01	19.26	1.41	Biological	>4	3 to 2	>4	2.91	11.49	7.0	
BHR25	A	19.17	20.63	20.11	1.46	Biological	>4	4 to 3	>4	2.37	5.19	4.0	
BHR25	B	20.22	21.39	20.82	1.17	Biological	>4	4 to 3	>4	2.31	9.03	4.4	4.2
BHR25	C	18.99	19.86	19.39	0.87	Biological	>4	4 to 3	>4	3.21	6.45	4.1	
BHR26	A	17.73	18.48	18.05	0.75	Biological	>4	3 to 2	>4	0.18	5.91	1.4	
BHR26	B	16.59	17.70	17.16	1.11	Biological	>4	3 to 2	>4	0.75	10.23	1.7	1.7
BHR26	C	16.38	17.70	17.17	1.32	Biological	>4	3 to 2	>4	0.93	3.75	2.1	
BHR27	A	15.45	16.17	15.77	0.72	Biological	>4	4 to 3	>4	1.26	4.96	2.1	
BHR27	B	19.36	20.44	19.83	1.08	Biological	>4	4 to 3	>4	1.20	6.54	5.2	3.8
BHR27	C	18.89	19.78	19.19	0.89	Biological	>4	4 to 3	>4	2.06	8.93	4.2	
BHR28	A	13.74	14.59	14.12	0.85	Biological	>4	4 to 3	>4	4.69	10.88	6.5	
BHR28	B	14.53	15.62	15.08	1.09	Biological	>4	4 to 3	>4	5.42	9.49	7.2	7.2
BHR28	C	14.21	15.65	14.75	1.44	Biological	>4	4 to 3	>4	4.68	10.02	8.0	
BHR29	A	16.26	17.46	16.69	1.20	Biological	>4	4 to 3	>4	3.39	10.47	4.7	
BHR29	B	16.98	18.33	17.80	1.35	Biological	>4	4 to 3	>4	3.18	17.76	6.0	5.6
BHR29	C	16.14	17.13	16.56	0.99	Biological	>4	4 to 3	>4	3.03	13.95	6.0	
BHR30	A	12.07	13.33	12.70	1.26	Biological	>4	4 to 3	>4	0.06	5.89	2.4	
BHR30	B	10.83	11.22	11.04	0.39	Biological	>4	4 to 3	>4	0.72	4.65	2.3	2.2
BHR30	C	10.83	12.06	11.51	1.23	Biological	>4	4 to 3	>4	0.12	5.61	1.8	
BHR31	A	19.16	20.15	19.73	0.99	Biological	>4	4 to 3	>4	1.92	13.09	3.0	
BHR31	B	19.17	20.97	19.97	1.85	Biological	>4	4 to 3	>4	0.63	10.68	3.3	3.4
BHR31	C	19.83	20.85	20.43	1.02	Biological	>4	4 to 3	>4	2.10	11.01	3.9	

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Stat_ID	Replicate	Penetration Depth (cm)			Boundary Roughness		Grain Size (phi)			Redox Potential Discontinuity (RPD) Depth (cm)			
					Thickness	Type			Major	Replicates			Station
		Minimum	Maximum	Mean	(cm)		Minimum	Maximum	Mode	Minimum	Maximum	Mean	Mean
BHR32	A	15.93	16.65	16.31	0.72	Physical	>4	4 to 3	4 to 3	0.51	8.79	1.9	
BHR32	B	15.51	16.17	15.80	0.66	Physical	>4	4 to 3	>4	0.22	3.75	1.4	1.6
BHR32	C	15.24	15.78	15.45	0.54	Physical	>4	4 to 3	>4	0.00	6.48	1.6	
BHR33	A	13.11	14.67	13.87	1.56	Indeterminate	>4	4 to 3	>4	0.00	4.41	1.4	
BHR33	B	20.04	20.46	20.23	0.42	Biological	>4	4 to 3	>4	0.69	6.87	3.0	1.9
BHR33	C	18.84	19.59	19.23	0.75	Biological	>4	4 to 3	>4	0.00	14.64	1.3	
BHR34	A	20.61	21.51	21.11	0.90	Indeterminate	>4	4 to 3	>4	0.00	1.71	0.4	
BHR34	B	21.27	22.14	21.88	0.87	Biological	>4	4 to 3	>4	0.15	3.96	2.5	1.9
BHR34	C	19.23	20.64	19.96	1.41	Indeterminate	>4	4 to 3	>4	1.41	4.41	2.7	
BHR35	A	18.45	19.17	18.77	0.72	Biological	>4	4 to 3	>4	0.30	5.28	2.0	
BHR35	B	13.80	14.91	14.43	1.11	Biological	>4	4 to 3	>4	0.00	4.89	1.9	1.7
BHR35	C	11.52	13.35	12.21	1.83	Indeterminate	>4	4 to 3	>4	0.18	3.87	1.2	
BHR36	B	5.70	6.42	6.09	0.72	Physical	>4	3 to 2	4 to 3	0.96	5.82	2.6	
BHR36	C	4.53	5.49	5.05	0.96	Physical	>4	<-1	3 to 2	1.17	5.49	3.5	3.0
BHR36	D	3.90	5.34	4.76	1.44	Physical	>4	<-1	3 to 2	1.62	5.34	3.0	
BHR37	A	11.70	13.53	12.95	1.83	Indeterminate	>4	4 to 3	>4	0.42	3.54	1.5	
BHR37	B	13.80	14.88	14.44	1.08	Biological	>4	3 to 2	>4	0.15	3.48	1.3	1.4
BHR37	C	11.19	12.48	11.60	1.29	Physical	>4	3 to 2	>4	0.36	5.34	1.4	
BHR38	A	16.11	16.50	16.31	0.39	Biological	>4	4 to 3	>4	0.81	4.47	1.7	
BHR38	B	18.30	19.26	18.76	0.96	Biological	>4	4 to 3	>4	0.93	6.45	2.6	2.0
BHR38	C	16.74	17.91	17.10	1.17	Biological	>4	4 to 3	>4	0.24	5.56	1.6	
BHR39	A	21.78	22.62	22.23	0.84	Biological	>4	4 to 3	>4	1.02	3.42	1.6	
BHR39	B	18.90	19.71	19.34	0.81	Biological	>4	3 to 2	>4	0.90	4.77	1.5	1.8
BHR39	C	19.89	20.61	20.25	0.72	Biological	>4	3 to 2	>4	0.57	4.02	2.2	
BHR40	A	15.57	16.02	15.81	0.45	Biological	>4	3 to 2	>4	0.11	5.22	1.6	
BHR40	B	16.02	16.80	16.47	0.78	Biological	>4	>4	>4	0.15	5.55	2.2	1.9
BHR40	C	14.04	15.21	14.77	1.17	Physical	>4	3 to 2	>4	0.18	4.29	1.8	
BHR41	A	17.55	18.66	18.17	1.11	Physical	>4	4 to 3	>4	0.81	4.77	2.0	
BHR41	B	16.77	17.40	17.22	0.63	Biological	>4	3 to 2	>4	0.36	4.05	1.6	1.7
BHR41	C	19.20	19.62	19.41	0.42	Biological	>4	4 to 3	>4	0.12	3.75	1.4	
BHR42	A	3.87	4.74	4.31	0.87	Physical	>4	0 to -1	4 to 3	0.00	4.74	Indeterminate	
BHR42	B	10.50	11.52	10.90	1.02	Biological	>4	3 to 2	>4	0.15	5.94	1.3	1.3
BHR42	C	3.99	5.13	4.61	1.14	Physical	>4	<-1	4 to 3	0.00	5.13	Indeterminate	
BHR43	A	21.30	21.66	21.44	0.36	Biological	>4	3 to 2	>4	0.06	2.01	0.7	
BHR43	B	21.00	21.90	21.42	0.90	Indeterminate	>4	4 to 3	>4	0.00	1.62	0.4	0.6
BHR43	C	20.76	21.27	21.05	0.51	Biological	>4	4 to 3	>4	0.00	2.04	0.7	
BHR44	A	20.67	21.45	21.15	0.78	Biological	>4	4 to 3	>4	0.09	3.51	1.4	
BHR44	B	18.21	20.31	19.34	2.10	Biological	>4	4 to 3	>4	0.18	4.05	1.3	1.5
BHR44	C	21.54	22.08	21.79	0.54	Biological	>4	4 to 3	>4	0.51	4.68	1.7	
BHR45	A	16.56	20.82	18.33	4.26	Biological	>4	3 to 2	4 to 3	4.38	10.80	7.0	
BHR45	B	18.24	20.25	19.60	2.01	Biological	>4	3 to 2	4 to 3	5.16	9.72	7.2	6.6
BHR45	C	20.49	22.59	21.28	2.10	Biological	>4	3 to 2	4 to 3	5.19	8.55	5.5	
BHR46	A	15.87	18.24	17.16	2.37	Biological	>4	3 to 2	>4	1.95	10.14	6.5	
BHR46	B	18.87	19.80	19.30	0.93	Biological	>4	3 to 2	>4	3.39	17.77	6.0	6.0
BHR46	C	18.27	19.23	18.83	0.96	Biological	>4	3 to 2	>4	3.12	11.04	5.5	

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Stat_ID	Replicate	Penetration Depth (cm)			Boundary Roughness		Grain Size (phi)			Redox Potential Discontinuity (RPD) Depth (cm)			
					Thickness	Type			Major	Replicates			Station
		Minimum	Maximum	Mean	(cm)		Minimum	Maximum	Mode	Minimum	Maximum	Mean	Mean
BHR47	A	16.20	16.80	16.47	0.60	Biological	>4	3 to 2	>4	0.57	10.86	2.9	
BHR47	B	17.94	19.53	18.98	1.59	Biological	>4	3 to 2	>4	1.08	10.50	2.2	2.2
BHR47	C	17.82	18.90	18.53	1.08	Biological	>4	4 to 3	>4	0.74	5.04	1.6	
BHR48	A	21.87	22.74	22.49	0.87	Biological	>4	3 to 2	>4	0.33	3.90	3.0	
BHR48	B	17.64	18.63	18.20	0.99	Biological	>4	3 to 2	>4	0.39	3.69	1.4	2.1
BHR48	C	13.56	14.76	14.40	1.20	Biological	>4	3 to 2	>4	0.18	8.85	2.0	
BHR49	A	17.28	17.82	17.48	0.54	Biological	>4	4 to 3	>4	0.66	6.60	2.5	
BHR49	B	17.76	18.81	18.35	1.05	Biological	>4	4 to 3	>4	1.23	7.40	2.7	3.8
BHR49	C	17.19	18.54	17.59	1.35	Biological	>4	4 to 3	>4	3.30	11.05	6.1	
BHR50	A	12.94	13.44	13.21	0.50	Biological	>4	3 to 2	4 to 3	4.42	13.12	9.0	
BHR50	B	14.56	15.59	15.08	1.03	Biological	>4	4 to 3	>4	3.63	8.05	5.5	6.6
BHR50	C	14.95	15.64	16.68	1.73	Biological	>4	4 to 3	>4	1.98	9.88	5.2	
BHR51	A	12.27	12.69	12.54	0.42	Biological	>4	4 to 3	>4	0.07	2.55	0.9	
BHR51	B	7.05	8.16	7.77	1.11	Indeterminate	>4	4 to 3	>4	0.00	5.85	1.4	1.0
BHR51	C	12.06	13.56	12.82	1.44	Biological	>4	4 to 3	>4	0.21	2.88	0.7	
BHR52	A	11.01	12.39	11.39	1.38	Indeterminate	>4	4 to 3	>4	0.33	3.99	1.2	
BHR52	B	10.89	12.00	11.57	0.11	Biological	>4	4 to 3	>4	0.12	3.96	1.1	1.1
BHR52	C	5.37	6.93	6.47	1.56	Physical	>4	4 to 3	>4	0.00	2.79	1.0	
BHR53	A	9.57	10.05	9.91	0.48	Biological	>4	3 to 2	>4	1.08	4.95	1.6	
BHR53	B	9.99	11.19	10.64	1.20	Biological	>4	3 to 2	4 to 3	0.05	5.94	0.9	1.3
BHR53	C	9.78	10.68	10.08	0.90	Biological	>4	4 to 3	>4	0.07	4.47	1.4	
BHT1	A	8.37	9.39	8.95	1.02	Physical	>4	2 to 1	4 to 3	1.44	5.49	2.4	
BHT1	C	7.95	9.66	8.74	1.71	Physical	>4	<-1	4 to 3	0.00	6.30	1.8	1.9
BHT1	D	8.13	9.09	8.76	0.96	Physical	>4	4 to 3	4 to 3	0.84	3.96	1.6	
BHT2	A	8.67	9.42	8.95	0.75	Physical	0 to -1	4 to 3	>4	0.00	4.74	0. 4	
BHT2	B	8.10	9.60	8.86	1.50	Physical	>4	<-1	>4	0.25	4.14	2.1	1.5
BHT2	C	12.87	13.44	13.11	0.57	Physical	>4	<-1	>4	0.00	7.89	2.0	
BHT3	A	20.82	21.78	21.27	0.96	Biological	>4	3 to 2	>4	3.27	12.03	7.5	
BHT3	B	20.37	21.06	20.80	0.69	Biological	>4	3 to 2	>4	4.62	11.53	8.5	7.5
BHT3	C	20.07	20.94	20.53	0.87	Biological	>4	3 to 2	>4	3.72	10.26	6.5	
BHT4	A'	23.60	23.60	23.60	Indeterminate	Indeterminate	>4	>4	>4	0.00	0.00	Indeterminate	
BHT4	B'	23.60	23.60	23.60	Indeterminate	Indeterminate	>4	>4	>4	0.00	0.00	Indeterminate	Indeterminate
BHT4	C'	23.60	23.60	23.60	Indeterminate	Indeterminate	>4	>4	>4	0.00	0.00	Indeterminate	
BHT5A	A	10.17	10.89	10.49	0.72	Physical	>4	1 to 0	4 to 3	0.87	3.50	1.9	
BHT5A	B	10.08	11.97	10.85	1.89	Physical	>4	3 to 2	4 to 3	0.00	3.03	0.4	1.1
BHT5A	C	4.02	4.98	4.42	0.96	Physical	>4	3 to 2	4 to 3	0.15	3.51	1.1	
BHT6	A	9.93	12.84	11.70	2.91	Biological	>4	4 to 3	>4	0.00	3.15	0.9	
BHT6	B	11.13	12.63	11.83	1.50	Biological	>4	4 to 3	>4	0.44	7.14	1.2	1.1
BHT6	C	10.05	11.34	10.88	1.26	Biological	>4	4 to 3	>4	0.18	4.17	1.2	
BHT7	A	15.81	16.77	16.28	0.96	Physical	>4	3 to 2	>4	0.00	4.98	1.3	
BHT7	B	11.52	15.45	14.24	3.93	Biological	>4	3 to 2	>4	0.00	2.82	0.5	1.0
BHT7	C	17.82	18.36	18.17	0.54	Biological	>4	3 to 2	>4	0.51	3.96	1.2	
BHT8	A	3.12	3.93	3.50	0.81	Physical	>4	<-1	3 to 2	>3.12	>3.93	> 3.5	
BHT8	B	2.40	4.68	3.24	2.28	Physical	4 to 3	<-1	3 to 2	>2.40	>4.68	> 3.2	>3.1
BHT8	C	1.26	3.06	2.47	1.80	Physical	>4	<-1	3 to 2	0.48	>3.06	> 2.5	

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Stat_ID	Replicate	Methane Bubbles		Anoxia	Successional	Organism	Comments
		Number	Depth in	Low DO	Stage	Sediment	
			sediment (cm)			Index (OSI)	
BHR02	A	0	-	No	Stage II	6	Healthy amphipod tube mat over dark sulfidic mud
BHR02	B	2	6.0	No	Stage II	4	Healthy amphipod tube mat over dark sulfidic mud
BHR02	C	1	14.0	No	Stage II	4	Healthy amphipod, inc. podocerids, tube mat over dark sulfidic mud
BHR03	A	0	-	No	Stage II	7	Ripped-up amphipod tube mat filling with silt; pelletized v. fine sand over mud
BHR03	B	0	-	No	Stage II on III	10	Ripped-up retrograde amphipod tube mat; pelletized fine and v. fine sand over mud
BHR03	C	0	-	No	Stage II	7	Ripped-up amphipod tube mat; pelletized v. fine sand over mud
BHR04	A	0	-	No	Stage I	4	Pelletized v. fine sand over sulfidic mud; high sed. rate; stage I's
BHR04	B	0	-	No	Stage I - II	4	Pelletized v. fine sand over mud; stage I's and about 2 amphipod tubes
BHR04	C	0	-	No	Stage I on III	7	Pelletized v. fine sand over sulfidic mud; high sed. rate
BHR05	A	0	-	No	Stage I on III	7	Pelletized v. fine sand over sulfidic mud; high sed. rate; stage I's
BHR05	B	0	-	No	Stage I	4	Pelletized v. fine sand over mud; stage I's and a few tubes
BHR05	C	0	-	No	Stage II on III	6	Pelletized v. fine sand over mud; high sed. rate; stage I's and a few amphipod tubes
BHR06	A	0	-	No	Indeterminate	Indeterminate	No penetration
BHR06	C	0	-	No	Stage I	Indeterminate	No penetration; bottom covered with cobbles
BHR06	D	0	-	No	Stage I	Indeterminate	Poorly sorted; surface covered with cobbles and granules
BHR07	A	0	-	No	Stage II on III	11	Healthy amphipod tube mat over sulfidic mud; pelletized v. fine sand over mud
BHR07	B	0	-	No	Stage II on III	7	Ripped-up amphipod tube mat
BHR07	C	0	-	No	Stage II on III	7	Healthy amphipod tube mat
BHR08	A	0	-	No	Indeterminate	Indeterminate	Well-sorted very fine sand; some cobbles; unstable bottom; low penetration
BHR08	B	0	-	No	Indeterminate	Indeterminate	Fairly well-sorted very fine sand; some pebbles; unstable bottom; rippled?
BHR08	C	0	-	No	Stage I - II	8	Well-sorted very fine sand; a few amphipod tubes in depression
BHR09	A	2	5.5	No	Stage II on III	8	Juvenile amphipod tubes; pelletized v. fine sand over sulfidic mud; high sed. rate
BHR09	B	0	-	No	Stage II	7	Juvenile amphipod tubes; pelletized fine and v. fine sand over sulfidic mud; high sed. rate
BHR09	C	0	-	No	Stage II	7	Juvenile amphipod tube mat; pelletized v. fine sand over sulfidic mud; high sed. rate
BHR10	B	0	-	No	Stage I	4	Very fine sand over low sulfide mud; high sed. rate; stage I's
BHR10	C	0	-	No	Stage I	5	Very fine sand over low sulfide mud; high sed. rate; stage I's
BHR10	D	0	-	No	Stage I	3	Very fine sand over low sulfide mud; high sed. rate; stage I's
BHR11	A	0	-	No	Stage II	9	Healthy amphipod tube mat filling with silt; pelletized v. fine sand over sulfidic mud
BHR11	C	5	20.0	No	Stage II	7	Healthy amphipod tube mat filling up with silt; pelletized v. fine sand over mud
BHR11	D	0	-	No	Stage II	9	Healthy amphipod tube mat filling up with silt; pelletized v. fine sand over mud
BHR12	A	0	-	No	Stage II on III	10	Healthy juvenile amphipod tube mat; pelletized v. fine sand over mud
BHR12	B	0	-	No	Stage II	7	Juvenile amphipod tube mat; pelletized v. fine sand over mud
BHR12	C	0	-	No	Stage II	7	Juvenile and ripped-up amphipod tube mat; pelletized v. fine sand over mud
BHR13	A	1	5.0	No	Stage I - II	2	Fine and v. fine sand over sulfidic mud; stage I's and a few amphipod tubes
BHR13	B	0	-	No	Stage I	4	Fine and v. fine sand over sulfidic mud; stage I's; rippled?; shell lag
BHR13	C	0	-	No	Stage I on III	9	Poorly sorted; fine and v. fine sand over mud; stage I's
BHR14	A	0	-	No	Stage I - II	5	Ripped-up tube mat; pelletized fine and v. fine sand over mud; stage I's; some cobbles
BHR14	B	0	-	No	Stage I - II	4	Thin layer fine and v. f. sand over low sulfide mud; stage I's; sm. cobbles; a few tubes
BHR14	C	0	-	No	Stage II	6	Ripped-up and decaying amphi. tube mat; pelletized fine and v. f. sand over low sulfide mud
BHR15	A	0	-	No	Stage I on III	8	Shell hash
BHR15	B'	0	-	No	Stage I - II	5	Decaying stage II tubes; fine and v. fine sand over mud; stage I's
BHR15	D	0	-	No	Stage I	2	Thin layer pelletized fine sand over mud; stage I's; shell hash
BHR16	A	0	-	No	Stage II	7	Some ripped-up amphipod tube mat; pelletized fine and v. fine sand over mud; shell frag.
BHR16	C	0	-	No	Stage II on III	10	Healthy amphipod tube mat; pelletized v. fine sand over mud
BHR16	D	0	-	No	Stage II on III	10	Healthy amphipod tube mat; pelletized fine and v. fine sand over mud

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Stat_ID	Replicate	Methane Bubbles		Anoxia	Successional	Organism	Comments
		Number	Depth in	Low DO	Stage	Sediment	
			sediment (cm)			Index (OSI)	
BHR17	A'	1	13.0	No	Stage I - II	3	Fine and v. fine sand over reduced mud; high sed. rate; stage I's; a few amphipod tubes
BHR17	B	0	-	No	Stage I	2	Thin layer v. fine sand over mud; high sed. rate; stage I's
BHR17	D'	0	-	No	Stage I	4	V. fine sand over reduced mud; high sed. rate; stage I's
BHR18	A	0	-	No	Stage II on III	9	Healthy amphipod tube mat filling up with silt; pelletized fine and v. fine sand over mud
BHR18	B	0	-	No	Stage II on III	8	Ripped-up amphipod tube mat filling up with silt; pelletized v. fine sand over mud
BHR18	C	0	-	No	Stage II on III	8	Amphipod tube mat filling up with silt; pelletized fine and v. f. sand over mud; high sed. rate
BHR19	A	0	-	No	Stage II	7	Decaying retrograde amphipod tube mat; pelletized fine sand
BHR19	B	0	-	No	Stage II	6	Decaying retrograde amphipod tube mat; surface rock with barnacles, brick, shells
BHR19	C	0	-	No	Stage II	5	Decaying retrograde amphipod tube mat; mostly reduced v. fine sand under the stones
BHR20	A	0	-	No	Stage II	7	Healthy amphipod tube mat; pelletized fine and v. fine sand over mud; high sed. rate
BHR20	B	0	-	No	Stage II	7	Healthy amphipod tube mat; pelletized fine and v. fine sand over mud; high sed. rate
BHR20	C	0	-	No	Stage II	8	Healthy amphipod tube mat; pelletized fine and v. fine sand over mud; high sed. rate
BHR21	A	0	-	No	Stage II on III	10	Healthy amphipod tube mat; pelletized fine and v. fine sand over mud
BHR21	B	0	-	No	Stage II	7	Healthy amphipod tube mat; pelletized fine and v. fine sand over mud
BHR21	C	0	-	No	Stage II	6	Healthy amphipod tube mat; fine sand over very fine sand
BHR22	A	0	-	No	Stage II	6	Healthy amphipod mat; fine and v. fine sand
BHR22	B	0	-	No	Stage I	4	Well-sorted fine sand; stage I's; erosional; hydroids and bryozoans on stones
BHR22	C	0	-	No	Stage I	3	Cobbles on surface; hydroids and bryozoans on rocks; some stage I's
BHR23	A	0	-	No	Stage II	7	Healthy amphipod tube mat; fine sand over mud
BHR23	B	0	-	No	Stage II	9	Healthy amphipod tube mat; fine salt and pepper sand over mud
BHR23	C	0	-	No	Stage II	8	Healthy amphipod tube mat; fine and v. fine sand over mud
BHR24	A	0	-	No	Stage II on III	11	Amphipod tube mat filling up with silt; pelletized fine and v. f. sand over mud; high sed. rate
BHR24	B	0	-	No	Stage II	9	Amphipod tube mat filling up with silt; pelletized fine and v. f. sand over mud; high sed. rate
BHR24	C	0	-	No	Stage II	9	Amphipod tube mat filling up with silt; pelletized fine and v. f. sand over mud; high sed. rate
BHR25	A	0	-	No	Stage II	9	Ripped-up amphipod tube mat filling up with silt; pelletized v. fine sand over mud
BHR25	B	0	-	No	Stage II on III	11	Healthy amphipod tube mat with some shelter fabric; pelletized v. fine sand over mud
BHR25	C	3	14.0	No	Stage II	7	Amphipod tube mat filling up with silt; pelletized v. fine sand over mud
BHR26	A	0	-	No	Stage II	5	Ripped-up amphipod tube mat; pelletized fine and v. fine sand over mud
BHR26	B	0	-	No	Stage II	6	Ripped-up amphipod tube mat; pelletized fine and v. fine sand over mud
BHR26	C	0	-	No	Stage II	6	Ripped-up amphipod tube mat; pelletized fine and v. fine sand over mud
BHR27	A	0	-	No	Stage II	6	Decaying amphipod tube mat filled with silt; pelletized v. fine sand over sulfidic mud
BHR27	B	0	-	No	Stage II	9	Decaying amphipod tube mat filled with silt; pelletized v. fine sand over sulfidic mud
BHR27	C	0	-	No	Stage II	9	Decaying amphipod tube mat filled with silt; pelletized v. fine sand over sulfidic mud
BHR28	A	0	-	No	Stage II	9	Ripped-up amphipod tube mat with shelter fabric; pelletized v. f. sand over mud
BHR28	B	0	-	No	Stage II on III	11	Amphipod tube mat with silt and shelter fabric; pelletized v. f. sand over mud
BHR28	C	0	-	No	Stage II	9	Decaying amphipod tube mat with silt and shelter fabric; pelletized v. f. sand over mud
BHR29	A	0	-	No	Stage II	9	Immature (i.e. juvenile) amphipod tube mat filling with silt; pelletized v. fine sand over mud
BHR29	B	0	-	No	Stage II on III	11	Amphipod tube mat filling with silt; some shelter fabric; pelletized v. fine sand over mud
BHR29	C	0	-	No	Stage II on III	11	Healthy amphipod tube mat; pelletized v. fine sand over mud
BHR30	A	0	-	No	Stage II	7	Healthy amphipod tube mat; pelletized v. fine sand over mud
BHR30	B	0	-	No	Stage II	7	Healthy amphipod tube mat with some shelter fabric; pelletized v. fine sand over mud
BHR30	C	0	-	No	Stage II	6	Healthy amphipod tube mat with some shelter fabric; pelletized v. fine sand over mud
BHR31	A	0	-	No	Stage II	7	Healthy amphipod tube mat; pelletized v. fine sand over mud
BHR31	B	0	-	No	Stage II on III	10	Healthy amphipod tube mat; pelletized v. fine sand over mud
BHR31	C	0	-	No	Stage II	9	Healthy amphipod tube mat; pelletized v. fine sand over mud

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Stat_ID	Replicate	Methane Bubbles		Anoxia	Successional	Organism	Comments
		Number	Depth in	Low DO	Stage	Sediment	
			sediment (cm)			Index (OSI)	
BHR32	A	0	-	No	Stage I - II	5	Pelletized v. fine sand over mud
BHR32	B	0	-	No	Stage I	3	Pelletized v. fine sand over mud; rippled
BHR32	C	0	-	No	Stage II on III	8	Pelletized v. fine sand over mud; erosional
BHR33	A	0	-	No	Indeterminate	Indeterminate	Thin irregular layer v. fine sand over mud
BHR33	B	0	-	No	Stage I	5	Very fine sand over mud; high sed. rate; stage I's
BHR33	C	0	-	No	Stage I	3	Thin layer v. fine sand over mud; high sed. rate
BHR34	A	0	-	No	Stage I	2	Thin, irregular layer v. fine sand over mud; high sed. rate; a few stage I's
BHR34	B	0	-	No	Stage I - II	6	Layer v. fine sand over mud; high sed. rate; stage I's; a few juvenile amphipod tubes
BHR34	C	0	-	No	Stage I on III	9	Very fine sand over mud; high sed. rate; some stage I's
BHR35	A	0	-	No	Stage I on III	8	V. fine sand over mud; stage I's; a few juvenile amphipod tubes?
BHR35	B	0	-	No	Stage I	4	Very fine sand over mud; stage I's
BHR35	C	0	-	No	Stage I	3	Thin layer v. fine sand over mud; stage I's
BHR36	B	0	-	No	Indeterminate	Indeterminate	Fine and very fine sand; rippled; some shell lag
BHR36	C	0	-	No	Indeterminate	Indeterminate	Poorly sorted; fine and very fine sand; some cobbles on surface; rippled
BHR36	D	0	-	No	Indeterminate	Indeterminate	Poorly sorted; unstable surface; low penetration; cobbles
BHR37	A	0	-	No	Stage I	3	Very fine sand over mud; stage I's
BHR37	B	0	-	No	Stage I	3	Pelletized fine and v. fine sand over low sulfide mud; stage I's
BHR37	C	0	-	No	Stage I	3	Ripped-up mat; pelletized fine and v. fine sand over low sulfide mud; stage I's
BHR38	A	0	-	No	Stage II	6	Ripped-up amphipod tube mat; pelletized v. fine sand over mud
BHR38	B	0	-	No	Stage II	7	Healthy amphipod tube mat; pelletized v. fine sand over mud
BHR38	C	0	-	No	Stage II	6	Ripped-up amphipod tube mat; pelletized v. fine sand over mud
BHR39	A	0	-	No	Stage II	6	Amphipod tube mat filling up with silt; pelletized v. f. sand over sulfidic mud; high sed. rate
BHR39	B	0	-	No	Stage II on III	7	Healthy amphipod tube mat; pelletized fine and v. fine sand over sulfidic mud
BHR39	C	0	-	No	Stage II	6	Amphipod tube mat filling up with silt; pelletized fine and v. f. sand over mud; high sed. rate
BHR40	A	0	-	No	Stage I on III	8	Fine and v. fine sand over low sulfide mud; stage I's and a few amphipod tubes
BHR40	B	0	-	No	Stage I on III	8	Very fine sand over low sulfide mud; stage I's and a few amphipod tubes
BHR40	C	0	-	No	Stage II on III	8	Fine and v. fine sand over low sulfide mud; stage I's; a few amphipod tubes; erosional
BHR41	A	0	-	No	Stage I - II	5	Ripped-up mat; v. fine sand over low sulfide mud; stage I's; a few juv. amphi. tubes
BHR41	B	0	-	No	Stage II on III	8	Juvenile amphipod tubes; pelletized fine and v. fine sand over low sulfide mud
BHR41	C	0	-	No	Stage II	5	Ripped-up tube (amphipods and other tubes) mat; v. fine sand over low sulfide mud
BHR42	A	0	-	No	Indeterminate	Indeterminate	Fine and v. fine salt and pepper sand; pebble; shell hash; underpenetrated
BHR42	B	0	-	No	Stage I	3	Fine and v. fine sand over mottled mud; stage I's
BHR42	C	0	-	No	Stage I	Indeterminate	Fine and very fine salt and pepper sand; cobbles; underpenetrated
BHR43	A	0	-	No	Stage I	2	Thin layer fine and v. fine sand over mud; high sed. rate; stage I's
BHR43	B	0	-	No	Stage I	2	Mostly low sulfide mud; high sed. rate; some stage I's; surf. lumpy, sediment dumped here?
BHR43	C	0	-	No	Stage I	2	Thin layer v. fine sand over low sulfide mud; high sed. rate; stage I's
BHR44	A	0	-	No	Stage I	3	Very fine sand over sulfidic mud; high sed. rate; stage I's and a few juvenile amphi. tubes
BHR44	B	0	-	No	Stage I	3	Thin layer very fine sand over sulfidic mud; high sed. rate; stage I's
BHR44	C	0	-	No	Stage I	4	Very fine sand over sulfidic mud; high sed. rate; stage I's
BHR45	A	0	-	No	Stage II on III	11	Ripped-up amphipod tube mat; pelletized fine and v. fine sand over reduced mud
BHR45	B	0	-	No	Stage II	9	Healthy amphipod tube mat filling up with silt
BHR45	C	0	-	No	Stage II	9	Healthy amphipod tube mat filling up with silt; pelletized fine and v. f. sand over reduced mud
BHR46	A	0	-	No	Stage II on III	11	Decaying amphipod tube mat; pelletized fine and v. fine sand over mud
BHR46	B	0	-	No	Stage II	9	Decaying amphipod tube mat; pelletized fine and v. fine sand over mud
BHR46	C	0	-	No	Stage II on III	11	Healthy amphipod tube mat; pelletized fine and v. fine sand over mud

