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Abundance, seasonality and community structure of fishes on the Mid-Atlantic Bight continental shelf

James Alden Colvocoresses

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Colvocoresses, James Alden

**ABUNDANCE, SEASONALITY AND COMMUNITY STRUCTURE OF FISHES ON
THE MID-ATLANTIC BIGHT CONTINENTAL SHELF**

The College of William and Mary in Virginia

PH.D. 1985

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ABUNDANCE, SEASONALITY AND COMMUNITY STRUCTURE OF FISHES
ON THE MID-ATLANTIC BIGHT CONTINENTAL SHELF

A Dissertation

Presented to

The Faculty of the School of Marine Science
The College of William and Mary in Virginia

In Partial Fulfillment
Of the Requirements for the Degree of
Doctor of Philosophy

by

James Alden Colvocoresses

1985

APPROVAL SHEET

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the requirements for the degree of

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ABSTRACT

Cluster analyses of seasonal (spring and fall) National Marine Fisheries Service Groundfish Survey bottom trawl catches on the Middle Atlantic Bight (Cape Hatteras to Cape Cod) continental shelf revealed consistent species associations and faunal zones over a nine year period during. Boundaries between faunal zones tended to follow isotherms on the inner and middle portions of the shelf and isobaths along the outer shelf.

During the late winter/early spring, four faunal zones were identified: a northern inner and middle shelf zone extending from Cape Cod southward to about Delaware Bay, a northern middle and outer shelf zone offshore of the first zone, a southern middle and outer shelf zone, and a fourth zone on the shelf break and upper slope. The southern inner shelf was a transition zone between the first and third zones. Five species groups were identified: a small cryophilic group restricted to the first zone, a cold-water boreal group found in the first two zones, a ubiquitous boreal/resident group containing the major dominants, a warm-temperate group confined to the warmer southern and outer shelf waters, and a group of slope residents confined to the deepest zone.

During the fall, five faunal zones were identified: a southern inner and middle shelf zone, a northern inner shelf zone, a northern mid-shelf zone, an outer shelf zone and a shelf break/upper slope zone. The five species associations recognized were largely analogous to those in the spring, with the following exceptions: the cryophilic group was absent, the ubiquitous group contained mixed boreal and warm-temperate elements, and a second outer shelf group was recognized. The most notable change in the distribution of groups from the spring was a general northward shift in the distributions of the boreal species and a sharply defined inshore movement of the warm temperate group.

Analyses of a single summer cruise showed patterns of distribution intermediate to those seen during the spring and fall. Absolute abundances, both of individual species and the total fish community, were highly variable between areas, seasons and years. Species diversity and its components appear to be of little utility in describing the fish communities of the open continental shelves.

ABUNDANCE, SEASONALITY AND COMMUNITY STRUCTURE OF FISHES
ON THE MID-ATLANTIC BIGHT CONTINENTAL SHELF

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INTRODUCTION

Until the present decade communities of fishes on the continental shelf had rarely been studied beyond the compilation of species lists for given areas. This is enigmatic when one considers the large amount of survey data that has been collected from much of the world's continental shelf waters in connection with fishery exploration and monitoring. While trawl survey data has traditionally been collected with the primary aim of assessing commercially harvestable stocks, it also provides an excellent base for evaluating the interspecific relationships among trawlable organisms.

The reluctance of ecologists to approach continental shelf fish populations as integrated communities may have in large part resulted from the very high mobility of many of these species. A given individual can exhibit seasonal movements over hundreds or even thousands of kilometers (McKeown 1984), a scale more familiar to zoogeographers than community ecologists, while the the standing fish community at a given specific location can change dramatically over a matter of hours (Helfman 1978).

Interest in addressing continental shelf fish populations as communities has been greatly stimulated by the recent surge of activity in the area of offshore mineral and petroleum exploration. Concern over the environmental impacts of such development, both under normal and catastrophic circumstances, has fostered an awareness of

the need of a much better understanding of the continental shelf ecosystem. The effect of environmental perturbations on this ecosystem and upon fishes in particular is of special concern because of the direct value of many of these species as commercial and recreational resources.

The few studies which have previously addressed community structure of open continental shelf fishes have found clearly definable species associations with distributions related to environmental parameters. Demersal fish species assemblages found using objective mathematical measures have been described for the continental shelves in the Gulf of Guinea (Fager and Longhurst 1968), northwest Pacific coast of the United States (Day and Pearcy 1968) and Campeche Bank off Mexico (Sauskan and Ryzhov 1977). Similar studies directed at specific subdivisions or substrate types have also found clearly definable communities (Chittenden and McEachran 1976; Wenner 1983; Sedberry and Van Dolah 1984).

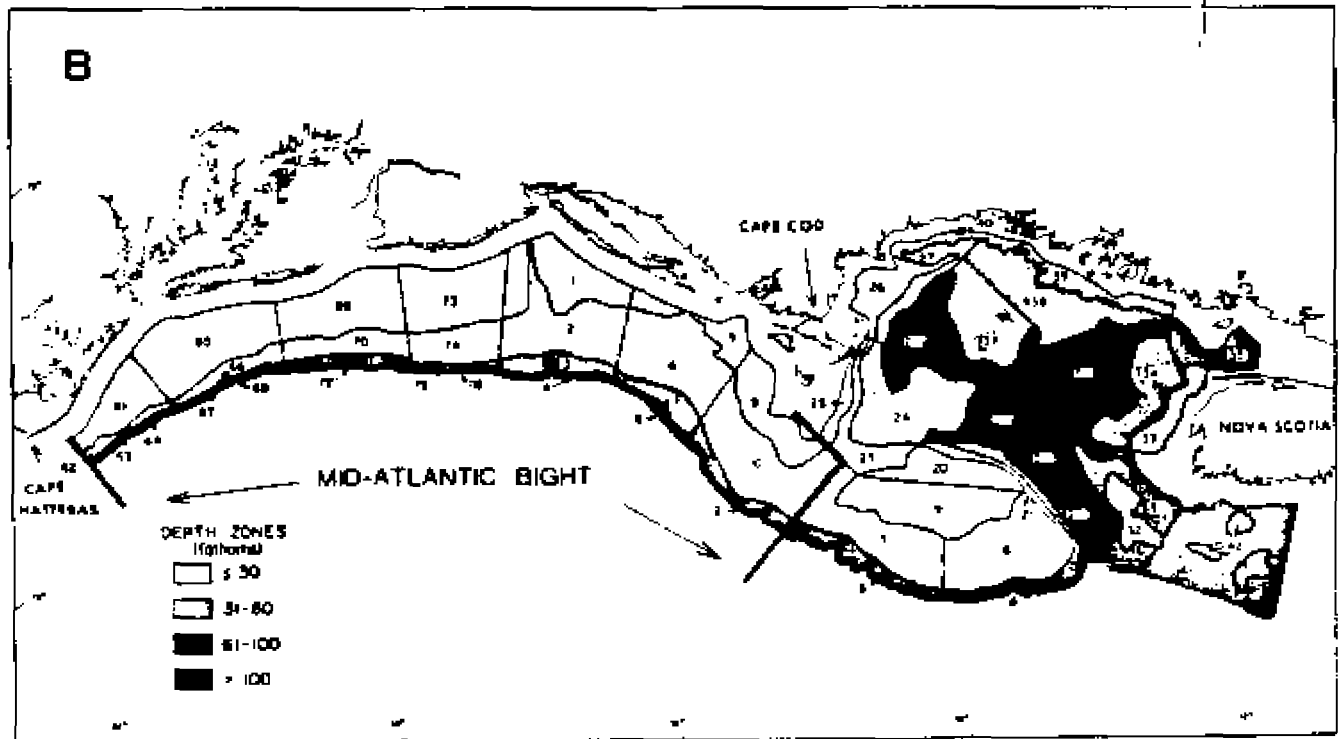
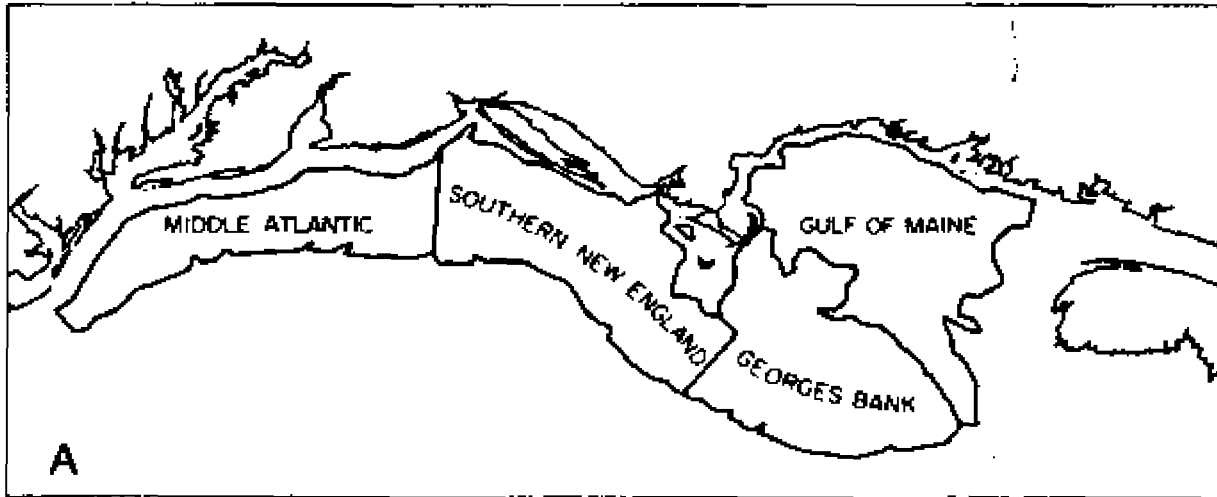
Since 1967 the National Marine Fisheries Service (formerly Bureau of Commercial Fisheries) has conducted a semi-annual bottom trawl survey of the continental shelf waters from Nova Scotia to Cape Hatteras (Grossolein 1969). This program has produced an extremely large data base which offers a unique opportunity for the analysis of the composition and variability of the fish communities in this region. The initiation of petroleum exploration off the United States Atlantic seaboard, the past success of other workers at classifying continental shelf fish communities, and the availability of this extensive data base on shelf fish populations prompted the present

study, an investigation of the fish community structure and its underlying determinants in this important area.

Previous analyses of these surveys have been primarily directed toward population assessment and management of commercially important species (Brown et al. 1976; Edwards 1976; Clark and Brown 1977). Clark and Brown recognized four sub-areas based primarily on differences in faunal assemblages (Fig. 1). The geographic scope of the present research encompasses Clark and Brown's Middle Atlantic and Southern New England areas, or that portion of these data collected in the Mid-Atlantic Bight (Cape Cod to Cape Hatteras).

The objectives of this study were to identify and define the composition and temporal (both seasonal and long-term) stability of the fish communities present within this area, and to attempt to establish which environmental parameters shape how these communities vary geographically and seasonally. The scope of this project was unique not only in the size of the study area (approx. 83,000 km²) but also in that it is the only continental shelf fish community analyses to simultaneously traverse both major bathymetric (27-365 m) and latitudinal (35° to 41° N) gradients. The extensive time series of the data set (data from spring and fall surveys from fall 1967 through spring 1976 were included in the present study, as well as a summer survey conducted in 1969) also afforded a unique opportunity to assess the long-term annual variability in these communities; a virtual necessity to the proper understanding of the determinants of community structure of such highly mobile animals in a variable environment.

Figure 1. Northwest Atlantic area sampled by NMFS Groundfish Survey A) delineated into major analytical units and B) delineated into sampling strata.



Beyond the descriptive aspects of the fish community structure and its underlying influences I will also address several questions of general ecological interest: What is the geographical extent of definable communities of such large and motile organisms? What are the relative contributions of the adjacent major faunal regions (Boreal and Warm Temperate) to the fish fauna in this zoogeographic transition zone (Briggs 1974), how do they vary seasonally, and what is the role of resident species? Are the fish communities shaped by the same factors throughout the entire shelf, or are environmental parameters of differential importance in different regions? And lastly, do the extensive migratory components of these communities maintain interspecific associations across the miles and seasons, or are the seasonal components of these communities simply the result of mosaics of different life history patterns?

METHODS

Sampling

Groundfish Survey cruises were conducted by the U.S. National Marine Fisheries Service during the fall and spring from fall 1967 through spring 1976, aboard either the RV Albatross IV or RV Delaware II, with between 91 and 145 stations being successfully occupied during each cruise (Table 1). In addition a summer cruise was made during 1969. The survey area extended from the 15 fathom (27 m) contour offshore to 200 fathoms (365 m). A stratified random sampling design was utilized, based on depth and geographical zones (Fig. 1). Catch data from strata 1-12 and 61-76 (Middle Atlantic Bight) were analyzed in the present study. Sampling intensity in each stratum was allocated according to the geographic area of each stratum (2-16 stations per stratum).

At each station a tow of 1/2 hour duration at a speed of 3.5 knots was made along the bottom. A standard #36 Yankee trawl (18 m headrope, 24 m footrope with 14-18" rubber rollers; stretch mesh sizes: 125 mm in body, 115 mm cod end with 13 mm liner) was utilized except during the spring cruises from 1973-1976, when a modified high-opening #41 Yankee trawl (24 m headrope, 30 m footrope with rollers; same mesh sizes) was used. The fishes captured were identified, counted, and weighed by species. A bathythermograph cast was made at each station. Further details of sampling design and sample

Table 1. WZFS Groundfish Survey Cruises, 1967-1976.

Cruise	Year	Season	Dates	No. Stations in		Vessel(s)	Trawl
				Mid-Atlantic	Yrawl		
67-20, 21	1967	Fall	17 Oct - 9 Dec	121		Albatross IV	#36 Yankee
68-3	1968	Spring	6 Mar - 22 Mar	108		"	"
68-17	1968	Fall	10 Oct - 13 Nov	223		"	"
69-2	1969	Spring	5 Mar - 29 Mar	109		"	"
69-8	1969	Summer	16 Jul - 12 Aug	103		"	"
69-11	1969	Fall	8 Oct - 8 Nov	109		"	"
70-3	1970	Spring	23 Mar - 29 Apr	124		"	"
70-6	1970	Fall	3 Sep - 31 Oct	113		"	"
71-1	1971	Spring	9 Mar - 11 Apr	116		"	"
71-6	1971	Fall	29 Sep - 25 Oct	115		"	"
72-2	1972	Spring	8 Mar - 7 Apr	120		"	"
72-8	1972	Fall	28 Sep - 30 Oct	103		"	"
73-3	1973	Spring	16 Mar - 26 Apr	185		Albatross IV & Delaware II	#61 Yankee
73-8	1973	Fall	26 Sep - 11 Oct	103		Albatross IV	#36 Yankee
74-4	1974	Spring	12 Mar - 11 Apr	91		"	#61 Yankee
74-11	1974	Fall	23 Sep - 25 Oct	99		"	#36 Yankee
75-3	1975	Spring	14 Mar - 29 Mar	90		"	#61 Yankee
75-11	1975	Fall	15 Oct - 7 Nov	111		Albatross IV & Delaware II	#36 Yankee
76-2	1976	Spring	4 Mar - 9 Apr	117		Albatross IV & Delaware II	#61 Yankee

processing may be found in Clark and Brown (1977) and Grosslein (1969).

Numerical Classification

The catch data were initially analyzed separately for each of the 19 cruises utilizing numerical classification (clustering). Assemblages of fishes were defined by computing a similarity coefficient, $S(j,k)$, among species from the species - station matrix and subsequently classifying species into clusters or groups (Sneath and Sokal 1973). Stations were clustered in the same manner from the inverted matrix, and species and station (site) groups were compared by nodal analysis (Lambert and Williams 1962). Matrix values entered were counts of individuals, as biomass measurements are overly influenced by the presence of relatively rare but large, motile fishes (which are poorly sampled by trawls) in the collections.

The similarity coefficient used was the Canberra metric (Lance and Williams 1967) which is particularly effective at producing ecologically meaningful classifications when the organisms under study are contagiously distributed (Clifford and Stephenson 1975) as most fishes are. Although this coefficient does not provide an accurate measure of percent similarity across the entire range of possible amounts of overlap (Bloom 1981), and therefore does not produce similarity matrices amenable to direct quantitative interpretation, it does provide a useful compromise between strictly qualitative measures of similarity and quantitative measures of percent similarity. The latter may be totally dominated by a few abundant species if the species present display highly varying levels of abundance (Boesch

1977), as is the case with continental shelf fish populations. Also, to further reduce the effects of contagion, the numerical abundance data were transformed [$\log_{10} (x + 1)$] before analysis (Taylor 1953). Species were eliminated from cluster analysis if they occurred at less than five percent of the stations occupied during a sampling period. Although this is a more severe data reduction than is commonly employed, examination of the raw matrix and trial runs at various cutoff levels showed that species occurring below this level showed highly inconsistent distributions.

The clustering strategy used was flexible fusion with beta set at the conventional value of -0.25 (Boesch, 1977). Calculations were performed on an IBM 370-115 at the Virginia Institute of Marine Science using the Fortran IV program COMPAH (Combinatorial Polythetic Agglomerative Hierarchical Program) developed at the institution. Output was in the form of similarity matrices and computer generated dendrograms.

The choice as to which branches in the dendrograms were to be identified as biologically significant groups was based on the following procedure. Each branch of the dendrogram which was composed solely of fusions involving only one entity as at least one half of each fusion was considered to constitute a minimal grouping. The distribution of each minimal grouping was then map-plotted, with logarithmic keyed symbols being used for plots of abundances of minimal species groupings. The plot of each grouping was then compared to that of the grouping with which it next fused; if no significant differences in distribution were evident the fusion was

considered to be intra-group. This procedure was repeated until all minimal groupings had been fused into groups showing evident distributional differences. In cases where there was any doubt as to whether two groups should be fused, nodal analyses diagrams were generated and compared for the two cases and the decision producing the "crisper" result (Clifford and Stephenson, 1975) utilized. While this method obviously involves some subjectivity in the recognition of groups, it has been pointed out by several authors that all methods of interpreting numerical classifications require a certain degree of subjectivity and that fixed stopping rules are especially inappropriate with fusion strategies which introduce a group size dependent element into inter-group relative affinities (Boesch 1977, Pielou 1977, Clifford and Stephenson 1975).

Two methods of nodal analysis were performed. The patterns of 'constancy' and 'fidelity' of species groups to site groups were expressed as relative densities of cells of a two-way table (Stephenson et al. 1972). Constancy is the proportion of the number of occurrences of each species group in the site group to the total number of occurrences possible (Boesch 1977). The index has a value of one when all members of a species group occur in all collections in a site group, and zero when a species group does not occur in a given site group. Fidelity is a measure of the degree to which species groups are limited to site groups. The fidelity index used was the constancy of a species group within a site group divided by the average constancy over all site groups. This index is unity when the constancy of a species group in a site group is equivalent to its overall constancy, greater than one when its constancy in the site

groups is greater than that overall, and between zero and one when its constancy is less than its overall constancy. A chi-square test was applied to the fidelity value of each cell to determine whether it varied significantly ($\alpha = 0.05$) from one. Fidelity values significantly greater than one indicate a positive association of species in a group with a site group, while values significantly less than one suggest a "negative" association. In the present analyses a highly positive (or strong) association was inferred if the number of occurrences of a given species group within a site group was twice that necessary to produce a fidelity value significantly greater than one and a highly negative association was assumed when the number of occurrences was less than half that necessary to produce a fidelity value significantly less than one. All nodal diagrams were drawn with the width of the rows and columns proportional to the number of entities in the respective site and species groups.

Species Dominance

Numerically dominant species have been used to characterize communities by ecologists for many years (Thorson 1957), and changes in dominant species often reflect faunal changes. In the present study, patterns of species dominance were compared among site groups. A species was included in dominance comparisons if it occurred among the five most abundant species in at least 20% of all the stations from a site group.

Abundance and Biomass

Estimates of mean log-transformed [$\ln(x+1)$] abundance and biomass were computed for each site cluster. Analysis of variance (ANOVA) was then performed among site clusters for each cruise. If ANOVA was significant at the 0.05 level, Scheffé's multiple range test for unequal sample sizes was performed to determine which site groups were different from one another at the same level (Guenther 1964).

Faunal Affinities

The faunal affinities of fishes captured were determined by examining published records of their usual ranges of occurrence (Bigelow and Schroeder 1953; Leim and Scott 1966; Struhsaker 1969; Musick 1972). Most warm-temperate species had resident populations south of Cape Hatteras in the "Carolinian" faunal province (Hazel 1970), and had their normal northern range limit somewhere within the Middle Atlantic Bight south of Cape Cod. Boreal species had permanent populations north of Cape Cod, and most had their southern range limit somewhere within the Middle Atlantic Bight north of Cape Hatteras. A few boreal species transcend Hatteras through bathymetric submergence. Certain components of the fauna tended to be residents on the inner shelf (Scophthalmus aquosus) or outer shelf (Paralichthys oblongus). Many species were resident on the shelf edge and upper slope (Musick 1976).

Community Structure Indices

The commonly reported measure of species diversity, H' , and its components evenness (J') and species richness were initially calculated for the fish species taken during each tow according to the following formulae:

$$H' = - \sum_{i=1}^S (p_i) (\log_2 p_i) \quad (\text{Pielou 1975})$$

where H' = species diversity expressed as bits/individual
 S = number of species
 p_i = proportion of total sample belonging to i th species

$$J' = H' / H'_{\max} \quad (\text{Pielou 1975})$$

where J' = equitability or evenness
 H' = observed species diversity
 $H'_{\max} = \log_2 S$

$$\text{Species Richness} = S - 1/\ln N$$

where S = number of species
 N = number of individuals (Margalef 1958)

As these values showed an extreme amount of erratic variation due to the highly contagious distributions encountered, these indices were

recalculated by pooling the catch data for each site group as identified by cluster analysis.

Pooling of Within-Season Cruises

The size of the data matrix was too large for simultaneous clustering of either of the two multiple year seasonal data sets. The results of the cluster, nodal and dominance analyses of the individual cruises, however, revealed a high degree of within season repetition in the composition and distribution of species groups and the faunal, geographic and hydrographic attributes of site groups. Major repetitive species groups were recognized for each season and site groups for each year were referred to generalized seasonal site groups. The validity of these groups was examined by subjecting the pooled seasonal data sets to nodal and dominance analyses based on these groupings and comparing these results to those for the individual cruises.

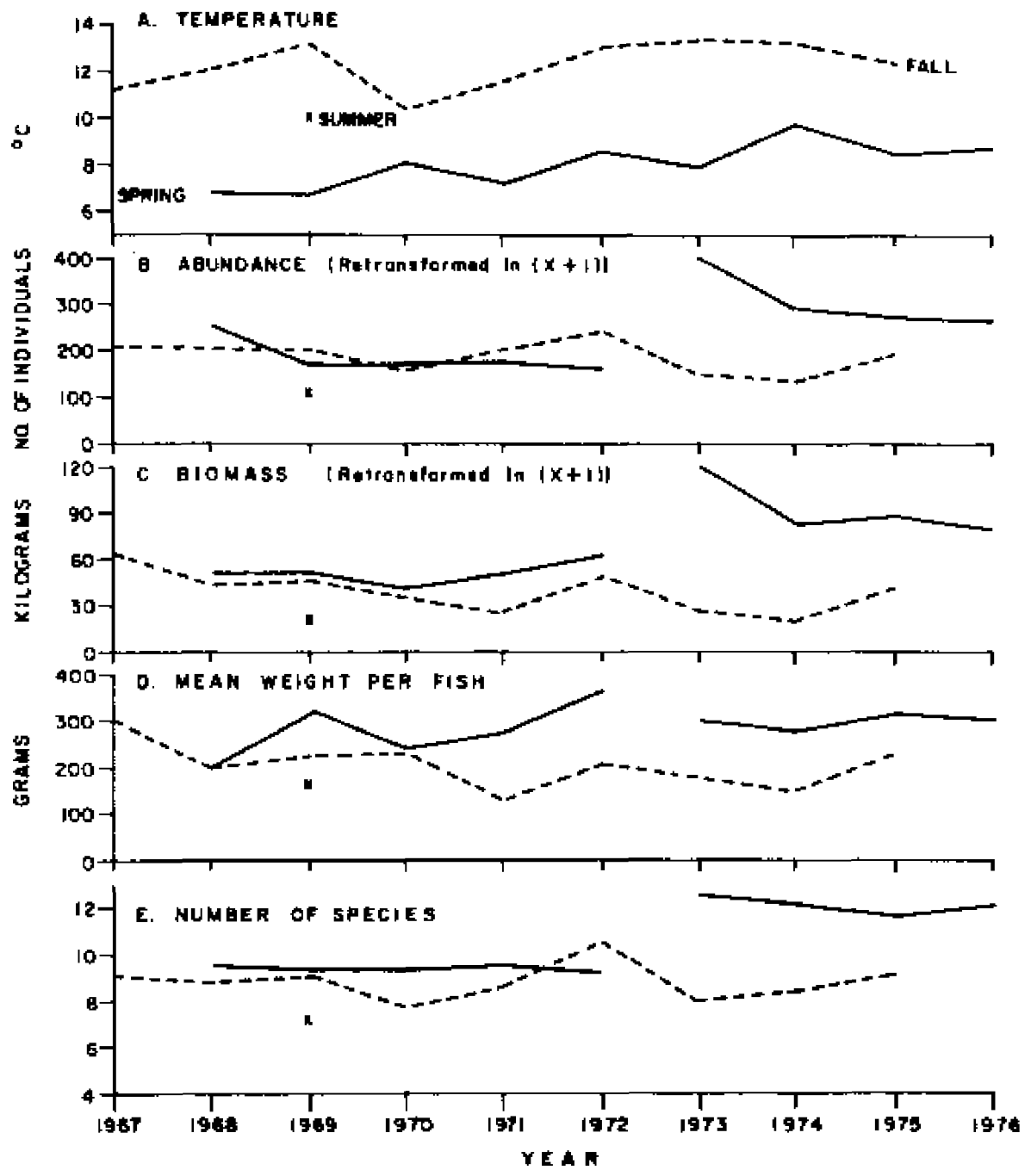
RESULTS

Thermal Regime

The geographic patterns of bottom water temperatures were variable among years within both of the sampling seasons, although these differences were minor compared to the seasonal variation within a given year. Variability among years within a season can be attributed to two sources: climatic differences among years and sampling artifacts (differences in the dates and duration of the sampling periods, and stochastic differences arising from the location of stations and the temporal sequence in which they were done). The rapidly changing nature of environmental conditions during the spring and fall and weather conditions which inhibited field operations made synoptic sampling during these seasons virtually impossible.

Spring Cruises. The spring sampling commenced between early and late March and was completed by late March to late April. This is the period at which water temperatures in the Middle Atlantic Bight are at a minimum (Walford and Wicklund 1968), and therefore it is more appropriate to consider these cruises as having sampled the late winter distribution of fishes (Musick and Mercer 1977). Bottom temperatures for these cruises ranged from 2-16°C (Appendix A) and mean temperatures for each cruise ranged from 6.7 to 9.7°C (Fig. 2A).

Figure 2. Mean A) bottom water temperature, B) retransformed ($\ln(x+1)$) number of individuals (fish), C) retransformed ($\ln(x+1)$) fish biomass, D) average fish size, and E) number of fish species per tow during NMFS Groundfish surveys, Cape Hatteras to Cape Cod, 1967-1976.

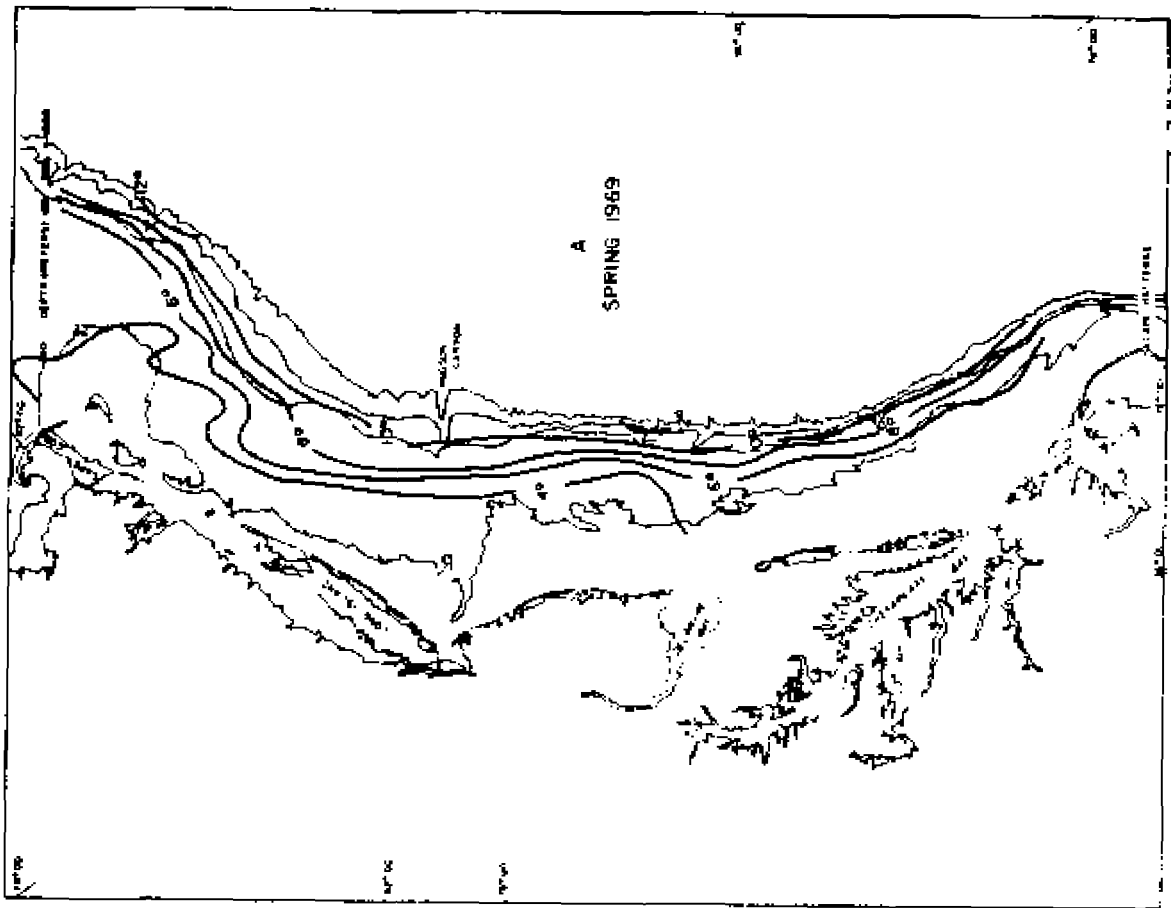
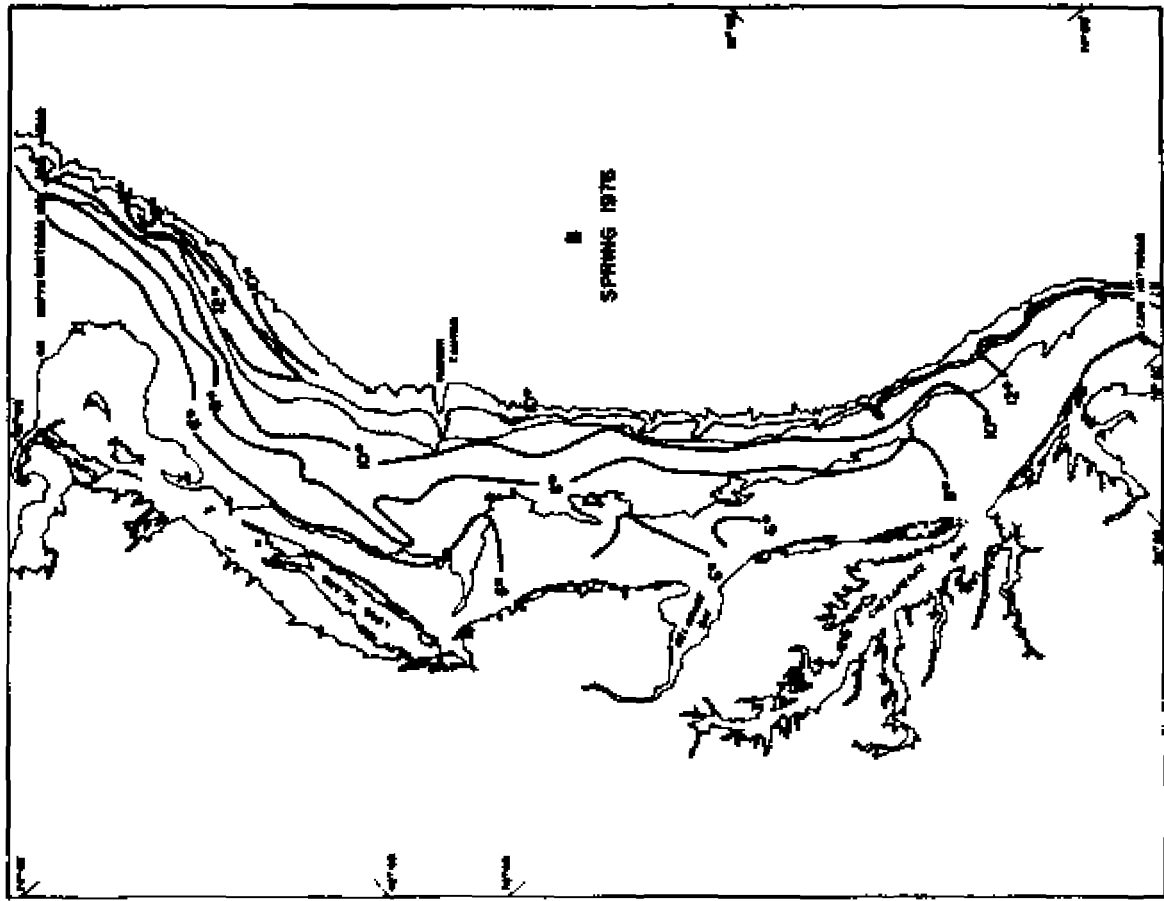


There was a definite trend toward warmer temperatures during the study period for this season which cannot be completely attributed to sampling artifacts (Davis 1979). Bottom isotherms extrapolated from the collection data are shown for two cruises representative of the warmer (1976) and cooler (1969) extremes (Fig. 3). During the 1969 cruise inshore and mid-shelf temperatures were less than 4°C north of Delaware Bay and between 4 and 6 C between Delaware Bay and Cape Hatteras. Temperatures increased toward the outer shelf, where the 10°C isotherm followed the shelf break with bottom temperatures on the upper slope exceeding 10°C.

In 1976 temperatures of less than 6°C were encountered only at northern inshore stations. Mid-shelf temperatures north of Chesapeake Bay increased from 6 to 10°C along the onshore-offshore axis, while South of Chesapeake Bay there was a southwardly increasing thermal gradient perpendicular to the shoreline and the outwardly increasing gradient was distributed across a greater portion of the shelf. Outer shelf and slope stations for the entire study area again ranged from 10-12°C. Bottom temperatures for the other spring cruises exhibited patterns intermediate between these two (Davis 1979).

Fall Cruises. The fall sampling cruises were conducted primarily in October. Because of water column turnover this is the time of maximum temperature for middle shelf bottom waters in this region (Bigelow 1933); however, coastal waters undergo rapid cooling during the fall (Parr 1933), initiating migrations for many fishes that spend

Figure 3. Bottom isotherms for spring A) 1969 and B) 1976
extrapolated from NMFS Groundfish Survey cruises.

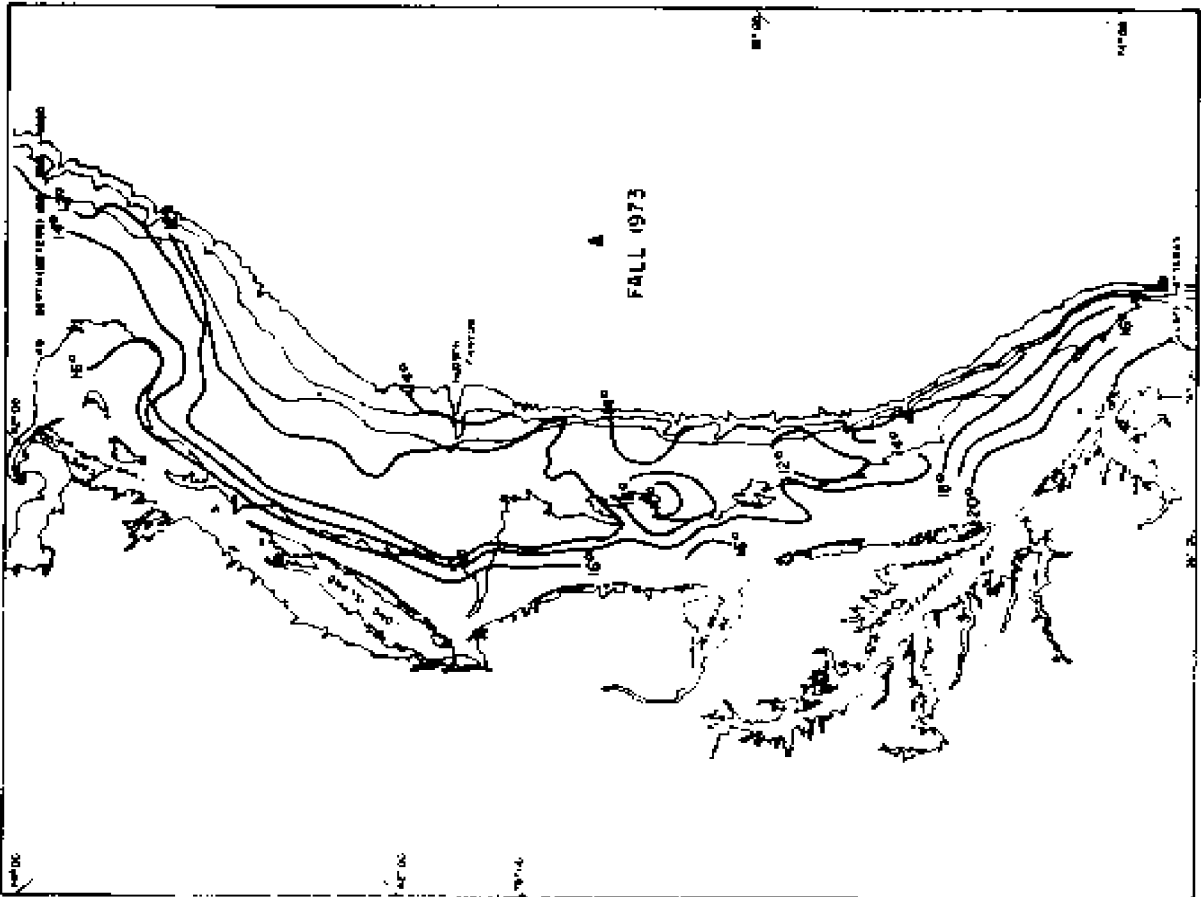
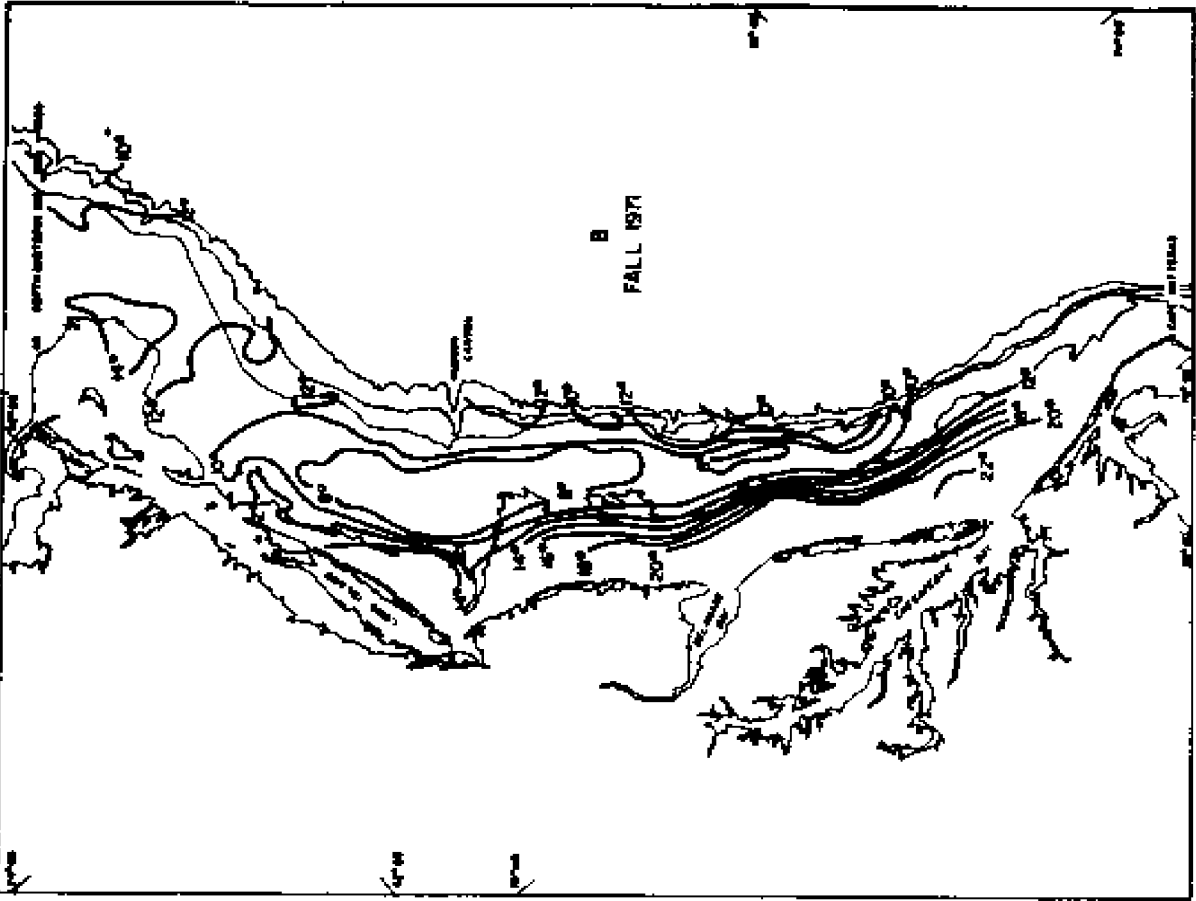


the summer inshore. Bottom temperatures ranged from 5 to 25°C (Appendix A), with the means for each cruise varying between 10.4 and 13.4°C (Fig. 2). There was no pronounced trend in the variation of mean temperature among years.

Bottom isotherms for a typical warm (1973) and cool (1971) fall sampling period are shown in Figure 4. In 1971 a strong thermal gradient was encountered along the mid-shelf from New York to Cape Hatteras. Temperatures ranged from 22°C inshore down to about 10°C at mid-shelf. A pocket of cooler water (6-9°C) was present offshore of this gradient, extending northward and inshore to occupy most of the mid-shelf off of Long Island. Turnover was in progress or just beginning at these colder stations. Temperatures gradually increased offshore and northward from this pocket, exceeding 14°C in shallow areas and ranging between 10 and 13°C along the outer shelf and the mid-shelf above Long Island.

During 1973 bottom water temperatures were less stratified and two to four degrees warmer throughout most of the study area. Inshore temperatures exceeded 16°C along the entire Bight, with temperatures above 18°C occurring only south of Chesapeake Bay. The coolest temperatures were found again on the mid-shelf off New Jersey and Long Island, but the "pocket" was much less clearly defined and was composed of waters between 10°C and 12°C, indicating that turnover had already occurred. The other fall cruises had thermal regimes intermediate to those of 1971 and 1973 (Davis 1979), with varying

Figure 4. Bottom isotherms for fall A) 1971 and B) 1973
extrapolated from NMFS Groundfish Survey cruises.



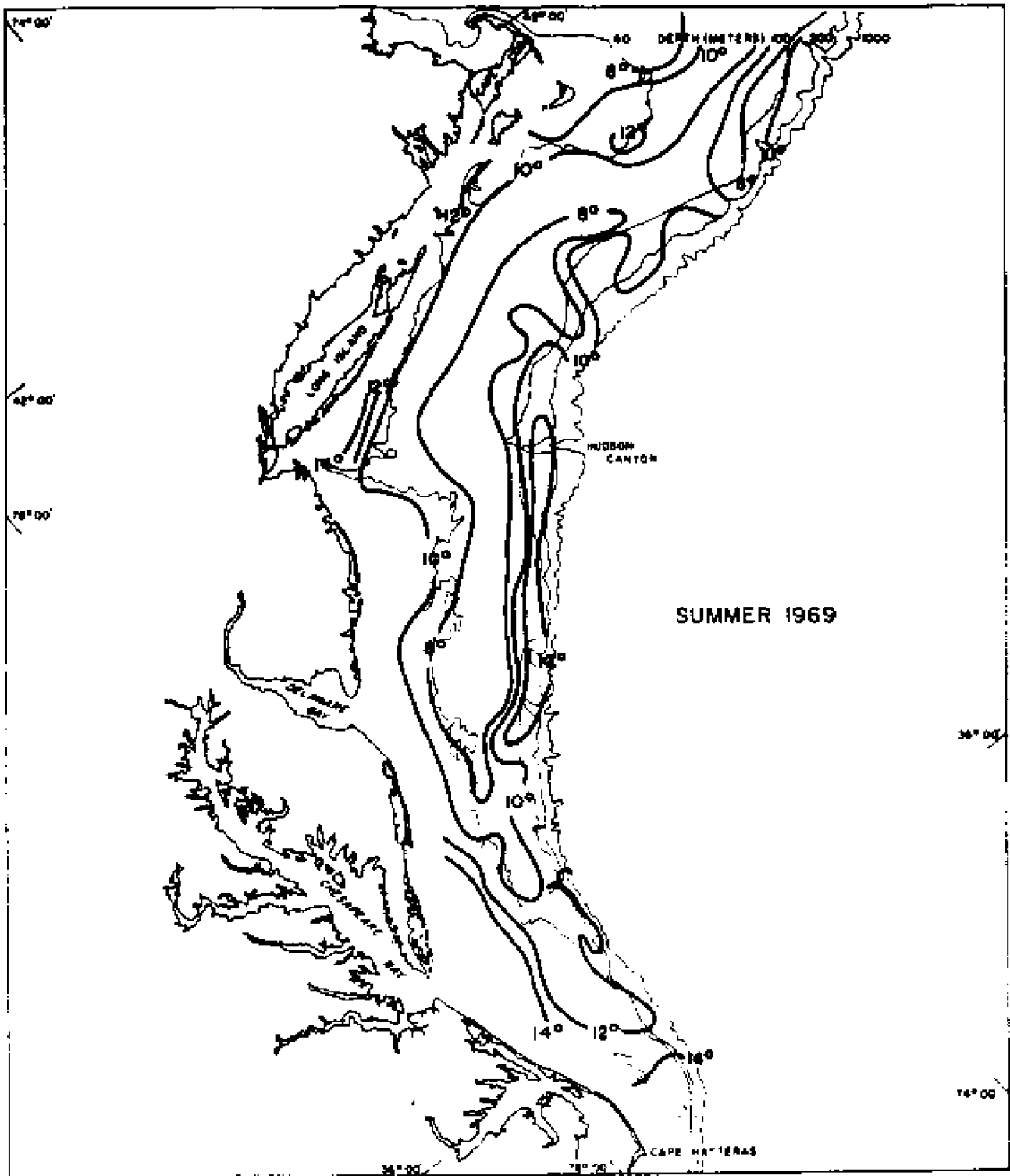
degrees of persistence of the 'cold pool' (Ketchum and Corwin 1964) and development of the mid-shelf thermal gradient.

Summer Cruise. The isotherms for the 1969 summer cruise are plotted in Figure 5. Bottom water temperatures ranged from 6 to 16°C (Appendix A), with a mean of 9.9°C (Fig. 2A), a value intermediate to that for the fall and spring cruises. The temperature distribution more closely resembled that for the fall cruises, with warmest temperatures being found inshore and the coolest waters being present on the mid-shelf in the northern portion of the study area.

Cluster Analyses - Site Groups

Spring Cruises. Station groups based on cluster analysis were determined for the nine spring cruises and are plotted in Appendix B. Between six and nine groups were recognized for each cruise. Group size ranged from 3 to 47 stations (Appendix A). Most groups were geographically contiguous and tended to be thermally and bathymetrically restricted. With the exception of the outermost upper slope groups, site groups were not precisely comparable from one year to the next, but could, however, be categorized on the basis of geographic location, bathymetry and temperature. The lack of complete correspondence among groups between years is highly understandable considering differences in sampling, thermal regime and the natural variability of fish populations among years.

Figure 5. Bottom isotherms for summer 1969 extrapolated from NMFS Groundfish Survey cruise.



During all nine cruises there was a group of site clusters of similar depth and temperature regimes which were contained between the shore and approximately the 8°C isotherm (groups I-III in 1968, 1970 and 1972; I-IV in 1969; I-II in 1973-1976). The geographic extent of these groups varied from year to year, but generally covered the inner and mid-shelf out to about 70 m from Cape Cod south to between Delaware Bay and Cape Hatteras, depending upon the southward extent of waters cooler than 8°C . Adjacent to these groups were two other categories of groups: northern outer shelf groups (group V in 1968, 1971 and 1976; VI in 1969; VII in 1970 and 1972; III in 1973; IV in 1975) extending from the previous cold water group to the shelf break (approximately 150 m), and southern groups which occupied the remaining shelf both outward and south of the 8°C isotherm (group IV in 1968, 1971, 1973 and 1976; V in 1969; IV, V and VI in 1970; V and VI in 1972; III and IV in 1974; III in 1975). The boundary between these two categories was generally off the New Jersey coast, at which point there was often considerable overlap. The remaining groups were located on the shelf break along the entire study area at depths of 150-350 m and, as noted above, were very closely comparable among years.

Fall Cruises. Between six and nine station groups were also recognized from cluster analyses for each of the fall cruises (Appendix B), ranging in size from 5 to 27 stations (Appendix A). The groups were not as geographically contiguous or as thermally restricted as during the spring cruises; in fact several of the groups

exhibited bottom temperature ranges of 14°C (Appendix A). Considering the synoptic nature of the sampling, the onset of the rapid autumnal cooling during the latter portion of the cruise periods and the high degree of migratory activity of many of these fish species during the fall, it is not surprising that the site groups are less clearly defined during this period. Again, with the exception of the upper slope groups, the site groups were not directly comparable from year to year but could still be readily grouped into categories.

During seven of the nine cruises there was a distinct southern inshore site group between shore and about 60 m extending from Cape Hatteras northward to between northern end of the Delmarva Peninsula and Delaware Bay, depending upon the year (group I in 1967-1972, 1975). These groups were generally contained behind a strong thermal gradient and exhibited the warmest bottom temperatures in the study area. Extending northward from these groups along the inner shelf was a second, colder site group which tended to be constricted toward shore between northern Long Island and Cape Cod (group II in 1967-1972; III in 1975). During 1973 and 1974, when thermal stratification was weaker and inshore water temperatures in the north were higher, there was no distinct break between northern and southern inshore stations groups, but instead there were two station groups with members in both northern and southern inshore and mid-shelf waters (groups I and II).

