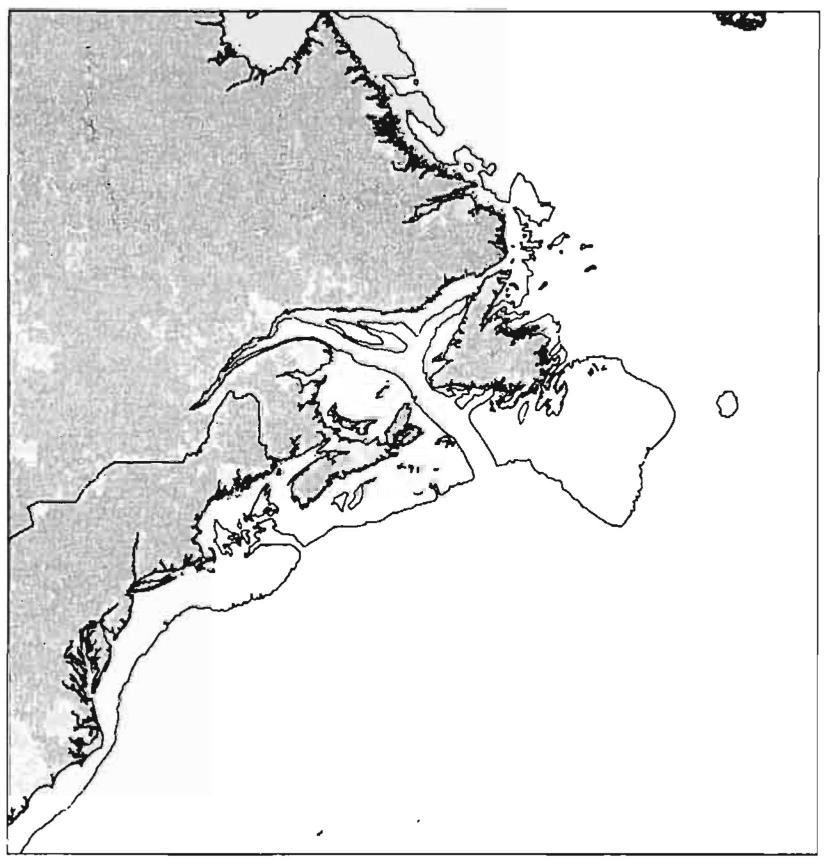
East Coast of North America Strategic Assessment Project

Partitioning the Total Mortality of Atlantic Cod Stocks Project

East Coast of North America Groundfish: Initial Explorations of Biogeography and Species Assemblages



Department of Fisheries and Oceans, Canada
and
National Oceanic and Atmospheric Administration, USA

August 1996

About the East Coast of North America Strategic Assessment Project

The East Coast of North America Strategic Assessment Project (ECNASAP) was initiated in the USA by NOAA's Strategic Environmental Assessments (SEA) Division to develop information and analytical resources for supporting integrated management of large portions of the region's coastal ocean. The ECNASAP Pilot Project consists of inshore and offshore case studies, and is a cooperative effort among several U.S. and Canadian agencies. Digital map and data products are being developed in the Offshore Case Study for groundfish, seabirds, temperature, salinity, and sediments. This report summarizes the initial results for the groundfish component.

About Partitioning the Total Mortality of Atlantic Cod Stocks Project

In 1995, Canada's Department of Fisheries and Oceans (DFO) initiated a series of research projects to address high priority issues for the Atlantic and Pacific coasts. The Cod Mortality Project is a component of this effort; its objective is to assess the main causes for the decline of cod resources since the mid-1980s. A subproject is to examine long-term changes in groundfish assemblages on a biogeographic scale, and to determine whether or not these changes coincided with changes in ocean climate. In collaboration with ECNASAP, this subproject is analysing groundfish community changes over the complete distributional ranges of many groundfish species, using trawl survey and environmental information from Cape Chidley to Cape Hatteras.

Internet Access

An abstract and ninety-nine species distribution maps derived from this report are available on the Internet. They can be accessed at: http://www-orca.nos.noaa.gov/ecnasap/ecnasap.html. ECNASAP products can also be accessed at: http://www.maritime.dfo.ca/science. The ECNASAP/Cod Mortality Project data sets can only be accessed through Stephen K. Brown at NOAA's SEA Division, Silver Spring, MD, USA (301/713-3000 ext. 181), or Robert N. O'Boyle at DFO's Bedford Institute of Oceanography, Dartmouth, NS, Canada (902/426-4890).

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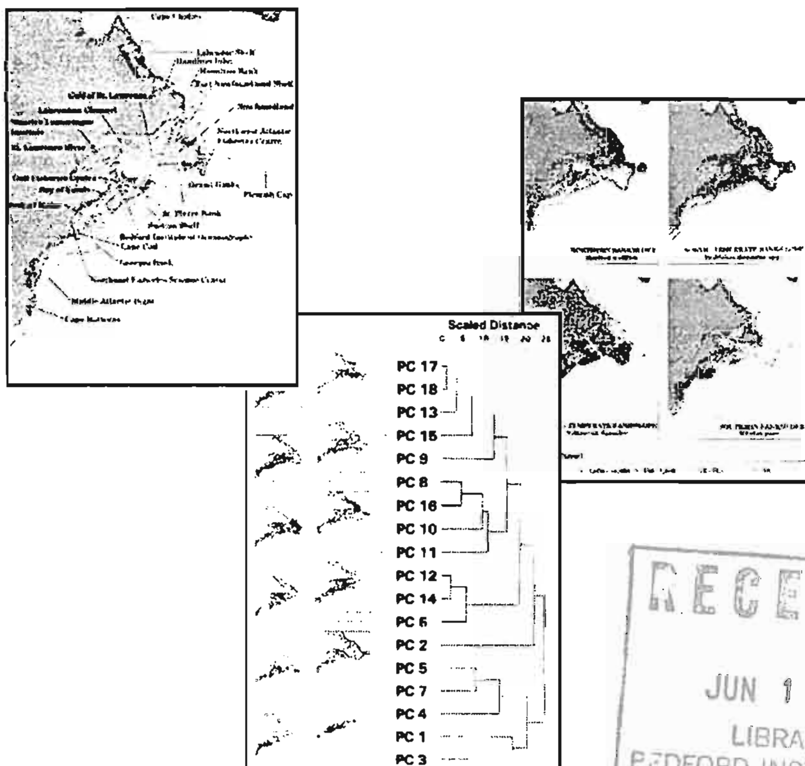

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Erratum

The data set used in the analyses of this report contains an error for Longnose eel (*Synaphobranchus kaupi*). The data analyzed comprise 3,678 individuals contained in the DFO data sets for the Northern Gulf of St. Lawrence and Newfoundland/Labrador regions. Data for an additional 458 individuals from the DFO Scotia-Fundy region were inadvertently omitted from the analysis. Readers should note that the common name for this species in the DFO Scotia-Fundy data set is Slatjaw cutthroat eel, and that the genus is incorrectly spelled as *Symaphobranchus* in that data set. These errors have been corrected in the ECNASAP/Cod Mortality Project data sets.

Table of Contents

List of Tables

List of Figures

EXECUTIVE SUMMARY

This report contains the initial analysis of research demersal trawl survey data for the east coast of North America from Cape Hatteras, North Carolina, USA in the south, to Cape Chidley, Labrador, Canada in the north, using individual trawl sets. The analyses were conducted as part of the process of defining and mapping demersal fish assemblages. The underlying goal is to describe and map species assemblages, and to evaluate evidence for ecological regime and assemblage distribution shifts on a decadal time scale. A related goal is to evaluate the extent to which the Atlantic cod decline along the east coast of North America can be explained by changes in the environment, as evidenced by changes in the ecosystem (Doubleday 1995). Because work is continuing on the project, recommendations are provided for future analyses, and implications of the results to data for fishery management are briefly discussed. The questions addressed in this report are:

- What are the demersal fish assemblages?
- What are the assemblage distributions, and what factors influence them?
- Are the assemblages stable over time?

This report, and several related data, mapping, and information products, are available on the Internet. Access instructions are provided inside the front cover.

This report is the result of a collaboration between the East Coast of North America Strategic Assessment Project (ECNASAP), a multi-partner collaboration among several Canadian and U.S. agencies, and the Canadian Department of Fisheries and Oceans' Cod Mortality Project. Strategic assessment products focused on living resources, habitats, and anthropogenic impacts in the coastal and oceanic regions of the east coast of North America are being developed under the ECNASAP Pilot Project (ACZISC and SEA Division 1995). The purpose is to provide resource and environmental managers with the information required to develop broad-scale and long-term management strategies. The Cod Mortality Project is focused on cod and ecosystem changes relevant to it. Both projects share a common goal - description of coastal ecosystems and changes in their characteristics over time.

Trawl survey data from Newfoundland and Labrador, the Northern Gulf of St. Lawrence, the Southern Gulf of St. Lawrence, the Scotian Shelf and Bay of Fundy, the Gulf of Maine, Georges Bank, and the Middle Atlantic Bight were combined into a single data set. The data were obtained from the four regional laboratories of the Canadian Department of Fisheries and Oceans and from the U.S. National Marine Fisheries Service's Northeast Fisheries Science Center. The combined data set contains one record per trawl tow; the variables are tow descriptors, environmental variables, and species catches. Files were created for both numbers caught and weight. Only the number caught per tow data were used in the analyses contained in this report. No attempt was made to intercalibrate the data from the different surveys, based on the assumption that strong signals would be detectable, even if differing trawl gears and vessels introduced some biases into the data set.

The trawl survey data were analysed using three different approaches to determine the patterns of demersal fish assemblages: visual analysis, principal components analysis (PCA), and cluster analysis. The first step was to generate distribution maps for the 108 most abundant demersal species. Nine species groups, based on spatial distribution and depth, were identified by visual inspection of the distribution plots. PCA of 66 species in 39,694 trawls sets, covering the major survey months from 1975 through 1994, extracted 18 principal components with eigenvalues > 1. The species with high loadings on a component were assumed to have a common distribution pattern, and were termed an assemblage. Site scores on the PCs were used to map spatial distribution of the assemblages, which exhibited considerable spatial coherence. These assemblages were characterized in terms of spatial distribution and preferences for depth and temperature. Using the same data set, species and sites were also subjected to cluster analyses, and the site cluster groups at the level of 18 groups were mapped. They also exhibited substantial spatial coherence. Similarities were noted between the assemblages detected in this project and those reported in several other previous studies, which typically covered only a portion of the ECNASAP/Cod Mortality Project study area.

The species groups derived from the various methods were compared, and several groups of species were found to emerge from all three approaches. Atlantic cod was grouped with thorny skate and American plaice by all of the methods. There was significant, but not one-to-one, correspondence between the site groups produced by PCA and cluster analysis. However, in both analyses, about 45% of the sites did not belong to an assemblage, suggesting that the demersal fish community of 1975-94 may not have been tightly structured into functional assemblages.

Temporal variation in abundance was examined using both single species and multivariate approaches. Presence/absence maps, and bivariate ellipses of latitude and longitude containing 50% of the individuals caught, were generated for five-year intervals for four test species. The results show that arctic cod has steadily extended its range southward since the 1980s, while the northern extent of Atlantic cod has contracted since 1990. Canonical discriminant analysis was performed on the same data set that was used for the PCA and cluster analyses, and yearly means for the first two canonical variables were plotted. Yearly means generally followed a linear trend through time for the first canonical variable, but the mid-1980s were quite distinct from 1975-81 and the 1990s for the second canonical variable. Species correlations with the first two canonical variables were also plotted; Atlantic cod had a strong negative correlation with the second canonical variable.

Recommendations for future analyses are provided. One major issue addressed is development of better methods for characterizing relationships between ubiquitous species, such as Atlantic cod, and the assemblages. The analytical techniques used to identify assemblages (PCA and cluster analysis) are designed to identify unique patterns of co-occurrence, which generally exist for species that co-occur at high frequency over relatively limited areas. Ubiquitous species co-occur with these species, but at relatively low frequencies relative to their overall distributions, and, therefore, are not strongly associated with the assemblages identified by these techniques.

Another major recommendation is to take greater advantage of GIS for mapping and analyzing the information. Many earlier studies of demersal assemblages and biogeography relied on less sophisticated methods for spatial and geographic analysis. However, GIS technology has greatly increased the analytical power available for such studies.

Several suggestions for new analyses are provided, which are intended either to improve upon the existing analyses, or to provide additional insights into the structure and function of the groundfish community. The purpose of the suggestions is to enable a better characterization of the biological and environmental systems in which the groundfish, and fishing, occur. The suggested new analyses are as follows.

- Effects of different gear on the trawl data: correcting the data for biases caused by the use of differing trawl gear by the different survey programs may provide more detailed results for assemblage analyses.

- Effects of spatial/temporal sampling bias: characterizing the effects of variation in sampling distribution over time may reduce possible artifacts, caused by sampling patterns, in the detection of temporal changes in spatial distribution.

- Size: including fish size and age in future assemblage analyses may provide more detailed results for species that change their ecological roles or habitat associations as they grow.

- Distribution and environment: analyzing relationships between species/assemblage distributions and the environmental characteristics that determine habitat may enable a better understanding of the biological and environmental systems within which groundfish exist, and a better definition of the context within which fishery activities may be managed.

- Fishing: Relating spatial and temporal patterns of fishing activity with spatial and temporal patterns of fish distribution and abundance may allow a credible analysis of the relative influences of anthropogenic and environmental factors.

Implications for fishery management are briefly discussed; this subject should be covered in more detail in the future. The following issues are addressed.

- If functional groupings exist in the groundfish community that can be viewed as ecological entities, harvest strategies could target assemblages, rather than single species. Management strategies could then be adapted to optimize harvest of assemblages, rather than single species. The initial analyses suggest that, when viewed over the entire study area, most groundfish assemblages are rather loose in structure. Additional analyses are required to determine the extent to which functional relationships exist within this loose framework.

- Assemblage information can be used as background for spatial allocation of fishing effort aimed at optimally harvesting a set of single species quotas, while reducing bycatch, as now being pursued by the U.S. National Marine Fisheries Service.

- Initial biogeographic analyses suggest the North Atlantic Fisheries Organization (NAFO) management areas may not recognize important distributional features. Also, initial temporal analyses show that species distributions can change over time, suggesting that stock distributions may shift among the static NAFO areas.

- A key basic assumption of many fisheries assessment and management models, that stocks represent closed populations within standard regions, may frequently be violated. This study has shown that the geographic limits of species distributions can vary over time, but fisheries management boundaries are static. Applying models to moving populations in static regions would violate this basic model assumption.

INTRODUCTION

Study Objectives

This report contains the analysis of research demersal trawl survey data for the east coast of North America from Cape Hatteras, North Carolina, USA in the south, to Cape Chidley, Labrador, Canada in the north, using individual trawl sets. The analyses were conducted as part of the process of defining and mapping demersal fish assemblages. The underlying goal is to describe and map species assemblages, and to evaluate evidence for ecological regime and assemblage distribution shifts on a decadal time scale. A related goal is to evaluate the extent to which the Atlantic cod decline along the east coast of North America can be explained by changes in the environment, as evidenced by changes in the ecosystem (Doubleday 1995). The questions addressed in this report are:

- What are the demersal fish assemblages?
- What are the assemblage distributions, and what factors influence them?
- Are the assemblages stable over time?

To answer these questions, three categories of analyses were undertaken: species by species descriptions of geographic distribution; multivariate analyses to define species assemblages; and evaluation of temporal variation in species and assemblage distributions.

Internet Access

Several related data, mapping, and information products are being made available on the Internet. Access instructions are provided inside the front cover.

Background

The East Coast of North America Strategic Assessment Project's (ECNASAP's) Offshore Case Study (ACZISC and SEA Division 1995) began in January 1994, and was completed in early 1996. Initial work focused on database compilation, analysis of fish community assemblages on the Scotian Shelf (Mahon 1995), and development of a desktop information system. In April 1995, a workshop was held to investigate expansion of the community analysis to include the Labrador Shelf, Grand Banks of Newfoundland, Gulf of St. Lawrence, and U.S. waters down to Cape Hatteras (O'Boyle, 1995). The Cod Mortality Project started in 1995 and is planned to last three years. While ECNASAP is examining many elements of the ecosystem, the Cod Mortality Project is focused on cod, and ecosystem changes relevant to it. However, both projects share a common goal - description of coastal ecosystems and changes in their characteristics over time. This report is the result of a collaboration between these two projects, and has benefited from a synergetic development of new ideas and knowledge, and from the efficiency of cooperative operations.

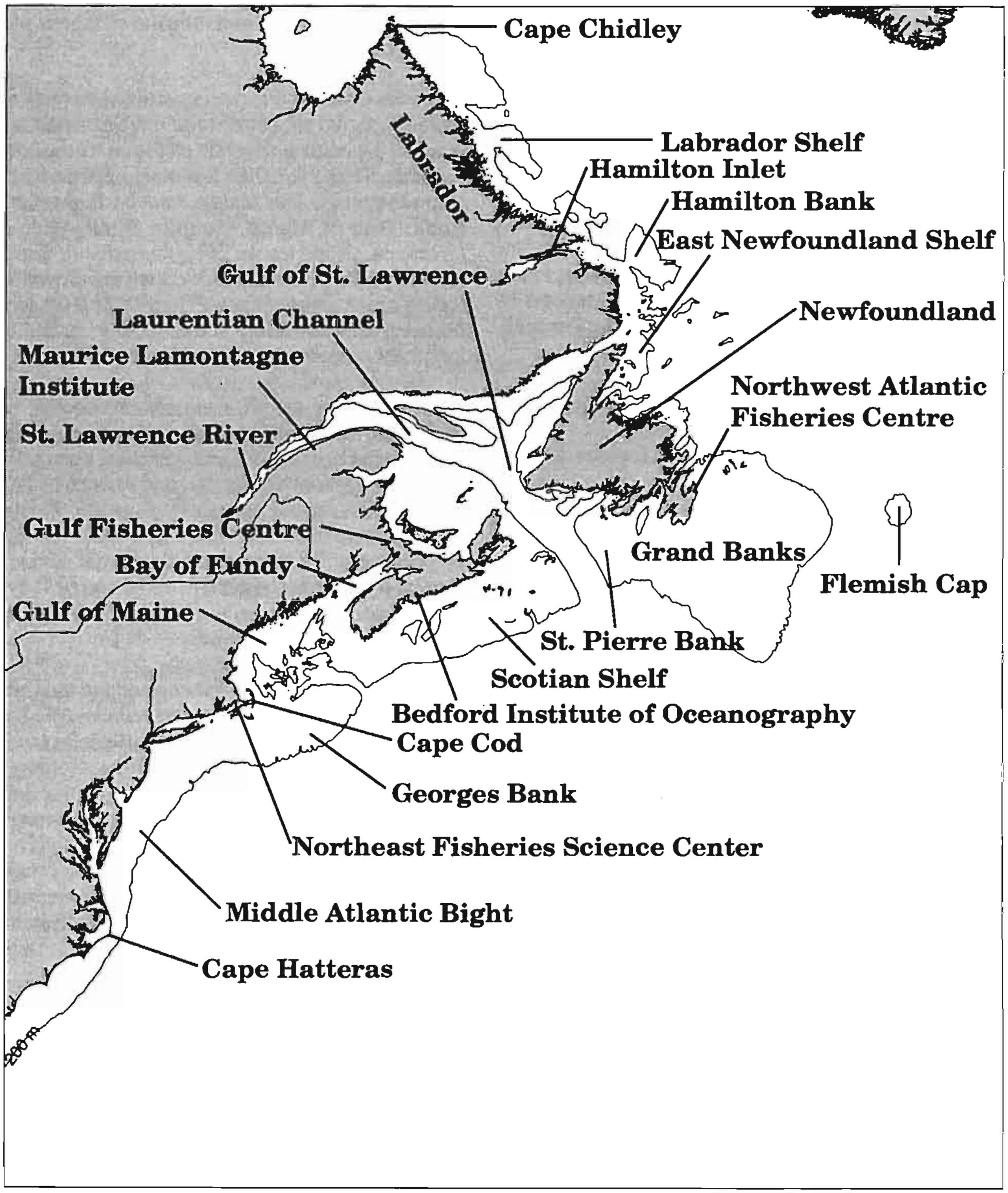
Since the Colonial era, demersal finfishes (groundfish) have supported substantial commercial fisheries along much of the continental shelf off the east coast of North America. These fisheries are most extensive north of Cape Hatteras. The Middle Atlantic Bight, Georges Bank, Gulf of Maine, Scotian Shelf, Gulf of St. Lawrence, Grand Banks of Newfoundland, East Newfoundland Shelf, and Labrador Shelf are all well-known fishing areas in the region (Figure 1). The fisheries are pursued using a variety of methods, including trawls, longlines, seines, and coastal fixed gear.

These fisheries target a variety of species, mainly gadids (the cod family), of which Atlantic cod and haddock are the best known, and flatfishes, such as American plaice, yellowtail flounder, and Atlantic halibut. Although each fishing operation generally targets only one or two species at a time, many demersal species co-occur, and the bycatch of non-target species can also be a valuable component of the catch. Therefore, most demersal fisheries, and trawl fisheries in particular, are multispecies in nature.

The history of groundfish fisheries off the east coast of North America is one of dramatic variations in landings and stock abundance (Sissenwine, 1986; Brown, 1987; Fogarty, *et al.* 1987; Angel *et al.* 1994; Gomes, *et al.* 1995). Most of the groundfish stocks in the area are currently or have been severely depleted. Although fishing is known to have been a driving force in the changes in groundfish abundance in the region, the relative effects of fishing, species interactions, and environmental variation remain poorly understood (Beddington 1986; Sissenwine 1986; Sherman 1990; Hutchings and Myers 1994).

The observation that little is understood about the ecosystem changes associated with removal of major quantities of fish biomass is true of all the ecosystems found off the east coast of North America, as well as for ecosystems in other parts of the world (Sherman and Alexander 1986). The geographical scale, ecological complexity, and multidisciplinary nature of the problem have hindered analysis and resolution. One thrust has been the large marine ecosystem (LME) concept being developed under the auspices of several U.S. and international organizations. Efforts have been under-

Figure 1. Study area map with place names.



taken to characterize the LMEs of the world and to promote LME research (Sherman and Alexander 1986, 1989; Sherman *et al.* 1990, 1993).

From a fisheries management point of view, a more direct approach to examining the possible effects of species interactions and environment on exploited fishery resources is to explore distributional patterns of demersal fish assemblages, and the effects of environmental variation on those patterns. Assemblages are groups of species that tend to occur together, either because they have similar habitat preferences, or because the species interact. The description and mapping of assemblages can indicate where various combinations of species may be caught by fishing, and where fishing may affect non-target species. It is the starting point in the process of examining possible interactions among species. The patterns alone do not indicate that species are interacting, but they do indicate where interactions are most likely to be taking place. Assemblages may also provide insight into the scale of biogeography and ecosystem processes, and thus provide a context for marine resource conservation and management.

There have been several previous studies of demersal fish assemblages on parts of the continental shelf off the east coast of North America (Colvocoresses and Musick 1984, Mahon and Sandeman 1985, Overholtz and Tyler 1985; Mahon and Smith 1989, Gabriel 1992, Gomes *et al.* 1992, Gomes 1993, Gomes *et al.* 1995, Guadalupe Villagarcia 1995), but the entire region has only been examined in one other study (Mahon and Sandeman 1985). Assemblages on the northern Labrador Shelf remain poorly known. Mahon and Sandeman (1985) analyzed 1970-80 trawl survey data from Cape Hatteras, North Carolina to Cape Chidley, Labrador by aggregating trawl sets into bands about 30 nmi in width. That approach, which was aimed at investigating broad biogeographical patterns, imposed the 30-nmi limit on the spatial scale at which assemblages could be resolved.

To better resolve the spatial distribution of assemblages, and to allow analysis of the effects of depth and other environmental factors on assemblage distribution, it is necessary to use the data in the least aggregated form possible. The analyses conducted for this report include the entire time series of available data, and address the needs of both ECNASAP and the Cod Mortality Project.

The analyses described in this report, although extensive, are merely the beginning of what will be a major international research effort. Substantial follow-up work is envisioned on most of the analyses completed to date, and many potentially useful lines of inquiry have not yet been undertaken. Therefore, this report contains several recommendations for refinement of the analyses already undertaken, as well as for new analyses.

THE DATA SET

This study comprises analyses of data collected by demersal (groundfish) research trawl surveys from 1970-1994. These were combined into a single data set as detailed in Appendix 1. The fish species captured by the trawl surveys were defined as demersal, pelagic, or mesopelagic. Only demersal species are considered in this study. The only invertebrate considered to be sufficiently well sampled by the trawl gear is the shortfin squid, which has been included in the analysis. The species composition of the overall data set is shown in Appendix 2.

The data set, which includes valid survey tows using standard survey gear, was acquired from five sources: Canada Department of Fisheries and Oceans, Northwest Atlantic Fisheries Centre, St. John's, Newfoundland (for Labrador Shelf from Cape Chidley south to the Grand Banks of Newfoundland, Flemish Cap, and the west coast of Newfoundland); Canada Department of Fisheries and Oceans, Marine Fish Division, Maurice Lamontagne Institute, Mon Joli, Quebec (for Northern Gulf of St. Lawrence); Canada Department of Fisheries and Oceans, Marine and Anadromous Fish Division, Gulf Fisheries Centre, Moncton, New Brunswick (for Southern Gulf of St. Lawrence); Canada Department of Fisheries and Oceans, Marine Fish Division, Scotia-Fundy Region, Bedford Institute of Oceanography, Dartmouth, Nova Scotia (for Scotian Shelf, Bay of Fundy, and part of Georges Bank); and the USA's National Marine Fisheries Service (NMFS), Northeast Fisheries Science Center (NEFSC), Woods Hole, Massachusetts (for Georges Bank, Gulf of Maine, and the Middle Atlantic Bight). The initial data set included all months in the years 1970-1994.

In several instances, specimens in the catch are not identified to species, and several aggregate groups are listed in Appendix 2. Four of these were created by combining species for which there is a high probability of misidentification. The only aggregate group used in the analysis is redfishes, which comprise three *Sebastes* species.

Trawl Surveys

The trawl surveys from which the data were derived have been described in several publications. Survey designs, stratification schemes, gears, etc. have been described in Doubleday and Rivard (1981), Doubleday (1981), and Grosslein (1969). Since these publications, there have been new vessels and gears used, and additional surveys have been carried out at other times of the year in various areas, but the basic designs have remained the same. The main trawl survey time-series in each area, which were established to provide indices of abundance for important commercial species, have been carried out continuously from the following years until the present: 1963 in the USA, 1970 in the Scotia-Fundy and Southern Gulf of St. Lawrence, 1983 in the Northern Gulf of St. Lawrence, and various starting years prior to and during the 1970s off Newfoundland and Labrador.

No attempt has been made to extensively describe the contents of the data set (e.g., by providing lists of vessels and cruises). This information can be derived directly from the data set by users as required. However, Table 1 shows the distribution of sets from each source by year and month.

METHODS

The analytical objectives of this project are to identify species assemblages, determine spatial and temporal patterns, and evaluate relationships between assemblages and the environment. These are summarized, along with the analytical methods used and the products generated, in Table 2. The first two objectives have received the most attention to date; work on environmental relationships is still underway.

No single method is widely accepted for identifying and mapping species assemblages. Because each methodological approach has strengths and weaknesses, several methods were used in this study. The rationale is that if several distinct analyses show similar results, the overall robustness of the conclusions is enhanced. Available approaches range from qualitative analyses that depend on the familiarity of the investigator with distributional patterns (e.g., Briggs 1974), univariate approaches, such as plotting distribution maps (e.g., Ray *et al.* 1980, Strategic Assessment Branch and Southeast Fisheries Center 1986, Strategic Assessment Branch 1989, Strategic Assessment Branch and Northwest and Alaska Fisheries Center 1990), to complex multivariate analyses (e.g., Mahon and Sandeman 1985, Overholtz and Tyler 1985, Mahon and Smith 1989, Gabriel 1992, Gomes *et al.* 1992, Gomes 1993, Gomes *et al.* 1995, Guadalupe Villagarcia 1995). Classification (usually cluster analysis) and ordination (Clifford and Stephenson 1975, Gauch 1982, Legendre and Legendre 1983) are multivariate approaches often used for assemblage analysis.

The assemblage analyses began with visually classifying single species distributional patterns. A multivariate ordination procedure, principal components analysis (PCA), was then used to identify assemblages statistically. Although other ordination methods exist that were developed specifically for ecological data, the available software cannot process the large number of cases found in the ECNASAP trawl survey data set (e.g., Gauch 1982, Ter Braak 1986).

Finally, cluster analysis was conducted for comparison with the PCA. Cluster analysis was performed on: 1) sites (i.e., tows), to generate mappable results comparable to maps of PCA scores; 2) species, to generate assemblages comparable to the assemblages derived from PCA; and 3) PCA loadings themselves, which provided an organizational hierarchy for the principal components. One disadvantage of PCA is that it does not provide a measure of the hierarchical interrelationships among assemblages. However, cluster analysis does show hierarchical relationships, which may be important for a biogeographical study aimed at identifying faunal discontinuities. These discontinuities could be the basis for defining ecosystems or biogeographic boundaries that may be appropriate spatial units for management.

Data Transformation

Trawl design may significantly affect the numbers and types of fish caught. Trawls may differ in several ways: swept area affects the number of fish encountered during a tow; height of the head rope affects the elevation above the bottom that is swept; and foot rope configuration and roller gear affect the extent to which benthic fishes, such as flatfishes, enter the trawl.

Because the ECNASAP data set consists of data from several sources, differences among the vessels and gears may have affected the catch per standard tow. Since there are some areas of overlap between surveys, and the same vessel and gear are sometimes used in more than one area, some limited intercalibration of vessels and gear would have been possible. However, previous studies have indicated that, even with comparative fishing experiments, intercalibration of vessels and gear is seldom statistically significant, and that the coefficients are usually determined by only a few data points (Mahon and Smith 1989). Furthermore, since intercalibration data are not available for all vessels and gear types used in the different surveys over the years, it was not deemed feasible to convert all surveys to a single standard.