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Stat_ID	Replicate	Methane Bubbles		Anoxia	Successional	Organism	Comments
		Number	Depth in	Low DO	Stage	Sediment	
			sediment (cm)			Index (OSI)	
BHR47	A	0	-	No	Stage II on III	9	Healthy amphipod tube mat
BHR47	B	0	-	No	Stage II on III	8	Healthy amphipod tube mat
BHR47	C	2	15.0	No	Stage II	4	Healthy amphipod tube mat; large void with methane bubble
BHR48	A	0	-	No	Stage I on III	10	Fine and v. fine sand over low sulfide mud; high sed. rate; stage I's
BHR48	B	0	-	No	Stage I	3	Pelletized fine and v. fine sand over low sulfide mud; stage I's
BHR48	C	0	-	No	Stage I	4	Pelletized fine and v. fine sand over low sulfide mud; stage I's
BHR49	A	0	-	No	Stage II	7	A few amphipod tubes; pelletized v. fine sand over mud
BHR49	B	0	-	No	Stage II	7	Pelletized v. fine sand over mud
BHR49	C	0	-	No	Stage II	9	Healthy amphipod tube mat; pelletized v. f. sand over mud
BHR50	A	0	-	No	Stage II on III	11	Healthy amphipod tube mat; pelletized v. f. sand over mud
BHR50	B	0	-	No	Stage II on III	11	Ripped-up amphipod tube mat; some shelter fabric; pelletized v. f. sand over mud
BHR50	C	0	-	No	Stage II on III	11	Ripped-up amphipod tube mat with shelter fabric; pelletized v. f. sand over mud
BHR51	A	0	-	No	Stage I - II	4	Thin layer ox. v. fine sand over mud; stage I's and a few juvenile amphipod tubes
BHR51	B	0	-	No	Stage I on III	7	Layer v. fine sand over mud; stage I's
BHR51	C	0	-	No	Stage I - II	3	Thin layer pelletized v. fine sand over mud; stage I's and a few juv. amphipod tubes
BHR52	A	0	-	No	Stage I - II	4	Thin layer pelletized v. fine sand over mud; stage I's; a few juv. amphipod tubes; rippled?
BHR52	B	0	-	No	Stage I	3	Thin layer pelletized v. fine sand over mud; stage I's
BHR52	C	0	-	No	Stage II	5	Decaying tube mat; thin irregular layer v. fine sand over mud; erosional
BHR53	A	0	-	No	Stage II	6	Decaying amphipod tube mat; pelletized fine and v. fine sand over mud
BHR53	B	0	-	No	Stage II	5	Decaying amphipod tube mat; pelletized fine and v. fine sand over low sulfide mud; erosional
BHR53	C	0	-	No	Stage II	5	Decaying amphipod tube mat; pelletized v. fine sand over mud; some shell lag
BHT1	A	0	-	No	Stage I	5	Poorly sorted; stage I's
BHT1	C	0	-	No	Stage I	4	Pebbles on surface; a few stage I's
BHT1	D	0	-	No	Stage I - II	5	Ripped-up tube mat; two amphipod tubes; a few stage I's
BHT2	A	0	-	No	Stage I - II	3	Ripped-up amphipod tube mat; some v. fine sand merging into mottled mud; some shell frags.
BHT2	B	0	-	No	Stage I on III	8	Layer of fine and v. fine sand over mottled mud; cobbles on surface
BHT2	C	0	-	No	Stage I	4	Some fine and v. fine sand over mottled mud; worm tubes on surface; shell hash
BHT3	A	0	-	No	Stage II	9	Amphipod tube mat; pelletized fine and v. fine sand over sulfidic mud
BHT3	B	0	-	No	Stage II on III	11	Healthy amphipod tube mat; pelletized fine and v. fine sand over sulfidic mud
BHT3	C	0	-	No	Stage II	9	Healthy amphipod tube mat; pelletized fine and v. fine sand over sulfidic mud
BHT4	A'	0	-	Indeterminate	Indeterminate	Indeterminate	Alternating layers of low and high sulfidic mud; high sed. rate; overpenetrated
BHT4	B'	1	-	Indeterminate	II	Indeterminate	Alternating layers of low and high sulfidic mud; high sed. rate; overpenetrated
BHT4	C'	0	-	Indeterminate	Indeterminate	Indeterminate	Alternating layers of low and high sulfidic mud; high sed. rate; overpenetrated
BHT5A	A	0	-	No	Stage I	4	V. fine sand over sulfidic mud; some stage I's; some pebbles; rippled?
BHT5A	B	0	-	No	Stage II	4	Some small ripped-up amphi. tubes; thin irregular layer f. sand over sulfidic mud; rippled?
BHT5A	C	0	-	No	Stage II	5	Some small amphipod tubes; fine sand over mud; rippled?
BHT6	A	0	-	No	Stage II on III	7	Healthy amphipod tube mat filling with silt; pelletized v. fine sand over mud
BHT6	B	0	-	No	Stage II	5	Ripped-up amphipod tube mat filling with silt; pelletized v. fine sand over mud
BHT6	C	0	-	No	Stage II	5	Ripped-up amphipod tube mat; pelletized v. fine sand over mud
BHT7	A	0	-	No	Stage I - II	4	Some ripped-up amphi. tubes; pelletized fine and v. fine sand over mud; stage I's; erosional
BHT7	B	0	-	No	Stage I	2	Thin layer pelletized fine and v. fine sand over mud; some stage I's; erosional
BHT7	C	0	-	No	Stage II on III	7	Some amphipod tubes; pelletized fine and v. fine sand over mud; stage I's
BHT8	A	0	-	No	Indeterminate	Indeterminate	Salt and pepper sand with a few shell fragments; unstable bottom; a few stage I's; rippled
BHT8	B	0	-	No	Indeterminate	Indeterminate	Salt and pepper sand with a few shell fragments; unstable bottom; erosional; rippled
BHT8	C	0	-	No	Indeterminate	Indeterminate	Salt and pepper sand with a few shell fragments; erosional; rippled

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Stat_ID	Replicate	Penetration Depth (cm)			Boundary Roughness		Grain Size (phi)			Redox Potential Discontinuity (RPD) Depth (cm)			
					Thickness	Type			Major	Replicates			Station
		Minimum	Maximum	Mean	(cm)		Minimum	Maximum	Mode	Minimum	Maximum	Mean	Mean
BHR02	A' *	10.06	10.60	10.32	0.54	Biological	>4	3 to 2	>4	1.82	6.70	3.99	
BHR02	B*	11.19	11.92	11.67	0.73	Biological	>4	3 to 2	>4	2.48	6.70	3.56	3.90- Aug.
BHR02	C*	10.91	12.08	11.49	1.17	Biological	>4	3 to 2	>4	0.19	6.51	4.14	
BHR03	A*	8.87	10.25	9.68	1.38	Biological	>4	3 to 2	>4	1.60	6.26	2.72	
BHR03	C*	10.69	11.57	11.12	0.88	Biological	>4	3 to 2	>4	0.85	5.09	3.06	2.94 - Aug.
BHR03	D*	8.65	10.57	9.82	1.92	Biological	>4	3 to 2	>4	0.60	7.61	3.04	
BHR04	A*	11.98	12.67	12.37	0.69	Biological	>4	4 to 3	>4	0.44	3.14	1.29	
BHR04	B*	10.50	11.35	10.97	0.85	Biological	>4	4 to 3	>4	0.00	2.04	0.90	1.12 - Aug.
BHR04	C*	10.75	11.70	11.21	0.95	Biological	>4	4 to 3	>4	0.19	3.40	1.16	
BHR05	A	14.21	14.53	14.39	0.32	Biological	>4	3 to 2	>4	0.88	3.68	1.75	
BHR05	B	12.52	13.40	12.94	0.88	Biological	>4	4 to 3	>4	0.00	2.45	1.17	1.27 - Oct.
BHR05	C	15.03	15.38	15.23	0.35	Biological	>4	3 to 2	>4	0.00	2.04	0.90	
BHR06	C*	1.64	3.21	2.57	1.57	Physical	4 to 3	<-1	3 to 2	Indeterminate	Indeterminate	Indeterminate	Indet. - Aug.
BHR06	A	0.97	2.01	1.47	1.04	Physical	4 to 3	<-1	4 to 3	0.13	1.73	0.81	1.02 - Oct.
BHR06	B	1.48	3.33	2.38	1.85	Physical	4 to 3	<-1	3 to 2	0.09	2.45	1.22	
BHR07	A*	13.68	15.00	14.26	1.32	Biological	>4	4 to 3	4 to 3	0.35	8.83	4.50	
BHR07	B*	11.35	12.64	12.13	1.29	Biological	>4	1 to 0	>4	4.06	8.11	5.59	4.56 - Aug.
BHR07	C*	10.66	12.11	11.50	1.45	Biological	>4	2 to 1	4 to 3	3.33	8.21	3.6	
BHR08	B*	6.22	7.11	6.55	0.89	Physical	>4	3 to 2	4 to 3	0.13	2.45	1.38	
BHR08	C*	7.20	7.77	7.55	0.57	Biological	>4	3 to 2	>4	0.22	4.06	1.91	1.65 - Aug.
BHR08	A	1.26	3.05	2.21	1.79	Physical	>4	<-1	4 to 3	0.47	>2.52	>1.65	>2.09 - Oct.
BHR08	B	1.92	2.67	2.45	0.75	Physical	>4	2 to 1	4 to 3	1.13	>2.58	>2.23	
BHR08	C	2.36	3.43	3.01	1.07	Physical	4 to 3	0 to -1	4 to 3	1.60	>2.89	>2.40	
BHR09	A*	8.21	10.69	9.92	2.48	Biological	>4	1 to 0	4 to 3	0.06	2.26	0.95	
BHR09	B*	9.31	9.91	9.65	0.60	Biological	>4	3 to 2	>4	0.03	3.96	2.15	1.54 - Aug.
BHR09	C*	10.63	11.48	10.99	0.85	Biological	>4	3 to 2	>4	0.35	3.77	1.52	
BHR10	A*	17.39	18.40	17.87	1.01	Biological	>4	2 to 1	>4	0.00	4.43	3.17	
BHR10	B' *	16.54	17.67	17.10	1.13	Indeterminate	>4	4 to 3	>4	0.00	1.57	0.63	1.64 - Aug.
BHR10	C*	16.35	17.83	17.31	1.48	Biological	>4	2 to 1	>4	0.56	2.20	1.11	
BHR11	A*	13.71	14.56	14.16	0.85	Biological	>4	1 to 0	>4	2.96	7.11	4.68	
BHR11	B*	9.53	12.45	10.91	2.92	Indeterminate	>4	2 to 1	>4	2.70	6.10	4.37	5.13 - Aug.
BHR11	C*	12.92	13.84	13.50	0.92	Biological	>4	1 to 0	>4	5.69	7.77	6.34	
BHR12	A*	14.12	14.72	14.40	0.60	Biological	>4	3 to 2	>4	4.18	7.39	5.82	
BHR12	B*	12.11	15.16	13.79	3.05	Biological	>4	2 to 1	>4	1.45	9.62	4.74	4.59 - Aug.
BHR12	C*	10.69	11.45	10.98	0.76	Biological	>4	3 to 2	>4	0.41	1.75	3.21	
BHR13	A	11.67	13.02	12.34	1.35	Physical	>4	<-1	4 to 3	0.22	2.58	1.06	
BHR13	B	11.98	14.75	13.41	2.77	Physical	>4	<-1	>4	0.44	4.25	1.86	1.50 - Oct.
BHR13	C	11.38	13.87	12.26	2.49	Physical	>4	<-1	>4	0.19	4.43	1.57	

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Stat_ID	Replicate	Penetration Depth (cm)			Boundary Roughness		Grain Size (phi)			Redox Potential Discontinuity (RPD) Depth (cm)			
					Thickness	Type			Major	Replicates			Station
		Minimum	Maximum	Mean	(cm)		Minimum	Maximum	Mode	Minimum	Maximum	Mean	Mean
BHR14	A*	8.46	9.78	9.17	1.32	Biological	>4	2 to 1	>4	2.48	6.42	4.33	
BHR14	C*	10.16	10.85	10.39	0.69	Biological	>4	3 to 2	4 to 3	2.01	7.61	4.05	4.19 - Aug.
BHR14	A	6.79	7.39	7.07	0.60	Physical	>4	1 to 0	4 to 3	0.38	3.49	1.31	1.78 - Oct.
BHR14	B	11.23	12.20	11.60	0.97	Physical	>4	2 to 1	>4	0.66	6.38	1.96	
BHR14	C	10.82	11.67	11.15	0.85	Biological	>4	3 to 2	>4	0.19	5.38	2.08	
BHR15	B'	5.47	6.01	5.72	0.54	Physical	>4	<-1	>4	0.25	5.13	1.06	
BHR15	C	5.94	6.64	6.29	0.70	Physical	>4	<-1	4 to 3	0.47	2.30	1.25	1.09 - Oct.
BHR15	D	7.55	8.58	8.01	1.03	Physical	>4	<-1	>4	0.00	2.26	0.95	
BHR16	A*	6.79	7.48	7.20	0.69	Physical	>4	0 to -1	4 to 3	0.13	2.01	1.19	
BHR16	B*	8.96	9.69	9.36	0.73	Biological	>4	1 to 0	4 to 3	3.18	8.99	6.55	4.41 - Aug.
BHR16	C*	8.21	9.72	9.12	1.51	Biological	>4	0 to -1	4 to 3	3.24	7.55	5.48	
BHR17	A*	13.99	14.87	14.51	0.88	Biological	>4	2 to 1	>4	0.69	4.34	2.41	
BHR17	B*	14.47	15.25	14.88	0.78	Biological	>4	2 to 1	>4	0.00	3.27	1.20	1.83 - Aug.
BHR17	C*	13.49	13.87	13.73	0.38	Biological	>4	2 to 1	>4	0.44	3.93	1.87	
BHR18	A*	11.48	12.30	11.85	0.82	Biological	>4	1 to 0	>4	2.86	6.19	4.01	
BHR18	B*	11.92	13.11	12.60	1.19	Biological	>4	1 to 0	>4	3.43	7.17	5.44	5.15 - Aug.
BHR18	C*	10.91	13.33	12.18	2.42	Biological	>4	1 to 0	>4	3.74	9.40	6.00	
BHR19	B*	1.13	3.14	1.91	2.01	Physical	4 to 3	<-1	<-1	Indeterminate	Indeterminate	Indeterminate	
BHR19	C*	1.60	3.65	2.67	2.05	Physical	4 to 3	<-1	<-1	Indeterminate	Indeterminate	Indeterminate	Indet. - Aug.
BHR19	E	1.32	1.92	1.62	0.60	Physical	4 to 3	<-1	3 to 2	>1.32	>1.92	>1.62	>1.62 - Oct.
BHR20	A' *	13.00	14.00	13.50	1.00	Biological	>4	3 to 2	>4	4.00	9.50	5.50	
BHR20	B*	10.13	11.38	10.73	1.25	Biological	>4	1 to 0	>4	2.36	6.73	4.57	4.79 - Aug.
BHR20	C*	11.86	12.80	12.41	0.94	Biological	>4	3 to 2	>4	2.99	5.97	4.31	
BHR21	A*	8.62	10.09	9.40	1.47	Biological	>4	3 to 2	>4	1.76	2.80	2.35	
BHR21	B*	10.13	11.38	10.73	1.25	Biological	>4	3 to 2	>4	1.19	8.90	4.61	3.56 - Aug.
BHR21	C*	8.58	9.72	9.13	1.14	Biological	>4	3 to 2	>4	1.44	5.72	3.73	
BHR22	A*	10.16	11.48	10.85	1.32	Biological	>4	3 to 2	>4	2.36	7.20	4.05	
BHR22	B*	10.88	11.76	11.36	0.88	Biological	>4	3 to 2	>4	2.33	7.39	4.54	4.19 - Aug.
BHR22	C*	9.06	10.09	9.65	1.03	Biological	>4	3 to 2	>4	1.95	8.80	3.97	
BHR23	A	5.44	6.86	6.14	1.42	Physical	>4	2 to 1	4 to 3	0.00	4.40	1.49	
BHR23	B'	6.35	6.92	6.69	0.57	Physical	>4	2 to 1	4 to 3	0.03	6.42	1.26	1.56 - Oct.
BHR23	C	7.96	9.25	8.71	1.29	Physical	>4	1 to 0	4 to 3	0.16	6.04	1.93	
BHR24	A	12.86	13.30	13.09	0.44	Biological	>4	2 to 1	>4	0.13	4.15	1.99	
BHR24	B	7.58	7.99	7.75	0.41	Indeterminate	>4	2 to 1	4 to 3	0.63	4.15	1.96	1.72 - Oct.
BHR24	C	4.15	5.53	4.67	1.38	Physical	>4	3 to 2	4 to 3	0.06	3.14	1.21	
BHR25	A' *	11.19	11.95	11.62	0.76	Biological	>4	3 to 2	4 to 3	2.74	9.78	5.63	
BHR25	B*	10.50	11.26	10.93	0.76	Biological	>4	3 to 2	>4	1.16	8.05	3.00	3.79 - Aug.
BHR25	C*	10.28	11.51	11.10	1.23	Biological	>4	2 to 1	4 to 3	0.35	7.39	2.74	

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Stat_ID	Replicate	Penetration Depth (cm)			Boundary Roughness		Grain Size (phi)			Redox Potential Discontinuity (RPD) Depth (cm)			
					Thickness	Type			Major	Replicates			Station
		Minimum	Maximum	Mean	(cm)		Minimum	Maximum	Mode	Minimum	Maximum	Mean	Mean
BHR26	B	10.91	11.29	11.11	0.38	Physical	>4	2 to 1	4 to 3	0.09	2.08	1.27	
BHR26	C	12.86	13.36	13.07	0.50	Physical	>4	3 to 2	4 to 3	0.00	2.54	1.31	1.22 - Oct.
BHR26	D	10.66	11.35	11.13	0.69	Indeterminate	>4	3 to 2	4 to 3	0.28	2.83	1.09	
BHR27	A*	9.43	10.09	9.77	0.66	Biological	>4	2 to 1	>4	0.72	6.67	2.02	
BHR27	B*	8.71	9.53	9.08	0.82	Physical	>4	2 to 1	>4	0.03	3.35	0.66	1.62 - Aug.
BHR27	C*	10.44	11.29	10.90	0.85	Biological	>4	2 to 1	>4	0.50	5.94	2.19	
BHR28	A*	7.76	9.28	8.53	1.52	Biological	>4	2 to 1	>4	1.89	5.97	3.01	
BHR28	B*	8.18	9.72	8.53	1.54	Biological	>4	3 to 2	>4	0.09	4.87	1.63	2.25 - Aug.
BHR28	C*	8.99	10.00	9.52	1.01	Biological	>4	3 to 2	>4	0.38	5.79	2.12	
BHR29	A*	7.86	9.81	8.82	1.95	Biological	>4	3 to 2	>4	1.16	3.33	2.16	
BHR29	B*	10.00	11.60	11.04	1.60	Biological	>4	3 to 2	>4	0.28	5.53	2.05	2.62 - Aug.
BHR29	C*	11.29	12.17	11.72	0.88	Biological	>4	2 to 1	>4	0.97	8.24	3.66	
BHR30	A*	7.70	8.58	8.30	0.88	Biological	>4	2 to 1	>4	0.00	4.59	2.36	
BHR30	B*	6.51	7.20	6.96	0.69	Biological	>4	3 to 2	>4	0.00	2.96	0.81	1.39 - Aug.
BHR30	C*	6.98	7.64	7.27	0.66	Biological	>4	3 to 2	>4	0.13	3.80	0.99	
BHR31	A*	8.62	9.84	9.24	1.22	Biological	>4	3 to 2	4 to 3	1.79	4.34	2.92	
BHR31	B*	9.50	11.57	10.85	2.07	Biological	>4	3 to 2	>4	1.57	10.82	6.22	3.84 - Aug.
BHR31	C*	10.16	12.17	11.29	2.01	Biological	>4	3 to 2	>4	0.16	10.00	2.37	
BHR32	A*	10.47	11.23	10.99	0.76	Biological	>4	3 to 2	>4	0.00	3.02	0.84	
BHR32	B*	9.87	10.35	10.08	0.48	Biological	>4	3 to 2	>4	0.00	3.21	1.10	0.88 - Aug.
BHR32	C*	10.25	11.19	10.55	0.94	Indeterminate	>4	3 to 2	>4	0.00	2.14	0.69	
BHR33	A*	10.60	12.23	11.64	1.63	Indeterminate	>4	0 to -1	>4	0.00	2.99	0.87	
BHR33	B*	11.22	12.58	12.00	1.36	Indeterminate	>4	3 to 2	>4	0.00	2.58	0.49	0.72 - Aug.
BHR33	C*	9.06	11.82	10.88	2.76	Indeterminate	>4	3 to 2	>4	0.00	3.58	0.79	
BHR34	B*	8.21	9.03	8.73	0.82	Biological	>4	4 to 3	>4	0.00	2.33	1.15	
BHR34	C*	10.22	10.50	10.34	0.28	Indeterminate	>4	3 to 2	>4	0.00	2.96	1.70	1.23 - Aug.
BHR34	D*	11.79	12.86	12.35	1.07	Indeterminate	>4	4 to 3	>4	0.00	1.26	0.83	
BHR35	A*	10.75	11.79	11.45	1.04	Biological	>4	4 to 3	>4	0.09	1.48	0.89	
BHR35	B*	11.67	12.08	11.81	0.41	Biological	>4	2 to 1	>4	0.00	3.05	0.39	0.73 - Aug.
BHR35	C*	9.50	10.53	10.19	1.03	Indeterminate	>4	2 to 1	4 to 3	0.09	2.80	0.92	
BHR36	A*	8.43	9.50	8.93	1.07	Biological	>4	3 to 2	>4	0.19	3.21	1.19	
BHR36	B*	7.20	7.83	7.44	0.63	Physical	>4	4 to 3	>4	0.00	1.86	0.43	
BHR36	C*	0.00	8.52	6.27	8.52	Physical	>4	3 to 2	>4	0.00	1.92	0.56	0.73 - Aug.
BHR36	A	1.45	1.92	1.66	0.47	Physical	>4	<-1	4 to 3	0.06	>1.92	>1.22	>1.54 - Oct.
BHR36	C	1.76	2.99	2.40	1.23	Physical	>4	<-1	3 to 2	0.06	>2.99	>1.86	
BHR37	A' *	7.39	8.84	8.17	1.45	Physical	>4	0 to -1	>4	0.00	3.49	1.12	
BHR37	B*	7.42	9.03	8.21	1.61	Physical	>4	0 to -1	>4	0.00	2.92	1.04	0.87 - Aug.
BHR37	C*	7.36	8.08	7.76	0.72	Indeterminate	>4	1 to 0	>4	0.00	1.48	0.44	

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Stat_ID	Replicate	Penetration Depth (cm)			Boundary Roughness		Grain Size (phi)			Redox Potential Discontinuity (RPD) Depth (cm)			
					Thickness	Type			Major	Replicates			Station
		Minimum	Maximum	Mean	(cm)		Minimum	Maximum	Mode	Minimum	Maximum	Mean	Mean
BHR38	A*	13.49	14.28	13.96	0.79	Biological	>4	2 to 1	>4	0.50	7.74	4.89	
BHR38	B*	13.99	15.00	14.51	1.01	Biological	>4	1 to 0	>4	3.84	8.65	6.27	5.29 - Aug.
BHR38	C*	14.28	15.85	15.29	1.57	Biological	>4	2 to 1	>4	1.16	9.09	4.71	
BHR39	A*	12.83	13.55	13.23	0.72	Biological	>4	2 to 1	4 to 3	1.01	10.66	6.46	
BHR39	B*	12.80	13.68	13.27	0.88	Indeterminate	>4	2 to 1	>4	0.00	0.00	0.00	3.87 - Aug.
BHR39	C*	10.19	11.26	10.76	1.07	Biological	>4	3 to 2	>4	2.99	8.43	5.16	
BHR40	A	0.91	5.22	4.25	4.31	Physical	>4	3 to 2	4 to 3	0.41	2.08	1.19	
BHR40	B	7.58	8.49	8.16	0.91	Physical	>4	3 to 2	4 to 3	0.69	3.93	2.29	1.27 - Oct.
BHR40	C	8.18	8.77	8.42	0.59	Physical	>4	2 to 1	4 to 3	0.00	1.73	0.34	
BHR41	A*	8.65	9.69	9.18	1.04	Biological	>4	2 to 1	>4	0.31	2.96	1.28	
BHR41	B*	9.69	10.75	10.15	1.06	Biological	>4	3 to 2	>4	0.69	3.93	2.29	1.55 - Aug.
BHR41	C*	9.50	10.25	9.82	0.75	Biological	>4	3 to 2	>4	0.28	2.78	1.08	
BHR42	A	2.20	3.93	3.28	1.73	Physical	>4	2 to 1	4 to 3	0.44	>3.93	>2.34	
BHR42	B	5.35	5.94	5.64	0.59	Physical	>4	2 to 1	4 to 3	0.63	2.83	1.39	>1.96 - Oct.
BHR42	C	2.86	3.96	3.43	1.10	Physical	>4	3 to 2	4 to 3	0.15	3.11	1.86	
BHR43	A*	9.43	10.53	10.01	1.10	Indeterminate	>4	3 to 2	>4	0.04	1.54	0.74	
BHR43	B*	10.79	11.42	11.11	0.63	Biological	>4	2 to 1	>4	0.50	2.48	1.10	0.95 - Aug.
BHR43	C*	11.38	12.61	12.07	1.23	Biological	>4	3 to 2	>4	0.06	3.02	1.01	
BHR44	A' *	11.70	12.70	12.27	1.00	Biological	>4	3 to 2	>4	0.31	2.39	1.99	
BHR44	B*	14.06	14.87	14.45	0.81	Biological	>4	3 to 2	>4	0.00	3.30	0.75	1.15 - Aug.
BHR44	C*	10.69	11.73	11.33	1.04	Biological	>4	2 to 1	>4	0.00	2.67	0.70	
BHR45	A*	10.88	11.73	11.30	0.85	Biological	>4	2 to 1	>4	2.64	10.00	5.05	
BHR45	B*	10.79	12.42	11.54	1.63	Biological	>4	3 to 2	>4	0.25	10.00	4.99	4.99 - Aug.
BHR45	C*	11.22	12.48	11.94	1.26	Biological	>4	3 to 2	>4	0.28	9.34	4.94	
BHR46	A*	9.50	10.22	9.76	0.72	Biological	>4	3 to 2	>4	1.75	7.39	3.51	
BHR46	B*	9.18	10.75	9.96	1.57	Biological	>4	2 to 1	>4	0.00	6.19	2.82	3.28 - Aug.
BHR46	C*	10.79	11.98	11.47	1.19	Biological	>4	1 to 0	>4	2.20	6.79	3.52	
BHR47	A' *	8.90	9.94	9.48	1.04	Biological	>4	3 to 2	>4	0.97	7.99	4.88	
BHR47	B*	9.97	11.67	10.97	1.70	Biological	>4	3 to 2	>4	2.67	9.65	5.40	5.29 - Aug.
BHR47	C' *	9.78	11.01	10.53	1.23	Biological	>4	3 to 2	>4	3.40	9.06	5.59	
BHR48	A	12.30	12.77	12.45	0.47	Biological	>4	3 to 2	>4	0.84	3.40	1.43	
BHR48	B	9.56	10.57	9.90	1.01	Indeterminate	>4	3 to 2	>4	0.06	4.37	1.60	1.40 - Oct.
BHR48	C	13.43	14.03	13.70	0.60	Biological	>4	3 to 2	>4	0.47	3.05	1.16	
BHR49	A*	5.13	6.16	5.64	1.03	Biological	>4	2 to 1	4 to 3	0.00	0.10	0.05	
BHR49	B*	8.02	9.15	8.70	1.13	Indeterminate	>4	3 to 2	>4	0.00	3.80	1.44	0.70 - Aug.
BHR49	C*	7.48	9.31	8.55	1.83	Indeterminate	>4	3 to 2	>4	0.00	2.45	0.61	
BHR50	A' *	8.05	10.16	8.93	2.11	Biological	>4	3 to 2	>4	0.00	6.26	2.15	
BHR50	B*	8.24	8.80	8.55	0.56	Biological	>4	2 to 1	>4	0.60	5.66	2.34	
BHR50	C*	6.48	7.86	7.01	1.38	Biological	>4	0 to -1	>4	0.00	2.30	0.74	1.74 - Aug.
BHR50	A	11.22	12.20	11.75	0.98	Biological	>4	3 to 2	4 to 3	0.88	11.41	3.43	3.53 - Oct.
BHR50	B	9.97	10.85	10.48	0.88	Biological	>4	2 to 1	4 to 3	1.54	7.45	3.62	

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Stat_ID	Replicate	Penetration Depth (cm)			Boundary Roughness		Grain Size (phi)			Redox Potential Discontinuity (RPD) Depth (cm)			
					Thickness	Type			Major	Replicates			Station
		Minimum	Maximum	Mean	(cm)		Minimum	Maximum	Mode	Minimum	Maximum	Mean	Mean
BHR51	A	6.10	7.52	6.89	1.42	Biological	>4	4 to 3	>4	0.00	1.70	0.90	
BHR51	B	5.35	6.57	6.14	1.22	Biological	>4	3 to 2	>4	0.00	2.52	0.55	0.84 - Oct.
BHR51	C	7.99	9.03	8.58	1.04	Biological	>4	3 to 2	>4	0.47	2.23	1.06	
BHR52	A	7.77	9.37	8.45	1.60	Indeterminate	>4	3 to 2	>4	0.06	1.89	0.87	
BHR52	B	8.05	9.78	9.13	1.73	Indeterminate	>4	3 to 2	>4	0.35	1.98	1.12	0.97 - Oct.
BHR52	C	6.79	7.26	7.09	0.47	Indeterminate	>4	3 to 2	>4	0.28	2.17	0.91	
BHR53	A	1.42	2.96	2.63	1.54	Physical	>4	2 to 1	4 to 3	0.00	2.71	1.14	
BHR53	B	2.93	4.62	4.04	1.69	Physical	>4	1 to 0	4 to 3	0.00	2.30	1.12	1.24 - Oct.
BHR53	C	3.65	3.90	3.80	0.25	Physical	>4	2 to 1	4 to 3	0.41	2.36	1.47	
BHT1	C*	2.70	4.87	4.03	2.17	Indeterminate	>4	<-1	4 to 3	1.60	3.96	2.79	
BHT1	E' *	5.50	6.70	6.11	1.20	Biological	>4	2 to 1	>4	0.31	2.17	1.20	2.00 - Aug.
BHT1	B	2.64	4.21	3.58	1.57	Physical	>4	2 to 1	4 to 3	0.03	3.52	1.35	1.32 - Oct.
BHT1	C	3.96	5.19	4.75	1.23	Physical	>4	1 to 0	4 to 3	0.28	2.52	1.28	
BHT2	A*	9.56	10.09	9.88	0.53	Biological	>4	3 to 2	>4	0.22	3.24	1.12	
BHT2	B*	8.68	9.18	8.98	0.50	Physical	>4	3 to 2	>4	0.09	1.89	0.60	0.75 - Aug.
BHT2	C*	8.20	9.40	8.99	1.20	Biological	>4	3 to 2	>4	0.13	1.79	0.53	
BHT3	A*	12.30	13.43	12.73	1.13	Biological	>4	2 to 1	4 to 3	4.37	7.39	5.59	
BHT3	B*	8.68	9.78	9.33	1.10	Biological	>4	3 to 2	4 to 3	2.20	7.55	3.99	4.68 - Aug.
BHT3	C*	9.97	11.95	10.87	1.98	Biological	>4	3 to 2	>4	3.02	7.04	4.46	
BHT4	A*	18.93	19.97	19.32	1.04	Biological	>4	3 to 2	>4	0.16	6.70	1.20	
BHT4	B*	20.00	21.13	20.61	1.13	Biological	>4	4 to 3	>4	0.47	1.45	0.79	0.88 - Aug.
BHT4	C*	18.05	19.02	18.50	0.97	Biological	>4	4 to 3	>4	0.00	1.16	0.66	
BHT5A	A*	3.36	4.34	3.80	0.98	Biological	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	Indeterminate	
BHT5A	B*	2.58	3.87	3.24	1.29	Biological	>4	3 to 2	4 to 3	0.53	3.33	2.04	
BHT5A	C*	1.38	2.48	2.09	1.10	Biological	Indeterminate	Indeterminate	Indeterminate	0.22	2.26	1.22	1.63 - Aug.
BHT5A	B	0.00	1.48	0.41	1.48	Physical	3 to 2	<-1	<-1	Indeterminate	Indeterminate	Indeterminate	Indet. - Oct.
BHT5A	C	0.63	4.03	2.40	3.40	Physical	3 to 2	<-1	<-1	Indeterminate	Indeterminate	Indeterminate	
BHT6	A*	8.27	9.56	8.71	1.29	Biological	>4	2 to 1	>4	0.76	3.92	1.59	
BHT6	B*	8.77	10.28	9.68	1.51	Biological	>4	3 to 2	>4	1.64	7.67	3.72	3.02 - Aug.
BHT6	C*	8.77	9.56	9.10	0.79	Biological	>4	2 to 1	>4	1.44	6.01	3.76	
BHT7	A*	5.53	6.35	6.01	0.82	Physical	>4	<-1	4 to 3	0.00	1.19	0.28	
BHT7	B*	8.90	9.78	9.34	0.88	Physical	>4	<-1	4 to 3	0.22	4.56	1.72	1.12 - Aug.
BHT7	C*	8.30	9.18	8.73	0.88	Physical	>4	<-1	>4	0.09	5.31	1.35	
BHT8	A	0.79	1.73	1.44	0.94	Physical	4 to 3	0 to -1	3 to 2	>0.79	>1.73	>1.44	
BHT8	B	2.62	3.40	2.89	0.78	Physical	4 to 3	0 to -1	3 to 2	>2.61	>3.40	>2.89	>2.30 - Oct.
BHT8	C	2.08	2.96	2.58	0.88	Physical	4 to 3	<-1	3 to 2	>2.08	>2.96	> 2.58	

* August sample — Remaining samples taken in October

August images only, analyzed for 39 stations; October images only, analyzed for 13 stations; August as well as October images analyzed for 8 stations.

