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U.S. Department of Commerce

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**ABSTRACT**

The benthic macrofauna of the New York Bight has been monitored extensively, primarily to determine trends over space and time in biological effects of waste inputs. In the present study, from 44 to 48 stations were sampled each summer from 1980–1985. Data from other Bight benthic studies are included to extend the temporal coverage from 1979 to 1989. Numbers of species and amphipods per sample, taken as relatively sensitive indicators of environmental stress, showed consistent spatial patterns. Lowest values were found in the Christiaensen Basin and other inshore areas, and numbers increased toward the outermost shelf and Hudson Shelf Valley stations. There were statistically significant decreases in species and amphipods at most stations from 1980 to 1985. (Preliminary data from a more recent study suggest numbers of species increased again between 1986 and 1989.) Cluster analysis of 1980–85 data indicated several distinct assemblages—sewage sludge dumpsite, sludge accumulation area, inner Shelf Valley, outer Shelf Valley, outer shelf—with little change over time. The "enriched" and "highly altered" assemblages in the Basin appear similar to those reported since sampling began there in 1968. No consistently defaunated areas have been found in any sampling programs over the past 20 years. On a gross level, therefore, recent faunal responses to any environmental changes are not evident, but the more sensitive measures used, i.e. numbers of species and amphipods, do indicate widespread recent effects. Causes of the faunal changes are not obvious; some possibilities, including increasing effects of sewage sludge or other waste inputs, natural factors, and sampling artifacts, are discussed.

## Introduction

The "apex" (northwest corner) of the New York Bight (Figs. 1, 2) has long received large organic carbon and toxicant inputs from the Hudson-Raritan estuary (since the 1800s) and from dumping of dredged material (since 1914) and sewage sludge (1924), with smaller inputs from several other sources (Mueller et al. 1976; New York City Department of Environmental Protection 1983; Stanford and Young 1988). Fates and biological effects of the introduced contaminants have been studied extensively; see Gross (1976) and Mayer (1982) for symposia reviewing Bight studies. Among the objectives have been to determine overall contaminant influences, to partition influences among the various sources, and to detect changes over time in fates and effects.

This report concentrates on benthic macrofauna as indicators of environmental change in the Bight. Benthic macrofauna (hereafter called "benthos," meaning the bottom-living invertebrates collected in "grab" samples and retained on sieves of 0.5–1.0 mm mesh size) are often used in this context. Their relative immobility and intimate association with contaminant-accumulating sediments make them among the best biological indicators of effects of contaminants and of environmental change in general (Kuiper 1986; Jackson and Resh 1989). The benthos is also monitored to assess actual or potential importance of an area as a food and contaminant source for bottom-feeding resource species. Some discussion of the Bight benthos in these contexts is given elsewhere (e.g., Boesch 1982; Steimle 1985).

There have been at least 17 major sediment-benthos sampling efforts in the Bight, beginning in 1966 (*see* Reid and Steimle [1988] for a summary of existing surveys). The largest was NOAA's Marine Ecosystems Analysis (MESA)-New York Bight

Project, with sampling from 1973–1976. One of the products of the MESA program was a recommendation for continued monitoring of several components of the Bight's ecosystem, including sediments and benthos. The monitoring plan proposed was described in Reid et al. (1982). The sediment-benthos portion of the plan was modified somewhat (*see* Methods), and annual sampling was conducted from 1980 through 1985.

This report presents data collected on macrobenthic species richness, numbers and biomass of dominant species, numbers of amphipods, and similarities of community structure over space and time. Raw data are available on request. The report also includes relevant data from NOAA's Northeast Monitoring Program (NEMP) (Reid et al. 1987), and initial data from a 1986–89 study of responses of the benthos to the phaseout of sewage sludge dumping in the Bight apex (Environmental Processes Division, Northeast Fisheries Center 1988, 1991). Data from this report provide baselines against which responses to phaseout can be measured. These data may also be useful in guiding future decisions such as where to relocate the present dredged material dumpsite and where and how to mine sand to minimize impacts on benthos (and potentially on resource species which interact with benthos).

## Methods

The basic monitoring scheme involved sampling 44 to 48 stations (Figs. 1, 2) each summer from 1980 through 1985. The annual samplings were conducted on 28 July–5 August 1980, 10–19 August 1981, 9–15 September 1982, 19–21 July and 22 August–7 September 1983, 21–31 August 1984, and 30 September–5 October 1985 (Table 1).

Six of the stations (4, 6, 7, 15, 26, and 31) were also part of the NEMP benthic program. These stations were sampled semiannually beginning in December 1979, and resulting data are included to extend the study's temporal coverage. For the same reason, preliminary data from a more recent study of benthic responses to the phaseout of sewage sludge disposal in the inner Bight are also presented. Stations 6 and 11 of the annual monitoring surveys were used as the "sludge accumulation" and "reference" stations, respectively, for the phaseout study. July, August, and September 1986–1989 samplings at these stations are also included to extend the report's temporal coverage (only data on numbers of species and of *Capitella* spp. for 1988, and preliminary data on species numbers for 1989, are available) (Environmental Processes Division, 1991).

In the annual monitoring survey, one sample per station was taken in 1980 and 1981, and two samples in 1982–85. The NEMP program took five samples per station, and the phaseout study, three samples. Table 1 gives dates on which individual stations were sampled, as well as numbers of samples analyzed, station locations and depths, and sediment grain sizes, carbon and nitrogen contents.

Loran C, with a nominal accuracy of ±50 m (Holme and McIntyre 1984), was used to locate stations. Samples were taken with a 0.1-$m^2$ Smith-McIntyre grab. Plastic tubes of 2.7-cm inner diameter were used to take one subsample from each grab for analysis of sediment grain size, organic carbon and nitrogen, and one subsample for heavy metals. The remainder of each grab was rinsed through a 0.5-mm sieve. Retained materials were fixed immediately in 10% buffered formalin with Rose Bengal biological stain, and were transferred to 70% ethanol with 5% glycerin one to three days later. After storage for at least six months, samples were sorted using dissecting microscopes. Identifications were to species level whenever possible, except for rhynchocoels. Oligochaetes, archiannelids, and colonial forms were not enumerated owing to uncertainty of identification and/or difficulty of quantification. Wet weight biomasses were determined by blot-drying each taxon on absorbent toweling for 3 minutes and weighing to the nearest milligram on an electronic balance.

Spatial contours of numbers of species and amphipods were drawn using Surface II software (Sampson 1978). In an exploratory attempt to describe trends in numbers of species and amphipods over time, linear regressions were calculated from the species and amphipod versus time data. The data are not ideally suited for linear regression analysis, for several reasons. Changes in the "dependent" variables, numbers of species and amphipods, are not actually caused by changes in the "independent" variable, time. There was no *a priori* hypothesis except for the implicit one that numbers of species and amphipods would not change over the course of the study unless there were underlying environmental change (the analysis does not address the processes behind any trends detected). A linear fit to the data may not best represent the underlying processes, but exploring non-linear fits may not be justified when those processes are not postulated *a priori.* However, the analysis does provide an objective way of describing and comparing trends. Time series or trend analysis could not be used

**Table 1**

Location, depth, mean grain size, carbon and nitrogen, and numbers of benthic samples analyzed for each New York Bight station and survey. The depth, grain size, carbon and nitrogen data are from summer 1980. TOC = total organic carbon; TKN = total Kjeldahl nitrogen.

| Station | Latitude (°N) | Longitude (°W) | Depth (m) | Mean Grain Size (phi units) | TOC (mg/g dry wt.) | TKN (mg/g dry wt.) | Months sampled (number of samples) 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 40°26.9' | 73°48.1' | 27 | 3.71 | 9.4 | 1.1 | | Jul (1) | Aug (1) | Sep (2) | Jul (2) | Aug (2) | Oct (2) |
| 2 | 40°28.2' | 73°45.8' | 29 | 3.35 | 10.1 | 1.4 | | Jul (1) | Aug (1) | Sep (2) | Jul (2)<br>Aug (2) | Aug (2) | Sep (2) |
| 3 | 40°28.0' | 73°43.8' | 28 | 3.43 | 7.1 | 0.83 | | Jul (1) | Aug (1) | Sep (2) | Jul (2) | Aug (2) | Oct (2) |
| 4[a] | 40°25.0' | 73°52.0' | 22 | 2.01 | 3.0 | 0.26 | Dec (5) | Jul (4)<br>Dec (5) | Aug (5) | Jan (5)<br>Sep (5) | Jul (5) | Aug (5) | Jun (5)<br>Oct (2) |
| 5 | 40°24.9' | 73°48.0' | 35 | 4.19 | 16.0 | 1.9 | | Aug (1) | Aug (1) | Sep (2) | Jul (2)<br>Aug (2) | Aug (2) | Oct (2) |
| 6[a,b] | 40°25.0' | 73°46.0' | 27 | 2.73 | 11.3 | 0.90 | Dec (5) | Jul (5)<br>Dec (5) | Aug (5) | Jan (5)<br>Sep (5)<br>Nov (5) | Jul (5)<br>Aug (2)<br>Nov (5) | Aug (5) | Jun (5)<br>Oct (2) |
| 7[a] | 40°25.0' | 73°44.0' | 25 | 1.86 | 2.4 | 0.21 | Dec (5) | Jul (5)<br>Dec (5) | Aug (5) | Jan (5)<br>Sep (5)<br>Nov (5) | Jul (5)<br>Nov (5) | Aug (5) | Jun (5)<br>Oct (2) |
| 8 | 40°21.8' | 73°51.6' | 24 | 2.37 | 34.0 | 1.5 | | Jul (1) | Aug (1) | Sep (2) | Jul (2)<br>Aug (2) | Aug (2) | Oct (2) |
| 9 | 40°21.6' | 73°47.8' | 36 | 3.49 | 13.0 | 1.5 | | Jul (1) | Aug (1) | Sep (2) | Jul (2) | Aug (2) | Oct (2) |
| 10 | 40°20.2' | 73°49.1' | 61 | −0.24 | 1.6 | 0.17 | | Jul (1) | Aug (1) | Sep (2) | Jul (2) | Aug (2) | Oct (2) |
| 11[b] | 40°19.1' | 73°45.8' | 31 | 3.3 | 5.1 | 0.71 | | Jul (1) | Aug (1) | Sep (2) | Jul (2) | Aug (2) | Oct (2) |
| 12 | 40°12.8' | 73°44.0' | 38 | 3.29 | 5.5 | 0.70 | | Jul (1) | Aug (1) | Sep (2) | Jul (2) | Aug (2) | Oct (2) |
| 13 | 40°09.8' | 73°41.9' | 56 | 4.25 | 11.0 | 1.8 | | Jul (1) | Aug (1) | Sep (2) | Jul (2) | Aug (2) | Oct (2) |
| 14 | 40°47.3' | 72°59.0' | 74 | 2.01 | 4.9 | 0.73 | | Aug (1) | Aug (1) | Sep (2) | Sep (2) | Aug (2) | Oct (2) |
| 15[a] | 40°01.4' | 73°25.6' | 62 | 3.31 | 8.4 | 1.0 | Dec (5) | Aug (5)<br>Dec (5) | Aug (5) | Jan (5)<br>Aug (5) | | Aug (5) | Jun (5)<br>Oct (2) |
| 16 | 40°07.6' | 73°36.8' | 71 | 4.68 | 15.0 | 2.2 | | Aug (1) | Aug (1) | Sep (2) | Jul (2)<br>Sep (2) | Aug (2) | Oct (2) |
| 17 | 40°05.4' | 73°31.3' | 73 | 3.62 | 11.0 | 1.5 | | Aug (1) | Aug (1) | Sep (2) | Jul (2)<br>Sep (2) | Aug (2) | Oct (2) |
| 18 | 40°25.0' | 73°53.8' | 24 | 2.2 | 14.0 | 1.1 | | Jul (1) | Aug (1) | Sep (2) | Jul (2) | Aug (2) | Oct (2) |
| 19 | 40°16.0' | 73°57.8' | 14 | 1.76 | 0.86 | 0.15 | | Jul (1) | Aug (1) | Sep (2) | Jul (2) | Aug (2) | Oct (2) |
| 20 | 40°27.9' | 73°56.0' | 12 | 1.96 | 0.95 | 0.17 | | Jul (1) | Aug (1) | Sep (2) | Jul (2) | Aug (2) | Sep (2) |
| 21 | 40°31.1' | 73°45.9' | 21 | 3.15 | 12.0 | 1.5 | | Jul (1) | Aug (1) | Sep (2) | Jul (2) | Aug (2) | Sep (2) |
| 22 | 40°25.0' | 73°39.8' | 24 | 3.07 | 2.4 | 0.36 | | Jul (1) | Aug (1) | Sep (2) | Aug (2) | Aug (2) | Oct (2) |
| 23 | 39°29.9' | 74°10.1' | 16 | 1.01 | 0.46 | 0.09 | | Aug (1) | Aug (1) | Sep (2) | Sep (2) | Aug (2) | Oct (2) |
| 24 | 39°55.0' | 73°55.8' | 18 | −0.52 | 1.8 | 0.12 | | Aug (1) | Aug (1) | Sep (2) | Jul (2)<br>Sep (2) | Aug (2) | Oct (2) |
| 25 | 40°01.9' | 73°55.1' | 19 | 0.26 | 0.49 | 0.08 | | Aug (1) | Aug (1) | Sep (2) | Jul (2)<br>Sep (2) | Aug (2) | Oct (2) |
| 26[a] | 39°35.8' | 73°54.2' | 28 | 1.29 | 1.03 | 0.08 | Dec (5) | Aug (5)<br>Dec (5) | Aug (5) | Jan (5)<br>Sep (5) | Jun (5) | Aug (2) | Jun (5)<br>Oct (2) |

**Table 1 (continued)**

| Station | Latitude (°N) | Longitude (°W) | Depth (m) | Mean Grain Size (phi units) | TOC (mg/g dry wt.) | TKN (mg/g dry wt.) | Months sampled (number of samples) 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 | 39°44.7' | 73°44.9' | 26 | 1.21 | 0.58 | 0.10 | | Aug (1) | Aug (1) | Sep (2) | Sep (2) | Aug (2) | Oct (2) |
| 28 | 39°25.5' | 73°30.6' | 40 | 2.27 | 0.82 | 0.13 | | Aug (1) | Aug (1) | Sep (2) | Sep (2) | Aug (2) | Oct (2) |
| 29 | 40°14.3' | 73°15.9' | 38 | 1.09 | 0.63 | 0.13 | | Jul (1) | Aug (1) | Sep (2) | Sep (2) | Aug (2) | Oct (2) |
| 30 | 40°14.8' | 73°25.1' | 34 | 1.83 | 0.81 | 0.16 | | Jul (1) | Aug (1) | Sep (2) | Sep (2) | Aug (2) | Oct (2) |
| 31[a] | 40°25.6' | 73°11.1' | 30 | 1.43 | 0.71 | 0.11 | Dec (4) | Jul (5)<br>Dec (5) | Aug (5) | Jan (5)<br>Aug (5) | Jun (5) | Aug (5) | Jun (5)<br>Oct (2) |
| 32 | 40°24.2' | 72°58.3' | 38 | 1.19 | 0.51 | 0.14 | | Jul (1) | Aug (1) | Sep (2) | Sep (2) | Aug (2) | Oct (2) |
| 33 | 40°34.1' | 72°37.8' | 40 | 2.37 | 1.8 | 0.29 | | Jul (1) | Aug (1) | Sep (2) | Sep (2) | Aug (2) | Sep (2) |
| 34 | 40°25.8' | 72°19.8' | 54 | 1.77 | 3.4 | 0.46 | | Jul (1) | Aug (1) | Sep (2) | Sep (2) | Aug (2) | Oct (2) |
| 35 | 40°30.2' | 72°13.3' | 55 | 2.34 | 3.9 | 0.69 | | Jul (1) | Aug (1) | Sep (2) | Jul (2)<br>Sep (2) | Aug (2) | Oct (2) |
| 36 | 40°08.1' | 72°51.6' | 56 | 1.19 | 0.81 | 0.15 | | Aug (1) | Aug (1) | Sep (2) | Sep (2) | Aug (2) | Oct (2) |
| 37 | 40°04.9' | 72°50.2' | 54 | 1.41 | 1.0 | 0.17 | | Aug (1) | Aug (1) | Sep (2) | Sep (2) | Aug (2) | Oct (2) |
| 38 | 40°10.7' | 72°40.3' | 56 | 1.05 | 1.1 | 0.70 | | Aug (1) | Aug (1) | Sep (2) | Sep (2) | Aug (2) | Oct (2) |
| 39 | 40°14.3' | 73°02.0' | 42 | 1.42 | 0.79 | 0.12 | | Jul (1) | Aug (1) | Sep (2) | Sep (2) | Aug (2) | Oct (2) |
| 40 | 40°24.9' | 73°49.7' | 29 | 3.35 | 12.0 | 1.5 | | Jul (5) | Aug (5) | Sep (2) | Jul (2) | Aug (2) | Oct (2) |
| 41 | 40°25.0' | 73°56.8' | 21 | 1.25 | 0.3 | 0.05 | | Jul (5) | Aug (5) | Sep (2) | Jul (2) | Aug (2) | Oct (2) |
| 42 | 40°21.2' | 73°56.6' | 13 | 1.98 | 3.4 | 0.36 | | Aug (5) | Aug (5) | Sep (2) | Jul (2) | Aug (2) | Oct (2) |
| 43 | 40°18.9' | 73°53.7' | 20 | −0.19 | 1.1 | 0.12 | | Jul (5) | Aug (5) | Sep (2) | Jul (2) | Aug (2) | Oct (2) |
| 44 | 40°13.0' | 73°57.8' | 19 | −0.2 | 2.6 | 0.17 | | Jul (5) | Aug (5) | Sep (2) | Jul (2) | Aug (2) | Oct (2) |
| 63 | 40°39.5' | 73°00.0' | 12 | 1.04 | 0.8 | 0.02 | | | Aug (1) | Sep (2) | Sep (2) | Aug (2) | Sep (2) |
| 64 | 40°35.5' | 73°22.0' | 11 | 2.28 | 0.5 | 0.02 | | | Aug (1) | Sep (2) | Jul (2) | Aug (2) | Sep (2) |
| 65 | 40°33.2' | 73°37.5' | 11 | −0.61 | 0.9 | 0.03 | | | Aug (1) | Sep (2) | Jul (2) | Aug (2) | Sep (2) |
| 158 | 39°46.2' | 73°08.2' | 48 | 0.86 | 1.3 | 0.03 | | | Aug (1) | Sep (2) | Sep (2) | Aug (2) | Oct (2) |

[a]Northeast Monitoring Program (NEMP) stations.
[b]Also three samples in July, August, and September 1986 and 1987.

because these require more data points, regularly spaced over time.

Q-mode cluster analysis (clustering stations according to abundances of species they have in common) was performed using all samples from the summers of 1980–85 to analyze trends in species composition over space and time. Where multiple samples were taken at a station and date, data were averaged. All data were transformed by natural logarithms (ln+1) before clustering. To facilitate computation, all species occurring at <10% of the station/date combinations were eliminated. The Bray-Curtis (1957) coefficient, $Cz = 2w/(a+b)$, was used to measure percent faunal similarities between stations. Here "$a$" is the sum of abundances of all species found in a given sample, "$b$" is the sum of species abundances for another sample, and "$w$" is the sum of the lower of the abundance values for each species common to both samples. Clustering was performed using flexible sorting with $\beta$ (the cluster intensity coefficient) $= -0.25$.

The Bight was divided into subareas based on geographical and depth considerations (Fig. 1) for analysis and presentation of results. The bathymetric depression at the head of Hudson Shelf Valley (HSV) is termed the Christiaensen Basin (CB) (Fig. 2). The Basin is actually part of the Shelf Valley (Freeland and Swift 1978), but for this study is arbitrarily defined as that portion north of lat. 40°20'N and in water deeper than 27.4 m (90 feet). The shelf was divided into New Jersey (NJ) and Long Island (LI) sections by a line from the northwest edge of the Basin to the middle of the Hudson-Raritan estuary's mouth. Shelf stations were further separated into "inshore" (I: <30 m depth) and "offshore" (O: ≥30 m).

## Results and Discussion

### Taxa Collected

A total of 699 taxa were collected. Polychaetes were the category with the most taxa (46% of the total), followed by crustaceans (24%), bivalves (11%), gastropods (9%), echinoderms (4%), coelenterates (2%), and miscellaneous taxa (4%). The species list is available on request.

### Numbers of Species

Number of species ($S$) per sample is a relatively clear indicator of environmental stress (Green 1977; Chapman et al. 1987). Within a habitat (e.g. shallow and sandy; deep and muddy), $S$ is generally lower in areas of natural or man-made stresses, whereas variables such as faunal density and diversity respond less predictably and are more likely to increase under moderate stress.

### Spatial Trends in Numbers of Species

There were clear spatial trends in $S$. Figure 3 shows contours of $S$ values for the most recent (1985) overall survey. The lowest $S$ by far ($\bar{x}$ = 5 species/0.1 $m^2$) occurred at station 6, in the sludge accumulation area. Next lowest $S$ values were found at stations 7 (the sludge dumpsite itself), 64 (7 km SW of Fire Island Inlet, Long Island), and 26 (26 km E of central New Jersey) (Fig. 1). Most remaining Christiaensen Basin stations and inshore (≥30 m) stations along both coasts had between 20 and 30 species per 0.1 $m^2$.

Most offshore (≥30 m) shelf stations had values >30. There were trends toward increasing $S$ with depth as well as toward the east. Numbers of species also increased with depth and distance from the Basin in the Hudson Shelf Valley.

Spatial trends in $S$ were consistent among years. In 1980 (Fig. 4) as in 1985, the sludge accumulation area had the lowest value (15/0.1 $m^2$), followed by Christiaensen Basin and inshore stations. Values again increased fairly regularly from inshore to offshore and west to east on the shelf, and with depth in the Shelf Valley.

### Temporal Trends in Numbers of Species

In contrast to the consistency of spatial trends in $S$, actual values of $S$ tended to decrease over time at many stations. Whereas much of the inshore and Basin area had $S$ values between 30 and 40 in 1980, almost all that area had 20–30 species/0.1 $m^2$ in 1985. Several offshore and Shelf Valley stations had 70–80+ species in 1980, but no station had more than 63 species in 1985.

As noted in the between-year comparison of $S$ contours, there were tendencies toward decreasing $S$ over time at most stations. Data for each of the six NEMP stations, for which the most data are available, are shown in Figure 5. Linear regression analysis of the species versus time data for all stations indicated nonsignificant ($P > 0.05$) increases in $S$ at only six of the 48 stations (Table 2). Conversely, six of the 42 decreases were significant ($P \leq 0.05$): at stations 2, 3,

**Table 2**

Signs and significance levels of linear regression slopes fitted for numbers of species and amphipods over time (– = decreasing, + = increasing; NS = not significant at 0.05 level). All stations combined: decreasing trends in numbers of species (significant at $P = 0.0007$) and amphipods ($P = 0.0004$).

| | Species | | Amphipods | |
|---|---|---|---|---|
| Station | Slope | Significance Level | Slope | Significance Level |
| **New Jersey Inshore** | | | | |
| 4 | – | NS | + | NS |
| 8 | – | NS | – | NS |
| 18 | – | NS | – | NS |
| 19 | – | NS | + | NS |
| 20 | – | NS | + | NS |
| 23 | + | NS | – | NS |
| 24 | + | NS | + | NS |
| 25 | – | NS | + | NS |
| 26 | – | NS | – | NS |
| 27 | – | NS | + | NS |
| 41 | – | NS | – | NS |
| 42 | – | NS | – | 0.02 |
| 43 | – | NS | – | NS |
| 44 | + | NS | – | NS |
| **New Jersey Offshore** | | | | |
| 28 | – | NS | – | NS |
| 158 | – | | NS | –0.002 |
| **Hudson Shelf Valley** | | | | |
| 11 | – | NS | – | NS |
| 12 | – | NS | – | NS |
| 13 | – | NS | – | 0.02 |
| 14 | – | NS | – | 0.02 |
| 15 | – | 0.0001 | – | 0.0001 |
| 16 | + | NS | – | NS |
| 17 | – | NS | – | 0.01 |
| **Long Island Inshore** | | | | |
| 2 | – | 0.024 | – | 0.02 |
| 3 | – | 0.011 | – | NS |
| 7 | – | 0.009 | – | NS |
| 21 | – | NS | + | NS |
| 22 | – | NS | – | 0.03 |
| 63 | + | NS | – | NS |
| 64 | – | NS | + | NS |
| 65 | + | NS | + | NS |
| **Long Island Offshore** | | | | |
| 29 | – | NS | – | 0.01 |
| 30 | – | NS | – | NS |
| 31 | – | NS | – | NS |
| 32 | – | NS | – | 0.006 |
| 33 | – | NS | – | NS |
| 34 | – | NS | – | NS |
| 35 | – | NS | – | 0.007 |
| 36 | – | NS | – | NS |
| 37 | – | NS | – | NS |
| 38 | – | NS | – | NS |
| 39 | – | NS | – | 0.005 |
| **Christiaensen Basin** | | | | |
| 1 | – | NS | – | NS |
| 5 | – | NS | – | NS |
| 6 | – | 0.0001 | – | 0.0001 |
| 9 | – | NS | – | 0.05 |
| 10 | – | 0.023 | – | NS |
| 40 | – | NS | – | NS |

and 7 (Long Island Inshore), 6 and 10 (Basin), and 15 (Shelf Valley). For all stations combined, there was a decreasing trend significant at the $P = 0.0007$ level. Similar trends in numbers of amphipods are discussed below.

Causes for the faunal changes are unclear. Locations of the stations with significant decreases circumstantially suggest that the declines could have been linked to increasing effects of sewage sludge with time. (Station 6 is the presumed center of sludge accumulation, and 7 is in the dumpsite itself. Stations 2, 3, and 10 are all within 10 km of station 6. Station 15 is 52 km SE of 6, but was considered by Boesch [1982] to be the inshore limit of a "pristine" benthic fauna in the Shelf Valley, as of the late 1970s.) Disposal of sewage sludge increased from an average of 4,266,210 metric tons (t)/yr in 1973–79 to 6,634,355 t/yr in 1980–85 (Suszkowski and Santoro 1986), and the recent inputs were the largest ever to any oceanic sludge dumpsite (Norton and Champ 1989). However, the New York City Department of Environmental Protection (1983) reported that recent increases in sludge amounts had been due mostly to increased water content, that sludge solids dumped increased only 5% from 1973 to 1981, and that mass loadings of most sludge contaminants decreased over that period. A comparison of 1973 and 1987 sludge loads (HydroQual, Inc. 1989) indicates decreases, some quite large, in loads of sludge solids, biochemical oxygen demand and heavy metals, although nutrient inputs increased; no 1973 data on organic contaminants are available for comparison.

There are of course other possible explanations for the widespread declines in *S* (and amphipods). If anthropogenic change in water or sediment quality, or both, is involved, other waste sources may be partly or wholly responsible. However, dredged material disposal in 1980–85 ($\bar{x}$ = 4,723,355 t/yr), decreased substantially from the 1973–79 average (9,124,785 t/yr) (Suszkowski and Santoro 1986). Changes in carbon, nutrient, and toxicant inputs from the Hudson-Raritan estuary and other sources over the study period have not been documented. Trends in natural environmental variables such as climate or predation could also cause the observed changes.

Finally, there are several possible sources of sampling and analytical error. The "summer" surveys were not all conducted at the same time of year. The 1985 survey, which showed the lowest numbers at many stations, was conducted the latest in the year (early October). Strict comparisons of October data to those from mid- to late-summer may be invalid owing to seasonal differences in such variables as temperature, dissolved oxygen, sulfide, larval recruitment, and predation. Gray (1981) notes that it is common for numbers of individuals and species to be highest following recruitment peaks in the warmer months, and then to decline to minima in winter. The monthly samplings in summer 1986 and 1987 at stations 6 (Fig. 5) and 11 did show declines in *S* from July to September, although, except for September 1986 at Station 11, all values were higher than in October 1985. Preliminary data for 1988 and 1989 again indicate higher *S* values at stations 6 and 11 in summer than were found in October 1985, with slight decreases between July and September. For both stations as well as the third primary station (northern Christiaensen Basin) in the more recent study of responses to phaseout of sewage sludge disposal, there were apparent increases in numbers of species between 1986 and 1989 (Environmental Processes Division, 1991). This may signal a reversal of the general decreasing trend observed for 1980–85.

Systematic changes in sampling or sample processing are possible but unlikely explanations for the trends, since there has been continuity of methods and senior field and taxonomic personnel over the study period. Sorting of samples and preliminary identifications were done by two different contractors, but each contract included a quality assurance program (resorting 10% of the samples to determine and maintain accuracy). All identifications were confirmed by one of the authors (ABF).

## Numbers of Amphipods

Amphipods are small crustaceans known to be important in the diets of some demersal fishes in the study area, e.g., cod, haddock, red hake, yellowtail and winter flounder (Musick and Sedberry 1977; Langton and Bowman 1980). Amphipods are also thought to be relatively sensitive to chemical contamination; this has been reported for members of the families Ampeliscidae (Lee et al. 1977; Sanders et al. 1980) and Phoxocephalidae (Swartz et al. 1982). Amphipod densities do sometimes increase with moderate organic enrichment.

## Spatial Trends in Numbers of Amphipods

Contours of amphipod densities for September 1985 (Fig. 6) show distinct spatial trends, which in general match those described above for numbers of species. Lowest numbers (almost always less than one amphipod per 0.1 $m^2$) were found in and near the Christiaensen Basin. Densities were only slightly higher at the New Jersey and Long Island Inshore stations. Numbers increased fairly steadily to >100 amphipods/0.1 $m^2$ at the stations furthest offshore and also in the outer Shelf Valley.

The spatial patterns were consistent over time. Figure 7 gives contours of amphipod densities for July–August 1980. The chief difference from 1985 is that in 1980 there were more inshore stations with densities elevated relative to those in the Basin. The spatial relationships are otherwise quite similar between the two years.

## Temporal Trends in Numbers of Amphipods

Again in agreement with data on numbers of species, there were marked decreases in numbers of amphipods at many stations over the study period. Linear regressions of numbers vs. time indicated nonsignificant ($P > 0.05$) positive slopes at only nine of the 48 stations (Table 2). Fourteen of the 39 declines, however, were significant ($P < 0.05$): at stations 6 and 9 (Basin), 42 (New Jersey Inshore), 13, 14, 15, and 17 (Shelf Valley), 2 and 22 (Long Island Inshore), 29, 32, 35 and 39 (Long Island Offshore), and 158 (New Jersey Offshore). For all stations combined, linear regression analysis indicated a decrease in numbers of amphipods significant at $P = 0.0004$.