Numbers caught per tow was used as the abundance measure in the analyses, based on the assumption that gear and vessel biases are likely to be small relative to sampling variability and the major signals. Also, other approaches, such as analyzing presence/absence or data grouped into intervals, degrade the information,

Table 1. Number of sets in the ECNASAP data base by source, year, and month.

USA, NMFS, Northeast Fisheries Science Center

	Month												
Year	1	2	3	4	5	6	7	8	9	10	11	12	Total
70	0	0	102	188	0	0			59	123	158		632
71	0	0	126	225	0	0			11	187	151		700
72	0	0	146	201	0	0			24	166	151		688
73	0	0	136	98	129	0				181	142		686
74	0	0	63	193	27	0			31	2	44		360
75	0	0	92	95	46	0				207	138		578
76	0	0	144	188	12	0			21	154	94		613
77	0	0	44	138	109	0	13	149	41	159	88	54	795
78	0	0	49	159	161	0	36	160	100	208	135		1008
79	0	0	43	261	67	0	45	121	60	232	173		1002
80	0	0	61	219	54	0	103	81	62	169	66		815
81	86	0	59	128	84	15	89		40	154	73		728
82	54	66	67	125	62	0			41	163	49		627
83	0	18	99	177	0	0			55	121	66		536
84	0	91	131	116	0	0			72	160	18		588
85	0	23	114	103	0	0			19	165	60		484
86	0	0	88	163	0	0			49	164	39	1	504
87	0	0	39	209	0	0			75	147	1		471
88	0	0	153	72	0	0			86	135			446
89	0	4	149	61	0	0			74	136	9		433
90	0	0	131	90	0	0			88	141			450
91	0	0	124	97	0	0	6		84	138			449
92	0	83	147	94	0	0	1		75	143			543
93	0	109	80	138	0	0	45	14	111	109			606
94	0	84	79	143	0	0							306
Total	140	478	2466	3681	751	15	338	525	1278	3664	1655	55	15048
%	0.9	3.2	16.4	24.5	5	0.1	2.2	3.5	8.5	24.3	11	0.4	100

Canada, DFO, Scotia-Fundy Region

	Month										
Year	2	3	4	6	7	8	9	10	11	12	Total
70					133						133
71				9	109						118
72				56	91						147
73					120	14					134
74					138	15					153
75					94	49					143
76					98	37					135
77					144						144
78					141				46	35	222
79		115			147			66	59		387
80		113			144		1	140			398
81	31	88			150		2	125			396
82		131			150		29	117	109		536
83		68	72		146			177	99		562
84		171			130	13		145			459
85		47			152			83			282
86		154			171			173			498
87		159	4	11	160	17		87			438
88		200			177						377
89	52	143			184						379
90	78	122			223						423
91	132	94			189						415
92	32	133		53	140						358
93		143			188	2					333
94					195						195
Total	325	1881	76	129	3714	147	32	1113	313	35	7765
%	4.2	24.2	1	1.7	47.8	1.9	0.4	14.3	4	0.5	100

Table 1. (continued)

Canada, DFO, Southern Gulf Region				
	Month			
Year	8	9	10	Total
70		39		39
71		66		66
72		70		70
73	1	73		74
74		66		66
75		67		67
76		66		66
77		66		66
78		51	12	63
79		70	4	74
80		70		70
81		70		70
82		65		65
83		66		66
84	21	87		108
85		224		224
86		173		173
87	4	158		162
88		155		155
89		169		169
90		147		147
91		192		192
92		169		169
93		188		188
94		189		189
Total	26	2756	16	2798
%	0.9	98.5	0.6	100

Canada, DFO, Northern Gulf Region					
	Month				
Year	1	7	8	9	Total
83	200				200
84	194	105			299
85	163		188		351
86	180		175		355
87	151		181		332
88	170	46	155		371
89	126		151	13	290
90	131		188	91	410
91	122		72	177	371
92	112		235	5	352
93	147		140	87	374
94	123		125	64	312
Total	1819	151	1610	437	4017
%	45.3	3.8	40.1	10.9	100

Canada, DFO, Newfoundland/Labrador Region													
	Month												
Year	1	2	3	4	5	6	7	8	9	10	11	12	Total
70		49	11		70	47	35	20		44			276
71	12	23	25	25	6	85				53	18		247
72	16	4	45		83					37	38		223
73		42	59	85	98	36	73	19	47	22	19	28	528
74			4	95	107	117			29		57		409
75					113	64			13	42		11	243
76	7	6		128	97	34			40	42	75	9	438
77	49	52		102	142	48			49	10	243	6	701
78	141	206	2	62	199	261	66	187	158	192	125		1599
79	99	146	37	47	265	137		171	115	120	98	26	1261
80	163	92	131	71	299	13		5	56	105	71	64	1070
81	179	115	84	56	123	67			158	112	288	100	1282
82	24	92	32	113	116	151				40	305	93	966
83		142	21	95	120	65	47			119	214	51	874
84	30	152		122	137	95	56	169	22	40	249	42	1114
85	124	260	112	232	169	114	43	165		226	319	13	1777
86	76	202	158	241	268	110	45	92	122	1	298	59	1672
87		82	102	84	280	121	44	258	4	184	216	54	1429
88	40	153		138	243	109	7	181	38	56	261	112	1338
89	43	199		123	359	25	4	14		174	205	105	1251
90	76	149	1	78	210	57	5	148		37	364	173	1298
91		206	2	169	239	24		149		89	559	121	1558
92	17	173	1	96	239	51	34	26		99	460	64	1260
93		176	2	186	214	121		162	6	88	384	96	1435
94				193	215	92				71	368	162	1101
95					52	13							65
Total	1096	2721	829	2541	4463	2057	459	1766	857	2003	5234	1389	25415
%	4.3	10.7	3.3	10	17.6	8.1	1.8	6.9	3.4	7.9	20.6	5.5	100

Table 2. Summary of major analytical objectives, methods, and products.

Products

Methods	Analytical objectives: Identify species assemblages	Analytical objectives: Determine spatial patterns	Analytical objectives: Determine temporal patterns
Visual Analysis	Eight species groups based on spatial distribution and depth	Distribution maps for 108 species	Table of numbers caught for 72 species by 5-year blocks
ACON Plots			Maps with presence/absence boundaries for 4 species in 5-year blocks
Bivariate Ellipses			Graphs of the latitudes and longitudes of ellipses containing 50% of the abundance for 4 species in 5-year blocks
Principal components analysis of 1975-94 data subset	Species assemblages identified using loadings on 18 principal components, and an organizational hierarchy of these assemblages based on Ward's method clustering of the 18 components	Maps of the "core" stations for each of the 18 principal components, based on stations scoring in the top 5% of stations for each component	Maps and tables of the stations scoring in the top 5% of stations for PC10 and PC11 in the analysis of the 1975-94 data subset
Principal components analysis of the 1975-94 data subset by 5-year blocks			Table assessing assemblage persistence by comparing 1975-94 and 5-year block assemblages
Sites cluster analysis of the 1975-94 data subset	Species assemblages identified by assessing affinities with 18 site cluster groups, based on maximum standardized log mean catch per tow	Maps of the stations assigned to the 18 site cluster groups	
Species cluster analysis of the 1975-94 data subset, obtained by Ward's method clustering of the transposed sites clusters by species matrix	Species assemblages identified for 18 cluster groups on the dendrogram		
Canonical discriminant analysis of the 1975-94 data subset			Patterns of species abundance changes identified by correlations of species with canonical variables 1 and 2 Patterns of yearly abundance changes in the groundfish community obtained by plotting yearly centroids against canonical variables 1 and 2

but do not eliminate the potential biases. Because trawl survey data frequently have a skewed distribution, $\log_{10}(x+1)$ transformed data were used in the analyses.

Visual Analysis

Visual analysis of species distributions was carried out as a background for interpreting the multivariate analyses. The purpose of this process was to develop an intuitive, knowledge-based classification that could be compared to the results of the more objective multivariate approaches. The distributions of 108 demersal species were mapped using $\log_{10}(x+1)$ transformed numbers caught per tow as the abundance scale. Data for all years and months were plotted together for each species. The plots were then classified into groups based on an intuitive interpretation of the distributions, combined with the biological and other background knowledge of the visual analysis team (M. Sinclair and R. O'Boyle).

Multivariate Analyses

Data selection. The multivariate analyses were conducted using a standard subset of the ECNASAP trawl survey data base. Several preliminary analyses were conducted to select the data subset most suitable for the multivariate studies.

Data were screened in five-year time periods for consistency in spatial coverage. For 1970-74, the Labrador Shelf was considered to be inadequately covered (Figure 2). Therefore, data prior to 1975 were excluded from the multivariate analyses.

Because the surveys are not conducted at the same times of year, it was necessary to select certain months to be analyzed. Preliminary runs were tried with various subsets of months. Ultimately, the main survey series in each area was used in the multivariate analysis. The Newfoundland/Labrador surveys are carried out at different times of year in different areas. Therefore, all months of Newfoundland/Labrador data were included in the data subset. The data taken from the rest of the surveys were primarily from the summer and autumn. For the Northern Gulf of St. Lawrence, data from July-September and January were used. For the Southern Gulf of St. Lawrence, data from August-October were used. For the Scotian Shelf and Bay of Fundy, data from July-September were used. For Georges Bank south to Cape Hatteras, data from September-December were used.

Most sites-times-species survey data have a relatively high proportion of rare species. These are either too rare, or are too poorly sampled, to provide useful information for assemblage analysis. After several exploratory analyses, three species selection criteria were applied to generate the multivariate data subset: 1) ≥ 500 individuals must have been caught for the 1975-94 period; 2) the species had to have been caught in ≥ 0.05% of the trawl sets for the 1975-94 period; and 3) ≥ 100 individuals had to have been caught in every five-year time block for the 1975-94 time period. VARIMAX-rotated PCAs converged on a solution for all analyses using the data set that met these criteria.

The final data subset used for the multivariate analyses contained 1975-94 data for 66 species collected in 39,694 tows (Table 3). It should be noted that the selection criteria excluded species that were fairly abundant during some periods, but were essentially absent during others, such as Atlantic spiny lumpsucker.

Principal Components Analysis. PCA was used as the primary multivariate analysis method. Species loadings on the principal components (PCs) were used to identify groups of species that tend to co-occur (i.e., assemblages). Previous analyses have shown that ubiquitous species may be a member of more than one assemblage, and PCA allows a species to be associated with more than one component.

The correlation matrix of $\log_{10}(x+1)$ transformed numbers caught per tow data was used as input for the PCA. Because this method tends to diminish the role of abundance in defining assemblages, use of the covariance matrix was also investigated. However, using the covariance matrix provided a less interpretable result, with fewer components. Moreover, the first few components had significant loadings for several species, but the remaining components were dominated by only one or two species.

Two categories of species loadings on PCs are recognized in this study. Species with loadings ≥ 0.5 on a component are considered the major species in the assemblage represented by that component. Species with loadings between 0.3 and 0.5 are also considered members of assemblages, albeit with weaker associations. The usual practice, using a loading of 0.5 (i.e., a PC contains 25% of the overall variability of a species) as the cutoff, is not based on statistical significance; it is merely a convention. The large size of the ECNASAP data set and the large number of PCs, which are distributed over a huge study area, enable recognition of the weaker class of associations (Gorsuch 1974).

PCs with eigenvalues ≥ 1 are considered to represent statistically significant assemblages. The eigenvalue associated with a PC indicates the relative importance of that component. Recognizing components with eigenvalues ≥ 1 as statistically significant is a common practice in PCA (Jolliffe 1986).

VARIMAX rotation was used for the PCs having eigenvalues ≥ 1 in the unrotated PC extraction. VARIMAX rotation is typically used when a relatively small number of species is strongly associated with (i.e., is highly loaded on) each PC (Jolliffe 1986). VARIMAX rotation also tends to find a solution with few negative loadings on the PCs, thus facilitating interpretation of the PCs as assemblages.

The site scores on each VARIMAX-rotated PC are used as a measure of the extent to which the assemblages defined by the PCs were present at each site. Every assemblage can potentially be present at every site, as the assemblages are not mutually exclusive in space. Thus, groups of sites can be defined on the basis of PC scores. In this study, the "core" sites of assemblages were determined by selecting the sites in the top 5% of the site scores for each PC. The effect of increasing this percentage on the spatial cohesiveness of assemblages was examined by mapping the sites in

Figure 2. Sampling spatial coverage by five-year intervals, 1970-94.

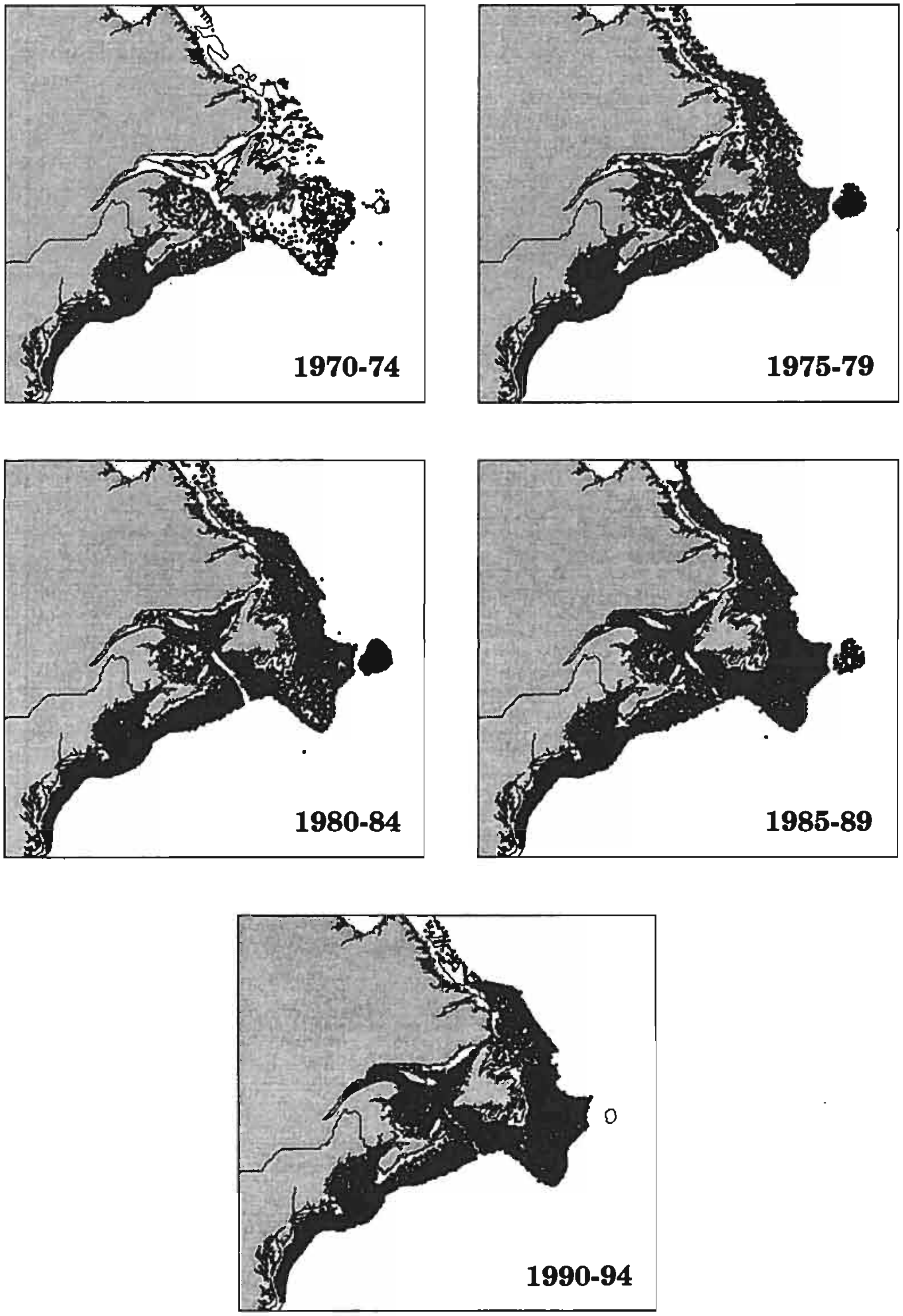


Table 3. Numbers of individuals caught per five-year time period for species with a total catch > 500.

	Time period					Time period			
Species[1]	75-79	80-84	85-89	90-94	Species1	75-79	80-84	85-89	90-94
Redfishes (Sebastes spp.)	2,291,514	2,581,080	2,259,409	2,007,064	Sea raven	3,241	3,568	5,099	3,700
American plaice	585,609	632,769	864,637	480,839	Northern (Common) searobin	4,924	2,486	3,470	3,721
Atlantic cod	221,160	399,575	961,117	589,339	Northern wolffish	5,305	4,953	2,318	862
Butterfish	134,043	241,423	211,793	159,600	Smooth skate	3,351	3,198	3,734	2,919
Silver hake	101,697	104,676	187,476	111,989	Roughnose grenadier	1,405	957	6,500	137
Greenland halibut	91,544	91,306	151,697	124,259	Blue hake	2,785	2,647	1,396	1,695
Arctic cod	249,455	40,196	86,902	47,883	Spotted wolffish	2,182	2,787	1,674	962
Yellowtail flounder	95,950	78,101	118,593	121,554	Goosefish (Angler)	1,889	1,734	1,816	1,464
Haddock	68,258	117,574	120,027	61,085	Blackbelly rosefish	2,125	1,474	1,140	1,562
Shortfin squid	125,184	75,618	59,490	89,368	Ocean pout	1,698	1,403	1,622	1,534
Northern sand lance	70,832	153,408	10,590	13,390	Fourbeard rockling	716	607	3,041	1,356
Spiny dogfish	47,280	52,799	70,042	64,776	Atlantic sea poacher	1,495	307	1,359	2,302
Thorny skate	35,759	46,618	74,342	71,763	Alligatorfish	695	480	2,527	1,645
Atlantic spiny lumpsucker	43	503	2,341	202,488	Fawn cusk eel	1,176	1,518	1,622	966
Witch flounder	38,102	43,771	66,544	52,929	Atlantic halibut	1,186	1,204	1,229	785
Black dogfish	6,395	14,530	52,416	68,160	Shorthorn sculpin	273	454	1,717	1,767
White hake	23,378	23,381	55,643	27,173	*Atlantic soft pout*	9	182	850	2,474
Winter flounder	16,418	16,878	48,991	46,252	Longnose eel	860	530	668	1,328
Atlantic argentine	20,591	13,507	57,278	19,325	Black sea bass	2,061	421	418	354
Longhorn sculpin	21,224	14,053	32,001	34,306	Cunner	146	224	2,196	605
Rock (Roundnose) grenadier	34,515	22,708	31,838	5,402	Atlantic hagfish	963	573	389	1,157
Marlin-spike (Common grenadier)	13,618	12,181	16,969	32,601	Polar sculpin	434	295	994	1,240
Red hake	22,035	18,132	19,873	11,414	Snowflake hookear sculpin	253	158	1,337	999
Lumpfish	3,063	4,936	26,079	25,777	Large scale tapirfish	887	862	658	291
Scup	28,115	10,641	16,776	3,580	*Fourline snakeblenny*	18	49	1,040	1,377
Spotted hake	18,782	14,778	16,039	7,058	Offshore hake	660	1,103	353	123
Roughhead grenadier	14,757	15,086	12,184	12,803	Cusk	794	502	474	236
Pollock	4,589	7,908	15,606	13,310	Spinytail skate	394	490	365	282
Atlantic wolffish	13,179	10,479	8,519	5,533	Snake blenny	187	252	304	677
Longfin hake	1,864	7,013	12,018	11,538	Shortnose greeneye	113	361	731	166
Little skate	10,047	7,875	7,591	5,839	Greenland cod	401	147	305	490
Fourspot flounder	6,890	8,908	6,960	4,574	Summer flounder	624	313	160	104
Moustache (Mailed) sculpin	5,760	5,852	7,855	7,382	*Viperfish*	43	186	178	680
Winter skate	3,949	6,808	7,266	4,725	Smooth dogfish	610	120	147	110
Windowpane	6,885	3,701	7,022	2,767	*Daubed shanny*	99	37	350	362
Gulfstream flounder	3,706	5,301	3,979	3,431	*Boa dragonfish*	10	354	158	175

[1]Species in italics were excluded from the multivariate analyses because of abundance < 100 in one or more time periods.

the top 5, 10, 15, and 20% of the scores for PC5 and PC10.

Hierarchical relationships among the PCs were identified using cluster analysis. The 18 x 66 matrix of components by species loadings was the input data. The distance coefficient was squared Euclidean distance; Ward's method of agglomerative hierarchical clustering was used to generate the dendrogram. These methods are discussed in more detail in the following section.

Cluster Analysis. Because of the large data set size and software limitations, a rather complex analytical process was used in the cluster analyses (Figure 3). Cluster analyses were performed using the same subset of the groundfish data that was used for the PCA. As with the PCA, number caught per tow data were $\log_{10}(x+1)$ transformed. Two clustering approaches were followed to define: 1) groups of sites that tended to have similar species composition; and 2) groups of species that tended to occur at the same sites. The results of the site clustering are directly comparable with the mappable groups derived by selecting the sites with the top 5% of PC scores. The results of the species clustering are directly comparable with the species assemblages defined using species loadings on the PCs.

Squared Euclidean distance was used as the distance coefficient for both analyses. Numerous similarity/dissimilarity coefficients are available (Clifford and Stephenson 1975), and the Bray-Curtis coefficient has been shown to best reflect relationships among species and sites in ecological studies of species distribution data (Bloom 1981). However, the Bray-Curtis coefficient could not be used in this study, because it is not available in any software package capable of clustering a sufficiently large number of records. Squared Euclidean distance was successfully used as the distance coefficient in the previous ECNASAP assemblage analysis of the Scotian Shelf (Mahon 1995).

Ward's method was used for hierarchical agglomerative clustering of the sites and species. This method is frequently used for ecological analyses. Hierarchical clustering uses a coefficient, such as squared Euclidean distance, that quantifies similarity or dissimilarity between pairs of entities, such as species or sites, and forms groups by successively combining the most similar pairs. An entity may be a single species or site, or a group of previously combined species or sites. Ward's method uses the increase in the sum of squared distances of entities from the group centroid as a criterion for combining groups. The sequence of grouping is displayed as a dendrogram, which shows the hierarchical relationships among all entities. The desired number of groups can be obtained by cutting the dendrogram at an appropriate level of intergroup similarity. To maintain consistency with the PCA, which extracted 18 PCs, clustering was stopped at 18 clusters.

Because the large size of the data set and software limitations precluded direct use of Ward's method, a nonhierarchical clustering method, nearest centroid sorting (SAS 1990; Anderberg 1973), was used to generate input for Ward's method. Nearest centroid sorting is an iterative algorithm that minimizes the sum of squared distances from cluster means. It requires cluster "seed points" as initial estimates of the cluster means. These were obtained using Ward's method on a random subset of 10% of the data (approximately 4,000 tows). To be consistent with the PCA, clustering for the 10% data subset was stopped at 18 cluster groups. Mean values for each species in each of the 10% subset cluster groups were used as seed points for the nearest centroid sorting of all tows, which resulted in a matrix of 18 site groups by 66 species means, based on the entire multivariate data subset (i.e., 39,694 tows). The final site clusters were obtained by clustering this matrix using Ward's method. Because these site clusters consist of sampling points, the results are mappable and can be compared to maps of the stations scoring in the top 5% for the PCs.

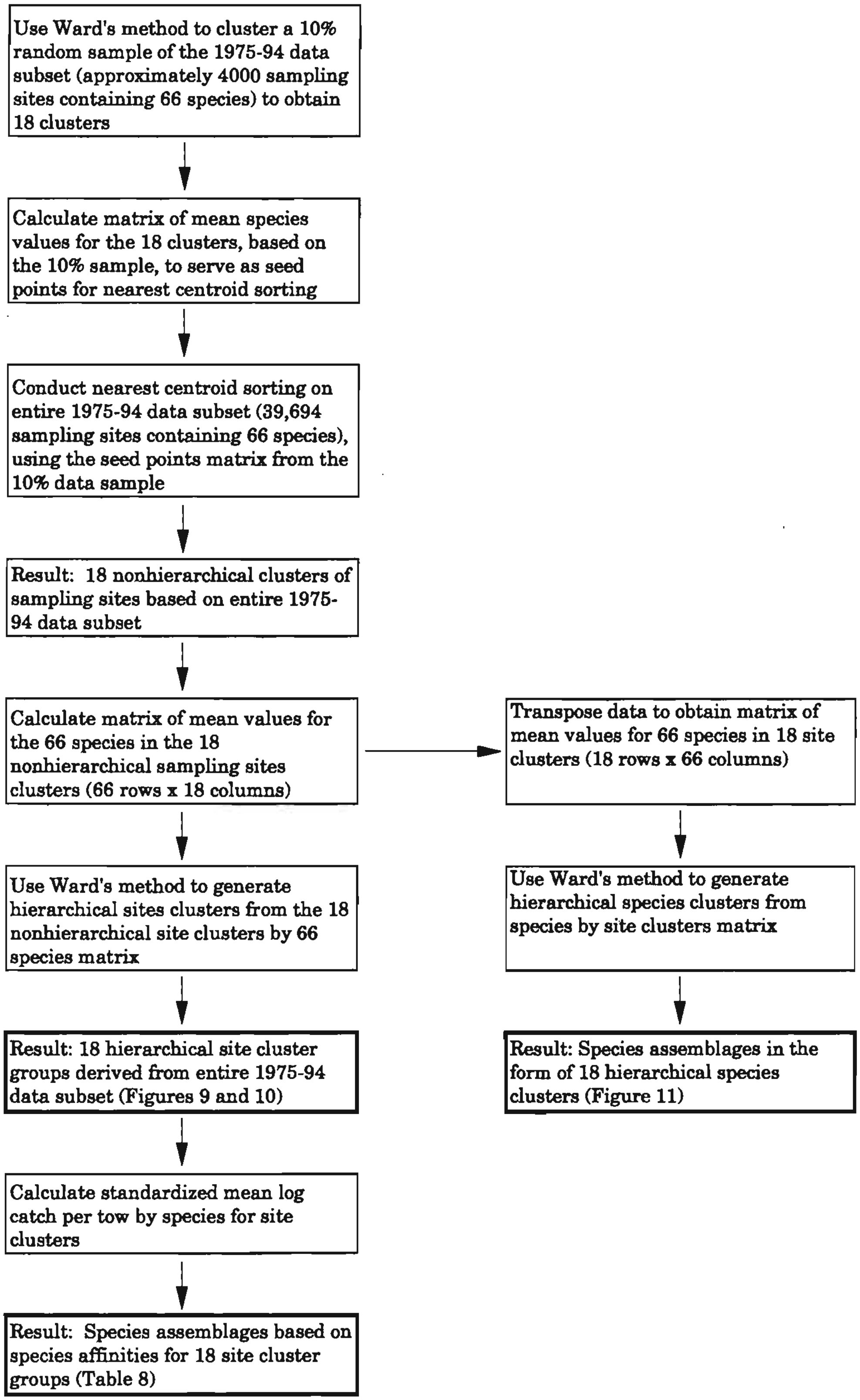
Species associations with the site cluster groups were determined by calculating a standardized abundance for every species in each site cluster. The calculation was performed by dividing the mean $\log_{10}(x+1)$ catch per tow for each site cluster group by the mean $\log_{10}(x+1)$ catch per tow for the entire database. This value is considered an index of the affinity of a species for the cluster groups, with high values indicating strong affinity. Species were assigned to the site cluster group for which they had their highest standardized abundance. Therefore, the methods used for the sites cluster analysis limited the species to only one assemblage.

The species clustering was performed on the matrix obtained by transposing the 18 tow groups by 66 species matrix generated by the nearest centroid sorting procedure described above. This 66 species by 18 site cluster groups matrix was then clustered using Ward's method, which resulted in a hierarchical clustering of the 66 species. To be consistent with the previous analyses, the dendrogram generated in this analysis was cut at the level of 18 clusters. The resulting 18 species groups are comparable to the species assemblages defined by species loadings on the PCs, as well as to the species affinities determined for the site clusters.

Temporal Analyses

Several methods were examined for analyzing temporal variation (Table 2). Because of time constraints, the temporal analyses were primarily limited to dem-

Figure 3. Cluster analysis flow diagram.



onstrating feasibility of the methods, and the results were not analyzed in great detail. Each analysis included, but was not always limited to, an examination of temporal variation in Atlantic and arctic cod, or in assemblages that included these species. More comprehensive temporal analyses are presently under way.

An inherent assumption in the temporal analyses is that entire species distributions are well sampled throughout the 1975-94 period, and that there are no sampling biases through space and time. This assumption is not completely met (e.g., sampling was discontinued on the Flemish Cap in the mid-1980s), so sampling biases may have had some impact on temporal patterns detected. This problem is likely to be more important for species at the periphery of the study area, where sampling intensity may have been variable, than for species widely distributed throughout the core of the study area.

Single species. The intent was to examine how the spatial distributions of species have changed over time. Example analyses were carried out for selected individual species, but the methods could also be applied to assemblages identified by multivariate analysis.

Two southern species (ocean pout and butterfish), one north-temperate species (Atlantic cod), and one northern species (arctic cod) were selected. The distribution data for these species were broken into five-year time periods and analysed in two ways: 1) presence/absence distributions were plotted using ACON software (Black 1993) to show catch locations and boundaries; and 2) bivariate ellipses on X-Y scatterplots were calculated (i.e., latitude and longitude weighted by $\log_{10}(x+1)$ numbers caught), such that 50% of the log-transformed catch was contained within the ellipses (SYSTAT, Inc. 1992). The bivariate ellipses emphasize patterns affecting the core of distributions, while the ACON plots emphasize patterns affecting the boundaries. Distributional changes were evaluated visually for both methods.

PCA assemblages. Two aspects of temporal variation in the PCA assemblages were examined: 1) temporal stability of assemblage structure; and 2) temporal variability of spatial distribution. Temporal stability of assemblage structure was examined by breaking the 1975-94 data set into five-year blocks and running separate PCAs on each block. Patterns of species loadings were compared among the five-year blocks and to the loadings for the entire 1975-94 data set. The difficulty with this approach is that objective statistical methods for these comparisons are not available.