One or two site groups each year occurred on the northern mid-shelf primarily between 35 and 90 m, in the region of the coolest shelf waters (groups III and IV in 1967-1968, 1970, 1972; III in 1969, 1971, 1973, 1976; IV in 1974). These groups occupied the coolest shelf

waters and were relatively bathymetrically restricted (the 192 m station in group IV in 1970 was anomalous; only two species were taken in that tow). The remaining site groups could be classified as outer shelf/shelf break (groups V and VI in 1967, 1974; V, VI, and VII in 1968, 1970; IV and V in 1969, 1971; V in 1972; IV, V and VI in 1973, 1976) or upper slope (highest numbered group for each year). The outer shelf/shelf break groups typically displayed wide depth ranges and temperatures intermediate between the northern mid-shelf and inshore groups. The upper slope groups often had average temperatures lower than those on the mid-shelf but were bathymetrically discrete from the and mid-shelf groups.

Summer Cruises. Five station groups were recognized for the summer cruise (Appendix B). These groups can be approximately classified as northern and southern inner shelf, outer shelf, shelf break, and upper slope; although the outer shelf group extended inshore in the vicinity of Hudson Canyon. The inshore groups were confined within the 90 m contour, whereas the other groups had wide bathymetric ranges. The groups showed much less variation in average temperature than during the spring and fall cruises (Appendix A).

Cluster Analyses - Species Associations

Spring Cruises. Between six and nine species clusters ranging in content from two to 14 species were recognized for each cruise. The species groups recognized were extremely homogeneous with respect to faunal affinity (Appendix C). If pelagic and resident species are

ignored, 58 of the 70 groups recognized were either exclusively boreal, warm temperate or slope-mesopelagic in their affinities. Only in one case, group F in 1975, was there a substantial degree of co-occurrence of boreal and warm temperate species within a species group, and this can be readily attributed to abbreviated sampling during this cruise in which the southern inshore and mid-shelf strata were either incompletely sampled or not sampled at all. Had more stations been made in these warmer strata, the three warm temperate species would have in all likelihood formed a distinct group.

The species groups showed a high degree of annual repetition, both of composition and distribution. One to three groups of boreal affinity (group A in 1968; A and B in 1973-1974; A, B and C in 1970-1972, 1975-1976; A, B and D in 1969) occurred almost exclusively within and had generally positive or high fidelities to the cold water site groups (Appendix D). The most commonly cooccurring among these species were Limanda ferruginea, Raja erinacea, and Scophthalmus aquosus (common names are given in Appendix C), which occurred within the same group during virtually every cruise. Also exclusive to these groups were the species Gadus morhua, Pseudopleuronectes americanus, Hemitripterus americanus, Hippoglossoides platessoides, Myoxocephalus octodecemspinosus, Macrozoarces americanus, and Raja ocellata, which all occurred commonly in these clusters in varying arrangements. The species Ammodytes dubius, Menidia menidia, Etropus microstomus, and Pollachius virens occurred infrequently but exclusively within these groups, whereas the pelagic species Alosa aestivalis, Alosa pseudoharengus, and Clupea harengus harengus occurred regularly but not exclusively within these groups.

A widespread, common, and usually exclusively boreal group was present during all cruises (group C in 1974; D in 1968, 1970-1973, and 1976; E in 1969; F in 1975). This group generally had moderate or better constancy to all site groups, and with the exception of two small site groups in 1970, did not display highly negative or positive fidelity to any site group (Appendix D). Squalus acanthias and Merluccius bilinearis occurred in this group during every spring cruise, Urophycis chuss in all but one, and Paralichthys oblongus (= Hippoglossina oblonga) in 6 of 9 cruises. The pelagic species Scomber scombrus and Alosa pseudoharengus each occurred four times within this assemblage. During the 1975 cruise the warm temperate species Peprilus triacanthus, Paralichthys dentatus, and Prionotus carolinus also occurred within this group, but as mentioned above, had the southern portion of the cruise been completed these species probably would have been sampled adequately enough to form their own group.

One to three warm temperate species clusters were present during each cruise (group C in 1968; G and H in 1969; E and F in 1970-1971; F and H in 1972; E, F and G in 1973; D and E in 1974; E in 1975-1976). These groups occurred across the southern shelf during warmer years and along the outer shelf during all years. Stenotomus chrysops and Centropristis striata were present in these groups during all nine years, Prionotus carolinus during 8 of 9, Peprilus triacanthus and Urophycis regia (= Urophycis regius) during 7 of 9, and Paralichthys dentatus and Prionotus evolans during 6 of 9 years. There were no consistent sub-groups when more than one group was recognized. Except for Peprilus triacanthus, which was present twice in the ubiquitous group, and Urophycis regia, which occurred twice with the

mesopelagic/slope group, all these species were found exclusively in these groups.

Those species with mesopelagic or slope affinities were found together in 1 to 3 groups which occurred along the shelf break and upper slope (groups E and F in 1968; I in 1969, 1972-1973; H in 1970; G and H in 1971 and 1974; G in 1975; H in 1976). These groups characteristically had highly positive fidelities to the upper slope site groups (Appendix D). Helicolenus dactylopterus was the only species to occur within these groups during all cruises. Merluccius albidus and species of the family Myctophidae appeared in these groups during 7 of 9 cruises. Other species present in the clusters less frequently but occurring exclusively in these groups included Chlorophthalmus arassizi, Maurollicus muelleri, Phycis chesteri, Ceratoscopelus naderensis, Argyropelecus aculeatus, Nemichthys scolopaceus, Raja garmani, and Lopholatilus chamaelioniceps. Also periodically present in, but not exclusive to these groups were the species Peristedion minium, Lepophidium cervinum, Urophycis tenuis, and Glyptocephalus cynoglossus. This last group of species was widespread across the outer shelf and upper slope but occurred infrequently, making them difficult to classify. When they were not present in the deep groups they tended to form their own small group (group E in 1968 and 1970; F in 1969 and 1974; D in 1972 and 1975; H in 1973). Occasionally present in these small groups were Lophius americanus and Citharichthys arctifrons, two other species which proved difficult to classify. Lophius occurred commonly throughout most of the study area but in very low abundances in shallow waters, and was variously classified with the ubiquitous, deep, and outer shelf

groups. Githarichthys was also widespread but more abundant in warmer outer shelf and upper slope waters and was variously classified with the ubiquitous, outer shelf, and warm temperate groups.

Fall Cruises. Between six and eleven species clusters, ranging in content from 1 to 9 species, were recognized for each of the fall cruises (Appendix C). The species groups recognized for the fall cruises were considerably less homogenous with respect to faunal affinity than were the spring species groups, with only about half of the groups composed entirely of species of the same affinity (Appendix C). The species groups were also much more variable with respect to composition and distribution.

One or two groups of warm temperate species were present at the inshore site groups during each cruise (group A in 1967 and 1970-1973; A and B in 1968-1969 and 1975; A and C in 1974), but the composition of these groups was highly variable. Paralichthys dentatus was the only species to occur within these groups during all nine cruises. Centropristis striata was present during eight cruises and absent from the cluster during the ninth, whereas Mustelus canis was present in these groups during six cruises, in another group twice, and otherwise absent. Prionotus carolinus, Stenotomus chrysops, and Scophthalmus aquosus appeared 6, 4, and 2 times respectively, but were present in other groups during the remaining years. Pomatomus saltatrix was present during four years, in another group once, and otherwise absent, while eight other warm temperate species were exclusive to these groups but appeared three times or less. The boreal species Pseudopleuronectes americanus appeared within these groups once, but

in other groups during the remaining eight years. Constancies and fidelities of these groups were generally higher in the southern portion of the inshore region when the inshore site groups were so divided (Appendix D).

During four years there were one or two species groups of mixed warm temperate and boreal affinity which were distributed along the inshore site groups and out onto the northern mid-shelf (group B in 1967, 1973; C in 1969; B and C in 1972). Stenotomus chrysops and Pseudopleuronectes americanus were present in these groups during all four years; Prionotus carolinus and Scophthalmus aquosus three times each, and Raja erinacea and Mustelus canis twice. Five other species appeared once.

One to four groups of almost exclusively boreal affinity occurred primarily at the northern inshore and mid-shelf site groups during 8 of 9 cruises (groups C-F in 1967; C in 1968 and 1971; E in 1969; B and C in 1970; E and F in 1972; B in 1974; C in 1975). Twenty-four species appeared within these groups throughout the study, but only seven recurred with any regularity. Raja erinacea was present 7 of 8 times, Limanda ferruginea and Myoxocephalus octodecemspinosus 6 times each, and Squalus acanthias 5 times. Hemitripterus americanus, Pseudopleuronectes americanus, and Scophthalmus aquosus each occurred 4 times in these cold water groups.

As during the spring cruises, there was a group (in one case, two groups) of species which occurred throughout most of the study area (group H in 1967; D in 1968-1970 and 1972-1974; E in 1971; D and E in 1975). Merluccius bilinearis, Paralichthys oblongus, and Urophycis chuss were present in this group during all nine cruises. Peprilus

triscanthus and Citharichthys arctifrons each appeared during six years, whereas Urophycis regia was present five times. Nine other species occurred in this group three times or less. Constancies of this group were usually lowest at the southern inshore site group and were often accompanied by highly negative fidelities, indicating that while some members of this group occurred in these warmer waters, in general the group avoided this area (Appendix D).

The upper slope groups for the fall cruises were unique in that they were more clearly defined than the corresponding groups for the spring cruises (groups J and K in 1967; G in 1968, 1970; H in 1969 and 1972; I in 1971; E in 1973; E and F in 1974; F in 1975). Helicolenus dactylopterus, Merluccius albidus, and myctophids were present in these groups during all nine cruises, and Chloropthalmus agassizi occurred with them during eight years and was absent from the cluster during the ninth. Eight other slope or mesopelagic species occurred exclusively within these groups but appeared only once or twice. Peristedion miniatum, which appeared 3 times, and Lophius americanus, which was present once, were the only species occurring within these groups that also occurred in other groups.

The remaining groups were generally small and poorly defined geographically. Lophius americanus, Glyptocephalus cynoglossus, Peristedion miniatum, Lepophidium ceryinum, and Urophycis tenuis often fell into these groups, but not in any consistent manner. Most of these species occurred sporadically from the mid-shelf offshore.

Summer Cruise. Six species groups were recognized, ranging in content from 3 to 8 species (Appendix C). Only two warm temperate

species, Peprilus triacanthus and Urophycis regia, occurred at a sufficient number of stations to be included within the cluster. As a result four of the six groups were composed entirely of boreal and resident species. Three of these (groups A, B, and C) occurred primarily within the northern inshore site group (Appendix D). Group B included the more abundant of these species (Limanda ferruginea, Pseudopleuronectes americanus) and also occurred sparsely in the southern inshore and outer shelf groups.

The fourth boreal group (D) occurred primarily at the northern inner shelf and outer shelf groups and was sparsely present at the shelf break and upper slope. Merluccius bilinearis, Melanogrammus aeglefinus, and Urophycis chuss were the most abundant members of this group. Peprilus triacanthus and Urophycis regia were joined by Lepophidium cervinum and Citharichthys arctifrons in a group (E) which occurred throughout the entire study area but was concentrated in the southern inshore, shelf-break and upper slope groups. The last group (F) was composed entirely of slope and mesopelagic species and occurred at the shelf-break and upper slope sites.

Dominance

Spring Cruises. Species dominance by cruise and station group are shown in Appendix E. Two species, Merluccius bilinearis and Squalus acanthias, were among the dominants at over 80% of the site groups. In the cold water site groups Limanda ferruginea was the dominant fish taken prior to 1973. During 1973 abundances of Limanda, M. bilinearis, and Raja erinacea were about equal in the cold water

groups; after 1973 abundances of M. bilinearis and R. erinacea exceeded those of Limanda. Because of the change in nets commencing in 1973 it is difficult to interpret this change. A relative decline in the population of Limanda may have occurred, or Limanda may have a lower catchability coefficient relative to the other tow species when the large net is used.

The site groups southward and offshore of the cold water group were fairly evenly dominated by Squalus acanthias, Merluccius bilinearis, and Peprilus triacanthus. Stenotomus chrysops, and Prionotus carolinus were periodically dominant in the southern portion of this area. Urophycis chuss, Helicolenus dactylopterus, and myctophids were often abundant along the shelf break and upper slope. There were no noticeable changes in dominance between the earlier cruises and those after 1972 outside of the colder groups.

Fall Cruises. Merluccius bilinearis, as during the spring, was among the dominant species at over 80% of the site groups (Appendix E). Peprilus triacanthus was dominant at over 75% of the site groups and had the greatest overall abundance. The inshore site groups were usually dominated by Peprilus, Prionotus carolinus, and Stenotomus chrysops. The northern mid-shelf groups showed a trend similar to that observed in the spring; Limanda ferruginea dominated these sites during the earlier cruises and then declined during the later half of the study, indicating that the decline seen in the spring was not entirely attributable to the change in nets. Merluccius bilinearis, Peprilus triacanthus, and Squalus acanthias were the other major dominants in this area.

Urophycis regia joined Merluccius bilinearis and Peprilus triacanthus as major dominants on the outer shelf. U. regia was much more abundant during the fall cruises than in the spring, when it seldom occurred among the dominants. The slope sites were regularly dominated by Helicolenus dactylopterus, myctophids, Citharichthys arctifrons, and Merluccius bilinearis. Peprilus and Urophycis regia occasionally reached dominant abundances on the slope.

Summer Cruise. Limanda ferruginea was the most abundant fish at the northern inshore site group (Appendix E). Merluccius bilinearis, Melanogrammus aeglefinus, and Urophycis chuss were also major dominants at this site. All of these species except U. chuss were also major dominants at the outer shelf group, where Peprilus triacanthus was the most abundant species. P. triacanthus and Urophycis regia accounted for over 90% of the individuals at the southern inner shelf site group, in roughly equal quantities. These two were joined by the other two members of their group, Lepophidium cervinum and Citharichthys arctifrons, as major dominants at the shelf break. The upper slope site was dominated by U. regia, Maurolicus muelleri, and Helicolenus dactylopterus.

Abundance and Biomass

Spring Cruises. Average total abundance and biomass of fishes fluctuated greatly among site groups and was subject to a high degree of variability (Appendix A). Scheffé's test detected almost no

significant differences during the period the smaller net was used (1968-1972), and only a limited number of differences, during the later cruises (Table 2). There was no evident pattern to the abundance data. Average biomass tended to be lowest along the shelf break and slope, and reached its highest values on the northern inner and mid-shelf.

Year to year comparisons of abundance and biomass were difficult due to the net differences. Both average abundance and biomass per tow increased sharply with the larger net (Fig. 2B&C). The overall average abundance was 1.7 times greater for the period 1973-1976 than 1968-1972, whereas the biomass averaged 1.8 times greater. Because these two values are similar, the two nets may have similar sampling characteristics, but as conversion factors they are probably high; 1973 appears to have been an exceptional year. It is not possible to discuss long-term trends in abundance or biomass of fishes during these cruises without knowing the actual relationships between these nets with respect to catchability of at least the dominant species. The average number of species per tow was consistently about 9 with the smaller net, and increased to 12 with the larger net (Figure 2E). The number of species was usually significantly higher at the upper slope and cold water site groups (Table 2).

Fall Cruises. Abundance and biomass estimates for the fall cruises were extremely variable, as in the spring (Appendix B). Scheffe's test detected more significant differences between site groups than for the spring cruises (Table 2), but no definite patterns

Table 2. Results of Scheffe's multiple range test for site group abundance, biomass, and number of species. Significant differences at $\alpha = .05$.

Date	Spring			Fall		
	Abundance	Biomass	No. of Species	Abundance	Biomass	No. of Species
1967				IIID>	I,IVVI,VII II,IIID>VI IIV>VI	IIID>,V-VI II,IVVI
1968	MSD0*	MS00	MS00	MS00	II,IIID>VI-VIII IIV>VI	II,IV>VI,IIII,V-VIII VI>VI
1969	MS00	MS00	IIIV,V	MS00	I>VI IIV>VI IIIV>VI	II,IIID>VI-VI IIV
1970	MS00	MS00	II>VI,IV-VI,VIII IIIV,VIII IIV>	II>VI,VIII	II,IIID>VI-VI	II>VI,VI,VIII IIIV,IV-VIII IIV
1971	V>	V>IV	II,V,VII>	I,IIIV>	II>VI,IIII-VI	I,IIIV,IV,VI
1972	MS00	MS00	I,II,V,VI,IIIV IIIV,IV-VI,VIII IIV>,VIII	II>VI,V,VI II,IIIV> IIV>	I,IIIV> II,IIIV>VI II,IIIV>VI,VI	II>VI,II,V,VI IIIV,II,V,VI IIV>VI
1973	MS00	IIIV>,VI	II>VI,IV-VI VI>VI,IV,V	II,IIII,V,VI>IV	IIV>,VI IIIV>	II,IIII,VIIV,V IIIV>
1974	I,IIIV>II	I-IV>	I,IIIV>,VIIV I,IIIV>	MS00	I,IIIV>,VI IIIV>	I,IIIV IIIV>,VI IIIV>-VI
1975	IV>	II,IIIV>,VI IIIV>	I,IIIV>VI VI>VI,IIIV>	II,IV,VI>VI IIIV>,VI,VIII	I>VI,IIII II,IIIV>VI,VI	I,IIII,VI,VIIV,II,V,VI VIIV
1976	V>II	IIIV> VI,IIII,IV,VI	VIIV VIIV>-IV,VI	MS00	MS00	

* MS00 = F significant but no specific differences detected.
 or MS - F value not significant

were evident for the abundance data and only a general trend may be noted for the biomass information. During most cruises greater biomass was found at the inshore and northern mid-shelf site groups than along the outer shelf and slope.

Average abundance and biomass per tow for the entire area fluctuated irregularly from year to year (Fig. 2B&C). Biomass tended to decline sharply from 1967 to 1974 (as noted by Clark and Brown 1977) although there was a fairly large peak in 1972. Abundances remained much more constant, reflecting a decrease in the average fish size (Figure 2D). Average size is a reflection of two factors, age structure within species, and relative abundances of different sized species. The greatest average size occurred in 1967, when the average size of a fish was over twice what it was at its low point in 1971. The influence of specific abundances on this index is discussed below. Biomass and abundance both increased sharply from 1974 to 1975, indicating that the declining trend was either artifact or was reversing. The average number of species per tow averaged about 9 as it had in the spring with the same net, but showed more variability between years (Fig. 2E) and no consistent pattern between site groups (Table 2).

Summer Cruise. Average abundances and biomass were lower during the summer cruise than during any of the fall or spring cruises (Appendix B, Fig. 2B&C). Biomass was significantly higher at the northern inner shelf site group; average abundance was also greatest there but was not significantly so. The average number of species per

tow was also lower than for any other cruise (Fig. 2E), and significantly higher at the northern inshore site group (Table 2).

Major Species. Overall abundance and biomass was largely determined by a small suite of species (Tables 3-5). Peprilus triacanthus was the most abundant species during both major sampling seasons, accounting for over 30% of the individuals in the fall and about 17% in the spring. Squalus acanthias exerted a dominating influence on total biomass, accounting for 40% of the total biomass during the fall cruises and over 55% during the spring cruises. In addition to Squalus acanthias and Peprilus triacanthus, four other species made consistent, important contributions to abundance and biomass, ranking in the top eight in total contribution in both categories during both sampling seasons. Prionotus carolinus ranked second in both abundance and biomass during the spring, and fourth and third respectively during the fall. Merluccius bilinearis was the third most abundant species during the fall and the fifth during the spring, while ranking fourth and fifth with respect to biomass. Limanda ferruginea ranked fourth in biomass and sixth in number during the fall and fifth and seventh respectively in the spring, while Stenotomus chrysops was fourth in abundance in the spring, fifth in the fall, and eighth in biomass during both seasons. These six species accounted for approximately two-thirds of both total abundance and biomass during both seasons. Variations in the average annual abundance and biomass of these six species were often large and unrelated (Figs. 6 and 7). Interestingly, three of these species are

Table 4. Average abundance and biomass per tow and percentage of total fish catch for major species during fall cruises.

Species	1967		1968		1969		1970		1971		1972		1973		1974		1975		Total
	D	Z	D	Z	D	Z	D	Z	D	Z	D	Z	D	Z	D	Z	D	Z	
<i>Peprilus triacanthus</i>	372.9	28.6	131.7	31.3	134.2	17.7	65.9	16.1	303.2	49.2	106.2	24.9	231.1	43.2	140.3	44.4	55.8	16.4	30.5
<i>Ereunetes linceus</i>	4.4	0.7	19.4	4.7	61.0	6.1	16.0	36.6	110.0	19.2	1.7	0.4	123.5	26.2	5.9	1.9	62.6	12.7	12.0
<i>Merluccius bilinearis</i>	29.3	4.3	38.2	14.3	33.4	4.4	31.2	7.4	62.0	10.1	67.6	18.8	20.4	4.0	65.1	20.6	43.1	12.8	9.1
<i>Prionotus carolinus</i>	222.4	32.5	45.0	11.0	15.0	2.0	20.9	5.1	10.5	3.7	22.7	3.4	7.1	1.4	6.4	2.1	3.4	1.0	6.4
<i>Stenotomus chrysops</i>	24.6	3.9	12.8	3.1	70.9	9.4	11.7	2.9	6.5	1.4	34.4	6.4	20.9	4.1	8.8	3.6	49.4	13.1	5.3
<i>Limanda ferruginea</i>	31.0	4.5	34.3	8.9	32.4	4.3	25.6	6.2	24.0	3.9	53.3	13.2	5.0	1.0	1.1	0.7	1.0	0.3	4.8
<i>Squalus acanthias</i>	61.8	9.0	28.8	7.0	32.6	4.3	31.6	5.3	6.7	1.1	10.1	2.5	19.0	2.7	4.1	1.3	21.4	6.4	6.8
<i>Urophycis exilis</i>	12.0	1.8	23.4	5.7	20.6	2.7	31.3	6.1	17.9	2.9	6.4	1.6	20.9	4.1	12.9	4.1	23.4	7.0	3.9
<i>Urophycis f. alb</i>	5.7	0.8	9.9	2.4	12.9	1.7	11.7	2.9	13.5	2.2	24.8	6.2	10.3	2.0	4.4	1.4	16.7	4.4	2.4
Total (all species)	684.8	100.0	408.3	757.3	757.3	100.0	610.8	614.1	614.1	100.0	402.5	510.9	510.9	100.0	315.8	336.2	336.2	100.0	336.2
Biomass																			
<i>Squalus acanthias</i>	59.5	41.7	27.3	38.4	57.3	51.8	32.3	49.9	7.8	17.1	18.6	24.9	31.8	37.1	9.5	30.0	24.1	42.3	38.8
<i>Peprilus triacanthus</i>	12.1	8.9	11.0	15.5	10.1	9.2	3.9	5.9	6.5	18.7	3.8	5.0	9.5	16.0	5.9	19.5	3.2	3.9	10.0
<i>Merluccius bilinearis</i>	39.0	25.9	5.3	7.4	2.0	1.6	2.5	3.8	4.3	2.4	3.9	3.9	4.8	1.3	0.7	2.3	0.3	0.4	7.9
<i>Prionotus carolinus</i>	6.2	4.6	6.9	9.7	7.7	7.0	6.3	9.5	4.6	10.0	13.6	8.1	8.2	2.3	0.6	2.0	0.2	0.3	7.0
<i>Limanda ferruginea</i>	3.5	2.6	2.4	3.7	1.3	1.2	1.5	2.3	2.8	6.1	2.6	3.5	1.8	3.0	0.7	3.3	1.9	2.3	2.8
<i>Urophycis exilis</i>	1.2	0.9	2.0	2.9	3.1	2.8	1.8	2.7	3.0	4.3	3.7	4.9	1.5	2.5	0.3	1.0	2.2	2.7	2.6
<i>Stenotomus chrysops</i>	0.3	0.2	0.4	0.6	2.2	2.0	4.4	6.5	2.9	6.3	0.1	0.1	3.4	5.8	0.2	0.5	1.6	2.0	2.2
<i>Urophycis f. alb</i>	1.3	1.0	0.5	0.7	3.2	2.9	0.2	0.4	0.7	0.6	2.1	2.8	0.8	1.4	0.9	3.0	3.0	3.7	1.8
Total (all species)	116.1	100.0	71.2	110.5	110.5	100.0	86.3	86.3	86.3	100.0	74.9	95.7	95.7	100.0	31.7	80.5	80.5	100.0	80.5

Table 5. Average abundance and biomass per tow and percentage of total fish catch for major species during summer 1969 cruise.

<u>Abundance</u>		<u>Biomass</u>	
<u>Species</u>	<u>n</u>	<u>Z</u>	<u>kg.</u>
<u>Scomber scombrus</u>	156.6	33.0	5.5
<u>Etrumeus teres</u>	100.2	21.2	3.9
<u>Peprilus triacanthus</u>	80.4	17.0	3.7
<u>Urophycis regia</u>	34.0	7.2	3.6
<u>Limanda ferruginea</u>	19.2	4.1	1.8
<u>Squalus acanthias</u>	13.0	2.8	1.7
<u>Melanogrammus aeglefinus</u>	10.4	2.2	1.7
<u>Anchoa mitchilli</u>	7.8	1.7	1.5
<u>Urophycis chuss</u>	7.3	1.6	1.5
<u>Peprilus triacanthus</u>			5.5
<u>Limanda ferruginea</u>			3.9
<u>Scomber scombrus</u>			3.7
<u>Squalus acanthias</u>			3.6
<u>Etrumeus teres</u>			1.8
<u>Urophycis regia</u>			1.7
<u>Gadus morhua</u>			1.7
<u>Urophycis chuss</u>			1.5
<u>Pseudopleuronectes americanus</u>			4.3

Figure 6. Mean number of individuals (—) and biomass (- - -) per tow of A) Squalus acanthias, B) Peprilus triacanthus, and C) Prionotus carolinus taken during NMFS Groundfish Surveys, Cape Hatteras to Cape Cod, 1967-76.

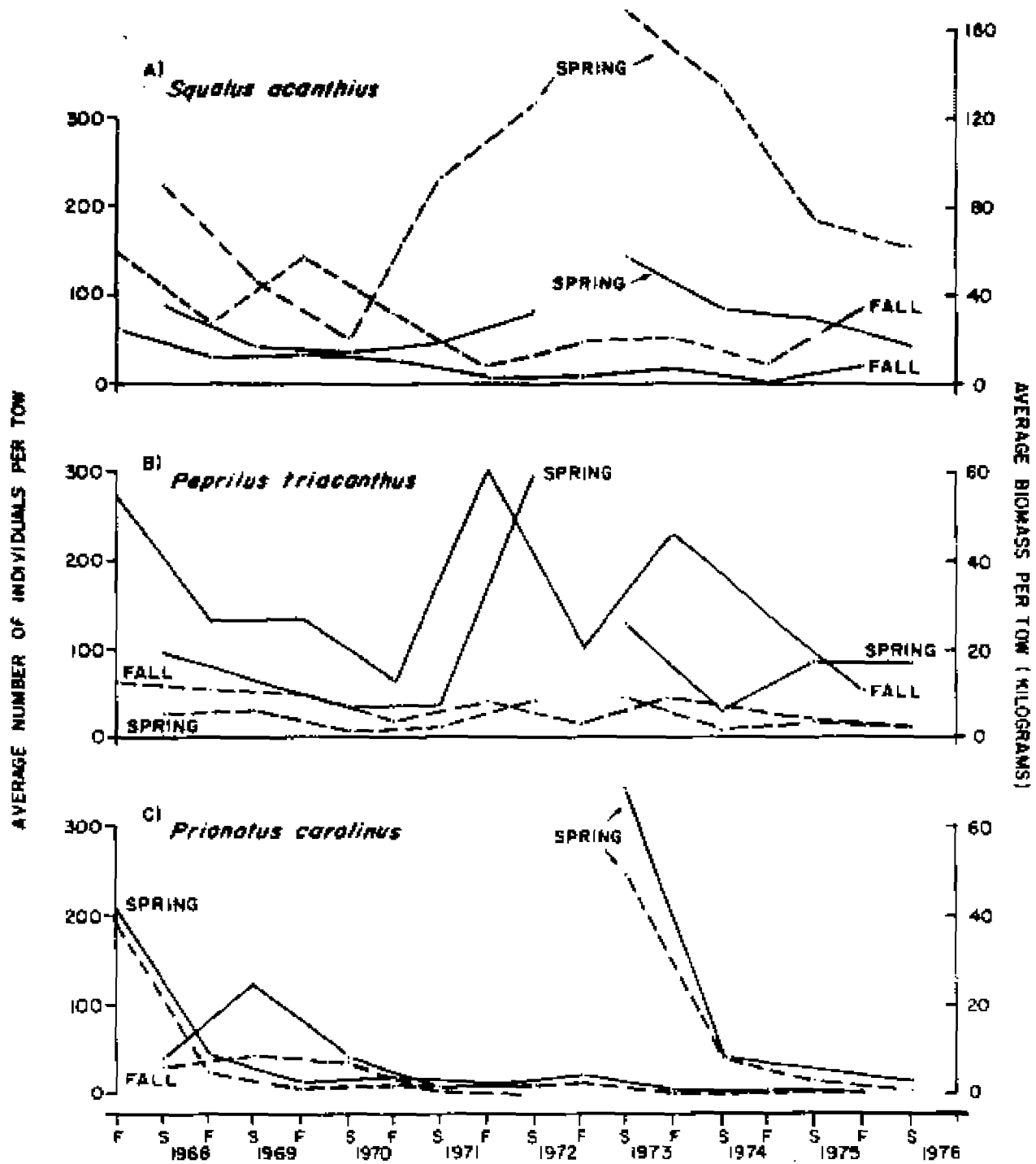
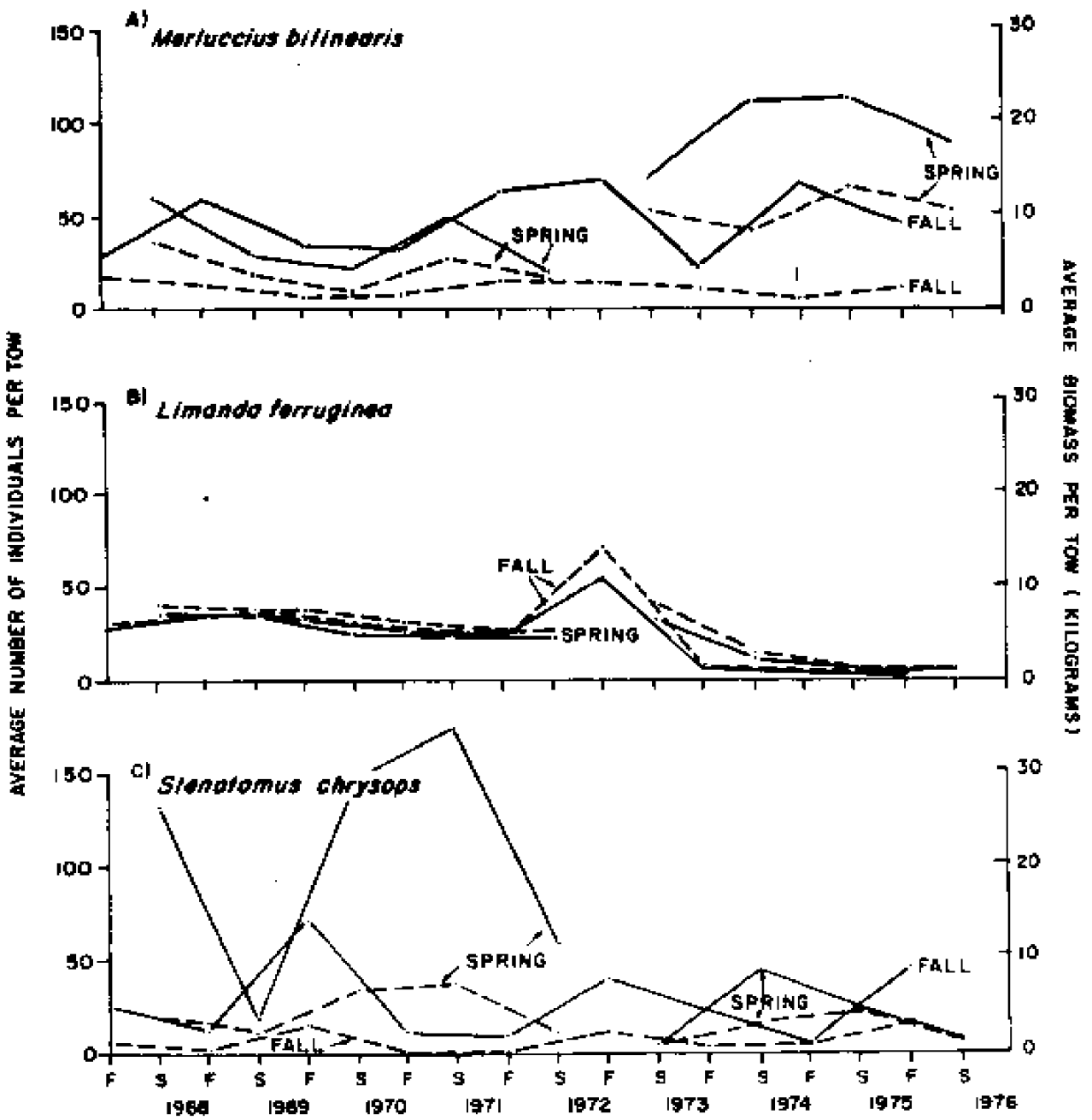


Figure 7. Mean number of individuals (—) and biomass (- - -) per tow of A) Merluccius bilinearis, B) Limanda ferruginea, and C) Stenotomus chrysops taken during NMFS Groundfish Surveys, Cape Hatteras to Cape Cod, 1967-76.



of boreal (Squalus, Merluccius and Limanda) affinity and three (Peprilus, Prionotus and Stenotomus) are warm temperate.

During the summer cruise total abundance was strongly dominated by two pelagic species, Scomber scombrus and Etrumeus teres, which accounted for over half of the fishes taken (Table 5). The former species made important contributions to abundance and biomass during the spring cruises (Table 3), while the latter was important only during the fall, when it was the second most abundant species (Table 4). Peprilus triacanthus was the third most abundant species during the summer cruise and accounted for the largest portion of the biomass of any single species. Limanda ferruginea ranked second in total biomass and fifth in number, Squalus was fourth and sixth respectively, but the other three species mentioned above did not make the same significant contributions to abundance and biomass as during the major sampling seasons. Urophycis regia, a species which appeared among the most important contributors to abundance and biomass during the fall but not during the spring, ranked fourth in number and seventh in biomass.

Community Structure Indices

As noted above, diversity and its components displayed highly erratic values when calculated on a per tow basis. Diversity values tended to follow evenness values much more closely than species richness, with lower values usually being the reflection of a single species being taken in great abundance relative to the other species present in a catch. Even when calculated on a pooled basis for each site group, species diversities were dominated by the equitability

component, with the richness component showing much more even values over the entire study area (Appendix F). There were no evident geographic patterns during either season, other than a tendency for the highest values of species richness to be encountered along the shelf break and outer slope.

Pooled Analyses

Because of the high degree of similarity in species associations and their distributions between years within each of the major sampling seasons, the data for each season were pooled by recurrent species associations and site groups of consistent similarities in faunal composition and geographic and hydrographic parameters. This pooling of data for each season serves not only to typify the 'average' patterns of community structure for that season, but also serves to identify the degree to which specific areas and species are influenced by inter-annual variations in environmental parameters, particularly variations in the thermal regime.

Site Groups. Site groups that were not precisely comparable from one year to the next could, however, be categorized on the basis of the similarities in geographic location, bathymetry and temperature noted above and faunal similarities as determined through nodal analyses (Appendix D) and comparisons of patterns of dominance (Appendix E). Site groups were pooled only if they showed a high degree of faunal similarity as well as geographic and hydrographic correspondence.

During the spring cruises the group of site clusters which were contained between the shore and approximately the 8°C isotherm were assigned as belonging to site group I (Table 6, Fig. 8) for the pooled analyses. The northern outer shelf groups extending from the cold water group to the shelf break (approximately 150 m) were assigned to pooled group II, while the southern groups which occupied the remaining shelf both outward and south of the 8°C isotherm were pooled as group III. The remaining outermost groups located along the shelf break at depths of 150-350 m were assigned to pooled group IV.

In general, the areas of geographic overlap between site groups seen in Figure 8 can be related to variations in the thermal regime. For example, there is considerable overlap between groups I and III on the inner and middle shelf south of Delaware Bay. This area showed the greatest temperature variation among years, with group I station clusters predominating in the area in colder years and group III station clusters in warmer years. Hydrographic parameters and basic catch data for each stratum are summarized in Table 7. The hydrographic parameters (depth, temperature) within a site group are much better represented by the mean and standard deviation than by the range of values encountered. At a small percentage of stations only a few species were taken, and in cases where these species occurred within all or several strata, some misclassifications occurred. Because the incidence of these obvious misclassifications was low, they have been ignored rather than introducing an arbitrary system of reclassification. Virtually all extremely variant values of depth and temperature and strong deviation in geographic location within a site

Table 6. Assignment of site clusters from spring and fall cruises to pooled site groups.

		SPRING CRUISES								
Site Group		I	II	III	IV	V	VI	VII	VIII	IX
Year										
1968		I	I	III	III	II	IV	IV		
1969		I	I	I	I	III	II	IV	IV	
1970		I	I	I	III	III	III	II	IV	IV
1971		I	I	I	III	II	IV			
1972		I	I	I	III	III	III	II	IV	IV
1973		I	I	II	III	IV	IV	IV		
1974		I	I	II	III	IV	IV			
1975		I	I	III	II	IV	IV			
1976		I	I	II	III	II	IV	IV		
		FALL CRUISES								
Site Group		I	II	III	IV	V	VI	VII	VIII	IX
Year										
1967		I	II	III	III	IV	IV	V		
1968		I	II	II	III	IV	IV	IV	V	
1969		I	II	III	IV	IV	V			
1970		I	II	III	III	IV	IV	IV	IV	V
1971		I	II	III	IV	IV	V			
1972		I	II	III	III	IV	V			
1973		I	II	III	IV	IV	IV	V		
1974		II	I	III	IV	IV	IV	V		
1975		I	I	II	III	IV	IV	IV	V	

Figure 8. Pooled site groups based on cluster analysis for
spring NMFS Groundfish Survey cruises, 1968-1976.

Table 7.-Hydrographic and average catch parameters by site group for Spring RDEFS Groundfish Survey cruises. Middle Atlantic Bight, 1968-76. The 1968-72 cruises used a #36 Yankee trawl, the 1973-76 cruises a #41 Yankee.

SITE GROUP	I		II		III		IV	
	1968-72	1973-76	1968-72	1973-76	1968-72	1973-76	1968-72	1973-76
No. of Stations	237	188	92	90	138	53	110	112
Abundance log (mtl)	\bar{x} 2.19(154) σ 0.40	2.47(296) 0.45	2.40(252) 0.54	2.52(416) 0.40	2.17(149) 0.68	2.35(224) 0.67	2.16(144) 0.54	2.36(230) 0.51
Biomass (kg) log (mtl)	\bar{x} 1.76(50) σ 0.40	1.97(95) 0.36	1.79(62) 0.54	2.14(130) 0.43	1.58(38) 0.59	1.92(64) 0.51	1.56(37) 0.57	1.65(45) 0.46
No. of Species	\bar{x} 10.1 σ 2.8	12.4 3.0	9.7 2.9	12.1 2.5	8.1 2.9	8.8 3.3	9.1 1.3	13.1 4.3
Depth (m)	range 18-101	18-90	24-329	29-152	18-349	27-152	66-379	53-341
	\bar{x} 50.0 σ 17.3	46.5 15.4	117.9 46.8	78.9 21.9	64.1 54.2	75.2 33.2	222.1 78.3	194.0 72.1
Temperature (°C)	range 2-9	3-11	4-14	7-16	5-13	5-14	5-16	5-25
	\bar{x} 4.6 σ 1.5	6.0 1.5	10.0 2.1	9.6 2.0	8.9 2.2	10.2 2.1	10.1 2.0	11.4 1.6

\bar{x} = mean value
 σ = standard deviation
 () = retransformed value

group were attributable to stations where only a few ubiquitous species were taken. Figure 9 illustrates temperature-depth envelopes for each site group. In order to reduce distortions introduced by misclassified stations, points which exceeded two standard deviations from either mean were not included. As may be seen by a comparison of Figures 8 and 9, groups I and IV are geographically, bathymetrically and thermally discrete from one another with groups II and III occupying the intermediate area and somewhat overlapping the first two groups in terms of bathymetry and thermal regime. Groups II and III are largely separable on the basis of latitude (as well as faunal composition).

Because the station groups recognized from cluster analysis of the fall cruises (Appendix B) were not as geographically contiguous or as thermally restricted as during the spring cruises, grouping into categories required careful consideration of faunal attributes. As noted above, the distinction between the southern inshore site groups contained between the strong thermal gradient and shore and the more northward and colder inshore site groups was evident only during seven of the nine cruises. During 1973 and 1974, when thermal stratification was weaker and inshore water temperatures in the north were higher, there was no distinct break between northern and southern inshore stations groups, but instead there were two station groups with members in both northern and southern inshore and mid-shelf waters. Although not geographically distinct, one group from each of these years was assignable to either the southern (pooled group I, Table 6, Fig. 10) or northern (pooled group II) categories based on faunal similarity. Such assignment, of course, led to the

Figure 9. Temperature-depth envelopes for pooled spring site groups, Middle Atlantic Bight area, 1968-1976. To avoid distortions introduced by misclassified stations, points falling over two standard deviations from either mean were excluded.

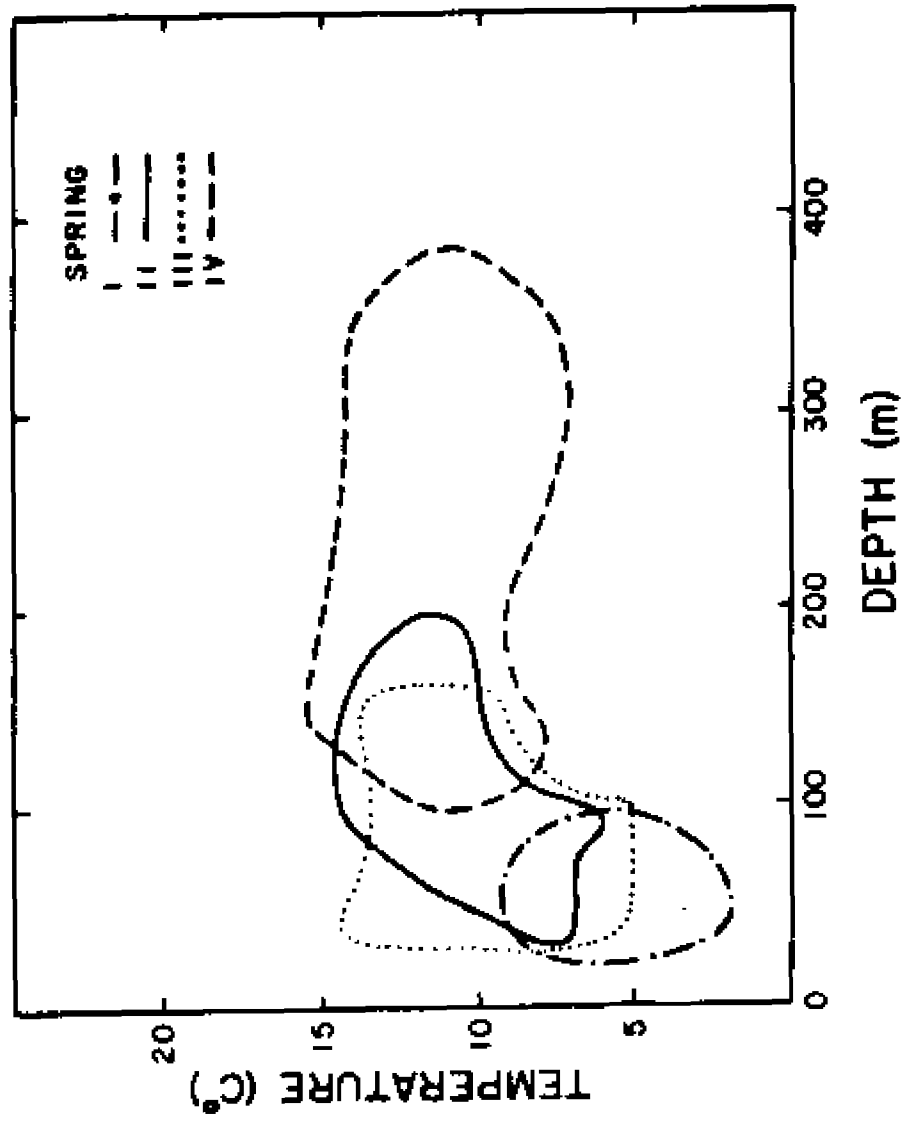
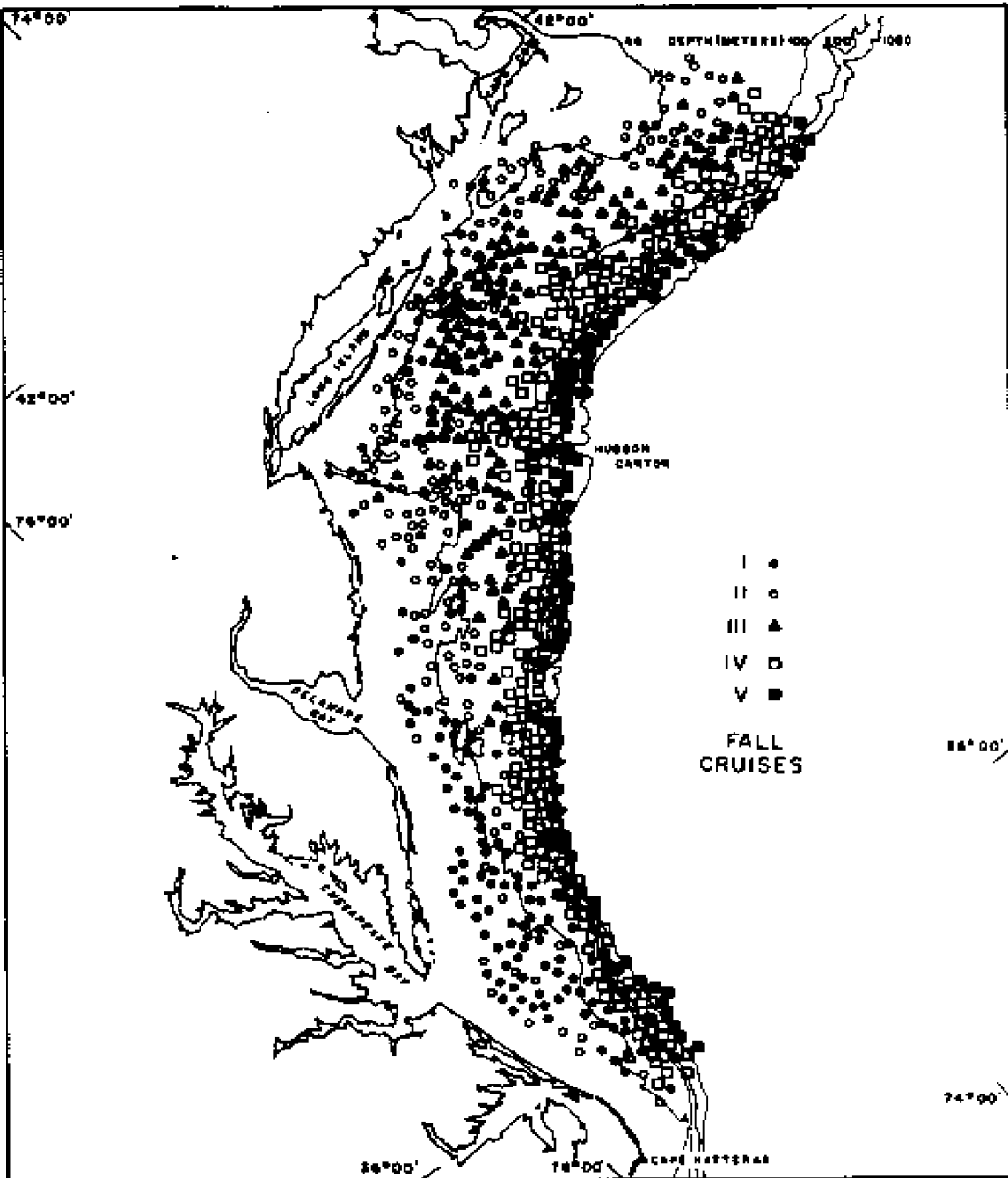


Figure 10. Pooled site groups based on cluster analysis for fall
NMFS Groundfish Survey cruises, 1967-1975.



considerable geographical overlap seen between groups I and II in Figure 10.

The site groups occurring on the northern mid-shelf primarily between 35 and 90 m, in the region of the coolest shelf waters were assigned to pooled group III. The remaining site groups were either classified as outer shelf/shelf break (pooled group IV) or upper slope (group V). The outer shelf/shelf break group displayed a wide depth range and a temperature range very similar to groups II and III, but occurred consistently offshore of those two groups (Table 8, Fig. 10). The upper slope group had the most restricted temperature range and was bathymetrically discrete from the inner and mid-shelf groups. The temperature-depth envelopes for the first four site groups (Fig. 11) show a large amount of overlap in the shallower portion of the study area, but much of this overlap is an artifact of combining data across years and over a wide area (i.e. thermal ranges and boundaries between groups varied between years and bathymetric boundaries varied with latitude).

Species associations. As with the station clusters, although there was some variation in group composition and distribution from year to year, the groupings were largely consistent over the nine year period of this study. Figure 12 shows the number of times the thirty-seven most commonly occurring and dominant species occurred within the same species group during the spring and fall cruises. With the exception of the first four widespread pelagic species listed at the top of this figure, the species are arranged so as to be closest to

Table 8. Hydrographic and average catch parameters by site group for Fall NMS Groundfish Survey cruise, Middle Atlantic Bight, 1987-75. All cruises used a #36 Yankee trawl.

SITE GROUP	I	II	III	IV	V
No. of Stations	114	176	209	382	114
Abundance log (x+1)	\bar{x} 2.19(130) σ 0.73	\bar{x} 2.30(200) σ 0.59	\bar{x} 2.20(249) σ 0.57	\bar{x} 2.05(111) σ 0.67	\bar{x} 1.92(84) σ 0.54
Biomass (kg) Log (x+1)	\bar{x} 1.55(36) σ 0.58	\bar{x} 1.78(61) σ 0.56	\bar{x} 1.73(54) σ 0.59	\bar{x} 1.09(11) σ 0.56	\bar{x} 0.86(8) σ 0.39
No. of Species	\bar{x} 8.2 σ 3.7	\bar{x} 10.8 σ 3.6	\bar{x} 10.8 σ 4.1	\bar{x} 6.8 σ 2.9	\bar{x} 9.3 σ 3.7
Depth (m) range \bar{x} σ	10-123 33.8 12.7	20-80 42.6 12.4	31-192 61.5 17.1	16-397 110.6 60.2	71-433 249.6 77.4
Temperature (°C) range \bar{x} σ	8-23 16.7 3.5	6-25 13.4 3.5	5-22 10.7 2.6	6-21 11.7 2.2	6-18 10.4 1.9

\bar{x} = mean value
 σ = standard deviation
 () = transformed value

Figure 11. Temperature-depth envelopes for pooled fall site groups, Middle Atlantic Bight area, 1967-1975. To avoid distortions introduced by misclassified stations, points falling outside two standard deviations of either mean were excluded.

