ASSESSMENT OF BENTHIC MACROFAUNA IN AN OCEAN DISPOSAL AREA NEAR CHARLESTON, SOUTH CAROLINA[1]

by

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Introduction

Charleston Harbor, South Carolina, is the site of an important commercial port and a United States Naval Base. Water depths throughout the harbor are typically shallow, and maintenance dredging is necessary to keep access channels at their prescribed depth because of shoaling. Ships enter the harbor via an entrance channel protected along its inner reaches by a pair of rubble jetties. The Charleston Harbor Project, authorized by the River and Harbor Act, provides that the entrance channel be maintained at a depth of 35 feet and a width of 1000 feet from the sea to the inner end of the jetties (U.S. Army Engineer District, Charleston, 1975). The depth of the entrance channel is maintained using a hopper dredge, and dredged material is disposed of in an open ocean disposal area just south of the jetties.

Relatively little is known about the marine life and sedimentologic processes of the Charleston Harbor Ocean Disposal Area (ODA) and vicinity. The South Carolina Wildlife and Marine Resources Department (1972) conducted surveys in this area using a shrimp trawl and found relatively few species and low numbers of individuals compared with inshore estuarine areas. However, no thorough benthic sampling has ever been conducted in the area, and no data base exists which might be used to assess the impact of disposing dredged material there. As a result, the U.S. Army Corps of Engineers, Charleston District, contracted with the South Carolina Marine Resources Research Institute for an assessment of the benthic fauna and sedimentologic conditions in and near the Charleston Harbor ODA. Specific goals related to the biological component of this study were to:

1) characterize the species composition and density of macrofaunal assemblages at 40 sites in and adjacent to the Ocean Disposal Area.

2) determine any differences in macrofaunal community structure which could be attributed to past disposal activities.

3) provide a data base for appraising the effects of future deposition of dredged material in the Ocean Disposal Area.

This report presents the findings of that study and provides the first detailed description of benthic macrofaunal assemblages found in sand bottom habitat of shallow continental shelf waters (8-17 m) off South Carolina.

Materials & Methods

Sampling was undertaken at 40 stations in and adjacent to the Ocean Disposal Area during August, 1978. Eight stations were sampled along each of five transects, (Fig. 1). Three of the transects crossed the disposal area, while the other two were located outside the disposal site to the northwest and southeast. This array of stations provided a total of 12 sampling sites within the Ocean Disposal Area and 28 sites outside. Stations were located using Loran-C aboard the R/V ATLANTIC SUN. The research vessel was anchored at each site for all sampling except dredge tows.

Water Chemistry and Sediment Analysis

Surface and bottom water chemistry samples were collected at each station using a Van Dorn bottle. Properties measured included temperature, salinity, dissolved oxygen, nitrates, silicates, phosphates, turbidity, and suspended and settleable solids. Water temperatures were measured in the field with stem thermometers mounted inside the Van Dorn bottles. All other samples were returned to the laboratory for analysis. Salinity samples were analyzed using a Beckman Model RS7B Induction Salinometer. Dissolved oxygen was determined by modified Winkler titration (Strickland and Parsons, 1972). Nutrients were analyzed using a Technicon Auto Analyzer II. Turbidities were measured using a Hach Model 2100A turbidimeter. Solids were determined using standard Methods 224C and 224F (American Public Health Association, 1971).

Bottom sediments were obtained at each station using a Smith-McIntyre grab. Sediment samples were analyzed for % weight of quartz sand, calcium carbonate, silt, and clay content. Silts and clays were separated from sand-size material by wet-sieving through a 62-μ screen. Silt was separated from clay by pipette analysis. Calcium carbonate was separated from the quartz sand by HCl digestion. Quartz sand-size fractions were sieved for 30 minutes in a nest of 1/4-Ø Tyler screens. Mean grain size ($\pm$ standard deviation) of the sand fraction was then computed. A more detailed analysis of the sediments and bedforms, conducted as a separate component of this study, is presented in the contract report for this study (South Carolina Wildlife and Marine Resources Dept., 1979).

Separate sediment samples for geochemical analysis were also taken with the Smith-McIntyre grab at 24 stations (Fig. 1). Collected sediments were placed in 3.8-l plastic bags, immediately frozen in dry ice, and delivered to the U.S. Army Corps' South Atlantic Division Laboratory, Marietta, Georgia for analysis of volatile solids, total organic carbon, COD, Kjeldahl nitrogen, oil and grease, lead, zinc, mercury, total phosphorus as PO_4, iron, cadmium, arsenic, chromium, nickel, copper, beryllium, selenium, and vanadium.

Benthic Sampling

Quantitative benthic samples were collected using a 0.10-m^2 Smith-McIntyre grab. Five replicate samples were taken at each of the 40 stations. The volume of each grab sample was measured and the contents were then washed through a 1-mm sieve. Organisms and sediment remaining on the sieve after washing were preserved in a 10% seawater-formaldehyde solution containing rose bengal. In the laboratory, all non-colonial fauna collected in the grabs were identified to the