Because the above analysis showed that species compositions of most assemblages were stable over the 1975-94 period, and because several other analyses have shown similar assemblage stability, temporal variation in the spatial distribution of the 1975-94 assemblages was investigated for PC 10 (thorny skate, America plaice, witch flounder, Atlantic cod, smooth skate) and PC11 (arctic cod, Atlantic sea poacher, Greenland halibut, polar sculpin). The sites within the top 5% of scores for these components were mapped by five-year time blocks. Mean latitudes and longitudes for the five-year time blocks were compared using analysis of variance. Prevalences of these assemblages over time was assessed by totaling the number of points in each time block. The assumption in this approach is that particular assemblages exist throughout the study period, but their spatial distributions may vary.

Canonical Discriminant Analysis. Canonical Discriminant Analysis (CDA) is the multivariate procedure used to examine the 1975-94 data subset for changes over time in the abundances of the groundfish community (i.e., the 66 species) throughout the study area. The analysis has two objectives: 1) detection of abundance trends through time; and 2) identification of the species responsible for the observed abundance trends.

CDA is related to PCA and canonical correlation analysis. It generates linear combinations of variables that define a series of statistically independent (i.e., uncorrelated) canonical variables, each of which provides maximum distinction among a group of specified classes.

In this study, CDA was used to generate linear combinations of species abundances that provide maximum distinction among the years. Year centroids from the CDA were projected onto the plane defined by the first two canonical variables. The location of the year centroid on a canonical variable's axis is the mean of all canonical tow scores for that particular year. Location on the plane is, thus, defined by the yearly mean scores for the two canonical variables. Temporal patterns were interpreted by inspection of the plot of the canonical variables 1 and 2 containing the yearly means for 1975-94. Bivariate confidence ellipses were calculated to determine statistically whether the year groups identified visually were statistically distinct. A macro provided by the SAS Institute was used for these calculations.

To identify patterns of species abundance variation giving rise to the year centroid pattern, between-year correlations between the individual species and the first two canonical variables were calculated. Correlations for $|r| \geq 0.5$ were projected as vectors originating from the center of the plane defined by the first two canonical variables. Because the same canonical plane was used for plotting the year centroids and the species correlations, the plots were overlain to associate abundance patterns with yearly community patterns. In this analysis, a species having a high positive correlation with a canonical variable were interpreted as being abundant in a year with a high score on that canonical variable.

RESULTS

The initial data set included 55,043 tows, with 26,286,369 individuals from 412 species (including some aggregate groups) (Appendix 3). The data selection described above reduced the number of tows to 39,694 and the number of species to 66 (Table 2).

Visual Analysis

The species plots were classified into nine groups (Table 4, Figure 4). Four groups occurring principally in water > 200-m depth were identified. The Cosmopolitan Deepwater group is found from Labrador to Cape Hatteras; the Northern Deepwater group is generally found north of the Scotian Shelf. The Temperate Deepwater group typically extends from the Gulf of St. Lawrence to the Gulf of Maine, and the Southern Deepwater group typically occurs south of the Scotian Shelf. Four bank and slope groups, which occur principally in water ≤ 200-m depth, were identified. The Northern and North-temperate Bank/Slope groups range from the eastern Scotian Shelf to Cape Chidley, and from Georges Bank to Cape Chidley, respectively. The South-temperate Bank/Slope group is the largest, with typical ranges extending from the Middle-Atlantic Bight to the Grand Banks of Newfoundland. The Southern Bank/Slope group extends from the eastern Scotian Shelf or southern Gulf of St. Lawrence to Cape Hatteras. The North-temperate and South-temperate Bank/Slope groups were judged to be those most likely to exhibit long-term changes in response to environmental change. Because the data set is sparse south of Cape Hatteras, the Southern Transitional group, which contains species primarily occurring south of Cape Hatteras, is not portrayed.

During the analysis, it was noted that details within these groups could not be discriminated by the qualitative approach taken. Further splitting would require the multivariate analyses described below.

Principal Components Analysis

The results of the PCAs for the entire 1975-94 time-period, and for the five-year blocks, are shown in Table 5. The results of the five analyses are similar in terms of the number of PCs with eigenvalues > 1.0 (18-19), the percentage of variance accounted for by the various PCs, and the cumulative percentage of variance accounted for, which ranged from 56.3% to 59.4%. These results suggest that the entire time series can be analyzed in one PCA.

The species loadings on the VARIMAX-rotated PCs with eigenvalues ≥ 1 are shown for the entire time period in Table 6. A dendrogram derived from clustering the species factor scores on the 18 PCs shows the organizational hierarchy of the species assemblages derived from the PCA (Figure 5). PCs were associated with 1-5 species with loadings ≥ 0.5 and with 0-5 species with loadings between 0.5 and 0.3. Under the loadings ≥ 0.5 criterion for high-level inclusion in an assemblage, 54 of the 66 species were members of an assemblage, but only one species, black dogfish, was a member of two. Under the loading ≥ 0.3 criterion for low-level inclusion in an assemblage, two species, roughhead grenadier and Greenland halibut, were members of three assemblages; 15 species were members of two assemblages; and two species, spinytail skate and Greenland cod, were not members of any assemblage. Species with very high loadings on one PC, such as blue hake, roughnose grenadier, and gulfstream flounder, may be considered assemblage specialists; species with low loadings on more than one PC may be considered assemblage generalists. Species without loadings ≥ 0.3 are not considered members of any assemblage.

Assemblage distribution maps from the PCA are given in Figure 6. These maps show only the sites in the top 5% of scores for each PC. There is considerable spatial aggregation of sites with high scores on individual PCs. Use of the top 5% of scores is an arbitrary choice, intended to depict the "core" sites of the assemblage associated with a PC. The apparent distribution of an assemblage core may vary with this percentage. For PC 5, the area of occurrence expands as sites with lower PC scores are included in the plot (Figure 7a). However, the apparent distribution of the PC 10 assemblage does not change greatly as this percentage rises (Figure 7b); instead, more points accumulate in the same general area.

Figure 8 combines the dendrogram of the hierarchical organization of assemblage distributions from Figure 5 with the assemblage distribution maps of Figure 6 (A poster-sized version of this figure is available upon request). The first branching in the dendrogram suggests a biogeographic break around the Grand Banks.

The site scores on the PCs were also used to characterize the depths and temperatures at which the assemblages occur. The average depth and temperature were calculated for the sites in the top 5% of scores for

Table 4. Species groups determined by visual analysis of distribution plots.

Species group
Cosmopolitan Deepwater
Boa dragonfish
Viperfish
Slender snipe eel
Northern Deepwater
Longnose eel
Largescale tapirfish
Blue hake
Rock (roundnose) grenadier
Roughhead grenadier
Spinytail skate
Stoutsaw palate
Black herring
Goitre black smelt
Temperate Deepwater
Marlin-spike
Black dogfish
Atlantic argentine
Roughnose grenadier
Longfin hake
Barracudinas
Southern Deepwater
Blackbelly rosefish
Offshore hake
Shortnose greeneye
Shortfin squid
Armoured sea robin
Buckler dory
Beardfish
Slatjaw cutthroat eel
Northern Bank/slope
Northern wolffish
Spotted wolffish
Atlantic sea poacher
Arctic cod
Greenland halibut
Polar scuplin
Greenland cod
Fourline snake blenny
Threebeard rockling
Atlantic spiny lumpsucker
Atlantic hookear sculpin
North-temperate Bank/slope
Redfishes
Witch flounder
Smooth skate
Atlantic wolffish
Atlantic cod
American plaice
Thorny skate
Alligator fish
Snowflake hookear sculpin
Moustache (mailed) sculpin
Daubed shanny
Atlantic halibut
Lumpfish
Shorthorn sculpin
Snake blenny
Cunner
Radiated shanny
South-temperate Bank/slope
Red hake
Goosefish (Angler)
Spiny dogfish
Silver hake
White hake
Pollock
Cusk
Yellowtail flounder
Winter flounder
Ocean pout
Sea raven
Longhorn sculpin
Winter skate
Northern sand lance
Atlantic hagfish
Fourbeard rockling
Haddock
Atlantic soft pout
Wrymouth
Threespine stickleback
Southern Bank/slope
Fourspot flounder
Butterfish
Spotted hake
Fawn cuskeel
Gulfstream flounder
Summer flounder
Scup
Black seabass
Northern (common) searobin
Smooth dogfish
Windowpane
Little skate
Bigeye scad
Rough scad
Round scad
Plainhead filefish
Smallmouth flounder
Southern Transitional
Vermilion snapper
Snake fish
Tomtate
Inshore lizard fish
Bank cusk eel
Offshore lizard fish
Tattler
Bank sea bass
Atlantic croaker
Spot
Longspine porgy

Figure 4. Example species maps for visual groups.

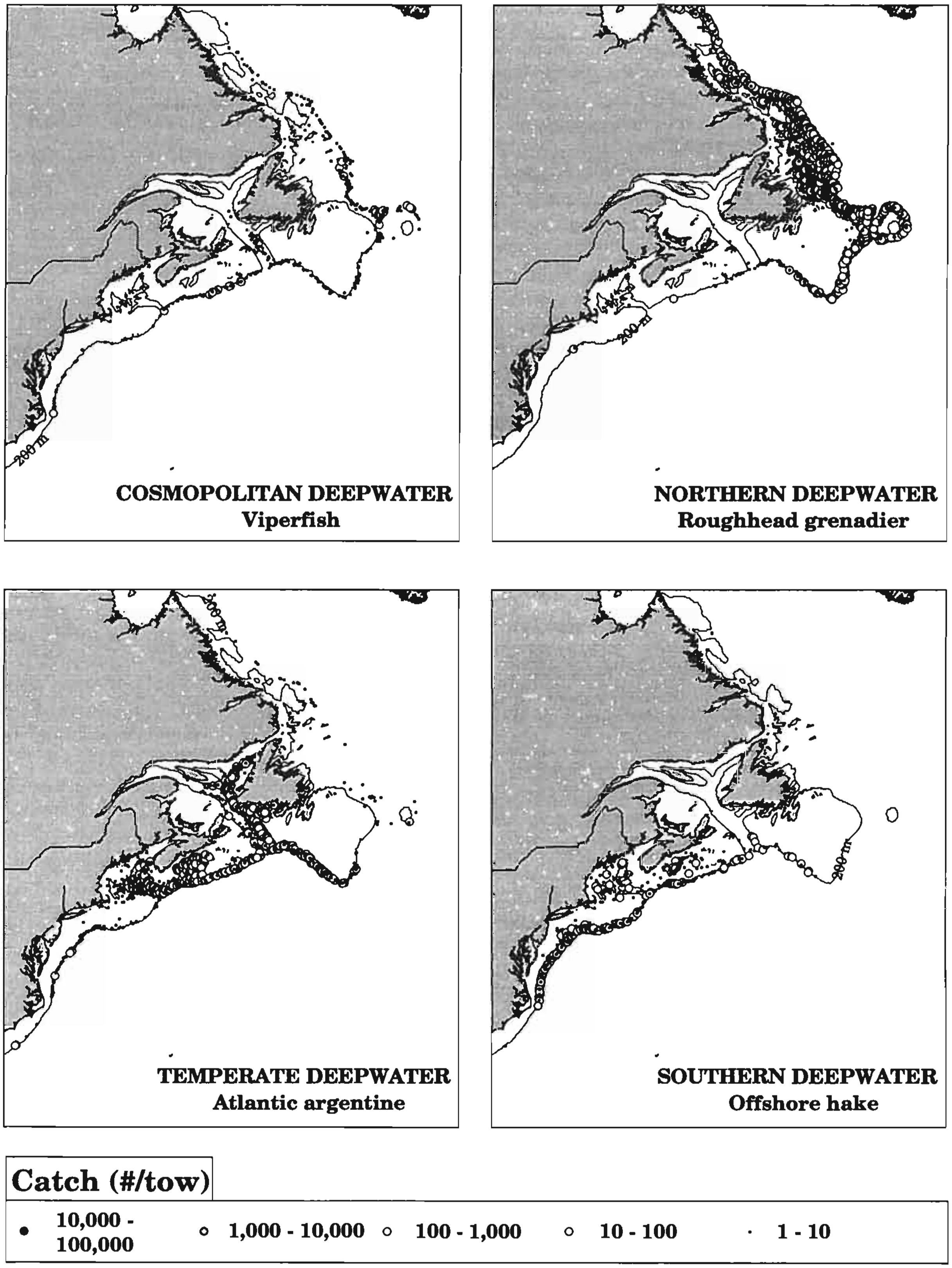
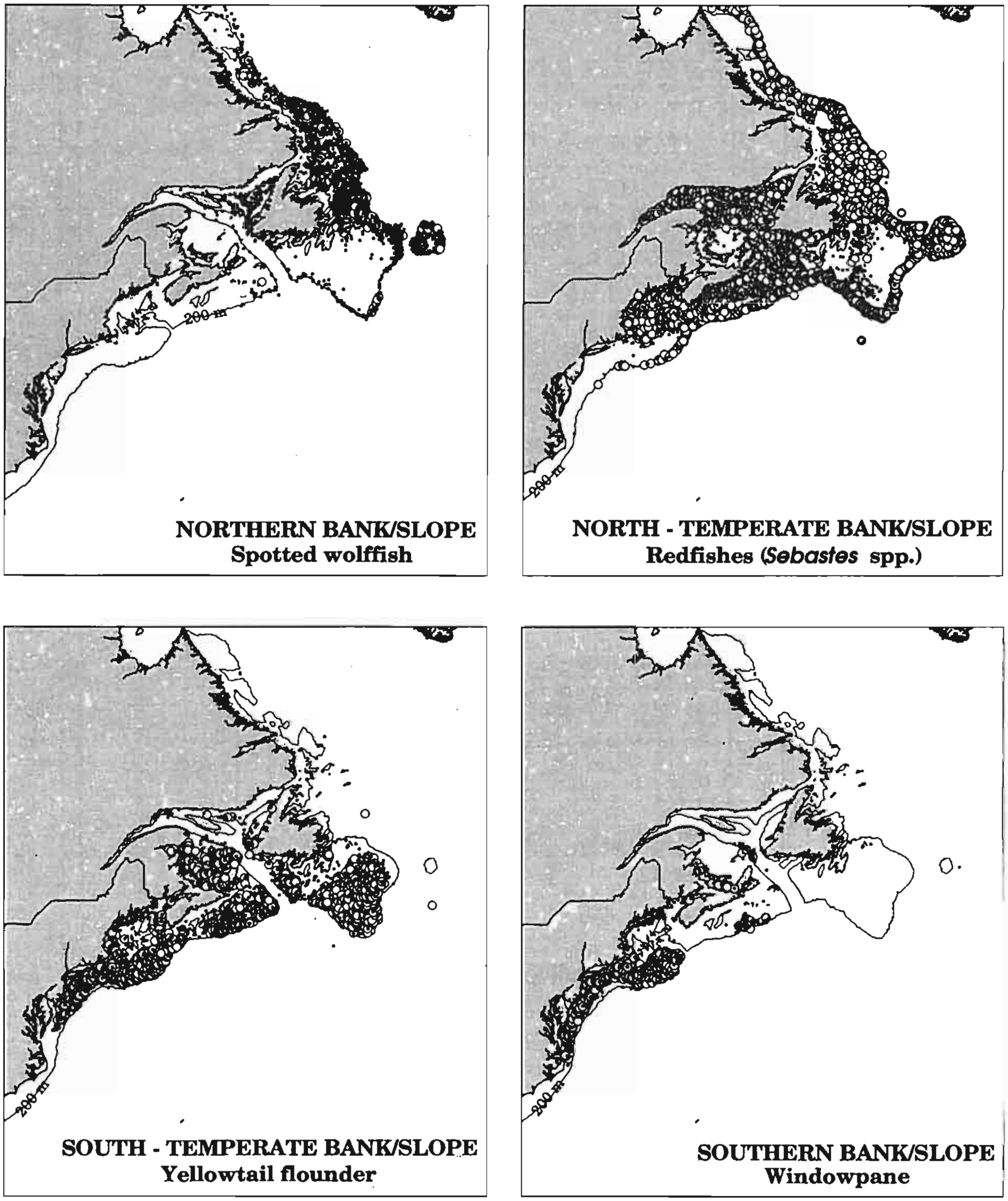


Figure 4. (continued)



Catch (#/tow)

• 10,000 - 100,000 ∘ 1,000 - 10,000 ○ 100 - 1,000 ○ 10 - 100 · 1 - 10

Table 5. PCA results for entire 1975-94 data subset and for five-year blocks.

1975-1994				1975-1979				1980-1984				1984-1989				1990-1994			
PC	Eigen value	% Var	Cum % var	PC	Eigen value	% Var	Cum % var	PC	Eigen value	% Var	Cum % var	PC	Eigen value	% Var	Cum % var	PC	Eigen value	% Var	Cum % var
1	5.815	8.8	8.8	1	6.544	9.9	9.9	1	6.159	9.3	9.3	1	5.431	8.2	8.2	1	5.580	8.5	8.5
2	3.970	6.0	14.8	2	4.016	6.1	16.0	2	3.984	6.0	15.4	2	4.287	6.5	14.7	2	4.189	6.3	14.8
3	3.418	5.2	20.0	3	3.477	5.3	21.3	3	3.321	5.0	20.4	3	3.541	5.4	20.1	3	3.673	5.6	20.4
4	2.890	4.4	24.4	4	2.946	4.5	25.7	4	2.943	4.5	24.9	4	2.962	4.5	24.6	4	2.947	4.5	24.8
5	2.524	3.8	28.2	5	2.527	3.8	29.6	5	2.326	3.5	28.4	5	2.621	4.0	28.5	5	2.773	4.2	29.0
6	2.264	3.4	31.6	6	2.370	3.6	33.2	6	2.248	3.4	31.8	6	2.100	3.2	31.7	6	2.234	3.4	32.4
7	1.888	2.9	34.5	7	1.859	2.8	36.0	7	1.800	2.7	34.5	7	2.045	3.1	34.8	7	2.019	3.1	35.5
8	1.688	2.6	37.1	8	1.795	2.7	38.7	8	1.715	2.6	37.1	8	1.781	2.7	37.5	8	1.772	2.7	38.2
9	1.643	2.5	39.5	9	1.658	2.5	41.2	9	1.669	2.5	39.6	9	1.680	2.5	40.1	9	1.682	2.5	40.7
10	1.597	2.4	42.0	10	1.583	2.4	43.6	10	1.582	2.4	42.0	10	1.536	2.3	42.4	10	1.600	2.4	43.1
11	1.376	2.1	44.0	11	1.374	2.1	45.7	11	1.383	2.1	44.1	11	1.449	2.2	44.6	11	1.442	2.2	45.3
12	1.358	2.1	46.1	12	1.264	1.9	47.6	12	1.303	2.0	46.1	12	1.346	2.0	46.6	12	1.379	2.1	47.4
13	1.297	2.0	48.1	13	1.209	1.8	49.4	13	1.275	1.9	48.0	13	1.310	2.0	48.6	13	1.341	2.0	49.4
14	1.165	1.8	49.8	14	1.185	1.8	51.2	14	1.188	1.8	49.8	14	1.217	1.8	50.5	14	1.251	1.9	51.3
15	1.107	1.7	51.5	15	1.100	1.7	52.9	15	1.137	1.7	51.6	15	1.144	1.7	52.2	15	1.165	1.8	53.1
16	1.101	1.7	53.2	16	1.082	1.6	54.5	16	1.123	1.7	53.3	16	1.107	1.7	53.9	16	1.083	1.6	54.7
17	1.026	1.6	54.7	17	1.058	1.6	56.1	17	1.072	1.6	54.9	17	1.041	1.6	55.5	17	1.052	1.6	56.3
18	1.020	1.5	56.3	18	1.042	1.6	57.7	18	1.021	1.5	56.4	18	1.024	1.6	57.0	18	1.018	1.5	57.9
				19	1.000	1.5	59.2	19	1.015	1.5	58.0	19	1.011	1.5	58.5	19	1.002	1.5	59.4

Table 6. Species loadings on VARIMAX-rotated principal components for 1975-94 data subset.

Species[1]	Loading
PC1	
Gulfstream flounder	0.808
Fourspot flounder	0.762
Fawn cusk eel	0.744
Spotted hake	0.663
Butterfish	0.528
Red hake	0.388
Goosefish (Angler)	0.330
PC2	
Blue hake	0.843
Rock grenadier	0.770
Longnose eel	0.763
Large-scale tapirfish	0.663
Roughhead grenadier	0.506
Marlin-spike (Common grenadier)	0.301
PC3	
Scup	0.796
Summer flounder	0.752
Northern (Common) searobin	0.751
Black sea bass	0.725
Smooth dogfish	0.578
PC4	
Silver hake	0.689
Red hake	0.574
Cusk	0.550
Pollock	0.539
Spiny dogfish	0.512
White hake	0.467
Ocean pout	0.405
Goosefish (Angler)	0.380
Haddock	0.361
Shortfin squid	0.350
PC5	
Longhorn sculpin	0.771
Sea raven	0.673
Yellowtail flounder	0.634
Winter flounder	0.598
Ocean pout	0.468

Species	Loading
PC6	
Marlin-spike (Common grenadier)	0.727
Redfishes	0.635
Witch flounder	0.529
Black dogfish	0.525
Atlantic argentine	0.492
White hake	0.443
Longfin hake	0.352
PC7	
Windowpane	0.755
Winter skate	0.748
Little skate	0.722
Northern sand lance	0.387
PC8	
Spotted wolffish	0.729
Atlantic wolffish	0.726
Northern wolffish	0.676
Roughhead grenadier	0.428
Atlantic cod	0.366
Greenland halibut	0.345
Redfishes	0.303
PC9	
Blackbelly rosefish	0.792
Offshore hake	0.775
Shortnose greeneye	0.680
PC10	
Thorny skate	0.687
American plaice	0.637
Witch flounder	0.415
Atlantic cod	0.372
Smooth skate	0.356
PC11	
Arctic cod	0.751
Atlantic sea poacher	0.742
Greenland halibut	0.451
Polar sculpin	0.304

Species	Loading
PC12	
Fourbeard rockling	0.681
Atlantic hagfish	0.619
Smooth skate	0.316
PC13	
Moustache (Mailed) sculpin	0.693
Alligatorfish	0.647
Snowflake hookear sculpin	0.604
PC14	
Roughnose grenadier	0.831
Longfin hake	0.604
Black dogfish	0.513
PC15	
Atlantic halibut	0.790
Haddock	0.587
PC16	
Polar sculpin	0.530
Roughhead grenadier	0.365
Greenland halibut	0.357
PC17	
Lumpfish	0.778
Shorthorn sculpin	0.635
Sea raven	0.339
PC18	
Cunner	0.630
Winter flounder	0.390
Snake blenny	0.361

[1]Bold type indicates species with loadings ≥ 0.5; standard type indicates species with loadings ≥ 0.3 and < 0.5.

Figure 5. Dendrogram derived from clustering the species factor scores on the 18 PCs showing the organizational hierarchy of the species assemblages derived from the PCA of the 1975-94 data subset.

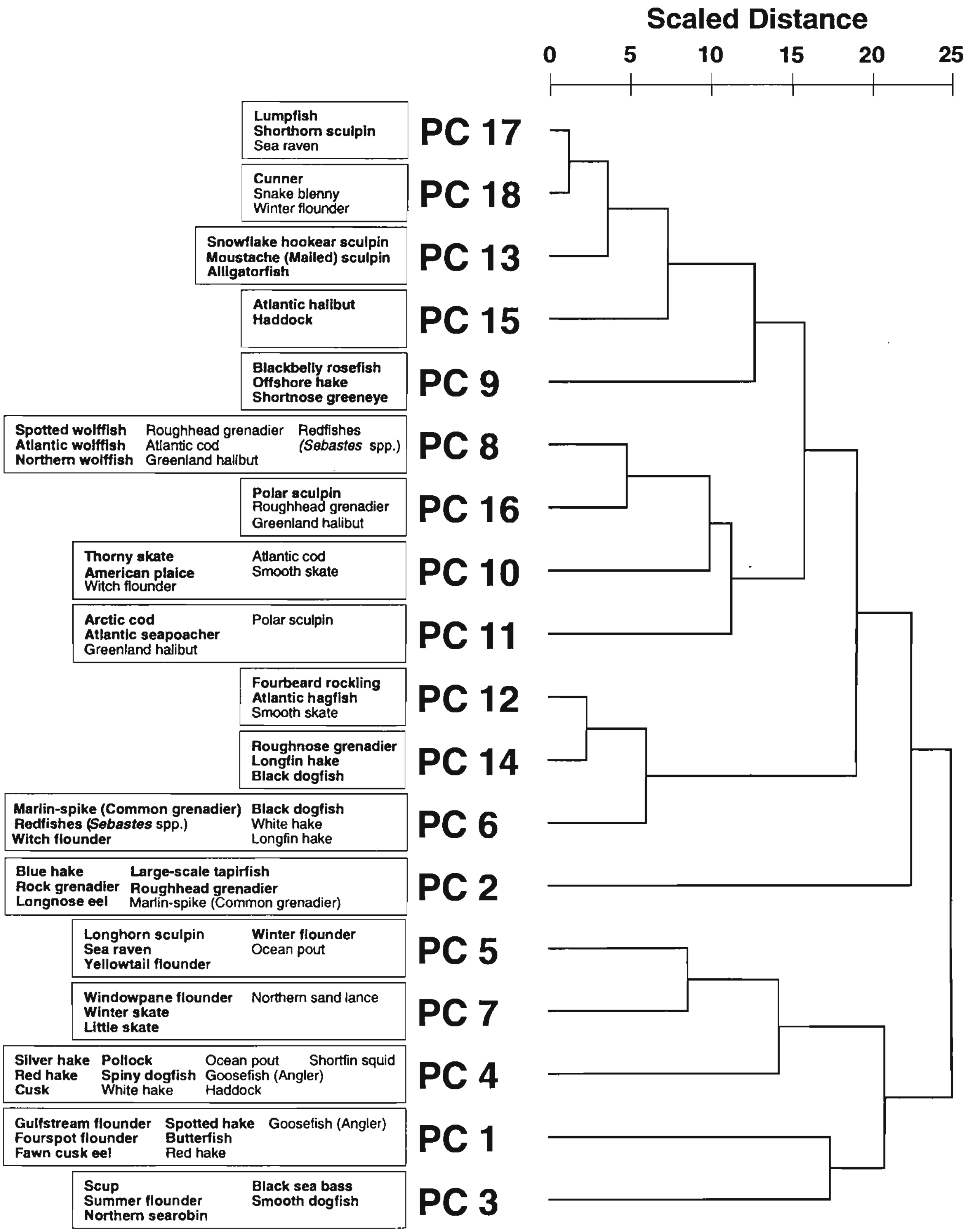


Figure 6. Maps of the sites in the top 5% of scores for the principal components derived from the 1975-94 data subset.