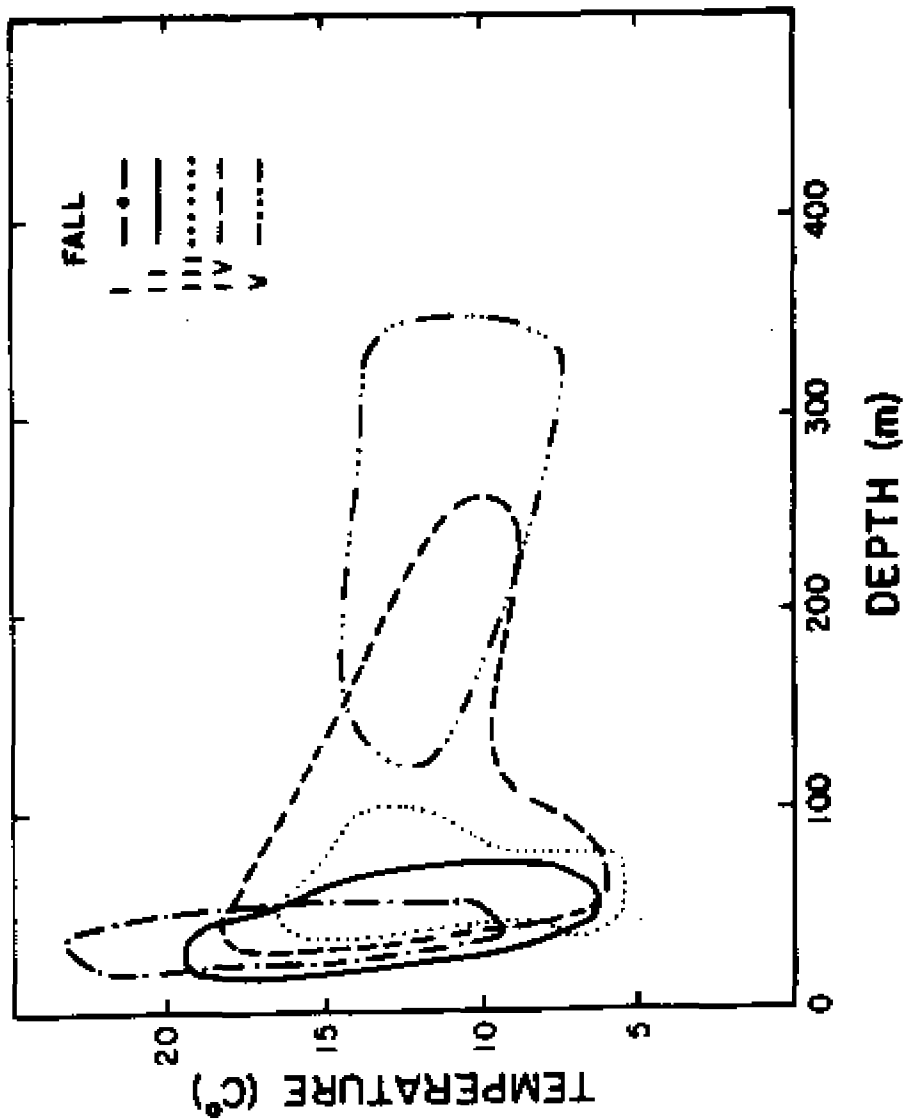


Figure 12. Co-occurrences within the same species cluster group for major species, spring and fall NMFS Groundfish Survey cruises, Middle Atlantic Bight area, 1967-1976.

those species they occurred with most often in the clusters, i.e. so that the densest cells fall along the diagonal border of the diagram.

Four strongly recurring species groups are evident from this diagram. Myoxocephalus octodecemspinosus, Scophthalmus aquosus, Raja erinacea, and Limanda ferruginea frequently appeared in the same group during both seasons. In the spring they were often joined by Macrozoarces americanus, a species generally absent from the clusters in the fall, while Squalus acanthias and Pseudopleuronectes americanus were common co-group members during the fall cruises. In the spring the latter species regularly occurred in a separate group which included Gadus morhua and Hemitripterus americanus. Except for S. aquosus, an inshore resident, all of these species are of boreal faunal affinity and are restricted to cold water (Bigelow and Schroeder 1953; Leim and Scott 1966).

Prionotus carolinus, Stenotomus chrysops, Paralichthys dentatus, and Centropristis striata, all warm temperate species, were regularly classified in the same group during both seasons. During the fall this group was often joined by Mustelus canis, another warm temperate species which was only rarely taken during the spring cruises. Two other warm temperate species, Peprilus triacanthus and Urophycis regia, regularly cooccurred with this group in the spring.

Merluccius bilinearis and Urophycis chuss were the two most consistently co-occurring species, appearing in the same group in all but one cruise. These two species formed the core of a third species group which was ubiquitous in the spring and widespread across the deeper portion of the study area in the fall. Both of these boreal species have broader temperature tolerances than the cold water groups

noted above (Mueick 1974; Bigelow and Schroeder 1953). Abundances of these two species were greater on the outer shelf and shelf break, and they often clustered with Paralichthys oblongus, an outer shelf resident, and, in the fall, with Citharichthys arctifrons, a slope resident which also occurs on the outer shelf (Richardson and Joseph 1973) and Lepophidium cervinum, another outer shelf resident. The warm temperate species Peprilus triacanthus and Urophycis regia were also common group members in the fall, while Lophius americanus regularly occurred in this group in the spring.

The fourth clearly defined recurring species group was an upper slope group composed of Helicolenus dactylopterus, Chloropthalmus agassizi, and Merluccius albidus, which appeared consistently during both seasons. Urophycis tenuis commonly co-occurred with members of this group during the spring, while in the fall this species was more widely distributed across the outer shelf and tended to appear in small groups with Lophius americanus and Glyptocephalus cynoglossus.

The major recurring species groups described above are listed for each season in Table 9. The groups are ordered in the same manner as the generalized station groups, that is, so as to roughly go from shallowest to deepest (distribution) while still maintaining nearest neighbor intergroup relationships as determined in the clusters. Because the pelagic species encountered in this study showed little consistency in either distribution or faunal associations and the sampling technique employed was not appropriate to properly assess the abundance of non-demersal organisms, pelagic species were not included in the pooled analyses.

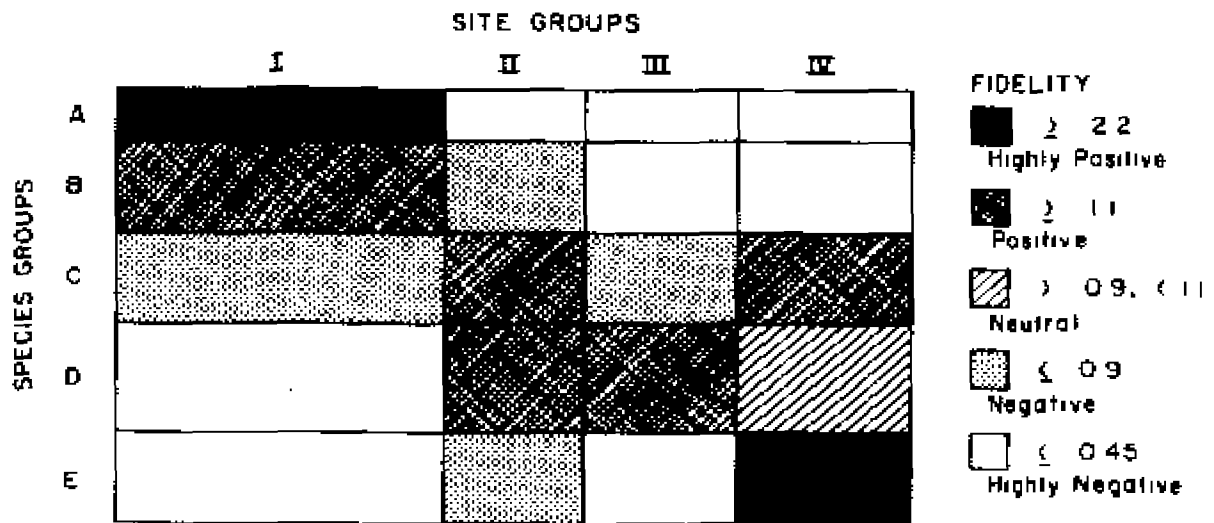
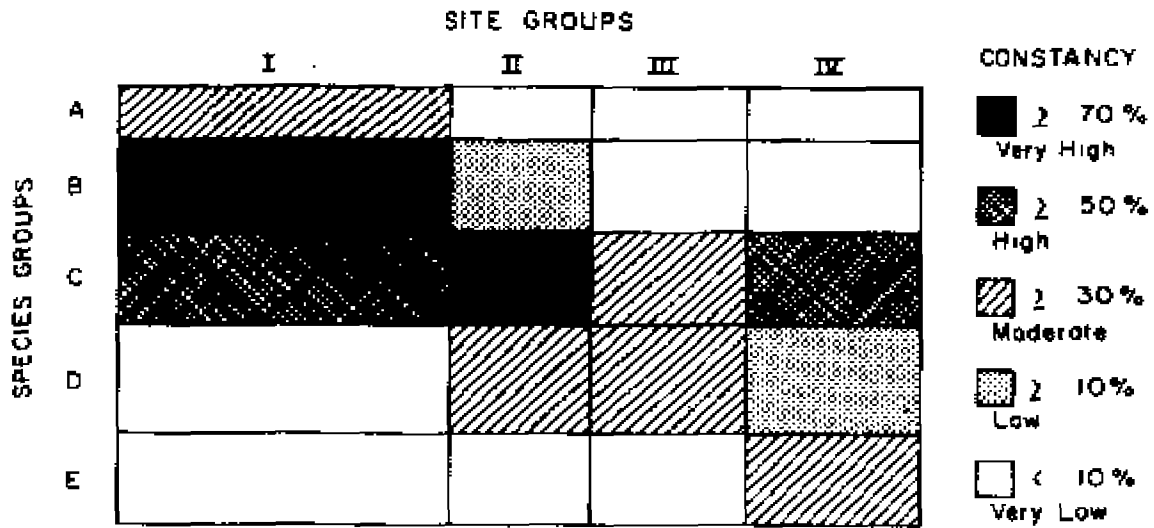
Table 9. Major recurrent species groups, NMFS Groundfish Survey, Mid-Atlantic Bight area, 1967-1976. Faunal affinity is designated after each species name: boreal, Bo; warm temperate, WT; inner shelf resident, IS; outer shelf resident, OS; slope resident, Sl.

SPRING CRUISES	FALL CRUISES
A	A
<u>Gadus morhua</u> Bo	<u>Centropristis striata</u> WT
<u>Hemirhamphus americanus</u> Bo	<u>Mustelus canis</u> WT
<u>Pseudopleuronectes americanus</u> Bo	<u>Paralichthys dentatus</u> WT
	<u>Prionotus carolinus</u> WT
	<u>Stenotomus chrysops</u> WT
B	B
<u>Limanda ferruginea</u> Bo	<u>Limanda ferruginea</u> Bo
<u>Macrocarpes americanus</u> Bo	<u>Hypochocephalus octodecemspinosus</u> Bo
<u>Hypochocephalus octodecemspinosus</u> Bo	<u>Pseudopleuronectes americanus</u> Bo
<u>Raja erinacea</u> Bo	<u>Raja erinacea</u> Bo
<u>Scophthalmus aquosus</u> IS	<u>Scophthalmus aquosus</u> IS
	<u>Squalus acanthias</u> Bo
C	C
<u>Lophius americanus</u> Bo	
<u>Merluccius bilinearis</u> Bo	
<u>Paralichthys oblongus</u> OS	
<u>Squalus acanthias</u> Bo	
<u>Urophycis chuss</u> Bo	
	C
	<u>Citharichthys arctifrons</u> OS
	<u>Lepophidium carvinum</u> OS
	<u>Merluccius bilinearis</u> Bo
	<u>Paralichthys oblongus</u> OS
	<u>Peprilus triacanthus</u> WT
	<u>Urophycis chuss</u> Bo
	<u>Urophycis regia</u> WT
D	D
<u>Centropristis striata</u> WT	
<u>Paralichthys dentatus</u> WT	
<u>Peprilus triacanthus</u> WT	
<u>Prionotus carolinus</u> WT	
<u>Stenotomus chrysops</u> WT	
<u>Urophycis regia</u> WT	
	D
	<u>Gyptlocephalus cynoglossus</u> Bo-Sl
	<u>Lophius americanus</u> Bo
	<u>Urophycis tenuis</u> Bo-Sl
E	E
<u>Chlorocephalus assisi</u> Sl	<u>Chlorocephalus assisi</u> Sl
<u>Helicolenus dactylopterus</u> Sl	<u>Helicolenus dactylopterus</u> Sl
<u>Merluccius albidus</u> Sl	<u>Merluccius albidus</u> Sl
<u>Urophycis tenuis</u> Bo-Sl	

Figures 13 and 14 show the distributional relationships between the major site and species groups as determined by nodal analyses. As noted above, these relationships are more sharply defined during the spring cruises than in the fall, but in both cases the nodal analyses show clear differences in the faunal composition of site groups and the distribution of species groups. The interrelationships seen here are also highly representative of those noted during analyses of the individual cruises.

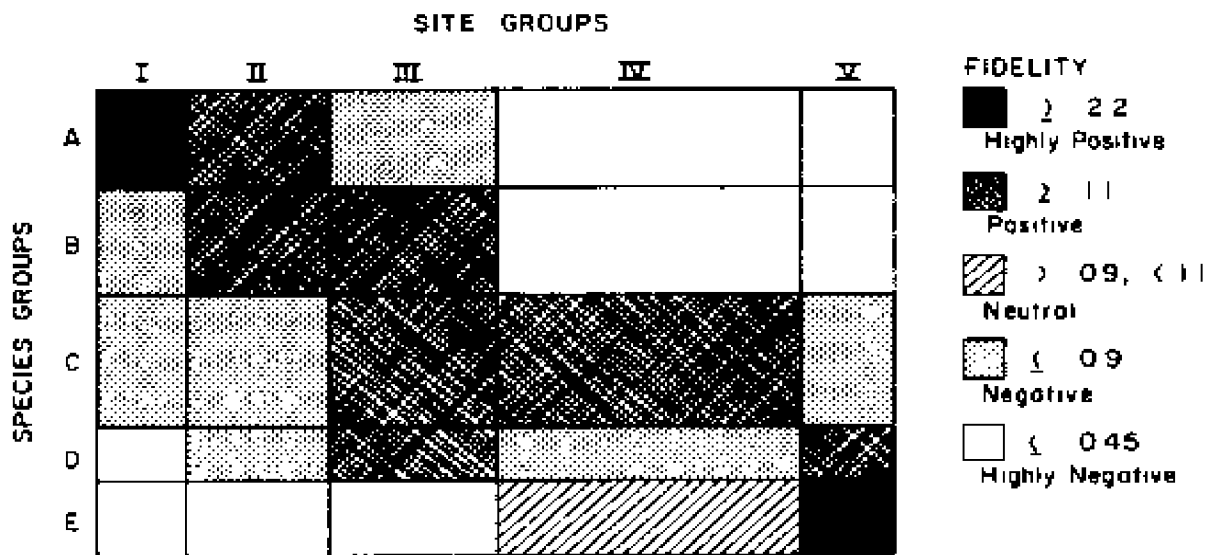
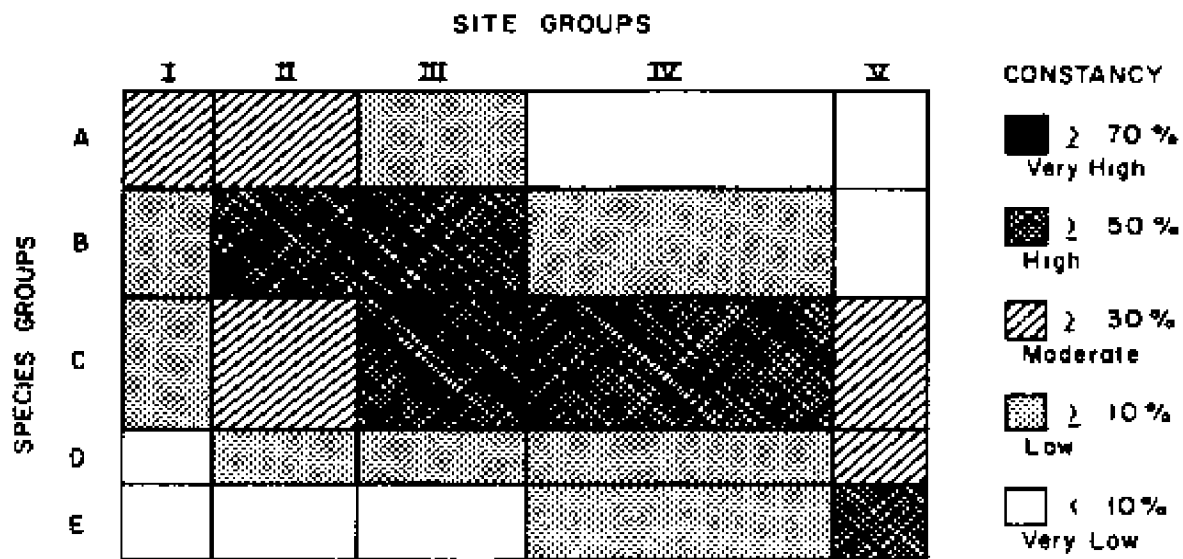
Dominance. The dominant species for each of the pooled site groups are given in Tables 10 and 11. During the spring Limanda ferruginea was the major dominant at the cold water, inshore site group (I), Squalus acanthias and Merluccius bilinearis were among the major dominants at all site groups, and Peprilus triacanthus was a major dominant at all but the cold water site group. Stenotomus chrysops was a major dominant along the southern outer shelf (group III). In the fall, the southern inshore site group (I) was strongly dominated by three warm temperate species: Prionotus carolinus, S. chrysops and P. triacanthus. These three species persisted as major dominants at the northern inshore site group, but were joined there in roughly equal dominance by three boreal species: L. ferruginea, S. acanthias and M. bilinearis. Peprilus triacanthus and the latter group were major dominants on the northern mid-shelf (group III). P. triacanthus and M. bilinearis were also major dominants at the outer shelf stations (group IV), where they were joined by Urophycis regia. The shelf break stations (group V) were dominated by M. bilinearis, Citharichthys arctifrons, and Helicolenus dactylopterus.

Figure 13. Nodal constancy (A) and fidelity (B) diagrams showing the inter-relation between pooled site and species groups, NMFS Groundfish Survey spring cruises, 1968-1976.



SPRING CRUISES

Figure 14. Nodal constancy (A) and fidelity (B) diagrams showing the inter-relation between pooled site and species groups, NMFS Groundfish Survey fall cruises, 1967-1975.



FALL CRUISES

Table 10. Dominant species by site group for Spring NMFS Groundfish Survey cruises, Mid-Atlantic Bight area, 1968-1976. A species was considered dominant if it occurred among the five most abundant species at at least 20% of all stations in the site group. Figures given are percentage of stations within each site group at which a species occurred (%) and the average percentage that the species contributed towards total abundance of non-pelagic fishes (\bar{x}) within the site group. Faunal affinities are as given in Table 3.

Species	Faunal Affinity	Species Group	Site Group							
			I		II		III		IV	
			\bar{x}	%	\bar{x}	%	\bar{x}	%	\bar{x}	%
<u>Gadus morhua</u>	Bo	A	44	1.4						
<u>Pseudopleuronectes americanus</u>	Bo	A	38	2.2						
<u>Limanda ferruginea</u>	Bo	B	88	28.5	22	1.4				
<u>Macrozoarces americanus</u>	Bo	B	68	5.2						
<u>Myoxocephalus octodecemspinosus</u>	Bo	B	56	5.0						
<u>Raja erinacea</u>	Bo	B	77	11.9	52	1.5				
<u>Scophthalmus aquosus</u>	IS	B	70	4.7						
<u>Rippoglossina oblonga</u>	OS	C	29	1.1	84	7.6	44	2.4	63	5.2
<u>Lophius americanus</u>	Bo	C			58	0.7			53	1.4
<u>Merluccius bilinearis</u>	Bo	C	79	20.5	97	22.4	66	13.0	90	27.2
<u>Squalus acanthias</u>	Bo	C	73	11.1	87	30.0	82	24.6	58	12.2
<u>Urophycis chuss</u>	Bo	C	54	3.9	84	9.3	25	1.9	74	9.5
<u>Centropristes striata</u>	WT	D			40	4.2				
<u>Paralichthys dentatus</u>	WT	D			47	2.2				
<u>Peprilus triacanthus</u>	WT	D			75	14.8	57	12.3	56	19.4
<u>Prionotus carolinus</u>	WT	D			50	7.1	51	9.8		
<u>Stenotomus chrysops</u>	WT	D			24	2.1	50	15.6		
<u>Urophycis regia</u>	WT	D			48	7.2			35	2.0
<u>Chlorophthalmus aggassizii</u>	SI	E							31	1.6
<u>Helicolenus dactylopterus</u>	SI	E							59	6.7
<u>Merluccius albidus</u>	SI	E							38	3.1
<u>Urophycis tenuis</u>	Bo-SI	E							38	1.6

Table 11. Dominant species by site group for Fall NMFS Groundfish Survey cruises, Mid-Atlantic Bight area, 1967-1975. A species was considered dominant if it occurred among the five most abundant species at at least 20% of all stations in the site group. Figures given are percentage of stations within each site group at which a species occurred (Σ) and the average percentage that the species contributed towards total abundance of non-pelagic fishes (\bar{x}) within the site group. Faunal affinities are as given in Table 3.

Species	Faunal Affinity					Species Group					
	I	II	III	IV	V	Σ	\bar{x}	Σ	\bar{x}	Σ	\bar{x}
<u>Centropristis striata</u>	WT					50	4.7				
<u>Mustelus canis</u>	WT					38	5.7				
<u>Paralichthys dentatus</u>	WT					61	6.7	51	13.5		
<u>Priacanthus carolinus</u>	WT					75	33.3	61	10.1		
<u>Stenotomus chrysops</u>	WT					53	17.5	51	13.5	30	2.4
<u>Limanda ferruginea</u>	Bo							65	14.1	79	18.0
<u>Myoxocephalus octodecemspinosus</u>	Bo									52	2.7
<u>Pseudopleuronectes americanus</u>	Bo							69	3.3	47	1.7
<u>Raja erinacea</u>	Bo							64	3.8	58	2.7
<u>Scophthalmus aquosus</u>	IS					52	2.9	62	3.4	25	1.0
<u>Squalus acanthias</u>	Bo							69	16.8	77	11.3
<u>Citharichthys arctifrons</u>	OS							59	2.2	35	2.7
<u>Hippoglossus oblongus</u>	OS									70	3.3
<u>Lepophidium cervinum</u>	OS										
<u>Merluccius bilinearis</u>	Bo							67	10.2	92	23.0
<u>Pleuronectes iriacanthus</u>	WT					59	15.8	65	11.1	72	19.6
<u>Urophycis chuss</u>	Bo							35	2.7	74	8.2
<u>Urophycis regius</u>	WT					40	6.5			57	14.8
<u>Lophius americanus</u>	Bo									31	2.2
<u>Chlorophthalmus agassizi</u>	SI									44	5.9
<u>Helicolenus dactylopterus</u>	SI									84	21.2
<u>Merluccius albidus</u>	SI									65	7.7

Abundance and Biomass. Absolute abundances and biomass, both of total catches and of individual species, varied to a much greater extent than the relative abundances among species throughout the study, so comparisons between the average abundance and biomass of the pooled site groups must be approached cautiously. The differences in the pooled site group characteristics with respect to these parameters (Tables 7 and 8) presents more of a composite than typical picture, with the patterns in individual years often deviating considerably (Appendix A). Average abundance and biomass were higher in the northern and inshore portion of the study area during both seasons. During the spring the greatest abundance and biomass was encountered in the northern mid-shelf site group (II), with values of these parameters being about 40% less throughout the rest of the study area. In the fall abundance and biomass was greater in both the northern inshore (II) and mid-shelf (III) areas, with lower values on the southern inner shelf (I) and considerably lower values, particularly with respect to biomass, along the outer-shelf/shelf break and upper slope. The very low biomass seen in this portion of the study area during the fall as opposed to the spring is the most noteworthy inter-seasonal difference with respect to catch rates.

Community structure indices. Mean values of the pooled community structure indices for each of pooled seasonal site groups reflected the pattern noted earlier; diversity varied almost linearly with evenness while species richness was much more uniform throughout the study area. During the spring, mean pooled diversity and evenness were lowest in the southern mid-shelf/outer shelf group (III) and

highest at the northern inner-/mid-shelf (I) and mid-/outer shelf (II) groups (Table 12). The shelf break/upper slope group (IV) had intermediate diversity and evenness but the highest species richness.

During the fall cruises diversity and evenness were again lowest in the southern (I) and outer shelf (IV) regions, and higher and fairly uniform through out the rest of the study area (Table 13). Species richness was again highest, but as not as distinctively so, on the shelf break and upper slope (V).

TABLE 12. Community structure indices for spring pooled site groups.
 Values are means of the pooled parameters from each original
 site group (Appendix F).

SITE GROUP		I	II	III	IV
No. of Groups		23	10	14	18
Diversity (H')	\bar{x}	2.78	2.72	1.78	2.41
	s	0.48	0.37	0.77	0.92
Evenness (J')	\bar{x}	0.60	0.56	0.38	0.48
	s	0.10	0.06	0.15	0.16
Species Richness	\bar{x}	3.14	3.21	2.87	3.88
	s	0.71	0.68	0.90	1.36

\bar{x} = mean value

s = standard deviation

TABLE 13. Community structure indices for fall pooled site groups.
 Values are means of the pooled parameters from each original
 site group (Appendix F).

SITE GROUP		I	II	III	IV	V
No. of Groups		10	10	12	23	9
Diversity (H')	\bar{x}	1.59	2.89	2.64	1.89	2.45
	s	0.66	0.51	0.49	0.83	1.06
Evenness (J')	\bar{x}	0.36	0.58	0.54	0.40	0.49
	s	0.17	0.13	0.10	0.17	0.21
Species Richness	\bar{x}	3.01	3.62	3.35	3.01	4.09
	s	0.77	0.71	0.54	0.95	1.11

\bar{x} = mean value

s = standard deviation

DISCUSSION

Despite large variation in the abundances of individual species, cluster analyses of nine years of survey data have shown clear and consistent patterns of community composition and distribution among demersal fishes of the Middle Atlantic continental shelf. Allowing for thermal variation and misclassification of small catches, persistent site and species clusters have indicated the presence of four relatively constant and well defined areas of faunal homogeneity in the spring and five more general areas in the fall, and five strongly recurring species associations during both seasons.

The spring site groups can be described approximately as northern inner and mid-shelf (I), extending from shore out to about 60-80 m from Cape Cod to south of Delaware Bay; northern mid-/outer shelf (II), occupying from around 60-80 m out to about 150 m from Cape Cod to Hudson Canyon; southern outer shelf (III), 60-150 m, from Delaware Bay to Cape Hatteras; and outer shelf break (IV), > 150 m. The southern inner and mid-shelf is a thermally-related transition zone between groups I and III. The outer shelf between Delaware Bay and Hudson Canyon was also a transition zone (between groups II and III), but this discontinuity does not appear to be directly related to temperature, but rather to the extent to which the northward migration of the warm-temperate species group has progressed by the time of the survey.

The five spring species groups contained one group specific to this season and four which contained common elements and properties with analogous fall groups. The first group (A) can be characterized as highly cryophilic, being virtually restricted to site group I and containing two members (Gadus morhua and Hemitripterus americanus) which were relatively absent from the study area during the fall. None of these species were major dominants, even within site group I. The second group (B) is also composed of primarily boreal, cold water species, but in this case is not completely restricted to site group I (although primarily distributed there) and contains the major dominant for that site, Limanda ferruginea. The third group (C) may be described as ubiquitous throughout the study area with moderate or better constancy to all site groups (Fig. 13). All members of this group are boreal or resident, and the major dominants Merluccius bilinearis and Squalus acanthias are the nuclear members. The fourth group (D) is composed entirely of warm-temperate members and is restricted to the warmer southern and outer-shelf waters (site groups II-IV). Peprilus triacanthus and Stenotomus chrysops are the major dominants from this group. The last group (E) is composed strictly of weakly dominant slope species mostly confined to the shelf break site group (IV).

The spring warming trend noted during the study period did not appear to have any major effect on the composition and distribution of fish communities in the area other than the latitudinal division between the inshore site groupings. The results of the present study are very much in accordance with the conclusions of Taylor et al. (1957) and Colton (1972) who found that while the ranges and

distributions of certain species did shift with a changing thermal regime, there were no obvious overall changes in faunal composition. This is understandable when one considers that the average change encountered (approximately 2°C) is relatively small compared to the temperature tolerances of the species involved and the seasonal and geographic temperature variation encountered.

The five fall site groups can best be described as southern inner and mid-shelf (I), extending out to about 60 m from Cape Hatteras to Delaware Bay and containing the area of warmest temperatures; northern inner shelf (II), extending northward from group I along a similar depth regime and containing cooler waters; northern mid-shelf (III), extending from group II out to about 90 m and occupying the area of the cold pool; outer shelf (IV), occupying the area between groups I and III and about 150 m; and shelf break (V), greater than 150 m. While again with these groups there is some overlap (particularly with groups I and II as discussed above) their definition is fairly good considering the rapidly changing environmental conditions and migratory activity of fish during this period.

The fall species associations, as noted above, have much in common with those noted in the spring. The small cryophilic group is absent, but the terms applied to the other four spring groups may be applied here as well. An exclusively boreal-resident group (B) persists on the northern inner and mid-shelf, including four members of the spring cold-water group B, one member of the cryophilic group, and Squalus acanthias, a ubiquitous dominant in the spring found only in the northern portion of the study area in the fall. The ubiquitous

spring group (C) persists with Merluccius bilinearis the major dominant, and two other common members from the spring group, but the fall group is no longer exclusively boreal-resident in faunal affinity and the group is distributed primarily in more northerly and deeper waters. Two warm-temperate species, Peprilus triacanthus and Urophycis regia, join this group as major dominants, while the other warm temperate species, dominated by Prionotus carolinus and Stenotomus chrysops, continue to occur in the same group (A) but show a dramatic change in distribution, occurring on the inner shelf rather than along the outer shelf as in the spring. The shelf break group (E) shows the same composition and distribution as in the spring, while the fifth group (D), which did not occur in the spring, is composed of nondominant eurybathic species which occur sporadically across all but the southern inner site group.

Despite the highly variable abundances of the species involved, there were few major changes in species dominance throughout the study. Merluccius bilinearis, Peprilus triacanthus, and Squalus scanthias were consistently the three most dominant species during both major seasons (Table 14). Limanda ferruginea was the only major species to undergo a notable change in dominance, and even that decline was only pronounced during the last two years of the study. Farrack (1973) has carefully linked the decline of this valuable commercial species to overfishing. Several less abundant cold water species, namely Pseudopleuronectes americanus, Myoxocephalus octodecemspinosus, and Macrozoarces americanus underwent declines in abundance similar to L. ferruginea, but in view of their close

Table 14. Dominant species. Number of site groups in which a species was dominant for each cruise.

No. of site groups	Spring									Fall									Total				
	1968	1969	1970	1971	1972	1973	1974	1975	1976	Total	1967	1968	1969	1970	1971	1972	1973	1974		1975	Total		
<i>Scudellum bispinosum</i>	4	3	3	3	4	1	3	2	1	28										0	2	30	
<i>Clupea harengus harengus</i>	3	5	3	2	2	2	2	1	1	20											0	0	20
<i>Alosa aestivalis</i>	2		1	1	1				4												0	0	4
<i>Alosa pseudoharengus</i>	5	6	4	3	3	3	2	1	3	28	1										1	1	29
<i>Ammodytes dubius</i>	1	1	2	1	1				2	4											0	0	4
<i>Pseudopleuronectes americanus</i>	1	1	2	1	1				1	7											2	2	14
<i>Hydrocephalus octodentatus</i>	3	3	3	1	2				1	14	2	1	2	2	1	1					9	1	23
<i>Scophthalmus aquosus</i>	3	3	1	3	2	2	3	2	3	13	2	1	1	1	2	1	1				10	1	23
<i>Sable tiliacea</i>	1	2	2	3	2	2	2	2	1	9	1	1	1	3	2	3	1	1			9	1	16
<i>Limanda ferruginea</i>	2	4	4	3	4	2	2	2	1	24	3	3	4	3	2	2	3	1			21	2	47
<i>Nectogadus americanus</i>	2	3	3	1	3				1	14											0	0	14
<i>Pleuronectes californicus</i>	1	3	5	2	2	2	2	2	2	21	2	2	3	2	3	4	2	2	3	3	23	2	44
<i>Stereonema chrysops</i>	1	3	3	2	1	1	1	1	2	12	5	2	2	3	2	3	2	1	4	20			32
<i>Ferizlichthys dentata</i>	1	1	1	1	1	1	1	1	3	11	1	1	1	1	1	1	2	2	2	8			11
<i>Centropristis striata</i>	1	1	1	1	1	1	1	1	3	6	1	1	1	2	2	3	2	4	4	16			16
<i>Merluccius canis</i>									1	1	1	1	1	1	1	1	1	1	2	4			7
<i>Peprilus triacanthus</i>	3	2	5	4	5	6	2	4	4	35	3	6	6	5	3	3	7	6	6	47			86
<i>Squalus acanthias</i>	6	6	5	6	6	6	4	5	7	53	3	6	3	3	3	2	2	3	26				81
<i>Merluccius bilinearis</i>	7	5	4	5	6	5	5	6	3	52	5	7	5	9	4	4	5	7	7	53			107
<i>Urophycis chuss</i>	3	2	5	3	3	3	4	2	3	28	2	2	3	2	3	3	1	2	4	22			52
<i>Hippoglossus oblongus</i>	1	2	1	1	1	4	3	3	4	25	2	1	2	1	2	4	3	3	3	19			45
<i>Citharichthys arcifrons</i>	1	1	1	1	1	1	2	2	2	9	2	3	2	3	2	4	2	3	4	25			37
<i>Lophius americanus</i>									1	1	1	1	1	1	1	2	2	2	4				7
<i>Urophycis regia</i>	1	2	1	2	1	1	1	1	3	14	2	5	2	5	4	2	4	3	4	31			48
<i>Lepophthalus carolinus</i>									2	2	1	1	1	3	1	1	1	1	10				20
<i>Glyptocephalus zyngonotus</i>									1	3	1	1	1	1	1	1	1	1	1				4
<i>Urophycis tenuis</i>	1	1	1	1	1				3	7	1	1	1										5
<i>Paristiodon violatus</i>									1	1	2												2
<i>Ammotocus mollis</i>									1	1	1												3
<i>Phycis chesteri</i>									3	1	1												5
<i>Myctophidae</i>	2		1	1	2				3	10													4
<i>Helicolenus dactylopterus</i>									2	2	1	1	1	1	2	1	1	1	10				21
<i>Chlorophthalmus agassizii</i>									1	7	1	1	1	1	2	1	1	2	1	12			20
<i>Meluccius albidus</i>									1	1	1	1	1	1	1	1	1	1	7				8
									1	1	1	1	1	1	1	1	1	1	1	9			13

association with the L. ferruginea, it can be assumed that they have been subjected to the same fishing pressure. Concurrent with the declines in dominance of these species was an increase in the dominance of Paralichthys oblongus. While P. oblongus is generally a deeper living species their ranges do overlap, and the increased abundance of P. oblongus occurred within the range of L. ferruginea. Some degree of replacement seems likely.

The only other notable change in dominance occurred among the pelagic species. Scomber scombrus, Clupea harengus, and Alosa pseudoharengus all showed declines in dominance through the study period. While these species have been subjected to considerable foreign fishing pressure (Brown et al. 1975) their abundances are so variable that the decline may be only apparent.

Clark and Brown (1977), in a previous analysis which included the present data, noted drastic declines in fish biomass on the Northwest Atlantic continental shelf, a change which they related to overfishing. Their data indicated that this change was most severe in the area of the present study, with a 74% decline occurring in the mid-Atlantic study area (southern half of the current study between the periods 1967-1968 and 1973-1974) and a 52% decline in the Southern New England area (northern half of current study area) between the periods 1963-1965 and 1972-1974. While the present study verifies their results, it also suggests that the decline may not be as severe as originally indicated or may have reversed.

Clark and Brown utilized data from the fall surveys (as noted above, interpretation of the spring data is made extremely tenuous by

the change in nets). Comparison of retransformed average biomass per tow for the periods 1967-1968 and 1973-1974 for both areas combined shows a decline in fish biomass of 57% (Table 15) which compares very well to Clark and Brown's figures if allowances are made for the greater biomass in the Southern New England area and the lower biomasses encountered in this area in 1967-1968 as compared to 1963-1965. In 1975, however, there was a sharp increase in biomass (Figure 14C), and if the years 1967-1968 are compared to 1975-1976, the decline is only 41%. In addition, Clark and Brown noted that the mid-Atlantic decline was strongly influenced by large catches of searobins in 1967. If these catches are considered anomalous, and the period of 1968-1969 is compared to 1974-1975, the decline in biomass is further reduced to 29% and 1975 may be considered an above average year. Analysis of the data from the more recent cruises should greatly clarify this trend.

As noted by Clark and Brown, total fish biomass in this area is largely dependent on one species, Squalus acanthias. The recovery in biomass in 1975 was largely due to this species. Spring and fall catches of S. acanthias were highly unrelated (Figure 6A), indicating the highly migratory nature of this species. Average total fish abundances remained much more constant than biomass (Fig. 2B&C), although there was a 24% decline between the 1967-1968 and 1974-1975 fall cruises.

Peprilus triacanthus, the most abundant species during both seasons did not exert the same large effect on overall abundance that Squalus acanthias did on biomass; in fact the variation in absolute abundances of P. triacanthus was quite different from the variation in

Table 15. Changes in average biomass and abundance per tow for fall cruises 1967-1975.

Year	Biomass per tow (kg)		No. Individuals per tow	
1967	64		210	
1968	41		205	
1969	46		201	
1970	36		155	
1971	25		198	
1972	48		238	
1973	26		147	
1974	19		130	
1975	43		187	

	Mean	% Change		Mean	% Change	
1967-68	52.5	-57	-41	207.5	-33	-24
1968-69	43.5			203.0		
1973-74	22.5	138.5		-22		
1974-75	31.0	158.5				

transformed total abundances, reflecting the highly contagious distribution of this species (Figs. 2B, 6B). In contrast, despite being the most consistently dominant species, Merluccius bilinearis only accounted for about 10% of the individuals and about 3% of the biomass taken, indicating a relatively uniform distribution. Its biomass and abundance followed similar patterns with the exception of fall 1974, when biomass levels were depressed despite relatively high abundances (Figure 7A), indicating a much higher proportion of younger fish. The stock did not appear to decline through the study period.

Prionotus carolinus was very abundant during the fall 1967 cruise and then declined steadily during the remaining fall cruises (Figure 6C). In the spring however, this species showed a marked peak in 1969, declined, and then showed another sharp increase in 1973, after which it declined again. These peaks seem to be related to migratory patterns and resultant availability rather than to yearclass strength because biomass always followed much the same pattern as abundance.

Limanda ferruginea, the most valuable commercial species in the area, as noted above underwent a drastic decline during the study period, although there was an anomalous peak in the fall of 1972 (Figure 7B). Spring and fall catches of this species were more closely related than for any other major species, indicating that a substantial portion of the population may reside within the study area on a year-round basis.

Stenotomus chrysops, like the other major warm temperate species discussed here, was subject to wide fluctuations in abundance, particularly in the spring (Figure 7C). As with Prionotus carolinus,

these fluctuations seemed more closely related to differential degrees of migration into the study area than yearclass strength. Whereas there appears to have been a large decline in the spring abundances of this species, the fall catches have remained relatively stable, suggesting the possibility of two separate stocks.

The two the most dominant species in terms of biomass and abundance, Squalus acanthias and Peprilus triacanthus, showed strong seasonal differences in the groups they clustered with. Squalus, a boreal cold water species, was widespread in the spring and occurred in the ubiquitous group, but during the fall cruises this species was restricted to the cooler waters on the northern shelf and generally clustered with the Limanda dominated cold water group. Peprilus triacanthus generally appeared in the same group as the other warm-temperate species in the spring when it was distributed along the outer shelf, but in the fall this species was widespread across the shelf and tended to be more concentrated in the cooler portions of the study area and usually clustered with the semi-ubiquitous Merluccius bilinearis - Urophycis chuss group. Peprilus triacanthus is considerably more tolerant of cooler temperatures than the other warm-temperate species encountered in this study (Horn 1970). Urophycis regia, another warm-temperate species which inhabits cooler waters (Struhsaker 1969), clustered similarly to P. triacanthus, occurring with the warm-temperate group in the spring and with the semi-ubiquitous group in the fall, but appeared to have slightly narrower temperature tolerances as it was more restricted to the southern portion of the outer shelf in spring and to be more concentrated in deeper, warmer waters in the fall.

It is obvious that although the two sampling periods included the two extremes of average water temperatures in the study area, the fall (warm extreme) is a much more dynamic period for the fish communities in the region than the spring (cool extreme). This appears to be in large part related to the much less stable thermal regime encountered in the fall, particularly in the shallower portions of the study area. The thermal gradients developed during the warmer months on the inner shelf are much stronger than those encountered on the mid-shelf during the spring, and because cooling waters mix or turn over while warming waters stratify, the fall gradients break down much more quickly than those in the spring. As a result a fish community in this region may be subjected to rapidly changing environmental temperatures by a number of factors. A relatively small shift of water masses in the vicinity of a strong thermal gradient, migration across a gradient or rapid cooling and mixing along the gradient all subject these communities to abrupt changes of temperature (Parr 1933), and it is not surprising that the site groupings based on faunal similarities found in the inner portion of the study area during the fall exhibited wide temperature ranges (Fig. 11). Parr (1933) pointed out that the temperature-related distributions of organisms in the vicinity of a strong thermal gradient may be more influenced by the magnitude of short term temperature changes than by the actual temperatures encountered. This concept may well have application to the formation of the three innermost site groups identified during the fall; for although the groups strongly overlap with respect to the temperature ranges encountered there is a considerable difference in the strength of the thermal gradients and presumably the short term temperature

variations encountered within each, with group I being primarily sited in the region of the sharpest gradients and group III being located in the most thermally stable area.

Conclusions concerning the patterns of community structure seen during the summer cruise are limited by the lack of any measure of inter-annual variability. The cold water species group (dominated by Limanda ferruginea) and the Merluccius bilinearis - Urophycis chuss group both persisted with basically the same composition as during the fall and spring cruises. A notable exception was the occurrence of Melanogrammus aeglefinus, a species rare during the other cruises, as a numerically dominant member of the M. bilinearis - U. chuss group. The catches of M. aeglefinus during this cruise were composed almost entirely of young of the year individuals which had probably drifted southwest of their spawning ground on George's Bank. As noted above, the geographic distributions of these two species groups were intermediate to those found during the other two seasons but more closely approximated that during the fall, with the Merluccius group avoiding the warmer southern and inshore waters.

Peprilus triacanthus and Urophycis regia were the only truly ubiquitous as well as the the only warm temperate species appearing in the summer cluster. The absence of the warm temperate species association found during the two major sampling periods (Prionotus carolinus, Stenotomus chrysops, Centropristia striata, Paralichthys dentatus) from the summer cluster is a reflection of the inshore migration of these species during the summer months. Sampling conducted inshore of the present study area during an associated study (discussed below) encountered large numbers of these species

(particularly P. carolinus and S. chrysops) during this period of the year. The absence of this group from the study area is no doubt at least partly responsible for the lower levels of abundance and biomass seen during the summer cruise. The summer slope species group appeared with the same composition and distribution as during the other cruises.

Although the patterns of fish distribution seen in the summer more closely resemble those of the fall than the spring, the homothermic nature of the site group clusters is much more similar to the situation in the spring. Even on the basis of only a single cruise it would appear that the summer fish communities in this region are considerably less dynamic than those seen in the fall and more carefully structured according to the thermal regime. By inference there must be a period of high migratory activity for the warm temperate species between the time of the spring cruises, when these species are distributed along the outer shelf, and the time of the summer cruise, when these species are primarily inshore of the study area. It is obvious that the general migratory patterns of the boreal and warm temperate species within the Mid-Atlantic Bight are quite different, with the warm temperate species often undergoing long and rapid cyclical migrations which traverse the entire periphery of the study area while the boreal species show a much more gradual expansion and contraction of ranges from the northern portion of the mid-shelf.

The traditional community structure indices (species diversity and its components) showed tremendous variability and inconsistency (even after the pooling of stations with similar faunal

characteristics) and are of little value in describing the communities described here except in the most general sense. While average diversity was lower in the southern and outer shelf portions of the study area over the long term, annual variations in the thermal regime or in the distribution of locally superabundant species such as Peprilus triacanthus and the scombrids often created exceptions to this pattern. Species richness appears to provide the most reliable index of community complexity, and it is not surprising that the maximal values are found on the shelf break, where the two major continental shelf faunal groups overlap with the shallower-living elements of the deep-sea fish fauna.

Direct comparison of the present results with those of a concurrently conducted companion study of the fish communities in the Chesapeake Bight (Musick, Colvocoresses and Foell 1985) is difficult. Despite an overlap in the study areas and utilization of the same analytical methods, there was considerable difference in sampling regimes; for example, although the Chesapeake Bight study was based on five seasonal cruises of which three nominally correspond to the seasons examined in the present study, the timing of the sampling periods for each season varied considerably between the two studies. The Chesapeake Bight study included a substantial portion of stations made inshore of and to the south of the present study area; conversely a majority of stations made during the cruises discussed here were north of or offshore the Chesapeake Bight study area. As a result a greater proportion of warm temperate and inshore species appeared in the clusters from the Chesapeake Bight survey and more boreal and

slope species are present in the present clusters. In addition, those species common to both analyses were sampled along different portions of their ranges and might therefore be expected to show different associations. Several of the major species associations noted above did, however, occur repeatedly in the Chesapeake Bight study.

Merluccius bilinearis, Urophycis chuss, and Paralichthys oblongus were in the same species group during four of the five cruises; during the fall cruise (which was later in the year than the present fall cruises), U. chuss was restricted to the northern portion of the study area and clustered with the cold water species groups. The boreal cold water species Limanda ferruginea, Raja erinacea, Myoxocephalus octodecemspinoeus, Pseudopleuronectes americanus, and Macrozoarces americanus all clustered in the same group during the fall and both winter cruises, while they were divided among two groups during the spring and summer. The warm temperate group consisting of Prionotus carolinus, Stenotomus chrysops, Paralichthys dentatus, and Centropristis striata all clustered together during two cruises while three of the four cooccurred during two cruises. The slope group species noted in the present study were not sampled adequately enough to make but isolated appearances in the Chesapeake Bight clusters.

CONCLUSIONS

The distributional patterns noted in this paper lead to the conclusion that continental shelf demersal fish communities in the Middle Atlantic Bight are largely structured by temperature on the inner and mid-shelf and by depth on the outer shelf and shelf break. This is not at all unexpected considering the sedimentary and topographical uniformity of the inner and mid-shelf (Emery and Uchupi 1972) and the large annual variation in bottom water temperature in the inshore region, with the converse holding true along the outer shelf and break. Scott (1982) found the distributions of a number of groundfish species on the Scotian Shelf to be related to bottom sediment type. Although substrate preference indices were not generated during the present study, comparisons of species group distribution with bottom sediment type maps do not indicate any strong species group-sedimentary relationships. This contrast may be the result of two major differences between the continental shelves in the Middle Atlantic Bight and off Nova Scotia; there is a much more variable sedimentary environment and a considerably smaller annual range of bottom water temperatures on the Scotian Shelf.

Tyler (1971) examined latitudinal variation in the regular and seasonal components of several near-shore Atlantic marine fish communities, and concluded that the proportion of seasonal and occasional components to regular components varied directly with

annual variation in water temperature. The results of the present study are certainly in accord with this conclusion, in that the most highly variable area in terms of annual water temperature variation (the southern inner and mid-shelf) was also the most variable area in terms of community composition, but it is also evident Tyler's statement cannot be taken axiomatically. The outer shelf, although very homothermic, was also subject to considerable seasonal variation in community structure because of the changing relationship between the stable thermal regime on the outer shelf and the highly varying regime in adjacent inshore waters. During the spring, when inshore water temperatures were depressed well below those on the outer shelf, the outer shelf served as a refuge for the warm-temperate species association which occurs largely inshore when water temperatures there become elevated above those on the outer shelf.

The present analysis of the determinants of continental shelf fish community structure is of course limited in that only environmental effects have been considered. Trophic relationships are of key importance to the structure of any biotic community, but are completely beyond the scope of any study encompassing such a large area and variety of species. It is noteworthy, however, that food habits studies of many of these species within the present study area have repeatedly shown low levels of selectivity, a high degree of dietary overlap, and dietary shifts within species across seasons and along ranges (Sedberry 1983), indicating that trophic relationships may be considerably less important than in more static fish communities.

It is also interesting to note that while for the most part the communities observed here are structured by species associations that behave as a group in response to environmental variation, two of the most successful species (Peprilus triacanthus and Squalus acanthias) are those which show the least permanent group affinities. As noted above, the success of P. triacanthus may in part be due to the species' very wide thermal tolerance, but S. acanthias was one of the more thermally restricted species encountered in the study, being restricted to waters less than 14 C.

In summary:

1. Despite large fluctuations in the abundance of individual species, the composition and distribution of fish species associations remained largely consistent over a nine year period on the Middle Atlantic shelf.
2. Four major types of species associations were noted; cold water, dominated by Limanda ferruginea, warm temperate, dominated by Prionotus carolinus and Stenotomus chrysops, a ubiquitous boreal group, dominated by Merluccius bilinearis and Urophycis chuss, and upper slope, dominated by Helicolenus dactylopterus.
3. The distributions of these groups within four identifiable areas of faunal homogeneity during the spring and five areas

ding the fall appears closely related to temperature and depth.

4. Despite the fluctuations in overall and specific abundances, species dominance remained generally stable throughout the study, with Merluccius bilinearis, Peprilus triacanthus, and Squalus acanthias the principal dominants. Limanda ferruginea showed a sharp decline during the study, presumably due to overfishing.

5. Boreal and warm temperate migrants dominated the observed communities in about equal proportion during both major seasons, but the relative contribution of each element varied greatly between faunal areas within seasons and within faunal areas between seasons. Resident species appear to play a minor role in the Mid-Atlantic Bight fish communities.

APPENDIX A

**Site group statistics for NMFS Groundfish Survey Cruises,
Fall 1967 - Spring 1976.**

Table A-1. Cruise 68-3, Spring 1968.