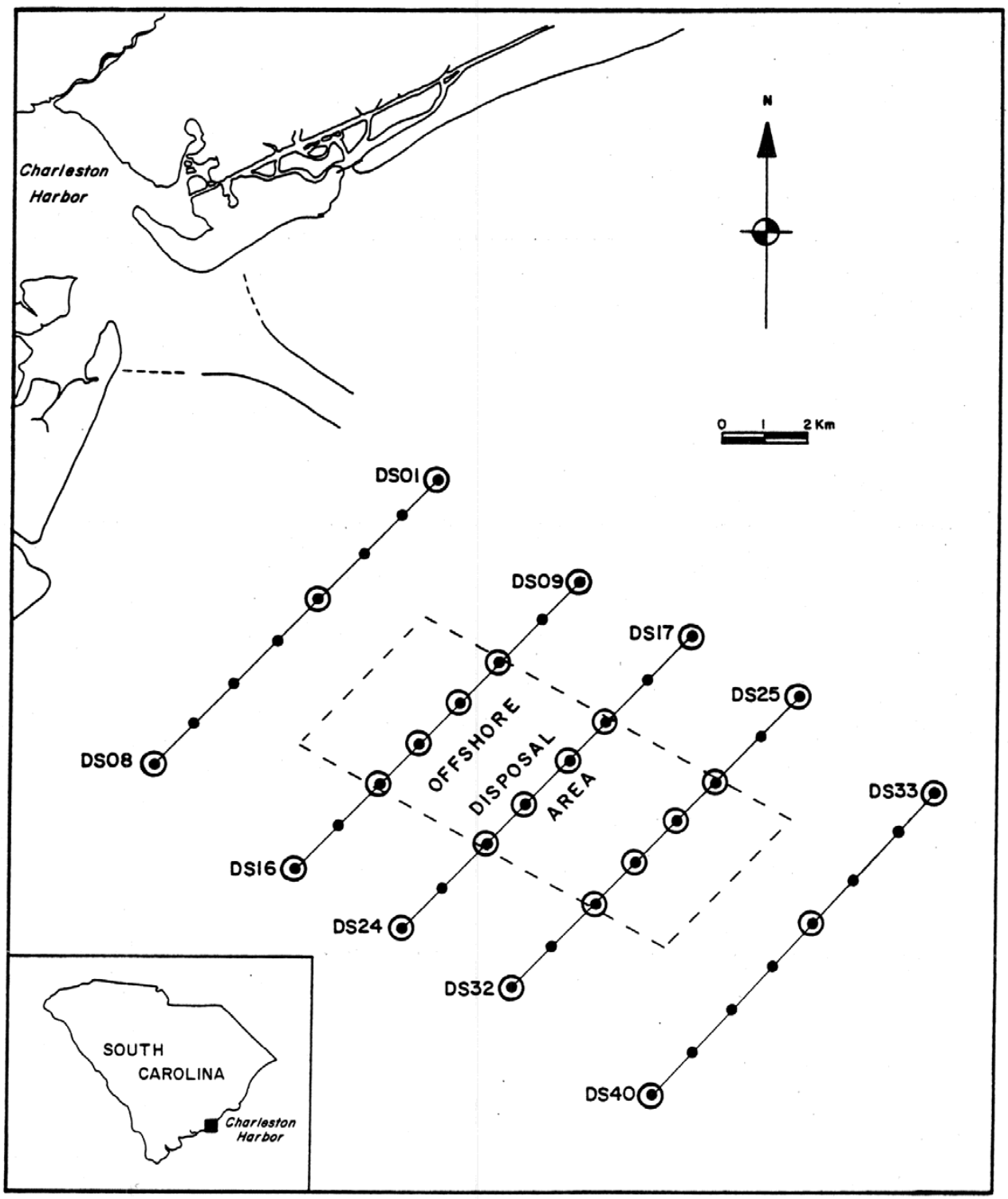

Figure 1. Map showing location of the 40 stations sampled in and adjacent to the Charleston Harbor Ocean Disposal Area. Stations circled represent those sampled for geochemical analysis.

lowest practical taxonomic level and counted.

Quantitative samples were supplemented with qualitative samples of the epifauna using a modified oyster dredge. The dredge consisted of a rectangular steel frame measuring 80 cm across the mouth, with a 1.5-m long bag of 2.5-cm stretch mesh polypropylene. A skirt of interlacing metal rings protected the bag from chafing. A single tow of five minutes was made at each station. After preliminary sorting of the catch in the field, unidentified epifaunal invertebrates and representative samples of firm substrata were preserved in 10% seawater-formalin and returned to the laboratory for examination. Small organisms, such as polychaetes and amphipods, were not considered in the analysis of dredge samples since these organisms were not adequately sampled by this type of gear.

Benthic Data Analysis

Benthic community structure was evaluated through cluster analysis and through evaluation of species numbers, number of individuals, and indices of species diversity including Shannon's diversity index (H'), species richness, and evenness (Margalef, 1958; Pielou, 1977). The Bray-Curtis coefficient (Boesch, 1977) was used in the normal cluster analysis to compare faunal similarity between stations. The normal analysis was performed on pooled data for each station using a flexible sorting strategy and a standard β value of -0.25 (Boesch, 1977). All data were log-transformed, and species which occurred in fewer than six grab samples were eliminated from the analysis. These deletions were made to simplify the data set, since rare species usually do not have easily defined distribution patterns and can confuse interpretation of cluster analysis.

Results & Discussion

Hydrography

The Charleston Harbor Ocean Disposal Area is located in coastal marine waters beyond the harbor mouth. Salinities were all in the euhaline range (30-40 °/oo) during field studies in August, 1978 (Appendix 1) and were lowest along the innermost transect (averaging 33.4 °/oo) and highest along the outermost transect (averaging 35.2 °/oo). Although salinities at all stations were higher on bottom than at the surface, vertical differences seldom exceeded 3.0 °/oo. High water temperatures reflected the season when sampling was undertaken, ranging from a low of 26.5°C in a bottom sample from station DS34 to a high of 30.1°C in a surface sample from station DS23. Most temperature readings were between 28 and 30°C, and differences from surface to bottom in most cases were rather small (Appendix 1). Dissolved oxygen concentrations were relatively high, despite the high temperature and salinity of the water. The lowest oxygen value observed was 4.0 mg/l^{-1} in a surface sample from station DS02. Most oxygen concentrations ranged between 5.0 and 6.8 mg/l^{-1} (Appendix 1). Values for other hydrographic properties measured during the study, including turbidity, nutrients, and solids, are given in Appendix 1.

Sediments

Quartz sand was the primary constituent at most of the 40 stations sampled in the vicinity of the Ocean Disposal Area (Appendix 2; Fig. 2). The average grain size of this component throughout much of the area was fine, although sands of medium grain size were common at the deeper stations (Fig. 2, Appendix 2). Only station DS38 had coarse sand ($\emptyset$ = 0.26). Stations in deeper water usually had a relatively high percentage of shell hash in comparison to most of the shallower stations (Fig. 3). Finally, silts and clay were detected only at stations on the transect nearest shore (DS01-DS08). These finer sediments never exceeded 15% of the total sample weight at any of the stations (Appendix 2).

Data resulting from the chemical analysis of sediment samples collected in the vicinity of the Charleston Harbor Ocean Disposal Area are presented in Appendix 3. These analyses revealed no high concentrations of toxic material.

Epifaunal Assemblages

At least 157 epifaunal (or partly epifaunal) macroinvertebrate species were obtained from the 40 oyster dredge collections (Table 1, Appendix 4). In terms of species, the fauna was dominated by bryozoans (39 species), cnidarians (33 species), mollusks (28 species), and arthropods (26 species). These four groups accounted for 75% of the total number of species identified from the samples. Of the species found, only six (the hydroid Clytia cylindrica; the bryozoans Membranipora tenuis, Microporella ciliata, and Parasmittina nitida; the bivalve Chama macerophylla; and the barnacle Balanus venustus) were found at 20 or more of the 40 stations. The most ubiquitous species was the barnacle Balanus venustus, which was present in samples from 29 stations.