The most pronounced decreases ($P = 0.0001$) at individual stations occurred at the same stations (6 and 15) as had the most significant declines in numbers of species. Station 6 was characterized by low numbers of amphipods throughout the study period. However, amphipods became more scarce with time, decreasing from an average of 1.5/0.1 $m^2$ in 1980–82 to only one occurrence in 27 grabs in 1983–85. Station 15 had been considered "pristine" based mostly on the large numbers of amphipods typically found there. Several early samplings revealed well over 1000 individuals/0.1 $m^2$, while more recent densities have been much lower (Fig. 8). As with species richness, the declines in amphipods could be due to anthropogenic or natural environmental change, or sampling/analysis artifacts.

## Species Composition (Cluster Analysis)

This analysis uses data on abundance and distribution of all but rare species. It thus augments the analyses of dominant species and numbers of species and amphipods. Since between-sample similarities are calculated using log-transformed abundances of numerous taxa, the analysis is relatively insensitive to changes in abundance of single taxa, e.g., amphipods. Changes in species composition over space and time can serve as a quantitative measure of effects of environmental change.

The total of 292 station/date combinations (hereafter "samplings") yielded 27 groups at the $\geq 30\%$ similarity level (Fig. 9). The 30% level was chosen for consistency with past analysis of New York Bight data (Reid et al. 1982), and because many of the groups formed at that level appeared ecologically meaningful (e.g., contained most or all samplings for a given station; contained stations that were spatially close and had similar depths and sediment types). Some groups contained few samplings and formed more reasonable patterns when merged with other groups at <30% similarity. The samplings occurring in each group are listed in Table 3. Numerically dominant species in each group are given in Table 4. Dominant species are defined as those among the top ten in abundance in at least 50% of the samplings in a group; the actual percentages are indicated in Table 4. Distribution of the groups among various subareas of the Bight is discussed below.

**Sewage Sludge Dumpsite**—Group I includes all samplings at Station 7, in the northwest corner of the dumpsite, as well as the 1983 sampling from Station 43 (NJI). The assemblage at Station 7 is distinct in part due to the abundance of the polychaetes, *Capitella* spp., which are discussed in more detail in Dominant Species section below. The consistency of species composition over time at the sludge dumpsite contradicts the suggestion from the trends in numbers of species and amphipods that degradation of the benthos there has recently increased.

**"Sewage Sludge Accumulation Area"**—Group J contains all samplings at Station 6 except for October 1985, which was the sole sampling in adjacent Group K. Groups J and K joined at $Cz = 0.03$ similarity, and they next merged with the sludge dumpsite fauna (Group I), at $Cz = -0.08$. J was the only group in which *Capitella* spp. were consistently the top dominants.The group is also distinguished by the consistent abundance of rhynchocoels (ribbon worms).

**Inner Hudson Shelf Valley**—Group D consists exclusively of all samplings at stations 13, 16, and 17. These

**Table 3**
Samplings included in each group formed by cluster analysis.

| Year | Station (number of samples) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Group A** | | | | | | | | | |
| 1980 | 1(1) | 2(1) | 3(1) | | | | | 18(1) | 40(5) |
| 1981 | 1(1) | 2(1) | 3(1) | | | 9(1) | 10(1) | | 40(5) |
| 1982 | 1(2) | 2(2) | 3(2) | 5(2) | 8(2) | 9(2) | 10(2) | 18(2) | 40(2) |
| 1983 | 1(2) | 2(2) | 3(2) | 5(2) | | | 10(2) | 18(2) | 40(2) |
| | | 2(2) | | 5(2) | | | | 18(2) | |
| 1984 | 1(2) | 2(2) | | | | 9(2) | | | |
| 1985 | | | | | | | | | |
| **Group B** | | | | | | | | | |
| 1980 | 5(1) | 8(1) | 9(1) | | | | | | |
| 1981 | | | | | | | | | |
| 1982 | 5(2) | | | 18(2) | | | | | |
| 1983 | | | 9(2) | | | | | | |
| 1984 | | | | | | | | | |
| 1985 | | | | | | | | | |
| **Group C** | | | | | | | | | |
| 1980 | | | | | | | | | |
| 1981 | | | | | | | | | |
| 1982 | | | | | | | | | |
| 1983 | | | | | | | | | |
| 1984 | | | | 5(2) | | 10(2) | 18(2) | | |
| 1985 | 1(2) | 2(2) | 3(2) | 5(2) | 9(2) | 10(2) | 18(2) | 40(2) | |
| **Group D** | | | | | | | | | |
| 1980 | 13(1) | 16(1) | 17(1) | | | | | | |
| 1981 | 13(1) | 16(1) | 17(1) | | | | | | |
| 1982 | 13(2) | 16(2) | 17(2) | | | | | | |
| 1983 | 13(2) | 16(2) | 17(2) | | | | | | |
| | | 16(2) | 17(2) | | | | | | |
| 1984 | 13(2) | 16(2) | 17(2) | | | | | | |
| 1985 | 13(2) | 16(2) | 17(2) | | | | | | |
| **Group E** | | | | | | | | | |
| 1980 | 11(1) | 12(1) | | | | | | | |
| 1981 | 11(1) | 12(1) | | | | | | | |
| 1982 | 11(2) | | | | | | | | |
| 1983 | 11(2) | | | | | | | | |
| 1984 | | | | | | | | | |
| 1985 | | | | | | | | | |
| **Group F** | | | | | | | | | |
| 1980 | 4(4) | | 10(1) | 21(1) | 42(5) | | | | |
| 1981 | 4(5) | 8(1) | | | | | | | |
| 1982 | 4(5) | | | 21(2) | | 43(2) | 44(2) | | |
| 1983 | | 8(2) | | | | | | | |
| | | 8(2) | | | | | | | |
| 1984 | | | | 21(2) | | | | | |
| 1985 | | 8(2) | | | | | | | |
| **Group G** | | | | | | | | | |
| 1980 | | 22(1) | | | | | | | |
| 1981 | | 22(1) | | | | | | | |
| 1982 | | 22(2) | | | | | | | |
| 1983 | | 22(2) | | | | | | | |
| 1984 | 11(2) | 22(2) | | | | | | | |
| 1985 | | | | | | | | | |

| Year | Station (number of samples) | | | | | | |
|---|---|---|---|---|---|---|---|
| **Group H** | | | | | | | |
| 1980 | | | | | | | |
| 1981 | | 21(1) | | 25(1) | | | |
| 1982 | | | | | | | |
| 1983 | | 21(2) | | | 44(2) | | |
| 1984 | | | | | | | |
| 1985 | 11(2) | 21(2) | 22(2) | | | | |
| **Group I** | | | | | | | |
| 1980 | 7(5) | | | | | | |
| 1981 | 7(5) | | | | | | |
| 1982 | 7(5) | | | | | | |
| 1983 | 7(5) | 43(2) | | | | | |
| 1984 | 7(5) | | | | | | |
| 1985 | 7(5) | | | | | | |
| | 7(2) | | | | | | |
| **Group J** | | | | | | | |
| 1980 | 6(5) | | | | | | |
| 1981 | 6(5) | | | | | | |
| 1982 | 6(5) | | | | | | |
| 1983 | 6(5) | | | | | | |
| | 6(2) | | | | | | |
| 1984 | 6(5) | | | | | | |
| 1985 | 6(5) | | | | | | |
| **Group K** | | | | | | | |
| 1980 | | | | | | | |
| 1981 | | | | | | | |
| 1982 | | | | | | | |
| 1983 | | | | | | | |
| 1984 | | | | | | | |
| 1985 | 6(2) | | | | | | |
| **Group L** | | | | | | | |
| 1980 | | 35(1) | | | | | |
| 1981 | 34(1) | 35(1) | | | | | |
| 1982 | | 35(2) | | | | | |
| 1983 | | 35(2) | | | | | |
| | | 35(2) | | | | | |
| 1984 | | 35(2) | | | | | |
| 1985 | | | | | | | |
| **Group M** | | | | | | | |
| 1980 | 14(1) | 15(5) | | | | | |
| 1981 | 14(1) | 15(5) | | | | | |
| 1982 | 14(2) | 15(5) | | | | | |
| 1983 | 14(2) | | | | | | |
| 1984 | 14(2) | 15(5) | | | | | |
| 1985 | 14(2) | 15(5) | | | | | |
| | | 15(2) | | | | | |
| **Group N** | | | | | | | |
| 1980 | | | 34(1) | 36(1) | 37(1) | 38(1) | |
| 1981 | | | | 36(1) | 37(1) | 38(1) | 39(1) |
| 1982 | 12(2) | 32(2) | 34(2) | 36(2) | 37(2) | 38(2) | 39(2) |
| 1983 | | | 34(2) | | | | |
| 1984 | | | 34(2) | | | 38(2) | |
| 1985 | | | | | | | |

**Table 3 (continued)**

| Year | Station (number of samples) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Group O** | | | | | | | | |
| 1980 | | 29(1) | | 32(1) | | | | 39(1) |
| 1981 | | 29(1) | 30(1) | | 33(1) | | | |
| 1982 | | 29(2) | 30(2) | | | | | |
| 1983 | 12(2) | 29(2) | 30(2) | 32(2) | | 36(2) | 37(2) | 39(2) |
| 1984 | 12(20 | 29(2) | 30(2) | | | 36(2) | 37(2) | 39(2) |
| 1985 | | | | | | | | |
| **Group P** | | | | | | | | |
| 1980 | | | | | | | | |
| 1981 | | | | 32(1) | | | | 158(1) |
| 1982 | | | | | | | | |
| 1983 | | | | | | | | 158(2) |
| 1984 | | | | 32(2) | | | | 158(2) |
| 1985 | 12(2) | 29(2) | 30(2) | 32(2) | 36(2) | 37(2) | | 158(2) |
| **Group Q** | | | | | | | | |
| 1980 | 33(1) | | | | | | | |
| 1981 | | | | | | | | |
| 1982 | 33(2) | | | | | | | |
| 1983 | | | | 38(2) | | | | |
| 1984 | 33(2) | | | | | | | |
| 1985 | 33(2) | 34(2) | 35(2) | 38(2) | 39(2) | | | |
| **Group R** | | | | | | | | |
| 1980 | 28(1) | | | | | | | |
| 1981 | 28(1) | | | | | | | |
| 1982 | | | | | | | | |
| 1983 | | | | | | | | |
| 1984 | | | | | | | | |
| 1985 | | | | | | | | |
| **Group S** | | | | | | | | |
| 1980 | | 30(1) | 31(5) | | | | | |
| 1981 | | | 31(5) | | | | | |
| 1982 | 28(2) | | 31(5) | | | | | |
| 1983 | | | 31(5) | | | | | |
| 1984 | | | 31(5) | | | | | |
| 1985 | | | 31(2) | | | | | |
| **Group T** | | | | | | | | |
| 1980 | | | | | | | | |
| 1981 | | 20(1) | | | 64(1) | | | |
| 1982 | 19(2) | 20(2) | 42(2) | | | | | |
| 1983 | | | | | 64(2) | | | |
| 1984 | 19(2) | 20(2) | | | 64(2) | | | |
| 1985 | 19(2) | 20(2) | | | 64(2) | | | |
| **Group U** | | | | | | | | |
| 1980 | | | 19(1) | 20(1) | | | | |
| 1981 | | | | | 42(5) | | | 44(5) |
| 1982 | | | | | | | | |
| 1983 | 4(5) | | | 20(2) | 42(2) | | | |

| Year | Station (number of samples) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Group U (continued)** | | | | | | | | |
| 1984 | 4(5) | 8(2) | | | 42(2) | 43(2) | | 44(2) |
| 1985 | 4(5) | | | | 42(2) | 43(2) | | 44(2) |
| | 4(2) | | | | | | | |
| **Group V** | | | | | | | | |
| 1980 | | | | 27(1) | | | | |
| 1981 | | | | 27(1) | | | | |
| 1982 | | 24(2) | | | | | | |
| 1983 | 19(2) | 24(2) | 25(2) | 27(2) | 28(2) | 63(2) | | |
| | | 24(2) | 25(2) | | | | | |
| 1984 | | 24(2) | 25(2) | 27(2) | 28(2) | | | |
| 1985 | | 24(20 | 25(2) | | 28(2) | | | |
| **Group W** | | | | | | | | |
| 1980 | 23(1) | | | | | | | |
| 1981 | | | | | | | | |
| 1982 | 23(2) | | | | | | | |
| 1983 | 23(2) | | | | | | | |
| 1984 | 23(2) | | | | | | | |
| 1985 | 23(2) | | | | | | | |
| **Group X** | | | | | | | | |
| 1980 | 26(5) | | | | | | | |
| 1981 | 23(1) | 26(5) | | | | | | |
| 1982 | 26(5) | | | | | | | |
| 1983 | 26(5) | | | | | | | |
| 1984 | 26(2) | | | | | | | |
| 1985 | 26(5) | | | | | | | |
| | 26(2) | | | | | | | |
| **Group Y** | | | | | | | | |
| 1980 | 41(5) | | | | | | | |
| 1981 | 41(5) | | | | | | | |
| 1982 | 41(2) | | | | | | | |
| 1983 | 41(2) | | | | | | | |
| 1984 | 41(2) | | | | | | | |
| 1985 | 41(2) | | | | | | | |
| **Group Z** | | | | | | | | |
| 1980 | 24(1) | 25(1) | 43(5) | 44(5) | | | | |
| 1981 | 24(1) | | 43(5) | | | | | |
| 1982 | | | | | | | | |
| 1983 | | | 43(1) | | | | | |
| 1984 | | | | | | | | |
| 1985 | | | | | | | | |
| **Group AA** | | | | | | | | |
| 1980 | | | | | | | | |
| 1981 | | 63(1) | 65(1) | | | | | |
| 1982 | 27(2) | | 65(2) | | | | | |
| 1983 | | | 65(2) | | | | | |
| 1984 | | 63(2) | 65(2) | | | | | |
| 1985 | 27(2) | 63(2) | 65(2) | | | | | |

**Table 4**

Consistently dominant species (in top 10 in numerical abundance in ≥50% of samplings, or station/date combinations) for each group formed by cluster analysis. Am = amphipod; An = anthozoan; Bi = bivalve; Cu = cumacean; Ec = echinoderm; Ga = gastropod; Ph = phoronid; Po = polychaete; Rh = rhynchocoel; Ta = tanaidacean.

| Group | Number of samplings | Species | Taxon | % of samplings |
|---|---|---|---|---|
| A | 33 | *Nucula proxima* | Bi | 100 |
| | | *Prionospio steenstrupi* | Po | 85 |
| | | *Nephtys incisa* | Po | 79 |
| | | *Phoronis architecta* | Ph | 76 |
| | | *Tharyx acutus* | Po | 73 |
| | | *Mediomastus ambiseta* | Po | 70 |
| | | *Tharyx dorsobranchialis* | Po | 67 |
| | | *Cossura longocirrata* | Po | 67 |
| | | *Ceriantheopsis americanus* | An | 52 |
| B | 6 | *Nucula proxima* | Bi | 100 |
| | | *Cossura longocirrata* | Po | 100 |
| | | *Nephtys incisa* | Po | 83 |
| | | *Phoronis architecta* | Ph | 83 |
| | | *Ceriantheopsis americanus* | An | 83 |
| | | *Levinsenia gracilis* | Po | 67 |
| | | *Mytilus edulis* | Bi | 67 |
| | | *Tharyx acutus* | Po | 50 |
| | | *Pherusa affinis* | Po | 50 |
| C | 11 | *Ceriantheopsis americanus* | An | 100 |
| | | *Nucula proxima* | Bi | 100 |
| | | *Nephtys incisa* | Po | 100 |
| | | *Pherusa affinis* | Po | 82 |
| | | *Phoronis architecta* | Ph | 73 |
| | | *Cossura longocirrata* | Po | 55 |
| | | *Lumbrineris hebes* | Po | 55 |
| D | 20 | *Nucula delphinodonta* | Bi | 100 |
| | | *Cossura longocirrata* | Po | 95 |
| | | *Levinsenia gracilis* | Po | 95 |
| | | *Ninoe nigripes* | Po | 85 |
| | | *Tharyx dorsobranchialis* | Po | 80 |
| | | *Aricidea (Acesta) catherinae* | Po | 75 |
| | | *Euchone incolor* | Po | 75 |
| | | *Lumbrineris hebes* | Po | 70 |
| | | *Prionospio steenstrupi* | Po | 70 |
| | | *Mediomastus ambiseta* | Po | 50 |
| E | 6 | *Nucula proxima* | Bi | 100 |
| | | Rhynchocoela spp. | Rh | 83 |
| | | *Tharyx dorsobranchialis* | Po | 83 |
| | | *Ninoe nigripes* | Po | 83 |
| | | *Aricidea (Acesta) catherinae* | Po | 83 |
| | | *Lumbrineris hebes* | Po | 83 |
| | | *Prionospio steenstrupi* | Po | 83 |
| | | *Spio filicornis* | Po | 50 |
| | | *Pholoe minuta* | Po | 50 |
| F | 14 | *Amastigos caperatus* | Po | 79 |
| | | *Tellina agilis* | Bi | 79 |
| | | *Mediomastus ambiseta* | Po | 71 |
| | | *Nucula proxima* | Bi | 64 |
| | | *Aricidea (Acesta) catherinae* | Po | 64 |
| | | *Tharyx acutus* | Po | 57 |
| | | *Parougia caeca* | Po | 50 |
| | | *Prionospio steenstrupi* | Po | 50 |
| G | 6 | *Nucula proxima* | Bi | 100 |
| | | *Pitar morrhuanus* | Bi | 100 |
| | | *Tellina agilis* | Bi | 83 |
| | | *Aricidea (Acesta) catherinae* | Po | 83 |
| | | *Spiophanes bombyx* | Po | 67 |
| | | *Nephtys picta* | Po | 67 |
| | | *Spio filicornis* | Po | 67 |
| | | *Lumbrineris hebes* | Po | 50 |
| | | *Tharyx acutus* | Po | 50 |
| H | 7 | *Nucula proxima* | Bi | 100 |
| | | *Tellina agilis* | Bi | 86 |
| | | *Nephtys picta* | Po | 86 |
| | | *Aricidea (Acesta) catherinae* | Po | 57 |
| | | *Pitar morrhuanus* | Bi | 57 |
| I | 8 | *Spiophanes bombyx* | Po | 100 |
| | | *Capitella* spp. | Po | 88 |
| | | *Tharyx acutus* | Po | 88 |
| | | *Nephtys picta* | Po | 88 |
| | | *Tellina agilis* | Bi | 88 |
| | | *Exogone hebes* | Po | 63 |
| | | Nephtyidae spp. (juvenile) | Po | 50 |
| J | 7 | *Capitella* spp. | Po | 100 |
| | | Rhynchocoela spp. | Rh | 100 |
| | | *Nephtys incisa* | Po | 86 |
| | | *Nucula proxima* | Bi | 86 |
| | | *Spio filicornis* | Po | 71 |
| | | *Pholoe minuta* | Po | 57 |
| K | 1 | (one sampling only) | | |
| | | *Nephtys incisa* | Po | 100 |
| | | *Glycera dibranchiata* | Po | 100 |
| | | *Pherusa affinis* | Po | 100 |
| | | *Nassarius trivittatus* | Ga | 100 |
| | | *Nucula proxima* | Bi | 100 |
| | | *Tellina agilis* | Bi | 100 |
| | | *Spisula solidissima* | Bi | 100 |
| L | 7 | *Ampelisca agassizi* | Am | 100 |
| | | *Unciola irrorata* | Am | 100 |
| | | *Leptocheirus pinguis* | Am | 100 |
| | | *Corophium crassicorne* | Am | 100 |
| | | *Erichthonius rubricornis* | Am | 86 |
| | | *Unicola* spp. (juvenile) | Am | 71 |
| | | *Exogone verugera* | Po | 71 |
| | | *Harpinia propinquua* | Am | 57 |
| | | *Eudorella pusilla* | Cu | 57 |
| M | 12 | *Ampelisca agassizi* | Am | 100 |
| | | *Aricidea (Acesta) catherinae* | Po | 83 |
| | | *Lumbrineris hebes* | Po | 75 |
| | | *Unciola irrorata* | Am | 58 |
| | | *Tharyx dorsobranchialis* | Po | 50 |
| | | *Nucula delphinodonta* | Bi | 50 |
| | | *Leptocheirus pinguis* | Am | 50 |

**Table 4 (continued)**

| Group | Number of samplings | Species | Taxon | % of samplings |
|---|---|---|---|---|
| N | 18 | *Exogone hebes* | Po | 100 |
| | | *Unciola inermis* | Am | 78 |
| | | *Byblis serrata* | Am | 72 |
| | | *Aricidea (Acesta) catherinae* | Po | 61 |
| | | *Caulleriella cf. killariensis* | Po | 56 |
| | | *Euchone elegans* | Po | 56 |
| O | 21 | *Unicola inermis* | Am | 100 |
| | | *Exogone hebes* | Po | 95 |
| | | *Caulleriella cf. killariensis* | Po | 90 |
| | | *Tanaissus liljeborgi* | Ta | 67 |
| | | *Rhepoxynius hudsoni* | Am | 57 |
| | | *Prionospio steenstrupi* | Po | 52 |
| | | *Aricidea (Acesta) catherinae* | Po | 52 |
| | | *Byblis serrata* | Am | 52 |
| P | 12 | *Caulleriella cf. killariensis* | Po | 100 |
| | | *Exogone hebes* | Po | 100 |
| | | *Goniadella gracilis* | Po | 100 |
| | | *Aricidea (Acesta) catherinae* | Po | 83 |
| | | *Lumbrinerides acuta* | Po | 75 |
| | | Nephtydae spp. (juvenile) | Po | 58 |
| | | *Unciola irrorata* | Am | 58 |
| | | *Tanaissus liljeborgi* | Ta | 50 |
| Q | 9 | *Exogone hebes* | Po | 56 |
| | | *Rhepoxynius hudsoni* | Am | 56 |
| | | *Unciola inermis* | Am | 56 |
| | | *Ampelisca agassizi* | Am | 56 |
| R | 2 | *Phyllodoce mucosa* | Po | 100 |
| | | *Glycera* spp. (juvenile) | Po | 50 |
| | | *Exogone hebes* | Po | 50 |
| | | *Aricidea (Aricidea) wassi* | Po | 50 |
| | | *Corophium crassicorne* | Am | 50 |
| | | *Aglaophamus circinati* | Po | 50 |
| | | *Unciola inermis* | Am | 50 |
| | | *Paraonis fulgens* | Po | 50 |
| | | *Echinarachnius parma* | Ec | 50 |
| | | *Spiophanes bombyx* | Po | 50 |
| | | *Parougia caeca* | Po | 50 |
| | | *Clymenella torquata* | Po | 50 |
| | | *Cerastoderma pinnulatum* | Bi | 50 |
| | | *Lumbrineris hebes* | Po | 50 |
| | | *Rhepoxynius hudsoni* | Am | 50 |
| | | *Sthenelais limicola* | Po | 50 |
| | | *Photis macrocoxa* | Am | 50 |
| | | Rhynchocoela spp. | Rh | 50 |
| | | *Ceriantheopsis americans* | Am | 50 |
| S | 9 | *Exogone hebes* | Po | 89 |
| | | *Caulleriella cf. killariensis* | Po | 89 |
| | | *Pseudunciola obliquua* | Am | 89 |
| | | *Aricidea (Acesta) catherinae* | Po | 67 |
| | | *Tanaissus liljeborgi* | Ta | 67 |
| | | *Rhepoxynius hudsoni* | Am | 56 |
| | | *Echinarachnius parma* | Ec | 56 |
| T | 12 | *Tellina agilis* | Bi | 92 |
| | | *Nephtys picta* | Po | 75 |
| | | *Spisula solidissima* | Bi | 67 |
| | | *Tanaissus liljeborgi* | Ta | 67 |
| | | *Aricidea (Acesta) catherinae* | Po | 58 |
| | | *Caulleriella cf. killariensis* | Po | 58 |
| | | *Magelona riojai* | Po | 58 |
| T (continued) | | *Pseudunciola obliquua* | Am | 58 |
| | | *Spiophanes bombyx* | Po | 50 |
| | | Nephtyidae spp. (juvenile) | Po | 50 |
| | | *Protohaustorius cf. deichmannae* | Po | 50 |
| U | 17 | *Tellina agilis* | Bi | 88 |
| | | *Goniadella gracilis* | Po | 64 |
| | | *Spiophanes bombyx* | Po | 64 |
| | | *Spisula solidissima* | Bi | 64 |
| | | *Caulleriella cf. killariensis* | Po | 59 |
| | | Nephtyidae spp. (juvenile) | Po | 59 |
| V | 18 | *Echinarachnius parma* | Ec | 78 |
| | | *Goniadella gracilis* | Po | 72 |
| | | *Astarte castanea* | Bi | 67 |
| | | *Exogone hebes* | Po | 61 |
| | | *Caulleriella cf. killariensis* | Po | 61 |
| | | *Pseudunciola obliquua* | Am | 61 |
| | | *Tanaissus liljeborgi* | Ta | 50 |
| W | 5 | *Goniadella gracilis* | Po | 100 |
| | | *Tellina agilis* | Bi | 80 |
| | | *Echinarachnius parma* | Ec | 80 |
| | | *Pseudunciola obliquua* | Am | 80 |
| | | *Astarte castanea* | Bi | 60 |
| | | *Spisula solidissima* | Bi | 60 |
| | | *Hemipodus roseus* | Po | 60 |
| | | *Sigalion arenicola* | Po | 60 |
| | | *Nephtys bucera* | Po | 60 |
| | | Rhynchocoela spp. | Rh | 60 |
| X | 8 | *Echinarachnius parma* | Ec | 100 |
| | | *Ceriantheopsis americana* | An | 88 |
| | | *Tharyx dorsobranchialis* | Po | 88 |
| | | Nephtyidae spp. (juvenile) | Po | 75 |
| | | *Goniadella gracilis* | Po | 63 |
| | | *Nephtys picta* | Po | 63 |
| | | *Tharyx acutus* | Po | 63 |
| | | *Hemipodus roseus* | Po | 50 |
| | | *Lumbrineris acicularum* | Po | 50 |
| Y | 6 | *Parapionosyllis longicirrata* | Po | 100 |
| | | *Goniadella gracilis* | Po | 100 |
| | | *Spisula solidissima* | Bi | 100 |
| | | *Tanaissus liljeborgi* | Ta | 100 |
| | | *Tellina agilis* | Bi | 83 |
| | | *Aricidea (Acesta) cerruti* | Po | 67 |
| | | *Nephtys bucera* | Po | 50 |
| | | Nephtyidae spp. (juvenile) | Po | 50 |
| | | *Scolelepis squamata* | Po | 50 |
| | | *Spiophanes bombyx* | Po | 50 |
| | | *Hemipodus roseus* | Po | 50 |
| Z | 7 | *Aricidea (Acesta) catherinae* | Po | 100 |
| | | *Lumbrineris acicularum* | Po | 100 |
| | | *Goniadella gracilis* | Po | 86 |
| | | *Parougia caeca* | Po | 86 |
| | | *Tharyx acutus* | Po | 71 |
| AA | 10 | *Cirrophorus brevicirratus* | Po | 100 |
| | | *Goniadella gracilis* | Po | 90 |
| | | *Hemipodus roseus* | Po | 80 |
| | | *Aricidea (Acesta) catherinae* | Po | 80 |
| | | *Tellina agilis* | Bi | 50 |

stations are located in the inner HSV, 28–41 km SSE of the sludge dumpsite and sludge accumulation area. That all 1980–85 samplings from the three stations clustered together, and without any trend toward early samplings segregating from later ones, is evidence against any gross effects of increasing sludge disposal or other environmental changes in the inner HSV over that period. However, the preponderance of polychaetes among the dominant species may be an indication of long-term enrichment or stress effects. Group D clustered most closely with Groups A, B, and C (samplings from the Christiaensen Basin and stations closest to the Hudson-Raritan estuary mouth), another sign that influences in those areas extend to the inner HSV.

The other two stations in the inner HSV clustered separately from stations 13, 16, and 17 (Group D). Station 11, just south of the Christiaensen Basin, was in the adjacent though quite dissimilar ($Cz = -1.4$) Group E for 1980 through 1983, and Station 12, located between 11 and 13, was in E in 1980 and 1981. Station 11 moved to Group G in 1984 and H in 1985; it thus moved closer to the sludge dumpsite and accumulation area on the dendrogram but was still quite dissimilar from them ($Cz = -0.36$). Station 12 samplings from 1982 through 1985 fell in the "offshore supergroup," with amphipods increasing in abundance in contrast to the trend at most stations.

**Outer Hudson Shelf Valley**—Unlike the inner HSV and CB, stations 14 and 15 (Group M) were dominated by amphipods. As with Group D in the inner HSV, the similarity (0.45) of all samplings in the outer HSV is evidence against major effects of environmental change over the study period, and contradicts the decreases in numbers of species and amphipods discussed above.

**Long Island Offshore (LIO)**—The fauna of the easternmost LI0 stations was most similar to that of the outer HSV. Group L, which contained samplings from stations 34 and 35, joined the outer HSV group at 0.15 similarity. As in the outer HSV, this group was dominated by *Ampelisca agassizi* and other amphipods, and had a relative scarcity of polychaetes. *A. agassizi* did decrease somewhat from the very high 1980–81 levels, and then increased again in 1985 when Station 35 fell into Group Q (discussed below). Polychaetes were more dominant in Group Q, so there are mixed indications of temporal change in species composition in this area.

All other LIO stations had somewhat similar faunas. All samplings fell within groups N, O, P, Q, and S, and all these groups joined at −0.21 similarity. The largest difference between these groups and Group L above was their lower abundance of *Ampelisca agassizi*.

**New Jersey Offshore**—The two stations (28 and 158) in this category had assemblages most similar to LIO stations. All samplings from Station 158 fell in Group P, which otherwise consisted of LIO samplings. The 1980 and 1981 samplings at Station 28 formed a separate group (R), with closest affinities to LIO Station 31. Station 28 occurred in Group S in 1982, and Group V (New Jersey·Inshore, below) in 1983 through 1985.

**New Jersey Inshore**—This is the largest (14 stations), most heterogeneous collection of stations. Samplings were split between two very dissimilar ($Cz = -3.0$) "supergroups," A through K and T through AA. The NJI stations closest to the Christiaensen Basin (4, 8, and 18) had most samplings in the A–K supergroup. Groups T through AA basically consisted of samplings from the more southern and inshore NJI stations (19, 20, 23–27 and 41–44). The cluster analysis did not distinguish northern coastal stations from other NJI areas, indicating that the Hudson-Raritan estuarine plume (which tends to follow the north NJ coast) did not have an overriding influence on species composition.

**Long Island Inshore**—As with NJI stations, the LII stations were split between the dissimilar supergroups A–K and T–AA. All samplings from the three stations nearest the Long Island coast (63, 64, and 65) were in group T–AA. All sampling from the remaining LII stations (2, 3, 21, and 22) were in groups A, C, F, G, and H, with fauna quite distinct from stations 63–65.