SITE GROUP	I	II	III	IV	V	VI	VII
	28	14	10	21	15	13	7
No. of Stations							
Abundance	\bar{x}	\bar{x}	\bar{x}	\bar{x}	\bar{x}	\bar{x}	\bar{x}
ln (x+1)	σ	σ	σ	σ	σ	σ	σ
No. of Species	\bar{x}	\bar{x}	\bar{x}	\bar{x}	\bar{x}	\bar{x}	\bar{x}
	σ	σ	σ	σ	σ	σ	σ
Biomass (kg)	\bar{x}	\bar{x}	\bar{x}	\bar{x}	\bar{x}	\bar{x}	\bar{x}
ln (x+1)	σ	σ	σ	σ	σ	σ	σ
Depth (m)	Range	Range	Range	Range	Range	Range	Range
	\bar{x}	\bar{x}	\bar{x}	\bar{x}	\bar{x}	\bar{x}	\bar{x}
Temperature (°C)	Range	Range	Range	Range	Range	Range	Range
	\bar{x}	\bar{x}	\bar{x}	\bar{x}	\bar{x}	\bar{x}	\bar{x}

\bar{x} = mean value

σ = standard deviation

Table A-2. Cruise 69-2, Spring 1969.

SITE GROUP	I	II	III	IV	V	VI	VII	VIII	
	7	24	13	5	9	24	16	11	
No. of Stations									
Abundance ln (x+1)	\bar{x} σ	5.59 0.887	5.39 0.794	4.66 0.619	3.39 0.380	4.21 1.002	5.13 0.990	4.94 1.878	5.26 1.345
No. of Species	\bar{x} σ	8.0 1.83	11.7 2.25	10.4 1.80	5.8 1.48	6.8 2.59	9.7 3.34	8.6 5.03	7.6 1.75
Biomass (kg) ln (x+1)	\bar{x} σ	4.00 0.920	4.48 0.666	3.43 0.671	2.31 0.227	3.95 1.213	3.94 1.126	3.40 2.027	3.88 1.289
Depth (m)	Range \bar{x}	27-51 36.7	22-75 49.4	29-77 53.7	22-27 23.4	26-128 67.1	24-329 112.0	69-280 146.9	128-379 265.2
Temperature (°C)	Range \bar{x}	2-4 2.9	2-4 3.3	3-7 4.5	4-5 4.6	5-11 7.3	4-12 8.7	6-13 9.6	10-12 11.1

\bar{x} = mean value

σ = standard deviation

Table A-3. Cruise 70-3, Spring 1970.

SITE GROUP	I	II	III	IV	V	VI	VII	VIII	IX
No. of Stations	10	8	30	7	16	12	19	6	16
Abundance									
\bar{x}	4.13	5.48	5.25	4.10	4.56	5.56	5.36	5.80	4.61
σ	0.854	0.569	0.636	1.291	1.590	1.668	1.371	1.482	0.806
No. of Species									
\bar{x}	8.0	12.0	11.5	5.0	8.5	7.8	9.1	5.8	10.1
σ	3.02	1.85	2.24	1.53	2.13	2.08	2.07	2.32	2.89
Biomass (kg)									
\bar{x}	1.43	4.70	3.87	2.35	3.09	3.23	3.88	3.11	3.57
σ	0.973	0.411	0.700	1.396	1.520	1.478	1.221	1.141	1.282
Depth (m)									
Range	29-75	35-86	31-101	18-110	29-143	37-126	91-165	66-232	128-329
\bar{x}	44.7	54.3	61.6	49.4	80.3	84.1	128.8	159.5	253.6
Temperature ($^{\circ}$ C)									
Range	5-7	4-5	4-8	7-12	5-12	7-13	5-14	7-16	9-13
\bar{x}	5.9	4.6	5.3	8.7	6.8	9.8	10.6	12.4	11.2

\bar{x} = mean value
 σ = standard deviation

Table A-4. Cruise 71-1, Spring 1971.

SITE GROUP	No. of Stations					
	I	II	III	IV	V	VI
	11	29	19	20	21	16
Abundance ln (x+1)	\bar{x} 4.30 σ 1.551	5.05 0.618	4.78 0.953	4.73 1.623	5.95 1.307	5.18 0.975
No. of Species	\bar{x} 6.2 σ 1.99	10.0 2.66	9.2 2.76	8.7 3.73	10.6 3.20	11.0 2.25
Biomass (kg) ln (x+1)	\bar{x} 3.20 σ 0.596	4.12 0.611	3.34 0.970	3.23 1.518	4.45 1.446	4.01 1.295
Depth (m)	Range 18-64 \bar{x} 39.2	27-80 49.3	22-95 59.5	20-221 96.4	33-214 111.1	135-329 265.9
Temperature (°C)	Range 4-9 \bar{x} 6.3	2-7 3.7	4-9 5.7	7-12 9.4	8-14 10.8	6-11 8.7

\bar{x} = mean value
 σ = standard deviation

Table A-5. Cruise 72-2, Spring 1972.

SITE GROUP	I	II	III	IV	V	VI	VII	VIII	IX
No. of Stations	6	15	18	6	26	11	13	13	12
Abundance									
\bar{x}	5.20	4.93	5.31	3.58	5.20	5.16	5.60	4.50	4.68
σ	0.757	1.084	0.528	0.475	1.710	1.485	0.719	1.196	0.598
No. of Species									
\bar{x}	10.5	8.6	12.9	3.3	8.0	7.4	10.4	6.9	11.4
σ	0.54	2.78	1.95	1.03	2.90	2.50	2.72	1.97	2.31
Biomass (kg)									
\bar{x}	4.64	3.65	4.70	4.31	4.03	3.51	4.25	3.73	3.61
σ	0.667	0.740	0.742	0.497	1.044	1.334	0.907	1.193	0.867
Depth (m)									
Range	27-44	29-80	35-86	26-46	26-132	33-349	53-161	84-285	88-336
\bar{x}	34.5	42.1	59.1	34.2	74.1	160.6	103.7	170.3	258.9
Temperature (°C)									
Range	3-4	4-7	3-9	8-9	5-13	8-13	8-14	8-14	5-13
\bar{x}	3.5	5.5	5.7	8.5	9.9	11.6	10.8	11.2	9.0

\bar{x} = mean value
 σ = standard deviation

Table A-6. Cruise 73-3, Spring 1973.

SITE GROUP	I	II	III	IV	V	VI	VII
No. of Stations	47	29	27	14	11	3	14
Abundance ln (x+1)	\bar{x} 6.06 σ 0.598	5.33 1.014	6.38 0.763	5.95 1.878	5.73 2.112	5.03 0.336	6.26 1.462
No. of Species	\bar{x} 14.6 σ 1.92	10.8 2.71	12.7 1.83	9.9 3.76	9.8 2.09	9.0 0.0	14.0 3.31
Biomass (kg) ln (x+1)	\bar{x} 4.90 σ 0.635	4.57 0.788	5.15 0.862	4.67 1.273	3.86 1.407	3.15 0.320	4.93 1.049
Depth (m)	Range 26-69 \bar{x} 47.4	24-75 42.3	60-152 85.7	48-152 94.1	95-179 141.5	110-135 123.7	188-335 253.4
Temperature (°C)	Range 3-8 \bar{x} 5.2	3-9 6.2	7-16 9.7	7-12 9.3	11-14 12.2	8-8 8.0	10-14 12.4

 \bar{x} = mean value σ = standard deviation

Table A-7. Cruise 74-4, Spring 1974.

SITE GROUP	I		II		III		IV		V		VI	
	19	12	12	27	11	10	12	10	12	10	12	
No. of Stations												
Abundance In (x+1)	\bar{x}	6.18	4.65	5.87	5.44	4.89	5.39					
	σ	1.015	0.895	1.050	1.441	0.380	0.661					
No. of Species	\bar{x}	14.1	10.5	12.2	7.5	12.5	14.5					
	σ	2.51	2.39	2.11	3.23	4.47	2.57					
Biomass (kg) In (x+1)	\bar{x}	4.74	4.51	4.38	4.58	2.90	4.11					
	σ	0.775	0.730	1.080	1.296	0.673	0.603					
Depth (m)	Range	22-82	35-82	29-123	27-148	66-300	219-338					
	\bar{x}	46.6	58.6	82.0	73.4	168.6	277.8					
Temperature (°C)	Range	5-8	6-11	7-13	10-14	9-14	8-15					
	\bar{x}	6.3	7.8	10.2	12.2	12.5	11.0					

 \bar{x} = mean value σ = standard deviation

Table A-8. Cruise 75-3, Spring 1975.

SITE GROUP	I		II		III		IV		V		VI	
	19	16	14	12	13	16	13	16				
No. of Stations	19	16	14	12	13	16	13	16				
Abundance ln (x+1)	\bar{x} 5.56 σ 0.998	5.67 0.680	5.55 1.679	6.22 0.852	4.57 0.874	5.58 0.627						
No. of Species	\bar{x} 13.2 σ 2.47	10.4 1.70	7.8 2.42	11.8 2.08	10.3 3.44	15.1 2.87						
Biomass (kg) ln (x+1)	\bar{x} 4.31 σ 0.624	4.79 0.825	4.60 1.152	5.20 0.845	3.27 1.054	3.69 0.842						
Depth (m)	Range 24-77 \bar{x} 42.6	38-73 57.0	33-115 70.9	57-104 86.3	66-201 126.5	123-302 213.2						
Temperature ($^{\circ}$ C)	Range 3-7 \bar{x} 4.8	5-8 6.4	5-11 8.6	7-11 9.5	8-12 10.9	8-12 10.8						

 \bar{x} = mean value σ = standard deviation

Table A-9. Cruise 76-2, Spring 1976.

SITE GROUP	I		II		III		IV		V		VI		VII	
	10	35	10	35	10	35	14	15	15	16	16	17	17	
No. of Stations	10	35	10	35	10	35	14	15	15	16	16	17	17	
Abundance	\bar{x}	5.84	5.63	4.99	4.70	6.18	5.25	5.68						
ln (x+1)	σ	1.849	1.122	0.800	0.906	0.521	1.316	0.753						
No. of Species	\bar{x}	9.7	12.0	8.1	9.8	13.7	10.8	17.3						
	σ	2.62	3.05	2.33	3.14	1.98	3.25	4.97						
Biomass (kg)	\bar{x}	3.59	4.27	4.99	3.90	5.27	3.48	4.13						
ln (x+1)	σ	1.019	0.991	0.941	0.959	0.896	0.924	0.700						
Depth (m)	Range	18-58	22-90	41-67	27-120	39-101	53-174	85-341						
	\bar{x}	28.8	46.1	53.2	62.3	72.5	126.4	244.7						
Temperature (°C)	Range	6-10	4-8	7-10	9-14	8-12	8-15	6-12						
	\bar{x}	7.7	5.7	8.2	11.1	9.7	11.8	10.1						

\bar{x} = mean value

σ = standard deviation

Table A-10. Cruises 67-20 and 67-21, Fall 1967.

SITE GROUP	I	II	III	IV	V	VI	VII
No. of Stations	14	13	23	5	24	25	17
Abundance	\bar{x}	5.58	5.88	6.03	5.15	4.82	4.34
ln (x+1)	σ	1.840	0.630	0.653	0.384	1.034	2.135
No. of Species	\bar{x}	8.3	10.8	12.6	13.0	8.3	5.7
	σ	3.77	3.51	3.11	0.71	2.64	2.72
Biomass (kg)	\bar{x}	3.91	4.96	5.12	4.04	3.47	2.01
ln (x+1)	σ	1.400	0.949	0.873	0.746	1.312	1.424
Depth (m)	Range	22-48	27-49	31-73	38-73	60-219	33-223
	\bar{x}	32.4	37.6	50.7	58.6	99.1	137.8
Temperature (°C)	Range	10-23	10-15	8-13	6-9	7-12	9-13
	\bar{x}	16.5	12.0	9.8	7.6	9.3	11.5
						11.5	11.1

\bar{x} = mean value

σ = standard deviation

Table A-11. Cruise 68-17, Fall 1968.

	I	II	III	IV	V	VI	VII	VIII
No. of Stations	19	13	14	18	12	27	9	9
Abundance ln (x+1)	\bar{x} 4.88 σ 1.539	5.88 0.488	5.34 1.238	6.01 0.638	5.20 1.755	4.87 1.040	4.73 1.779	4.35 0.646
No. of Species	\bar{x} 7.4 σ 2.73	13.4 2.10	7.1 2.16	12.7 2.40	4.8 1.86	9.0 2.94	5.9 2.37	7.6 3.17
Biomass (kg) ln (x+1)	\bar{x} 3.55 σ 1.415	4.55 0.748	4.25 1.548	4.35 0.619	2.88 1.766	2.53 0.872	2.29 1.401	2.05 0.723
Depth (m)	Range 18-44 \bar{x} 30.8	27-62 39.5	33-57 43.4	46-91 63.2	16-287 95.2	53-315 127.4	66-172 122.4	203-357 300.3
Temperature ($^{\circ}$ C)	Range 11-21 \bar{x} 17.7	8-15 11.7	8-14 10.4	7-15 10.1	7-21 12.1	7-15 11.3	11-15 12.8	8-11 9.6

 \bar{x} = mean value σ = standard deviation

Table A-12. Cruise 69-11, Fall 1969.

SITE GROUP	I	II	III	IV	V	VI
	15	15	13	27	21	18
No. of Stations	15	15	13	27	21	18
Abundance ln (x+1)	\bar{x} 5.05 σ 1.462	6.07 0.739	5.97 0.661	4.62 1.666	4.95 1.634	4.85 1.778
No. of Species	\bar{x} 10.5 σ 3.20	13.5 2.53	12.4 2.22	6.1 2.48	7.9 2.50	7.7 2.57
Biomass (kg) ln (x+1)	\bar{x} 3.65 σ 1.200	4.84 1.003	4.56 0.643	3.31 1.582	2.88 1.325	2.09 1.152
Depth (m)	Range 24-59 \bar{x} 37.1	33-80 49.7	57-80 66.5	37-218 68.5	55-196 103.2	71-351 226.0
Temperature (°C)	Range 17-21 \bar{x} 19.1	12-18 14.1	10-12 10.8	9-18 12.6	9-13 11.3	10-18 12.1

\bar{x} = mean value
 σ = standard deviation

Table A-13. Cruise 70-6, Fall 1970.

	I	II	III	IV	V	VI	VII	VIII	IX
No. of Stations	10	17	21	13	14	11	12	8	7
Abundance	\bar{x}	4.79	6.00	3.12	4.95	4.23	4.92	3.30	4.18
ln ($x+1$)	σ	1.560	1.098	1.392	0.725	0.977	2.311	1.489	0.511
No. of Species	\bar{x}	9.9	11.7	3.6	7.6	6.5	4.9	4.0	9.9
	σ	2.99	3.67	2.77	1.76	2.02	2.47	2.51	2.41
Biomass (kg)	\bar{x}	3.07	4.47	4.46	1.82	2.48	2.74	1.59	1.84
ln ($x+1$)	σ	1.446	1.325	0.789	1.631	0.801	1.890	1.744	0.519
Depth (m)	Range	20-40	26-80	33-80	33-192	46-230	86-232	37-274	26-313
	\bar{x}	28.6	46.1	59.9	63.2	85.1	146.4	129.3	134.3
Temperature ($^{\circ}$ C)	Range	8-18	7-15	8-13	5-13	6-13	9-13	8-13	8-11
	\bar{x}	12.4	11.9	9.9	7.1	9.4	11.6	10.0	9.6

 \bar{x} = mean value σ = standard deviation

Table A-14. Cruise 71-6, Fall 1971.

SITE GROUP	I	II	III	IV	V	VI	
No. of Stations	11	28	28	27	10	11	
Abundance ln (x+1)	\bar{x} σ	5.97 1.628	5.73 1.401	4.59 1.540	4.99 1.144	5.59 2.436	3.72 0.972
No. of Species	\bar{x} σ	7.6 3.29	13.2 2.84	6.9 3.51	8.0 2.34	4.9 1.73	7.0 3.00
Biomass (kg) ln (x+1)	\bar{x} σ	4.28 0.660	3.78 1.116	2.58 1.515	2.13 1.018	2.94 1.817	1.17 0.566
Depth (m)	Range \bar{x}	22-123 38.9	27-80 47.5	31-124 62.8	33-315 122.6	48-219 106.3	274-320 295.7
Temperature ($^{\circ}$ C)	Range \bar{x}	10-22 17.5	6-17 10.7	6-22 10.9	7-13 10.5	12-16 13.0	9-13 10.2

 \bar{x} = mean value σ = standard deviation

Table A-15. Cruise 72-8, Fall 1972.

	I	II	III	IV	V	VI
No. of Stations	8	16	25	11	21	22
Abundance ln ($\bar{x}+1$)	\bar{x} 4.69 σ 1.412	3.61 0.819	6.35 1.088	6.09 0.743	4.69 1.434	4.28 1.157
No. of Species	\bar{x} 8.8 σ 2.86	7.7 1.85	13.9 3.88	13.6 2.76	8.0 2.89	10.0 4.52
Biomass (kg) ln ($\bar{x}+1$)	\bar{x} 3.76 σ 1.263	2.86 0.957	4.81 1.121	4.38 0.637	2.56 0.897	1.72 0.892
Depth (m)	Range \bar{x} 18-38 28.3	29-59 37.8	40-79 57.2	60-88 72.1	42-165 102.4	119-340 235.9
Temperature ($^{\circ}$ C)	Range \bar{x} 19-21 20.4	12-20 16.4	9-18 12.4	10-13 11.1	9-18 12.4	7-13 10.1

 \bar{x} = mean value σ = standard deviation

Table A-16. Cruise 73-8, Fall 1973.

SITE GROUP	I	II	III	IV	V	VI	VII
No. of Stations	12	23	20	13	8	21	6
Abundance ln (x+1)	\bar{x} 4.43 σ 2.179	5.14 1.598	5.50 0.937	2.76 1.312	5.48 2.355	4.89 1.176	4.03 1.594
No. of Species	\bar{x} 6.7 σ 2.10	9.9 3.55	10.5 2.83	3.8 1.28	3.6 1.68	8.8 2.23	7.2 1.60
Biomass (kg) ln (x+1)	\bar{x} 3.17 σ 1.217	3.95 1.368	3.52 0.892	1.64 0.878	2.88 1.715	2.58 0.915	2.36 0.832
Depth (m)	Range 26-40 \bar{x} 31.4	26-79 38.7	48-101 73.0	40-271 101.0	80-137 102.3	57-320 151.9	241-366 321.5
Temperature (°C)	Range 11-19 \bar{x} 15.6	10-21 15.7	10-14 11.5	9-15 11.5	11-16 13.8	11-16 13.1	6-16 10.7

 \bar{x} = mean value σ = standard deviation

Table A-17. Cruise 74-11, Fall 1974.

SITE GROUP	I	II	III	IV	V	VI	VII
No. of Stations	14	12	14	16	18	16	9
Abundance In ($\bar{x} \pm 1$)	\bar{x} 4.75 σ 2.027	4.47 0.757	5.12 1.155	4.69 1.458	4.77 1.896	5.22 0.660	4.76 1.059
No. of Species	\bar{x} 8.5 σ 4.48	9.8 2.58	11.4 4.21	8.1 3.04	4.1 1.77	7.0 2.12	13.3 4.03
Biomass (kg) In ($\bar{x} \pm 1$)	\bar{x} 3.50 σ 1.498	3.18 1.124	3.83 0.703	1.99 0.681	2.24 1.355	2.01 0.548	2.64 0.819
Depth (m)	Range \bar{x}	20-60 35.7	27-51 36.2	33-77 57.1	33-243 106.6	33-397 118.2	40-146 98.4 236-433 310.9
Temperature ($^{\circ}$ C)	Range \bar{x}	12-25 17.2	10-21 15.3	11-16 12.9	10-13 11.1	9-17 12.4	11-18 13.3 9-13 9.8

 \bar{x} = mean value σ = standard deviation

Table A-18. Cruise 75-12, Fall 1975.

SITE GROUP	I		II		III		IV		V		VI		VII		VIII	
	6	7	23	18	20	12	10	15								
No. of Stations																
Abundance ln (x+1)	\bar{x}	4.71	2.73	5.94	5.59	4.24	5.56	3.96	4.53							
	σ	2.283	0.842	0.772	1.090	1.167	0.951	0.889	1.102							
No. of Species	\bar{x}	12.2	4.1	12.0	9.2	5.6	10.7	4.9	11.6							
	σ	8.13	1.77	1.88	2.09	1.87	1.72	1.85	3.97							
Biomass (kg) ln (x+1)	\bar{x}	4.64	2.62	4.38	4.28	2.66	3.37	2.08	2.43							
	σ	1.843	1.388	1.027	1.184	1.147	0.856	1.278	0.952							
Depth (m)	Range	26-68	20-82	22-69	42-82	27-144	60-155	29-229	187-338							
	\bar{x}	35.3	41.7	44.9	59.4	85.3	102.8	111.4	261.2							
Temperature (°C)	Range	14-19	12-18	10-16	10-14	10-17	10-12	10-17	7-13							
	\bar{x}	16.8	15.3	13.6	11.4	12.3	11.4	12.7	10.1							

 \bar{x} = mean value σ = standard deviation

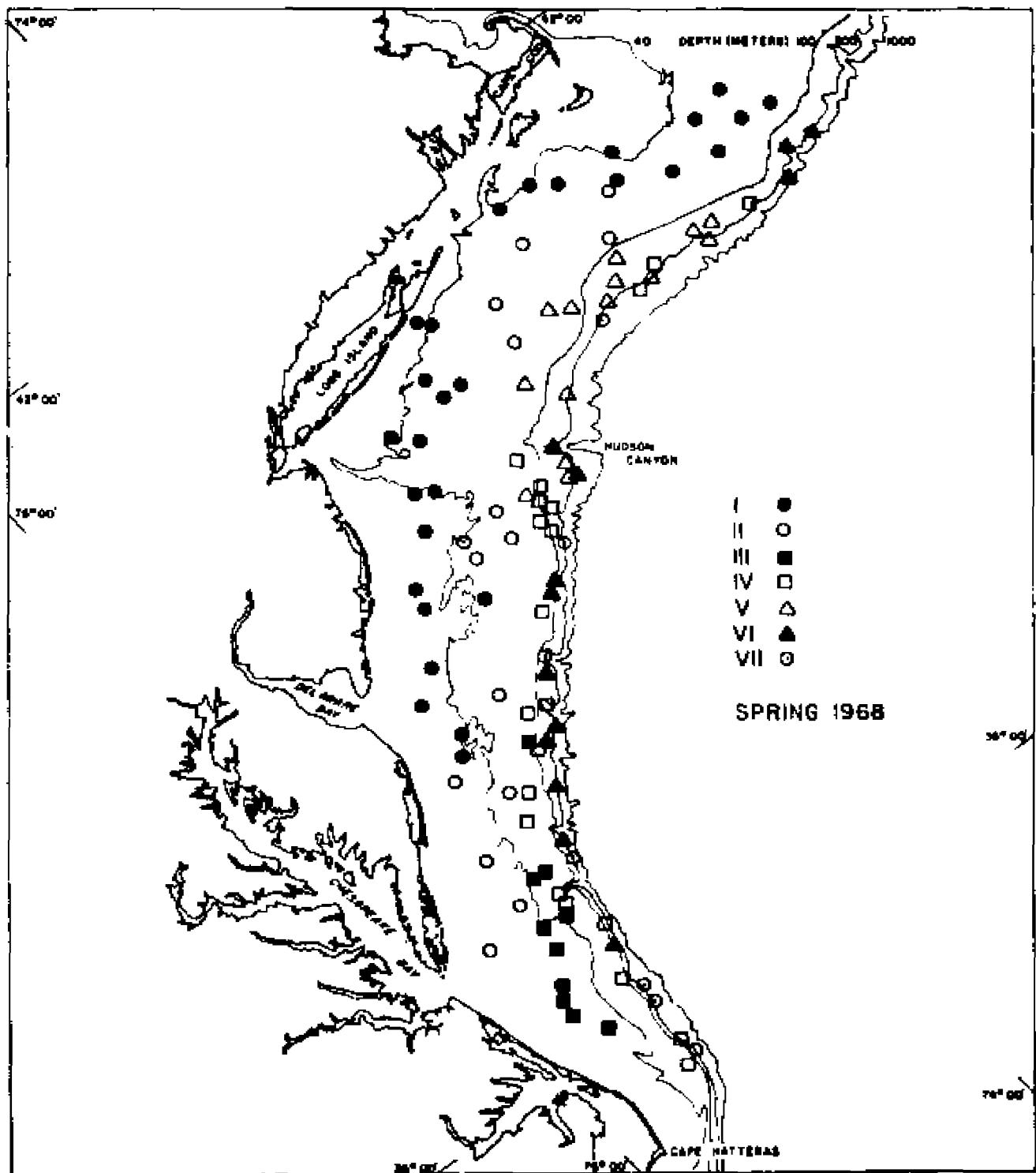
Table A-19. Cruise 69-8, Summer 1969.

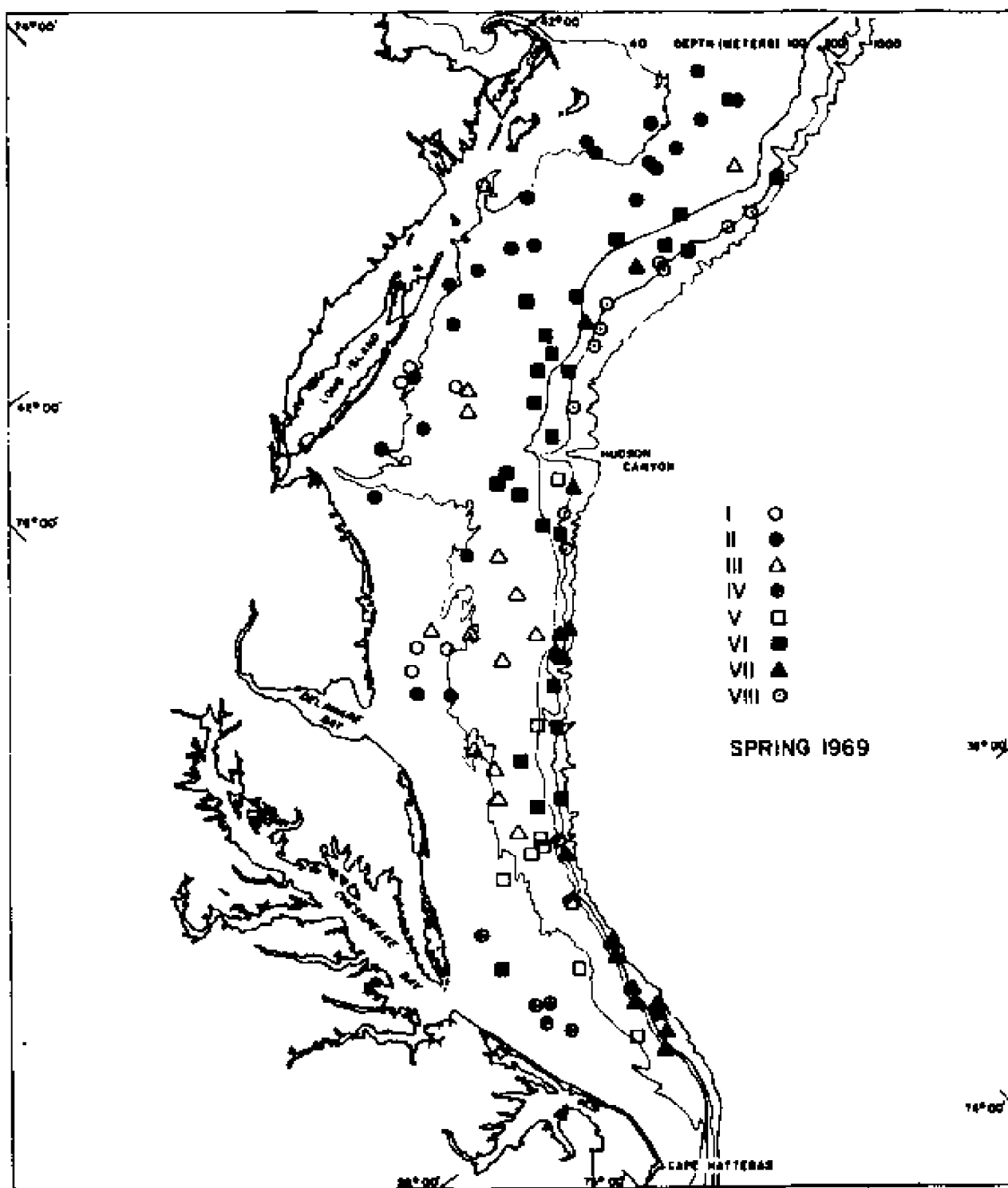
SITE GROUP	I					II					III					IV					V				
	23					37					15					12					16				
Abundance ln (x+1)	\bar{x}	5.28				\bar{x}	4.35				\bar{x}	4.32				\bar{x}	4.69				\bar{x}	3.64			
	σ	0.843				σ	2.224				σ	1.818				σ	1.393				σ	1.539			
No. of Species	\bar{x}	11.8				\bar{x}	5.7				\bar{x}	4.0				\bar{x}	6.8				\bar{x}	7.2			
	σ	2.76				σ	2.74				σ	1.96				σ	2.83				σ	3.99			
Biomass (kg) ln (x+1)	\bar{x}	3.55				\bar{x}	2.35				\bar{x}	1.77				\bar{x}	2.27				\bar{x}	1.40			
	σ	0.997				σ	1.662				σ	1.547				σ	1.770				σ	0.962			
Depth (m)	Range	31-86				Range	27-141				Range	24-88				Range	60-187				Range	66-375			
	\bar{x}	56.1				\bar{x}	67.5				\bar{x}	43.3				\bar{x}	128.5				\bar{x}	235.1			
Temperature (°C)	Range	6-13				Range	6-16				Range	7-15				Range	10-14				Range	8-12			
	\bar{x}	9.0				\bar{x}	9.2				\bar{x}	11.0				\bar{x}	11.9				\bar{x}	10.1			

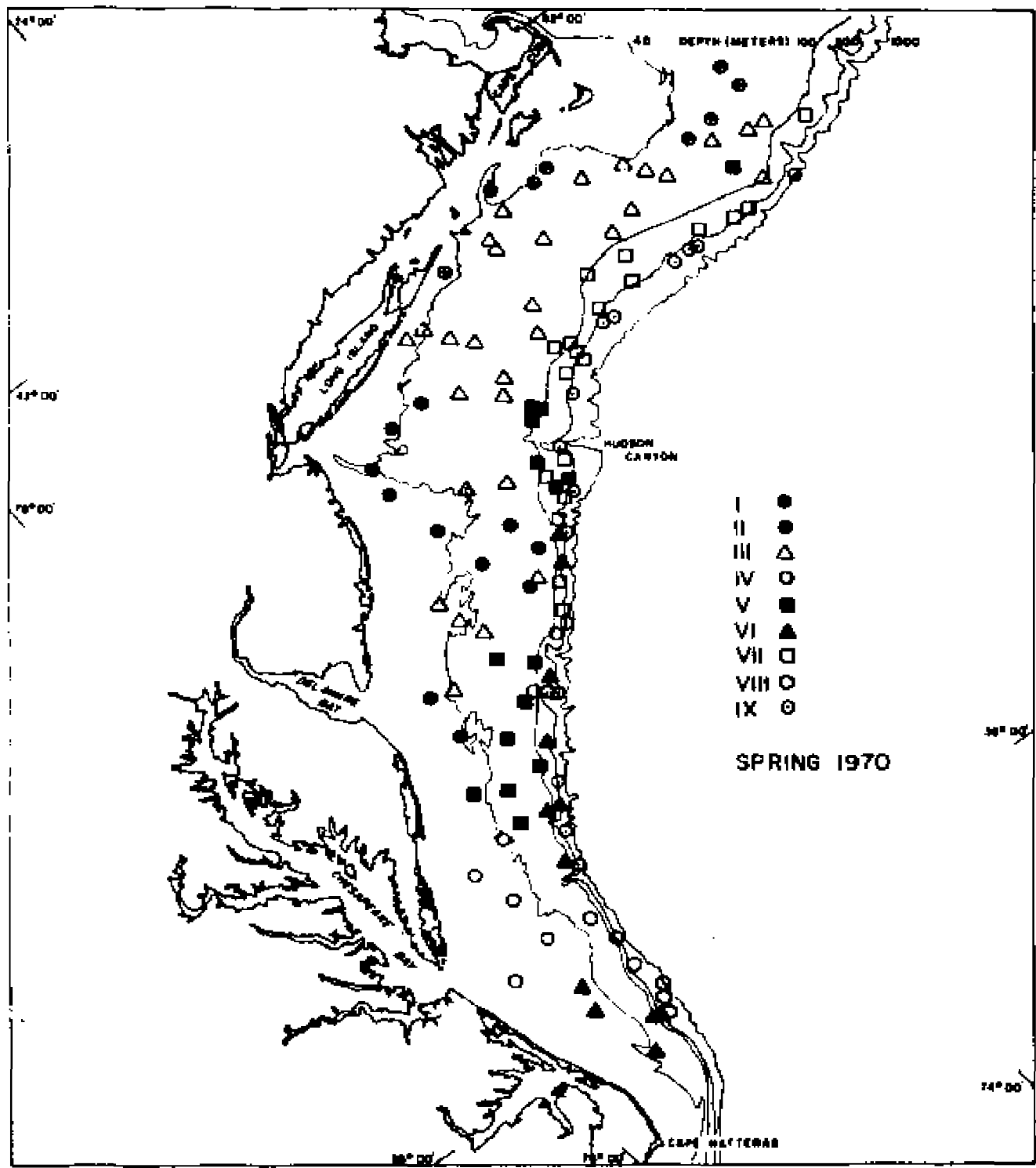
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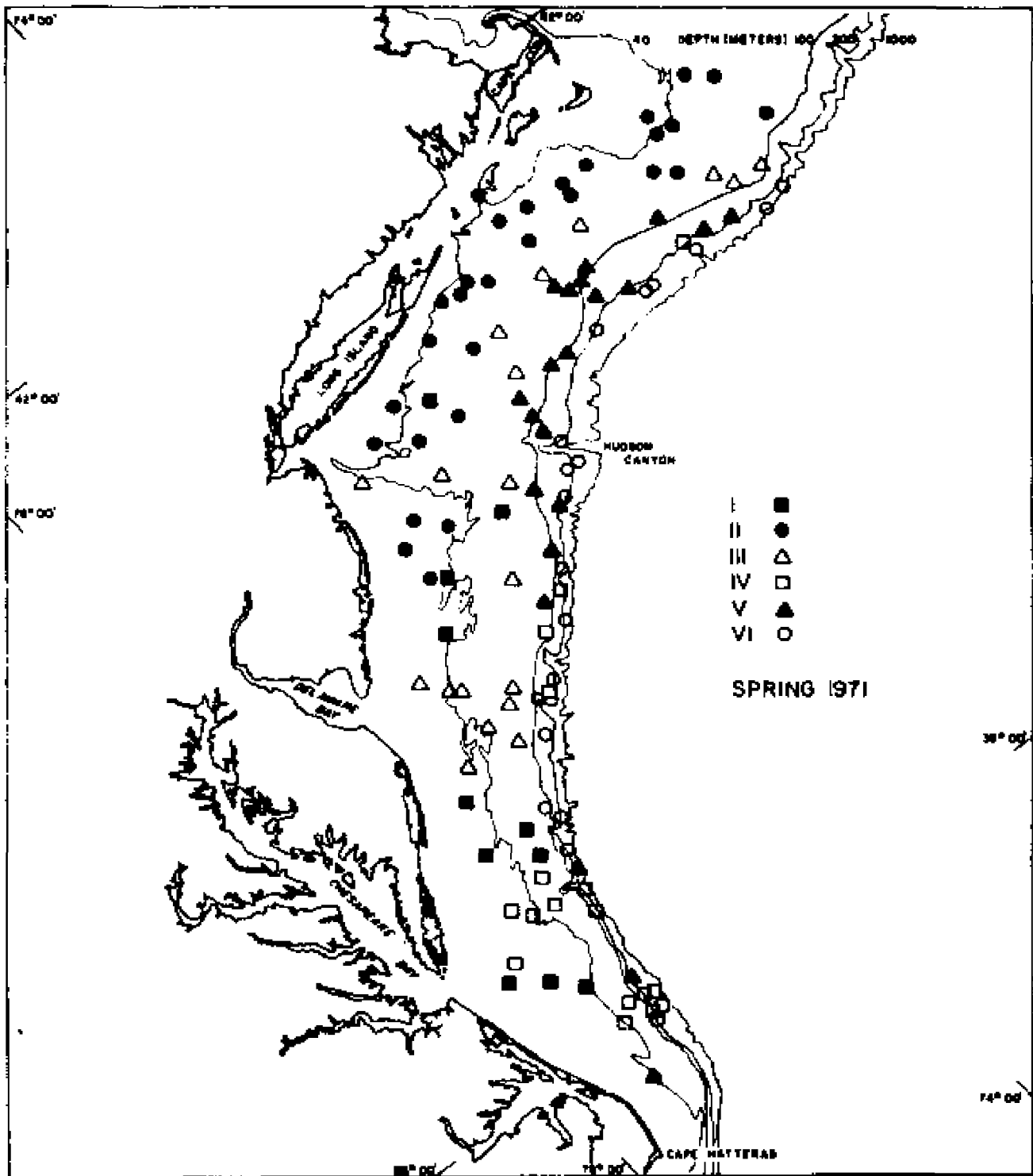
APPENDIX B

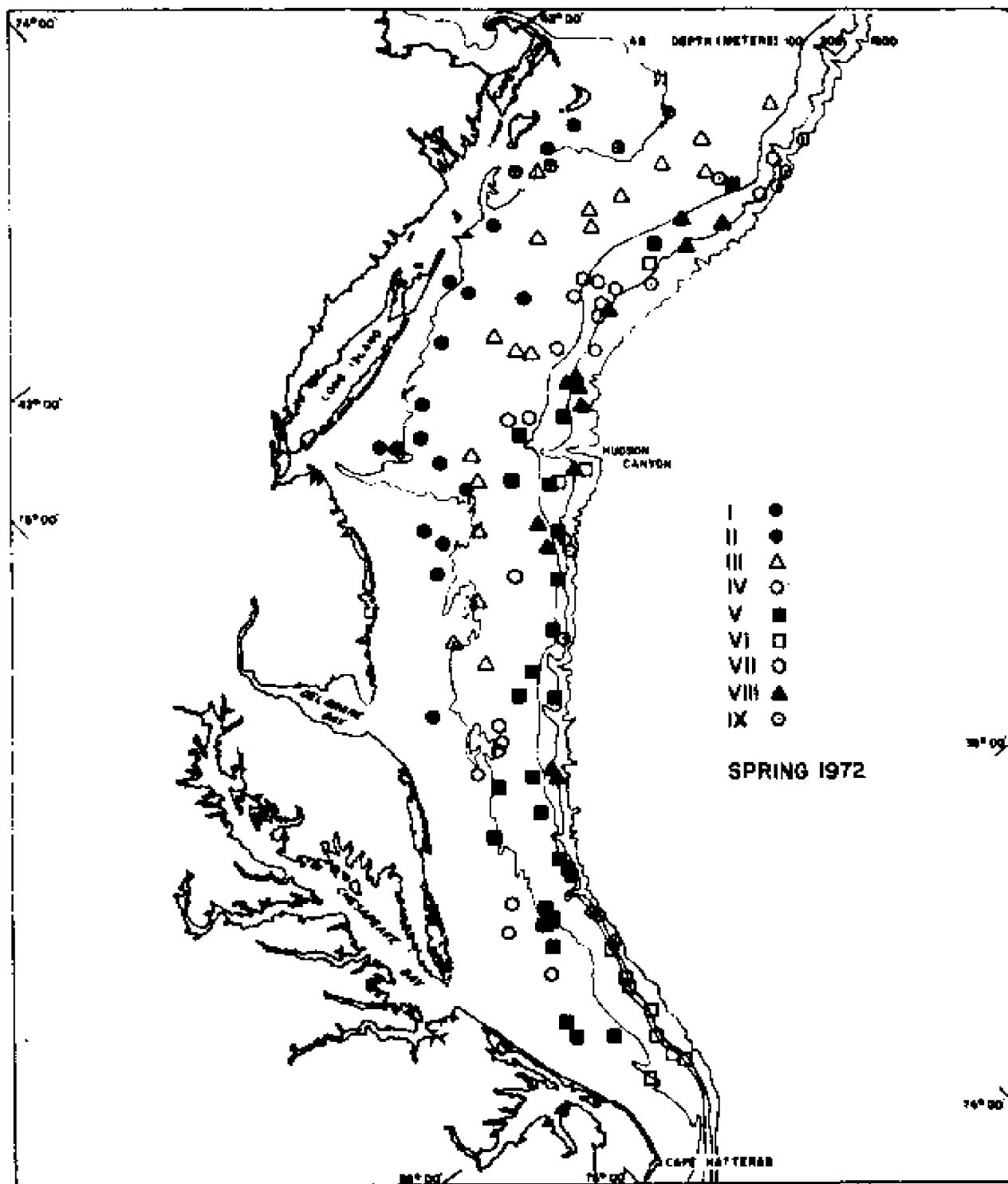
**Site groups identified for NMFS Groundfish Survey Cruises,
Fall 1967 - Spring 1976.**