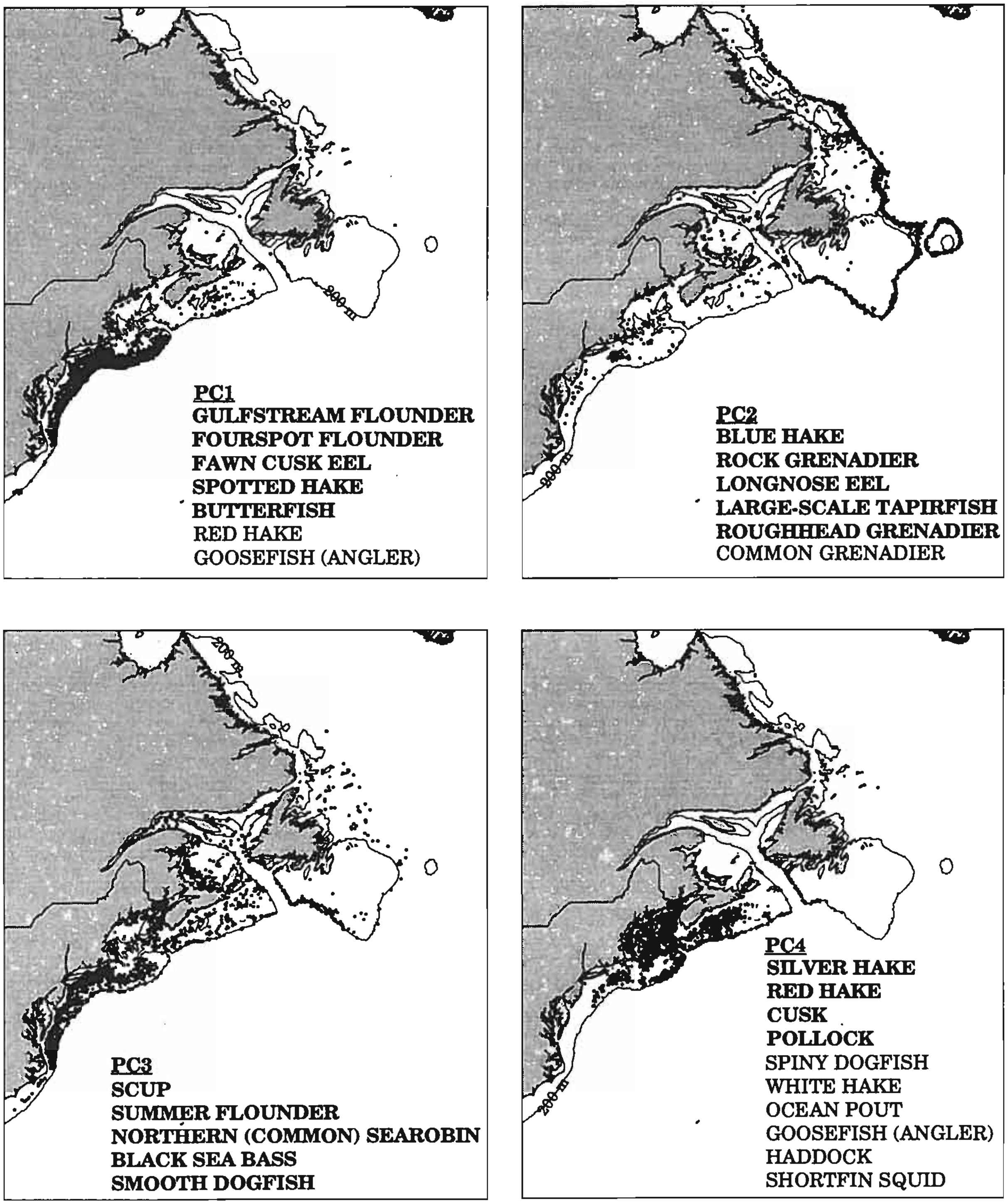


Figure 6. (continued)

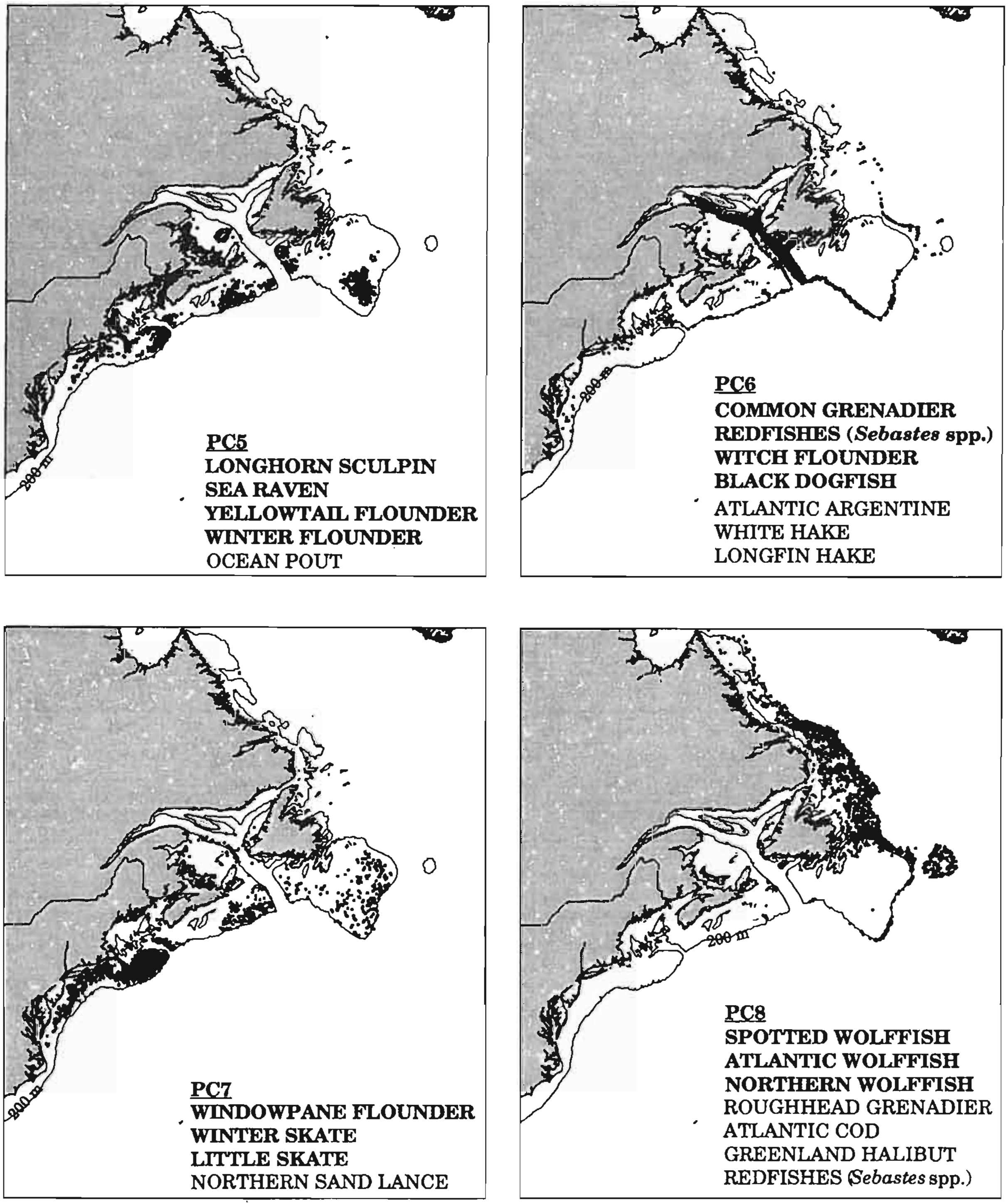


Figure 6. (continued)

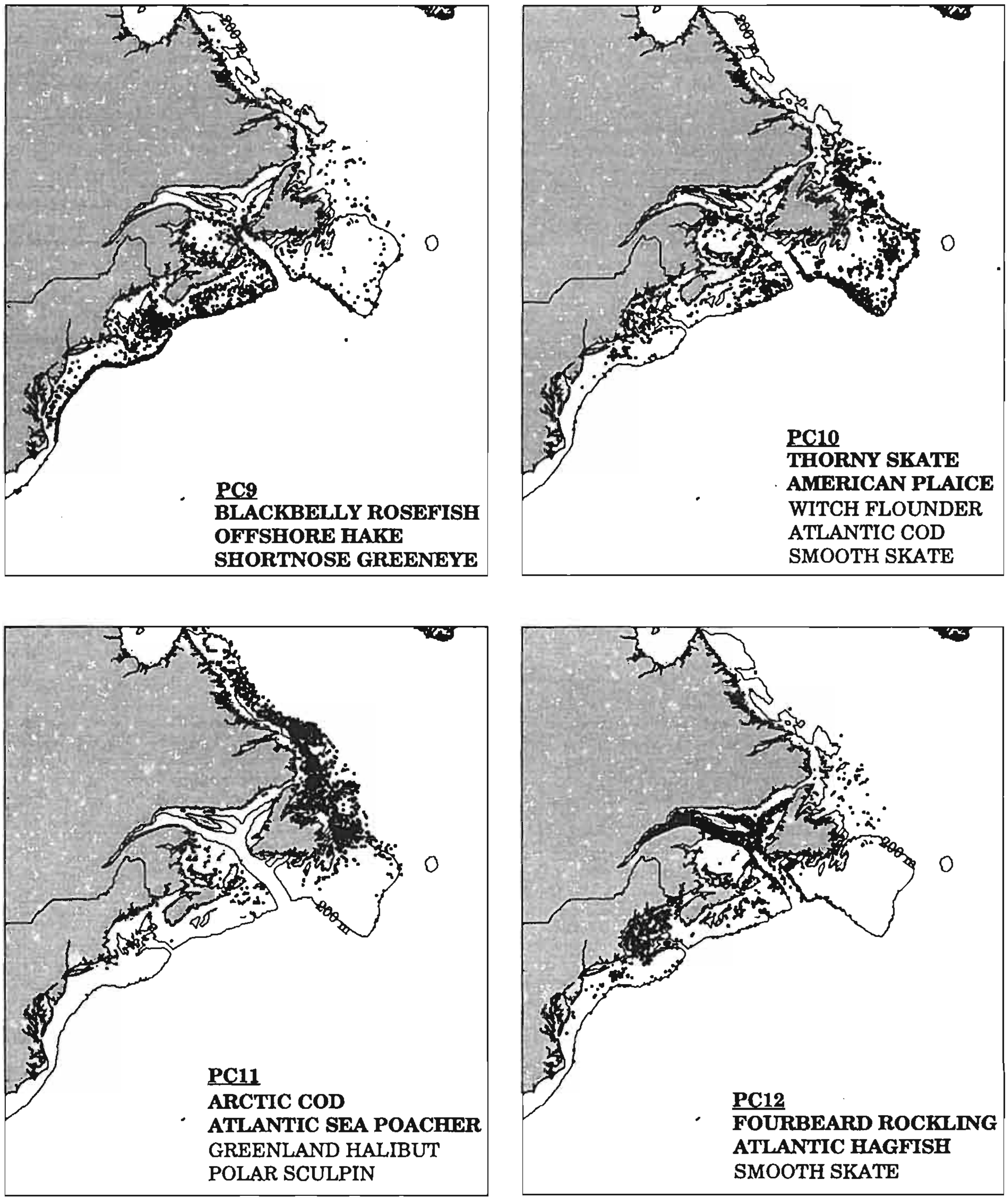


Figure 6. (continued)

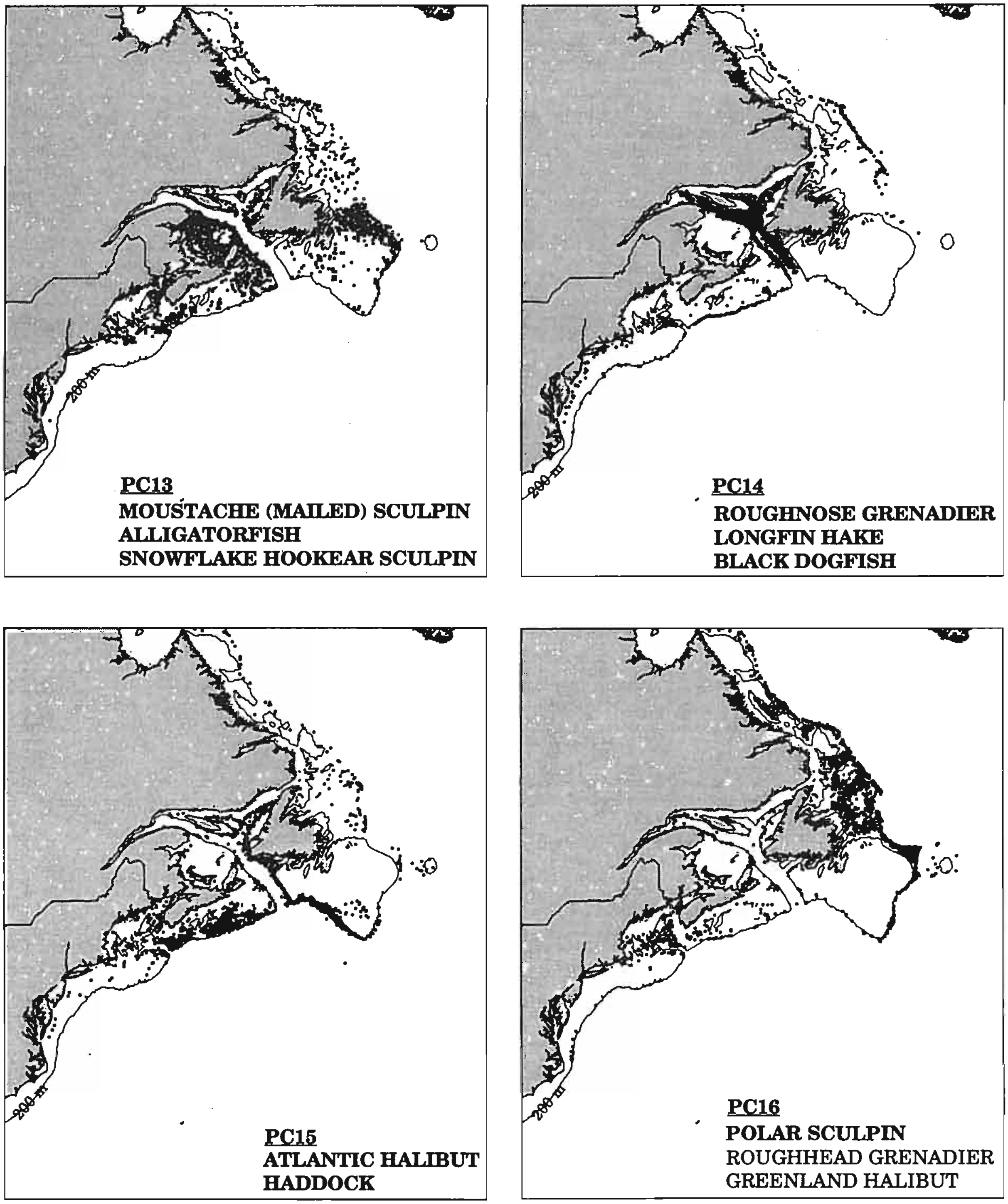


Figure 6. (continued)

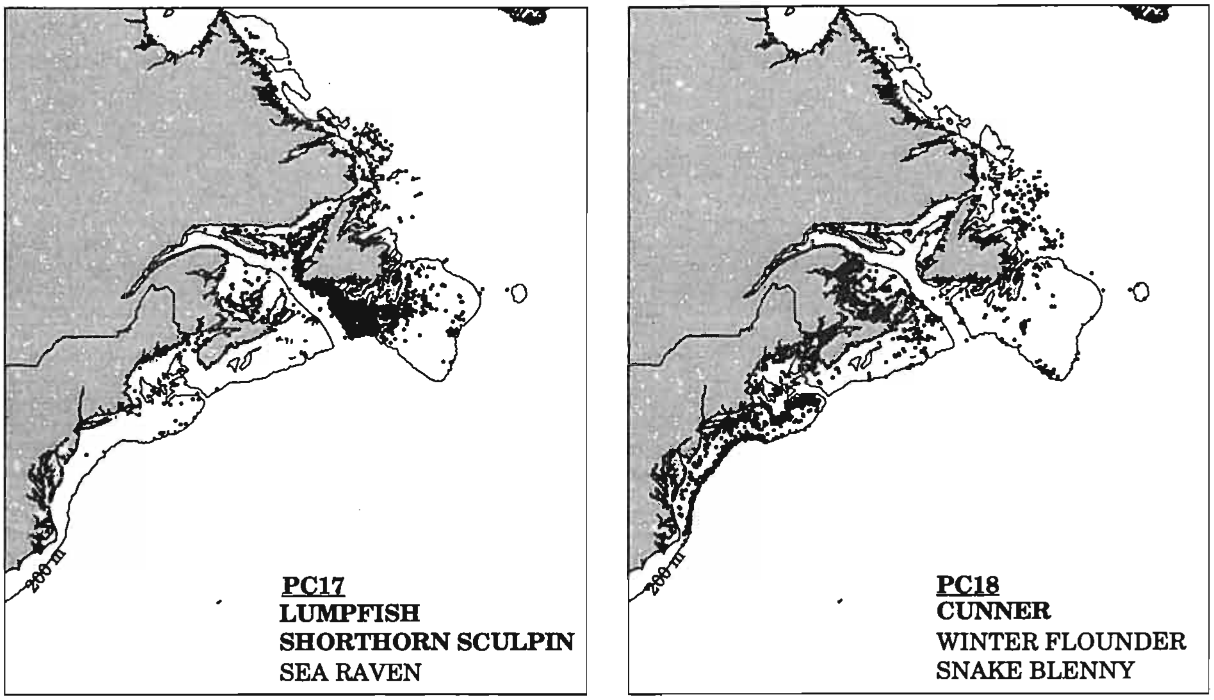


Figure 7a. Maps of the sites in the top 5, 10, 15, and 20% of scores for PC5 from the 1975-94 data subset.

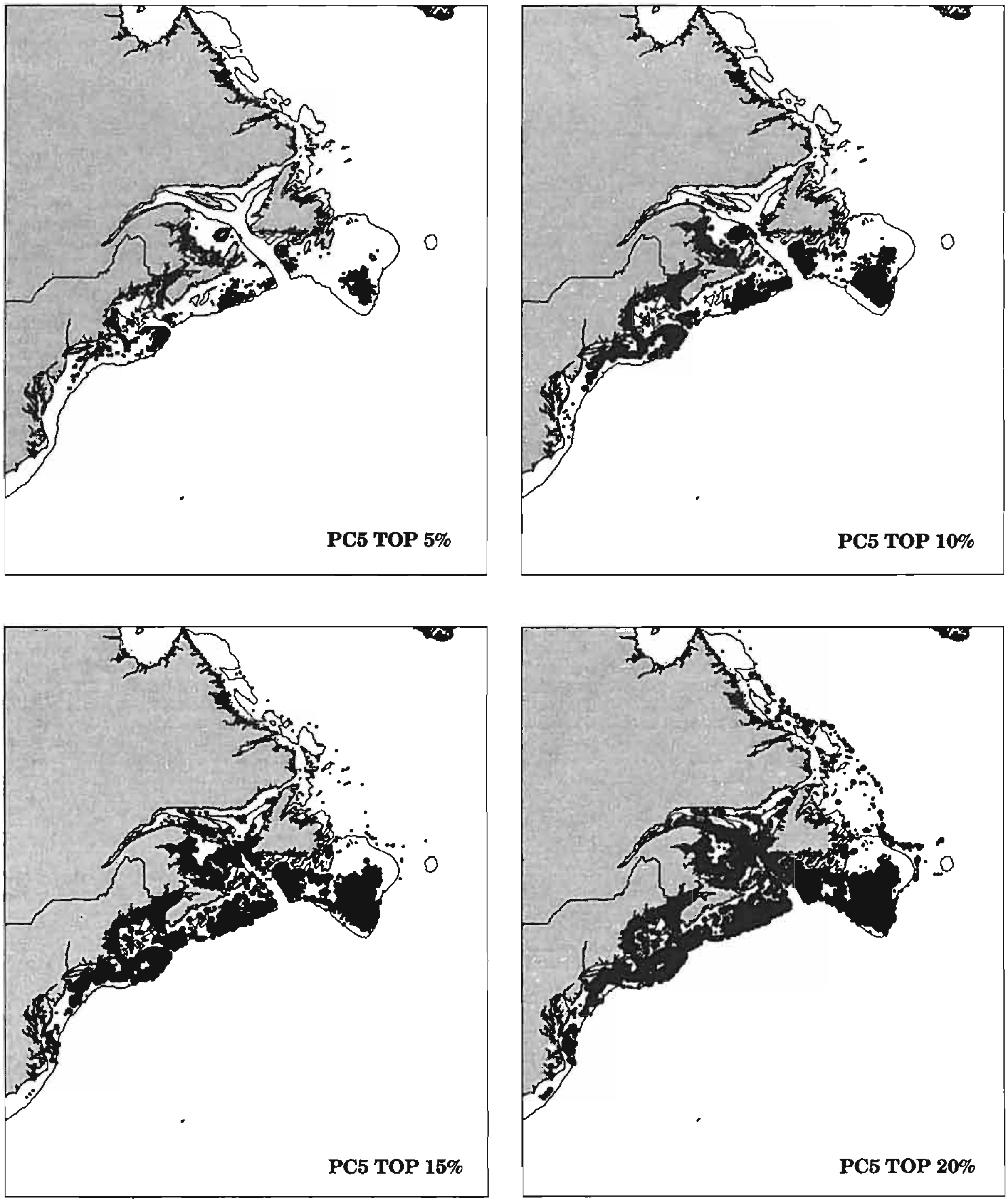


Figure 7b. Maps of the sites in the top 5, 10, 15, and 20% of scores for PC10 from the 1975-94 data subset.

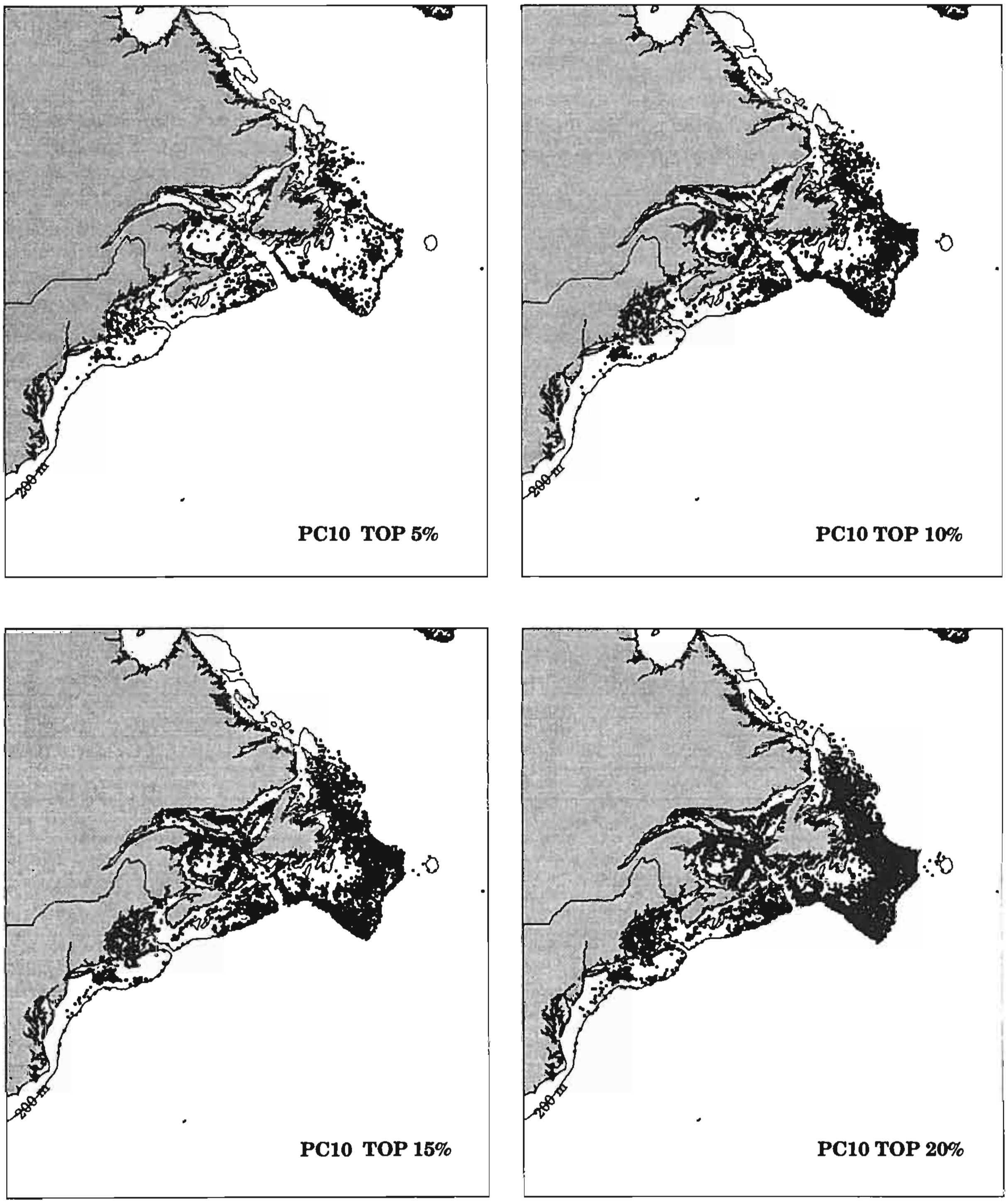
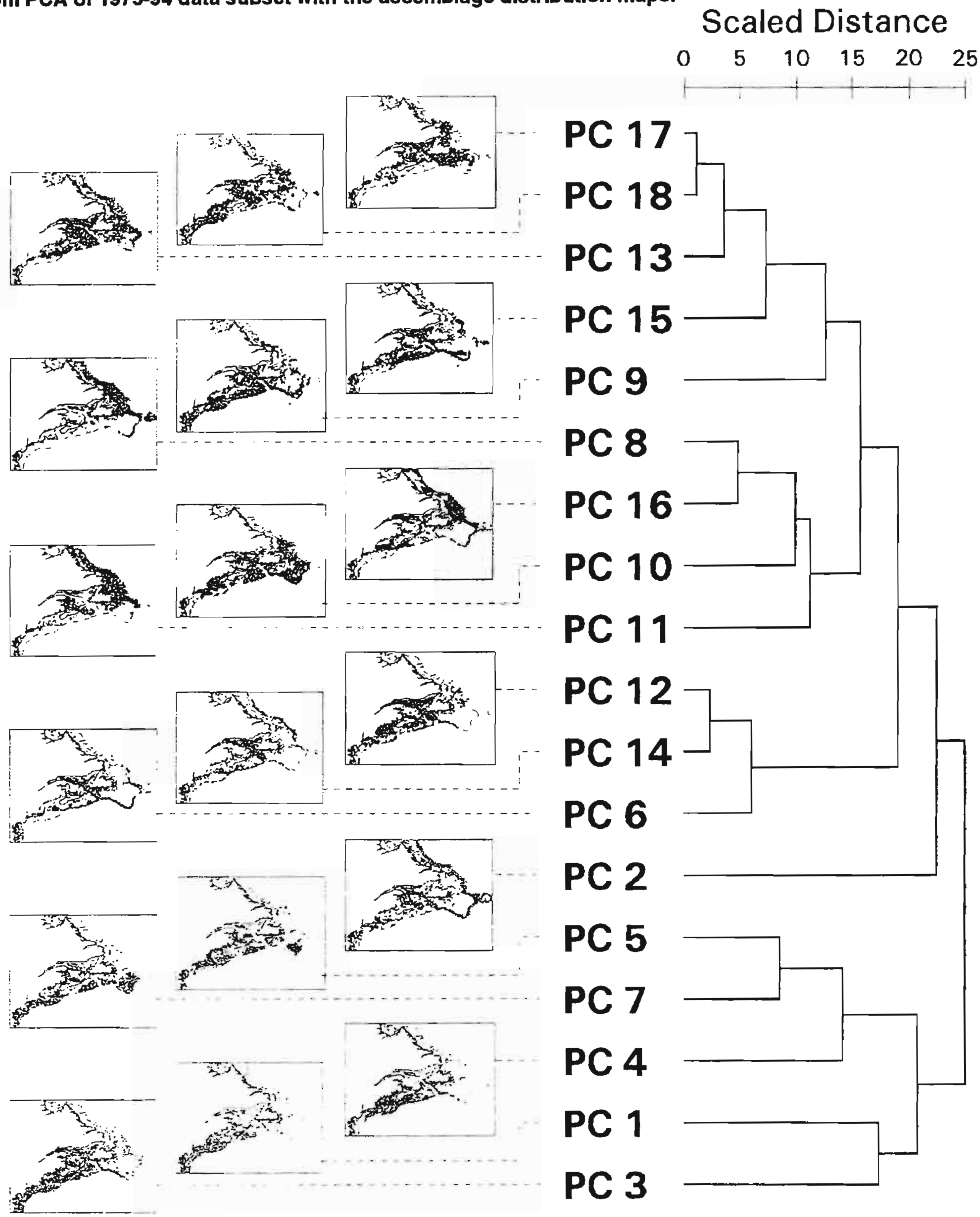


Figure 8. Dendrogram showing the hierarchical organization of groundfish assemblage distributions from PCA of 1975-94 data subset with the assemblage distribution maps.



each PC (Table 7). Mean bottom temperatures range from 1.0 to 11.2° C; mean depths range from 52 to 537 m. Substantial variation is evident, as standard deviations are 70% and 60% of the mean bottom temperatures and depths, respectively. However, assemblages close to each other in mean bottom temperature tend to be further apart in mean depth, and vice versa. For example, PCs 11 and 17 are consecutive on the temperature list (Table 7), with mean temperatures of 1.0 and 1.2° C. However, in the depth list, there are five PCs between them, and they have mean depths of 131 and 261 m. This pattern suggests that assemblages with similar depth preferences tend to be separated latitudinally, while assemblages that occur in the same region tend to have different depth preferences.

The temperature and depth preferences of the assemblages shown in Table 7 may have some biases within them, and should not be over interpreted. The data subset used for the PCA contained a mixture of data from different times of year (see Methods section). Hence, the assemblages represented by the different PCs may be based on data from different months and seasons, which could distort the apparent temperature and depth preferences. Developing a more refined analysis of assemblage temperature and depth preferences awaits further work.

Cluster Analysis

Site Clusters. Species compositions of the 18 site cluster groups are shown in Table 8. The numeric value in the table is the relative abundance of a species in a site cluster group (the average $\log_{10}(x+1)$ transformed number caught/tow of the species in that site cluster group divided by its average $\log_{10}(x+1)$ transformed number caught/tow in the entire data set, including the trawl sets which did not contain the species). Each species is assigned to the site cluster group in which it has its highest relative abundance.

Species compositions of the 18 site cluster groups ranged from 0-8 species. Two site cluster groups, numbers 1 and 7, did not contain any species with their highest relative abundance. Unlike PCA, the methods used to identify species compositions of the sites groups constrain each species to be associated with only one site cluster group. However, maximum relative abundances vary considerably. Three species, thorny skate, American plaice, and Atlantic cod, had maximum relative abundances < 2, indicating that their maximum abundance within a site cluster group is less than ten times their average abundance. These species are loosely associated with several site cluster groups, and occur at lower relative abundances in most of the remaining groups. They may be considered assemblage

Table 7. Mean, standard deviation, and range of bottom temperature and depth for the sets included in the top 5% of the principal components.

Bottom temperature(°C)					Depth (m)				
PC	Mean	SD	Min	Max	PC	Mean	SD	Min	Max
11	1.0	1.6	-1.9	14.6	5	52	26	13	313
17	1.2	2.8	-1.7	16.2	7	68	53	13	496
8	2.3	1.4	-1.6	11.7	1	98	65	18	590
13	2.5	3.2	-1.5	18.0	18	101	98	13	835
10	3.2	2.8	-1.6	15.6	3	105	124	13	1485
16	3.4	1.9	-0.9	17.1	4	124	62	17	525
2	4.1	2.2	-1.2	19.9	13	127	82	20	695
6	5.5	1.7	-0.4	20.4	17	131	72	20	499
14	5.7	1.9	-1.5	21.7	9	159	115	13	1276
15	5.8	2.5	-1.2	19.9	15	163	125	13	960
12	6.1	2.3	-1.2	19.9	10	188	133	22	696
5	6.6	4.1	-1.6	18.4	12	230	112	15	1239
9	7.9	4.0	-1.6	23.0	11	261	108	27	889
18	8.0	5.2	-1.5	24.3	8	280	83	58	790
4	8.1	2.0	0.9	16.9	6	363	117	25	695
3	9.4	5.1	-1.2	26.8	16	371	156	18	1100
7	9.6	4.9	-1.5	24.0	14	391	187	20	1485
1	11.2	2.5	-0.8	25.9	2	537	245	20	1485

generalists. Three other species, snowflake hookear sculpin, roughnose grenadier, and black sea bass, had maximum relative abundances > 60, indicating that they were strongly associated with their primary site cluster group. These species tended to associate with only a few assemblages, and were absent from many of the assemblages. These species may be considered assemblage specialists.

Geographical distributions of the 18 site cluster groups are mapped in Figure 9. Species compositions on the site cluster maps of Figure 9 are taken from Table 8. The majority of the cluster groups shows a considerable degree of spatial aggregation. However, site cluster group 1, which contains 16,475 sites (42.6% of the sites), is distributed over the entire study area. A dendrogram showing hierarchical relationships among the site cluster groups, together with the maps for the 18 groups, is shown in Figure 10. A poster-sized version of this figure is available upon request. The dendrogram was produced by agglomerative hierarchical clustering (squared Euclidean distance, Ward's method) of the 18 site groups using the species mean $\log_{10}(x+1)$ catch per tow in each site group. The first branching in this dendrogram suggests a biogeographic break around Georges Bank. This dendrogram is directly comparable to the equivalent dendrogram of the PCA-derived assemblages (Figure 8).