With a few exceptions, the study area was sparcely populated by epifaunal invertebrates. The bottom, consisting largely of sand sediments with various amounts of shell hash, provided an unsuitable substrate for most epibenthic species. The volume of most oyster dredge catches was very small, typically consisting of a few shells along with occasional decapods and echinoderms.

Areas with large octocorals (Titanideum frauenfeldii), sponges, and other hard-bottom organisms were infrequent and quite localized, and none of the stations were characterized as "live-bottom" areas. Sand dollars (Mellita quinquiesperforata) were abundant at fine sand stations (DS01, DS02, DS03, and DS04) along the innermost transect, but they were infrequent or absent elsewhere.

Considerable variation was observed in the number of species from one station to another (Fig. 4). The number of species collected at a given site was often a function of the presence or absence of large shells, which provided substrate for the sessile epifauna. Species numbers were quite high

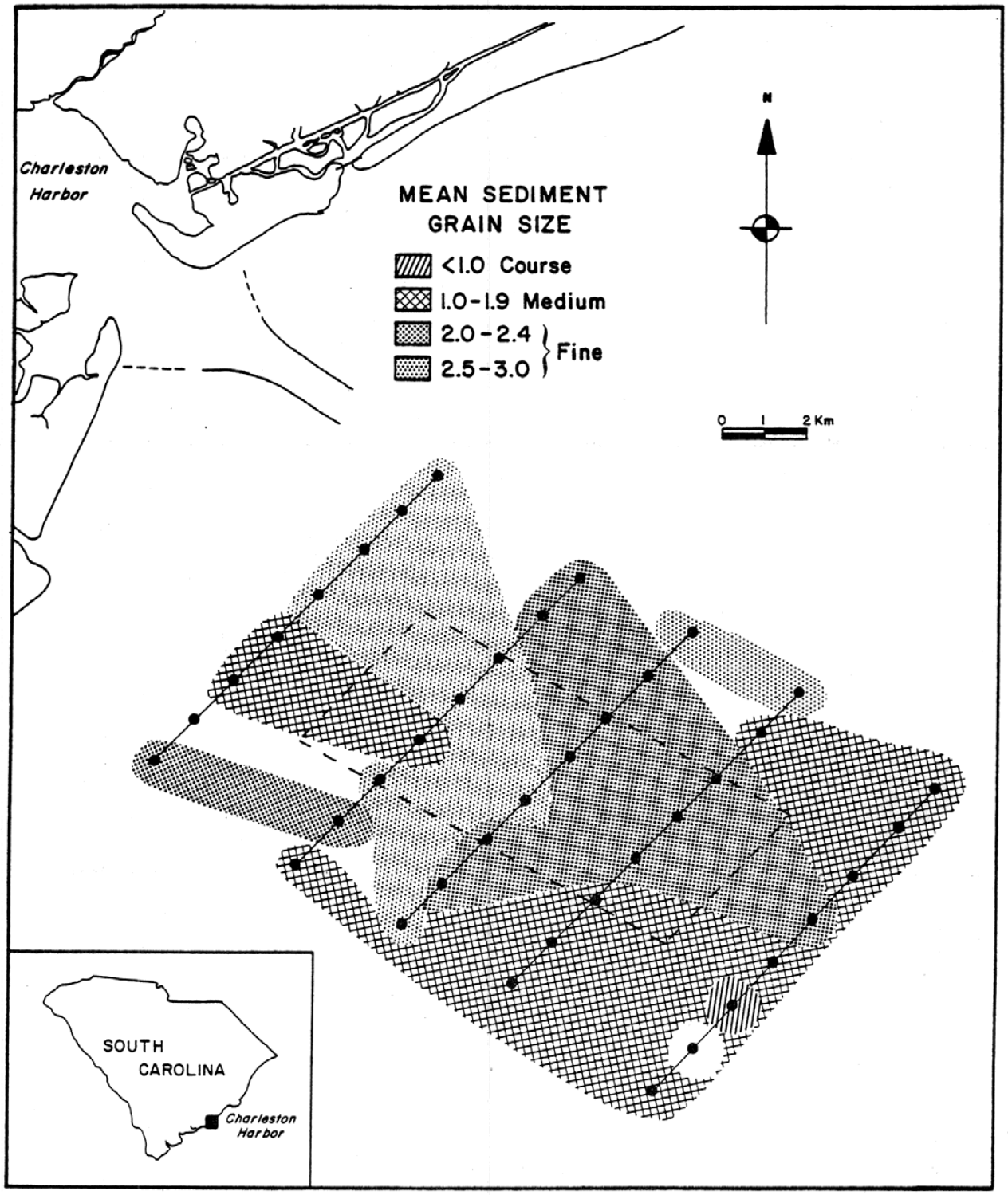

Figure 2. Distribution of mean sediment grain size in the study area. Values are in Ø units.