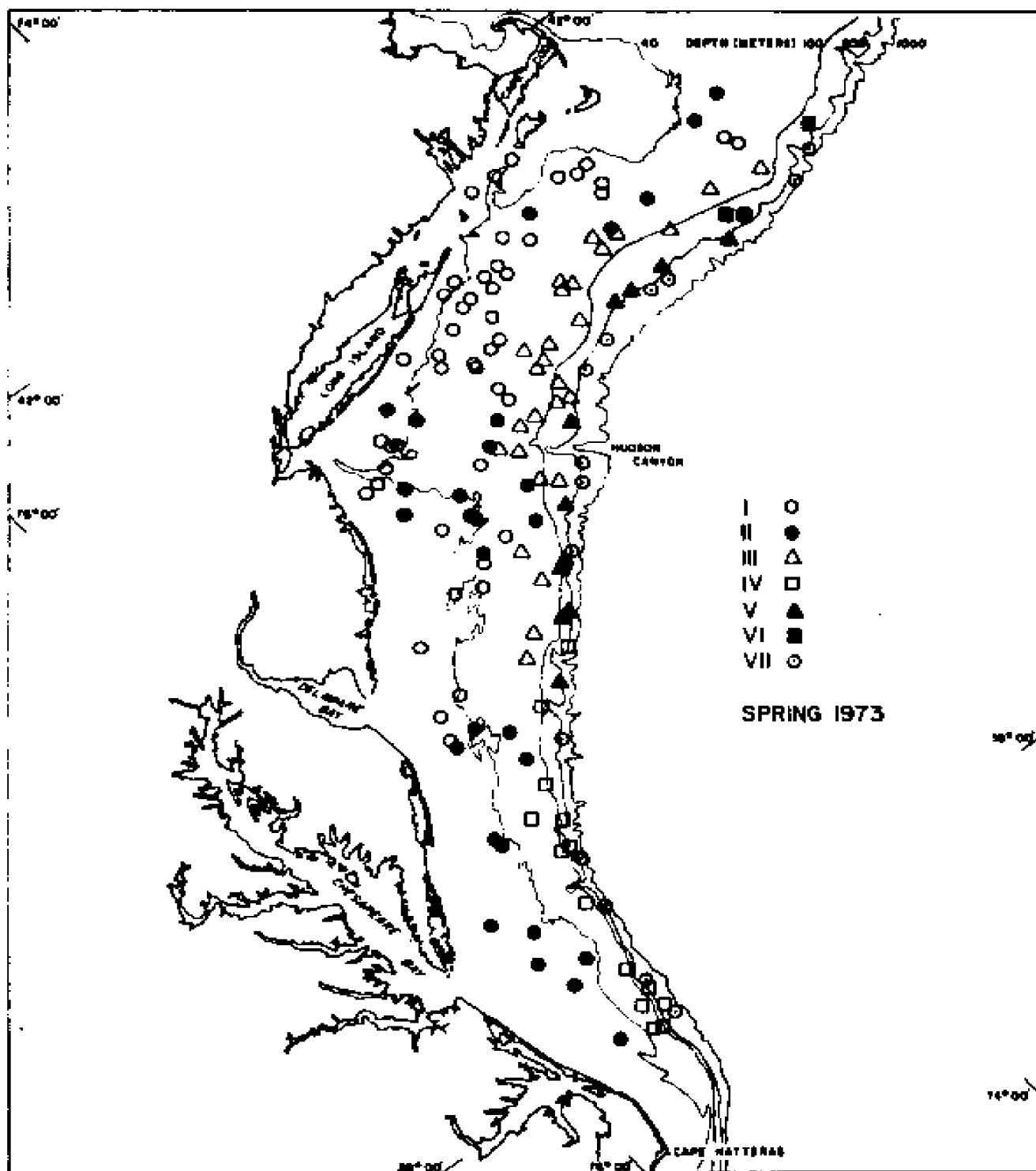


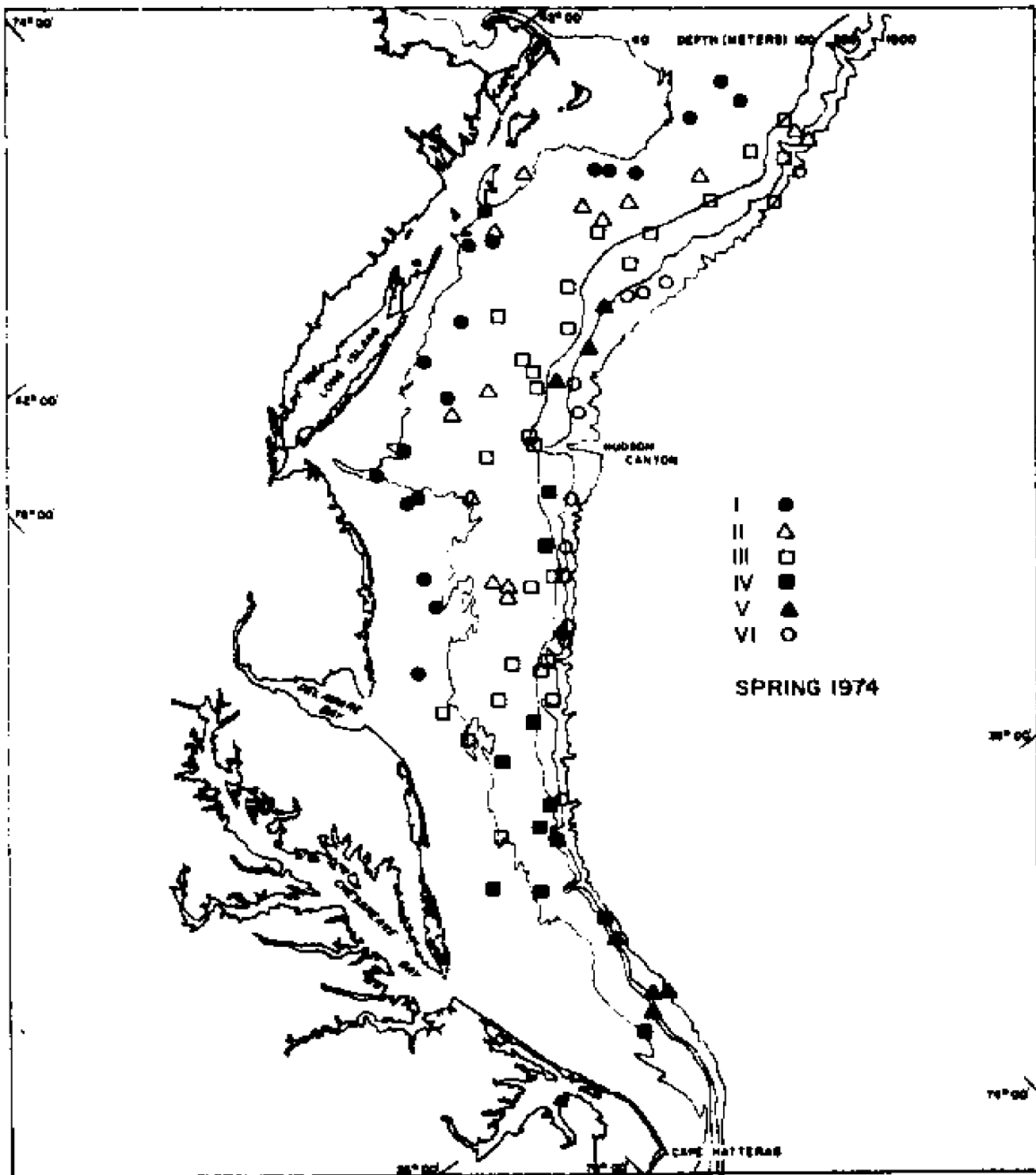


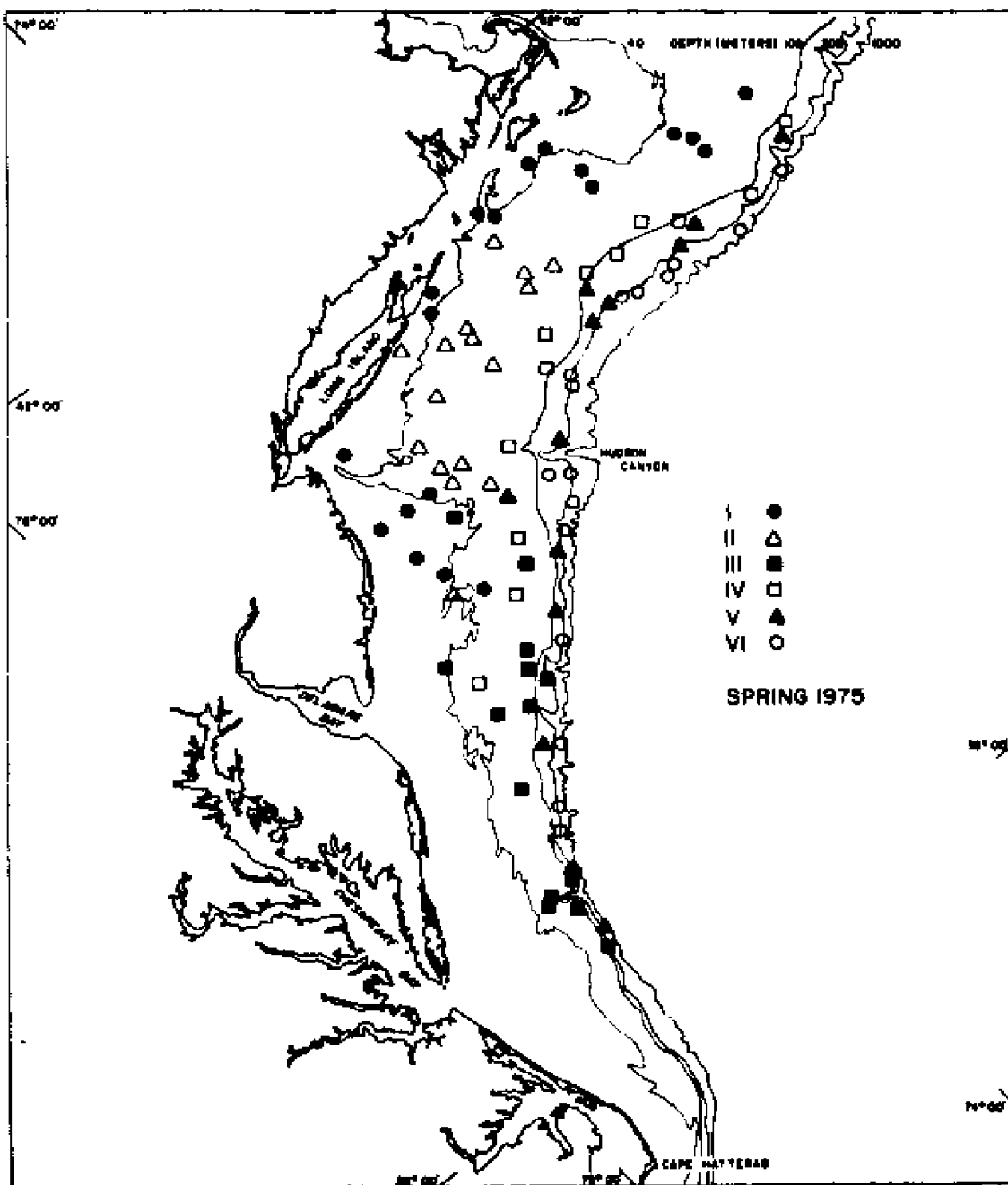


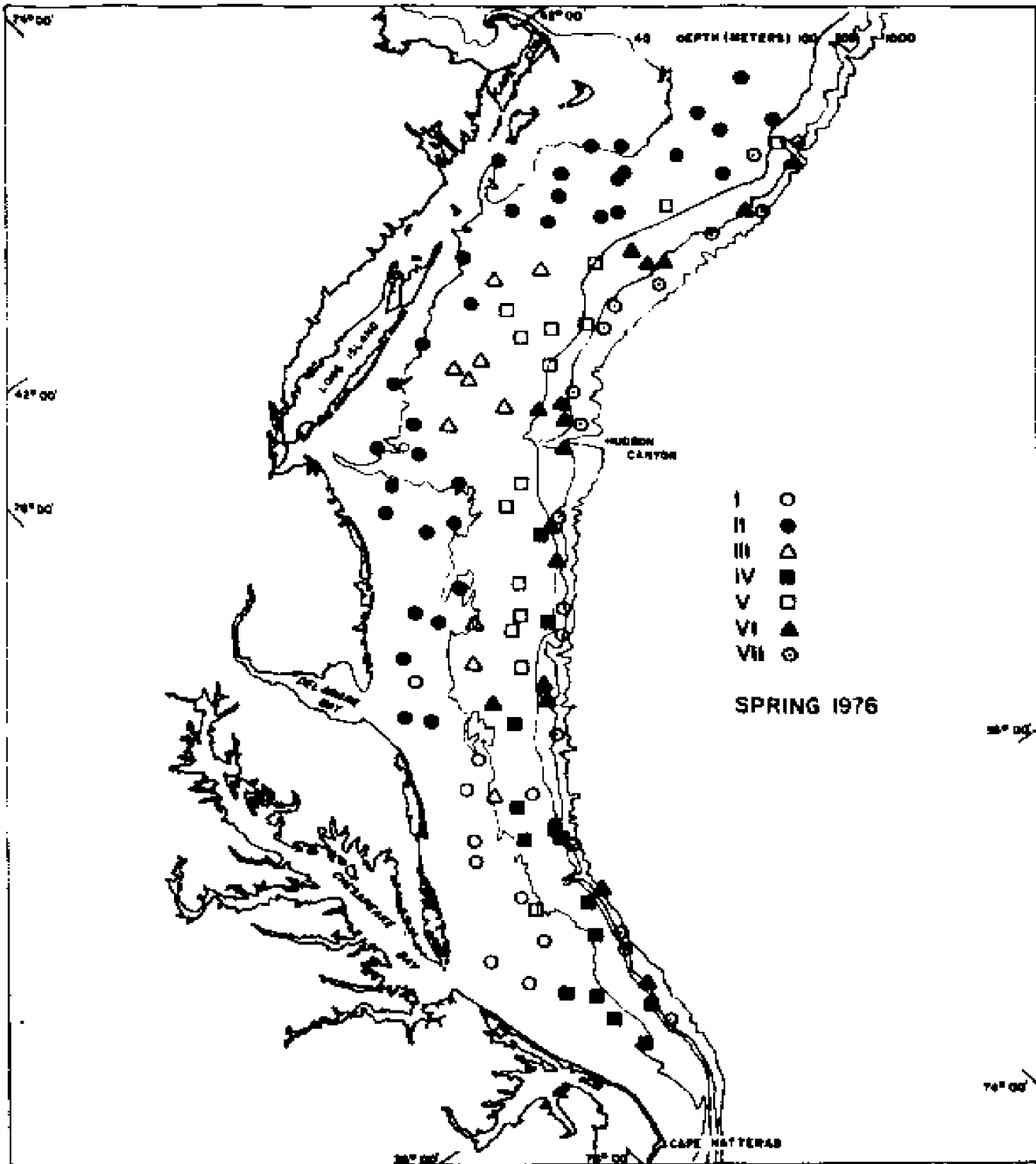


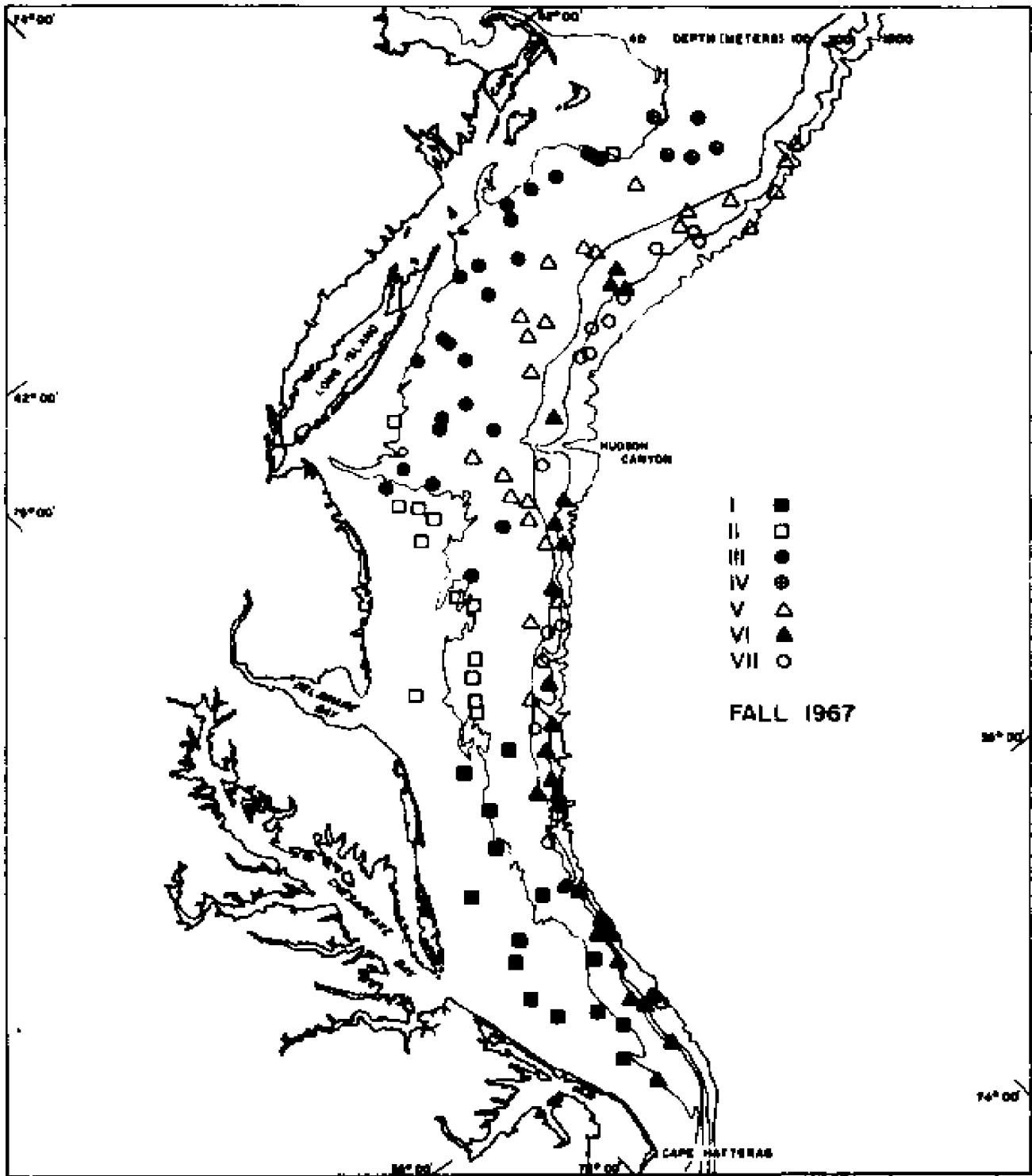


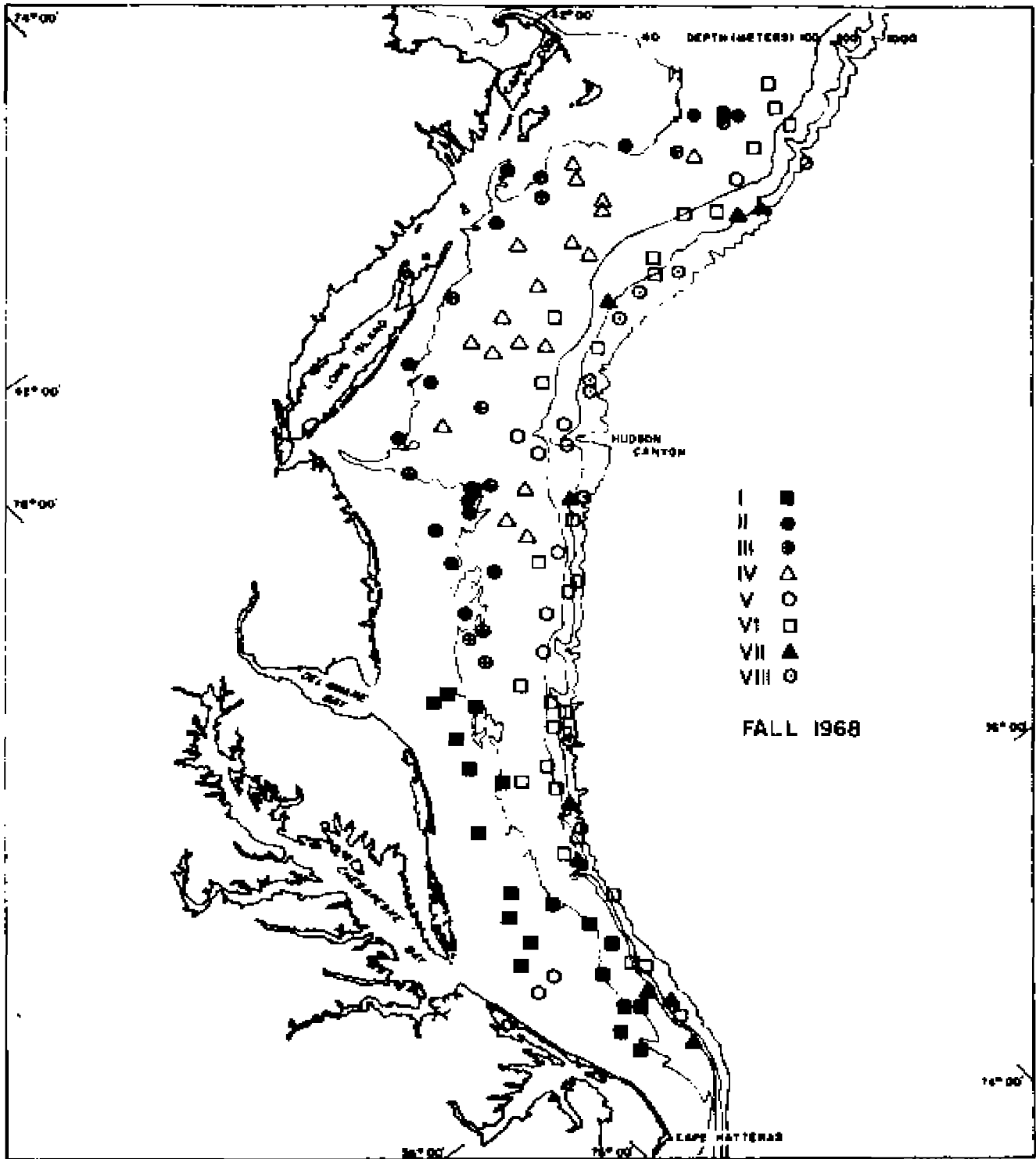


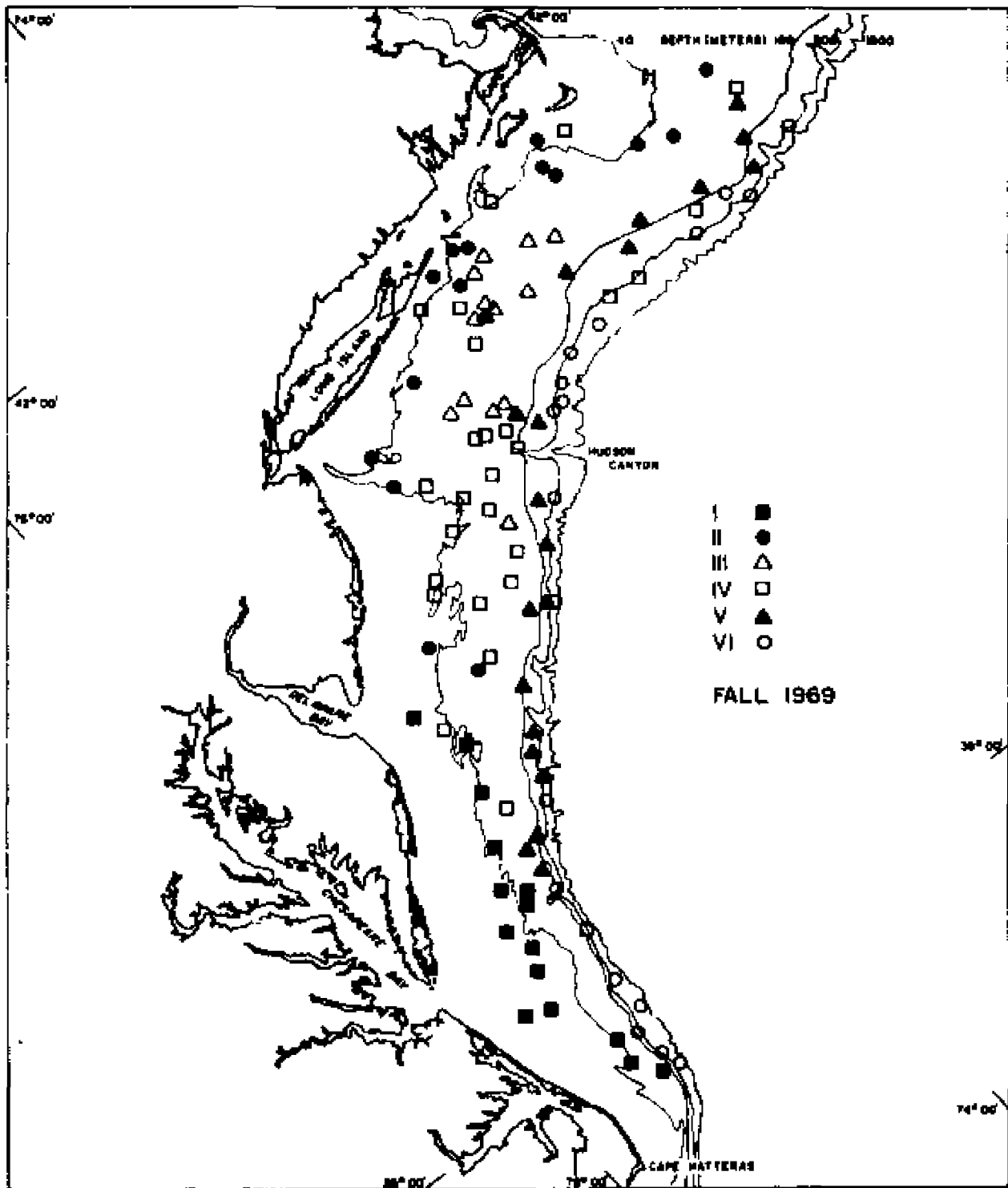


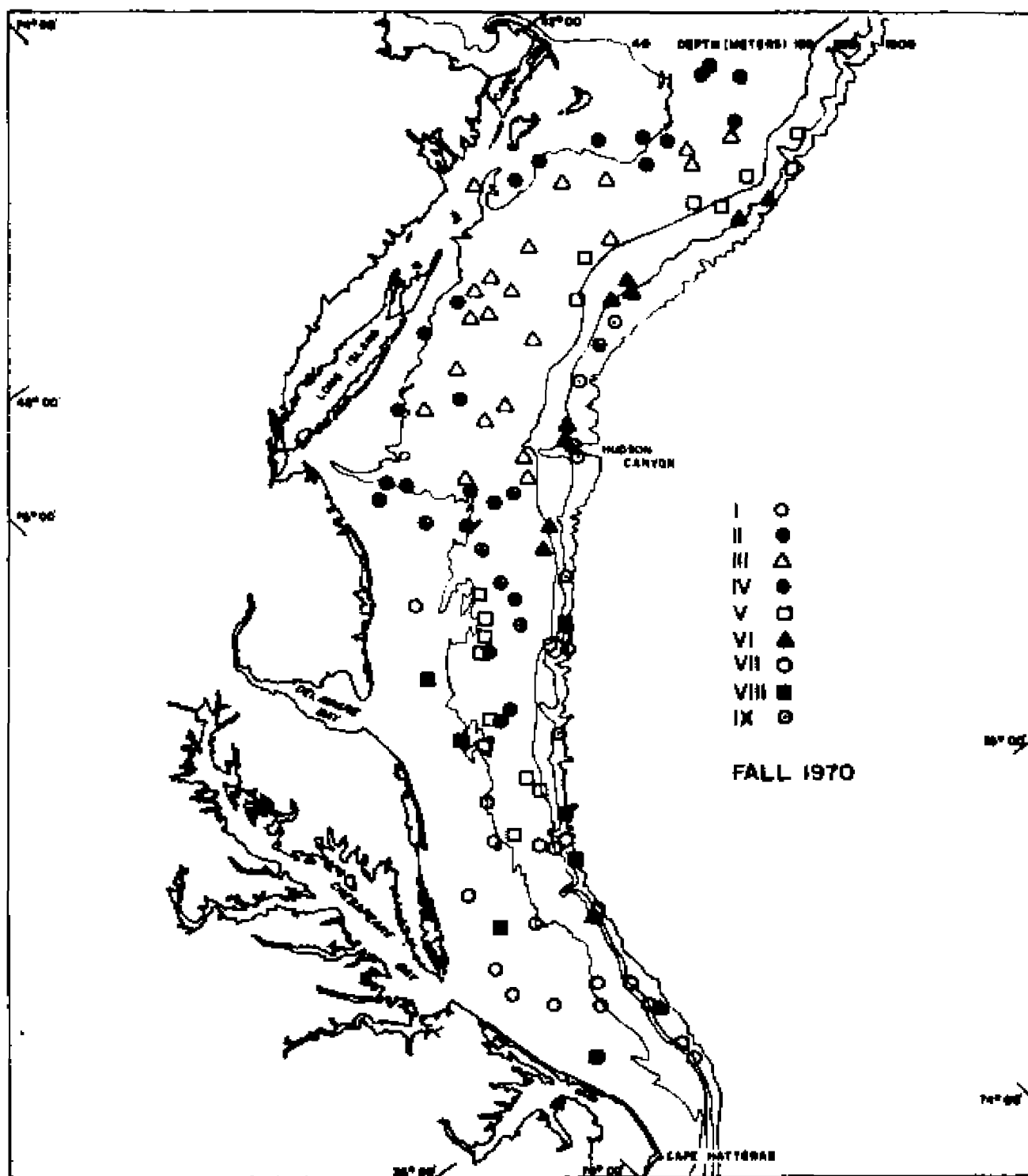


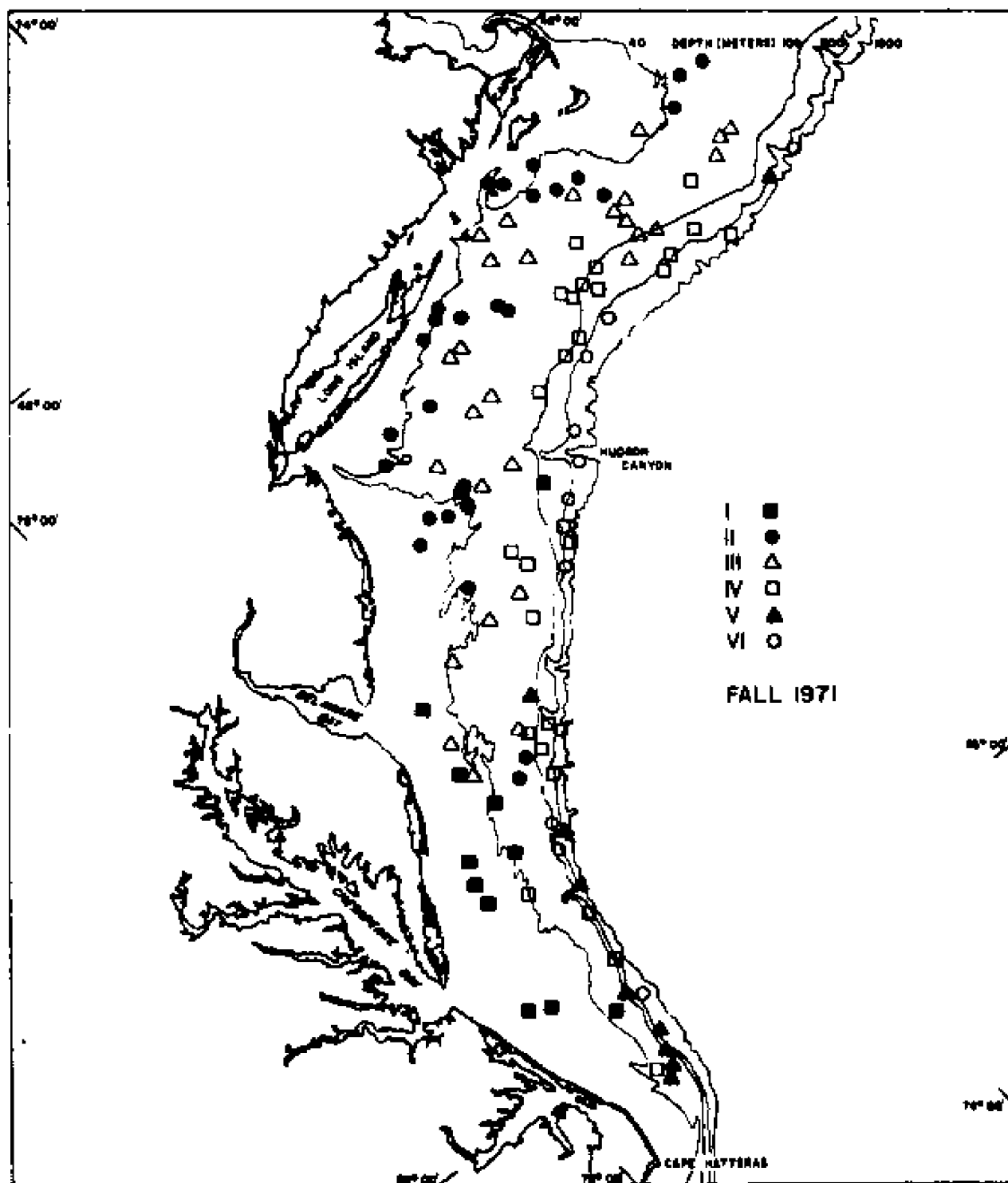


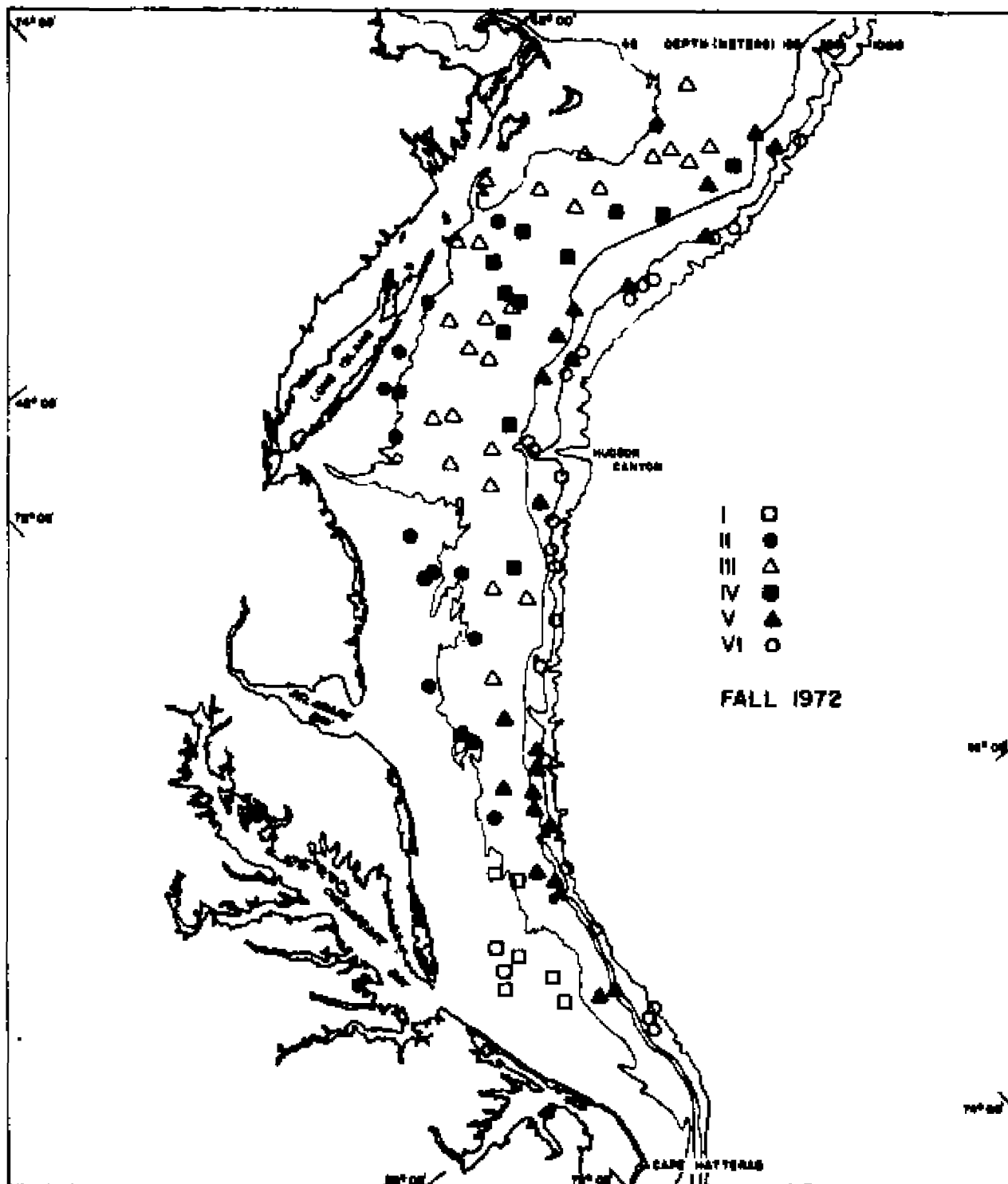


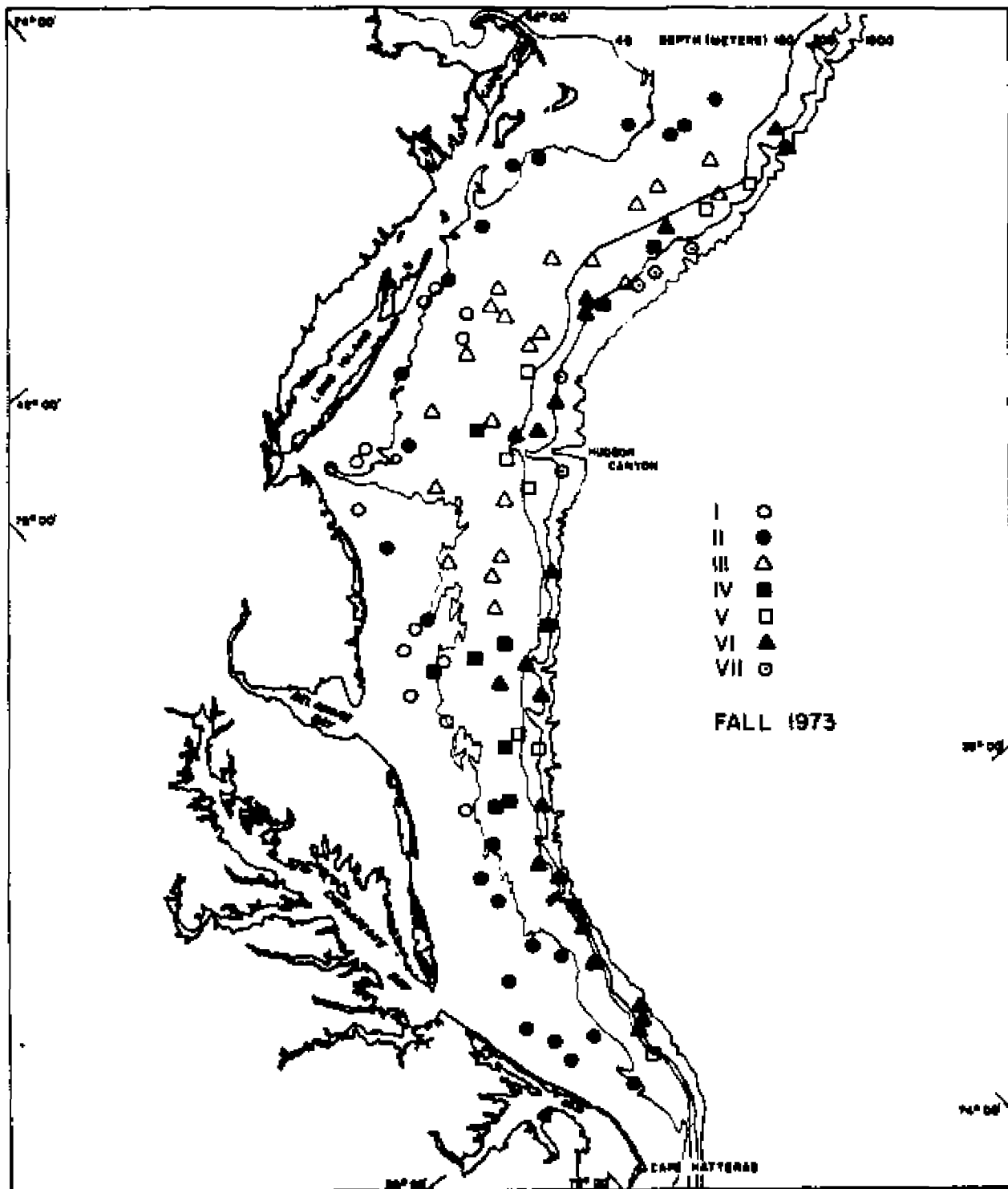


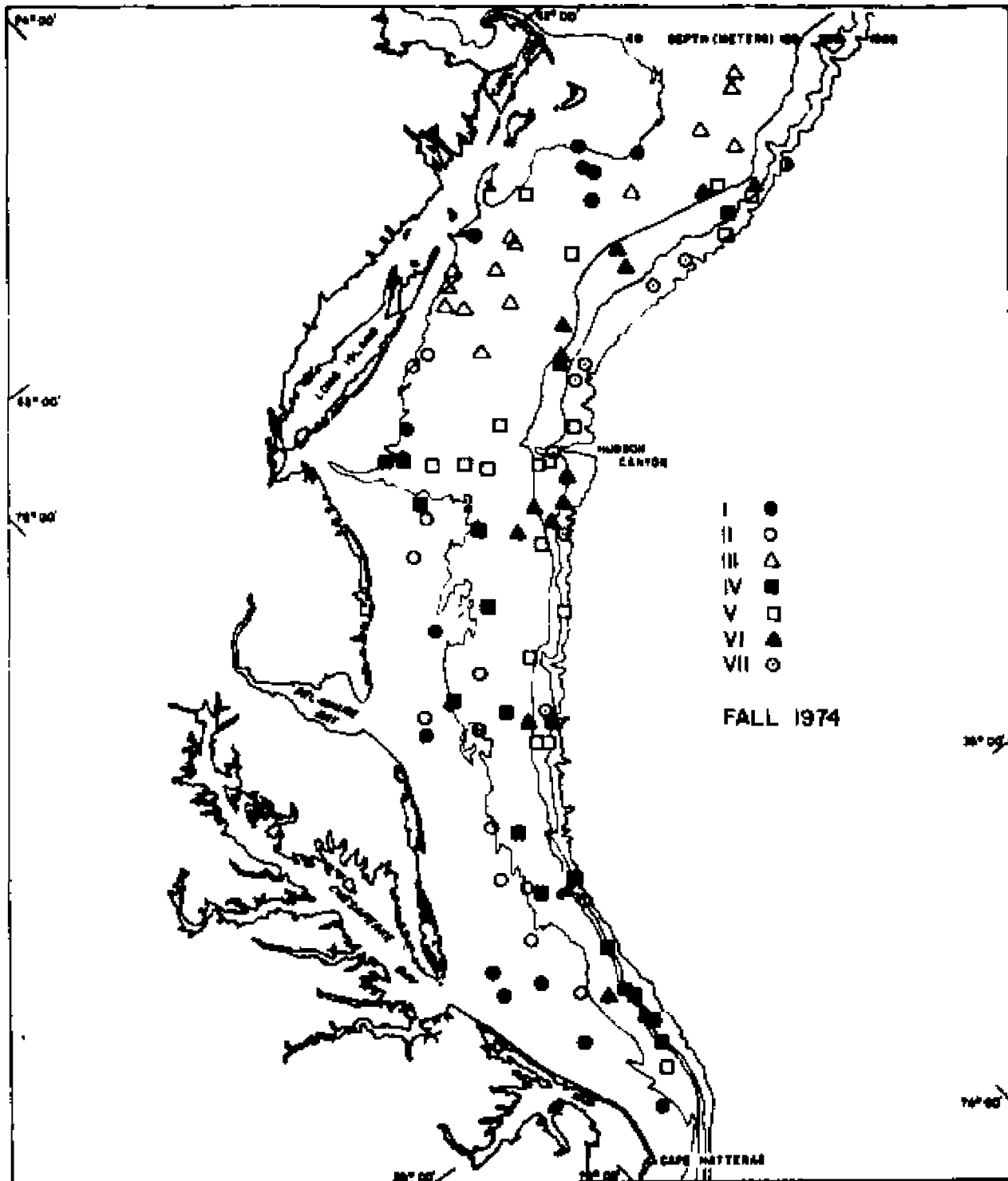


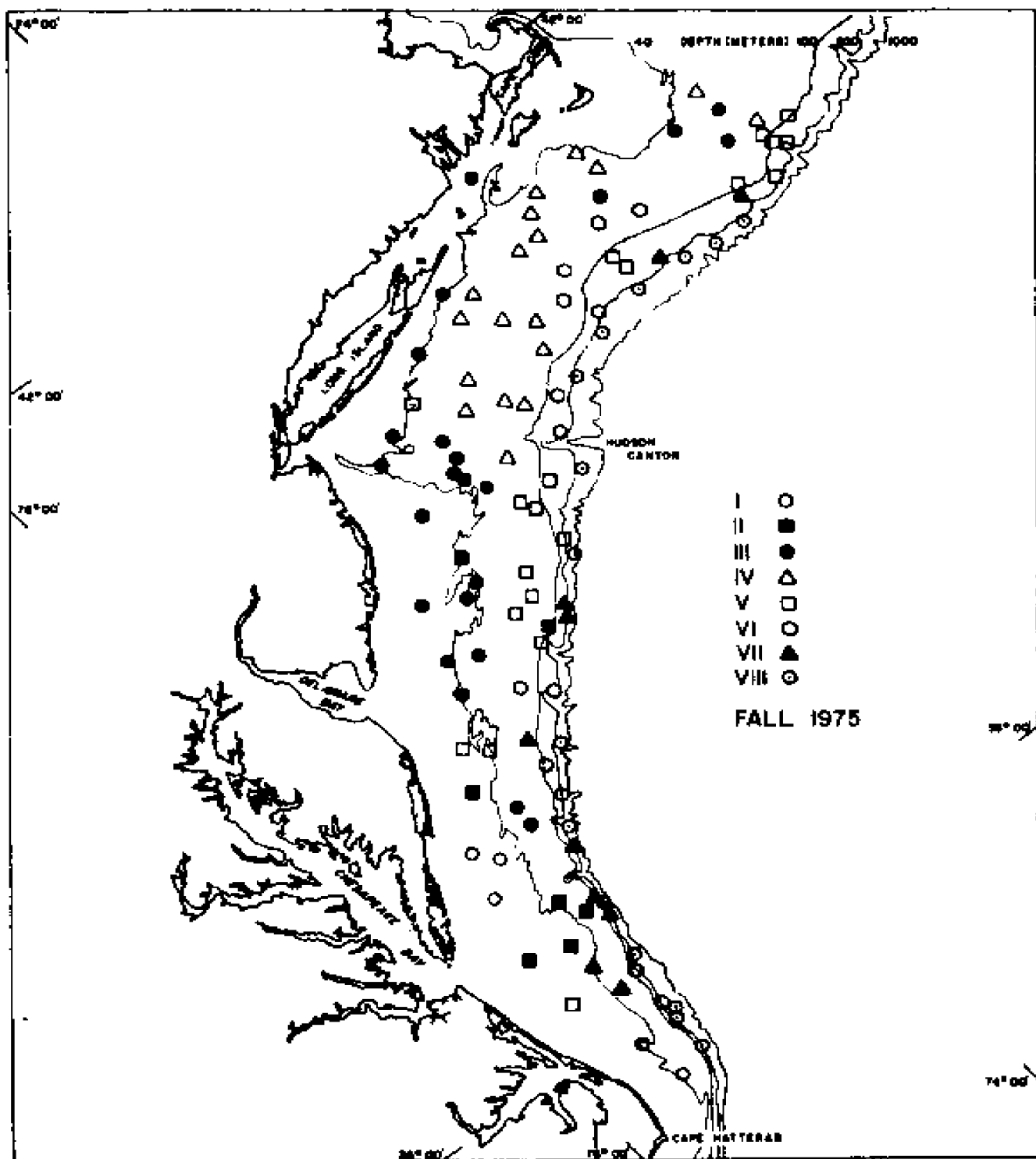


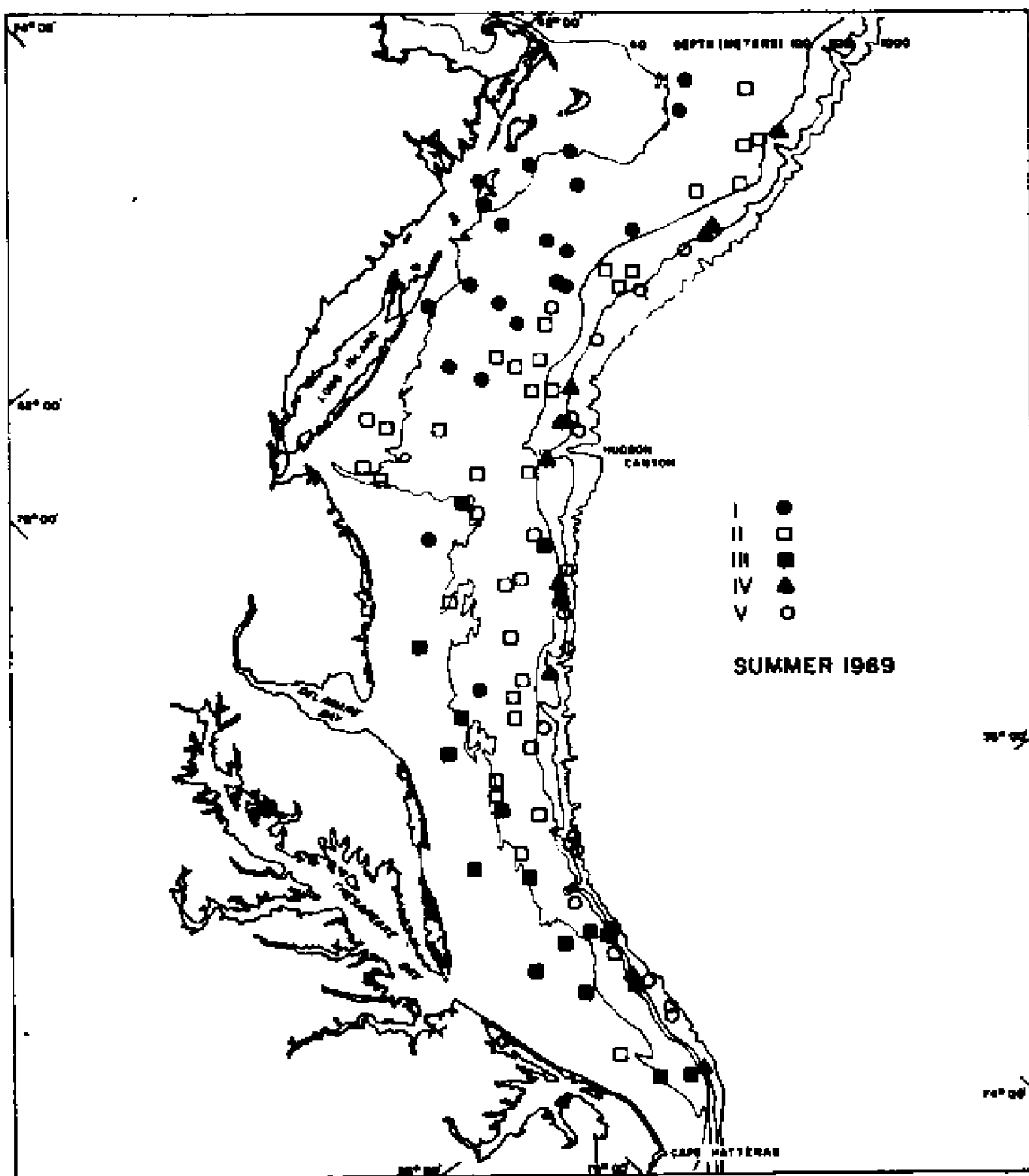












APPENDIX C

**Species groups identified for NMFS Groundfish Survey Cruises,
Fall 1967 - Spring 1976.**

Table C-2. Cruise 69-2, Spring 1969.*

A	B	C
<u>Gadus morhua</u> Bo	<u>Melanogrammus aeglefinus</u> Bo	<u>Alosa aestivialis</u> WT
<u>Pseudopleuronectes americanus</u> Bo	<u>Hippoglossoides platessoides</u> Bo	<u>Menidia menidia</u> WT
<u>Hemitripterus americanus</u> Bo		
	D	E
<u>Myoxocephalus octodecemspinosus</u> Bo	<u>Alosa pseudoharengus</u> Bo	<u>Glyptocephalus cynoglossus</u> Bo-SI
<u>Limanda ferruginea</u> Bo	<u>Clupea harengus harengus</u> Bo	<u>Urophycis tenuis</u> Bo-SI
<u>Macrozoarces americanus</u> Bo	<u>Merluccius bilinearis</u> Bo	<u>Lophius americanus</u> Bo
<u>Scophthalmus aquosus</u> IS	<u>Squalus acanthias</u> Bo	
<u>Raja ocellata</u> Bo	<u>Urophycis chuss</u> Bo	
<u>Raja eripatea</u> Bo		
	F	G
<u>Peprilus triacanthus</u> WT	<u>Prionotus evolvans</u> WT	<u>Helicolenus dactylopterus</u> SI
<u>Hippoglossina oblonga</u> OS	<u>Centropristis striata</u> WT	<u>Urophycis regius</u> WT
<u>Prionotus carolinus</u> WT	<u>Stenotomus chrysops</u> WT	<u>Peristedion miniatum</u> Bo
<u>Citharichthys arctifrons</u> SI		<u>Scomber scombrus</u> Bo
<u>Lepophidium cervinum</u> OS		
	H	I

*Faunal affinity is designated after each species name: boreal, Bo; warm-temperate, WT; outer-shelf, OS; inner-shelf, IS; slope, SI; mesopelagic, Mp.

Table C-3. Cruise 70-3, Spring 1970.*

A	B	C
<u>Gadus morhua</u> Bo	<u>Hemirhamphus americanus</u> Bo	<u>Raja erinacea</u> Bo
<u>Pseudopleuronectes americanus</u> Bo	<u>Scophthalmus aquosus</u> IS	<u>Myoxocephalus octodecemspinosus</u> Bo
	<u>Hippoglossoides platessoides</u> Bo	<u>Clupea harengus harengus</u> Bo
		<u>Limanda ferruginea</u> Bo
		<u>Macrozoarces americanus</u> Bo
D	E	F
<u>Merluccius bilinearis</u> Bo	<u>Stenotomus chrysops</u> WT	<u>Lepophidium cervinum</u> OS
<u>Urophycis chuss</u> Bo	<u>Peprilus triacanthus</u> WT	<u>Citharichthys arctifrons</u> S1
<u>Squalus acanthias</u> Bo	<u>Prionotus carolinus</u> WT	<u>Urophycis tenuis</u> Bo-S1
<u>Scorpaenopsis diabolus</u> Bo		<u>Glyptocephalus cynoglossus</u> Bo-S1
<u>Hippoglossina oblonga</u> OS		<u>Lophius americanus</u> Bo
<u>Alosa pseudoharengus</u> Bo		
G	H	
<u>Centropristis striata</u> WT	Myctophidae Mp	
<u>Prionotus evolvans</u> WT	<u>Chlorophthalmus agassizi</u> S1	
<u>Urophycis regia</u> WT	<u>Helicolenus dactylopterus</u> S1	
	<u>Merluccius albidus</u> S1	

*Famnal affinity is designated after each species name: boreal, Bo; warm-temperate, WT; outer-shelf, OS; inner-shelf, IS; slope, S1; mesopelagic, Mp.

Table C-5. Cruise 72-2, Spring 1972.*

A	B	C
<u>Aloea aestivialis</u> WT	<u>Limanda ferruginea</u> Bo	<u>Hemitripterus americanus</u> Bo
<u>Clupea harengus harengus</u> Bo	<u>Macrozoarces americanus</u> Bo	<u>Gadus merhua</u> Bo
<u>Pseudopleuronectes americanus</u> Bo	<u>Raja erinacea</u> Bo	
<u>Menidia menidia</u> WT	<u>Scophthalmus aquosus</u> IS	
	<u>Myoxocephalus octodecemspinosus</u> Bo	
	<u>Raja ocellata</u> Bo	
		F
D	E	
<u>Lophius americanus</u> Bo	<u>Squalus acanthias</u> Bo	<u>Prionotus carolinus</u> WT
<u>Citharichthys arctifrons</u> SI	<u>Merluccius bilinearis</u> Bo	<u>Peprius triacanthus</u> WT
	<u>Hippoglossina oblonga</u> OS	
	<u>Urophycis chuss</u> Bo	
		H
G	I	
<u>Aloea pseudoharengus</u> Bo	<u>Urophycis regius</u> WT	<u>Phycis chesteri</u> SI
<u>Scorpaenopsis barbatula</u> Bo	<u>Paralichthys dentatus</u> WT	<u>Myctophidae</u> Mp
	<u>Stenotomus chrysops</u> WT	<u>Helicolenus dactylopterus</u> SI
	<u>Centropristis striata</u> WT	<u>Urophycis tenuis</u> Bo-SI
	<u>Prionotus evolans</u> WT	<u>Merluccius albidus</u> SI
		<u>Glyptocephalus cynoglossus</u> Bo-SI

*Faunal affinity is designated after each species name: boreal, Bo; warm-temperate, WT; outer-shelf, OS; inner-shelf, IS; slope, SI; mesopelagic, Mp.

Table C-9. Cruise 76-2, Spring 1976.*

A	B	C
<u>Clupea harengus harengus</u> Bo	<u>Gadus morhua</u> Bo	<u>Raja erinacea</u> Bo
<u>Pseudopleuronectes americanus</u> Bo	<u>Myoxcephalus octodecemspinosus</u> Bo	<u>Scophthalmus aquosus</u> IS
<u>Alosa aestivalis</u> WT	<u>Pollachius virens</u> Bo	<u>Limanda ferruginea</u> Bo
<u>Hemitripterus americanus</u> Bo		<u>Macrozoarces americanus</u> Bo
<u>Ammodytes dubius</u> Bo		<u>Alosa pseudoharengus</u> Bo
<u>Etropus microstomus</u> IS		
<u>Scorpaenopsis scabrata</u> Bo		
D	E	F
<u>Merluccius bilinearis</u> Bo	<u>Urophycis regius</u> WT	Myctophidae Mp
<u>Squalus acanthias</u> Bo	<u>Centropristis striata</u> WT	<u>Merluccius albidus</u> S1
<u>Hippoglossina oblonga</u> OS	<u>Stenotomus chrysops</u> WT	<u>Helicolenus dactylopterus</u> S1
<u>Lophius americanus</u> Bo	<u>Peprilus triacanthus</u> WT	<u>Chloropthalmus agassizi</u> S1
<u>Urophycis chuss</u> Bo	<u>Paralichthys dentatus</u> WT	<u>Lepophidium cervinum</u> OS
<u>Citharichthys arctifrons</u> S1	<u>Prionotus carolinus</u> WT	<u>Peristedion miniatum</u> Bo
		<u>Maurolicus muelleri</u> Mp
		<u>Polymixia lowei</u> S1
		<u>Glyptocephalus cynoglossus</u> Bo-S1
		<u>Urophycis tenuis</u> Bo-S1
		Cynoglossidae

*Faunal affinity is designated after each species name: boreal, Bo; warm-temperate, WT; outer-shelf, OS; inner-shelf, IS; slope, S1; mesopelagic, Mp.

Table C-14. Cruise 71-6, Fall 1971.*

A	B	C
<u>Mustelus canis</u> WT	<u>Etrumeus teres</u> WT	<u>Melanogrammus aeglefinus</u> Bo
<u>Pomatomus saltatrix</u> WT	<u>Scomber scombrus</u> Bo	<u>Myoxocephalus octodecemspinosus</u> Bo
<u>Stenotomus chrysops</u> WT		<u>Scophthalmus aquosus</u> IS
<u>Paralichthys dentatus</u> WT		<u>Pseudopleuronectes americanus</u> Bo
<u>Prionotus carolinus</u> WT		<u>Raja erinacea</u> Bo
<u>Centropristis striata</u> WT		<u>Squalus acanthias</u> Bo
		<u>Limanda ferruginea</u> Bo
D	E	F
<u>Macropodus americanus</u> Bo	<u>Urophycis chuss</u> Bo	<u>Lophius americanus</u> Bo
<u>Hemitripterus americanus</u> Bo	<u>Merluccius bilinearis</u> Bo	<u>Glyptocephalus cynoglossus</u> Bo-SI
	<u>Hippoglossina oblonga</u> OS	
	<u>Citharichthys arctifrons</u> SI	
	<u>Peprilus triacanthus</u> WT	
	<u>Urophycis regius</u> WT	
G	H	I
<u>Alosa aestivalis</u> WT	<u>Lepophidium cervinum</u> OS	<u>Helicolenus dactylopterus</u> SI
<u>Alosa sapidissima</u> Bo		<u>Myctophidae</u> Mp
<u>Urophycis tenuis</u> Bo-SI		<u>Chlorocephalus agassizi</u> SI
		<u>Merluccius albidus</u> SI
		<u>Nezumia bairdii</u> SI

*Faunal affinity is designated after each species name: boreal, Bo; warm-temperate, WT; outer-shelf, OS; inner-shelf, IS; slope, SI; mesopelagic, Mp.

