1985

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

James Alden Colvocoresses
College of William and Mary - Virginia Institute of Marine Science

8604298

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

University Microfilms International 300 N. Zeeb Road, Ann Arbor, MI 48106

PLEASE NOTE:

In all cases this material has been filmed in the best possible way from the available copy. Problems encountered with this document have been identified here with a check mark __✓__.

1. Glossy photographs or pages _____
2. Colored illustrations, paper or print ______
3. Photographs with dark background _____
4. Illustrations are poor copy ______
5. Pages with black marks, not original copy ______
6. Print shows through as there is text on both sides of page _______
7. Indistinct, broken or small print on several pages __✓__
8. Print exceeds margin requirements ______
9. Tightly bound copy with print lost in spine _______
10. Computer printout pages with indistinct print ______
11. Page(s) ___________ lacking when material received, and not available from school or author.
12. Page(s) ___________ seem to be missing in numbering only as text follows.
13. Two pages numbered ______. Text follows.
14. Curling and wrinkled pages _____
15. Dissertation contains pages with print at a slant, filmed as received _________
16. Other ____

University
Microfilms
International

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

This dissertation is submitted in partial fulfillment of
the requirements for the degree of

Doctor of Philosophy

Author

Approved, December 1985

John A. Musick

Herbert M. Austin

Richard L. Wetzel

Craig L. Smith

Ray S. Birdsong
Old Dominion University

TABLE OF CONTENTS

Page

ACKNOWLEDGMENTS

I would like to thank Dr. Marvin Grosslein and the staff of the Groundfish Survey Unit, Northeast Fisheries Center Woods Hole Laboratory for their helpful assistance in making this data base and supporting information available to researchers here at VIMS, and also to express my heartfelt appreciation to the hundreds of individuals who have participated in the survey over the years. Dr. Grosslein and the staff at NEFC, particularly William Overholtz, also provided a helpful review of a manuscript drawn from this work (Colvocoresses and Musick 1984), for which I am also indebted to Jim Price and Eric Anderson of VIMS and two anonymous reviewers. The same thanks are of course due my committee (Drs. John A. Musick, Richard L. Wetzel, Craig Smith, Herbert S. Austin and Ray Birdsong) and the numerous individuals who reviewed the contract report for this research (Colvocoresses and Musick 1979).

Eric Foell and William Blystone provided a large measure of assistance in preliminary data analyses and computer programming respectively. Typing of the various manuscripts was performed by the VIMS report center under the direction of Ruth Hershner. Drafting and final preparation of figures and tables was ably done by Kay Stubblefield, Bill Jenkins and the staff of the VIMS Art, Photographic and Reproduction Center. Data analyses for this study were supported by contract no. AA550-CT6-62 of the Bureau of Land Management.

I would like to offer special thanks my major professor, Jack Musick, for providing me the opportunity to do this study; to my wife, Martha, for bearing with the tribulations of being married to an over-committed husband; and, lastly and most importantly, to my father, Dr. Alden Colvocoresses, for his unflagging determination to see this graduate program completed.

LIST OF TABLES

LIST OF FIGURES

Figure		Page

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

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.

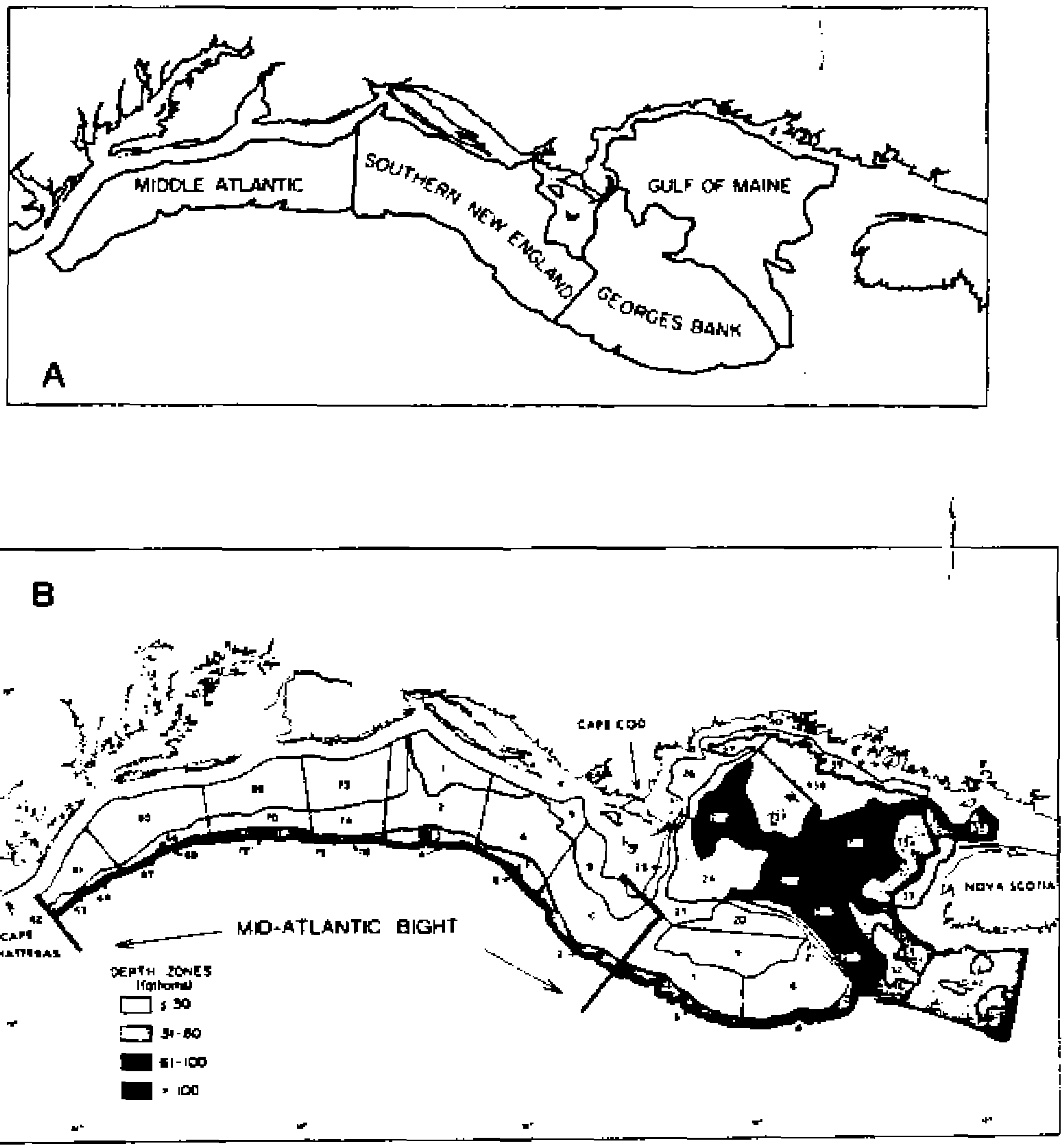
The few studies which have previously addressed community structure of open continental shelf fishes have found clearly definable species associations with distributions related to environmental parameters. Demersal fish species assemblages found using objective mathematical measures have been described 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 (Grosslein 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 km^2) 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.


A
MIDDLE ATLANTIC
SOUTHERN NEW ENGLAND
GULF OF MAINE
GEORGES BANK
B
CAPE COD
NOVA SCOTIA
MID-ATLANTIC BIGHT
CAPE HATTERAS
DEPTH ZONES
(fathoms)
≤ 30
31-60
61-100
> 100

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. NMFS Groundfish Survey Cruises, 1967-1976.

Cruise	Year	Season	Dates	No. Stations in Mid-Atlantic	Vessel(s)	Trawl
67-20,21	1967	Fall	17 Oct - 9 Dec	121	Albatross IV	#36 Yankee
68-3	1968	Spring	4 Mar - 22 Mar	108	"	"
68-17	1968	Fall	10 Oct - 13 Nov	122	"	"
69-2	1969	Spring	5 Mar - 29 Mar	109	"	"
69-8	1969	Summer	14 Jul - 12 Aug	103	"	"
69-11	1969	Fall	8 Oct - 8 Nov	109	"	"
70-3	1970	Spring	25 Mar - 29 Apr	124	"	"
70-6	1970	Fall	3 Sep - 31 Oct	113	"	"
71-1	1971	Spring	9 Mar - 22 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 - 24 Apr	145	Albatross IV & Delaware II	#41 Yankee
73-8	1973	Fall	26 Sep - 11 Oct	103	Albatross IV	#36 Yankee
74-4	1974	Spring	12 Mar - 11 Apr	91	"	#41 Yankee
74-11	1974	Fall	23 Sep - 25 Oct	99	"	#36 Yankee
75-3	1975	Spring	14 Mar - 29 Mar	90	"	#41 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	#41 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 (α = 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:

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

where H' = species diversity expressed as bits/individual

S = number of species

p_i = proportion of total sample belonging to ith species

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

where J' = equitability or evenness

H' = observed species diversity

$H'_{max} = \log_2 S$

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.

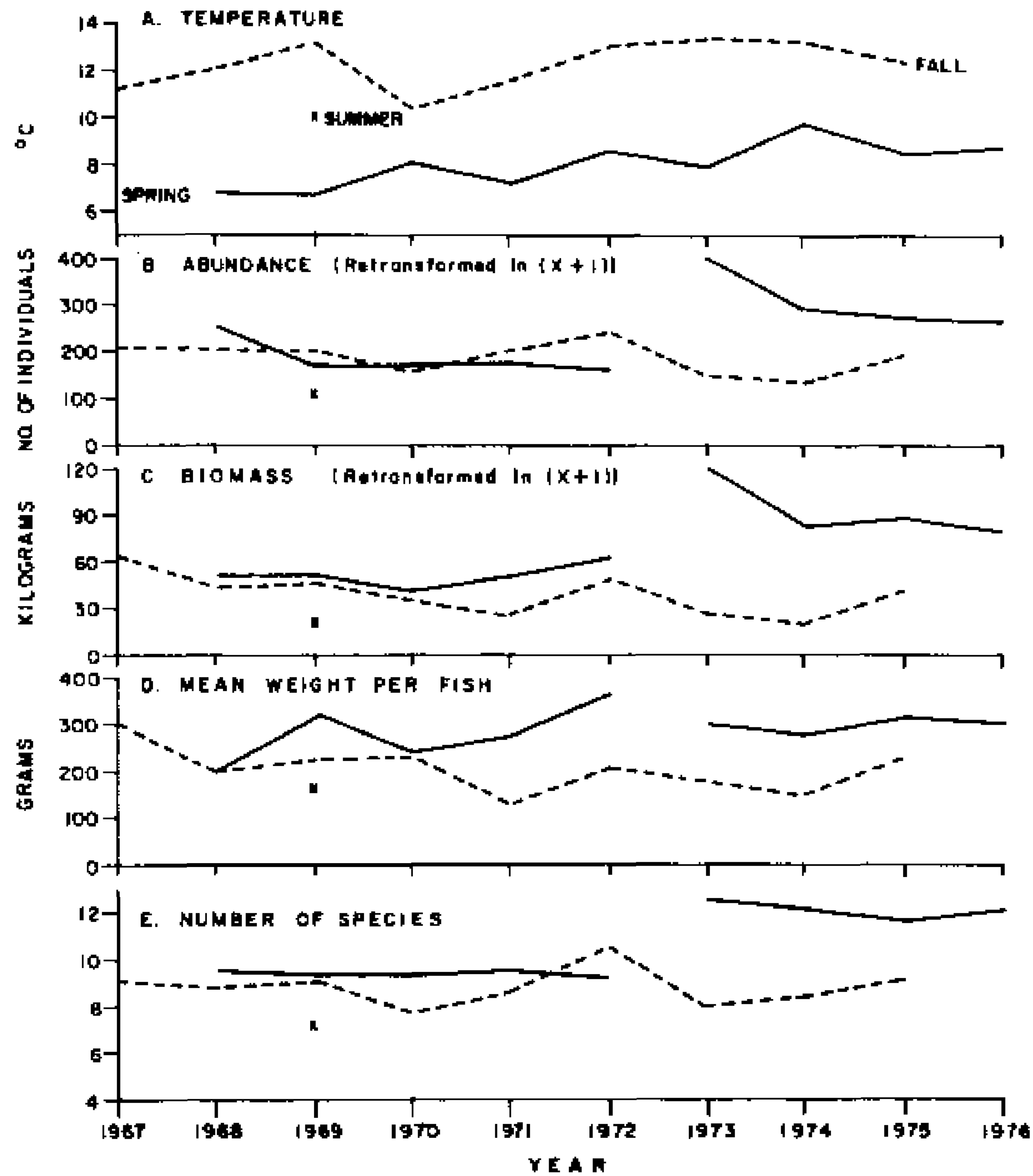
RESULTS

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.



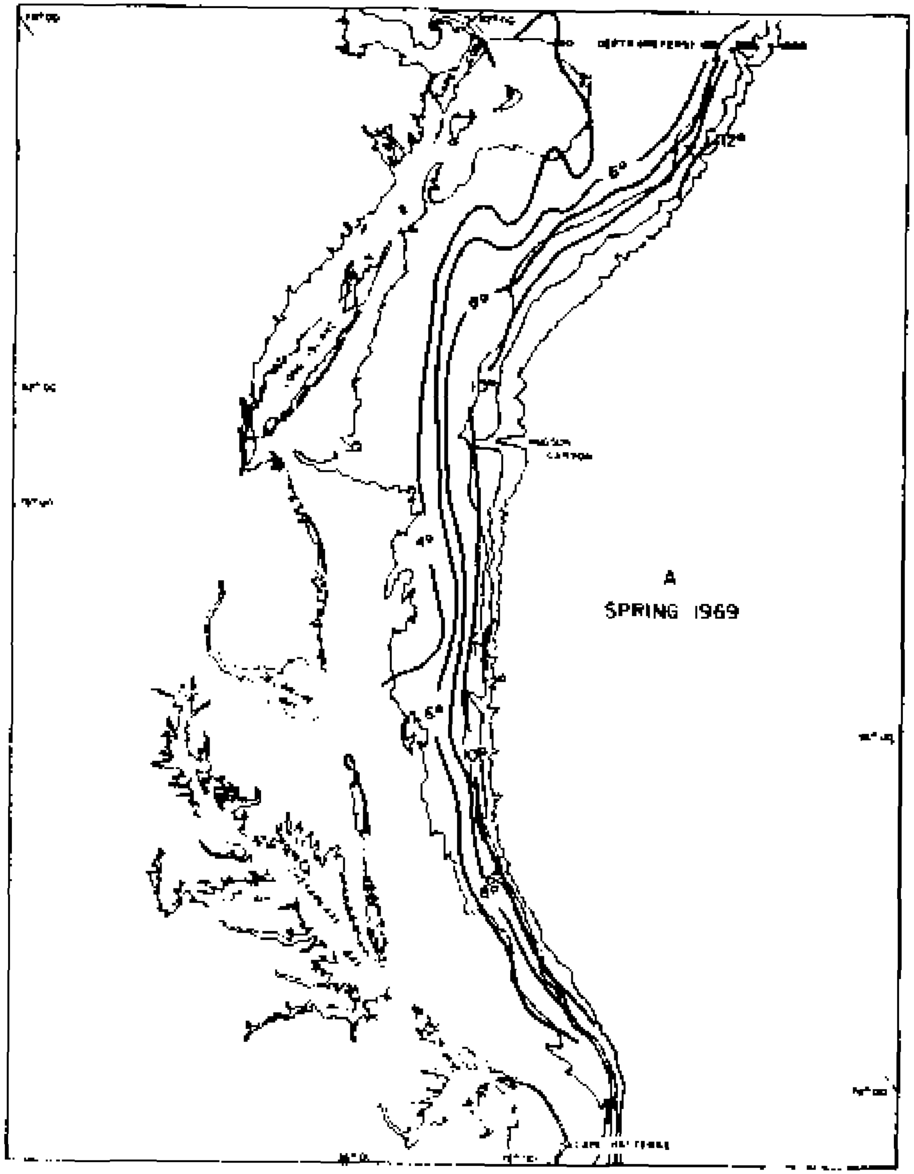
A. TEMPERATURE
°C
FALL
SUMMER
SPRING
B ABUNDANCE (Retransformed ln (X + 1))
NO. OF INDIVIDUALS
C BIOMASS (Retransformed ln (X+1))
KILOGRAMS
D. MEAN WEIGHT PER FISH
GRAMS
E. NUMBER OF SPECIES
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
YEAR

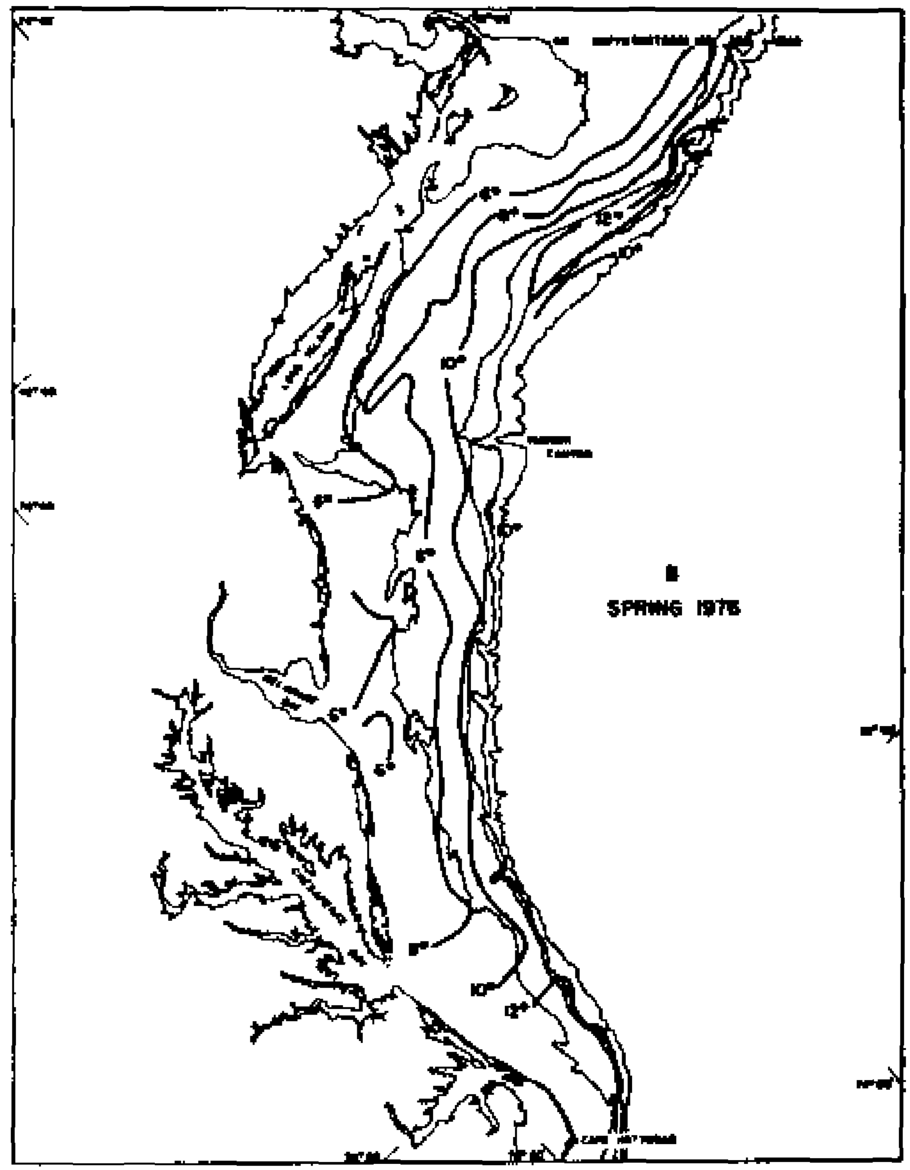
There was a definite trend toward warmer temperatures during the study period for this season which cannot be completely attributed to sampling artifacts (Davis 1979). Bottom isotherms extrapolated from the collection data are shown for two cruises representative of the warmer (1976) and cooler (1969) 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.


12°
6°
8°
HUDSON CANYON
6°
A
SPRING 1969
CAPE HATTERAS

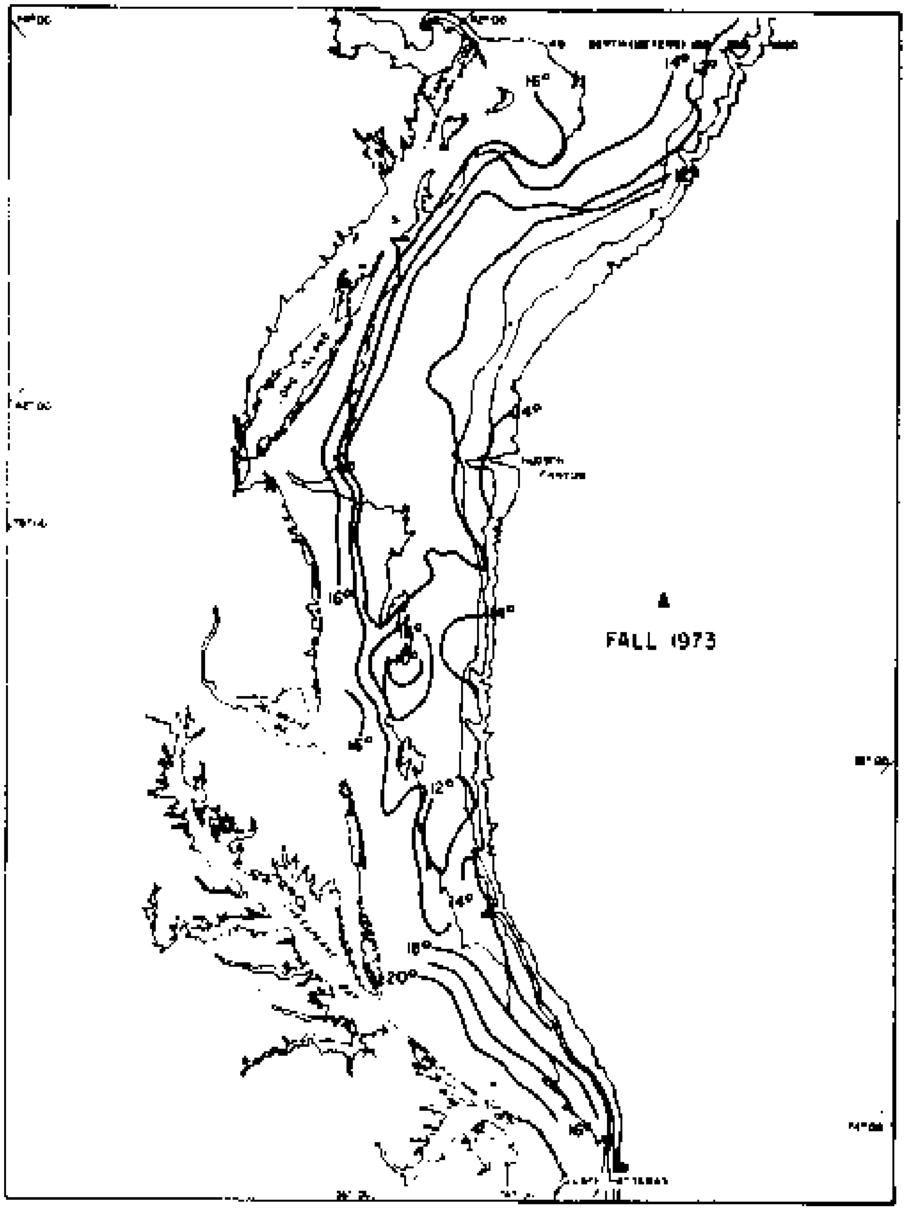

6°
12°
10°
HUDSON CANYON
B
SPRING 1976
10°
12°
CAPE HATTERAS

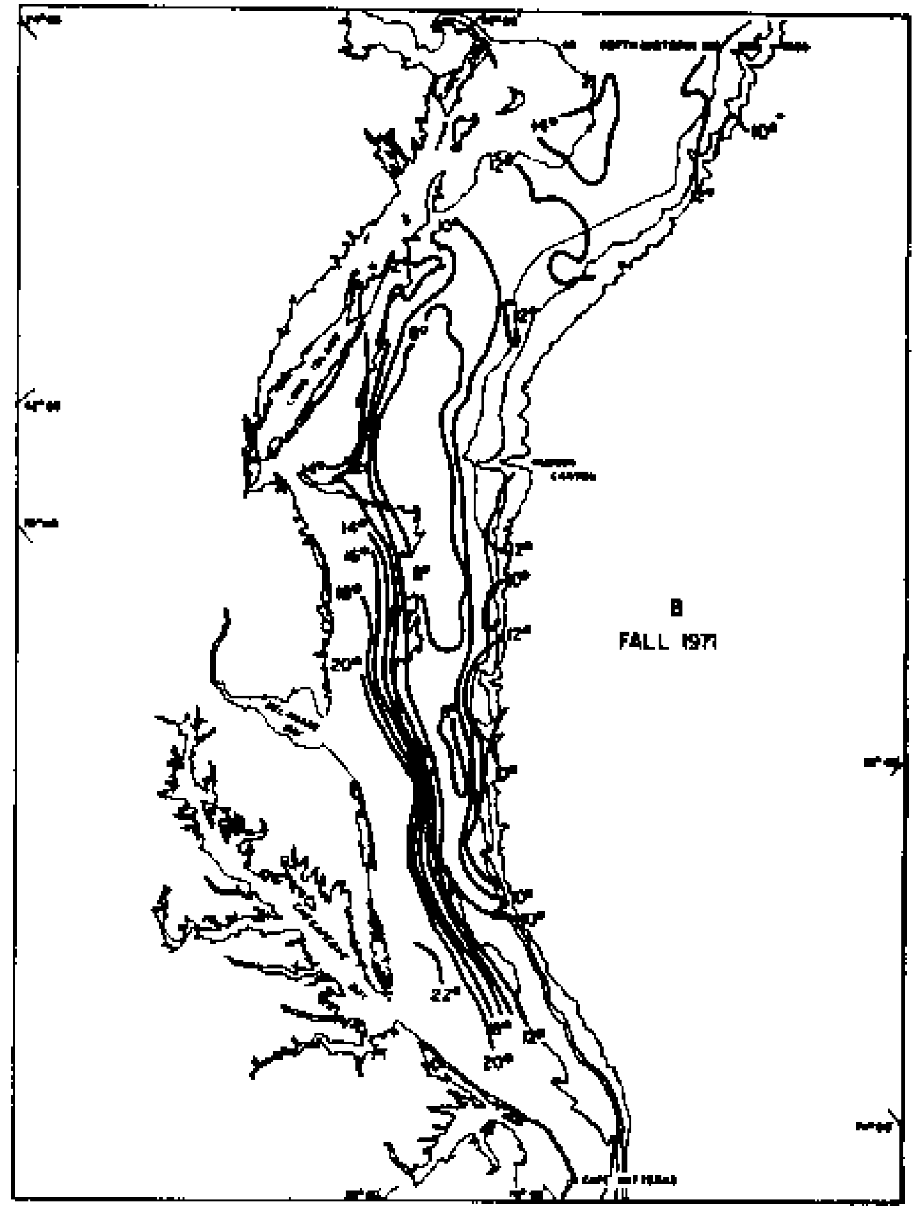
the summer inshore. Bottom temperatures ranged from 5 to 25°C (Appendix A), with the means for each cruise varying between 10.4 and 13.4°C (Fig. 2). There was no pronounced trend in the variation of mean temperature among years.

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°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.


A
FALL 1973
16°
14°
12°
18°
20°


B
FALL 1971
10°
12°
14°
16°
18°
20°
22°

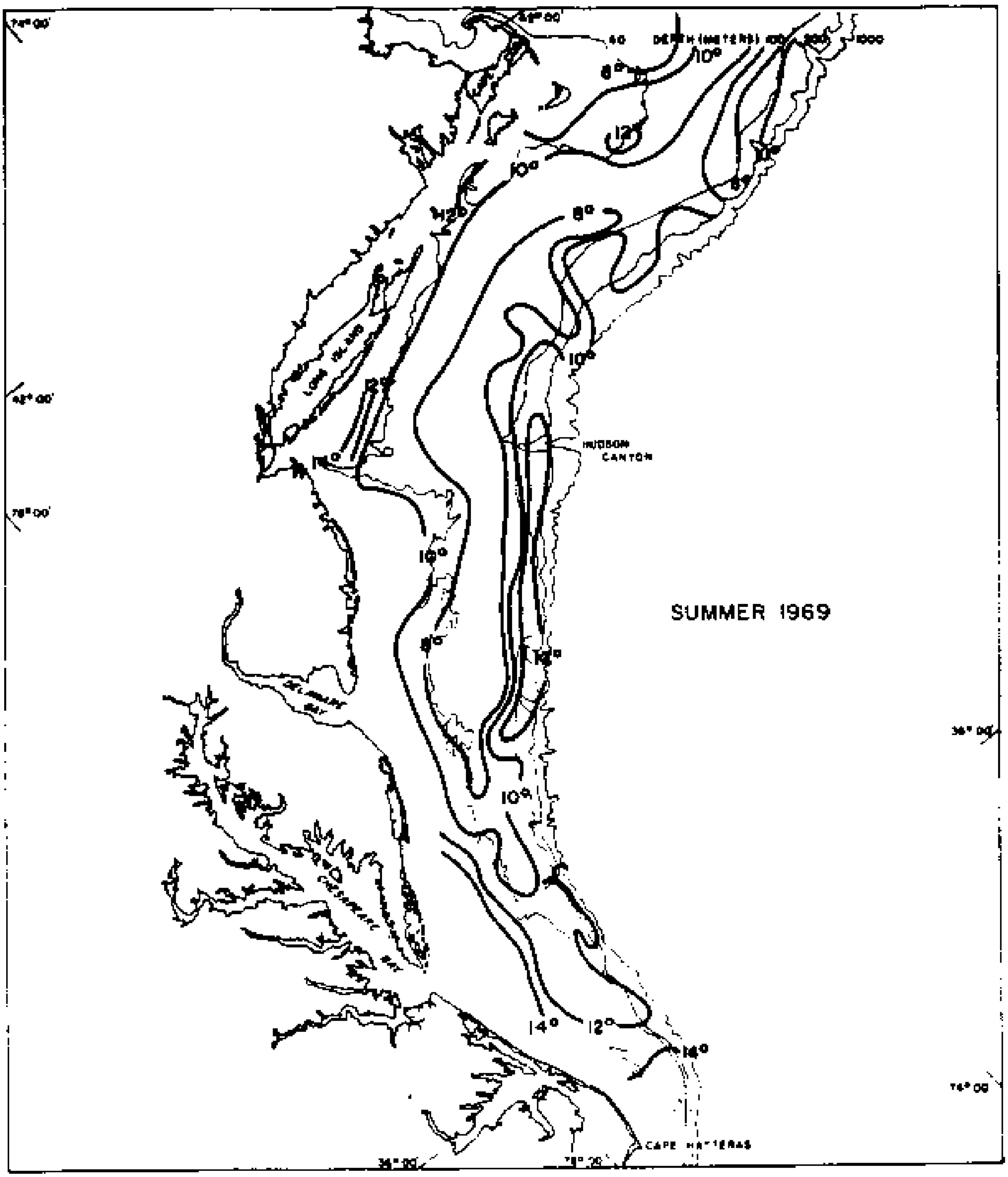
degrees of persistence of the 'cold pool' (Ketchum and Corwin 1964) and development of the mid-shelf thermal gradient.

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.


SUMMER 1969
DEPTH (METERS)
LONG ISLAND
HUDSON
CANYON
DELAWARE
BAY
CHESAPEAKE BAY
CAPE HATTERAS
8°
10°
12°
14°

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 asynoptic 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 Cruise. 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 cooccuring 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 Chloropthalmus agassizi, Maurolicus muelleri, Phycis chesteri, Ceratoscopelus maderensis, Argyropelecus aculeatus, Nemichthys scolopaceus, Raja garmani, and Lopholatilus chamaelionticeps. Also periodically present in, but not exclusive to these groups were the species Peristedion miniatum, 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 Citharichtys 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. Citharichthys 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 triacanthus 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 cervinum, 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, inn 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).

<u>Fall Cruises</u>. Abundance and biomass estimates for the fall cruises were extremely variable, as in the spring (Appendix B). Scheffé'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 α = .05.

	Spring			Fall		
Date	Abundance	Biomass	No. of Species	Abundance	Biomass	No. of Species
1967				III>VI	I,V>VI,VII II,III>V-VI IV>VI	III>I,V-VI II,IV>VI
1968	NSDD*	NSDD	NSDD	NSDD	II,III>VI-VIII IV>V-VI	II,IV>I,III,V-VIII VI>V
1969	NSDD	NSDD	II>IV,V	NSDD	I>VI II>IV-VI III>V,VI	II,III>IV-VI I>IV
1970	NSDD	NSDD	III>I,IV-VI,VIII II>IV,VIII IX>IV	III>IV,VIII	II,III>IV-IX	II>IV,VII,VIII III>I,IV-VIII IX>IV
1971	V>I	V>IV	II,V,VI>I	I,II>IV	II>I,III-VI	I,II>III,IV,VI
1972	NSDD	NSDD	I,II,V,VI,IX>IV III>II,IV-VI,VIII IX>V,VIII	III>I,V,VI III,IV>II IV>VI	I,II>VI III,IV>II,V,VI	III>I,II,V,VI IV>II,V
1973	NSDD	III>V,VI	I>II,IV-VI VII>II,IV,V	II,III,V,VI>IV	II>IV,VI III>IV	II,III,VI>IV,V III>I
1974	I,III>II	I-IV>V	I,III,V,VI>IV I,IV>II	FNS**	I,III>IV,VI III>V	I,II>V III>V,VI VI>IV-VI
1975	IV>V	II,IV>V,VI III>V	I,IV>III VI>II,III,V	III,IV,VI>II III>V,VII,VIII	I>VII,VIII III,IV>V,VII,VIII	I,III,VI,VII>II,V,VII IV>II
1976	V>IV	III>VI V>I,III,IV,VI	V>III VII>I-IV,VI			

* NSDD - F significant but no specific differences detected.

** FNS - 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 3. Average abundance and biomass per tow and percentage of total fish catch for major species during spring cruises.

Species	1968		1969		1970		1971		1972		1973		1974		1975		1976		Total
Abundance																			
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	%
Peprilus triacanthus	95.0	14.7	64.1	15.7	38.4	9.3	37.8	8.3	293.7	50.3	120.0	12.4	33.5	7.3	86.2	19.5	86.2	15.5	17.4
Prionotus carolinus	42.0	6.5	126.9	31.0	45.2	10.9	11.8	2.6	13.6	2.3	344.9	33.4	45.2	9.9	28.4	6.4	15.5	2.8	14.7
Squalus acanthias	88.5	13.7	42.8	10.5	35.3	8.6	46.4	10.1	80.8	13.8	144.1	14.0	86.1	18.8	76.8	17.4	44.5	8.0	12.8
Stenotomus chrysops	133.5	20.7	14.0	3.4	146.0	35.3	170.1	37.1	58.0	9.9	3.6	0.4	39.3	8.6	20.4	4.7	4.2	0.8	11.6
Merluccius bilinearis	60.0	9.3	27.9	6.8	21.4	5.2	47.3	10.3	18.3	3.1	68.0	6.6	109.0	23.8	113.6	25.7	67.5	15.7	10.3
Scomber Scombrus	79.0	12.3	1.4	0.4	18.2	4.4	18.4	4.0	13.0	2.2	113.1	11.0	9.8	2.1	4.5	1.0	6.7	1.2	5.7
Limanda ferruginea	36.5	5.7	35.1	8.6	23.9	5.8	22.7	5.0	21.4	3.7	31.9	3.1	8.9	1.9	2.9	0.7	3.1	0.6	3.8
Urophycis chuss	7.7	1.2	7.9	1.9	8.2	2.0	29.1	6.3	16.4	2.8	32.2	3.1	20.3	4.4	13.8	3.1	20.0	3.4	3.1
Raja erinacea	4.6	0.7	7.9	1.9	2.8	0.7	9.5	2.1	5.2	0.9	36.4	3.5	11.5	2.5	24.3	5.5	11.7	2.1	2.3
Total (all species)	607.3		409.4		413.1		458.1		584.0		032.8		458.8		441.6		557.3		
Biomass																			
	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%	%
Squalus acanthias	89.6	58.2	47.6	44.0	20.3	29.5	92.9	65.1	126.6	72.4	168.8	49.7	135.0	64.0	74.1	55.1	63.4	52.9	55.7
Prionotus carolinus	6.7	4.3	8.6	7.9	6.8	9.9	1.9	1.3	1.4	0.8	50.1	14.9	8.9	4.2	3.5	2.6	1.4	1.2	4.8
Scomber scombrus	5.9	3.8	0.2	0.2	4.4	6.5	4.6	3.2	2.9	1.6	36.4	10.7	3.1	1.5	0.9	0.7	1.1	0.9	4.6
Merluccius bilinearis	7.3	4.7	3.9	3.6	1.8	2.7	5.2	3.6	2.9	1.7	10.1	3.0	8.3	3.9	12.8	9.6	10.3	8.6	3.7
Limanda ferruginea	8.1	5.3	7.5	6.9	6.1	8.9	5.3	3.7	5.5	3.2	8.3	2.4	2.7	1.9	0.9	0.7	0.9	0.8	3.2
Raja erinacea	2.5	1.7	4.0	3.7	1.4	2.0	3.4	2.4	2.3	1.3	13.1	3.9	4.3	2.0	10.0	7.5	4.8	4.0	3.1
Peprilus triacanthus	5.4	3.5	6.2	5.7	1.8	2.7	2.6	1.8	8.8	5.0	9.8	2.9	2.3	1.1	3.9	2.9	2.8	2.4	3.0
Stenotomus chrysops	4.4	2.9	2.5	2.3	6.9	10.1	7.7	5.4	2.5	1.4	0.9	0.3	3.4	1.6	4.1	3.1	0.6	0.5	2.2
Urophycis chuss	1.7	1.1	1.8	1.7	1.7	2.4	4.9	3.4	3.5	2.0	5.8	1.7	3.6	1.7	3.1	2.3	5.4	4.5	2.2
Total (all species)	154.0		108.1		68.9		142.8		175.0		339.7		210.8		136.5		119.6		

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

Species	1967 n	1967 %	1968 n	1968 %	1969 n	1969 %	1970 n	1970 %	1971 n	1971 %	1972 n	1972 %	1973 n	1973 %	1974 n	1974 %	1975 n	1975 %	Total %
Abundance																			
Peprilus triacanthus	272.9	28.8	131.7	32.3	134.2	17.7	65.9	16.1	302.2	49.2	100.2	24.9	231.1	45.2	140.3	44.4	55.8	16.4	30.5
Etrumeus teres	4.4	0.7	19.4	4.7	61.0	8.1	16.0	38.8	118.0	19.2	1.7	0.4	123.5	24.2	5.9	1.9	42.6	12.7	12.0
Merluccius bilinearis	29.3	4.3	58.2	14.3	33.4	4.4	31.2	7.6	62.0	10.1	67.8	16.8	20.4	4.0	65.1	20.6	43.1	12.8	9.1
Prionotus carolinus	222.4	32.5	45.0	11.0	15.0	2.0	20.9	5.1	10.9	1.7	22.7	5.6	7.1	1.4	6.4	2.1	3.4	1.0	8.4
Stenotomus chrysops	26.6	3.9	12.8	3.1	70.9	9.4	11.7	2.9	8.5	1.4	34.4	8.6	20.9	4.1	8.8	2.8	43.9	13.1	5.3
Limanda ferruginea	31.0	4.5	36.3	8.9	32.4	4.3	25.6	6.2	24.0	3.9	53.3	13.2	5.0	1.0	2.1	0.7	1.0	0.3	4.8
Squalus acanthias	61.8	9.0	28.8	7.0	32.6	4.3	21.6	5.3	6.7	1.1	10.1	2.5	19.0	3.7	4.1	1.3	21.4	6.4	4.8
Urophycis chuss	12.0	1.8	23.4	5.7	20.6	2.7	33.3	8.1	17.9	2.9	6.4	1.6	20.9	4.1	12.9	4.1	23.4	7.0	3.9
Urophycis regius	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	14.7	4.4	2.4
Total (all species)	684.9		408.3		757.3		410.8		614.1		402.5		510.9		315.8		336.2		
Biomass																			
	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%	kg	%	%
Squalus acanthias	59.5	43.7	27.3	38.4	57.3	51.8	32.3	48.6	7.8	17.1	18.6	24.9	21.8	37.1	9.5	30.0	34.1	42.3	39.8
Peprilus triacanthus	12.1	8.9	11.0	15.5	10.1	9.2	3.9	5.9	8.5	18.7	3.8	5.0	9.5	16.0	5.9	18.5	3.2	3.9	10.0
Prionotus carolinus	39.0	25.9	5.3	7.4	2.0	1.8	2.5	3.8	1.1	2.4	2.9	3.9	0.8	1.3	0.7	2.3	0.3	0.4	7.9
Limanda ferruginea	6.2	4.6	6.9	9.7	7.7	7.0	6.3	9.5	4.6	10.0	13.6	8.1	1.2	2.1	0.6	2.0	0.2	0.3	7.0
Merluccius bilinearis	3.5	2.6	2.6	3.7	1.3	1.2	1.5	2.3	2.8	6.1	2.6	3.5	1.8	3.0	0.7	2.3	1.9	2.3	2.8
Urophycis chuss	1.2	0.9	2.0	2.9	3.1	2.8	1.8	2.7	2.0	4.5	3.7	4.9	1.5	2.5	0.3	1.0	2.2	2.7	2.6
Etrumeus teres	0.3	0.2	0.4	0.6	2.2	2.0	4.4	6.6	2.9	6.3	0.1	0.1	3.4	5.8	0.2	0.5	1.6	2.0	2.2
Stenotomus chrysops	1.3	1.0	0.5	0.7	3.2	2.9	0.2	0.4	0.3	0.6	2.1	2.8	0.8	1.4	0.9	3.0	3.0	3.7	1.8
Urophycis regius	0.8	0.6	1.8	2.6	1.3	1.2	1.6	2.5	1.3	2.9	0.5	0.7	1.5	2.5	0.8	2.7	2.2	2.7	1.8
Total (all species)	136.1		71.2		110.5		66.5		47.8		74.9		58.7		31.7		80.5		

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

Abundance			Biomass		
Species	n	%	Species	kg.	%
Scomber scombrus	156.6	33.0	*Peprilus triacanthus*	5.5	16.4
Etrumeus teres	100.2	21.2	*Limanda ferruginea*	3.9	11.6
Peprilus triacanthus	80.4	17.0	*Scomber scombrus*	3.7	10.8
Urophycis regia	34.0	7.2	*Squalus acanthias*	3.6	10.7
Limanda ferruginea	19.2	4.1	*Etrumeus teres*	1.8	5.3
Squalus acanthias	13.0	2.8	*Urophycis regia*	1.7	5.1
Melanogrammus aeglefinus	10.4	2.2	*Gadus morhua*	1.7	5.0
Anchoa mitchilli	7.8	1.7	*Urophycis chuss*	1.5	4.5
Urophycis chuss	7.3	1.6	*Pseudopleuronectes americanus*	1.5	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.