HOM-1997 BOSTON HARBOR SEDIMENT PROFILE SURVEY RESULTS

Stat_ID	Replicate	Methane Bubbles		Anoxia	Successional	Organism	Comments
		Number	Depth in sediment (cm)	Low DO	Stage	Sediment Index (OSI)	
BHR02	A' *	0	-	No	Stage II on III	11	Healthy amphipod tube mat; pelletal (II's) sand (2 cm) over v. sulfidic mud
BHR02	B*	0	-	No	Stage II	8	Healthy amphipod tube mat; pelletal (II's) sand (3 cm) over v. sufidic mud
BHR02	C*	0	-	No	Stage II	9	Healthy amphipod tube mat; pelletal (II's) sand (4 cm) over v. sulfidic mud
BHR03	A*	0	-	No	Stage II	7	Healthy amphipod tube mat, juveniles?; pelletal (II's) sand (3 cm) over mud; green water
BHR03	C*	0	-	No	Stage II	8	Retrograde amphipod tube mat; pelletal (II's) sand (2.5 cm) over mud:green water
BHR03	D*	0	-	No	Stage II on III	10	Amphipod tube mat, inc. podocerids; pelletal (II's) sand (3 cm) over mud; green water
BHR04	A*	0	-	No	Stage I	3	Pelletal (I's) sand (2 cm) over mud
BHR04	B*	0	-	No	Stage I	3	Sand (1 cm) over mud
BHR04	C*	0	-	No	Stage I	3	Stage I's
BHR05	A	0	-	No	Stage I on III	8	Pelletal (I's) sand (2 cm) over mud; uniform RPD; stage III voids
BHR05	B	0	-	No	Stage I on III	7	Pelletal (I's) sand (1 cm) over mud
BHR05	C	0	-	No	Stage I on III	7	Pelletal (I's) sand (1 cm) over mud
BHR06	C*	0	-	No	Indeterminate	Indeterminate	Hard ground; low penetration; poor sorting; erosional; cobbles; green water
BHR06	A	0	-	No	Stage I	3	Hard ground; low penetration; poor sorting; erosional; rocks
BHR06	B	0	-	No	Stage I	3	Hard ground; low penetration; poor sorting, erosional; cobbles
BHR07	A*	0	-	No	Stage II on III	11	Retrograde amphipod tube mat; pelletal (II's) sand (4 cm) over mud
BHR07	B*	0	-	No	Stage II on III	11	Retrograde amphipod tube mat; pelletal (II's) sand (4 cm) over mud; shelter fabric, rebound
BHR07	C*	0	-	No	Stage II on III	10	Retrograde amphipod tube mat; pelletal (II's) sand (4 cm) over mud; rebound
BHR08	B*	0	-	No	Stage I	3	Sand (1.5 cm) over mud; rippled; some shell lag
BHR08	C*	0	-	No	Stage II	6	Retrograde amphipod tube mat; sand (2 cm) over mud
BHR08	A	0	-	No	Stage I	4	Oweniidae? Cobbles and sand; rippled; some shell lag; green water
BHR08	B	0	-	No	Stage I	4	Rippled; some shell lag; green water
BHR08	C	0	-	No	Stage I	5	Rippled; green water
BHR09	A*	0	-	No	Stage II	5	Pelletal (II's) sand (1.5 cm) over mud; amphipod tube covered mound
BHR09	B*	0	-	No	Stage II on III	8	Pelletal (II's) sand (2 cm) over sulfitic mud
BHR09	C*	0	-	No	Stage II	6	Pelletal (II's) sand (1.5 cm) over dark sulfitic mud
BHR10	A*	0	-	No	Stage I	6	Pelletal (I's) sand (1 cm) over mud; stage I aggregation
BHR10	B' *	0	-	No	Stage I	2	Sand (1 cm) over dark sulfitic mud
BHR10	C*	0	-	No	Stage II on III	7	Pelletal (I's) sand (1 cm) over 2-3 layers mud
BHR11	A*	0	-	No	Stage II on III	11	Retrograde amphipod tube mat; pelletal (II's) sand (3.5 cm) over mud
BHR11	B*	0	-	No	Stage II	9	Retrograde amphipod tube mat; pelletal (II's) sand (3.5 cm) over mud
BHR11	C*	0	-	No	Stage II	9	Retrograde amphipod tube mat; tube frag/ pelletal (II's) sand (9 cm) over mud
BHR12	A*	0	-	No	Stage II on III	11	Healthy amphipod tube mat; pelletal (II's) sand (7 cm) over mud
BHR12	B*	0	-	No	Stage II on III	11	Healthy amphipod tube mat; pelletal (II's) sand (5 cm) over mud
BHR12	C*	0	-	No	Stage II	8	Retrograde amphipod tube mat; pelletal (II's) sand (1.5 cm) over mud
BHR13	A	0	-	No	Stage I	3	Poor sorting; erosion; some shell lag
BHR13	B	0	-	No	Stage I	4	Sulfidic, poor sorting; erosional ?; some shell lag; mud-draped shells
BHR13	C	0	-	No	Stage I	4	Erosional?; some shell lag; mud-draped shell; piece of brick, pebble

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Stat_ID	Replicate	Methane Bubbles		Anoxia	Successional	Organism	Comments
		Number	Depth in sediment (cm)	Low DO	Stage	Sediment Index (OSI)	
BHR14	A*	0	-	No	Stage II on III	11	Healthy amphipod tube mat; pelletal (II's) sand (4 cm) over mud
BHR14	C*	0	-	No	Stage II on III	11	Retrograde amphipod tube mat; pelletal (II's) sand (5 cm) over mud
BHR14	A	0	-	No	Stage II	5	Sand (2.5 cm) over mud; a few amphipod tubes; rippled; eroded mat; shell fragments
BHR14	B	0	-	No	Stage II	6	Retrograde amphipod tube mat; pelletal (II's) sand (1.5 cm) over mud; rippled?
BHR14	C	0	-	No	Stage I-II	5	Juvenile amphipod tube mat; pelletal (II's) sand (3 cm) over mud
BHR15	B'	0	-	No	Stage I	3	Poorly sorted; med sand (0.5-1 cm) over mud; erosional; some shell hash/lag; green water
BHR15	C	0	-	No	Stage I	3	Poorly sorted; erosional?; some shell hash/pebbles lag; green water
BHR15	D	0	-	No	Stage I	3	Sand over mud; 3 cm rebound; erosional; shell hash and pebbles; green water
BHR16	A*	0	-	No	Stage I-II	4	Retrograde stage II; pelletal (II's) sand (1.5 cm) over mud; erosional?; poor image
BHR16	B*	0	-	No	Stage II on III	11	Pelletal (I- II's) sand (8 cm) over mud; amphipod aggregation
BHR16	C*	0	-	No	Stage II	9	Pelletal (II's) sand (4 cm) over mud; large shell on surface, a few pebbles
BHR17	A*	0	-	No	Stage I-II	6	Tube aggregation; stage I's; a few amphipod tubes?; pelletal (I-II's) sand (3 cm) over mud
BHR17	B*	0	-	No	Stage I	3	Tube aggregation; stage I's; pelletal (I's) sand (1.5 cm) over mud
BHR17	C*	0	-	No	Stage I-II	5	Pelletal (I-II's) sand (3 cm) over dark sulfitic mud
BHR18	A*	0	-	No	Stage II on III	11	Retrograde tube mat; tube frag/ pelletal (II) sand; 2 cm shelter fabric
BHR18	B*	0	-	No	Stage II	9	Retrograde tube mat; tube frag/ pelletal (II's) sand; 2 cm shelter fabric
BHR18	C*	0	-	No	Stage II	9	Retrograde tube mat; tube frag/ pelletal (II's) sand; 4 cm shelter fabric; 3 crabs on surface
BHR19	B*	0	-	No	Indeterminate	Indeterminate	Erosional; shell and pebble lag
BHR19	C*	0	-	No	Indeterminate	Indeterminate	Erosional; shell and pebble lag
BHR19	E	0	-	No	Indeterminate	Indeterminate	Low penetration; erosional; rippled?; shell lag
BHR20	A' *	0	-	No	Stage II	9	Retrograde tube mat, only a few amphipods seen; top 3.5 cm is shelter fabric
BHR20	B*	0	-	No	Stage II on III	11	Retrograde tube mat, no amphipods left?; top 4.5 cm is shelter fabric
BHR20	C*	0	-	No	Stage II on III	11	Retrograde mat, no tubes left?; top 3.5 cm is shelter fabric
BHR21	A*	0	-	No	Stage II on III	9	Retrograde tube mat; top 1 cm is shelter fabric
BHR21	B*	0	-	No	Stage II on III	11	Retrograde amphipod tube mat; top 1-2 cm is shelter fabric
BHR21	C*	0	-	No	Stage II on III	10	Retrograde tube mat; top 1 cm is shelter fabric
BHR22	A*	0	-	No	Stage II on III	11	Healthy amphipod tube mat; pelletal (II's) sand; 3 cm rebound
BHR22	B*	0	-	No	Stage II	9	Healthy amphipod tube mat; pelletal (II's) sand; 2 cm rebound; shelter fabric
BHR22	C*	0	-	No	Stage II on III	11	Healthy amphipod tube mat; pelletal (II's) sand; 4 cm rebound
BHR23	A	0	-	No	Stage I	3	Sand over mud; erosional; 2 cm rebound; green water
BHR23	B'	0	-	No	Stage I-II	4	A few amphipod tubes? retrograde; sandy; erosional?; 3 cm rebound; green water
BHR23	C	0	-	No	Stage I-II	5	A few amphipod tubes; retrograde; sandy; erosional; 3-4 cm rebound; green water
BHR24	A	0	-	No	Stage I-II	5	Retrograde tube mat?; pelletal (II's) sand (4 cm) over mud; 3-5 cm rebound; green water
BHR24	B	0	-	No	Stage I	4	V. fine sand over mud; 5 cm rebound; green water
BHR24	C	0	-	No	Stage I	3	Sand over mud; rebound to depth; rippled; scour lag; green water
BHR25	A' *	0	-	No	Stage II on III	11	Retrograde amphipod tube mat; tube frag/ pelletal (II's) sand; 3 cm rebound; green water
BHR25	B*	0	-	No	Stage II on III	9	Tube frag/ pelletal sand; 3 cm rebound; green water
BHR25	C*	0	-	No	Stage I-II	6	Retrograde amphipod tube mat; pelletal (I-II's) sand; 3-5 cm rebound; green water

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Stat_ID	Replicate	Methane Bubbles		Anoxia	Successional	Organism	Comments
		Number	Depth in sediment (cm)	Low DO	Stage	Sediment Index (OSI)	
BHR26	B	0	-	No	Stage I	3	Sand (8 cm) over mud; snails (Ilyanassa) on surface; rippled?; green water
BHR26	C	0	-	No	Stage I-II	4	Sand (9 cm) over mud; rippled?; green water
BHR26	D	0	-	No	Stage I	3	Sand (8 cm) over mud; 2 cm rebound; green water
BHR27	A*	0	-	No	Stage II	6	Retrograde tube mat; pelletal (II's) sand (6 cm) over mud; 5 cm rebound; green water
BHR27	B*	0	-	No	Stage II on III	6	Scattered amphipod tubes; pelletal (II's?) sand (1 cm) over mud; erosional?
BHR27	C*	0	-	No	Stage II	6	Retrograde tube mat; pelletal (II's) sand (3 cm) over mud
BHR28	A*	0	-	No	Stage II	8	Healthy amphipod tube mat; pelletal (II's) sand (3 cm) over mud
BHR28	B*	0	-	No	Stage II	6	Healthy amphipod tube mat; pelletal (II's) sand (3 cm) over mud; shelter fabric
BHR28	C*	0	-	No	Stage II on III	8	Retrograde tube mat; pelletal (II's) sand (4 cm) over mud
BHR29	A*	0	-	No	Stage II	6	Retrograde amphipod tube mat; pelletal (II's) sand (2.5 cm) over mud
BHR29	B*	0	-	No	Stage II	6	Retrograde amphipod tube mat; pelletal (II's) sand (2 cm) over mud
BHR29	C*	0	-	No	Stage II	8	Retrograde amphipod tube mat; tube frag/ pelletal (II's) sand (5 cm) over mud
BHR30	A*	0	-	No	Stage II	7	Juvenile tube mat?; pelletal (II's) sand (2.5 cm) over mud; green water
BHR30	B*	0	-	No	Stage II	5	Juv. amphipod tubes at low density; pelletal (II's) sand (2.5 cm) over mud; green water
BHR30	C*	0	-	No	Stage II	5	Retrograde tube mat; pelletal (II's) sand (1.5 cm) over mud; green water
BHR31	A*	0	-	No	Stage II	7	Amphipod tube mat; pelletal (II's) sand (7 cm) over mud; shelter fabric
BHR31	B*	0	-	No	Stage II on III	11	Healthy amphipod tube mat; tube frag/ pelletal (II's) sand (6 cm) over mud
BHR31	C*	0	-	No	Stage II on III	9	Amphipod tube mat trapping sediment; pelletal (II's) sand (9 cm) over mud; 4 cm shelter fabric
BHR32	A*	0	-	No	Stage I	3	Pelletal (I's) sand (1 cm) over mud; green water
BHR32	B*	0	-	No	Stage I	3	Pelletal (I's) sand (1.5 cm) over mud
BHR32	C*	0	-	No	Stage I	2	Pelletal (I's) sand (0.5 cm) over mud
BHR33	A*	0	-	No	Stage I	3	Retrograde II?; pelletal (I's) sand (1 cm) over mud; erosional?
BHR33	B*	0	-	No	Stage I	2	Amphipod tube debris?; sand (patchy 0.5 cm) over mud; erosional; feeding pit?; green water
BHR33	C*	0	-	No	Stage I	3	Pelletal (I's) sand (patchy 0.5 cm) over mud; erosional?; rippled?; feeding pit?; green water
BHR34	B*	0	-	No	Stage I	3	Stage I's; pelletal (I's) sand (1.5 cm) over sulftic mud
BHR34	C*	0	-	No	Stage I	4	Stage I's; brown mud? over pelletal (I's) sand (2.5 cm) over mud (RDSI?)
BHR34	D*	0	-	No	Stage I	3	Pelletal (I's) patchy sand (1.5 cm) over sulfitic mud
BHR35	A*	0	-	No	Stage I	3	Pelletal (I's) sand (1 cm) over sulfitic mud; green water
BHR35	B*	0	-	No	Stage I	2	Pelletal (I's) sand (1.5 cm) over sulfitic mud; green water
BHR35	C*	0	-	No	Stage I	3	Pelletal (I's) sand (2 cm) over sulfitic mud; (RDSI?); green water
BHR36	A*	0	-	No	Stage I	3	Pelletal (I's) sand (1.5 cm) over mud; RDSI; green water
BHR36	B*	0	-	No	Stage I	2	Pelletal (I's) patchy sand (0.5 cm) over mud; erosional in recent past; green water
BHR36	C*	0	-	No	Stage I	2	Pelletal (I's) patchy sand (1 cm) over mud; green water
BHR36	A	0	-	No	Indeterminate	Indeterminate	Low penetration; sandy/ hard ground; erosional; green water
BHR36	C	0	-	No	Indeterminate	Indeterminate	Low penetration; sandy/ hard ground; erosional; green water
BHR37	A' *	0	-	No	Stage I	3	Patchy sand (2 cm) over mud; erosional; green water
BHR37	B*	0	-	No	Stage I	3	Patchy sand (2 cm) over mud; erosional?; green water
BHR37	C*	0	-	No	Stage II	4	Juvenile amphipods?; patchy sand (1 cm) over mud; green water

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Stat_ID	Replicate	Methane Bubbles		Anoxia	Successional	Organism	Comments
		Number	Depth in sediment (cm)	Low DO	Stage	Sediment Index (OSI)	
BHR38	A*	0	-	No	Stage II	9	Retro. amphipod tube mat; tube frag/ pelletal (II's) sand (6 cm) over mud; 2 cm rebound; green water
BHR38	B*	0	-	No	Stage II on III	11	Retrograde tube mat; tube frag/ pelletal (II's) sand (5-6 cm) over mud; green water
BHR38	C*	0	-	No	Stage II	9	Juvenile amphipods; tube frag/ pelletal (II's) sand (5 cm) over mud; green water
BHR39	A*	0	-	No	Stage I on III	11	Small amphipod tubes?; tube frag/ pelletal (I-II's) sand (8 cm) over mud; 3 cm rebound
BHR39	B*	0	-	Yes	Stage I	-3	A few tubes seen; a few thin worms at 3-6 cm depth
BHR39	C*	0	-	No	Stage II on III	11	Retrograde tube mat; tube frag/ pelletal (I-II's) sand (6 cm) over mud; 2 cm rebound
BHR40	A	0	-	No	Stage I	3	1.5 cm sand over sulfitic mud; rippled; some shell lag; green water
BHR40	B	0	-	No	Stage I	5	Very fine sand over mud; rippled?; 6 cm rebound; green water
BHR40	C	0	-	No	Stage I on III	6	Stage I's; erosional; rippled?; green water
BHR41	A*	0	-	No	Stage II	5	Retrograde tube mat; pelletal (II's) sand (1.5 cm) over mud
BHR41	B*	0	-	No	Stage I-II	6	Retrograde amphipod tube mat; pelletal (I-II's) sand (cm) over sulfitic mud
BHR41	C*	0	-	No	Stage I-II	4	Patchy pelletal (I-II's) sand (1.5 cm) over sulfitic mud
BHR42	A	0	-	No	Stage I	5	Pelletal (I's) sandy layer; rippled; green water
BHR42	B	0	-	No	Stage I	3	Pelletal (I's) sandy layer; rippled?; green water
BHR42	C	0	-	No	Stage I	4	Pelletal (I's) sandy layer; rippled/ erosional; Ulva, dead algae on bottom; green water
BHR43	A*	0	-	No	Stage I	2	Pelletal (I's) sand (1 cm) over sulfitic mud; surface disturbed, sampling artifact?
BHR43	B*	0	-	No	Stage I	3	Pelletal (I's) sand (1.5 cm) over sulfitic mud
BHR43	C*	0	-	No	Stage I	3	Pelletal (I's) sand (1-2 cm) over sulfitic mud
BHR44	A' *	0	-	No	Stage I	4	Pelletal (I's) sand (2 cm) over sulfitic mud
BHR44	B*	0	-	No	Stage I	2	Pelletal (I's) sand (1-2 cm) over sulfitic mud
BHR44	C*	0	-	No	Stage I	2	Pelletal (I's) sand (0.1-1 cm) over sulfitic mud
BHR45	A*	0	-	No	Stage II on III	11	Healthy amphipod tube mat; pelletal (II's) sand (6 cm) over low sulfide mud; shelter fabric
BHR45	B*	0	-	No	Stage II	9	Healthy amphipod tube mat; pelletal (II's) sand (6 cm) over low sulfide mud; shelter fabric
BHR45	C*	0	-	No	Stage II	9	Healthy amphi. tube mat; pelletal (II's) sand (6 cm) over low sulfide mud; shelter fabric; nemertean?
BHR46	A*	0	-	No	Stage II	8	Healthy amphipod tube mat; pelletal (II's) sand (4 cm) over low sulfide mud; shelter fabric
BHR46	B*	0	-	No	Stage II	7	Healthy amphipod tube mat; pelletal (II's) sand (3 cm) over mud; shelter fabric
BHR46	C*	0	-	No	Stage II	8	Retrograde tube mat; pelletal (II's) sand (3 cm) over mud
BHR47	A' *	0	-	No	Stage II	9	Retro. amphi. tube mat; tube frag/ pelletal (II's) sand (6 cm) over mud; shelter fabric; green water
BHR47	B*	0	-	No	Stage II on III	11	Retro. amphi. tube mat; tube frag/ pelletal (II's) sand (6 cm) over mud; shelter fabric; green water
BHR47	C' *	0	-	No	Stage II on III	11	Retro. amphi. tube mat; tube frag/ pelletal (II's) sand (6 cm) over mud; shelter fabric; green water
BHR48	A	0	-	No	Stage I	3	Pelletal (I's) sand (3 cm) over low sulfide mud; shell fragments to depth; green water
BHR48	B	0	-	No	Stage I	4	Pelletal (I's) sand (2 cm) over low sulfide mud; shell fragments to depth; green water
BHR48	C	0	-	No	Stage I	3	Pelletal (I's) sand (2.5 cm) over low sulfide mud; 3 cm rebound; green water
BHR49	A*	0	-	Yes	Stage I	-2	V. thin RPD; recently eroded?
BHR49	B*	0	-	No	Stage I	3	Pelletal (I's) sand (2 cm) over sulfitic mud
BHR49	C*	0	-	No	Stage I	2	Recently eroded?
BHR50	A' *	0	-	No	Stage II	6	Retrograde amphipod tube mat; pelletal (II's) sand (3 cm) over mud
BHR50	B*	0	-	No	Stage II	7	Retrograde?; pelletal (II's) sand (2 cm) over mud
BHR50	C*	0	-	No	Stage II	4	Retrograde tube mat; 2 cm sand over mud; some pebbles
BHR50	A	0	-	No	Stage II	8	Healthy amphipod tube mat trapping sediment; pelletal (II's) sand (6 cm) over mud; green water
BHR50	B	0	-	No	Stage II	8	Healthy amphipod tube mat; pelletal (II's) sand (4-6 cm) over mud; green water

HOM-1997 BOSTON HARBOR SEDIMENT PROFILE SURVEY RESULTS

Stat_ID	Replicate	Methane Bubbles		Anoxia	Successional	Organism	Comments
		Number	Depth in	Low DO	Stage	Sediment	
			sediment (cm)			Index (OSI)	
BHR51	A	0	-	No	Stage I	3	Pelletal v. fine (I's) sand (2 cm) over low sulfide mud; algal detritus on surface?; green water
BHR51	B	0	-	No	Stage I	2	V. fine sand (2.5 cm) over low sulfide mud; algal detritus on surface; green water
BHR51	C	0	-	No	Stage I on III	7	Pelletal (I's) v. fine sand (2 cm) over low sulfide mud; green water
BHR52	A	0	-	No	Stage I	3	Pelletal (I's) sand (2 cm) over mud; algal detritus on surface?; green water
BHR52	B	0	-	No	Stage I	3	Pelletal (I's) sand (1 cm) over mud; algal detritus on surface?; green water
BHR52	C	0	-	No	Stage I	3	Pelletal (I's) sand (2 cm) over low sulfide mud; algal detritus on surface; green water
BHR53	A	0	-	No	Stage I	5	Sandy to depth; rippled?; green water
BHR53	B	0	-	No	Stage I	3	Sandy to depth; rippled?; green water
BHR53	C	0	-	No	Stage I	3	Sandy to depth; rippled?; green water
BHT1	C*	0	-	No	Stage I	5	Stage I's, snail, attached algal frond; a few shell fragments on surface; green water
BHT1	E' *	0	-	No	Stage I	3	Stage I's; 1.5 cm sand over mud; green water
BHT1	B	0	-	No	Stage I	3	Stage I's; sandy to depth; rippled; green water
BHT1	C	0	-	No	Stage I	3	Stage I's; mostly sandy to depth; a few pebbles on surface; rippled; green water
BHT2	A*	0	-	No	Stage II	5	Recently settled? amphipod tubes; pelletal (II's) sand (1.5 cm) over mud
BHT2	B*	0	-	No	Stage II	4	Retrograde amphipod tube mat; pelletal (II's) sand (1 cm) over sulfitic mud; erosional?
BHT2	C*	0	-	No	Stage II	4	Retrograde amphipod tube mat; pelletal (II's) sand (1.5 cm) over sulfitic mud
BHT3	A*	0	-	No	Stage II on III	11	Retrograde amphipod tube mat; tube frag/ pelletal (II's) sand (6 cm) over mud; 3 cm rebound
BHT3	B*	0	-	No	Stage II on III	11	Healthy amphipod tube mat; pelletal (II's) sand (5 cm) over mud; 3 cm rebound
BHT3	C*	0	-	No	Stage II	9	Healthy amphi. mat; pelletal (II's) sand (6 cm) over mud; podocerid tube; shelter fabric; 3 cm rebound
BHT4	A*	0	-	No	Stage I	3	High sedimentation rate; stage I "mounds"; pelletal (I's) sand (1-2 cm) over sulfitic mud; 3 cm rebound
BHT4	B*	0	-	No	Stage I	3	High sedimentation rate; stage I "mounds", pelletal (I's) sand (1-2 cm) over sulfitic mud; 3 cm rebound
BHT4	C*	2 large	14	No	Stage I	0	High sedimentation rate; stage I "mounds"; pelletal (I's) sand (1-2 cm) over sulfitic mud; 3 cm rebound
BHT5A	A*	0	-	No	Stage II	Indeterminate	Healthy amphipod tube mat; sandy to depth; poor slide
BHT5A	B*	0	-	No	Stage II	6	Healthy amphipod tube mat; pelletal (II's) sand (2-3 cm) over mud; shelter fabric
BHT5A	C*	0	-	No	Stage II	5	Healthy amphipod tube mat; 1.5 cm sand over mud; dark slide
BHT5A	B	0	-	No	Indeterminate	Indeterminate	Bottom is cobble/ poorly sorted; erosional
BHT5A	C	0	-	No	Indeterminate	Indeterminate	Mud-draped cobble
BHT6	A*	0	-	No	Stage II	6	Retrograde amphipod tube mat; tube frag/ pelletal (II's) sand (3 cm) over mud; green water
BHT6	B*	0	-	No	Stage II	8	Retro. amphi. tube mat; tube frag/ pelletal (II's) sand (3 cm) over mud; 3 cm rebound; green water
BHT6	C*	0	-	No	Stage II	9	Retrograde amphipod tube mat; tube frag/ pelletal (II's) sand (4 cm) over mud; green water
BHT7	A*	0	-	No	Stage I	2	Stage I's; erosional; shell lag?
BHT7	B*	0	-	No	Stage I	4	Erosional; shell lag; some shelter fabric
BHT7	C*	0	-	No	Stage I	3	Erosional; shell lag
BHT8	A	0	-	No	Stage II	>or=5	Retrograde; salt and pepper sand to depth; rippled?; shell lag; green water
BHT8	B	0	-	No	Stage II	>or=7	Retrograde; salt and pepper sand to depth; shell lag; green water
BHT8	C	0	-	No	Stage II	>or=7	Retrograde; salt and pepper sand; clinker, pebble, shells; shell lag; erosional; green water

* August sample — Remaining samples taken in October

Appendix C

Sediment Grain Size, TOC/TON, and *Clostridium perfringens* Data

Appendix C96-1. **Grain-size composition of sediment taken from the eight Boston Harbor Traditional stations in April and August 1996. Data are percentages of total initial sample weight.**

Station	% Gravel	% Very Coarse Sand	% Coarse Sand	% Medium Sand	% Fine Sand	% Very Fine Sand	% Total Sand	% Silt	% Clay	Mean Phi
	>2.00 mm	>1.00 to 2.00 mm	>0.50 to 1.00 mm	>0.25 to 0.50 mm	>0.125 to 0.25 mm	>0.0625 to 0.125 mm	>0.0625 to 2.00 mm	>0.0039 to 0.0625 mm	<0.0039 mm	
	Phi < -1	-1 < Phi < 0	0 < Phi < 1	1 < Phi < 2	2 < Phi < 3	3 < Phi < 4	-1 < Phi < 4	4 < Phi < 8	Phi > 8	
April										
T-1	1.8	1.06	1.19	2.80	12.16	54.18	71.4	16.4	10.3	4.13
T-2	0.7	0.88	0.66	2.09	5.69	27.79	37.1	39.1	23.1	5.56
T-3	12.8	4.17	3.56	4.46	9.71	12.85	34.8	31.7	20.7	4.33
T-4	0.0	0.16	0.37	1.11	2.66	5.16	9.5	59.6	31.0	6.63
T-5A	0.3	0.53	0.28	1.26	35.56	47.68	85.3	9.6	4.8	3.58
T-6	0.3	0.45	1.16	1.68	1.88	17.27	22.4	46.1	31.2	6.25
T-7	23.2	4.23	3.44	3.74	4.56	11.04	27.0	29.1	20.7	3.82
T-8	0.2	0.28	0.35	2.57	72.52	10.91	86.6	6.2	7.0	3.23
August										
T-1	12.4	0.71	1.60	5.02	15.93	44.07	67.3	14.9	5.4.	3.21
T-2	0.0	0.52	0.55	0.85	6.55	44.66	53.1	36.5	10.4	4.86
T-3	0.9	0.91	1.09	1.50	4.87	12.07	20.5	53.4	25.3	6.03
T-4	0.0	0.11	0.77	1.42	1.20	2.13	5.6	79.8	14.6	6.23
T-5A	0.2	0.27	0.53	1.63	31.95	54.70	89.1	7.2	3.5	3.48
T-6	0.0	1.08	1.56	0.96	2.40	13.69	19.7	54.7	25.6	6.14
T-7	5.1	1.80	1.51	2.53	5.30	16.10	27.2	52.1	15.6	5.19
T-8	0.0	0.28	0.42	4.05	66.40	11.47	82.6	9.7	7.6	3.39

Appendix C96-2. **Total Organic Carbon (%C), Total Organic Nitrogen (%N), and Carbon/Nitrogen Ratio (C/N) in sediment samples taken from the eight Boston Harbor Traditional stations in April and August 1996.**

Station	Total Organic Carbon %C	Total Organic Nitrogen %N	Carbon/Nitrogen Ratio C/N
April			
T-1	0.926	0.118	9.17
T-2	2.020	0.240	9.81
T-3	2.837	0.330	10.04
T-4	3.814	0.359	12.39
T-5A	0.419	0.068	7.23
T-6	2.641	0.330	9.33
T-7	2.831	0.345	9.57
T-8	0.690	0.086	9.40
August			
T-1	1.896	0.141	15.68
T-2	1.978	0.222	10.38
T-3	3.844	0.456	9.83
T-4	4.752	0.511	10.84
T-5A	0.884	0.094	10.96
T-6	3.890	0.522	8.69
T-7	2.726	0.342	9.29
T-8	0.893	0.108	9.67

Appendix C96-3. **Analysis of *Clostridium perfringens* spores in sediment samples taken from the eight Traditional Boston Harbor stations in April and August 1996.**

Station	% Water	Counts	Mean	Coefficient of Variation	*C. perfringens* Wet Weight	Spores/Gram Dry Weight Sample Mean	Spores/Gram Dry Weight Station Mean
April							
T-1	42	7, 10	8.5	.25	600	1000	1000
T-2	55	95, 88	91.5	.05	14000	31000	31000
T-3	56	57, 63	60.0	.07	9600	22000	22000
T-4	69	96, 98	97.0	.01	7800	25000	25000
T-5A	23	18, 23	20.5	.17	1500	1900	1900
T-6	59	108, 97	102.5	.08	15000	37000	37000
T-7	65	100, 92	96.0	.06	7200	21000	21000
T-8	29	78, 89	83.5	.09	6200	8700	8650
T-8 Dup.	31	84, 80	82.0	.03	5900	8600	-
August							
T-1	33	94, 91	92.5	.02	6300	9400	9400
T-2	48	18, 16	17.0	.08	12000	23000	23000
T-3	63	164, 175	169.5	.05	11000	29000	29000
T-4	65	30, 41	35.5	.22	23000	67000	67000
T-5A	36	33, 37	35.0	.08	2200	3400	3400
T-6	63	31, 38	34.5	.14	22000	59000	59000
T-7	60	17, 26	21.5	.30	14000	35000	35000
T-8	38	90, 93	91.5	.02	6200	7000	7000

Appendix C97-1.Grain-size composition of sediment taken from the eight Boston Harbor Traditional stations in April and August 1997. Data are percentages of total initial sample weight.

Station	% Gravel	% Very Coarse Sand	% Coarse Sand	% Medium Sand	% Fine Sand	% Very Fine Sand	% Total Sand	% Silt	% Clay	Mean Phi
	>2.00 mm	>1.00 to 2.00 mm	>0.50 to 1.00 mm	>0.25 to 0.50 mm	>0.125 to 0.25 mm	>0.0625 to 0.125 mm	>0.0625 to 2.00 mm	>0.0039 to 0.0625 mm	<0.0039 mm	
	Phi < -1	-1 < Phi < 0	0 < Phi < 1	1 < Phi < 2	2 < Phi < 3	3 < Phi < 4	-1 < Phi < 4	4 < Phi < 8	Phi > 8	
April										
T-1	9.0	0.62	0.95	3.12	13.92	50.13	68.7	13.9	8.3	3.60
T-2	0.9	0.47	0.47	1.02	8.07	36.07	46.1	32.1	20.9	5.27
T-3	0.0	0.09	0.36	1.96	2.77	12.68	17.9	44.7	37.4	6.60
T-4	0.3	0.00	0.22	0.36	0.57	3.80	4.9	57.8	37.0	6.94
T-5A	0.0	0.29	0.39	1.06	11.45	42.83	56.0	27.5	16.4	4.93
T-6	0.0	1.10	1.92	2.01	6.13	36.63	47.8	30.6	21.6	5.25
T-7	1.4	0.66	0.89	12.24	72.33	4.76	90.9	3.6	4.2	2.73
T-8	4.3	2.45	2.52	2.39	4.15	20.88	32.4	34.1	29.2	5.48
August										
T-1-1	25.7	2.15	2.70	6.54	10.13	39.01	60.5	6.0	7.8	2.39
T-1-2	12.4	1.87	2.01	3.64	9.19	42.32	59.0	19.0	9.5	3.58
T-1-3	7.3	2.01	3.47	7.51	13.51	46.30	72.8	14.6	5.3	3.32
T-2-1	0.1	0.23	0.63	1.13	4.07	38.90	45.0	33.4	21.5	5.42
T-2-2	0.1	0.14	0.40	0.68	4.39	43.50	49.1	31.2	19.6	5.28
T-2-3	0.0	0.10	0.15	1.60	2.96	34.39	39.2	36.3	24.5	5.68
T-3-1	0.2	0.12	1.00	1.95	2.66	11.45	17.2	46.3	36.3	6.55
T-3-2	0.2	0.15	0.45	1.36	1.74	9.61	13.3	47.3	39.2	6.76
T-3-3	0.3	0.34	0.42	1.87	2.29	16.13	21.1	40.0	38.6	6.52

Appendix C97-1 continued.

Station	% Gravel >2.00 mm Phi < -1	% Very Coarse Sand >1.00 to 2.00 mm -1 < Phi < 0	% Coarse Sand >0.50 to 1.00 mm 0 < Phi < 1	% Medium Sand >0.25 to 0.50 mm 1 < Phi < 2	% Fine Sand >0.125 to 0.25 mm 2 < Phi < 3	% Very Fine Sand >0.0625 to 0.125 mm 3 < Phi < 4	% Total Sand >0.0625 to 2.00 mm -1 < Phi < 4	% Silt >0.0039 to 0.0625 mm 4 < Phi < 8	% Clay <0.0039 mm Phi > 8	Mean Phi
T-4-1	1.8	0.00	0.08	0.51	0.76	1.02	2.4	55.9	39.9	6.99
T-4-2	0.0	0.00	0.11	0.32	0.11	0.97	1.5	55.4	43.1	7.24
T-4-3	0.0	0.00	0.00	0.26	0.77	1.03	2.1	57.9	40.0	7.14
T-5A-1	0.4	0.59	1.24	1.60	27.78	42.02	73.2	16.5	9.9	4.07
T-5A-2	0.0	0.11	0.17	0.46	7.42	45.15	53.3	29.8	16.9	5.08
T-5A-3	0.1	0.21	0.33	1.00	24.06	50.97	76.6	16.2	7.1	4.01
T-6-1	0.1	0.16	0.28	1.11	7.79	42.64	52.0	28.3	19.6	5.17
T-6-2	0.1	0.10	0.42	1.20	6.51	39.04	47.3	33.9	18.7	5.27
T-6-3	5.8	1.18	1.39	2.78	12.60	53.64	71.6	16.7	6.0	3.69
T-7-1	20.5	5.26	2.89	3.22	4.31	18.14	33.8	30.6	15.2	3.67
T-7-2	11.3	2.43	2.00	2.72	4.29	17.13	28.6	42.2	17.9	4.72
T-7-3	15.5	1.65	1.60	1.80	3.59	16.48	25.1	44.6	14.8	4.47
T-8-1	0.1	0.16	0.39	6.21	78.33	8.69	93.8	2.9	3.3	2.82
T-8-2	0.4	0.43	0.56	6.40	75.82	7.65	90.9	3.7	5.0	2.93
T-8-3	1.1	0.18	0.41	31.80	60.08	3.47	95.9	1.1	1.9	2.32

Appendix C97-2.Total Organic Carbon (%), Total Organic Nitrogen (%), and C/N (as molar ratio)in sediment samples taken from the eight Traditional Boston Harbor stations in April and August 1997. (BDL=Below Detection Levels)

Station	Total Organic Carbon %	Station Mean	Total Organic Nitrogen %	Station Mean	C/N	Station Mean
April						
T-1	1.05	1.05	<0.09	<0.09	BDL	BDL
T-2	1.59	1.59	0.19	0.19	9.61	9.61
T-3	3.38	3.38	0.39	0.39	10.00	10.00
T-4	4.08	4.08	0.42	0.42	11.39	11.39
T-5A	1.13	1.13	0.14	0.14	9.10	9.10
T-6	3.00	3.00	0.35	0.35	9.91	9.91
T-7	3.16	3.16	0.37	0.37	9.98	9.98
T-8	0.37	0.37	<0.05	<0.05	BDL	BDL
August						
T-1; Rep. 1, Rep. 2, Rep. 3	1.27; 2.03; 2.18	1.83	0.12; 0.15; 0.26	0.18	12.76; 15.87; 9.89	12.84
T-2; Rep. 1, Rep. 2, Rep. 3	0.90; 1.62; 1.87	1.46	<0.07; 0.19; 0.23	<0.16	BDL; 9.93; 9.51	9.72
T-3; Rep. 1, Rep. 2, Rep. 3	3.53; 3.75; 3.43	3.57	0.44; 0.48; 0.42	0.45	9.32; 9.08; 9.49	9.30
T-4; Rep. 1, Rep. 2, Rep. 3	3.81; 3.83; 4.00	3.88	0.41; 0.43; 0.46	0.43	10.73; 10.44; 10.10	10.42
T-5A; Rep. 1, Rep. 2, Rep. 3	1.34; 1.88; 1.03	1.42	0.17; 0.24; 0.14	0.18	9.09; 9.13; 8.73	8.98
T-6; Rep. 1, Rep. 2, Rep. 3	2.29; 2.39; 0.97	1.88	0.29; 0.29; 0.11	0.23	9.23; 9.49; 10.54	9.75
T-7; Rep. 1, Rep. 2, Rep. 3	3.14; 3.13; 3.02	3.10	0.32; 0.36; 0.35	0.34	11.47; 10.17; 10.03	10.56
T-8; Rep. 1, Rep. 2, Rep. 3	0.60; 0.49; 0.25	0.45	0.05; 0.07; 0.03	0.05	14.10; 8.67; 9.60	10.79

Appendix C97-3. Analysis of *Clostridium perfringens* spores in sediment samples taken from the eight Boston Harbor Traditional stations in April and August 1997.