**Christiaensen Basin**—Finally, all remaining CB stations (1, 5, 9, 10, and 40) clustered together in groups A–C, except for Station 10 in 1980 (Group F). These are the stations physically closest to Station 6 in the sludge accumulation area. Their depths are similar to that at Station 6 (Table 1) and, as indicated by amounts of fine sediments, they also have somewhat depositional environments (Station 10 is deeper but has coarser sediments). These stations should be among the first to show signs of any increasing influence of sludge or other contaminant inputs to the Basin. That their species composition remained consistent over time, and distinct from the fauna at Station 6, from 1980–85 is evidence against large increases in anthropogenic effects.

**Table 5**

Mean densities and biomasses per 0.1 m with standard errors and numbers of replicate samples analyzed, for the numerically dominant species at Station 6 on each sampling date.

| Date | No. of samples | Species | Density Mean | Density SE | Species | Biomass (mg.) Mean | Biomass (mg.) SE |
|---|---|---|---|---|---|---|---|
| Dec 1979 | 5 grabs | *Phoronis architecta* | 764.0 | 205.5 | *Phoronis architecta* | 2321.0 | 707.0 |
| | | *Asabellides oculata* | 490.8 | 81.2 | *Nephtys incisa* | 1688.2 | 474.3 |
| | | *Tharyx acutus* | 342.2 | 38.4 | Rhynchocoela spp. | 1440.4 | 334.4 |
| | | *Capitella* spp. | 118.6 | 28.3 | *Ceriantheopsis americanus* | 1248.4 | 380.9 |
| | | *Mediomastus ambiseta* | 79.2 | 11.7 | *Pherusa affinis* | 467.6 | 254.9 |
| | | *Cossura longocirrata* | 68.2 | 13.1 | *Ninoe nigripes* | 375.6 | 245.5 |
| | | *Prionospio steenstrupi* | 50.0 | 12.9 | *Asabellides oculata* | 372.4 | 51.7 |
| | | *Parougia caeca* | 45.8 | 13.7 | *Cancer irroratus* | 297.6 | 251.0 |
| | | *Unciola irrorata* | 44.6 | 7.2 | *Crangon septemspinosa* | 106.4 | 38.0 |
| | | *Nephtys incisa* | 42.4 | 8.2 | *Tharyx acutus* | 82.6 | 5.9 |
| Jul 1980 | 5 grabs | *Capitella* spp. | 545.6 | 118.4 | *Capitella* spp. | 497.2 | 245.5 |
| | | *Edotea triloba* | 27.4 | 8.5 | Rhynchocoela spp. | 201.0 | 109.3 |
| | | Rhynchocoela spp. | 8.4 | 3.0 | *Edotea triloba* | 111.2 | 38.3 |
| | | *Spiophanes bombyx* | 8.2 | 6.8 | *Ceriantheopsis americanus* | 106.4 | 93.4 |
| | | *Cancer irroratus* | 7.0 | 3.4 | *Cancer irroratus* | 70.8 | 46.0 |
| | | *Tellina agilis* | 4.2 | 2.1 | *Spiophanes bombyx* | 56.4 | 50.6 |
| | | *Tharyx acutus* | 3.6 | 2.7 | *Nephtys incisa* | 42.4 | 18.3 |
| | | *Nephtys incisa* | 3.2 | 1.6 | *Phoronis architecta* | 15.4 | 13.9 |
| | | *Unciola irrorata* | 2.2 | 0.6 | *Pherusa affinis* | 15.2 | 13.3 |
| | | *Pitar morrhuanus* | 1.8 | 1.8 | *Tellina agilis* | 12.8 | 6.8 |
| Dec 1980 | 5 grabs | *Spiophanes bombyx* | 166.2 | 34.4 | *Ceriantheopsis americanus* | 832.2 | 434.5 |
| | | *Capitella* spp. | 86.4 | 44.5 | *Nephtys picta* | 254.8 | 67.3 |
| | | *Pherusa affinis* | 46.0 | 14.5 | *Pherusa affinis* | 228.8 | 79.5 |
| | | Nephtyidae spp. | 35.8 | 6.9 | *Diopatra cuprea* | 173.6 | 132.8 |
| | | *Nephtys picta* | 14.2 | 2.8 | *Spiophanes bombyx* | 167.6 | 18.6 |
| | | *Parougia caeca* | 11.0 | 4.0 | *Glycera dibranchiata* | 62.6 | 23.3 |
| | | *Edotea tribola* | 5.4 | 1.7 | *Capitella* spp. | 49.8 | 29.7 |
| | | *Tharyx acutus* | 4.8 | 2.5 | Rhynchocoela spp. | 45.8 | 45.1 |
| | | *Ceriantheopsis americanus* | 3.4 | 1.7 | *Pitar morrhuanus* | 15.2 | 15.2 |
| | | *Diopatra cuprea* | 3.4 | 2.0 | *Edotea tribola* | 13.4 | 5.3 |
| Aug 1981 | 5 grabs | *Capitella* spp. | 637.8 | 157.7 | *Capitella* spp. | 2475.6 | 630.9 |
| | | Rhynchocoela spp. | 27.2 | 6.8 | Rhynchocoela spp. | 1670.4 | 509.2 |
| | | *Phoronis architecta* | 14.6 | 6.3 | *Nephtys incisa* | 223.8 | 39.8 |
| | | *Nucula proxima* | 7.4 | 2.6 | *Nucula proxima* | 82.6 | 26.8 |
| | | *Phyllodoce (anatides) mucosa* | 7.0 | 2.1 | *Ovalipes ocellatus* | 49.4 | 49.4 |
| | | *Nephtys incisa* | 6.4 | 0.6 | *Cancer irroratus* | 28.6 | 14.6 |
| | | *Pholoe minuta* | 3.8 | 0.4 | *Phersusa affinis* | 22.8 | 12.3 |
| | | *Microphthalmus sczelkowii* | 2.0 | 0.8 | *Phoronis architecta* | 19.2 | 8.4 |
| | | *Prionospio steenstrupi* | 2.0 | 1.4 | *Tharyx dorsobranchialis* | 17.6 | 17.1 |
| | | *Tharyx acutus* | 2.0 | 0.9 | *Ceriantheopsis americanus* | 14.2 | 9.3 |
| Jan 1982 | 5 grabs | *Nucula proxima* | 51.4 | 13.7 | Rhynchocoela spp. | 337.2 | 107.3 |
| | | *Phoronis architecta* | 16.2 | 7.3 | *Nucula proxima* | 270.0 | 55.3 |
| | | *Edotea triloba* | 4.4 | 2.0 | *Nephtys incisa* | 189.0 | 60.3 |
| | | Rhynchocoela spp. | 3.8 | 0.6 | *Phersusa affinis* | 49.6 | 36.7 |
| | | *Tharyx acutus* | 3.8 | 1.6 | *Phoronis architecta* | 40.2 | 16.8 |
| | | *Nephtys incisa* | 3.6 | 1.2 | *Edotea triloba* | 11.6 | 4.4 |
| | | *Capitella* spp. | 3.2 | 0.9 | *Amphioplus abditus* | 8.2 | 8.2 |
| | | Nephtyidae spp. | 2.4 | 1.2 | *Spiophanes bombyx* | 5.8 | 2.2 |
| | | *Cirratulus cirratus* | 2.4 | 2.4 | *Ceriantheopsis americanus* | 5.2 | 3.6 |
| | | *Parougia caeca* | 2.2 | 1.1 | *Crangon septemspinosa* | 5.2 | 4.5 |

**Table 5 (continued)**

| Date | No. of samples | Species | Density Mean | Density SE | Species | Biomass (mg) Mean | Biomass (mg) SE |
|---|---|---|---|---|---|---|---|
| Aug 1982 | 5 grabs | *Capitella* spp. | 989.2 | 379.0 | Rhynchocoela spp. | 2139.4 | 486.7 |
| | | *Ceriantheopsis americanus* | 55.2 | 18.6 | *Capitella* spp. | 360.0 | 107.5 |
| | | *Pholoe minuta* | 41.4 | 16.9 | *Ceriantheopsis americanus* | 334.8 | 76.9 |
| | | *Spio filicornis* | 16.6 | 4.4 | *Nephtys incisa* | 316.0 | 95.3 |
| | | *Phyllodoce (anatides) mucosa* | 16.2 | 4.3 | *Cancer irroratus* | 162.6 | 100.0 |
| | | Rhynchocoela spp. | 14.4 | 3.2 | *Spio filicornis* | 140.6 | 41.5 |
| | | *Parougia caeca* | 9.0 | 1.8 | *Pherusa affinis* | 18.2 | 17.5 |
| | | *Tharyx acutus* | 8.4 | 3.4 | *Phyllodoce (anatides) mucosa* | 17.0 | 4.5 |
| | | *Nucula proxima* | 8.4 | 1.8 | *Crangon septemspinosa* | 17.0 | 17.0 |
| | | *Mediomastus ambiseta* | 7.4 | 3.8 | *Glycera dibranchiata* | 16.2 | 13.6 |
| Nov 1982 | 5 grabs | *Nucula proxima* | 11.8 | 4.7 | *Nephtys incisa* | 364.0 | 103.5 |
| | | *Nephtys incisa* | 8.6 | 1.9 | *Ceriantheopsis americanus* | 30.6 | 30.6 |
| | | *Diastylis polita* | 8.2 | 2.6 | Rhynchocoela spp. | 28.2 | 19.9 |
| | | *Pherusa affinis* | 6.6 | 2.8 | *Nucula proxima* | 25.2 | 10.2 |
| | | *Tellina agilis* | 5.8 | 3.0 | *Pherusa affinis* | 19.2 | 7.8 |
| | | *Asabellides oculata* | 2.2 | 1.2 | *Diastylis polita* | 10.8 | 3.7 |
| | | *Spiophanes bombyx* | 2.0 | 0.9 | *Crangon septemspinosa* | 10.8 | 4.7 |
| | | *Edotea tribola* | 1.8 | 0.6 | *Asabellides oculata* | 5.8 | 5.1 |
| | | *Crangon septemspinosa* | 1.6 | 0.7 | *Edotea triloba* | 2.4 | 0.9 |
| | | *Capitella* spp. | 1.4 | 0.7 | *Spiophanes bombyx* | 2.2 | 1.5 |
| Jul 1983 | 5 grabs | *Capitella* spp | 86.8 | 52.5 | *Capitella* spp. | 358.0 | 125.2 |
| | | Rhynchocoela spp. | 4.0 | 1.8 | Rhynchocoela spp. | 119.0 | 71.0 |
| | | *Pholoe minuta* | 3.2 | 2.2 | *Nucula proxima* | 18.8 | 18.1 |
| | | *Nucula proxima* | 2.6 | 1.9 | *Nephtys incisa* | 12.4 | 9.8 |
| | | *Tharyx dorsobranchialis* | 1.6 | 1.6 | *Spio filicornis* | 2.8 | 2.6 |
| | | *Nephtys incisa* | 1.4 | 0.7 | *Harmothoe extenuata* | 2.0 | 2.0 |
| | | *Spio filicornis* | 1.4 | 0.9 | *Pholoe minuta* | 0.8 | 0.6 |
| | | *Ceriantheopsis americanus* | 0.4 | 0.4 | *Tharyx dorsobranchialis* | 0.8 | 0.8 |
| | | *Mytilus edulis* | 0.4 | 0.4 | *Cancer irroratus* | 0.8 | 0.8 |
| | | *Harmothoe extenuata* | 0.2 | 0.2 | *Ceriantheopsis americanus* | 0.6 | 0.6 |
| Aug 1983 | 2 grabs | *Capitella* spp. | 5604.0 | 5092.0 | *Capitella* spp. | 3985.5 | 3643.5 |
| | | Rhynchocoela spp. | 39.5 | 6.5 | Rhynchocoela spp. | 959.0 | 200.0 |
| | | *Ceriantheopsis americanus* | 23.5 | 15.5 | *Ceriantheopsis americanus* | 212.5 | 188.5 |
| | | *Pholoe minuta* | 16.0 | 7.0 | *Nucula proxima* | 46.0 | 4.0 |
| | | *Nucula proxima* | 14.5 | 1.5 | *Spio filicornis* | 12.0 | 3.0 |
| | | *Phoronis architecta* | 4.0 | 3.0 | *Nephtys incisa* | 10.0 | 0.0 |
| | | *Nephtys incisa* | 3.0 | 0.0 | *Pherusa affinis* | 5.0 | 5.0 |
| | | *Spio filicornis* | 3.0 | 0.0 | *Edwardsia elegans* | 2.5 | 2.5 |
| | | *Parougia caeca* | 2.0 | 1.0 | *Pholoe minuta* | 2.5 | 0.5 |
| | | *Prionospio steenstrupi* | 2.0 | 1.0 | *Eteone longa* | 2.0 | 2.0 |
| Nov 1983 | 5 grabs | *Capitella* spp. | 414.8 | 368.8 | *Nephtys incisa* | 1082.4 | 305.0 |
| | | *Nereis succinea* | 35.2 | 31.7 | *Pherusa affinis* | 321.8 | 241.9 |
| | | *Nucula proxima* | 28.2 | 6.6 | Rhynchocoela spp. | 296.0 | 85.6 |
| | | *Nephtys incisa* | 27.2 | 5.2 | *Capitella* spp. | 191.4 | 175.5 |
| | | *Parougia caeca* | 21.0 | 9.8 | *Ceriantheopsis americanus* | 181.8 | 44.5 |
| | | *Asabellides oculata* | 16.2 | 3.5 | *Nucula proxima* | 120.0 | 28.8 |
| | | *Nephtys picta* | 12.0 | 4.1 | *Dichelopandalus leptocerus* | 56.0 | 56.0 |
| | | *Pherusa affinis* | 4.8 | 2.6 | *Nereis succinea* | 55.6 | 54.1 |
| | | *Tellina agilis* | 4.0 | 1.3 | *Asabellides oculata* | 37.0 | 12.7 |
| | | *Ceriantheopsis americanus* | 3.4 | 0.8 | *Tellina agilis* | 6.2 | 2.6 |

**Table 5 (continued)**

| Date | No. of samples | Species | Density Mean | Density SE | Species | Biomass (mg.) Mean | Biomass (mg.) SE |
|---|---|---|---|---|---|---|---|
| Aug 1984 | 5 grabs | *Capitella* spp. | 117.4 | 54.2 | *Capitella* spp. | 1310.4 | 831.5 |
| | | Rhynchocoela spp. | 3.4 | 1.3 | Rhynchocoela spp. | 336.6 | 169.2 |
| | | *Nucula proxima* | 1.0 | 0.6 | *Tellina agilis* | 12.8 | 7.8 |
| | | *Pherusa affinis* | 0.8 | 0.6 | *Pherusa affinis* | 11.4 | 7.2 |
| | | *Nephtys incisa* | 0.6 | 0.4 | *Nephty incisa* | 7.6 | 5.2 |
| | | *Edotea triloba* | 0.6 | 0.4 | *Ceriantheopsis americanus* | 7.0 | 7.0 |
| | | *Spio filicornis* | 0.4 | 0.4 | *Crangon Septemspinosa* | 4.0 | 2.5 |
| | | *Tellina agilis* | 0.4 | 0.2 | *Nucula proxima* | 3.0 | 2.0 |
| | | *Crangon Septemspinosa* | 0.4 | 0.2 | *Edotea triloba* | 2.8 | 2.0 |
| | | *Ceriantheopsis americanus* | 0.2 | 0.2 | *Spio filicornus* | 1.8 | 1.8 |
| Jun 1985 | 5 grabs | *Capitella* spp. | 99.8 | 45.0 | *Capitella* spp. | 326.8 | 193.0 |
| | | *Nucula proxima* | 19.6 | 4.7 | Rhynchocoela spp. | 239.6 | 113.5 |
| | | *Nephtys incisa* | 12.6 | 1.1 | *Nephtys incisa* | 196.6 | 40.3 |
| | | *Arctica islandica* | 5.2 | 2.0 | *Nucula proxima* | 126.8 | 30.3 |
| | | *Edotea triloba* | 3.6 | 1.0 | *Nassarius trivittatus* | 17.8 | 17.8 |
| | | Rhynchocoela spp. | 2.4 | 0.5 | *Edotea Triloba* | 11.2 | 1.7 |
| | | Anthozoa spp. | 2.2 | 0.7 | *Artica islandica* | 6.0 | 2.7 |
| | | *Spio filicornus* | 1.0 | 0.3 | *Cancer irroratus* | 5.0 | 2.3 |
| | | *Cancer irroratus* | 1.0 | 0.4 | *Mulinia lateralis* | 4.0 | 2.5 |
| | | *Crangon septemspinosa* | 0.6 | 0.6 | Anthozoa spp. | 3.2 | 1.0 |
| Oct 1985 | 2 grabs | *Nephtys incisa* | 7.0 | 1.0 | *Nephtys incisa* | 180.0 | 4.0 |
| | | *Nassarius trivittatus* | 1.0 | 0.0 | *Glycera dibranchiata* | 30.0 | 30.0 |
| | | *Nucula proxima* | 1.0 | 1.0 | *Tellina agilis* | 3.0 | 1.0 |
| | | *Tellina agilis* | 1.0 | 0.0 | *Nassarius trivittatus* | 2.5 | 0.5 |
| | | *Glycera dibranchiata* | 0.5 | 0.5 | *Nucula proxima* | 2.5 | 2.5 |
| | | *Pherusa affinis* | 0.5 | 0.5 | *Pherusa affinis* | 1.0 | 1.0 |
| | | *Spisula solidissima* | 0.5 | 0.5 | *Spisula solidissima* | 1.0 | 1.0 |
| Jul 1986 | 3 grabs | *Capitella* spp. | 2177.3 | 1433.3 | Rhynchocoela spp. | 3792.3 | 1478.7 |
| | | *Asabellides oculata* | 486.3 | 92.7 | *Asabellides oculata* | 3128.0 | 1440.7 |
| | | *Pherusa affinis* | 72.3 | 39.1 | *Capitella* spp. | 2552.7 | 2289.1 |
| | | *Nucula proxima* | 68.0 | 42.0 | *Pherusa affinis* | 622.0 | 365.2 |
| | | Rhynchocoela spp. | 60.3 | 17.9 | *Paranaitis speciosa* | 287.0 | 26.2 |
| | | *Tellina agilis* | 50.3 | 33.2 | *Nephtys incisa* | 253.3 | 237.0 |
| | | *Paraougia caeca* | 40.0 | 40.0 | *Ceriantheopsis americanus* | 243.7 | 217.8 |
| | | *Paranaitus speciosa* | 31.7 | 3.2 | *Cancer irroratus* | 219.0 | 81.2 |
| | | *Tharyx acutus* | 24.0 | 10.0 | *Asterias forbesi* | 122.7 | 122.7 |
| | | *Cancer irroratus* | 16.3 | 7.4 | *Nucula proxima* | 119.7 | 48.0 |
| Aug 1986 | 3 grabs | *Tharyx* spp. | 33.7 | 33.7 | Rhynchocoela spp. | 2283.0 | 835.0 |
| | | Rhynchocoela spp. | 23.3 | 11.6 | *Cancer irroratus* | 891.0 | 611.3 |
| | | *Nucula proxima* | 22.0 | 18.0 | *Nephtys incisa* | 521.0 | 278.9 |
| | | *Tharyx acutus* | 16.7 | 14.7 | *Ceriantheopsis americanus* | 361.0 | 209.3 |
| | | *Cancer irroratus* | 12.3 | 2.6 | *Nucula proxima* | 63.0 | 41.7 |
| | | *Cerioantheopsis americanus* | 12.0 | 8.3 | *Pherusa affinis* | 30.3 | 13.0 |
| | | *Pherusa affinis* | 11.3 | 6.4 | *Nassarius trivittatus* | 28.0 | 28.0 |
| | | *Nephtys incisa* | 4.7 | 2.3 | *Tharyx* spp. | 7.3 | 7.3 |
| | | *Mediomastus ambiseta* | 4.3 | 2.3 | *Tharyx acutus* | 7.3 | 5.9 |
| | | *Tellina agilis* | 2.3 | 1.5 | *Phoronis architecta* | 7.0 | 6.0 |
| Sep 1986 | 3 grabs | Rhynchocoela spp. | 39.7 | 14.4 | Rhynchocoela spp. | 2169.0 | 853.0 |
| | | *Tharyx acutus* | 22.3 | 5.9 | *Ceriantheopsis americanus* | 552.0 | 251.0 |
| | | *Nucula proxima* | 22.0 | 10.2 | *Pherusa affinis* | 199.7 | 193.2 |
| | | *Ceriantheopsis americanus* | 20.3 | 9.0 | *Nephtys incisa* | 135.0 | 45.3 |

Table 5 (continued)

| Date | No. of samples | Species | Density Mean | Density SE | Species | Biomass (mg) Mean | Biomass (mg) SE |
|---|---|---|---|---|---|---|---|
| | | *Capitella* spp. | 6.7 | 3.3 | *Glycera dibranchiata* | 94.3 | 52.6 |
| | | *Mediomastus ambiseta* | 6.3 | 2.3 | *Nucula proxima* | 51.3 | 15.8 |
| | | *Nephtys incisa* | 2.3 | 0.9 | *Spio filicornis* | 11.0 | 11.0 |
| | | *Tellina agilis* | 2.3 | 1.5 | *Ninoe nigripes* | 8.0 | 8.0 |
| | | *Parougis caeca* | 2.0 | 2.0 | *Tharyx acutus* | 8.0 | 3.6 |
| | | *Pherusa affinis* | 2.0 | 1.2 | *Tellina agilis* | 2.3 | 1.9 |
| Jul 1987 | 3 grabs | Rhynchocoela spp. | 71.7 | 40.2 | Rhynchocoela spp. | 9054.7 | 4015.4 |
| | | *Parougia caeca* | 37.0 | 21.0 | *Ceriantheopsis americanus* | 1507.0 | 796.7 |
| | | *Ceriantheopsis americanus* | 36.3 | 21.3 | *Nephtys incisa* | 243.3 | 224.4 |
| | | *Nucula proxima* | 27.3 | 13.7 | *Nucula proxima* | 134.7 | 58.7 |
| | | *Capitella* spp. | 15.0 | 14.0 | *Edotea triloba* | 106.0 | 36.8 |
| | | *Edotea triloba* | 13.0 | 3.5 | *Parougia caeca* | 45.0 | 28.4 |
| | | *Cancer irroratus* | 4.3 | 2.8 | *Cancer irroratus* | 36.3 | 28.3 |
| | | *Nephtys incisa* | 3.7 | 1.5 | *Pitar morrhuanus* | 18.3 | 18.3 |
| | | *Spio filicornis* | 2.0 | 2.0 | *Spio filicornis* | 10.0 | 10.0 |
| | | *Harmothoe extenuata* | 1.3 | 0.7 | *Spiophanes bombyx* | 8.7 | 8.7 |
| Aug 1987 | 3 grabs | *Parougia caeca* | 48.3 | 29.1 | Rhynchocoela spp. | 3691.0 | 1441.4 |
| | | Rhynchocoela spp. | 37.0 | 16.1 | *Ceriantheopsis americanus* | 782.7 | 530.0 |
| | | *Capitella* spp. | 34.7 | 16.8 | *Nucula proxima* | 152.3 | 70.4 |
| | | *Nucula proxima* | 25.7 | 13.6 | *Pherusa affinis* | 45.0 | 23.1 |
| | | *Ceriantheopsis americanus* | 9.3 | 6.2 | *Edotea triloba* | 34.0 | 21.1 |
| | | *Edotea triloba* | 5.0 | 3.1 | *Spio filicornis* | 22.3 | 22.3 |
| | | *Pherusa affinis* | 2.0 | 0.6 | *Cancer irroratus* | 21.7 | 11.5 |
| | | *Cancer irroratus* | 1.3 | 0.9 | *Parougia caeca* | 15.3 | 10.5 |
| | | *Spio filicornis* | 1.0 | 1.0 | *Nephtys incisa* | 9.7 | 9.7 |
| | | *Tharyx acutus* | 0.7 | 0.7 | *Capitella* spp. | 6.7 | 3.8 |
| Sep 1987 | 3 grabs | *Capitella* spp. | 2187.3 | 867.3 | Rhynchocoela spp. | 3542.7 | 1172.9 |
| | | *Nucula proxima* | 63.0 | 29.6 | *Ceriantheopsis americanus* | 1429.7 | 1336.3 |
| | | Rhynchocoela spp. | 22.7 | 5.2 | *Capitella* spp. | 1089.3 | 394.4 |
| | | *Ceriantheopsis americanus* | 19.0 | 18.0 | *Cancer irroratus* | 936.3 | 936.3 |
| | | *Parougia caeca* | 4.3 | 2.0 | *Nucula proxima* | 154.7 | 23.7 |
| | | *Prionospio steenstrupi* | 3.3 | 2.8 | *Nephtys incisa* | 26.7 | 12.1 |
| | | *Edotea triloba* | 2.7 | 1.2 | *Pherusa affinis* | 17.3 | 17.3 |
| | | *Nephtys incisa* | 2.3 | 0.7 | *Parougia caeca* | 5.0 | 2.6 |
| | | *Unciola irrorata* | 1.0 | 1.0 | *Edotea triloba* | 3.7 | 1.5 |
| | | *Jassa falcata* | 0.7 | 0.3 | *Dyopedos monocanthus* | 3.3 | 1.7 |

**Table 6**

Mean densities and biomasses per 0.1 m with standard errors and numbers of replicate samples analyzed, for the numerically dominant species at Station 7 on each sampling date.

| Date | No. of samples | Species | Density Mean | Density SE | Species | Biomass (mg) Mean | Biomass (mg) SE |
|---|---|---|---|---|---|---|---|
| Dec 1979 | 5 grabs | *Capitella* spp. | 372.0 | 181.5 | *Diopatra cuprea* | 1032.8 | 479.6 |
| | | *Tharyx acutus* | 296.0 | 46.1 | *Ceriantheopsis americanus* | 633.2 | 201.4 |
| | | *Parougia caeca* | 98.8 | 22.8 | *Nephtys picta* | 631.8 | 99.9 |
| | | *Exogone hebes* | 69.8 | 10.4 | Rhynchocoela spp. | 523.4 | 231.4 |
| | | *Spiophanes bombyx* | 60.8 | 23.9 | *Asabellides oculata* | 300.2 | 64.5 |
| | | *Asabellides oculata* | 57.4 | 24.0 | *Ensis directus* | 262.8 | 158.4 |
| | | *Unciola irrorata* | 44.8 | 20.2 | *Spiophanes bombyx* | 220.4 | 59.9 |
| | | *Mephtys picta* | 37.8 | 3.0 | *Nassarius trivittatus* | 209.4 | 129.5 |
| | | Nephtyidae spp. | 23.0 | 5.1 | *Glycera dibranchiata* | 180.4 | 22.5 |
| | | *Phoronis architecta* | 13.4 | 5.8 | *Tharyx acutus* | 177.2 | 26.3 |
| Jul 1980 | 5 grabs | *Edotea triloba* | 62.0 | 13.6 | *Lumbrineris acicularum* | 522.0 | 334.6 |
| | | *Capitella* spp. | 42.8 | 16.8 | *Ceriantheopsis americanus* | 351.6 | 260.8 |
| | | *Tharyx acutus* | 28.6 | 12.7 | Rhynchocoela spp. | 280.3 | 98.9 |
| | | *Tellina agilis* | 23.3 | 5.4 | *Edotea triloba* | 236.4 | 89.1 |
| | | *Nephtys picta* | 17.4 | 10.2 | *Nephtys picta* | 225.6 | 141.1 |
| | | *Amastigos caperatus* | 15.7 | 9.9 | *Glycera dibranchiata* | 145.6 | 105.4 |
| | | *Parougia caeca* | 13.4 | 5.5 | *Tellina agilis* | 111.1 | 44.4 |
| | | *Spiophanes bombyx* | 13.4 | 5.9 | *Nephtys incisa* | 102.8 | 102.8 |
| | | *Tharyx acutus* | 11.7 | 11.6 | *Spiophanes bombyx* | 99.4 | 74.8 |
| | | *Exogone hebes* | 9.1 | 9.0 | *Nephtys bucera* | 73.3 | 73.2 |
| Dec 1980 | 5 grabs | *Spiophanes bombyx* | 108.5 | 26.1 | *Arctica islandica* | 15400.0 | 15400.0 |
| | | *Capitella* spp. | 32.6 | 11.0 | *Nassarius trivittatus* | 1091.1 | 615.5 |
| | | *Parougia caeca* | 30.8 | 18.4 | *Diopatra cuprea* | 417.0 | 415.8 |
| | | *Pherusa affinis* | 25.3 | 12.3 | *Ceriantheopsis americanus* | 403.5 | 189.0 |
| | | Nephtyidae spp. | 14.7 | 5.2 | *Nephtys picta* | 251.1 | 132.9 |
| | | *Tharyx acutus* | 10.1 | 6.1 | Rhynchocoela spp. | 207.9 | 169.8 |
| | | *Nephtys picta* | 9.1 | 2.9 | *Spiophanes bombyx* | 182.6 | 124.6 |
| | | *Diopatra cuprea* | 4.5 | 3.7 | *Pherusa affinis* | 107.3 | 55.0 |
| | | *Exogone hebes* | 3.8 | 2.6 | *Crangon septemspinosa* | 28.7 | 4.2 |
| | | Nereidae spp. (juv.) | 3.5 | 2.1 | *Laonice cirrata* | 17.9 | 17.8 |
| Aug 1981 | 5 grabs | *Spiophanes bombyx* | 158.4 | 29.5 | *Spiophanes bombyx* | 1516.7 | 210.2 |
| | | *Capitella* spp. | 79.1 | 33.8 | *Diopatra cuprea* | 370.0 | 370.0 |
| | | *Tharyx acutus* | 24.6 | 20.7 | *Ceriantheopsis americanus* | 346.7 | 97.5 |
| | | *Exogone hebes* | 17.8 | 2.6 | Rhynchocoela spp. | 216.6 | 103.4 |
| | | *Spio filicornis* | 13.9 | 5.7 | *Nephtys picta* | 187.4 | 44.5 |
| | | *Tellina agilis* | 13.3 | 6.6 | *Nassarius trivittatus* | 158.3 | 158.2 |
| | | *Tharyx dorsobranchialis* | 11.1 | 9.5 | *Spio filicornis* | 99.7 | 31.5 |
| | | *Ceriantheopsis americanus* | 10.8 | 1.1 | *Tellina agilis* | 91.7 | 38.0 |
| | | *Nephtys picta* | 8.9 | 3.2 | *Glycera dibranchiata* | 71.7 | 29.4 |
| | | Nephtyidae spp. | 4.9 | 3.1 | *Capitella* spp. | 60.9 | 17.2 |
| Jan 1982 | 5 grabs | *Echinarachnius parma* | 192.4 | 48.5 | *Spiophanes bombyx* | 1428.6 | 336.2 |
| | | *Spiophanes bombyx* | 120.4 | 14.0 | *Ceriantheopsis americanus* | 630.0 | 226.1 |
| | | Nephtyidae spp. | 82.6 | 6.7 | Rhynchocoela spp. | 317.4 | 143.9 |
| | | *Exogone hebes* | 26.0 | 6.8 | *Nephtys picta* | 202.4 | 37.5 |
| | | *Tellina agilis* | 25.4 | 3.8 | *Diopatra cuprea* | 200.6 | 179.6 |
| | | *Parougia caeca* | 22.2 | 5.3 | *Nassarius trivittatus* | 121.8 | 79.9 |
| | | *Tharyx acutus* | 17.8 | 6.2 | Nephtyidae spp. | 68.8 | 9.9 |
| | | *Capitella* spp. | 17.2 | 2.7 | *Pherusa affinis* | 60.0 | 33.3 |
| | | *Nephtys picta* | 7.6 | 1.2 | *Glycera dibranchiata* | 53.6 | 20.1 |
| | | Glycera spp. (juv.) | 7.2 | 1.9 | *Tellina agilis* | 33.4 | 20.8 |