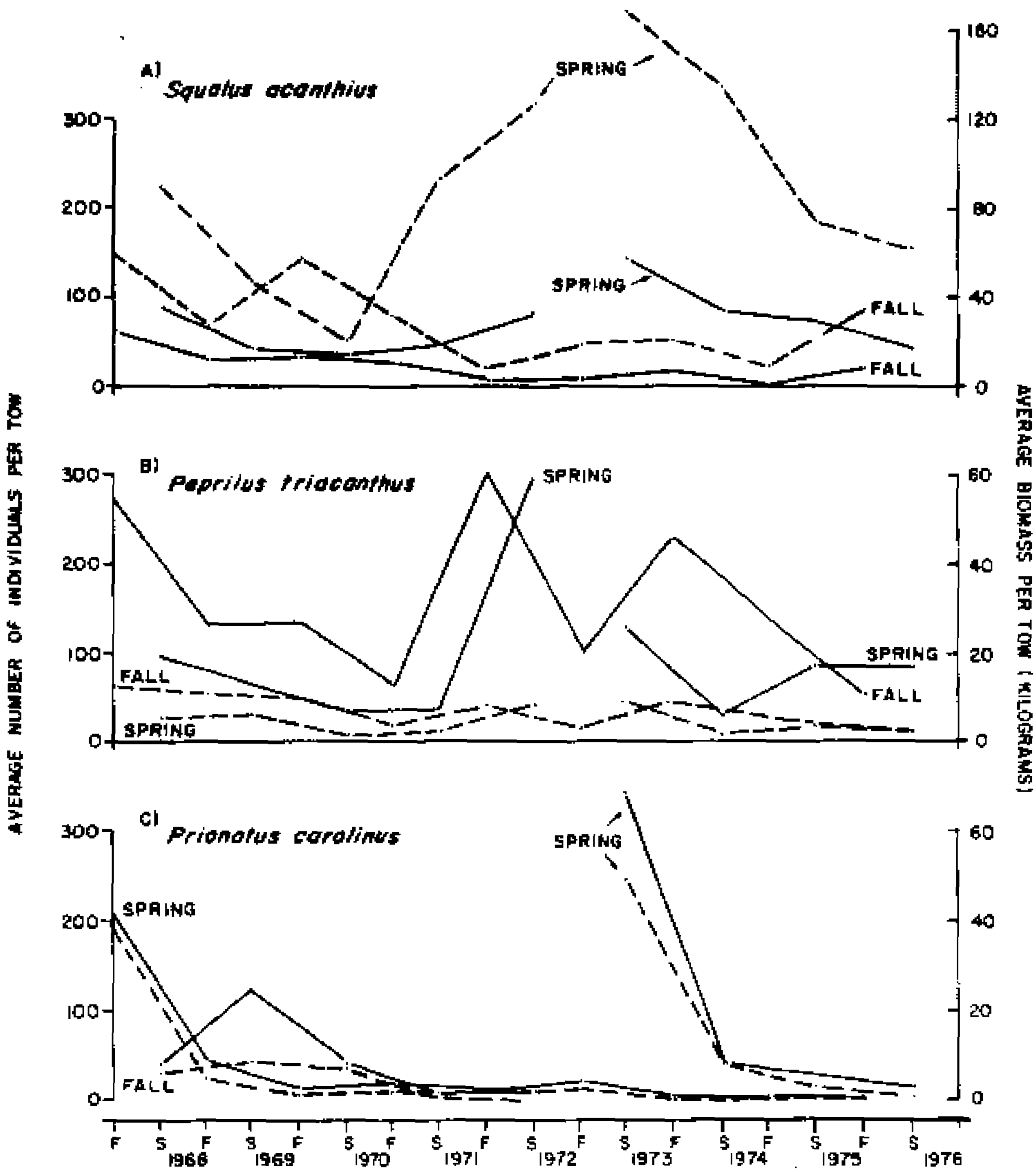
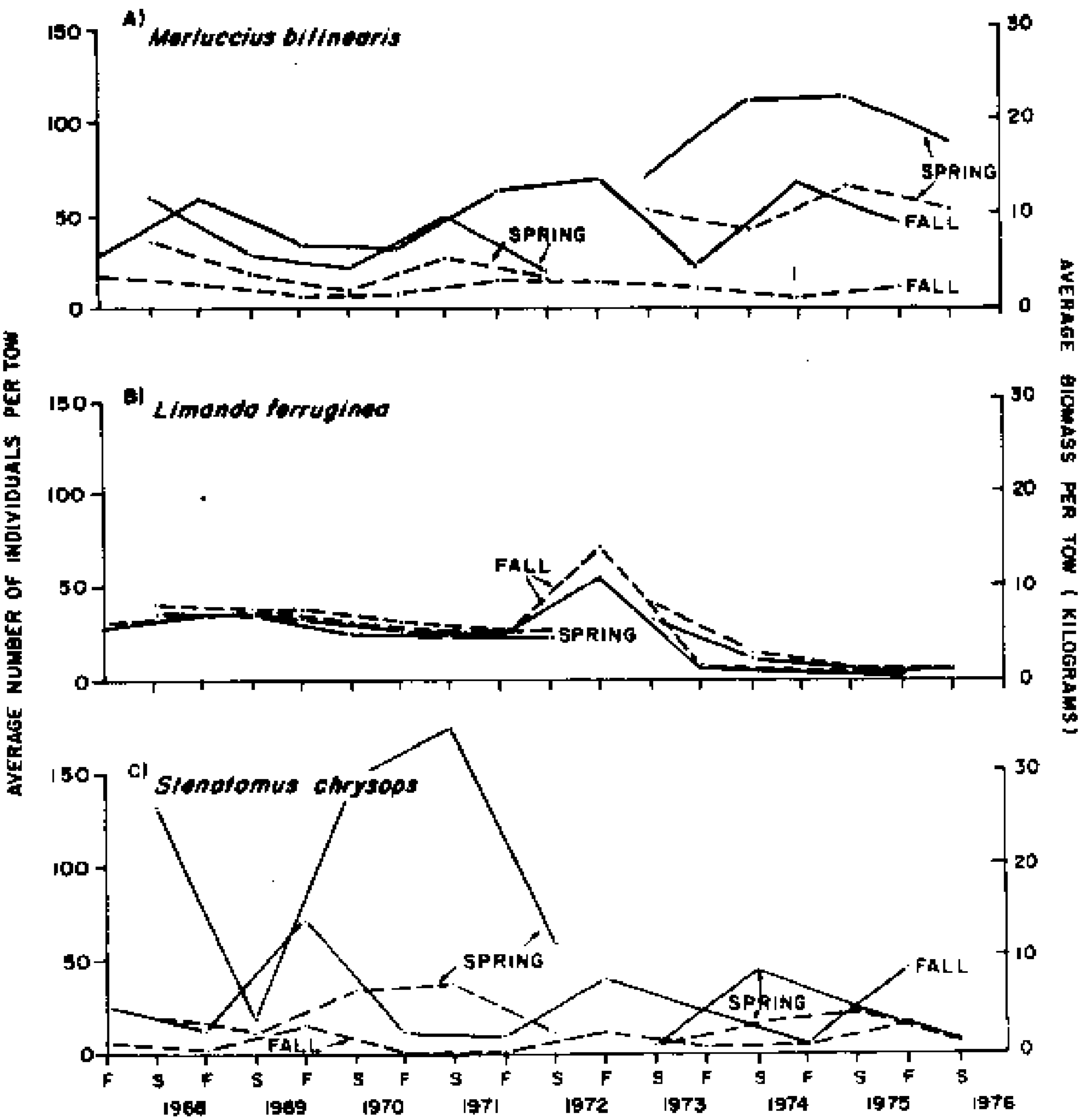

A) Squalus acanthius
B) Peprilus triacanthus
C) Prionotus carolinus
SPRING
FALL
AVERAGE NUMBER OF INDIVIDUALS PER TOW
AVERAGE BIOMASS PER TOW (KILOGRAMS)
F S F S F S F S F S F S F S F S F S
1968 1969 1970 1971 1972 1973 1974 1975 1976

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.


A) Merluccius bilinearis
B) Limanda ferruginea
C) Stenotomus chrysops
SPRING
FALL
AVERAGE NUMBER OF INDIVIDUALS PER TOW
AVERAGE BIOMASS PER TOW (KILOGRAMS)
150
100
50
0
30
20
10
F
S
1968
1969
1970
1971
1972
1973
1974
1975
1976

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 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 / Year	I	II	III	IV	V	VI	VII	VIII	IX
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 / Year	I	II	III	IV	V	VI	VII	VIII	IX
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.

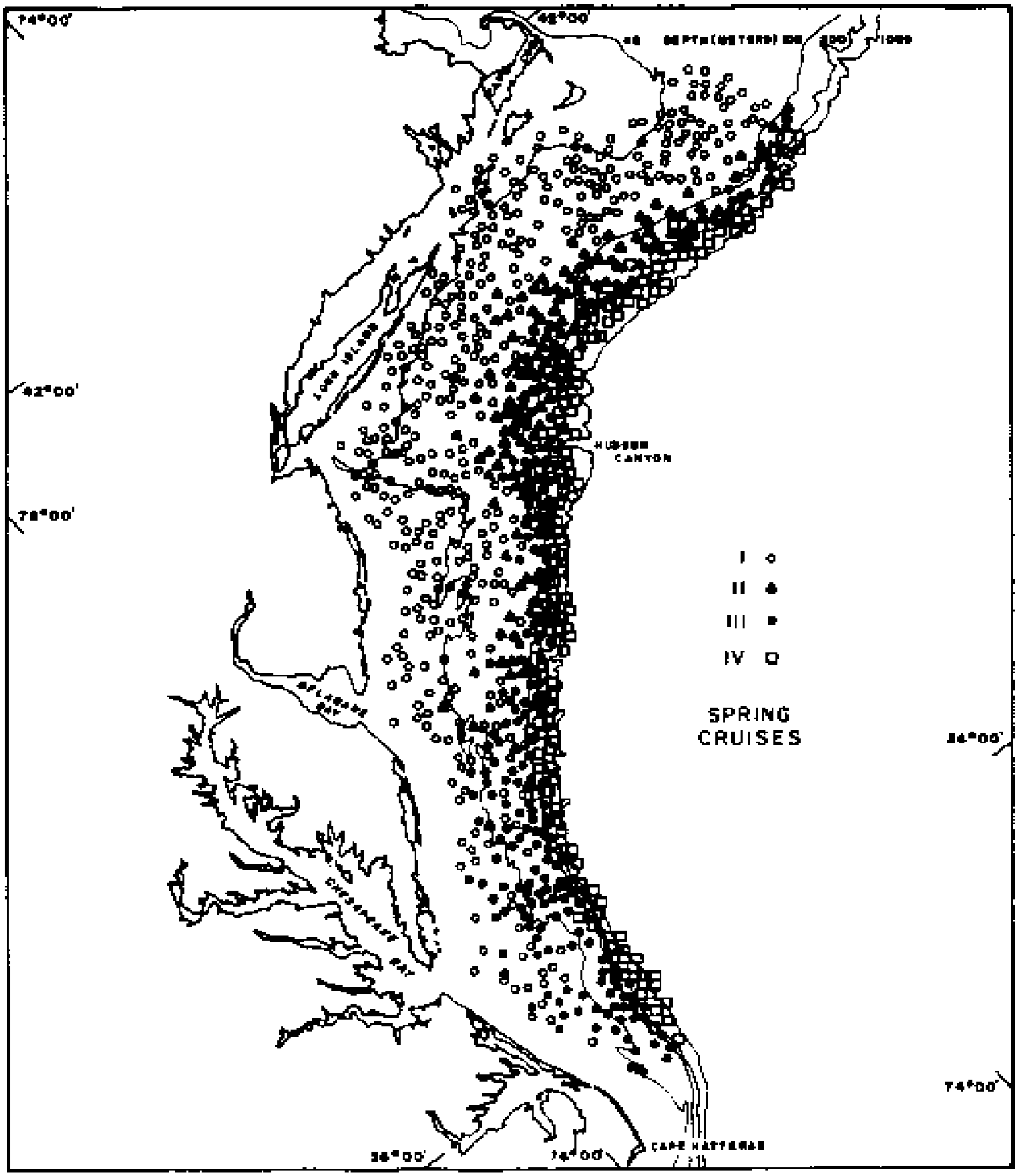

I
II
III
IV
SPRING
CRUISES

Table 7.—Hydrographic and average catch parameters by site group for Spring NMFS 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 (x+1)	$\bar{x}$	2.19(154)	2.47(296)	2.40(252)	2.62(416)	2.17(149)	2.35(224)	2.16(144)	2.36(230)
	σ	0.40	0.45	0.54	0.40	0.68	0.67	0.54	0.51
Biomass (kg) log (x+1)	$\bar{x}$	1.70(50)	1.97(95)	1.79(62)	2.14(138)	1.58(38)	1.92(84)	1.56(37)	1.65(45)
	σ	0.40	0.36	0.54	0.43	0.59	0.51	0.57	0.46
No. of Species	$\bar{x}$	10.1	12.4	9.7	12.1	8.1	8.8	9.1	13.1
	σ	2.8	3.0	2.9	2.5	2.9	3.3	3.3	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	46.5	117.9	78.9	84.1	75.2	222.1	194.0
	σ	17.3	15.4	46.8	21.9	54.2	33.2	78.3	72.1
Temperature (°C)	range	2-9	3-11	4-14	7-16	5-13	5-14	5-16	5-15
	$\bar{x}$	4.6	6.0	10.0	9.6	8.9	10.2	10.1	11.4
	σ	1.5	1.5	2.1	2.0	2.2	2.1	2.0	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.

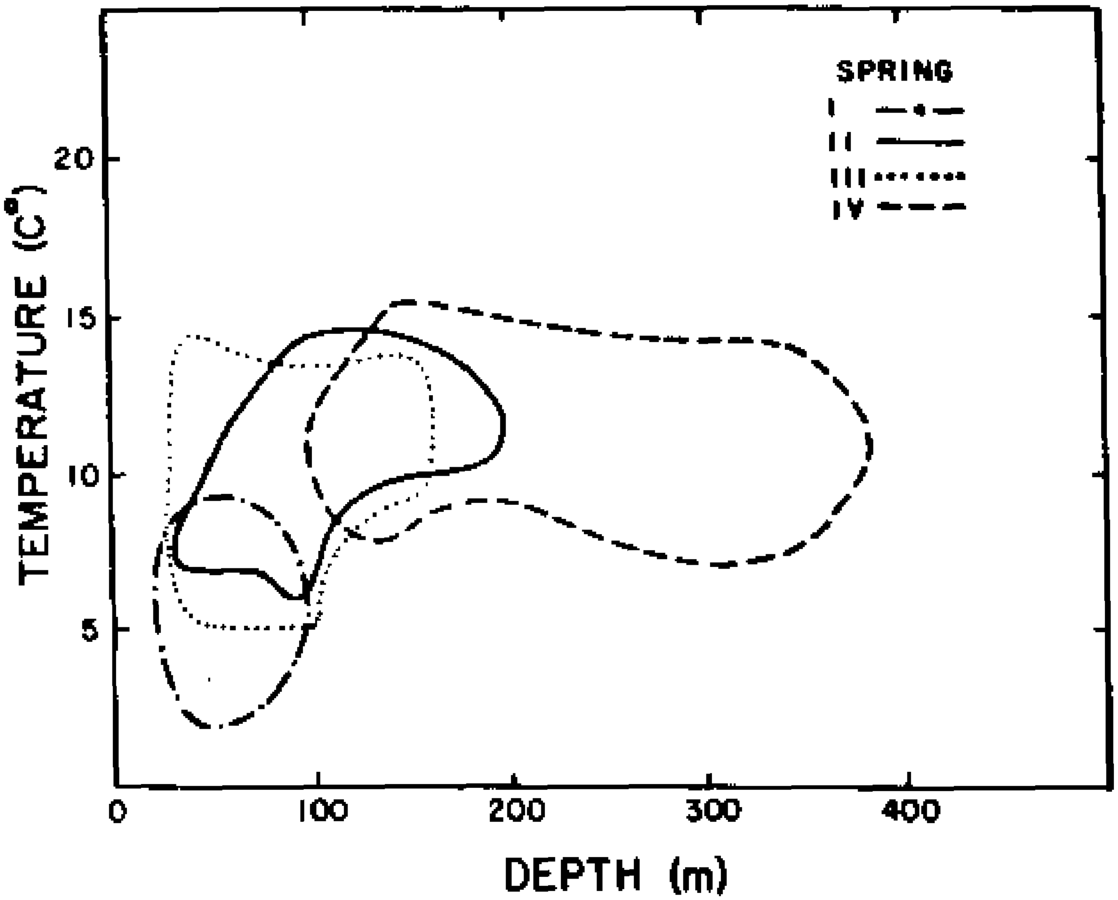
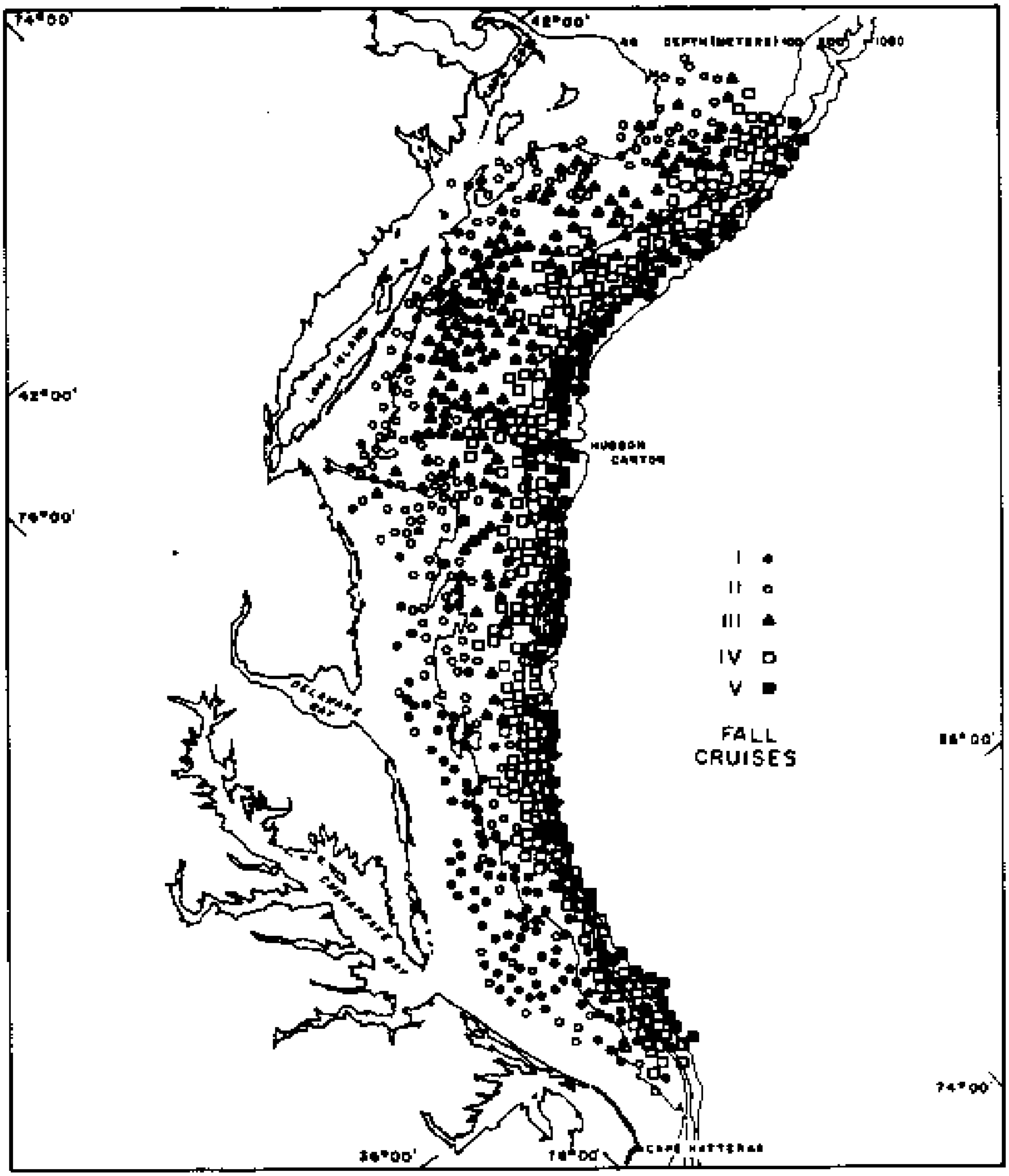

SPRING
I
II
III
IV
20
15
10
5
TEMPERATURE (C°)
0
100
200
300
400
DEPTH (m)

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



DEPTH (METERS)
LONG ISLAND
HUDSON CANYON
DELAWARE BAY
CHESAPEAKE BAY
CAPE HATTERAS
I
II
III
IV
V
FALL CRUISES

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).

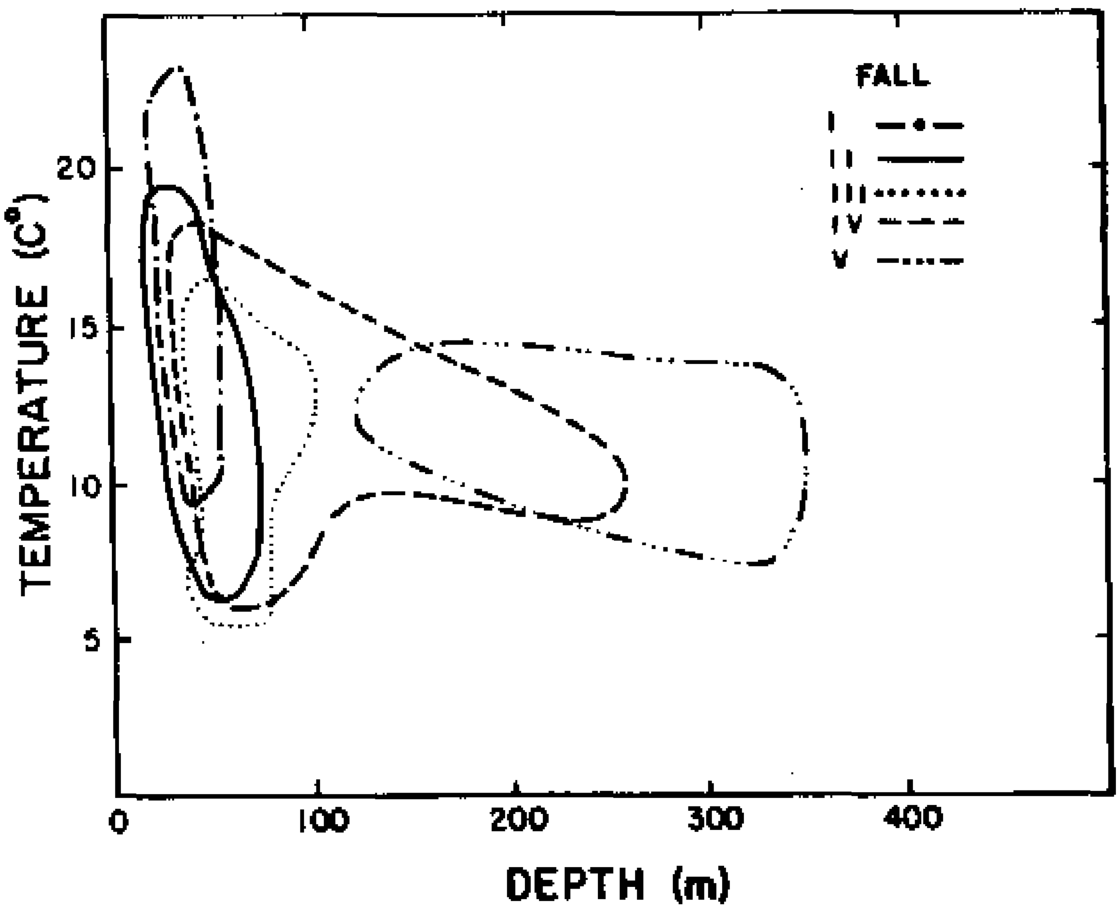
Species associations. As with the station clusters, although there was some variation in group composition and distribution from year to year, the groupings were largely consistent over the nine year period of this study. Figure 12 shows the number of times the thirty-seven most commonly occurring and 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 NMFS Groundfish Survey cruises, Middle Atlantic Bight, 1967-75. 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)	2.30(200)	2.20(249)	2.05(111)	1.92(84)
	σ	0.73	0.59	0.57	0.67	0.54
Biomass (kg) log (x+1)	$\bar{x}$	1.55(36)	1.78(61)	1.73(54)	1.09(11)	0.86(6)
	σ	0.58	0.56	0.59	0.36	0.39
No. of Species	$\bar{x}$	8.2	10.8	10.8	6.8	9.3
	σ	3.7	3.6	4.1	2.9	3.7
Depth (m)	range	18-123	20-80	31-192	16-397	71-433
	$\bar{x}$	33.8	42.6	61.5	110.6	249.6
	σ	12.7	12.4	17.1	60.2	77.4
Temperature (°C)	range	8-23	6-25	5-22	6-21	6-18
	$\bar{x}$	16.7	13.4	10.7	11.7	10.4
	σ	3.5	3.5	2.6	2.2	1.9

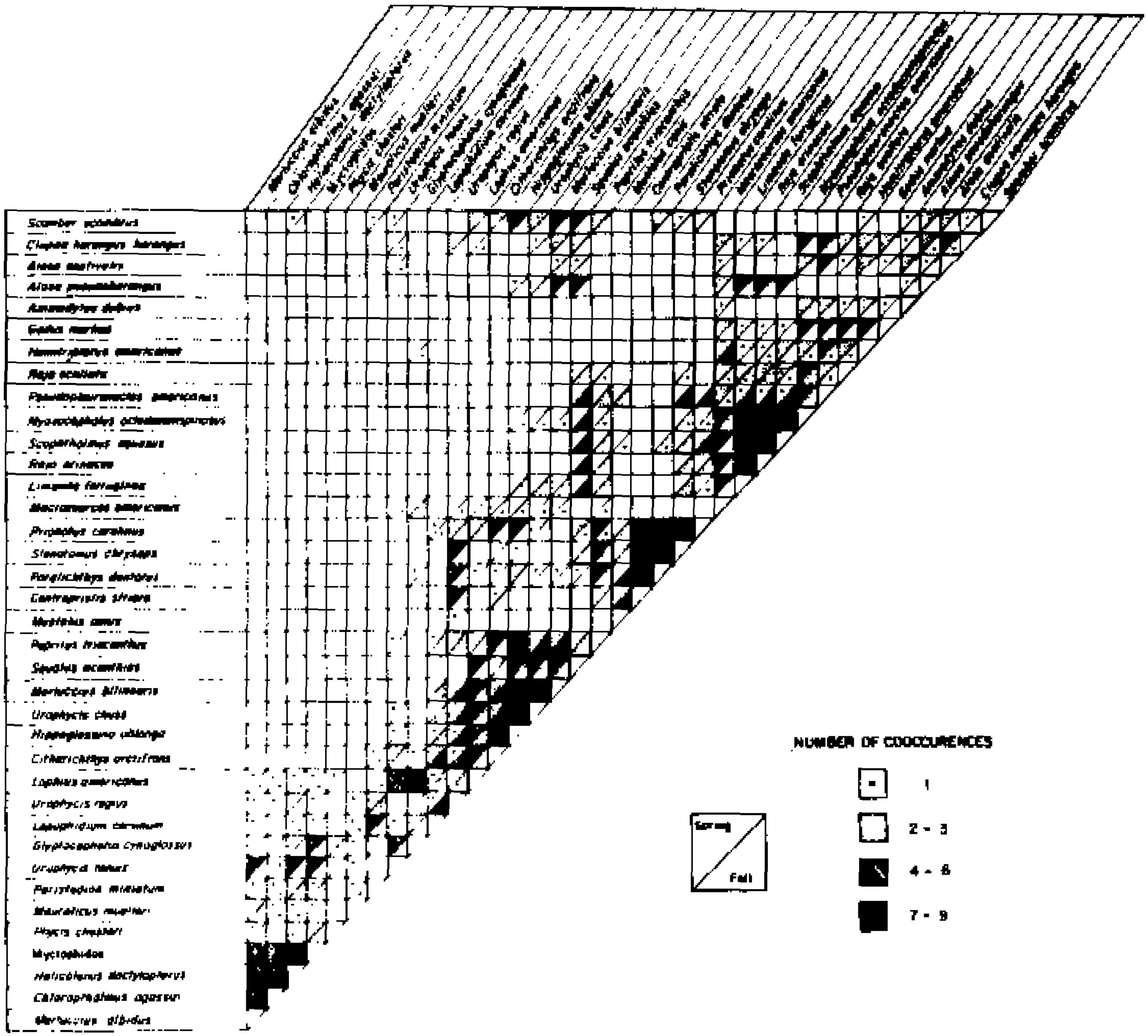
$\bar{x}$ = mean value
σ = standard deviation
( ) = retransformed value

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.



FALL
I
II
III
IV
V
TEMPERATURE (C°)
20
15
10
5
0
100
200
300
400
DEPTH (m)

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.


Scomber scombrus
Clupea harengus harengus
Alosa aestivalis
Alosa pseudoharengus
Ammodytes dubius
Gadus morhua
Hemitripterus americanus
Raja ocellata
Pseudopleuronectes americanus
Myoxocephalus octodecemspinosus
Scophthalmus aquosus
Raja erinacea
Limanda ferruginea
Macrozoarces americanus
Prionotus carolinus
Stenotomus chrysops
Paralichthys dentatus
Centropristis striata
Mustelus canis
Peprilus triacanthus
Squalus acanthias
Merluccius bilinearis
Urophycis chuss
Hippoglossina oblonga
Citharichthys arctifrons
Lophius americanus
Urophycis regius
Lepophidium cervinum
Glyptocephalus cynoglossus
Urophycis tenuis
Peristedion miniatum
Maurolicus muelleri
Phycis chesteri
Myctophidae
Helicolenus dactylopterus
Chlorophthalmus agassizi
Merluccius albidus
Spring
Fall
NUMBER OF COOCCURENCES
1
2 - 3
4 - 6
7 - 9

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 (Musick 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

A

Gadus morhua Bo
Hemitripterus americanus Bo
Pseudopleuronectes americanus Bo

B

Limanda ferruginea Bo
Macrozoarces americanus Bo
Myoxocephalus octodecemspinosus Bo
Raja erinacea Bo
Scophthalmus aquosus IS

C

Lophius americanus Bo
Merluccius bilinearis Bo
Paralichthys oblongus OS
Squalus acanthias Bo
Urophycis chuss Bo

D

Centropristes striata WT
Paralichthys dentatus WT
Peprilus triacanthus WT
Prionotus carolinus WT
Stenotomus chrysops WT
Urophycis regia WT

E

Chloropthalmus agassizi Sl
Helicolenus dactylopterus Sl
Merluccius albidus Sl
Urophycis tenuis Bo-Sl

FALL CRUISES

A

Centropristes striata WT
Mustelus canis WT
Paralichthys dentatus WT
Prionotus carolinus WT
Stenotomus chrysops WT

B

Limanda ferruginea Bo
Myoxocephalus octodecemspinosus Bo
Pseudopleuronectes americanus Bo
Raja erinacea Bo
Scophthalmus aquosus IS
Squalus acanthias Bo

C

Citharichthys arctifrons OS
Lepophidium cervinum OS
Merluccius bilinearis Bo
Paralichthys oblongus OS
Peprilus triacanthus WT
Urophycis chuss Bo
Urophycis regia WT

D

Glyptocephalus cynoglossus Bo-Sl
Lophius americanus Bo
Urophycis tenuis Bo-Sl

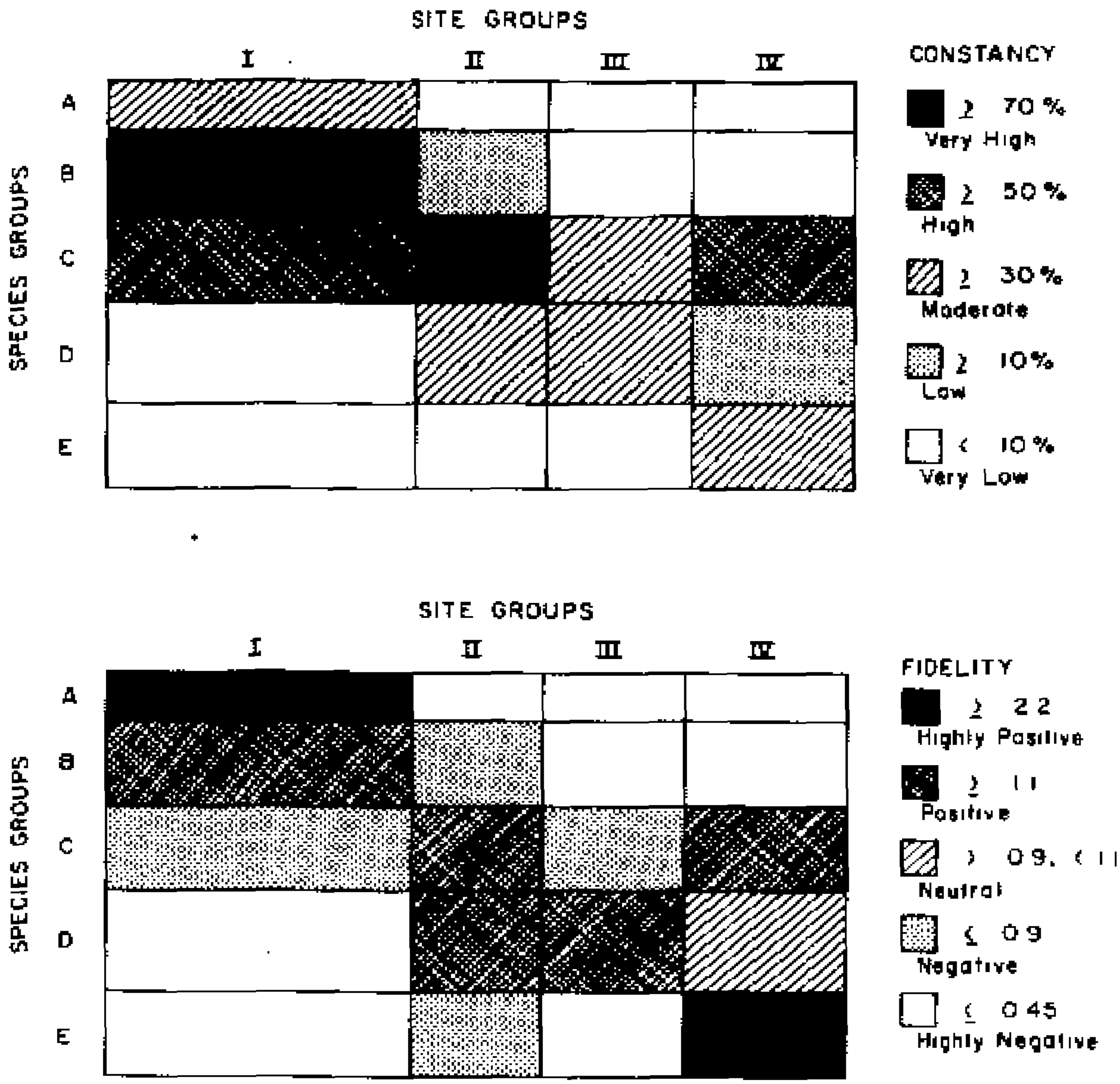
E

Chloropthalmus agassizi Sl
Helicolenus dactylopterus Sl
Merluccius albidus 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.

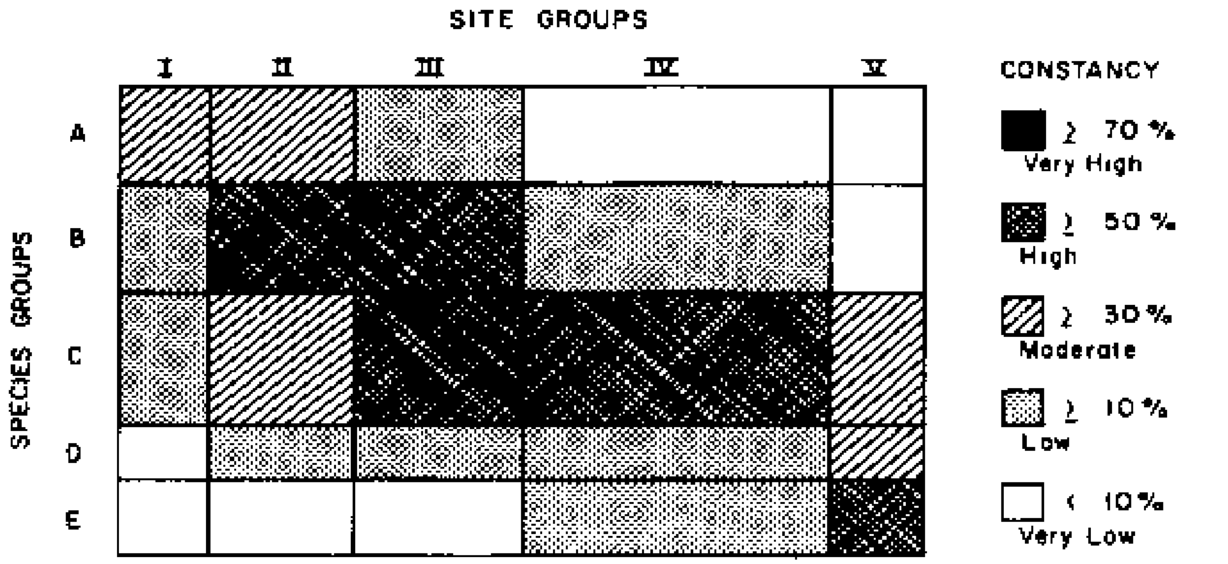
Dominance. The dominant species for each of the pooled site groups are given in Tables 10 and 11. During the spring *Limanda ferruginea* was the major dominant at the cold water, inshore site group (I), *Squalus acanthias* and *Merluccius bilinearis* were among the major dominants at all site groups, 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*.

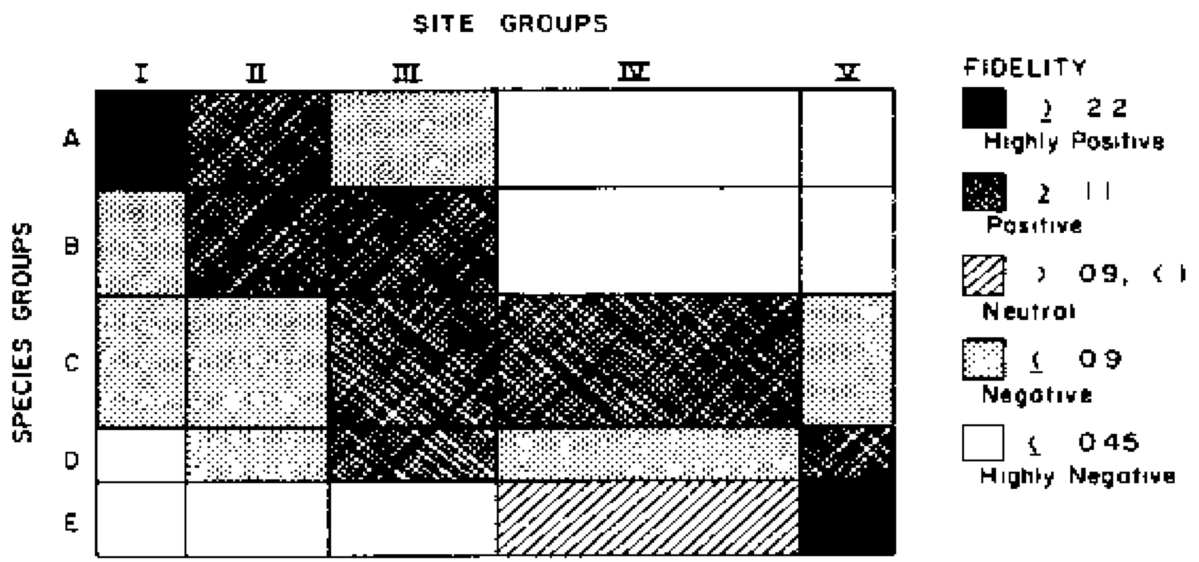
Figure 13. Nodal constancy (A) and fidelity (B) diagrams showing the inter-relation between pooled site and species groups, NMFS Groundfish Survey spring cruises, 1968-1976.



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 occured (%) 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		Site Group II		Site Group III		Site Group IV	
			%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$
Gadus morhua	Bo	A	44	1.4						
Pseudopleuronectes americanus	Bo	A	38	2.2						
Limanda ferruginea	Bo	B	88	28.5	22	1.4				
Macrozoarces americanus	Bo	B	68	5.2						
Myoxocephalus octodecemspinosus	Bo	B	56	5.0						
Raja erinacea	Bo	B	77	11.9	52	1.5				
Scophthalmus aquosus	IS	B	70	4.7						
Hippoglossina oblonga	OS	C	29	1.1	84	7.6	44	2.4	63	5.2
Lophius americanus	Bo	C			58	0.7			53	1.4
Merluccius bilinearis	Bo	C	79	20.5	97	22.4	66	13.0	90	27.2
Squalus acanthias	Bo	C	73	11.1	87	30.0	82	24.6	58	12.2
Urophycis chuss	Bo	C	54	3.9	84	9.3	25	1.9	74	9.5
Centropristes striata	WT	D					40	4.2		
Paralichthys dentatus	WT	D					47	2.2		
Peprilus triacanthus	WT	D			75	14.8	57	12.3	56	19.4
Prionotus carolinus	WT	D			50	7.1	51	9.8		
Stenotomus chrysops	WT	D			24	2.1	50	15.6		
Urophycis regius	WT	D					48	7.2	35	2.0
Chloropthalmus aggasaizi	Sl	E							31	1.6
Helicolenus dactylopterus	Sl	E							59	6.7
Merluccius albidus	Sl	E							38	3.1
Urophycis tenuis	Bo-Sl	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 ut 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	Species Group I		II		III		IV		V	
			%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$
Centropristes striata	WT	A	50	4.7								
Mustelus canis	WT	A	38	5.7								
Paralichthys dentatus	WT	A	61	6.7	51	13.5						
Prionotus carolinus	WT	A	75	33.3	61	10.1						
Stenotomus chrysops	WT	A	53	17.5	51	13.5	30	2.4				
Limanda ferruginea	Bo	B			65	14.1	79	18.0				
Myoxocephalus octodecemspinosus	Bo	B					52	2.7				
Pseudopleuronectes americanus	Bo	B			69	3.3	47	1.7				
Raja erinacea	Bo	B			64	3.8	58	2.7				
Scophthalmus aquosus	IS	B	52	2.9	62	3.4	25	1.0				
Squalus acanthias	Bo	B			69	16.8	77	11.3	23	5.1		
Citharichthys arctifrons	OS	C					35	2.7	49	6.4	68	11.8
Hippoglossina oblonga	OS	C			59	2.2	70	3.3	53	3.6	34	1.4
Lepophidium cervinum	OS	C							32	2.9	27	2.9
Merluccius bilinearis	Bo	C			67	10.2	92	23.0	80	20.8	58	11.3
Peprilus triacanthus	WT	C	59	15.8	65	11.1	72	19.6	65	26.5	28	5.1
Urophycis chuss	Bo	C			35	2.7	74	8.2	37	4.2	30	2.1
Urophycis regius	WT	C	40	6.5					57	14.8	40	7.9
Lophius americanus	Bo	D							31	2.2	57	3.0
Chlorophthalmus agassizi	Sl	E									44	5.9
Helicolenus dactylopterus	Sl	E									84	21.2
Merluccius albidus	Sl	E									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	$\bar{x}$	2.78	2.72	1.78	2.41
(H′)	s	0.48	0.37	0.77	0.92
Evennness	$\bar{x}$	0.60	0.56	0.38	0.48
(J′)	s	0.10	0.06	0.15	0.16
Species	$\bar{x}$	3.14	3.21	2.87	3.88
Richness	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	$\bar{x}$	1.59	2.89	2.64	1.89	2.45
(H′)	s	0.66	0.51	0.49	0.83	1.06
Evennness	$\bar{x}$	0.36	0.58	0.54	0.40	0.49
(J′)	s	0.17	0.13	0.10	0.17	0.21
Species	$\bar{x}$	3.01	3.62	3.35	3.01	4.09
Richness	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 <u>Squalus acanthias</u>, 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 eurybathyic 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 acanthias 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. Parrack (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.