Station	% Water	Counts	Mean	Coefficient of Variation	*C. perfringens* Wet Weight	Spores/Gram Dry Weight Sample Mean	Spores/Gram Dry Weight Station Mean
April							
T-1	38	84, 70	77.0	.13	4100	6500	6500
T-2	49	104, 99	101.5	.03	10000	20000	20000
T-3	67	91, 96	93.5	.04	13000	39000	39000
T-4	70	49, 45	47.0	.06	6000	20000	20000
T-5A	43	63, 58	60.5	.06	3200	5600	5600
T-6	60	126, 140	133.0	.07	17000	42000	42000
T-7	61	106, 100	103.0	.04	9900	25000	25000
T-8	30	50, 54	52.0	.05	2300	3300	3850
T-8 Dup.	30	64, 68	66.0	.04	3100	4400	-
August							
T-1-1	31	97, 99	98.0	.01	4800	7000	-
T-1-2	37	59, 56	57.5	.04	6400	10000	7833
T-1-3	37	108, 98	103.0	.07	4100	6500	-
T-2-1	40	107, 107	107.0	.00	12000	20000	-
T-2-2	46	92, 92	92.0	.00	9300	17000	18333
T-2-3	55	85, 89	87.0	.03	8100	18000	-
T-3-1	67	71, 73	72.0	.02	6500	20000	-
T-3-2	68	48, 51	49.5	.04	4300	13000	18667
T-3-3	63	92, 86	89.0	.05	8700	23000	-
T-4-1	70	50, 56	53.0	.08	5300	18000	-
T-4-2	70	72, 75	73.5	.03	5600	19000	17000
T-4-3	71	44, 47	45.5	.05	4100	14000	-
T-5A-1	56	21, 27	24.0	.18	2000	4500	-
T-5A-2	57	27, 28	27.5	.03	2200	5100	3933
T-5A-3	36	18, 17	17.5	.04	1400	2200	-
T-6-1	58	111, 119	115.0	.05	7600	18000	-
T-6-2	61	113, 114	113.5	.01	10000	26000	17233
T-6-3	42	86, 77	81.5	.08	4500	7700	-
T-7-1	51	80, 90	85.0	.08	7600	15000	-
T-7-2	52	102, 90	96.0	.09	8500	18000	18000
T-7-3	60	92, 97	94.5	.04	8500	21000	-
T-8-1	20	28, 28	28.0	.00	1400	1800	-
T-8-2	27	44, 47	45.5	.05	2100	2800	1900
T-8-3	25	88, 86	87.0	.02	850	1100	-

Appendix D

Chemistry Data

Appendix D1. Analysis of metals in sediment samples from the eight Boston HarborTraditional stations taken in August 1997. (LOD= Level of Detection)

Station	Aluminum %	Iron %	Cadmium µg/g	Chromium µg/g	Copper µg/g	Lead µg/g	Mercury µg/g	Nickel µg/g	Silver µg/g	Zinc µg/g
T-1 Rep. 1	5.71	1.94	0.24	24.8	42.6	39.7	0.27	22.1	0.93	86.2
T-1 Rep. 2	5.85	2.14	0.30	76.6	41.2	41.2	0.34	21.9	1.03	84.7
T-1 Rep. 3	5.30	1.71	<LOD	50.4	25.5	32.2	0.16	16.9	<LOD	60.7
T-2 Rep. 1	6.10	2.40	0.54	98.0	61.6	57.2	0.40	29.7	2.36	103
T-2 Rep. 2	6.95	2.70	0.37	102	59.6	61.1	0.81	31.5	2.16	109
T-2 Rep. 3	7.76	3.30	0.45	123	72.4	69.3	0.61	35.5	2.32	126
T-3 Rep. 1	7.47	3.92	0.19	165	98.6	119	0.86	40.7	3.39	153
T-3 Rep. 2	8.07	4.29	0.19	186	97.1	129	1.03	42.8	3.19	171
T-3 Rep. 3	7.07	3.72	0.27	168	107	117	1.01	41.0	3.10	159
T-4 Rep. 1	7.61	4.13	1.08	178	132	159	1.10	42.5	4.17	228
T-4 Rep. 2	7.21	3.84	1.14	166	122	149	1.11	43.1	3.97	216
T-4 Rep. 3	7.32	3.89	1.09	167	121	148	1.14	37.9	4.34	208
T-5A Rep. 1	6.00	2.14	0.34	57.6	27.6	32.7	0.20	17.6	0.99	69.7
T-5A Rep. 2	7.05	3.10	0.22	95.9	45.0	53.1	0.31	24.7	1.62	101
T-5A Rep. 3	6.26	2.14	0.30	54.1	36.1	34.3	0.16	17.1	0.77	82.3
T-6 Rep. 1	6.56	2.87	0.23	91.8	56.2	66.7	0.95	24.1	2.95	97.4
T-6 Rep. 2	6.54	3.00	0.20	103	56.3	72.9	0.64	24.6	2.54	107
T-6 Rep. 3	5.90	2.21	0.18	57.8	31.2	48.8	0.47	16.6	1.26	73.8
T-7 Rep. 1	5.76	2.60	0.78	137	85.4	105	1.28	24.8	4.46	130
T-7 Rep. 2	6.18	2.99	0.69	151	89.3	115	0.94	26.5	4.68	138
T-7 Rep. 3	6.44	2.85	0.66	149	94.1	112	1.30	29.9	4.99	146
T-7 Rep. 3 Dup.	6.62	2.94	0.86	141	87.5	112	1.00	27.2	5.64	146
T-8 Rep. 1	4.36	1.49	0.11	19.0	7.43	28.8	0.12	6.02	0.51	28.0
T-8 Rep. 2	4.83	1.63	0.09	34.3	13.9	28.3	0.16	11.6	0.58	45.2
T-8 Rep. 2 Dup.	4.73	1.64	0.10	36.4	14.8	29.3	0.14	12.3	0.61	46.4
T-8 Rep. 3	4.14	1.43	0.08	25.8	8.41	23.1	0.10	10.9	0.30	42.6

Appendix D2. Concentrations (ng/g) of polychlorinated biphenyls (PCBs) and pesticides in sediments from the eight Boston Harbor Traditional stations taken in August 1997. (ND=not detected; L=value >10-20% above calibration range, therefore analysis rerun on diluted sample).

Chemistry Analytes	T-1 Rep.1	T-1 Rep. 2	T-1 Rep. 3	T-2 Rep. 1	T-2 Rep. 2	T-2 Rep. 3	T-3 Rep. 1	T-3 Rep. 2	T-3 Rep.3	T-4 Rep. 1	T-4 Rep. 2	T-4 Rep. 3
Polychlorinated Biphenyls (PCBs)												
2,4-Cl2(8)	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.2	2.3	3.2
2,2',5-Cl3(18)	ND	ND	0.59	ND	ND	2.1	ND	ND	ND	ND	ND	ND
2,4,4'-Cl3(28)	2.7	2.6	0.54	2.9	2	2.7	5	4.4	4.6	19	19	25
2,2',3,5'-Cl4(44)	ND	ND	ND	ND	ND	ND	2.7	2.2	2.4	ND	ND	ND
2,2',5,5'-Cl4(52)	3.5	4.5	1.4	4.2	2.8	ND	3.3	2.9	2.6	7.6	7.6	9
2,3',4,4'-Cl4(66)	2.6	2.4	1	2.6	2	3	6.5	4	3.5	17	16	21
3,3',4,4'-Cl4(77)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2',4,5,5'-Cl5(101)	6.7	8.8	2.8	7.8	6	6.2	8.8	7.4	7.4	19	22	27
2,3,3',4,4'-Cl5(105)	3.4	4.4	1.7	4.2	3.5	3.7	6.4	5.4	5.6	14	16	18
2,3',4,4',5-Cl5 (118)	8.5	9.7	3.5	9.8	8.8	9.3	14	13	13	27	27	37
3,3',4,4',5-Cl5(126)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2',3,3',4,4'-Cl6(128)	1.8	2.3	0.66	2.3	2.1	1.8	3.6	3.3	3.2	5.7	6.3	7.7
2,2',3,4,4',5'-Cl6(138)	12	14	5.6	22	17	21	14	12	13	17	21	24
2,2',4,4',5,5'-Cl6(153)	4.5	8.9	3.5	12	9.9	11	19	13	13	25	27	30
2,2',3,3',4,4',5-Cl7(170)	0.91	2.8	1.2	2.6	3.4	7	2.2	2.6	3.9	2.6	3.5	ND
2,2',3,4,4',5,5'-Cl7(180)	4.6	6.1	1.6	8.1	6.9	ND	15	5.8	14	15	16	5.6
2,2',3,4,5,5',6-Cl7(187)	2.7	3.5	2.2	8.3	7.3	9.3	12	10	12	21	22	28
2,2',3,3',4,4',5,6-Cl8 (195)	ND	ND	ND	3.2	2.2	ND	ND	ND	ND	ND	ND	ND
2,2',3,3',4,4',5,5',6-Cl9 (206)	0.49	0.54	0.31	0.96	1	1	1.8	1.6	1.8	2.6	2.2	2.6
Decachlorobiphenyl-Cl10(209)	0.6	0.5	0.36	1	0.8	1.1	1.4	1.3	1.5	ND	ND	ND
Pesticides												
Hexachlorobenzene	ND	0.21	ND	ND	0.32	ND	0.73	ND	1.5	ND	ND	ND
Lindane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachloroepoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ALPHA-CHLORDANE	1.2	1.5	0.23	1.7	1.2	1.6	2.6	2	2.7	2.5	2.9	3.3
TRANS-NONACHLOR	1	0.93	0.47	1.6	1.4	1.4	2.9	2.2	2.5	4.1	4.4	5.5
Dieldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mirex	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4'-DDD	1.7	1.9	0.57	2	1.5	1.9	3.5	3.8	3.2	3.5	5.9	5.8
4,4'-DDD	4.7	8.1	2.1	5.4	4.6	5.4	8.3	7.6	6.7	14	17	20
2,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDE	3.1	5.1	1.7	5	4.4	3.7	7.6	5.2	6	8.5	11	12
2,4'-DDT	ND	ND	ND	ND	0.94	0.66	ND	ND	ND	1.4	1.5	ND
4,4'-DDT	ND	4.5	ND	1.6	ND	1.3	1.4	1.7	ND	ND	ND	ND
DDMU	0.9	0.96	0.53	1.5	0.86	1.2	ND	ND	ND	ND	ND	ND

Appendix D2 continued.

Chemistry Analytes	T-5A Rep. 1	T-5A Rep. 2	T-5A Rep.3	T-6 Rep. 1	T-6 Rep. 2	T-6 Rep. 3	T-7 Rep. 1	T-7 Rep. 2	T-7 Rep. 3	T-8 Rep. 1	T-8 Rep. 2	T-8 Rep. 3
Polychlorinated Biphenyls (PCBs)												
2,4-Cl2(8)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2',5-Cl3(18)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,4'-Cl3(28)	2	0.77	1.1	1.9	1.7	1.7	5.7	6.8	2.1	0.59	0.63	0.12
2,2',3,5'-Cl4(44)	ND	ND	ND	0.76	1	0.77	ND	ND	ND	ND	0.18	ND
2,2',5,5'-Cl4(52)	2.8	0.49	1.8	1.5	1.9	0.78	2.7	3.9	0.91	ND	0.44	ND
2,3',4,4'-Cl4(66)	5.1	0.74	0.78	3.1	2.7	2	6.3	6.8	3.5	0.66	0.76	0.16
3,3',4,4'-Cl4(77)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2',4,5,5'-Cl5(101)	4.7	2.5	4	3.9	3.7	3.2	17	16	5.2	1.2	1.3	0.32
2,3,3',4,4'-Cl5(105)	3	1.4	2	3.2	2.4	2	12	9.9	3.5	0.87	0.94	0.24
2,3',4,4',5-Cl5 (118)	7.1	4.1	6.1	6.5	5.9	4.9	23	22	7.8	2.5	2.8	0.56
3,3',4,4',5-Cl5(126)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2',3,3',4,4'-Cl6(128)	1.7	0.75	ND	1.6	1.4	1.2	5.8	5.6	2	0.57	0.49	0.15
2,2',3,4,4',5'-Cl6(138)	13	9.3	8.5	17	14	11	21	20	6.8	3.9	5	2.1
2,2',4,4',5,5'-Cl6(153)	4.8	4.1	4.6	7.6	5.6	4.4	23	23	8	2.2	2.5	0.64
2,2',3,3',4,4',5-Cl7(170)	1.5	1.3	0.96	2.3	1.2	1.2	2.3	3.3	0.94	0.44	0.81	0.19
2,2',3,4,4',5,5'-Cl7(180)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,2',3,4,5,5',6-Cl7(187)	12	3.6	9	5.7	5.1	4.6	13	13	5.5	2.8	2.6	0.62
2,2',3,3',4,4',5,6-Cl8 (195)	ND	ND	ND	ND	ND	ND	2.4	3.7	ND	ND	ND	ND
2,2',3,3',4,4',5,5',6-Cl9 (206)	0.49	0.43	ND	0.84	0.66	0.6	2.4	2.6	0.84	0.21	0.27	0.056
Decachlorobiphenyl-Cl10(209)	ND	ND	ND	0.77	0.62	0.53	2.3	1.6	0.69	ND	0.26	0.043
Pesticides												
Hexachlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lindane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachloroepoxide	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ALPHA-CHLORDANE	1.7	0.56	0.97	1.7	1.2	0.72	2.6	2.3	0.86	0.21	0.25	0.084
TRANS-NONACHLOR	1.2	0.69	0.87	1.1	0.86	0.75	3.7	3.4	1	0.38	0.41	0.11
Dieldrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mirex	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4'-DDD	1.1	0.71	0.56	1	0.69	0.88	3.9	4.3	1.3	0.35	0.39	0.098
4,4'-DDD	4.6	1.8	2.7	3	2.4	2.1	16	13	4.5	1	1.2	0.22
2,4'-DDE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4,4'-DDE	3	1.8	1.2	3.5	3.2	2.2	18	16	5.2	1.5	1.7	0.29
2,4'-DDT	ND	ND	ND	0.59	ND	10	ND	ND	ND	ND	ND	0.11
4,4'-DDT	ND	ND	ND	ND	ND	50	ND	ND	ND	ND	ND	ND
DDMU	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Appendix D3. Concentrations (ng/g) of polynuclear aromatic hydrocarbons (PAHs) and linear alkyl benzenes (LABs) in sediments from the eight Traditional Boston Harbor stations taken in August 1997.

Chemistry Analytes	T-1 Rep. 1	T-1 Rep. 2	T-1 Rep. 3	T-2 Rep. 1	T-2 Rep. 2	T-2 Rep. 3	T-3 Rep. 1	T-3 Rep. 2	T-3 Rep. 3	T-4 Rep. 1	T-4 Rep. 2	T-4 Rep.3
Polynuclear Aromatic Hydrocarbons (PAHs)												
Naphthalene	48	70	28	89	89	68	120	120	120	100	100	99
C1-naphthalenes	95	92	19	40	35	30	89	100	110	46	44	44
C2-naphthalenes	280	250	51	56	61	51	120	130	140	72	72	71
C3-naphthalenes	230	240	62	62	59	51	98	100	100	81	73	75
C4-naphthalenes	120	140	41	55	54	53	64	70	58	64	65	68
Benzothiazole	11	5.1	3.6	6.4	6.8	5.3	8.4	8	8.9	12	11	12
Acenaphthylene	24	32	26	48	48	44	46	56	50	79	76	75
Acenaphthene	15	35	7.3	21	21	28	21	26	26	44	43	42
Biphenyl	22	28	6.7	14	10	9.4	20	20	20	16	16	16
Dibenzofuran	30	25	12	21	20	22	26	32	29	41	40	40
Fluorene	52	92	30	37	37	43	36	56	43	66	64	63
C1-fluorenes	120	190	46	38	28	34	38	48	37	46	46	48
C2-fluorenes	250	290	65	54	61	51	63	73	58	72	67	78
C3-fluorenes	270	320	110	150	150	140	150	170	160	280	250	260
Phenanthrene	240	390L	160	260	270	310	280	370	320	580	560L	550
Anthracene	60	120	63	98	98	100	90	230	350	160	150	160
C1-phenanthrenes/anthracene	400	590	210	230	240	230	220	290	250	360	350	370
C2-phenanthrenes/anthracene	460	600	200	260	260	230	230	270	270	380	340	370
C3-phenanthrenes/anthracene	280	360	120	210	200	180	150	170	200	280	230	260
C4-phenanthrenes/anthracene	280	420	180	340	330	300	250	340	410	510	470	510
Dibenzothiophene	31	47	14	22	23	26	25	29	27	45	44	43
C1-dibenzothiophenes	80	120	29	40	41	39	39	42	39	61	52	54
C2-dibenzothiophenes	120	170	45	91	84	77	73	78	80	110	100	97
C3-dibenzothiophenes	100	140	40	120	110	100	76	76	99	130	130	130
Fluoranthene	300L	560L	380L	580L	560L	620L	550	650L	670L	1300L	1200L	1200L
Pyrene	310L	540L	350L	580L	560L	610L	550	640L	600L	1200L	1100L	1200L
C1-fluoranthenes/pyrenes	360	580	300	450	480	410	360	450	500	660	630	660
C2-fluoranthenes/pyrenes	400	570	220	350	380	310	320	350	400	580	520	560
C3-fluoranthenes/pyrenes	400	430	140	190	210	180	190	190	240	320	270	310
Benzo(a)anthracene	190	330L	220	350	350	340	310	380	420	600	530	600
Chrysene	200	310	180	290	310	310	300	430	460	580	540	560
C1-chrysene	240	380	130	240	260	230	210	250	260	370	330	370
C2-chrysene	220	280	100	160	170	150	160	160	180	270	220	250
C2-chrysene	170	210	89	140	130	120	160	170	180	260	230	250
C4-chrysene	110	120	50	78	85	71	94	98	100	160	150	150
Benzo(b)fluoranthene	380L	380L	200	480L	470L	490L	560L	580L	620L	1100L	1100L	1000L
Benzo(k)fluoranthene	120	120	70	110	130	120	95	200	180	330	370	320
Benzo(e)pyrene	190	180	110	230	230	240	270	290	320	540	500	510
Benzo(a)pyrene	260	280	170	330	340L	340	370	420	400	690L	640L	640L
Perylene	64	66	42	88	88	90	100	120	120	190	180	180
Indeno(1,2,3-c,d)pyrene	180	210	120	290	300	300	400	440	420	610L	580L	560L
Diabenzo(a,h)anthracene	47	53	29	63	62	65	79	92	87	160	150	160
Benzo(g,h,i)perylene	150	170	100	260	250	260	330	380	350	670	500L	670
Linear Alkyl Benzenes												
C10-alkylbenzene	81	110	45	290	180	210	120	130	140	200	190	190
C11-alkylbenzene	110	140	74	440	310	340	230	200	240	340	330	340
C12-alkylbenzene	72	99	46	310	210	200	130	120	140	240	200	240
C13-alkylbenzene	19	26	19	180	90	69	66	95	100	140	130	130
C14-alklybenzene	120	180	100	140	150	200	300	220	160	380	380	360

Appendix D3 continued.

Chemistry Analytes	T-5A Rep.1	T-5A Rep. 2	T-5A Rep. 3	T-6 Rep. 1	T-6 Rep. 2	T-6 Rep. 3	T-7 Rep. 1	T-7 Rep. 2	T-7 Rep. 3	T-8 Rep. 1	T-8 Rep. 2	T-8 Rep. 3
Polynuclear Aromatic Hydrocarbons (PAHs)												
Naphthalene	100	36	230	39	42	34	53	61	24	30	17	5.3
C1-naphthalenes	49	21	74	30	29	21	31	31	13	14	5.4	2.2
C2-naphthalenes	81	35	130	51	46	41	47	51	21	24	15	4.1
C3-naphthalenes	88	36	110	47	44	42	46	56	23	23	20	4.3
C4-naphthalenes	63	28	140	30	26	24	36	31	19	17	14	3.8
Benzothiazole	5.4	3.6	4.1	4.1	3.4	3.7	6.2	5.2	2.2	2.4	2	2
Acenaphthylene	69	30	120	30	29	21	36	38	15	20	16	5.1
Acenaphthene	79	13	60	17	16	16	18	16	8.6	14	7	ND
Biphenyl	15	5.8	21	7.5	6.9	6.2	9.6	10	4.2	3.8	2.1	ND
Dibenzofuran	62	9.9	46	16	17	14	20	20	9.5	15	6.2	1.4
Fluorene	120	22	100	28	27	26	30	29	15	28	14	2.7
C1-fluorenes	78	24	150	25	21	22	26	29	13	19	16	3.4
C2-fluorenes	88	36	280	35	27	30	38	44	18	24	21	5.3
C3-fluorenes	230	65	380	87	81	84	97	110	53	58	52	14
Phenanthrene	970L	160	740L	210	200	200	230	210	110	200	110	20
Anthracene	240	56	250	71	54	60	68	68	33	51	29	5.5
C1-phenanthrenes/anthracene	560	160	970	160	130	140	170	170	79	130	89	20
C2-phenanthrenes/anthracene	460	160	1200	140	130	140	170	180	87	100	83	21
C3-phenanthrenes/anthracene	270	99	460L	89	85	84	140	140	62	55	48	13
C4-phenanthrenes/anthracene	530	170	1100	170	130	170	210	230	100	110	91	22
Dibenzothiophene	70	14	84	16	16	15	20	20	9.4	18	8.4	1.8
C1-dibenzothiophenes	84	28	290	23	20	20	30	31	13	22	14	4.1
C2-dibenzothiophenes	140	55	610	37	34	33	56	55	25	31	23	7.6
C3-dibenzothiophenes	120	54	350L	35	38	33	66	70	29	24	22	6.9
Fluoranthene	1400L	320	1400L	370	330	370	410	400	230L	240	210	41
Pyrene	1300L	330	1700L	350	310	350	420	410	190	220	190	40
C1-fluoranthenes/pyrenes	850	290	1500	260	220	250	260	270	120	170	140	34
C2-fluoranthenes/pyrenes	620	200	1100	190	170	180	240	250	100	120	99	26
C3-fluoranthenes/pyrenes	300	110	520	110	110	100	170	160	62	68	56	13
Benzo(a)anthracene	780L	210	970L	210	180	210	210	210	110	140	120	23
Chrysene	710L	180	850L	190	160	180	210	200	90	120	100	23
C1-chrysene	450	140	750	120	110	120	170	160	62	86	70	16
C2-chrysene	260	100	480	83	80	82	130	130	52	51	41	11
C2-chrysene	200	84	220L	80	75	82	130	140	52	43	37	10
C4-chrysene	99	46	130	54	48	49	95	87	35	24	21	6.3
Benzo(b)fluoranthene	860L	230	810L	300	280	280	380	390	190	150	130	27
Benzo(k)fluoranthene	280	82	300	73	71	80	140	130	46	48	42	11
Benzo(e)pyrene	430	130	490L	140	140	140	210	200	94	74	67	15
Benzo(a)pyrene	690L	210	820L	210	200	210	270	270	130	110	99	20
Perylene	170	50	200	59	54	55	76	76	35	30	29	6
Indeno(1,2,3-c,d)pyrene	420L	150	410L	200	180	180	290	320	130	86	82	17
Diabenzo(a,h)anthracene	110	33	130	41	37	34	59	64	27	17	15	3
Benzo(g,h,i)perylene	410	140	380L	170	160	150	260	270	110	72	70	15
Linear Alkyl Benzenes												
C10-alkylbenzene	140	69	91	110	110	100	420	420	160	33	45	19
C11-alkylbenzene	180	120	130	200	220	240	710	770	280	75	85	31
C12-alkylbenzene	140	71	90	150	190	180	460	530	180	66	65	29
C13-alkylbenzene	28	24	27	93	94	110	340	430	120	51	37	16
C14-alklybenzene	140	250	74L	280	170	110	140	100	65	26	62	25

Appendix D4. Concentrations (ng/g) of polynuclear aromatic hydrocarbons (PAHs), linear alkyl benzenes (LABs), polychlorinated biphenyls (PCBs), and pesticides in sediments from Boston Harbor station T-8 taken in August 1997 reported as original data, Matrix Spike (MS) and Matrix Spike Duplicate (MSD) values.

Chemistry Analytes	T-8 Rep. 2	T-8 Rep. 2 MS	T-8 Rep. 2 MSD
Polynuclear Aromatic Hydrocarbons (PAHs)			
Naphthalene	17	75	67
C1-naphthalenes	5.4	9.9	6.8
C2-naphthalenes	15	20	13
C3-naphthalenes	20	28	17
C4-naphthalenes	14	17	12
Benzothiazole	2	44	43
Acenaphthylene	16	66	65
Acenaphthene	7	70	54
Biphenyl	2.1	3	2.1
Dibenzofuran	6.2	68	60
Fluorene	14	91	70
C1-fluorenes	16	19	12
C2-fluorenes	21	24	20
C3-fluorenes	52	57	47
Phenanthrene	110	230	120
Anthracene	29	110	70
C1-phenanthrenes/anthracene	89	100	66
C2-phenanthrenes/anthracene	83	97	71
C3-phenanthrenes/anthracene	48	53	44
C4-phenanthrenes/anthracene	91	83	74
Dibenzothiophene	8.4	12	6
C1-dibenzothiophenes	14	12	11
C2-dibenzothiophenes	23	21	20
C3-dibenzothiophenes	22	19	18
Fluoranthene	210	300	180
Pyrene	190	260	180
C1-fluoranthenes/pyrenes	140	150	98
C2-fluoranthenes/pyrenes	99	100	80
C3-fluoranthenes/pyrenes	56	64	50
Benzo(a)anthracene	120	190	130
Chrysene	100	170	120
C1-chrysene	70	75	49
C2-chrysene	41	46	39
C2-chrysene	37	37	31
C4-chrysene	21	23	22
Benzo(b)fluoranthene	130	190	160
Benzo(k)fluoranthene	42	100	78
Benzo(e)pyrene	67	66	48
Benzo(a)pyrene	99	160	120
Perylene	29	29	20
Indeno(1,2,3-c,d)pyrene	82	150	130
Diabenzo(a,h)anthracene	15	75	71
Benzo(g,h,i)perylene	70	130	110
Linear Alkyl Benzenes			
C10-alkylbenzene	45	120	120
C11-alkylbenzene	85	180	170
C12-alkylbenzene	65	160	170
C13-alkylbenzene	37	130	130
C14-alklybenzene	62	160	150

Chemistry Analytes	T-8 Rep. 2	T-8 Rep. 2 MS	T-8 Rep. 2 MSD
Polychlorinated Biphenyls (PCBs)			
2,4-Cl2(8)	ND	6.2	6.3
2,2',5-Cl3(18)	ND	ND	ND
2,4,4'-Cl3(28)	0.63	8	8.3
2,2',3,5'-Cl4(44)	0.18	0.18	0.16
2,2',5,5'-Cl4(52)	0.44	6.9	6.5
2,3',4,4'-Cl4(66)	0.76	0.68	0.85
3,3',4,4'-Cl4(77)	ND	ND	ND
2,2',4,5,5'-Cl5(101)	1.3	8.6	8.2
2,3,3',4,4'-Cl5(105)	0.94	1.1	1.1
2,3',4,4',5-Cl5 (118)	2.8	2.4	2.4
3,3',4,4',5-Cl5(126)	ND	8.1	7.8
2,2',3,3',4,4'-Cl6(128)	0.49	7.6	7
2,2',3,4,4',5'-Cl6(138)	5	4.4	4.9
2,2',4,4',5,5'-Cl6(153)	2.5	10	9.8
2,2',3,3',4,4',5-Cl7(170)	0.81	0.74	0.74
2,2',3,4,4',5,5'-Cl7(180)	ND	9.1	8.4
2,2',3,4,5,5',6-Cl7(187)	2.6	2	2
2,2',3,3',4,4',5,6-Cl8 (195)	ND	ND	ND
2,2',3,3',4,4',5,5',6-Cl9 (206)	0.27	6.7	6
Decachlorobiphenyl-Cl10(209)	0.26	6.3	5.4
Pesticides			
Hexachlorobenzene	ND	ND	ND
Lindane	ND	6.9	8
Heptachlor	ND	6.7	6.9
Aldrin	ND	ND	ND
Heptachloroepoxide	ND	ND	ND
ALPHA-CHLORDANE	0.25	0.22	0.23
TRANS-NONACHLOR	0.41	7.1	7.1
Dieldrin	ND	7.3	7.5
Endrin	ND	ND	ND
Mirex	ND	5.9	5.8
2,4'-DDD	0.39	0.39	0.43
4,4'-DDD	1.2	0.69	0.58
2,4'-DDE	ND	ND	ND
4,4'-DDE	1.7	1.4	1.6
2,4'-DDT	ND	7.6	8.5
4,4'-DDT	ND	ND	ND
DDMU	ND	ND	ND

Appendix E

Species List

Appendix E. List of species identified from the benthic infaunal samples taken April 1995-August 1997 at the Boston Harbor Traditional stations. Numbers in parenthesis indicate year(s) of occurrence: 5 = 1995, 6 = 1996, 7 = 1997, All = all three years.

CNIDARIA
- *Ceriantheopsis americanus* (Verrill, 1866) (All)
- Actiniaria spp. (6,7)

PLATYHELMINTHES
- Turbellaria spp. (All)

NEMERTEA
- *Amphiporus* spp. (6,7)
- *Cerebratulus lacteus* (Leidy, 1851) (All)
- Micrura spp. (6)
- Nemertea sp. 5 (6,7)
- Nemertea spp. (All)
- *Proneurotes* spp. (7)

ANNELIDA
- Polychaeta
  - Ampharetidae
    - *Ampharete finmarchica* (Sars, 1865) (All)
    - *Anobothrus gracilis* (Malmgren, 1866) (6)
    - *Asabellides oculata* (Webster, 1879) (All)
  - Arenicolidae
    - *Arenicola marina* (Linnaeus, 1758) (7)
  - Capitellidae
    - *Capitella capitata* complex (Fabricius, 1780) (All)
    - *Heteromastus filiformis* (Claparède, 1864) (6)
    - *Mediomastus californiensis* Hartman, 1944 (All)
  - Cirratulidae
    - *Aphelochaeta marioni* (Saint-Joseph, 1894) (7)
    - *Caulleriella* sp. B (7)
    - *Chaetozone* sp. A (7)
    - *Chaetozone vivipara* (Christie, 1985) (All)
    - *Cirriformia grandis* (Verrill, 1873) (All)
    - *Cirratulus cirratus* (O.F. Müller, 1776) (7)
    - *Dodecaceria* spp. (6,7)
    - *Monticellina baptisteae* Blake, 1991 (All)
    - *Tharyx acutus* Webster & Benedict, 1887 (All)
  - Dorvilleidae
    - Dorvilleidae sp. A (All)
    - *Ophryotrocha* spp. (7)
    - *Parougia caeca* (Webster & Benedict, 1884)(All)
  - Flabelligeridae
    - *Pherusa affinis* (Leidy, 1855) (All)
  - Hesionidae
    - *Microphthalmus aberrans* (Webster & Benedict, 1887) (All)
  - Lumbrineridae
    - *Scoletoma acicularum* (Webster & Benedict, 1887) (5,6)
    - *Scoletoma hebes* (Verrill, 1880) (All)
    - *Ninoe nigripes* Verrill, 1873 (All)
  - Maldanidae
    - *Clymenella torquata* (Leidy, 1855) (All)
    - *Sabaco elongatus* (Verrill, 1873) (7)
  - Nephtyidae
    - *Aglaophamus circinata* (Verrill, 1874) (All)
    - *Nephtys caeca* (Fabricius, 1780) (All)
    - *Nephtys ciliata* (O.F. Müller, 1776) (6,7)
    - *Nephtys cornuta* Berkeley & Berkeley, 1945(All)
    - *Nephtys incisa* Malmgren, 1865 (5,6)
  - Nereididae
    - *Neanthes virens* Sars, 1835 (All)
    - *Nereis diversicolor* Müller, 1776 (5)
  - Orbiniidae
    - *Leitoscoloplos robustus* (Verrill, 1873) (All)
  - Paraonidae
    - *Aricidea catherinae* Laubier, 1967 (All)
    - *Paraonis fulgens* (Levinsen, 1883) (6,7)
  - Pectinariidae
    - *Pectinaria granulata* (Linnaeus, 1767) (5,7)
    - *Pectinaria hyperborea* (Malmgren, 1866) (5)
  - Pholoidae
    - *Pholoe minuta* (Fabricius, 1780) (All)
    - *Pholoe tecta* Stimpson, 1854 (6,7)
  - Phyllodocidae
    - *Eteone flava* (Fabricius, 1780) (6)
    - *Eteone heteropoda* Hartman, 1951 (All)
    - *Eteone longa* (Fabricius, 1780) (All)
    - *Eulalia bilineata* (Johnston, 1840) (6)
    - *Eulalia viridis* (Linnaeus, 1767) (7)
    - *Eumida sanguinea* (Oersted, 1843) (6,7)
    - *Paranaitis speciosa* (Webster, 1870) (All)
    - *Phyllodoce arenae* Webster, 1879 (6)
    - *Phyllodoce groenlandica* Oersted, 1843 (5)
    - *Phyllodoce maculata* (Linnaeus, 1767) (All)
    - *Phyllodoce mucosa* Oersted, 1843 (All)
  - Polygordiidae
    - *Polygordius* sp. A (All)
  - Polynoidae
    - *Harmothoe extenuata* (Grube, 1840) (6)
    - *Harmothoe imbricata* (Linnaeus, 1767) (All)
    - *Hartmania moorei* Pettibone, 1955 (7)
    - *Lepidonotous squamatus* (Linnaeus, 1758) (7)
  - Sabellariidae
    - *Sabellaria vulgaris* Verrill, 1873 (6)
  - Sabellidae
    - *Euchone incolor* Hartman, 1978 (7)
    - *Fabricia stellaris stellaris* (Müller, 1774) (All)
  - Spionidae
    - *Dipolydora caulleryi* Mesnil, 1897 (All)
    - *Dipolydora concharum* Verrill, 1880 (6)
    - *Dipolydora quadrilobata* Jacobi, 1883 (All)
    - *Dipolydora socialis* (Schmarda, 1861) (All)
    - *Polydora aggregata* Blake, 1969 (All)
    - *Polydora cornuta* Bosc, 1802 (All)
    - *Polydora websteri* Hartman, 1943 (5,6)
    - *Prionospio steenstrupi* Malmgren, 1867 (All)
    - *Pygospio elegans* Calparède, 1863 (All)
    - *Scolelepis texana* Foster, 1971 (All)
    - *Spio filicornis* (O.F.Müller, 1766) (All)
    - *Spio limicola* Verrill, 1880 (5,6)
    - *Spio setosa* Verrill, 1873 (All)
    - *Spio thulini* Maciolek, 1990 (All)
    - *Spiophanes bombyx* Claparède, 1870 (All)
    - *Streblospio benedicti* Webster, 1879 (All)
  - Syllidae
    - *Exogone hebes* (Webster & Benedict, 1884) (All)
    - *Exogone verugera* (Claparède, 1868) (All)
    - *Proceraea cornuta* Agassiz, 1863 (All)
    - *Typosyllis alternata* (Moore, 1908) (5)

Terebellidae

Neoamphitrite figulus (Dalyell, 1853) (7)
Nicolea zostericola (Oersted, 1844) (5,7)
Pista cristata (O.F. Müller, 1776) (6,7)
Polycirrus eximus (leidy, 1855) (7)
Polycirrus cf. *haematodes* (Claparède, 1864) (6,7)
Polycirrus medusa Grube, 1850 (5,6)