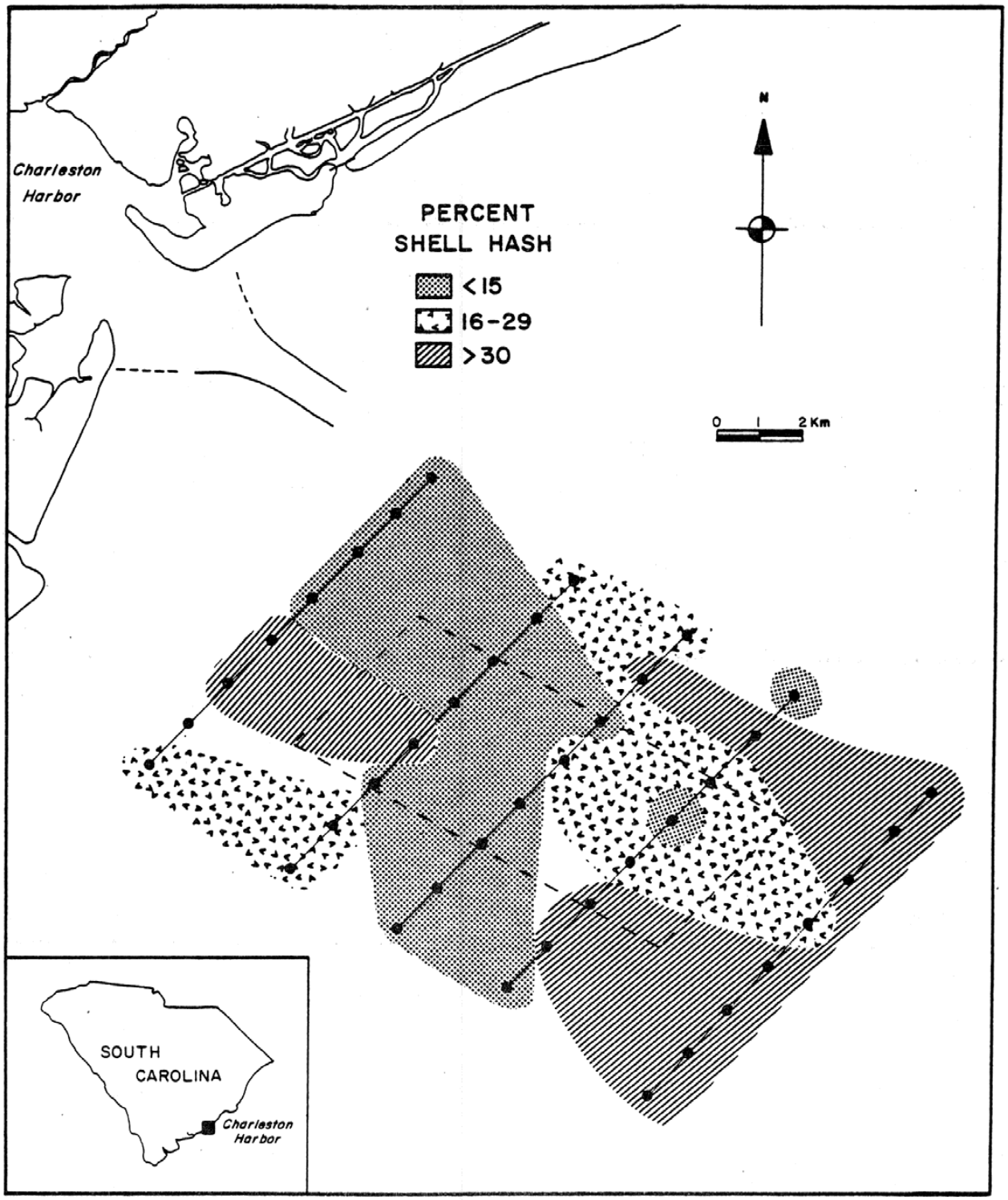

Figure 3. Distribution of shell hash content of sediment in the study area.

Table 1. List of epifaunal species collected in oyster dredge samples, and their frequency of occurrence at 40 stations in the study area.

Species	Occurrence at Number of Stations
Phylum Porifera	
Cliona sp.	13
Clathrina coriacea	5
Porifera (undet.)	4
Spheciospongia vesparia	1
Phylum Cnidaria	
Clytia cylindrica	25
Astrangia danae	17
Turritopsis nutricula	16
Schizotricha tenella	15
Eudendrium sp.	14
Dynamena cornicina	13
Telesto sanguinea	12
Ectopleura dumortieri	11
Halecium dysymmetrum	8
Telesto fruticulosa	8
Leptogorgia setacea	7
Zanclea costata	5
Actiniaria (undet.)	4
Halecium sp.	3
Lovenella grandis	3
Titanideum frauenfeldii	3
Chrysaora quinquecirrha (polyp)	2
Leptogorgia virgulata	2
Lovenella gracilis	2
Monostaechas quadridens	2
Plumularia floridana	2
Proboscidactyla ornata	2
Bougainvillia sp.	1
Campanulina sp.	1
Clytia fragilis	1
Clytia kincaidi	1
Clytia paulensis	1
Cuspidella humilis	1
Epizoanthus americanus	1
Hydractinia echinata	1
Lophogorgia hebes	1
Pandeidae (undet.)	1
Sertularella conica	1
Phylum Entoprocta	
Barentsia sp.	1
Entoproct (undet.)	1
Phylum Bryozoa	
Parasmittina nitida	24
Membranipora tenuis	23
Microporella ciliata	21
Schizoporella cornuta	17
Aetea anguina	15
Cribrilaria radiata	14
Hippopleurifera mucronata	13

Species	Occurrence at Number of Stations
Phylum Bryozoa	
Hippoporina verrilli	12
Phylactellipora aviculifera	12
Trypsostega venusta	9
Cleidochasma porcellanum	8
Cyclostomata A (undet.)	8
Schizoporella errata	8
Bowerbankia gracilis	7
Crisia sp.	7
Floridina parvicella	7
Hippoporella uvulifera	7
Copidozoum tenuirostre	6
Lichenopora sp.	6
Celleporidae (undet.)	4
Reptadeonella violacea	3
Sundanella sibogae	3
Aeverrillia setigera	2
Amathia distans	2
Caulibugula pearsei	2
Reginella floridana	2
Cryptosula pallasiana	2
Hippaliosina rostrigera	2
Hippoporina contracta	2
Alcyonidium hauffi	1
Amathia alternata	1
Amathia sp.	1
Anasca A (undet.)	1
Celleporina hassalli	1
Ctenostomata (undet.)	1
Discoporella umbellata	1
Electra monostachys	1
Membranipora arborescens	1
Nolella stipata	1
Phylum Mollusca	
Chama macerophylla	21
Crepidula fornicata	14
Anadara transversa	13
Ostrea equestris	13
Anomia simplex	10
Chaetopleura apiculata	8
Crepidula plana	8
Mitrella lunata	8
Octopus vulgaris	4
Anachis translirata	3
Musculus lateralis	3
Oliva sayana	3
Polinices duplicatus	3
Eupleura caudata	2
Modiolus modiolus squamosus	2

Table 1. (Continued)

Species	Occurrence at Number of Stations
Phylum Mollusca	
Acanthodoris pilosa	1
Argopecten gibbus	1
Dinocardium robustum	1
Diodora cayenensis	1
Diplothyra smithi	1
Fasciolaria lilium hunteria	1
Gastropoda (undet.)	1
Lithophaga bisulcata	1
Muricidae (undet.)	1
Prunum apicinum	1
Sinum perspectivum	1
Turbo castanea	1
Urosalpinx cinerea	1
Phylum Arthropoda	
Balanus venustus	29
Balanus calidus	12
Ovalipes stephensoni	11
Kochlorine floridana	8
Xanthidae (undet.)	7
Pilumnus sp.	5
Portunus gibbesii	5
Pagurus pollicaris	3
Podochela sidneyi	3
Libinia dubia	2
Ovalipes ocellatus	2
Portunus spinimanus	2
Squilla empusa	2
Balanus galeatus	1
Balanus improvisus	1
Callinectes sapidus	1
Chelonibia patula	1
Hepatus pudibundus	1
Hypoconcha sabulosa	1
Metoporhaphis calcarata	1
Micropanope xanthiformis	1
Paguridae (undet.)	1
Pilumnus sayi	1
Synalpheus townsendi	1
Tanystylum orbiculare	1
Trachypenaeus constrictus	1