Table C-15. Cruise 72-8, Fall 1972.*

A	B	C
<u>Centropristis striata</u> WT	<u>Stenotomus chrysops</u> WT	<u>Mustelus canis</u> WT
<u>Raja eglanteria</u> WT	<u>Pseudopleuronectes americanus</u> Bo	<u>Raja ocellata</u> Bo
<u>Paralichthys dentatus</u> WT	<u>Prionotus carolinus</u> WT	<u>Pomatomus saltatrix</u> WT
<u>Dasyatis centroura</u> WT	<u>Scophthalmus aquosus</u> IS	<u>Etrumeus teres</u> WT
		F
<u>Merluccius bilinearis</u> Bo	<u>Raja erinacea</u> Bo	<u>Hemirhamphus americanus</u> Bo
<u>Citharichthys arctifrons</u> S1	<u>Limanda ferruginea</u> Bo	<u>Glyptocephalus cynoglossus</u> Bo-S1
<u>Lophius americanus</u> Bo	<u>Myoxocephalus octodecemspinosus</u> Bo	<u>Macrozoarces americanus</u> Bo
<u>Hippoglossina oblongus</u> Bo	<u>Squalus acanthias</u> Bo	<u>Ophichthus ctenotifer</u> OS
<u>Urophycis chuss</u> Bo		<u>Urophycis tenuis</u> Bo-S1
<u>Urophycis regius</u> WT		<u>Enchelyopus cimbrius</u> S1
<u>Peprilus triacanthus</u> WT		
<u>Lepophidium cervinum</u> OS		
		H
	<u>Raja garmani</u> S1	<u>Merluccius albidus</u> S1
	<u>Peristedion miniatum</u> Bo	<u>Helicolenus dactylopterus</u> S1
	<u>Scorpaenopsis diabolus</u> Bo	<u>Myctophidae</u> Mp
		<u>Chlorophthalmus agassizii</u> S1
		<u>Argentina silus</u> S1
		<u>Stomatolides</u> Mp
		<u>Nezumia bairdii</u> S1

*Faunal affinity is designated after each species name: boreal, Bo; warm-temperate, WT; outer-shelf, OS; inner-shelf, IS; slope, S1; mesopelagic, Mp.

Table C-16. Cruise 73-8, Fall 1973.*

A	B	C
<u>Frimotus carolinus</u> WT	<u>Mustelus canis</u> WT	<u>Squalus acanthias</u> Bo
<u>Scophthalmus aquosus</u> IS	<u>Raja erinacea</u> Bo	<u>Raja ocellata</u> Bo
<u>Paralichthys dentatus</u> WT	<u>Pseudopleuronectes americanus</u> Bo	
<u>Pomatobius saltatrix</u> WT	<u>Stenotomus chrysops</u> WT	
<u>Raja eglanteria</u> WT	<u>Limanda ferruginea</u> Bo	
D	E	
<u>Merluccius bilinearis</u> Bo	<u>Helicolenus dactylopterus</u> SI	
<u>Hippoglossina oblonga</u> OS	<u>Merluccius albidus</u> SI	
<u>Citharichthys arcifrons</u> SI	<u>Myctophidae</u> Mp	
<u>Lophius americanus</u> Bo	<u>Peristedion ministum</u> Bo	
<u>Urophycis regius</u> WT	<u>Zenopsis ocellata</u> SI	
<u>Peprilus triacanthus</u> WT		
<u>Lepophidium cervinum</u> OS		
<u>Macrzoarces americanus</u> Bo		
<u>Urophycis chuss</u> Bo		

*Patnal affinity is designated after each species name: boreal, Bo; warm-temperate, WT; outer-shelf, OS; inner-shelf, IS; slope, SI; mesopelagic, Mp.

Table C-18. Cruise 75-12, Fall 1975.*

A	B	C
<u>Micropogon undulatus</u> WT	<u>Mustelus canis</u> WT	<u>Raja erinacea</u> Bo
<u>Decapterus punctatus</u> WT	<u>Paralichthys dentatus</u> WT	<u>Pseudopleuronectes americanus</u> Bo
<u>Pomatomus saltatrix</u> WT	<u>Prionotus carolinus</u> WT	<u>Scophthalmus aquosus</u> IS
<u>Carcharhinus milberti</u> WT	<u>Centropristis striata</u> WT	<u>Limanda ferruginea</u> Bo
D	E	F
<u>Squalus acanthias</u> Bo	<u>Merluccius bilinearis</u> Bo	<u>Chlorophthalmus agassizi</u> S1
<u>Stenotomus chrysops</u> WT	<u>Hippoglossina oblonga</u> OS	<u>Myctophidae</u> Mp
<u>Peprilus triacanthus</u> WT	<u>Citharichthys arctifrons</u> S1	<u>Peristedion miniatum</u> Bo
	<u>Urophycis chuss</u> Bo	<u>Merluccius albidus</u> S1
	<u>Lophius americanus</u> Bo	<u>Mautolicus muelleri</u> Mp
	<u>Urophycis regius</u> WT	<u>Helicolenus dactylopterus</u> S1
		<u>Lepophidium cervinum</u> OS

*Faunal affinity is designated after each species name: boreal, Bo; warm-temperate, WT; outer-shelf, OS; inner-shelf, IS; slope, S1; mesopelagic, Mp.

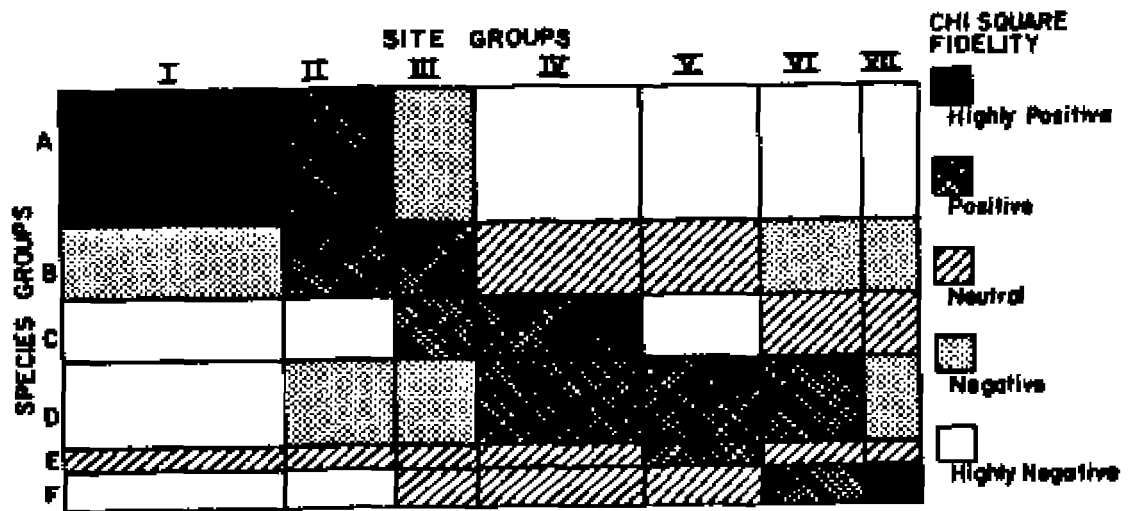
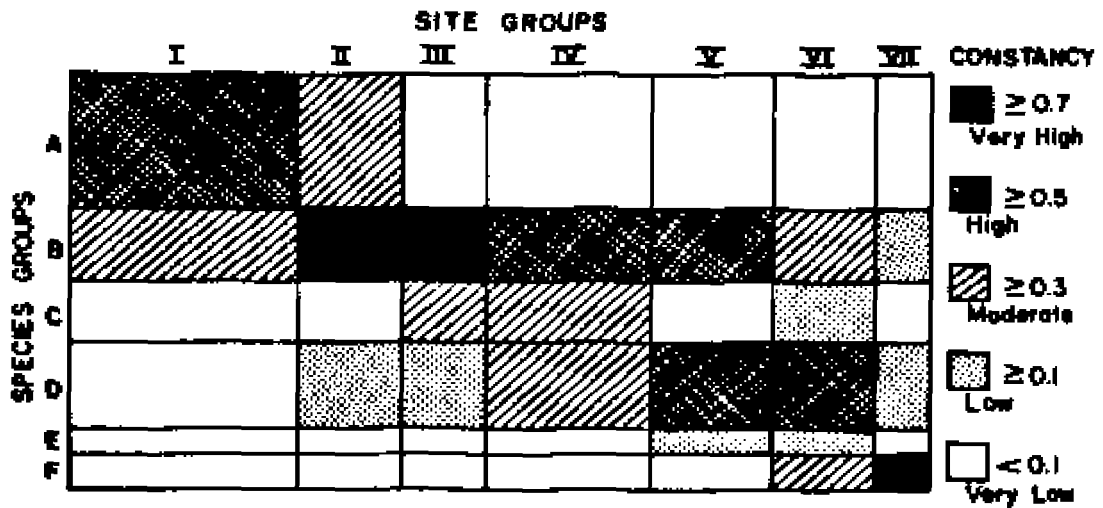
Table C-19. Cruise 69-8, Summer 1969.*

A	B	C
<u>Macrozoarcea americana</u> Bo	<u>Pseudopleuronectes americanus</u> Bo	<u>Alosa pseudoharengus</u> Bo
<u>Gadus morhua</u> Bo	<u>Limanda ferruginea</u> Bo	<u>Alosa sapidissima</u> Bo
<u>Hemitripterus americanus</u> Bo	<u>Raja erinacea</u> Bo	<u>Glyptocephalus cynoglossus</u> Bo-SI
	<u>Scophthalmus aquosus</u> IS	<u>Hippoglossoides platessoides</u> Bo
		<u>Urophycis tenuis</u> Bo-SI
D	E	F
<u>Merluccius bilinearis</u> Bo	<u>Lepophidium cervinum</u> OS	<u>Maurolicus muelleri</u> Mp
<u>Melanogrammus aeglefinus</u> Bo	<u>Citharichthys arctifrons</u> SI	<u>Myctophidae</u> Mp
<u>Urophycis chuss</u> Bo	<u>Peprilus triacanthus</u> WT	<u>Helicolenus dactylopterus</u> SI
<u>Myoxocephalus octodecemspinosus</u> Bo	<u>Urophycis regius</u> WT	<u>Ceratoscopelus maderensis</u> Mp
<u>Hippoglossina oblonga</u> OS		<u>Merluccius albidus</u> SI
<u>Lophius americanus</u> Bo		<u>Chlorophthalmus agassizi</u> SI
<u>Squalus acanthias</u> Bo		
<u>Scomber scombrus</u> Bo		

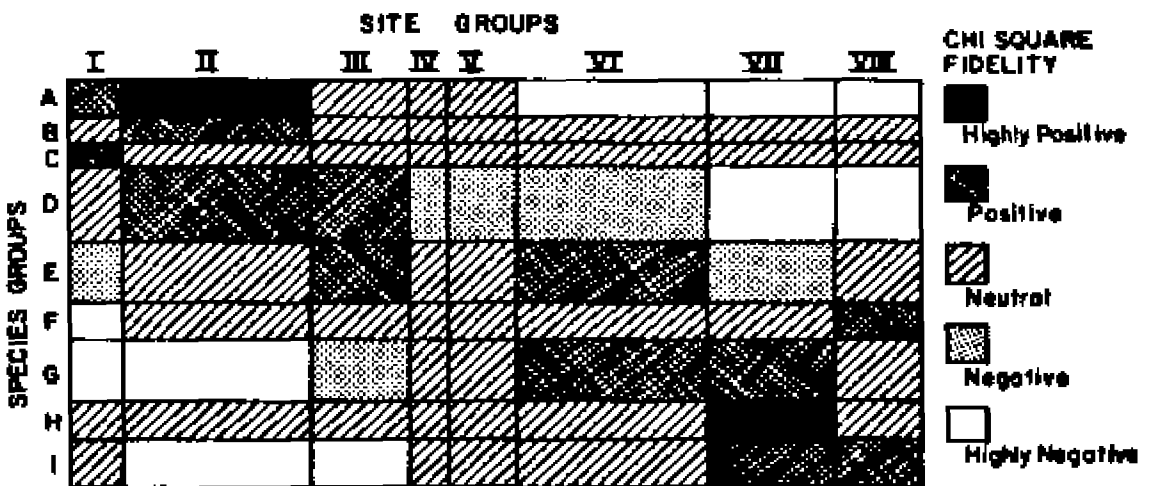
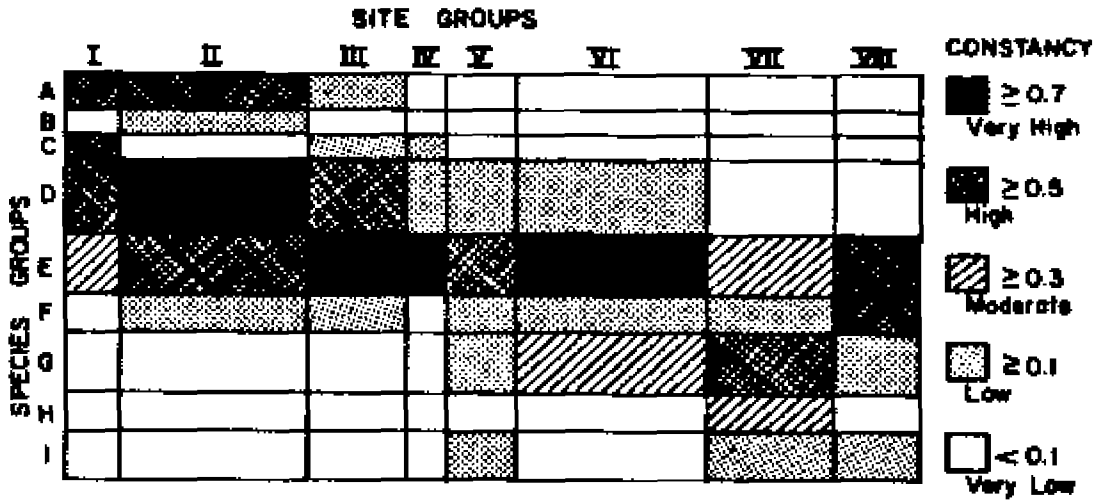
*Faunal affinity is designated after each species name: boreal, Bo; warm-temperate, WT; outer-shelf, OS; inner-shelf, IS; slope, SI; mesopelagic, Mp.

APPENDIX D

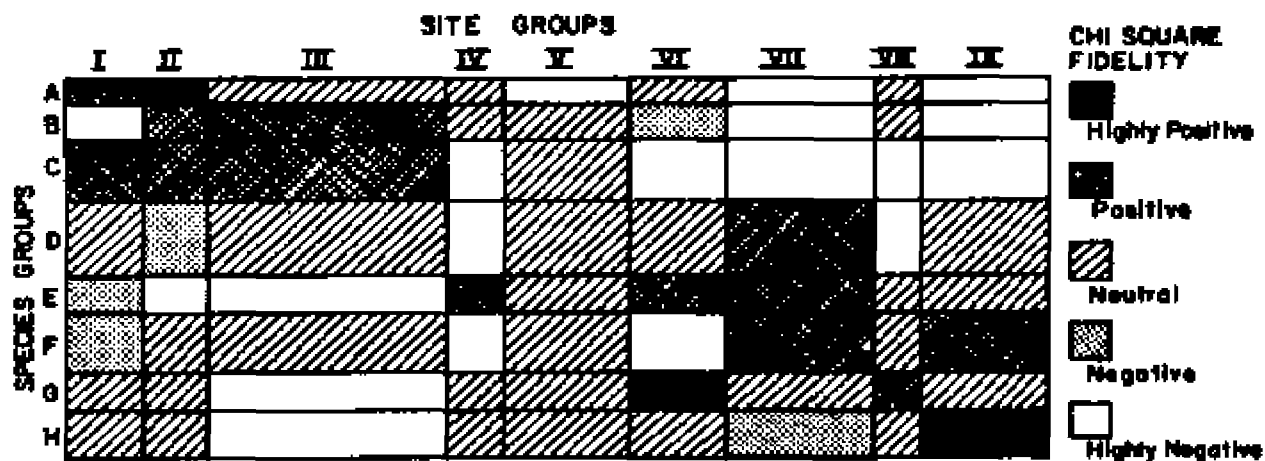
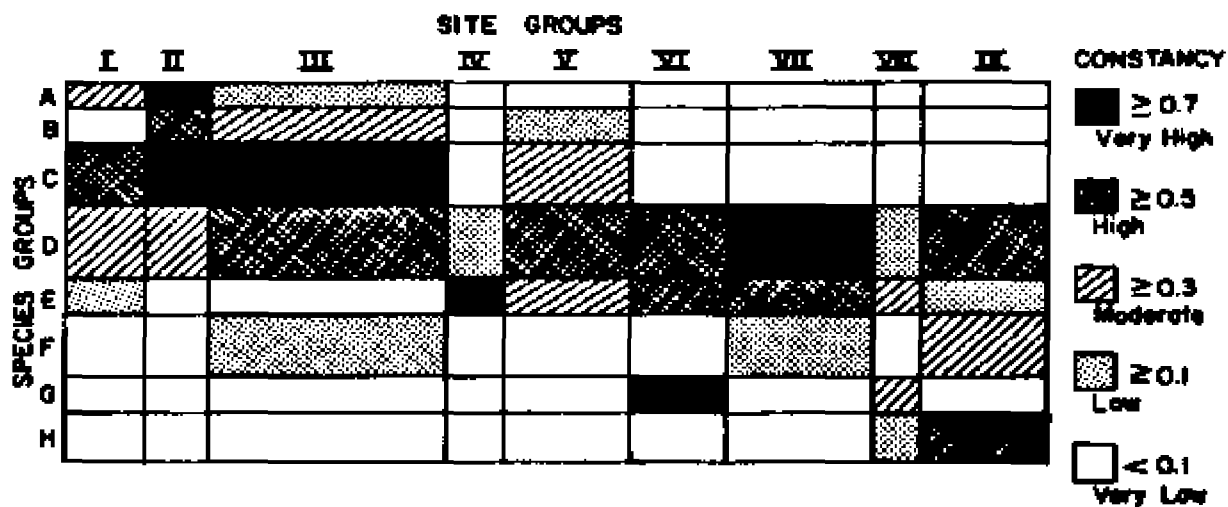
**Nodal constancy and fidelity diagrams for NMFS Groundfish
Survey Cruises, Fall 1967 - Spring 1976.**



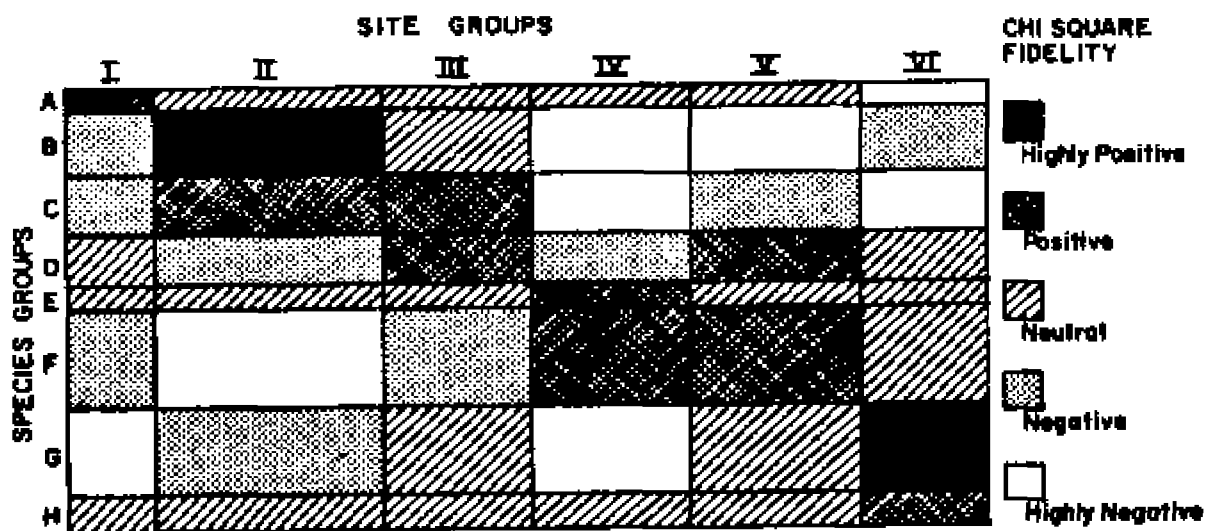
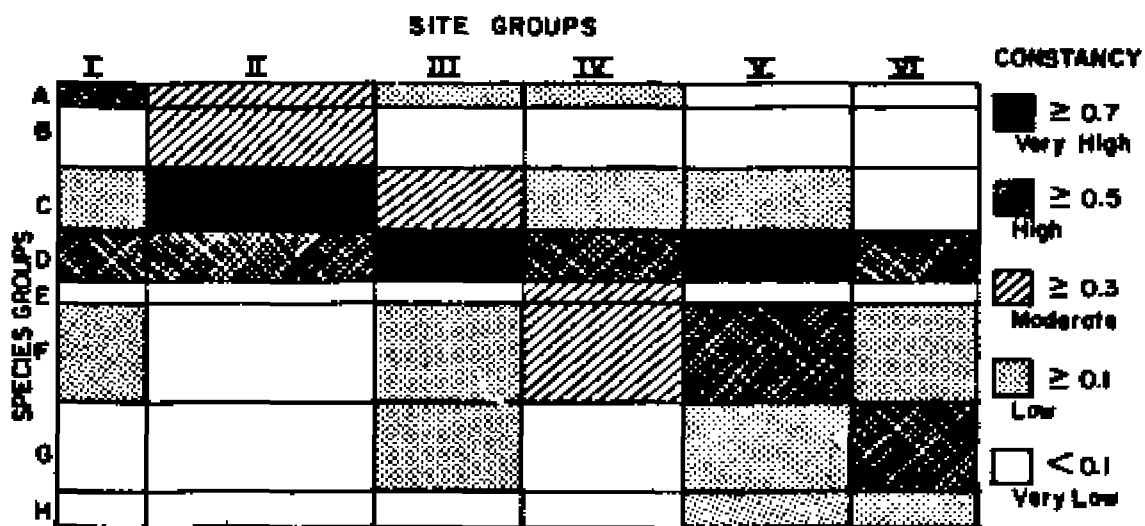
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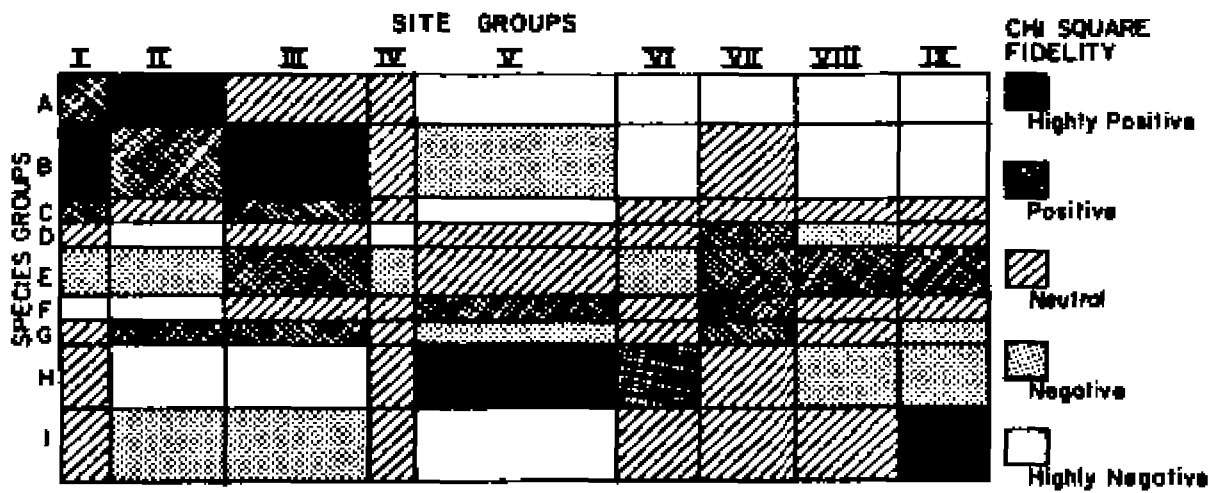
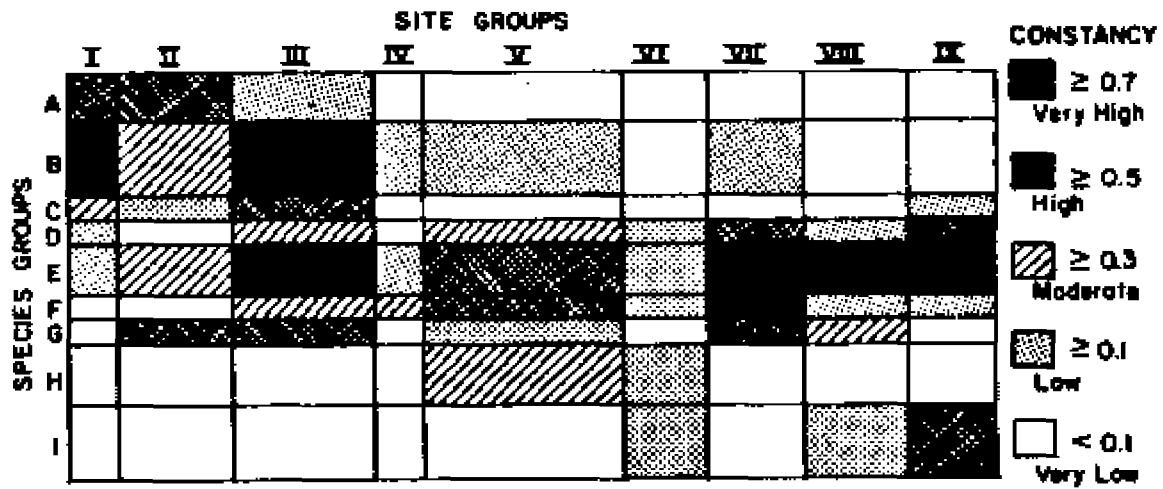


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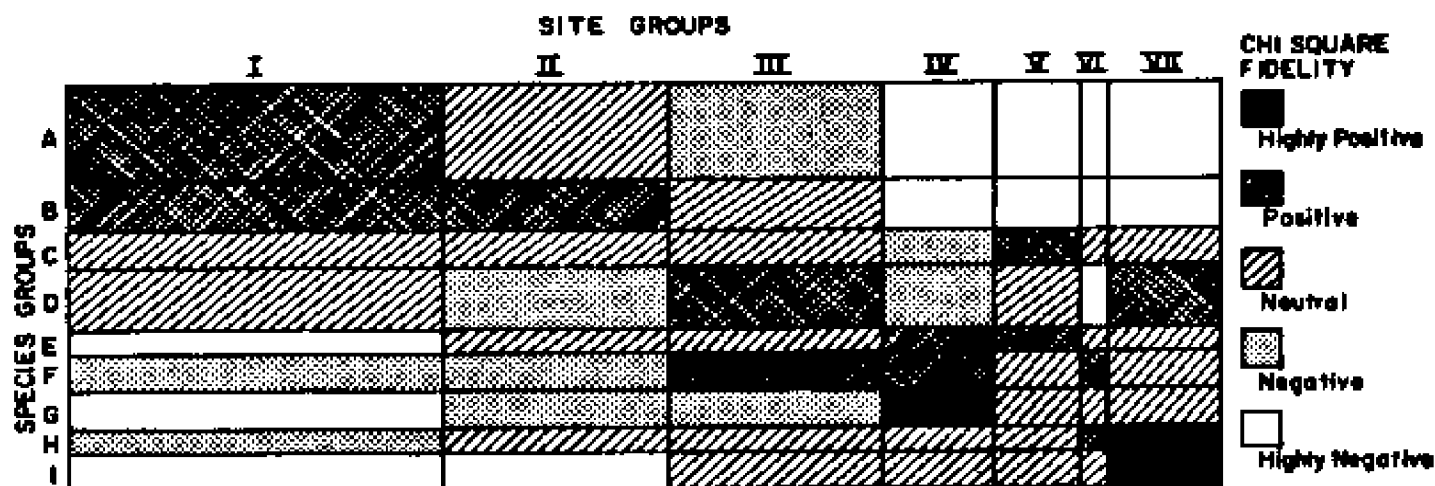
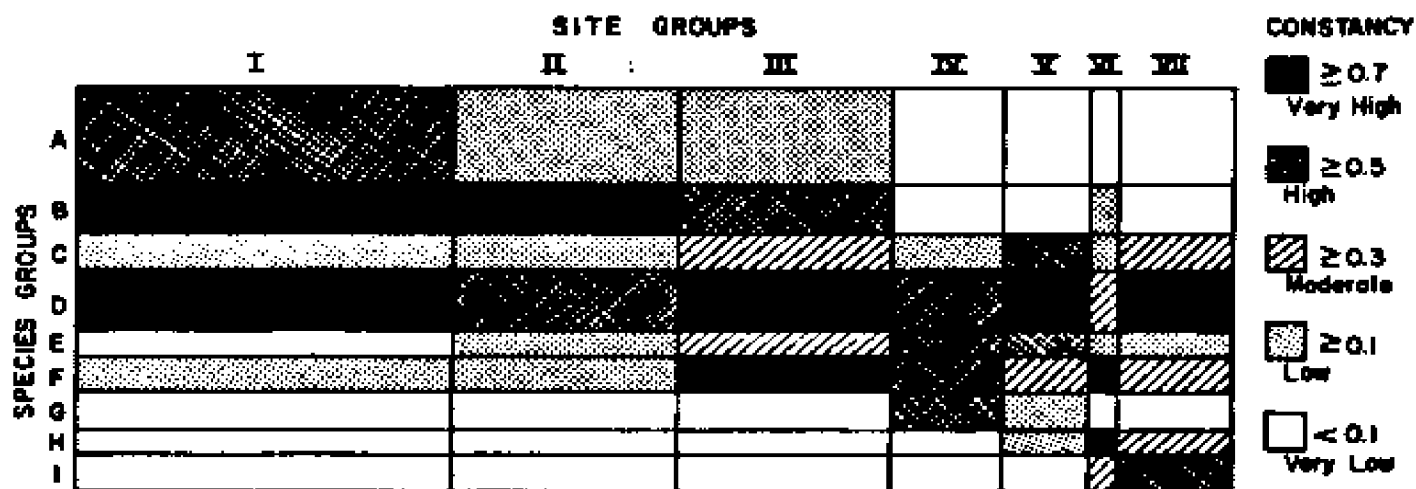


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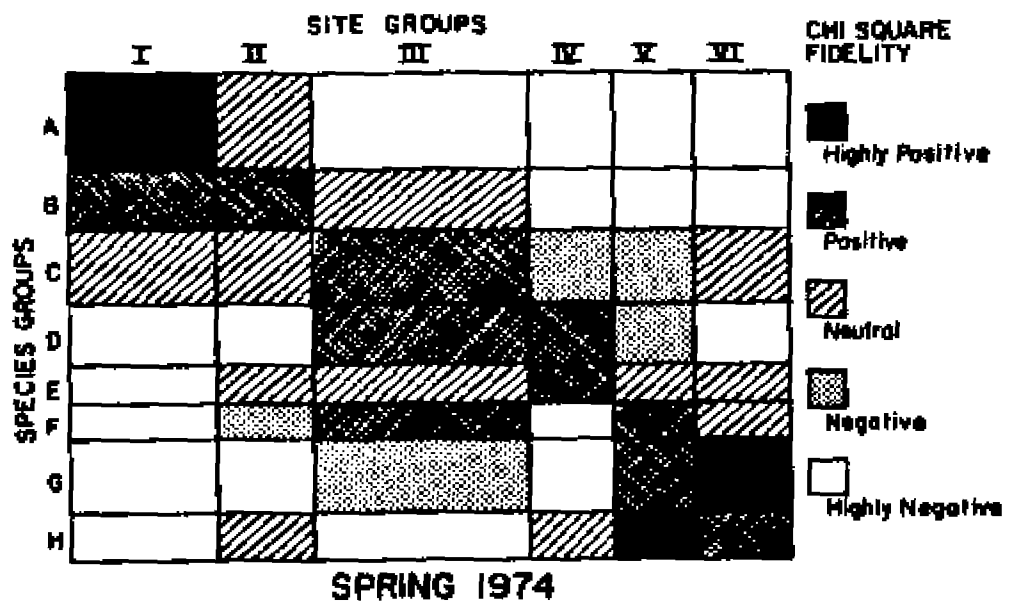
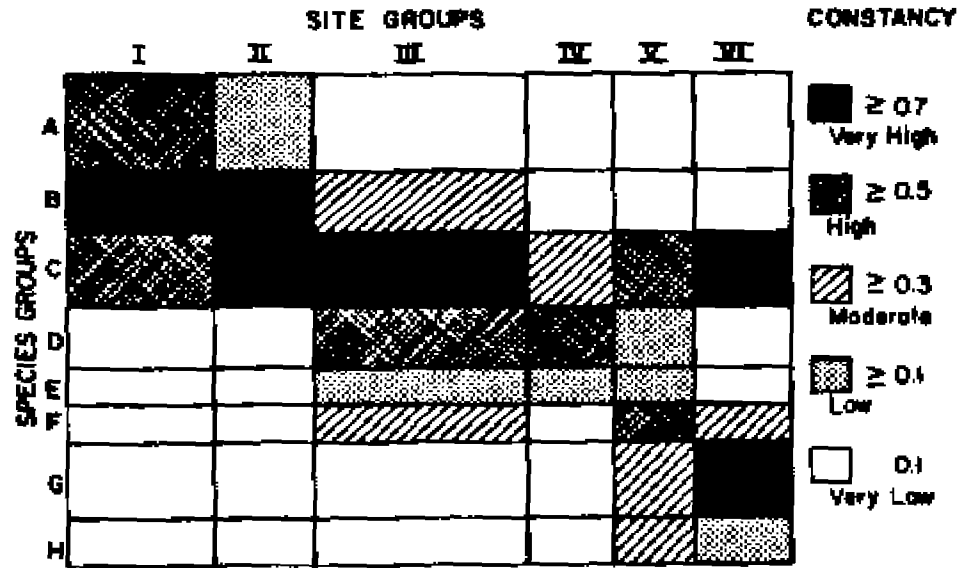


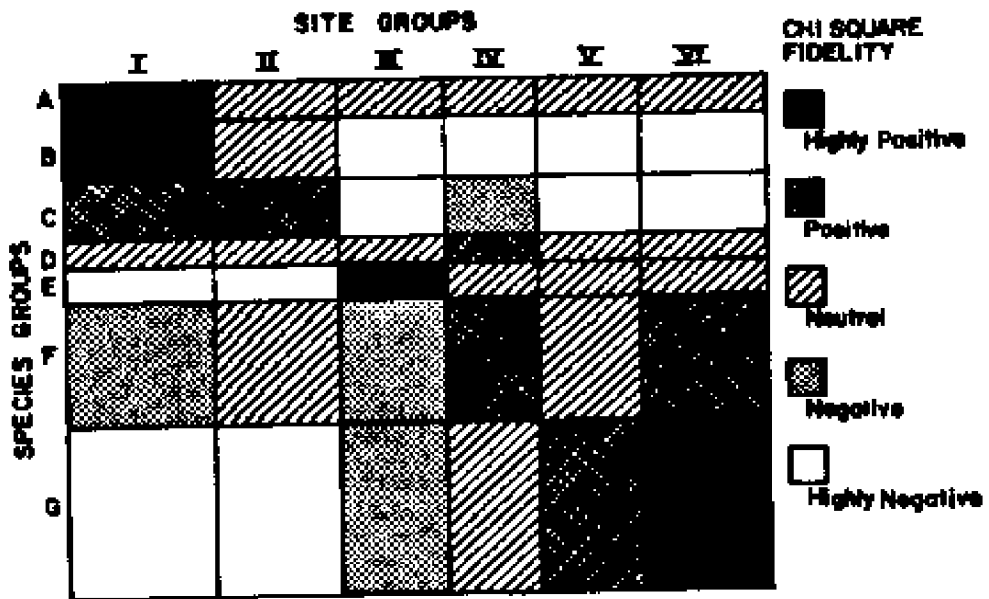
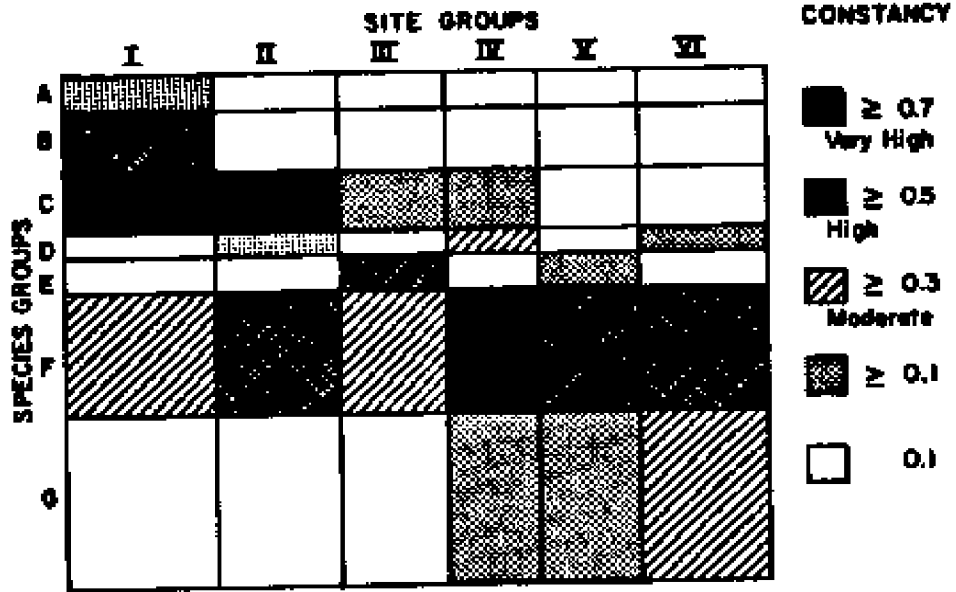


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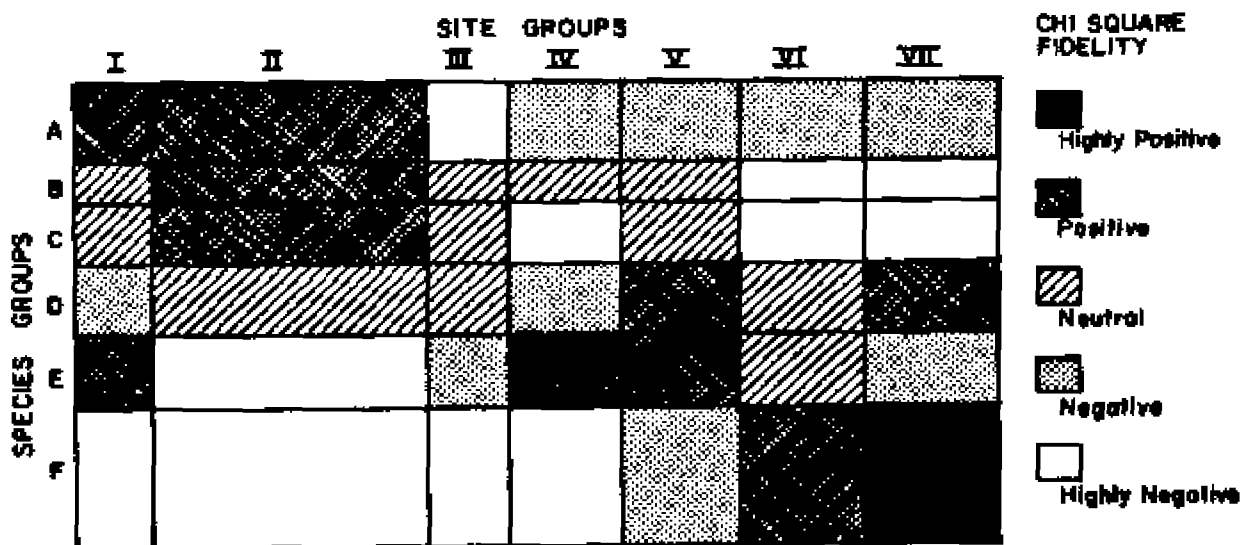
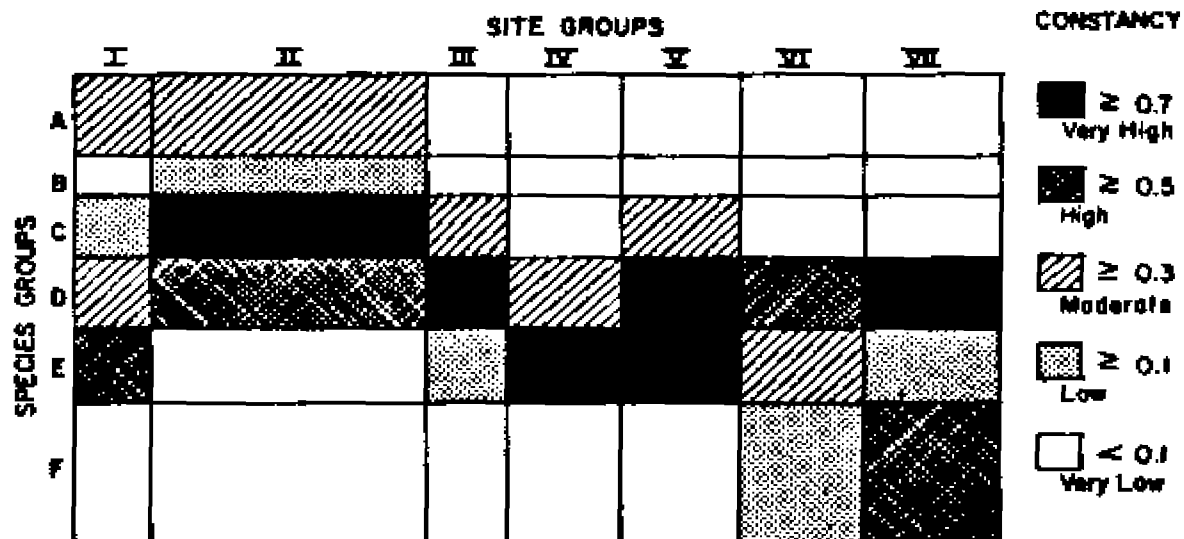


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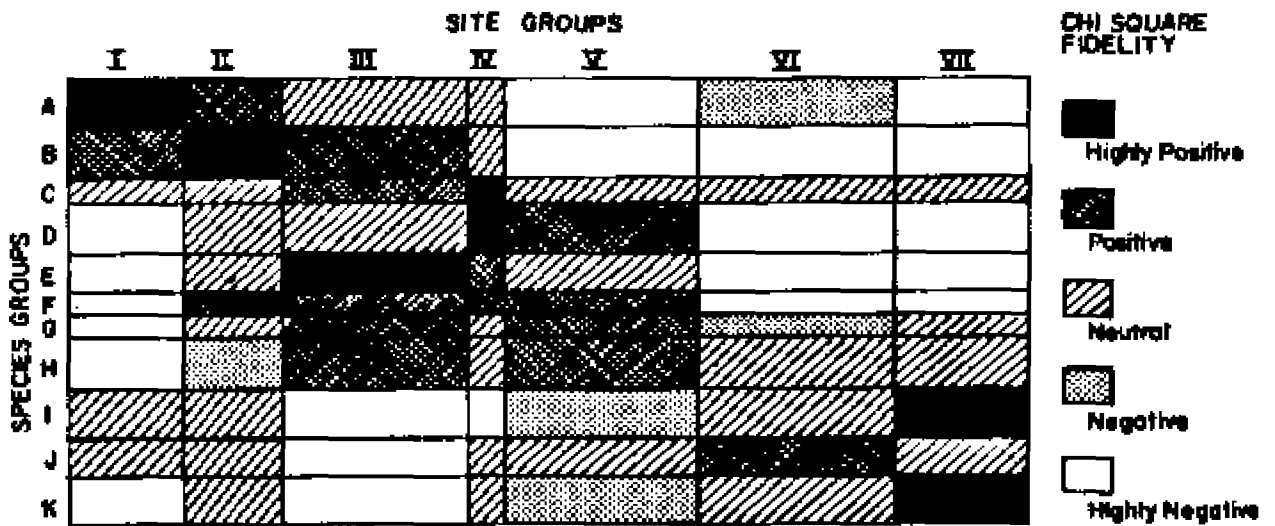
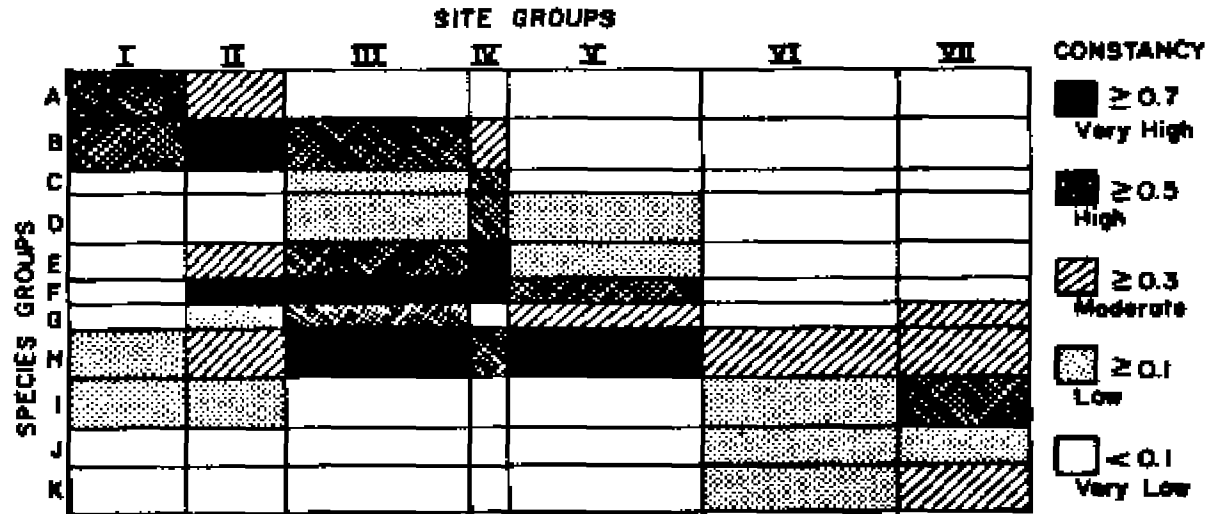




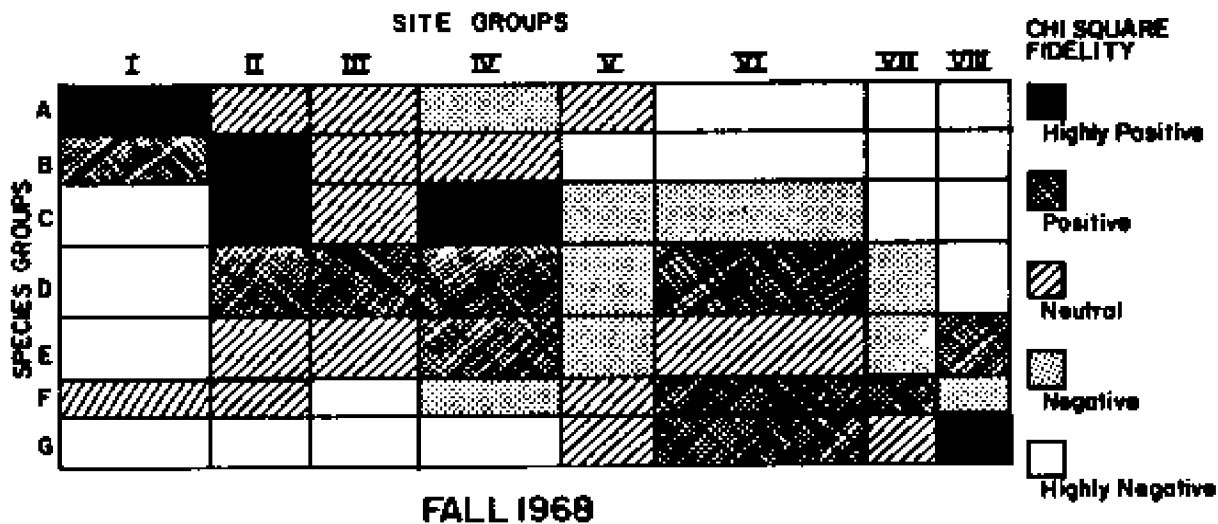
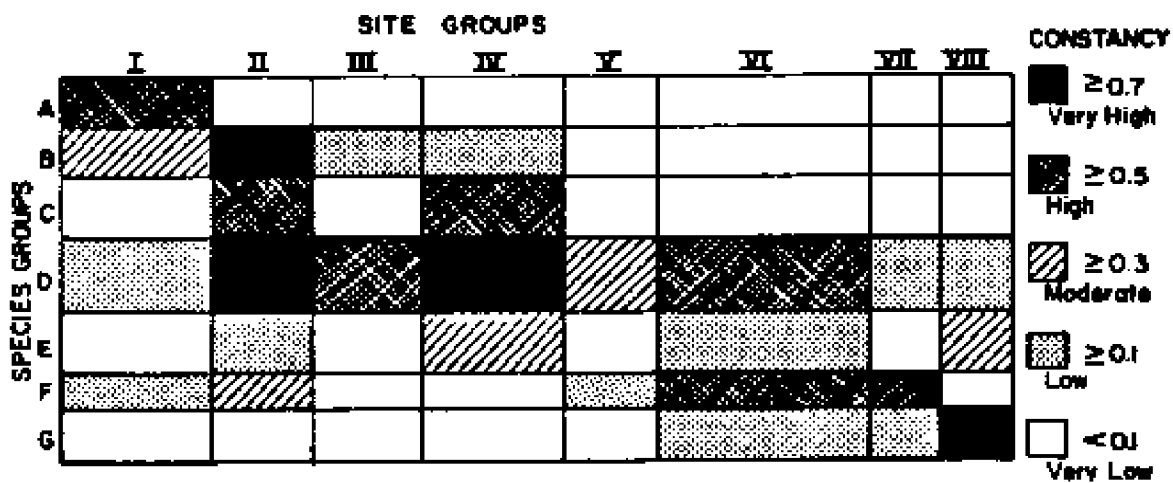
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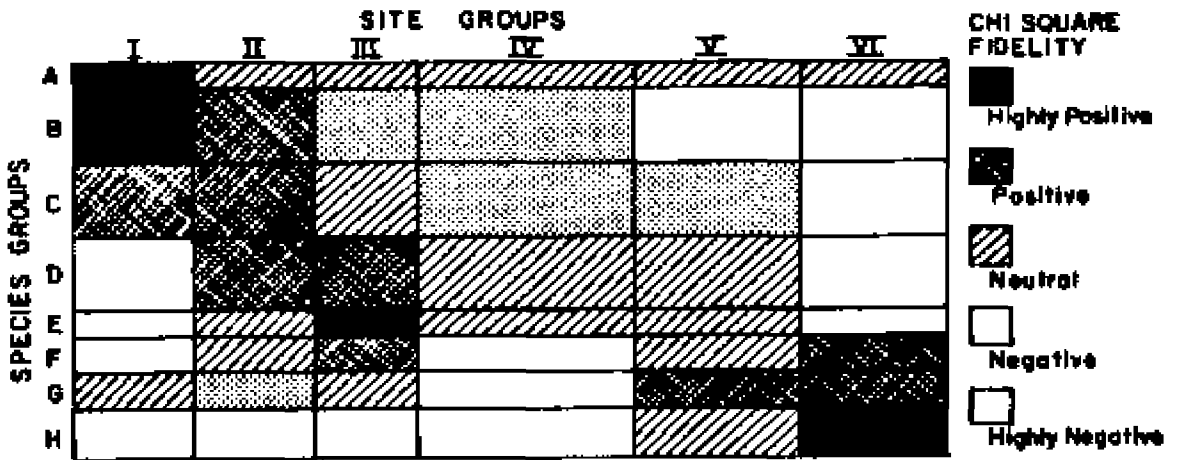
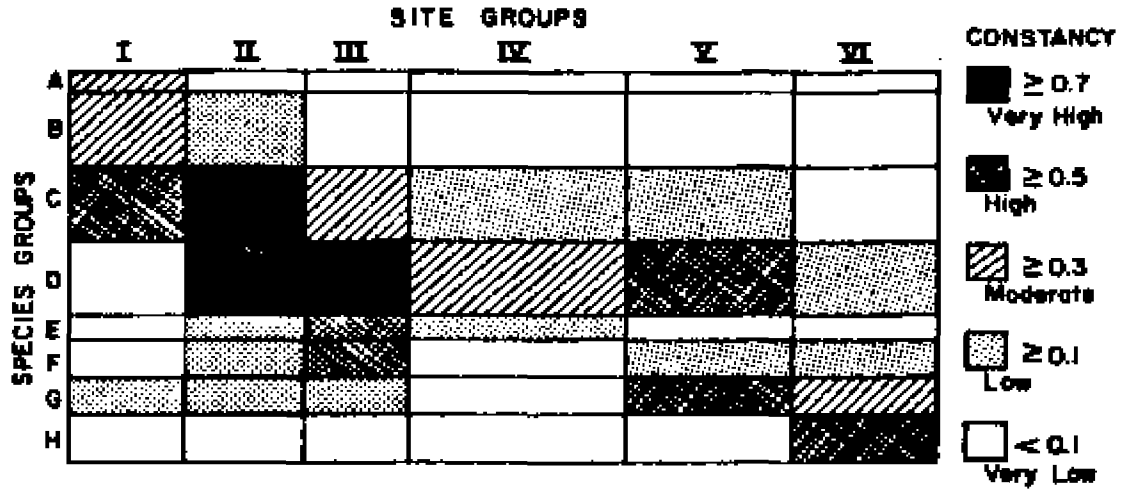