Trochochaetidae

Trochochaeta multisetosa (Oersted, 1844) (7)

Oligochaeta

Enchytraiedae

Enchytraiedae sp. 1 (7)

Tubificidae

Tubificidae sp. 3 (5,6)
Tubificoides apectinatus Brinkhurst, 1965 (All)
Tubificoides benedeni Udekem, 1855 (All)
Tubificoides nr. *pseudogaster* Dahl, 1960 (All)
Tubificoides sp. 1 (6,7)
Tubificoides sp. 2 (5)

SIPUNCULA

Sipuncula spp. (5,6)

ARTHROPODA

Pycnogonida

Achelia spinosa (Stimpson, 1853) (5)

CRUSTACEA

Amphipoda

Ampeliscidae

Ampelisca abdita Mills, 1964 (All)
Ampelisca vadorum Mills, 1963 (All)

Aoridae

Lembos websteri Bate, 1856 (5,7)
Leptocheirus pinguis (Stimpson, 1853) (All)
Microdeutopus anomalus (Rathke, 1843) (6,7)
Unciola irrorata Say, 1818 (All)

Argissidae

Argissa hamatipes (Norman, 1869) (All)

Caprellidae

Aeginina longicornis (Krøyer, 1842-43) (5,7)
Caprella linearis (Linnaeus, 1767) (5)
Paracaprella tenuis Mayer, 1903 (All)

Corophiidae

Apocorophium acutum (Chevreux, 1908) (All)
Corophium sp. A (5)
Crassicorophium bonelli (Milne Edwards, 1830) (All)
Crassicorophium crassicorne (Bruzelius, 1859) (All)
Monocorophium acherusicum (Costa, 1857) (5,6)
Monocorophium insidiosum (Crawford, 1937) (5,6)
Monocorophium tuberculatum (Shoemaker, 1934) (All)

Dexaminidae

Dexamine thea Sars, 1893 (5,7)

Gammaridae

Gammarus lawrencianus Bousfield, 1956 (5,7)

Isaeidae

Photis pollex Walker, 1895 (All)

Ischyroceridae

Ischyrocerus anguipes (Krøyer, 1842) (All)
Jassa marmorata Holmes, 1903 (All)

Lysianassidae

Orchomenella minuta (Krøyer, 1842) (All)

Phoxocephalidae

Phoxocephalus holbolli (Krøyer, 1842) (All)
Rhepoxinius hudsoni Barnard & Barnard, 1982 (6)

Podoceridae

Dyopedos monacanthus (Metzger, 1875) (All)

Pontogeniidae

Pontogenia inermis (Krøyer, 1842) (All)

Stenothoidae

Metopella angusta Shoemaker, 1949 (All)
Metopella carinata (Hansen, 1887) (5)
Proboloides holmesi Bousfield, 1973 (All)
Stenothoe gallensis Walker 1904 (7)
Stenothoe minuta Holmes, 1905 (5)

Cirripedia

Balanidae

Balanus crenatus Bruguiere, 1789 (All)
Balanus improvisus Darwin, 1854 (5,6)

Cumacea

Diastylidae

Diastylis polita (S.I. Smith, 1879) (All)
Diastylis sculpta Sars, 1871 (All)

Lampropidae

Lamprops quadriplicata S.I. Smith, 1879 (5)

Leuconidae

Eudorella pusilla Sars, 1871 (5)

Decapoda

Brachyura

Cancridae

Cancer irroratus Say, 1817 (All)

Portunidae

Carcinus maenas (Linnaeus, 1758) (7)

Caridea

Crangonidae

Crangon septemspinosa Say, 1818 (All)

Paguridae

Pagurus acadianus Benedict, 1901 (6,7)
Pagurus longicarpus Say, 1817 (5)

Isopoda

Anthuriidae

Ptilanthura tenuis Harger, 1879 (7)

Chaetiiidae

Chiridotea tuftsi (Stimpson, 1883) (5)

Idoteidae

Edotia triloba (Say, 1818) (All)

Limnoriidae

Limnoria lignorum (Rathke, 1799) (6)

Paramunnidae

Pleurogonium inerme Sars, 1882 (5,7)

Mysidacea

Heteromysis formosa S.I. Smith, 1873 (7)
Neomysis americana (S.I. Smith, 1873) (All)

Tanaidacea

Nototanaidae

Tanaissus psammophilus (Wallace, 1919) (All)

MOLLUSCA

Bivalvia

Anomiidae

Anomia simplex Orbigny, 1842 (7)

Arcidae

Arctica islandica (Linnaeus, 1767) (5,7)

Cardiidae
Cerastoderma pinnulatum (Conrad, 1831) (All)
Hiatellidae
Hiatella arctica (Linnaeus, 1767) (All)
Lasaeidae
Aligena elevata (Stimpson, 1851) (All)
Lyonsiidae
Lyonsia arenosa Möller, 1842 (5,7)
Lyonsia hyalina Conrad, 1831 (5)
Mactridae
Mulinia lateralis (Say, 1822) (5,7)
Spisula solidissima (Dillwyn, 1817) (5)
Montacutidae
Mysella planulata (Stimpson, 1857) (6,7)
Myidae
Mya arenaria Linnaeus, 1758 (All)
Mytilidae
Musculus niger (Gray, 1824) (5)
Mytilus edulis Linnaeus, 1758 (All)
Nuculanidae
Yoldia limatula (Say, 1831) (6)
Nuculanidae spp. (All)
Nuculidae
Nucula annulata Hampson, 1971 (5,6)
Nucula delphinodonta Mighels & Adams, 1842 (All)
Pandoridae
Pandora gouldiana Dall, 1886 (6,7)
Petricolidae
Petricola pholadiformis (Lamarck, 1818) (All)
Solenidae
Ensis directis Conrad, 1843 (All)
Tellinidae
Macoma balthica (Linnaeus, 1758) (5,7)
Tellina agilis Stimpson, 1857 (All)
Thraciidae
Asthenothaerus hemphilli Dall, 1886 (6,7)
Veneridae
Pitar morrhuanus Linsley, 1848 (5,6)

Gastropoda
Nudibranchia
Nudibranchia spp. (All)
Prosobranchia
Calyptraeidae
Crepidula fornicata (Linnaeus, 1758) (All)
Crepidula plana Say, 1822 (6,7)
Crepidula spp. (All)
Cylichnidae
Cylichnidae spp. (6,7)
Diaphanidae
Diaphana minuta (Brown, 1827) (6,7)
Lacunidae
Lacuna vincta (Montagu, 1803) (5,7)
Littorinidae
Littorina littorea (Linnaeus, 1758) (7)
Nassariidae
Ilyanassa obsoleta (Say, 1822) (6)
Ilyanassa trivittata (Say, 1822) (All)
Naticidae
Polinices duplicatus (Say, 1822) (5)
Pyramidellidae
Odostomia spp. (7)

PHORONIDA
Phoronis architecta Andrews, 1890 (All)

ECHINODERMATA
Echinoidea
Echinoidea spp. (6)
Asteroidea
Asteroidea spp. (6,7)
Ophiuroidea
Ophiuroidea spp. (All)

HEMICHORDATA
Enteropneusta spp. (6)
Saccoglossus bromophenolosus King, Giray, & Kornfield, 1997 (7)

CHORDATA
Ascidiacea spp. (5)
Molgulidae
Molgula manhattensis (DeKay, 1843) (6)
Molgula spp. (5)

Appendix F

Dominant Species

Appendix F1. Dominant species at Boston Harbor Traditional stations in April 1996.

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. 0.12m^{-2})
	Station T1 - Deer Island Flats			
1	*Tubificoides* nr. *pseudogaster* (oligochaete)	50.14	55.31	2004
2	*Streblospio benedicti* (polychaete)	12.56	13.86	502
3	*Mytilus edulis* (bivalve)	7.86	8.67	314
4	*Microphthalmus aberrans* (polychaete)	3.18	3.51	127
5	*Dipolydora socialis* (polychate)	3.03	3.34	121
6	*Ilyanassa trivitta*a (gastropod)	2.10	2.32	84
7	*Polydora cornuta* (polychaete)	1.95	2.15	78
8	*Dyopedos monacanthus* (amphipod)	1.18	1.30	47
9	*Polydora aggregata* (polychaete)	0.65	0.72	26
10	*Nephtys caeca* (polychaete)	0.53	0.58	21
	Total - 10 Taxa	83.18	91.76	3324
	Remaining Fauna - 73 Taxa	16.82	--	673
	Total Fauna - 83 Taxa	100.00	--	3997
	Station T2 - Logan Airport			
1	*Streblospio benedicti* (polychaete)	61.36	64.65	4745
2	*Tubificoides* nr. *pseudogaster* (oligochaete)	16.60	17.49	1284
3	*Polydora cornuta* (polychaete)	8.90	9.37	688
4	*Mytilus edulis* (bivalve)	1.28	1.35	99
5	*Mya arenaria* (bivalve)	1.01	1.06	78
6	*Dipolydora socialis* (polychaete)	0.84	0.89	65
7	*Ilyanassa trivittata* (gastropod)	0.76	0.80	59
8	*Ampelisca abdita* (amphipod)	0.61	0.64	47
9	*Leptocheirus pinguis* (amphipod)	0.47	0.49	36
10	*Petricola pholadiformis* (bivalve)	0.43	0.45	33
	Total - 10 Taxa	92.26	97.19	7134
	Remaining Fauna - 59 Taxa	7.74	--	599
	Total Fauna - 69 Taxa	100.00	--	7733

Appendix F1 continued.

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. 0.12m^{-2})
	Station T3 - Long Island			
1	*Tharyx acutus* (polychaete)	23.94	25.70	2455
2	*Ampelisca abdita* (amphipod)	21.41	22.99	2196
3	*Tubificoides nr. pseudogaster* (oligochaete)	15.41	16.54	1580
4	*Tubificoides apectinatus* (oligochaete)	11.33	12.16	1162
5	*Aricidea catherinae* (polychaete)	10.86	11.66	1114
6	*Polydora cornuta* (polychaete)	2.57	2.76	264
7	*Phoxocephalus holbolli* (amphipod)	1.48	1.59	152
8	*Photis pollex* (amphipod)	1.28	1.37	131
9	*Mytilus edulis* (bivalve)	1.00	1.07	102
10	*Ilyanassa trivittata* (gastropod)	0.50	0.53	51
	Total - 10 Taxa	89.78	96.37	9207
	Remaining Fauna - 53 Taxa	10.22	--	1048
	Total Fauna - 63 Taxa	100.00	--	10255
	Station T4 - Dorchester Bay			
1	*Streblospio benedicti* (polychaete)	82.22	83.15	1826
2	*Tubificoides* nr. *pseudogaster* (oligochaete)	7.29	7.38	162
3	*Capitella* spp. complex (polychaete)	2.43	2.46	54
4	*Spio setosa* (polychaete)	1.85	1.87	41
5	*Polydora cornuta* (polychaete)	1.22	1.23	27
6	*Mytilus edulis* (bivalve)	0.59	0.59	13
7	*Ampelisca abdita* (amphipod)	0.54	0.55	12
8	*Tubificoides benedeni* (oligochaete)	0.36	0.36	8
9	*Dipolydora quadrilobata* (polychaete)	0.32	0.32	7
10	*Eteone heteropoda* (polychaete)	0.32	0.32	7
	Total - 10 Taxa	97.14	98.23	2157
	Remaining Fauna - 19 Taxa	2.86	--	64
	Total Fauna - 29 Taxa	100.00	--	2221

Appendix F1 continued.

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. $0.12m^{-2}$)
	Station T5a- off Deer Island Flats			
1	*Ilyanassa trivittata* (gastropod)	15.21	24.48	118
2	*Tubificoides* nr. *pseudogaster* (oligochaete)	10.82	17.43	84
3	*Mytilus edulis* (bivalve)	10.57	17.01	82
4	*Tubificoides apectinatus* (oligochaete)	4.12	6.64	32
5	*Edotia triloba* (amphipod)	2.45	3.94	19
6	*Tellina agilis* (bivalve)	2.19	3.53	17
7	*Petricola pholadiformis* (bivalve)	1.93	3.11	15
8	*Polygordius* sp. A (polychaete)	1.80	2.90	14
9	*Spiophanes bombyx* (polychaete)	1.68	2.70	13
10	*Nephtys caeca* (polychaete)	1.29	2.07	10
	Total - 10 Taxa	52.06	83.81	404
	Remaining Fauna - 36 Taxa	47.94	--	372
	Total Fauna - 46 Taxa	100.00	--	776
	Station T6 - Peddocks Island			
1	*Tubificoides* nr. *pseudogaster* (oligochaete)	49.97	50.88	5572
2	*Ampelisca abdita* (amphipod)	25.37	25.83	2829
3	*Aricidea catherinae* (polychaete)	11.34	11.55	1265
4	*Tubificoides apectinatus* (oligochaete)	2.98	3.03	332
5	*Petricola pholadiformis* (bivalve)	2.65	2.70	296
6	*Phoxocephalus holbolli* (amphipod)	0.90	0.91	100
7	*Scoletoma hebes* (polychaete)	0.88	0.89	98
8	*Mytilus edulis* (bivalve)	0.61	0.62	68
9	*Photis pollex* (amphipod)	0.56	0.57	62
10	*Dyopedos monacanthus* (amphipod)	0.44	0.45	49
	Total - 10 Taxa	95.70	97.43	10671
	Remaining Fauna - 50 Taxa	4.30	--	480
	Total Fauna - 60 Taxa	100.00	--	11151

Appendix F1 continued.

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. $0.12m^{-2}$)
	Station T7 - Quincy Bay			
1	*Tubificoides apectinatus* (oligochaete)	35.06	36.82	528
2	*Aricidea catherinae* (polychaete)	24.24	25.45	365
3	*Streblospio benedicti* (polychaete)	11.22	11.79	169
4	*Nephtys cornuta* (polychaete)	8.30	8.72	125
5	*Scoletoma hebes* (polychaete)	4.65	4.88	70
6	*Microphthalmus aberrans* (polychaete)	2.46	2.58	37
7	*Tharyx acutus* (polychaete)	1.99	2.09	30
8	*Tubificoides* nr. *pseudogaster* (oligochaete)	1.59	1.67	24
9	*Mytilus edulis* (bivalve)	1.39	1.46	21
10	*Ilyanassa trivittata* (gastropod)	0.66	0.70	10
	Total - 10 Taxa	91.56	96.16	1379
	Remaining Fauna - 37 Taxa	8.44	--	127
	Total Fauna - 47 Taxa	100.00	--	1506
	Station T8 - Hingham Bay			
1	*Ampelisa abdita* (amphipod)	35.30	36.66	7517
2	*Tubificoides* nr. *pseudogaster* (oligochaete)	19.75	20.51	4205
3	*Aricidea catherinae* (polychaete)	11.60	12.05	2471
4	*Tubificoides apectinatus* (oligochaete)	9.74	10.12	2075
5	*Nucula delphinodonta* (bivalve)	7.95	8.26	1693
6	*Scoletoma hebes* (polychaete)	2.30	2.39	490
7	*Mytilus edulis* (bivalve)	1.91	1.98	407
8	*Leptocheirus pinguis* (amphipod)	1.03	1.07	220
9	*Ampelisca vadorum* (amphipod)	0.93	0.97	198
10	*Exogone hebes* (polychaete)	0.75	0.78	159
	Total - 10 Taxa	91.26	94.79	19435
	Remaining Fauna - 91 Taxa	8.74	--	1861
	Total Fauna - 101 Taxa	100.00	--	21296

Appendix F2. Dominant species at Boston Harbor Traditional stations in August 1996.

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. 0.12m^{-2})
	Station T1 - Deer Island Flats			
1	*Tubificoides* nr. *pseudogaster* (oligochaete)	39.10	41.83	1727
2	*Streblospio benedicti* (polychaete)	18.47	19.76	816
3	*Microphthalmus aberrans* (polychaete)	7.22	7.73	319
4	*Polydora aggregata* (polychaete)	6.22	6.66	275
5	*Aricidea catherinae* (polychaete)	5.12	5.47	226
6	*Clymenella torquata* (polychaete)	2.11	2.25	93
7	*Polydora cornuta* (polychaete)	1.97	2.11	87
8	*Ilyanassa trivittata* (gastropod)	1.74	1.86	77
8	*Balanus crenatus* (cirripede)	1.74	1.86	77
10	*Chaetozone vivipara* (polychaete)	1.29	1.38	57
	Total - 10 Taxa	84.98	90.91	3754
	Remaining Fauna - 70 Taxa	15.02	--	663
	Total Fauna - 80 Taxa	100.00	--	4417
	Station T2 - Logan Airport			
1	*Streblospio benedicti* (polychaete)	37.84	40.49	781
2	*Tubificoides* nr. *pseudogaster* (oligochaete)	37.69	40.33	778
3	*Microphthalmus aberrans* (polychaete)	6.93	7.41	143
4	*Ampelisca abdita* (amphipod)	2.86	3.06	59
5	*Neomysis americana* (mysid)	1.36	1.45	28
6	*Ninoe nigripes* (polychaete)	1.31	1.40	27
7	*Ilyanassa trivittata* (gastropod)	1.16	1.24	24
8	*Mytilus edulis* (bivalve)	0.73	0.78	15
9	*Tharyx acutus* (polychaete)	0.34	0.36	7
10	*Tellina agilis* (bivalve)	0.29	0.31	6
10	*Nephtys caeca* (polychaete)	0.29	0.31	6
	Total - 11 Taxa	90.80	97.14	1874
	Remaining Fauna - 34 Taxa	9.20	--	190
	Total Fauna - 44 Taxa	100.00	--	2064

Appendix F2 continued.

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. $0.12m^{-2}$)
	Station T3 - Long Island			
1	*Ampelisca abdita* (amphipod)[1]	30.03	32.54	6613
2	*Leptocheirus pinguis* (amphipod)	15.95	17.28	3512
3	*Tharyx acutus* (polychaete)	11.67	12.64	2569
4	*Phoxocephalus holbolli* (amphipod)	7.88	8.54	1735
5	*Aricidea catherinae* (polychaete)	6.50	7.05	1432
6	*Polydora cornuta* (polychaete)	5.73	6.20	1261
7	*Tubificoides apectinatus* (oligochaete)	4.88	5.29	1075
8	*Tubificoides* nr. *pseudogaster* (oligochaete)	4.56	4.94	1004
9	*Photis pollex* (amphipod	1.47	1.59	324
10	*Phyllodoce mucosa* (polychaete)	0.52	0.57	115
	Total - 10 Taxa	89.19	96.64	19640
	Remaining Fauna - 63 Taxa	24.62	--	2381
	Total Fauna - 73 Taxa	100.00	--	22021
	Station T4 - Dorchester Bay			
1	*Streblospio benedicti* (polychaete)	77.96	84.80	290
2	*Tubificoides* nr. *pseudogaster* (oligochaete)	6.18	6.73	23
3	Turbellaria (platyhelminth)	5.65	6.14	21
4	*Mytilus edulis* (bivalve)	1.88	2.05	7
5	*Neomysis americana* (mysid)	1.08	1.17	4
	Total - 5 Taxa	92.75	99.89	345
	Remaining Fauna - 9 Taxa	7.63	--	27
	Total Fauna - 14 Taxa	100.00	--	372

[1]includes juveniles not identified to species

Appendix F2 continued.

Station T5a- off Deer Island Flats				
Rank	**Species**	**Percent of Total Fauna**	**Percent of Indentified Fauna**	**Density (Ind. $0.12m^{-2}$)**
1	*Tellina agilis* (bivalve)	17.77	23.28	142
2	*Ampelisca abdita* (amphipod)	8.09	10.33	63
3	*Neomysis americana* (mysid)	7.76	10.16	62
4	*Chaetozone vivpara* (polychaete)	5.01	6.56	40
5	*Spiophanes bombyx* (polychaete)	4.76	6.23	38
6	*Tubificoides apectinatus* (oligochaete)	4.63	6.07	37
7	*Tubificoides* nr. *pseudogaster* (oligochaete)	4.38	5.74	35
8	*Tharyx acutus* (polychaete)	4.26	5.57	34
9	*Ilyanassa trivittata* (gastropod)	3.00	3.93	24
10	*Aricidea catherinae* (polychaete)	2.38	3.11	19
	Total - 10 Taxa	62.04	80.98	494
	Remaining Fauna - 36 Taxa	37.96	--	305
	Total Fauna - 46 Taxa	100.00	--	799
Station T6 - Peddocks Island				
1	*Ampelisca abdi*ta (amphipod)[1]	51.48	53.26	11882
2	*Tubificoides* nr. *pseudogaster* (oligochaete)	12.67	13.11	2924
3	*Phoxocephalus holbolli* (amphipod)	11.51	11.91	2656
4	*Aricidea catherinae* (polychaete)	8.51	8.80	1963
5	*Photis pollex* (amphipod)	3.41	3.53	787
6	*Phyllodoce mucosa* (polychaete)	1.71	1.77	394
7	*Polydora cornuta* (polychaete)	1.28	1.32	295
8	*Leptocheirus pinguis* (amphipod)	1.25	1.30	289
9	*Unciola irrorata* (amphipod)	0.83	0.86	191
10	*Tubificoides apectinatus* (oligochaete)	0.75	0.78	174
	Total - 10 Taxa	93.40	96.64	21555
	Remaining Fauna - 47 Taxa	6.60	--	1525
	Total Fauna - 57 Taxa	100.00	--	23080

[1]includes proportional number of juveniles not identified to species

Appendix F2 continued.

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. $0.12m^{-2}$)
	Station T7 - Quincy Bay			
1	*Aricidea catherinae* (polychaete)	30.50	33.79	445
2	*Streblospio benedicti* (polychaete)	18.85	20.88	275
3	*Tubificoides apectinatus* (oligochaete)	12.95	14.35	189
4	*Microphthalmus aberrans* (polychaete)	9.53	10.55	139
5	*Tubificoides* nr. *pseudogaster* (oligochaete)	3.56	3.95	52
6	*Tharyx acutus* (polychaete)	2.26	2.50	33
7	*Ilyanassa trivittata* (gastropod)	1.78	1.97	26
7	*Polydora cornuta* (polychaete)	1.78	1.97	26
9	*Scoletoma hebes* (polychaete)	1.64	1.82	24
10	*Ampelisca abdita* (amphipod)	1.51	1.67	22
	Total - 10 Taxa	86.62		1658
	Remaining Fauna - 35 Taxa	13.38		256
	Total Fauna - 45 Taxa	100.00		1914
	Station T8 - Hingham Bay			
1	*Ampelisa abdita* (amphipod)[1]	56.60	61.33	8439
2	*Aricidea catherinae* (polychaete)	7.59	8.22	1131
3	*Spiophanes bombyx* (polychaete)	6.25	6.77	932
4	*Ampelisca vadorum* (amphipod)[1]	3.63	3.93	541
5	*Polygordius* sp. A (polychaete)	3.48	3.77	519
6	*Exogone hebes* (polychaete)	2.43	2.63	362
7	*Phyllodoce mucosa* (polychaete)	2.07	2.25	309
8	*Nucula delphinodonta* (bivalve)	1.80	1.95	269
9	*Tubificoides* nr. *pseudogaster* (oligochaete)	1.62	1.76	242
10	*Ilyanassa trivittata* (gastropod)	0.85	0.92	127
	Total - 10 Taxa	86.32	93.53	12871
	Remaining Fauna - 78 Taxa	13.68	--	2038
	Total Fauna - 88 Taxa	100.00	--	14909

[1]includes proportional number of juveniles not identified to species

Appendix F3. Dominant species at Boston Harbor Traditional stations in April 1997.

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. $0.12m^{-2}$)
Station T1 - Deer Island Flats				
1	*Tubificoides* nr. *pseudogaster* (oligochaete)	55.81	62.07	2545
2	*Mytilus edulis* (bivalve)	7.04	7.83	321
3	*Streblospio benedicti* (polychaete)	5.64	6.27	257
4	*Aricidea catherinae* (polychaete)	4.30	4.78	196
5	*Tharyx acutus* (polychaete)	3.22	3.59	147
6	*Dipolydora socialis* (polychaete)	2.21	2.46	101
7	*Polydora aggregata* (polychaete)	1.89	2.10	86
8	*Dipolydora quadrilobata* (polychaete)	1.49	1.66	68
9	*Ilyanassa trivittata* (gastropod)	1.27	1.41	58
10	*Scoletoma hebes* (polychaete)	0.81	0.85	35
	Total - 10 Taxa	83.68	93.02	3814
	Remaining Fauna - 63 Taxa	16.32		746
	Total Fauna - 73 Taxa	100.00		4560
Station T2 - Logan Airport				
1	*Tubificoides* nr. *pseudogaster* (oligochaete)	39.22	45.03	919
2	*Mytilus edulis* (bivalve)	14.81	17.00	347
3	*Streblospio benedicti* (polychaete)	5.76	6.61	135
4	*Polydora aggregata* (polychaete)	4.99	5.73	117
5	*Orchomenella minuta* (amphipod)	3.33	3.82	78
6	*Microphthalmus aberrans* (polychaete)	2.56	2.94	60
7	*Tharyx acutus* (polychaete)	1.88	2.16	44
8	*Ilyanassa trivittata* (gastropod)	1.84	2.11	43
9	*Capitella* spp. complex (polychaeta)	1.79	2.06	42
10	*Fabricia stellaris stellaris* (polychaete)	1.66	1.91	39
	Total - 10 Taxa	77.85	89.37	1824
	Remaining Fauna - 58 Taxa	22.15		519
	Total Fauna - 68 Taxa	100.00		2343

Appendix F3 continued.

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. $0.12m^{-2}$)
Station T3 - Long Island				
1	*Tharyx acutus* (polychaete)	31.08	35.65	5422
2	*Ampelisca abdita* (amphipod)	14.23	16.33	2483
3	*Aricidea catherinae* (polychaete)	12.30	14.11	2146
4	*Tubificoides* nr. *pseudogaster* (oligochaete)	10.05	11.53	1753
5	*Tubificoides apectinatus* (oligochaete)	6.94	7.96	1210
6	*Leptocheirus pinguis* (amphipod)	5.90	6.77	1029
7	*Phoxocephalus holbolli* (amphipod)	2.49	2.85	434
8	*Mytilus edulis* (bivalve)	0.87	1.00	152
9	*Polydora cornuta* (polychaete)	0.66	0.76	115
10	*Ilyanassa trivittata* (gastropod)	0.45	0.52	79
	Total - 10 Taxa	84.97	97.48	14823
	Remaining Fauna - 71 Taxa	15.03		2622
	Total Fauna - 81 Taxa	100.00		17445
Station T4 - Dorchester Bay				
1	*Capitella* spp. complex (polychaete)	33.03	39.98	393
2	*Streblospio benedicti* (polychaete)	28.40	34.38	338
3	*Polydora cornuta* (polychaete)	15.21	18.41	181
4	*Mytilus edulis* (bivalve)	1.68	2.03	20
5	*Tubificoides* nr. *pseudogaster* (oligochaete)	1.60	1.93	19
6	*Tharyx acutus* (polychaete)	0.59	0.71	7
7	*Spio thulini* (polychaete)	0.42	0.51	5
8	*Tubificoides benedeni* (oligochaete)	0.42	0.51	5
9	*Fabricia stellaris stellaris* (polychaete)	0.17	0.20	2
10	*Ilyanassa trivittata* (gastropod)	0.17	0.20	2
11	*Mya arenaria* (bivalve)	0.17	0.20	2
12	*Spio setosa* (polychaete)	0.17	0.20	2
13	*Nephthys cornuta* (polychaete)	0.17	0.20	2
	Total - 13 Taxa	82.19	99.46	978
	Remaining Fauna - 13 Taxa	17.81		212
	Total Fauna - 26 Taxa	100.00		1190

Appendix F3 continued.

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. $0.12m^{-2}$)
Station T5A - Deer Island Flats				
1	*Mytilus edulis* (bivalve)	31.30	47.87	764
2	*Tubificoides apectinatus* (oligochaete)	7.58	11.59	185
3	*Ilyanassa trivittata* (gastropod)	6.15	9.40	150
4	*Tharyx acutus* (polychaete)	3.81	5.83	93
5	*Tubificoides* nr. *pseudogaster* (oligochaete)	3.36	5.14	82
6	*Capitella* spp. complex (polychaete)	2.62	4.01	64
7	*Polygordius* sp. A (polychaete)	1.35	2.07	33
8	*Ampelisca abdita* (amphipod)	1.23	1.88	30
9	*Tubificoides benedeni* (oligochaete)	1.07	1.63	26
10	*Aricidea catherinae* (polychaete)	0.86	1.32	21
11	*Dipolydora socialis* (polychaete)	0.86	1.32	21
	Total - 11 Taxa	60.18	92.06	1469
	Remaining Fauna - 49 Taxa	39.82		972
	Total Fauna - 59 Taxa	100.00		2441
Station T6 - Peddocks Island				
1	*Tubificoides* nr. *pseudogaster* (oligochaete)	35.05	36.30	5721
2	*Ampelisca abdita* (amphipod)	32.45	33.61	5297
3	*Aricidea catherinae* (polychaete)	11.36	11.76	1854
4	*Phoxocephalus holbolli* (amphipod)	4.06	4.21	663
5	*Leptocheirus pinguis* (amphipod)	3.87	4.01	632
6	*Tubificoides apectinatus* (oligochaete)	1.71	1.77	279
7	*Phyllodoce mucosa* (polychaete)	1.37	1.42	224
8	*Orchomenella minuta* (amphipod)	0.81	0.84	133
9	*Nucula delphinodonta* (bivalve)	0.80	0.83	131
10	*Crassicorophium bonelli* (amphipod)	0.66	0.69	108
	Total - 10 Taxa	92.16	95.44	15042
	Remaining Fauna - 64 Taxa	7.84		1280
	Total Fauna - 74 Taxa	100.00		16322

Appendix F3 continued.

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. $0.12m^{-2}$)
	Station T7 - Quincy Bay			
1	*Aricidea catherinae* (polychaete))	29.64	30.78	559
2	*Tubificoides apectinatus* (oligochaete)	24.81	25.77	468
3	*Tubificoides* nr. *pseudogaster* (oligochaete)	14.05	14.59	265
4	*Streblospio benedicti* (polychaete)	10.60	11.01	200
5	*Microphthalmus aberrans* (polychaete)	2.92	3.03	55
5	*Mytilus edulis* (bivalve)	2.92	3.03	55
7	*Scoletoma hebes* (polychaete)	2.01	2.09	38
8	*Ampelisca abdita* (amphipod)	1.59	1.65	30
9	*Nephtys cornuta* (polychaete)	1.33	1.38	25
10	*Tharyx acutus* (polychaete)	0.95	1.00	18
	Total - 10 Taxa	90.83	94.33	1713
	Remaining Fauna - 45 Taxa	9.17		173
	Total Fauna - 55 Taxa	100.00		1886
	Station T8 - Hingham Bay			
1	*Aricidea catherinae* (polychaete)	34.09	36.95	2751
2	*Ampelisca abdita* (amphipod)	15.31	16.59	1235
3	*Tubificoides* nr. *pseudogaster* (oligochaete)	13.24	14.35	1068
4	*Tubificoides apectinatus* (oligochaete)	5.07	5.49	409
5	*Nucula delphinodonta* (bivalve)	4.72	5.12	381
6	*Polygordius* sp. A (polychaete)	4.29	4.65	346
7	*Scoletoma hebes* (polychaete)	2.31	2.50	186
8	*Tharyx acutus* (polychaete)	2.19	2.38	177
9	*Exogone hebes* (polychaete)	1.93	2.10	156
10	*Spiophanes bombyx* (polychaete)	1.69	1.83	136
	Total - 10 Taxa	84.83	91.96	6845
	Remaining Fauna - 75 Taxa	15.17		1224
	Total Fauna - 85 Taxa	100.00		8069

Appendix F4. Dominant species at Boston Harbor Traditional stations in August 1997.

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. 0.12m^{-2})
Station T1 - Deer Island Flats				
1	*Polydora cornuta* (polychaete)	29.34	31.23	3671
2	*Tubificoides apectinatus* (oligochaete)	16.12	17.15	2016
3	*Streblospio benedicti* (polychaete)	15.60	16.60	1952
4	*Ampelisca abdita* (amphipod)	5.70	6.06	713
5	*Aricidea catherinae* (polychaete)	4.62	4.92	578
6	*Tubificoides* nr. *pseudogaster* (oligochaete)	3.80	4.04	475
7	*Polydora aggregata* (polychaete)	3.00	3.19	375
8	*Clymenella torquata* (polychaete)	2.68	2.85	335
9	*Tharyx acutus* (polychaete)	2.19	2.33	274
10	*Microphthalmus aberrans* (polychaete)	2.00	2.13	250
	Total - 10 Named Species	85.05	90.50	10639
	Remaining Fauna - 76 Taxa	14.95		1871
	Total Fauna - 86 Taxa	100.00		12510
Station T2 - Logan Airport				
1	*Ampelisca abdita* (amphipod)	34.72	36.15	1659
2	*Streblospio benedicti* (polychaete)	21.68	22.58	1036
3	*Tubificoides apectinatus* (oligochaete)	21.07	21.94	1007
4	*Polydora cornuta* (polychaete)	8.89	9.26	425
5	*Tharyx acutus* (polychaete)	3.68	3.84	176
-	Cirratulidae spp. (polychaete)	2.07	--	99
6	*Microphthalmus aberrans* (polychaete)	1.38	1.44	66
-	*Nephtys* spp. (polychaete)	1.26	1.31	60
7	*Ilyanassa trivittata* (gastropod)	0.84	0.87	40
8	*Leptocheirus pinguis* (amphipod)	0.71	0.74	34
9	*Nephtys cornuta* (polychaete)	0.40	0.41	19
-	*Unciola* spp. (amphipod)	0.29	--	14
10	*Pholoe minuta* (polychaete)	0.29	0.30	14
10	*Prionospio steenstrupi* (polychaete)	0.29	0.30	14
	Total - 11 Named Species	93.95	99.14	4490
	Remaining Fauna - 38 Taxa	6.05		289
	Total Fauna - 49 Taxa	100.00		4779

Appendix F4 continued.

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. $0.12m^{-2}$)
	Station T3 - Long Island			
-	*Corophium* spp. (amphipod)	31.22	--	20667
1	*Crassicorophium bonelli* (amphipod)	19.94	31.84	13200
2	*Polydora cornuta* (polychaete)	14.09	22.51	9330
3	*Ampelisca abdita* (amphipod)	10.18	16.26	6739
-	Cirratulidae spp. (polychaete)	4.28	--	2836
4	*Tharyx acutus* (polychaete)	3.92	6.26	2594
5	*Aricidea catherinae* (polychaete)	2.89	4.62	1915
6	*Phoxocephalus holbolli* (amphipod)	2.75	4.38	1817
7	*Tubificoides* nr. *pseudogaster* (oligochaete)	2.72	4.34	1800
8	*Tubificoides apectinatus* (oligochaete)	2.60	3.86	1721
-	*Unciola* spp. (amphipod)	1.37	--	904
9	*Leptocheirus pinguis* (amphipod)	0.88	1.41	585
10	*Unciola irrorata* (amphipod)	0.44	0.70	290
	Total - 10 Named Species	60.41	96.18	39991
	Remaining Fauna - 65 Taxa	39.59		26207
	Total Fauna - 75 Taxa	100.00		66198
	Station T4 - Dorchester Bay			
1	*Streblospio benedicti* (polychaete)	77.50	82.94	248
2	*Tubificoides apectinatus* (oligochaete)	6.56	7.02	21
-	Gastropoda spp. (gastropod)	4.06	--	13
3	*Nephtys cornuta* (polychaete)	3.12	3.34	10
4	*Crangon septemspinosa* (decapod)	2.50	2.68	8
-	Bivalvia spp. (bivalve)	1.25	--	4
5	*Mulinia lateralis* (bivalve)	1.25	1.34	4
-	*Crepidula* spp. (gastropod)	0.62	--	2
6	*Mytilus edulis* (bivalve)	0.62	0.67	2
7	*Neomysis americana* (mysid)	0.62	0.67	2
8	*Ampelisca abdita* (amphipod)	0.31	0.33	1
9	*Neanthes virens* (polychaete)	0.31	0.33	1
10	*Tubificoides* nr. *pseudogaster* (oligochaete)	0.31	0.33	1
11	*Tharyx acutus* (polychate)	0.31	0.33	1
	Total - 11 Named Species	93.34	99.98	299
	Remaining Fauna - 5 Taxa	6.66		22
	Total Fauna - 16 Taxa	100.00		320

Appendix F4 continued.