**Table 6 (continued)**

| Date | No. of samples | Species | Density Mean | Density SE | Species | Biomass (mg) Mean | Biomass (mg) SE |
|---|---|---|---|---|---|---|---|
| Aug 1982 | 5 grabs | *Capitella* spp. | 678.3 | 123.7 | Rhynchocoela spp. | 8553.3 | 1749.8 |
| | | *Parougia caeca* | 167.4 | 12.8 | *Ceriantheopsis americanus* | 2080.6 | 903.1 |
| | | *Exogone hebes* | 79.3 | 26.7 | Capitella spp. | 1915.3 | 356.1 |
| | | *Spiophanes bombyx* | 44.6 | 16.0 | *Spiophanes bombyx* | 875.7 | 343.7 |
| | | *Nephtys picta* | 38.0 | 17.0 | *Nephtys picta* | 533.7 | 222.9 |
| | | *Tharyx acutus* | 24.4 | 3.7 | *Diopatra cuprea* | 368.0 | 185.4 |
| | | *Tellina agilis* | 17.8 | 5.0 | *Nassarius trivittatus* | 365.6 | 218.5 |
| | | Rhynchocoela spp. | 13.7 | 4.6 | *Glycera dibranchiata* | 277.5 | 167.0 |
| | | *Ceriantheopsis americanus* | 5.1 | 1.2 | *Cancer irroratus* | 188.3 | 126.0 |
| | | *Amastigos caperatus* | 3.8 | 1.7 | *Tellina agilis* | 164.1 | 76.6 |
| Nov 1982 | 5 grabs | *Capitella* spp. | 82.6 | 44.1 | *Diopatra cuprea* | 1597.2 | 1294.4 |
| | | *Nereis succinea* | 27.8 | 23.5 | *Pitar morrhuanus* | 924.0 | 924.0 |
| | | *Spio filicornis* | 23.8 | 14.0 | *Spio filicornis* | 179.0 | 113.8 |
| | | *Spiophanes bombyx* | 14.4 | 6.0 | *Glycera dibranchiata* | 168.4 | 119.0 |
| | | *Pherusa affinis* | 9.8 | 3.0 | Rhynchocoela spp. | 103.6 | 71.3 |
| | | *Diopatra cuprea* | 9.0 | 6.3 | *Ceriantheopsis americanus* | 88.4 | 63.3 |
| | | *Gammarus lawrencianus* | 8.6 | 8.6 | *Capitella* spp. | 83.0 | 46.0 |
| | | *Euchone incolor* | 6.6 | 6.4 | *Nereis succinea* | 80.4 | 72.3 |
| | | *Tellina agilis* | 5.6 | 1.0 | *Nephtys picta* | 74.6 | 27.3 |
| | | *Nephtys picta* | 5.2 | 1.2 | *Cancer irroratus* | 67.6 | 67.6 |
| Jul 1983 | 5 grabs | *Tellina agilis* | 160.6 | 27.0 | *Nassarius trivittatus* | 903.4 | 463.3 |
| | | *Capitella* spp. | 34.8 | 7.7 | *Ceriantheopsis americanus* | 678.0 | 260.7 |
| | | Nephtyidae spp. | 16.4 | 7.5 | *Diopatra cuprea* | 333.4 | 204.3 |
| | | *Spiophanes bombyx* | 13.2 | 3.1 | *Tellina agilis* | 272.8 | 72.1 |
| | | *Ensis directus* | 11.2 | 4.1 | *Nephtys picta* | 164.0 | 56.3 |
| | | *Nephtys picta* | 8.4 | 3.4 | Rhynchocoela spp. | 134.2 | 82.0 |
| | | *Tharyx acutus* | 8.2 | 3.5 | *Spiophanes bombyx* | 54.2 | 17.6 |
| | | *Ceriantheopsis americanus* | 7.0 | 1.6 | *Glycera dibranchiata* | 29.0 | 17.7 |
| | | *Spisula solidissima* | 6.8 | 2.4 | *Ensis directus* | 22.4 | 8.1 |
| | | *Cerastoderma pinnulatum* | 3.8 | 1.2 | *Cancer irroratus* | 21.2 | 10.3 |
| Nov 1983 | 5 grabs | *Nephtys picta* | 83.4 | 29.9 | *Diopatra cuprea* | 832.2 | 482.1 |
| | | *Spiophanes bombyx* | 65.0 | 19.3 | *Ceriantheopsis americanus* | 603.4 | 294.3 |
| | | *Capitella* spp. | 33.2 | 23.3 | *Nassarius trivittatus* | 495.0 | 303.6 |
| | | *Echinarachnius parma* | 22.8 | 10.2 | *Nephtys picta* | 112.2 | 62.0 |
| | | *Ampelisca vadorum* | 18.4 | 13.1 | *Spiophanes bombyx* | 102.6 | 36.9 |
| | | *Parougia caeca* | 14.4 | 4.7 | *Asabellides oculata* | 47.4 | 20.1 |
| | | Nephtyidae spp. | 11.6 | 11.6 | *Capitella* spp. | 19.8 | 12.7 |
| | | *Asabellides oculata* | 11.2 | 4.1 | Rhynchocoela spp. | 16.0 | 15.0 |
| | | *Nereis succinea* | 10.6 | 3.9 | *Nereis succinea* | 13.2 | 8.8 |
| | | *Tharyx* spp. | 8.4 | 2.2 | *Tellina agilis* | 12.6 | 3.4 |
| Aug 1984 | 5 grabs | *Spiophanes bombyx* | 110.8 | 45.5 | *Nassarius trivittatus* | 604.4 | 453.6 |
| | | *Tellina agilis* | 34.8 | 10.4 | *Tellina agilis* | 391.2 | 145.2 |
| | | *Nephtys picta* | 24.4 | 7.6 | *Spiophanes bombyx* | 242.2 | 135.7 |
| | | *Capitella* spp. | 21.6 | 20.1 | *Capitella* spp. | 181.6 | 179.9 |
| | | *Tharyx acutus* | 8.4 | 4.6 | *Nephtys picta* | 119.2 | 52.3 |
| | | *Exogone hebes* | 3.4 | 1.7 | *Ceriantheopsis americanus* | 79.8 | 48.0 |
| | | *Ceriantheopsis americanus* | 1.8 | 0.6 | *Cancer irroratus* | 54.8 | 24.7 |
| | | *Nassarius trivittatus* | 1.6 | 0.9 | *Ensis directus* | 19.8 | 10.5 |
| | | *Ensis directus* | 1.6 | 0.7 | *Pherusa affinis* | 15.4 | 9.4 |
| | | *Cancer irroratus* | 1.6 | 0.5 | *Diopatra cuprea* | 9.2 | 9.2 |

**Table 6 (continued)**

| Date | No. of samples | Species | Density Mean | Density SE | Species | Biomass (mg) Mean | Biomass (mg) SE |
|---|---|---|---|---|---|---|---|
| Jul 1985 | 5 grabs | *Spiophanes bombyx* | 111.4 | 46.1 | *Spiophanes bombyx* | 1130.0 | 591.6 |
| | | *Tellina agilis* | 51.0 | 10.2 | *Diopatra cuprea* | 545.4 | 458.3 |
| | | Nephtyidae spp. | 29.4 | 7.5 | *Nassarius trivittatus* | 333.0 | 172.8 |
| | | *Unciola irrorata* | 23.2 | 9.6 | *Nephtys picta* | 290.6 | 65.8 |
| | | *Nephtys picta* | 21.4 | 5.2 | *Ceriantheopsis americanus* | 249.6 | 115.7 |
| | | *Tharyx* spp. | 14.8 | 5.5 | *Tellina agilis* | 174.2 | 60.5 |
| | | *Edotea triloba* | 12.8 | 2.3 | *Lumbrineris acicularum* | 130.4 | 49.6 |
| | | *Cancer irroratus* | 9.6 | 3.4 | *Cancer irroratus* | 85.2 | 31.2 |
| | | *Capitella* spp. | 8.2 | 2.2 | *Edotea triloba* | 63.0 | 14.4 |
| | | *Tharyx acutus* | 7.8 | 5.2 | *Unciola irrorata* | 49.8 | 24.8 |
| Oct 1985 | 2 grabs | *Asabellides oculata* | 71.0 | 18.0 | *Nassarius trivittatus* | 2262.5 | 1537.5 |
| | | *Tharyx* spp. | 10.0 | 7.0 | *Diopatra cuprea* | 378.0 | 235.0 |
| | | *Nephtys picta* | 9.0 | 7.0 | *Pherusa affinis* | 295.0 | 294.0 |
| | | *Nassarius trivittatus* | 7.0 | 5.0 | *Ceriantheopsis americanus* | 127.0 | 127.0 |
| | | *Pherusa affinis* | 6.5 | 1.5 | *Cancer irroratus* | 103.0 | 103.0 |
| | | *Spiophanes bombyx* | 6.0 | 0.0 | *Lumbrineris acicularum* | 52.5 | 52.5 |
| | | *Nereis succinea* | 5.0 | 5.0 | *Nephtys picta* | 48.0 | 35.0 |
| | | *Mysella planata* | 5.0 | 5.0 | Rhynchocoela spp. | 40.0 | 25.0 |
| | | *Exogone hebes* | 3.0 | 3.0 | *Asabellides oculata* | 14.0 | 7.0 |
| | | *Diopatra cuprea* | 3.0 | 0.0 | *Nereis succinea* | 8.5 | 8.5 |

**Table 7**

Mean densities and biomasses per 0.1 m with standard errors and numbers of replicate samples analyzed, for the numerically dominant species at Station 4 on each sampling date.

| Date | No. of samples | Species | Density Mean | Density SE | Species | Biomass (mg) Mean | Biomass (mg) SE |
|---|---|---|---|---|---|---|---|
| Dec 1979 | 5 grabs | *Amastigos caperatus* | 772.2 | 380.8 | *Tharyx acutus* | 215.2 | 132.7 |
| | | *Tharyx acutus* | 452.6 | 284.7 | *Amastigos caperatus* | 203.6 | 133.1 |
| | | *Spisula solidissima* | 67.4 | 10.9 | *Nephtys picta* | 169.4 | 51.3 |
| | | Nephtyidae spp. | 43.6 | 6.9 | *Echinarachnius parma* | 145.4 | 143.7 |
| | | *Tellina agilis* | 41.2 | 12.8 | *Tellina agilis* | 79.6 | 35.5 |
| | | *Phoronis architecta* | 33.6 | 21.7 | *Glycera dibranchiata* | 43.2 | 16.6 |
| | | *Spiophanes bombyx* | 28.6 | 6.1 | *Spisula solidissima* | 38.4 | 8.6 |
| | | *Nephtys picta* | 26.8 | 8.1 | *Lumbrineris acicularum* | 32.0 | 13.8 |
| | | *Glycera* spp. (juv.) | 13.0 | 2.2 | Rhynchocoela spp. | 26.6 | 7.0 |
| | | *Echinarachnius parma* | 12.2 | 5.9 | *Magelona riojai* | 26.0 | 21.1 |
| Jul 1980 | 4 grabs | *Tharyx acutus* | 776.0 | 291.5 | *Cancer borealis* | 22750.0 | 22750.0 |
| | | *Nucula proxima* | 295.0 | 272.7 | *Nucula proxima* | 1635.8 | 1548.0 |
| | | *Tellina agilis* | 284.3 | 94.6 | *Tellina agilis* | 1118.5 | 408.9 |
| | | *Polydora ligni* | 242.3 | 161.1 | *Nephtys incisa* | 664.5 | 445.7 |
| | | *Amastigos caperatus* | 159.3 | 101.1 | *Phoronis architecta* | 428.8 | 427.1 |
| | | *Phyllodoce (anatides) mucosa* | 144.5 | 86.0 | *Cancer irroratus* | 412.3 | 266.0 |
| | | *Phoronis architecta* | 71.8 | 69.4 | *Tharyx acutus* | 336.3 | 165.1 |
| | | *Mediomastus ambiseta* | 46.3 | 46.3 | *Lumbrineris acicularum* | 238.8 | 88.6 |
| | | *Spiophanes bombyx* | 27.5 | 14.5 | Rhynchocoela spp. | 223.5 | 128.9 |
| | | Rhynchocoela spp. | 27.3 | 11.8 | *Glycera dibranchiata* | 178.8 | 118.0 |
| Dec 1980 | 5 grabs | Nephtyidae spp. | 34.4 | 12.0 | *Ensis directus* | 506.4 | 503.4 |
| | | *Tellina agilis* | 26.4 | 5.6 | *Lunatia heros* | 258.0 | 258.0 |
| | | *Spiophanes bombyx* | 24.2 | 9.8 | *Tellina agilis* | 108.2 | 30.6 |
| | | *Tanaissus liljeborgi* | 20.8 | 12.4 | *Nephtys bucera* | 100.4 | 27.5 |
| | | *Nephtys bucera* | 14.6 | 4.0 | *Sthenelais limicola* | 64.4 | 57.4 |
| | | *Rhepoxynius hudsoni* | 10.2 | 4.9 | Rhynchocoela spp. | 32.8 | 22.7 |
| | | *Ensis directus* | 7.4 | 1.2 | *Crangon septemspinosa* | 25.8 | 24.1 |
| | | *Pseudunciola obliquua* | 7.4 | 5.3 | *Nephtys picta* | 25.4 | 12.2 |
| | | *Magelona riojai* | 7.2 | 3.7 | *Spisula solidissima* | 24.8 | 24.8 |
| | | Rhynchocoela spp. | 2.6 | 1.0 | *Lumbrineris acicularum* | 15.0 | 12.1 |
| Aug 1981 | 5 grabs | *Nephtys picta* | 79.0 | 22.0 | *Spisula solidissima* | 986.6 | 849.9 |
| | | *Pseudunciola obliquua* | 60.8 | 33.0 | *Cancer irroratus* | 595.8 | 389.9 |
| | | *Spiophanes bombyx* | 48.0 | 14.0 | *Ovalipes ocellatus* | 568.2 | 212.9 |
| | | *Tharyx acutus* | 41.8 | 40.6 | *Nephtys picta* | 205.2 | 68.7 |
| | | *Tellina agilis* | 30.6 | 7.4 | *Tellina agilis* | 180.2 | 38.3 |
| | | *Tanaissus liljeborgi* | 29.6 | 15.8 | *Ensis directus* | 164.0 | 101.2 |
| | | *Spisula solidissima* | 23.6 | 14.1 | *Lumbrineris acicularum* | 127.8 | 75.1 |
| | | *Phoxocephalus holbolli* | 16.8 | 15.6 | *Glycera robusta* | 100.8 | 89.4 |
| | | *Parougia caeca* | 15.6 | 14.9 | *Spiophanes bombyx* | 89.8 | 24.2 |
| | | *Prionospio steenstrupi* | 10.4 | 10.4 | *Spio filicornis* | 51.4 | 51.4 |
| Jan 1982 | 5 grabs | *Amastigos caperatus* | 781.2 | 345.1 | *Ensis directus* | 1194.8 | 614.3 |
| | | *Tellina agilis* | 600.4 | 220.3 | *Lumbrineris acicularum* | 521.4 | 350.0 |
| | | Nephtyidae spp. | 141.6 | 21.7 | *Tellina agilis* | 415.4 | 165.3 |
| | | *Mediomastus ambiseta* | 118.6 | 84.6 | *Pitar morrhuanus* | 153.8 | 32.2 |
| | | *Tharyx acutus* | 110.8 | 73.9 | *Phoronis architecta* | 143.6 | 88.8 |
| | | *Pitar morrhuanus* | 59.8 | 29.3 | *Mediomastus ambiseta* | 114.0 | 108.5 |
| | | *Spiophanes bombyx* | 40.4 | 7.3 | Nephtyidae spp. | 103.4 | 22.1 |
| | | *Nucula proxima* | 31.0 | 14.5 | *Glycera dibranchiata* | 94.8 | 30.7 |
| | | *Phoronis architecta* | 25.4 | 16.7 | *Pandora gouldiana* | 87.0 | 87.0 |
| | | *Sthenelais limicola* | 10.8 | 3.8 | *Sthenelais limicola* | 75.2 | 21.8 |

**Table 7 (continued)**

| Date | No. of samples | Species | Density Mean | Density SE | Species | Biomass (mg) Mean | Biomass (mg) SE |
|---|---|---|---|---|---|---|---|
| Aug 1982 | 5 grabs | *Mytilus edulis* | 551.6 | 536.9 | *Mytilus edulis* | 1859.6 | 1560.4 |
| | | *Amastigos caperatus* | 97.4 | 60.8 | *Cancer irroratus* | 809.4 | 765.9 |
| | | *Tellina agilis* | 57.0 | 11.8 | *Tellina agilis* | 345.4 | 104.8 |
| | | *Nephtys picta* | 38.6 | 9.8 | *Ophioglycera gigantea* | 324.0 | 324.0 |
| | | *Tharyx acutus* | 27.2 | 22.3 | *Pitar morrhuanus* | 276.4 | 275.7 |
| | | *Polydora socialis* | 18.6 | 17.6 | *Nephtys picta* | 242.0 | 19.2 |
| | | *Harmothoe extenuata* | 15.2 | 15.0 | *Asterias vulgaris* | 236.8 | 236.8 |
| | | *Parougia caeca* | 10.8 | 4.6 | *Lumbrineris acicularum* | 141.0 | 118.9 |
| | | *Spisula solidissima* | 10.6 | 3.6 | *Glycera robusta* | 81.4 | 79.2 |
| | | *Scalibregma inflatum* | 5.2 | 5.0 | *Glycera dibranchiata* | 78.4 | 29.9 |
| Jul 1983 | 5 grabs | *Tellina agilis* | 53.0 | 16.3 | *Lumbrineris acicularum* | 244.4 | 72.8 |
| | | Nephtyidae spp. | 27.2 | 5.5 | *Tellina agilis* | 149.0 | 60.6 |
| | | *Goniadella gracilis* | 23.8 | 15.2 | *Nephtys picta* | 59.4 | 27.3 |
| | | *Chiridotea tuftsi* | 8.0 | 4.6 | Rhynchocoela spp. | 48.2 | 15.9 |
| | | *Nephtys picta* | 6.8 | 3.4 | *Glycera dibranchiata* | 38.8 | 21.6 |
| | | *Caulleriella cf killariensis* | 6.4 | 4.2 | *Nephtys bucera* | 35.8 | 11.7 |
| | | *Spisula solidissima* | 6.2 | 1.2 | *Yoldia* spp. | 34.4 | 34.4 |
| | | *Spiophanes bombyx* | 5.2 | 1.9 | *Cancer irroratus* | 31.4 | 15.2 |
| | | *Pseudoleptocuma minor* | 4.4 | 1.6 | *Glycera robusta* | 22.6 | 22.6 |
| | | *Hemipodus roseus* | 4.2 | 4.2 | *Spisula solidissima* | 19.4 | 6.3 |
| Aug 1984 | 5 grabs | *Spiophanes bombyx* | 26.0 | 7.9 | *Nephtys bucera* | 187.4 | 78.4 |
| | | *Nephtys picta* | 11.4 | 4.0 | *Lumbrineris acicularum* | 106.6 | 79.3 |
| | | *Goniadella gracilis* | 9.0 | 8.8 | *Spiophanes bombyx* | 77.2 | 34.1 |
| | | *Pseudunciola obliquua* | 8.2 | 8.0 | *Nephtys picta* | 73.0 | 42.7 |
| | | *Tellina agilis* | 7.4 | 1.3 | *Tellina agilis* | 66.6 | 26.7 |
| | | *Spisula solidissima* | 7.0 | 5.3 | *Nassarius trivittatus* | 55.8 | 39.2 |
| | | *Glycera* spp. (juv.) | 6.2 | 1.1 | *Ensis directus* | 39.8 | 24.5 |
| | | *Tanaissus liljeborgi* | 6.2 | 6.0 | *Cancer irroratus* | 26.0 | 26.0 |
| | | *Caulleriella cf. killariensis* | 6.0 | 2.6 | *Glycera* spp. (juv.) | 21.6 | 11.2 |
| | | *Tharyx acutus* | 3.0 | 1.5 | *Glycera dibranchiata* | 21.0 | 10.7 |
| Jun 1985 | 5 grabs | *Pseudunciola obliquua* | 85.2 | 58.3 | *Tellina agilis* | 197.4 | 84.3 |
| | | *Tellina agilis* | 42.4 | 14.5 | *Lumbrineris acicularum* | 156.2 | 79.6 |
| | | Nephtyidae spp. | 17.0 | 5.2 | *Glycera dibranchiata* | 87.0 | 70.4 |
| | | *Tanaissus liljeborgi* | 14.0 | 3.5 | *Spisula solidissima* | 46.8 | 15.4 |
| | | *Caulleriella cf killariensis* | 9.8 | 2.7 | Rhynchocoela spp. | 30.4 | 12.0 |
| | | *Spisula solidissima* | 7.8 | 3.4 | *Nassarius trivittatus* | 29.0 | 29.0 |
| | | *Rhepoxynius hudsoni* | 6.6 | 2.8 | *Pseudunciola obliquua* | 27.6 | 14.5 |
| | | *Spiophanes bombyx* | 6.2 | 2.0 | *Nephtys picta* | 26.0 | 7.7 |
| | | *Ensis directus* | 5.4 | 1.7 | Nephtyidae spp. | 21.4 | 4.8 |
| | | *Magelona riojai* | 5.2 | 3.3 | *Spiophanes bombyx* | 15.4 | 6.1 |
| Oct 1985 | 2 grabs | *Nephtys picta* | 24.5 | 11.5 | *Nephtys picta* | 212.0 | 39.0 |
| | | *Tellina agilis* | 24.5 | 3.5 | *Tellina agilis* | 122.0 | 70.0 |
| | | *Spisula solidissima* | 17.5 | 0.5 | *Spisula solidissima* | 96.5 | 71.5 |
| | | *Caulleriella cf. killariensis* | 16.5 | 11.5 | *Arctica islandica* | 95.0 | 95.0 |
| | | *Tharyx acutus* | 14.5 | 14.5 | *Lumbrineris acicularum* | 77.5 | 15.5 |
| | | *Magelona rosea* | 7.0 | 7.0 | *Glycera dibranchiata* | 67.0 | 52.0 |
| | | *Chiridotea tuftsi* | 4.5 | 2.5 | *Ensis directus* | 55.0 | 55.0 |
| | | Rhynchocoela spp. | 4.0 | 0.0 | *Nassarius trivittatus* | 46.0 | 46.0 |
| | | *Lumbrineris acicularum* | 4.0 | 3.0 | Rhynchocoela spp. | 15.0 | 7.0 |
| | | *Goniada maculata* | 3.0 | 2.0 | *Caulleriella cf. killariensis* | 6.0 | 4.0 |

**Table 8**

Mean densities and biomasses per 0.1 m with standard errors and numbers of replicate samples analyzed, for the numerically dominant species at Station 26 on each sampling date.

| Date | No. of samples | Species | Density Mean | Density SE | Species | Biomass (mg) Mean | Biomass (mg) SE |
|---|---|---|---|---|---|---|---|
| Dec 1979 | 5 grabs | *Echinarachnius parma* | 56.6 | 19.2 | *Echinarachnius parma* | 16846.0 | 5403.9 |
| | | *Spisula solidissima* | 10.2 | 4.7 | *Ceriantheopsis americanus* | 331.8 | 212.5 |
| | | *Nephtys picta* | 9.2 | 4.0 | *Lumbrineris acicularum* | 83.8 | 24.9 |
| | | *Lumbrineris acicularum* | 7.4 | 1.2 | *Nephtys bucera* | 58.2 | 43.3 |
| | | Nephtyidae spp. | 6.4 | 2.4 | *Spisula solidissima* | 40.6 | 23.4 |
| | | *Tellina agilis* | 4.6 | 2.2 | *Nephtys picta* | 25.2 | 15.4 |
| | | *Caulleriella cf. killariensis* | 4.2 | 1.1 | *Crangon septemspinosa* | 24.0 | 12.8 |
| | | *Ceriantheopsis americanus* | 3.6 | 2.0 | Rhynchocoela spp. | 19.0 | 16.8 |
| | | *Photis macrocoxa* | 3.6 | 1.0 | *Tellina agilis* | 14.2 | 6.8 |
| | | *Parougia caeca* | 3.2 | 1.4 | *Astarte castanea* | 13.8 | 11.9 |
| Jul 1980 | 5 grabs | *Echinarachnius parma* | 27.8 | 9.7 | *Echinarachnius parma* | 19332.1 | 7682.7 |
| | | *Nephtys picta* | 12.7 | 2.5 | *Ceriantheopsis americanus* | 1311.9 | 0.4 |
| | | *Ceriantheopsis americanus* | 12.2 | 0.6 | *Spisula solidissima* | 432.3 | 427.0 |
| | | *Lumbrineris acicularum* | 8.2 | 0.6 | *Astarte castanea* | 271.3 | 207.0 |
| | | *Cancer irroratus* | 7.3 | 2.2 | *Lumbrineris acicularum* | 241.4 | 36.4 |
| | | *Tharyx dorsobranchialis* | 2.8 | 0.9 | *Nassarius trivittatus* | 92.4 | 92.4 |
| | | Rhynchocoela spp. | 2.3 | 1.0 | *Euclymene zonalis* | 65.7 | 63.6 |
| | | *Tellina agilis* | 2.3 | 1.5 | *Cancer irroratus* | 51.7 | 16.8 |
| | | *Euclymene zonalis* | 2.0 | 0.8 | Rhynchocoela spp. | 49.5 | 29.3 |
| | | *Glycera dibranchiata* | 1.6 | 0.6 | *Clymenella torquata* | 48.0 | 48.0 |
| Dec 1980 | 5 grabs | *Echinarachnius parma* | 36.3 | 11.5 | *Echinarachnius parma* | 34208.9 | 14360.2 |
| | | *Goniadella gracilis* | 16.4 | 9.2 | *Ceriantheopsis americanus* | 1845.1 | 626.4 |
| | | *Spisula solidissima* | 12.4 | 8.7 | *Cancer irroratus* | 1229.1 | 1229.0 |
| | | *Ceriantheopsis americanus* | 7.6 | 2.0 | *Astarte undata* | 486.9 | 486.8 |
| | | *Glycera* spp. (juv.) | 7.1 | 3.3 | *Astarte castanea* | 449.0 | 392.1 |
| | | *Lumbrineris acicularum* | 6.4 | 1.8 | *Lumbrineris acicularum* | 385.8 | 129.2 |
| | | *Aglaophamus igalis* | 6.1 | 1.7 | Rhynchocoela spp. | 81.4 | 73.7 |
| | | Pelecypoda spp. (unidentifiable) | 6.1 | 5.1 | *Nephtys picta* | 66.1 | 22.6 |
| | | *Tharyx acutus* | 4.9 | 3.1 | *Nephtys bucera* | 64.4 | 64.4 |
| | | Rhynchocoela spp. | 4.5 | 2.9 | *Sigalion arenicola* | 26.3 | 20.4 |
| Aug 1981 | 5 grabs | *Goniadella gracilis* | 24.3 | 15.4 | *Echinarachnius parma* | 17019.8 | 13878.8 |
| | | *Hemipodus roseus* | 13.1 | 6.5 | *Ceriantheopsis americanus* | 821.3 | 373.9 |
| | | *Echinarachnius parma* | 10.3 | 7.2 | *Nassarius trivittatus* | 384.3 | 186.7 |
| | | *Lumbrineris acicularum* | 10.0 | 4.5 | *Lumbrineris acicularum* | 254.0 | 27.9 |
| | | *Tharyx dorsobranchialis* | 9.3 | 3.1 | *Nephtys bucera* | 162.4 | 96.9 |
| | | *Harmothoe extenuata* | 8.3 | 2.4 | *Lunatia triseriata* | 93.1 | 93.0 |
| | | *Spiophanes bombyx* | 7.9 | 3.8 | *Astarte castanea* | 75.4 | 69.4 |
| | | *Ceriantheopsis americanus* | 3.3 | 1.3 | *Nephtys picta* | 59.7 | 18.1 |
| | | *Nephtys picta* | 3.3 | 1.0 | *Aglaophamus circinata* | 53.8 | 26.8 |
| | | Nephtyidae spp | 3.0 | 1.0 | *Cancer irroratus* | 33.7 | 14.9 |
| Jan 1982 | 5 grabs | *Tharyx acutus* | 27.8 | 10.5 | *Echinarachnius parma* | 55693.4 | 10755.1 |
| | | *Hemipodus roseus* | 27.4 | 14.3 | *Spisula solidissima* | 29603.4 | 29600.4 |
| | | *Echinarachnius parma* | 24.6 | 4.1 | *Ceriantheopsis americanus* | 1613.2 | 387.8 |
| | | Rhynchocoela spp. | 15.0 | 5.8 | *Astarte castanea* | 442.0 | 326.0 |
| | | *Goniadella gracilis* | 13.2 | 5.6 | *Nassarius trivittatus* | 221.0 | 221.0 |
| | | Nephtyidae spp. | 9.4 | 2.5 | Rhynchocoela spp. | 138.0 | 103.1 |
| | | *Spisula solidissima* | 8.4 | 2.8 | *Lumbrineris acicularum* | 74.0 | 45.6 |
| | | *Ceriantheopsis americanus* | 5.6 | 1.5 | *Nephtys bucera* | 59.2 | 21.8 |
| | | *Parougia caeca* | 3.0 | 0.8 | *Nephtys picta* | 48.8 | 35.2 |
| | | *Nephtys bucera* | 2.6 | 0.7 | *Sigalion arenicola* | 29.6 | 21.8 |