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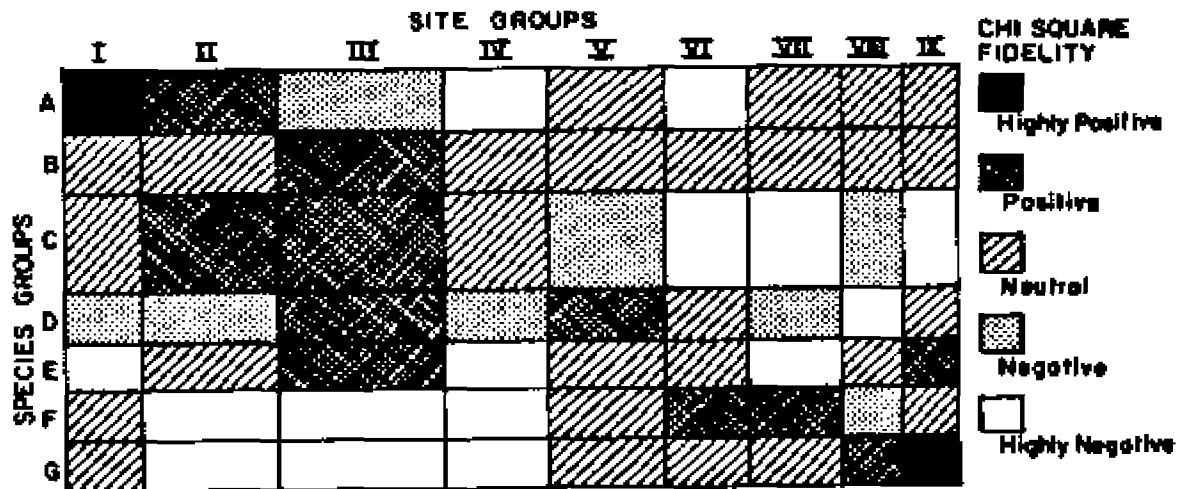
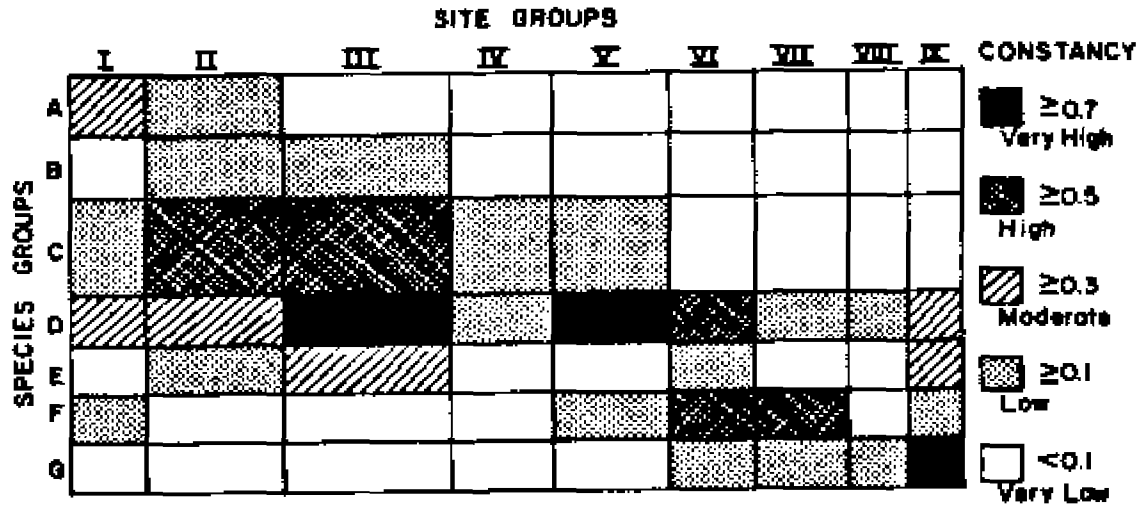


FALL 1967

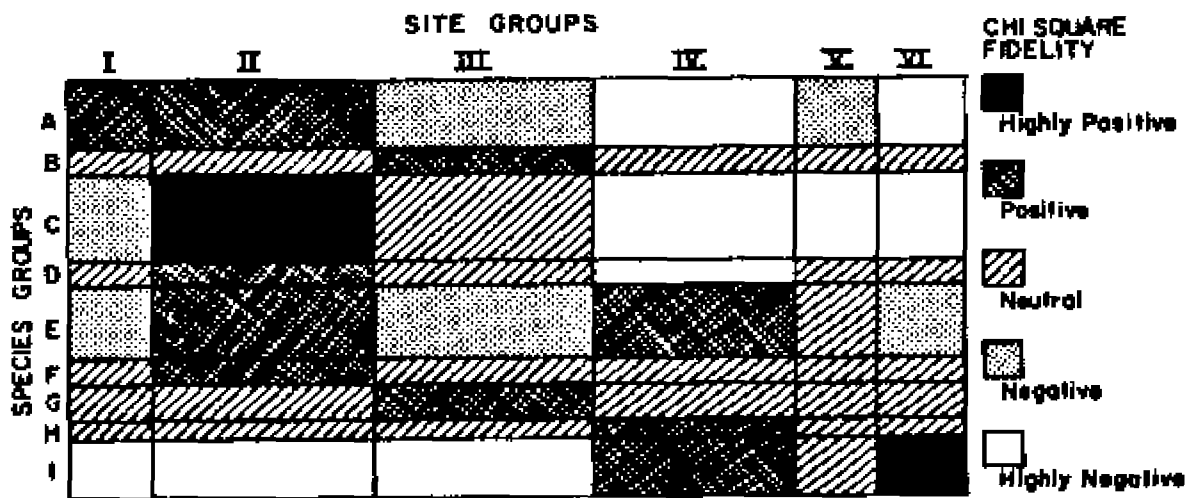
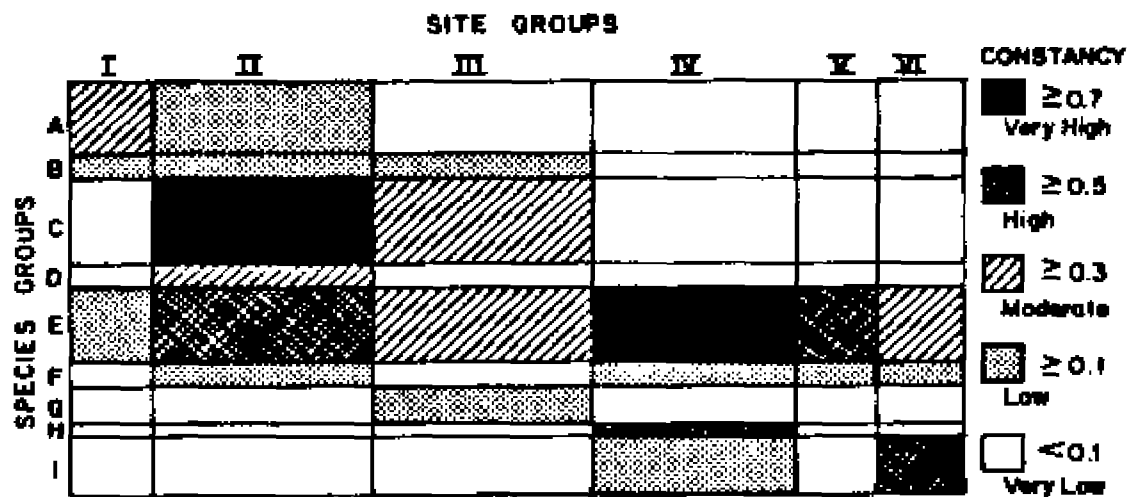




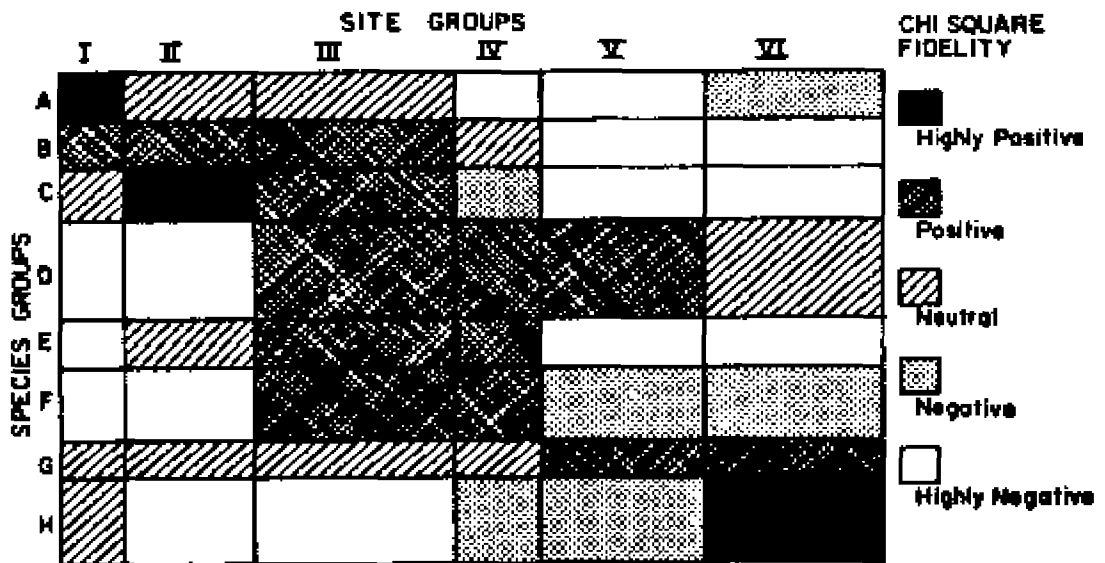
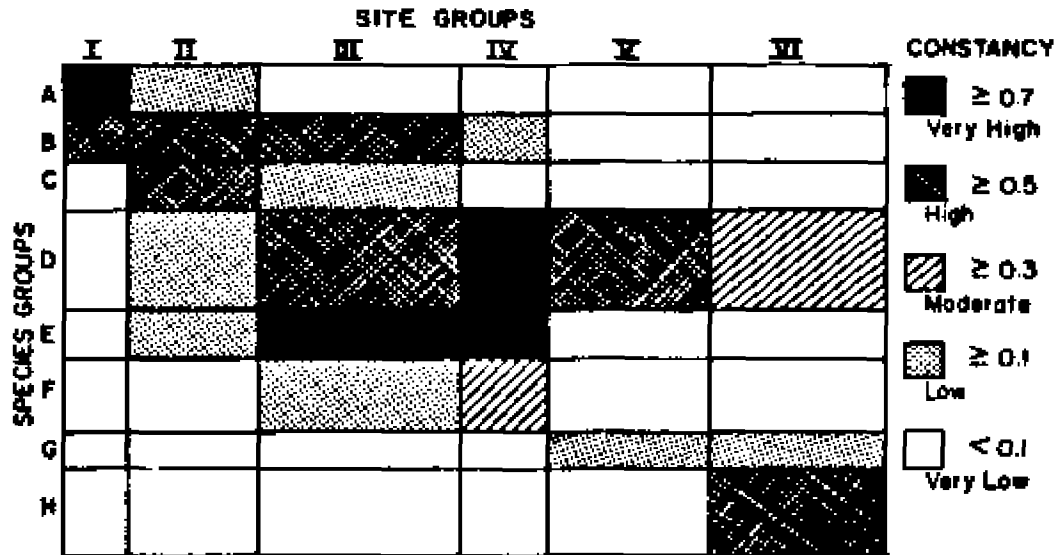
FALL 1969



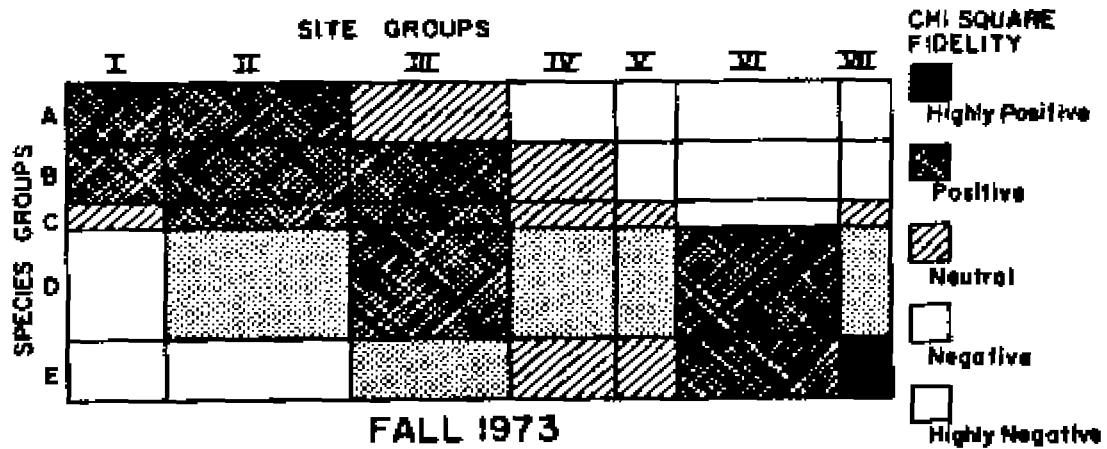
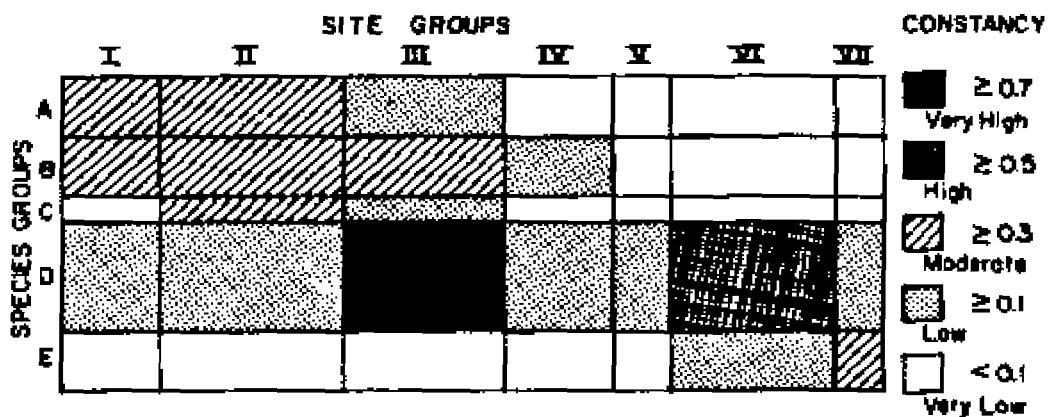
FALL 1970

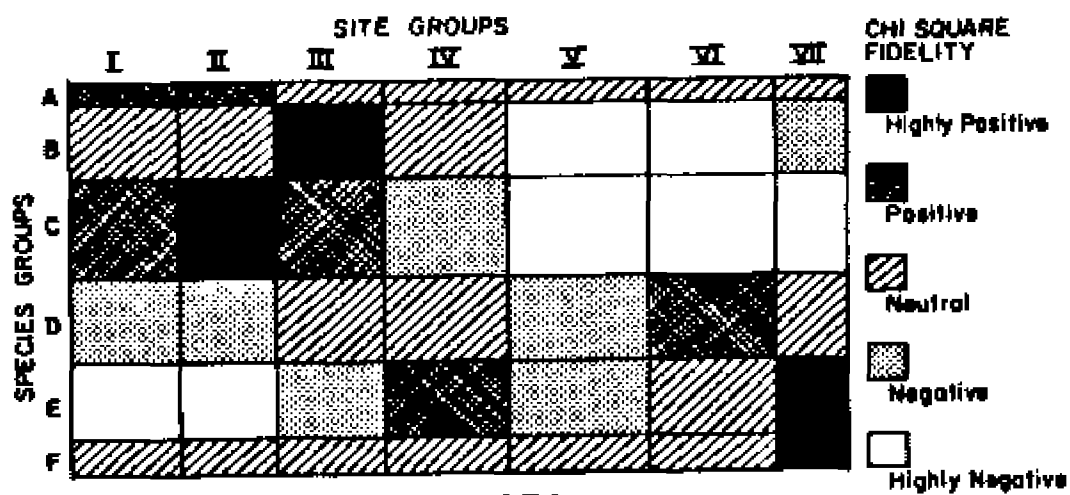
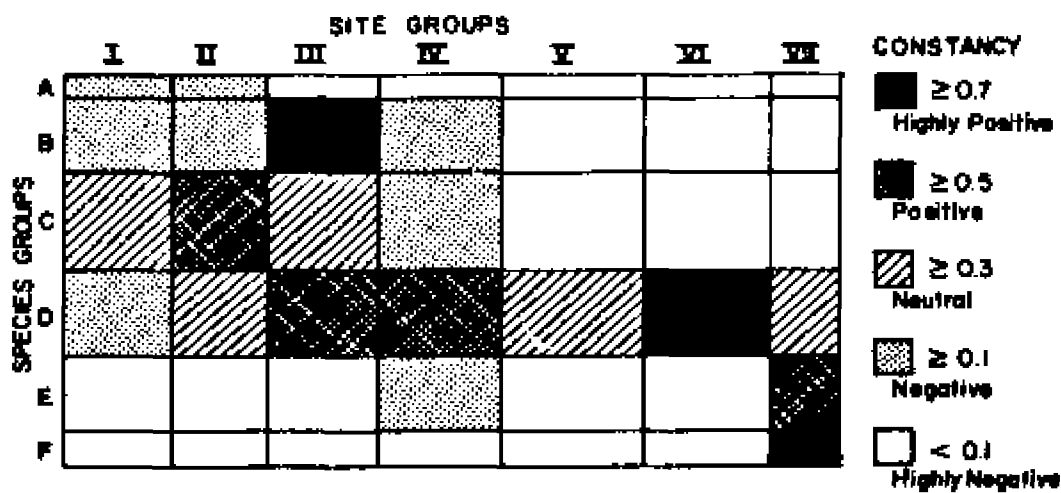


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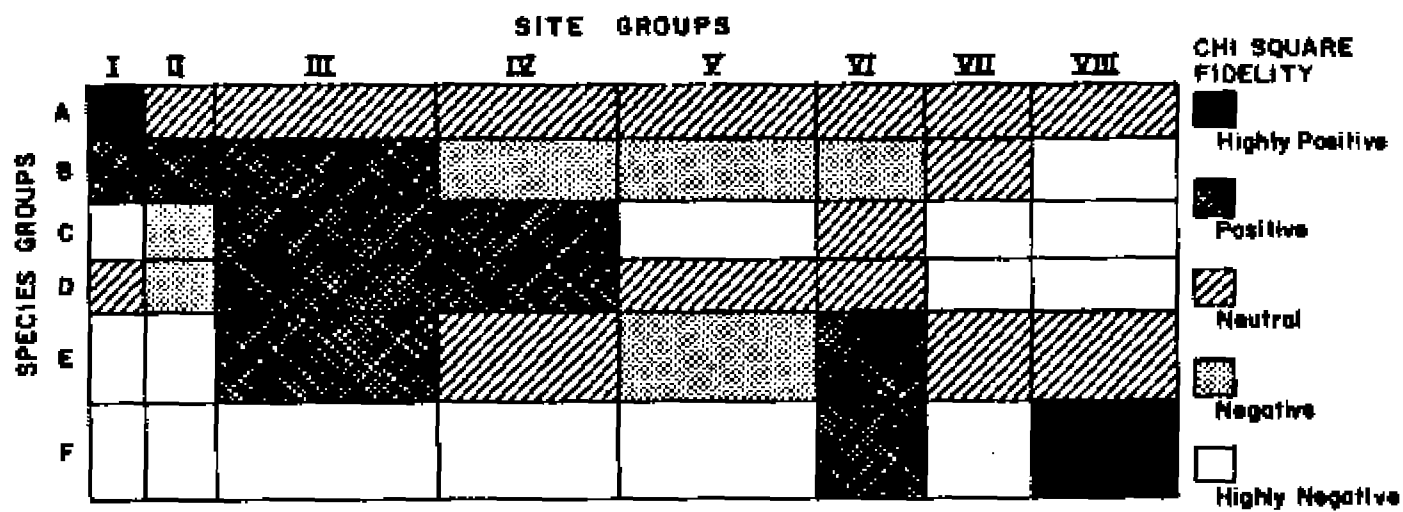
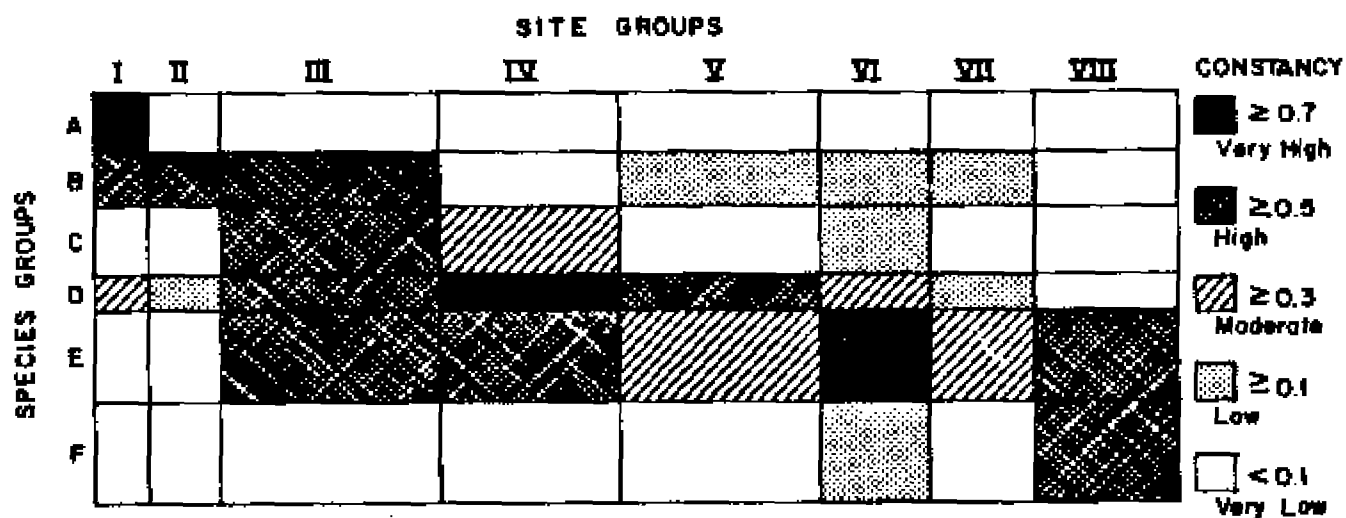


FALL 1972

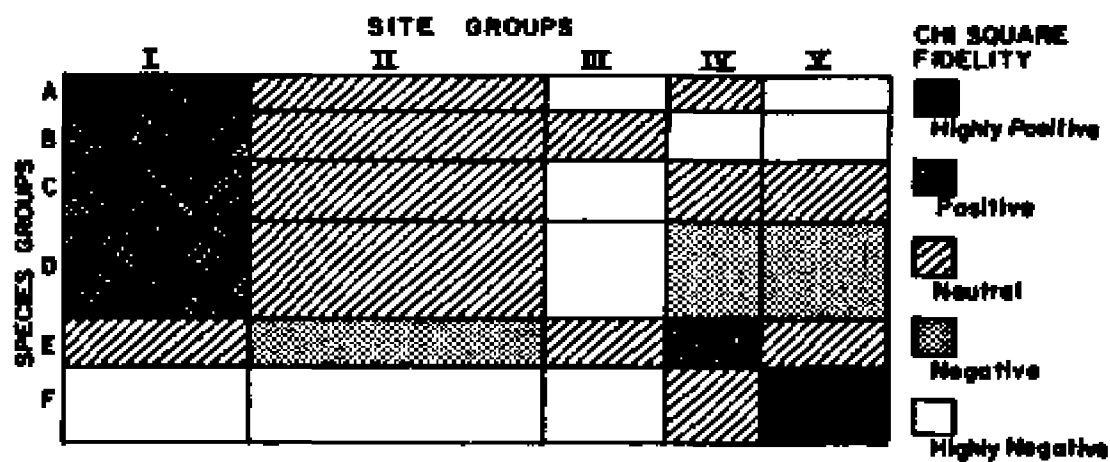
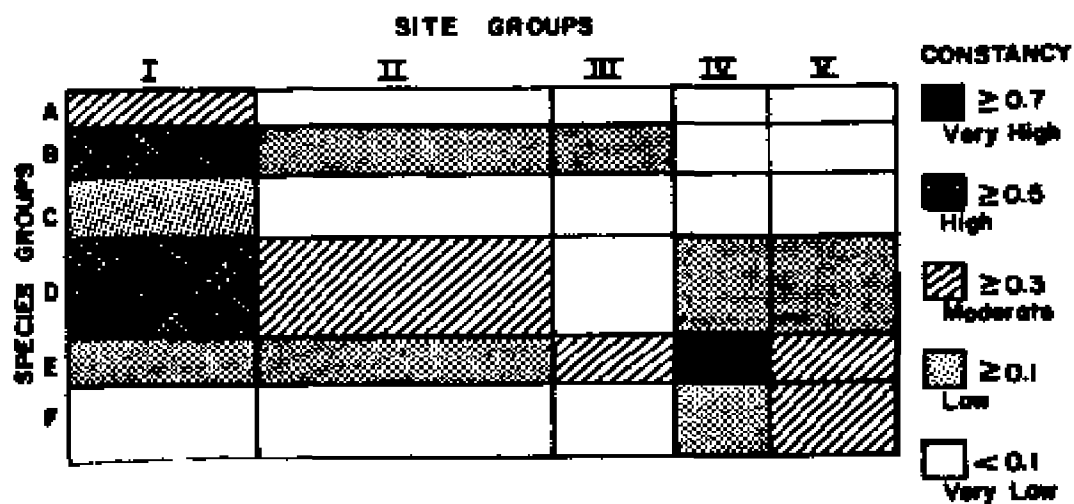




FALL 1974



FALL 1975



SUMMER 1969

APPENDIX E

**Species dominance tables for NMFS Groundfish
Survey Cruises, Fall 1967 - Spring 1976.**

Table I-1. Cruise 66-3, Spring 1966.

Species	Faunal Affinity*	Species Group	Site Group†															
			I		II		III		IV		V		VI		VII			
			%	Z	%	Z	%	Z	%	Z	%	Z	%	Z	%	Z		
<u>Bala affinis</u>	Bo	A	79	7.8														
<u>Hyomysphalus ocellodominans</u>	Bo	A	96	10.0														
<u>Limada ferrugina</u>	Bo	A	100	41.9	74	22.2												
<u>Macropsalis americana</u>	Bo	A	75	6.1	64	4.1												
<u>Pandoplaurocetes serricollis</u>	Bo	A	57	3.6														
<u>Neutle media</u>	WT	A			50	3.5												
<u>Scutiger acanthus</u>	Bo	B	79	6.3	95	17.9	67	19.1	62	8.1	57	23.1						
<u>Merivictus bilinearis</u>	Bo	B	63	4.6	79	6.4	100	5.1	90	28.6	180	34.7	100	37.5	86	12.0		
<u>Aloea pseudotarsus</u>	Bo	B	50	3.6	79	5.9	90	6.4	67	6.0	100	9.6						
<u>Aloea australis</u>	WT	B			86	20.5	60	7.5										
<u>Scaber rombus</u>	Bo	B	50	6.0	100	67.1	68	9.0	23	3.5								
<u>Clupea harengus harengus</u>	Bo	B	56	16.8	86	16.0	100	6.4										
<u>Centropages striata</u>	WT	C									24	3.6						
<u>Prionotus carolinus</u>	WT	C									57	5.5						
<u>Stomatopus chryseus</u>	WT	C									29	8.8						
<u>Uromysia chusa</u>	Bo	D									57	3.0	73	6.2			57	14.0
<u>Miroglossus oblongus</u>	OS	D									90	4.0						
<u>Paralichthys trilineatus</u>	WT	D									71	8.3	60	16.2	92	34.6		
<u>Lepeophtheirus curvatus</u>	OS	E											33	3.6				
<u>Myctophidae</u>	MP	F											44	3.5	86	37.6		
<u>Anguilliformes</u>		F													71	6.2		

* Faunal affinity is designated as boreal (Bo), warm-temperate (WT), inner-shell resident (IS), outer-shell resident (OS), deep resident (SI), and mesogeic (MP).

† % percent of stations in each site group at which each dominant species occurred.

Z = average percent that individuals of each species contributed to stations in each site group.

A species was considered to be dominant in a site group if it occurred among the five most abundant species in at least 20% of all stations included in that site group.

Table B-2. Crates 69-2, Spring 1969.

Species	Formal Affinity*	Species Group	Site Groups ^b													
			I		II		III		IV		VI		VII		VIII	
			X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
<u>Paralichthys micropinna</u>	No	A		71	71	3.7										
<u>Hyasophthalmus octolineatus</u>	No	B	71	7.9	100	14.3	85	4.3								
<u>Limanda ferruginea</u>	No	D	100	21.9	100	35.9	100	27.2					30	4.2		
<u>Neomysis americana</u>	No	D	86	10.3	88	8.0	62	3.7								
<u>Scaphalphegus spumosa</u>	IS	D		75	2.3	62	3.4	80	4.2							
<u>Bala exilis</u>	No	D		83	4.8											
<u>Bala sinensis</u>	No	D		100	11.9	62	10.9									
<u>Alona pseudoharemski</u>	No	Z	86	33.5	58	3.3	100	21.9	100	35.5	67	6.1	58	6.4		
<u>Clupea harengus harengus</u>	No	E	100	19.5	63	5.5	56	6.1	100	14.8	64	9.2				
<u>Merluccius bilinearis</u>	No	E			92	6.1	100	31.1					100	30.9	75	12.3
<u>Squalus acanthias</u>	No	E			85	10.0	60	4.3					100	30.2	81	17.7
<u>Urophycis chuss</u>	No	E											92	7.3		82
<u>Urophycis tenuis</u>	No-SI	F														100
<u>Peptilus triacanthus</u>	VT	G													100	33.2
<u>Filippionus oblongus</u>	OS	G											75	5.9	56	3.5
<u>Prionobus astrolius</u>	VT	C											66	14.1	38	3.4
<u>Urolog microneus</u>	SI	G						60	5.2							
<u>Scorpaenopsis</u>	No	I											11	8.9	50	4.4

* Formal affinity is designated as boreal (No), warm-temperate (VT), inner-shell resident (SI), outer-shell

resident (OS), slope resident (SI), and mesopelagic (Sp).

or % = percent of stations in each site group at which each dominant species occurred.

X = average percent that individuals of each species contributed to stations in each site group.

A species was considered to be dominant in a site group if it occurred among the five most abundant

species in at least 20% of all stations included in that site group.

Table E-3. Crustaceans 70-3, Spring 1970.

Species	Faunal Affinity*	Species Group	Site Groups															
			I	II	III	IV	V	VI	VII	VIII	IX							
<i>Pandeglyptostictus maritimus</i>	Bo	A	40	2.4	88	5.1												
<i>Bala acinacis</i>	Bo	C		63	10.8	77	3.3											
<i>Brachycephalus scolobrombiformis</i>	Bo	C		100	18.9	67	4.9	25	3.0									
<i>Clupea harengus harengus</i>	Bo	C		50	16.2	90	8.1	50	3.9									
<i>Limnoda ferruginea</i>	Bo	C	100	36.4	100	21.4	100	37.7	56	7.3								
<i>Macropodicea maritima</i>	Bo	C	100	7.7	100	12.5	67	4.5										
<i>Merluccius bilinearis</i>	Bo	D	80	3.0		90	17.7		88	16.7	75	6.7	89	20.1			68	10.6
<i>Urophycis chuss</i>	Bo	D	40	4.5		93	5.8		88	6.5			74	10.0			81	4.3
<i>Squalus acanthias</i>	Bo	D	80	14.6		73	3.0		56	11.5			68	9.3			81	27.4
<i>Merluccius scorpius</i>	Bo	D	60	4.8		27	4.4	29	10.3	44	17.6	50	12.7	89	10.6		31	4.2
<i>Limnolaima oblonga</i>	OS	D															75	4.6
<i>Alema pseudoharengus</i>	Bo	D	40	3.0	75	5.4											31	10.3
<i>Stomatopus chirocephalus</i>	WT	E							100	59.7							58	19.6
<i>Parryella trilobatus</i>	WT	E							57	5.8							58	12.9
<i>Pleuromma carolinense</i>	WT	E							71	9.1	50	7.6	83	18.9	58	14.0		31
<i>Urophycis tenuis</i>	Bo-RI	F																50
<i>Pleuromma carolinense</i>	WT	G																33
<i>Urophycis exilis</i>	WT	G															92	20.5
<i>Urophycidae</i>	My	H																44
<i>Mellicolaima decylopterus</i>	SI	H																100

* Faunal affinity is designated as boreal (Bo), warm-temperate (WT), inner-shelf resident (IS), outer-shelf

resident (OS), slope resident (SI), and mesopelagic (My).

n = percent of stations in each site group at which each dominant species occurred.

% = average percent that individuals of each species contributed to stations in each site group.

A species was considered to be dominant in a site group if it occurred among the five most abundant

species in at least 10% of all stations included in that site group.

Table B-4. Crabs 71-1, Spring 1971.

Species	Fungal Affinity* Group	Site Groups																										
		I	II	III	IV	V	VI	VI	VI	VI	VI																	
<u>Clupea harengus harengus</u>	Bo	A	64	10.2	55	5.4																						
<u>Alosa mactivalis</u>	VT	A	64	13.8																								
<u>Penaeus aztecus aztecus</u>	Bo	B		52	4.4																							
<u>Callinectes</u>	Bo	C		83	16.5	63	5.8	35	3.1																			
<u>Libinia farrulana</u>	Bo	C		45	17.5	97	61.0	86	16.4																			
<u>Microdeca americana</u>	Bo	C				83	5.8																					
<u>Microdeca americana</u>	Bo	C				72	4.9																					
<u>Microdeca americana</u>	Bo	C				59	3.2																					
<u>Scyllarides squameus</u>	IS	C																										
<u>Scyllarides squameus</u>	Bo	D	100	15.9	46	3.2	66	5.9	75	12.5	86	22.7	63	13.0														
<u>Callinectes bilineatus</u>	Bo	D				66	5.4	100	33.8	90	21.1	90	11.5	100	16.2													
<u>Uca chrys</u>	Bo	D				95	10.6																					
<u>Alosa pseudoharengus</u>	Bo	D	82	8.7	52	3.9	100	11.1																				
<u>Urophycis regia</u>	VT	F														75	13.4											
<u>Paralichthys dentatus</u>	VT	F														40	3.6											
<u>Stomatopus chrysops</u>	VT	F														40	11.2	33	6.8									
<u>Scorpaenopsis</u>	Bo	F														26	8.7	45	2.6	67	10.0	56	4.6					
<u>Paralichthys dentatus</u>	VT	F														56	13.9				65	20.3	76	11.9	44	3.7		
<u>Pilodius carolinus</u>	VT	F														50	2.4	48	5.5									
<u>Urophycis regia</u>	OS	F																			86	8.1						
<u>Callinectes bilineatus</u>	SI	F																				71	4.0					
<u>Callinectes bilineatus</u>	SI	G																						100	8.6			
<u>Paralichthys dentatus</u>	SI	G																							44	3.2		
<u>Stomatopus</u>	Sp	M																							25	3.8		

* Fungal affinity is designated as boreal (Bo), warm-temperate (VT), inner-shell resident (IS), outer shell resident (OS), slope resident (SI), and mesopelagic (Sp).
 ** % = percent of stations in each site group at which each dominant species occurred.
 † = average percent that individuals of each species contributed to stations in each site group.
 ‡ = average percent that individuals of each species contributed to stations in a site group if it occurred among the five most abundant species in at least 20% of all stations included in that site group.

Table 2-3. Cruise 72-2, Spring 1972.

Species	Faunal affinity*	Species Group	Site Groups**																
			I	II	III	IV	V	VI	VII	VIII	IX								
<u>Ampelisca</u>	VT	A		80	12.6														
<u>Clione borealis</u>	Bo	A	67	6.7	33	7.2													
<u>Parafolidiopsis americana</u>	Bo	A	100	6.8															
<u>Lionida ferruginea</u>	Bo	B	100	19.1	100	35.2	100	29.2	50	6.5									
<u>Macronereis americana</u>	Bo	B	83	7.0	100	5.7	83	4.4											
<u>Mela stimpsoni</u>	Bo	B	100	13.3			89	7.5											
<u>Scobinella annulus</u>	Bo	B	83	4.4			89	9.4											
<u>Hydrobia ulvae</u>	Bo	B	100	24.6			72	3.0											
<u>Mela cellata</u>	Bo	B	100	8.6															
<u>Speleobolus</u>	Bo	B		73	3.7	84	15.6	100	74.1	100	22.5	18	9.1	85	29.1	77	16.8	43	12.3
<u>Mercuria bilinearis</u>	Bo	B					100	14.4				58	6.9	36	6.5	92	10.8	100	29.2
<u>Allogasteria oblonga</u>	OS	B		20	5.6	71	3.9									92	13.5	69	7.8
<u>Dryobates chads</u>	Bo	B		20	5.6	72	3.3							100	12.6	85	8.2	100	20.3
<u>Friemontia carolinae</u>	VT	F										62	4.3	18	7.9				
<u>Levinsia bilinearis</u>	VT	F					67	18.0	73	18.3	36	11.9	92	17.3	54	5.7			
<u>Aloa pedunculata</u>	Bo	C		67	10.9														
<u>Scobinella</u>	Bo	C		40	8.2	64	3.9							65	6.9	55	10.2		
<u>Urosalpinx</u>	VT	H																	
<u>Stomatopoda</u>	VT	H												38	18.1				
<u>Comptosia</u>	VT	H														35	4.9		
<u>Trionyx</u>	VT	H												23	3.2				
<u>Physa physalis</u>	SI	I														18	2.4		36
<u>Pyrosoma</u>	Bo	I														65	21.3		
<u>Halimorpha dactyloptera</u>	SI	I																	91
<u>Dryobates</u>	Bo-SI	I																	73
<u>Glyptostethus</u>	Bo-SI	I																	71

* Faunal affinity is designated as boreal (Bo), warm-temperate (VT), inner-shelf resident (SI), outer-shelf resident (OS), slope resident (SI), and mesopelagic (Bo).

** I = percent of stations in each site group at which each dominant species occurred.

‡ = average percent that individuals of each species contributed to stations in each site group.

A species was considered to be dominant in a site group if it occurred among the five most abundant species in at least 20% of all stations included in that site group.

Table B-6. Cruise 73-3, Spring 1973.

Species	Fossil Affinity	Species Group	Site Group*															
			I	II	III	IV	V	VI	VII	I	II	III	IV	V	VI	VII		
<u>Clemba bartoloni</u> <u>Baroloni</u>	20	A	83	6.6	39	9.2												
<u>Amelocera americana</u>	20	A	26	4.9	43	7.0												
<u>Mela arisae</u>	20	B	100	16.0	89	13.5												
<u>Aloea pseudobartoloni</u>	20	B	100	13.7	82	6.3	96	12.6										
<u>Ligula spectabilis</u>	20	B	100	17.5	57	7.6												
<u>Stenobothrus missouri</u>	13	B	96	5.4	26	6.0												
<u>Scaber scabra</u>	20	C												73	11.1			
<u>Brachinus bilinearis</u>	20	D	100	16.3	71	10.0	100	11.6						100	8.4	93	26.2	
<u>Drosophila obscura</u>	20	D			89	10.3								100	5.2	100	8.0	
<u>Lophium spicatum</u>	20	D										79	3.6					
<u>Scaptomyza maculipes</u>	20	D	62	4.0	93	17.4	96	23.7	93	22.8	36	6.4					79	18.6
<u>Musca domestica</u>	20	D			96	5.2								93	7.7	100	6.5	
<u>Drosophila nigra</u>	27	E			25	4.5												
<u>Scaptomyza trilineata</u>	27	F	25	4.5	25	4.5	25	4.5	25	4.5	25	4.5	25	4.5	25	4.5	25	4.5
<u>Triantopus carolinus</u>	27	F			24	9.6	29	13.4										
<u>Clethrionomys ruficeps</u>	31	F																
<u>Triantopus chrysops</u>	27	G																
<u>Coenocricia stricata</u>	27	G																
<u>Triantopus rosaceus</u>	27	G																
<u>Leptocryptus carolinus</u>	28	H																
<u>Melospiza albicollis</u>	31	I																
<u>Polioptila caerulea</u>	31	I																
<u>Polioptila caerulea</u>	31	I																

* Fossil affinity is designated as normal (20), warm-temperate (27), inner-shelf resident (15), outer-shelf resident (28), slope resident (31), and mangrove (29).

† I = percent of stations in each site group in which each dominant species occurred.

‡ = average percent that individuals of each species contributed to stations in each site group.

§ A species was considered to be dominant in a site group if it occurred among the five most abundant

species in at least 20% of all stations included in that site group.

Table 2-7. *Croton* 74-4, Spring 1974.

Species	Faunal Affinity*	Species Group	Site Group ^b														
			I	II	III	IV	V	VI	7	8	9	10	11	12			
<i>Clusia baronius</i> <u>baronius</u>	Ba	A	5d	5.6	58	8.6											
<i>Raja arinacea</i>	Ba	B	100	7.5	92	11.1											
<i>Lumada ferruginea</i>	Ba	B	100	10.1	92	7.0											
<i>Scaphthalma epusajae</i>	LS	b	100	5.6													
<i>Alota pseudoharropi</i>	Ba	B	79	12.4	67	2.9											
<i>Macrosolenia apicicornis</i>	Ba	B			58	3.3											
<i>Urophycis chusa</i>	Ba	C	74	3.4	67	8.1	67	2.3									100
<i>Spadix nantiana</i>	Ba	C	95	8.9	100	26.3	93	27.3	91	22.1							
<i>Merluccius bilinearis</i>	Ba	C	95	12.1	100	12.4	96	18.5									80
<i>Hypoclinemus oblonga</i>	US	C			83	5.2	89	7.3									40
<i>Scorpaenocoma</i>	Ba	C	85	3.8			63	2.8	18	6.1							
<i>Peperilus triangulatus</i>	WT	b					81	16.5									40
<i>Sigambra chrysona</i>	WT	D							64	26.4							
<i>Prionoxystus</i>	WT	D					52	5.9	73	20.2							
<i>Centropomus</i>	WT	D							82	6.7							
<i>Urophycis vagus</i>	WT	E															40
<i>Mutulus canis</i>	WT	E															37
<i>Citharus arcifrons</i>	SI	F															70
<i>Lepididion ceryleum</i>	DS	F															80
<i>Glyptocephalus cyanopterus</i>	Ba-SI	G															100
<i>Chlorothalpus acipalis</i>	SI	G															75
<i>Merluccius albidus</i>	SI	G															92
<i>Helicolenus dactylopterus</i>	SI	G															67
<i>Myctophidæ</i>	Np	G															30
<i>Ceratotrypanus mederensis</i>	Np	H															30

* Faunal affinity is designated as boreal (Ba), warm-temperate (WT), temperate resident (TS), outer-what resident (DS), slope resident (SI), and mesopelagic (Np).

** 1 - percent of stations in each site group at which each dominant species occurred.
 % = average percent that individuals of each species group at which each dominant species occurred.
 A species was considered to be dominant in a site group if it occurred among the five most abundant species in at least 20% of all stations included in that site group.

Table 1-9. Cruise 76-2, Spring 1976.

Species	Faunal Affinity*	Species Group	Site Groups**														
			I	II	III	IV	V	VI	VII								
<u>Cliona baronius halibutis</u>	B0	A	30	5.6													
<u>Ammocetes dubius</u>	B0	A	50	14.8	57	23.5											
<u>Scolecoceros</u>	B0	A	60	11.3													
<u>Paje eribacis</u>	B0	C			94	8.7											
<u>Scaphthalus noronae</u>	S1	C			94	5.7											
<u>Lissoda ferruginea</u>	B0	C			80	6.6											
<u>Macroscoelus antarcticus</u>	B0	C			71	2.7											
<u>Alpheo penaeobarengus</u>	B0	C			57	4.1	40	14.3				73	4.6				
<u>Merluccius bilinearis</u>	B0	D	80	30.7	91	21.3	100	23.1	79	11.2	100	8.8	86	13.1	94	41.0	
<u>Squalus acanthias</u>	B0	D	100	8.3	69	7.1	100	44.1	71	20.9	93	36.0	50	11.0	59	3.8	
<u>Hippoglossus oblongus</u>	G5	D			90	4.6						100	8.8	94	10.2	59	3.7
<u>Urophycis chuss</u>	B0	D			69	3.7						100	1.5			76	1.8
<u>Citharichthys arctifrons</u>	S1	D							21	4.6	91	4.3					
<u>Urophycis regia</u>	WT	E	50	12.7					64	8.0			81	5.4			
<u>Centropristis striata</u>	WT	E							93	14.2							
<u>Stenotomus chrysops</u>	WT	E							86	12.9	60	3.6					
<u>Pleuronectes triacanthus</u>	WT	L							60	7.0	64	4.7	93	6.0	86	12.2	
<u>Paralichthys dentatus</u>	WT	E							86	4.9							
<u>Pleuronectes setulosus</u>	WT	L	70	11.6					57	6.4	80	11.9					
<u>Myxophidius</u>	MP	F											38	8.1	86	4.4	
<u>Merluccius albidus</u>	S1	F													76	8.4	
<u>Neilonemus dactylopterus</u>	S1	F													88	11.2	
<u>Leptophidius carpinus</u>	G8	F											47	3.9	76	4.7	
<u>Cyrtocostellus synaglossus</u>	B0-S1	F													76	3.0	

* Faunal affinity is designated as boreal (Bo), near-temperate (NT), inner-shelf resident (IS), outer-shelf resident (OS), slope resident (Sl), and mesopelagic (Mp).

** % = percent of stations in each site group at which each dominant species occurred.

‡ = average percent that individuals of each species contributed to stations in each site group.

A species was considered to be dominant in a site group if it occurred among the five most abundant species in at least 50% of all stations included in that site group.

Table E-10. Crabs 67-20 and 67-21, Fall 1967.

Species	Fernal Affinity	Species Group	Site Groups															
			I	II	III	IV	V	VI	VI	VI	VI	VI						
<u>Portunus emilis</u>	WT	A	57	5.4														
<u>Paralichthys dentatus</u>	WT	A	50	3.1														
<u>Protonotus epollinus</u>	WT	A	71	61.1	100	33.6												
<u>Scaphthalmus atropurpureus</u>	IS	B		85	3.6		100	2.4										
<u>Pseudosquilla munitissima</u>	Bo	B		100	5.5													
<u>Protonotus chinensis</u>	WT	B	57	26.1	54	3.5	57	2.2										
<u>Alona pseudoharengus</u>	Bo	D					100	20.4										
<u>Alia eriantha</u>	Bo	B					60	3.9										
<u>Stomatopoda</u>	Bo	B					60	8.0										
<u>Stomatopoda</u>	Bo	B					87	6.0	60	8.0								
<u>Stomatopoda</u>	Bo	B					92	22.1	100	22.1			83	29.9				
<u>Stomatopoda</u>	Bo	B					91	12.2	100	32.8	100	32.5						
<u>Stomatopoda</u>	Bo-SI	C											58	3.2				
<u>Stomatopoda</u>	Bo	B					94	9.8	80	7.1			100	20.9	84	37.0	76	18.9
<u>Stomatopoda</u>	WT	B	43	12.2			61	7.8	60	12.1			88	22.3	44	15.9		
<u>Stomatopoda</u>	OS	H													36	5.4	65	3.0
<u>Stomatopoda</u>	Bo	H											83	4.2				
<u>Stomatopoda</u>	SI	I													29	3.6		
<u>Stomatopoda</u>	OS	I																
<u>Stomatopoda</u>	WT	I	36	3.5											64	16.2	82	9.7
<u>Stomatopoda</u>	SI	K															47	5.9
<u>Stomatopoda</u>	SI	K															61	4.9
<u>Stomatopoda</u>	Bo	K													20	10.0	35	16.5

* Fernal affinity is designated as boreal (Bo), very-temperate (WT), inner-shell resident (IS), outer-shell resident (OS), slope resident (SI), and mesopelagic (Mo).
 ** Z = percent of stations in each site group at which each dominant species occurred.
 † Z = average percent that individuals of each species contributed to stations in each site group.
 ‡ A species was considered to be dominant in a site group if it occurred among the five most abundant species in at least 20% of all stations included in that site group.