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. 0.12m^{-2})
Station T5A - Deer Island Flats				
1	*Ampelisca abdita* (amphipod)	40.41	42.95	26374
2	*Polydora cornuta* (polchaete)	38.64	41.07	25221
-	*Unciola* spp. (amphipod)	4.28	--	2795
3	*Leptocheirus pinguis* (amphipod)	2.40	2.56	1571
4	*Unciola irrorata* (amphipod)	2.12	2.26	1386
5	*Mytilus edulis* (bivalve)	1.96	2.08	1278
6	*Chaetozone vivipara* (polychaete)	1.61	1.71	1051
7	*Ilyanassa trivittata* (gastropod)	1.16	1.23	758
8	*Edotia triloba* (isopod)	1.06	1.13	692
9	*Photis pollex* (amphipod)	0.69	0.73	448
10	*Tubificoides* nr. *pseudogaster* (oligochaete)	0.62	0.66	405
	Total - 10 Named Species	90.67	96.38	59184
	Remaining Fauna - 89 Taxa	9.33		6088
	Total Fauna - 99 Taxa	100.00		65272
Station T6 - Peddocks Island				
1	*Tubificoides* nr. *pseudogaster* (oligochaete)	41.06	43.29	7491
2	*Ampelisca abdita* (amphipod)	24.38	25.70	4447
3	*Aricidea catherinae* (polychaete)	9.29	9.79	1695
4	*Phoxocephalus holbolli* (amphipod)	6.38	6.73	1164
5	*Polydora cornuta* (polychaete)	3.62	3.82	661
6	*Tubificoides apectinatus* (oligochaete)	3.42	3.60	623
-	*Corophium* spp. (amphipod)	2.41	--	440
-	*Unciola* spp. (amphipod)	1.78	--	325
7	*Photis pollex* (amphipod)	1.28	1.35	234
8	*Crassicorophium bonelli* (amphipod)	0.70	0.74	128
9	*Mediomastus californiensis* (polychaete)	0.69	0.72	125
10	*Leptocheirus pinguis* (amphipod)	0.57	0.60	104
	Total - 10 Named Species	91.39	96.34	16672
	Remaining Fauna - 49 Taxa	8.61		1570
	Total Fauna - 59 Taxa	100.00		18242

Appendix F4 continued.

Rank	Species	Percent of Total Fauna	Percent of Identified Fauna	Density (Ind. $0.12m^{-2}$)
	Station T7 - Quincy Bay			
1	*Aricidea catherinae* (polychaete)	25.86	27.38	1009
2	*Tubificoides apectinatus* (oligochaete)	18.86	19.97	736
3	*Polydora cornuta* (polychaete)	13.97	14.79	545
4	*Streblospio benedicti* (polychaete)	13.69	14.49	534
5	*Tharyx acutus* (polychaete)	6.84	7.25	267
6	*Ampelisca abdita* (amphipod)	5.87	6.21	229
7	*Tubificoides* nr. *pseudogaster* (oligochaete)	2.71	2.88	106
-	Cirratulidae spp. (polychaete)	2.00	--	78
-	Lumbrineridae spp. (polychaete)	1.82	--	71
8	*Nephtys cornuta* (polychaete)	1.46	1.55	57
9	*Microphthalmus aberrans* (polychaete)	1.03	1.09	40
10	*Ilyanassa trivittata* (gastropod)	0.82	0.87	32
	Total - 10 Named Species	91.11	96.48	3555
	Remaining Fauna - 37 Taxa	8.89		347
	Total Fauna - 47 Taxa	100.00		3902
	Station T8 - Hingham Bay			
1	*Ampelisca abdita* (amphipod)	38.63	40.16	6873
2	*Aricidea catherinae* (polychaete)	17.28	17.96	3074
3	*Spiophanes bombyx* (polychaete)	8.75	9.10	1557
4	*Polydora cornuta* (polychaete)	5.95	6.18	1058
5	*Tubificoides* nr. *pseudogaster* (oligochaete)	4.72	4.91	840
6	*Nucula delphinodonta* (bivalve)	4.24	4.41	755
7	*Prionospio steenstrupi* (polychaete)	2.18	2.27	388
8	*Polygordius* sp. A (polychaete)	1.95	2.03	347
9	*Exogone hebes* (polychaete)	1.52	1.58	270
10	*Tubificoides apectinatus* (oligochaete)	1.44	1.50	257
	Total - 10 Named Species	86.66	90.10	15419
	Remaining Fauna - 83 Taxa	13.34		2374
	Total Fauna - 93 Taxa	100.00		17793

Appendix G

Diversity of Boston Harbor Samples 1991-1997

Appendix G. Diversity of all 311 Boston Harbor Samples Collected in 1991-1997.

		No.	Tot	Shannon		Brillouin		Sanders-Hurlbert E(Sn),0 if Sample total <n							Log-	Dev	Abs diff
Sample	Date	Ind	Spp	H′	J′	H	V	2	10	17	50	100	200	500	Series alpa	fromlog series	from log series
T1-1	Sep-91	164	12	2.3	0.6	1.5	0.6	1.7	4.1	5.2	8.0	10.2	0.0	0.0	3.0	0.9	0.1
T1-2	Sep-91	532	27	3.1	0.6	2.0	0.6	1.8	5.5	7.2	11.4	14.9	19.5	26.6	6.0	0.9	0.2
T1-3	Sep-91	136	12	2.5	0.7	1.6	0.7	1.7	4.7	6.2	9.9	11.7	0.0	0.0	3.2	1.1	0.1
Mean		**277.3**	**27**	**2.6**	**0.6**	**1.7**	**0.6**	**1.7**	**4.8**	**6.2**	**9.8**	**12.3**	**N/A**	**N/A**			
T1-1	Apr-92	512	32	3.6	0.7	2.4	0.7	1.9	6.4	8.7	14.6	19.1	24.3	31.8	7.6	1.0	0.1
T1-2	Apr-92	399	26	3.4	0.7	2.3	0.7	1.9	6.1	8.2	13.2	16.9	20.9	0.0	6.2	1.1	0.1
T1-3	Apr-92	556	28	3.3	0.7	2.2	0.7	1.8	5.8	8.0	13.6	17.3	21.2	27.2	6.2	1.0	0.0
Mean		**489.0**	**40**	**3.4**	**0.7**	**2.3**	**0.7**	**1.9**	**6.1**	**8.3**	**13.8**	**17.8**	**22.1**	**N/A**			
T1-1	Aug-92	8031	46	2.4	0.4	1.6	0.4	1.6	4.3	5.7	9.4	12.3	15.8	21.6	6.5	0.7	0.3
T1-2	Aug-92	7124	47	2.4	0.4	1.6	0.4	1.6	4.3	5.8	9.7	12.3	15.3	20.9	6.8	0.7	0.3
T1-3	Aug-92	5197	43	1.6	0.3	1.1	0.3	1.4	3.1	4.0	6.9	9.5	13.3	20.1	6.4	0.5	0.5
Mean		**6784.0**	**62**	**2.1**	**0.4**	**1.4**	**0.4**	**1.5**	**3.9**	**5.2**	**8.7**	**11.4**	**14.8**	**20.9**			
T1-1	Apr-93	364	17	2.4	0.6	1.6	0.6	1.7	4.3	5.4	8.2	10.5	13.7	0.0	3.7	0.8	0.2
T1-2	Apr-93	772	21	2.4	0.5	1.6	0.5	1.7	4.3	5.4	7.8	10.0	12.8	18.0	4.0	0.8	0.3
T1-3	Apr-93	151	11	2.3	0.7	1.5	0.7	1.7	4.1	5.0	7.2	9.5	0.0	0.0	2.7	0.9	0.1
Mean		**429.0**	**26**	**2.4**	**0.6**	**1.6**	**0.6**	**1.7**	**4.2**	**5.3**	**7.7**	**10.0**	**N/A**	**N/A**			
T1-1	Aug-93	6923	42	2.1	0.4	1.4	0.4	1.6	3.7	4.8	8.4	11.8	15.9	22.4	6.0	0.6	0.4
T1-2	Aug-93	3933	38	2.0	0.4	1.4	0.4	1.6	3.6	4.6	7.9	10.9	14.9	21.7	5.8	0.6	0.4
T1-3	Aug-93	4438	36	2.1	0.4	1.4	0.4	1.6	3.7	4.9	8.7	12.1	16.3	22.8	5.4	0.6	0.4
Mean		**5098.0**	**49**	**2.1**	**0.4**	**1.4**	**0.4**	**1.6**	**3.7**	**4.8**	**8.3**	**11.6**	**15.7**	**22.3**			
T1-1	Apr-94	504	28	3.4	0.7	2.3	0.7	1.9	6.2	8.2	12.7	16.4	20.9	27.9	6.4	0.9	0.1
T1-2	Apr-94	615	26	2.9	0.6	1.9	0.6	1.8	5.2	6.8	10.9	14.1	17.9	24.4	5.5	0.9	0.1
T1-3	Apr-94	460	32	3.1	0.6	2.0	0.6	1.8	5.3	7.4	13.4	18.5	24.4	0.0	7.8	0.8	0.2
Mean		**526.3**	**44**	**3.1**	**0.6**	**2.1**	**0.6**	**1.8**	**5.6**	**7.5**	**12.3**	**16.3**	**21.1**	**N/A**			
T1-1	Aug-94	3349	36	2.3	0.4	1.6	0.4	1.7	3.9	4.8	7.7	10.5	14.2	20.6	5.6	0.6	0.4
T1-2	Aug-94	4375	39	2.8	0.5	2.0	0.5	1.8	5.0	6.4	10.1	13.1	16.7	22.5	5.9	0.8	0.2
T1-3	Aug-94	3414	39	2.5	0.5	1.7	0.5	1.7	4.3	5.2	8.1	10.8	14.3	20.9	6.2	0.6	0.4
Mean		**3712.7**	**53**	**2.5**	**0.5**	**1.8**	**0.5**	**1.7**	**4.4**	**5.5**	**8.6**	**11.5**	**15.1**	**21.3**			
T1-1	Apr-95	557	24	2.7	0.6	1.8	0.6	1.7	4.8	6.5	11.3	15.1	19.1	23.6	5.1	0.9	0.1
T1-2	Apr-95	956	26	1.8	0.4	1.2	0.4	1.5	3.3	4.4	7.4	10.5	14.7	21.3	4.9	0.6	0.4
T1-3	Apr-95	1334	20	1.5	0.3	1.0	0.3	1.5	2.8	3.4	5.6	7.9	10.6	14.8	3.3	0.6	0.4
Mean		**949.0**	**35**	**2.0**	**0.4**	**1.3**	**0.4**	**1.6**	**3.6**	**4.8**	**8.1**	**11.2**	**14.8**	**19.9**			
T1-1	Aug-95	1665	33	3.0	0.6	2.0	0.6	1.8	5.2	6.5	10.1	13.5	17.8	24.3	5.8	0.8	0.2
T1-2	Aug-95	4407	44	2.8	0.5	1.9	0.5	1.8	4.8	6.2	10.0	13.3	17.4	23.9	6.8	0.7	0.3
T1-3	Aug-95	2772	38	2.4	0.5	1.6	0.5	1.7	4.0	5.0	8.3	11.6	15.9	22.1	6.2	0.6	0.4
Mean		**2948.0**	**57**	**2.7**	**0.5**	**1.8**	**0.5**	**1.8**	**4.7**	**5.9**	**9.5**	**12.8**	**17.0**	**23.4**			
T1-1	Apr-96	1411	45	2.5	0.5	1.7	0.4	1.6	4.2	5.8	10.5	15.2	21.8	33.0	8.9	0.6	0.4
T1-2	Apr-96	1260	37	2.8	0.5	1.9	0.5	1.8	4.8	6.3	10.7	14.7	19.8	28.2	7.2	0.7	0.3
T1-3	Apr-96	899	27	1.8	0.4	1.2	0.4	1.5	3.3	4.2	6.8	9.4	13.1	20.3	5.2	0.5	0.5
Mean		**1190.0**	**54**	**2.4**	**0.5**	**1.6**	**0.4**	**1.6**	**4.1**	**5.4**	**9.3**	**13.1**	**18.2**	**27.2**			

		No.	Tot	Shannon		Brillouin		Sanders-Hurlbert E(Sn),0 if Sample total <n							Log-Series alpa	Dev fromlog series	Abs diff from log series
Sample	Date	Ind	Spp	H′	J′	H	V	2	10	17	50	100	200	500			
T1-1	Aug-96	719	37	3.5	0.7	2.3	0.7	1.9	6.1	8.3	14.1	18.8	24.6	33.6	8.3	0.9	0.1
T1-2	Aug-96	1090	28	2.8	0.6	1.9	0.6	1.8	4.9	6.2	9.8	13.0	16.9	22.6	5.2	0.8	0.2
T1-3	Aug-96	2286	43	2.5	0.5	1.7	0.5	1.7	4.3	5.8	9.9	13.8	18.6	26.1	7.5	0.6	0.4
Mean		**1365.0**	**54**	**2.9**	**0.6**	**2.0**	**0.6**	**1.8**	**5.1**	**6.8**	**11.3**	**15.2**	**20.0**	**27.4**			
T1-1	Apr-97	1495.0	28	2.5	0.5	1.7	0.5	1.7	4.3	5.7	9.4	12.8	16.7	21.8	4.9	0.8	0.2
T1-2	Apr-97	886.0	25	2.2	0.5	1.5	0.5	1.6	4.0	5.5	9.6	12.9	16.6	21.7	4.8	0.8	0.3
T1-3	Apr-97	1719.0	38	2.1	0.4	1.4	0.4	1.5	3.7	5.3	10.4	14.6	19.2	25.7	6.9	0.6	0.4
Mean		**1366.7**	**47**	**2.3**	**0.5**	**1.5**	**0.5**	**1.6**	**4.0**	**5.5**	**9.8**	**13.4**	**17.5**	**23.1**			
T1-1	Aug-97	3975.0	47	3.2	0.6	2.2	0.6	1.8	5.5	7.3	12.2	16.1	20.5	28.2	7.5	0.8	0.2
T1-2	Aug-97	3084.0	43	3.1	0.6	2.1	0.6	1.8	5.3	6.9	11.7	15.8	20.9	28.9	7.1	0.8	0.2
T1-3	Aug-97	4697.0	51	3.4	0.6	2.4	0.6	1.9	6.0	8.1	13.0	16.6	20.7	27.4	8.0	0.8	0.2
Mean		**3918.7**	**59**	**3.2**	**0.6**	**2.2**	**0.6**	**1.8**	**5.6**	**7.4**	**12.3**	**16.2**	**20.7**	**28.2**			
T2-1	Sep-91	48.0	5	0.7	0.3	0.4	0.3	1.2	2.0	2.7	0.0	0.0	0.0	0.0	1.4	0.7	0.3
T2-2	Sep-91	17.0	2	0.3	0.3	0.2	0.3	1.1	1.6	2.0	0.0	0.0	0.0	0.0	0.6	1.0	0.0
T2-3	Sep-91	25.0	6	1.9	0.7	1.1	0.7	1.7	3.8	5.0	0.0	0.0	0.0	0.0	2.5	1.0	0.0
Mean		**30.0**	**9**	**1.0**	**0.4**	**0.6**	**0.4**	**1.3**	**2.5**	**3.2**	**N/A**	**N/A**	**N/A**	**N/A**			
T2-1	Apr-92	612.0	13	1.4	0.4	0.9	0.4	1.4	2.9	3.7	5.6	7.1	9.0	12.2	2.3	0.8	0.3
T2-2	Apr-92	599.0	20	1.7	0.4	1.1	0.4	1.5	3.3	4.3	7.2	9.6	12.9	18.6	4.0	0.7	0.4
T2-3	Apr-92	672.0	17	1.1	0.3	0.7	0.3	1.3	2.4	3.2	5.7	7.7	10.3	15.2	3.2	0.5	0.5
Mean		**627.7**	**22**	**1.4**	**0.4**	**0.9**	**0.4**	**1.4**	**2.9**	**3.7**	**6.2**	**8.1**	**10.7**	**15.3**			
T2-1	Aug-92	3836	34	2.5	0.5	1.7	0.5	1.8	4.5	5.3	7.4	9.6	12.2	16.6	5.1	0.6	0.4
T2-2	Aug-92	2001	28	2.6	0.5	1.8	0.5	1.8	4.6	5.9	9.1	11.7	14.7	19.3	4.6	0.8	0.2
T2-3	Aug-92	2283	34	2.5	0.5	1.7	0.5	1.7	4.3	5.6	9.8	13.3	17.3	23.1	5.7	0.7	0.3
Mean		**2706.7**	**50**	**2.5**	**0.5**	**1.7**	**0.5**	**1.8**	**4.5**	**5.6**	**8.8**	**11.5**	**14.7**	**19.7**			
T2-1	Apr-93	242.0	16	2.3	0.6	1.5	0.6	1.7	4.3	5.4	8.3	11.3	15.1	0.0	3.9	0.8	0.2
T2-2	Apr-93	431.0	14	2.3	0.6	1.6	0.6	1.8	4.2	5.0	6.9	8.8	11.1	0.0	2.8	0.8	0.2
T2-3	Apr-93	319.0	19	2.4	0.6	1.6	0.6	1.8	4.2	5.2	8.4	11.7	15.7	0.0	4.4	0.7	0.3
Mean		**330.7**	**23**	**2.3**	**0.6**	**1.6**	**0.6**	**1.8**	**4.2**	**5.2**	**7.9**	**10.6**	**14.0**	**N/A**			
T2-1	Aug-93	2719	35	2.9	0.6	2.0	0.6	1.8	5.0	6.5	10.7	13.7	17.0	21.9	5.7	0.8	0.2
T2-2	Aug-93	2414	39	3.1	0.6	2.1	0.6	1.8	5.5	7.3	11.7	14.9	18.6	25.3	6.6	0.8	0.2
T2-3	Aug-93	2627	34	3.0	0.6	2.1	0.6	1.8	5.3	6.8	10.9	14.1	17.7	23.4	5.5	0.9	0.2
Mean		**2586.7**	**45**	**3.0**	**0.6**	**2.1**	**0.6**	**1.8**	**5.3**	**6.9**	**11.1**	**14.2**	**17.8**	**23.5**			
T2-1	Apr-94	1641	31	3.0	0.6	2.1	0.6	1.8	5.3	6.7	10.6	14.1	18.1	23.3	5.4	0.8	0.2
T2-2	Apr-94	1089	24	3.0	0.6	2.0	0.6	1.8	5.3	6.8	10.3	13.2	16.3	19.9	4.3	1.1	0.1
T2-3	Apr-94	1869	31	2.9	0.6	2.0	0.6	1.8	5.0	6.3	9.8	13.3	17.3	22.6	5.3	0.8	0.2
Mean		**1533.0**	**40**	**3.0**	**0.6**	**2.0**	**0.6**	**1.8**	**5.2**	**6.6**	**10.2**	**13.5**	**17.2**	**21.9**			
T2-1	Aug-94	13000	47	2.7	0.5	1.9	0.5	1.8	4.7	6.0	9.4	12.9	17.4	23.7	6.1	0.7	0.3
T2-2	Aug-94	15006	51	2.5	0.5	1.8	0.5	1.7	4.4	5.5	8.8	12.1	16.2	22.8	6.6	0.6	0.4
T2-3	Aug-94	13294	53	2.6	0.5	1.8	0.5	1.7	4.5	5.6	8.9	12.0	15.9	21.8	7.0	0.6	0.4
Mean		**13766.**	**63**	**2.6**	**0.5**	**1.8**	**0.5**	**1.7**	**4.5**	**5.7**	**9.0**	**12.3**	**16.5**	**22.8**			

Sample	Date	No. Ind	Tot Spp	Shannon H′	Shannon J′	Brillouin H	Brillouin V	Sanders-Hurlbert E(Sn),0 if Sample total <n 2	10	17	50	100	200	500	Log-Series alpa	Dev fromlog series	Abs diff from log series
T2-1	Apr-95	1495	28	2.6	0.5	1.8	0.5	1.7	4.5	5.8	9.2	12.3	15.9	21.1	4.9	0.8	0.2
T2-2	Apr-95	862	20	2.5	0.6	1.7	0.6	1.7	4.6	5.9	9.4	11.9	14.4	18.1	3.7	0.9	0.1
T2-3	Apr-95	2437	26	2.3	0.5	1.6	0.5	1.7	4.1	5.2	8.1	10.6	13.3	17.1	4.1	0.8	0.2
Mean		**1598**	**32**	**2.5**	**0.5**	**1.7**	**0.5**	**1.7**	**4.4**	**5.6**	**8.9**	**11.6**	**14.5**	**18.8**			
T2-1	Aug-95	11160	40	2.5	0.5	1.8	0.5	1.8	4.5	5.3	7.5	9.8	12.7	17.2	5.2	0.6	0.4
T2-2	Aug-95	10518	41	2.4	0.5	1.7	0.5	1.7	4.2	5.2	7.6	9.7	12.5	17.3	5.4	0.6	0.4
T2-3	Aug-95	6343	33	2.6	0.5	1.8	0.5	1.8	4.7	5.7	8.2	10.2	12.7	17.2	4.6	0.7	0.3
Mean		**9340**	**52**	**2.5**	**0.5**	**1.8**	**0.5**	**1.8**	**4.5**	**5.4**	**7.8**	**9.9**	**12.6**	**17.2**			
T2-1	Apr-96	3509	31	1.5	0.3	1.0	0.3	1.5	3.0	3.6	5.3	7.2	9.9	14.7	4.7	0.5	0.5
T2-2	Apr-96	1072	34	2.6	0.5	1.8	0.5	1.7	4.4	5.8	10.0	13.6	18.0	26.0	6.7	0.7	0.3
T2-3	Apr-96	2755	31	1.6	0.3	1.1	0.3	1.5	3.0	3.7	5.6	7.6	10.6	16.0	4.9	0.5	0.5
Mean		**2445.3**	**53**	**1.9**	**0.4**	**1.3**	**0.4**	**1.6**	**3.5**	**4.4**	**7.0**	**9.5**	**12.8**	**18.9**			
T2-1	Aug-96	550	17	1.8	0.4	1.2	0.4	1.6	3.1	3.7	6.1	8.2	10.9	16.3	3.3	0.6	0.4
T2-2	Aug-96	584	20	2.0	0.5	1.3	0.5	1.7	3.5	4.2	6.4	8.9	12.4	18.8	4.0	0.6	0.4
T2-3	Aug-96	818	28	2.4	0.5	1.6	0.5	1.7	4.1	5.2	8.4	11.4	15.9	24.0	5.6	0.7	0.4
Mean		**650.7**	**34**	**2.1**	**0.5**	**1.4**	**0.5**	**1.7**	**3.6**	**4.4**	**7.0**	**9.5**	**13.1**	**19.7**			
T2-1	Apr-97	1267	40	3.1	0.6	2.1	0.6	1.8	5.2	7.0	12.1	16.6	22.1	30.6	7.9	0.8	0.2
T2-2	Apr-97	271	19	2.4	0.6	1.6	0.6	1.7	4.4	5.9	10.3	13.8	17.4	0.0	4.7	0.8	0.2
T2-3	Apr-97	503	24	2.2	0.5	1.5	0.5	1.6	4.0	5.2	8.6	11.8	16.3	23.9	5.3	0.7	0.3
Mean		**680.3**	**47**	**2.6**	**0.6**	**1.7**	**0.6**	**1.7**	**4.5**	**6.0**	**10.3**	**14.1**	**18.6**	**N/A**			
T2-1	Aug-97	1612	24	2.3	0.5	1.6	0.5	1.7	4.1	5.0	7.4	9.6	12.4	17.4	4.0	0.7	0.3
T2-2	Aug-97	1643	28	2.5	0.5	1.7	0.5	1.8	4.3	5.2	7.6	9.9	13.1	19.2	4.8	0.7	0.4
T2-3	Aug-97	1334	25	2.3	0.5	1.6	0.5	1.7	4.2	5.0	7.1	8.8	11.3	16.5	4.4	0.6	0.4
Mean		**1529.7**	**36**	**2.4**	**0.5**	**1.6**	**0.5**	**1.7**	**4.2**	**5.1**	**7.4**	**9.4**	**12.3**	**17.7**			
T3-1	Sep-91	506	20	2.4	0.6	1.6	0.5	1.7	4.3	5.7	9.3	12.2	15.3	20.0	4.2	0.8	0.2
T3-2	Sep-91	232	20	2.8	0.6	1.8	0.6	1.8	5.0	6.5	10.2	13.7	18.6	0.0	5.3	0.8	0.2
T3-3	Sep-91	199	17	2.7	0.7	1.8	0.7	1.8	5.0	6.5	10.3	13.4	0.0	0.0	4.5	0.9	0.1
Mean		**312.3**	**24**	**2.6**	**0.6**	**1.7**	**0.6**	**1.8**	**4.8**	**6.2**	**9.9**	**13.1**	**N/A**	**N/A**			
T3-1	Apr-92	413	23	3.5	0.8	2.3	0.8	1.9	6.4	8.4	12.5	15.6	19.0	0.0	5.3	1.1	0.1
T3-2	Apr-92	241	18	3.6	0.9	2.4	0.9	1.9	6.8	9.1	13.3	15.4	17.4	0.0	4.5	1.3	0.3
T3-3	Apr-92	361	26	3.6	0.8	2.4	0.8	1.9	6.5	8.7	13.6	17.6	22.2	0.0	6.4	1.1	0.1
Mean		**338.3**	**33**	**3.6**	**0.8**	**2.4**	**0.8**	**1.9**	**6.6**	**8.7**	**13.1**	**16.2**	**19.5**	**N/A**			
T3-1	Aug-92	3503	35	2.8	0.5	1.9	0.5	1.8	4.7	6.2	10.5	14.1	18.5	25.0	5.4	0.8	0.2
T3-2	Aug-92	3149	35	2.9	0.6	2.0	0.6	1.8	5.0	6.3	9.8	12.8	16.5	22.5	5.5	0.8	0.2
T3-3	Aug-92	2745	38	3.1	0.6	2.1	0.6	1.8	5.4	7.0	10.9	14.1	17.9	24.2	6.2	0.8	0.2
Mean		**3132.3**	**44**	**2.9**	**0.6**	**2.0**	**0.6**	**1.8**	**5.0**	**6.5**	**10.4**	**13.7**	**17.6**	**23.9**			
T3-1	Apr-93	3468	32	2.8	0.6	1.9	0.6	1.8	5.0	6.4	10.1	12.8	15.9	20.8	4.9	0.9	0.2
T3-2	Apr-93	3362	35	2.9	0.6	2.0	0.6	1.8	5.1	6.7	10.9	14.1	17.6	22.9	5.5	0.9	0.2
T3-3	Apr-93	2548	33	3.3	0.6	2.2	0.6	1.8	5.8	7.7	11.9	14.7	18.1	23.3	5.4	0.9	0.1
Mean		**3126.0**	**42**	**3.0**	**0.6**	**2.0**	**0.6**	**1.8**	**5.3**	**6.9**	**11.0**	**13.9**	**17.2**	**22.3**			

Sample	Date	No. Ind	Tot Spp	Shannon H′	Shannon J′	Brillouin H	Brillouin V	Sanders-Hurlbert E(Sn),0 if Sample total <n 2	10	17	50	100	200	500	Log-Series alpa	Dev fromlog series	Abs diff from log series
T3-1	Aug-93	4906	35	3.3	0.7	2.3	0.7	1.9	6.0	7.9	12.1	15.1	18.3	22.8	5.1	1.1	0.1
T3-2	Aug-93	12518	39	3.0	0.6	2.1	0.6	1.8	5.3	7.0	11.0	14.0	17.2	21.3	5.0	0.9	0.1
T3-3	Aug-93	8313	44	2.9	0.5	2.0	0.5	1.8	5.1	6.9	11.3	14.6	18.3	23.2	6.1	0.8	0.2
Mean		**8579.0**	**53**	**3.1**	**0.6**	**2.1**	**0.6**	**1.8**	**5.5**	**7.3**	**11.5**	**14.6**	**17.9**	**22.4**			
T3-1	Apr-94	2811	37	1.9	0.4	1.3	0.4	1.5	3.5	4.7	8.1	10.9	14.4	20.1	6.0	0.6	0.4
T3-2	Apr-94	1896	32	2.7	0.5	1.8	0.5	1.7	4.8	6.2	9.8	12.8	16.5	22.4	5.5	0.8	0.2
T3-3	Apr-94	1349	29	3.0	0.6	2.1	0.6	1.8	5.4	6.9	10.6	13.6	17.0	22.5	5.2	0.9	0.1
Mean		**2018.6**	**45**	**2.5**	**0.5**	**1.7**	**0.5**	**1.7**	**4.6**	**5.9**	**9.5**	**12.4**	**16.0**	**21.7**			
T3-1	Aug-94	9939	46	1.9	0.4	1.3	0.4	1.5	3.5	4.5	7.9	11.0	14.9	21.2	6.2	0.6	0.5
T3-2	Aug-94	8553	39	1.9	0.4	1.3	0.4	1.5	3.4	4.4	7.3	9.7	12.5	17.3	5.3	0.6	0.4
T3-3	Aug-94	9599	44	1.8	0.3	1.3	0.3	1.5	3.3	4.4	7.8	11.1	15.2	21.5	6.0	0.5	0.5
Mean		**9363.6**	**54**	**1.9**	**0.4**	**1.3**	**0.4**	**1.5**	**3.4**	**4.4**	**7.7**	**10.6**	**14.2**	**20.0**			
T3-1	Apr-95	6011	42	2.9	0.5	2.0	0.5	1.8	5.1	6.5	9.8	12.1	14.7	19.4	6.1	0.7	0.3
T3-2	Apr-95	5958	42	3.0	0.6	2.0	0.6	1.8	5.2	7.0	11.4	14.4	17.6	23.2	6.1	0.8	0.2
T3-3	Apr-95	4162	36	3.0	0.6	2.1	0.6	1.8	5.4	7.1	11.1	14.0	17.3	22.7	5.4	0.9	0.1
Mean		**5377.0**	**54**	**3.0**	**0.6**	**2.0**	**0.6**	**1.8**	**5.2**	**6.9**	**10.8**	**13.5**	**16.5**	**21.8**			
T3-1	Aug-95	6058	46	3.0	0.6	2.1	0.6	1.8	5.2	6.8	10.9	14.5	19.0	25.9	6.8	0.8	0.2
T3-2	Aug-95	5349	42	3.0	0.6	2.1	0.6	1.8	5.2	6.8	10.6	13.5	17.1	23.2	6.2	0.8	0.2
T3-3	Aug-95	3243	38	3.0	0.6	2.1	0.6	1.8	5.3	6.9	10.8	13.8	17.6	24.0	6.0	0.8	0.2
Mean		**4883.3**	**53**	**3.0**	**0.6**	**2.1**	**0.6**	**1.8**	**5.2**	**6.8**	**10.8**	**13.9**	**17.9**	**24.4**			
T3-1	Apr-96	3410	35	2.8	0.5	1.9	0.5	1.8	4.9	6.1	8.8	11.2	14.4	20.0	5.4	0.7	0.3
T3-2	Apr-96	2880	33	2.6	0.5	1.8	0.5	1.8	4.7	5.8	8.5	10.9	14.0	19.7	5.2	0.7	0.3
T3-3	Apr-96	3233	37	2.9	0.6	2.0	0.6	1.8	5.1	6.4	9.4	12.1	15.7	21.7	5.9	0.7	0.3
Mean		**3174.3**	**47**	**2.8**	**0.5**	**1.9**	**0.5**	**1.8**	**4.9**	**6.1**	**8.9**	**11.4**	**14.7**	**20.5**			
T3-1	Aug-96	7943	45	3.1	0.6	2.1	0.6	1.8	5.5	7.1	10.3	12.6	15.7	21.7	6.3	0.7	0.3
T3-2	Aug-96	6344	45	3.0	0.6	2.1	0.6	1.8	5.5	7.2	10.7	13.1	16.0	21.5	6.5	0.7	0.3
T3-3	Aug-96	6172	38	3.1	0.6	2.1	0.6	1.8	5.5	7.1	10.1	12.3	15.5	21.3	5.4	0.8	0.2
Mean		**6819.6**	**57**	**3.1**	**0.6**	**2.1**	**0.6**	**1.8**	**5.5**	**7.1**	**10.4**	**12.7**	**15.7**	**21.5**			
T3-1	Apr-97	4420	39	2.9	0.5	2.0	0.5	1.8	5.1	6.4	9.6	11.8	14.5	19.8	5.9	0.7	0.3
T3-2	Apr-97	6325	42	2.7	0.5	1.9	0.5	1.8	5.0	6.3	8.5	10.2	12.7	17.6	6.0	0.6	0.4
T3-3	Apr-97	4462	37	2.7	0.5	1.9	0.5	1.8	4.9	5.9	7.9	9.8	12.2	16.6	5.5	0.6	0.4
Mean		**5069.0**	**55**	**2.8**	**0.5**	**1.9**	**0.5**	**1.8**	**5.0**	**6.2**	**8.7**	**10.6**	**13.1**	**18.0**			
T3-1	Aug-97	14993	49	2.5	0.4	1.7	0.4	1.7	4.3	5.6	9.6	12.5	15.7	20.8	6.3	0.7	0.3
T3-2	Aug-97	13863	41	2.8	0.5	2.0	0.5	1.8	5.1	6.4	9.4	11.3	13.8	18.6	5.2	0.7	0.3
T3-3	Aug-97	12598	46	3.1	0.6	2.1	0.6	1.8	5.5	7.1	10.4	12.7	15.7	21.0	6.0	0.7	0.3
Mean		**13818.**	**54**	**2.8**	**0.5**	**1.9**	**0.5**	**1.8**	**5.0**	**6.4**	**9.8**	**12.2**	**15.1**	**20.1**			
T4-1	Sep-91	89	3	0.2	0.2	0.1	0.1	1.1	1.3	1.5	2.4	0.0	0.0	0.0	0.6	0.8	0.2
T4-2	Sep-91	117	3	0.2	0.1	0.1	0.1	1.1	1.3	1.4	2.1	2.8	0.0	0.0	0.6	0.7	0.3
T4-3	Sep-91	147	5	0.2	0.1	0.1	0.1	1.1	1.3	1.5	2.4	3.7	0.0	0.0	1.0	0.5	0.5
Mean		**117.7**	**6**	**0.2**	**0.1**	**0.1**	**0.1**	**1.1**	**1.3**	**1.5**	**2.3**	**N/A**	**N/A**	**N/A**			