Species	Occurrence at Number of Stations
Phylum Echinodermata	
Arbacia punctulata	14
Astropecten duplicatus	11
Ophiothrix angulata	11
Asterias forbesi	9
Mellita quinquiesperforata	8
Luidia clathrata	3
Clypeaster rosaceus	2
Lytechinus variegatus	2
Astropecten articulatus	1
Clypeaster subdepressus	1
Luidia bernasconiae	1
Ophioderma appressum	1
Ophiolepis elegans	1
Phylum Chordata	
Didemnum candidum	12
Ascidiacea A (undet.)	8
Styela plicata	7
Ascidiacea B (undet.)	6
Amaroucium sp.	4
Amaroucium constellatum	2
Ascidiacea C (undet.)	2
Ascidiacea (undet.)	1
Ascidiacea D (undet.)	1
Clavelina picta	1
Molgulidae (undet.)	1
Styela sp.	1

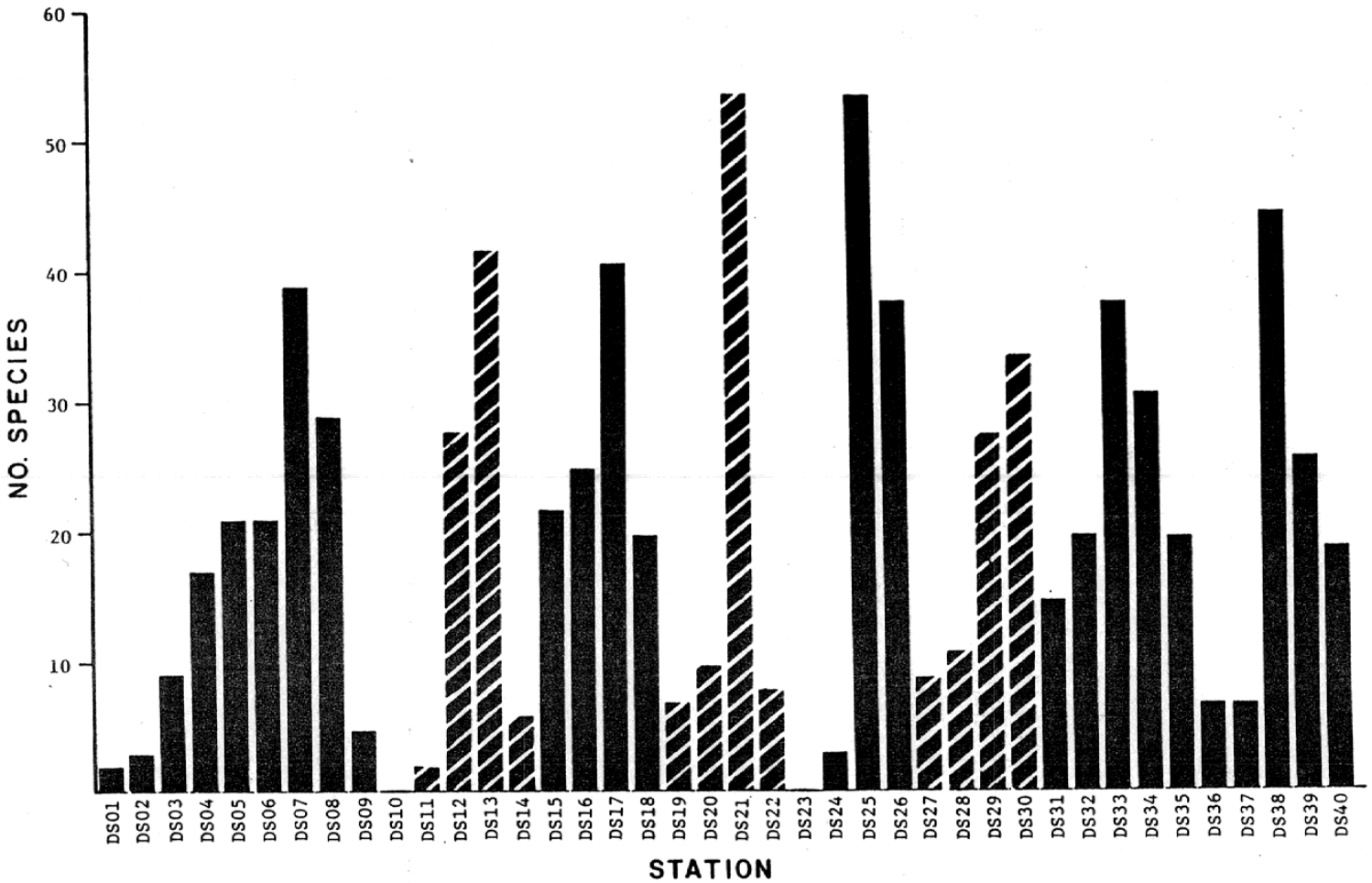

Figure 4. Number of species in oyster dredge collections from the 40 stations in the study area. Histograms with slanted lines represent stations within the Ocean Disposal Area.

where such substrates occurred, and typically low where the bottom was sand or sand and shell hash only. Forty or more species were identified in collections from six of the stations (DS13, DS17, DS21, DS25, DS33, and DS38). The maximum number of species (53) occurred in a sample from station DS25. The average number of species per station was 20.5.

No faunal differences that could be attributed to deposition of dredged material were detected between the Ocean Disposal Area and adjacent sites. Species numbers averaged 22.0 inside the Ocean Disposal Area and 21.3 outside. Faunal composition of the two areas was similar, with 96 species identified inside the disposal area, 139 outside the site, and 78 species common to the two areas. The lower total number of species collected from sites in the Ocean Disposal Area is probably due to the smaller number of stations sampled there (only 12 of the 40 stations) rather than to any disposal effects. In addition, the innermost and outermost transects, neither of which crossed the Ocean Disposal Area, were somewhat different from the three middle transects with respect to environmental characteristics and faunal composition.

Infaunal Assemblages

Nearly 34,000 benthic macroinvertebrates, representing 439 species, were obtained in quantitative Smith-McIntyre grab collections from the study area (Appendix 5). Of the total number of organisms collected, 37.5% were polychaetes, 19.6% were the cephalochordate Branchiostoma caribaeum, 10.0% were amphipods, and 7.0% were pelecypods. Representatives of 24 other major taxa comprised the remaining 26% of individuals collected (Table 2). Polychaetes also dominated the fauna taxonomically, with 211 species accounting for 42.8% of the total. Pelecypods comprised 10.8% of the total number of species, while decapods and gastropods contributed 9.9% each. Knott et al. (1983) documented that polychaetes also dominated subtidal infaunal assemblages of nearshore areas at Murrells Inlet, South Carolina.