**Table 8 (continued)**

| Date | No. of samples | Species | Density Mean | Density SE | Species | Biomass (mg) Mean | Biomass (mg) SE |
|---|---|---|---|---|---|---|---|
| Aug 1982 | 5 grabs | *Echinarachnius parma* | 71.9 | 13.0 | *Echinarachnius parma* | 12900.1 | 30175.3 |
| | | *Tharyx acutus* | 20.6 | 2.0 | *Spisula solidissima* | 9128.8 | 9117.8 |
| | | Nephtyidae spp. | 10.1 | 4.4 | *Ceriantheopsis americanus* | 1079.4 | 502.6 |
| | | *Hemipodus roseus* | 9.7 | 9.1 | *Nassarius trivittatus* | 383.3 | 157.9 |
| | | *Nephtys picta* | 9.3 | 2.1 | *Cerastoderma pinnulatum* | 173.6 | 173.6 |
| | | *Tharyx dorsobranchialis* | 8.4 | 2.8 | *Nephtys picta* | 86.4 | 20.1 |
| | | Rhynchocoela spp. | 8.3 | 4.4 | *Lumbrineris acicularum* | 57.0 | 25.7 |
| | | *Goniadella gracilis* | 8.3 | 5.1 | Rhynchocoela spp. | 48.3 | 31.2 |
| | | *Harmothoe extenuata* | 5.5 | 2.7 | *Cancer irroratus* | 21.6 | 9.0 |
| | | *Ceriantheopsis americanus* | 5.3 | 1.7 | Nephtyidae spp. | 19.0 | 8.3 |
| Jul 1983 | 5 grabs | *Tharyx acutus* | 63.8 | 33.2 | *Echinarachnius parma* | 40284.2 | 15300.4 |
| | | *Goniadella gracilis* | 56.8 | 26.0 | *Ceriantheopsis americanus* | 1628.0 | 315.5 |
| | | Nephtyidae spp. | 28.8 | 6.6 | *Astarte castanea* | 453.0 | 232.1 |
| | | *Echinarachnius parma* | 18.6 | 8.0 | *Lumbrineris acicularum* | 383.6 | 61.6 |
| | | *Tharyx dorsobranchialis* | 15.4 | 5.9 | Rhynchocoela spp. | 74.0 | 57.8 |
| | | *Ceriantheopsis americanus* | 9.6 | 2.9 | *Tharyx marioni* | 41.6 | 41.6 |
| | | *Astarte castanea* | 9.6 | 4.1 | *Sigalion arenicola* | 30.0 | 27.1 |
| | | *Leitoscoloplos acutus* | 8.4 | 6.2 | *Nephtys bucera* | 24.2 | 21.8 |
| | | *Lumbrineris acicularum* | 6.8 | 1.6 | *Tharyx acutus* | 19.8 | 13.3 |
| | | *Hemipodus roseus* | 3.4 | 3.2 | *Nephtys picta* | 11.2 | 2.5 |
| Aug 1984 | 2 grabs | *Ceriantheopsis americanus* | 34.0 | 24.0 | *Echinarachnius parma* | 33717.5 | 20079.5 |
| | | *Tharyx acutus* | 33.5 | 18.5 | *Ceriantheopsis americanus* | 1112.0 | 675.0 |
| | | *Goniadella gracilis* | 15.5 | 9.5 | *Nassarius trivittatus* | 323.0 | 323.0 |
| | | *Echinarachnius parma* | 14.5 | 8.5 | *Spisula solidissima* | 312.0 | 312.0 |
| | | *Caulleriella cf. killariensis* | 7.0 | 6.0 | *Cirriformia grandis* | 219.0 | 219.0 |
| | | *Spiophanes bombyx* | 3.5 | 2.5 | *Nephtys bucera* | 123.5 | 123.5 |
| | | *Tharyx dorsobranchialis* | 3.5 | 1.5 | *Lumbrineris acicularum* | 123.5 | 123.5 |
| | | Nephtyidae spp. | 1.5 | 0.5 | *Tharyx acutus* | 27.5 | 19.5 |
| | | *Glycera* spp. (juv.) | 1.5 | 0.5 | *Astarte castanea* | 24.0 | 24.0 |
| | | *Ensis directus* | 1.5 | 0.5 | *Cancer irroratus* | 22.0 | 22.0 |
| Jun 1985 | 5 grabs | *Echinarachnius parma* | 42.6 | 5.5 | *Echinarachnius parma* | 10487.1 | 13261.5 |
| | | *Caulleriella cf. killariensis* | 12.2 | 4.7 | *Ensis directus* | 595.6 | 589.4 |
| | | *Tharyx acutus* | 11.6 | 4.3 | *Ceriantheopsis americanus* | 503.0 | 201.8 |
| | | *Nephtys picta* | 7.4 | 3.2 | *Lumbrineris acicularum* | 476.4 | 53.1 |
| | | *Cancer irroratus* | 6.2 | 0.9 | *Nephtys bucera* | 174.6 | 130.3 |
| | | Nephtyidae spp. | 5.6 | 3.5 | *Nephtys picta* | 85.2 | 35.6 |
| | | *Lumbrineris acicularum* | 5.0 | 0.8 | *Cancer irroratus* | 45.8 | 11.6 |
| | | *Ceriantheopsis americanus* | 4.8 | 0.8 | *Astarte castanea* | 36.6 | 21.6 |
| | | *Ensis directus* | 3.8 | 1.1 | Rhynchocoela spp. | 27.0 | 12.1 |
| | | *Tharyx dorsobranchialis* | 3.0 | 1.0 | *Periploma leanum* | 21.0 | 21.0 |
| Oct 1985 | 2 grabs | *Tellina agilis* | 43.0 | 30.0 | *Echinarachnius parma* | 36130.0 | 31990.0 |
| | | *Echinarachnius parma* | 30.0 | 2.0 | *Lumbrineris acicularum* | 122.5 | 121.5 |
| | | *Caulleriella cf. killariensis* | 24.0 | 18.0 | *Ceriantheopsis americanus* | 75.5 | 10.5 |
| | | *Tharyx* spp. | 16.0 | 8.0 | *Cancer irroratus* | 36.0 | 36.0 |
| | | *Tharyx dorsobranchialis* | 10.5 | 9.5 | *Astarte castanea* | 12.5 | 12.5 |
| | | *Magelona rosea* | 4.5 | 4.5 | *Tellina agilis* | 8.0 | 6.0 |
| | | *Spiophanes bombyx* | 4.0 | 4.0 | *Nephtys bucera* | 7.0 | 2.0 |
| | | Nephtyidae spp. | 3.0 | 3.0 | *Caulleriella cf. killariensis* | 4.5 | 3.5 |
| | | *Nephtys bucera* | 2.0 | 0.0 | *Nephtys picta* | 4.0 | 4.0 |
| | | *Syllides* sp. 1 | 1.5 | 1.5 | *Tharyx* spp. | 3.0 | 2.0 |

**Table 9**

Mean densities and biomasses per 0.1 m with standard errors and numbers of replicate samples analyzed, for the numerically dominant species at Station 31 on each sampling date.

| Date | No. of samples | Species | Density Mean | Density SE | Species | Biomass (mg) Mean | Biomass (mg) SE |
|---|---|---|---|---|---|---|---|
| Dec 1979 | 4 grabs | *Echinarachnius parma* | 552.8 | 106.3 | *Echinarachnius parma* | 34150.0 | 8350.4 |
| | | *Pseudunciola obliquua* | 197.5 | 46.5 | *Lumbrineris acicularum* | 454.5 | 441.9 |
| | | *Tanaissus liljeborgi* | 96.8 | 40.1 | *Acanthohaustorius spinosus* | 128.8 | 60.9 |
| | | *Byblis serrata* | 79.0 | 58.2 | *Byblis serrata* | 112.8 | 78.5 |
| | | *Tellina agilis* | 40.5 | 21.8 | *Pseudunciola obliquua* | 72.8 | 16.2 |
| | | *Rhepoxynius hudsoni* | 38.8 | 17.9 | *Rhepoxynius hudsoni* | 61.0 | 32.8 |
| | | *Tharyx acutus* | 29.0 | 2.7 | *Aglaophamus circinata* | 37.5 | 35.8 |
| | | *Exogone hebes* | 22.8 | 6.3 | *Pandora gouldiana* | 31.5 | 31.5 |
| | | *Aricidea (acesta) catherinae* | 22.3 | 5.5 | *Euclymene zonalis* | 27.8 | 5.8 |
| | | *Corophium crassicorne* | 21.0 | 13.1 | *Nephtys incisa* | 21.5 | 21.5 |
| Jul 1980 | 5 grabs | *Pseudunciola obliquua* | 135.3 | 45.4 | *Echinarachnius parma* | 2546.6 | 1025.9 |
| | | *Tanaissus liljeborgi* | 88.9 | 17.3 | *Ensis directus* | 284.9 | 283.8 |
| | | *Exogone hebes* | 69.3 | 13.3 | *Byblis serrata* | 248.1 | 72.1 |
| | | *Byblis serrata* | 40.5 | 10.7 | *Nassarius trivittatus* | 111.1 | 111.0 |
| | | Aoridae spp. (juv.) | 29.3 | 29.2 | *Sigalion arenicola* | 76.4 | 32.7 |
| | | *Unciola irrorata* | 23.0 | 4.8 | *Unciola irrorata* | 39.0 | 10.5 |
| | | *Aricidea (acesta) catherinae* | 20.6 | 4.6 | *Cancer irroratus* | 33.8 | 8.4 |
| | | *Goniadella gracilis* | 18.4 | 9.0 | *Rhepoxynius hudsoni* | 21.3 | 12.9 |
| | | *Caulleriella cf. killariensis* | 17.6 | 7.2 | *Drilonereis magna* | 18.9 | 13.8 |
| | | *Rhepoxynius hudsoni* | 16.6 | 5.8 | *Pseudunciola obliquua* | 18.9 | 2.8 |
| Dec 1980 | 5 grabs | *Byblis serrata* | 111.3 | 25.7 | *Echinarachnius parma* | 12436.0 | 6483.8 |
| | | *Exogone hebes* | 37.0 | 10.3 | *Astarte undata* | 2580.1 | 2580.0 |
| | | *Tanaissus liljeborgi* | 36.0 | 11.0 | *Nassarius trivittatus* | 231.6 | 231.6 |
| | | *Pseudunciola obliquua* | 32.6 | 12.9 | *Byblis serrata* | 191.6 | 63.5 |
| | | *Rhepoxynius hudsoni* | 29.0 | 2.7 | Rhynchocoela spp. | 145.9 | 140.6 |
| | | Nephtyidae spp. | 18.8 | 5.4 | *Ensis directus* | 130.4 | 129.4 |
| | | *Spiophanes bombyx* | 17.3 | 2.8 | *Cirolana polita* | 63.8 | 35.7 |
| | | *Unciola irrorata* | 13.4 | 3.5 | *Cancer irroratus* | 60.0 | 36.8 |
| | | *Aricidea (acesta) catherinae* | 13.3 | 4.2 | *Lumbrineris acicularum* | 46.8 | 24.5 |
| | | *Corophium crassicorne* | 10.9 | 3.0 | *Euclymene zonalis* | 46.7 | 16.1 |
| Aug 1981 | 5 grabs | *Pseudunciola obliquua* | 534.3 | 218.8 | *Echinarachnius parma* | 2973.6 | 1877.5 |
| | | *Tanaissus liljeborgi* | 82.9 | 20.7 | Ascidiacean spp. | 819.5 | 452.4 |
| | | *Corophium crassicorne* | 68.1 | 13.6 | *Ceriantheopsis americanus* | 645.8 | 211.1 |
| | | *Exogone hebes* | 53.3 | 19.1 | *Sigalion arenicola* | 156.1 | 92.2 |
| | | *Echinarachnius parma* | 45.3 | 9.4 | *Corophium crassicorne* | 153.6 | 111.8 |
| | | *Rhepoxynius hudsoni* | 31.0 | 10.0 | *Pherusa affinis* | 145.6 | 145.6 |
| | | *Aricidea (acesta) catherinae* | 27.3 | 8.5 | *Unicola irrorata* | 145.1 | 89.8 |
| | | *Euclymene zonalis* | 20.3 | 10.2 | *Spiophanes bombyx* | 84.4 | 20.6 |
| | | *Cauleriella cf killariensis* | 15.4 | 3.0 | *Psuedunciola obliquua* | 77.7 | 36.3 |
| | | *Unciola irrorata* | 14.7 | 3.1 | Rhynchocoela spp. | 69.7 | 31.8 |
| Jan 1982 | 5 grabs | *Tanaissus liljeborgi* | 310.0 | 67.9 | *Echinarachnius parma* | 20801.6 | 7236.3 |
| | | *Echinarachnius parma* | 185.8 | 32.1 | *Astarte castenea* | 2385.0 | 2383.8 |
| | | *Pseudunciola obliquua* | 161.8 | 52.8 | *Ceriantheopsis americanus* | 1043.4 | 597.3 |
| | | *Exogene hebes* | 78.2 | 15.6 | *Cancer irroratus* | 129.4 | 79.5 |
| | | *Aricidea (acesta) catherinae* | 36.4 | 7.4 | Rhynchocoela spp. | 120.6 | 66.5 |
| | | *Caulleriella cf. killariensis* | 19.8 | 4.2 | *Pseudunciola obliquua* | 76.2 | 26.2 |
| | | *Tharyx acutus* | 14.8 | 8.9 | *Cirolana polita* | 47.0 | 47.0 |
| | | *Spiophanes bombyx* | 11.2 | 2.7 | *Sthenelais limicola* | 36.8 | 14.7 |
| | | *Tellina agilis* | 10.8 | 4.3 | Nereidae spp. | 36.4 | 36.4 |
| | | *Polydora caulleryi* | 9.8 | 3.1 | *Tharyx acutus* | 24.8 | 13.7 |

**Table 9 (continued)**

| Date | No. of samples | Species | Density Mean | Density SE | Species | Biomass (mg) Mean | Biomass (mg) SE |
|---|---|---|---|---|---|---|---|
| Sep 1982 | 5 grabs | *Pseudunciola obliquua* | 390.8 | 256.4 | *Echinarachnius parma* | 14277.3 | 5865.1 |
| | | *Tanaissus liljeborgi* | 70.5 | 32.8 | *Phoronius architecta* | 742.7 | 740.4 |
| | | *Echinarachnius parma* | 65.1 | 25.6 | *Ceriantheopsis americanus* | 616.5 | 17.2 |
| | | *Phoronis architecta* | 62.0 | 60.3 | *Nassarius trivittatus* | 383.3 | 237.8 |
| | | *Euclymene zonalis* | 38.3 | 18.3 | *Lunatia triseriata* | 225.6 | 195.2 |
| | | *Exogene hebes* | 29.4 | 9.4 | *Rhepoxynius hudsoni* | 93.7 | 15.7 |
| | | *Clymenella torquata* | 28.6 | 18.2 | *Pseudunciola obliquua* | 91.4 | 57.2 |
| | | *Rhepoxynius hudsoni* | 26.3 | 5.1 | *Cancer irroratus* | 90.1 | 47.7 |
| | | *Corophium crassicorne* | 25.6 | 3.9 | *Clymenella torquata* | 66.1 | 41.6 |
| | | *Caulleriella cf. killariensis* | 23.8 | 12.5 | *Pherusa affinis* | 50.5 | 40.9 |
| Jul 1983 | 5 grabs | *Pseudunciola obliquua* | 455.4 | 63.1 | *Echinarachnius parma* | 36167.2 | 21809.7 |
| | | *Tanaissus liljeborgi* | 234.8 | 40.8 | *Lumbrineris acicularum* | 178.4 | 119.5 |
| | | *Exogene hebes* | 87.2 | 42.3 | Ascidiacean spp. | 160.8 | 160.8 |
| | | *Caulleriella cf. killariensis* | 27.4 | 2.5 | *Nassarius trivittatus* | 83.0 | 83.0 |
| | | *Polydora caulleryi* | 23.6 | 17.8 | *Sigalion arenicola* | 81.4 | 18.8 |
| | | *Goniadella gracilis* | 19.6 | 6.6 | *Pseudunciola obliquua* | 64.2 | 4.2 |
| | | *Aricidea (acesta) catherinae* | 19.4 | 4.0 | Rhynchocoela spp. | 51.0 | 36.7 |
| | | *Echinarachnius parma* | 14.4 | 6.3 | *Cancer irroratus* | 39.8 | 14.4 |
| | | Rhynchocoela spp. | 9.2 | 3.3 | *Orbinia swani* | 31.4 | 31.4 |
| | | *Rhepoxynius hudsoni* | 8.6 | 0.8 | *Aglaophamus circinata* | 23.0 | 17.6 |
| Aug 1984 | 5 grabs | *Spiophanes bombyx* | 145.8 | 64.5 | *Echinarachnius parma* | 11087.6 | 7056.0 |
| | | *Pseudunciola obliquua* | 133.4 | 28.1 | Ascidiacean spp. | 1321.6 | 849.4 |
| | | *Exogone hebes* | 52.0 | 15.8 | *Ceriantheopsis americanus* | 670.4 | 292.3 |
| | | *Caulleriella cf. killariensis* | 34.8 | 10.3 | *Lumbrineris acicularum* | 523.4 | 225.9 |
| | | *Tharyx acutus* | 24.4 | 6.1 | *Pherusa affinis* | 185.2 | 129.4 |
| | | *Tanaissus liljeborgi* | 22.4 | 9.3 | *Spiophanes bombyx* | 157.6 | 87.3 |
| | | *Ceriantheopsis americanus* | 21.0 | 8.7 | *Pseudunciola obliquua* | 138.4 | 87.4 |
| | | Ascidiacean spp. | 15.4 | 8.2 | *Sigalion arenicola* | 107.6 | 39.6 |
| | | *Arcidea (acesta) catherinae* | 14.8 | 3.0 | *Tellina agilis* | 100.0 | 17.2 |
| | | *Phoxocephalus holbolli* | 13.8 | 7.6 | *Glycera dibranchiata* | 94.2 | 76.3 |
| Jun 1985 | 5 grabs | Nephtyidae spp. | 26.4 | 3.1 | *Echinarachnius parma* | 13566.8 | 4145.4 |
| | | *Tellina agilis* | 25.8 | 5.8 | *Pitar morrhuanus* | 2733.2 | 2727.7 |
| | | *Tharyx acutus* | 24.8 | 8.5 | *Nassarius trivittatus* | 473.6 | 193.4 |
| | | *Phoxocephalus holbolli* | 18.2 | 8.2 | *Ceriantheopsis americanus* | 306.2 | 104.5 |
| | | *Spiophanes bombyx* | 15.4 | 6.6 | *Tellina agilis* | 205.8 | 65.9 |
| | | *Harmothoe extenuata* | 10.8 | 4.1 | *Sthenelais limicola* | 88.8 | 38.0 |
| | | *Tharyx dorsobranchialis* | 10.4 | 6.7 | Rhynchocoela spp. | 83.4 | 22.3 |
| | | *Caulleriella cf. killariensis* | 10.0 | 5.7 | *Spiophanes bombyx* | 48.6 | 31.4 |
| | | *Exogone hebes* | 9.4 | 5.1 | *Lyonsia hyalina* | 42.2 | 17.2 |
| | | *Ensis directus* | 8.0 | 1.7 | *Nucula proxima* | 41.2 | 16.2 |
| Oct 1985 | 2 grabs | *Glycera* spp. | 16.5 | 4.5 | *Echinarachnius parma* | 16950.5 | 16949.5 |
| | | *Tellina agilis* | 13.5 | 5.5 | *Nassarius trivittatus* | 212.0 | 212.0 |
| | | *Echinarachnius parma* | 6.5 | 2.5 | *Tellina agilis* | 38.0 | 35.0 |
| | | *Nucula proxima* | 5.5 | 5.5 | *Cancer irroratus* | 37.0 | 37.0 |
| | | *Asabellides oculata* | 5.0 | 2.0 | *Sigalion arenicola* | 21.5 | 21.5 |
| | | *Pseudunciola obliquua* | 5.0 | 1.0 | *Solen viridis* | 20.5 | 20.5 |
| | | *Aricidea (acesta) catherinae* | 4.0 | 1.0 | *Nucula proxima* | 18.0 | 18.0 |
| | | *Tanaissus liljeborgi* | 3.5 | 2.5 | *Pherusa affinis* | 12.0 | 11.0 |
| | | *Exogone hebes* | 3.0 | 2.0 | Rhynchocoela spp. | 11.5 | 3.5 |
| | | *Polycirrus eximius* | 3.0 | 0.0 | *Sthenelais limicola* | 11.0 | 11.0 |

**Table 10**

Mean densities and biomasses per 0.1 m with standard errors and numbers of replicate samples analyzed, for the numerically dominant species at Station 15 on each sampling date.

| Date | No. of samples | Species | Density Mean | Density SE | Species | Biomass (mg) Mean | Biomass (mg) SE |
|---|---|---|---|---|---|---|---|
| Dec 1979 | 5 grabs | *Ampelisca agassizi* | 1297.4 | 303.1 | *Pitar morrhuanus* | 3168.2 | 3158.0 |
| | | *Tharyx acutus* | 881.6 | 271.5 | *Ampelisca agassizi* | 1914.4 | 633.9 |
| | | *Euchone incolor* | 571.6 | 274.0 | *Nephtys incisa* | 1085.6 | 275.2 |
| | | *Cossura longocirrata* | 360.8 | 71.6 | *Asterias* spp. a | 384.0 | 384.0 |
| | | *Levinsenia gracilis* | 248.4 | 38.2 | *Chone infundibuliformis* | 355.2 | 135.0 |
| | | *Euclymene zonalis* | 172.2 | 40.8 | *Nicolea venustula* | 341.6 | 121.4 |
| | | *Aricidea (acesta) catherinae* | 156.6 | 58.8 | *Periploma papyratium* | 315.0 | 175.3 |
| | | *Mediomastus ambiseta* | 151.2 | 58.0 | *Tharyx acutus* | 292.4 | 67.3 |
| | | *Prionospio steenstrupi* | 145.2 | 26.9 | Rhynchocoela spp. | 276.6 | 96.1 |
| | | *Nucula delphinodonta* | 113.4 | 51.0 | *Nucula delphinodonta* | 273.8 | 192.4 |
| Jul 1980 | 5 grabs | *Ampelisca agassizi* | 1475.5 | 235.0 | *Ampelisca agassizi* | 2811.3 | 404.8 |
| | | *Euchone elegans* | 740.6 | 717.1 | *Nephtys incisa* | 1166.8 | 448.8 |
| | | *Tharyx dorsobranchialis* | 583.3 | 347.2 | *Thyasira trisinuata* | 482.3 | 258.8 |
| | | *Photis macrocoxa* | 231.4 | 130.0 | *Solemya borealis* | 472.0 | 472.0 |
| | | *Mediomastus ambiseta* | 170.4 | 80.0 | *Chone infundibuliformis* | 392.9 | 273.5 |
| | | *Nucula delphinodonta* | 161.9 | 49.9 | *Pherusa affinis* | 381.3 | 60.5 |
| | | *Levinsenia gracilis* | 154.3 | 79.7 | *Leptocheirus pinguis* | 314.5 | 121.3 |
| | | *Lumbrineris hebes* | 132.2 | 52.2 | *Anobothrus gracilis* | 272.9 | 138.2 |
| | | *Euchone incolor* | 119.7 | 61.3 | *Tharyx dorsobranchialis* | 242.4 | 145.8 |
| | | *Diastylis abbreviata* | 100.5 | 49.5 | *Mediomastus ambiseta* | 238.3 | 114.9 |
| Dec 1980 | 5 grabs | *Ampelisca* spp. | 235.6 | 58.5 | *Astarte undata* | 2429.3 | 2172.0 |
| | | *Ampelisca agassizi* | 145.4 | 28.1 | *Astarte crenata subequilatera* | 2244.1 | 2244.0 |
| | | *Leptocheirus pinguis* | 129.4 | 54.5 | *Nephtys incisa* | 779.8 | 486.6 |
| | | *Nucula delphinodonta* | 115.1 | 32.5 | *Leptocheirus pinguis* | 562.5 | 180.4 |
| | | *Ninoe nigripes* | 49.6 | 13.6 | *Chone infundibuliformis* | 474.5 | 99.5 |
| | | *Erichthonius rubricornis* | 41.0 | 17.3 | *Cyclocardia borealis* | 456.3 | 145.9 |
| | | *Unciola irrorata* | 37.8 | 9.2 | *Cancer irroratus* | 436.9 | 285.2 |
| | | *Scalibregma inflatum* | 37.3 | 6.7 | *Scalibregma inflatum* | 394.6 | 73.1 |
| | | *Lumbrineris hebes* | 35.4 | 12.7 | *Ninoe nigripes* | 361.6 | 164.8 |
| | | *Nucula proxima* | 32.0 | 5.2 | *Periploma papyratium* | 352.6 | 83.6 |
| Aug 1981 | 5 grabs | *Euchone incolor* | 1245.5 | 262.1 | *Nephtys incisa* | 1985.1 | 320.3 |
| | | *Tharyx dorsobranchialis* | 437.6 | 123.4 | *Thyasira trisinuata* | 1795.8 | 331.9 |
| | | *Nucula delphinodonta* | 380.3 | 128.0 | *Pherusa affinis* | 1130.8 | 456.3 |
| | | *Ampelisca agassizi* | 283.0 | 161.0 | *Yoldia sapotilla* | 1101.4 | 345.7 |
| | | *Cossura longocirrata* | 252.1 | 97.6 | *Nucula delphinodonta* | 809.5 | 311.5 |
| | | *Lumbrineris hebes* | 212.0 | 60.3 | *Pentamera calcigera* | 706.7 | 432.0 |
| | | *Photis macrocoxa* | 180.1 | 40.5 | *Nucula proxima* | 543.3 | 286.8 |
| | | *Levinsenia gracilis* | 174.4 | 47.3 | *Edotea triloba* | 390.6 | 62.0 |
| | | *Aricidea (Acesta) catherinae* | 160.3 | 52.7 | *Periploma papyratium* | 372.6 | 164.1 |
| | | *Polydora socialis* | 147.4 | 44.5 | *Ceriantheopsis americanus* | 342.3 | 69.8 |
| Jan 1982 | 5 grabs | *Ampelisca agassizi* | 1247.8 | 189.2 | *Pitar morrhuanus* | 5654.4 | 3467.0 |
| | | *Euchone incolor* | 861.8 | 152.1 | *Ampelisca agassizi* | 2264.4 | 332.8 |
| | | *Lumbrineris hebes* | 169.0 | 17.7 | *Nephtys incisa* | 1660.0 | 589.4 |
| | | *Tharyx dorsobranchialis* | 159.2 | 29.7 | *Axius serratus* | 1370.2 | 1370.2 |
| | | *Ninoe nigripes* | 136.4 | 7.7 | *Asterias vulgaris* | 986.8 | 986.8 |
| | | *Nucula delphinodonta* | 124.0 | 9.2 | *Glycera robusta* | 810.0 | 810.0 |
| | | Maldanidae spp. 4 | 70.2 | 28.4 | *Ninoe nigripes* | 351.4 | 66.6 |
| | | *Levinsenia gracilis* | 60.8 | 9.0 | *Pherusa affinis* | 305.2 | 160.7 |
| | | *Photis dentata* | 59.6 | 13.4 | *Nicolea venustula* | 291.0 | 131.0 |
| | | *Erichthonius rubricornis* | 56.4 | 11.1 | *Periploma papyratium* | 177.6 | 42.1 |

## Table 10 (continued)

| Date | No. of samples | Species | Density Mean | Density SE | Species | Biomass (mg) Mean | Biomass (mg) SE |
|---|---|---|---|---|---|---|---|
| Sep 1982 | 5 grabs | *Ampelisca agassizi* | 490.8 | 160.6 | *Nephtys incisa* | 1421.1 | 664.6 |
| | | *Euchone incolor* | 433.4 | 196.1 | *Ampelisca agassizi* | 710.5 | 253.4 |
| | | *Tharyx dorsobranchialis* | 292.3 | 114.7 | *Periploma papyratium* | 404.0 | 114.4 |
| | | *Nucula delphinodonta* | 219.1 | 110.6 | *Ninoe nigripes* | 372.5 | 101.2 |
| | | *Polydora socialis* | 186.1 | 123.4 | *Yoldia sapotilla* | 353.5 | 226.0 |
| | | *Lumbrineris hebes* | 173.0 | 40.2 | *Nucula delphinodonta* | 311.5 | 168.0 |
| | | *Ninoe nigripes* | 136:7 | 16.5 | *Rhodine gracilior* | 218.4 | 117.6 |
| | | *Cossura longocirrata* | 99.1 | 29.3 | *Nucula proxima* | 209.3 | 131.7 |
| | | *Levinsenia gracilis* | 96.3 | 28.3 | *Chone infundibuliformis* | 162.4 | 76.6 |
| | | *Aricidea (Acesta) catherinae* | 75.7 | 32.1 | *Thyasira trisinuata* | 142.1 | 126.5 |
| Aug 1984 | 5 grabs | *Euchone incolor* | 420.0 | 192.7 | *Nephtys incisa* | 3069.6 | 618.1 |
| | | *Ampelisca agassizi* | 179.4 | 119.7 | *Rhodine gracilior* | 1388.8 | 442.3 |
| | | *Tharyx dorsobranchialis* | 152.4 | 77.3 | *Havelockia scabra* | 1281.8 | 1281.8 |
| | | *Prionospio steenstrupi* | 147.4 | 34.4 | *Glycera robusta* | 1045.0 | 1045.0 |
| | | *Aricidea (Acesta) catherinae* | 123.2 | 99.2 | *Ampelisca agassizi* | 502.6 | 229.5 |
| | | *Cossura longocirrata* | 109.2 | 36.4 | *Pitar morrhuanus* | 362.6 | 338.6 |
| | | *Nucula delphinodonta* | 107.4 | 64.9 | *Periploma papyratium* | 273.4 | 109.1 |
| | | *Lumbrineris hebes* | 99.4 | 35.7 | *Thyasira trisinuata* | 254.2 | 64.1 |
| | | *Levinsenia gracilis* | 89.8 | 45.1 | *Yoldia sapotilla* | 232.0 | 170.3 |
| | | *Ninoe nigripes* | 57.8 | 10.9 | *Drilonereis longa* | 198.6 | 35.0 |
| Jun 1985 | 5 grabs | *Ampelisca agassizi* | 392.4 | 73.1 | *Arctica islandica* | 13533.8 | 13237.8 |
| | | *Eudorella pusilla* | 118.6 | 18.6 | *Ninoe nigripes* | 1332.8 | 230.7 |
| | | *Aricidea (Acesta) catherinae* | 57.8 | 16.7 | *Ampelisca agassizi* | 635.8 | 124.3 |
| | | *Ninoe nigripes* | 52.2 | 12.7 | *Chone infundibuliformis* | 460.2 | 321.7 |
| | | *Harpinia propinqua* | 49.4 | 12.5 | *Astarte undata* | 272.2 | 163.5 |
| | | Nephtyidae spp. | 45.6 | 6.1 | *Nephtys incisa* | 201.8 | 85.9 |
| | | *Diastylis quadrispinosa* | 35.4 | 10.1 | *Pitar morrhuanus* | 198.8 | 105.0 |
| | | *Unciola irrorata* | 34.4 | 12.1 | *Periploma fragile* | 163.4 | 71.7 |
| | | *Crenella glandula* | 32.4 | 7.8 | *Cyclocardia borealis* | 151.0 | 58.9 |
| | | *Lumbrineris hebes* | 29.8 | 3.4 | *Diastylis quadrispinosa* | 146.4 | 44.2 |
| Oct. 1985 | 2 grabs | *Ampelisca agassizi* | 358.5 | 30.5 | *Nephtys incisa* | 2743.0 | 1708.0 |
| | | *Nucula proxima* | 90.0 | 84.0 | *Ensis directus* | 606.0 | 606.0 |
| | | *Lumbrineris hebes* | 79.5 | 20.5 | *Ampelisca agassizi* | 579.0 | 170.0 |
| | | *Prionospio steenstrupi* | 74.5 | 22.5 | *Chone infundibuliformis* | 271.5 | 263.5 |
| | | *Levinsenia gracilis* | 62.0 | 22.0 | *Periploma papyratium* | 260.0 | 48.0 |
| | | *Tharyx dorsobranchialis* | 59.0 | 30.0 | *Pherusa affinis* | 239.0 | 91.0 |
| | | *Harpinia propinqua* | 57.0 | 20.0 | *Nucula proxima* | 179.5 | 171.5 |
| | | *Aricidea (Acesta) catherinae* | 37.5 | 26.5 | *Rhodine gracilior* | 111.5 | 61.5 |
| | | *Nucula delphinodonta* | 37.0 | 29.0 | *Lumbrineris hebes* | 108.5 | 19.5 |
| | | *Nephtys incisa* | 36.0 | 22.0 | *Thyasira trisinuata* | 87.5 | 25.5 |