	Spring										Fall										Summer	
	1968	1969	1970	1971	1972	1973	1974	1975	1976	Total	1967	1968	1969	1970	1971	1972	1973	1974	1975	Total	1969	Total
No. of site groups	7	8	9	6	9	7	6	6	7	65	7	8	6	9	6	6	7	7	8	64	5	134
Scomber scombrus	4	1	7	5	4	1	3	2	1	28										0	2	30
Clupea harengus harengus	3	5	3	2	2	2	2		1	20										0		20
Alosa aestivalis	2			1	1					4										0		4
Alosa pseudoharengus	5	6	4	3	1	3	2	1	3	28	1									1		29
Ammodytes dubius					2				2	4										0		4
Pseudopleuronectes americanus	1	1	2	1	1			1		7		2	1	2	1	2	1			9	2	18
Myoxocephalus octodecemspinosus	1	3	3	1	2			1		11	2	1	2	2	1	1				9	1	21
Scophthalmus aquosus		3		1	2	2	1	2	1	12	2	1	1	1	1	2	1	1		10	1	23
Raja erinacea	1	2	2	3	2	2	2	2	1	7	1				1	2	3	1	1	9		16
Limanda ferruginea	2	4	4	3	4	2	2	2	1	24	3	3	4	3	2	2	3	1		21	2	47
Macrozoarces americanus	2	3	3	1	3		1		1	14										0		14
Prionotus carolinus	1	3	5	2	2	2	2	2	2	21	2	2	3	2	3	4	2	2	3	23		44
Stenotomus chrysops	1		3	2	1	1	1	1	2	12	3	2	2	1	2	3	2	1	4	20		32
Paralichthys dentatus				1				1	1	3	1	1	1		1			2	2	8		11
Centropristis striata	1				1	1	1	1	1	6		1	1	2		1		1	2	8		14
Mustelus canis							1			1	1					1	1	1	2	6		7
Peprilus triacanthus	3	2	5	4	5	6	2	4	4	35	5	6	6	5	5	3	7	6	6	47	4	86
Squalus acanthias	6	6	5	6	8	6	4	5	7	53	3	6	3	3	3	3	2	2	3	26	2	81
Merluccius bilinearis	7	5	6	5	6	5	5	6	7	52	5	7	5	9	4	4	5	7	7	53	2	107
Urophycis chuss	3	2	5	3	3	3	4	2	3	28	2	2	3	2	3	3	1	2	4	22	2	52
Hippoglossina oblonga	1	2	1	1	4	3	3	3	4	25	2		1	2	1	4	3	3	3	19	1	45
Citharichthys arctifrons		1		1		1	2	2	2	9	2	1	2	3	2	6	2	3	4	25	3	37
Lophius americanus						1				1		1	1			2	2			6		7
Urophycis regius			2	1	2	1	1	1	3	11	2	5	2	5	4	2	4	3	4	31	4	46
Lepophidium cervinum	1					1	2	2	2	8	1	1		3	1	1	1	1	1	10	2	20
Glyptocephalus cynoglossus					1		1		1	3				1						1		4
Urophycis tenuis		1	1		1					3	1	1								2		5
Peristedion miniatum		1								1							1			1		2
Maurolicus muelleri								1		1	2								1	3	1	5
Phycis chesteri				1	2					3								1		1		4
Myctophidae	2		1		1		2	2	2	10		1	1	1	2	1	2	1	1	10	1	21
Helicolenus dactylopterus			1	1	1	1	1	1	1	7	1	1	1	2	2	1	1	2	1	12	1	20
Chlorophthalmus agassizi							1			1		1	1	2	1	1		1		7		8
Merluccius albidus						1	1		1	3	1	1	1	1	1	1	1	1	1	9	1	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				207.5			
1968-69	43.5	-57			203.0	-33		
1973-74	22.5		-41	-29	138.5		-24	-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, Centropristis 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 inconsistantcy (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 octodecemspinosus*, *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

duing 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
No. of Stations		28	14	10	21	15	13	7
Abundance	$\bar{x}$	5.44	4.91	6.32	5.42	5.73	5.57	4.44
ln (x+1)	σ	0.831	1.103	1.071	1.384	1.598	0.870	1.426
No. of Species	$\bar{x}$	9.3	10.1	9.7	10.2	8.9	10.2	6.7
	σ	2.02	2.54	1.57	1.87	2.84	3.06	1.11
Biomass (kg)	$\bar{x}$	4.10	3.35	4.36	3.95	4.14	3.64	2.76
ln (x+1)	σ	0.713	1.226	0.944	1.358	1.477	0.710	1.619
Depth (m)	Range	26-75	20-84	24-77	55-238	60-201	126-280	152-329
	$\bar{x}$	45.4	50.1	41.1	101.2	135.5	204.6	273.6
Temperature (°C)	Range	2-4	2-6	6-8	5-11	4-11	8-10	9-9
	$\bar{x}$	3.0	4.7	6.8	8.6	9.6	9.6	9.0

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

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

SITE GROUP		I	II	III	IV	V	VI	VII	VIII
No. of Stations		7	24	13	5	9	24	16	11
Abundance	$\bar{x}$	5.59	5.39	4.66	3.39	4.21	5.13	4.94	5.26
ln (x+1)	σ	0.887	0.794	0.619	0.380	1.002	0.990	1.878	1.345
No. of Species	$\bar{x}$	8.0	11.7	10.4	5.8	6.8	9.7	8.6	7.6
	σ	1.83	2.25	1.8C	1.48	2.59	3.34	5.03	1.75
Biomass (kg)	$\bar{x}$	4.00	4.48	3.43	2.31	3.95	3.94	3.40	3.88
ln (x+1)	σ	0.920	0.666	0.671	0.227	1.213	1.126	2.027	1.289
Depth (m)	Range	27-51	22-75	29-77	22-27	26-128	24-329	69-280	128-379
	$\bar{x}$	36.7	49.4	53.7	23.4	67.1	112.0	146.9	265.2
Temperature (°C)	Range	2-4	2-4	3-7	4-5	5-11	4-12	6-13	10-12
	$\bar{x}$	2.9	3.3	4.5	4.6	7.3	8.7	9.6	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
ln (x+1)	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)	$\bar{x}$	3.43	4.70	3.87	2.35	3.09	3.23	3.88	3.11	3.57
ln (x+1)	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 (°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		I	II	III	IV	V	VI
No. of Stations		11	29	19	20	21	16
Abundance	$\bar{x}$	4.30	5.05	4.78	4.73	5.95	5.18
ln (x+1)	σ	1.551	0.618	0.953	1.623	1.307	0.975
No. of Species	$\bar{x}$	6.2	10.0	9.2	8.7	10.6	11.0
	σ	1.99	2.66	2.76	3.73	3.20	2.25
Biomass (kg)	$\bar{x}$	3.20	4.12	3.34	3.23	4.45	4.01
ln (x+1)	σ	0.596	0.611	0.970	1.518	1.446	1.295
Depth (m)	Range	18-64	27-80	22-95	20-221	33-214	135-329
	$\bar{x}$	39.2	49.3	59.5	96.4	111.1	265.9
Temperature (°C)	Range	4-9	2-7	4-9	7-12	8-14	6-11
	$\bar{x}$	6.3	3.7	5.7	9.4	10.8	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
ln (x+1)	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	8.8	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
ln (x+1)	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	$\bar{x}$	6.06	5.33	6.38	5.95	5.73	5.03	6.26
ln (x+1)	σ	0.598	1.014	0.763	1.878	2.112	0.336	1.462
No. of Species	$\bar{x}$	14.6	10.8	12.7	9.9	9.8	9.0	14.0
	σ	1.92	2.71	1.83	3.76	2.09	0.0	3.31
Biomass (kg)	$\bar{x}$	4.90	4.57	5.15	4.67	3.86	3.15	4.93
ln (x+1)	σ	0.635	0.788	0.862	1.273	1.407	0.320	1.049
Depth (m)	Range	26-69	24-75	60-152	48-152	95-179	110-135	188-335
	$\bar{x}$	47.4	42.3	85.7	94.1	141.5	123.7	253.4
Temperature (°C)	Range	3-8	3-9	7-16	7-12	11-14	8-8	10-14
	$\bar{x}$	5.2	6.2	9.7	9.3	12.2	8.0	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
No. of Stations		19	12	27	11	10	12
Abundance	$\overline{x}$	6.18	4.65	5.87	5.44	4.89	5.39
ln (x+1)	σ	1.015	0.895	1.050	1.441	0.380	0.661
No. of Species	$\overline{x}$	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)	$\overline{x}$	4.74	4.51	4.38	4.58	2.90	4.11
ln (x+1)	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
	$\overline{x}$	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
	$\overline{x}$	6.3	7.8	10.2	12.2	12.5	11.0

$\overline{x}$ = mean value
σ = standard deviation

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

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

$\overline{x}$ = mean value
σ = standard deviation

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

SITE GROUP		I	II	III	IV	V	VI	VII
No. of Stations		10	35	10	14	15	16	17
Abundance	$\overline{x}$	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	$\overline{x}$	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)	$\overline{x}$	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
	$\overline{x}$	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
	$\overline{x}$	7.7	5.7	8.2	11.1	9.7	11.8	10.1

$\overline{x}$ = 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	$\overline{x}$	5.58	5.88	6.03	5.15	4.82	4.34	4.63
ln (x+1)	σ	1.840	0.630	0.653	0.384	1.034	2.135	1.306
No. of Species	$\overline{x}$	8.3	10.8	12.6	13.0	8.3	5.7	8.7
	σ	3.77	3.51	3.11	0.71	2.64	2.72	1.69
Biomass (kg)	$\overline{x}$	3.91	4.96	5.12	4.04	3.47	2.01	1.96
ln (x+1)	σ	1.400	0.949	0.873	0.746	1.312	1.424	0.655
Depth (m)	Range	22-48	27-49	31-73	38-73	60-219	33-223	93-320
	$\overline{x}$	32.4	37.6	50.7	58.6	99.1	137.8	160.5
Temperature (°C)	Range	10-23	10-15	8-13	6-9	7-12	9-18	9-13
	$\overline{x}$	16.5	12.0	9.8	7.6	9.3	11.5	11.1

$\overline{x}$ = mean value
σ = standard deviation

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

SITE GROUP		I	II	III	IV	V	VI	VII	VIII
No. of Stations		19	13	14	18	12	27	9	9
Abundance	$\bar{x}$	4.88	5.88	5.34	6.01	5.20	4.87	4.73	4.35
ln (x+1)	σ	1.539	0.488	1.238	0.638	1.755	1.040	1.779	0.646
No. of Species	$\bar{x}$	7.4	13.4	7.1	12.7	4.8	9.0	5.9	7.6
	σ	2.73	2.10	2.16	2.40	1.86	2.94	2.37	3.17
Biomass (kg)	$\bar{x}$	3.55	4.55	4.25	4.35	2.88	2.53	2.29	2.05
ln (x+1)	σ	1.415	0.748	1.548	0.619	1.766	0.872	1.401	0.723
Depth (m)	Range	18-44	27-62	33-57	46-91	16-287	53-315	66-172	203-357
	$\bar{x}$	30.8	39.5	43.4	63.2	95.2	127.4	122.4	300.3
Temperature (°C)	Range	11-21	8-15	8-14	7-15	7-21	7-15	11-15	8-11
	$\bar{x}$	17.7	11.7	10.4	10.1	12.1	11.3	12.8	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
No. of Stations		15	15	13	27	21	18
Abundance	$\bar{x}$	5.05	6.07	5.97	4.62	4.95	4.85
ln (x+1)	σ	1.462	0.739	0.661	1.666	1.634	1.778
No. of Species	$\bar{x}$	10.5	13.5	12.4	6.1	7.9	7.7
	σ	3.20	2.53	2.22	2.48	2.50	2.57
Biomass (kg)	$\bar{x}$	3.65	4.84	4.56	3.31	2.88	2.09
ln (x+1)	σ	1.200	1.003	0.643	1.582	1.325	1.152
Depth (m)	Range	24-59	33-80	57-80	37-218	55-196	71-351
	$\bar{x}$	37.1	49.7	66.5	68.5	103.2	226.0
Temperature (°C)	Range	17-21	12-18	10-12	9-18	9-13	10-18
	$\bar{x}$	19.1	14.1	10.8	12.6	11.3	12.1

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

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

SITE GROUP		I	II	III	IV	V	VI	VII	VIII	IX
No. of Stations		10	17	21	13	14	11	12	8	7
Abundance	$\overline{x}$	5.09	4.79	6.00	3.12	4.95	4.23	4.92	3.30	4.18
ln (x+1)	σ	1.560	1.170	1.098	1.392	0.725	0.977	2.311	1.489	0.511
No. of Species	$\overline{x}$	6.6	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	1.90	2.02	2.47	2.51	2.41
Biomass (kg)	$\overline{x}$	3.07	4.47	4.46	1.82	2.48	1.52	2.74	1.59	1.84
ln (x+1)	σ	1.446	1.325	0.789	1.631	0.801	0.926	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	199-329
	$\overline{x}$	28.6	46.1	59.9	63.2	85.1	146.4	129.3	134.3	266.3
Temperature (°C)	Range	8-18	7-15	8-13	5-13	6-13	9-13	8-13	8-13	8-11
	$\overline{x}$	12.4	11.9	9.9	7.1	9.4	11.6	11.6	10.0	9.6

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

$\overline{x}$ = mean value
σ = standard deviation

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

SITE GROUP		I	II	III	IV	V	VI
No. of Stations		8	16	25	11	21	22
Abundance	$\bar{x}$	4.69	3.61	6.35	6.09	4.69	4.28
ln (x+1)	σ	1.412	0.819	1.088	0.743	1.434	1.157
No. of Species	$\bar{x}$	8.8	7.7	13.9	13.6	8.0	10.0
	σ	2.86	1.85	3.88	2.76	2.89	4.52
Biomass (kg)	$\bar{x}$	3.76	2.86	4.81	4.38	2.56	1.72
ln (x+1)	σ	1.263	0.957	1.121	0.637	0.897	0.892
Depth (m)	Range	18-38	29-59	40-79	60-88	42-165	119-340
	$\bar{x}$	28.3	37.8	57.2	72.1	102.4	235.9
Temperature (°C)	Range	19-21	12-20	9-18	10-13	9-18	7-13
	$\bar{x}$	20.4	16.4	12.4	11.1	12.4	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	$\bar{x}$	4.43	5.14	5.50	2.76	5.48	4.89	4.03
ln (x+1)	σ	2.179	1.598	0.937	1.312	2.355	1.176	1.594
No. of Species	$\bar{x}$	6.7	9.9	10.5	3.8	3.6	8.8	7.2
	σ	2.10	3.55	2.83	1.28	1.68	2.23	1.60
Biomass (kg)	$\bar{x}$	3.17	3.95	3.52	1.64	2.88	2.58	2.36
ln (x+1)	σ	1.217	1.368	0.892	0.878	1.715	0.915	0.832
Depth (m)	Range	26-40	26-79	48-101	40-271	80-137	57-320	241-366
	$\bar{x}$	31.4	38.7	73.0	101.0	102.3	151.9	321.5
Temperature (°C)	Range	11-19	10-21	10-14	9-15	11-16	11-16	6-16
	$\bar{x}$	15.6	15.7	11.5	11.5	13.8	13.1	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	$\bar{x}$	4.75	4.47	5.12	4.69	4.77	5.22	4.76
ln (x+1)	σ	2.027	0.757	1.155	1.458	1.896	0.660	1.059
No. of Species	$\bar{x}$	8.5	9.8	11.4	8.1	4.1	7.0	13.3
	σ	4.48	2.58	4.21	3.04	1.77	2.12	4.03
Biomass (kg)	$\bar{x}$	3.50	3.18	3.83	1.99	2.24	2.01	2.44
ln (x+1)	σ	1.498	1.124	0.703	0.681	1.355	0.548	0.819
Depth (m)	Range	20-60	27-51	33-77	33-243	33-397	40-146	236-433
	$\bar{x}$	35.7	36.2	57.1	106.6	118.2	98.4	310.9
Temperature (°C)	Range	12-25	10-21	11-16	10-13	9-17	11-18	9-13
	$\bar{x}$	17.2	15.3	12.9	11.1	12.4	13.3	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
No. of Stations		6	7	23	18	20	12	10	15
Abundance	$\bar{x}$	4.71	2.73	5.94	5.59	4.24	5.56	3.96	4.53
ln (x+1)	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)	$\bar{x}$	4.64	2.62	4.38	4.28	2.66	3.37	2.08	2.43
ln (x+1)	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.

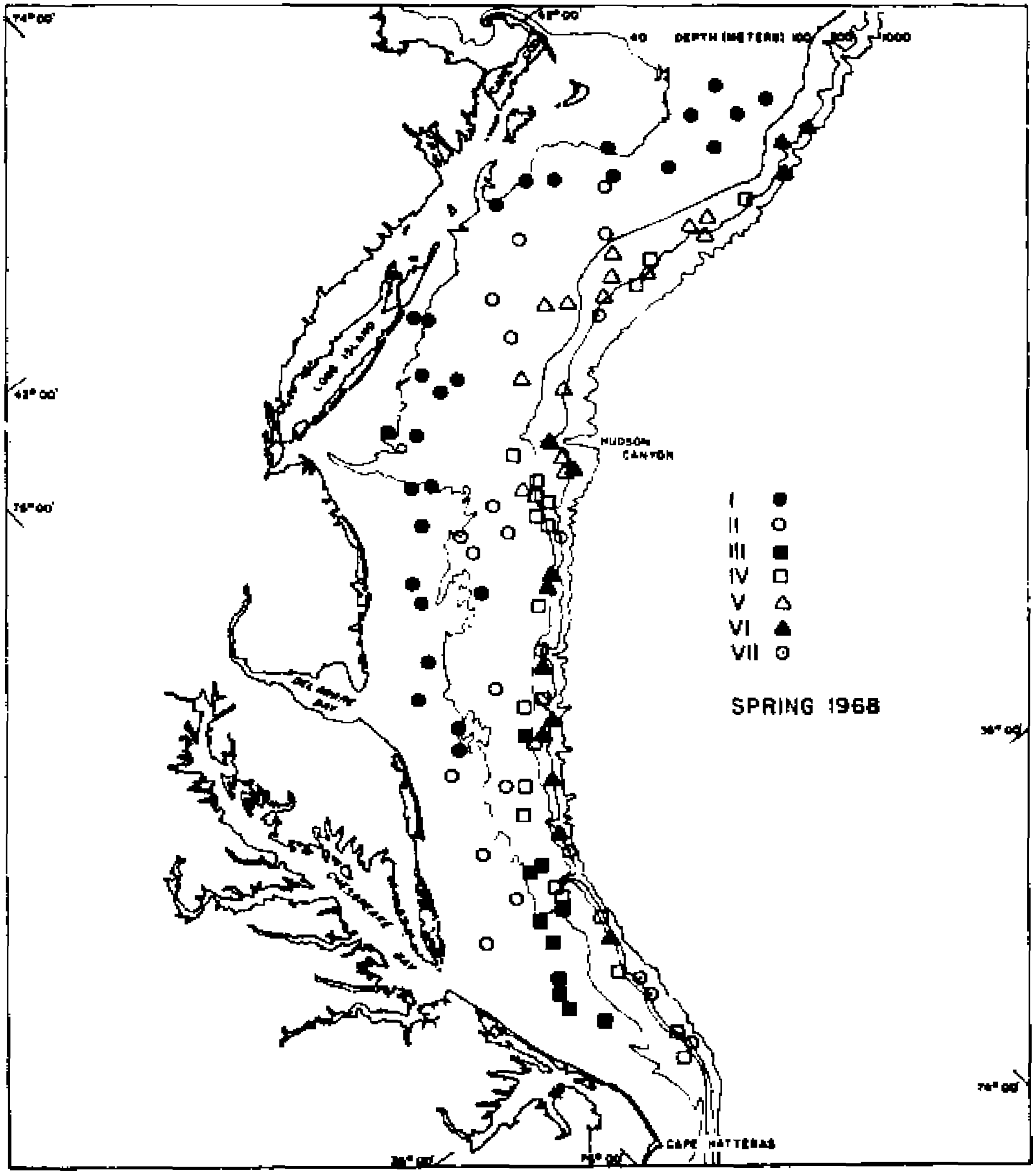
SITE GROUP		I	II	III	IV	V
No. of stations		23	37	15	12	16
Abundance	$\bar{x}$	5.28	4.35	4.32	4.69	3.64
ln (x+1)	σ	0.843	2.224	1.818	1.393	1.539
No. of Species	$\bar{x}$	11.8	5.7	4.0	6.8	7.2
	σ	2.76	2.74	1.96	2.83	3.99
Biomass (kg)	$\bar{x}$	3.55	2.35	1.77	2.27	1.40
ln (x+1)	σ	0.997	1.662	1.547	1.770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

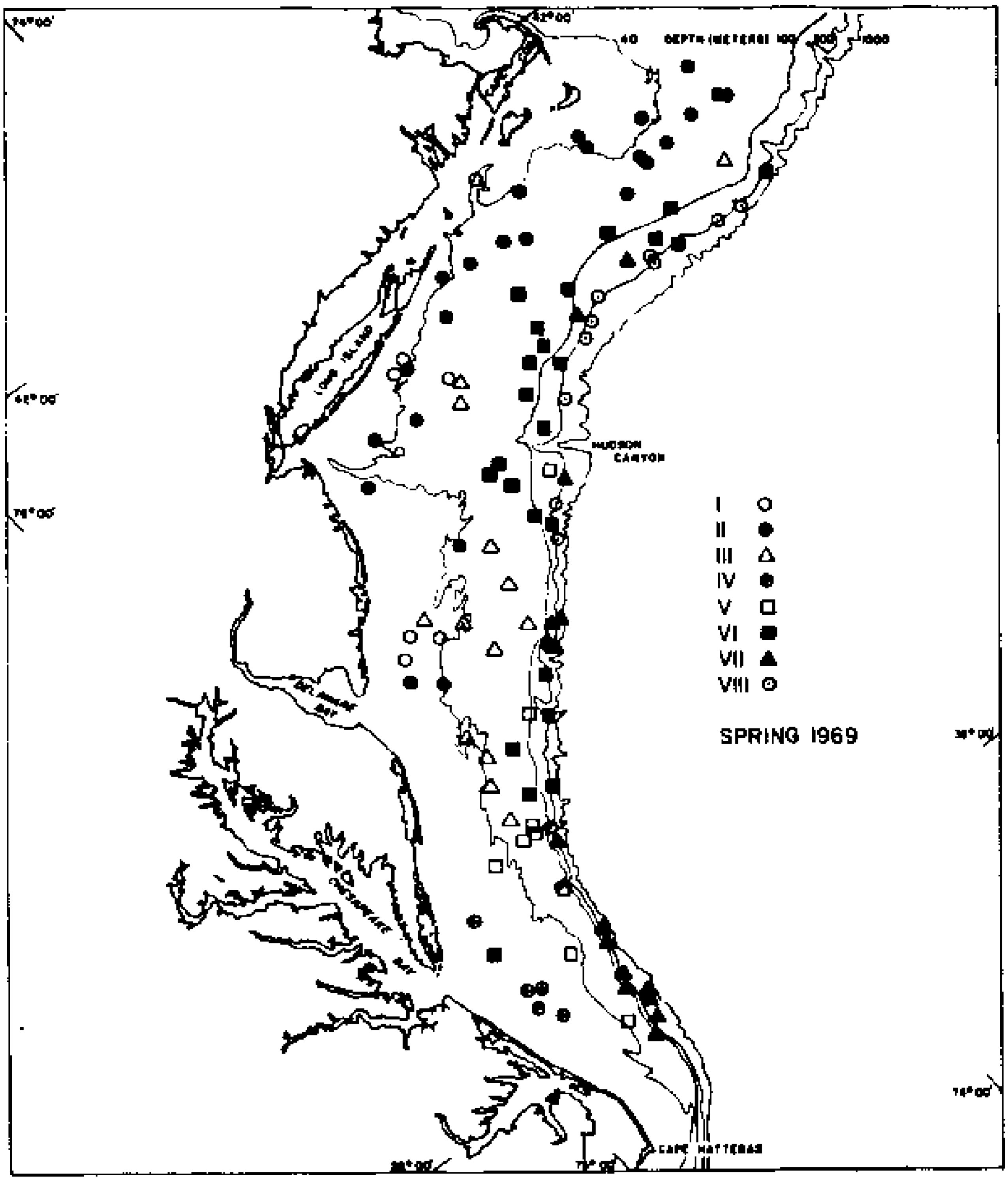
$\bar{x}$ = mean value
σ = standard deviation

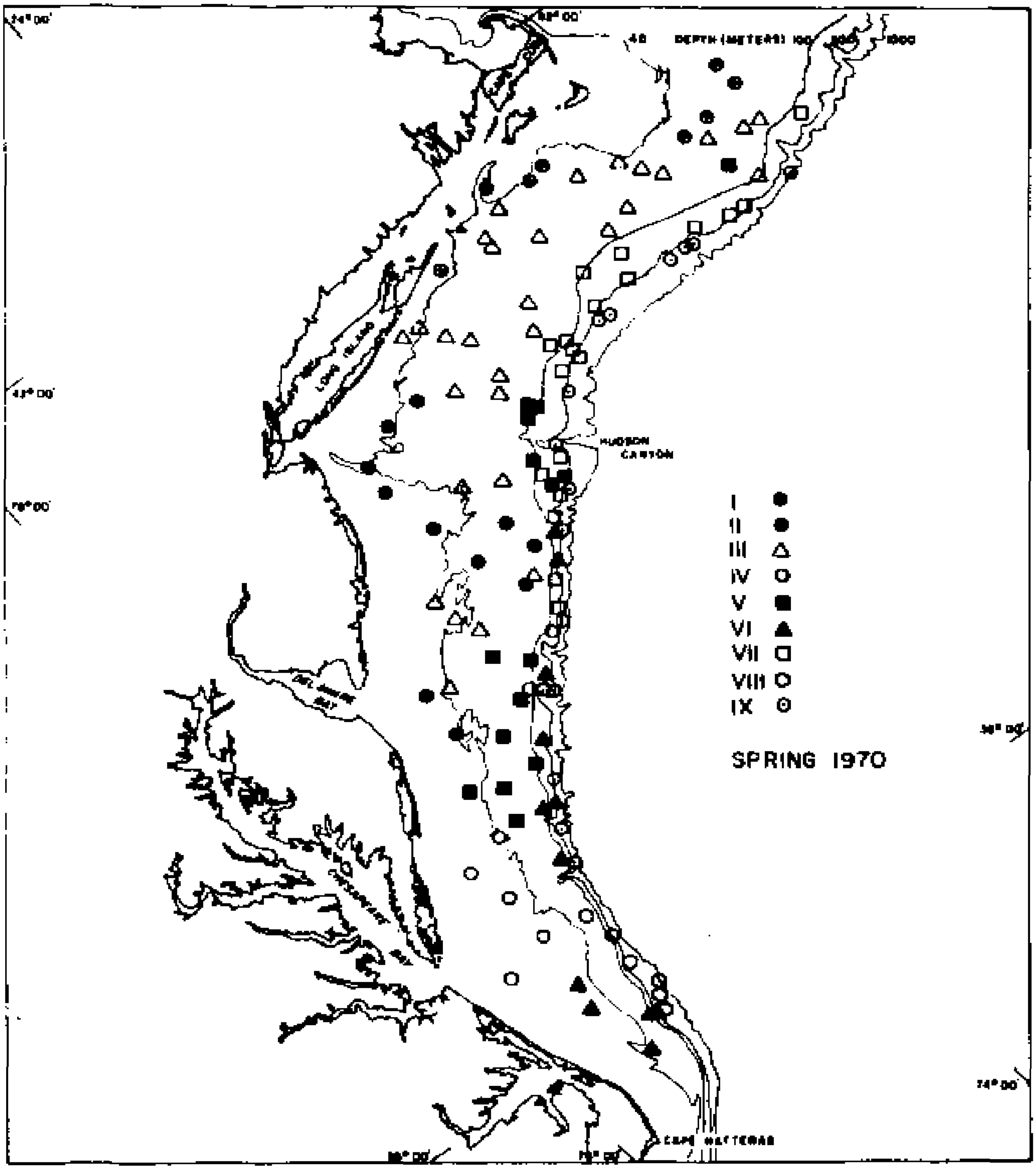
APPENDIX B

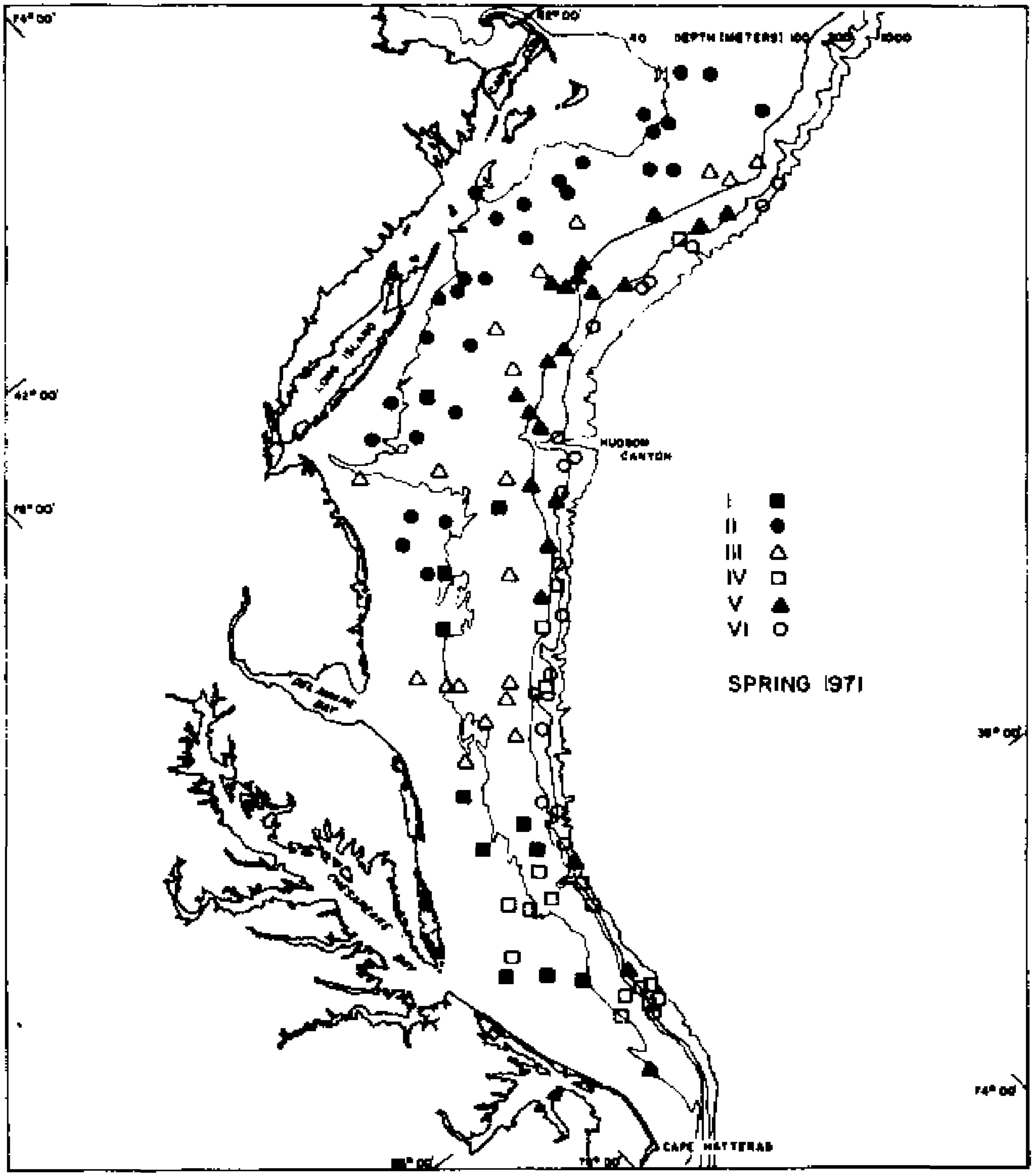
Site groups identified for NMFS Groundfish Survey Cruises,

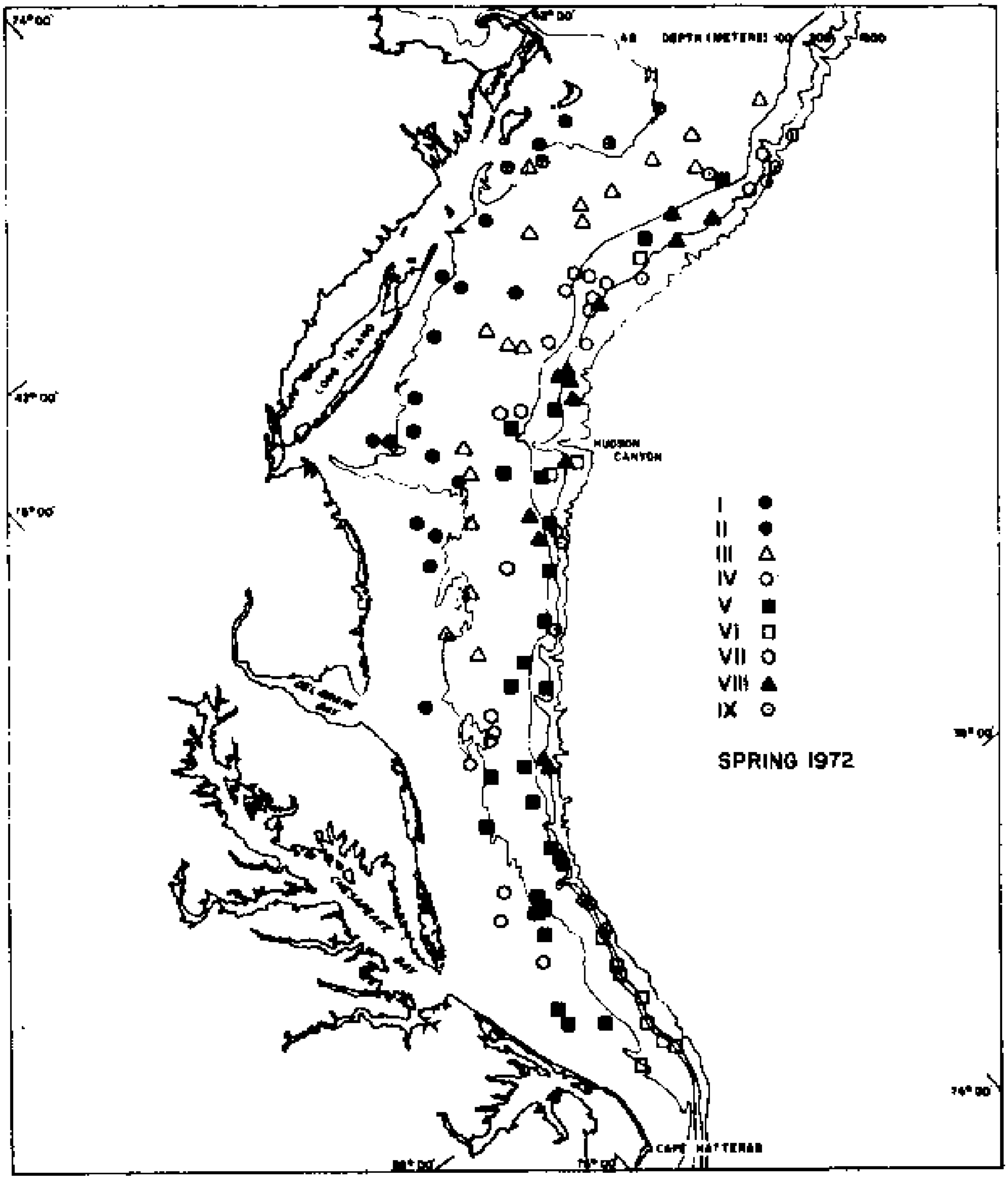
Fall 1967 - Spring 1976.

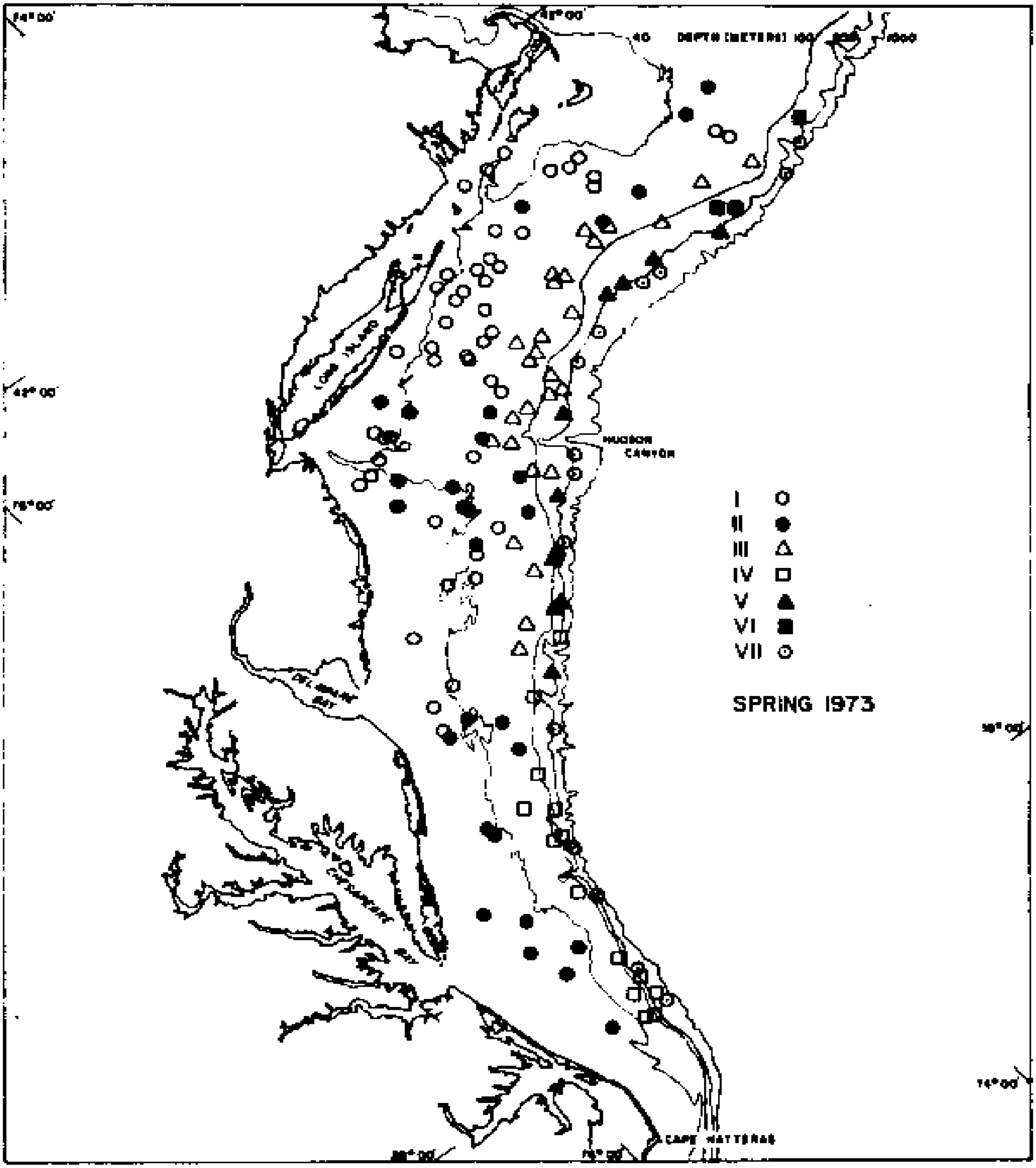

40
DEPTH (METERS) 100
200
1000
LONG ISLAND
HUDSON CANYON
I
II
III
IV
V
VI
VII
SPRING 1968
CAPE HATTERAS

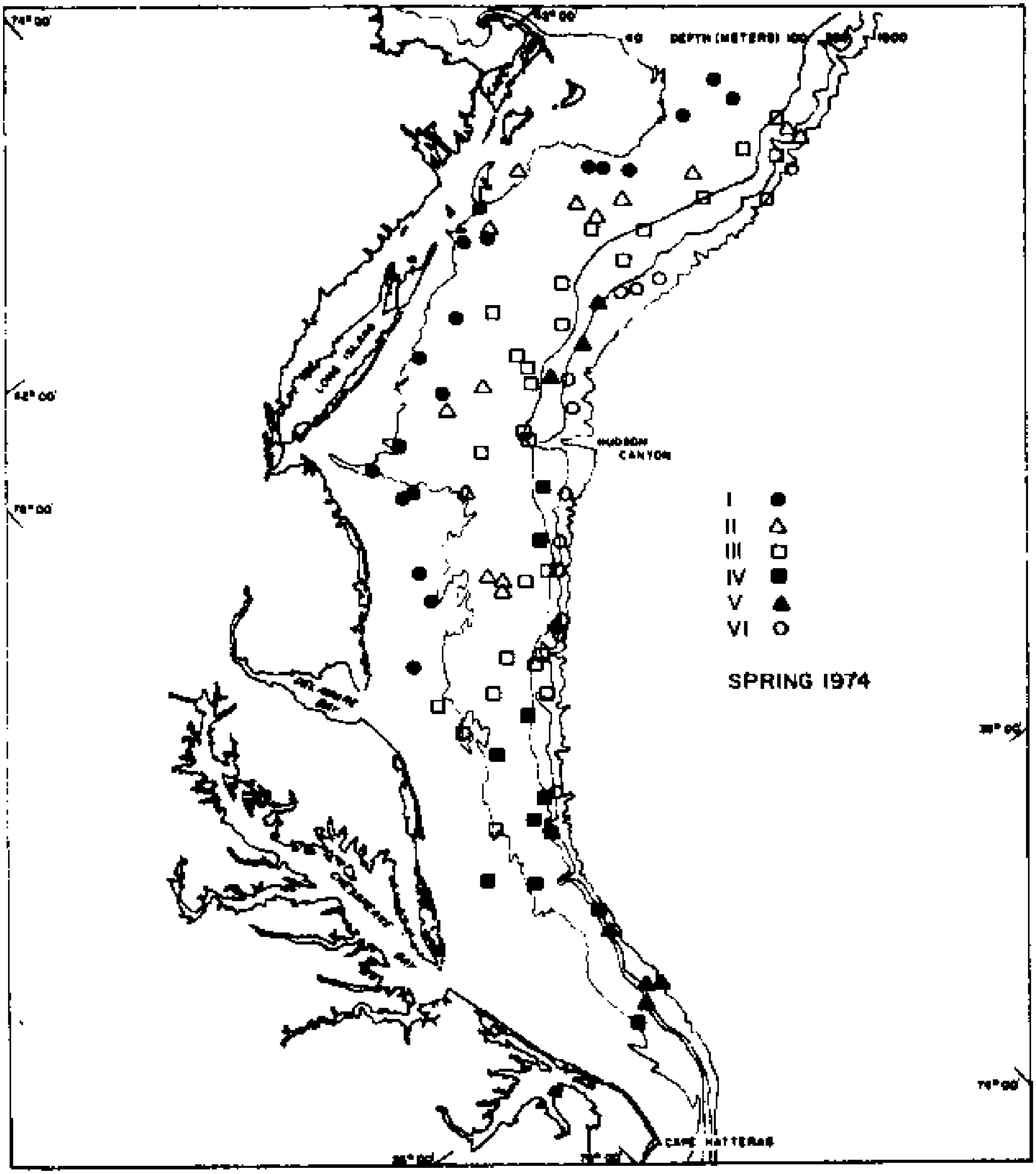

HUDSON
CANYON
I
II
III
IV
V
VI
VII
VIII
SPRING 1969
CAPE HATTERAS

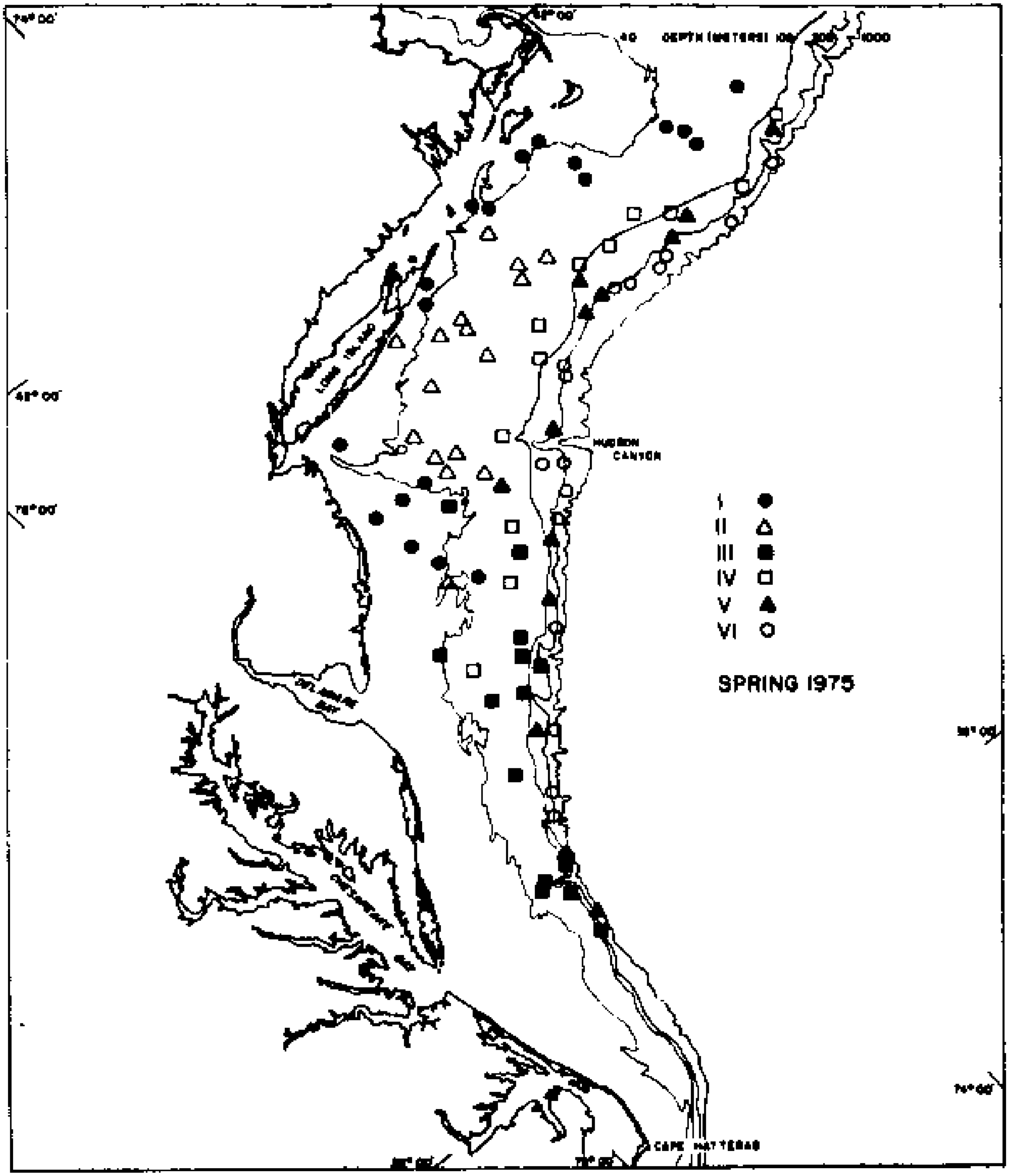

DEPTH (METERS)
HUDSON CANYON
DELAWARE BAY
CAPE HATTERAS
I
II
III
IV
V
VI
VII
VIII
IX
SPRING 1970

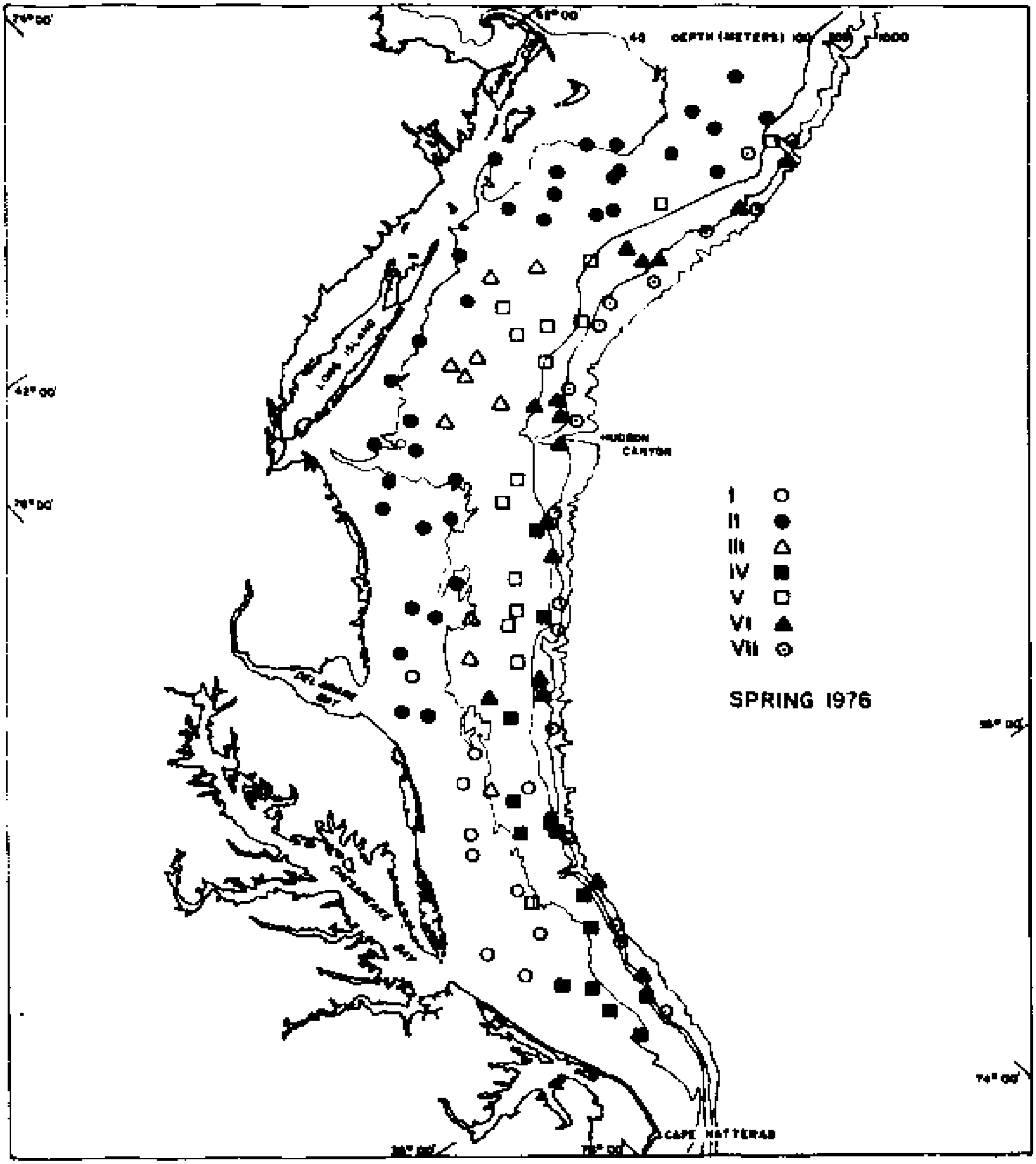

DEPTH (METERS) 40 100 200 1000
LONG ISLAND
HUDSON CANYON
DELAWARE BAY
CHESAPEAKE BAY
CAPE HATTERAS
I ■
II ●
III △
IV □
V ▲
VI ○
SPRING 1971