The most abundant species in the samples was the lancelet Branchiostoma caribaeum, which comprised nearly one-fifth of the total number of individuals. This species was collected at 31 of the 40 stations included in the study. B. caribaeum was either absent or present in low densiites at several of the shallower stations inshore, particularly those characterized by finer sediments (see Appendix 2). Highest numbers were encountered at stations with bottoms of coarser sand. For example, densities of 2750 and 2788 individuals per m^2 were found at stations DS33 and DS40, respectively. These concentrations exceed the maximum densities of 1345 lancelets per m^2 recorded by Frankenberg and Leiper (1977) in summer samples from shelf waters off Georgia. In a study of the ecology and distribution of B. caribaeum on the shelf of the southeastern United States, Cory and Pierce (1967) found maximum densities of 204 individuals per m^2 off Sapelo Island, Georgia. They noted that optimal conditions for aggregations of B. caribaeum included the presence of coarse, shelly, siliceous sand in areas of subsurface wave action and tidal current.

Ranking second in abundance was the sipunculid Aspidosiphon spinalis, which accounted for 3.4% of the total fauna. It was present in collections from 30 of the 40 stations sampled. Other species contributing more than 2% of the total fauna included the polychaetes Spiophanes bombyx, Goniadides carolinae, Spio pettiboneae, Nephtys picta, and Prionospio cristata, the lunulitiform bryozoan Cupuladria doma, the amphipod Trichophoxus floridanus, and nematodes of undetermined identity. The polychaete Spiophanes bombyx was the most ubiquitous species in this study, occurring at all of the 40 stations sampled. This species is also abundant in shallower nearshore sand bottom areas, as well as in deeper live bottom areas of the South Atlantic Bight (Knott et al., 1983; Wenner et al., 1983). Other species widely distributed throughout our study area included the polychaete Nephtys picta (35 stations), Nemertina A (37 stations), the amphipods Eudevenopus honduranus and Tiron tropakis (33 stations each), nematodes (33 stations), the decapod Pagurus longicarpus (32 stations), and the pelecypods Tellina probrina and Ervilia concentrica (30 stations each).

Species diversity (H') ranged from 3.46 to 6.13 in samples from the study area (Table 3). Diversity measurements (H') did not reveal any significant differences ($p > 0.4$, Mann-Whitney U test) between stations inside and outside the Ocean Disposal Area. The mean value for H' was 4.64 for stations in the disposal area and 4.62 for the surrounding stations. Diversity values over the entire study area were generally higher than those observed in shallow shelf waters off Virginia (Boesch, 1972) and Rhode Island (Saila, et al., 1972). In fact, H' values were generally equivalent to those noted for hard bottom reef areas located further offshore in the South Atlantic Bight (Wenner et al., 1983). The high diversity if partly attributable to the high species richness component of diversity (SR), which ranged from 5.52 at DS10 to 22.90 at DS38 (Table 3). The number of species collected at these stations was 31 and 173, respectively. Neither the number of species per station nor species richness was significantly different between stations inside and outside the disposal area ($p > 0.2$, Mann-Whitney U test). High diversities were also partly attributable to the evenness component (J'), which measures the distribution of individuals among species present. In spite of the numerical dominance of Branchiostoma caribaeum, 19 other species each contributed more than 1% of the total number of individuals collected. Yet these 20 species accounted for only 56.4% of the total number of animals present. This is a substantially more even distribution of individuals among the species collected than Dorjes (1972) found on transects off Georgia, where the 10 most abundant species contributed 86% of the total. Likewise, the 10 most

Table 2. Number of individuals and number of species for each of the major invertebrate taxa of infaunal organisms from the study area.

Taxon	Number of Individuals	% of Total	Cumul. %
Polychaeta	12,713	37.47	37.47
Cephalochordata	6,633	19.55	57.02
Amphipoda	3,406	10.04	67.06
Pelecypoda	2,369	6.98	74.04
Sipunculida	1,768	5.21	79.25
Ectoprocta	1,329	3.92	83.17
Nematoda	1,142	3.36	86.53
Decapoda	1,052	3.10	89.63
Isopoda	590	1.74	91.37
Gastropoda	535	1.58	92.95
Polyplacophora	451	1.33	94.28
Echinodermata	405	1.19	95.47
Rhynchocoela	366	1.08	96.55
Oligochaeta	296	0.87	97.42
Tanaidacea	203	0.60	98.02
Cumacea	195	0.57	98.59
Ostracoda	119	0.35	98.94
Mysidacea	111	0.33	99.27
Unknown Taxa	66	0.19	99.46
Brachiopoda	63	0.18	99.64
Turbellaria	59	0.17	99.81
Scaphapoda	21	0.06	99.87
Anthozoa	16	0.05	99.92
Pycnogonida	14	0.04	99.96
Stomatopoda	6	0.02	99.98
Phoronida	2	<0.01	
Hemichordata	1	<0.01	
Echiurida	1	<0.01	100.00

Taxon	Number of Species	% of Total	Cumul. %
Polychaeta	211	42.80	42.80
Pelecypoda	53	10.75	53.55
Decapoda	49	9.94	63.49
Gastropoda	49	9.94	73.43
Amphipoda	43	8.72	82.15
Echinodermata	20	4.06	86.21
Isopoda	12	2.43	88.64
Cumacea	7	1.42	90.06
Mysidacea	7	1.42	91.48
Sipunculida	6	1.22	92.70
Polyplacophora	5	1.01	93.71
Stomatopoda	4	0.81	94.52
Tanaidacea	4	0.81	95.33
Rhynchocoela	3	0.61	95.94
Scaphapoda	3	0.61	96.55
Anthozoa	2	0.40	96.95
Ectoprocta	2	0.40	97.35
Pycnogonida	2	0.40	97.75
Unknown Taxa	2	0.40	98.15
Brachiopoda	1	0.20	98.35
Cephalochordata	1	0.20	98.55
Echiurida	1	0.20	98.75
Hemichordata	1	0.20	98.95
Nematoda	1	0.20	99.15
Oligochaeta	1	0.20	99.35
Ostracoda	1	0.20	99.55
Phoronida	1	0.20	99.75
Turbellaria	1	0.20	99.95

Table 3. Species diversity and faunal density of grab samples collected in the study area.