		No.	Tot	Shannon		Brillouin		Sanders-Hurlbert E(Sn),0 if Sample total <n							Log-Series alpa	Dev fromlog series	Abs diff from log series
Sample	Date	Ind	Spp	H′	J′	H	V	2	10	17	50	100	200	500			
T4-1	Apr-92	491	8	1.3	0.4	0.9	0.4	1.5	2.6	3.0	4.4	5.8	7.1	0.0	1.4	0.8	0.2
T4-2	Apr-92	242	5	1.2	0.5	0.8	0.5	1.5	2.3	2.6	3.5	4.3	5.0	0.0	0.9	1.2	0.2
T4-3	Apr-92	429	10	1.4	0.4	0.9	0.4	1.6	2.6	2.9	3.9	5.0	6.8	0.0	1.8	0.6	0.4
Mean		**387.33**	**11**	**1.3**	**0.4**	**0.9**	**0.4**	**1.5**	**2.5**	**2.8**	**3.9**	**5.0**	**6.3**	**N/A**			
T4-1	Aug-92	1601	6	0.1	0.0	0.1	0.0	1.0	1.1	1.2	1.5	1.9	2.6	4.0	0.8	0.4	0.6
T4-2	Aug-92	1797	6	0.1	0.0	0.0	0.0	1.0	1.1	1.1	1.3	1.6	2.1	3.3	0.8	0.4	0.6
T4-3	Aug-92	1803	8	0.1	0.0	0.0	0.0	1.0	1.1	1.1	1.3	1.6	2.2	3.6	1.1	0.3	0.7
Mean		**1733.6**	**9**	**0.1**	**0.0**	**0.0**	**0.0**	**1.0**	**1.1**	**1.1**	**1.4**	**1.7**	**2.3**	**3.6**			
T4-1	Apr-93	442	12	1.3	0.4	0.9	0.4	1.4	2.7	3.5	5.4	6.9	8.9	0.0	2.3	0.7	0.3
T4-2	Apr-93	335	13	0.9	0.2	0.6	0.2	1.2	2.1	2.7	5.2	7.6	10.7	0.0	2.7	0.5	0.5
T4-3	Apr-93	377	16	1.0	0.3	0.7	0.3	1.3	2.3	3.1	5.9	8.7	12.3	0.0	3.4	0.5	0.5
Mean		**384.67**	**19**	**1.1**	**0.3**	**0.7**	**0.3**	**1.3**	**2.4**	**3.1**	**5.5**	**7.7**	**10.6**	**N/A**			
T4-1	Aug-93	471	7	0.5	0.2	0.3	0.2	1.1	1.7	2.0	3.3	4.5	5.9	0.0	1.2	0.6	0.4
T4-2	Aug-93	216	9	0.6	0.2	0.4	0.2	1.1	1.7	2.2	4.0	6.1	8.7	0.0	1.9	0.5	0.5
T4-3	Aug-93	425	10	0.5	0.1	0.3	0.1	1.1	1.5	1.9	3.3	5.0	7.3	0.0	1.8	0.4	0.6
Mean		**370.67**	**13**	**0.5**	**0.2**	**0.3**	**0.2**	**1.1**	**1.6**	**2.0**	**3.5**	**5.2**	**7.3**	**N/A**			
T4-1	Apr-94	1493	14	0.4	0.1	0.2	0.1	1.1	1.4	1.6	2.7	4.1	6.3	10.0	2.1	0.3	0.7
T4-2	Apr-94	503	10	0.3	0.1	0.2	0.1	1.1	1.3	1.5	2.3	3.5	5.5	10.0	1.8	0.4	0.7
T4-3	Apr-94	2446	12	1.2	0.3	0.8	0.3	1.4	2.6	3.1	4.3	4.9	5.8	7.7	1.6	0.7	0.3
Mean		**1480.6**	**20**	**0.6**	**0.2**	**0.4**	**0.2**	**1.2**	**1.8**	**2.1**	**3.1**	**4.2**	**5.9**	**9.2**			
T4-3	Aug-94	2649	14	0.2	0.1	0.2	0.1	1.1	1.3	1.4	2.2	3.1	4.4	6.8	1.9	0.3	0.7
T4-1	Aug-94	631	9	0.2	0.1	0.1	0.1	1.0	1.2	1.4	2.1	3.1	4.8	8.3	1.5	0.4	0.6
T4-2	Aug-94	1261	19	0.7	0.2	0.4	0.2	1.1	1.7	2.2	4.3	6.7	10.2	15.1	3.2	0.4	0.6
Mean		**1513.6**	**24**	**0.4**	**0.1**	**0.2**	**0.1**	**1.1**	**1.4**	**1.7**	**2.9**	**4.3**	**6.5**	**10.1**			
T4-1-3	Apr-95	541	13	1.7	0.5	1.1	0.5	1.6	3.2	3.8	5.2	6.8	8.9	12.6	2.4	0.7	0.3
T4-2	Apr-95	204	11	1.6	0.5	1.0	0.4	1.5	3.1	3.8	5.7	7.7	10.9	0.0	2.5	0.7	0.3
Mean		**752.89**	**17**	**1.2**	**0.4**	**0.8**	**0.3**	**1.4**	**2.6**	**3.1**	**4.6**	**6.3**	**8.8**	**N/A**			
T4-1	Aug-95	2984	13	0.2	0.0	0.1	0.0	1.0	1.2	1.3	1.7	2.4	3.4	5.5	1.8	0.3	0.7
T4-2	Aug-95	2340	16	0.2	0.0	0.1	0.0	1.0	1.2	1.3	1.8	2.5	3.8	6.8	2.3	0.2	0.8
T4-3	Aug-95	1436	14	0.3	0.1	0.2	0.1	1.1	1.3	1.4	2.2	3.1	4.7	8.0	2.2	0.3	0.7
Mean		**2253.3**	**22**	**0.2**	**0.0**	**0.1**	**0.0**	**1.0**	**1.2**	**1.3**	**1.9**	**2.7**	**4.0**	**6.8**			
T4-1	Apr-96	123	7	1.5	0.5	1.0	0.5	1.5	2.9	3.6	5.5	6.9	0.0	0.0	1.6	0.9	0.1
T4-2	Apr-96	1754	16	0.6	0.2	0.4	0.2	1.2	1.7	2.2	3.9	5.7	8.2	11.9	2.4	0.4	0.6
T4-3	Apr-96	316	13	2.2	0.6	1.5	0.6	1.7	4.0	5.0	7.6	9.4	11.4	0.0	2.7	0.9	0.1
Mean		**731.00**	**21**	**1.4**	**0.4**	**1.0**	**0.4**	**1.5**	**2.9**	**3.6**	**5.7**	**7.3**	**N/A**	**N/A**			
T4-1	Aug-96	133	6	0.7	0.3	0.4	0.2	1.2	1.9	2.4	4.1	5.4	0.0	0.0	1.3	0.7	0.3
T4-2	Aug-96	119	6	0.6	0.2	0.4	0.2	1.2	1.9	2.4	4.0	5.5	0.0	0.0	1.3	0.7	0.3
T4-3	Aug-96	80	6	1.1	0.4	0.7	0.4	1.4	2.5	3.1	4.8	0.0	0.0	0.0	1.5	0.8	0.2
Mean		**110.67**	**10**	**0.8**	**0.3**	**0.5**	**0.3**	**1.3**	**2.1**	**2.6**	**4.3**	**N/A**	**N/A**	**N/A**			

Sample	Date	No. Ind	Tot Spp	Shannon H′	Shannon J′	Brillouin H	Brillouin V	Sanders-Hurlbert E(Sn),0 if Sample total <n 2	10	17	50	100	200	500	Log-Series alpa	Dev fromlog series	Abs diff from log series
T4-1	Apr-97	286	9	1.4	0.4	0.9	0.4	1.6	2.6	3.0	4.3	5.7	7.7	0.0	1.8	0.7	0.3
T4-2	Apr-97	516	13	1.9	0.5	1.3	0.5	1.7	3.4	3.9	5.3	7.0	9.3	12.9	2.4	0.7	0.3
T4-3	Apr-97	181	9	1.6	0.5	1.1	0.5	1.6	3.1	3.7	5.5	7.1	0.0	0.0	2.0	0.8	0.2
Mean		**327.67**	**18**	**1.6**	**0.5**	**1.1**	**0.5**	**1.6**	**3.0**	**3.5**	**5.0**	**6.6**	**N/A**	**N/A**			
T4-1	Aug-97	101	7	1.0	0.4	0.6	0.4	1.3	2.5	3.2	5.2	7.0	0.0	0.0	1.7	0.8	0.2
T4-2	Aug-97	84	7	1.0	0.4	0.6	0.3	1.3	2.4	3.2	5.4	0.0	0.0	0.0	1.8	0.7	0.3
T4-3	Aug-97	114	8	1.1	0.4	0.7	0.3	1.3	2.5	3.3	5.8	7.6	0.0	0.0	2.0	0.7	0.3
Mean		**99.67**	**11**	**1.0**	**0.4**	**0.6**	**0.3**	**1.3**	**2.5**	**3.2**	**5.5**	**N/A**	**N/A**	**N/A**			
T5-1	Sep-91	25	5	1.5	0.6	0.8	0.6	1.5	3.3	4.3	0.0	0.0	0.0	0.0	1.9	1.0	0.0
T5-2	Sep-91	17	4	1.7	0.8	0.9	0.8	1.7	3.4	4.0	0.0	0.0	0.0	0.0	1.7	1.2	0.2
T5-3	Sep-91	32	6	1.7	0.6	1.0	0.6	1.6	3.4	4.4	0.0	0.0	0.0	0.0	2.2	0.9	0.1
Mean		**24.60**	**8**	**1.6**	**0.7**	**0.9**	**0.7**	**1.6**	**3.4**	**4.2**	**N/A**	**N/A**	**N/A**	**N/A**			
T5-1	Aug-92	1702	42	3.0	0.6	2.0	0.6	1.8	5.2	7.1	11.7	15.6	20.7	29.5	7.8	0.8	0.3
T5-2	Aug-92	4432	39	1.9	0.4	1.3	0.4	1.6	3.2	3.9	6.5	9.0	12.2	17.5	5.9	0.5	0.5
T5-3	Aug-92	3880	45	1.7	0.3	1.2	0.3	1.4	3.1	4.2	7.7	11.4	16.0	22.7	7.1	0.5	0.5
Mean		**3338.0**	**61**	**2.2**	**0.4**	**1.5**	**0.4**	**1.6**	**3.8**	**5.1**	**8.6**	**12.0**	**16.3**	**23.2**			
T5A-1	Apr-92	494	16	2.0	0.5	1.3	0.5	1.6	3.7	4.8	7.6	9.8	12.3	0.0	3.2	0.8	0.2
T5A-2	Apr-92	198	13	1.8	0.5	1.1	0.5	1.5	3.5	4.8	8.3	10.7	0.0	0.0	3.1	0.8	0.2
T5A-3	Apr-92	292	10	1.4	0.4	0.9	0.4	1.4	2.8	3.5	5.5	7.1	8.9	0.0	2.0	0.8	0.2
Mean		**328.00**	**19**	**1.7**	**0.5**	**1.1**	**0.5**	**1.5**	**3.3**	**4.4**	**7.1**	**9.2**	**N/A**	**N/A**			
T5A-1	Apr-93	921	26	2.8	0.6	1.9	0.6	1.8	4.9	6.5	10.7	14.3	18.2	22.9	5.0	0.9	0.1
T5A-2	Apr-93	1092	22	2.4	0.5	1.6	0.5	1.7	4.3	5.5	8.7	11.6	15.1	19.3	3.9	0.8	0.2
T5A-3	Apr-93	1014	27	2.6	0.6	1.8	0.6	1.7	4.6	6.0	10.1	14.0	18.5	23.9	5.1	0.8	0.2
Mean		**1009.0**	**35**	**2.6**	**0.6**	**1.8**	**0.6**	**1.7**	**4.6**	**6.0**	**9.8**	**13.3**	**17.3**	**22.0**			
T5A-1	Aug-93	969	34	3.7	0.7	2.5	0.7	1.9	6.5	8.8	14.4	18.7	23.4	29.5	6.9	1.1	0.1
T5A-2	Aug-93	482	34	3.8	0.7	2.5	0.7	1.9	6.7	9.2	15.4	20.1	25.4	0.0	8.4	0.9	0.1
T5A-3	Aug-93	436	28	3.7	0.8	2.5	0.8	1.9	6.7	9.1	14.9	18.9	23.3	0.0	6.7	1.1	0.1
Mean		**629.00**	**41**	**3.7**	**0.7**	**2.5**	**0.7**	**1.9**	**6.6**	**9.0**	**14.9**	**19.2**	**24.0**	**N/A**			
T5A-1	Apr-94	318	26	3.4	0.7	2.3	0.7	1.9	6.2	8.3	13.0	16.8	21.7	0.0	6.7	0.9	0.1
T5A-2	Apr-94	616	27	3.7	0.8	2.5	0.8	1.9	6.7	8.9	13.6	16.8	20.6	25.9	5.8	1.1	0.1
T5A-3	Apr-94	1043	27	3.2	0.7	2.1	0.7	1.8	5.5	7.2	11.7	15.3	19.0	23.5	5.1	1.1	0.1
Mean		**659.00**	**37**	**3.4**	**0.7**	**2.3**	**0.7**	**1.9**	**6.1**	**8.1**	**12.8**	**16.3**	**20.4**	**N/A**			
T5A-1	Aug-94	3337	29	1.7	0.4	1.2	0.3	1.4	3.2	4.3	7.9	10.9	14.6	19.9	4.4	0.6	0.4
T5A-2	Aug-94	4147	29	1.6	0.3	1.1	0.3	1.4	3.1	4.2	7.9	10.9	14.1	18.5	4.2	0.6	0.4
T5A-3	Aug-94	2458	32	1.6	0.3	1.1	0.3	1.4	3.1	4.2	7.7	10.6	13.8	18.7	5.2	0.6	0.4
Mean		**3314.0**	**39**	**1.6**	**0.3**	**1.1**	**0.3**	**1.4**	**3.1**	**4.2**	**7.8**	**10.8**	**14.2**	**19.0**			
T5A-1	Apr-95	108	18	3.7	0.9	2.3	0.9	1.9	6.9	9.5	15.0	17.7	0.0	0.0	6.2	1.2	0.2
T5A-2	Apr-95	77	14	3.3	0.9	2.1	0.9	1.9	6.5	8.5	12.3	0.0	0.0	0.0	5.0	1.2	0.2
T5A-3	Apr-95	74	12	3.1	0.9	1.9	0.9	1.9	6.1	8.0	11.2	0.0	0.0	0.0	4.1	1.2	0.2
Mean		**86.33**	**21**	**3.4**	**0.9**	**2.1**	**0.9**	**1.9**	**6.5**	**8.7**	**12.8**	**N/A**	**N/A**	**N/A**			

								Sanders-Hurlbert									
		No.	**Tot**	**Shannon**		**Brillouin**		**E(Sn),0 if Sample total <n**									
Sample	**Date**	**Ind**	**Spp**	**H′**	**J′**	**H**	**V**	**2**	**10**	**17**	**50**	**100**	**200**	**500**	**Log-Series alpa**	**Dev fromlog series**	**Abs diff from log series**
T5A-1	Aug-95	9468	41	1.9	0.4	1.3	0.4	1.6	3.5	4.3	6.4	8.1	10.7	15.9	5.5	0.5	0.5
T5A-2	Aug-95	8522	45	1.9	0.4	1.3	0.4	1.6	3.5	4.4	6.7	8.8	11.8	17.6	6.2	0.5	0.5
T5A-3	Aug-95	550	27	2.0	0.4	1.3	0.4	1.5	3.7	5.2	10.2	14.1	18.4	26.0	6.0	0.6	0.4
Mean		**6180.0**	**52**	**1.9**	**0.4**	**1.3**	**0.4**	**1.6**	**3.6**	**4.6**	**7.8**	**10.3**	**13.6**	**19.8**			
T5A-1	Apr-96	164	24	3.2	0.7	2.0	0.7	1.8	5.7	8.0	14.9	20.3	0.0	0.0	7.7	0.9	0.1
T5A-2	Apr-96	175	20	3.2	0.7	2.0	0.7	1.8	5.7	7.9	13.0	16.7	0.0	0.0	5.8	1.0	0.0
T5A-3	Apr-96	142	24	3.3	0.7	2.1	0.7	1.8	5.8	8.1	15.2	20.8	0.0	0.0	8.3	0.9	0.1
Mean		**160.33**	**37**	**3.2**	**0.7**	**2.0**	**0.7**	**1.8**	**5.7**	**8.0**	**14.4**	**19.3**	**N/A**	**N/A**			
T5A-1	Aug-96	310	25	3.4	0.7	2.2	0.7	1.9	6.1	8.2	13.7	17.6	21.9	0.0	6.4	1.0	0.0
T5A-2	Aug-96	142	27	3.9	0.8	2.4	0.8	1.9	7.0	10.0	18.0	23.7	0.0	0.0	9.9	1.0	0.0
T5A-3	Aug-96	184	23	3.6	0.8	2.3	0.8	1.9	6.6	8.9	14.0	18.1	0.0	0.0	6.9	1.1	0.1
Mean		**212.00**	**34**	**3.6**	**0.8**	**2.3**	**0.8**	**1.9**	**6.6**	**9.0**	**15.2**	**19.8**	**N/A**	**N/A**			
T5A-1	Apr-97	651	26	2.7	0.6	1.8	0.6	1.7	4.8	6.5	10.9	14.2	18.2	24.2	5.4	0.8	0.2
T5A-2	Apr-97	578	29	2.4	0.5	1.6	0.5	1.6	4.2	5.9	10.9	15.1	19.8	27.6	6.4	0.7	0.3
T5A-3	Apr-97	367	31	3.5	0.7	2.3	0.7	1.9	6.0	8.2	14.3	19.6	25.9	0.0	8.1	0.9	0.1
Mean		**532.00**	**41**	**2.9**	**0.6**	**1.9**	**0.6**	**1.7**	**5.0**	**6.9**	**12.0**	**16.3**	**21.3**	**N/A**			
T5A-1	Aug-97	21010	51	2.0	0.4	1.4	0.4	1.6	3.4	4.2	7.2	9.9	13.1	17.7	6.3	0.5	0.5
T5A-2	Aug-97	21159	55	2.0	0.3	1.4	0.3	1.6	3.3	4.2	7.1	10.0	13.2	17.8	6.8	0.5	0.5
T5A-3	Aug-97	19236	61	2.3	0.4	1.6	0.4	1.7	3.7	4.8	8.3	11.8	16.2	23.4	7.8	0.5	0.5
Mean		**20468.**	**71**	**2.1**	**0.4**	**1.5**	**0.4**	**1.6**	**3.5**	**4.4**	**7.5**	**10.6**	**14.2**	**19.6**			
T6-1	Sep-91	1699	24	2.2	0.5	1.5	0.5	1.7	3.8	4.8	7.8	10.6	13.9	18.5	4.0	0.7	0.3
T6-2	Sep-91	1167	21	1.9	0.4	1.3	0.4	1.6	3.5	4.5	7.3	10.0	13.2	17.1	3.6	0.7	0.3
T6-3	Sep-91	1720	28	2.3	0.5	1.6	0.5	1.7	4.0	5.0	7.8	10.4	13.6	18.8	4.8	0.7	0.3
Mean		**1528.6**	**30**	**2.1**	**0.5**	**1.5**	**0.5**	**1.7**	**3.8**	**4.8**	**7.6**	**10.3**	**13.6**	**18.1**			
T6-1	Apr-92	825	31	3.0	0.6	2.0	0.6	1.8	5.1	6.8	12.1	16.1	20.2	26.8	6.4	0.8	0.2
T6-2	Apr-92	752	32	3.0	0.6	2.0	0.6	1.8	5.1	6.8	11.8	16.0	20.8	28.3	6.8	0.8	0.2
T6-3	Apr-92	997	27	2.9	0.6	1.9	0.6	1.8	4.9	6.5	11.5	15.3	18.9	24.0	5.1	0.9	0.1
Mean		**858.00**	**41**	**3.0**	**0.6**	**2.0**	**0.6**	**1.8**	**5.0**	**6.7**	**11.8**	**15.8**	**20.0**	**26.4**			
T6-1	Aug-92	7957	34	2.6	0.5	1.8	0.5	1.8	4.6	5.6	8.2	10.8	13.9	18.5	4.6	0.7	0.3
T6-2	Aug-92	8266	42	2.5	0.5	1.7	0.5	1.8	4.3	5.1	7.1	9.5	12.9	18.6	5.8	0.5	0.5
T6-3	Aug-92	6352	43	2.6	0.5	1.8	0.5	1.8	4.6	5.6	8.5	11.4	14.8	20.0	6.2	0.6	0.4
Mean		**7525.0**	**51**	**2.6**	**0.5**	**1.8**	**0.5**	**1.8**	**4.5**	**5.4**	**7.9**	**10.6**	**13.9**	**19.0**			
T6-1	Apr-93	2630	28	2.4	0.5	1.6	0.5	1.7	4.2	5.0	7.4	9.7	12.9	18.4	4.4	0.7	0.3
T6-2	Apr-93	4240	33	2.5	0.5	1.7	0.5	1.7	4.4	5.9	9.6	12.4	15.6	20.6	4.9	0.8	0.2
T6-3	Apr-93	4053	36	2.6	0.5	1.8	0.5	1.7	4.5	5.9	9.9	13.2	16.9	22.3	5.4	0.8	0.2
Mean		**3641.0**	**40**	**2.5**	**0.5**	**1.7**	**0.5**	**1.7**	**4.4**	**5.6**	**9.0**	**11.8**	**15.1**	**20.4**			
T6-1	Aug-93	10598	33	2.6	0.5	1.8	0.5	1.8	4.7	6.0	9.1	11.1	13.1	16.3	4.2	0.8	0.2
T6-2	Aug-93	19551	40	2.6	0.5	1.8	0.5	1.8	4.6	5.8	8.9	11.2	13.2	16.3	4.8	0.7	0.3
T6-3	Aug-93	16250	35	2.6	0.5	1.8	0.5	1.8	4.7	5.8	8.6	10.7	12.8	15.6	4.2	0.8	0.2
Mean		**15466.**	**50**	**2.6**	**0.5**	**1.8**	**0.5**	**1.8**	**4.7**	**5.9**	**8.9**	**11.0**	**13.0**	**16.1**			

Sample	Date	No. Ind	Tot Spp	Shannon H′	Shannon J′	Brillouin H	Brillouin V	Sanders-Hurlbert E(Sn),0 if Sample total <n: 2	10	17	50	100	200	500	Log-Series alpa	Dev fromlog series	Abs diff from log series
T6-1	Apr-94	2163	28	2.4	0.5	1.7	0.5	1.7	4.2	5.2	8.3	11.0	14.3	19.4	4.5	0.7	0.3
T6-2	Apr-94	3655	30	2.2	0.5	1.5	0.5	1.7	3.8	4.7	7.5	10.3	13.8	18.8	4.5	0.7	0.3
T6-3	Apr-94	2388	25	2.6	0.6	1.8	0.6	1.8	4.5	5.6	8.5	11.2	14.3	18.5	3.9	0.8	0.2
Mean		**2735.3**	**35**	**2.4**	**0.5**	**1.7**	**0.5**	**1.7**	**4.2**	**5.2**	**8.1**	**10.8**	**14.1**	**18.9**			
T6-1	Aug-94	3350	35	2.5	0.5	1.7	0.5	1.8	4.3	5.2	8.0	10.8	14.5	20.6	5.5	0.6	0.4
T6-2	Aug-94	2941	32	2.4	0.5	1.7	0.5	1.7	4.1	5.1	8.4	11.9	16.2	21.7	5.0	0.7	0.3
T6-3	Aug-94	2710	30	2.6	0.5	1.8	0.5	1.8	4.5	5.6	9.1	12.7	16.8	22.1	4.7	0.8	0.2
Mean		**3000.3**	**41**	**2.5**	**0.5**	**1.7**	**0.5**	**1.8**	**4.3**	**5.3**	**8.5**	**11.8**	**15.8**	**21.5**			
T6-1	Apr-95	1853	31	2.2	0.4	1.5	0.4	1.6	3.9	5.0	8.2	10.8	13.7	18.5	5.3	0.7	0.4
T6-2	Apr-95	1808	29	2.8	0.6	1.9	0.6	1.8	5.0	6.4	9.7	12.1	14.8	19.5	4.9	0.8	0.2
T6-3	Apr-95	3519	32	2.5	0.5	1.7	0.5	1.7	4.4	5.5	8.8	11.6	14.7	19.4	4.9	0.7	0.3
Mean		**2393.3**	**44**	**2.5**	**0.5**	**1.7**	**0.5**	**1.7**	**4.4**	**5.6**	**8.9**	**11.5**	**14.4**	**19.1**			
T6-1	Aug-95	8034	43	2.4	0.4	1.7	0.4	1.7	4.2	5.4	8.6	11.4	14.9	20.2	6.0	0.6	0.4
T6-2	Aug-95	7859	44	2.2	0.4	1.5	0.4	1.6	3.9	5.1	8.3	11.2	14.7	20.4	6.2	0.6	0.4
T6-3	Aug-95	10542	44	2.3	0.4	1.6	0.4	1.7	4.1	5.3	8.3	11.1	14.5	19.6	5.9	0.6	0.4
Mean		**8811.6**	**53**	**2.3**	**0.4**	**1.6**	**0.4**	**1.7**	**4.1**	**5.3**	**8.4**	**11.2**	**14.7**	**20.1**			
T6-1	Apr-96	3261	35	2.1	0.4	1.5	0.4	1.7	3.7	4.6	7.2	9.7	13.0	18.9	5.5	0.6	0.4
T6-2	Apr-96	4302	35	2.3	0.4	1.5	0.4	1.7	3.9	4.6	7.1	9.7	13.0	18.2	5.2	0.6	0.4
T6-3	Apr-96	3388	37	1.8	0.4	1.2	0.4	1.5	3.3	4.2	6.9	9.4	12.7	18.8	5.8	0.5	0.5
Mean		**3650.3**	**48**	**2.1**	**0.4**	**1.4**	**0.4**	**1.6**	**3.6**	**4.5**	**7.1**	**9.6**	**12.9**	**18.6**			
T6-1	Aug-96	7889	37	2.3	0.5	1.6	0.5	1.7	4.2	5.4	7.9	10.2	13.2	18.0	5.0	0.7	0.3
T6-2	Aug-96	7398	32	2.5	0.5	1.7	0.5	1.7	4.4	5.6	8.6	11.1	13.8	17.6	4.3	0.8	0.2
T6-3	Aug-96	6895	36	2.2	0.4	1.5	0.4	1.6	3.9	5.2	8.4	11.0	14.1	18.8	5.0	0.7	0.3
Mean		**7394.0**	**42**	**2.3**	**0.5**	**1.6**	**0.5**	**1.7**	**4.2**	**5.4**	**8.3**	**10.8**	**13.7**	**18.1**			
T6-1	Apr-97	5028	41	2.5	0.5	1.7	0.5	1.7	4.3	5.4	8.5	11.1	14.6	20.9	6.1	0.6	0.4
T6-2	Apr-97	5162	39	2.6	0.5	1.8	0.5	1.7	4.4	5.7	9.7	13.2	17.0	22.3	5.7	0.7	0.3
T6-3	Apr-97	5572	42	2.5	0.5	1.7	0.5	1.7	4.3	5.3	8.4	11.3	15.3	21.8	6.2	0.6	0.4
Mean		**5254.0**	**45**	**2.5**	**0.5**	**1.7**	**0.5**	**1.7**	**4.3**	**5.5**	**8.9**	**11.9**	**15.6**	**21.7**			
T6-1	Aug-97	5230	36	2.6	0.5	1.8	0.5	1.7	4.7	6.0	8.9	11.3	14.6	20.0	5.2	0.7	0.3
T6-2	Aug-97	5315	41	2.5	0.5	1.7	0.5	1.7	4.3	5.4	8.5	11.4	15.1	21.2	6.1	0.6	0.4
T6-3	Aug-97	6760	39	2.4	0.5	1.6	0.5	1.7	4.1	5.2	8.1	10.8	14.1	19.1	5.5	0.6	0.4
Mean		**5768.3**	**47**	**2.5**	**0.5**	**1.7**	**0.5**	**1.7**	**4.4**	**5.5**	**8.5**	**11.2**	**14.6**	**20.1**			
T7-1	Sep-91	880	15	2.3	0.6	1.6	0.6	1.7	4.1	5.2	7.7	9.3	11.0	13.4	2.6	1.1	0.1
T7-2	Sep-91	968	14	2.2	0.6	1.5	0.6	1.7	4.0	5.0	7.4	9.0	10.7	12.8	2.3	1.1	0.1
T7-3	Sep-91	927	12	2.2	0.6	1.5	0.6	1.7	4.0	4.9	6.8	7.8	8.9	10.6	2.0	1.2	0.2
Mean		**925.00**	**18**	**2.2**	**0.6**	**1.5**	**0.6**	**1.7**	**4.0**	**5.0**	**7.3**	**8.7**	**10.2**	**12.3**			
T7-1	Apr-92	515	18	1.9	0.5	1.3	0.5	1.5	3.6	4.9	8.4	10.9	13.4	17.8	3.6	0.8	0.2
T7-2	Apr-92	558	18	2.0	0.5	1.3	0.5	1.6	3.7	4.9	8.6	11.7	14.8	17.7	3.6	0.8	0.2
T7-3	Apr-92	376	17	1.8	0.4	1.2	0.4	1.5	3.5	4.8	8.8	11.5	14.2	0.0	3.7	0.7	0.3
Mean		**483.00**	**25**	**1.9**	**0.5**	**1.3**	**0.5**	**1.5**	**3.6**	**4.9**	**8.6**	**11.4**	**14.1**	**N/A**			