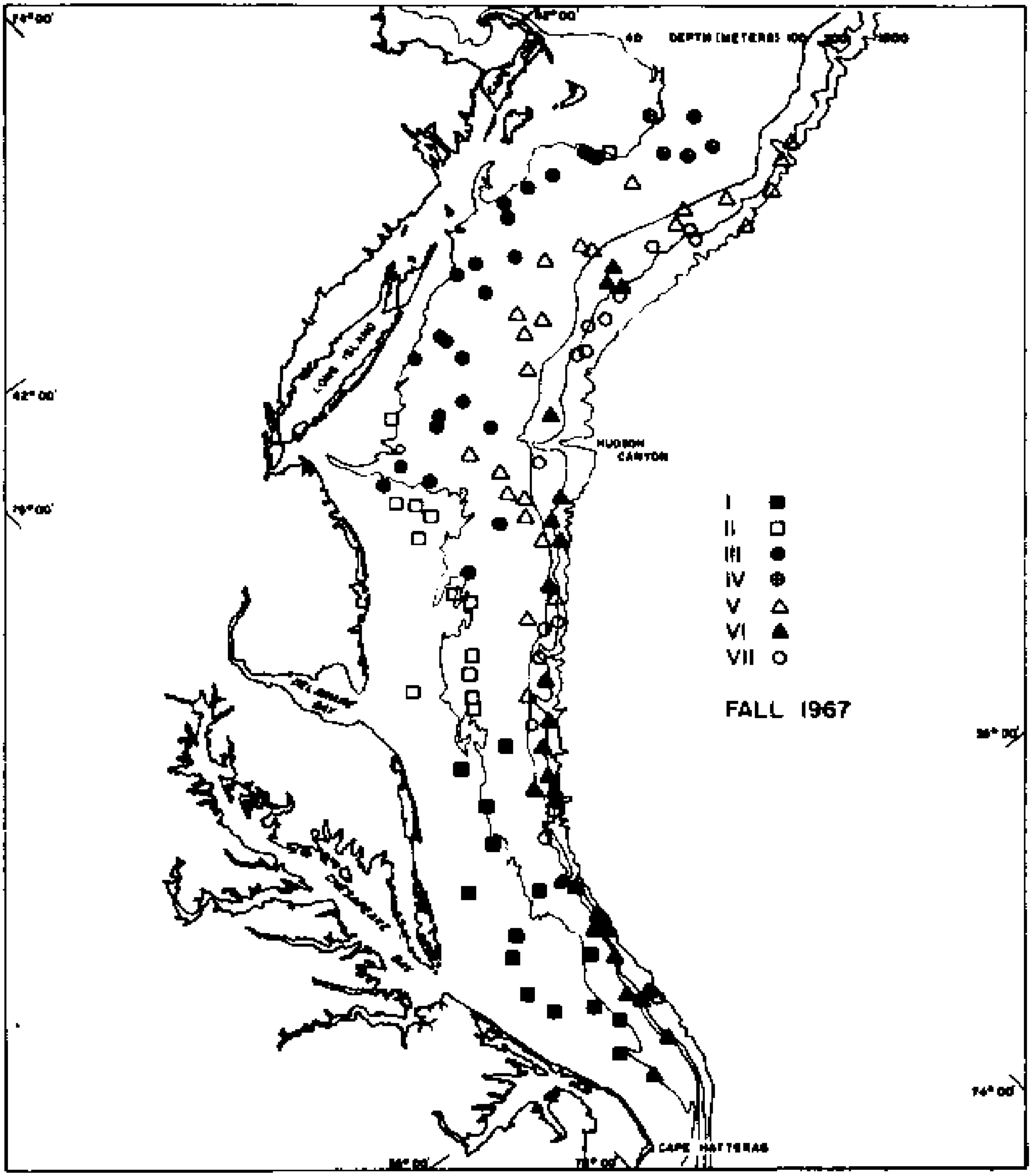

HUDSON CANYON
I
II
III
IV
V
VI
VII
VIII
IX
SPRING 1972
CAPE HATTERAS

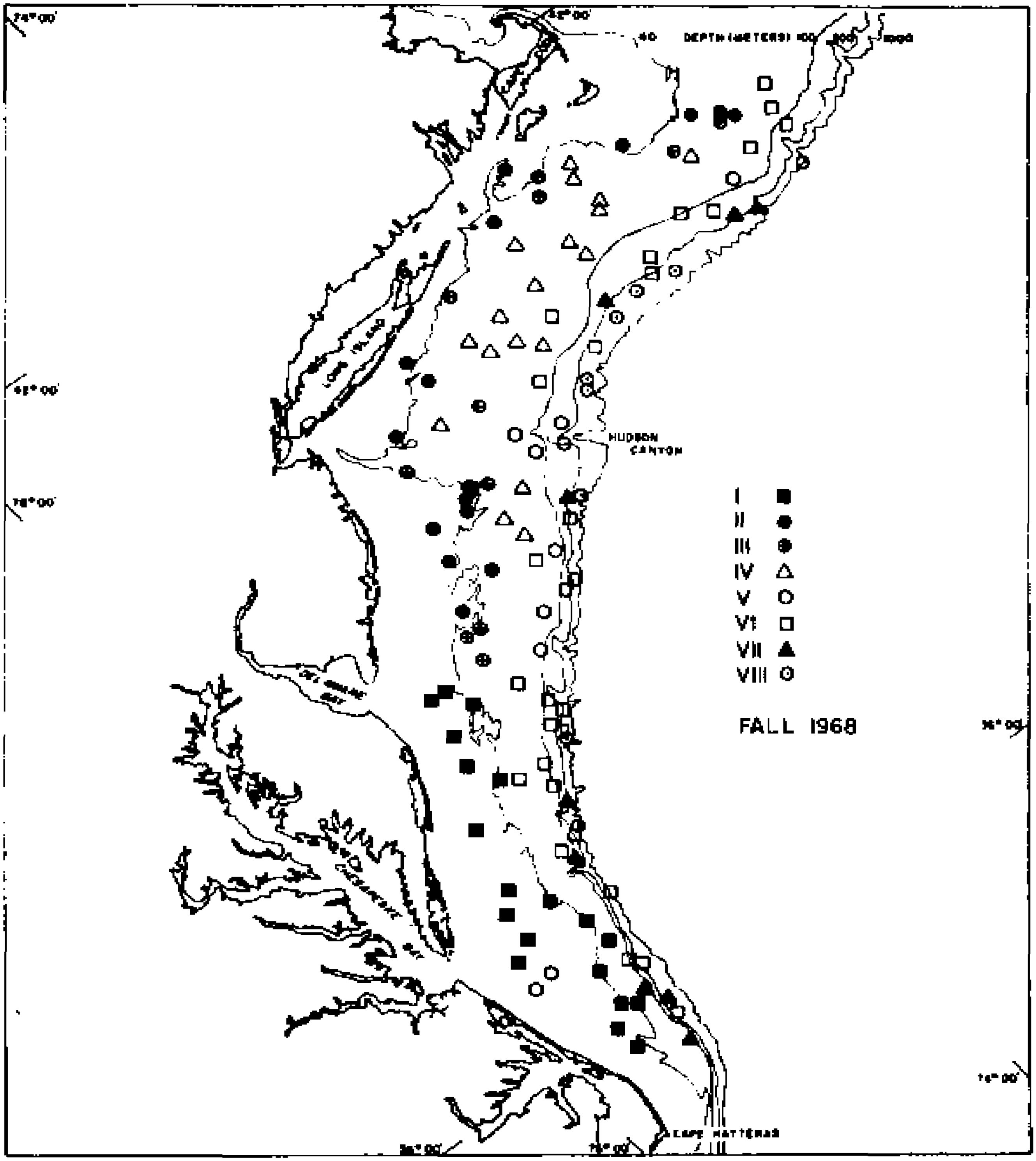

DEPTH (METERS)
HUDSON CANYON
CAPE HATTERAS
I ○
II ●
III △
IV □
V ▲
VI ■
VII ⊙
SPRING 1973

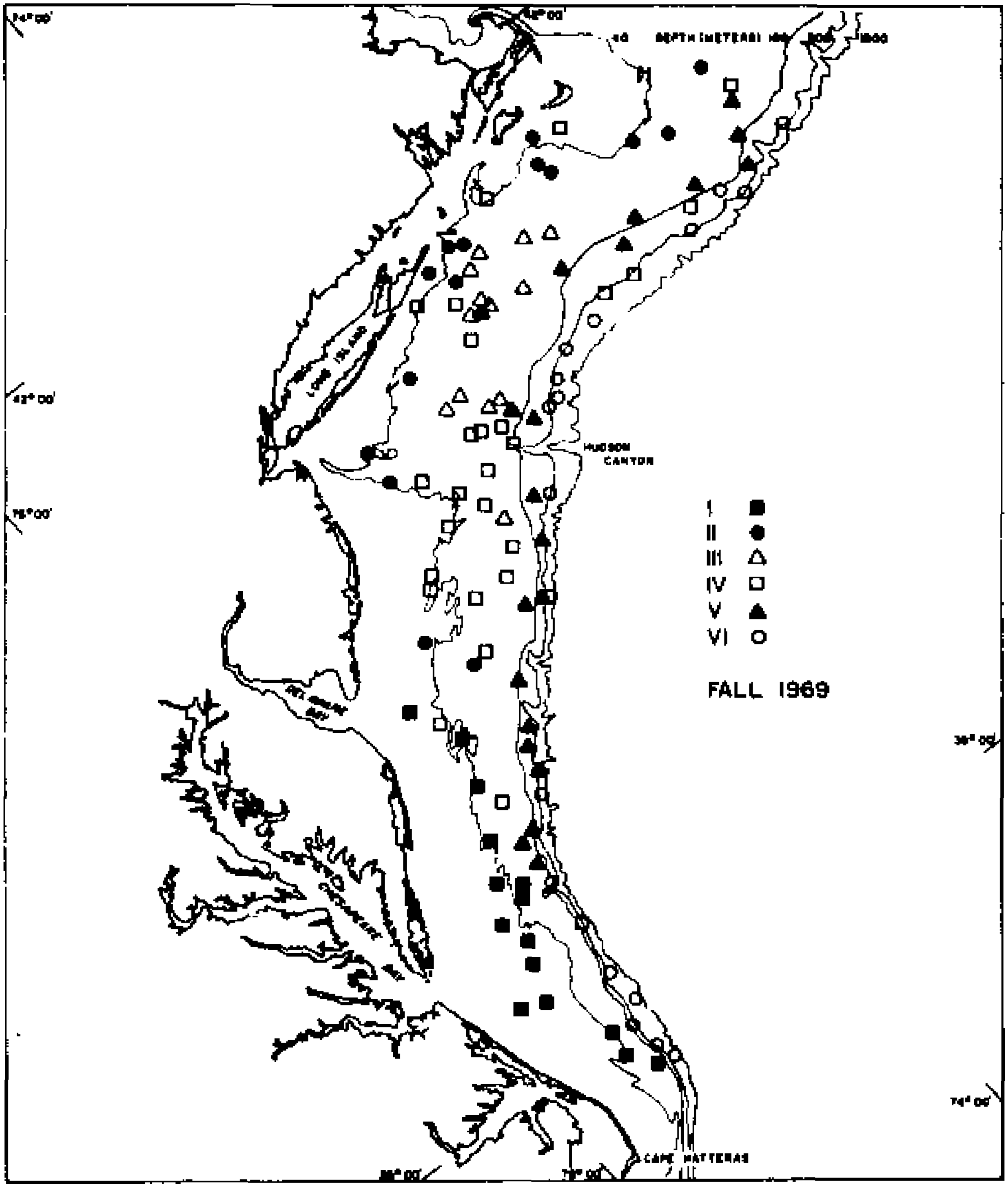

DEPTH (METERS) 100
1000
LONG ISLAND
HUDSON CANYON
CAPE HATTERAS
I ●
II △
III □
IV ■
V ▲
VI ○
SPRING 1974

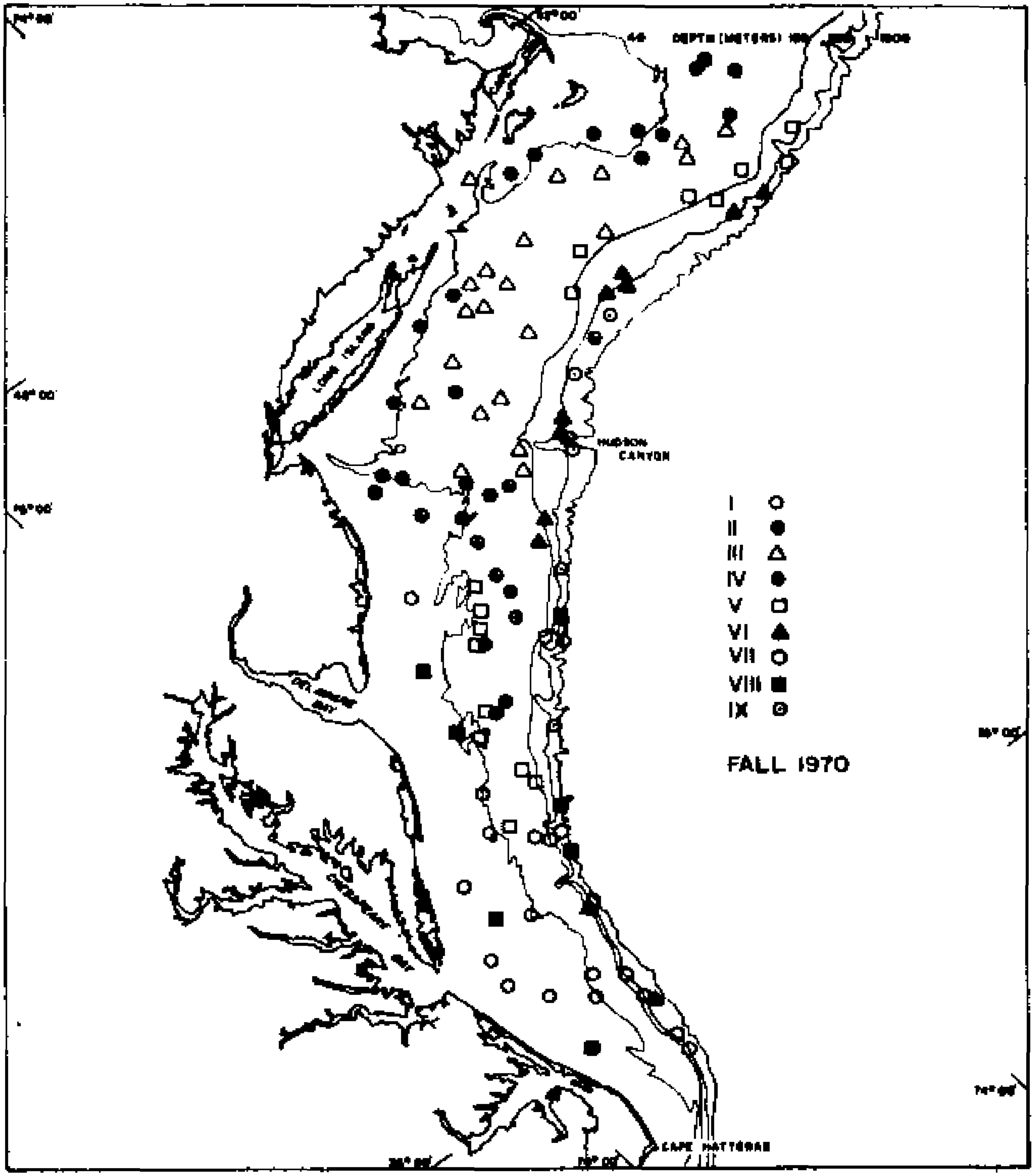

HUDSON
CANYON
I ●
II △
III ■
IV □
V ▲
VI ○
SPRING 1975
CAPE HATTERAS

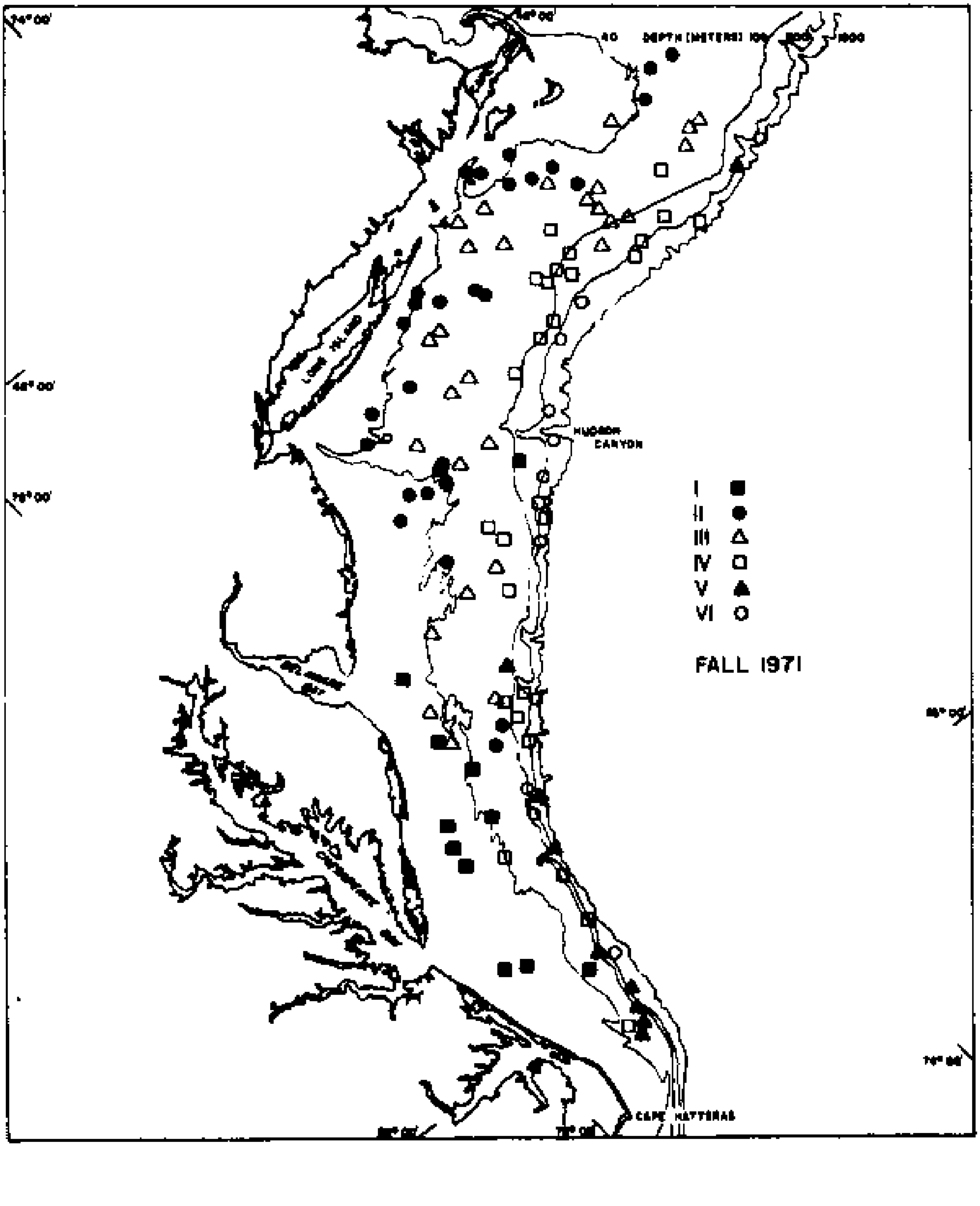

DEPTH (METERS) 100 200 1000
LONG ISLAND
HUDSON CANYON
DELAWARE BAY
CHESAPEAKE BAY
CAPE HATTERAS
I
II
III
IV
V
VI
VII
SPRING 1976


DEPTH (METERS) 100 200 1000
HUDSON CANYON
I
II
III
IV
V
VI
VII
FALL 1967
CAPE HATTERAS

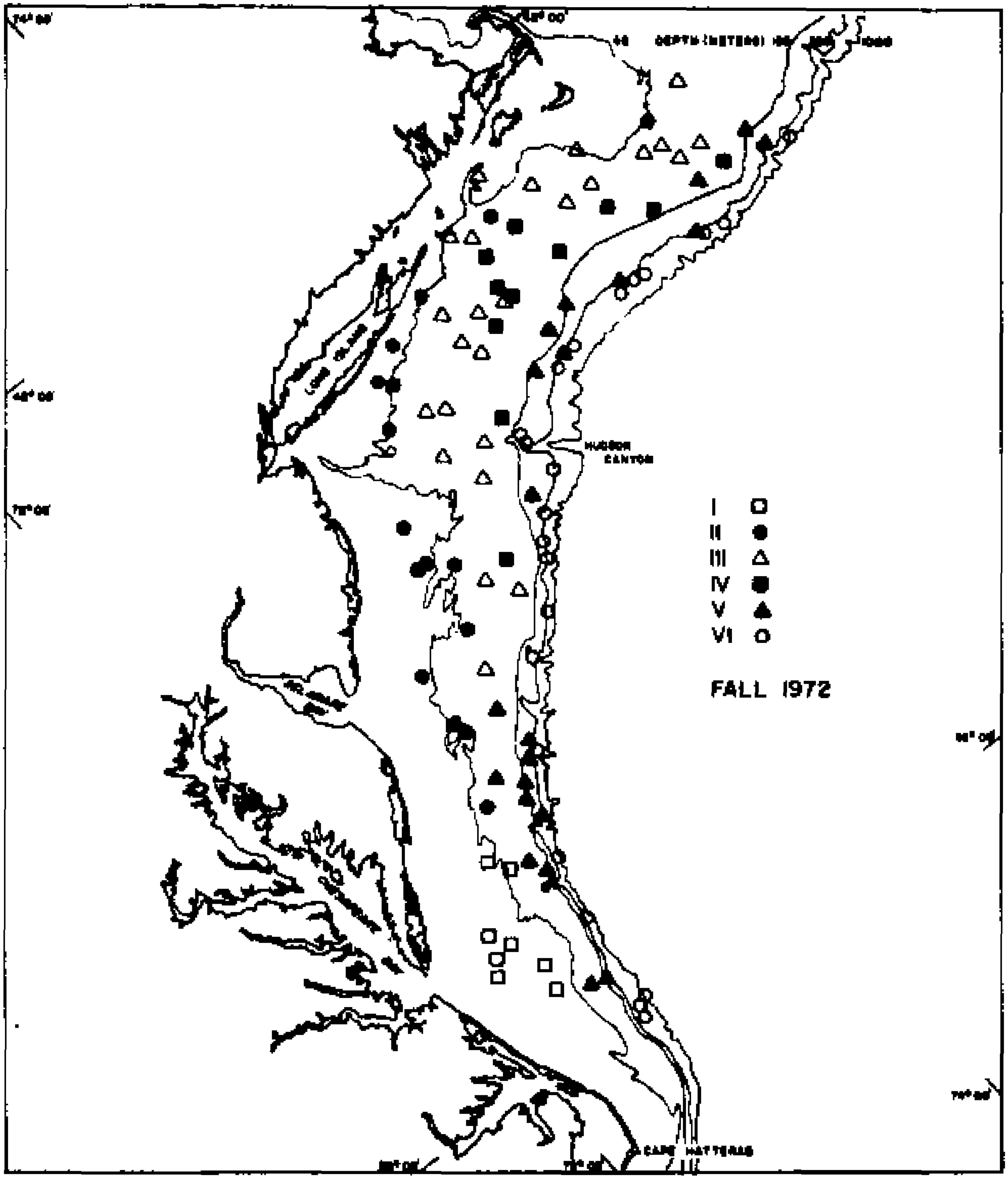

DEPTH (METERS) 100 200 2000
HUDSON CANYON
I
II
III
IV
V
VI
VII
VIII
FALL 1968
CAPE HATTERAS

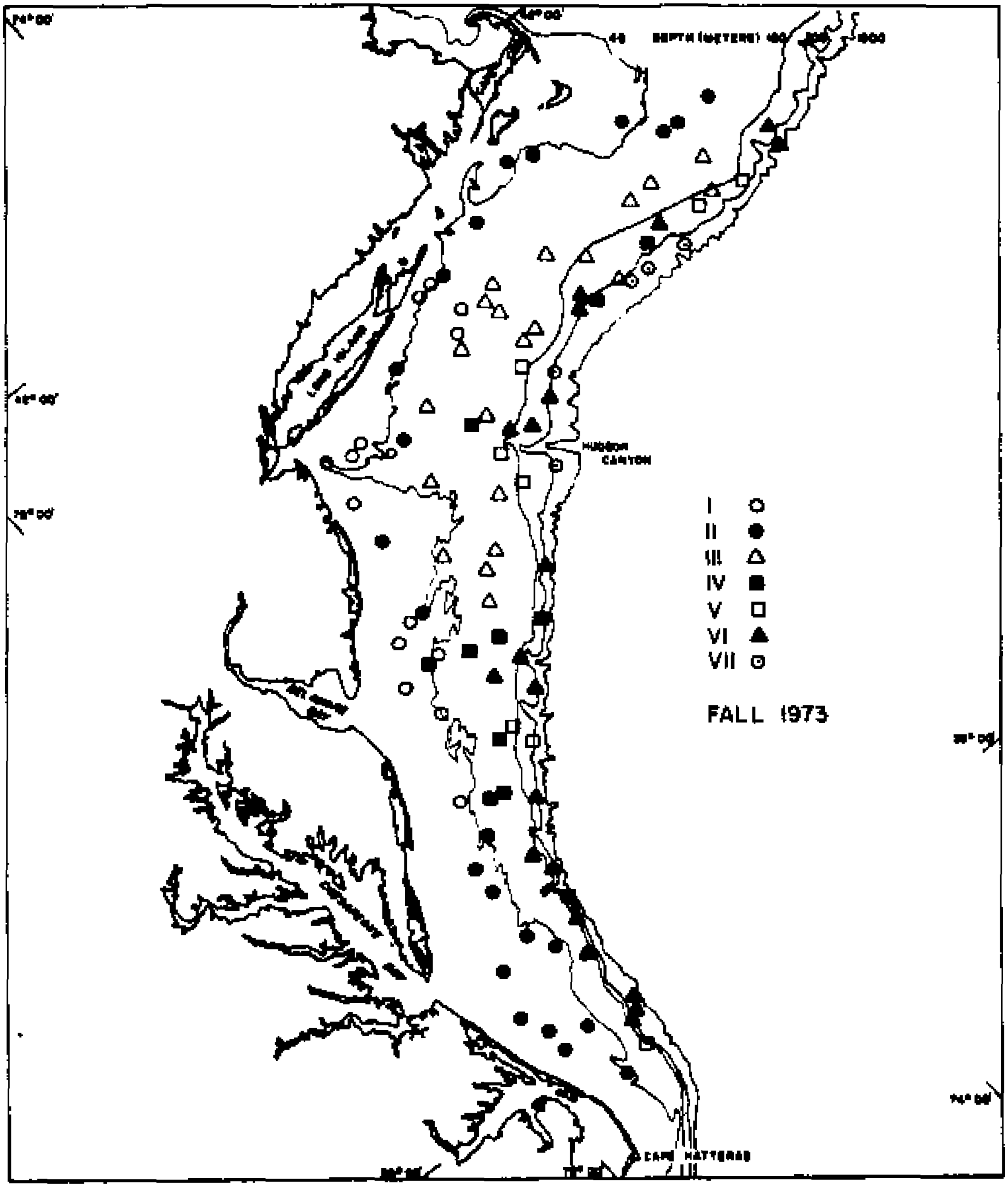

HUDSON
CANYON
I
II
III
IV
V
VI
FALL 1969
CAPE HATTERAS

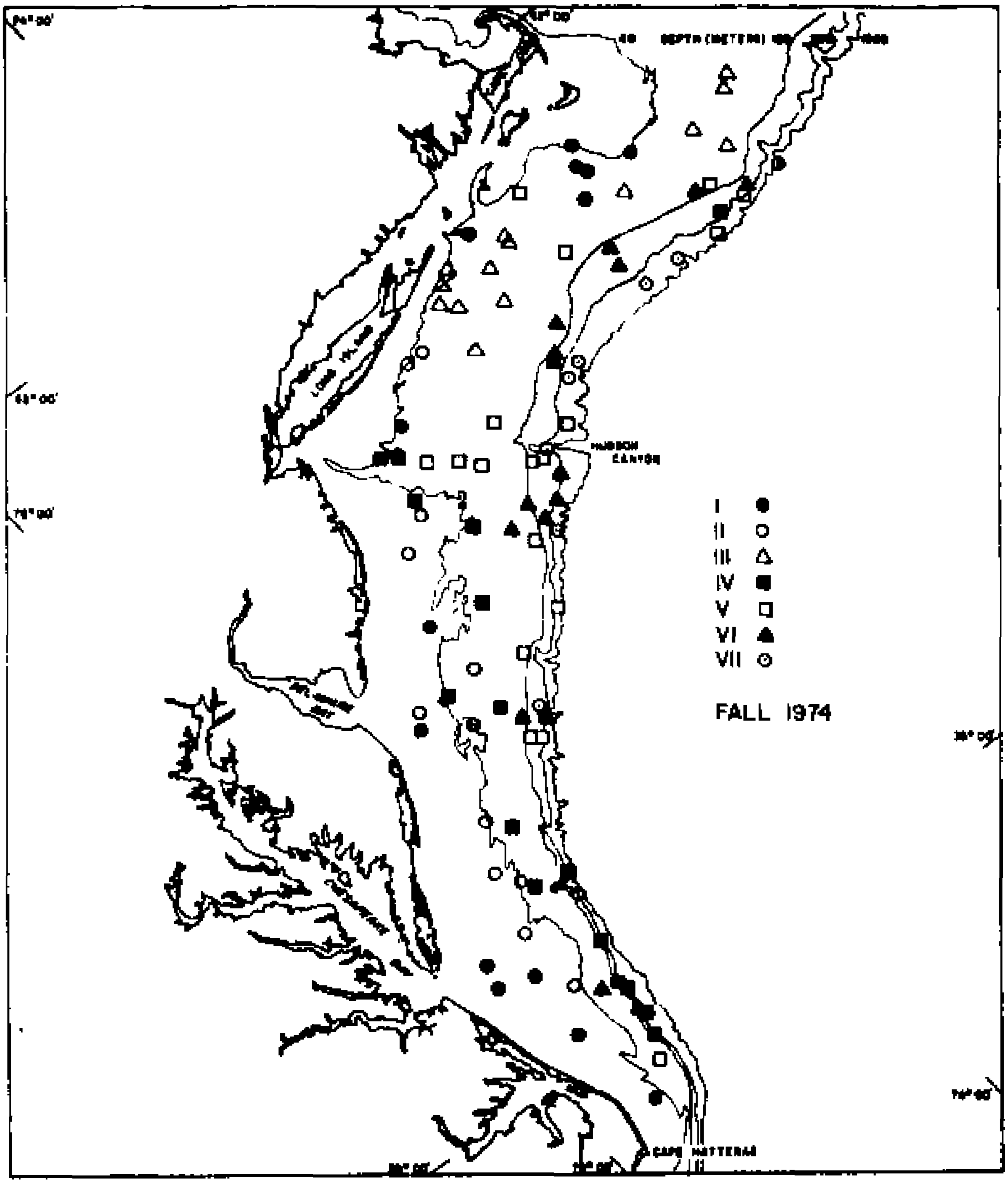

HUDSON CANYON
I
II
III
IV
V
VI
VII
VIII
IX
FALL 1970
CAPE HATTERAS

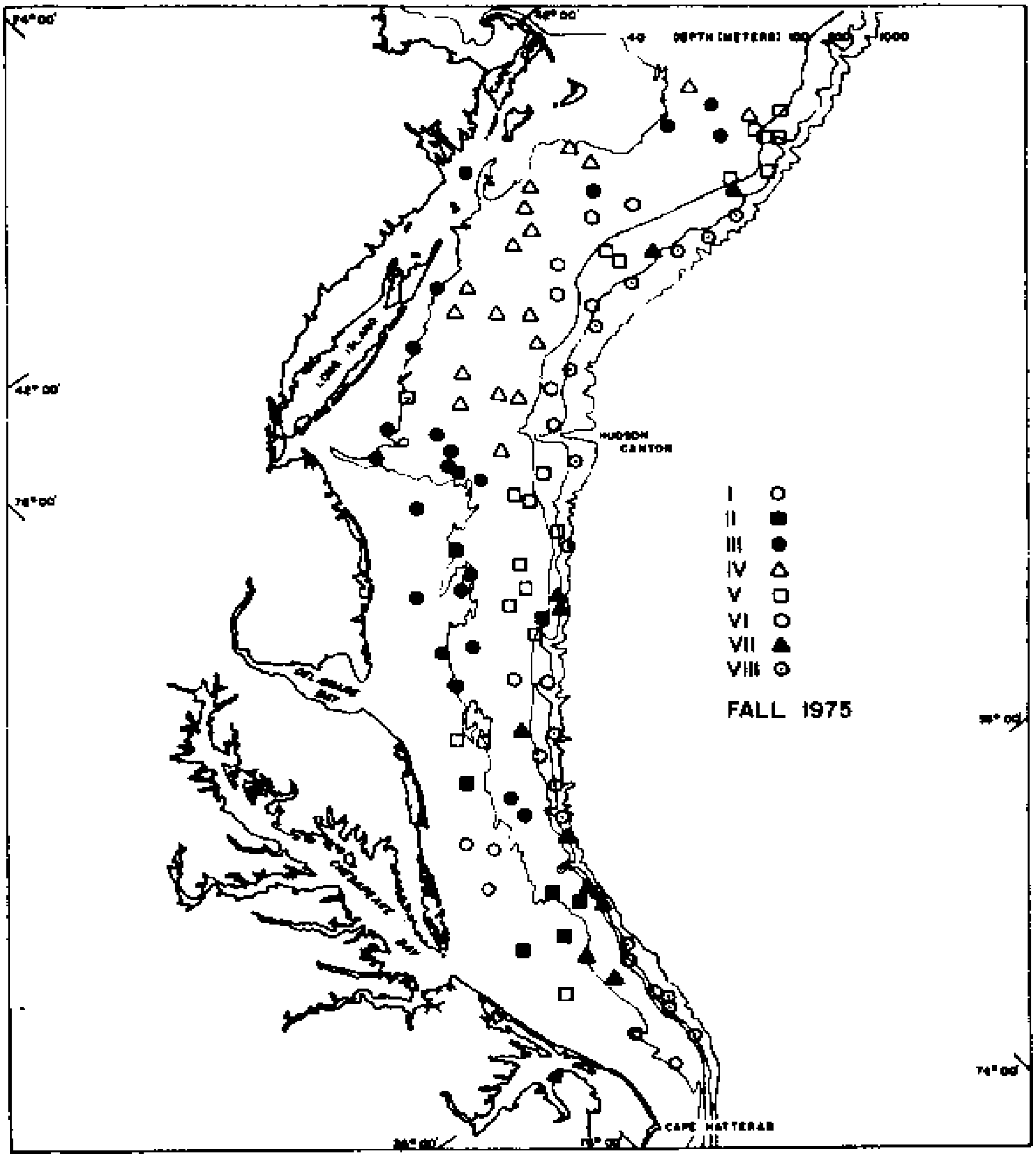


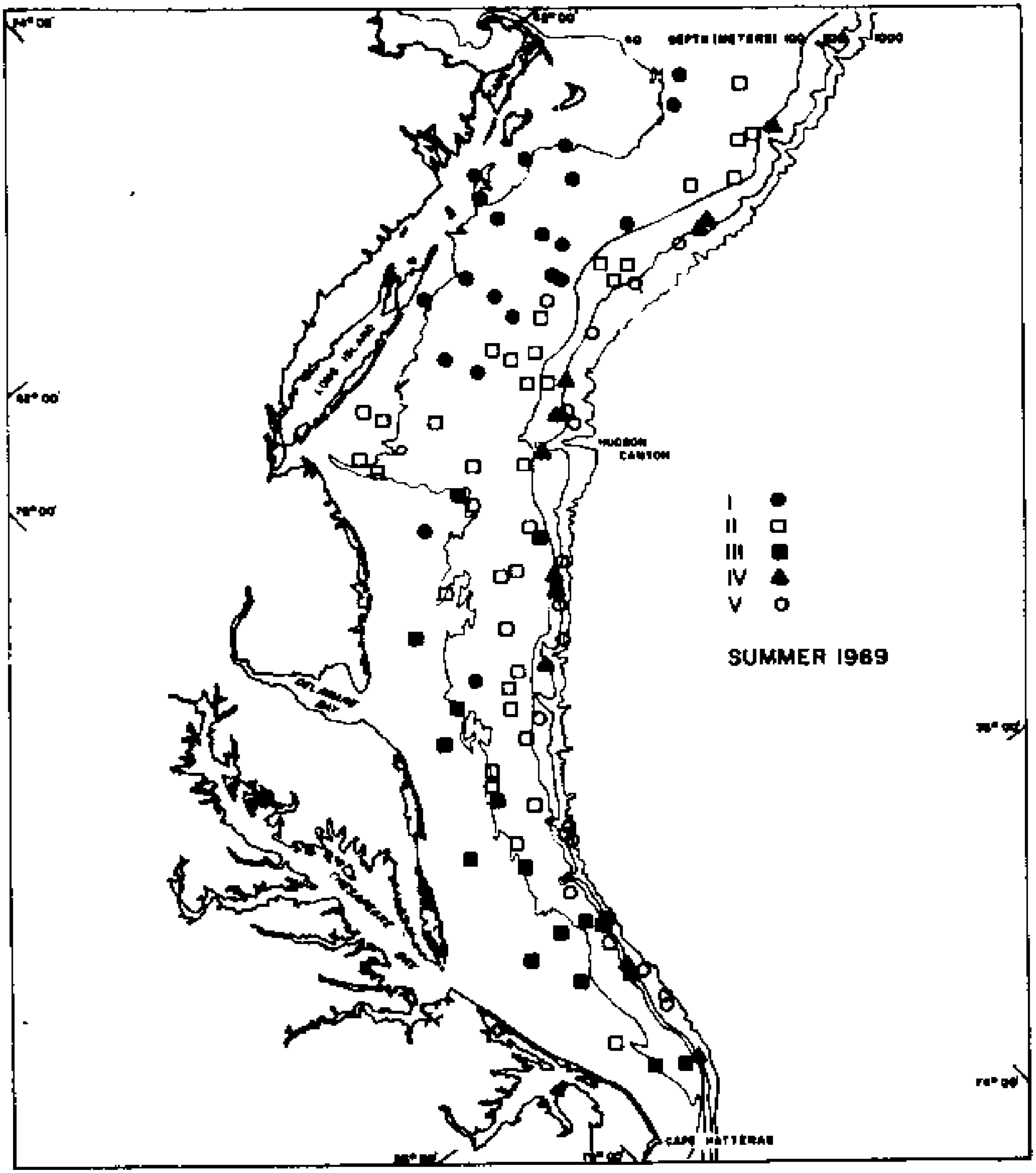
DEPTH (METERS)
HUDSON CANYON
I
II
III
IV
V
VI
FALL 1971
CAPE HATTERAS


DEPTH (METERS)
HUDSON CANYON
CAPE HATTERAS
I
II
III
IV
V
VI
FALL 1972


DEPTH (METERS)
LONG ISLAND
HUDSON CANYON
I
II
III
IV
V
VI
VII
FALL 1973
CAPE HATTERAS


HUDSON CANYON
CAPE HATTERAS
I
II
III
IV
V
VI
VII
FALL 1974


HUDSON
CANYON
I ○
II ■
III ●
IV △
V □
VI ○
VII ▲
VIII ⊙
FALL 1975
CAPE HATTERAS



HUDSON CANYON
I ●
II □
III ■
IV ▲
V ○
SUMMER 1969
CAPE HATTERAS

APPENDIX C

Species groups identified for NMFS Groundfish Survey Cruises,

Fall 1967 - Spring 1976.