Average depth and bottom temperatures were calculated for the 18 cluster site groups (Table 9). The patterns are similar to those observed for the PCA (Table 7). Mean bottom temperatures range between 0.7 and 11.9° C; mean depths range between 58 and 504 m. Standard deviations are 79% and 64% of the mean bottom temperatures and depths, respectively. As with the PCA-derived assemblages, the temperature and depth preferences may have been biased by differences among the cluster groups in sampling months and seasons.

Species Clusters. The species groups, and their hierarchical relationships derived from the species clustering, are shown in the dendrogram in Figure 11. The species clusters contain from one to fifteen species. Some species pairs are very close (e.g., American plaice and Atlantic cod, redfishes and witch flounder, arctic cod and Atlantic sea poacher, blue hake and longnose eel). As with the species groups derived from the sites cluster analysis, every species is assigned to only one species cluster group. The species cluster dendrogram (Figure 11) can be compared directly with the dendrogram derived by clustering the species using the factor scores on the 18 PCs described above (Figure 5), and with the species groups derived from the site cluster analysis (Table 8).

Temporal Variation

Single Species. The ACON distribution plots for the four test species show interesting patterns (Figure 12a-d) for the boundaries of species distributions, suggesting that more analyses of this type could be useful. The lack of surveys in the early-mid 1970s over the Northern Grand Banks, off Labrador, and over the Flemish Cap, and the cessation of surveys over Flemish Cap in the mid 1980s have clearly influenced the Atlantic cod and arctic cod data, and preclude interpretation for these areas and time periods. However, other meaningful results are available. For Atlantic cod, the major shift has been in the north, where the boundary moved southward during the 1990s. For arctic cod, there has been an increase in frequency of catches through time, as well as a southward expansion onto the north and east Grand Banks. For ocean pout, the major concentrations were south of 42° N throughout the entire period. There was a separate area in the Gulf of St. Lawrence, with distribution variable on the Scotian Shelf. The range of butterfish gradually expanded northward during 1970-90, and has contracted since.

The bivariate ellipses show similar trends affecting the core of species distributions (Figure 13). For Atlantic cod, the latitudinal range of the core distribution has contracted, with a marked southward retreat of the northern range in the 1990s. For Arctic cod, there has been a clear expansion south and east since 1980. For both ocean pout and butterfish, the two southerly species, there was an expansion north and east during 1970-90, with contraction south and west during 1990-94. Butterfish exhibited less change than the other three species.

Assemblages. The assemblages identified by PCA of the entire 1975-94 time period are compared with those identified by PCA of the five-year time periods in Table 10. Species loadings on the PCs for the individual five-year time periods are in Appendix 4A-D. There was considerable persistence of the 1975-94 assemblages through time. Six assemblages (1, 7, 9, 10, 11, 12) contained a consistent core of high-level species (i.e., with loadings ≥ 0.5) throughout, although other species sometimes joined assemblages during certain five-year blocks. Five assemblages (2, 5, 8, 17, 18) always retained their high-level species, but some of the loadings dropped below 0.5 during one or more five-year blocks. Five assemblages (3, 4, 6, 13, 14) split into two assemblages during at least one five-year block. Three assemblages (6, 14, 15) disappeared from one five-year block, but generally retained their high-level species during the other blocks.

Table 8. Standardized mean log catch per tow (standardized to overall species mean log catch per tow) of each species in the site cluster groups.[1]

Species	Site cluster group																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Lumpfish	0.73	**9.70**	0.81	0.41	1.20	0.66	0.08	0.44	0.74	1.95	0.14	0.01	0.50	0.32	0.06	0.00	0.07	0.04
Shorthorn sculpin	0.60	**13.75**	1.04	0.16	0.33	0.46	0.02	2.40	0.30	0.00	1.32	0.00	0.40	0.78	0.00	0.23	0.00	0.00
Arctic cod	0.71	0.96	**8.53**	0.11	0.34	0.80	0.00	1.55	0.38	0.01	0.04	0.00	0.62	0.15	0.00	0.00	0.01	0.00
Atlantic sea poacheer	0.55	0.60	**9.29**	0.08	0.44	0.88	0.00	2.06	0.39	0.00	0.01	0.00	1.09	1.15	0.00	0.00	0.00	0.00
Atlantic argentine	0.39	0.44	0.09	**3.85**	2.83	0.36	0.21	0.15	0.79	2.81	0.08	0.24	0.46	0.47	0.04	0.25	3.69	0.34
Atlantic halibut	0.63	0.66	0.32	**3.02**	1.22	0.94	0.43	0.55	1.10	1.80	1.45	0.22	0.83	0.81	0.50	0.14	1.05	0.12
Haddock	0.55	0.30	0.08	**4.26**	0.40	0.23	1.43	0.17	0.38	0.67	3.62	1.08	0.20	1.36	1.13	1.03	1.77	1.10
Pollock	0.27	0.38	0.07	**5.07**	1.01	0.19	1.80	0.10	0.25	1.96	2.22	0.44	0.30	2.28	1.38	1.27	2.54	1.39
Atlantic hagfish	0.54	0.13	0.13	1.11	**4.49**	0.55	1.25	0.11	1.04	0.99	0.52	0.41	0.94	1.85	1.11	2.12	1.85	0.41
Marlin-spike (Common grenadier)	0.49	0.67	0.43	0.34	**4.44**	1.39	0.03	0.29	3.80	0.03	0.03	0.04	2.59	0.65	0.05	0.02	0.35	0.00
White hake	0.40	0.29	0.11	2.37	**2.84**	0.27	2.02	0.48	0.52	2.60	2.72	1.10	0.36	1.86	1.86	1.51	2.26	1.92
Spotted wolffish	0.77	0.46	1.29	0.26	0.65	**3.31**	0.00	1.22	1.93	0.26	0.10	0.00	1.46	0.35	0.00	0.00	0.04	0.00
American plaice	1.24	0.94	1.14	0.58	0.64	1.17	0.34	**1.87**	0.94	0.70	0.63	0.08	0.73	1.35	0.34	0.33	0.41	0.38
Atlantic cod	1.10	0.83	0.87	0.70	0.81	1.39	0.28	**1.87**	0.74	1.18	1.23	0.21	0.68	1.63	0.23	0.18	0.32	0.15
Greenland cod	0.45	0.04	0.23	0.12	0.28	0.40	0.00	**55.64**	0.51	0.00	0.44	0.00	0.12	1.02	0.00	0.00	0.00	0.00
Snake blenny	0.88	0.52	1.29	0.22	0.37	0.43	0.10	**21.00**	0.79	0.00	2.13	0.22	0.34	8.32	0.00	0.18	0.00	0.00
Large-scale tapirfish	0.62	0.92	0.82	0.15	0.90	1.48	0.00	0.22	**14.16**	0.31	0.04	0.00	9.42	0.27	0.00	0.00	0.00	0.00
Black dogfish	0.35	0.76	0.20	0.16	5.59	0.68	0.01	0.18	1.47	**9.95**	0.02	0.07	3.55	0.24	0.00	0.00	0.02	0.00
Longfin hake	0.21	0.24	0.04	0.90	6.13	0.07	0.40	0.11	0.17	**13.98**	0.13	0.24	0.00	1.23	0.26	0.12	5.57	0.23
Redfishes (Sebastes spp.)	0.70	0.57	0.51	0.97	2.42	1.58	0.33	0.54	1.95	**2.59**	0.13	0.06	1.39	1.53	0.28	0.27	0.69	0.40
Roughnose grenadier	0.36	0.07	0.09	0.17	0.40	0.29	0.00	0.00	0.85	**65.54**	0.00	0.12	2.07	1.11	0.00	0.00	0.00	0.00
Witch flounder	0.72	0.55	0.48	0.95	2.31	1.51	0.45	0.66	1.62	**3.56**	0.35	0.10	1.28	1.48	0.47	0.37	0.56	0.46
Cunner	0.17	0.07	0.00	2.44	0.03	0.00	2.74	0.00	0.00	0.00	**12.09**	10.12	0.00	0.36	2.06	1.52	3.98	0.73
Longhorn sculpin	0.61	1.34	0.11	1.70	0.15	0.17	2.22	1.04	0.29	0.01	**8.93**	3.82	0.19	1.17	1.74	1.33	1.46	1.26
Ocean pout	0.33	0.09	0.07	2.60	0.19	0.04	4.46	0.91	0.08	0.21	**8.65**	2.17	0.00	3.27	3.24	3.90	4.23	2.64
Sea raven	0.73	3.37	0.19	1.20	0.34	0.42	2.02	0.46	0.53	0.42	**6.06**	1.94	0.45	1.31	1.42	1.37	1.56	1.33
Winter flounder	0.21	0.09	0.01	1.28	0.02	0.00	2.43	1.00	0.00	0.02	**16.98**	5.18	0.00	0.41	1.84	2.80	1.96	3.72
Yellowtail flounder	1.27	0.55	0.17	0.98	0.20	0.42	0.88	1.00	0.69	0.05	**4.81**	1.76	0.37	0.17	0.56	0.75	0.84	0.83
Butterfish	0.32	0.00	0.00	2.50	0.05	0.00	8.52	0.00	0.00	0.00	2.54	**9.43**	0.00	0.02	8.36	8.74	5.50	6.63
Fourspot flounder	0.29	0.02	0.00	2.41	0.05	0.00	8.60	0.00	0.00	0.00	2.20	**10.61**	0.00	0.00	9.78	8.40	5.18	9.68

Table 8 continued.

Species	Site cluster group																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Little skate	0.25	0.03	0.00	3.04	0.06	0.00	5.81	0.00	0.00	0.02	3.80	**14.05**	0.01	0.21	3.75	5.09	3.25	5.47
Northern sand lance	1.12	0.68	0.29	1.18	0.33	0.94	1.55	0.93	1.47	0.08	0.92	**4.46**	0.67	0.39	1.33	0.83	1.44	1.38
Spiny dogfish	0.32	0.08	0.02	3.71	0.31	0.07	4.29	0.42	0.09	0.15	4.37	**5.52**	0.08	1.16	3.78	3.81	2.77	4.59
Windowpane	0.21	0.00	0.00	2.43	0.15	0.04	4.56	0.00	0.06	0.40	4.91	**18.42**	0.11	0.00	2.99	5.14	2.69	8.37
Winter skate	0.35	0.23	0.01	2.55	0.30	0.10	2.38	0.35	0.13	0.59	8.06	**10.85**	0.06	0.55	1.67	0.86	2.58	1.30
Blue hake	0.65	0.74	1.01	0.12	0.42	1.40	0.00	0.16	9.33	0.05	0.08	0.00	**19.84**	0.16	0.00	0.00	0.00	0.00
Greenland halibut	0.78	0.49	2.14	0.20	1.49	2.15	0.00	0.60	1.87	1.81	0.03	0.01	**2.59**	0.37	0.00	0.00	0.01	0.00
Longnose (slatjaw cutthroat) eel	0.58	0.56	1.11	0.05	0.69	1.46	0.00	0.00	9.18	0.00	0.00	0.00	**21.05**	0.00	0.00	0.00	0.00	0.00
Northern wolffish	0.85	0.57	0.99	0.32	0.87	2.75	0.00	0.80	2.67	0.13	0.07	0.00	**2.84**	0.30	0.00	0.00	0.00	0.00
Polar sculpin	0.54	0.34	2.54	0.18	0.67	3.33	0.00	0.36	3.24	0.09	0.00	0.00	**3.85**	0.34	0.00	0.00	0.00	0.00
Roughhead grenadier	0.72	0.44	0.78	0.17	0.62	3.24	0.00	0.37	4.65	0.03	0.02	0.00	**4.84**	0.25	0.00	0.00	0.01	0.00
Rock (Roundnose) grenadier	0.67	0.60	0.80	0.14	0.97	1.20	0.00	0.17	3.89	0.25	0.03	0.00	**25.62**	0.00	0.00	0.00	0.00	0.00
Spinytail skate	0.73	0.70	0.84	0.17	0.89	3.07	0.00	0.40	3.26	0.42	0.00	0.00	**4.82**	0.26	0.00	0.00	0.00	0.00
Alligatorfish	0.71	0.86	1.43	0.46	0.33	0.86	0.76	7.00	0.79	0.08	4.72	0.38	0.68	**11.38**	0.73	0.31	0.84	0.33
Atlantic wolffish	0.93	0.71	0.88	0.63	0.62	2.48	0.21	0.64	0.98	0.21	0.52	0.03	0.88	**3.08**	0.12	0.11	0.29	0.07
Fourbeard rockling	0.39	0.21	0.26	0.76	4.75	0.48	1.51	0.75	0.46	2.99	1.11	0.78	0.67	**4.90**	2.27	1.15	1.92	1.36
Moustach (Mailed) sculpin	1.05	0.57	0.57	1.02	0.40	0.63	0.48	4.50	0.57	0.00	2.13	0.45	0.43	**12.00**	0.51	0.73	0.83	0.39
Snowflake hookear sculpin	0.42	0.40	0.09	0.32	0.66	0.04	0.00	2.81	0.00	0.62	0.34	0.22	0.00	**76.83**	0.00	0.00	0.18	0.00
Smooth skate	0.69	0.56	0.43	1.16	2.46	1.41	0.68	0.48	0.64	1.56	0.81	0.14	0.69	**3.18**	0.72	0.55	0.80	0.68
Thorny skate	1.13	1.15	0.94	0.64	0.94	1.29	0.37	0.89	1.21	0.95	0.63	0.11	0.74	**1.46**	0.30	0.34	0.47	0.29
Fawn cusk eel	0.31	0.00	0.00	2.46	0.04	0.00	6.85	0.00	0.00	0.00	2.18	6.39	0.00	0.00	**24.66**	6.44	6.67	6.45
Gulfstream flounder	0.29	0.06	0.00	2.48	0.09	0.00	8.29	0.00	0.00	0.00	2.10	8.50	0.00	0.00	**14.54**	7.43	6.90	6.88
Red hake	0.25	0.01	0.00	3.92	0.07	0.00	6.81	0.00	0.01	0.02	2.78	5.83	0.00	0.15	**7.21**	5.17	4.59	6.18
Spotted hake	0.35	0.02	0.00	1.63	0.04	0.00	9.02	0.00	0.00	0.00	2.00	8.42	0.00	0.00	**14.86**	9.50	10.65	14.23
Smooth dogfish	0.30	0.00	0.00	1.64	0.07	0.00	6.94	0.00	0.00	0.00	2.14	5.34	0.00	0.00	6.69	**33.55**	4.61	29.26
Blackbelly rosefish	0.25	0.00	0.00	3.57	0.23	0.00	5.26	0.00	0.00	0.00	1.66	3.84	0.00	0.00	4.53	6.00	**31.86**	2.74
Cusk	0.25	0.09	0.01	6.28	0.15	0.12	2.79	0.06	0.22	0.15	0.64	0.57	0.06	0.75	2.03	2.81	**6.40**	4.96
Offshore hake	0.36	0.06	0.00	2.39	0.39	0.00	4.08	0.00	0.00	2.49	1.44	5.77	0.00	1.00	2.35	7.58	**40.01**	2.54
Shortfin squid	0.52	0.02	0.07	3.50	0.66	0.12	3.55	0.43	0.27	0.25	2.21	4.19	0.16	0.92	3.34	3.23	**4.86**	2.73
Shortnose greeneye	0.21	0.00	0.00	2.48	0.07	0.00	5.75	0.00	0.00	0.00	2.64	5.64	0.00	0.00	8.18	0.83	**47.92**	3.03
Black sea bass	0.21	0.00	0.00	1.35	0.00	0.00	8.29	0.00	0.00	0.00	2.29	8.61	0.00	0.00	10.40	14.57	5.07	**62.92**
Goosefish (Angler)	0.35	0.30	0.08	3.35	1.54	0.20	3.88	0.19	0.48	1.39	1.61	2.36	0.30	0.38	4.51	3.62	4.17	**4.63**
Northern (Common) searobin	0.31	0.00	0.00	1.56	0.01	0.00	8.37	0.00	0.00	0.00	2.32	9.41	0.00	0.00	11.03	15.80	4.62	**29.08**
Scup	0.25	0.01	0.00	1.66	0.00	0.00	8.48	0.00	0.00	0.00	2.28	7.47	0.00	0.00	8.87	23.81	3.63	**31.45**
Silver hake	0.31	0.13	0.05	3.91	0.56	0.09	5.00	0.06	0.17	0.85	2.55	3.72	0.10	0.43	4.64	4.51	4.01	**5.48**
Summer flounder	0.29	0.00	0.00	1.45	0.02	0.00	7.23	0.00	0.00	0.00	1.56	11.06	0.00	0.00	9.75	25.17	4.31	**27.88**

[1]Values in bold type indicate the species assigned to a site cluster group, based on having their highest mean standardized catch per tow in that site cluster.
No species reached its maximum standardized mean catch per tow in site clusters 1 and 7.

Figure 9. Geographical distributions of the 18 site cluster groups with associated species.

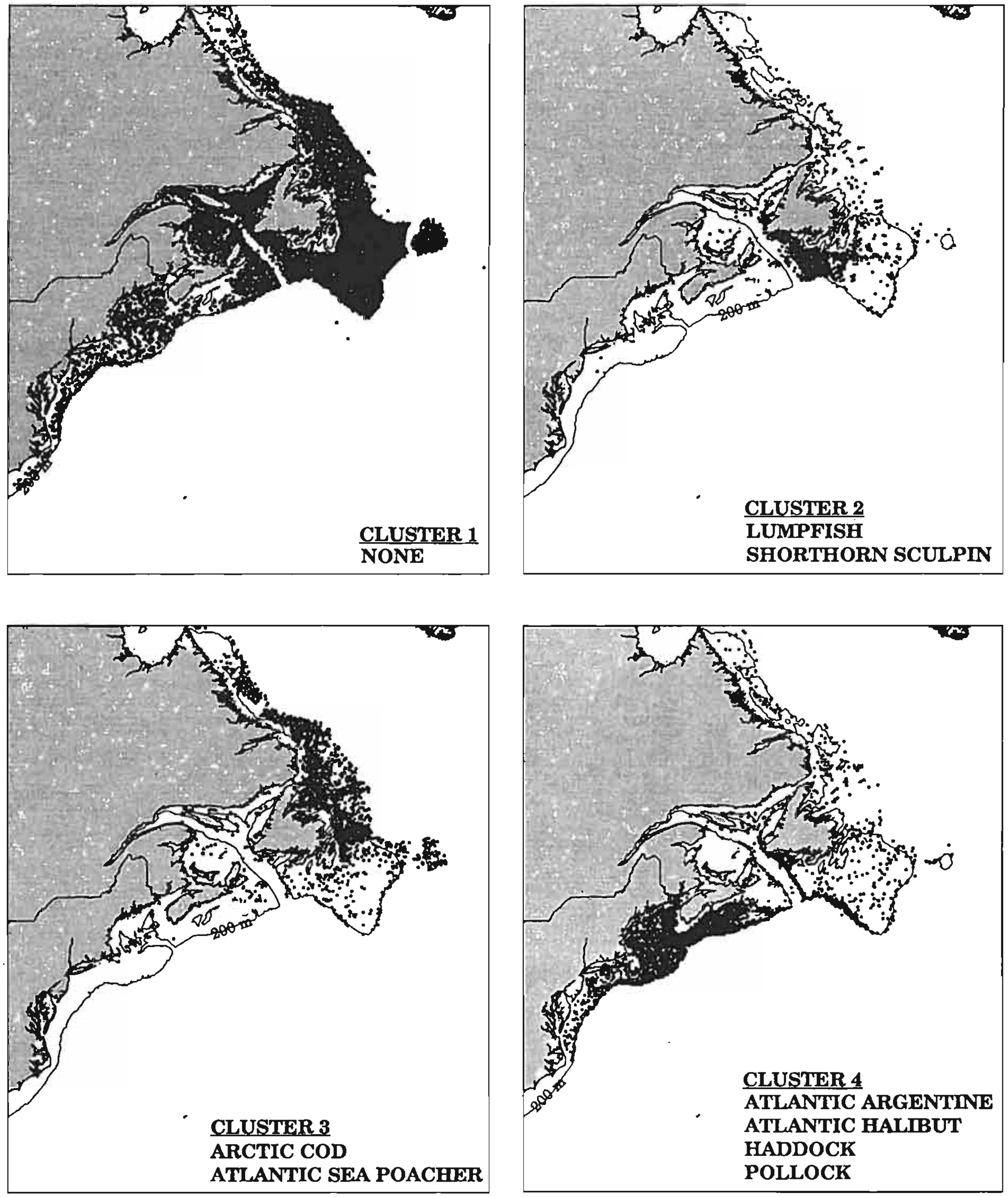


Figure 9. (continued)

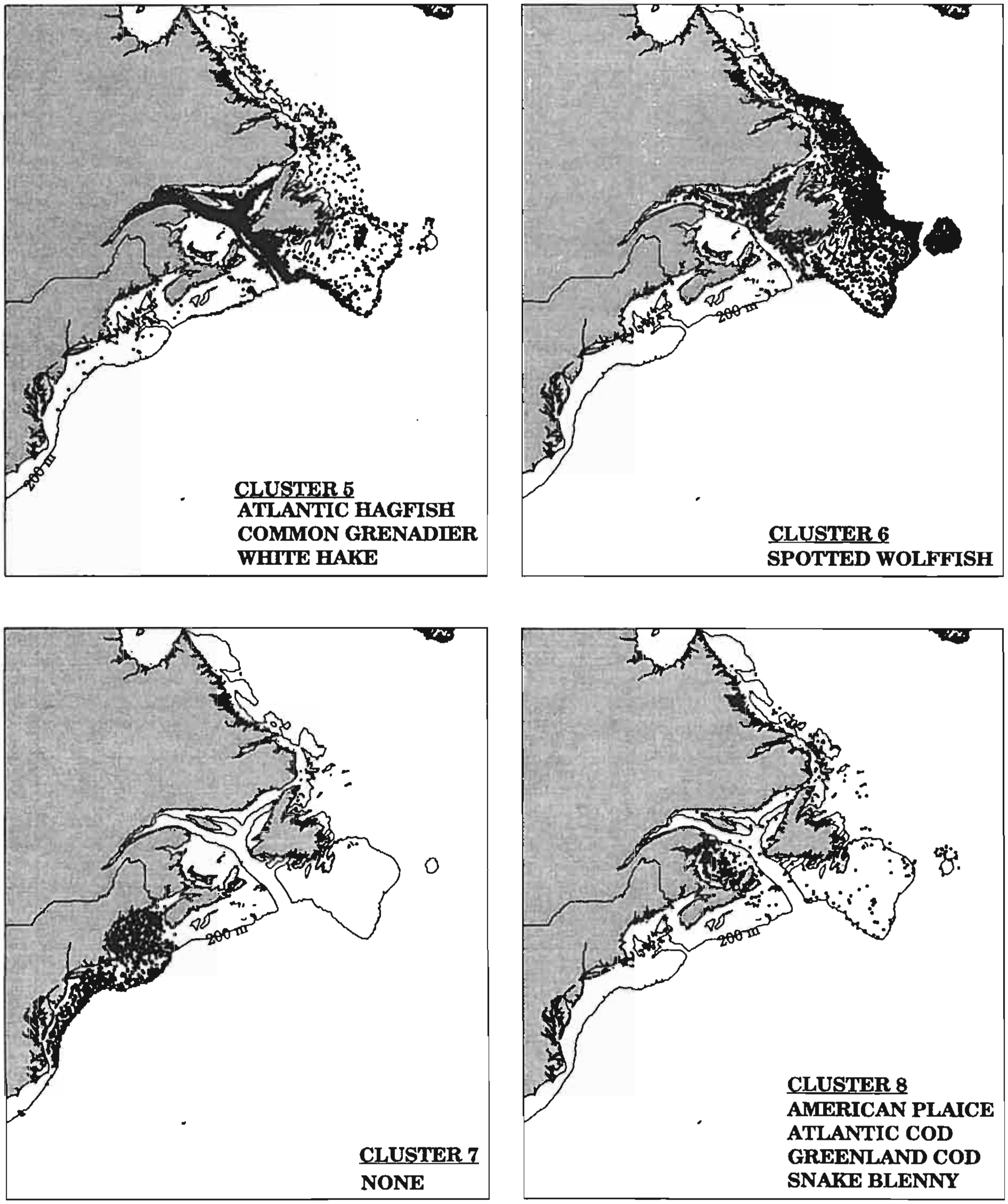


Figure 9. (continued)

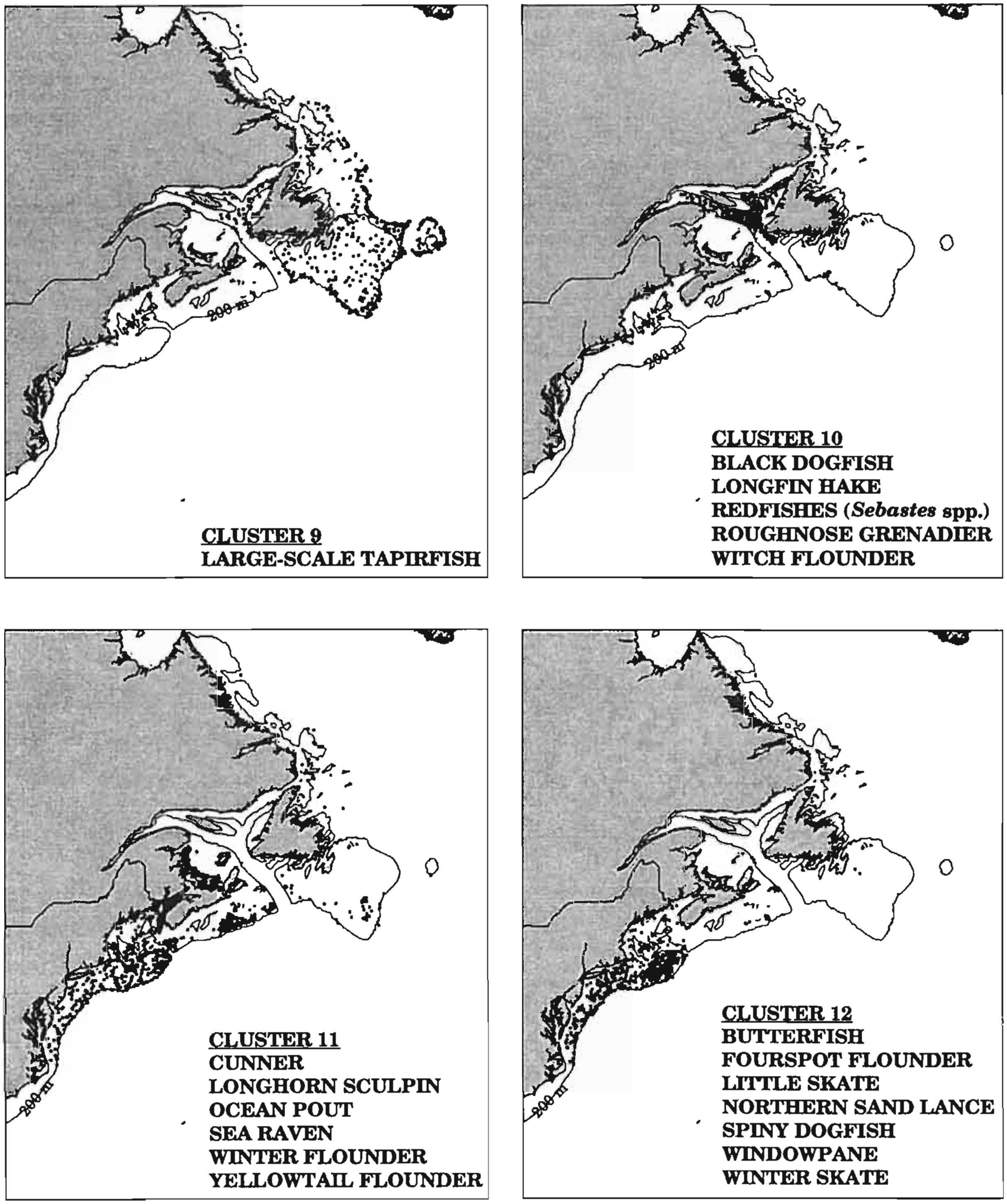


Figure 9. (continued)