Station	Diversity (H')	Evenness (J')	Richness (SR)	Number of Individuals/0.5 m^2	Number of Species
DS01	3.96	0.83	5.62	102	27
DS02	3.48	0.70	5.68	234	32
DS03	3.70	0.69	7.13	273	41
DS04	4.34	0.75	8.99	407	55
DS05	4.66	0.79	9.03	550	58
DS06	5.50	0.79	17.69	1,108	125
DS07	4.81	0.70	16.83	1,107	119
DS08	5.40	0.80	16.24	643	106
DS09	5.18	0.83	12.13	447	75
DS10	3.66	0.74	5.52	230	31
DS11*	3.86	0.73	6.99	264	40
DS12*	4.63	0.77	10.43	419	64
DS13*	5.98	0.81	22.00	1,978	168
DS14*	4.78	0.82	10.02	296	58
DS15	5.17	0.82	13.10	416	80
DS16	5.53	0.75	20.86	2,593	165
DS17	4.78	0.84	9.06	310	53
DS18	4.83	0.75	12.69	812	86
DS19*	5.09	0.85	10.38	475	65
DS20*	5.04	0.80	12.75	531	81
DS21*	4.20	0.71	9.39	596	61
DS22*	4.74	0.80	10.09	347	60
DS23	4.30	0.81	6.77	274	39
DS24	5.34	0.86	12.93	262	73
DS25	4.60	0.76	10.43	462	65
DS26	5.13	0.79	13.94	551	89
DS27*	3.46	0.55	10.90	1,169	78
DS28*	4.31	0.72	9.84	546	63
DS29*	4.95	0.73	14.85	1,253	107
DS30*	5.23	0.70	21.00	3,966	175
DS31**	4.11	0.63	13.55	1,031	95
DS32	4.20	0.65	12.42	1,197	89
DS33	3.98	0.58	14.79	2,919	119
DS34	4.02	0.61	13.04	1,459	96
DS35	5.11	0.72	18.30	1,690	137
DS36	3.97	0.62	12.06	974	84
DS37	4.64	0.71	13.57	759	91
DS38	6.13	0.82	22.90	1,830	173
DS39	3.91	0.58	13.67	2,169	106
DS40	4.20	0.60	15.73	3,420	129

* stations located in disposal area
** number of individuals in 0.4 m^2

abundant species of shallow nearshore infaunal communities at Murrells Inlet, South Carolina, contributed 80.2% of the total number of animals collected (Knott et al., 1983).

Many more species were identified from the study area off Charleston then have been reported from similar areas off the Georgia coast. Collections from supratidal, intertidal, and subtidal shallow shelf areas out to depths of about 15 m off Sapelo Island yielded 298 species (Dorjes, 1972). Three stations sampled by Frankenberg and Leiper (1977) off Sapelo Island with sediment characteristics and water depths similar to the present study area, yielded an average of 68 species per 1.2 m^2 for August collections. By comparison, we collected 493 species with an average of approximately 84 species per 0.5 m^2 in the study area off Charleston (Table 3). In the only previous study of this nature in South Carolina, 205 species were identified in samples collected over four seasons from nine subtidal stations (maximum depths of 5 m) in the Murrells Inlet area (Knott et al., 1983).

Cluster analysis of ODA samples revealed five distinct station groups based on their degree of faunal similarity (Fig. 5). All but one of the groups contained stations located both inside and outside the disposal area boundaries (Fig. 6). This suggests that past disposal activities have not noticeably modified faunal composition in that area. Rather, most station groupings can be related to natural variation in sediment composition.

Stations in Group 1 were characterized by medium to coarse sand with a relatively high content of shell hash (Figs. 2, 3, 6). Branchiostoma caribaeum was by far the most common species at Group 1 stations, reflecting its preference for coarse, shelly sediments. Aspidosiphon spinalis was also very abundant at these stations. This species is known to live chiefly in empty mollusc shells (Cutler, 1973), which is consistent with its dominance at stations having greater amounts of coarse shell hash. Stations in Groups 2 and 3, on the other hand, contained mostly finer sediments with moderate to high shell content. Differences between these two groups appeared to be related to the amount of shell hash (Figs. 3 and 6), with more of this material in sediments at Group 3 stations. Finally, stations in Groups 4 and 5 were located in areas of fine sediment having little shell hash. The polychaete Nephtys picta was an important constituent of the species assemblages in both of these groups, particularly among Group 5 stations, where sediments contained a notably greater percentage of silt and clay (Appendix 2). This species has been reported to show higher abundance with increasing amounts of these finer sediments (Kinner and Maurer, 1978).

The lack of any detectable disposal effects, based on comparisons among stations using cluster analysis, diversity indices and faunal abundance, is probably due to two factors. First, no sediments had been recently disposed in the area prior to this study. Rather, our study was intended to provide baseline data before more intensive disposal activities are begun. Secondly, the small volume of sediments placed in the Charleston Ocean Disposal Area prior to this study had been dredged from the entrance channel, and thus were similar in composition to those at the disposal site (South Carolina Wildlife and Marine Resources Department, 1979). Deposition of dredged material of a different particle size, such as muds from Charleston Harbor, could have a much more severe and potentially long-term impact on the bottom communities (Windom, 1976; Morton, 1977), if these sediments were not rapidly diluted and dispersed.