Table C-1. Cruise 68-3, Spring 1968.*

A	B	C
Raja erinacea Bo	Squalus acanthias Bo	Paralichthys dentatus WT
Myoxocephalus octodecemspinosus Bo	Merluccius bilinearis Bo	Centropristis striata WT
Limanda ferruginea Bo	Alosa pseudoharengus Bo	Prionotus carolinus WT
Macrozoarces americanus Bo	Alosa aestivalis WT	Stenotomus chrysops WT
Gadus morhua Bo	Scomber scombrus Bo	Urophycis regius WT
Scophthalmus aquosus OS	Clupea harengus harengus Bo	
Pseudopleuronectes americanus Bo		
Raja ocellata Bo		
Hemitripterus americanus Bo		
Hippoglossoides platessoides Bo		
Menidia menidia WT		
D	**E**	**F**
Urophycis chuss Bo	Peristedion miniatum Bo	Helicolenus dactylopterus Sl
Hippoglossina oblonga OS	Lepophidium cervinum OS	Myctophidae Mp
Peprilus triacanthus WT		Anguilliformes
Urophycis tenuis Bo		
Lophius americanus Bo		
Citharichthys arctifrons Sl		
Alosa sapidissima Bo		

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

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

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

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

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

A	B	C
Gadus morhua Bo	Hemitripterus americanus Bo	Raja erinacea Bo
Pseudopleuronectes americanus Bo	Scophthalmus aquosus IS	Myoxocephalus octodecemspinosus Bo
	Hippoglossoides platessoides Bo	Clupea harengus harengus Bo
		Limanda ferruginea Bo
		Macrozoarces americanus Bo
D	**E**	**F**
Merluccius bilinearis Bo	Stenotomus chrysops WT	Lepophidium cervinum OS
Urophycis chuss Bo	Peprilus triacanthus WT	Citharichthys arctifrons Sl
Squalus acanthias Bo	Prionotus carolinus WT	Urophycis tenuis Bo-Sl
Scomber scombrus Bo		Glyptocephalus cynoglossus Bo-Sl
Hippoglossina oblonga OS		Lophius americanus Bo
Alosa pseudoharengus Bo		
G	**H**	
Centropristis striata WT	Myctophidae Mp	
Prionotus evolans WT	Chloropthalmus agassizi Sl	
Urophycis regius WT	Helicolenus dactylopterus Sl	
	Merluccius albidus Sl	

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

Table C-4. Cruise 71-1, Spring 1971.*

A	B	C
Clupea harengus harengus Bo	Gadus morhua Bo	Raja erinacea Bo
Alosa aestivalis WT	Pseudopleuronectes americanus Bo	Limanda ferruginea Bo
	Raja ocellata Bo	Macrozoarces americanus Bo
	Hemitripterus americanus Bo	Myoxocephalus octodecemspinosus Bo
	Hippoglossoides platessoides Bo	Scophthalmus aquosus IS

D	E	F
Squalus acanthias Bo	Squatina dumerili WT	Urophycis regius WT
Merluccius bilinearis Bo	Centropristis striata WT	Paralichthys dentatus WT
Urophycis chuss Bo		Stenotomus chrysops WT
Alosa pseudoharengus Bo		Scomber scombrus Bo
		Peprilus triacanthus WT
		Prionotus carolinus WT
		Hippoglossina oblonga OS
		Citharichthys arctifrons Sl

G	H
Urophycis tenuis Bo-Sl	Lepophidium cervinum OS
Lophius americanus Bo	Nemichthys scolopaceus Mp
Merluccius albidus Sl	Stomiatoidei Mp
Myctophidae Mp	
Glyptocephalus cynoglossus Bo-Sl	
Helicolenus dactylopterus Sl	
Phycis chesteri Sl	

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

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

A	B	C
Alosa aestivalis WT	Limanda ferruginea Bo	Hemitripterus americanus Bo
Clupea harengus harengus Bo	Macrozoarces americanus Bo	Gadus morhua Bo
Pseudopleuronectes americanus Bo	Raja erinacea Bo	
Menidia menidia WT	Scophthalmus aquosus IS	
	Myoxocephalus octodecemspinosus Bo	
	Raja ocellata Bo	
D	**E**	**F**
Lophius americanus Bo	Squalus acanthias Bo	Prionotus carolinus WT
Citharichthys arctifrons Sl	Merluccius bilinearis Bo	Peprilus triacanthus WT
	Hippoglossina oblonga OS	
	Urophycis chuss Bo	
G	**H**	**I**
Alosa pseudoharengus Bo	Urophycis regius WT	Phycis chesteri Sl
Scomber scombrus Bo	Paralichthys dentatus WT	Myctophidae Mp
	Stenotomus chrysops WT	Helicolenus dactylopterus Sl
	Centropristis striata WT	Urophycis tenuis Bo-Sl
	Prionotus evolans WT	Merluccius albidus Sl
		Glyptocephalus cynoglossus Bo-Sl

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

Table C-6. Cruise 73-3, Spring 1973.*

A	B	C
Myoxocephalus octodecemspinosus Bo	Raja erinacea Bo	Alosa sapidissima Bo
Macrozoarces americanus Bo	Alosa pseudoharengus Bo	Scomber scombrus Bo
Clupea harengus harengus Bo	Limanda ferruginea Bo	Glyptocephalus cynoglossus Bo-Sl
Gadus morhua Bo	Scophthalmus aquosus IS	
Pseudopleuronectes americanus Bo		
Hemitripterus americanus Bo		
Alosa aestivalis WT		
Ammodytes dubius Bo		
D	**E**	**F**
Merluccius bilinearis Bo	Paralichthys dentatus WT	Peprilus triacanthus WT
Urophycis chuss Bo	Urophycis regius WT	Prionotus carolinus WT
Lophius americanus Bo		Citharichthys arctifrons Sl
Squalus acanthias Bo		
Hippoglossina oblonga OS		
G	**H**	**I**
Stenotomus chrysops WT	Lepophidium cervinum OS	Merluccius albidus Sl
Centropristis striata WT	Peristedion miniatum Bo	Helicolenus dactylopterus Sl
Prionotus evolans WT		Urophycis tenuis Bo-Sl

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

Table C-7. Cruise 74-4, Spring 1974.*

A	B	C
Myoxocephalus octodecemspinosus Bo	*Raja erinacea* Bo	*Urophycis chuss* Bo
Pseudopleuronectes americanus Bo	*Limanda ferruginea* Bo	*Lophius americanus* Bo
Alosa aestivalis WT	*Scophthalmus aquosus* IS	*Squalus acanthias* Bo
Clupea harengus harengus Bo	*Alosa pseudoharengus* Bo	*Merluccius bilinearis* Bo
Raja ocellata Bo	*Macrozoarces americanus* Bo	*Hippoglossina oblonga* OS
Gadus morhua Bo		*Scomber scombrus* Bo
Ammodytes dubius Bo		
Hemitripterus americanus Bo		
D	**E**	**F**
Peprilus triacanthus WT	*Urophycis regius* WT	*Citharichthys arctifrons* Sl
Paralichthys dentatus WT	*Prionotus evolans* WT	*Lepophidium cervinum* OS
Stenotomus chrysops WT	*Mustelus canis* WT	*Peristedion miniatum* Bo
Prionotus carolinus WT		
Centropristis striata WT		
	G	**H**
	Glyptocephalus cynoglossus Bo-Sl	*Maurolicus muelleri* Mp
	Urophycis tenuis Bo-Sl	Ephippidae
	Chloropthalmus agassizi Sl	*Ventrifossa occidentalis* Sl
	Merluccius albidus Sl	*Ceratoscopelus maderensis* Mp
	Helicolenus dactylopterus Sl	
	Myctophidae Mp	

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

Table C-8. Cruise 75-3, Spring 1975.*

A

Alosa aestivalis WT
Etropus microstomus IS
Ammodytes dubius Bo

B

Myoxocephalus octodecemspinosus Bo
Raja ocellata Bo
Gadus morhua Bo
Clupea harengus harengus Bo
Pseudopleuronectes americanus Bo

C

Scophthalmus aquosus IS
Limanda ferruginea Bo
Macrozoarces americanus Bo
Alosa pseudoharengus Bo
Raja erinacea Bo

D

Urophycis tenuis Bo-Sl
Alosa sapidissima Bo

E

Centropristis striata WT
Stenotomus chrysops WT
Priontotus evolans WT

F

Squalus acanthias Bo
Merluccius bilinearis Bo
Urophycis chuss Bo
Hippoglossina oblonga OS
Lophius americanus Bo
Citharichthys arctifrons Sl
Scomber scombrus Bo
Peprilus triacanthus WT
Paralichthys dentatus WT
Prionotus carolinus WT

G

Lopholatilus chamaeleonticeps WT
Conger oceanicus Bo-Sl
Raja garmani Sl
Chloropthalmus agassizi Sl
Merluccius albidus Sl
Myctophidae Mp
Peristedion miniatum Bo
Helicolenus dactylopterus Sl
Lepophidium cervinum OS
Glyptocephalus cynoglossus Bo-Sl
Maurolicus muelleri Mp
Argyropelecus aculeatus Mp
Urophycis regius WT
Nemichthys scolopaceus Mp

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

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

A	B	C
Clupea harengus harengus Bo	Gadus morhua Bo	Raja erinacea Bo
Pseudopleuronectes americanus Bo	Myoxocephalus octodecemspinosus Bo	Scophthalmus aquosus IS
Alosa aestivalis WT	Pollachius virens Bo	Limanda ferruginea Bo
Hemitripterus americanus Bo		Macrozoarces americanus Bo
Ammodytes dubius Bo		Alosa pseudoharengus Bo
Etropus microstomus IS		
Scomber scombrus Bo		

D	E	F
Merluccius bilinearis Bo	Urophycis regius WT	Myctophidae Mp
Squalus acanthias Bo	Centropristis striata WT	Merluccius albidus Sl
Hippoglossina oblonga OS	Stenotomus chrysops WT	Helicolenus dactylopterus Sl
Lophius americanus Bo	Peprilus triacanthus WT	Chloropthalmus agassizi Sl
Urophycis chuss Bo	Paralichthys dentatus WT	Lepophidium cervinum OS
Citharichthys arctifrons Sl	Prionotus carolinus WT	Peristedion miniatum Bo
		Maurolicus muelleri Mp
		Polymixia lowei Sl
		Glyptocephalus cynoglossus Bo-Sl
		Urophycis tenuis Bo-Sl
		Cynoglossidae

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

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

A	B	C
Mustelus canis WT	Prionotus carolinus WT	Gadus morhua Bo
Paralichthys dentatus WT	Scophthalmus aquosus IS	Pollachius virens Bo
Stephanolepis hispidus WT	Pseudopleuronectes americanus Bo	
Centropristis striata WT	Stenotomus chrysops WT	
D	**E**	**F**
Alosa pseudoharengus Bo	Raja erinacea Bo	Squalus acanthias Bo
Clupea harengus harengus Bo	Myoxocephalus octodecemspinosus Bo	Limanda ferrugina Bo
Alosa aestivalis WT	Macrozoarces americanus Bo	
Hippoglossoides platessoides Bo		
G	**H**	**I**
Lophius americanus Bo	Merluccius bilinearis Bo	Citharichthys arctifrons Sl
Urophycis tenuis Bo-Sl	Peprilus triacanthus WT	Lepophidium cervinum OS
	Hippoglossina oblonga OS	Urophycis regius WT
	Urophycis chuss Bo	Peristedion miniatum Bo
J	**K**	
Zenopsis ocellata Sl	Helicolenus dactylopterus Sl	
Raja garmani Sl	Merluccius albidus Sl	
Myctophidae Mp	Maurolicus muelleri Mp	
	Chloropthalmus agassizi Sl	

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

Table C-11. Cruise 68-17, Fall 1968.*

A	B	C
Paralichthys dentatus WT	Prionotus carolinus WT	Macrozoarces americanus Bo
Centropristis striata WT	Scophthalmus aquosus IS	Myoxocephalus octodecemspinosus Bo
Stenotomus chrysops WT	Pseudopleuronectes americanus Bo	Raja ocellata Bo
Decapterus macarellus WT	Mustelus canis WT	Raja erinacea Bo
		Hemitripterus americanus Bo
D	**E**	**F**
Squalus acanthias Bo	Glyptocephalus cynoglossus Bo-S1	Lepophidium cervinum OS
Limanda ferruginea Bo	Hippoglossoides platessoides Bo	Citharichthys arctifrons S1
Merluccius bilinearis Bo	Lophius americanus Bo	Urophycis regius WT
Peprilus triacanthus WT	Urophycis tenuis Bo-S1	
Urophycis chuss Bo	Clupea harengus harengus Bo	
Hippoglossina oblonga OS		
	G	
	Myctophidae Mp	
	Helicolenus dactylopterus S1	
	Merluccius albidus S1	
	Chloropthalmus agassizi 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-12. Cruise 69-11, Fall 1969.*

A	B	C
Squatina dumerili WT	Centropristis striata WT	Raja erinacea Bo
Raja eglanteria WT	Paralichthys dentatus WT	Pseudopleuronectes americanus Bo
	Stephanolepis hispidus WT	Scophthalmus aquosus IS
	Decapterus macarellus WT	Prionotus carolinus WT
	Mustelus canis WT	Stenotomus chrysops WT
	Prionotus evolans WT	Peprilus triacanthus WT
D	**E**	**F**
Squalus acanthias Bo	Macrozoarces americanus Bo	Lophius americanus Bo
Limanda ferruginea Bo	Hemitripterus americanus Bo	Urophycis tenuis Bo-Sl
Myoxocephalus octodecemspinosus Bo		Glyptocephalus cynoglossus Bo-Sl
Hippoglossina oblonga OS		
Urophycis chuss Bo		
Merluccius bilinearis Bo		
	G	**H**
	Citharichthys arctifrons Sl	Chloropthalmus agassizi Sl
	Lepophidium cervinum OS	Merluccius albidus Sl
	Urophycis regius WT	Myctophidae Mp
		Helicolenus dactylopterus Sl

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

Table C-13. Cruise 70-6, Fall 1970.*

A	B	C
Prionotus carolinus WT	Melanogrammus aeglefinus Bo	Squalus acanthias Bo
Stenotomus chrysops WT	Hemitripterus americanus Bo	Limanda ferruginea Bo
Paralichthys dentatus WT	Alosa sapidissima Bo	Myoxocephalus octodecemspinosus Bo
Prionotus evolans WT	Alosa pseudoharengus Bo	Pseudopleuronectes americanus Bo
Centropristis striata WT	Etrumeus teres WT	Peprilus triacanthus WT
		Raja ocellata Bo
		Scophthalmus aquosus IS
		Raja erinacea Bo
D	**E**	**F**
Urophycis chuss Bo	Lophius americanus Bo	Urophycis regius WT
Merluccius bilinearis Bo	Urophycis tenuis Bo-Sl	Lepophidium cervinum OS
Hippoglossina oblonga OS	Macrozoarces americanus Bo	Peristedion miniatum Bo
Citharichthys arctifrons Sl	Glyptocephalus cynoglossus Bo-Sl	Zenopsis ocellata Sl
	G	
	Myctophidae Mp	
	Merluccius albidus Sl	
	Chloropthalmus agassizi Sl	
	Helicolenus dactylopterus Sl	

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

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

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

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

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

A	B	C
Centropristis striata WT	Stenotomus chrysops WT	Mustelus canis WT
Raja eglanteria WT	Pseudopleuronectes americanus Bo	Raja ocellata Bo
Paralichthys dentatus WT	Prionotus carolinus WT	Pomatomus saltatrix WT
Dasyatis centroura WT	Scophthalmus aquosus IS	Etrumeus teres WT
D	**E**	**F**
Merluccius bilinearis Bo	Raja erinacea Bo	Hemitripterus americanus Bo
Citharichthys arctifrons Sl	Limanda ferruginea Bo	Glyptocephalus cynoglossus Bo-Sl
Lophius americanus Bo	Myoxocephalus octodecemspinosus Bo	Macrozoarces americanus Bo
Hippoglossina oblongus Bo	Squalus acanthias Bo	Ophichthus cruentifer OS
Urophycis chuss Bo		Urophycis tenuis Bo-Sl
Urophycis regius WT		Enchelyopus cimbrius Sl
Peprilus triacanthus WT		
Lepophidium cervinum OS		
	G	**H**
	Raja garmani Sl	Merluccius albidus Sl
	Peristedion miniatum Bo	Helicolenus dactylopterus Sl
	Scomber scombrus Bo	Myctophidae Mp
		Chloropthalmus agassizi Sl
		Argentina silus Sl
		Stomiatoidei Mp
		Nezumia bairdii Sl

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

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

A	B	C
Prionotus carolinus WT	Mustelus canis WT	Squalus acanthias Bo
Scophthalmus aquosus IS	Raja erinacea Bo	Raja ocellata Bo
Paralichthys dentatus WT	Pseudopleuronectes americanus Bo	
Pomatomus saltatrix WT	Stenotomus chrysops WT	
Raja eglanteria WT	Limanda ferruginea Bo	

D	E
Merluccius bilinearis Bo	Helicolenus dactylopterus Sl
Hippoglossina oblonga OS	Merluccius albidus Sl
Citharichthys arctifrons Sl	Myctophidae Mp
Lophius americanus Bo	Peristedion miniatum Bo
Urophycis regius WT	Zenopsis ocellata Sl
Peprilus triacanthus WT	
Lepophidium cervinum OS	
Macrozoarces americanus Bo	
Urophycis chuss Bo	

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

Table C-17. Cruise 74-11, Fall 1974.*

A	B	C
Micropogon undulatus WT	Raja erinacea Bo	Stephanolepis hispidus WT
Squatina dumerili WT	Scophthalmus aquosus IS	Centropristis striata WT
	Pseudopleuronectes americanus Bo	Prionotus carolinus WT
	Squalus acanthias Bo	Stenotomus chrysops WT
	Limanda ferruginea Bo	Paralichthys dentatus WT
	Myoxocephalus octodecemspinosus Bo	Mustelus canis WT
		Pomatomus saltatrix WT
		Etropus microstomus IS
D	**E**	**F**
Urophycis regius WT	Helicolenus dactylopterus Sl	Phycis chesteri Sl
Citharichthys arctifrons Sl	Lophius americanus Bo	Merluccius albidus Sl
Lepophidium cervinum OS	Chloropthalmus agassizi Sl	Macrouridae Sl
Merluccius bilinearis Bo	Peristedion miniatum Bo	
Hippoglossina oblonga OS	Myctophidae Mp	
Peprilus triacanthus WT	Argyropelecus aculeatus Mp	
Urophycis chuss Bo		

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

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

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

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

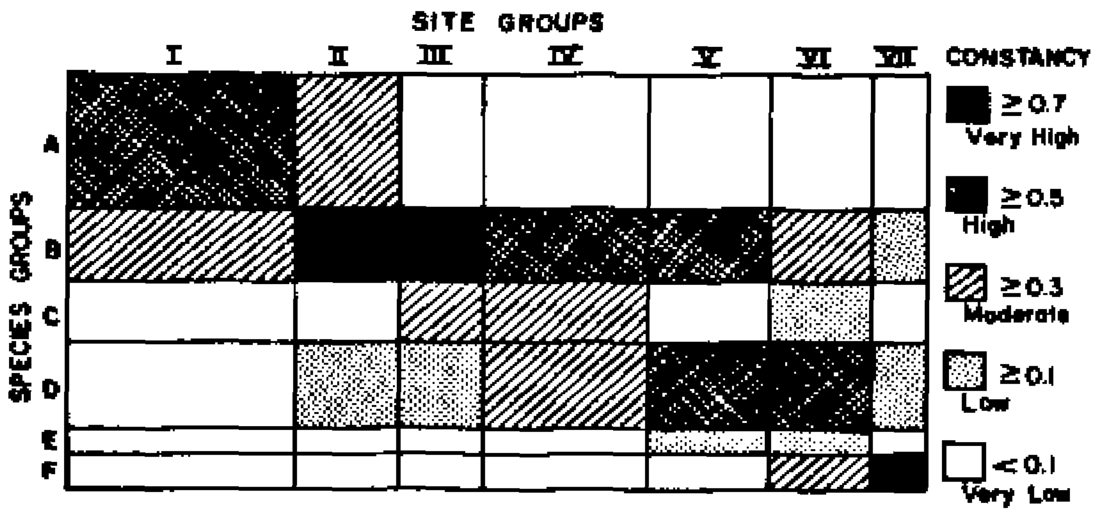
Table C-19. Cruise 69-8, Summer 1969.*

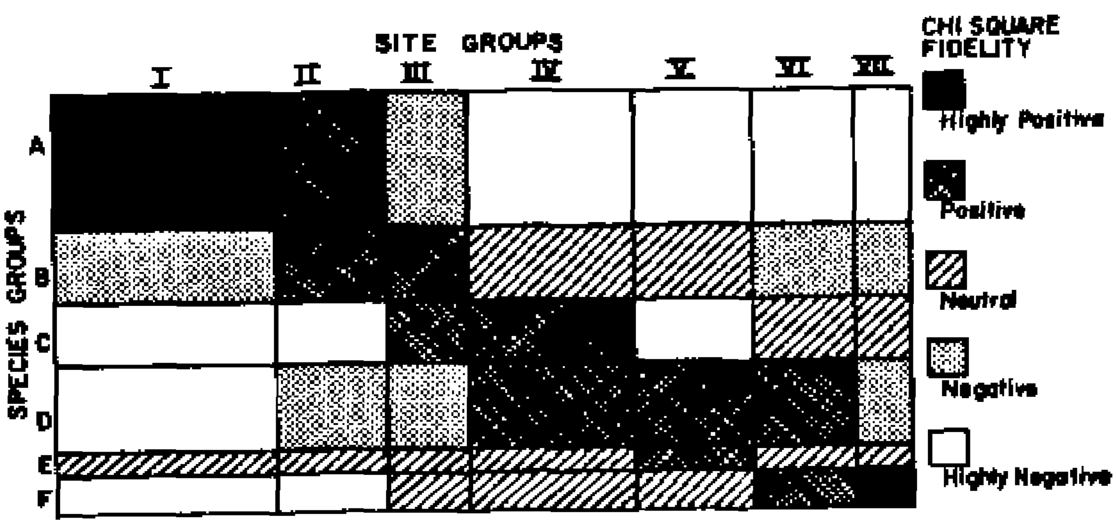
A	B	C
Macrozoarces americanus Bo	Pseudopleuronectes americanus Bo	Alosa pseudoharengus Bo
Gadus morhua Bo	Limanda ferruginea Bo	Alosa sapidissima Bo
Hemitripterus americanus Bo	Raja erinacea Bo	Glyptocephalus cynoglossus Bo-Sl
	Scophthalmus aquosus IS	Hippoglossoides platessoides Bo
		Urophycis tenuis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

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

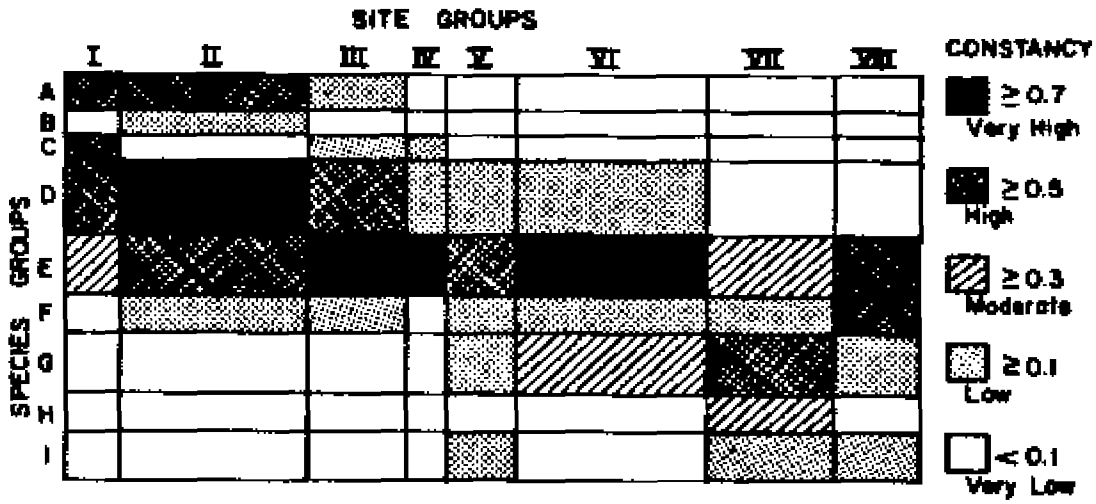
APPENDIX D

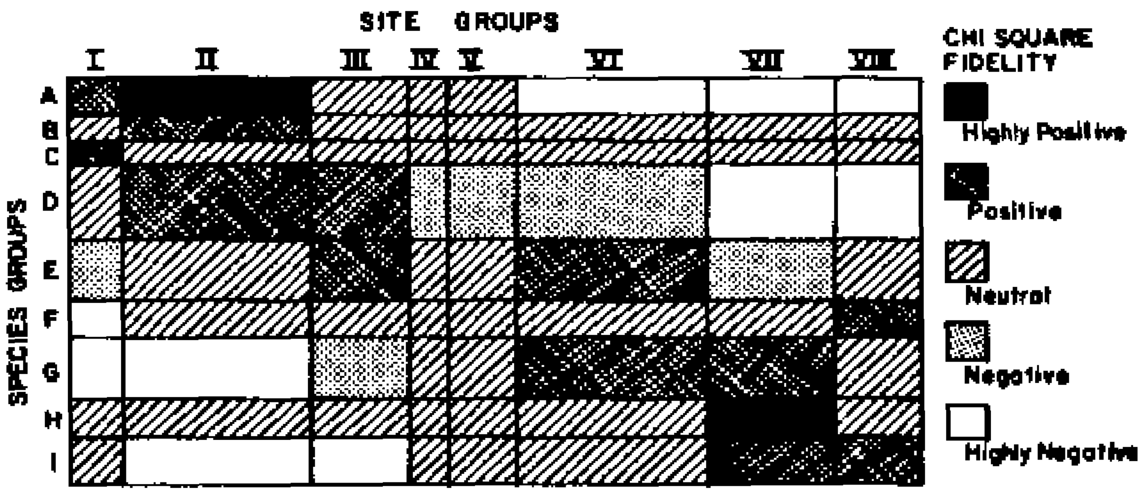
Nodal constancy and fidelity diagrams for NMFS Groundfish Survey Cruises, Fall 1967 - Spring 1976.


SITE GROUPS
I
II
III
IV
V
VI
VII
CONSTANCY
≥ 0.7 Very High
≥ 0.5 High
≥ 0.3 Moderate
≥ 0.1 Low
< 0.1 Very Low
SPECIES GROUPS
A
B
C
D
E
F

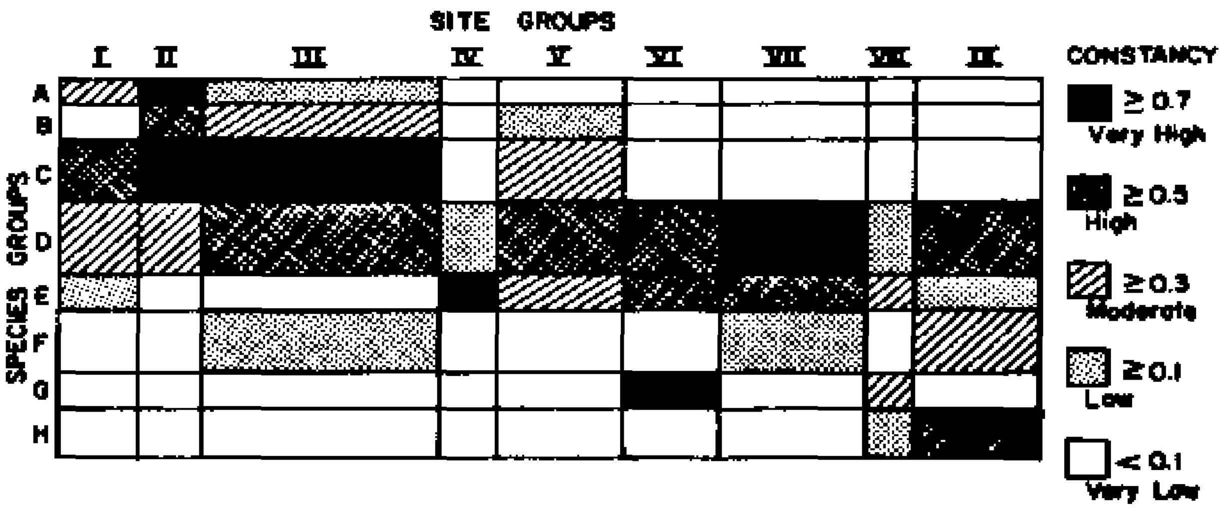

SITE GROUPS
I
II
III
IV
V
VI
VII
CHI SQUARE FIDELITY
Highly Positive
Positive
Neutral
Negative
Highly Negative
SPECIES GROUPS
A
B
C
D
E
F

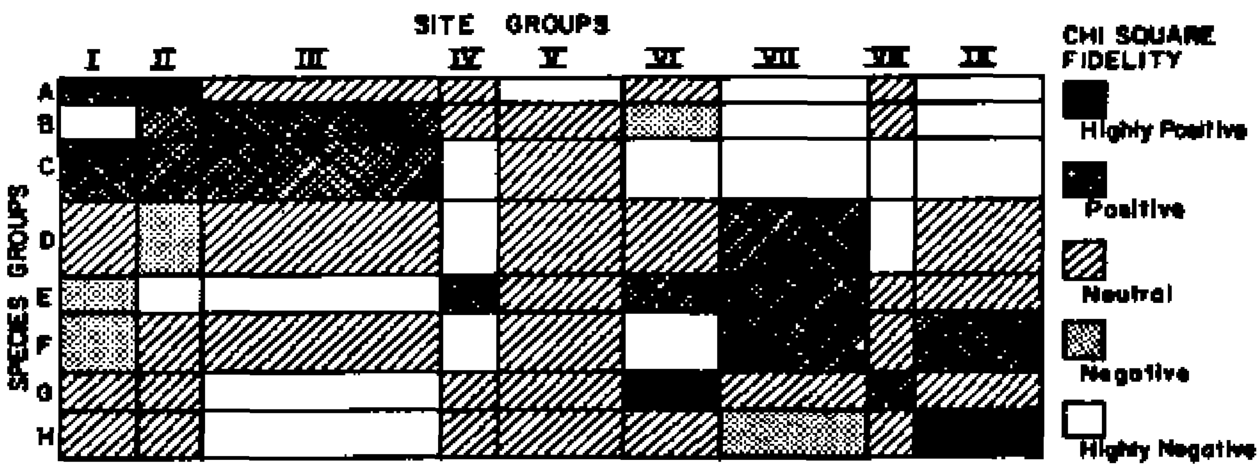
SPRING 1968


SITE GROUPS
I
II
III
IV
V
VI
VII
VIII
A
B
C
D
E
F
G
H
I
SPECIES GROUPS
CONSTANCY
≥ 0.7
Very High
≥ 0.5
High
≥ 0.3
Moderate
≥ 0.1
Low
< 0.1
Very Low

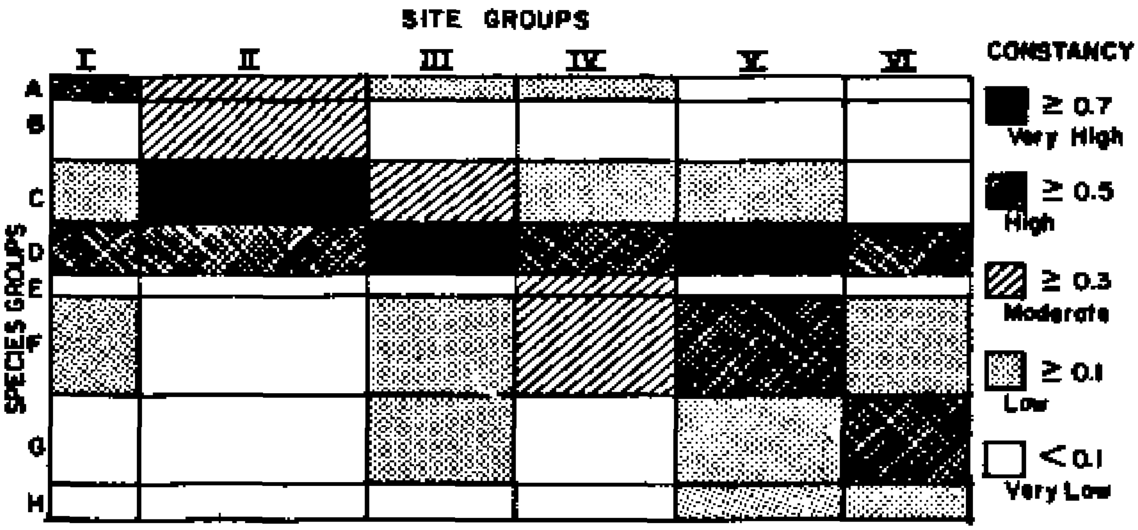

SITE GROUPS
I
II
III
IV
V
VI
VII
VIII
A
B
C
D
E
F
G
H
I
SPECIES GROUPS
CHI SQUARE
FIDELITY
Highly Positive
Positive
Neutral
Negative
Highly Negative

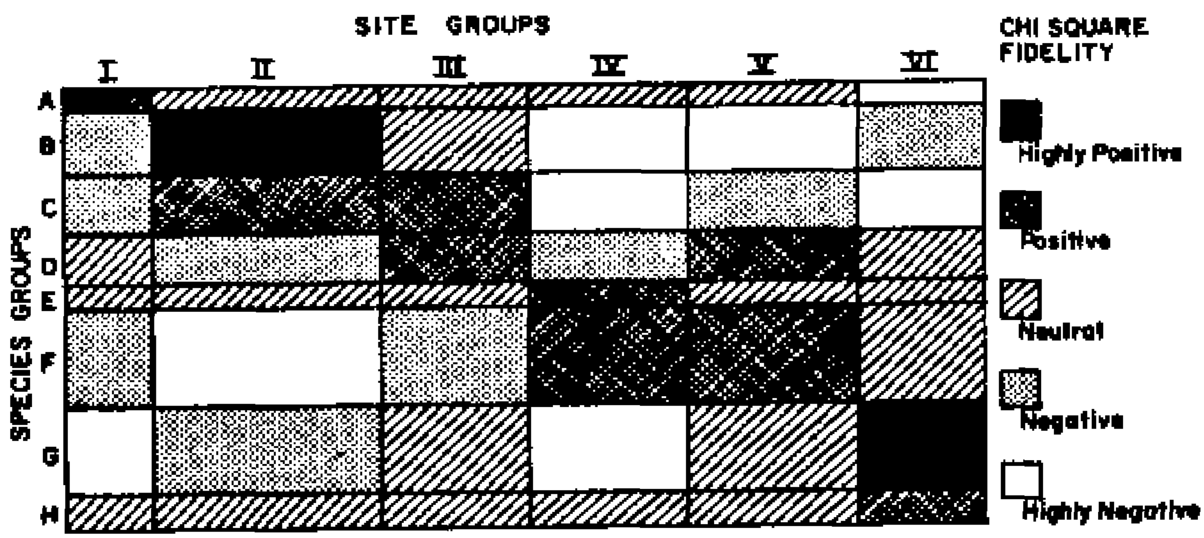
SPRING 1969


SITE GROUPS
I
II
III
IV
V
VI
VII
VIII
IX
SPECIES GROUPS
A
B
C
D
E
F
G
H
CONSTANCY
≥ 0.7 Very High
≥ 0.5 High
≥ 0.3 Moderate
≥ 0.1 Low
< 0.1 Very Low

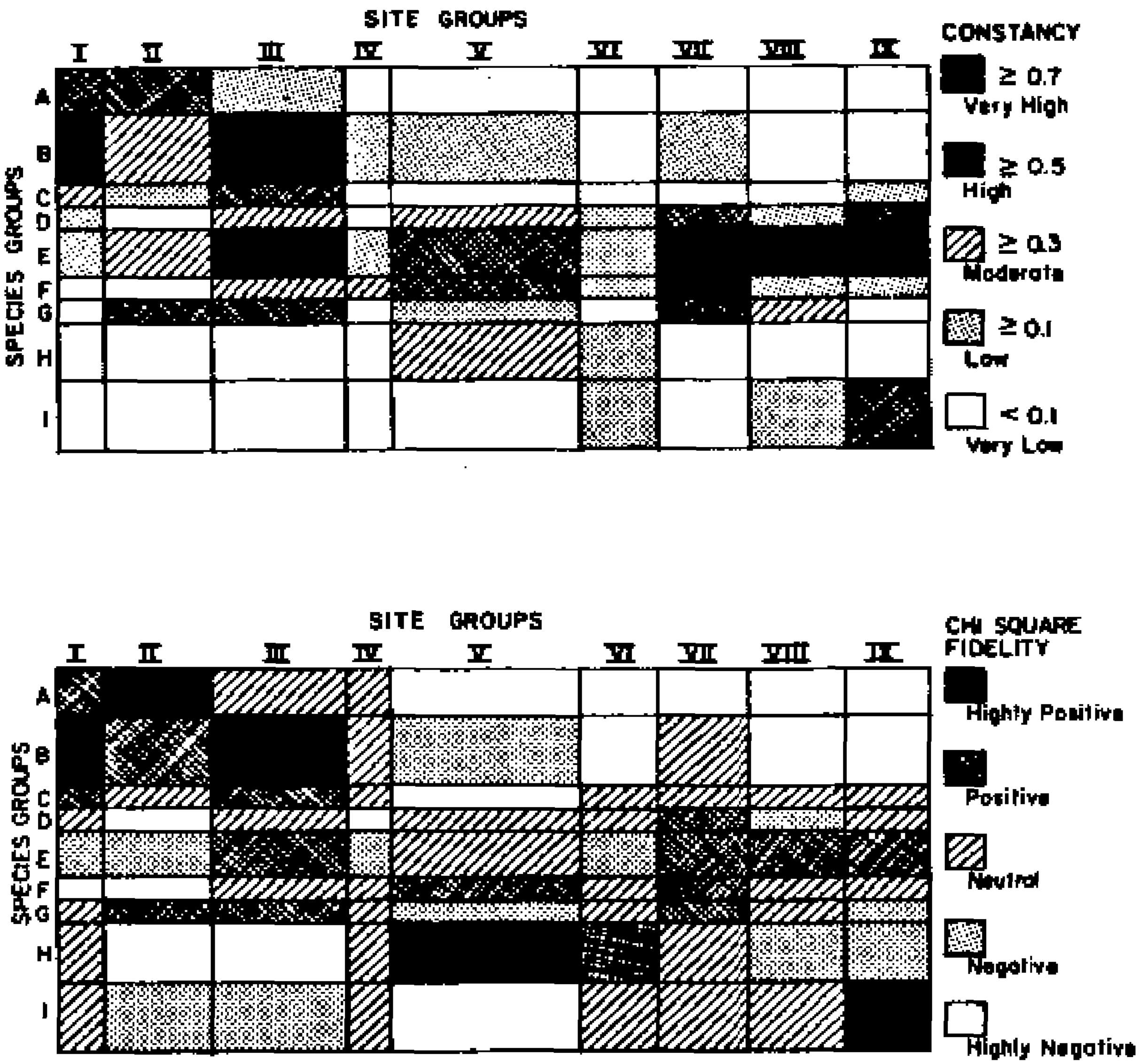

SITE GROUPS
I
II
III
IV
V
VI
VII
VIII
IX
SPECIES GROUPS
A
B
C
D
E
F
G
H
CHI SQUARE FIDELITY
Highly Positive
Positive
Neutral
Negative
Highly Negative

SPRING 1970

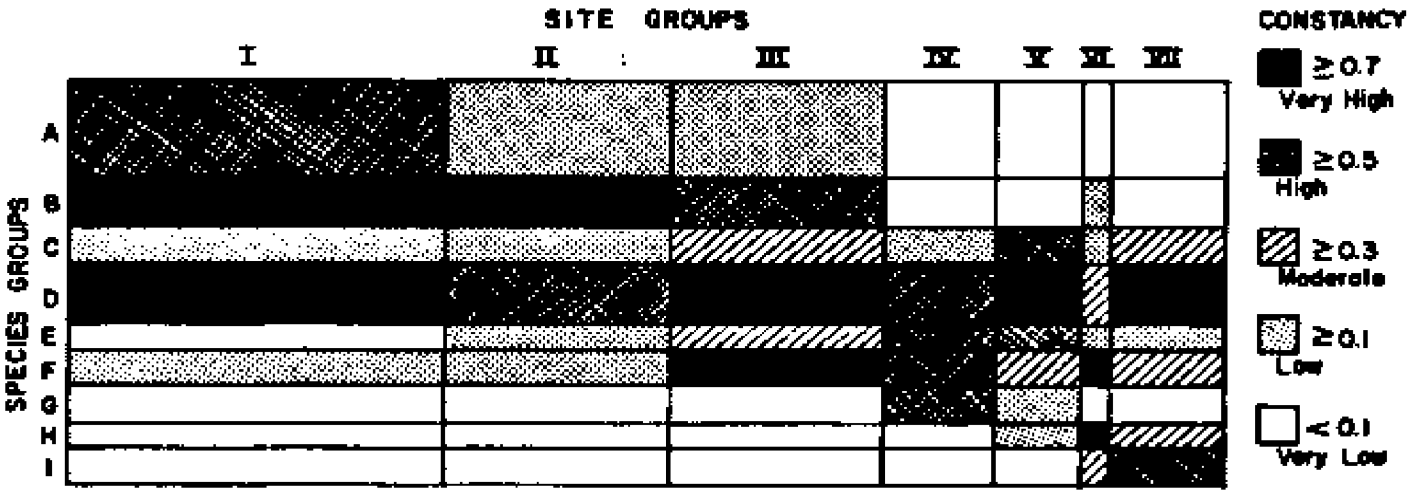

SITE GROUPS
I
II
III
IV
V
VI
A
B
C
D
E
F
G
H
SPECIES GROUPS
CONSTANCY
≥ 0.7
Very High
≥ 0.5
High
≥ 0.3
Moderate
≥ 0.1
Low
< 0.1
Very Low

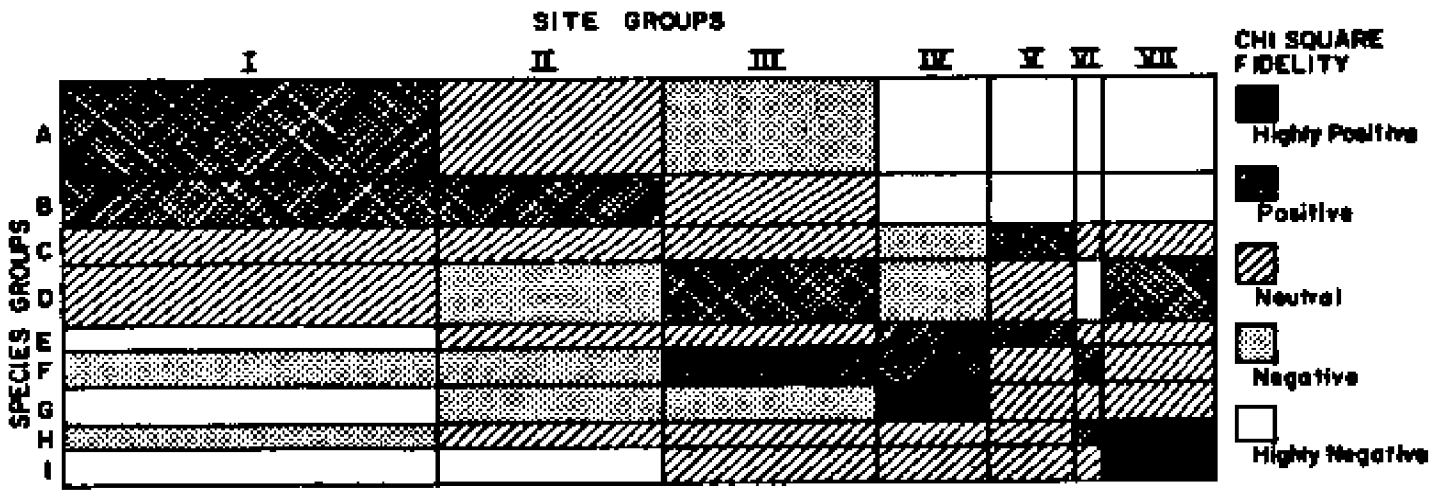

SITE GROUPS
I
II
III
IV
V
VI
A
B
C
D
E
F
G
H
SPECIES GROUPS
CHI SQUARE
FIDELITY
Highly Positive
Positive
Neutral
Negative
Highly Negative