**Table 11**

Mean densities and biomasses per 0.1 m with standard errors and numbers of replicate samples analyzed, for the numerically dominant species at Station 1 on each sampling date.

| Date | No. of samples | Species | Density | | Species | Biomass (mg) | |
|---|---|---|---|---|---|---|---|
| | | | Mean | SE | | Mean | SE |
| Jul 1980 | 1 grab | *Nucula proxima* | 2283.1 | 0.0 | *Arctica Islandica* | 25301.1 | 0.0 |
| | | *Phoronis architecta* | 842.0 | 0.0 | *Phoronis architecta* | 5825.0 | 0.0 |
| | | *Tharyx acutus* | 507.0 | 0.0 | *Nucula proxima* | 5617.0 | 0.0 |
| | | *Nephtys incisa* | 160.1 | 0.0 | *Ceriantheopsis americanus* | 3536.1 | 0.0 |
| | | *Photis macrocoxa* | 80.1 | 0.0 | *Nephtys incisa* | 3475.1 | 0.0 |
| | | *Cossura longocirrata* | 67.1 | 0.0 | *Pherusa affinis* | 2876.1 | 0.0 |
| | | *Tellina agilis* | 50.0 | 0.0 | *Tharyx acutus* | 346.0 | 0.0 |
| | | *Mediomastus ambiseta* | 48.0 | 0.0 | *Ensis directus* | 289.0 | 0.0 |
| | | *Prionospio steenstrupi* | 41.0 | 0.0 | *Tellina agilis* | 263.0 | 0.0 |
| | | *Ceriantheopsis americanus* | 37.0 | 0.0 | *Crangon septemspinosa* | 39.0 | 0.0 |
| Aug 1981 | 1 grab | *Nucula proxima* | 1348.1 | 0.0 | *Nereis virens* | 9242.0 | 0.0 |
| | | *Tharyx acutus* | 1112.1 | 0.0 | *Nucula proxima* | 7640.0 | 0.0 |
| | | *Phoronis architecta* | 446.0 | 0.0 | *Nephtys incisa* | 5240.0 | 0.0 |
| | | *Cossura longocirrata* | 156.1 | 0.0 | *Phoronis architecta* | 4020.0 | 0.0 |
| | | *Nephtys incisa* | 59.0 | 0.0 | *Ceriantheopsis americanus* | 3360.1 | 0.0 |
| | | *Cerianth eopsis americanus* | 48.0 | 0.0 | *Tharyx acutus* | 680.0 | 0.0 |
| | | *Prionospio steenstrupi* | 40.0 | 0.0 | *Yoldia limatula* | 634.0 | 0.0 |
| | | *Mediomastus ambiseta* | 38.0 | 0.0 | *Pherusa affinis* | 383.0 | 0.0 |
| | | *Pherusa affinis* | 30.0 | 0.0 | *Cerastoderma pinnulatum* | 31.0 | 0.0 |
| | | *Lumbrineris hebes* | 15.0 | 0.0 | *Phyllodoce (Anatides) mucosa* | 26.0 | 0.0 |
| Aug 1982 | 2 grabs | *Tharyx acutus* | 4492.5 | 502.5 | *Nucula proxima* | 15587.0 | 2716.0 |
| | | *Nucula proxima* | 4086.1 | 140.0 | *Phoronis architecta* | 7535.5 | 413.5 |
| | | *Cossura longocirrata* | 895.5 | 19.5 | *Nephtys incisa* | 4084.1 | 927.0 |
| | | *Phoronis architecta* | 737.0 | 112.0 | *Ceriantheopsis americanus* | 3328.1 | 224.0 |
| | | *Mediomastus ambiseta* | 364.0 | 52.0 | *Pherusa affinis* | 1897.1 | 54.0 |
| | | *Euchone incolor* | 174.6 | 82.5 | *Tharyx acutus* | 932.5 | 256.5 |
| | | *Prionospio steenstrupi* | 124.1 | 10.0 | *Edwardsia elegans* | 184.1 | 89.0 |
| | | *Nephtys incisa* | 73.1 | 4.0 | *Yoldia sapotilla* | 159.6 | 159.5 |
| | | *Lumbrineris hebes* | 61.5 | 9.5 | *Mediomastus ambiseta* | 123.1 | 10.0 |
| | | *Ninoe nigripes* | 51.0 | 0.0 | *Lumbrioneris hebes* | 112.0 | 14.0 |
| Sep 1983 | 2 grabs | *Nucula proxima* | 4331.0 | 205.0 | *Nucula proxima* | 19675.5 | 184.5 |
| | | *Tharyx acutus* | 2615.5 | 747.5 | *Arctica islandica* | 12299.0 | 12299.0 |
| | | *Prionospio steenstrupi* | 1222.5 | 386.5 | *Phoronis architecta* | 11467.5 | 1932.5 |
| | | *Cossura longocirrata* | 905.0 | 124.0 | *Pherusa affinis* | 5442.5 | 1280.5 |
| | | *Mediomastus ambiseta* | 460.5 | 1.5 | *Nephtys incisa* | 4520.5 | 205.5 |
| | | *Phoronis architecta* | 459.5 | 76.5 | *Ceriantheopsis americanus* | 3230.5 | 170.5 |
| | | *Tharyx dorsobranchialis* | 117.5 | 11.5 | *Tharyx acutus* | 2021.5 | 568.0 |
| | | *Pherusa affinis* | 94.5 | 32.5 | *Rhynchocoela* | 769.5 | 719.5 |
| | | *Ceriantheopsis americanus* | 88.0 | 5.0 | *Prionospio steenstrupi* | 368.5 | 145.5 |
| | | *Lumbrineris hebes* | 62.5 | 9.5 | *Yoldia limtula* | 275.0 | 275.0 |
| Aug 1984 | 2 grabs | *Nucula proxima* | 3650.5 | 1171.5 | *Nucula proxima* | 16482.5 | 5730.5 |
| | | *Tharyx acutus* | 1330.5 | 43.5 | *Pherusa affinis* | 7866.0 | 2722.0 |
| | | *Cossura longocirrata* | 321.5 | 146.5 | *Phoronis architecta* | 6584.5 | 1328.5 |
| | | *Phoronis architecta* | 234.0 | 9.0 | *Nereis virens* | 5026.0 | 5026.0 |
| | | *Prionospio steenstrupi* | 197.0 | 21.0 | *Nephtys incisa* | 4434.0 | 652.0 |
| | | *Mediomastus ambiseta* | 78.0 | 17.0 | *Ceriantheopsis americanus* | 2877.0 | 652.0 |
| | | *Ceriantheopsis americanus* | 69.0 | 28.0 | *Glycera robusta* | 990.0 | 990.0 |
| | | *Pherusa affinis* | 59.5 | 5.5 | *Tharyx acutus* | 963.5 | 13.5 |
| | | *Nephtys incisa* | 55.5 | 7.5 | *Pitar morrhuanus* | 798.5 | 784.5 |
| | | *Lumbrineris hebes* | 44.0 | 5.0 | *Goniada norvegica* | 648.0 | 648.0 |

**Table 11 (continued)**

| Date | No. of samples | Species | Density Mean | Density SE | Species | Biomass (mg) Mean | Biomass (mg) SE |
|---|---|---|---|---|---|---|---|
| Oct 1985 | 2 grabs | *Nucula proxima* | 2592.5 | 50.5 | *Pherusa affinis* | 12313.5 | 8388.5 |
| | | *Tharyx* spp. | 716.5 | 687.5 | *Nucula proxima* | 8122.0 | 351.0 |
| | | *Phoronis architecta* | 191.5 | 88.5 | *Nephtys incisa* | 2148.0 | 82.0 |
| | | *Tharyx acutus* | 191.0 | 127.0 | *Ceriantheopsis americanus* | 1429.0 | 35.0 |
| | | *Cossura longocirrata* | 169.0 | 120.0 | *Phoronis architecta* | 1428.0 | 672.0 |
| | | *Pherusa affinis* | 102.0 | 44.0 | Rhynchoceola spp. | 254.9 | 8.0 |
| | | *Mediomastus ambiseta* | 47.0 | 23.0 | *Tharyx* spp. | 184.0 | 176.0 |
| | | *Nephtys incisa* | 41.0 | 10.0 | *Edwardsia elegans* | 70.5 | 0.5 |
| | | *Lumbrineris hebes* | 37.5 | 16.5 | *Nassarius trivittatus* | 58.5 | 58.5 |
| | | *Ceriantheopsis americanus* | 31.0 | 6.0 | *Tharyx acutus* | 52.5 | 28.5 |

## Dominant Species

Lists of the ten most abundant species in both numbers and biomass for each station and sampling have been prepared. These lists complement the above treatments of higher taxa, such as amphipods, and the broader analyses (species richness, clustering) by revealing which species are responsible for any spatial-temporal trends detected. Analysis of dominant species can indicate whether these trends are due to pollution-sensitive or tolerant species. The dominant species lists can be combined with information on fish diets (summarized in Reid and Steimle 1988) to estimate the forage value of a site's macrobenthos and whether that value has been altered.

Dominant species for the six NEMP stations (4, 6, 7, 15, 26, and 31) (Fig. 1) are emphasized because these stations have more samplings, including winter collections, and greater replication (usually five grabs). For Station 6, there is the added advantage of having monthly data available for summer 1986 and 1987 and counts for the polychaetes, *Capitella* spp., for summer 1988. The NEMP stations provide fairly good spatial coverage of the overall study area. They also include most of the habitat types and faunal assemblages encountered. Data on dominant species for the NEMP stations are given in Tables 5–10. Conspicuously absent from the NEMP sites is an assemblage consistently found in and near the Christiaensen Basin, with high densities and biomasses of polychaetes, bivalves, and an anthozoan (Pearce et al. 1981; Steimle 1985). The high abundances in this assemblage may be due to organic enrichment (Boesch 1982). Lists of dominant species from Station 1 (Table 11) illustrate trends in the "enriched" assemblage. Tables of dominant species for other non-NEMP stations are available on request. Some noteworthy features of Tables 5–11 are discussed below.

**Station 6 (sewage sludge accumulation area-Table 5)**—As noted above, this area apparently contained the most altered assemblage of any station. The fauna is characterized by *Capitella* spp.[1], which Awere the numerical dominants in eight of the 13 samplings at Station 6, with a peak mean density of 5604 individuals/0.1 $m^2$. *Capitella* spp. were rarely the most abundant taxa outside of Station 6, and maximum density never exceeded 678/0.1 $m^2$ elsewhere.

There may be a seasonality in abundance of *Capitella* spp. at Station 6 (Fig. 10). In winter samplings from 1979 through 1983, *Capitella* spp. were the top dominant only once (November 1983), and mean densities ranged from 1-415/0.1 $m^2$. Conversely, *Capitella* spp. were the top dominants in all summer samplings from 1980 through 1985, though abundances were quite variable ($\bar{x}$ = 87-5604/0.1 $m^2$). Where there were multiple samplings in a given summer, shorter-term fluctuations are indicated. There were large increases in abundance between July and August 1983 and between July and September 1987,

[1] *Capitella capitata* is widely used as an indicator of organic enrichment, although it also reaches high densities in response to other disturbances, such as defaunation (Caracciolo and Steimle 1983). *Capitella capitata* is actually a complex of several species which are morphologically similar but have distinct genomes and life histories (Grassle and Grassle 1976; Grassle et al. 1987). The differences may be important in interpreting population fluctuations and in using *Capitella* spp. as pollution indicators. The *Capitella* specimens from our sampling that have been examined closely appear to resemble species 1a in Grassle and Grassle (1976) (Judith Grassle, Marine Biological Laboratory, Woods Hole, MA 02543, pers. commum., November 1988). Species 1a produces a relatively large number (200–2000) of small eggs which remain in the plankton for several days, whereas the planktonic phase is shorter or absent in most other *Capitella* species examined to date. Since most of our specimens have not been positively identified, they will be referred to as *Capitella* spp.

and a major decrease between July and August 1986. Densities were low (<10/0.1 $m^2$) in July through September 1988.

One hypothesis to explain the sudden changes is that populations of *Capitella* spp. are limited by deteriorating water quality (e.g., high temperature, low dissolved oxygen, concentrations of hydrogen sulfide), for variable periods during at least some summers. Recurrent hypoxia, and occasional sulfide generation, have been observed at Station 6 (Andrew Draxler, NMFS, Sandy Hook Laboratory, Highlands, NJ 07732, pers. commun., November 1988). Some species of the genus *Capitella* have been reported to have only a moderate tolerance for hypoxia (Reish 1970). Tsutsumi (1987) documented the disappearance of a dense *C. capitata* population from an organically polluted cove in Japan in mid-summer; the population did not begin to reestablish itself until late October, when dissolved oxygen increased and sediment sulfide content began to fall. The factors controlling *Capitella* spp. densities at Station 6 will be examined by comparing densities to physical/chemical data (e.g., temperature, oxygen, redox potential, and sulfide) being collected in the sludge dumpsite Recovery" study (Environmental Processes Division, Northeast Fisheries Center 1988), and also to the limited historical data available.

There are of course other possible causes for the observed variability, perhaps acting in concert with changing water quality. Laboratory populations of *Capitella* spp. are known to have oscillations in abundance, which have been linked to declining food supplies and overshooting a habitat's carrying capacity, even under constant conditions (Chesney 1985). Much of the variability is undoubtedly due to the combination of spatial patchiness in densities of *Capitella* spp. and inexact station relocation for multiple sampling, as shown by the wide confidence limits in Figure 10. In October 1985, no *Capitella* spp. were found at Station 6. There were also no rhynchocoels, normally a top dominant in biomass and perhaps more useful than *Capitella* spp. in characterizing the sludge accumulation area, since rhynchocoels generally did not show such large short-term fluctuations (Table 5). The variability of the Station 6 assemblage makes it difficult to use in monitoring changes following phaseout of dumping.

**Station 7 (sewage sludge dumpsite-Table 6)**—As in the sludge accumulation area, *Capitella* spp. were numerical dominants in all Station 7 samplings from December 1979 through June 1985 and then were not found in the last sampling in October 1985. Densities were less variable over time than those at Station 6, and peak abundances were about an order of magnitude less. Similarly, rhynchocoels were generally a biomass dominant as at Station 6, but were considerably less abundant at Station 7. The lower densities are taken as an indication that the effects of organic enrichment in the dumpsite itself were fairly small; the dumpsite is not a markedly depositional area, as indicated by its relative coarse, low-carbon sediments (Table 1). Conspicuous among other biomass dominants were the anthozoan *Ceriantheopsis americanus* and polychaete *Diopatra cuprea,* both large tube-dwelling species whose abundances may have been enhanced by the sludge input; both were less abundant at Station 22, 5.6 km east of Station 6 and with similar depth and sediments. There were no obvious faunal trends indicative of changing effects of either organic enrichment or toxicants over the study period.

**Station 4 (New Jersey Inshore, 2.4 km NNE of dredged material dumpsite - Table 7**—The fauna was variable, with no consistently dominant species. This may be related to the sediment patchiness we have encountered at Station 4, which in turn is probably due in part to the history of past dumping. (We have found no distinctly altered assemblage near this dumpsite comparable to that of the sewage sludge accumulation area.) Early collections at Station 4 had high densities of several species, e.g., the polychaetes *Amastigos caperatus* and *Tharyx* spp. In 1983–85 there were no very abundant species, and the overall fauna was sparse.

**Station 26 (New Jersey Offshore, 24.8 km E of central NJ coast-Table 8)**—This station was situated at the center of the 1976 hypoxia event off New Jersey (Steimle and Radosh 1979). The benthos appeared to have largely recovered by the beginning of this study (unpubl. data). The fauna was numerically sparse throughout the study period with no obvious trends over time and no consistently abundant species, except perhaps for the sand dollar *Echinarachnius parma,* which was always the overwhelming biomass dominant. Steimle (1990) gives a more detailed analysis of biomass data for *E. parma* and other species at the NEMP stations.

**Station 31 (Long Island Offshore, 25.0 km SSE of Fire Island Inlet-Table 9)**—As a rule, this station was dominated numerically by crustaceans, including the amphipods *Pseudunciola obliquua, Byblis serrata,* *Corophium crassicorne and Rhepoxynius hudsoni,* and tanaidacean *Tanaissus liljeborgi.* Abundances of all these species decreased between 1979 and 1985. The sand dollar was always the biomass dominant, usually by more than an order of magnitude, with levels roughly comparable to those at Station 26 (above) and with no clear trend between 1979 and 1985.

**Station 15 (Outer Hudson Shelf Valley, 48.7 km SE of Sewage Sludge Dumpsite-Table 10)**—This station had been considered to represent the innermost part of the Shelf Valley in which contaminant concentrations and the macrofaunal assemblage were not influenced by pollution (Boesch 1982). The significant decrease in overall numbers of amphipods at this station over the study period was noted above. One species, *Ampelisca agassizi,* was responsible for most of the decrease. *A. agassizi* was the numerical dominant in seven of the nine samplings. Mean densities of over 1000 individuals/0.1 $m^2$ were found in several of the early samplings, but all counts from September 1982 on were $\leqslant$ 490/0.1 $m^2$, with an apparent continuing decline through 1985. The species is thought to be useful for trend monitoring owing to its sensitivity and natural stability of populations (Boesch et al. 1977; Radosh et al. 1978; Schaffner and Boesch 1982). The trend in A. *agassizi* is another indication, along with the general decreases in numbers of total species and amphipods discussed above, that some natural or pollution-related changes have recently affected at least the sensitive components of the benthos. Station 15 also had marked declines in several other species, e.g., the polychaetes *Levinsenia gracilis* and *Euchone incolor,* and the bivalve *Nucula delphinodonta.* Overall numerical abundance decreased here, as part of a trend that was widespread but not universal among Bight stations (e.g., also apparent at 4 and 31 but not at 6, 7, or 26, or in the "enriched" assemblage discussed next).

**Station 1 (Northern Christiaensen Basin, 5.6 km NW of Sewage Sludge Dumpsite-Table 11)**—This station had an "enriched" assemblage characterized by high numbers and biomasses of several deposit-feeding species, especially the polychaetes *Nephtys incisa* and *Pherusa affinis* and bivalve *Nucula proxima. Tharyx* spp. and *Cossura longocirrata* were other numerically important polychaetes, and the phoronid worm *Phoronis architecta* and anthozoan *Ceriantheopsis americanus* were consistent dominants in both numbers and biomasses.

The assemblage was quite stable over the study period. There was an apparent tendency toward increasing abundance and dominance for *Pherusa affinis.* More recent sampling for the sludge dumpsite "recovery" study indicates the continued persistence of the assemblage, with *P. affinis* remaining the biomass dominant, at least into early 1989.

Components of the enriched assemblage were also sometimes found in the sludge accumulation area, and the assemblage was consistently present at all other Christiaensen Basin stations, as well as at stations 2 and 3 immediately to the north of the Basin. There were no clear changes over time at stations 2, 3, or 5, the CB station closest to the sludge area (2.8 km W of Station 6). There were, however, decreases in overall faunal abundance at 9, 10, and 40.

## Comparisons to Other Studies

The spatial pattern of assemblages in the Basin fits the model of Pearson and Rosenberg (1978) for successional changes in response to organic inputs. Areas of high organic loading are often characterized by large populations of a few small opportunistic species—this is represented by the *Capitella* spp.-dominated fauna at Station 6. Areas with somewhat lower organic loading typically have high abundances of several species, as in the enriched assemblage just described for most of the remaining Christiansen Basin and some areas immediately outside the Basin. Pearson and Rosenberg (1978) also note that sediments in the vicinity of a large organic input are sometimes devoid of benthic macrofauna. No consistently defaunated zone has been found in the Basin; for example, no azoic samples were collected in our 1979–85 surveys at Station 6, and only one of 40 grabs in the intensive sampling of the sludge accumulation area in the summers of 1986–1988 had no macrofauna. The implication is that organic loading rates in the Basin have not been as high, relative to compensating phenomena such as dispersion and microbial breakdown, as in many other areas of organic enrichment, e.g. the Saltkallefjord, Sweden; Loch Creran, Scotland; Frazer River estuary, British Columbia; Kiel Bay, Germany (Pearson and Rosenberg 1978). This agrees with the Segar and Davis (1984) global review of contaminated coastal areas, which did not consider the New York Bight to be among the most pollution-susceptible regions.

Detailed, quantitative comparisons of the 1979–87 data with results of earlier New York Bight surveys are beyond the scope of this report. On a qualitative level, there are clear long-term similarities. The enriched assemblage has been present in much of the Basin at least since the first benthic surveys there in 1968 (National Marine Fisheries Service 1972; Pearce 1972; Pearce et al. 1981; Boesch 1982; Steimle et al. 1982; Steimle 1985). The *Capitella* spp.-dominated fauna in the sludge accumulation area was not reported in the 1968–71 studies (National Marine Fisheries Service 1972; Pearce 1972). They were, however, consistently found in the intensive 1973–75 MESA sampling (Pearce et al. 1981). In that sampling, as in ours, recurring high densities of *Capitella* spp. were limited to a small area (the vicinity of Station 6). The persistence of the enriched and *Capitella* spp. assemblages is evidence against gross changes in the benthic environment of the Bight over the past 15–20 years. More sensitive measures such as numbers of species and amphipods, however, do indicate that there has recently been widespread environmental change in the Bight.

## Summary

There were clear spatial patterns in the benthic macrofauna of the New York Bight. Numbers of species and amphipods, considered relatively sensitive indicators of environmental quality, were lowest in the "sludge accumulation area," followed by other Christiaensen Basin and inshore Bight stations. Both variables reached highest values at the outermost shelf stations and in the outer Hudson Shelf Valley.

Cluster analysis of species composition also showed spatial differences. This was expected, given the ranges encountered in variables such as depth, substrate, and distance from estuaries and dumpsites. There were several distinct assemblages, especially in the sludge dumpsite, sludge accumulation area, mid-Hudson Shelf Valley, and outer Shelf Valley. Long Island and New Jersey offshore stations were broadly similar. All remaining Christiaensen Basin stations fell into several related groups. The other inshore samplings were less similar to one another and were spread over much of the dendrogram.

None of the variables examined distinguished northern New Jersey inshore stations from stations further south or along the Long Island coast. This implies that the Hudson-Raritan plume, which tends to follow the north Jersey coast and influence temperature, salinity, dissolved oxygen, carbon and toxicant levels there, has no overriding effect on the benthos of that area.

The spatial patterns in numbers of species and amphipods were consistent between surveys. However, absolute numbers of species and amphipods decreased at a large majority of stations between 1980 and 1985. Decreases for all stations combined were highly significant ($P = 0.0007$ for species, 0.0004 for amphipods). The most significant decreases in numbers of species and amphipods were in the Basin's sludge accumulation area and at a site 52 km SE of that area in the Hudson Shelf Valley. The latter site had been chosen to represent the innermost part of the Shelf Valley that had not been noticeably influenced by pollution. The pattern of decreases superficially suggests increasing effects of sludge or overall waste loading, but the limited data available do not indicate that waste inputs have increased, and there are other feasible explanations for the observed changes. At three inner Bight stations sampled more recently, numbers of species generally rose somewhat between 1986 and 1989, perhaps signalling a reversal of the general downward trend from 1980 to 1985. Temporal changes in species composition and dominants were less evident.

Spatial trends in numbers of species and amphipods, and dominant species, were similar to those observed since sampling in the Christiaensen Basin area began in 1968. A small area with a "highly altered" assemblage dominated by the organic-enrichment indicator polychaetes *Capitella* spp. has been present in the Basin since the early sampling, and an "enriched" faunal assemblage with high biomasses of several species has consistently been found over most of the remaining basin. Samples devoid of benthic macrofauna have been very rare or absent in all surveys. Gross changes in the benthic environment of the New York Bight are therefore not evident over the past 15 years or more.

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## Citations


Boesch, D.F.
1982. Ecosystem consequences of alterations of benthic community structure and function in the New York Bight region. *In* Ecological stress and the New York Bight: science and management (G.F. Mayer, ed.), p. 543–568. Estuarine Research Federation, Columbia, SC 29203.

Boesch, D.F., J.N. Kraeuter, and D.K. Serafy.
1977. Benthic ecological studies: megabenthos and macrobenthos. *In* Chemical and biological benchmark studies on the Middle Atlantic Outer Continental Shelf. Report to Bureau of Land Management from Virginia Institute of Marine Science, Gloucester Point, VA 23062. Unpubl. manuscr., 110 p.

Bray, J.R., and J.T. Curtis.
1957. An ordination of the upland forest communities of southern Wisconsin. Ecol. Monogr. 27: 325–349.

Caracciolo, J.V., and F.W. Steimle Jr.
1983. An atlas of the distribution and abundance of dominant benthic invertebrates in the New York Bight Apex with reviews of their life histories. NOAA Tech. Rep. NMFS SSRF-766, 58 p.

Chapman, P.M., R.N. Dexter, and E.R. Long.
1987. Synoptic measures of sediment contamination, toxicity and infaunal community composition (the Sediment Quality Triad) in San Francisco Bay. Mar. Ecol. Prog. Ser. 37:75–96

Chesney, E.J. Jr.
1985. Succession in soft-bottom benthic environments: are pioneering species really outcompeted? *In* Proc. nineteenth European mar. biol. symp. (P.E. Gibbs, ed.), p. 277–286. Cambridge Univ. Press, Cambridge, England.

Environmental Processes Division, Northeast Fisheries Center
1988. A plan for study: response of the habitat and biota of the inner New York Bight to abatement of sewage sludge dumping. NOAA Tech. Memo. NMFS-F/NEC-55, 34 p.
1991. Response of the habitat and biota of the inner New York Bight to abatement of sewage sludge dumping. Third annual progress report—1989. NOAA Tech. Memo. NMFS-F/NEC-82, 57 p.

Freeland, G.L., and D.J. P. Swift.
1978. Surficial sediments. MESA New York Bight Atlas Monograph 10. New York Sea Grant Institute, Albany, NY 12246. 93 p.

Grassle, J.P., and J.F. Grassle.
1976. Sibling species in the marine pollution indicator *Capitella* (Polychaeta). Science 192:567–569.

Grassle, J.P., C.E. Gelfman, and S.W. Mills.
1987. Karyotypes of *Capitella* sibling species, and of several species in the related genera *Capitellides* and *Capitomastus* (Polychaeta). Bull. Biol. Soc. Wash. 1:17–88.

Gray, J.
1981. The Ecology of Marine Sediments. Cambridge Univ. Press, Cambridge, England, 185 p.

Green, R.H.
1977. Some methods for hypothesis testing with biological monitoring data. *In* Biological monitoring of water and effluent quality (J. Cairns Jr. et al., eds.), p. 200–211. ASTM (American Society for Testing Materials) STP 607.

Gross, M.G., ed.
1976. Middle Atlantic Continental Shelf and the New York Bight. Am. Soc. Limnol. Oceanogr., Spec. Symp. 2. Allen Press, Inc. Lawrence, KS 66045, 441 p.

Holme, N.A., and A.D. McIntyre, eds.
1984. Methods for the Study of Marine Benthos. International Biological Programme Handbook 16. Blackwell Scientific Publ., Oxford, England, 387 p.

HydroQual, Inc.
1989. Assessment of pollutant inputs to New York Bight. Report to U. S. Environmental Protection Agency from HydroQual, Inc., 1 Lethbridge Plaza, Mahwah, NJ 07430. Unpubl. manuscr., 117 p.

Jackson, J.K., and V.H. Resh.
1989. Sequential decision plans, benthic macro-invertebrates, and biological monitoring programs. Environ. Manage. 13:455–468.

Kuiper, J.
1986. Monitoring of fate and effects of oil in the marine environment. Environ. Monit. Assess. 7:221–232.

Langton, R.W., and R.E. Bowman.
1980. Food of fifteen Northwest Atlantic gadiform fishes. NOAA Tech. Rep. NMFS SSRF-740, 23 p.

Lee, W.Y., M.F. Welch, and J.A.C. Nicol.
1977. Survival of two species of amphipods in aqueous extracts of petroleum oils. Mar. Poll. Bull. 8:92–94.

Mayer, G.F., ed.
1982. Ecological stress and the New York Bight: science and management. Estuarine Research Federation, Columbia, SC 29203, 715 p.

Mueller, J.A., J.S. Jeris, A.R. Anderson, and C.F. Hughes.
1976. Contaminant inputs to the New York Bight. NOAA Tech. Memo, ERL MESA-6, 347 p.

Musick, J., and G. Sedberry.
1977. Food habits of fishes. *In* Environmental data acquisition and analysis, p. 108–119. Mid-Atlantic OCS Third Quarterly Summary Report to the Bureau of Land Management. Virginia Institute of Marine Science, Gloucester Point, VA 23062.

National Marine Fisheries Service.
1972. The effects of waste disposal in the New York Bight. Final Report to Coastal Engineering Research Center, U.S. Army Corps of Engineers, Little Falls Rd., Washington D.C., NMFS, Sandy Hook Laboratory, Highlands, NJ 07732. Unpubl. manuscr., 749 p.

New York City Department of Environmental Protection.
1983. Technical information to support the redesignation of the 12-mile site for ocean disposal of municipal sewage sludge. NYC DEP, 2358 Municipal Bldg., New York, NY 10007. Unpubl. manuscr., 438 p., plus appendices.

Norton, M.G., and M.A. Champ.
1989. The influence of site-specific characteristics on the effects of sewage sludge dumping. *In* Oceanic processes in marine pollution, Volume 4 (D.W. Hood, A. Schoener, and P. Kilho Park, eds.), p. 161–183. Scientific Monitoring Strategies for Ocean Waste Disposal. Robert E. Krieger Co., Malabar, FL.

Pearce, J.B.
1972. The effects of solid waste disposal on benthic communities in the New York Bight. *In* Marine pollution and sea life (M. Ruivo, ed.), p. 404–411. Fishing News, Ltd., Surrey, England.