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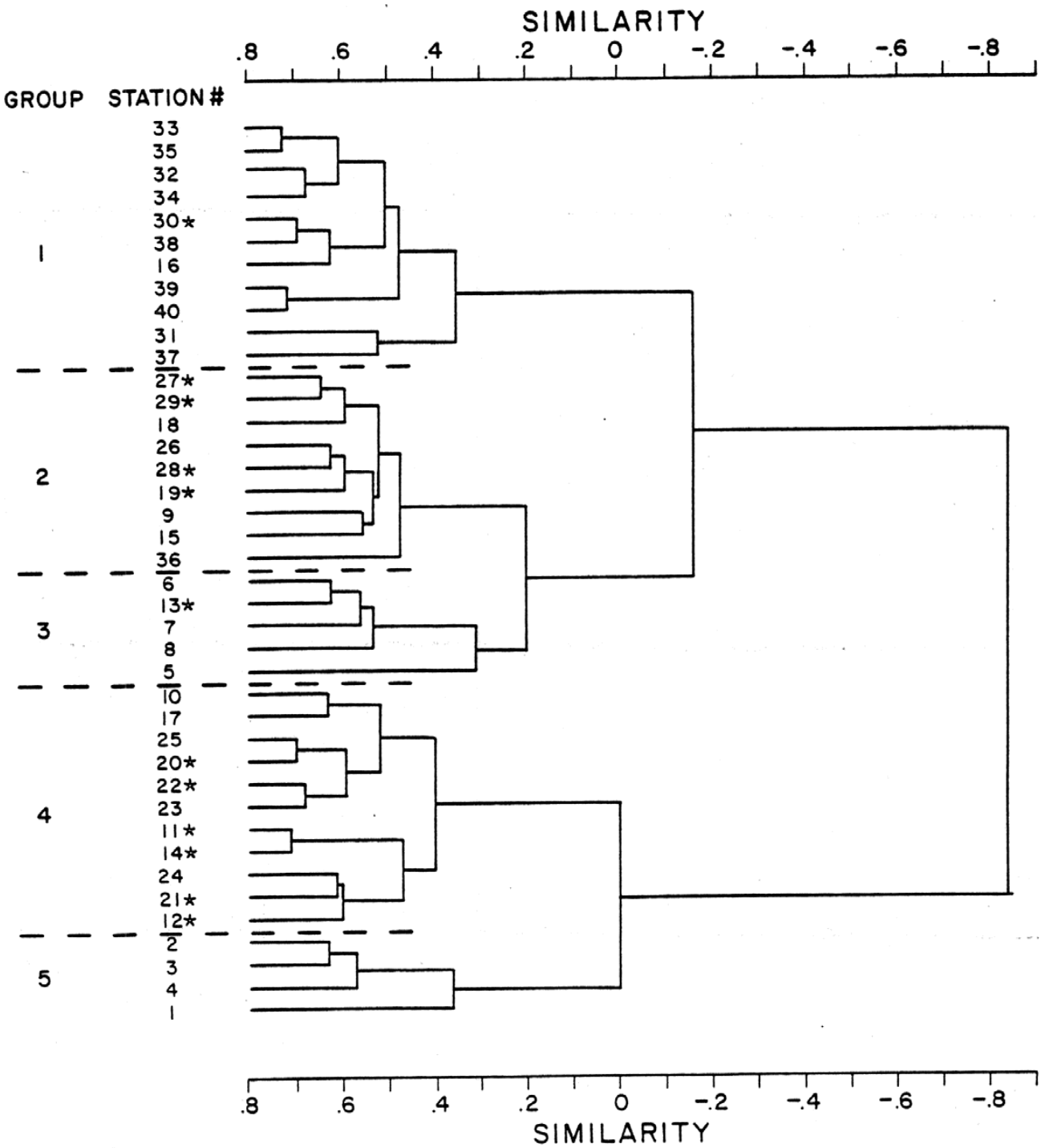

Figure 5. Normal cluster dendrogram showing heirarchy of station groups formed using the Bray-Curtis similarity coefficient and flexible sorting.

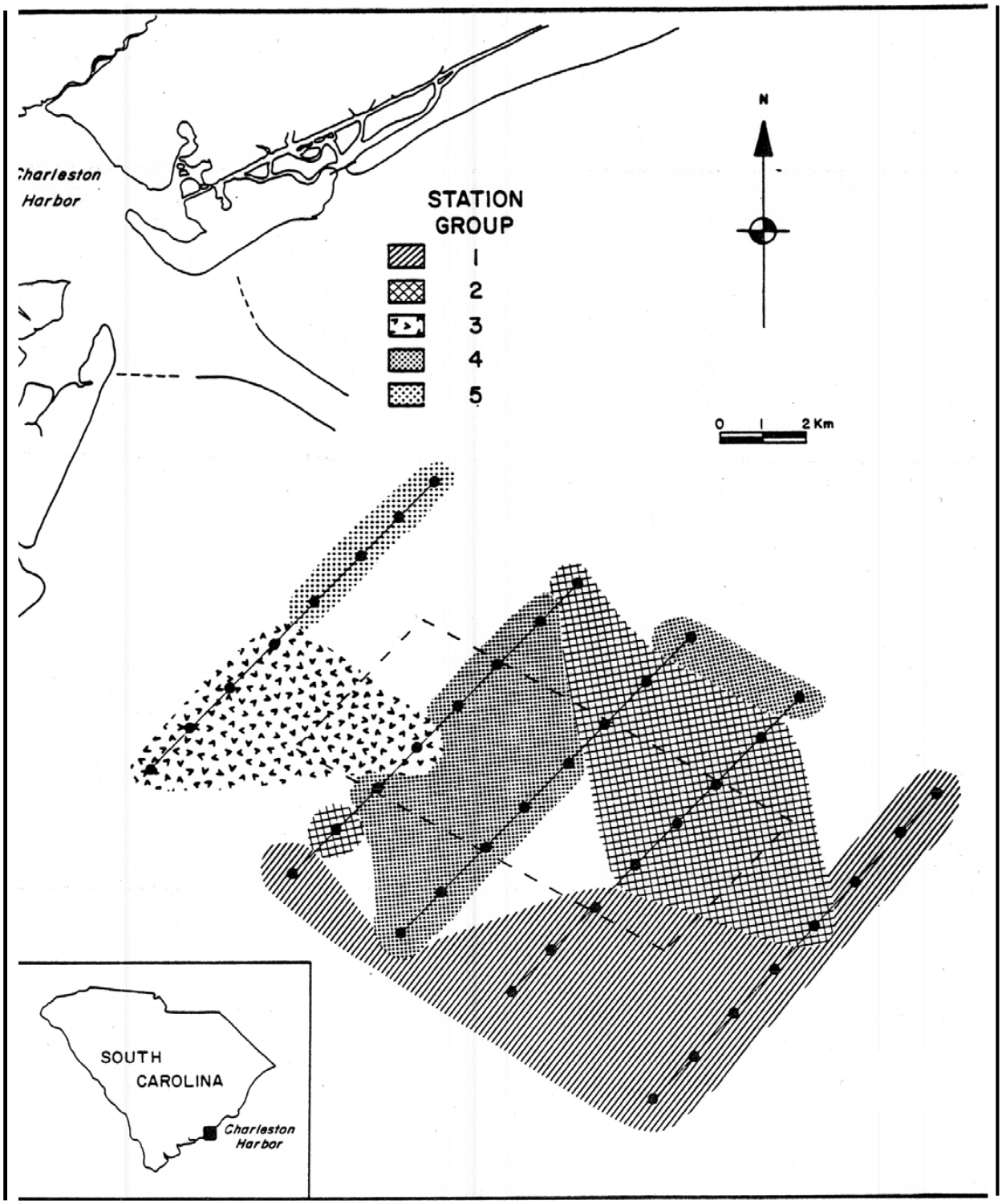

Figure 6. Location of station groups resulting from normal cluster analysis. See Figure 5 for the degree of similarity.

Click her to continue