SPRING 1971

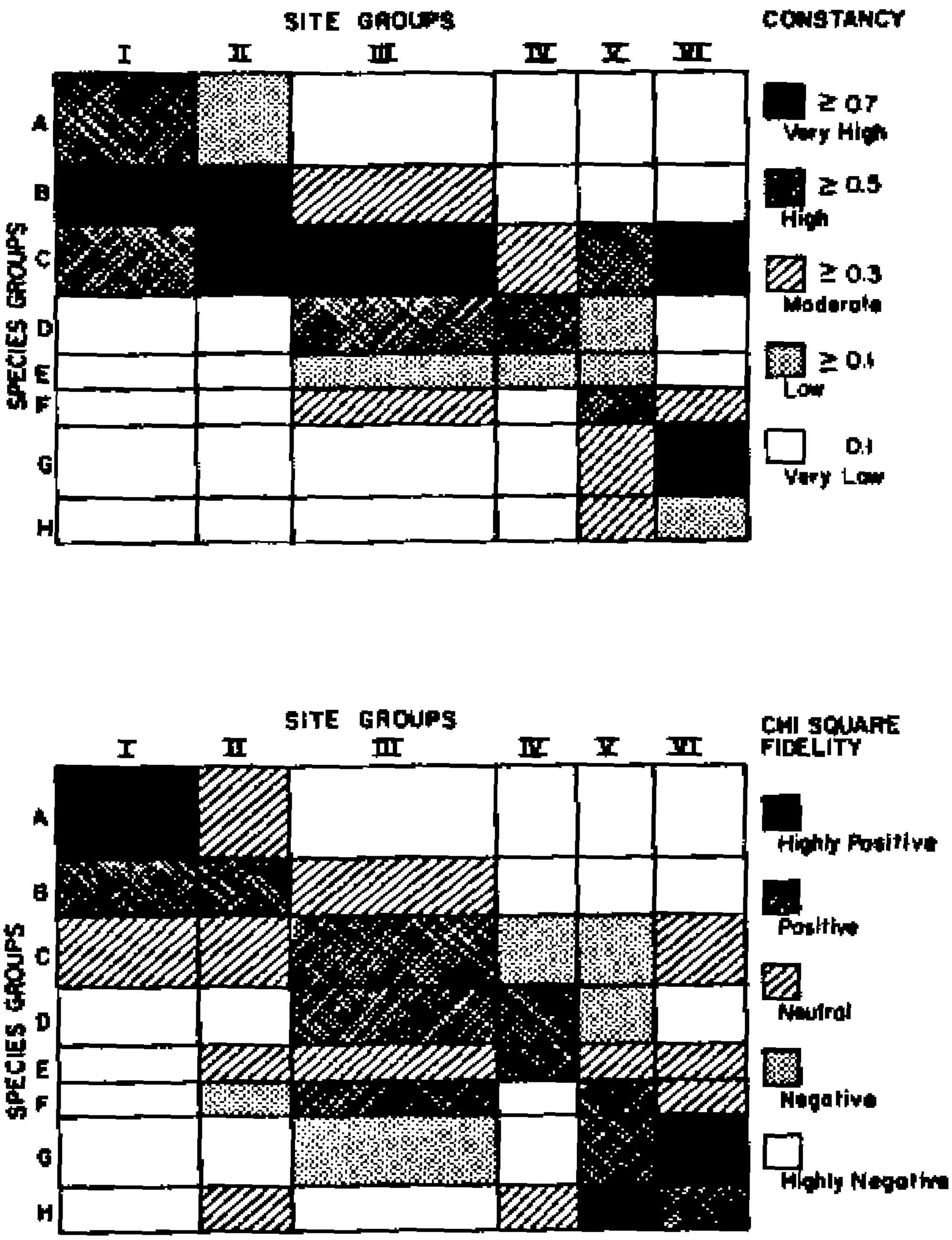

SITE GROUPS
I II III IV V VI VII VIII IX
SPECIES GROUPS
A B C D E F G H I
CONSTANCY
≥ 0.7 Very High
≥ 0.5 High
≥ 0.3 Moderate
≥ 0.1 Low
< 0.1 Very Low
SITE GROUPS
I II III IV V VI VII VIII IX
SPECIES GROUPS
A B C D E F G H I
CHI SQUARE FIDELITY
Highly Positive
Positive
Neutral
Negative
Highly Negative

SPRING 1972

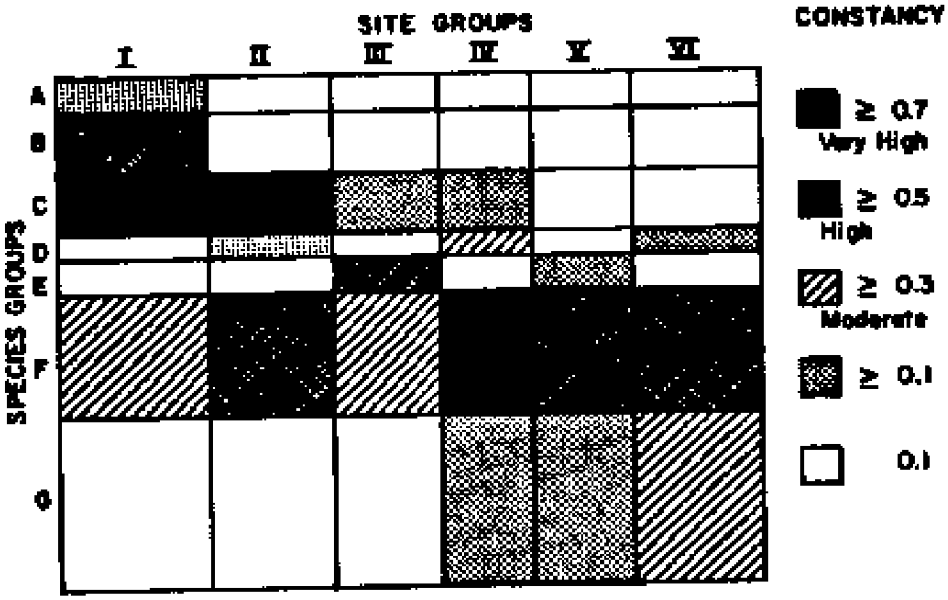

SITE GROUPS
I II III IV V VI VII
SPECIES GROUPS
A B C D E F G H I
CONSTANCY
≥ 0.7 Very High
≥ 0.5 High
≥ 0.3 Moderate
≥ 0.1 Low
< 0.1 Very Low

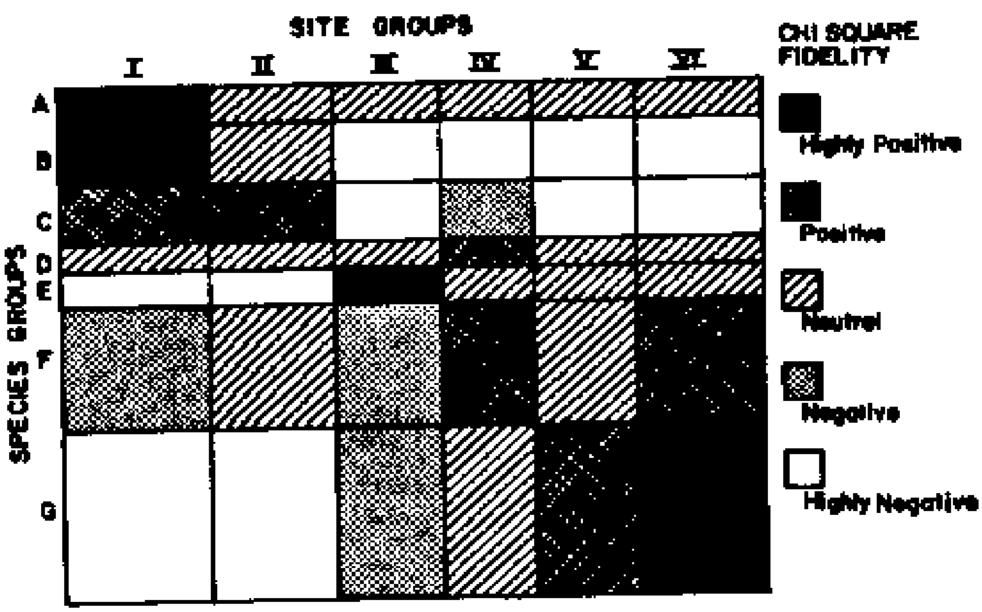

SITE GROUPS
I II III IV V VI VII
SPECIES GROUPS
A B C D E F G H I
CHI SQUARE FIDELITY
Highly Positive
Positive
Neutral
Negative
Highly Negative

SPRING 1973

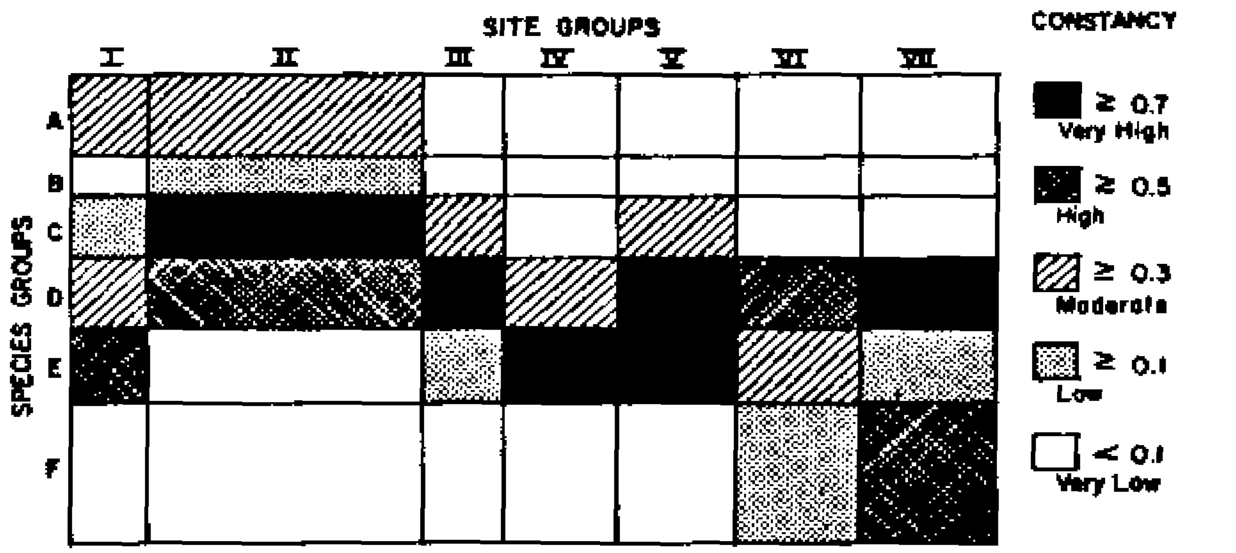

SITE GROUPS
I
II
III
IV
V
VI
CONSTANCY
SPECIES GROUPS
A
B
C
D
E
F
G
H
≥ 0.7
Very High
≥ 0.5
High
≥ 0.3
Moderate
≥ 0.1
Low
0.1
Very Low
SITE GROUPS
CHI SQUARE
FIDELITY
Highly Positive
Positive
Neutral
Negative
Highly Negative

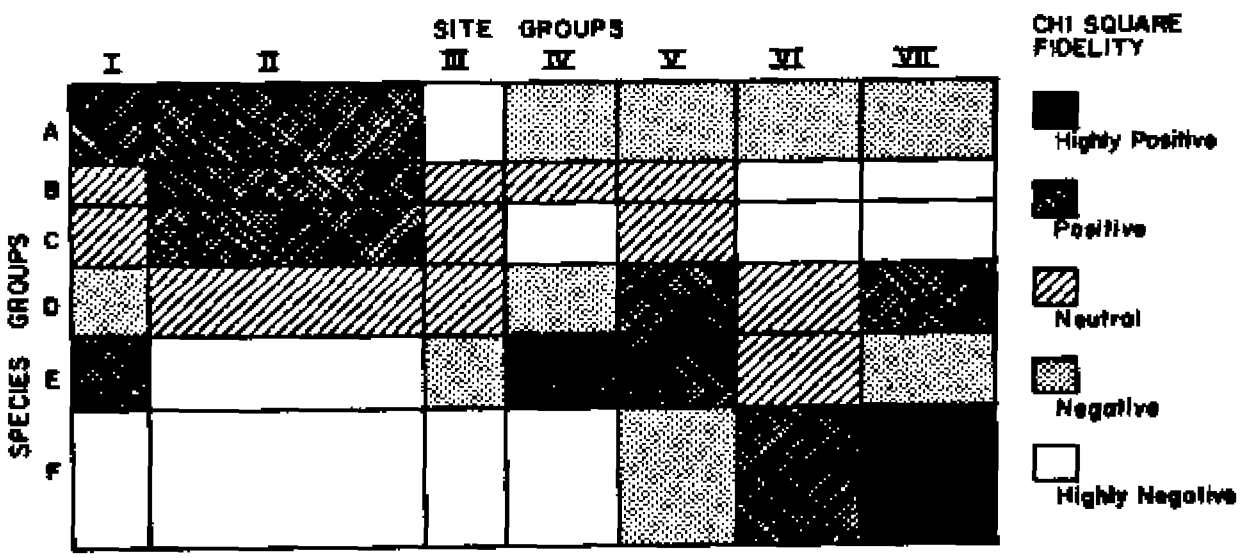
SPRING 1974


SITE GROUPS
I
II
III
IV
V
VI
SPECIES GROUPS
A
B
C
D
E
F
G
CONSTANCY
≥ 0.7
Very High
≥ 0.5
High
≥ 0.3
Moderate
≥ 0.1
0.1

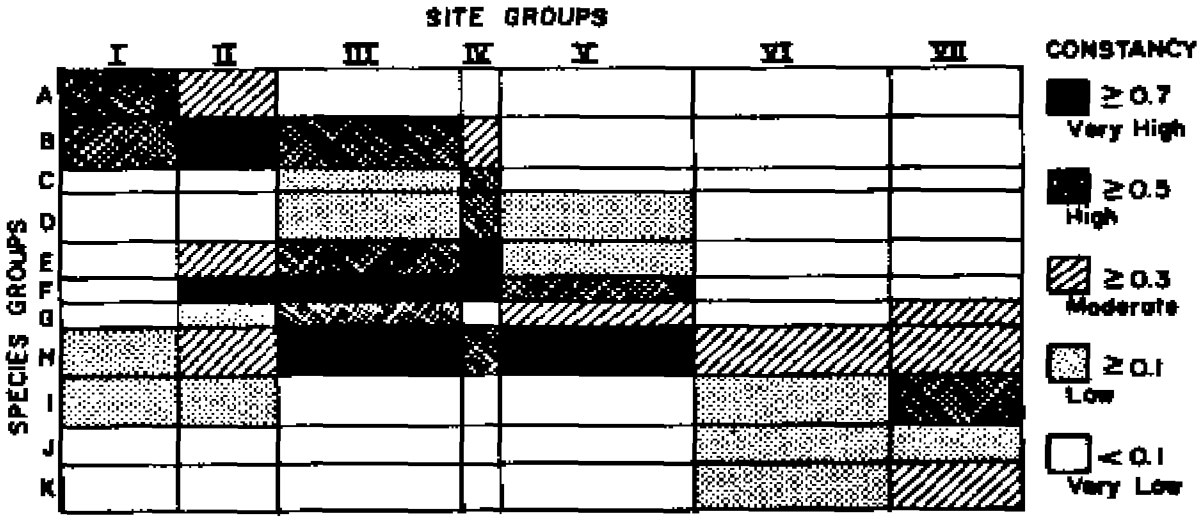

SITE GROUPS
I
II
III
IV
V
VI
SPECIES GROUPS
A
B
C
D
E
F
G
CHI SQUARE
FIDELITY
Highly Positive
Positive
Neutral
Negative
Highly Negative

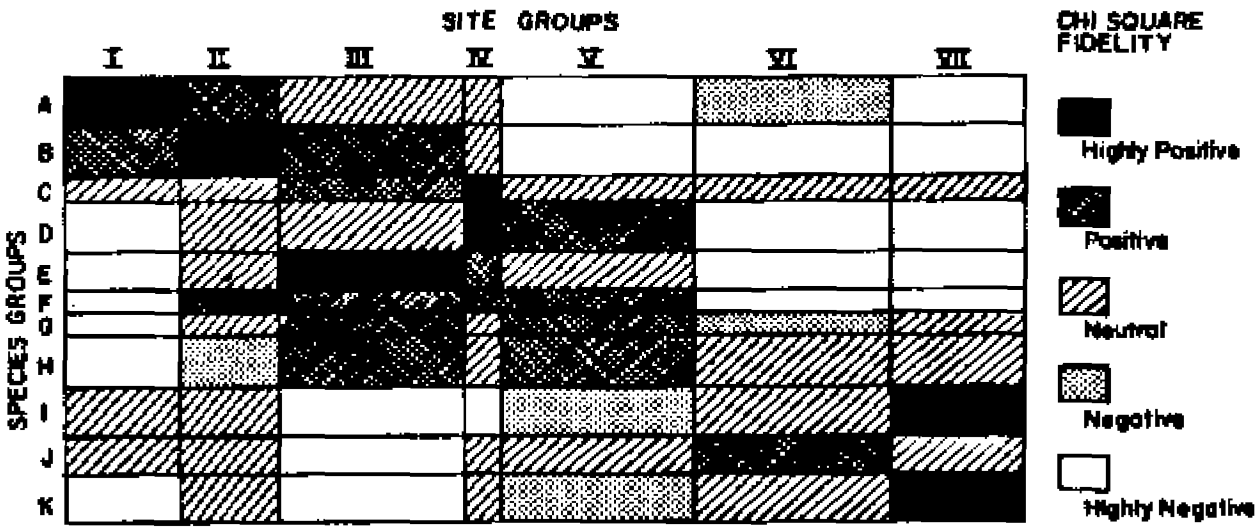
SPRING 1975


SITE GROUPS
I
II
III
IV
V
VI
VII
SPECIES GROUPS
A
B
C
D
E
F
CONSTANCY
≥ 0.7 Very High
≥ 0.5 High
≥ 0.3 Moderate
≥ 0.1 Low
< 0.1 Very Low

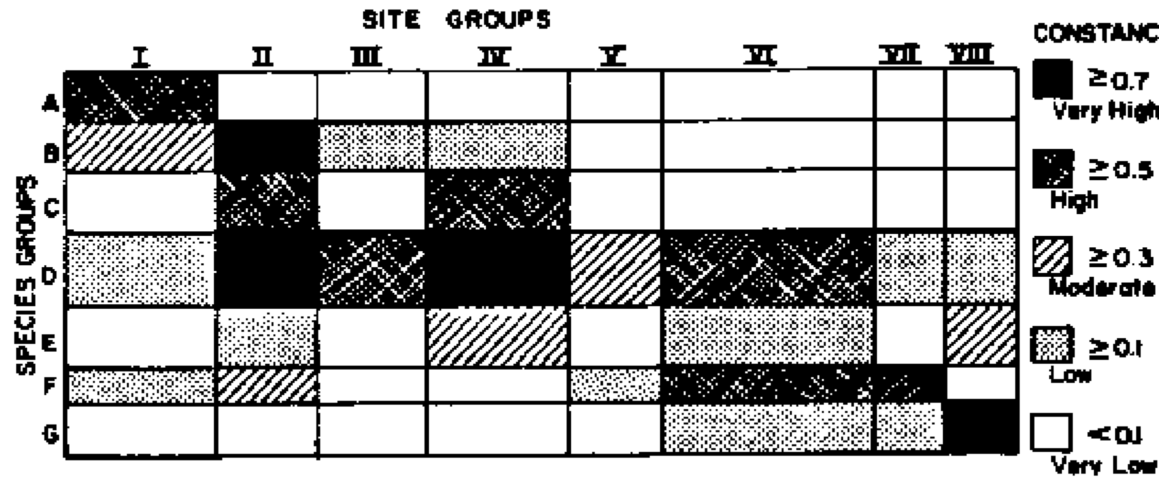

SITE GROUPS
I
II
III
IV
V
VI
VII
SPECIES GROUPS
A
B
C
D
E
F
CHI SQUARE FIDELITY
Highly Positive
Positive
Neutral
Negative
Highly Negative

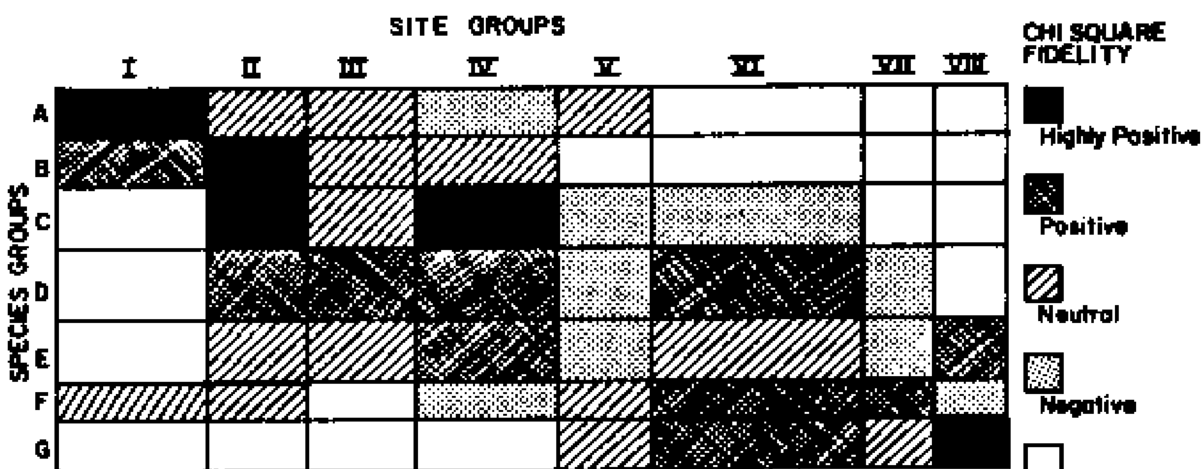
SPRING 1976


SITE GROUPS
I
II
III
IV
V
VI
VII
SPECIES GROUPS
A
B
C
D
E
F
G
H
I
J
K
CONSTANCY
≥ 0.7
Very High
≥ 0.5
High
≥ 0.3
Moderate
≥ 0.1
Low
< 0.1
Very Low

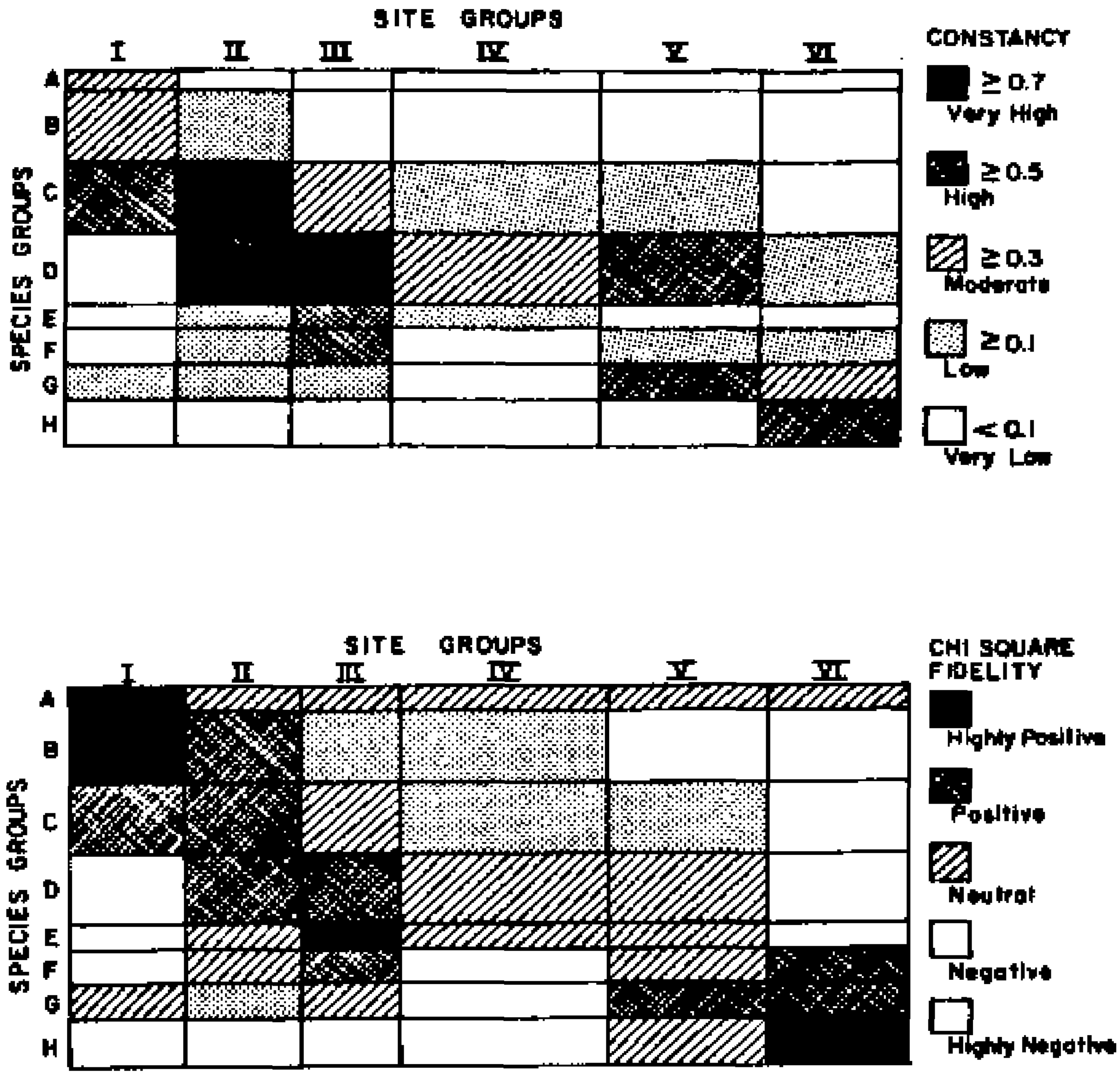

SITE GROUPS
I
II
III
IV
V
VI
VII
SPECIES GROUPS
A
B
C
D
E
F
G
H
I
J
K
CHI SQUARE FIDELITY
Highly Positive
Positive
Neutral
Negative
Highly Negative

FALL 1967

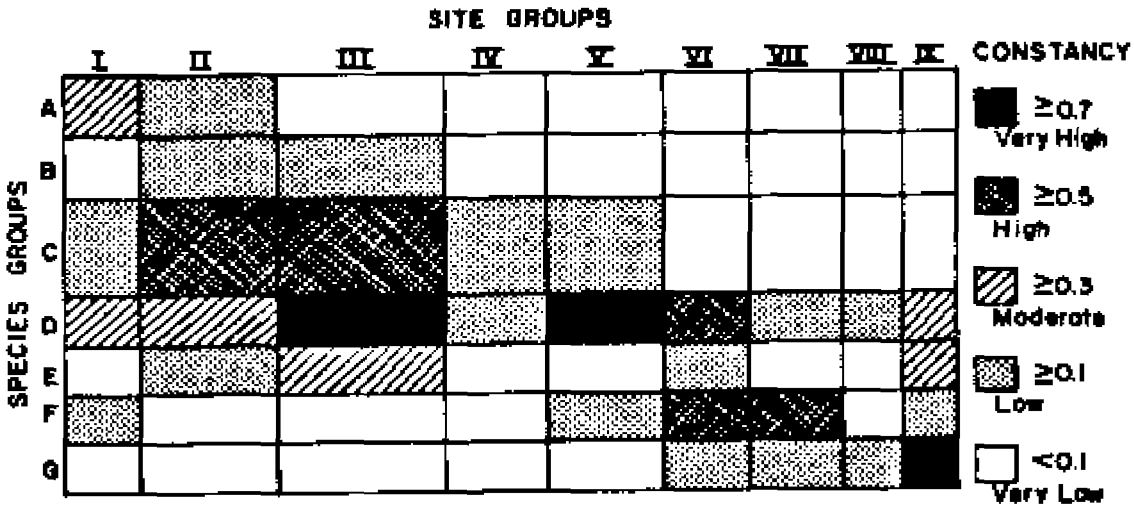

SITE GROUPS
I
II
III
IV
V
VI
VII
VIII
SPECIES GROUPS
A
B
C
D
E
F
G
CONSTANCY
≥ 0.7
Very High
≥ 0.5
High
≥ 0.3
Moderate
≥ 0.1
Low
< 0.1
Very Low

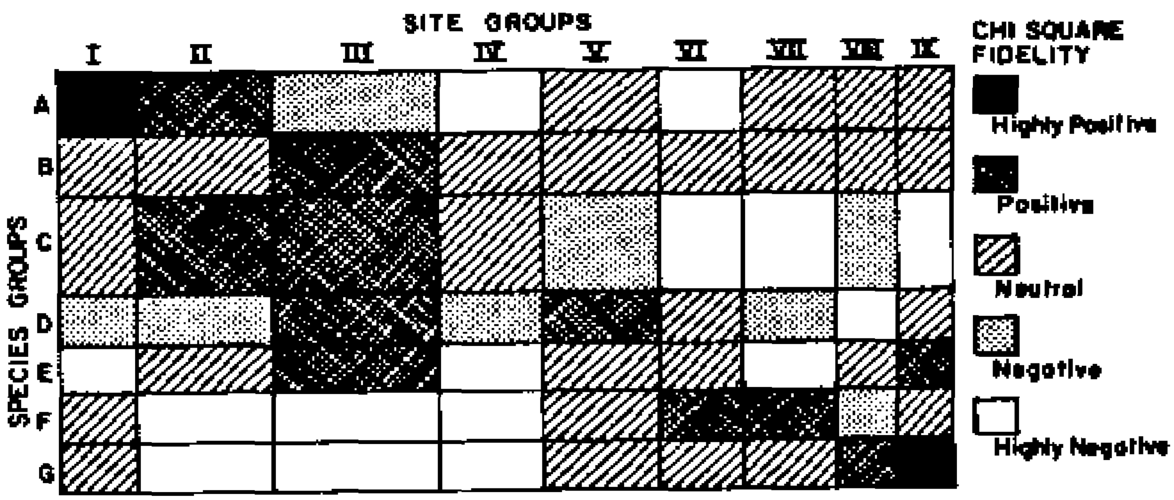

SITE GROUPS
I
II
III
IV
V
VI
VII
VIII
SPECIES GROUPS
A
B
C
D
E
F
G
CHI SQUARE FIDELITY
Highly Positive
Positive
Neutral
Negative
Highly Negative

FALL 1968

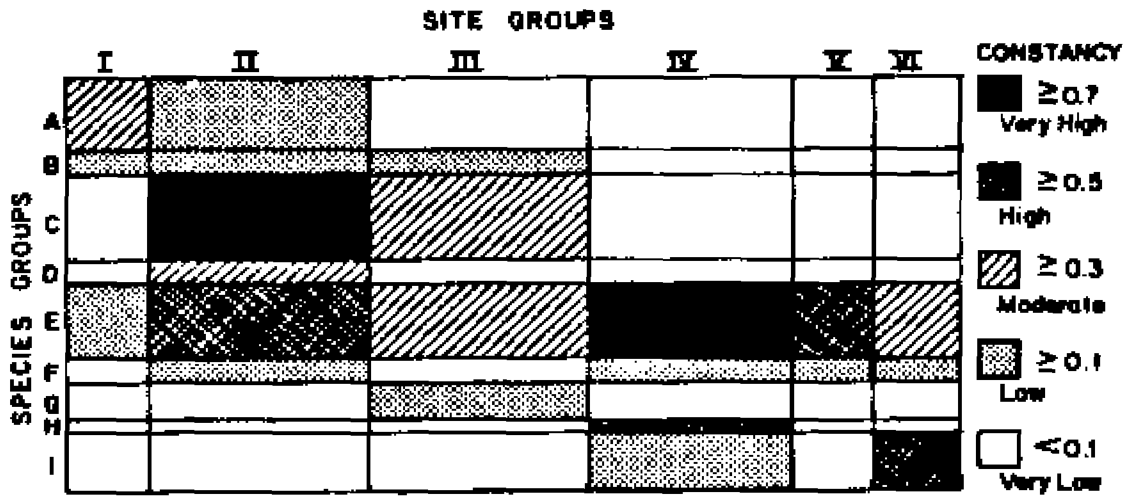

SITE GROUPS
I II III IV V VI
SPECIES GROUPS
A B C D E F G H
CONSTANCY
≥ 0.7 Very High
≥ 0.5 High
≥ 0.3 Moderate
≥ 0.1 Low
< 0.1 Very Low
SITE GROUPS
I II III IV V VI
SPECIES GROUPS
A B C D E F G H
CHI SQUARE FIDELITY
Highly Positive
Positive
Neutral
Negative
Highly Negative

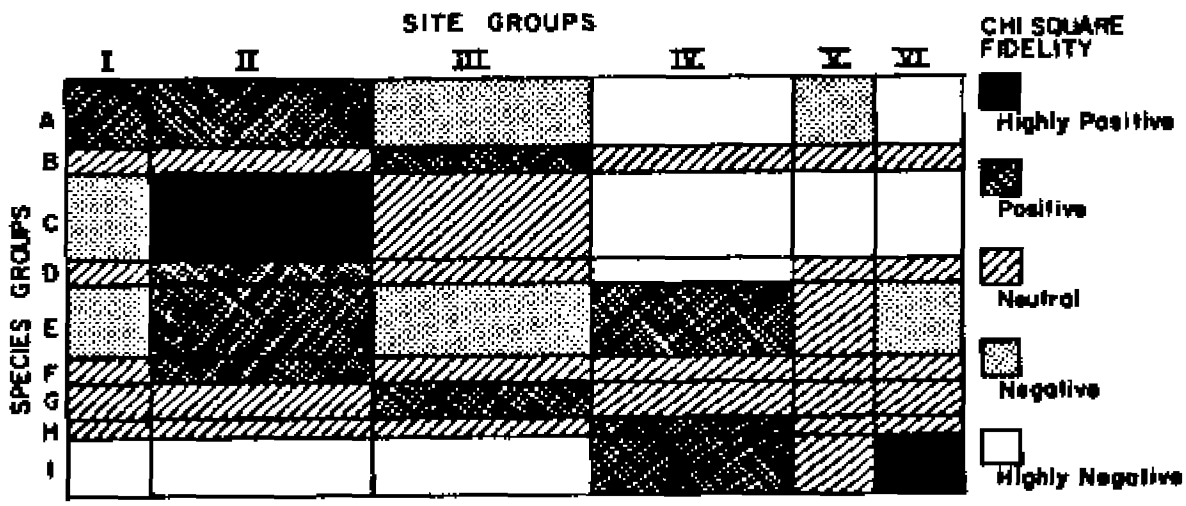
FALL 1969


SITE GROUPS
I II III IV V VI VII VIII IX
CONSTANCY
SPECIES GROUPS
A B C D E F G
≥0.7 Very High
≥0.5 High
≥0.3 Moderate
≥0.1 Low
<0.1 Very Low

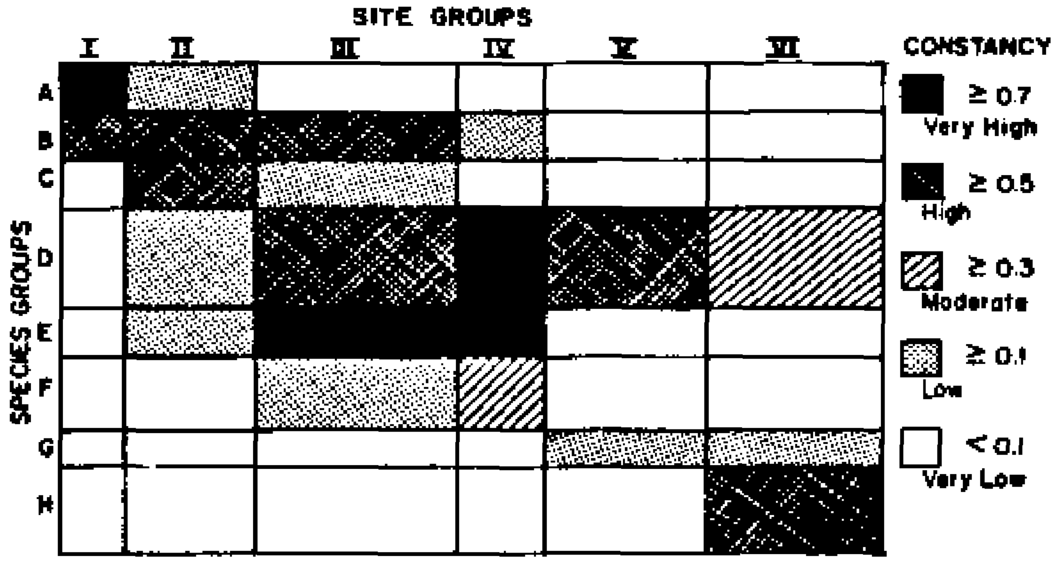

SITE GROUPS
I II III IV V VI VII VIII IX
CHI SQUARE FIDELITY
SPECIES GROUPS
A B C D E F G
Highly Positive
Positive
Neutral
Negative
Highly Negative

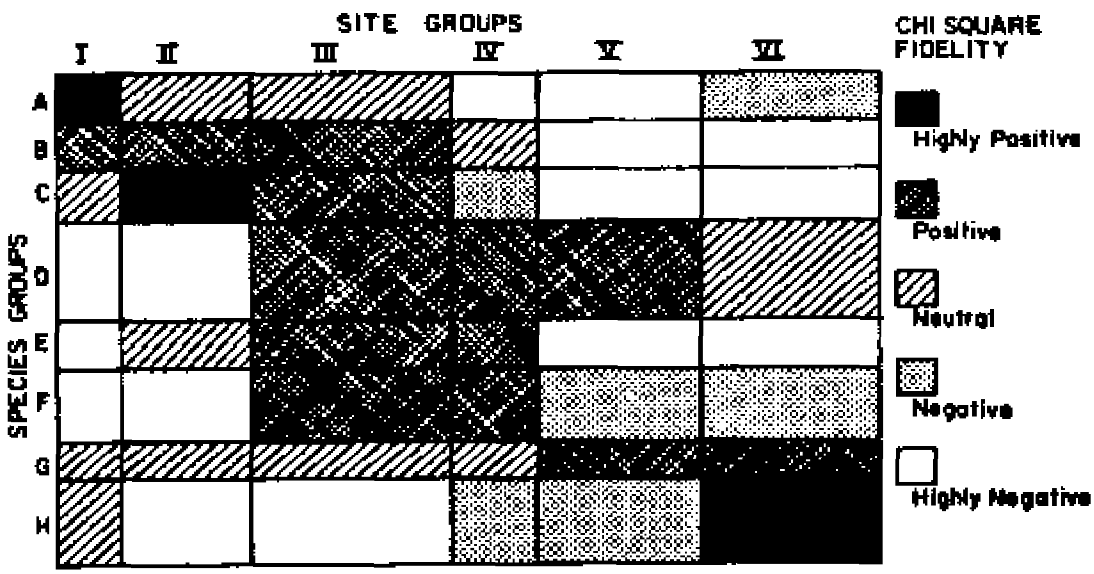
FALL 1970


SITE GROUPS
I
II
III
IV
V
VI
SPECIES GROUPS
A
B
C
D
E
F
G
H
I
CONSTANCY
≥0.7 Very High
≥0.5 High
≥0.3 Moderate
≥0.1 Low
<0.1 Very Low

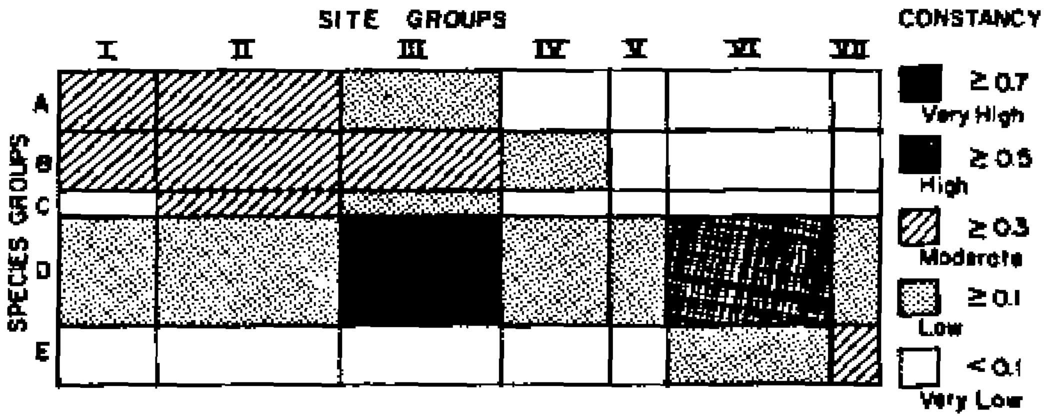

SITE GROUPS
I
II
III
IV
V
VI
SPECIES GROUPS
A
B
C
D
E
F
G
H
I
CHI SQUARE FIDELITY
Highly Positive
Positive
Neutral
Negative
Highly Negative

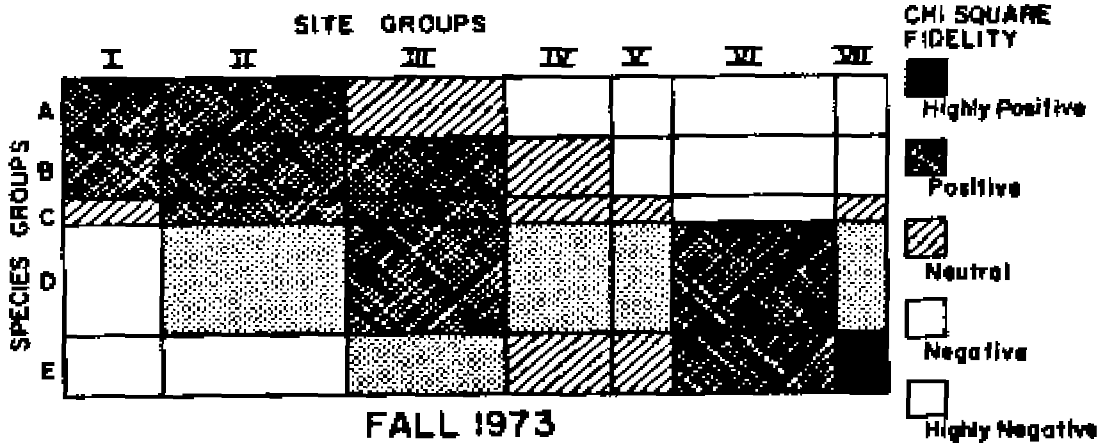
FALL 1971


SITE GROUPS
I
II
III
IV
V
VI
SPECIES GROUPS
A
B
C
D
E
F
G
H
CONSTANCY
≥ 0.7
Very High
≥ 0.5
High
≥ 0.3
Moderate
≥ 0.1
Low
< 0.1
Very Low