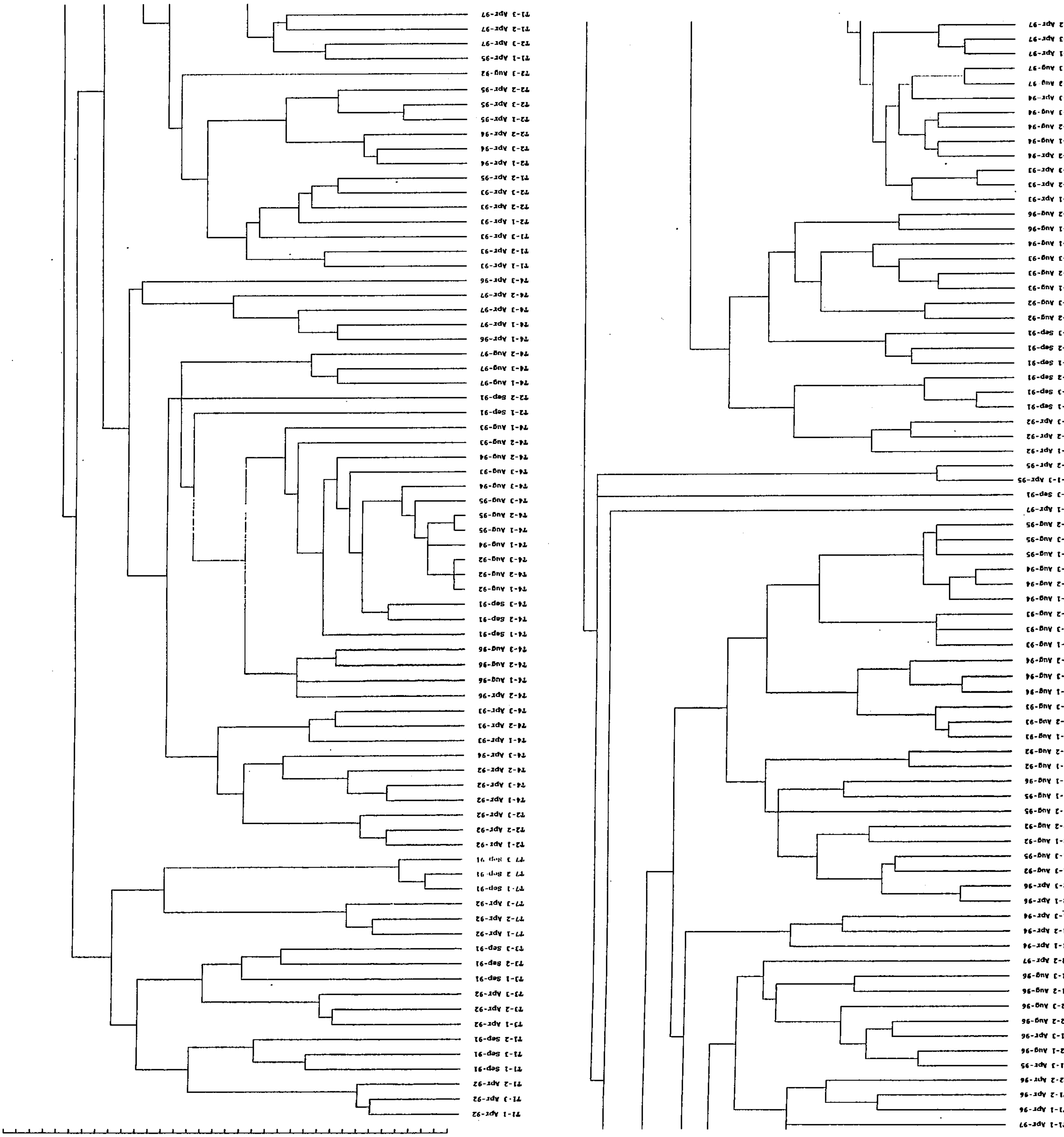
								Sanders-Hurlbert									
		No.	Tot	Shannon		Brillouin		E(Sn),0 if Sample total <n									
Sample	Date	Ind	Spp	H′	J′	H	V	2	10	17	50	100	200	500	Log-Series alpa	Dev fromlog series	Abs diff from log series
T7-1	Aug-92	1710	24	2.6	0.6	1.8	0.6	1.8	4.7	5.8	7.6	9.1	11.4	16.1	4.0	0.7	0.3
T7-2	Aug-92	1836	26	2.5	0.5	1.7	0.5	1.8	4.5	5.4	7.6	9.4	11.8	16.4	4.3	0.7	0.3
T7-3	Aug-92	354	12	2.1	0.6	1.4	0.6	1.7	3.9	4.8	6.7	8.2	10.1	0.0	2.4	0.9	0.1
Mean		**1300.0**	**33**	**2.4**	**0.6**	**1.6**	**0.6**	**1.8**	**4.4**	**5.3**	**7.3**	**8.9**	**11.1**	**N/A**			
T7-1	Apr-93	919	14	2.2	0.6	1.5	0.6	1.8	4.1	4.7	5.9	7.1	8.6	11.4	2.3	0.8	0.2
T7-2	Apr-93	531	14	2.3	0.6	1.5	0.6	1.8	4.2	4.9	6.7	8.2	10.2	13.7	2.6	0.8	0.2
T7-3	Apr-93	255	14	2.2	0.6	1.5	0.6	1.7	4.0	5.0	7.8	10.0	12.8	0.0	3.2	0.9	0.2
Mean		**568.33**	**22**	**2.2**	**0.6**	**1.5**	**0.6**	**1.8**	**4.1**	**4.9**	**6.8**	**8.4**	**10.5**	**N/A**			
T7-1	Aug-93	1216	25	2.6	0.6	1.7	0.6	1.8	4.5	5.5	8.3	10.8	13.7	18.6	4.5	0.8	0.3
T7-2	Aug-93	974	27	2.6	0.5	1.7	0.5	1.8	4.4	5.5	8.6	11.4	15.0	21.1	5.1	0.7	0.3
T7-3	Aug-93	1531	26	2.7	0.6	1.9	0.6	1.8	4.9	6.0	8.4	10.4	13.0	17.8	4.5	0.7	0.3
Mean		**1240.3**	**34**	**2.6**	**0.6**	**1.8**	**0.6**	**1.8**	**4.6**	**5.7**	**8.4**	**10.9**	**13.9**	**19.2**			
T7-1	Apr-94	289	19	2.7	0.6	1.8	0.6	1.8	4.7	6.0	9.6	12.8	16.8	0.0	4.6	0.8	0.2
T7-2	Apr-94	291	22	3.2	0.7	2.1	0.7	1.8	5.6	7.4	12.1	16.1	20.1	0.0	5.5	0.9	0.1
T7-3	Apr-94	649	25	2.7	0.6	1.8	0.6	1.8	4.8	6.2	9.6	12.5	16.2	22.6	5.2	0.8	0.2
Mean		**409.67**	**31**	**2.9**	**0.6**	**1.9**	**0.6**	**1.8**	**5.0**	**6.5**	**10.4**	**13.8**	**17.7**	**7.5**			
T7-1	Aug-94	996	26	3.1	0.7	2.1	0.7	1.8	5.6	7.3	11.3	14.1	17.3	22.4	4.9	0.9	0.1
T7-2	Aug-94	1148	29	3.0	0.6	2.0	0.6	1.8	5.3	6.9	11.0	14.2	17.7	23.2	5.4	0.9	0.1
T7-3	Aug-94	696	26	2.9	0.6	1.9	0.6	1.8	5.1	6.4	9.8	12.8	16.5	23.1	5.3	0.8	0.2
Mean		**946.67**	**37**	**3.0**	**0.6**	**2.0**	**0.6**	**1.8**	**5.3**	**6.9**	**10.7**	**13.7**	**17.2**	**22.9**			
T7-1	Apr-95	1160	22	1.8	0.4	1.2	0.4	1.6	3.2	3.9	6.7	9.6	13.2	18.2	3.9	0.6	0.4
T7-2	Apr-95	282	18	2.7	0.7	1.8	0.7	1.8	4.9	6.3	9.8	12.6	16.1	0.0	4.3	0.9	0.1
T7-3	Apr-95	279	17	2.8	0.7	1.8	0.7	1.8	5.0	6.3	9.3	11.5	14.7	0.0	4.0	0.9	0.1
Mean		**573.67**	**27**	**2.4**	**0.6**	**1.6**	**0.6**	**1.7**	**4.4**	**5.5**	**8.6**	**11.2**	**14.7**	**N/A**			
T7-1	Aug-95	5582	40	2.1	0.4	1.5	0.4	1.7	3.8	4.7	7.3	9.5	12.4	17.7	5.8	0.6	0.5
T7-2	Aug-95	2514	36	2.6	0.5	1.8	0.5	1.8	4.5	5.6	8.6	11.1	14.2	19.9	6.0	0.6	0.4
T7-3	Aug-95	2315	31	2.5	0.5	1.7	0.5	1.7	4.6	6.0	9.1	10.9	13.2	18.0	5.1	0.7	0.3
Mean		**3470.3**	**44**	**2.4**	**0.5**	**1.7**	**0.5**	**1.7**	**4.3**	**5.4**	**8.3**	**10.5**	**13.3**	**18.5**			
T7-1	Apr-96	835	20	2.3	0.5	1.6	0.5	1.7	4.2	5.3	8.0	10.1	13.0	17.4	3.7	0.8	0.2
T7-2	Apr-96	287	18	2.9	0.7	1.9	0.7	1.8	5.2	6.5	9.5	12.2	15.8	0.0	4.3	0.9	0.1
T7-3	Apr-96	306	16	2.6	0.7	1.7	0.7	1.8	4.9	6.3	9.2	11.3	14.0	0.0	3.6	0.9	0.1
Mean		**476.00**	**31**	**2.6**	**0.6**	**1.7**	**0.6**	**1.8**	**4.8**	**6.0**	**8.9**	**11.2**	**14.3**	**N/A**			
T7-1	Aug-96	358	18	2.8	0.7	1.9	0.7	1.8	5.1	6.6	10.4	13.1	15.6	0.0	4.0	1.0	0.0
T7-2	Aug-96	479	26	2.9	0.6	1.9	0.6	1.8	5.1	6.5	10.4	14.0	18.7	0.0	5.9	0.8	0.2
T7-3	Aug-96	480	23	3.0	0.7	2.0	0.7	1.8	5.3	7.0	11.5	14.9	18.6	0.0	5.0	0.9	0.1
Mean		**439.00**	**32**	**2.9**	**0.7**	**1.9**	**0.7**	**1.8**	**5.2**	**6.7**	**10.8**	**14.0**	**17.6**	**N/A**			
T7-1	Apr-97	201	18	2.9	0.7	1.9	0.7	1.8	5.2	6.7	10.6	13.7	18.0	0.0	4.8	0.9	0.1
T7-2	Apr-97	756	28	2.9	0.6	2.0	0.6	1.8	5.2	6.5	9.8	12.9	17.2	24.4	5.7	0.8	0.3
T7-3	Apr-97	859	26	2.7	0.6	1.8	0.6	1.8	4.6	5.8	9.2	12.4	16.1	21.9	5.1	0.8	0.2
Mean		**605.33**	**39**	**2.8**	**0.6**	**1.9**	**0.6**	**1.8**	**5.0**	**6.3**	**9.9**	**13.0**	**17.1**	**N/A**			

								Sanders-Hurlbert									
		No.	Tot	Shannon		Brillouin		E(Sn),0 if Sample total <n									
Sample	Date	Ind	Spp	H′	J′	H	V	2	10	17	50	100	200	500	Log-Series alpa	Dev fromlog series	Abs diff from log series
T7-1	Aug-97	1708	28	2.9	0.6	2.0	0.6	1.8	5.3	6.5	9.5	11.8	14.8	19.6	4.8	0.8	0.2
T7-2	Aug-97	1005	21	3.0	0.7	2.0	0.7	1.8	5.4	6.8	9.7	11.9	14.5	18.0	3.8	1.1	0.1
T7-3	Aug-97	972	23	2.9	0.6	1.9	0.6	1.8	5.2	6.6	9.2	11.4	14.4	19.4	4.2	0.8	0.2
Mean		**1228.3**	**34**	**2.9**	**0.6**	**2.0**	**0.6**	**1.8**	**5.3**	**6.6**	**9.5**	**11.7**	**14.6**	**19.0**			
T8-1	Sep-91	1377	36	3.3	0.6	2.2	0.6	1.8	5.7	7.7	12.7	16.4	20.5	27.1	6.8	0.9	0.1
T8-2	Sep-91	1871	38	3.0	0.6	2.1	0.6	1.8	5.2	7.0	12.0	15.8	20.1	26.8	6.8	0.8	0.2
T8-3	Sep-91	3027	45	3.1	0.6	2.1	0.6	1.8	5.2	6.9	12.5	17.2	22.0	28.7	7.5	0.8	0.2
Mean		**2091.6**	**53**	**3.1**	**0.6**	**2.1**	**0.6**	**1.8**	**5.4**	**7.2**	**12.4**	**16.5**	**20.9**	**27.5**			
T8-1	Apr-92	1234	30	3.0	0.6	2.0	0.6	1.8	5.3	7.0	11.3	14.5	18.0	23.4	5.6	0.9	0.1
T8-2	Apr-92	1053	31	3.0	0.6	2.0	0.6	1.8	5.2	7.0	11.2	14.3	17.7	23.5	6.0	0.8	0.2
T8-3	Apr-92	780	22	2.9	0.7	2.0	0.7	1.8	5.2	6.9	11.1	14.1	17.0	20.6	4.2	1.1	0.1
Mean		**1022.3**	**44**	**3.0**	**0.6**	**2.0**	**0.6**	**1.8**	**5.2**	**7.0**	**11.2**	**14.3**	**17.6**	**22.5**			
T8-1	Aug-92	4125	40	2.0	0.4	1.3	0.4	1.5	3.6	4.8	8.3	11.4	15.3	21.4	6.1	0.6	0.4
T8-2	Aug-92	3784	45	3.1	0.6	2.1	0.6	1.8	5.3	7.2	12.4	16.3	20.8	27.5	7.2	0.8	0.2
T8-3	Aug-92	3950	44	3.0	0.6	2.1	0.6	1.7	5.2	7.3	13.2	17.6	22.6	29.8	6.9	0.8	0.2
Mean		**3953.0**	**59**	**2.7**	**0.5**	**1.8**	**0.5**	**1.7**	**4.7**	**6.4**	**11.3**	**15.1**	**19.6**	**26.2**			
T8-1	Apr-93	1450	29	2.6	0.5	1.8	0.5	1.8	4.6	5.5	8.0	10.5	14.1	20.1	5.1	0.7	0.4
T8-2	Apr-93	1608	26	2.5	0.5	1.7	0.5	1.8	4.4	5.2	7.4	10.0	13.5	18.9	4.4	0.7	0.3
T8-3	Apr-93	1870	36	2.8	0.6	1.9	0.6	1.8	5.0	6.1	8.9	11.6	15.3	21.7	6.3	0.6	0.4
Mean		**1642.6**	**45**	**2.6**	**0.5**	**1.8**	**0.5**	**1.8**	**4.7**	**5.6**	**8.1**	**10.7**	**14.3**	**20.2**			
T8-1	Aug-93	5225	52	2.7	0.5	1.8	0.5	1.7	4.5	6.1	11.0	15.2	20.0	27.4	8.0	0.7	0.3
T8-2	Aug-93	5474	55	2.9	0.5	2.0	0.5	1.7	4.9	6.8	12.5	17.1	22.2	29.8	8.5	0.7	0.3
T8-3	Aug-93	5324	49	2.3	0.4	1.6	0.4	1.6	4.1	5.6	10.0	13.8	18.3	25.4	7.5	0.6	0.4
Mean		**5341.0**	**70**	**2.6**	**0.5**	**1.8**	**0.5**	**1.7**	**4.5**	**6.2**	**11.2**	**15.4**	**20.2**	**27.5**			
T8-1	Apr-94	1050	37	3.7	0.7	2.5	0.7	1.9	6.4	8.9	16.0	21.4	26.6	32.7	7.5	1.1	0.1
T8-2	Apr-94	1078	36	3.4	0.7	2.3	0.7	1.9	6.2	8.1	12.3	15.7	20.0	27.6	7.2	0.8	0.2
T8-3	Apr-94	1321	41	3.6	0.7	2.5	0.7	1.9	6.3	8.6	14.4	18.8	23.8	31.1	8.0	0.9	0.1
Mean		**1149.6**	**54**	**3.6**	**0.7**	**2.4**	**0.7**	**1.9**	**6.3**	**8.5**	**14.2**	**18.6**	**23.5**	**30.5**			
T8-1	Aug-94	8785	57	2.4	0.4	1.7	0.4	1.6	4.1	5.8	10.9	15.6	21.2	29.5	8.2	0.6	0.4
T8-2	Aug-94	1274	40	3.3	0.6	2.3	0.6	1.9	5.9	7.7	11.8	15.5	20.1	28.2	7.9	0.8	0.3
T8-3	Aug-94	723	37	3.7	0.7	2.5	0.7	1.9	6.6	9.0	14.5	18.6	23.7	32.5	8.3	0.9	0.1
Mean		**3594.0**	**70**	**3.1**	**0.6**	**2.2**	**0.6**	**1.8**	**5.5**	**7.5**	**12.4**	**16.6**	**21.7**	**30.1**			
T8-1	Apr-95	586	34	3.4	0.7	2.2	0.7	1.9	5.9	7.8	13.2	17.5	22.6	31.9	7.9	0.8	0.2
T8-2	Apr-95	623	28	3.3	0.7	2.2	0.7	1.9	5.9	7.6	11.8	15.3	19.7	26.3	6.0	0.9	0.1
T8-3	Apr-95	346	18	2.7	0.6	1.8	0.6	1.8	4.7	6.1	10.1	13.5	16.7	0.0	4.0	0.9	0.1
Mean		**518.33**	**44**	**3.1**	**0.7**	**2.1**	**0.7**	**1.9**	**5.5**	**7.2**	**11.7**	**15.4**	**19.7**	**N/A**			
T8-1	Aug-95	1023	33	3.4	0.7	2.3	0.7	1.9	6.0	8.0	12.4	15.5	19.5	27.0	6.5	0.9	0.2
T8-2	Aug-95	477	24	3.4	0.8	2.3	0.8	1.9	6.2	8.2	13.1	16.9	20.6	0.0	5.3	1.1	0.1
T8-3	Aug-95	744	46	4.0	0.7	2.7	0.7	1.9	6.9	9.6	16.7	22.6	29.7	40.7	10.8	0.9	0.1
Mean		**748.00**	**56**	**3.6**	**0.7**	**2.4**	**0.7**	**1.9**	**6.4**	**8.6**	**14.1**	**18.3**	**23.3**	**N/A**			

Sample	Date	No. Ind	Tot Spp	Shannon H′	Shannon J′	Brillouin H	Brillouin V	Sanders-Hurlbert E(Sn),0 if Sample total <n 2	10	17	50	100	200	500	Log-Series alpa	Dev fromlog series	Abs diff from log series
T8-1	Apr-96	3486	51	3.1	0.5	2.1	0.5	1.8	5.2	6.8	11.4	15.6	21.0	29.2	8.5	0.7	0.3
T8-2	Apr-96	9073	52	2.8	0.5	1.9	0.5	1.8	4.9	6.2	9.5	12.5	16.7	23.6	7.3	0.6	0.4
T8-3	Apr-96	7930	50	2.8	0.5	1.9	0.5	1.8	4.8	6.1	9.1	11.7	15.1	21.4	7.1	0.6	0.4
Mean		**6829.6**	**70**	**2.9**	**0.5**	**2.0**	**0.5**	**1.8**	**5.0**	**6.4**	**10.0**	**13.3**	**17.6**	**24.7**			
T8-1	Aug-96	6160	51	2.2	0.4	1.5	0.4	1.5	3.8	5.3	9.9	13.7	18.2	25.6	7.6	0.6	0.4
T8-2	Aug-96	6562	53	2.2	0.4	1.5	0.4	1.6	3.9	5.4	9.6	13.1	17.4	24.0	7.9	0.6	0.4
T8-3	Aug-96	1046	30	3.3	0.7	2.2	0.7	1.8	5.8	7.7	12.5	16.2	20.3	26.1	5.8	1.0	0.1
Mean		**4589.3**	**64**	**2.6**	**0.5**	**1.7**	**0.5**	**1.6**	**4.5**	**6.1**	**10.7**	**14.3**	**18.6**	**25.2**			
T8-1	Apr-97	965	34	3.4	0.7	2.3	0.7	1.9	6.0	8.2	13.6	17.6	22.2	29.2	6.9	0.9	0.1
T8-2	Apr-97	5388	52	2.7	0.5	1.8	0.5	1.8	4.6	5.8	8.7	11.5	15.2	22.1	8.0	0.6	0.5
T8-3	Apr-97	1092	35	3.1	0.6	2.1	0.6	1.8	5.4	7.4	12.5	16.3	20.7	27.8	6.9	0.9	0.1
Mean		**2481.6**	**60**	**3.1**	**0.6**	**2.1**	**0.6**	**1.8**	**5.3**	**7.1**	**11.6**	**15.1**	**19.4**	**26.4**			
T8-1	Aug-97	3719	48	3.0	0.5	2.1	0.5	1.8	5.1	7.0	12.5	17.1	22.3	30.1	7.8	0.8	0.2
T8-2	Aug-97	1082	57	2.4	0.4	1.7	0.4	1.6	4.2	5.8	10.4	14.2	18.9	26.1	7.9	0.6	0.4
T8-3	Aug-97	2565	41	3.2	0.6	2.2	0.6	1.8	5.5	7.4	12.1	15.8	20.4	27.9	6.9	0.8	0.2
Mean		**2455.3**	**67**	**2.9**	**0.5**	**2.0**	**0.5**	**1.7**	**4.9**	**6.7**	**11.7**	**15.7**	**20.5**	**28.0**			

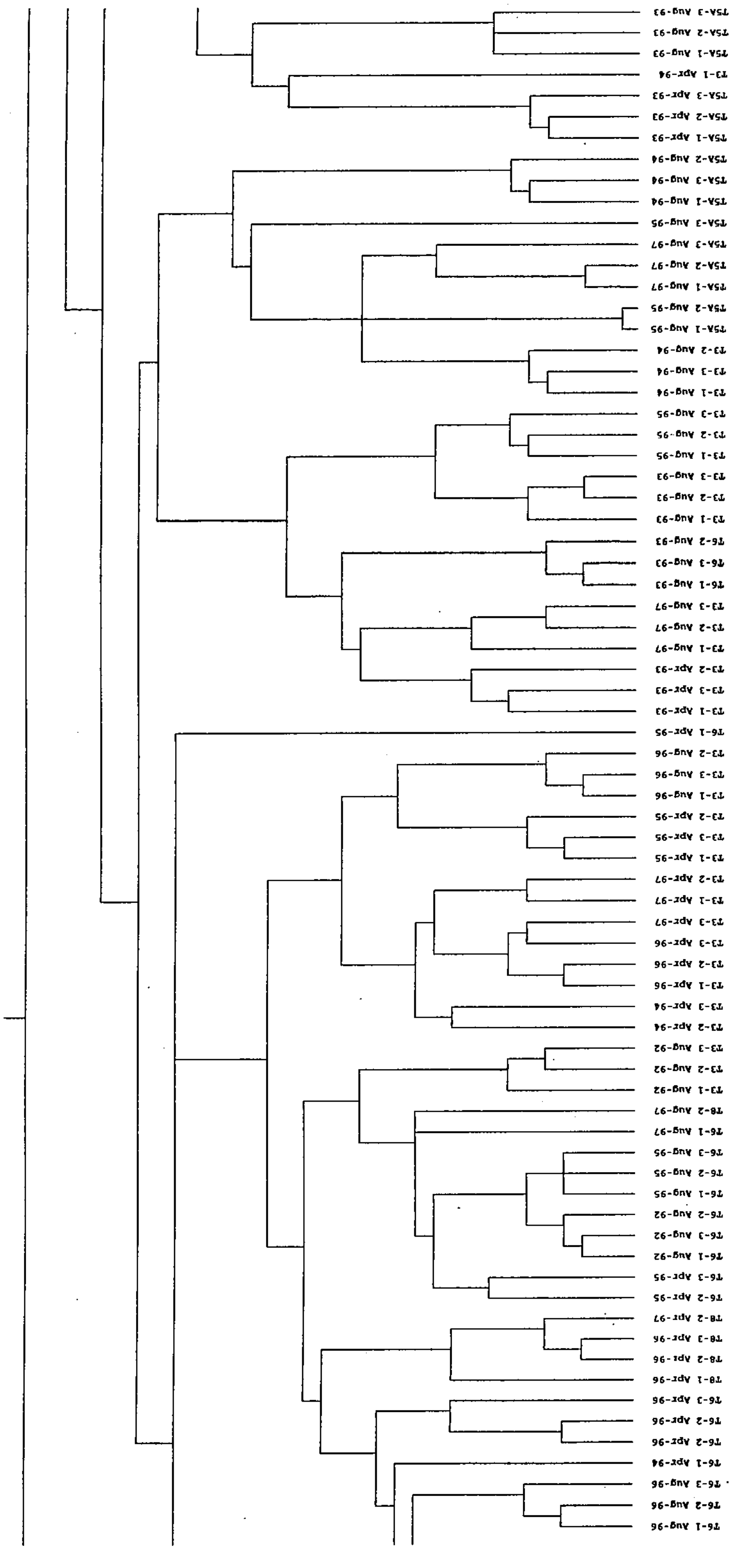
Appendix H

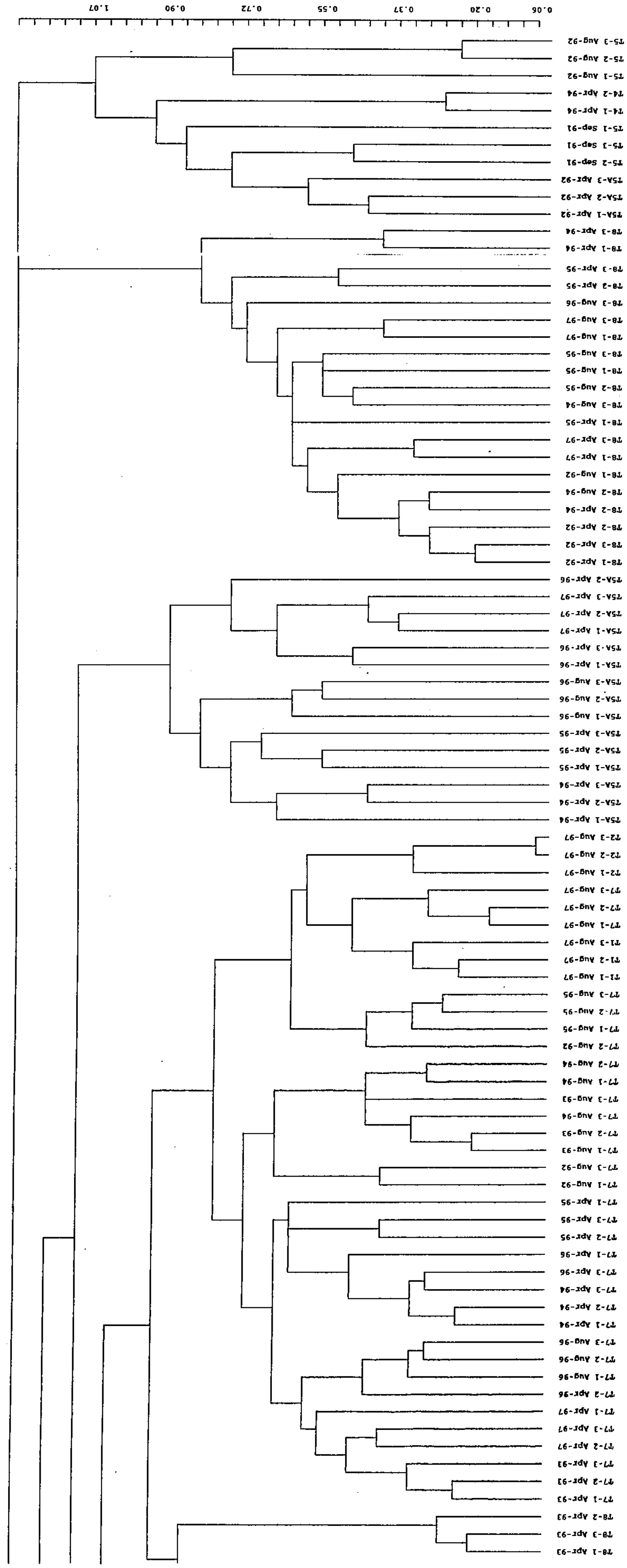
Cluster Analysis of 1991-1997 Boston Harbor Benthic Samples

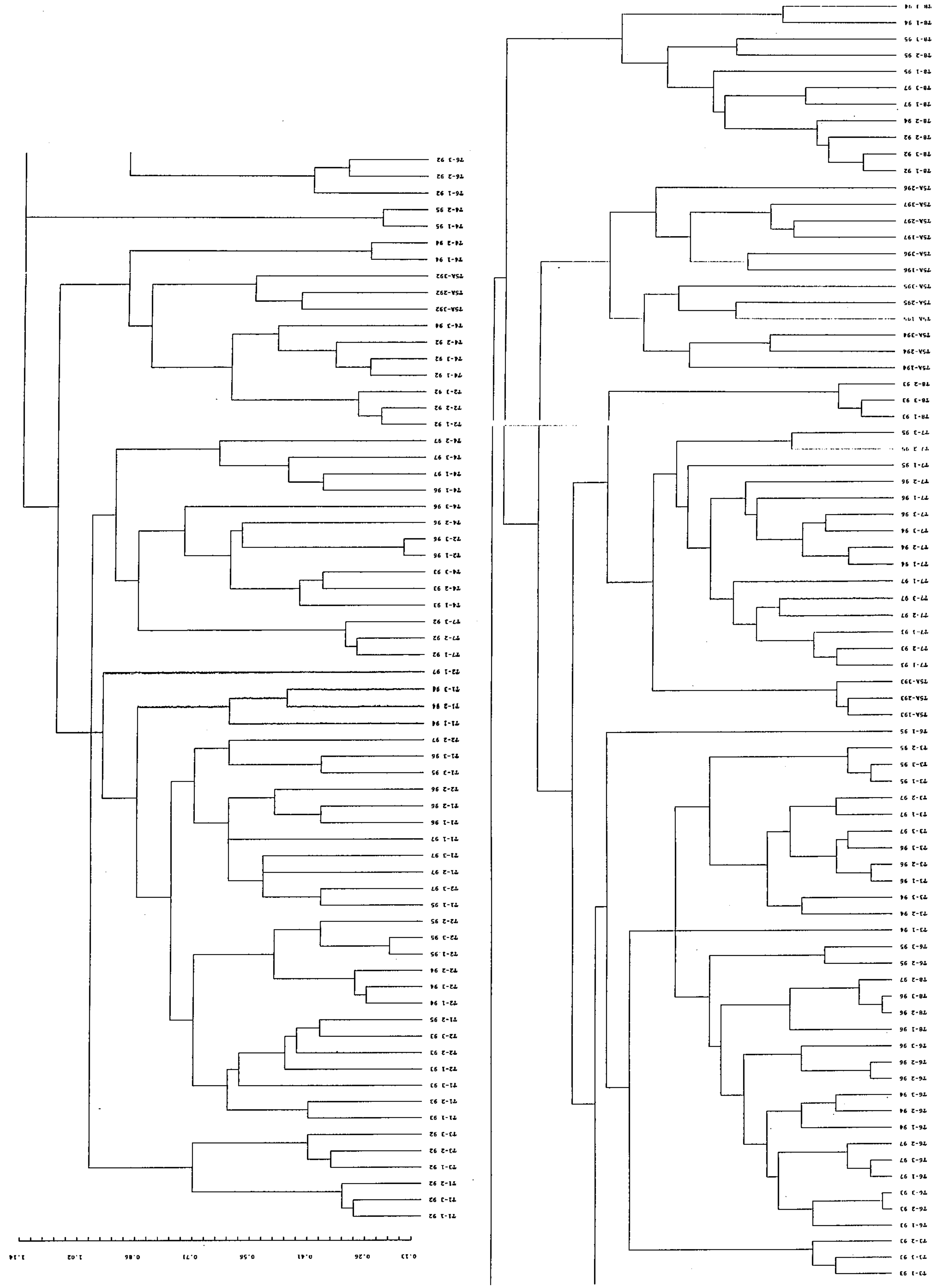


Appendix H1. Cluster analysis of all 311 Boston Harbor benthic samples for the period September 1991 through August 1997.

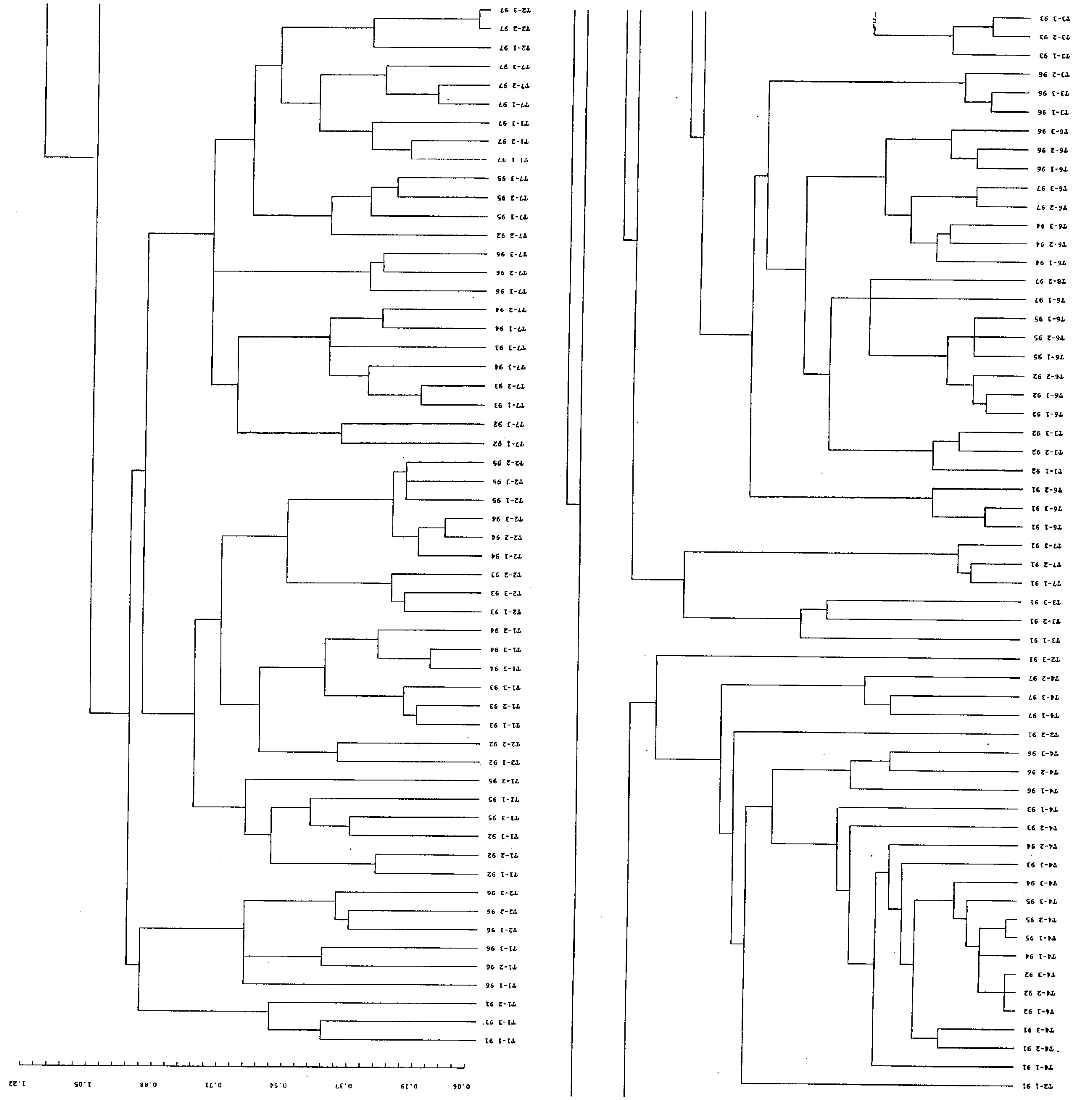
H1, cont'd.



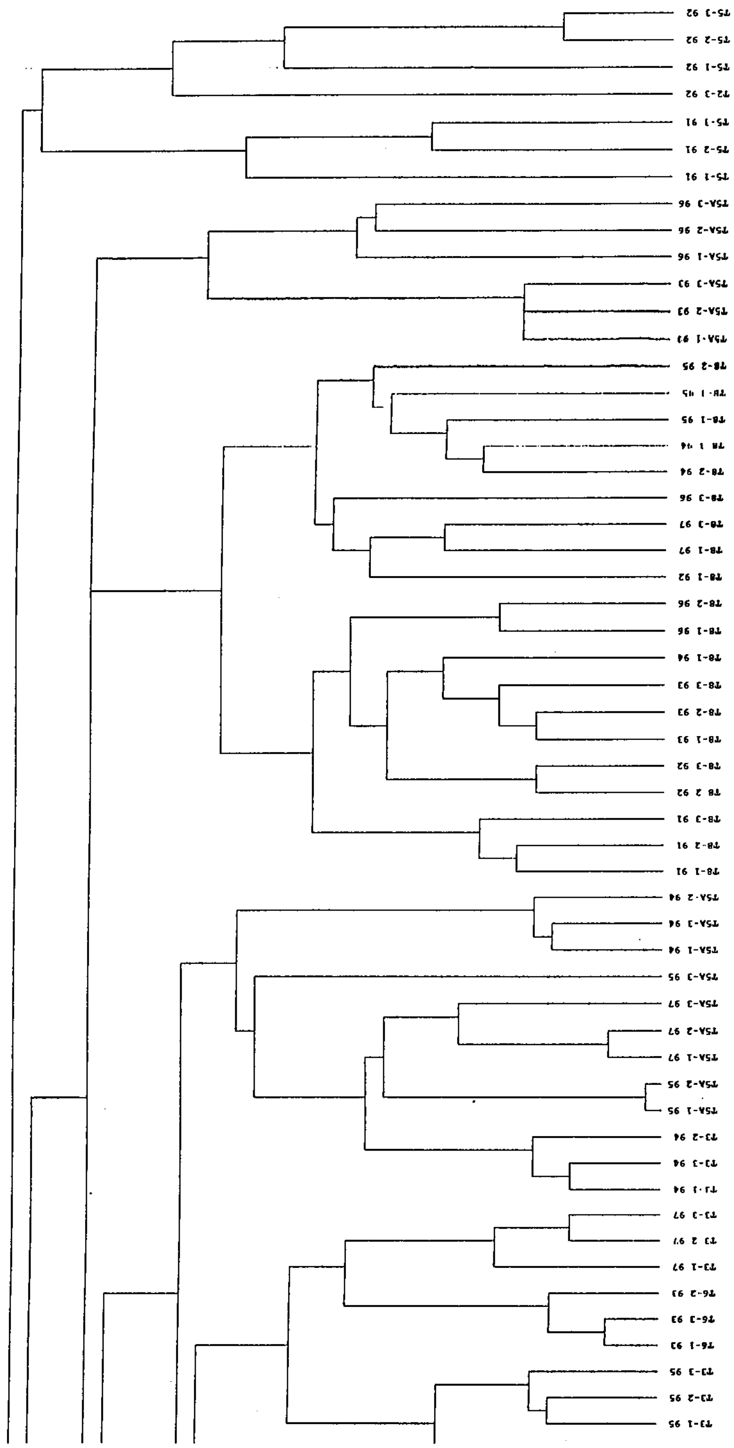




Appendix H2. Cluster analysis of the 143 Spring Boston Harbor benthic samples for the period May 1992 through May 1997.



Appendix H3. Cluster analysis of the 168 Summer Boston Harbor benthic samples for the period September 1991 through August 1997.


T5-3 92
T5-2 92
T5-1 92
T2-3 92
T5-1 91
T5-2 91
T5-1 91
T5A-3 96
T5A-2 96
T5A-1 96
T5A-3 93
T5A-2 93
T5A-1 93
T8-2 95
T8-1 95
T8-1 95
T8 1 94
T8-2 94
T8-3 96
T8-3 97
T8-1 97
T8-1 92
T8-2 96
T8-1 96
T8-1 94
T8-3 93
T8-2 93
T8-1 93
T8-3 92
T8 2 92
T8-3 91
T8-2 91
T8-1 91
T5A-2 94
T5A-3 94
T5A-1 94
T5A-3 95
T5A-3 97
T5A-2 97
T5A-1 97
T5A-2 95
T5A-1 95
T3-2 94
T3-3 94
T3-1 94
T3-3 97
T3 2 97
T3-1 97
T6-3 93
T6-3 93
T6-1 93
T3-3 95
T3-2 95
T3-1 95

H3, cont'd.

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