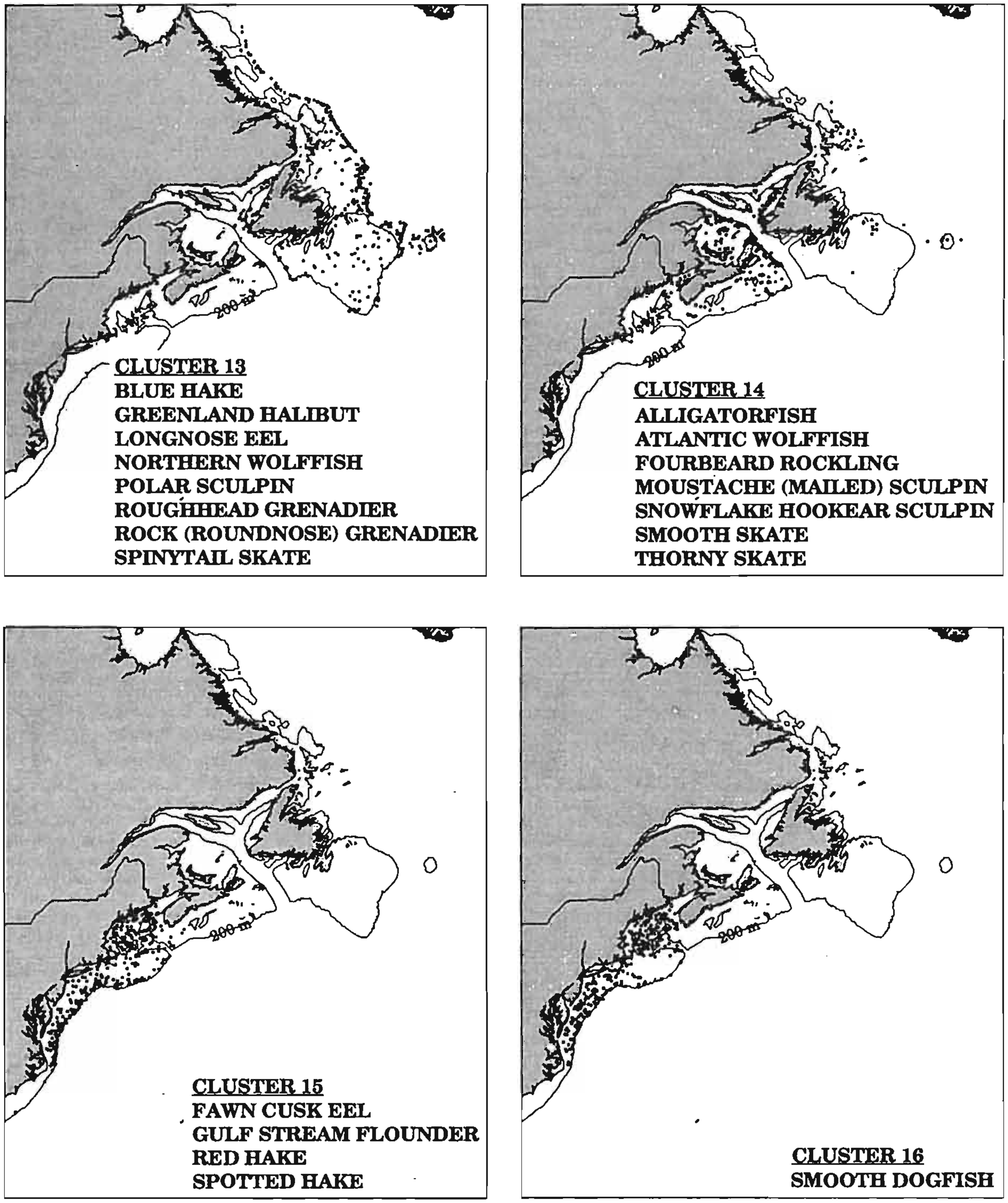
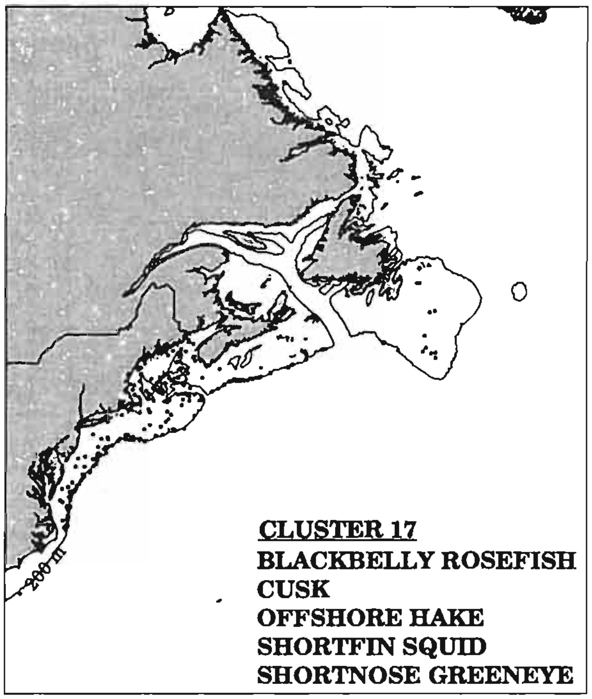


Figure 9. (continued)



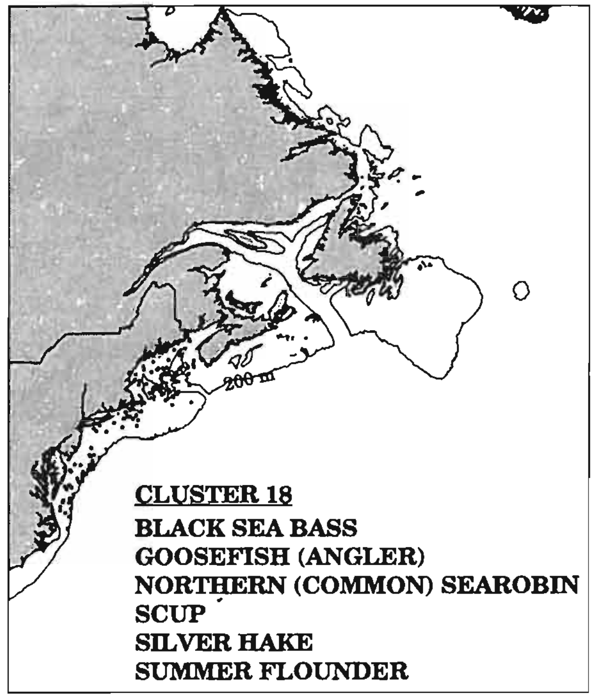


Figure 10. Dendrogram showing the hierarchical organization of groundfish assemblages from the site cluster analysis of the 1975-94 data subset, with assemblage distribution maps.

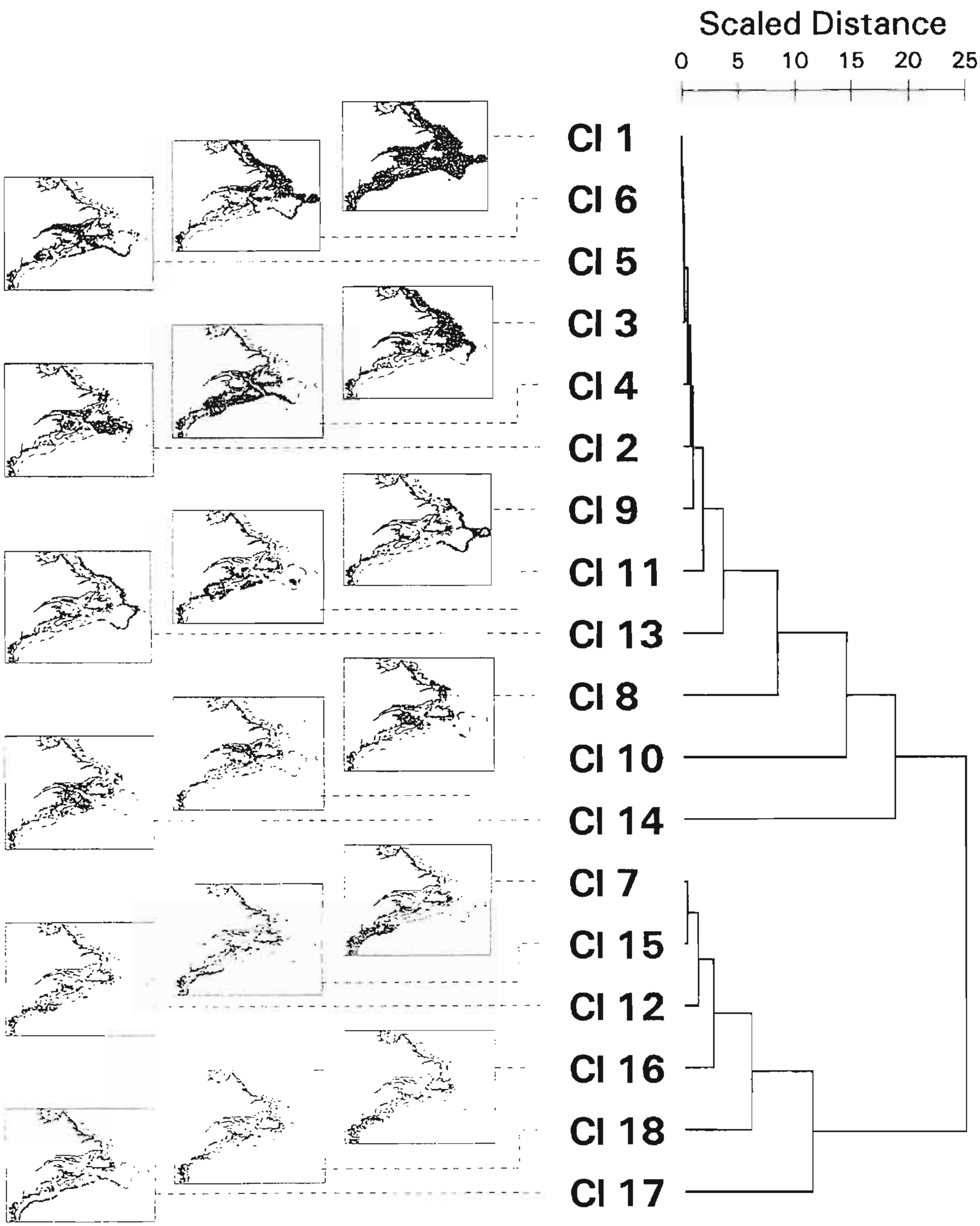


Table 9. Mean, standard deviation, and range of bottom temperature and depth for the sites in each site cluster group (CG).

Bottom temperature (°C)					Depth (m)				
CG	Mean	SD	Min	Max	CG	Mean	SD	Min	Max
2	0.7	2.3	-1.7	15.6	11	58	54	13	579
3	1.0	1.8	-1.7	10.2	12	85	67	15	382
8	1.7	2.4	-1.5	14.6	18	101	63	20	265
1	2.1	3.2	-1.5	27.1	16	111	78	20	380
6	2.5	1.9	-1.7	12.5	15	114	67	24	336
14	2.7	2.4	-1.1	11.0	7	117	76	16	457
9	3.0	2.0	-1.6	8.2	8	129	109	27	808
13	3.1	1.9	-1.4	8.4	4	133	91	13	1105
5	4.5	2.1	-1.7	14.9	14	134	93	33	578
10	5.8	1.6	-1.5	12.6	17	140	82	27	382
4	7.5	3.4	-1.6	28.0	2	151	115	27	1168
11	8.5	3.7	-1.3	23.1	1	173	136	14	1485
17	9.3	3.2	-1.2	19.9	3	255	129	37	1226
7	10.3	3.1	3.5	24.4	6	295	150	40	1375
15	10.8	3.4	3.2	24.1	5	304	127	23	1375
16	10.9	3.7	4.9	24.3	10	339	101	84	790
18	11.0	3.8	4.9	21.3	9	372	226	40	1331
12	11.9	2.9	-0.8	25.9	13	504	308	42	1432

Because of the stability of assemblages, mapping 1975-94 PCA-based assemblages in five-year blocks was deemed an effective way to examine temporal variability in assemblage distribution. However, the cessation of sampling on the Flemish Cap in the mid 1980s may have introduced an apparent westward movement in distribution for the 1990-94 period. Sites scoring in the top 5% of the scores for PC 10 (thorny skate, American plaice, witch flounder, Atlantic cod, smooth skate) and PC 11 (arctic cod, Atlantic sea poacher, Greenland halibut, polar sculpin) are mapped in five-year intervals (Figures 14a and 14b). Prevalence of the PC 10 assemblage, a north-central, cool-water group, increased between 1975 and 1989, and declined after 1990 (Table 11). During 1975-89, mean position moved to the north and east, followed by a return to approximately the original mean position for 1990-94. Both latitudinal and longitudinal ranges decreased throughout 1975-94. This group occupied waters northeast of Newfoundland prior to 1990, but was absent from this area after 1990. Prevalence of the PC 11 assemblage, the most northern, coldest-water assemblage, initially declined, but increased markedly after 1985. Mean position moved to the south and east. Variation in range was erratic, driven in part by a few atypical points, some of which were north of the ECNASAP study area boundary, in areas that have been poorly sampled. Much of the recent increase in this group occurred in deep waters between Hamilton Bank and Northern Grand Banks.

Canonical discriminant analysis. The first two canonical variables (CAN1 and CAN2) had the strongest correlations with the species (Table 12); correlations ($|r| \geq 0.5$) are plotted in Figure 15a. A few species have high positive correlations with CAN1; these species are generally northern in distribution. Many species had high negative correlations with CAN1; the majority of these species are distributed from the Scotian Shelf south. This pattern suggests that forcing functions affecting CAN1 favored northern species over southern species. Most of the species with high positive or negative correlations with CAN2 are distributed north of Cape Cod, suggesting that variation in the forcing functions affecting CAN2 occurred primarily in northern or central portions of the study area.

Year centroids plotted on the CAN1 vs CAN2 plane are shown in Figure 15b. The centroids for 1975-81 remain in the upper left quadrant of the plot, without systematic change. For the CAN1 axis, the yearly means then follow an increasing trend for 1982-86, remain stable for 1987-90, and resume increasing for 1991-94. The yearly means fluctuate along the CAN2 axis, with the 1975-81 period of minor erratic variation followed a decline for 1982-84, stability for 1985-87, and a fairly steady increase for 1988-94, which returned CAN2 to values similar to those of the mid-1970s. Together, these two contrasting temporal patterns give rise to an apparent progression in the state of the groundfish community. Phenomena associated with

Figure 11. Dendrogram of species cluster analysis for the 1975-94 data subset.

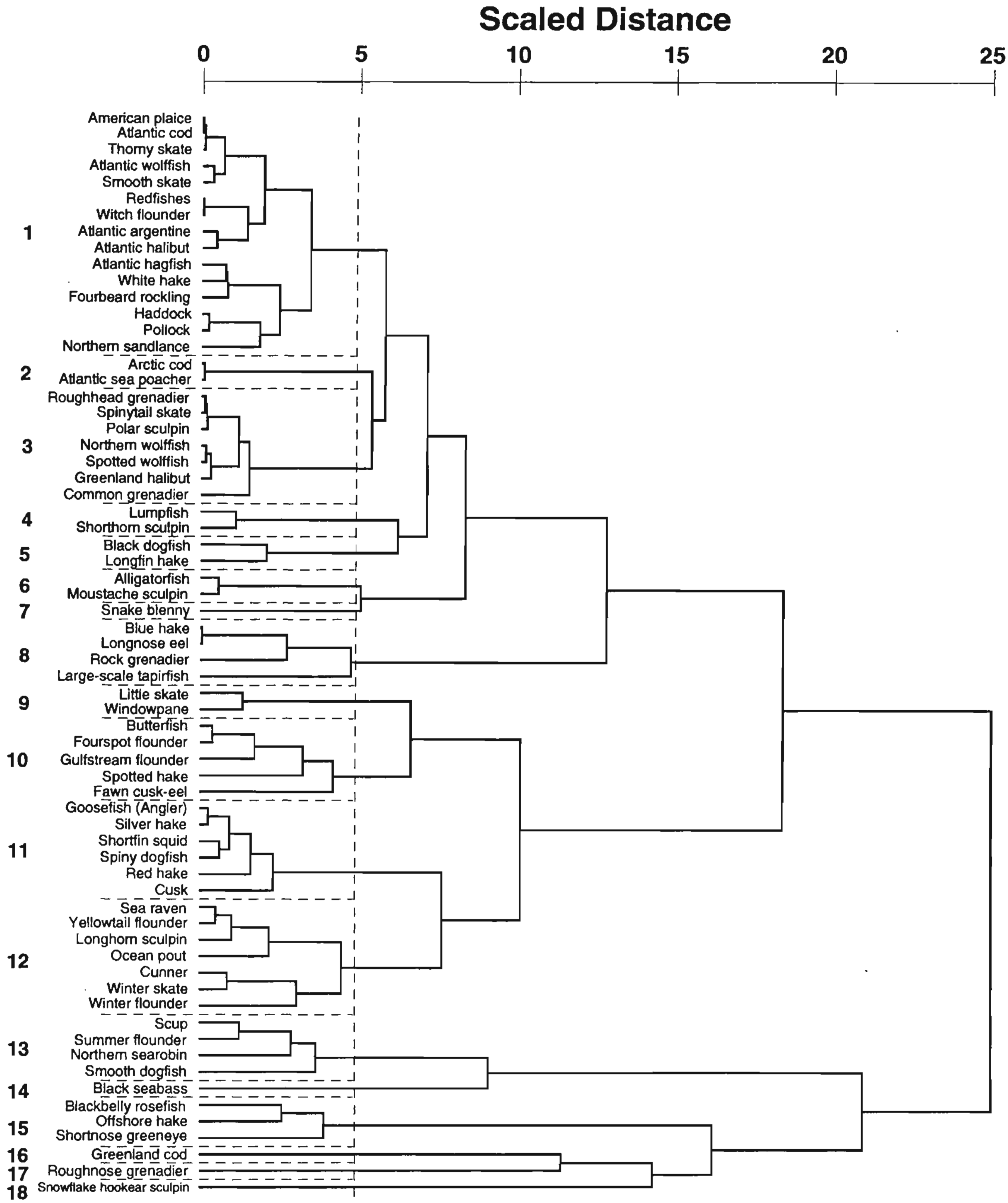


Figure 12a. ACON plots of Atlantic cod presence/absence by five-year intervals.

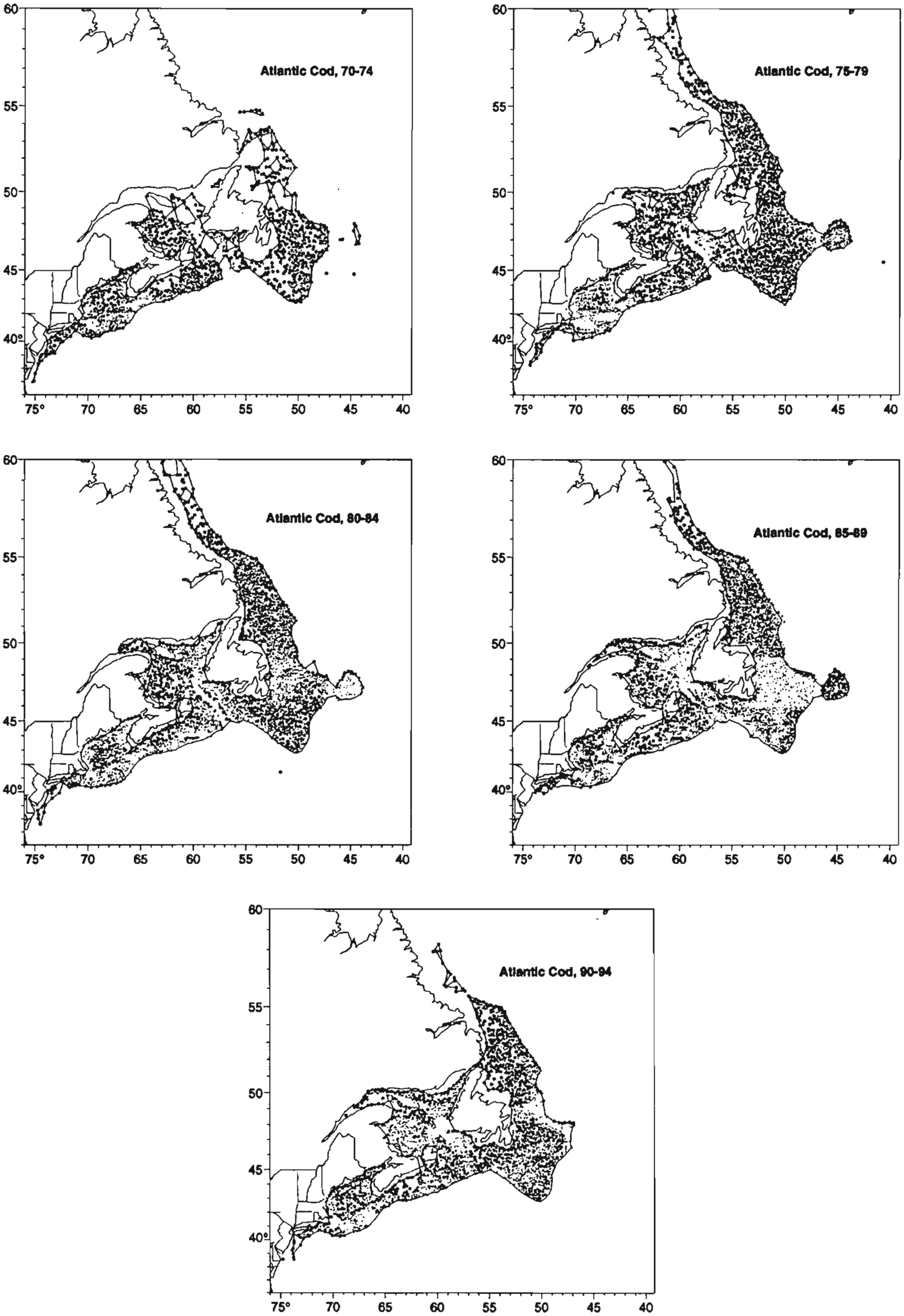


Figure 12b. ACON plots of Artic cod presence/absence by five-year intervals.

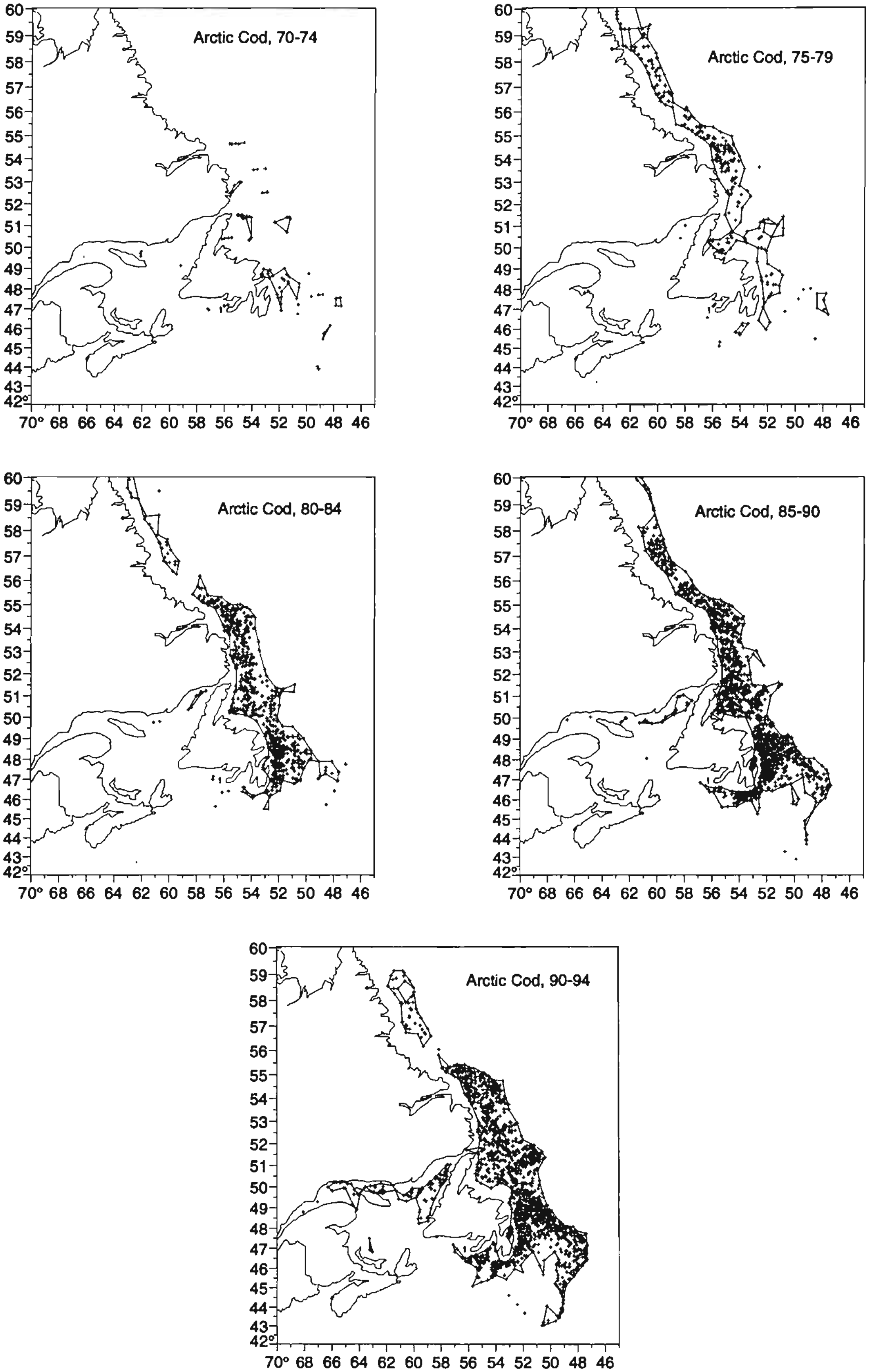


Figure 12c. ACON plots of Butterfish presence/absence by five-year intervals.

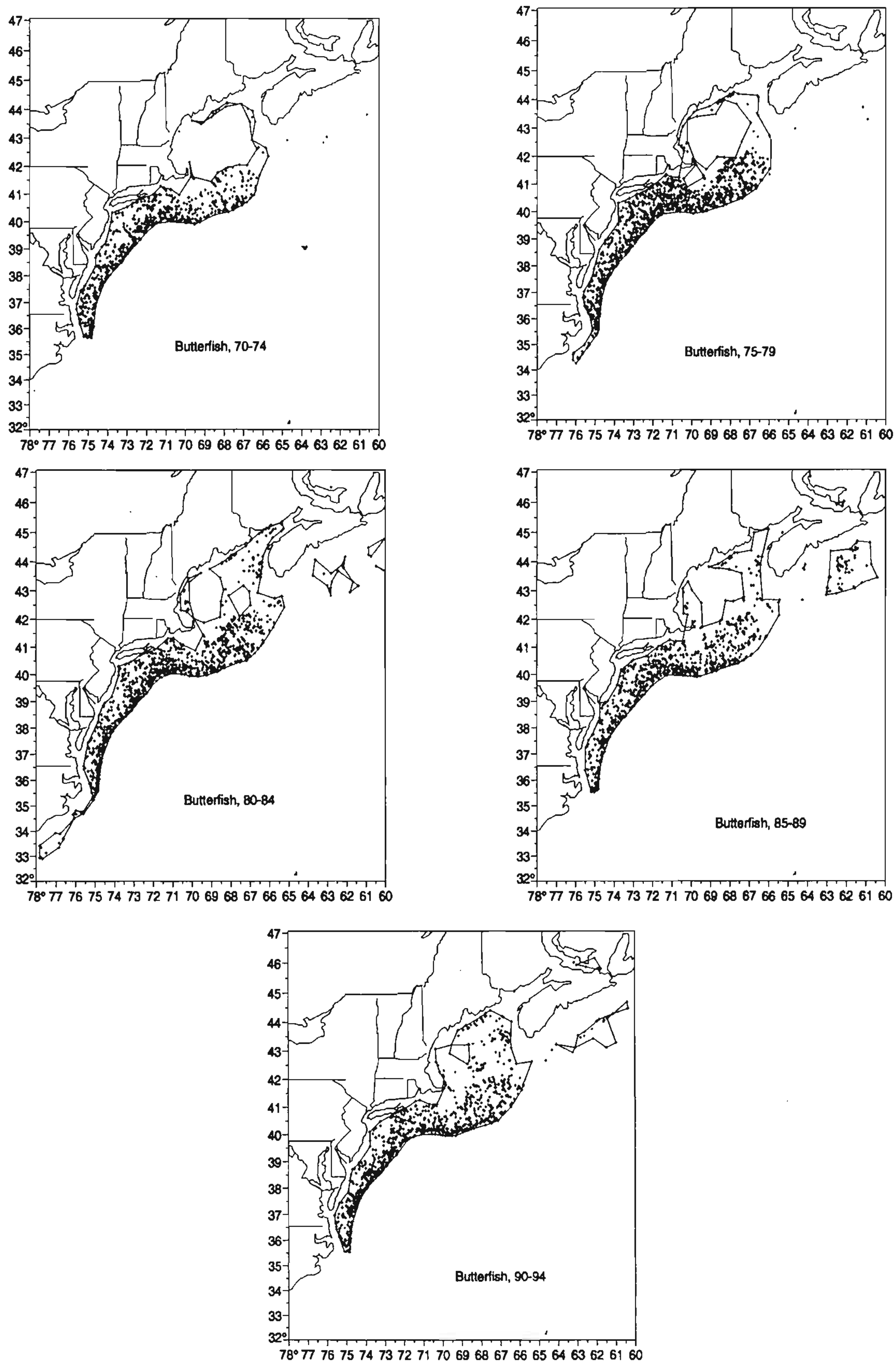


Figure 12d. ACON plots of ocean pout presence/absence by five-year intervals.

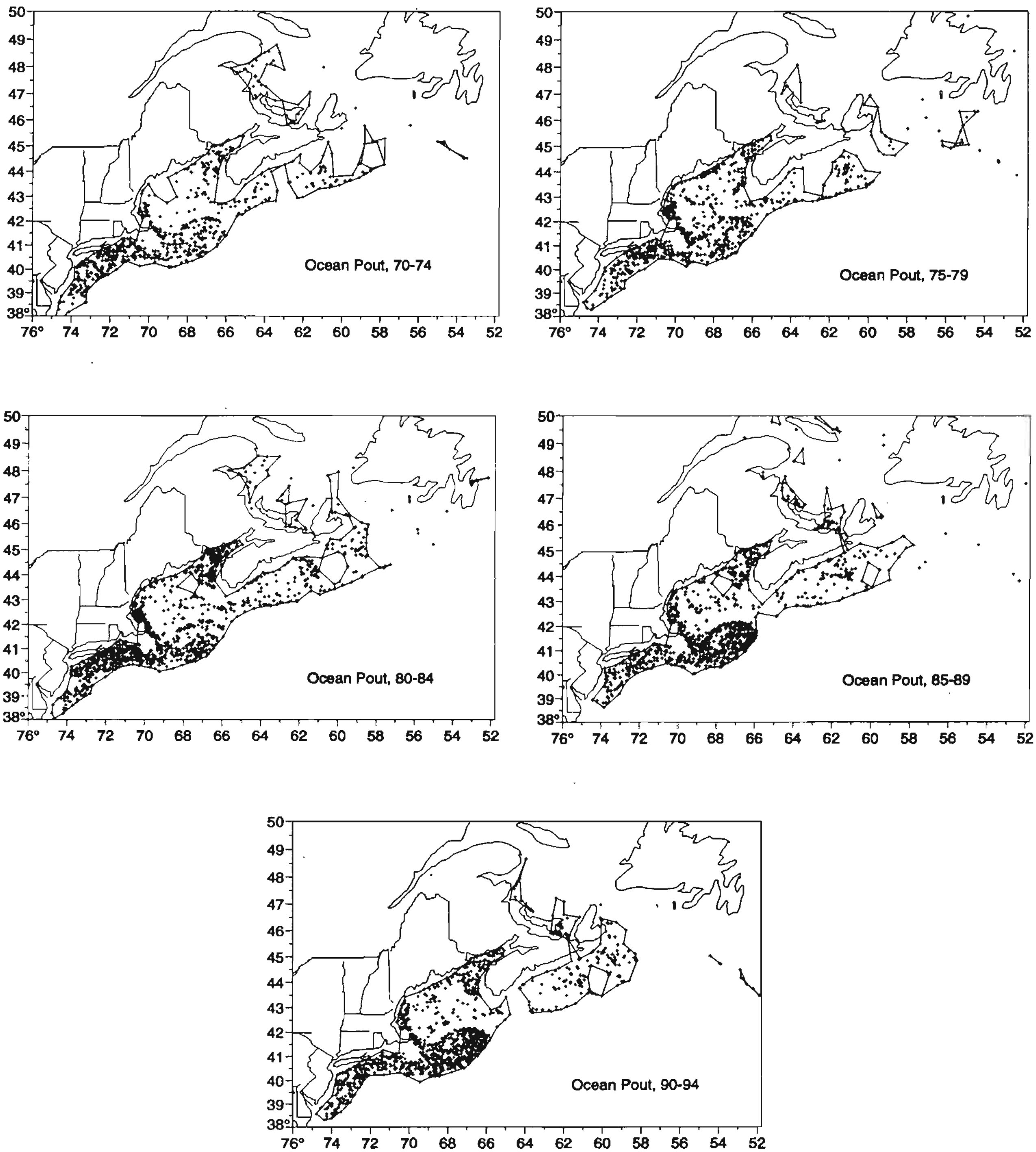


Figure 13. Bivariate (latitude/longitude) ellipses containing 50% of the abundances of Atlantic cod, arctic cod, ocean pout, and butterfish by five-year intervals.