Pearce, J.B., D.J. Radosh, J.V. Caracciolo, and F.W. Steimle Jr.
1981. Benthic fauna. MESA New York Bight Atlas Monograph 14. New York Sea Grant Institute, Albany, NY 12246, 79 p.
Pearson, T.H., and R. Rosenburg.
1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanogr. Mar. Biol. Ann. Rev. 16:229–311.
Radosh, D.J. , A.B. Frame,. T.E. Wilhelm, and R.N. Reid.
1978. Benthic survey of the Baltimore Canyon Trough, May 1974. Sandy Hook Laboratory Report No. 78-8, Sandy Hook Lab, Northeast Fish. Cent., Natl. Mar. Fish. Serv., NOAA, Highlands, NJ 07732. Unpubl. manuscr., 133 p.
Reid, R.N., and F.W. Steimle Jr.
1988. Benthic macrofauna of the Middle Atlantic continental shelf. *In* Characterization of the Middle Atlantic Water Management Unit of the Northeast Regional Action Plan (A. Pacheco, ed.), p. 125–160. NOAA Tech. Memo. NMFS-F/NEC-56.
Reid, R.N., M.C. Ingham, and J.B. Pearce, eds.
1987. NOAA's Northeast Monitoring Program (NEMP): A report on progress of the first five years (1979–84) and a plan for the future. NOAA Tech. Memo. NMFS-F/NEC-44, 138 p.
Reid, R.N., J.E. O'Reilly, and V.S. Zdanowicz.
1982. Contaminants in New York Bight and Long Island Sound sediments and demersal species, and contaminant effects on benthos, summer 1980. NOAA Tech. Memo. NMFS-F/NEC-16, 96 p.
Reish, D.
1970. The effects of varing concentrations of nutrients, chlorinity, and dissolved oxygen on polychaetous annelids. Water Res. 4:721–735.
Sampson, R.J.
1978. Surface II graphics system. Series on Spatial Analysis No. 1. Kansas Geological Survey, Lawrence, KS 66045, 240 p.
Sanders, H., F. Grassle, G. Hampson, L. Morse, S. Garner-Price, and C. Jones.
1980. Anatomy of an oil spill: Long-term effects from the grounding of the barge *Florida* off West Falmouth, Mass. J. Mar. Res. 38:265–380.
Schaffner, L.C., and D.F. Boesch.
1982. Spatial and temporal resource use by dominant benthic Amphipoda (Ampeliscidae and Corophidae) on the Middle Atlantic Bight outer continental shelf. Mar. Ecol. Prog. Ser. 9:231–243.
Segar, D.A., and P.G. Davis.
1984. Contamination of populated estuaries and adjacent coastal ocean — a global review. NOAA Tech. Memo. NOS OMA 11, 120 p.
Stanford, H.M., and D.R. Young.
1988. Pollutant loadings to the New York Bight apex. *In* Oceans 88 conference record, p. 745–751. Marine Technological Society, Washington, DC 20006.
Steimle Jr., F.W.
1985. Biomass and estimated productivity of the benthic macrofauna in the New York Bight: a stressed coastal area. Est. Coast. Shelf. Sci. 21:539–554.
1990. Benthic macrofauna and habitat monitoring on the continental shelf of the northeastern United States. I. Biomass. NOAA Tech. Rep. NMFS 86, 28 p.
Steimle Jr., F.W., and D.J. Radosh.
1979. Effects on the benthic invertebrate community. *In* Oxygen depletion and associated benthic mortalities in the New York Bight, 1976 (L. Swanson and C. Sindermann, eds.), p. 281–293. NOAA Prof. Pap. 11.
Steimle Jr., F.W., J. Caracciolo, and J. Pearce.
1982. Impacts of dumping on New York Bight apex benthos. *In* Ecological stress and the New York Bight: Science and management (G. F. Mayer, ed.), p. 213–223. Estuarine Research Federation, Columbia, SC 29203.
Suszkowski, D.J., and E.D. Santoro.
1986. Marine monitoring in the New York Bight. *In* Oceans 86 conference record, p. 754–759. Marine Technological Society, Washington, DC 20006.
Swartz, R.C., W.A. Deben, K.A. Sercu, and J.O. Lamberson.
1982. Sediment toxicity and the distribution of amphipods in Commencement Bay, Washington, U.S.A. Mar. Poll. Bull. 13:359–364.
Tsutsumi, H.
1987. Population dynamics of *Capitella capitata* (Polychaeta; Capitellidae) in an organically polluted cove. Mar. Ecol. 36:139–149.

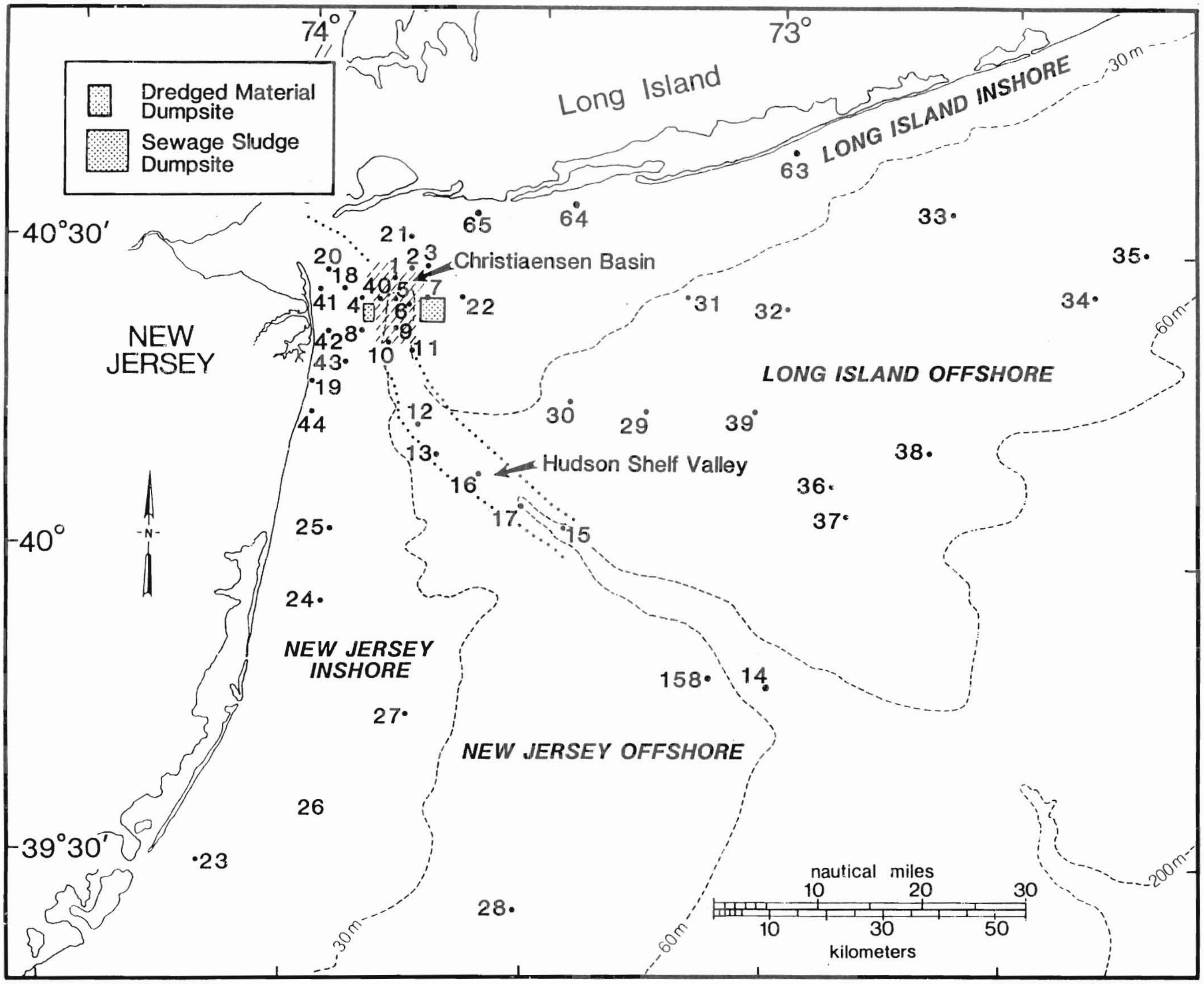



**Figure 1**
Station locations in New York Bight, with subareas discussed in text. Diagonal lines indicate Christiaensen Basin.

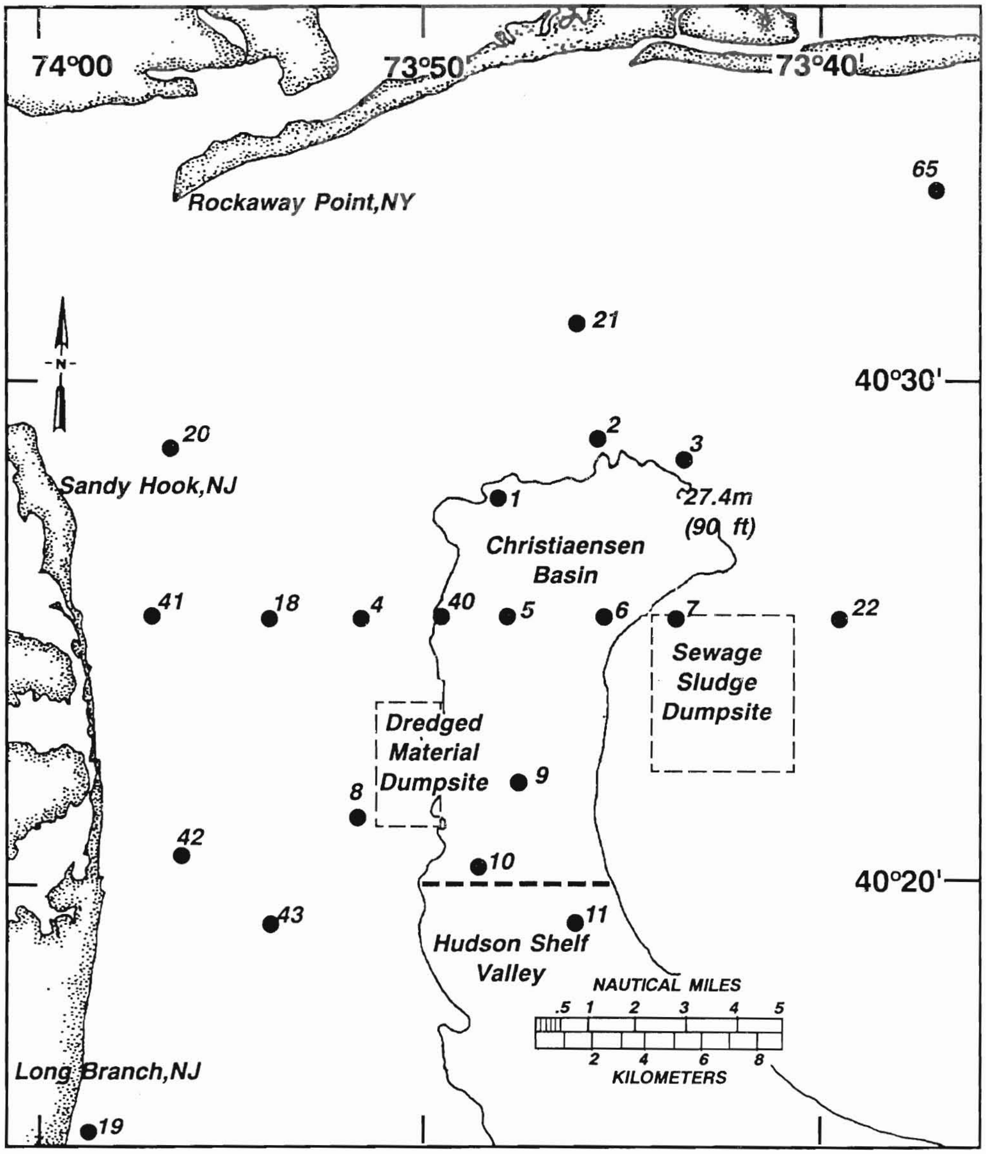



**Figure 2**
Details of inner New York Bight.

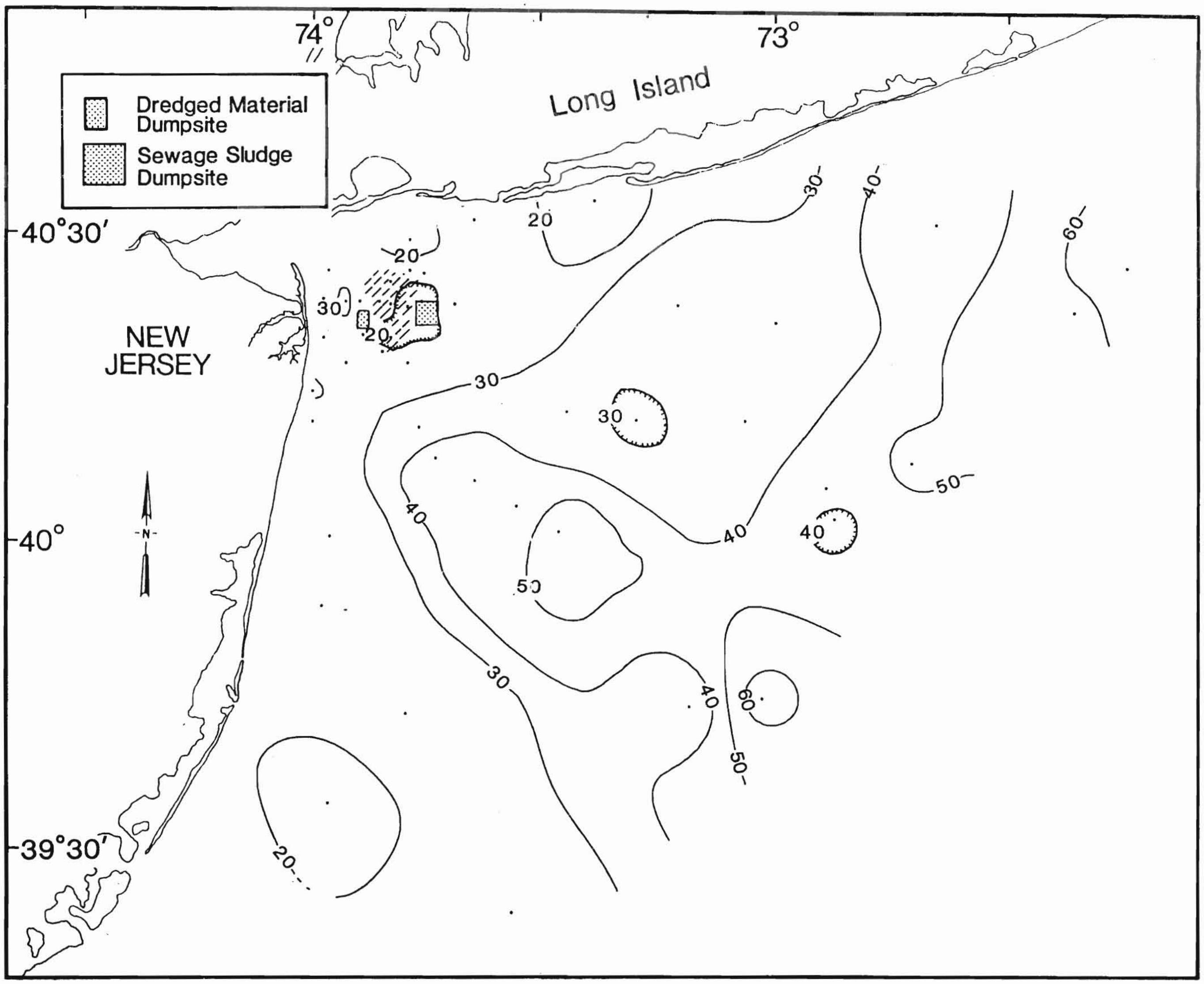



**Figure 3**
Numbers of species per 0.1 m², September–October 1985.

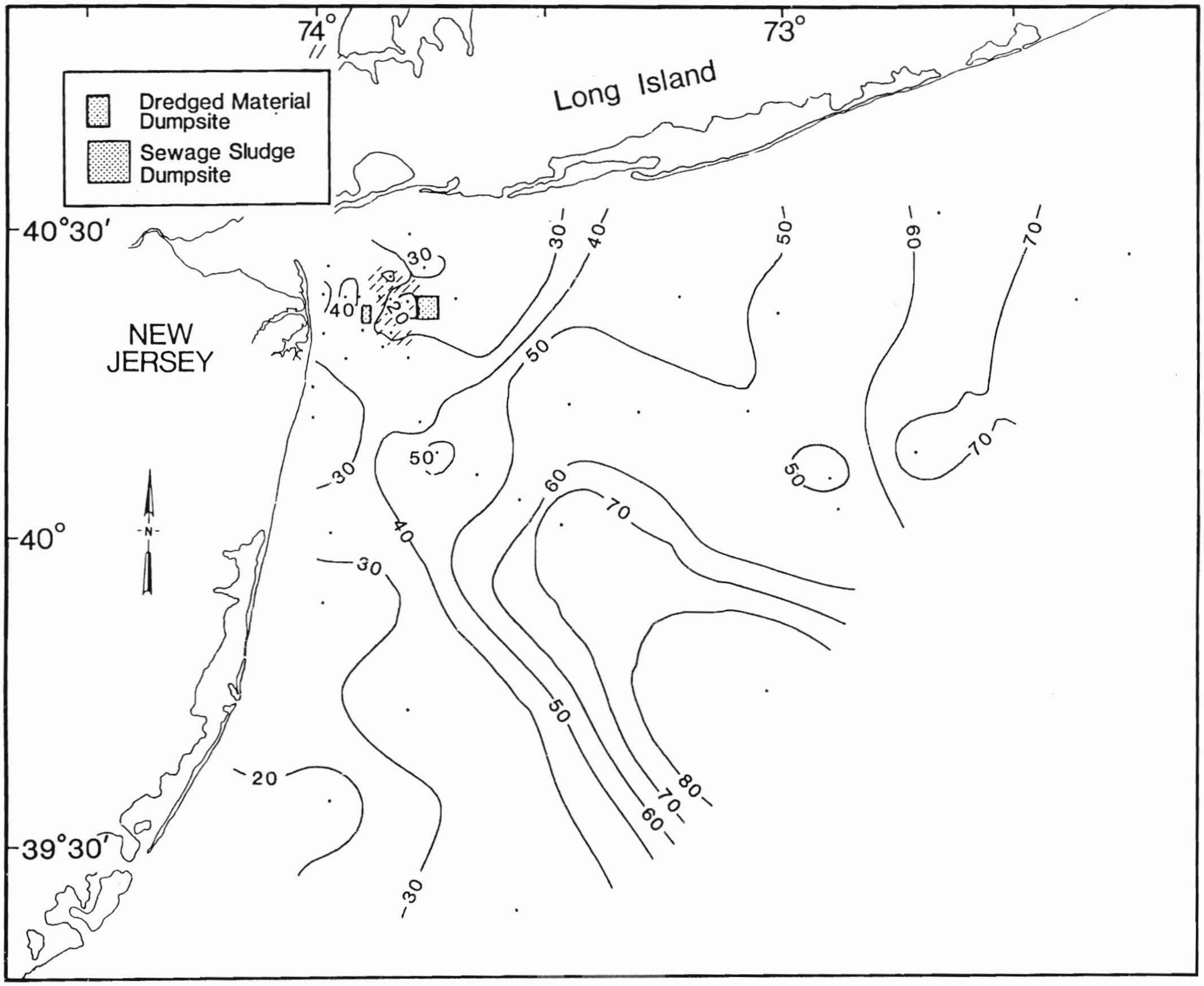



**Figure 4**
Numbers of species per 0.1 m$^2$, July–August 1980.

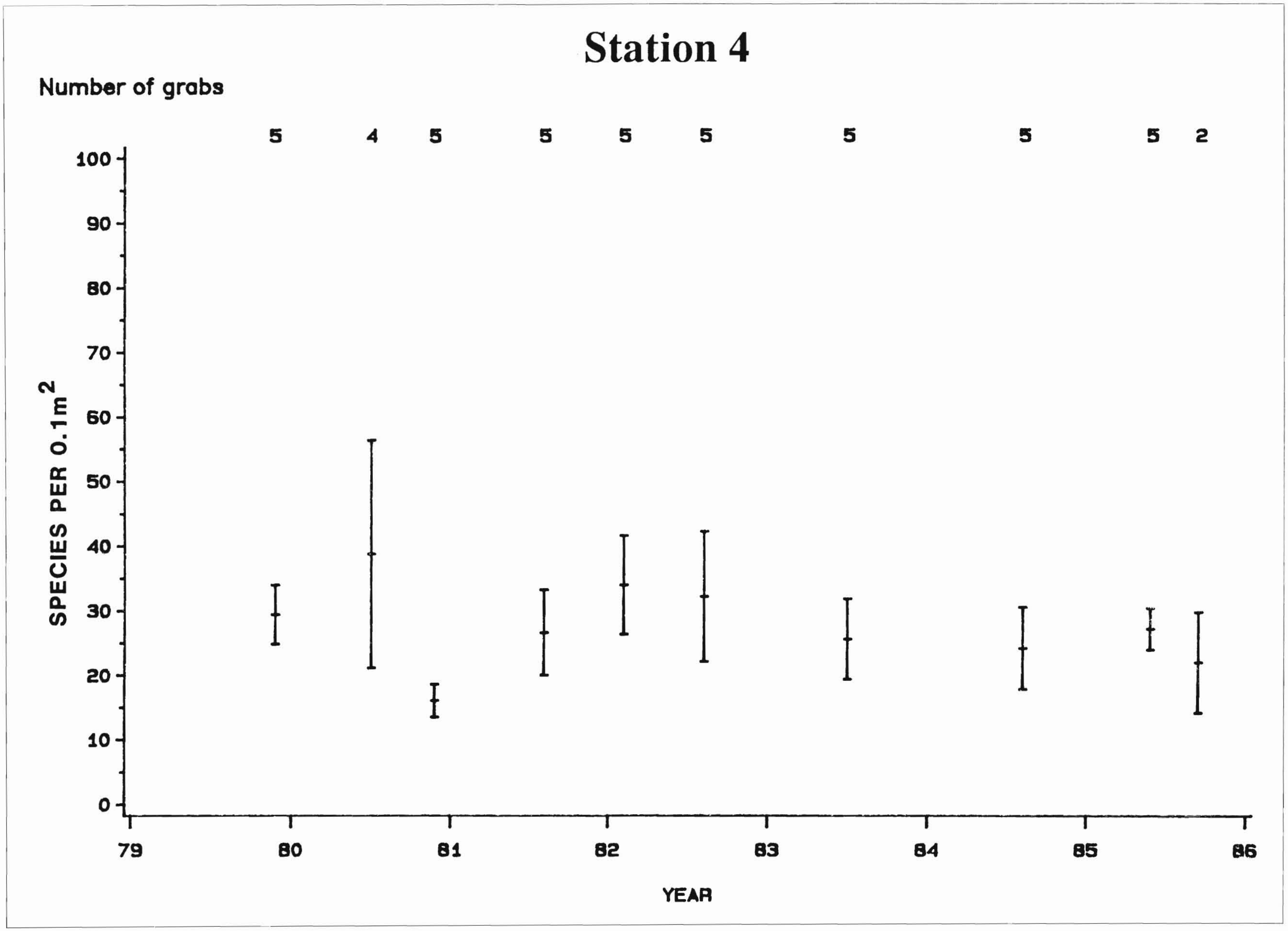
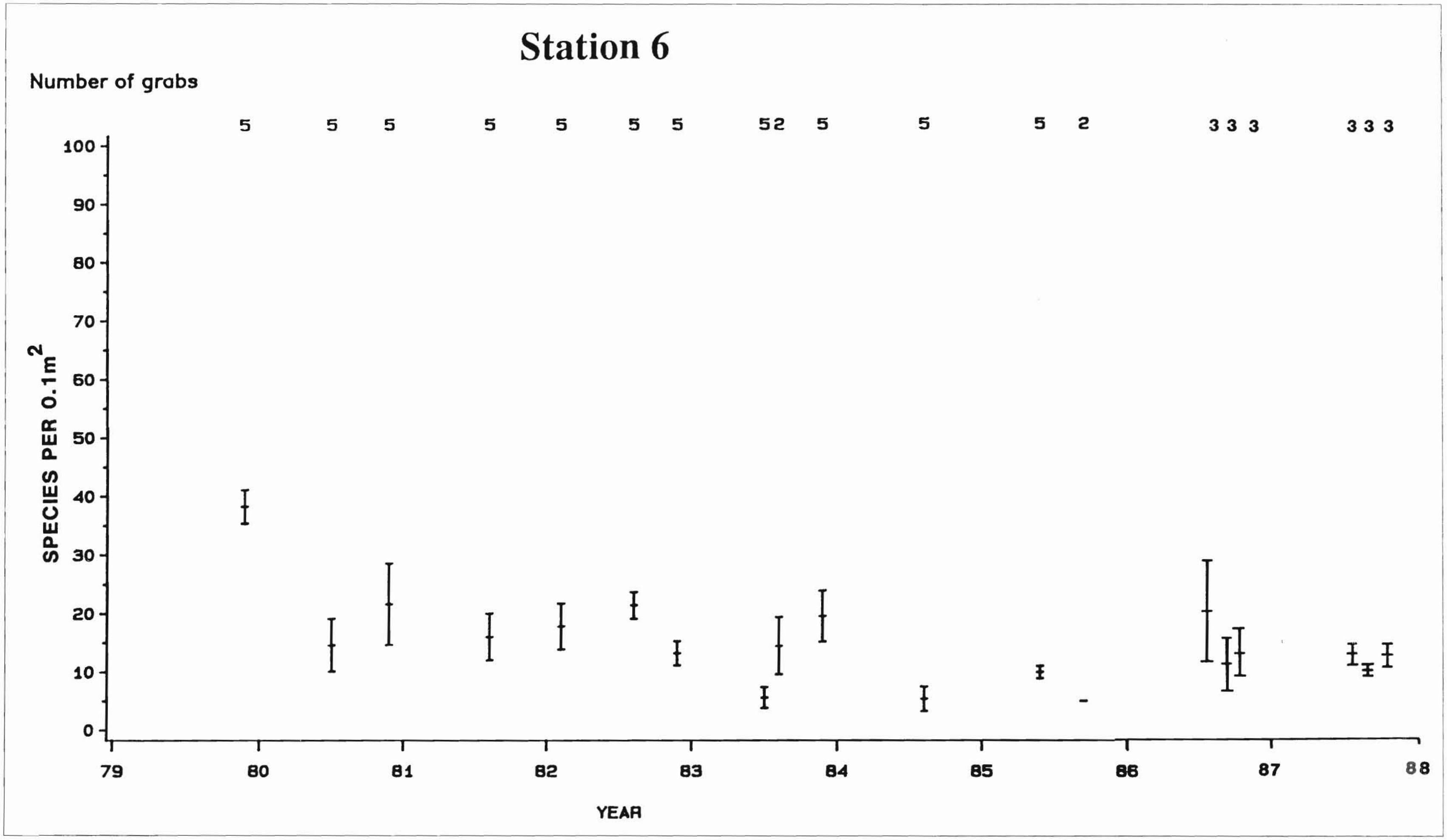



**Figure 5**
Means and 95% confidence limits for numbers of species per 0.1 $m^2$ at each NEMP station on each sampling date, with numbers of replicate samples indicated.