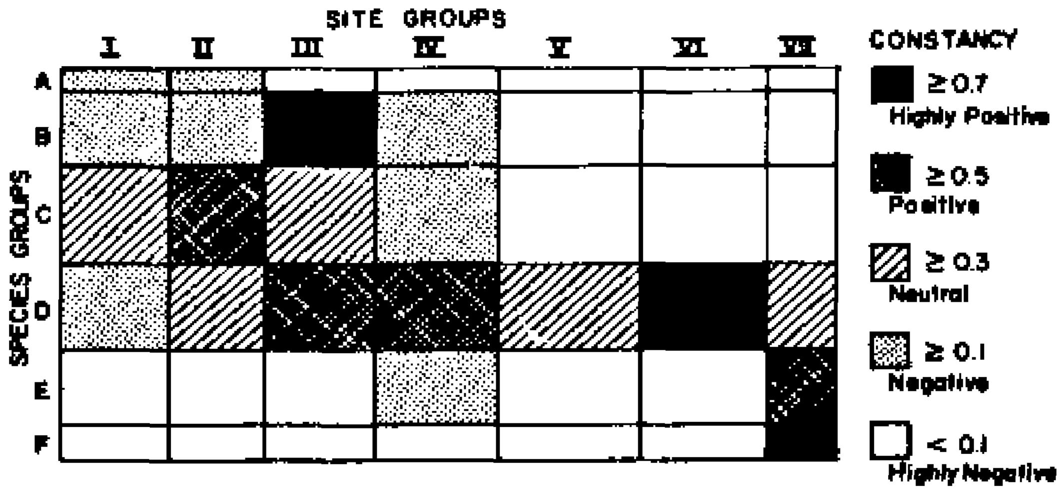

SITE GROUPS
I
II
III
IV
V
VI
SPECIES GROUPS
A
B
C
D
E
F
G
H
CHI SQUARE
FIDELITY
Highly Positive
Positive
Neutral
Negative
Highly Negative

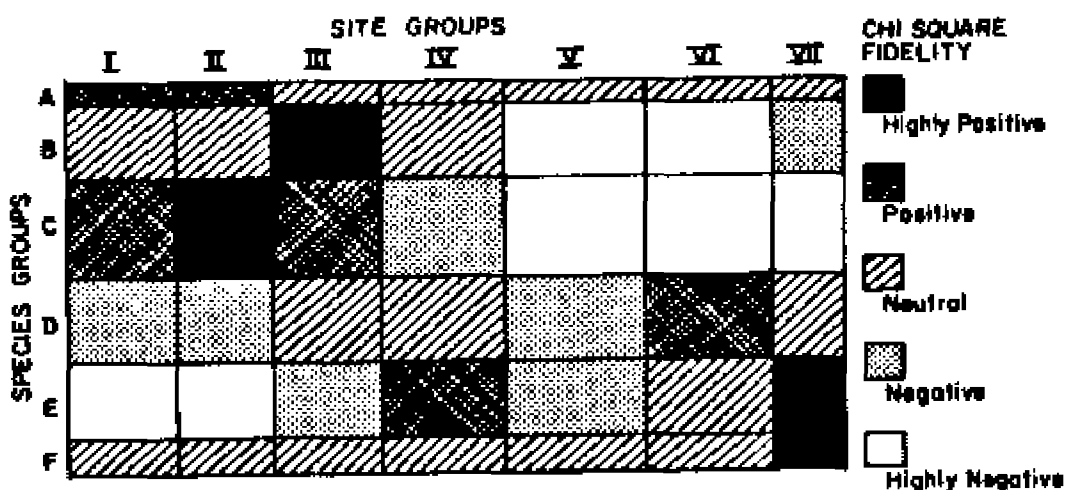
FALL 1972


SITE GROUPS
I
II
III
IV
V
VI
VII
SPECIES GROUPS
A
B
C
D
E
CONSTANCY
≥ 0.7
Very High
≥ 0.5
High
≥ 0.3
Moderate
≥ 0.1
Low
< 0.1
Very Low

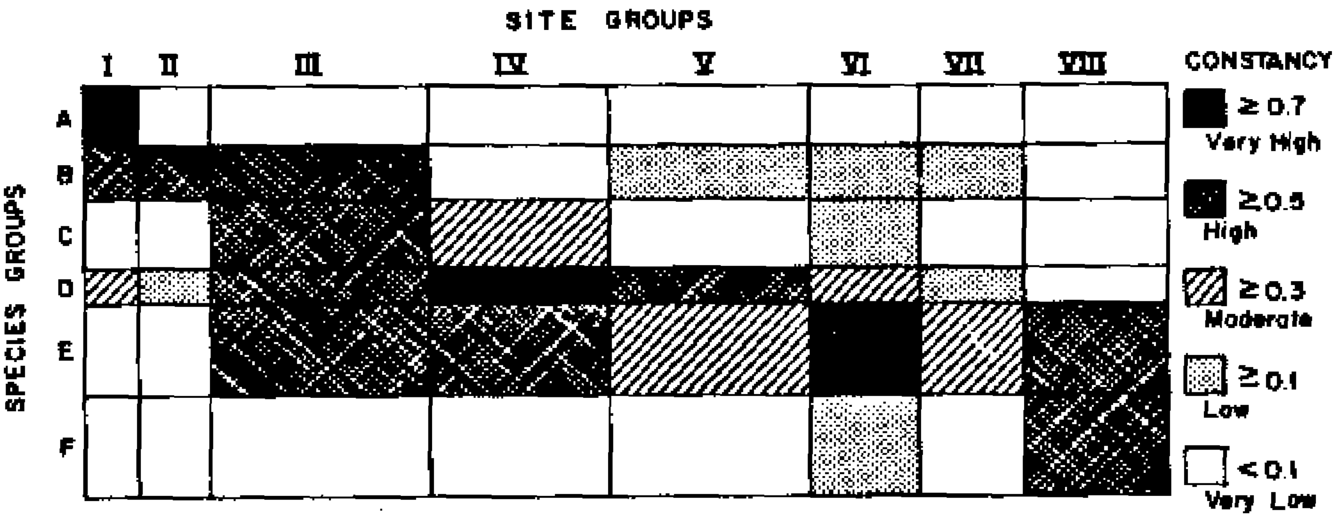

SITE GROUPS
I
II
III
IV
V
VI
VII
SPECIES GROUPS
A
B
C
D
E
CHI SQUARE
FIDELITY
Highly Positive
Positive
Neutral
Negative
Highly Negative

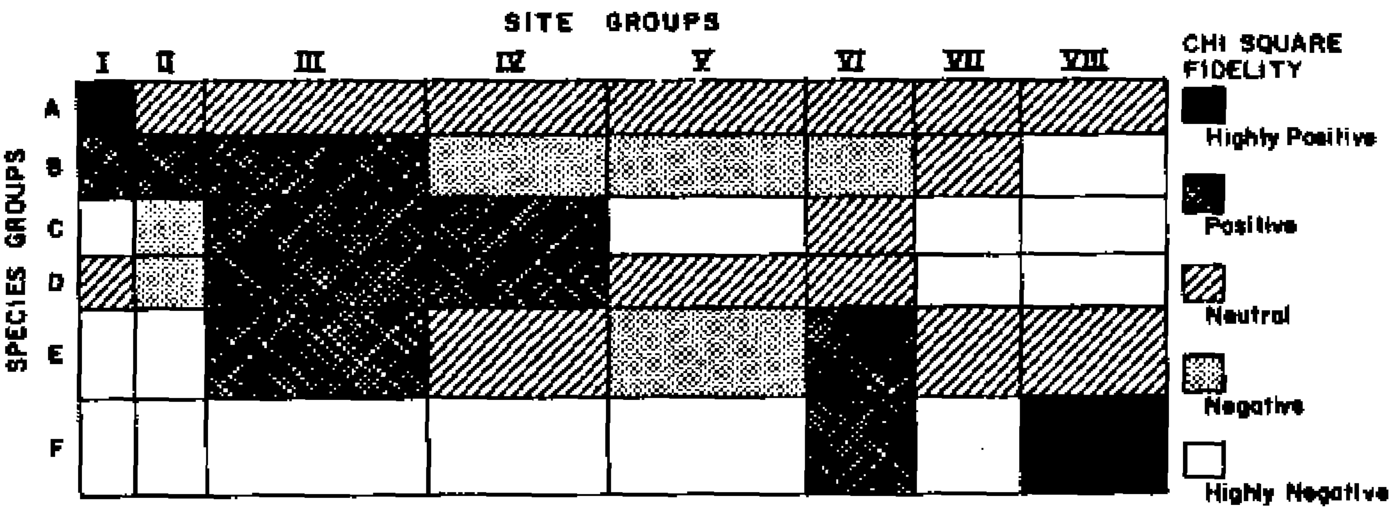
FALL 1973


SITE GROUPS
I II III IV V VI VII
A B C D E F
SPECIES GROUPS
CONSTANCY
≥ 0.7 Highly Positive
≥ 0.5 Positive
≥ 0.3 Neutral
≥ 0.1 Negative
< 0.1 Highly Negative

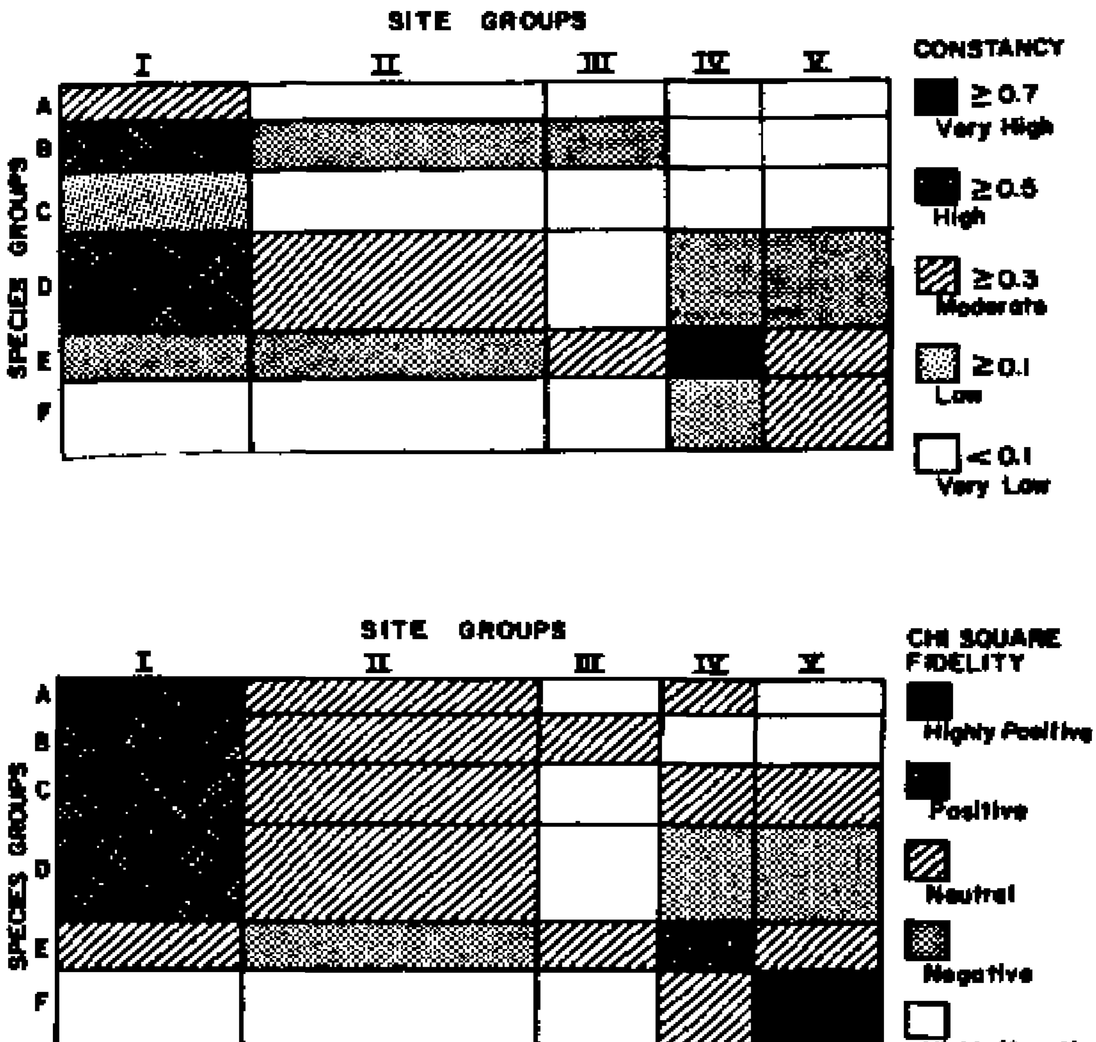

SITE GROUPS
I II III IV V VI VII
A B C D E F
SPECIES GROUPS
CHI SQUARE FIDELITY
Highly Positive
Positive
Neutral
Negative
Highly Negative

FALL 1974


SITE GROUPS
I
II
III
IV
V
VI
VII
VIII
SPECIES GROUPS
A
B
C
D
E
F
CONSTANCY
≥ 0.7
Very High
≥ 0.5
High
≥ 0.3
Moderate
≥ 0.1
Low
< 0.1
Very Low


SITE GROUPS
I
II
III
IV
V
VI
VII
VIII
SPECIES GROUPS
A
B
C
D
E
F
CHI SQUARE
FIDELITY
Highly Positive
Positive
Neutral
Negative
Highly Negative

FALL 1975


SITE GROUPS
I
II
III
IV
V
SPECIES GROUPS
A
B
C
D
E
F
CONSTANCY
≥ 0.7
Very High
≥ 0.5
High
≥ 0.3
Moderate
≥ 0.1
Low
< 0.1
Very Low
SITE GROUPS
I
II
III
IV
V
SPECIES GROUPS
A
B
C
D
E
F
CHI SQUARE
FIDELITY
Highly Positive
Positive
Neutral
Negative
Highly Negative

SUMMER 1969

APPENDIX E

Species dominance tables for NMFS Groundfish

Survey Cruises, Fall 1967 - Spring 1976.

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

Species	Faunal Affinity*	Species Group	I		II		III		IV		V		VI		VII	
			%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$
Raja erinacea	Bo	A	79	7.8												
Myoxocephalus octodecemspinosus	Bo	A	96	10.0												
Limanda ferruginea	Bo	A	100	41.9	79	22.2										
Macrozoarces americanus	Bo	A	75	6.1	64	4.1										
Pseudopleuronectes americanus	Bo	A	57	3.6												
Menidia menidia	WT	A			50	3.5										
Squalus acanthias	Bo	B			79	6.3	90	4.4	95	17.9	47	19.1	62	8.1	57	23.1
Merluccius bilinearis	Bo	B	43	4.6	79	6.4	100	5.1	90	28.8	100	34.7	100	37.5	86	12.0
Alosa pseudoharengus	Bo	B	50	3.6	79	5.9	90	6.4	67	6.0	100	9.6				
Alosa aestivalis	WT	B			86	20.5	80	7.5								
Scomber scombrus	Bo	B			50	6.0	100	67.1	48	9.0			23	3.5		
Clupea harengus harengus	Bo	B	64	16.8	86	16.0	100	6.4								
Centropristis striata	WT	C							24	3.6						
Prionotus carolinus	WT	C							57	5.5						
Stenotomus chrysops	WT	C							29	8.8						
Urophycis chuss	Bo	D							57	3.0	73	6.2			57	14.0
Hippoglossina oblonga	OS	D							90	4.0						
Peprilus triacanthus	WT	D							71	8.3	60	16.2	92	34.4		
Lepophidium cervinum	OS	E									33	3.6				
Myctophidae	Mp	F											46	3.5	86	37.6
Anguilliformes		F													71	6.4

Site Group** spans columns I–VII.

* Faunal 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.
$\bar{x}$ = 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 B-2. Cruise 69-2, Spring 1969.

Species	Faunal Affinity*	Species Group	Site Group** I %	I $\bar{x}$	II %	II $\bar{x}$	III %	III $\bar{x}$	IV %	IV $\bar{x}$	V %	V $\bar{x}$	VI %	VI $\bar{x}$	VII %	VII $\bar{x}$	VIII %	VIII $\bar{x}$
Pseudopleuronectes americanus	Bo	A			71	3.7												
Myxocephalus octodecemspinosus	Bo	D	71	7.9	100	14.3	85	4.3										
Limanda ferruginea	Bo	D	100	21.8	100	35.9	100	27.2					50	4.2				
Macrozoarces americanus	Bo	D	86	10.3	88	8.0	62	3.7										
Scophthalmus aquosus	IS	D			75	3.3	62	3.6	80	4.2								
Raja ocellata	Bo	D			83	4.8												
Raja erinacea	Bo	D			100	11.9	62	10.9										
Alosa pseudoharengus	Bo	E	86	33.5	58	3.1	100	21.9	100	35.5	67	6.1	58	6.4				
Clupea harengus harengus	Bo	E	100	19.5	63	5.5	54	6.1	100	14.8	44	9.2						
Merluccius bilinearis	Bo	E					92	6.1	100	11.1			100	30.9	75	12.3	100	34.4
Squalus acanthias	Bo	E					85	10.0	60	4.3	89	46.8	100	30.2	81	17.7	45	13.2
Urophycis chuss	Bo	E											92	7.3			82	21.5
Urophycis tenuis	Bo-Sl	F															100	3.1
Peprilus triacanthus	WT	G													100	33.2	45	18.4
Hippoglossina oblonga	OS	G											75	5.9	56	3.5		
Prionotus carolinus	WT	G									44	14.1	38	3.4	44	13.3		
Etropus microstomus	Sl	G							40	5.2								
Scomber scombrus	Bo	I									11	8.9			50	4.4		

* Faunal affinity is designated as boreal (Bo), warm-temperate (WT), 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.
$\bar{x}$ = 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. Cruise 70-3, Spring 1970.

Species	Faunal Affinity*	Species Group	Site Groups** I %	I x̄	II %	II x̄	III %	III x̄	IV %	IV x̄	V %	V x̄	VI %	VI x̄	VII %	VII x̄	VIII %	VIII x̄	IX %	IX x̄
Pseudopleuronectes americanus	Bo	A	40	2.4	88	5.1														
Raja erinacea	Bo	C			63	10.8	77	3.3												
Myoxocephalus octodecemspinosus	Bo	C			100	18.9	67	4.9			25	3.0								
Clupea harengus harengus	Bo	C			50	16.2	90	8.1			50	3.9								
Limanda ferruginea	Bo	C	100	38.4	100	21.4	100	37.7			56	7.3								
Macrozoarces americanus	Bo	C	100	7.7	100	12.5	67	4.5												
Merluccius bilinearis	Bo	D	60	3.0			90	17.3			88	16.7	75	6.7	89	20.1			88	10.6
Urophycis chuss	Bo	D	40	4.5			93	5.8			88	6.5			74	10.0			81	4.3
Squalus acanthias	Bo	D	80	14.8			73	3.0			56	11.5			68	9.3			81	27.4
Scomber scombrus	Bo	D	60	4.8			27	4.4	29	10.3	44	17.6	50	12.3	89	10.6			31	4.2
Hippoglossina oblonga	OS	D									75	4.6								
Alosa pseudoharengus	Bo	D	40	3.0	75	5.4					31	10.3			84	4.9				
Stenotomus chrysops	WT	E							100	59.3			58	19.6	42	4.9				
Peprilus triacanthus	WT	E							57	5.8			58	12.9	79	19.0	100	88.7	38	3.0
Prionotus carolinus	WT	E							71	9.1	50	7.6	83	18.9	58	14.0			31	3.0
Urophycis tenuis	Bo-Sl	F																	50	6.4
Prionotus evolans	WT	G															33	3.5		
Urophycis regius	WT	G											92	20.5			53	6.5		
Myctophidae	Mp	H																	44	7.0
Helicolenus dactylopterus	Sl	H																	100	21.5

* Faunal affinity is designated as boreal (Bo), warm-temperate (WT), 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.
x̄ = 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-4. Cruise 71-1, Spring 1971.

Species	Faunal Affinity*	Species Group	Site Group** I		II		III		IV		V		VI	
			%	x̄	%	x̄	%	x̄	%	x̄	%	x̄	%	x̄
Clupea harengus harengus	Bo	A	64	10.2	55	5.4								
Alosa aestivalis	WT	A	64	13.8										
Pseudopleuronectes americanus	Bo	B			52	4.4								
Raja erinacea	Bo	C			83	14.5	63	5.8	35	3.1				
Limanda ferruginea	Bo	C	45	17.5	97	41.0	64	16.4						
Macrozoarces americanus	Bo	C			83	5.8								
Myoxocephalus octodecemspinosus	Bo	C			72	4.9								
Scophthalmus aquosus	IS	C			59	3.2								
Squalus acanthias	Bo	D	100	15.9	44	3.2	68	5.9	75	12.5	86	22.7	63	13.0
Merluccius bilinearis	Bo	D			66	5.4	100	33.8	90	21.1	90	11.5	100	36.2
Urophycis chuss	Bo	D					95	10.6			86	14.9	100	14.5
Alosa pseudoharengus	Bo	D	82	8.7	52	3.9	100	11.1						
Urophycis regius	WT	F							75	13.4				
Paralichthys dentatus	WT	F							40	2.6				
Stenotomus chrysops	WT	F							40	11.2	33	4.8		
Scomber scombrus	Bo	F	45	13.3			26	8.7	45	2.6	67	10.0	56	4.6
Peprilus triacanthus	WT	F	56	13.9					65	20.3	76	11.9	44	3.7
Prionotus carolinus	WT	F							50	2.4	48	5.5		
Hippoglossina oblonga	OS	F									86	6.1		
Citharichthys arctifrons	SI	F									71	4.0		
Helicolenus dactylopterus	SI	G											100	8.6
Phycis chesteri	SI	G											44	3.2
Stomiatoidei	Mp	H											25	3.8

* Faunal 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.
x̄ = 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-5. Cruise 72-2, Spring 1972.

Species	Faunal Affinity*	Species Group	Site Group** I		II		III		IV		V		VI		VII		VIII		IX	
			%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$
Alosa aestivalis	WT	A			80	12.6														
Clupea harengus harengus	Bo	A	67	4.7	53	7.2														
Pseudopleuronectes americanus	Bo	A	100	6.8																
Limanda ferruginea	Bo	B	100	19.1	100	35.2	100	29.2	50	6.5										
Macrozoarces americanus	Bo	B	83	7.0	100	5.7	83	4.4												
Raja erinacea	Bo	B	100	13.3			89	7.5												
Scophthalmus aquosus	IS	B	83	4.4			89	9.4												
Myoxocephalus octodecemspinosus	Bo	B	100	24.6			72	3.0												
Raja ocellata	Bo	B	100	8.6																
Squalus acanthias	Bo	E			73	5.7	94	15.6	100	74.1	100	22.5	18	9.1	85	29.1	77	14.8	45	12.3
Merluccius bilinearis	Bo	E					100	14.4			58	6.9	36	6.5	92	10.8	100	29.2	100	30.3
Hippoglossina oblonga	OS	E			20	5.6	72	3.3							92	13.5	69	7.8		
Urophycis chuss	Bo	E			20	5.6	72	3.3							100	12.6	85	8.2	100	20.3
Prionotus carolinus	WT	F									42	4.3	18	7.9						
Peprilus triacanthus	WT	F							67	18.0	73	18.3	36	11.9	92	17.3	54	5.7		
Alosa pseudoharengus	Bo	G			67	10.9														
Scomber scombrus	Bo	G			40	8.2	44	3.4							85	4.1	69	26.6		
Urophycis regius	WT	H									65	8.3	55	10.2						
Stenotomus chrysops	WT	H									38	18.1								
Centropristis striata	WT	H											55	4.9						
Prionotus evolans	WT	H									23	3.2								
Phycis chesteri	Sl	I											18	2.4					36	5.7
Myctophidae	Mp	I											45	21.3						
Helicolenus dactylopterus	Sl	I																	91	11.1
Urophycis tenuis	Bo-Sl	I																	73	7.8
Glyptocephalus cynoglossus	Bo-Sl	I																	73	3.1

* Faunal affinity is designated as boreal (Bo), warm-temperate (WT), 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.
$\bar{x}$ = 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 B-4. Cruise 73-3, Spring 1973.

Species	Faunal Affinity*	Species Group	Site Group** I %	I $\bar{x}$	II %	II $\bar{x}$	III %	III $\bar{x}$	IV %	IV $\bar{x}$	V %	V $\bar{x}$	VI %	VI $\bar{x}$	VII %	VII $\bar{x}$
Clupea harengus harengus	Bo	A	83	6.6	39	9.2										
Ammodytes americanus	Bo	A	26	4.9	43	7.0										
Raja erinacea	Bo	B	100	16.0	89	13.5										
Alosa pseudoharengus	Bo	B	100	13.7	82	6.3	96	12.6								
Limanda ferruginea	Bo	B	100	17.5	57	7.6										
Scophthalmus aquosus	IS	B	96	5.4	86	4.0										
Scomber scombrus	Bo	C									73	11.1				
Merluccius bilinearis	Bo	D	100	16.3	71	10.0	100	11.6			100	8.4			93	36.2
Urophycis chuss	Bo	D					89	10.2			100	5.2			100	8.0
Lophius americanus	Bo	D							79	3.6						
Squalus acanthias	Bo	D	62	4.0	93	17.4	96	25.7	93	22.8	36	8.4			79	18.6
Hippoglossina oblonga	OS	D					96	5.2			91	7.7	100	6.5		
Urophycis regius	WT	E			25	4.5										
Peprilus triacanthus	WT	F			25	4.5	93	17.0	79	13.4	91	49.0	100	69.3	43	11.2
Prionotus carolinus	WT	F					76	9.6	79	28.8						
Citharichthys arctifrons	SI	F											100	10.3		
Stenotomus chrysops	WT	G							100	12.2						
Centropristis striata	WT	G							50	3.9						
Prionotus evolans	WT	G							43	3.9						
Lepophidium cervinum	OS	H											100	7.8		
Merluccius albidus	SI	I													57	8.6
Helicolenus dactylopterus	SI	I													71	6.9

* Faunal 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.
$\bar{x}$ = 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 B-7. Cruise 74-4, Spring 1974.

Species	Faunal Affinity*	Species Group	Site Group** I		II		III		IV		V		VI	
			%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$
Clupea harengus harengus	Bo	A	58	5.6	58	8.6								
Raja erinacea	Bo	B	100	7.5	92	11.1								
Limanda ferruginea	Bo	B	100	10.1	92	7.0								
Scophthalmus aquosus	IS	B	100	5.6										
Alosa pseudoharengus	Bo	B	79	12.4	67	2.9								
Macrozoarces americanus	Bo	B			58	3.3								
Urophycis chuss	Bo	C	74	3.4	67	8.1	67	2.5					100	25.3
Squalus acanthias	Bo	C	95	8.9	100	26.3	93	27.3	91	22.1				
Merluccius bilinearis	Bo	C	95	32.1	100	12.4	96	18.5			80	8.7	92	30.3
Hippoglossina oblonga	OS	C			83	5.2	89	7.3			40	5.0		
Scomber scombrus	Bo	C	85	3.8			63	2.8	18	6.1				
Peprilus triacanthus	WT	D					81	16.5			40	6.8		
Stenotomus chrysops	WT	D							64	26.4				
Prionotus carolinus	WT	D					52	5.9	73	20.2				
Centropristis striata	WT	D							82	6.7				
Urophycis regius	WT	E									40	5.3		
Mustelus canis	WT	E							27	9.1				
Citharichthys arctifrons	Sl	F					67	5.2			70	10.5		
Lepophidium cervinum	OS	F					30	3.1			80	13.8		
Glyptocephalus cynoglossus	Bo-Sl	G											100	3.4
Chlorophthalmus agassizi	Sl	G											75	6.6
Merluccius albidus	Sl	G											92	8.0
Helicolenus dactylopterus	Sl	G											67	10.1
Myctophidae	Mp	G									30	10.1	58	2.9
Ceratoscopelus maderensis	Mp	H									30	8.1	25	3.0

* Faunal affinity is designated as boreal (Bo), warm-temperate (WT), 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.
$\bar{x}$ = 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 in at least 20% of all stations included in that site group.

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

Species	Faunal Affinity*	Species Group	Site Groups** I %	I $\bar{x}$	II %	II $\bar{x}$	III %	III $\bar{x}$	IV %	IV $\bar{x}$	V %	V $\bar{x}$	VI %	VI $\bar{x}$
Myoxocephalus octodecemspinosus	Bo	B	74	4.4										
Pseudopleuronectes americanus	Bo	B	63	3.0										
Scophthalmus aquosus	IS	C	100	5.7	63	3.3								
Limanda ferruginea	Bo	C	95	3.5	75	2.8								
Alosa pseudoharengus	Bo	C			63	3.2								
Raja erinacea	Bo	C	95	23.3	100	13.0								
Centropristis striata	WT	E					71	8.0						
Stenotomus chrysops	WT	E					86	28.0						
Squalus acanthias	Bo	F	79	2.8	100	24.5	100	24.3	100	39.7	54	8.3		
Merluccius bilinearis	Bo	F	84	41.4	100	41.9	79	2.8	100	24.2	85	11.5	100	22.0
Urophycis chuss	Bo	F							92	7.0			94	11.4
Hippoglossina oblonga	OS	F							100	6.4	85	10.3	88	6.0
Citharichthys arctifrons	Sl	F			50	2.9					54	3.9		
Scomber scombrus	Bo	F	21	2.7									44	5.6
Peprilus triacanthus	WT	F					79	17.8	92	9.4	85	24.9	63	5.5
Paralichthys dentatus	WT	F									54	6.4		
Prionotus carolinus	WT	F					29	7.1	67	3.7				
Myctophidae	Mp	G									23	8.3	81	17.0
Helicolenus dactylopterus	Sl	G											63	4.6
Lepophidium cervinum	OS	G									23	4.1	75	6.2
Maurolicus muelleri	Mp	G											31	5.6
Urophycis regius	WT	G									62	4.4		

* Faunal affinity is designated as boreal (Bo), warm-temperate (WT), 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.
$\bar{x}$ = 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 B-9. Cruise 76-2, Spring 1976.

Species	Faunal Affinity*	Species Group	Site Group** I %	I x̄	II %	II x̄	III %	III x̄	IV %	IV x̄	V %	V x̄	VI %	VI x̄	VII %	VII x̄
Clupea harengus harengus	Bo	A	30	5.6												
Ammodytes dubius	Bo	A	50	14.8	57	23.5										
Scomber scombrus	Bo	A	60	11.3												
Raja erinacea	Bo	C			94	8.7										
Scophthalmus aquosus	IS	C			94	5.7										
Limanda ferruginea	Bo	C			80	6.6										
Macrozoarces americanus	Bo	C			71	2.7										
Alosa pseudoharengus	Bo	C			57	4.1	40	14.3			73	4.6				
Merluccius bilinearis	Bo	D	80	30.7	91	21.3	100	23.1	79	11.2	100	6.8	66	13.1	94	41.0
Squalus acanthias	Bo	D	100	6.3	69	7.1	100	44.1	71	20.9	93	36.8	50	11.8	59	3.4
Hippoglossina oblonga	OS	D					90	4.6			100	8.8	94	10.2	59	3.7
Urophycis chuss	Bo	D			69	5.7					100	3.5			76	3.8
Citharichthys arctifrons	SI	D							21	4.6	93	4.3				
Urophycis regius	WT	E	50	12.7					64	8.0			81	5.4		
Centropristis striata	WT	E							93	14.2						
Stenotomus chrysops	WT	E							86	12.9	60	3.6				
Peprilus triacanthus	WT	E					60	7.0	64	4.7	93	6.0	88	32.2		
Paralichthys dentatus	WT	E							86	4.9						
Prionotus carolinus	WT	E	70	11.6					57	6.4	80	11.9				
Myctophidae	Mp	F											38	8.1	88	4.4
Merluccius albidus	SI	F													76	8.4
Helicolenus dactylopterus	SI	F													88	11.2
Lepophidium cervinum	OS	F									47	3.9			76	4.7
Glyptocephalus cynoglossus	Bo-SI	F													76	3.0

* Faunal 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.
x̄ = 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-10. Cruises 67-20 and 67-21, Fall 1967.

Species	Faunal Affinity*	Species Group	Site Groups** I		II		III		IV		V		VI		VII	
			%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$
Mustelus canis	WT	A	57	5.4												
Paralichthys dentatus	WT	A	50	3.1												
Prionotus carolinus	WT	A	71	41.1	100	33.6										
Scophthalmus aquosus	IS	B			85	3.4			100	2.4						
Pseudopleuronectes americanus	Bo	B			100	5.5										
Stenotomus chrysops	WT	B	57	26.1	54	3.5	57	2.2								
Alosa pseudoharengus	Bo	D							100	20.4						
Raja erinacea	Bo	E							60	3.9						
Myoxocephalus octodecemspinosus	Bo	E					87	6.0	60	8.0						
Squalus acanthias	Bo	F			92	22.1	100	22.1			83	29.9				
Limanda ferruginea	Bo	F			92	12.2	100	32.8	100	32.5						
Urophycis tenuis	Bo-Sl	C									58	3.3				
Merluccius bilinearis	Bo	H					96	9.8	80	7.1	100	20.9	84	37.0	76	18.9
Peprilus triacanthus	WT	H	43	12.2			61	7.8	60	12.1	88	22.3	44	15.9		
Hippoglossina oblonga	OS	H											36	5.4	65	3.0
Urophycis chuss	Bo	H					83	4.2			71	6.9				
Citharichthys arctifrons	Sl	I									29	3.6			82	13.7
Lepophidium cervinum	OS	I													71	13.4
Urophycis regius	WT	I	36	3.5									64	16.2	82	9.7
Helicolenus dactylopterus	Sl	K													47	5.9
Merluccius albidus	Sl	K													41	4.9
Maurolicus muelleri	Mp	K											20	10.0	35	16.3

* Faunal affinity is designated as boreal (Bo), warm-temperate (WT), 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.
$\bar{x}$ = 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 9-11. Cruise 68-17, Fall 1968.

Species	Faunal Affinity*	Species Group	Site Group** I %	I x̄	II %	II x̄	III %	III x̄	IV %	IV x̄	V %	V x̄	VI %	VI x̄	VII %	VII x̄	VIII %	VIII x̄
Paralichthys dentatus	WT	A	68	4.7														
Centropristis striata	WT	A	68	3.1														
Stenotomus chrysops	WT	A	47	13.0	23	3.2												
Decapterus macarellus	WT	A	47	5.2														
Prionotus carolinus	WT	B	95	49.6	85	10.9												
Scophthalmus aquosus	IS	B			100	7.6												
Pseudopleuronectes americanus	Bo	B			77	5.0	86	2.9										
Myoxocephalus octodecemspinosus	Bo	C			77	2.6												
Squalus acanthias	Bo	D			100	10.7	100	46.1	94	10.1	33	5.2	52	5.4	22	5.9		
Limanda ferruginea	Bo	D			92	34.8	100	13.8	100	27.7								
Merluccius bilinearis	Bo	D			100	11.9	86	7.4	100	30.2	67	3.5	93	28.2	67	23.6	89	22.8
Peprilus triacanthus	WT	D	74	7.7			93	10.4	94	11.2	92	54.8	52	8.1	33	22.7		
Urophycis chuss	Bo	D							94	8.6			81	8.0				
Lophius americanus	Bo	E															56	3.8
Urophycis tenuis	Bo-Sl	E															56	2.9
Lepophidium cervinum	OS	F													78	2.9		
Citharichthys arctifrons	Sl	F											74	9.0	22	7.9	22	2.1
Urophycis regius	WT	F	42	4.8	69	3.9					25	2.9	70	12.2	89	33.3		
Myctophidae	Mp	G															89	33.3
Helicolenus dactylopterus	Sl	G															100	24.5
Merluccius albidus	Sl	G															67	4.7
Chlorophthalmus agassizi	Sl	G															[illegible]	2.9

* Faunal affinity is designated as boreal (Bo), warm-temperate (WT), 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.
x̄ = 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 5-12. Cruise 69-11, Fall 1969.

Species	Faunal Affinity*	Species Group	Site Group** I %	I x̄	II %	II x̄	III %	III x̄	IV %	IV x̄	V %	V x̄	VI %	VI x̄
Centropristis striata	WT	B	73	4.3										
Paralichthys dentatus	WT	B	67	4.0										
Pseudopleuronectes americanus	Bo	C			80	3.8								
Scophthalmus aquosus	IS	C			93	2.6								
Prionotus carolinus	WT	C	100	25.1	80	8.7			33	5.6				
Stenotomus chrysops	WT	C	93	34.0	60	7.8								
Peprilus triacanthus	WT	C	93	21.8	87	8.0	85	9.0	56	21.1	67	27.4	28	7.1
Squalus acanthias	Bo	D			93	16.4	100	10.5	74	24.5				
Limanda ferruginea	Bo	D			93	19.6	100	23.1	67	15.0	33	3.1		
Myoxocephalus octodecemspinosus	Bo	D			73	4.6	92	5.1						
Hippoglossina oblonga	OS	D									90	3.9		
Urophycis chuss	Bo	D					100	20.0	30	2.2	67	8.2		
Merluccius bilinearis	Bo	D			93	17.2	100	22.5	56	7.9	90	19.5	39	6.0
Lophius americanus	Bo	F											44	2.4
Citharichthys arctifrons	Sl	G									67	6.2	56	11.1
Urophycis regius	WT	G									71	19.2	61	13.8
Chlorophthalmus agassizi	Sl	H											39	6.8
Merluccius albidus	Sl	H											33	3.2
Myctophidae	Mp	H											56	31.2
Helicolenus dactylopterus	Sl	H											89	8.5

* Faunal affinity is designated as boreal (Bo), warm-temperate (WT), 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.
x̄ = 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-13. Cruise 70-6, Fall 1970.

Species	Faunal Affinity*	Species Group	Site Group** I %	I $\bar{x}$	II %	II $\bar{x}$	III %	III $\bar{x}$	IV %	IV $\bar{x}$	V %	V $\bar{x}$	VI %	VI $\bar{x}$	VII %	VII $\bar{x}$	VIII %	VIII $\bar{x}$	IX %	IX $\bar{x}$
Prionotus carolinus	WT	A	40	32.2													25	24.0		
Stenotomus chrysops	WT	A			35	5.6														
Centropristis striata	WT	A	40	5.9													13	8.3		
Etrumeus teres	WT	B			24	3.4									25	6.9				
Squalus acanthias	Bo	C			100	39.8	100	11.8	23	13.8										
Limanda ferruginea	Bo	C			100	21.4	100	27.4	46	10.3										
Myoxocephalus octodecemspinosus	Bo	C			65	3.2	71	2.1												
Pseudopleuronectes americanus	Bo	C			82	4.6			54	3.4										
Peprilus triacanthus	WT	C					76	6.1	54	15.0	36	5.8			33	24.0	63	19.5		
Scophthalmus aquosus	IS	C	90	10.6																
Urophycis chuss	Bo	D					100	12.1			93	14.8								
Merluccius bilinearis	Bo	D	30	3.9	76	12.0	100	18.8	92	51.0	100	31.1	82	26.7	50	10.2	50	6.0	57	19.5
Hippoglossina oblonga	OS	D					76	2.9			86	3.2								
Citharichthys arctifrons	Sl	D									100	10.7	100	23.2					57	4.4
Glyptocephalus cynoglossus	Bo-Sl	E																	43	3.7
Urophycis regius	WT	F	100	38.8							50	22.3	91	35.9	100	50.5			29	3.8
Lepophidium cervinum	OS	F									43	3.2	91	18.6					29	5.3
Myctophidae	Mp	G																	71	7.3
Merluccius albidus	Sl	G																	100	9.4
Chlorophthalmus agassizi	Sl	G															38	8.3	57	10.5
Helicolenus dactylopterus	Sl	G															38	26.7	100	26.3

* Faunal affinity is designated as boreal (Bo), warm-temperate (WT), 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.
$\bar{x}$ = 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-14. Cruise 71-6, Fall 1971.

Species	Faunal Affinity*	Species Group	Site Group** I %	I $\bar{x}$	II %	II $\bar{x}$	III %	III $\bar{x}$	IV %	IV $\bar{x}$	V %	V $\bar{x}$	VI %	VI $\bar{x}$
Stenotomus chrysops	WT	A	55	8.5	39	4.8								
Paralichthys dentatus	WT	A	64	5.5										
Prionotus carolinus	WT	A	45	16.9	43	3.3	21	2.4						
Etrumeus teres	WT	B	36	32.5	14	4.9	43	6.4						
Myoxocephalus octodecemspinosus	Bo	C			68	3.3								
Scophthalmus aquosus	IS	C			71	3.0								
Pseudopleuronectes americanus	Bo	C			86	3.7								
Raja erinacea	Bo	C			93	8.1								
Squalus acanthias	Bo	C					54	6.9						
Limanda ferruginea	Bo	C			93	22.7	64	7.7						
Urophycis chuss	Bo	E			79	10.3	46	3.9	58	5.7				
Merluccius bilinearis	Bo	E			96	14.8	79	15.0	100	32.3	80	9.8		
Hippoglossina oblonga	OS	E			79	3.1								
Citharichthys arctifrons	Sl	E							96	9.0			55	14.9
Peprilus triacanthus	WT	E	64	13.5	71	9.3	96	49.0	89	16.1	90	63.5		
Urophycis regius	WT	E	27	13.2					46	10.7	100	23.7	36	2.6
Lepophidium cervinum	Sl	H							50	6.1				
Helicolenus dactylopterus	Sl	I							42	5.7			82	31.4
Myctophidae	Mp	I							31	9.2			73	18.0
Chlorophthalmus agassizi	Sl	I											64	13.1
Merluccius albidus	Sl	I											73	11.2

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

** % = percent of stations in each site group at which each dominant species occurred.
$\bar{x}$ = 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 8-15. Cruise 72-8, Fall 1972.

Species	Faunal Affinity*	Species Group	Site Group** I %	I x̄	II %	II x̄	III %	III x̄	IV %	IV x̄	V %	V x̄	VI %	VI x̄
Centropristis striata	WT	A	100	10.1										
Raja eglanteria	WT	A	88	5.5										
Stenotomus chrysops	WT	B	50	43.7	69	14.9	56	7.4						
Pseudopleuronectes americanus	Bo	B			38	4.0	64	3.4						
Prionotus carolinus	WT	B	100	26.7	69	14.4	48	6.1			19	7.6		
Scophthalmus aquosus	IS	B	88	4.7	56	5.8								
Mustelus canis	WT	C			91	9.0								
Raja ocellata	Bo	C			50	7.2								
Etrumeus teres	WT	C			31	7.4								
Merluccius bilinearis	Bo	D					90	15.0	100	34.5	71	8.8	73	6.6
Citharichthys arctifrons	Sl	D					48	3.0	91	9.1	57	5.0	91	11.0
Lophius americanus	Bo	D							100	3.3	86	9.1		
Hippoglossina oblonga	OS	D			25	5.1	92	3.9	91	4.6	67	5.0		
Urophycis chuss	Bo	D					76	4.9	100	26.7	48	7.0		
Urophycis regius	WT	D									76	9.8	27	6.3
Peprilus triacanthus	WT	D			56	10.0	64	14.0			90	36.1		
Lepophidium cervinum	OS	D									38	4.7		
Raja erinacea	Bo	E			69	6.5	92	6.0						
Limanda ferruginea	Bo	E					92	20.5	91	9.4				
Myoxocephalus octodecemspinosus	Bo	E					68	3.7						
Squalus acanthias	Bo	E			25	3.1	76	4.9	73	3.2				
Helicolenus dactylopterus	Sl	H											42	24.2
Merluccius albidus	Sl	H											77	7.9
Myctophidae	Mp	H											77	23.3
Chlorophthalmus agassizi	Sl	H											41	4.2

* Faunal affinity is designated as boreal (Bo), warm-temperate (WT), 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.
x̄ = 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-16. Cruise 73-8, Fall 1973.

Species	Faunal Affinity*	Species Group	Site Group** I %	I $\bar{x}$	II %	II $\bar{x}$	III %	III $\bar{x}$	IV %	IV $\bar{x}$	V %	V $\bar{x}$	VI %	VI $\bar{x}$	VII %	VII $\bar{x}$
Prionotus carolinus	WT	A	50	4.9	78	23.4										
Scophthalmus aquosus	IS	A			70	4.8										
Mustelus canis	WT	B	100	15.7												
Raja erinacea	Bo	B	83	8.2	61	4.7			31	4.2						
Pseudopleuronectes americanus	Bo	B	33	4.9												
Stenotomus chrysops	WT	B	25	2.0	43	14.1										
Limanda ferruginea	Bo	B			30	5.5	45	8.3	15	3.4						
Squalus acanthias	Bo	C			35	7.9	45	7.4								
Merluccius bilinearis	Bo	D					100	24.0	69	24.2	75	9.4	71	8.3	33	3.6
Hippoglossina oblonga	OS	D					100	9.5	31	6.3			76	6.2		
Citharichthys arctifrons	Sl	D					80	12.7					90	9.8		
Lophius americanus	Bo	D							100	25.4			76	6.9	63	10.4
Urophycis regius	WT	D			39	6.3			31	11.1	75	7.2	81	16.6		
Peprilus triacanthus	WT	D	92	43.7	78	12.9	75	17.2	15	6.7	100	82.8	62	29.4	50	35.5
Lepophidium cervinum	OS	D											71	6.0		
Urophycis chuss	Bo	D					85	8.9								
Helicolenus dactylopterus	Sl	E													100	20.6
Merluccius albidus	Sl	E													81	20.0
Myctophidae	Mp	E											43	7.1	33	5.6
Peristedion miniatum	Sl	E							15	3.8						

* Faunal affinity is designated as boreal (Bo), warm-temperate (WT), 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.
$\bar{x}$ = 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-17. Cruise 74-11, Fall 1974.