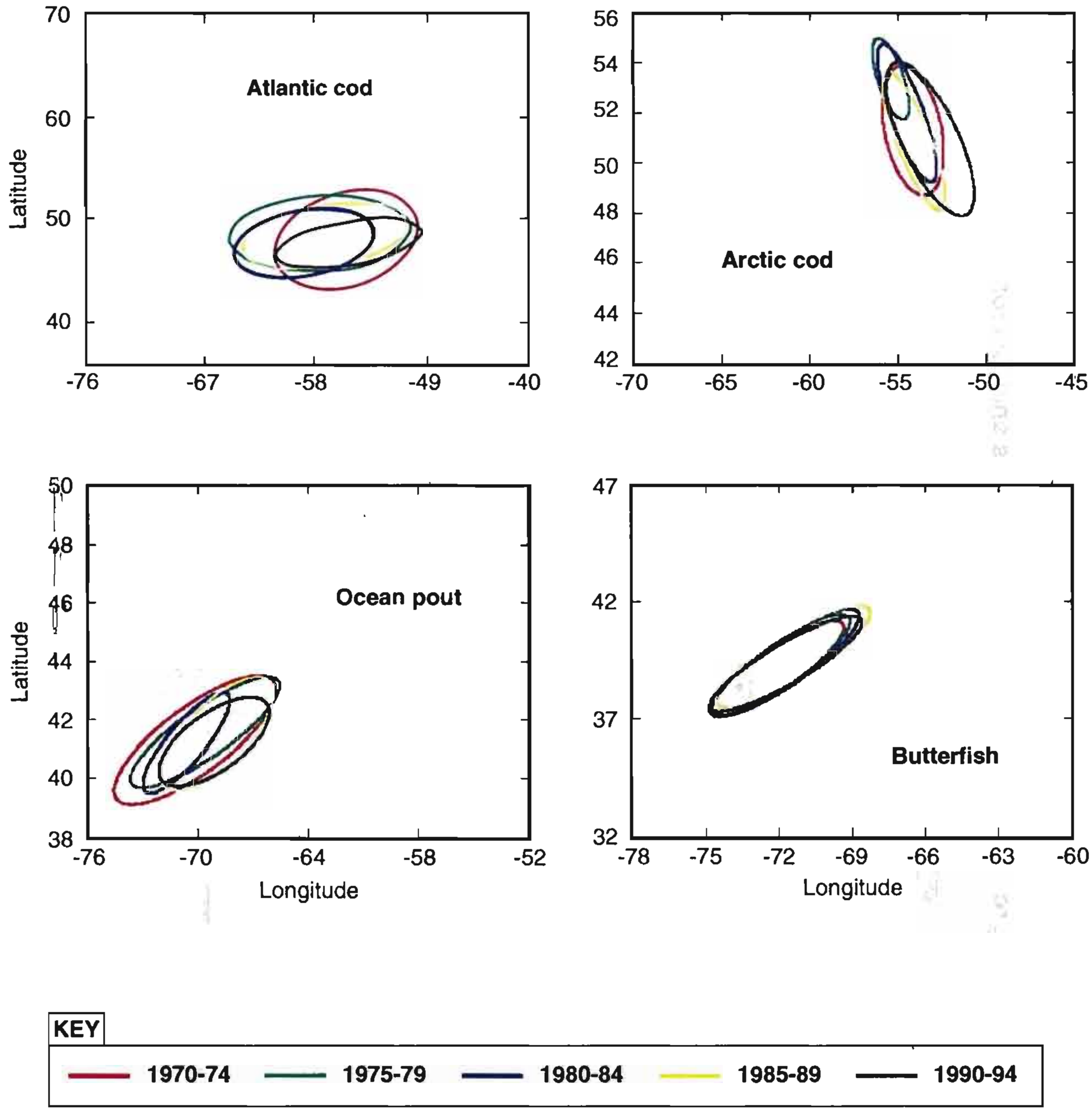


Table 10. Comparison of species groupings from principal components analysis for all years and by five year periods.[1]

All years		75-79		80-84		85-89		90-94	
PC	Species	PC	Species	PC	Species	PC	Species	PC	Species
1	**Gulfstream flounder**	6	**Gulfstream flounder**	2	**Fawn cusk eel**	1	**Gulfstream flounder**	4	**Gulfstream flounder**
1	**Fourspot flounder**	6	**Fawn cusk eel**	2	**Spotted hake**	1	**Fourspot flounder**	4	**Fourspot flounder**
1	**Fawn cusk eel**	6	**Spotted hake**	2	**Gulfstream flounder**	1	**Fawn cusk eel**	4	**Fawn cusk eel**
1	**Spotted hake**	6	**Fourspot flounder**	2	**Fourspot flounder**	1	**Spotted hake**	4	**Spotted hake**
1	**Butterfish**	6	**Butterfish**	2	**Butterfish**	1	**Butterfish**	4	**Butterfish**
1	Red hake			2	Shortfin squid	1	Red hake	4	Little skate
1	Goosefish (Angler)					1	Little skate	4	Red hake
						1	Goosefish (Angler)		
2	**Blue hake**	2	**Blue hake**	1	**Blue hake**	2	**Blue hake**	1	**Blue hake**
2	**Rock (Roundnose) grenadier**	2	**Rock (Roundnose) grenadier**	1	**Longnose (Slatjaw cutthroat) eel**	2	**Longnose (slatjaw cutthroat) eel**	1	**Longnose (slatjaw cutthroat) eel**
2	**Longnose (slatjaw cutthroat) eel**	2	**Longnose (slatjaw cutthroat) eel**	1	**Large-scale tapirfish**	2	**Rock (Roundnose) grenadier**	1	**Rock (Roundnose) grenadier**
2	**Large-scale tapirfish**	2	**Large-scale tapirfish**	1	**Rock (Roundnose) grenadier**	2	**Large-scale tapirfish**	1	**Roughhead grenadier**
2	**Roughhead grenadier**	2	**Roughnose grenadier**	1	Marlin-spike (Common grenadier)	2	Roughhead grenadier	1	Large-scale tapirfish
2	Marlin-spike (Common grenadier)	2	Black dogfish	1	Roughhead grenadier			1	Northern wolffish
		2	Roughhead grenadier	1	Northern wolffish			1	Spinytail skate
								1	Greenland halibut
								1	Marlin-spike (Common grenadier)
3	**Scup**	7	**Black sea bass**	3	**Summer flounder**	3	**Black sea bass**	3	**Black sea bass**
3	**Summer flounder**	7	**Northern (Common) searobin**	3	**Scup**	3	**Northern (Common) searobin**	3	**Northern (Common) searobin**
3	**Northern (Common) searobin**	7	**Scup**	3	**Northern (Common) searobin**	3	**Scup**	3	**Summer flounder**
3	**Black sea bass**	7	Spotted hake	3	**Black sea bass**	3	**Summer flounder**	3	**Scup**
3	**Smooth dogfish**	7	Fourspot flounder	3	**Smooth dogfish**	19	**Smooth dogfish**	3	**Smooth dogfish**
		13	**Smooth dogfish**	3	Windowpane	19	Summer flounder		
		13	**Summer flounder**						
		13	**Scup**						
4	**Silver hake**	5	**Red hake**	4	**Red hake**	4	**Silver hake**	6	**Silver hake**
4	**Red hake**	5	**Silver hake**	4	**Silver hake**	4	**Red hake**	6	**Red hake**
4	**Cusk**	5	**Goosefish (Angler)**	4	**Ocean pout**	4	**Spiny dogfish**	6	**Goosefish (Angler)**
4	**Pollock**	5	Ocean pout	4	**Goosefish (Angler)**	4	**Cusk**	6	**White hake**
4	**Spiny dogfish**	5	White hake	4	Fourspot flounder	4	Ocean pout	6	Ocean pout
4	White hake	5	Fourspot flounder	4	Gulfstream flounder	4	Pollock	6	Spiny dogfish
4	Ocean pout	14	**Pollock**	4	Longhorn sculpin	4	Shortfin squid	9	**Cusk**
4	Goosefish (Angler)	14	**Cusk**	4	Little skate	4	White hake	9	**Pollock**
4	Haddock	14	Haddock	11	**Cusk**			9	Atlantic argentine
4	Shortfin squid			11	**Pollock**			9	Spiny dogfish
				11	Spiny dogfish				
				11	Haddock				
5	**Longhorn sculpin**	4	**Sea raven**	6	**Winter flounder**	5	**Longhorn sculpin**	5	**Longhorn sculpin**
5	**Sea raven**	4	**Longhorn sculpin**	6	**Sea raven**	5	**Winter flounder**	5	**Sea raven**
5	**Yellowtail flounder**	4	**Yellowtail flounder**	6	**Longhorn sculpin**	5	**Sea raven**	5	**Yellowtail flounder**
5	**Winter flounder**	4	Winter flounder	6	**Cunner**	5	**Yellowtail flounder**	5	**Winter flounder**
5	Ocean pout	4	Ocean pout	6	Yellowtail flounder	5	Ocean pout	5	Ocean pout
		4	Haddock	6	Ocean pout	5	Alligatorfish	5	Haddock
						5	Winter skate		

Table 10. (continued)

All years		75-79		80-84		85-89		90-94	
PC	Species	PC	Species	PC	Species	PC	Species	PC	Species
6	**Marlin-spike (Common grenadier)**	11	**Atlantic argentine**			6	**Atlantic argentine**	2	**Black dogfish**
6	**Redfishes (*Sebastes spp*)**	11	**White hake**			6	**Redfishes (*Sebastes spp*)**	2	**Marlin-spike (Common grenadier)**
6	**Witch flounder**	11	**Redfishes (*Sebastes spp*)**			6	**White hake**	2	**Longfin hake**
6	**Black dogfish**	11	Marlin-spike (Common grenadier)			6	**Marlin-spike (Common grenadier)**	2	**Redfishes (*Sebastes spp*)**
6	Atlantic argentine	11	Longfin hake			6	Pollock	2	**Witch flounder**
6	White hake	11	Witch flounder			6	Witch flounder	2	White hake
6	Longfin hake	11	Atlantic halibut			6	Goosefish (Angler)	2	Greenland halibut
						7	**Roughnose grenadier**		
						7	**Longfin hake**		
						7	**Black dogfish**		
						7	Witch flounder		
						7	Redfishes (*Sebastes spp.*)		
7	**Windowpane**	1	**Little skate**	5	**Winter skate**	8	**Winter skate**	7	**Windowpane**
7	**Winter skate**	1	**Windowpane**	5	**Windowpane**	8	**Little skate**	7	**Winter skate**
7	**Little skate**	1	**Winter skate**	5	**Little skate**	8	**Windowpane**	7	**Little skate**
7	Northern sand lance	1	**Spiny dogfish**	5	Spiny dogfish	8	**Northern sand lance**	7	Fourspot flounder
		1	Winter flounder					19	**Northern sand lance**
		1	Longhorn sculpin						
		1	Northern sand lance						
		1	Red hake						
		1	Fourspot flounder						
8	**Spotted wolffish**	8	**Atlantic wolffish**	8	**Atlantic wolffish**	10	**Spotted wolffish**	11	**Atlantic wolffish**
8	**Atlantic wolffish**	8	**Spotted wolffish**	8	**Spotted wolffish**	10	**Atlantic wolffish**	11	**Spotted wolffish**
8	**Northern wolffish**	8	**Atlantic cod**	8	**Northern wolffish**	10	**Northern wolffish**	11	Northern wolffish
8	Roughhead grenadier	8	**Northern wolffish**	8	**Atlantic cod**	10	Atlantic cod		
8	Atlantic cod			8	Greenland halibut	10	Roughhead grenadier		
8	Greenland halibut					10	Greenland halibut		
8	Redfishes (*Sebastes spp.*)								
9	**Blackbelly rosefish**	12	**Blackbelly rosefish**	9	**Blackbelly rosefish**	11	**Offshore hake**	10	**Shortnose greeneye**
9	**Offshore hake**	12	**Offshore hake**	9	**Offshore hake**	11	**Blackbelly rosefish**	10	**Offshore hake**
9	**Shortnose greeneye**	12	**Shortnose greeneye**	9	**Shortnose greeneye**	11	**Shortnose greeneye**	10	**Blackbelly rosefish**
10	**Thorny skate**	15	**American plaice**	12	**Thorny skate**	12	**Thorny skate**	12	**Thorny skate**
10	**American plaice**	15	**Thorny skate**	12	**Yellowtail flounder**	12	**American plaice**	12	**American plaice**
10	Witch flounder	15	Witch flounder	12	**American plaice**	12	Atlantic cod	12	Smooth skate
10	Atlantic cod	15	Atlantic cod	12	Northern sand lance	12	Witch flounder	12	Atlantic cod
10	Smooth skate					12	Shortfin squid	12	Witch flounder
11	**Arctic cod**	9	**Arctic cod**	14	**Arctic cod**	15	**Arctic cod**	13	**Atlantic sea poacher**
11	**Atlantic sea poacher**	9	**Atlantic sea poacher**	14	**Atlantic sea poacher**	15	**Atlantic sea poacher**	13	**Arctic cod**
11	Greenland halibut	9	**Greenland cod**	14	Greenland halibut	15	Greenland cod	13	Greenland halibut
11	Polar sculpin	9	Shorthorn sculpin	14	Greenland cod	15	Greenland halibut		
		9	Greenland halibut	14	Northern wolffish				
		9	Northern wolffish						
12	**Fourbeard rockling**	10	**Atlantic hagfish**	15	**Fourbeard rockling**	9	**Fourbeard rockling**	14	**Atlantic hagfish**
12	**Atlantic hagfish**	10	**Fourbeard rockling**	15	**Atlantic hagfish**	9	**Atlantic hagfish**	14	**Fourbeard rockling**
12	Smooth skate	10	**Black dogfish**	15	Marlin-spike (Common grenadier)	9	**Smooth skate**	14	Smooth skate
		10	**Marlin-spike (Common grenadier)**	15	White hake	9	Marlin-spike (Common grenadier)	14	Snowflake hookear sculpin
		10	Witch flounder			9	White hake		
		10	Redfishes (*Sebastes spp.*)			9	Redfishes (*Sebastes spp.*)		

Table 10. (continued)

All years		75-79		80-84		85-89		90-94	
PC	Species	PC	Species	PC	Species	PC	Species	PC	Species
13	**Moustache (Mailed) sculpin**	16	**Moustache (Mailed) sculpin**	16	**Moustache (Mailed) sculpin**	13	**Moustache (Mailed) sculpin**	8	**Moustache (Mailed) sculpin**
13	**Alligatorfish**	16	**Alligatorfish**	16	**Alligatorfish**	13	**Snowflake hookear sculpin**	8	**Alligatorfish**
13	**Snowflake hookear sculpin**	17	**Smooth skate**	19	**Snowflake hookear sculpin**	13	**Alligatorfish**	8	**Greenland cod**
		17	**Snowflake hookear sculpin**					8	**Snowflake hookear sculpin**
		17	Polar sculpin					8	Snake blenny
14	**Roughnose grenadier**			10	**Roughnose grenadier**	7	**Roughnose grenadier**	18	**Roughnose grenadier**
14	**Longfin hake**			10	**Black dogfish**	7	**Longfin hake**	2	**Black dogfish**
14	**Black dogfish**			10	**Longfin hake**	7	**Black dogfish**	2	**Marlin-spike (Common grenadier)**
				10	Witch flounder	7	**Witch flounder**	2	**Longfin hake**
						7	Redfishes (Sebastes spp.)	2	**Redfishes (Sebastes spp.)**
								2	**Witch flounder**
								2	White hake
								2	Greenland halibut
15	**Atlantic halibut**			13	**Atlantic halibut**	16	**Atlantic halibut**	15	**Atlantic halibut**
15	**Haddock**			13	Atlantic argentine	16	**Haddock**	15	**Haddock**
				13	White hake				
				13	Redfishes (Sebastes spp.)				
				13	Haddock				
				13	Marlin-spike (Common grenadier)				
				13	Goosefish (Angler)				
16	**Polar sculpin**	3	**Roughhead grenadier**	7	**Witch flounder**	14	**Polar sculpin**	1	**Blue hake**
16	Roughhead grenadier	3	**Spinytail skate**	7	**Greenland halibut**	14	**Greenland halibut**	1	**Longnose (slatjaw cutthroat) eel**
16	Greenland halibut	3	**Greenland halibut**	7	**Smooth skate**	14	Roughhead grenadier	1	**Rock (Roundnose) grenadier**
		3	**Northern wolffish**	7	**Roughhead grenadier**			1	**Roughhead grenadier**
		3	Redfishes (Sebastes spp.)	7	**Polar sculpin**			1	Large-scale tapirfish
		3	Polar sculpin	7	**Spinytail skate**			1	**Northern wolffish**
		3	Marlin-spike (Common grenadier)	7	Redfishes (Sebastes spp.)			1	Spinytail skate
		3	Large-scale tapirfish					1	Greenland halibut
								1	Marlin-spike (Common grenadier)
17	**Lumpfish**	18	Atlantic halibut	17	**Lumpfish**	17	**Lumpfish**	16	**Lumpfish**
17	**Shorthorn sculpin**	18	**Lumpfish (-)**	17	**Shorthorn sculpin**	17	**Shorthorn sculpin**	16	**Shorthorn sculpin**
17	Sea raven	18	Shorthorn sculpin (-)	17	Sea raven	17	Sea raven	16	Sea raven
18	**Cunner**	19	**Cunner**	6	**Winter flounder**	18	**Cunner**	17	**Cunner**
18	Winter flounder	19	Snake blenny	6	**Sea raven**	18	Winter flounder	17	Butterfish
18	Snake blenny			6	**Longhorn sculpin**	18	Snake blenny		
				6	**Cunner**				
				6	Yellowtail flounder				
				6	Ocean pout				

[1] Groups are determined by species scores on the PCs. Species in bold type have loadings ≥ 0.5; species in standard type have loadings between 0.3 and 0.5. Assemblages from the 5-year time periods are grouped with the overall time-period assemblages they resemble most closely.

Figure 14a. Sites in the top 5% of scores for PC10 (thorny skate, American plaice, witch flounder, Atlantic cod, smooth skate) from the analysis of the 1975-94 data subset by five-year intervals.

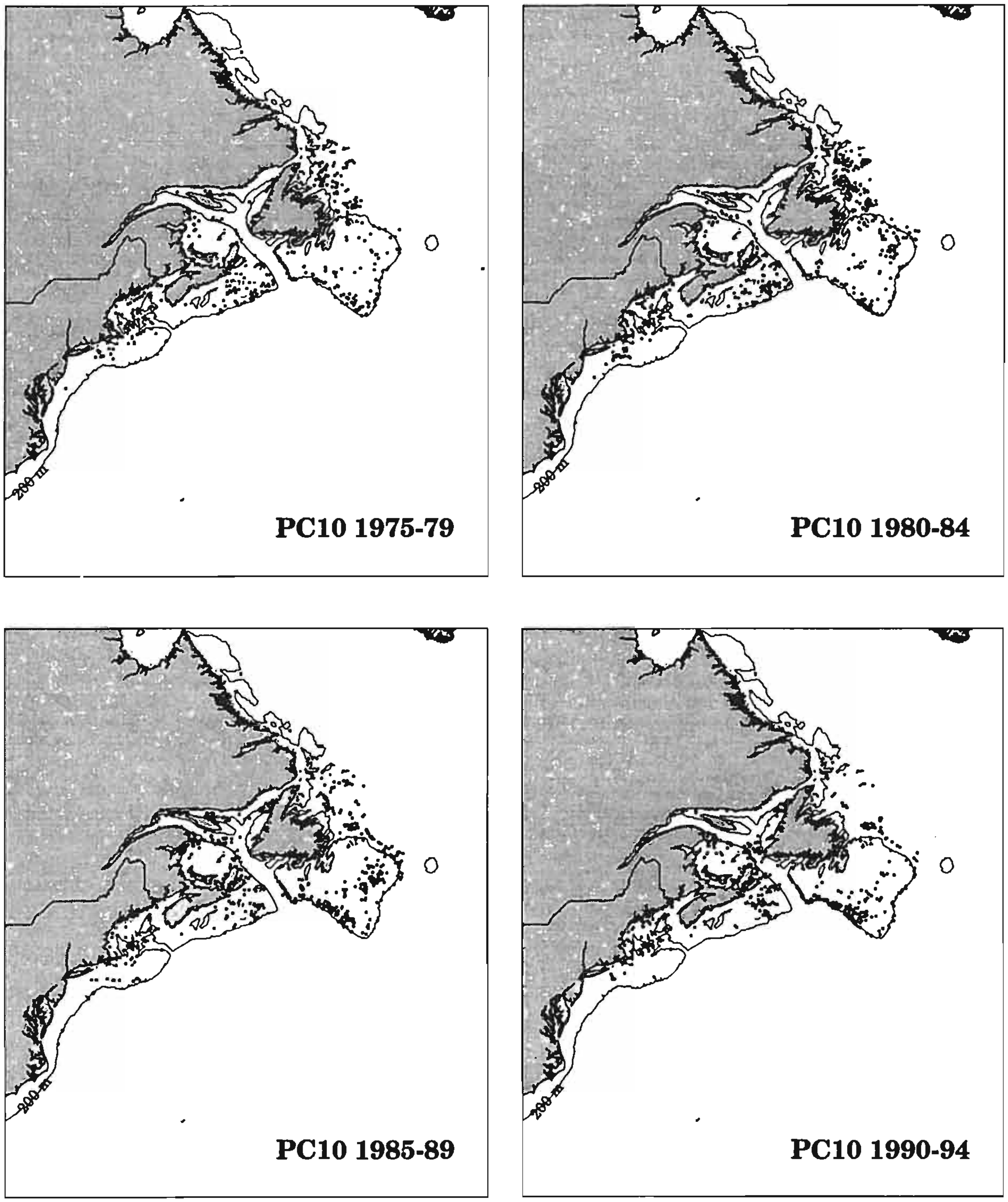


Figure 14b. Sites in the top 5% of scores for PC11 (arctic cod, Atlantic sea poacher, Greenland halibut, polar sculpin) from the analysis of the 1975-94 data subset by five-year intervals.

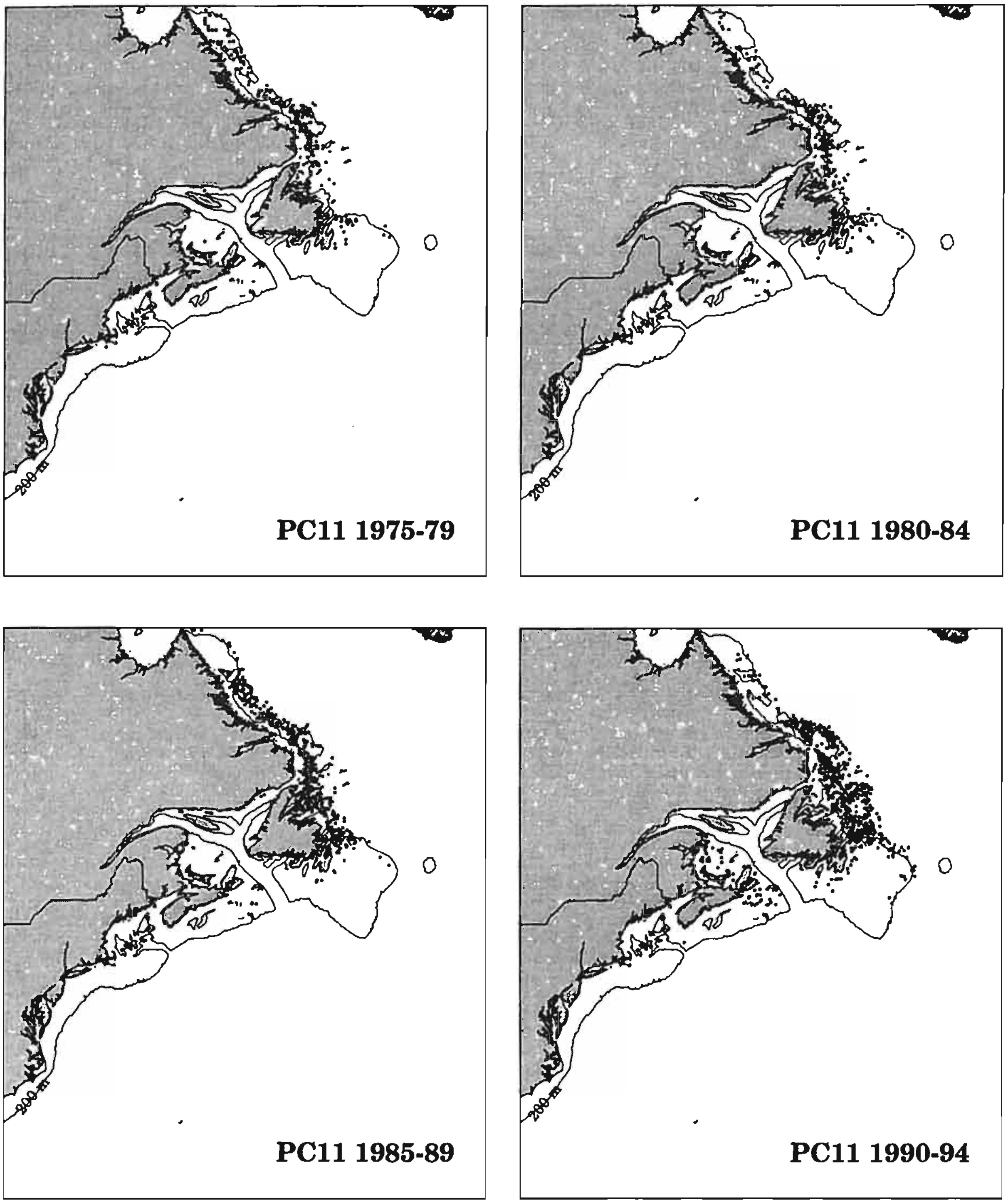


Table 11. Comparisons of numbers of points and mean positions for PC10 and PC11 by five-year time block.

Component	Time Period	# points	Latitude (degrees N) Mean	Latitude Std dev.	Latitude Range	Longitude (degrees W) Mean	Longitude Std. dev.	Longitude Range
PC10	1975-79	414	46.2	3.1	20.1	-57.4	6.6	34.0
	1980-84	476	46.9	3.2	16.0	-56.4	6.5	27.5
	1985-89	598	47.0	2.6	18.0	-55.1	6.2	27.5
	1990-94	446	46.2	2.3	12.8	-57.1	5.9	24.6
			P<.0001[1]			P=.03		
PC11	1975-79	287	54.8	4.3	24.9	-57.2	3.5	22.6
	1980-84	233	52.5	3.1	14.3	-55.1	2.6	16.9
	1985-89	631	53.8	5.5	24.8	-56.0	3.3	17.2
	1990-94	783	51.1	3.0	16.6	-54.1	3.6	18.4
			P<.0001			P<.0001		

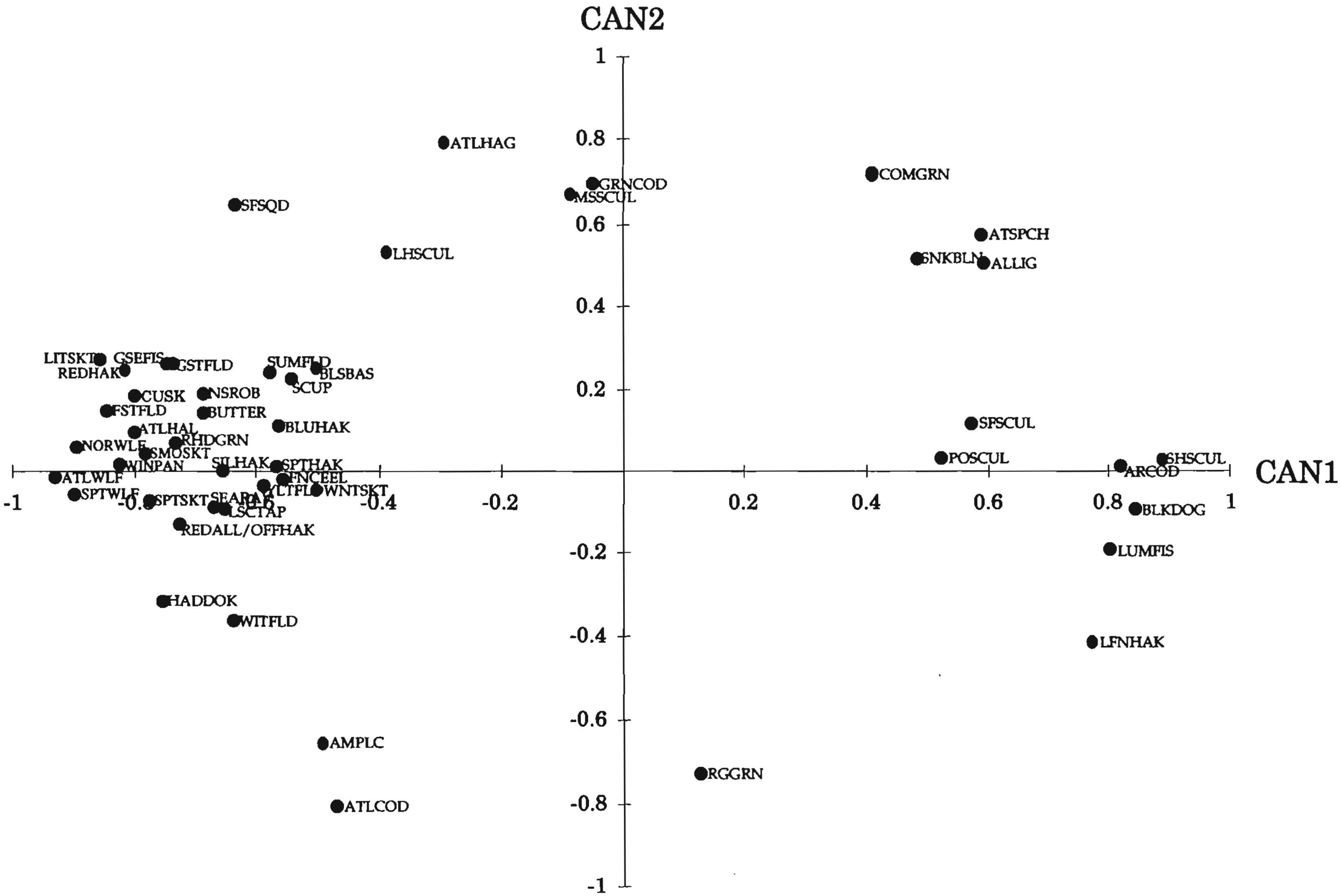
[1]P values are for comparing means using one-way analysis of variance.