Table 2-11. Cruise 68-17, Fall 1968.

Species	Fossil Affinity	Species Group	Site Occupancy																	
			I	II	III	IV	V	VI	VII	VIII										
<u>Paralichthys dentatus</u>	WT	A	68	6.7																
<u>Centropristis striata</u>	WT	A	68	3.1																
<u>Stenotomus chrysops</u>	WT	A	67	13.0	23	3.2														
<u>Deopterus macerellus</u>	WT	A	67	5.2																
<u>Prionotus carolinus</u>	WT	B	93	49.6	85	10.9														
<u>Scophthalmus aquosus</u>	IS	B			100	7.6														
<u>Panulirus argus</u>	Bo	B	77	5.0	86	2.9														
<u>Hyomyschilus scolodactylus</u>	Bo	C	77	2.6																
<u>Squalus acanthias</u>	Bo	D	100	10.7	100	48.1	94	10.1	33	5.7	52	5.4	22	5.9						
<u>Lingula ferruginea</u>	Bo	D	92	36.8	100	13.8	100	27.7												
<u>Merluccius bilinearis</u>	Bo	D	100	11.9	86	7.4	100	30.2	67	3.5	93	28.2	67	23.6	89	22.8				
<u>Paralichthys reticulatus</u>	WT	D	74	7.7			93	10.4	94	11.2	92	54.8	52	8.1	33	22.7				
<u>Urophycis chuss</u>	Bo	D					94	8.6			81	8.0								
<u>Lophius americanus</u>	Bo	E															56	3.8		
<u>Urophycis tenuis</u>	Bo-SI	E															56	2.9		
<u>Lepidion carolinum</u>	OS	F													78	2.9				
<u>Githarichthys arctifrons</u>	SI	F													74	9.0	22	7.9	22	2.1
<u>Urophycis regia</u>	WT	F	62	4.8	69	3.9									25	2.9	70	12.2	89	11.3
<u>Nezumia</u>	Bo	G																	89	33.8
<u>Helicolenus dactylopterus</u>	SI	G																	100	24.5
<u>Merluccius albidus</u>	SI	G																	87	5.7
<u>Chlorophthalmus strasseri</u>	SI	G																	84	2.9

* Fossil affinity is designated as boreal (Bo), warm-temperate (WT), inner-shelf resident (IS), outer-shelf resident (OS), slope resident (SI), and mesopelagic (Mp).

† % = percent of stations in each site group at which each dominant species occurred.

‡ = average percent that individuals of each species contributed to stations in each site group.

§ = species was considered to be dominant in a site group if it occurred among the five most abundant species in at least 20% of all stations included in that site group.

Table F-13. Crows 69-11, Fall 1969.

Species	Faunal Affinity Group	Species Group	Site Group*										VI			
			I	II	III	IV	V	VI	VII	VIII	IX	X				
<u>Gastrophysalis viridis</u>	WT	B	73	4.3												
<u>Paralichthys dentatus</u>	WT	B	67	4.0												
<u>Pygostolus americanus</u>	Ba	C	80	3.8												
<u>Scophthalmus aquosus</u>	IS	C	93	2.6												
<u>Prionotus carolinus</u>	WT	C	100	25.1	80	8.7	30	5.6								
<u>Stenotomus chrysops</u>	WT	C	93	24.0	60	7.8										
<u>Merluccius triacanthus</u>	WT	C	93	21.8	87	8.0	85	9.0	56	21.1	67	27.4	28	7.1		
<u>Zeus setiferus</u>	Ba	D			93	16.8	100	30.5	74	26.5						
<u>Limanda ferruginea</u>	Ba	D			93	19.6	100	23.1	67	15.0	33	3.1				
<u>Hyperoplus reticulatus</u>	Ba	D			73	4.6	92	5.1								
<u>Hippoclinemus phloxus</u>	OS	D									90	3.9				
<u>Parabrycon ebano</u>	Ba	D					100	20.0	30	2.2	67	8.2				
<u>Merluccius bilinearis</u>	Ba	D					93	17.2	100	22.5	56	7.9	90	19.5	39	6.0
<u>Lopholatilus chamaeleleo</u>	Ba	F													64	2.4
<u>Clupeichthys arcifrons</u>	SI	G											67	8.2	56	11.1
<u>Hypoclinemus</u>	WT	C											71	19.2	61	13.8
<u>Chlorophthalmus maculatus</u>	SI	H													39	6.8
<u>Merluccius albidus</u>	SI	H													33	3.2
<u>Myxodolichopus</u>	My	H													56	31.2
<u>Merluccius dactylopterus</u>	SI	H													89	8.5

* Faunal affinity is designated as boreal (Ba), warm-temperate (WT), inner-shelf resident (IS), outer-shelf resident (OS), slope resident (SI), and meso-pelagic (My).

** I = percent of stations in each site group at which each dominant species occurred.

† = average percent that individuals of each species contributed to stations in each site group.

A species was considered to be dominant in a site group if it occurred among the five most abundant species in at least 20% of all stations included in that site group.

Table 2-13. Chytrid Fungi in Fall 1970.

Species	Fungal Affinity*	Species Group	Site Groups**															
			I	II	III	IV	V	VI	VII	VIII	IX							
<u>Protomyces carolinus</u>	WT	A	60	32.2												25	24.0	
<u>Stenomyces chrysonea</u>	WT	A			25	5.6												
<u>Centropogon stricta</u>	VI	A	60	5.9												13	8.3	
<u>Atrium lutea</u>	VI	B			24	3.4									25	6.9		
<u>Spizelus nebulosus</u>	Bo	C			100	19.8	100	13.8	23	13.8								
<u>Lizania ferruginea</u>	Bo	C			100	21.4	100	27.4	46	16.3								
<u>Hydrocephalus octodecimnotatus</u>	Bo	C			65	3.2	71	2.1										
<u>Pseudoplectonites americanus</u>	Bo	C			82	4.6		54	3.4									
<u>Pyralium triseptatum</u>	VI	C					76	6.1	54	15.0	36	5.8			33	24.0	63	19.5
<u>Scopthalma squabum</u>	IS	C																
<u>Dromyella chusa</u>	Bo	D																
<u>Merluccius bilinearis</u>	Bo	D																
<u>Hypobryonia oblonga</u>	OS	D																
<u>Citherichya arctifrons</u>	SI	D																
<u>Glyptoccephalus symyloides</u>	Bo-SI	E																
<u>Dromyella lutea</u>	VI	F																
<u>Lamproloma carvinae</u>	OS	F																
<u>Mycetozoa</u>	Sp	G																
<u>Mellicopeus albidus</u>	SI	G																
<u>Chlorophthalmus greenii</u>	SI	G																
<u>Halictoloma decyloperus</u>	SI	G																

* Fungal affinity is designated as boreal (Bo), warm-temperate (WT), temperate (T), outer-shell (OS), outer-shell

resident (SI), slope resident (SI), and mesopelagic (Mp).

** % = percent of stations in each site group at which each dominant species occurred.

z = average percent that individuals of each species contributed to stations in each site group.

A species was considered to be dominant in a site group if it occurred among the five most abundant

species in at least 30% of all stations included in that site group.

Table E-14. Species 71-6, Fall 1971.

Species	Faunal Affinity*	Species Group	Site Groups											RT			
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI				
<u>Stenotodus chrysops</u>	WT	A	55	8.5	29	6.8											
<u>Psittichthys denticulata</u>	WT	A	64	5.3													
<u>Pisomatus carolinus</u>	WT	A	45	16.9	43	3.3	21	2.4									
<u>Strombus torus</u>	WT	B	36	32.5	14	4.9	43	6.4									
<u>Microcephalus metodesmophilus</u>	Bo	C			60	3.3											
<u>Amphibalanus spumans</u>	IS	C			71	3.0											
<u>Proclimacostes similis</u>	Bo	C			86	3.7											
<u>Malv erinacea</u>	Bo	C			93	8.1											
<u>Amalus manihies</u>	Bo	C					34	6.9									
<u>Camada irritabilis</u>	Bo	C			93	22.7	64	7.7									
<u>Drepania chana</u>	Bo	E			79	10.3	46	3.9	38	5.7							
<u>Marluccius bilinearis</u>	Bo	E			90	14.8	79	15.0	100	32.3	80	9.8					
<u>Alloglossinus oblonga</u>	DS	E			79	3.1											
<u>Gibberichthys arcifrons</u>	SI	E							96	9.0							55
<u>Leptus triscantus</u>	WT	E	64	13.5	71	9.3	96	49.0	89	18.1	90	63.5					
<u>Urosalpinx carolinus</u>	WT	E	27	13.2					46	10.7	100	23.7	76	2.6			
<u>Leptochelone carolinus</u>	SI	V							50	6.1							
<u>Malacocheilus decipiens</u>	SI	I							42	5.7							82
<u>Metopidae</u>	WT	I							31	9.2							73
<u>Chlorocheilus sparsus</u>	SI	I															64
<u>Marluccius albidus</u>	SI	I															73

* Faunal affinity is designated as boreal (Bo), warm-temperate (WT), lower-half resident (LS), outer-shelf

resident (DS), and slope resident (SI), and mesopelagic (Mp).

** I = Percent of stations in each site group at which each dominant species occurred.

‡ = Average percent that individuals of each species contributed to stations in each site group.

A species was considered to be dominant in a site group if it occurred among the five most abundant

species in at least 20% of all stations included in that site group.

Table 8-15. Cruise 12-8, Fall 1972.

Species	Faunal Affinity*	Species Group	Site Groups																				
			I	II	III	IV	V	VI	VII	VIII	IX	X											
<u>Callinectes</u> <u>viridis</u>	VT	A	100	10.1																			
<u>Callinectes</u> <u>viridis</u>	VT	A	88	5.5																			
<u>Stomatopoda</u> <u>chrysops</u>	VT	B	50	43.7	67	14.9	56	7.4															
<u>Panopeus</u> <u>leucometopus</u> <u>americanus</u>	Bo	B			36	4.0	64	3.4															
<u>Portunus</u> <u>scyllarus</u>	VT	B	100	26.7	69	14.4	48	6.1			19	3.6											
<u>Stomatopoda</u> <u>equipes</u>	IS	B	66	4.7	56	5.8																	
<u>Callinectes</u> <u>viridis</u>	VT	C			91	9.0																	
<u>Callinectes</u> <u>viridis</u>	Bo	C			50	7.2																	
<u>Stomatopoda</u> <u>terres</u>	VT	C			31	7.4																	
<u>Callinectes</u> <u>viridis</u>	Bo	D			90	15.0	100	34.5	71	8.8	73	6.6											
<u>Clibanarius</u> <u>viridis</u>	SI	D			48	3.0	91	9.1	37	5.0	91	11.0											
<u>Callinectes</u> <u>viridis</u>	Bo	D					100	3.3	66	9.1													
<u>Hippidae</u> <u>oblonga</u>	OS	D			25	5.1	92	3.9	91	4.6	67	5.0											
<u>Urocheilichthys</u> <u>oblonga</u>	Bo	D					76	4.9	100	26.7	48	7.0											
<u>Urocheilichthys</u> <u>regalis</u>	VT	D									76	9.8	27	6.3									
<u>Portunus</u> <u>viridis</u>	VT	D									90	36.1											
<u>Lepidochelone</u> <u>carolinensis</u>	OS	D									38	4.7											
<u>Callinectes</u> <u>viridis</u>	Bo	E			69	6.5	92	6.0															
<u>Callinectes</u> <u>viridis</u>	Bo	E					92	20.5	91	9.4													
<u>Callinectes</u> <u>viridis</u>	Bo	E					68	3.7															
<u>Callinectes</u> <u>viridis</u>	Bo	E			25	3.1	76	4.9	73	3.2													
<u>Callinectes</u> <u>viridis</u>	SI	H																		42	26.2		
<u>Callinectes</u> <u>viridis</u>	SI	H																			77	7.9	
<u>Callinectes</u> <u>viridis</u>	Sp	H																				77	25.3
<u>Callinectes</u> <u>viridis</u>	SI	H																				41	6.2

* Faunal affinity is designated as boreal (Bo), warm-temperate (VT), near-shelf resident (SI), outer shelf resident (OS), slope resident (SI) and mesopelagic (Sp).

** % = percent of stations in each site group at which each dominant species occurred.

† = average percent that individuals of each species contributed to stations in each site group.

‡ A species was considered to be dominant in a site group if it occurred among the five most abundant species in at least 20% of all stations included in that site group.

Table 3-16. Crickets 73-8, Fall 1973.

Species	Fossil Affinity*	Species Group	Site Group ^b													
			I		II		III		IV		V		VI		VII	
			1	2	1	2	1	2	1	2	1	2	1	2	1	2
<i>Prionocera carolinia</i>	VT	A	50	4.9	70	23.4										
<i>Strophthalpa siccata</i>	US	A			70	4.8										
<i>Parasita calia</i>	VT	B	100	15.7												
<i>Lele arlancea</i>	Mo	B	83	8.2	61	4.7	31	4.2								
<i>Pseudoplectambus anglicanus</i>	Mo	B	33	4.9												
<i>Stenocoma chrysope</i>	VT	B	25	2.0	63	14.1										
<i>Limonis ferruginea</i>	Mo	B			30	5.5	45	8.3	15	3.4						
<i>Enallus montana</i>	Mo	C			35	7.8	45	7.4								
<i>Perlocetus bilineatus</i>	Mo	D			100	24.0	89	24.2	75	9.4	71	8.3	33	3.6		
<i>Hemilobus oblongus</i>	OS	D			100	9.5	31	6.3			36	6.2				
<i>Stenarctia americana</i>	SI	D			80	12.7					90	9.8				
<i>Leobius sparsus</i>	Mo	D					100	25.4			76	6.9	83	10.4		
<i>Drobylla regia</i>	VT	D			39	6.3			31	11.1	75	7.2	81	16.6		
<i>Enallus triseriatus</i>	VT	D	92	43.7	78	12.8	75	17.2	15	6.7	100	82.8	62	29.4	50	35.5
<i>Leobius ferrugineus</i>	OS	D									71	6.0				
<i>Enallus clausi</i>	Mo	D					85	9.9								
<i>Bellesiella dactylopterus</i>	SI	E													100	20.6
<i>Maricoma albida</i>	SI	E													81	20.0
<i>Nyctophilus</i>	NY	E													43	7.1
<i>Pericladia minutus</i>	Mo	E									13	3.8			33	5.6

* Fossil affinity is designated as boreal (Bo), near-temperate (NT), inner-shelf resident (IS), outer-shelf resident (OS), deep resident (SI), and mesopelagic (Mp).
 % = percent of stations in each site group at which each dominant species occurred.
 † = average percent that individuals of each species contributed to stations in each site group.
 ‡ A species was considered to be dominant in a site group if it occurred among the five most abundant species in at least 20% of all stations included in that site group.

Table E-17. Cruise 74-11, Fall 1974.

Species	Faunal Affinity*	Species Group	Site Groupings													
			I	II	III	IV	V	VI	VII							
<u>Microgaster undulatus</u>	WT	A	28	3.8												
<u>Paia griseata</u>	Bo	B			100	12.3										
<u>Scophthalmus aquosus</u>	IS	B			64	3.1										
<u>Squalus acanthias</u>	Bo	B	43	8.3	71	7.7										
<u>Limanda ferruginosa</u>	Bo	B			34	12.7										
<u>Stephanolepis hispidus</u>	WT	C		92	8.2											
<u>Centropristis striata</u>	WT	C		30	6.5											
<u>Pleuronectes carolinus</u>	WT	C		63	44.1		38	9.6								
<u>Stenotomus chrysops</u>	WT	C	86	29.3												
<u>Paralichthys dentatus</u>	WT	C	86	3.2	75	6.2										
<u>Mustelus canis</u>	WT	C		33	5.3											
<u>Urophycis regia</u>	WT	D		75	2.9		94	29.5		81	10.0					
<u>Clupeichthys struttirostris</u>	SI	B					56	7.3		100	18.3	89	12.4			
<u>Leptocottus armatus</u>	OS	D								88	7.4					
<u>Merluccius bilinearis</u>	Bo	II	21	5.0	58	15.6	88	25.1	50	15.7	94	24.9	67	10.2		
<u>Hippoglossus oblongus</u>	OS	D					93	7.3	69	6.7	39	4.9				
<u>Psyllus irroratus</u>	WT	D	86	36.5	33	3.0	21	3.2	94	62.8	100	35.4	56	13.2		
<u>Urophycis chuss</u>	Bo	D					57	5.7		28	4.8					
<u>Heterostichus rostratus</u>	SI	B							22	3.3						
<u>Chlorosthalmus aeneus</u>	SI	E														
<u>Myxopristichus</u>	Mo	E					31	17.7								
<u>Physiculus chesteri</u>	SI	F													56	7.3
<u>Merluccius albidus</u>	SI	F													89	4.9
<u>Macrouridae</u>	SI	F													78	6.2

* Faunal affinity is designated as boreal (Bo), warm-temperate (WT), inner-shelf resident (IS), water-shelf resident (OS), slope resident (SI), and mesopelagic (Mo).

** % = percent of stations in each site group at which each dominant species occurred.

‡ = average percent that individuals of each species contributed to stations in each site group.

A species was considered to be dominant in a site group if it occurred among the five most abundant species in at least 20% of all stations included in that site group.

Table 3-16. Crayfish 75-12, Fall 1975.

Species	Femal Affinity*	Species Group	Site Group†																						
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII											
<u>Microgeges umbellatus</u>	VT	A	100	42.1																					
<u>Desmarestia punctatus</u>	VT	A	67	15.5																					
<u>Desmarestia canis</u>	VT	B	67	9.4	43	16.0																			
<u>Paralichthys apocurus</u>	VT	B	83	13.3	100	25.1																			
<u>Triodites capillaris</u>	VT	B			86	37.6	78	3.8									30	7.6							
<u>Camptopeltis striata</u>	VT	B	67	5.2														50	8.3						
<u>Bala trilineata</u>	Bo	C			91	4.4																			
<u>Annulus maculatus</u>	Bo	D			70	10.4	100	19.0	35	6.9															
<u>Stomatopus chrysope</u>	VT	D			71	10.9	83	26.6	89	13.3	63	23.4													
<u>Parasilus triacanthus</u>	VT	D	50	6.5					52	2.5	89	43.8	100	38.1	75	6.2	60	10.6							
<u>Meristina bilineata</u>	Bo	E			29	6.6	78	19.1	100	14.5	65	7.4	100	19.9	100	34.0	53	9.5							
<u>Megalumnus oblongus</u>	OB	E			96	2.0																			
<u>Citharichthys scutiformis</u>	SI	E			52	6.8													80	13.7					
<u>Prochelis chana</u>	Bo	E			63	4.1	72	6.3												60	6.4				
<u>Dromochia rufus</u>	VT	E																		47	14.7				
<u>Speopelma</u>	Sp	F																			47	6.0			
<u>Meristina libidus</u>	SI	F																				73	7.8		
<u>Neuroleus papillae</u>	Sp	F																					73	7.1	
<u>Halichinus dactylopterus</u>	SI	F																					93	23.0	
<u>Lepidochela cervinus</u>	OB	F																						83	4.0

* Femal affinity is designated as boreal (Bo), warm-temperate (Sp), inner-shelf resident (SI), outer-shelf resident (OB), slope resident (SI), and mesopelagic (Sp).

† I = percent of stations in each site group at which each dominant species occurred.

‡ = average percent that individuals of each species contributed to stations in each site group.

§ = species was considered to be dominant in a site group if it occurred among the five most abundant

species in at least 20% of all stations included in that site group.

Table E-19. Cruise 69-8, Summer 1969.

Species	Faunal Species Affinity* Group	Site Group**													
		I	II	III	IV	V	VI	VII	VIII	IX	X				
<u>Pseudopleuronectes americanus</u>	Ba	57	6.3	35	6.9										
<u>Littoridia ferruginea</u>	Ba	78	21.0	43	11.0										
<u>Scophthalmus aquosus</u>	IS	2		40	6.7										
<u>Merluccius bilinearis</u>	Ba	96	11.7	76	11.4										
<u>Melanogrammus aeglefinus</u>	Ba	78	12.6	41	11.1				17	3.9					
<u>Tropocyris chuss</u>	Ba	91	14.0						17	2.8					
<u>Myoxocephalus octodactylus</u>	Ba	74	5.0												
<u>Hippoglossus oblongus</u>	OS	70	2.4												
<u>Squalus acanthias</u>	Ba	43	2.6	30	5.2										
<u>Sebastes nemurus</u>	Ba	39	5.7	30	5.8										
<u>Leptopidium carvinum</u>	OS								100	26.2	31	2.4			
<u>Citharichthys scottiana</u>	SI			27	2.7				92	30.2	30	7.2			
<u>Zeprilus trilineatus</u>	VI	74	3.6	37	20.7	100	47.2	50	11.2						
<u>Urophycis regia</u>	VI			24	9.8	93	46.9	75	27.4	63	20.5				
<u>Neupolius muelleri</u>	IV											44	15.9		
Myctophidae	IV											36	6.8		
<u>Helicolenus dactylopterus</u>	SI											56	10.6		
<u>Merluccius bilinearis</u>	SI											50	5.4		

* Faunal affinity is designated as boreal (Ba), warm-temperate (Wt), inner-shelf resident (IS), outer-shelf resident (OS), slope resident (SI), and mesopelagic (Mp).

** % = percent of stations in each site group at which each dominant species occurred.

‡ = average percent that individuals of each species contributed to stations in each site group.

§ = species was considered to be dominant in a site group if it occurred among the five most abundant species in at least 20% of all stations included in that site group.

APPENDIX F

**Community structure indices for NMFS Groundfish
Survey Cruises, Fall 1967 - Spring 1976.**

DIVERSITY (H')

SPRING CRUISES

Site Group	I	II	III	IV	V	VI	VII	VIII	IX
Year									
1968	2.64	3.08	1.05	2.20	2.19	2.39	1.60		
1969	2.38	2.96	3.05	2.32	2.40	2.88	1.82	1.20	
1970	3.02	2.83	3.15	1.28	2.13	1.10	2.66	0.79	3.06
1971	1.91	3.19	2.75	1.18	3.16	2.62			
1972	3.11	3.11	3.17	1.50	1.42	2.66	2.95	2.48	3.07
1973	3.51	2.90	2.84	0.55	1.21	1.72	2.36		
1974	2.72	3.31	2.91	1.90	4.09	3.01			
1975	2.08	2.38	1.90	2.31	3.55	3.59			
1976	1.47	2.87	2.13	3.67	3.19	1.55	3.32		

FALL CRUISES

Site Group	I	II	III	IV	V	VI	VII	VIII	IX
Year									
1967	0.87	2.60	3.28	3.21	2.26	1.14	1.75		
1968	1.75	3.06	2.41	2.60	0.55	3.43	1.43	2.77	
1969	1.51	3.33	2.85	2.40	1.53	0.67			
1970	1.64	2.77	2.00	2.31	2.74	2.27	1.46	2.30	3.61
1971	1.49	2.52	1.83	2.31	0.32	2.92			
1972	1.08	3.91	3.14	2.73	2.22	3.51			
1973	0.48	3.21	3.12	1.56	0.07	2.35	0.74		
1974	2.01	2.86	2.36	2.33	0.96	2.33	3.14		
1975	1.95	2.32	3.09	2.26	1.88	2.73	2.81	2.95	

SUMMER CRUISE

Site Group	I	II	III	IV	V	VI	VII	VIII	IX
Year									
1969	3.34	2.10	1.25	2.06	3.26				

EVENNESS (J')

SPRING CRUISES

Site Group	I	II	III	IV	V	VI	VII	VIII	IX
Year									
1968	0.55	0.65	0.24	0.43	0.46	0.46	0.38		
1969	0.64	0.58	0.65	0.70	0.50	0.55	0.36	0.26	
1970	0.69	0.63	0.64	0.35	0.45	0.26	0.56	0.21	0.59
1971	0.47	0.63	0.58	0.22	0.59	0.50			
1972	0.75	0.68	0.65	0.47	0.29	0.52	0.63	0.57	0.62
1973	0.66	0.55	0.60	0.11	0.27	0.43	0.43		
1974	0.54	0.70	0.54	0.42	0.76	0.57			
1975	0.40	0.53	0.40	0.48	0.68	0.66			
1976	0.33	0.55	0.52	0.72	0.66	0.30	0.56		

FALL CRUISES

Site Group	I	II	III	IV	V	VI	VII	VIII	IX
Year									
1967	0.17	0.54	0.63	0.73	0.45	0.23	0.35		
1968	0.37	0.64	0.53	0.50	0.12	0.63	0.34	0.64	
1969	0.30	0.67	0.61	0.46	0.31	0.13			
1970	0.40	0.56	0.40	0.59	0.58	0.55	0.35	0.54	0.77
1971	0.30	0.47	0.36	0.43	0.08	0.64			
1972	0.24	0.88	0.60	0.55	0.43	0.63			
1973	0.11	0.58	0.60	0.38	0.02	0.45	0.17		
1974	0.37	0.59	0.48	0.45	0.20	0.55	0.58		
1975	0.38	0.69	0.60	0.47	0.41	0.54	0.67	0.54	

SUMMER CRUISE

Site Group	I	II	III	IV	V	VI	VII	VIII	IX
Year									
1969	0.65	0.39	0.31	0.44	0.65				

SPECIES RICHNESS

SPRING CRUISES

Site Group	I	II	III	IV	V	VI	VII	VIII	IX
Year									
1968	2.97	3.19	2.19	3.23	2.73	4.22	2.45		
1969	1.54	3.75	3.38	1.79	4.00	4.25	3.34	2.58	
1970	2.95	2.85	3.40	1.66	2.87	1.72	2.82	1.60	4.71
1971	1.91	3.84	3.17	4.07	4.01	4.26			
1972	2.35	2.83	3.48	1.46	2.69	3.91	2.98	2.47	4.19
1973	3.87	3.94	2.92	2.77	2.09	2.43	4.28		
1974	3.36	3.47	4.22	2.56	5.51	4.71			
1975	4.03	2.44	2.67	2.99	4.96	4.93			
1976	2.16	3.57	2.10	4.31	3.10	4.00	7.04		

FALL CRUISES

Site Group	I	II	III	IV	V	VI	VII	VIII	IX
Year									
1967	3.50	3.13	3.73	2.94	3.74	3.06	3.61		
1968	2.85	3.16	2.54	3.95	2.23	4.74	2.16	2.82	
1969	3.59	3.33	2.75	3.56	3.03	3.38			
1970	1.93	3.63	3.21	2.14	3.19	2.28	1.81	2.93	4.02
1971	3.40	3.92	3.79	4.72	1.66	3.56			
1972	3.01	3.14	3.67	3.43	4.07	5.71			
1973	2.11	4.90	4.07	2.37	1.15	4.10	2.74		
1974	4.82	3.89	3.47	4.16	2.96	2.20	5.59		
1975	4.02	1.83	3.63	3.02	2.85	3.65	2.55	5.43	

SUMMER CRUISE

Site Group	I	II	III	IV	V	VI	VII	VIII	IX
Year									
1969	4.00	3.75	1.78	3.08	4.27				

APPENDIX G

List of species taken during NMFS Groundfish Survey Cruises,
Fall 1967 - Spring 1976, with abundances, occurrences
and environmental ranges.

	SPECIES GROUP		ABUNDANCE				ENVIRONMENTAL RANGES			
	SPRING	FALL	W	F	M	W	TEMP. RANGE (°C)	DEPTH RANGE (M)		
	196-197- B90123456	196-197- 789012345								
<i>Phycis chesteri</i> (longfin hake)	+++G++ +	+++++++F+	481	36.5	36	239	14.1	31	6-14	165-433
<i>Alopias amplifrons</i> (American shark)	D+++C+D+	+++BC+ ++	388	97.2	114	151	32.6	32	3-17	26-280
<i>Parastichia miniata</i> (armored xenobry)	EI ++BFG	I++F+CFE	346	44.5	80	181	20.9	65	5-18	27-347
<i>Pseudisparus americanus</i> (sea raven)	ADBCAAA+	+CEHP+++	256	134.4	124	130	46.2	69	2-18	26-327
<i>Pseudocyttus salivarius</i> (bluefish)	+++	++++ACACA	13	16.5	8	369	441.2	77	7-22	20-102
<i>Merluccius merluccius</i> (Atlantic silverside)	AC A+ ++		372	5.2	42				2-14	20-203
<i>Decapterus rubescens</i> (round scad)	+ + +	++ + +A	23	0.2	2	329	9.0	17	10-23	22-95
<i>Melanostomus aequalis</i> (haddock)	+++++++	+++BC +++	165	281.2	34	146	68.4	37	3-15	33-115
<i>Hippoglossoides platessoides</i> (American plaice)	ABBA+++	DE+++	160	39.1	57	147	36.9	39	2-15	37-338
<i>Merluccius bilinearis</i> (planehead filefish)	+ + ++	+++	97	3.7	11	187	3.1	27	6-21	18-366
<i>Stenotomus</i>										
<i>Cratichthys waltonii</i> (horned lanternfish)	+ + +	++ + +	140	0.9	9	103	1.1	11	8-13	86-341
<i>Cratichthys argentea</i> (weakfish)	++++++	+ + + + +	150	175.9	12	54	14.4	10	6-22	22-135
<i>Urophycis regia</i> (tanner)	++ + + +	++++ +	159	51.8	15	36	23.1	9	3-15	27-86
<i>Anchoa mitchilli</i> (bay anchovy)	+ + +	+ + +	8	0.2	2	168	0.6	2	5-21	22-46
<i>Scombroideus maculatus</i> (northern puffer)	+ + +	+++ + + + +	1	0.1	1	169	9.5	17	13-22	18-187
<i>Demersus maculatus</i> (mackerel scad)	++ ++	A+B+	158	14.3	7	6	0.8	4	3-14	37-336
<i>Sebastes marinus</i> (redfish)										
<i>Stenopus</i> sp.										
<i>Etropus microdonus</i> (smallmouth flounder)	+ + + +	++ +	149	2.1	21	162	0.7	3	12-15	22-48
<i>Trachurus labrax</i> (rough scad)	++ +	++ + +	27	0.6	6	12	0.8	8	2-22	18-68
<i>Trachurus urbelli</i> (smiled scalpin)	++ +	++ + +	149	0.7	5	124	5.8	16	6-22	20-212
<i>Isurus paucus</i> (Atlantic angel shark)	+++ + +	++A+++++	84	102.1	29	58	390.5	35	6-23	18-320
<i>Isurus paucus</i> (Atlantic angel shark)	++++ +	+++F++G+	42	7.4	22	82	8.0	51	7-18	33-335
<i>Zenopsis eschmueri</i> (packler dory)	++++ +	+++IH++	67	3.4	27	53	3.4	30	6-14	119-366
<i>Merluccius bilinearis</i> (marlin-spine)	++++ +	++++ + + +	84	14.9	36	27	6.7	24	7-16	80-320
<i>Scyliorhinus retifer</i> (chain dogfish)	++ + + +	++A++A++	73	2.2	22	29	0.5	5	8-22	18-336
<i>Scyliorhinus retifer</i> (chain dogfish)	++ + + +	+++G+++	30	16.4	21	69	57.0	36	6-22	18-336
<i>Halargyreus melanostictus</i> (black skate)	++ + + +	+++G+++	26	5.7	22	69	12.4	40	7-21	27-338
<i>Halargyreus melanostictus</i> (black skate)	+ + + + +	++++ +	47	2.1	20	45	4.5	20	7-14	80-340
<i>Argentina silus</i> (Atlantic argentine)	++ + + +	+++ + + + +	56	24.1	31	34	12.8	26	8-21	21-252
<i>Conus scammis</i> (conger eel)	+ + +	+ + + +	8	0.6	6	77	2.8	15	7-13	213-433
<i>Macrouridae</i>										
<i>Engraulidae</i>										
<i>Polypnus setiferus</i> (hatchet fish)	++++ +	++++ + +	42	1.3	13	35	1.6	18	6-13	174-633
<i>Enchelyopus gibbus</i> (fourbeard rockling)	+++ + +	++++F+++	18	1.8	18	54	4.5	26	2-15	40-329
<i>Pollachius virens</i> (pollack)	++ + + +	CD+++	30	171.9	20	38	17.1	13	3-15	38-150
<i>Cyclopteridae</i>										
<i>Nyctobatiformes</i>										
<i>Oxycorhinus rufipinnis</i> (longnose batfish)	++++ +	+ + + + +	39	2.3	19	20	1.1	11	7-14	33-336
<i>Dasyatis centroura</i> (southern stingray)	++ + + +	+++ + +	55	1233.9	19	14-21	22-59			
<i>Argyroscopus scintillans</i> (silver hatchetfish)	+ + + + +	+ + + + +	43	0.8	8	5	0.5	5	8-13	183-333
<i>Ophichthus truttae</i> (marginated snake eel)	++ + + +	+ + + + +	23	1.3	13	18	0.6	8	6-15	85-327
<i>Cynoglossidae</i>										
<i>Arnoglossus tetrurus</i> (Atlantic seahead)	+ + + + +	+ + + + +	38	3.5	8	3	1.0	2	4-19	20-90

APPENDIX G (cont.)

	SPECIES GROUP		ABUNDANCE				ENVIRONMENTAL RANGES					
	FALL		SPRING CRUISES		FALL CRUISES		TEMP. RANGE (°C)		DEPTH RANGE (M)			
	196-197-890123456	196-197-789012345	N	WEIGHT (KG.)	N	WEIGHT (KG.)	MO. OCC.	DEC.	MO. OCC.	DEC.		
<i>Coeloclinchus carolinatus</i> (longnose grenadier)	+	++++	+	+	29	1.2	7	11	0.4	4	4-12	187-341
<i>Melichthys firmivillei</i> (bullnose ray)			++	+++	6	0.5	5	38	268.7	13	17-22	22-35
Ophichthidae												
<i>Aia lavis</i> (barndoor skate)	++++	++	++	+	6	0.5	5	31	0.4	4	8-14	113-433
<i>Etmopterus triesteri</i>	+		++	+	27	65.5	15	10	7.0	8	3-20	38-196
Anguilliformes												
<i>Dasyatis centroura</i> (roughskin stingray)	+	++++	++	+++	22	1.6	3	15	0.6	2	8-11	183-341
<i>Gemmarus fabricii</i> (black dogfish)	+	++++	++	+++	34	3.8	15	2	0.2	2	8-13	33-329
<i>Chimaera sp.</i>			+	+++	32	1.2	5	4	0.4	4	9-16	115-349
<i>Macruronus angulosus</i> (longspine snipefish)	++	++	+	+++	26	0.1	1	8	0.2	2	8-11	205-338
<i>Lopholatilus chamaeleonticeps</i> (tilefish)	+	++++	+	+++	17	1.0	10	17	0.9	9	9-14	73-433
<i>Raja radialis</i> (thorny skate)	++++	++	+	+++	27	110.0	22	6	22.9	5	10-15	104-333
<i>Dasyatis saxi</i> (bluntnose stingray)	++++	++	+	+++	30	22.8	8	1	2.7	1	3-10	60-340
Triglidae												
<i>Pleuronectiformes</i>												
<i>Berkela dumerilii</i> (amberjack)	+		+	+	27	2.5	4	2	0.1	1	10-23	33-274
Sphippidae												
<i>Hopllostethus mediterraneus</i> (rosy soldierfish)	++	+	++	+	22	1.1	11	3	0.2	2	9-11	205-276
<i>Stomias affinis</i>	++	+	++	+	19	0.1	1	19	0.4	4	9-13	183-335
<i>Alopias borealis</i> (common ray)												
<i>Trichiurus leucurus</i> (Atlantic cutlassfish)	+	++	+	+++	5	1.6	3	14	1.3	5	9-22	22-433
<i>Synagrops bellus</i> (blacksnout bass)	+	+	+	+	4	0.2	2	15	0.5	5	10-13	84-338
<i>Carbarthius obscurus</i> (dusky shark)	+	+++	+	+	3	21.3	2	16	315.7	13	12-21	18-124
<i>Spharodon stonatus</i> (longtooth anglemouth)	++	+	++	+	5	0.3	3	13	0.4	4	8-11	219-338
<i>Carbarthius plumbeus</i> (sandbar shark)	+	+	++	+	4	36.0	2	14	128.4	12	11-19	22-121
<i>Selene setipinna</i> (Atlantic moonfish)	+	+	+	+	17	0.6	6	12	0.6	6	12-21	26-271
<i>Squalus fuscus</i> (northern pipefish)	+	++	+	+	16	1.3	13	1	0.1	1	3-11	24-95
<i>Cymatogaster maculatus</i> (wrymouth)	++++	+	++++	+	7	1.0	6	9	0.9	5	3-12	53-433
<i>Antionia minor</i> (deepbody boarfish)	+	+	+	++	11	0.4	4	4	0.3	3	9-13	124-311
<i>Diabius dumerilii</i> (bedlight fish)	+	+	+	+	11	0.1	1	4	0.1	1	10-11	148-221
<i>Simenchelys parasiticus</i> (slime eel)	+		+	+	15	0.5	5	12	58.1	4	11-21	26-86
<i>Blennius lewini</i> (sand tiger)	+	+	+	+	3	18.6	1	15	179.7	7	5-23	31-320
Eleutherobranchii												
<i>Ethiopianus chrysopsis</i> (pigfish)			+	+								
<i>Torpedo nobiliana</i> (Atlantic torpedo)	++++	++	++	+	10	108.0	10	4	1.0	3	18-19	26-31
<i>Scorpaenonotus arctatus</i> (chub wackerel)	+	+	+	+					128.4	3	8-17	33-349
<i>Macrourus barbatus</i> (rough-headed grenadier)	+	+	+	+	13	1.6	3	13	1.6	3	9-10	71-176
<i>Brama brama</i> (cwek)	++	+	+	+	12	0.5	1	1	0.1	1	10-10	280-357
<i>Urophycis subbifasciata</i> (radiated shanny)	+	+	+	+	12	0.2	2	1	0.1	1	12-14	44-119
<i>Belar crenophthalma</i> (bigeye scad)	+	+	++	+	12	0.5	5	12	0.6	6	10-21	22-44
<i>Ventrifona octidactyla</i>												
Verrucidae												
<i>Chamliedus alouai</i> (viperfish)	+	+	++	+	11	0.8	8	1	0.1	1	8-13	187-338
			++	+	7	0.4	4	5	0.4	4	7-13	57-341
			+	++	4	0.3	3	6	0.7	7	8-13	128-340

APPENDIX G (cont.)

	SPECIES GROUP		ABUNDANCE				ENVIRONMENTAL RANGES				
	FALL		SPRING CRUISES		FALL CRUISES		TEMP. RANGE (°C)	DEPTH RANGE (M)			
	196-197-890123456	196-197-789012345	N	WEIGHT (KG.)	N	WEIGHT (KG.)					
<i>Gaidropsarus ensis</i> (Arctic threebeard rockling)			11	0.4	4		10	5.0	9	9-13	78-361
<i>Gadus aoteanus</i> (smooth skate)			1	0.1	1					7-21	29-327
<i>Lautoga grimaldi</i> (tautog)			10	6.1	5					5-7	22-29
<i>Parachanna atlantica</i> (Atlantic botfish)			6	0.4	3		4	0.3	3	7-13	124-334
<i>Parandia kneri</i> (longnose greeneye)			10	0.7	2					6-11	244-254
<i>Stenopterus leucostictus</i> (spiny butterfly ray)							10	274.9	3	14-21	26-68
<i>Myoxocephalus thompsoni</i> (deepwater flounder)			5	0.9	5		3	0.3	3	7-11	190-338
<i>Halibut</i> (slippery dick)			8	0.4	4					6-7	24-40
<i>Stenobrama leucostictus</i> (polka-dot cusk-eel)			1	0.1	1		8	1.2	5	11-22	22-102
<i>Stenopterygiidae</i>			8	0.5	5		7	0.2	2	8-13	123-203
<i>Alepis heterostictus</i> (hickory shad)			8	3.3	3					8-10	227-341
<i>Polynema nobilii</i>			4	0.3	3		3	0.3	3	10-19	35-311
<i>Halargyreus sabini</i> (gray triggerfish)			3	0.3	3		6	0.6	6	7-22	20-137
<i>Pholis nebulosa</i> (rock gunnel)							3	0.3	3	4-12	44-88
<i>Synsphyronema</i>							6	0.2	2	11-13	225-338
<i>Trachurus medius</i> (bandtail searobin)			4	0.4	3		6	0.1	1	19-19	31-31
<i>Urophycis regia</i> (striped cusk-eel)			2	0.1	1		2	0.6	2	3-21	24-39
<i>Chlorophthalmidae</i>			6	0.2	2		4	0.2	2	9-12	213-397
<i>Gonistius</i>							6	0.1	1	9-11	205-341
<i>Squalidae</i>							5	0.1	1	13-13	333-333
<i>Protonotaria prostrata</i> (rabbitfish)							5	0.2	2	10-10	126-276
<i>Berranidae</i>							5	0.1	1	15-15	27-27
<i>Leucichthys verrillii</i> (wolf eelpout)			5	0.2	2					9-11	205-341
<i>Myxobolus punctatus</i> (spotted lanternfish)							5	0.1	1	11-11	148-148
<i>Synodontidae</i>							5	1.1	4	10-25	22-33
<i>Alicia boudi</i> (silver-teg)							6	0.3	3	7-17	38-322
<i>Lampanyctus maculatus</i> (dubbed saury)			4	0.2	2					4-4	55-55
<i>Merluccius merluccius</i> (northern kingfish)			3	1.1	2		1	0.1	1	9-14	29-64
<i>Calappa gryllus</i> (blue runner)							4	0.3	3	14-22	18-86
<i>Melanogrammus aeneus</i>			3	0.2	2		1	0.1	1	8-11	234-292
<i>Phycichthys phycius</i> (hake)			3	0.3	3		1	0.1	1	13-13	119-329
<i>Opesichthys</i> (rainbow smelt)			4	0.1	1					4-4	44-44
<i>Hippoglossus hippoglossus</i> (Atlantic halibut)			2	23.6	2		1	5.4	1	4-13	33-69
<i>Stenobrama maculatus</i> (Spadish mackerel)			1	0.1	1		2	5.0	2	19-25	27-29
<i>Merluccius bilinearis</i> (goby flathead)							3	0.1	1	4-14	29-146
<i>Lachnolaimus maximus</i> (hogfish)			3	0.2	2		3	0.1	1	13-13	256-256
<i>Apogonidae</i>							3	0.3	3	11-11	128-165
<i>Seriola lalandi</i> (lookdown)			2	0.2	2		1	0.1	1	10-13	64-210
<i>Carangidae</i>							3	0.6	2	20-20	24-37
<i>Decapterus volitans</i> (flying gurnard)							3	0.1	1	19-19	31-31
<i>Trisopterus luscus</i> (bighead sculpin)							3	0.3	3	11-16	40-69
<i>Limularia isabellina</i> (bluespotted coronetfish)											
<i>Gastrophysus scintillans</i> (threespine stickleback)			3	0.3	3					4-5	46-276

	SPECIES GROUP		ABUNDANCE				ENVIRONMENTAL RANGES	
	SPRING	FALL	SPRING CRUISES	FALL CRUISES	YALL CRUISES	TEMP. RANGE (°C)	DEPTH RANGE (M)	
	196-197-198-199-200-201-202-203-204-205-206-207-208-209-210-211-212-213-214-215-216-217-218-219-220-221-222-223-224-225-226-227-228-229-230-231-232-233-234-235-236-237-238-239-240-241-242-243-244-245-246-247-248-249-250-251-252-253-254-255-256-257-258-259-260-261-262-263-264-265-266-267-268-269-270-271-272-273-274-275-276-277-278-279-280-281-282-283-284-285-286-287-288-289-290-291-292-293-294-295-296-297-298-299-300-301-302-303-304-305-306-307-308-309-310-311-312-313-314-315-316-317-318-319-320-321-322-323-324-325-326-327-328-329-330-331-332-333-334-335-336-337-338-339-340-341-342-343-344-345-346-347-348-349-350-351-352-353-354-355-356-357-358-359-360-361-362-363-364-365-366-367-368-369-370-371-372-373-374-375-376-377-378-379-380-381-382-383-384-385-386-387-388-389-390-391-392-393-394-395-396-397-398-399-400-401-402-403-404-405-406-407-408-409-410-411-412-413-414-415-416-417-418-419-420-421-422-423-424-425-426-427-428-429-430-431-432-433-434-435-436-437-438-439-440-441-442-443-444-445-446-447-448-449-450-451-452-453-454-455-456-457-458-459-460-461-462-463-464-465-466-467-468-469-470-471-472-473-474-475-476-477-478-479-480-481-482-483-484-485-486-487-488-489-490-491-492-493-494-495-496-497-498-499-500-501-502-503-504-505-506-507-508-509-510-511-512-513-514-515-516-517-518-519-520-521-522-523-524-525-526-527-528-529-530-531-532-533-534-535-536-537-538-539-540-541-542-543-544-545-546-547-548-549-550-551-552-553-554-555-556-557-558-559-560-561-562-563-564-565-566-567-568-569-570-571-572-573-574-575-576-577-578-579-580-581-582-583-584-585-586-587-588-589-590-591-592-593-594-595-596-597-598-599-600-601-602-603-604-605-606-607-608-609-610-611-612-613-614-615-616-617-618-619-620-621-622-623-624-625-626-627-628-629-630-631-632-633-634-635-636-637-638-639-640-641-642-643-644-645-646-647-648-649-650-651-652-653-654-655-656-657-658-659-660-661-662-663-664-665-666-667-668-669-670-671-672-673-674-675-676-677-678-679-680-681-682-683-684-685-686-687-688-689-690-691-692-693-694-695-696-697-698-699-700-701-702-703-704-705-706-707-708-709-710-711-712-713-714-715-716-717-718-719-720-721-722-723-724-725-726-727-728-729-730-731-732-733-734-735-736-737-738-739-740-741-742-743-744-745-746-747-748-749-750-751-752-753-754-755-756-757-758-759-760-761-762-763-764-765-766-767-768-769-770-771-772-773-774-775-776-777-778-779-780-781-782-783-784-785-786-787-788-789-790-791-792-793-794-795-796-797-798-799-800-801-802-803-804-805-806-807-808-809-810-811-812-813-814-815-816-817-818-819-820-821-822-823-824-825-826-827-828-829-830-831-832-833-834-835-836-837-838-839-840-841-842-843-844-845-846-847-848-849-850-851-852-853-854-855-856-857-858-859-860-861-862-863-864-865-866-867-868-869-870-871-872-873-874-875-876-877-878-879-880-881-882-883-884-885-886-887-888-889-890-891-892-893-894-895-896-897-898-899-900-901-902-903-904-905-906-907-908-909-910-911-912-913-914-915-916-917-918-919-920-921-922-923-924-925-926-927-928-929-930-931-932-933-934-935-936-937-938-939-940-941-942-943-944-945-946-947-948-949-950-951-952-953-954-955-956-957-958-959-960-961-962-963-964-965-966-967-968-969-970-971-972-973-974-975-976-977-978-979-980-981-982-983-984-985-986-987-988-989-990-991-992-993-994-995-996-997-998-999-1000	NO. OCC.	NO. OCC.	NO. OCC.	NO. OCC.	NO. OCC.		
Ophidiidae								
<i>Echlophila</i> sp.	+		3	0.3	3			8-10 27-300
<i>Aetobatus arimari</i> (spotted eagle ray)		+						9-9 433-433
<i>Aluterus schoepfi</i> (orange filefish)		+						21-21 24-24
<i>Pseudisyllium beana</i>		+						22-22 20-22
<i>Urolophus harrisi</i> (fringed flounder)		+	1	0.1	1			8-8 335-335
<i>Paralichthys punctatus</i> (barrelfish)		+	1	0.1	1			5-16 24-37
<i>Paralichthys atlantica</i> (snake mackerel)		+	1	0.1	1			11-12 146-229
<i>Amorpha loma</i> (Atlantic wolfid)		+	2	39.0	1			9-13 157-433
<i>Aburrua borealis</i> (northern sennet)		+	1	0.1	1			4-4 69-69
<i>Rachycentrus canadensis</i> (cobia)		++						10-25 29-219
<i>Cyprinodon philadelphia</i> (rock sea bass)		+						17-25 29-35
<i>Cyprinodon longispinus</i> (lumpfish)		++	2	6.2	2			19-19 31-31
<i>Melanostomus atlanticum</i> (Atlantic soft pout)		+	2	0.1	1			4-5 49-55
<i>Ophiodon elongatus</i> (blotched cuck-ee)		+	1	0.1	1			14-14 335-335
<i>Paralichthys atlantica</i> (duskybill barracudina)		+	1	0.1	1			9-10 41-60
<i>Ammodytes americanus</i> (offshore lizardfish)		+	1	0.1	1			10-12 136-232
<i>Ammodytes americanus</i> (inshore lizardfish)		+	1	0.1	1			16-16 192-241
<i>Ophiodon elongatus</i> (Atlantic thread herring)		+						9-14 32-249
<i>Moridae</i>		+						22-22 24-24
<i>Paralichthys atlantica</i> (jumbo)		+	1	0.1	1			8-11 40-71
<i>Larocentrus laevis</i> (smooth puffer)		+	1	0.1	1			12-12 261-261
<i>Symphurus carolinensis</i>		+	1	0.1	1			13-13 115-115
<i>Leptocottus armatus</i> (encolar)		+	1	0.5	1			13-13 76-76
<i>Leptocottus armatus</i> (swordfish)		+	1	0.5	1			11-11 244-244
<i>Scorpaenopsis diabolus</i> (king mackerel)		+						11-11 117-117
<i>Lumpenus lotus</i> (snake blenny)		+	1	0.1	1			16-16 31-31
<i>Coelacanthus atlanticus</i> (freckled starfish)		+	1	0.1	1			5-5 35-35
<i>Uroscopus</i>		+	1	0.1	1			13-13 225-225
<i>Lutjanidae</i>		+	1	0.1	1			11-11 205-205
<i>Scorpaenopsis diabolus</i> (remora)		+	1	0.1	1			13-13 76-76
<i>Caracanthus</i>		+	1	0.1	1			25-25 29-29
<i>Myoxocephalus scorpius</i> (grubby)		+	1	0.1	1			9-9 283-283
<i>Myoxocephalus scorpius</i> (northern sculpin)		+	1	0.1	1			4-4 69-69
<i>Trachurus atlanticus</i> (Mexican sea robin)		+	1	0.1	1			5-5 77-77
<i>Apogon niger</i> (trumpetfish)		+	1	0.1	1			12-12 106-106
<i>Apogon niger</i> (lined sea bream)		+	1	0.1	1			18-18 27-27
<i>Antipora holbrooki</i> (blue hahe)		+	1	0.1	1			10-10 276-276
<i>Cyclopterus</i>		+	1	0.1	1			9-9 433-433
<i>Antennarius radiatus</i> (single-spot frogfish)		+	1	0.1	1			13-13 101-101
<i>Ctenopoma</i>		+	1	0.1	1			10-10 55-55
<i>Serranus hepatus</i> (scalloped hammerhead)		+	1	11.3	1			10-10 276-276
<i>Eubrychium</i>		+	1	6.3	1			14-14 113-113
<i>Eubrychium</i>		+	1	6.3	1			22-22 22-22

ALL STATIONS

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