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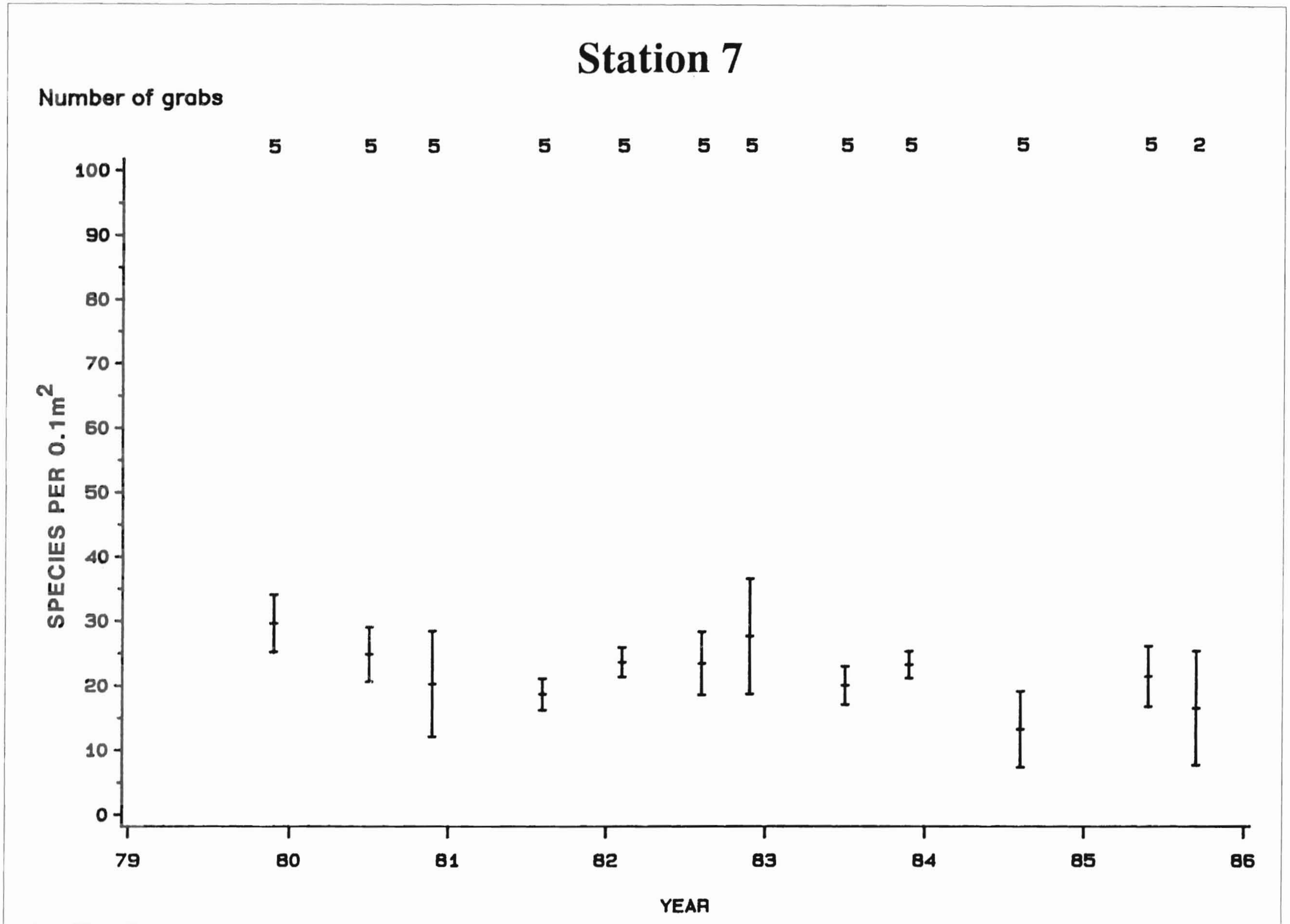


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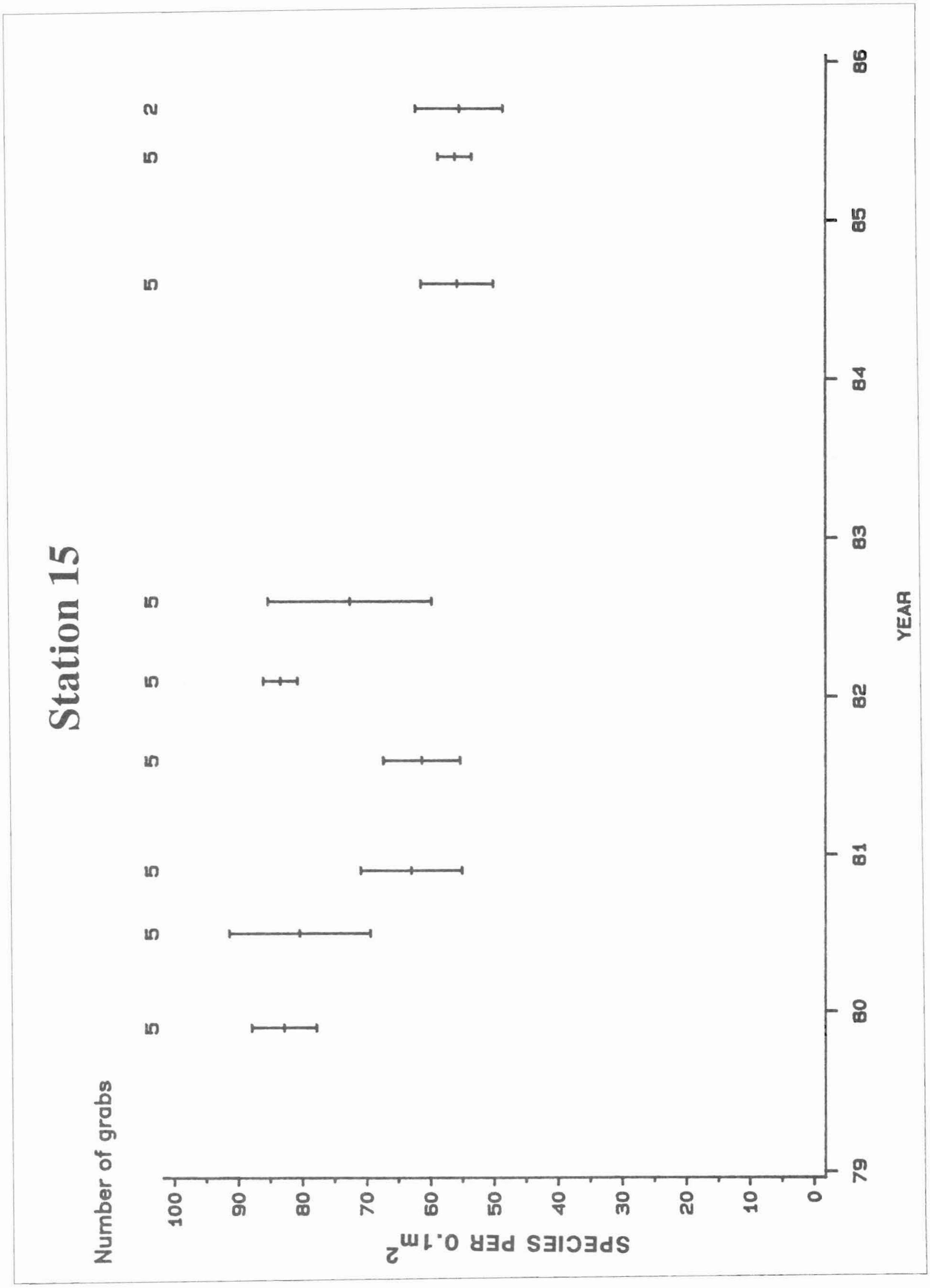


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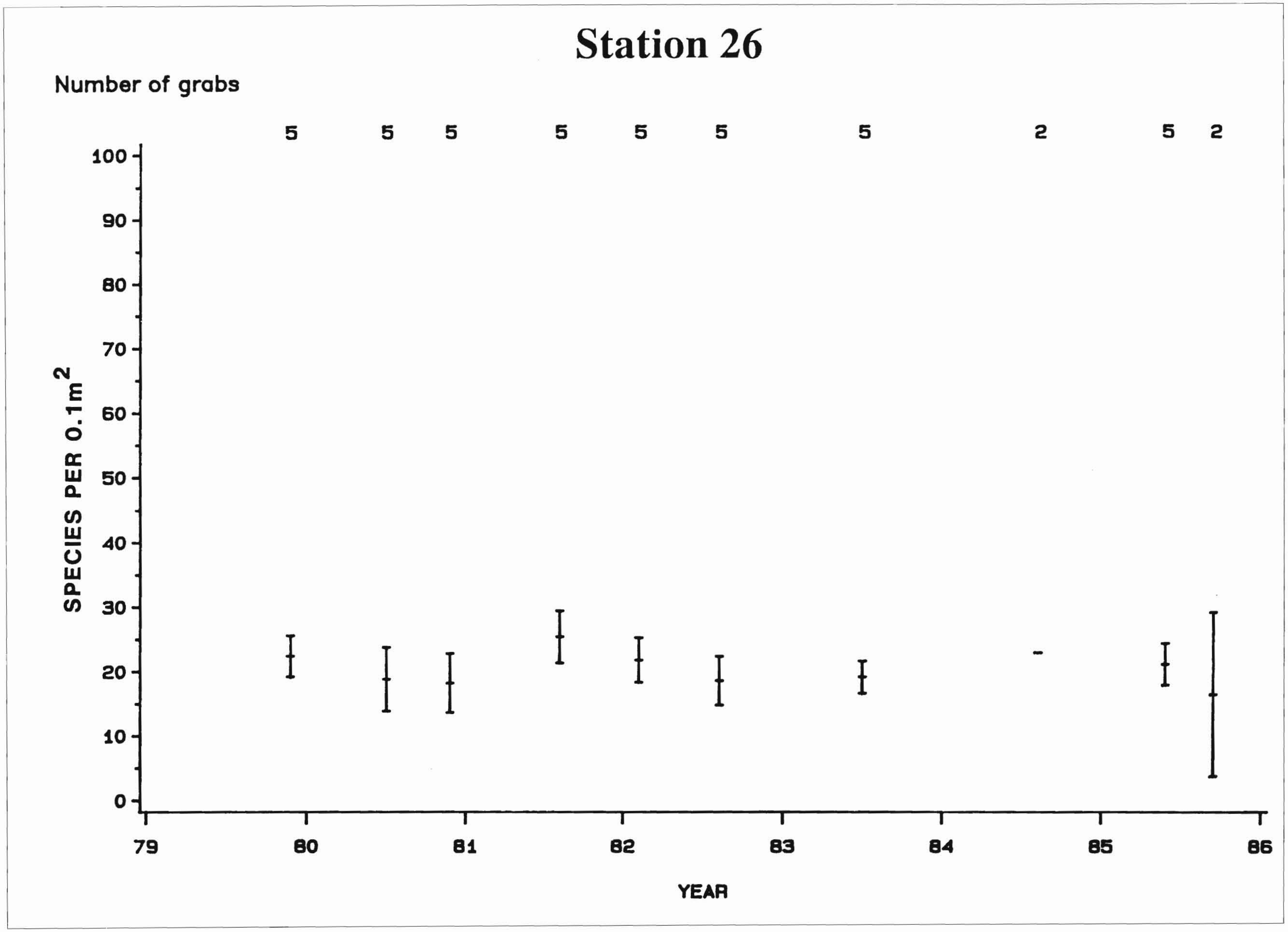


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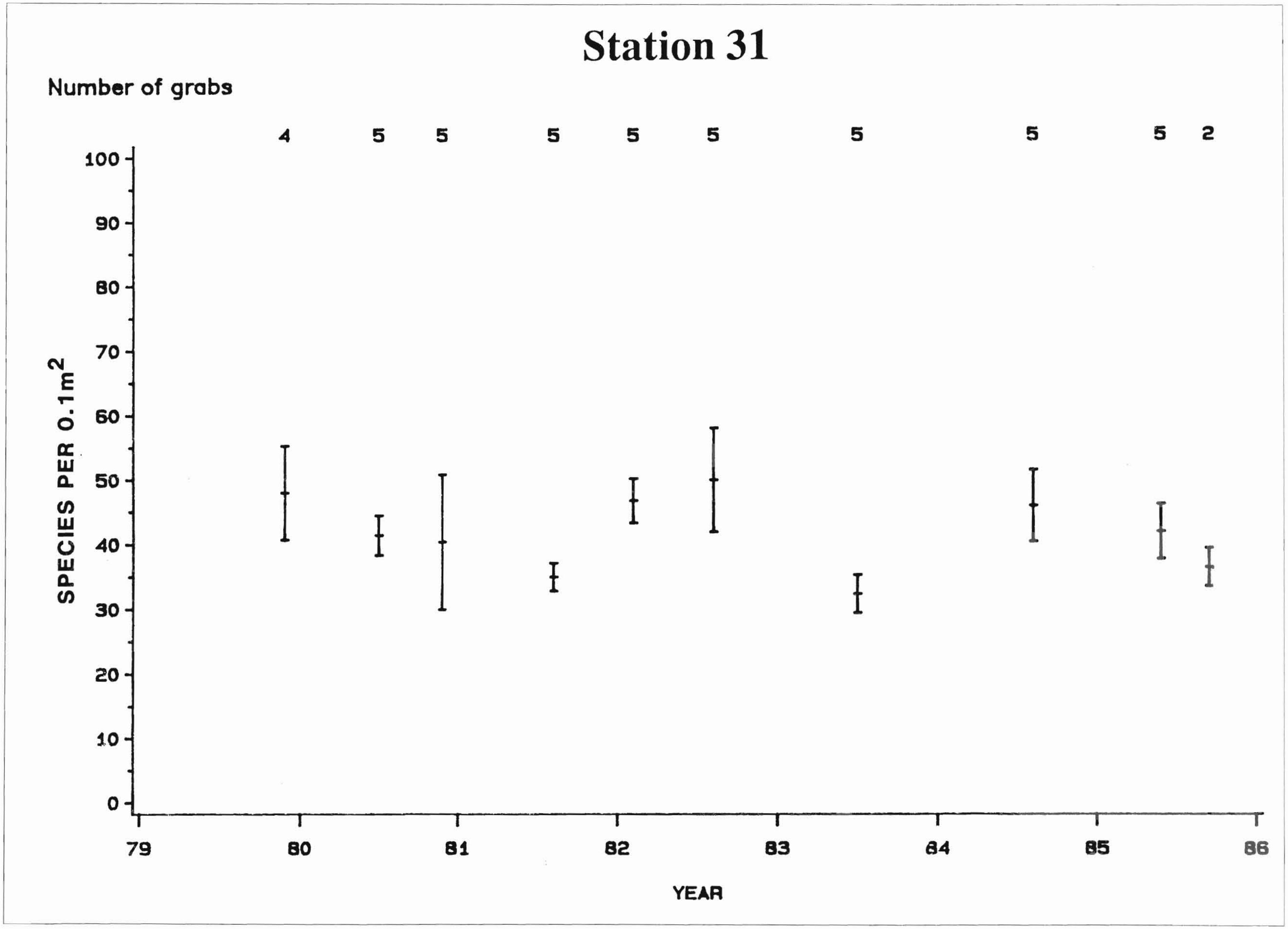


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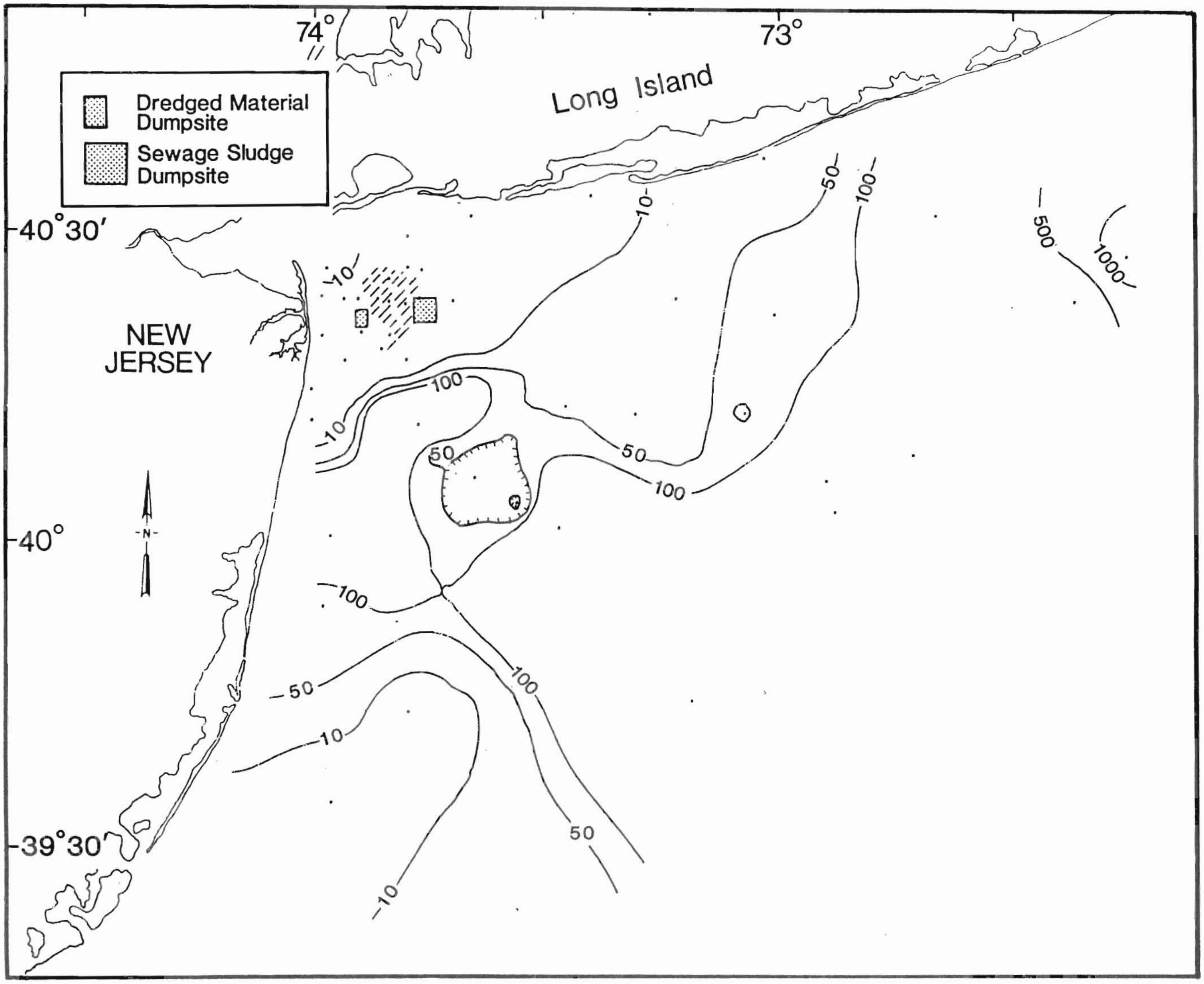


**Figure 6**
Numbers of amphipods per 0.1 $m^2$, September–October 1985.

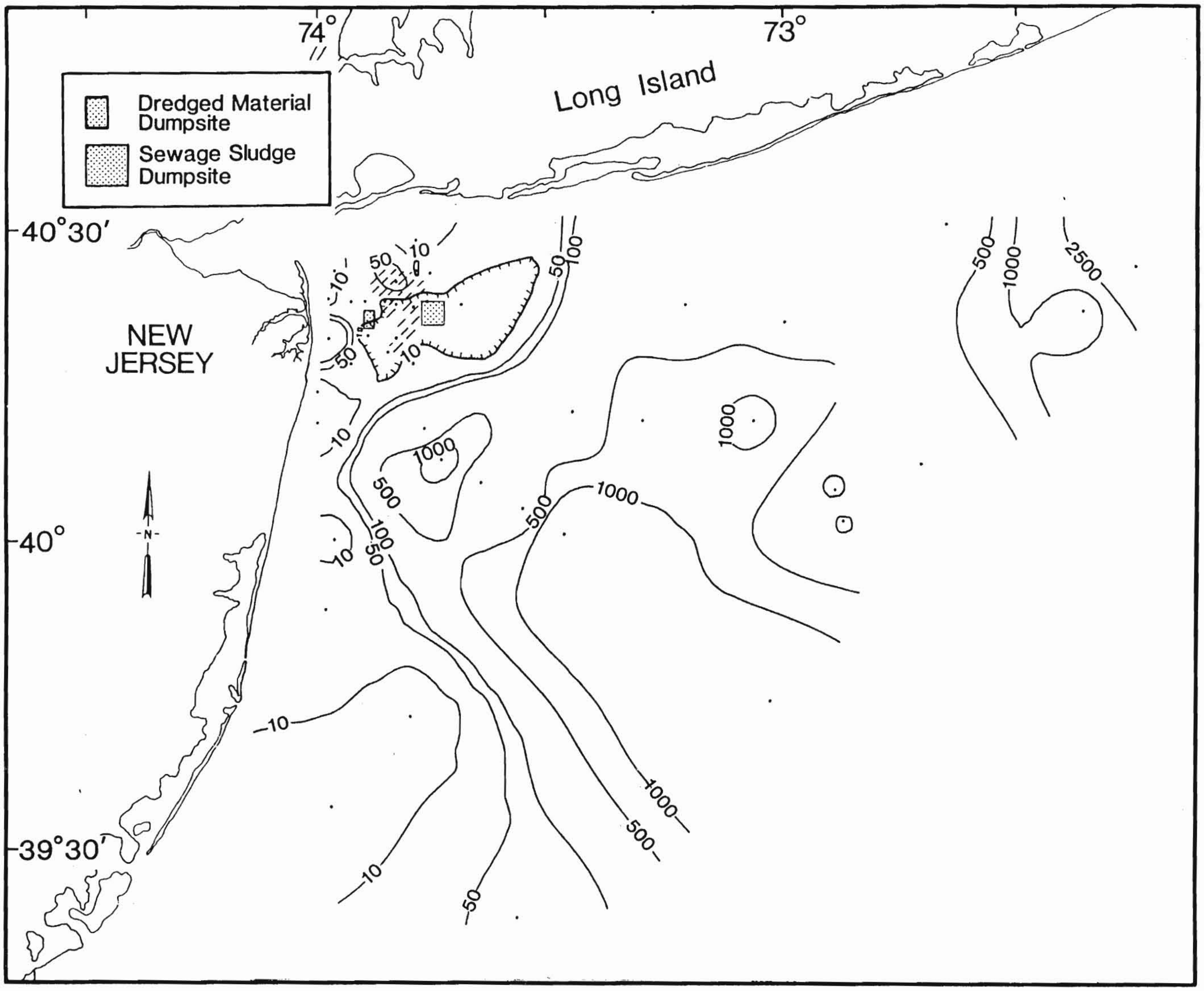


**Figure 7**
Numbers of amphipods per 0.1 m$^2$, July–August 1980.

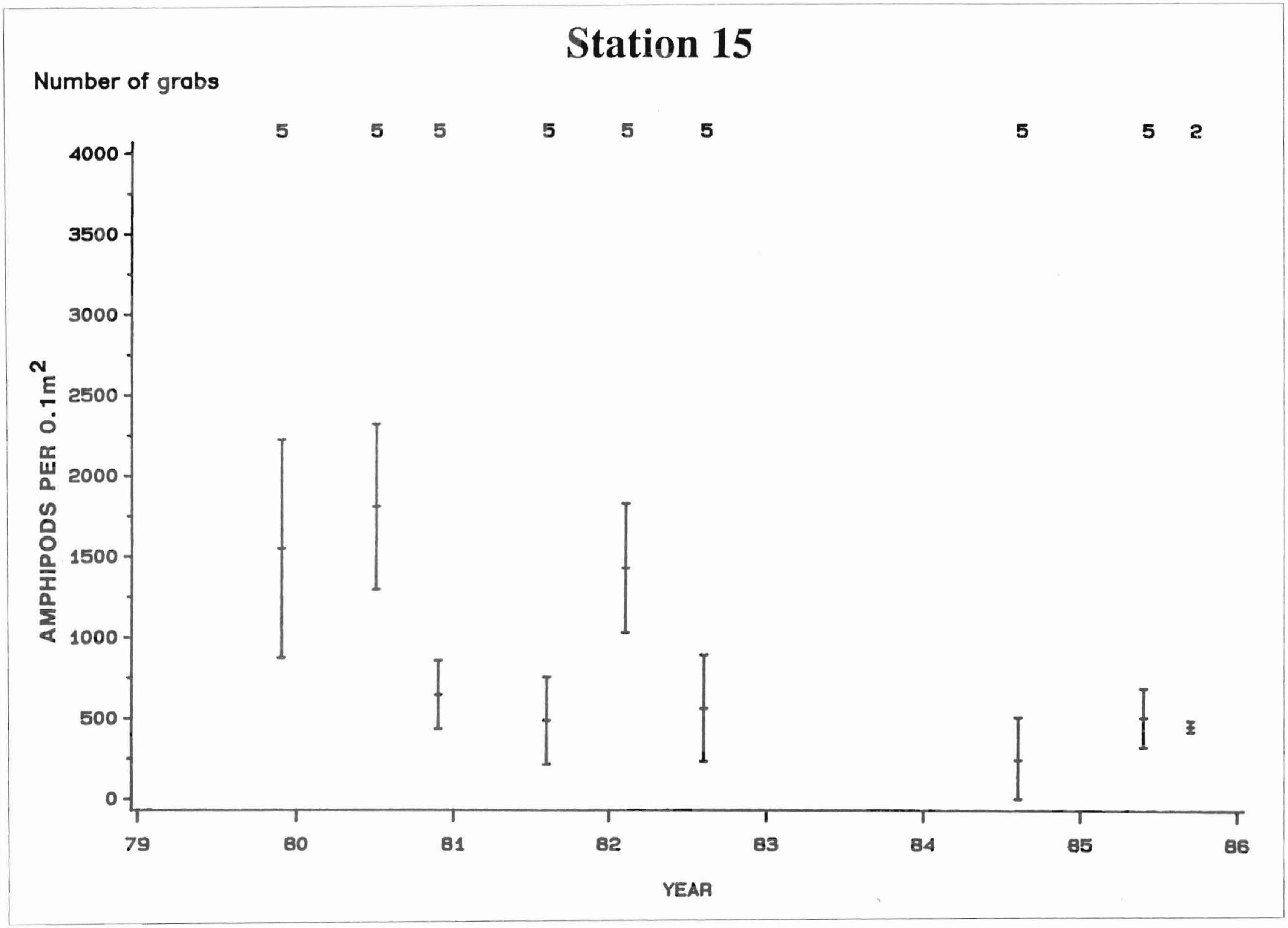


**Figure 8**

Means and 95% confidence limits for numbers of amphipods per 0.1 $m^2$ at Station 15 in mid-Hudson Shelf Valley for each sampling date. Numbers of replicate samples are indicated.

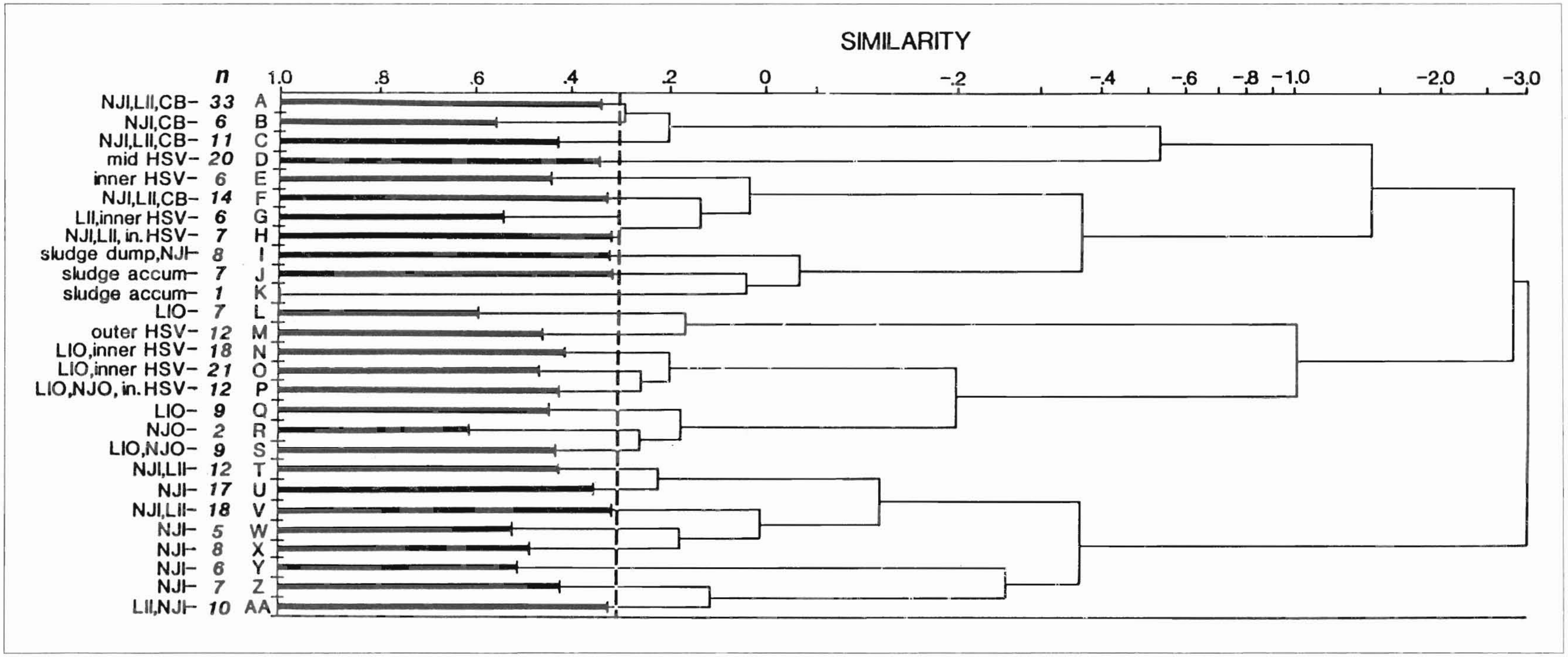


**Figure 9**

Dendrogram showing between-group similarities in species composition, with groups formed at 30% similarity levels. Each wider bar to left indicates the level of similarity of samplings within a given group. Areas: NJI = New Jersey Inshore; NJO = New Jersey Offshore; LII = Long Island Inshore; LIO = Long Island Offshore; CB = Christiaensen Basin; HSV = Hudson Shelf Valley. ***n*** = number of samplings in group. Samplings in each group are given in Table 3. Note log scale at negative similarities.

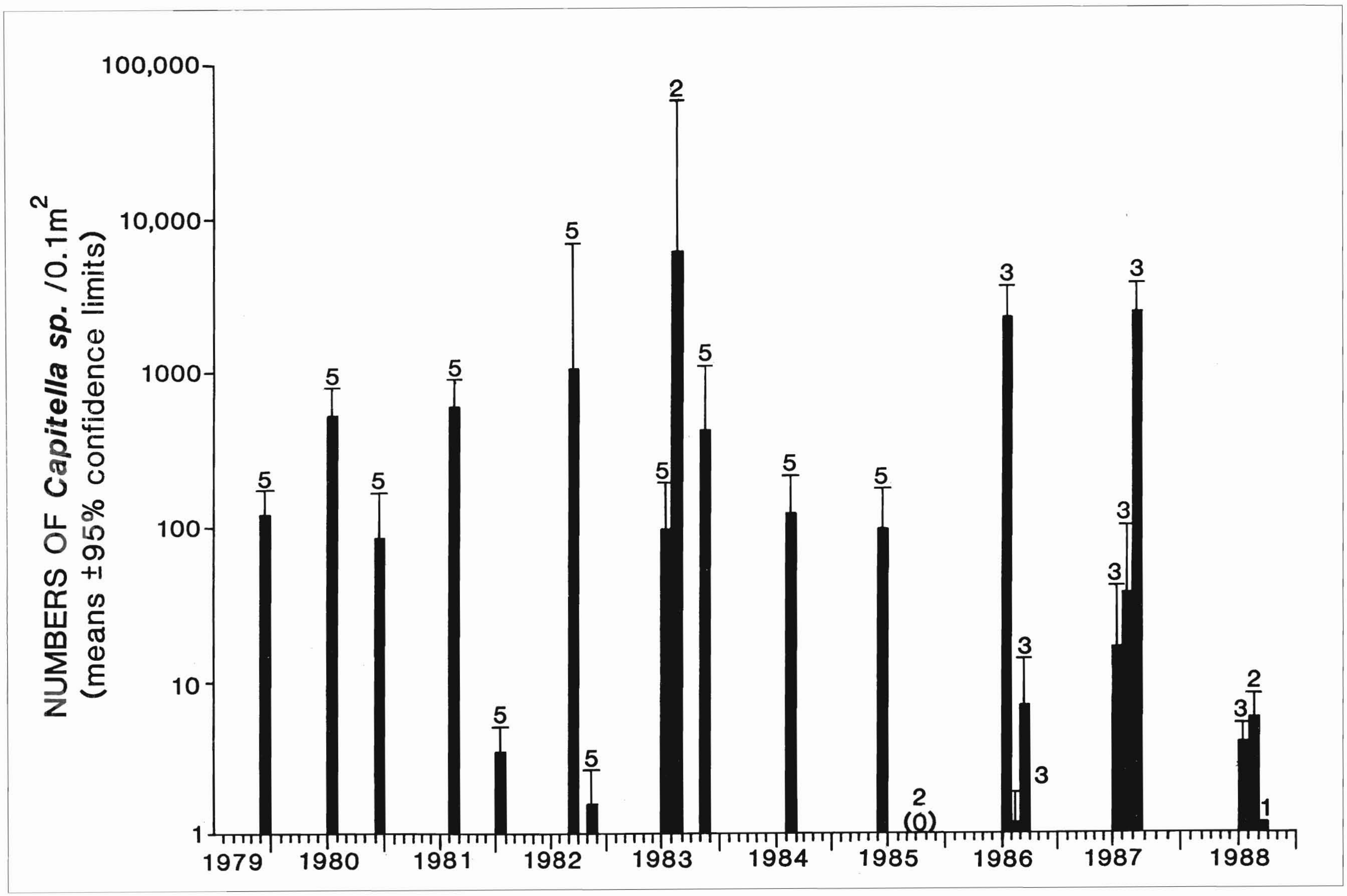


**Figure 10**

Means and 95% confidence limits for numbers of *Capitella* sp. per 0.1 $m^2$ at Station 6 ("sewage sludge accumulation area") for each sampling date. Numbers of replicate samples are indicated.