Species	Faunal Affinity*	Species Group	Site Groups** I %	I $\bar{x}$	II %	II $\bar{x}$	III %	III $\bar{x}$	IV %	IV $\bar{x}$	V %	V $\bar{x}$	VI %	VI $\bar{x}$	VII %	VII $\bar{x}$
Micropogon undulatus	WT	A	29	3.8												
Raja erinacea	Bo	B					100	12.3								
Scophthalmus aquosus	IS	B					64	3.1								
Squalus acanthias	Bo	B	43	8.2			71	7.7								
Limanda ferruginea	Bo	B					79	12.2								
Stephanolepis hispidus	WT	C			92	8.2										
Centropristis striata	WT	C			50	6.5										
Prionotus carolinus	WT	C			63	44.1			38	9.6						
Stenotomus chrysops	WT	C	86	29.3												
Paralichthys dentatus	WT	C	86	9.2	75	4.2										
Mustelus canis	WT	C			33	5.3										
Urophycis regius	WT	D			75	2.9			94	29.5			81	10.0		
Citharichthys arctifrons	SI	D							56	5.1			100	18.0	89	12.4
Lepophidium cervinum	OS	D											88	7.4		
Merluccius bilinearis	Bo	D	21	4.0	58	15.6	86	36.4	88	25.1	50	15.7	94	24.9	67	10.2
Hippoglossina oblonga	OS	D					93	7.3	69	6.7	39	4.9				
Peprilus triacanthus	WT	D	86	36.5	33	3.0	21	3.2			94	62.8	100	35.4	56	13.2
Urophycis chuss	Bo	D					57	5.7			28	4.8				
Helicolenus dactylopterus	SI	E									22	3.3			100	21.4
Chlorophthalmus agassizi	SI	E													78	14.1
Myctophidae	Mp	E							31	17.7						
Phycis chesteri	SI	F													56	7.3
Merluccius albidus	SI	F													89	4.9
Macrouridae	SI	F													78	6.2

* Faunal 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.
$\bar{x}$ = 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 B-18. Cruise 75-12, Fall 1975.

Species	Faunal Affinity*	Species Group	Site Group** I %	I $\bar{x}$	II %	II $\bar{x}$	III %	III $\bar{x}$	IV %	IV $\bar{x}$	V %	V $\bar{x}$	VI %	VI $\bar{x}$	VII %	VII $\bar{x}$	VIII %	VIII $\bar{x}$
Micropogon undulatus	WT	A	100	42.1														
Decapterus punctatus	WT	A	67	15.5														
Mustelus canis	WT	B	67	9.4	43	16.0												
Paralichthys dentatus	WT	B	83	13.3	100	25.1												
Prionotus carolinus	WT	B			86	37.4	78	3.8							30	7.6		
Centropristis striata	WT	B	67	5.2											50	8.3		
Raja erinacea	Bo	C					91	4.4										
Squalus acanthias	Bo	D					70	10.4	100	19.0	35	4.9						
Stenotomus chrysops	WT	D			71	10.9	83	34.8	89	12.3	65	25.4						
Peprilus triacanthus	WT	D	50	6.5			52	2.5	89	43.8	100	38.1	75	6.2	40	10.6		
Merluccius bilinearis	Bo	E			29	8.6	78	19.1	100	14.5	65	7.4	100	19.9	100	34.0	53	9.5
Hippoglossina oblonga	OS	E					96	3.0			50	3.6	92	3.8				
Citharichthys arctifrons	Sl	E					52	6.8			35	5.7	100	18.4			80	13.7
Urophycis chuss	Bo	E					43	4.1	72	4.3			58	14.3			60	6.4
Urophycis regius	WT	E									40	5.4	67	24.3	90	33.3	47	14.7
Myctophidae	Mp	F															47	6.0
Merluccius albidus	Sl	F															73	7.8
Maurolicus muelleri	Mp	F															73	2.1
Helicolenus dactylopterus	Sl	F															93	23.0
Lepophidium cervinum	OS	F											83	4.0				

* Faunal affinity is designated as boreal (Bo), warm-temperate (WT), 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.
$\bar{x}$ = 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-19. Cruise 69-6, Summer 1969.

Species	Faunal Affinity*	Species Group	Site Groups** I		II		III		IV		V	
			%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$	%	$\bar{x}$
Pseudopleuronectes americanus	Bo	B	57	4.3	35	4.9						
Limanda ferruginea	Bo	B	78	21.0	43	11.0						
Scophthalmus aquosus	IS	B					40	4.7				
Merluccius bilinearis	Bo	D	96	13.7	76	11.4						
Melanogrammus aeglefinus	Bo	D	78	12.6	41	11.1			17	3.9		
Urophycis chuss	Bo	D	91	14.0					17	2.8		
Myoxocephalus octodecemspinosus	Bo	D	74	5.0								
Hippoglossina oblonga	OS	D	70	2.4								
Squalus acanthias	Bo	D	43	2.6	30	5.2						
Scomber scombrus	Bo	D	39	8.7	30	5.8						
Lepophidium cervinum	OS	E							100	26.2	31	2.4
Citharichthys arctifrons	SI	E			27	2.7			92	20.2	50	7.2
Peprilus triacanthus	WT	E	74	5.6	57	20.7	100	47.2	50	11.2		
Urophycis regius	WT	E			24	9.8	93	44.9	75	27.4	63	20.5
Maurolicus muelleri	Mp	F									44	15.9
Myctophidae	Mp	F									56	6.8
Helicolenus dactylopterus	SI	F									56	10.6
Merluccius albidus	SI	F									50	5.4

* Faunal 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.
$\bar{x}$ = 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.

APPENDIX F

Community structure indices for NMFS Groundfish

Survey Cruises, Fall 1967 - Spring 1976.

DIVERSITY (H′)

SPRING CRUISES

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

EVENNESS (J′)

SPRING CRUISES

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

SPECIES RICHNESS

SPRING CRUISES

Site Group Year	I	II	III	IV	V	VI	VII	VIII	IX
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 Year	I	II	III	IV	V	VI	VII	VIII	IX
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 Year	I	II	III	IV	V	VI	VII	VIII	IX
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 evironmental ranges.

APPENDIX C - Species taken during NMFS Groundfish Survey cruises, Middle Atlantic Bight, 1967-1976. Species group designations based on cluster analysis of each cruise are indicated by letters, a (+) symbol is given when a species was taken but did not occur at a sufficient number of stations (5% or more) to be included in the analysis. Total number, weight and number of occurences are given for each season. Environmental ranges are for the entire study. Species are ordered by total number taken. Common names (in parentheses) after Robins et al. (1980). Higher taxonomic designations refer only to members which were not identified to species.

	SPECIES GROUP		ABUNDANCE						ENVIRONMENTAL RANGES	
	SPRING	FALL	SPRING CRUISES			FALL CRUISES				
	196- 197- 890123456	196- 197- 789012345	N	WEIGHT (KG.)	NO. OCC.	N	WEIGHT (KG.)	NO. OCC.	TEMP. RANGE (°C)	DEPTH RANGE (M)
__Peprilus triacanthus__ (butterfish)	DGEFFFDFE	HDCCEDDDD	101079	5147.5	410	150808	7621.3	606	5-22	16-397
__Prionotus carolinus__ (northern searobin)	CGEFFFDFE	BBCAABACB	85464	11511.6	280	41652	6017.9	283	3-22	18-379
__Merluccius bilinearis__ (silver hake)	BEDDEDCFD	EDDDEDDDE	60105	6982.9	838	45207	2114.2	703	2-21	16-379
__Squalus acanthias__ (spiny dogfish)	BEDDEDCFD	FDDGCECBD	74537	94196.2	753	23509	30229.0	374	2-18	18-379
__Stenotomus chrysops__ (scup)	CHEFHGDEE	BACAABBCD	67189	3677.3	155	26245	1345.2	231	5-25	16-302
__Etrumeus teres__ (round herring)	+ +	+++BBC+++	55	3.6	7	59312	1705.2	112	8-23	18-274
__Limanda ferruginea__ (yellowtail flounder)	ADCCBBBCC	FDDCCEBBC	21966	5372.7	436	23657	5279.4	343	2-18	22-287
__Scomber scombrus__ (Atlantic mackerel)	BIDFGCCFA	++++BG+++	33121	7854.8	333	6106	362.1	60	4-21	18-336
Myctophidae	F+BGI+GGF	JGHGIHEEF	2795	13.1	97	32911	54.6	111	6-16	68-433
__Urophycis chuss__ (red hake)	DEDDEDCFD	EDDDEDDDE	18119	3655.5	594	11855	1971.2	394	2-20	18-379
__Urophycis regia__ (spotted hake)	CIGFHEEGE	IFGFEDDDE	6425	269.4	224	19050	1339.5	381	5-21	16-349
__Ammodytes americanus__ (American sand lance)	+++++AAAA	++ +++++	24858	387.3	87	161	3.5	13	2-19	18-357
__Alosa pseudoharengus__ (alewife)	BEDDGBBCC	D++B++ ++	18683	2695.0	467	512	74.1	42	2-22	18-329
__Raja erinacea__ (little skate)	ADCCBBBCC	ECCCCEBBC	13331	5300.3	468	4173	1667.1	308	2-21	20-329
__Citharichthys arctifrons__ (Gulf Stream flounder)	DGFFDFFFD	IFGDEDDDE	3015	50.6	293	8499	86.8	383	3-21	22-341
__Clupea harengus harengus__ (Atlantic herring)	BECAAAABA	DE+++ +	10809	1410.5	282	143	27.5	35	2-21	18-141
__Paralichthys oblongus__ (fourspot flounder)	DGDFEDCDF	EDDDEDDDE	6169	922.2	499	4518	608.3	509	4-21	16-379
__Myoxocephalus octodecemspinosus__ (longhorn sculpin)	ADCCBAABB	ECDCCE+B+	4100	735.0	256	2891	416.9	186	2-18	22-311
__Maurolicus muelleri__ (pearlsides)	+++ BGF	E+++++++F	759	3.5	27	5755	11.8	45	5-14	73-433
__Scophthalmus aquosus__ (windowpane)	ADBCBBBCC	BBCCCBABC	3971	842.4	338	2138	411.7	243	2-21	18-101
__Helicolenus dactylopterus__ (blackbelly rosefish)	FIBGIIGGF	KGHGIHEEF	2408	104.0	150	2564	114.5	180	6-18	33-433
__Macrozoarces americanus__ (ocean pout)	ADCCBABCC	ECEEDFD+	4120	2730.9	352	608	122.5	124	2-18	22-433
__Centropristis striata__ (black sea bass)	CHGEHGDEE	AABAAA+CB	2757	741.6	115	1121	115.8	114	6-22	18-335
__Pseudopleuronectes americanus__ (winter flounder)	AAABAAABA	BBCCCBBBC	1110	440.7	163	2555	817.5	260	2-21	22- 97
__Lepophidium cervinum__ (fawn cusk-eel)	EGFH+HFGF	IFGFHDDDF	1874	47.5	132	1638	47.1	174	5-21	22-340
__Alosa aestivalis__ (blueback herring)	BC+AAAAAA	D+ +G+ +	2585	214.0	161	247	51.3	29	2-14	18-280
__Micropogonias undulatus__ (Atlantic croaker)	+	+ +++++AA	17	3.3	2	2740	778.9	24	13-23	20- 68
__Lophius americanus__ (goosefish)	DFFGDDCFD	GEFEFDDEE	1375	4504.0	443	1310	2044.4	344	2-18	18-433
__Leiostomus xanthurus__ (spot)		+ +++				1909	178.4	12	14-22	20- 68
__Merluccius albidus__ (offshore hake)	++HGIIGGF	KGHGIHEFF	1239	309.1	90	548	105.9	89	6-15	80-433
__Mustelus canis__ (smooth dogfish)	++++++E++	ABB ACBCB	880	2057.1	30	647	1955.6	118	8-21	18-333
__Raja ocellata__ (winter skate)	AD+BBA+B+	+C+C+CC++	1053	1056.3	111	444	400.7	92	2-20	20-117
__Paralichthys dentatus__ (summer flounder)	C++FHEDFE	AABAAAACB	800	702.4	215	624	572.0	166	4-25	18-229
__Polymixia lowei__ (beardfish)	+ + +F	++ + +	182	10.4	13	1045	31.9	14	9-14	117-338
__Chlorophthalmus agassizii__ (shortnose greeneye)	++H+++GGF	KGHGIH EF	489	7.8	74	710	8.0	73	7-14	115-433
__Urophycis tenuis__ (white hake)	DFFGIIGDF	GEFEGF+++	750	715.7	105	354	312.6	105	2-18	23-379
__Anchoa hepsetus__ (striped anchovy)	+	+ ++	1	0.1	1	1065	16.9	4	13-22	20-123
__Glyptocephalus cynoglossus__ (witch flounder)	+FFGICGGF	+EFEFF+++	765	222.2	207	244	133.7	71	2-15	22-433
__Prionotus evolans__ (striped searobin)	+HG+HGEE+	++BA++ ++	793	216.9	57	72	17.9	25	6-20	20-341
__Gadus morhua__ (Atlantic cod)	AAABCAABB	C+++++ ++	666	2190.9	190	185	562.5	36	2-17	22- 91

APPENDIX C (con't.)

	SPECIES GROUP		ABUNDANCE						ENVIRONMENTAL RANGES	
	SPRING	FALL	SPRING CRUISES			FALL CRUISES				
	196- 197- 890123456	196- 197- 789012345	N	WEIGHT (KG.)	NO. OCC.	N	WEIGHT (KG.)	NO. OCC.	TEMP. RANGE (ºC)	DEPTH RANGE (M)
Phycis chesteri (longfin hake)	+++CI++ +	+++++++F+	481	36.5	36	259	14.1	31	6-14	165-433
Alosa sapidissima (American shad)	D++++C+D+	+++BG+ ++	388	97.2	114	151	32.6	32	3-17	26-280
Peristedion miniatum (armored searobin)	EI ++HFGF	I++F+GEEF	346	44.5	80	181	20.9	65	5-18	27-347
Hemitripterus americanus (sea raven)	AABECAA+A	+CEHDF+++	256	134.4	124	130	46.2	69	2-18	26-327
Pomatomus saltatrix (bluefish)	+++	++++ACACA	13	16.5	8	369	441.2	77	7-22	20-102
Menidia menidia (Atlantic silverside)	AC A+ ++		372	5.2	42				2-14	20-203
Decapterus punctatus (round scad)	+ +	++ + +A	23	0.2	2	329	9.0	17	10-23	22- 95
Melanogrammus aeglefinus (haddock)	+B+++++++	+++BC +++	165	281.2	34	146	68.4	37	3-15	35-115
Hippoglossoides platessoides (American plaice)	ABBB+++	DE++++	160	39.1	57	147	36.9	39	2-15	37-338
Monacanthus hispidus (planehead filefish)		A+B++++C+				288	17.8	81	8-22	20-243
Stomiatoidei	+ + ++	+++	97	3.7	11	187	3.1	27	6-21	18-366
Ceratoscopelus maderensis (horned lanternfish)	+ +	+ ++ + +	140	0.9	9	103	1.1	11	8-13	86-341
Cynoscion regalis (weakfish)	++++++ +	+ +++++	150	175.9	12	54	14.4	10	6-22	22-135
Tautogolabrus adspersus (cunner)	++ ++++	+++++ +	159	51.8	15	36	23.1	9	3-15	27- 86
Anchoa mitchilli (bay anchovy)	+ +	+ +	8	0.2	2	168	0.6	2	5-21	22- 46
Sphoeroides maculatus (northern puffer)	+	+++ ++++	1	0.1	1	169	9.5	17	13-22	18-187
Decapterus macarellus (mackerel scad)		A+B+ +				169	6.4	35	9-21	16-271
Sebastes marinus (redfish)	+ ++ ++	+ +++	158	14.3	7	6	0.8	4	3-14	37-336
Etropus sp.		+				162	0.7	3	12-15	22- 48
Etropus microstomus (smallmouth flounder)	+ +++	++	149	2.1	21	12	0.8	8	2-22	18- 68
Trachurus lathami (rough scad)	++ +	+ ++++ +	27	0.6	6	124	5.8	16	8-22	20-212
Triglops murrayi (moiled sculpin)	++ +		149	0.7	3				3- 4	60- 69
Squatina dumerili (Atlantic angel shark)	+++E++ +	++A++++A+	84	102.1	29	58	390.5	35	6-23	18-320
Zenopsis conchifera (buckler dory)	++++++ ++	+++F++E++	42	7.4	22	82	8.0	51	7-18	33-335
Nezumia bairdii (marlin-spike)	+++++++ +	++++IH++	67	3.4	27	53	3.4	30	6-14	119-366
Scyliorhinus retifer (chain dogfish)	+++++++++	+++++++++	84	14.9	36	27	6.7	24	7-16	80-320
Nemichthys scolopaceus (slender snipe eel)	H+ +G+	+ + +	73	2.2	22	29	0.5	5	8-13	68-349
Raja eglanteria (clearnose skate)	++ +++ +	++A++AA++	30	16.4	21	69	57.0	36	6-22	18-336
Raja garmani (rosette skate)	++ ++++G+	+++++G+++	26	5.7	22	69	12.4	40	7-21	27-338
Argentina silus (Atlantic argentine)	+ +++++	+++++++	47	2.1	20	45	4.5	20	7-14	80-340
Conger oceanicus (conger eel)	+++G+	+++ +++++	56	24.1	31	34	12.8	26	8-21	21-252
Macrouridae	+ + +	+ + ++	8	0.6	6	77	2.8	15	7-13	213-433
Engraulidae	+	++	58	0.1	1	23	0.4	4	9-19	31-333
Polyipnus asteroides (hatchet fish)	++++ +	+++++ ++	42	1.3	13	35	1.8	18	6-13	174-433
Enchelyopus cimbrius (fourbeard rockling)	++++ +++	+++++F+++	18	1.8	18	54	4.5	26	2-15	40-329
Pollachius virens (pollock)	++ +++ +B	CD+++	30	171.9	20	38	17.1	13	3-15	38-150
Cyclopteridae	+	+ +++ ++	3	0.1	1	60	1.4	14	6-17	40-121
Myliobatiformes		+ ++++ +				61	1035.3	16	13-22	18- 37
Ogcocephalus vespertilio (longnose batfish)	+++++++	+ +++	39	2.3	19	20	1.1	11	7-14	33-338
Dasyatis americana (southern stingray)		+++ + +				35	1233.9	19	14-21	22- 59
Argyropelecus aculeatus (silver hatchetfish)	+G	+	43	0.8	8	5	0.5	5	8-13	183-333
Ophichthus cruentifer (margined snake eel)	+ ++++ +	+ +++F+	14	1.6	12	31	2.1	21	5-23	38-379
Cynoglossidae	++ ++ +	+ +++	23	1.3	13	18	0.8	8	6-15	85-327
Brevoortia tyrannus (Atlantic menhaden)	+ + + +	+ +	38	3.5	8	3	1.0	2	4-19	20- 90

	SPECIES GROUP		ABUNDANCE						ENVIRONMENTAL RANGES	
	SPRING	FALL	SPRING CRUISES			FALL CRUISES				
	196- 197- 890123456	196- 197- 789012345	N	WEIGHT (KG.)	NO. OCC.	N	WEIGHT (KG.)	NO. OCC.	TEMP. RANGE (ZC)	DEPTH RANGE (M)
Coelorinchus carminatus (longnose grenadier)	+ ++++	+ +	29	1.2	7	11	0.4	4	8-12	187-341
Myliobatis fremimvillei (bullnose ray)		++ +++				38	268.7	13	17-22	22- 35
Ophichthidae	+	+	6	0.5	5	31	0.4	4	8-14	113-433
Raja laevis (barndoor skate)	++++ ++	++ +	27	65.5	15	10	7.0	8	3-20	38-196
Etmopterus princeps	+ +	+	22	1.6	3	15	0.6	2	8-11	183-341
Anguilliformes	+ +++ +++	++	34	3.8	15	2	0.2	2	8-13	33-329
Dasyatis centroura (roughtail stingray)		+ + A+++				36	527.5	17	13-21	24- 40
Centroscyllium fabricii (black dogfish)	+ +	+ +++	32	1.2	5	4	0.4	4	9-16	115-349
Epigonus sp.	+	+	26	0.1	1	8	0.2	2	8-11	205-338
Macrorhamphosus scolopax (longspine snipefish)	++ + ++	+ ++++	17	1.0	10	17	0.9	9	9-14	73-433
Lopholatilus chamaeleonticeps (tilefish)	+ +++++G+	+ +++	27	110.0	22	6	22.9	5	10-15	104-333
Raja radiata (thorny skate)	++++ ++	+	30	22.8	8	1	2.7	1	3-10	60-340
Dasyatis sayi (bluntnose stingray)		+ + +++				30	359.7	8	17-21	22- 33
Triglidae	+	+	27	2.5	4	2	0.1	1	10-13	35-274
Pleuronectiformes	+	+	27	0.5	5	1	0.1	1	4-13	22-320
Seriola dumerili (amberjack)		++ +				27	13.7	6	13-21	22- 44
Ephippidae	++ +		22	1.1	11				8-13	117-333
Hoplostethus mediterraneus (rosy soldierfish)	+	+	19	0.1	1	3	0.2	2	9-11	205-276
Stomias affinis	++	+ ++	2	0.2	2	19	0.4	4	8-13	183-335
Rhinoptera bonasus (cownose ray)		+				20	160.2	2	21-21	18- 29
Trichiurus lepturus (Atlantic cutlassfish)	+ ++	+++	5	1.6	3	14	1.3	5	9-22	22-433
Synagrops bellus (blackmouth bass)	+	+ +	4	0.2	2	15	0.5	5	10-13	84-338
Carcharhinus obscurus (dusky shark)	+	+++ +	3	21.3	2	16	315.7	13	12-21	18-124
Gonostoma elongatum (longtooth anglemouth)	++	+ ++	5	0.3	3	13	0.4	4	8-11	219-338
Carcharhinus plumbeus (sandbar shark)	+	+ ++A	4	36.0	2	14	128.4	12	11-19	22-121
Selene setapinnis (Atlantic moonfish)		+ +				17	0.6	6	12-21	26-271
Syngnathus fuscus (northern pipefish)	+ + + ++	+	16	1.3	13	1	0.1	1	3-11	24- 95
Cryptacanthodes maculatus (wrymouth)	+++++ +	+++++	7	1.0	6	9	0.9	5	3-12	53-433
Antigonia capros (deepbody boarfish)	+ +	+ ++	11	0.4	4	4	0.3	3	9-13	124-311
Diaphus dumerilii (headlight fish)	+	+	11	0.1	1	4	0.1	1	10-11	148-221
Simenchelys parasiticus (slime eel)	+		15	0.5	5				6-11	102-311
Odontaspis taurus (sand tiger)	+	+ +	3	18.6	1	12	58.1	4	11-21	26- 66
Elasmobranchii		+ + ++				15	179.7	7	5-23	31-320
Orthopristis chrysoptera (pigfish)		+ +				14	1.0	3	18-19	26- 31
Torpedo nobiliana (Atlantic torpedo)	++++ ++	+ + +	10	108.0	10	4	128.4	3	8-17	33-349
Scomber japonicus (chub mackerel)		+ +				13	1.6	3	9-10	71-176
Priacanthus arenatus (bigeye)		+ + +				13	1.6	3	8-19	31-340
Macrourus berglax (rough-headed grenadier)	+	+	12	0.5	1	1	0.1	1	10-10	280-357
Brosme brosme (cusk)	++	+	12	0.2	2	1	0.1	1	12-14	44-119
Ulvaria subbifurcata (radiated shanny)	+ +		12	0.5	5				3- 5	38- 60
Selar crumenophthalmus (bigeye scad)		++ +				12	0.6	6	10-21	22- 44
Ventrifossa occidentalis	H++	+	11	0.8	8	1	0.1	1	8-13	187-338
Merlucciidae	++	+ + ++	7	0.4	4	5	0.4	4	7-13	57-341
Chauliodus sloani (viperfish)	+ +	++ +	4	0.3	3	8	0.7	7	8-13	128-340

APPENDIX G (con't.)

	SPECIES GROUP		ABUNDANCE						ENVIRONMENTAL RANGES	
	SPRING	FALL	SPRING CRUISES			FALL CRUISES				
	196- 197- 890123456	196- 197- 789012345	N	WEIGHT (KG.)	NO. OCC.	N	WEIGHT (KG.)	NO. OCC.	TEMP. RANGE (ºC)	DEPTH RANGE (M)
Gaidropsarus ensis (Artic threebeard rockling)	· +		11	0.4	4				9-13	78-341
Raja senta (smooth skate)	+	+ ++++ +	1	0.1	1	10	5.0	9	7-21	29-327
Tautoga onitis (tautog)	+ ++ +		10	6.1	5				5- 7	22- 29
Dibranchus atlanticus (Atlantic batfish)	+	+	6	0.4	3	4	0.3	3	7-13	124-324
Parasudis truculenta (longnose greeneye)	+		10	0.7	2				8-11	244-254
Gymnura altavela (spiny butterfly ray)		+ +				10	274.9	3	14-21	26- 68
Monolene sessilicauda (deepwater flounder)	+ ++ +	+ +	5	0.9	5	3	0.3	3	7-11	190-338
Halichoeres bivittatus (slippery dick)	+		8	0.4	4				6- 7	24- 40
Seriola zonata (banded rudderfish)		++ ++				8	1.2	5	11-22	22-102
Otophidium omostigmum (polka-dot cusk-eel)	+	+ +	1	0.1	1	7	0.2	2	8-13	123-283
Sternoptychidae	+		8	0.5	5				8-10	227-341
Alosa mediocris (hickory shad)	+		8	3.3	3				6- 7	35- 68
Polymixia nobilis	+ +	+ + +	4	0.3	3	3	0.3	3	10-19	35-311
Balistes capriscus (gray triggerfish)		+ +++				6	0.6	6	7-22	20-137
Pholis gunnellus (rock gunnel)	+ +	+ +	3	0.3	3	3	0.3	3	4-12	44- 88
Synagrops spinosus		+				6	0.2	2	11-13	225-338
Prionotus ophryas (bandtail searobin)		+				6	0.1	1	19-19	31- 31
Ophidion marginatum (striped cusk-eel)	++	+ +	4	0.4	3	2	0.6	2	5-21	24- 59
Chlorophthalmidae	+	+	2	0.1	1	4	0.2	2	9-12	213-397
Gonostomatidae	+		6	0.2	2				9-11	205-341
Squalidae		+				6	0.1	1	13-13	333-333
Promethichthys prometheus (rabbitfish)		++				5	0.2	2	10-10	126-276
Serranidae		+				5	0.1	1	15-15	27- 27
Lycenchelys verrillii (wolf eelpout)	+		5	0.2	2				9-11	205-341
Myctophum punctatum (spotted lanternfish)		+				5	0.1	1	11-11	148-148
Synodontidae		++				5	1.1	4	18-25	22- 33
Ariomma bondi (silver-rag)		+ + +				4	0.3	3	7-17	38-322
Lumpenus maculatus (daubed shanny)	+		4	0.2	2				4- 4	55- 55
Menticirrhus saxatilis (northern kingfish)	+ +	+	3	1.1	2	1	0.1	1	9-14	29- 64
Caranx crysos (blue runner)		+++				4	0.3	3	14-22	18- 86
Melanonus zugmayeri	+	+	3	0.2	2	1	0.1	1	8-11	234-292
Physiculus fulvus (hakeling)	+ ++	+	3	0.3	3	1	0.1	1	13-13	119-329
Osmerus mordax (rainbow smelt)	+		4	0.1	1				4- 4	44- 44
Hippoglossus hippoglossus (Atlantic halibut)	+ +	+	2	23.6	2	1	5.4	1	4-13	33- 69
Scomberomorus maculatus (Spanish mackerel)		++				3	5.0	2	19-25	27- 29
Bembrops gobioides (goby flathead)	+	+	1	0.1	1	2	0.1	1	4-14	29-146
Lachnolaimus maximus (hogfish)		+				3	0.1	1	13-13	256-256
Apogonidae	+		3	0.2	2				11-11	128-165
Selene vomer (lookdown)		+ +				3	0.3	3	17-21	29- 42
Carangidae	+ +	+	2	0.2	2	1	0.1	1	10-13	66-210
Dactylopterus volitans (flying gurnard)		+				3	0.6	2	20-20	24- 37
Prionotus tribulus (bighead searobin)		+				3	0.1	1	19-19	31- 31
Fistularia tabacaria (bluespotted cornetfish)		+ +				3	0.3	3	11-16	40- 69
Gasterosteus aculeatus (threespine stickleback)	+ + +		3	0.3	3				4- 5	46-276

APPENDIX C (con't.)

	SPECIES GROUP		ABUNDANCE						ENVIRONMENTAL RANGES	
	SPRING	FALL	SPRING CRUISES			FALL CRUISES				
	196- 197- 890123456	196- 197- 789012345	N	WEIGHT (KG.)	NO. OCC.	N	WEIGHT (KG.)	NO. OCC.	TEMP. RANGE (°C)	DEPTH RANGE (M)
Ophidiidae	+ +		3	0.3	3				8-10	27-300
<u>Echiophis</u> sp.		+				3	0.1	1	9- 9	433-433
<u>Aetobatus</u> <u>narinari</u> (spotted eagle ray)		+				3	1.8	1	21-21	24- 24
<u>Aluterus</u> <u>schoepfi</u> (orange filefish)		+				2	1.0	2	22-22	20- 22
<u>Poecilopsetta</u> <u>beanii</u>		+				2	0.1	1	8- 8	335-335
<u>Etropus</u> <u>crossotus</u> (fringed flounder)	+	+	1	0.1	1	1	0.1	1	5-16	24- 37
<u>Hyperoglyphe</u> <u>perciformis</u> (barrelfish)	+	+	1	0.1	1	1	0.1	1	11-12	146-229
<u>Benthodesmus</u> <u>atlanticus</u> (snake mackerel)		+				2	0.2	2	9-13	157-433
<u>Anarhichas</u> <u>lupus</u> (Atlantic wolffish)	+		2	39.0	1				4- 4	69- 69
<u>Sphyraena</u> <u>borealis</u> (northern sennet)	+	+	1	0.1	1	1	0.1	1	10-25	29-219
<u>Rachycentron</u> <u>canadum</u> (cobia)		++				2	51.3	2	17-25	29- 35
<u>Centropristis</u> <u>philadelphica</u> (rock sea bass)		+				2	0.1	1	19-19	31- 31
<u>Cyclopterus</u> <u>lumpus</u> (lumpfish)	++		2	8.2	2				4- 5	49- 55
<u>Melanostigma</u> <u>atlanticum</u> (Atlantic soft pout)	+		2	0.1	1				14-14	335-335
<u>Ophidion</u> <u>grayi</u> (blotched cusk-eel)	+	+	1	0.1	1	1	0.1	1	9-10	41- 60
<u>Paralepis</u> <u>atlantica</u> (duckbill barracudina)	+	+	1	0.1	1	1	0.1	1	10-12	136-232
<u>Synodus</u> <u>poeyi</u> (offshore lizardfish)		+				2	0.2	2	16-16	192-241
<u>Synodus</u> <u>foetens</u> (inshore lizardfish)	+	+	1	0.1	1	1	0.1	1	9-14	32-249
<u>Opisthonema</u> <u>oglinum</u> (Atlantic thread herring)		+				2	0.5	1	22-22	24- 24
Rajiformes		+ +				2	0.6	2	8-11	40- 71
<u>Parahollardia</u> <u>lineata</u> (jambeau)	+		1	0.1	1				12-12	261-261
<u>Lagocephalus</u> <u>laevigatus</u> (smooth puffer)	+		1	0.1	1				13-13	115-115
<u>Symphurus</u> <u>marginatus</u>	+		1	0.1	1				13-13	78- 78
<u>Lepidocybium</u> <u>flavobrunneum</u> (escolar)	+		1	0.5	1				11-11	244-244
<u>Xiphias</u> <u>gladius</u> (swordfish)		+				1	5.9	1	11-11	117-117
<u>Scomberomorus</u> <u>cavalla</u> (king mackerel)		+				1	4.1	1	18-18	31- 31
<u>Lumpenus</u> <u>lumpretaeformis</u> (snake blenny)	+		1	0.1	1				5- 5	35- 35
<u>Gnathagnus</u> <u>egregius</u> (freckled stargazer)		+				1	0.1	1	13-13	225-225
Uranoscopidae	+		1	0.1	1				11-11	205-205
Lutjanidae	+		1	0.1	1				13-13	78- 78
<u>Remora</u> <u>remora</u> (remora)		+				1	0.1	1	25-25	29- 29
<u>Careproctus</u> <u>ranula</u>		+				1	0.1	1	9- 9	283-283
<u>Myoxocephalus</u> <u>aenaeus</u> (grubby)	+		1	0.1	1				4- 4	69- 69
<u>Myoxocephalus</u> <u>scorpius</u> (shorthorn sculpin)	+		1	0.1	1				5- 5	77- 77
<u>Prionotus</u> <u>paralatus</u> (Mexican searobin)		+				1	0.1	1	12-12	106-106
<u>Aulostomus</u> <u>maculatus</u> (trumpetfish)		+				1	2.3	1	18-18	27- 27
<u>Hippocampus</u> <u>erectus</u> (lined seahorse)		+				1	0.1	1	10-10	276-276
<u>Antimora</u> <u>rostrata</u> (blue hake)		+				1	0.1	1	9- 9	433-433
Ogcocephalidae		+				1	0.1	1	13-13	101-101
<u>Antennarius</u> <u>radiosus</u> (singlespot frogfish)	+		1	0.1	1				10-10	55- 55
Clupeidae		+				1	0.1	1	10-10	276-276
<u>Sphyrna</u> <u>lewini</u> (scalloped hammerhead)		+				1	11.3	1	14-14	113-113
<u>Rhizoprionodon</u> <u>terraenovae</u> (Atlantic sharpnose shark)		+				1	6.3	1	22-22	22- 22
ALL STATIONS			585125	169069	1023	494527	75860	999	2-25	16-433

LITERATURE CITED

Bigelow, H. B. 1933. Studies of the waters on the continental shelf, Cape Cod to Chesapeake Bay. I. The cycle of temperature. Pap. Phys. Oceanogr. Meterol. 2:1-135.

Bigelow, H. B., and W. C. Schroeder. 1953. Fishes of the Gulf of Maine. U.S. Fish Wildl. Serv., Fish. Bull. 53. 577 p.

Bloom, S. A. 1981. Similarity indices in community studies: potential pitfalls. Mar. Ecol. Prog. Ser. 5:125-128.

Boesch, D. F. 1977. Application of numerical classification in ecological investigations of water pollution. E.P.A., Ecol. Res. Series EPA-600/3-77-033. 115 p.

Briggs, J. C. 1974. Marine zoogeography. McGraw-Hill, N.Y., 475 p.

Brown, B. E., J. A. Brennan, M. D. Grosslein, E. G. Heyerdahl, and R. C. Hennemuth. 1976. The effect of fishing on the marine finfish biomass in the Northwest Atlantic form the Gulf of Maine to Cape Hatteras. Int. Comm. Northwest Atl. Fish. Res. Bull. 12:49-68.

Clark, S. H. and B. E. Brown. 1977. Changes in biomass of finfishes and squids from the Gulf of Maine to Cape Hatteras, 1963-74, as determined from research vessel survey data. Fish. Bull 75(1):1-21.

Chittenden, M. E. and J. D. McEachran. 1976. Composition, ecology and dynamics of demersal fish communities on the Northwestern Gulf of Mexico continental shelf, with a similar synopsis for the entire Gulf. Texas A&M University Sea Grant Publ. TAMU-SG-76-208. 104 p.

Clifford, H. T. and W. T. Stephenson. 1975. Introduction to numerical classification. Academic Press, N.Y. 229 p.

Colton, J.B., Jr. 1972. Temperature trends and the distribution of groundfish in continental shelf waters, Nova Scotia to Long Island. Fish. Bull., U.S. 70:637-657.

Colvocoresses, J. A. and J. A. Musick. 1979. Historical community structure analysis of finfishes. Section II: NMFS Groundfish Survey. Va. Inst. Mar. Sci. Spec. Rep. Appl. Mar. Sci. Ocean Eng. 198, 211 p.

Davis, C. W. 1979. Bottom-water temperature trends in the Middle Atlantic Bight during spring and autumn, 1964-76. NOAA Tech. Rep. NMFS SSRF-739, 13 p.

Day, D. S. and W. G. Pearcy. 1968. Species associations of benthic fishes on the continental shelf and slope off Oregon. J. Fish. Res. Board Can. 25(12):2665-2675.

Emery, K. O. and E. Uchupi. 1972. Western North Atlantic: topography, rocks, structure, water, life and sediments. Amer. Assoc. Petr. Geol., Tulsa, 532 p.

Fager, E. W. and A. R. Longhurst. 1968. Recurrent group analysis of species assemblages of demersal fish in the Gulf of Guinea. J. Fish. Res. Board Can. 25(7):1405-1421.

Grosslein, M. D. 1969. Groundfish survey program of BCF Woods Hole. Commer. Fish. Rev. 31(8-9):22-35.

Guenther, W. C. 1964. Analysis of variance. Prentice-Hall Inc., Englewood Cliffs, N.J. 199 p.

Hazel, J. E. 1970. Atlantic Continental Shelf and slope of the United States. Ostracod zoogeography in the southern Nova Scotian and northern Virginian faunal provinces. U.S. Geol. Surv. Prof. Paper 529-E:1-21.

Helfman, G. S. 1978. Patterns of community structure in fishes: summary and overview. Env. Biol. Fish. 3(1):129-148.

Horn, M. H. 1970. Systematics and biology of the stromateid fishes of the genus Peprilus. Bull. Mus. Comp. Zool. 140:165-261.

Ketchum, B. H. and N. Corwin. 1964. The persistence of "winter" water on the continental shelf south of Long Island, New York. Limnol. Oceanogr. 9(4): 467-475.

Lambert, J. M. and W. T. Williams. 1962. Multi-variate methods in plant ecology. IV. Nodal analysis. J. Ecol. 50:775-802.

Lance, G. N. and W. T. Williams. 1967. Mixed-data classificatory programs. I. Agglomerative systems. Australian Computer J. 1:15-20.

Leim, A. H. and W. B. Scott. 1966. Fishes of the Atlantic coast of Canada. Fish. Res. Board Can. Bull. 155. 485 p.

Margalef, D. R. 1958. Information theory in ecology. Gen. Syst. 3: 36-71.

McKeown, B. A. 1984. Fish migration. Croom Helm. London. 224 p.

Musick, J. A. 1972. Fishes of Chesapeake Bay and the adjacent coastal plain. Pages 175-212 in M. L. Wass et al., compilers. A check list of the biota of lower Chesapeake Bay. Va. Inst. Mar. Sci., Spec. Sci. Rep. 65.

Musick, J. A. 1974. Seasonal distribution of sibling hakes, Urophycis chuss and U. tenuis (Pisces, Gadidae) in New England. Fish Bull. 72:481-495.

Musick, J. A. 1976. Community structure of fishes on the continental slope and rise off the middle Atlantic Coast of the U.S. Abstr. Joint Oceanogr. Assembly, Edinburgh. 146 p.

Musick, J. A., J. A. Colvocoresses and E. J. Foell. 1985. Seasonality and the distribution, availability and composition of fish assembelages in Chesapeake Bight. In: "Fish Community Ecology in Estuaries and Coastal Lagoons: Towards an Ecosystem Integration"; A. Yanez-Arancibia, ed., Univ. Mexico Press.

Musick, J. A. and L. P. Mercer. 1977. Seasonal distribution of black seabass, Centropristis striata, in the mid-Atlantic Bight with comments on the ecology and fisheries of the species. Trans. Am. Fish. Soc. 106:12-25.

Parrack, M. L. 1973. Current status of the yellowtail flounder fishery in ICNAF Subarea 5. Int. Comm. Northwest Atl. Fish., Res. Doc. 73/104, Ser. No. 3067, 3 p.

Parr, A. E. 1933. A geographic ecological analysis of the seasonal changes in temperature conditions in shallow water along the Atlantic coast of the U.S. Bull. Bingham Oceanogr. Collect., Yale Univ. 4:1-90.

Pielou, E. C. 1975. Ecological diversity. John Wiley and Sons, New York, 165p.

Pielou, E. C. 1977. Mathematical ecology. John Wiley and Sons, New York. 385 p.

Richardson, S. L. and E. B. Joseph. 1973. Larvae and young of western north Atlantic bothid flatfishes Etropus microstomus and Citharichthys arctifrons in the Chesapeake Bight. Fish. Bull. 71(3):735-767.

Robins, C. R., R. M. Bailey, C. E. Bond, J. R. Brooker, E. A. Lachner, R. N. Lea and W. B. Scott. 1980. A list of common and scientific names of fishes from the United States and Canada. Amer. Fish. Soc. Spec. Publ. 12. 174 p.

Sauskan, V. I. and V. N. Ryzhov. 1977. Investigation of communities of demersal fish of Campeche Bank. Oceanology 17(2):223-227.

Scott, J. S. 1982. Selection of bottom type by groundfishes of the Scotian Shelf. Can. J. Fish. Aquat. Sci. 39:943-947.

Sedberry, G. R. 1983. Food habits and trophic relationships of a community of fishes on the Outer Continental Shelf. NOAA Tech Rep. NMFS SSRF-773. 56 p.

Sedberry, G. R. and R. F. Van Dolah. 1984. Demersal fish assemblages associated with hard bottom habitat in the South Atlantic Bight of the U.S.A. Envir. Biol. Fishes 11(4):241-258.

Sneath, L. H. A. and R. R. Sokal. 1973. Numerical taxonomy. W. H. Freeman, San Francisco, 573 pp.

Stephenson, E., W. T. Williams and S. D. Cook. 1972. Computer analyses of Peterson's original data on bottom communities. Ecol. Monogr. 42:387-415.

Struhsaker, P. 1969. Demersal fish resources: Composition, distribution and commercial potential of the continental shelf stocks off the Southeastern United States. U.S. Fish Wildl. Serv., Fish. Ind. Res. 4:261-300.

Taylor, C. C. 1953. Nature of variability in trawl catches. U.S. Fish Wildl. Serv., Fish. Bull. 54:145-166.

Taylor, C. C., H. B. Bigelow, and H. W. Graham. 1957. Climatic trends and the distribution of marine animals in New England. U.S. Fish Wildl. Serv., Fish Bull. 57:293-345.

Thorson, G. 1957. Bottom communities. Pages 463-534 in J. W. Hedgepeth, ed. Treatise on marine ecology and paleoecology. Vol. I. Ecology. Geol. Soc. Am., Mem. 67.

Tyler, A. V. 1971. Periodic and resident components in communities of Atlantic fishes. J. Fish. Res. Board Can. 28(7):935-946.

Walford, L. A. and R. I. Wicklund. 1968. Serial atlas of the marine environment. Monthly sea temperature structure from the Florida Keys to Cape Cod. Am Geog. Soc., Folio 15.

Wenner, C. A. 1982. Species associations and day-night variability of trawl-caught fishes from the inshore sponge-coral habitat, South Atlantic Bight. Fish. Bull. 81(3):537-552.

Williams, W. T. 1971. Principles of clustering. Ann. Rev. Ecol. Syst. 2:303-326.

VITA

James Alden Colvocoresses

Born in Superior, Arizona, 5 March 1950. Attended Carnegie-Mellon Unviversity, the University of Miami (Fla.) and Tulane University, earning a Bachelor of Science degree (Biology) from the latter institution in May 1971. Recieved a Master of Arts degree in Marine Science from the College of William and Mary in May 1973.