Table 12. Correlations between species and canonical variables 1 and 2.[1]

Species	CAN1	CAN2	Species	CAN1	CAN2
Redfishes (Sebastes spp.)	**-0.740**	-0.091	Atlantic wolffish	**-0.933**	-0.016
American plaice	-0.494	**-0.656**	Moustache (Mailed) sculpin	-0.082	**0.674**
Atlantic cod	-0.468	**-0.808**	Gulfstream flounder	**-0.738**	0.259
Silver hake	**-0.655**	0.002	Sea raven	**-0.670**	-0.089
Butterfish	**-0.685**	0.139	Smooth skate	**-0.782**	0.040
Spiny dogfish	-0.398	0.123	Goosefish (Angler)	**-0.749**	0.259
Haddock	**-0.754**	-0.316	Blackbelly rosefish	-0.362	0.360
Northern sand lance	-0.458	0.369	Black sea bass	**-0.502**	0.252
Yellowtail flounder	**-0.588**	-0.037	Fawn cusk eel	**-0.558**	-0.019
Greenland halibut	0.356	0.041	Northern wolffish	**-0.893**	0.055
Shortfin squid	**-0.636**	**0.647**	Roughnose grenadier	0.126	**-0.728**
Arctic cod	**0.821**	0.011	Fourbeard rockling	0.435	-0.306
Thorny skate	-0.173	-0.395	Summer flounder	**-0.579**	0.239
Longhorn sculpin	-0.386	**0.533**	Blue hake	**-0.565**	0.111
Witch flounder	**-0.638**	-0.365	Spotted wolffish	**-0.898**	-0.060
White hake	-0.288	-0.117	Offshore hake	**-0.728**	-0.132
Northern (Common) searobin	**-0.686**	0.189	Alligatorfish	**0.595**	**0.503**
Red hake	**-0.816**	0.244	Atlantic halibut	**-0.798**	0.092
Little skate	**-0.858**	0.272	Atlantic sea poacher	**0.593**	**0.572**
Winter flounder	-0.392	0.220	Smooth dogfish	-0.417	0.246
Atlantic argentine	-0.176	-0.292	Cusk	**-0.799**	0.180
Black dogfish	**0.843**	-0.094	Atlantic hagfish	-0.290	**0.794**
Spotted hake	**-0.568**	0.009	Cunner	-0.306	-0.021
Pollock	0.208	-0.112	Shorthorn sculpin	**0.887**	0.028
Fourspot flounder	**-0.848**	0.146	Snowflake hookear sculpin	**0.575**	0.117
Rock (Roundnose) Grenadier	-0.397	-0.170	Longnose (Slatjaw cutthroat) eel	0.106	0.473
Marlin-spike (Common grenadier)	0.412	**0.718**	Polar sculpin	**0.522**	0.033
Winter skate	**-0.503**	-0.047	Shortnose greeneye	-0.266	-0.093
Lumpfish	**0.802**	-0.193	Large-scale tapirfish	**-0.652**	-0.095
Longfin hake	**0.771**	-0.415	Snake blenny	0.485	**0.515**
Windowpane	**-0.825**	0.018	Spinytail skate	**-0.774**	-0.073
Roughhead grenadier	**-0.735**	0.069	Greenland cod	-0.046	**0.698**
Ocean pout	-0.486	0.363	Scup	**-0.543**	0.224

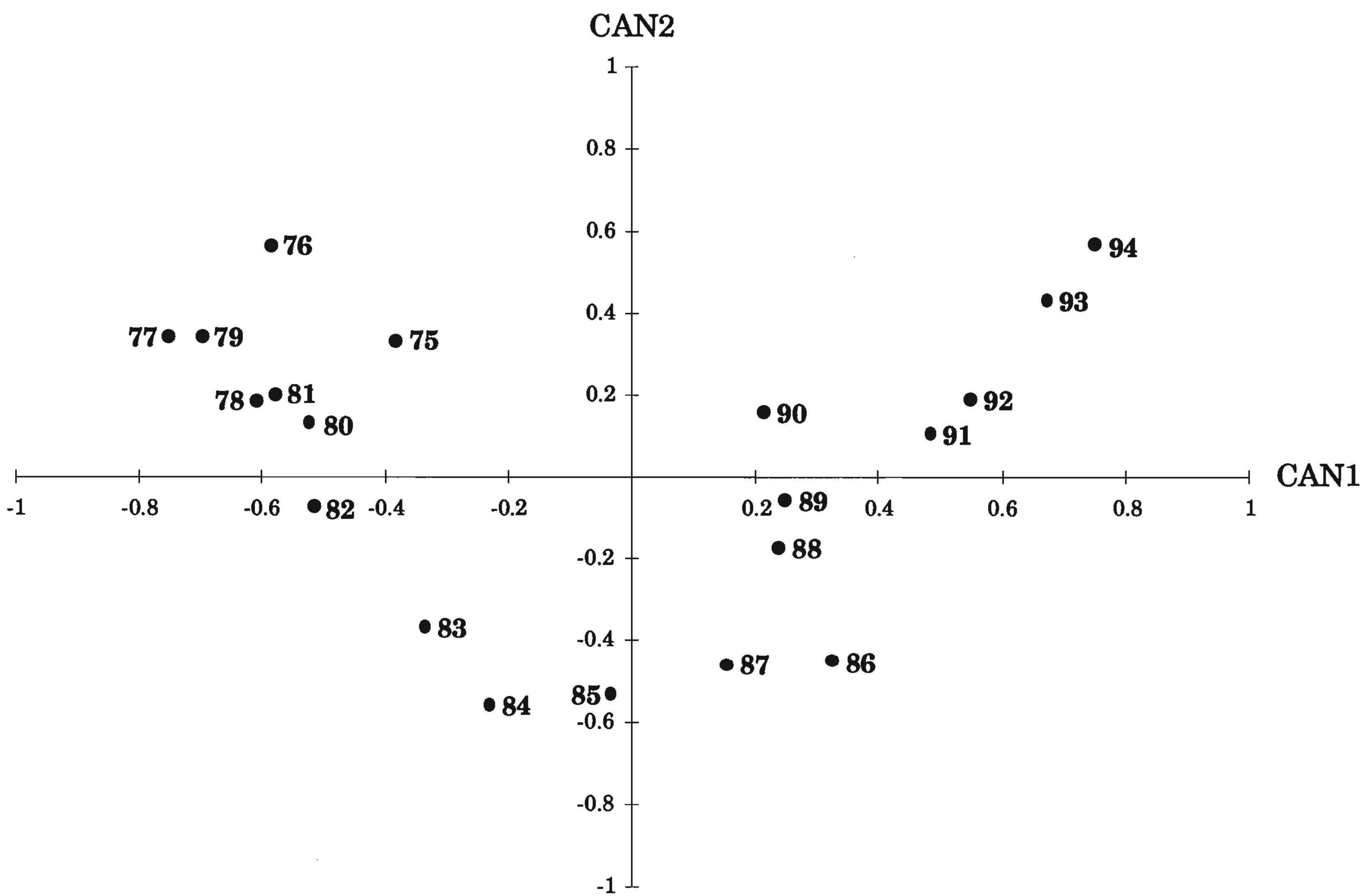
[1]Bold type indicates correlations with |r| ≥ 0.5.

Figure 15a. Species correlations (|r|≥0.05) with canonical variables 1 and 2.



[1]Species codes are given in Appendix 2.

Figure 15b. Yearly centroids for canonical variables 1 and 2.



CAN1 have steadily increased since the early 1980s, whereas phenomena associated with CAN2 have changed through time, but by 1994 had returned to a state similar to that of the late 1970s.

For insight into associations between yearly patterns of community abundance and trends in species abundances, the species and yearly plots of CAN1 vs CAN2 (Figures 15A, B) can be interpreted together. For example, Atlantic cod has a strong negative correlation with CAN2 and a weaker negative correlation with CAN1. By inspection of the yearly plot, high abundances of this species are associated with the mid-1980s, with lower abundances occurring during the mid-1970s and mid-1990s. Greenland cod would be interpreted as having the opposite abundance pattern through time. Abundances of the many species with negative correlations with CAN1 would be interpreted as having declined through time, while the species with positive correlations with CAN1, which are mostly northern species, such as shorthorn sculpin and black dogfish, would have increased in abundance through time.

The bivariate confidence ellipses developed for the year centroid plots were large, and did not support any additional interpretation. However, inspection of Figures 15A and 15B suggests that groups of species exist that have similar relationships with CAN1 and CAN2. For example, the large group of species with strong negative correlations with CAN1 and weak correlations with CAN2 (e.g., little skate, Atlantic wolffish, redfishes, and blue hake) could be termed a 1975-82 group, which is when these species would be expected to have had their highest abundances. Similarly, overlaying the species correlation and year centroid plots suggests two other groups, 1983-87 and 1988-94. Out of 37 species assigned by visual inspection to one of these three year groups, 33 (89%) had their highest average catch per tow during the assigned time period.

SYNTHESIS AND DISCUSSION

Visual Analysis

The value of the visual analysis is that it provided a check on the more sophisticated multivariate analyses, to ensure that the results of these analyses were generally consistent with the patterns identified intuitively by knowledgeable fisheries scientists. This function is important, because conducting multivariate analyses involves a series of decisions that are inherently subjective, which could cause misleading results. This is not to imply that the visual and multivariate approaches yielded identical results. The visual analysis of the individual species distributions resulted in fewer groups than the PCA. This was because groups with the same general geographical distributions, but different depth distributions, could not easily be distinguished in the plots at the scale used (Table 4). With larger plots showing more isobaths, the species groups might have been separable into smaller units. Also, the PCA results were based on co-occurrence within trawl samples, while the visual analysis results were based on spatial distribution, whether or not particular species co-occurred within the same samples.

Principal Components Analysis

Mapping the high 5% of scores on each PC, assumed to represent the distributional core of the assemblage associated with that PC, indicated a high degree of spatial aggregation of the sites, and a wide variety of distributional patterns. Some assemblages are clearly associated with deep-slope areas (e.g., 2, 6, 8, 10, 16), while others occur primarily on the tops of banks (e.g., 1, 3, 4, 5, 7, 13, 17, 18). In addition, the PCA results suggests a biogeographic break around the Grand Banks (Figure 8). The patterns show that assemblages occur at spatial scales that can be detected with trawl surveys, and that can be perceived at the overall scale of the study. The degree to which these assemblages are biologically functional units, or merely consist of species with similar responses to environmental gradients, remains unknown.

Although the PCA appears to perform well in identifying groups of co-occurring species, the use of site scores on PCs for mapping assemblages requires further methodological development. As shown in Figures 7A and 7B, different views of an assemblage distribution are obtained with different cutoff points for site scores. There is a need to explore different approaches (e.g., contouring) for interpretation and visual presentation of assemblage distributions based on PC scores.

In contrast to the site cluster analysis, where all stations are assigned to a particular assemblage group, the PCA approach allows more than one assemblage to occur at a site, and also allows no assemblage to occur at a site. The numbers of assemblages occurring per site are shown in Table 13. Just under half of the sites (45.5%) did not fall into the top 5% of scores on any PC. Assuming that the 5% selection criterion is a good measure of assemblage integrity, this indicates that assemblages can only be identified at 54.5% of the sites. The fish fauna at the remaining 45.5% of sites would, therefore, be considered unstructured. Only one assemblage was detected at 31.8% of the sites, while more than one assemblage occurred at 22.7% of sites, with 10 sites having as many as 8 assemblages.

One problem with using site scores from PCA is that an assemblage may be shown at a site where one of the major species of that assemblage does not occur.

Table 13. The number of assemblages per site, based on the criterion of selecting sites with scores in the top 5% for a principal component.

Number of assemblages	Number of sites	Percentage of sites
0	17,612	45.5
1	12,292	31.8
2	5,624	14.5
3	2,023	5.2
4	762	1.9
5	266	0.7
6	98	0.3
7	43	0.1
8	10	<0.1

PC 15, Atlantic halibut/haddock, provides a simple example (Figure 6). No haddock were caught north of Hamilton Bank, yet the assemblage is shown as present along the slope of the Labrador Shelf, because Atlantic halibut is relatively abundant there. Similarly, although the map of PC 17 (Figure 6) shows the area where lumpfish and shorthorn sculpin co-occur around St. Pierre Bank, it also shows this assemblage on the shelf northwest of Newfoundland, where the latter species was seldom caught.

An additional problem with the correlation matrix-based PCA method used is that associations involving ubiquitous species are de-emphasized, because assemblages are defined by species that tend to co-occur at unusually high frequencies, even if they are not particularly abundant overall. For example, gulfstream and fourspot flounder are the species with the highest loadings on PC1 (0.81 and 0.76 respectively), which explains 8.8% of the total variance (Tables 5 and 6). Although they are not particularly abundant, these species both occur primarily south of Cape Cod (Appendix 3). In contrast, widespread or abundant species, which may co-occur with many other species over their ranges, are much less strongly associated with assemblages identified by the PCA. For example, American plaice and Atlantic cod are caught in large numbers throughout the study area. American plaice is fairly strongly associated with PC10, and Atlantic cod is weakly associated with PC8 and PC10. These two components explain only 2.6% and 2.4% of the total variance, respectively. This pattern can also be seen in Table 14, which summarizes species compositions of PCs 10 and 11, using the top 5% of sites. Mean absolute catch per tow shows that the core species may actually be less abundant than other species (e.g., Atlantic sea poacher and American plaice for PC 11). Relative catch/tow, calculated by dividing the mean catch per tow for the sites with the top 5% of PC scores by the overall mean catch per tow, provides a better, although not perfect, indication of the basis for the PCA extraction of assemblages.

The above problem occurred because the PCA approach has the implicit assumption that assemblages are determined by species that tend to occur primarily together, and not by widespread species that co-occur with many other species. However, widespread species may be present in considerable numbers where these assemblages occur, and they may play an important role in assemblage dynamics. To gain a better understanding of how PCA site scores relate to species composition, it would be useful to examine changes in species composition of subsets of sites with different scores on several PCs (e.g., top 5%, 5-10%, 10-15%, etc.). An alternative approach to defining the assemblages would be to use abundance of the major species identified by the PCA at some specified level of abundance or relative abundance (e.g., greater than the overall average catch/tow) as a cutoff, rather than the site scores. In this case, an assemblage could be considered present at sites where all the major species occurred in significant numbers.

Cluster Analysis

The large site cluster group 1, which has no associated species (Table 8), and which is widely distributed over the entire study area (Figure 9), can be interpreted as a group of sites without any distinguishing assemblages. Accordingly, site cluster groups 2-18 can be interpreted as assemblages. The sites in cluster group

Table 14. Species loadings, mean catch/tow, and relative catch/tow of top 5% of sites for PCs 10 and 11 (1975-94 data).

PC 10				PC 11			
Loading	Species	Mean catch/tow	Relative catch/tow	Loading	Species	Mean catch/tow	Relative catch/tow
0.687	Thorny skate	40.06	6.83	0.751	Arctic cod	298.15	21.24
0.637	American plaice	183.68	2.78	0.742	Atlantic sea poacher	2.51	18.71
0.415	Witch flounder	31.70	6.14	0.451	Greenland halibut	72.53	6.07
0.372	Atlantic cod	129.07	2.41	0.304	Polar sculpin	.54	7.45
0.356	Smooth skate	2.54	7.27	0.258	Greenland cod	.55	16.03
0.189	Goosefish (Angler)	.97	5.49	0.162	Northern wolffish	2.07	3.69
0.182	Yellowtail flounder	27.00	2.46	0.123	Alligatorfish	.40	2.88
0.178	Snake blenny	.48	12.99	0.079	Shorthorn sculpin	.17	2.81
0.142	Greenland halibut	25.89	2.19	0.066	Spotted wolffish	.64	2.60
0.128	Spinytail skate	.17	4.00	0.063	American plaice	96.74	1.40
0.098	Moustache (Mailed) sculpin	1.19	1.72	0.062	Snake blenny	.10	2.45
0.089	Red hake	8.26	4.37	0.034	Roughhead grenadier	1.26	0.81
0.067	Spotted wolffish	.29	1.77	0.031	Atlantic halibut	.05	0.44
0.053	Northern sand lance	12.71	1.11	0.026	Ocean pout	.06	0.33
0.051	Atlantic wolffish	.88	.92	0.019	Red hake	.01	0.00
0.048	Fourbeard rockling	.39	2.88	0.019	Black sea bass	.05	0.17
0.046	Atlantic sea poacher	.18	1.21	0.012	Northern searobin	.49	0.71
0.042	Roughnose grenadier	.28	.99	0.012	Gulf Stream Flounder	.00	0.00
0.038	Lumpfish	3.90	2.10	0.009	Little skate	.05	0.04
0.032	Ocean pout	.70	3.76	0.008	Spinytail skate	.06	1.23
0.031	Roughhead grenadier	1.69	1.17	0.006	Goosefish (Angler)	.00	0.00
0.029	Polar sculpin	.12	1.96	0.006	Fourspot flounder	.04	0.04
0.022	Shortnose greeneye	.30	6.48	0.005	Winter flounder	2.07	0.76
0.018	Atlantic halibut	.24	2.30	0.002	Roughnose grenadier	.00	0.00
0.015	Silver hake	24.67	1.93	0.001	Windowpane	.07	0.11
0.015	Gulf Stream flounder	2.00	4.40				
0.010	Snowflake hookear sculpin	.15	2.15				
0.009	Greenland cod	.03	.91				
0.007	Sea raven	.50	1.22				
0.003	White hake	5.12	1.71				

1 probably have several widespread species occurring in average or below average abundance. Cluster group 1 contains 42.6% of the sites, which is consistent with the number of sites that did not fall into any PCA-based assemblage (45.5%) under the top 5% of site scores criterion.

The dendrogram showing the hierarchical relationships among the mapped site cluster groups (Figure 10) indicates a biogeographic separation near Cape Cod and Georges Bank. Five of the six southern cluster groups (7, 12, 15, 16, 18) are distributed exclusively south of this region, while the sixth (cluster 17) extends somewhat to the north. With the exception of the ubiquitous cluster group 1, the southern boundary of the remaining site cluster groups is in the Cape Cod/Georges Bank region, or further north. This boundary has frequently been recognized in previous biogeographic studies (Briggs 1974; Mahon and Sandeman 1985).

Temporal Change

The example analyses for the individual species (i.e., Atlantic cod, arctic cod, ocean pout, and butterfish) indicate that future work of this sort could be useful. The ACON plots (or plots generated using other similar graphics packages) enable visualization of species locations (presence/absence), as well as how distributions have expanded or contracted over time. However, simple presence/absence is not adequate, and some consideration of abundance throughout the species range is required to understand fringe versus central changes in distribution. Expanding symbol plots could address this somewhat, although overplotting in areas of high abundance remains a problem. Developing contour or change maps might provide more interpretable results. Change maps would be color coded to indicate areas (or grid cells) where abundance has increased, decreased, or remained the same over time.

The bivariate ellipses, on the other hand, illustrate central tendencies of distribution. They may be most effective where the study area is fairly linear in shape (e.g., Labrador or Middle-Atlantic coasts), so that distributional shifts occur along a geographic axis. Distributions of species occurring in areas with more complex shapes, such as the Gulf of St. Lawrence, may have geometrically complex patterns of expansion or contraction, which could complicate interpretation of the ellipses.

In further analyses, the annual survey estimates could be rescaled to the mean abundance of the species survey data set, and the analysis done on the rescaled data. This would focus the analysis on distribution, rather than on abundance trends.

Another approach to examining temporal trends would be to examine changes in assemblage distribution and/or species composition through time. The assemblages for the entire time period were judged to be sufficiently consistent with those for five-year time blocks that the former could be used to represent the overall assemblages (Table 10). This result suggests that assemblages are fairly stable entities, but that their development and distribution may vary through time as species distributions and abundances fluctuate. Examining temporal shifts in location for assemblages PC 10 and PC 11 (Figure 14, Table 11), revealed substantial distributional shifts over the four five-year time periods. However, the extent to which these were shifts of entire assemblages, or were only shifts in one of the major species, has not been determined. As with the single species distributions above, this example analysis suggests that this approach could be pursued in greater detail for the major assemblages. Although not attempted for this report, ACON plots and bivariate ellipses could also be developed for assemblages. In addition, it might prove informative to examine temporal changes in assemblage structure by mapping annual anomalies in geographical distribution and species composition relative to the PCs extracted for the overall time period.

Another factor to consider is the time frame in which comparisons are being made. In this project, five-year time blocks were used, but other time periods could be compared. For example, known warm and cold periods could be compared, as long as each contained enough data to yield meaningful plots.

The results obtained in the CDA suggest that this approach should be explored more fully. Methodological enhancements are needed to improve the analysis of relationships between changes in community structure over time and temporal changes in species abundances. The existing analyses could be extended by examining relationships between the canonical variables and environmental variation (e.g., temperature), and relationships with other variables, such as fishing effort. Also, more specific questions could be analyzed using subsets of data, such as comparisons between warm and cold periods, or between periods of high and low abundance.

The problem of spatial bias in sampling over time also merits consideration. The mean position of all samples shifted from 44.9° N, 61.5° W for 1975-79 to 45.3° N, 57.8° W for 1990-94. The degree to which spatial variation over time in sampling contributes to apparent changes in spatial patterns over time is not known.

Comparison of Assemblage Analyses

Given the relatively subjective nature of the assemblage analyses, it is useful to compare the results of the different methods. Consistency of results among the approaches would enhance credibility, while major inconsistencies would bring the results into question.

The species groupings resulting from the visual, principal components, and cluster analyses are compared in Table 15. There is a high degree of consistency among the four grouping methods used. Species occurring on the same PC or in the same branch of the dendrogram usually fell within the same visually defined group. This indicates that the multivariate methods produced results consistent with the obvious major distributional patterns. One exception was the haddock/Atlantic halibut pair, which emerged together in all the multivariate analyses, but was placed in different groups during the visual analysis. The probable cause of this discrepancy is that Atlantic halibut is distributed further north than haddock, but they co-occur frequently in their area of overlap.

Several groups were identified consistently by the visual and multivariate analyses (Table 15); these may be the most well defined. Further studies of these groups are suggested, focusing on species interactions or linkages as possible determinants of assemblage structure. There are a few instances of consistently occurring groups of four to five species, such as smooth skate/thorny skate/Atlantic cod/American plaice in the North Temperate Bank/Slope group, and summer flounder/scup/black seabass/northern searobin/smooth dogfish in the Southern Bank/Slope group. There are also many smaller groups, particularly pairs, of species that appear to co-occur consistently. For example, the Southern Deepwater Group of blackbelly rosefish/offshore hake/shortnose greeneye was identified in all analyses, and appears to have a distinctive distribution.

The correspondence between PCA site groups (top 5% of sites on each PC) and site cluster groups is variable (Figure 16). In some cases, for example PC17 with CG

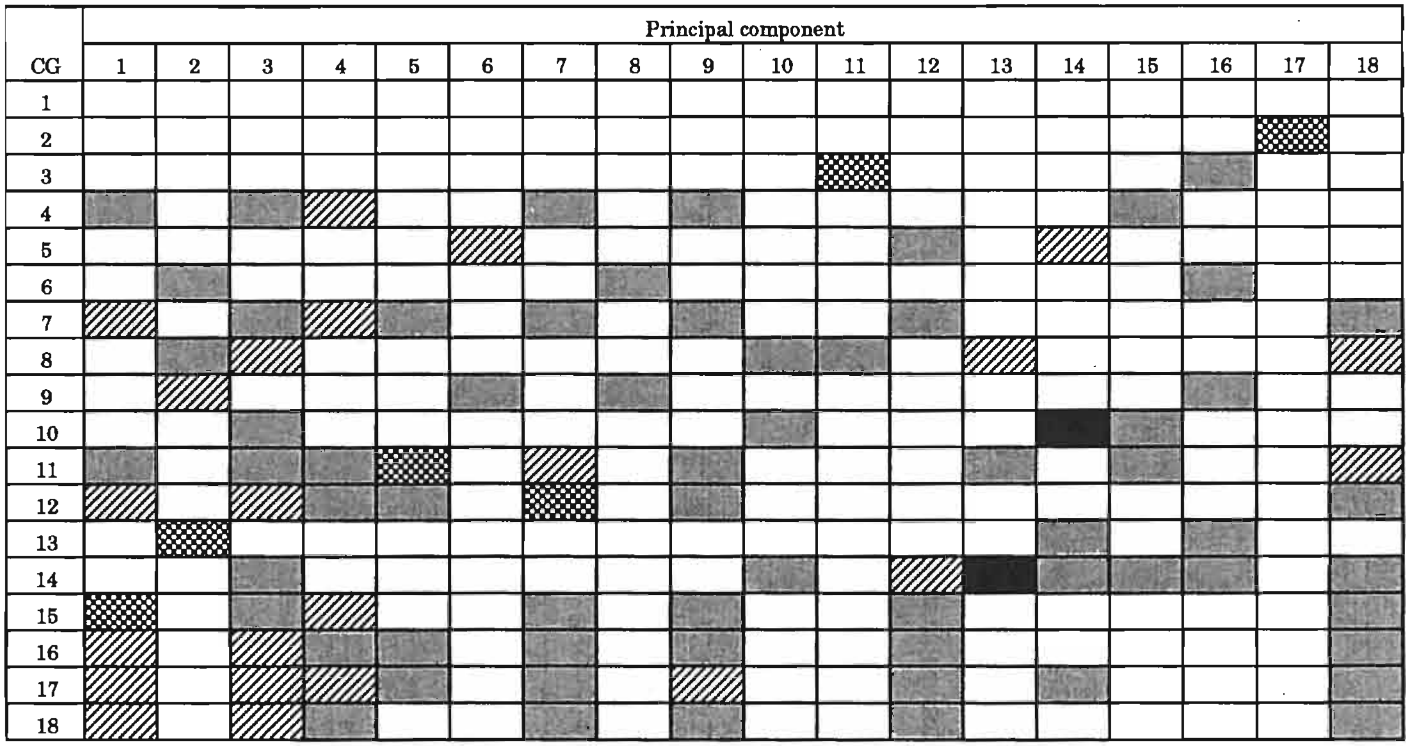
Table 15. Comparisons among species groups determined by visual analysis with groups determined by the multivariate analyses.[1]

Visual Species Group	PC	SG	CG
Northern Deepwater			
Longnose eel	2	8	13
Largescale tapirfish	2	8	9
Blue hake	2	8	13
Rock (roundnose) grenadier	2	8	13
Roughhead grenadier	2	3	13
Spinytail skate	--	4	13
Temperate Deepwater			
Atlantic argentine	6	1	4
Marlin-spike	6	3	5
Black dogfish	6	5	10
Longfin hake	14	5	10
Roughnose grenadier	14	17	10
Southern Deepwater			
Shortfin squid	4	11	17
Blackbelly rosefish	9	15	17
Offshore hake	9	15	17
Shortnose greeneye	9	15	17
Northern Bank/slope			
Northern wolffish	8	3	13
Spotted wolffish	8	3	6
Atlantic sea poacher	11	2	3
Arctic cod	11	2	3
Greenland halibut	11	3	13
Polar scuplin	16	3	13
North - temperate Bank/slope			
Redfishes	6	1	10
Witch flounder	6	1	10
Atlantic wolffish	8	1	14
Smooth skate	10	1	14
Thorny skate	10	1	14
Atlantic cod	10	1	8
American plaice	10	1	8
Alligator fish	13	6	14
Moustache (mailed) sculpin	13	6	14
Snowflake hookear sculpin	13	18	14
Atlantic halibut	15	1	4
Lumpfish	17	4	2
Shorthorn sculpin	17	4	2
Snake blenny	18	7	8
Cunner	18	12	11

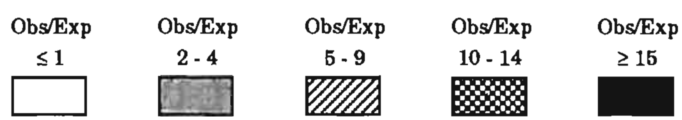
Visual Species Group	PC	SG	CG
South - temperate Bank/slope			
Goosefish (Angler)	4	11	18
Silver hake	4	11	18
Cusk	4	11	17
Red hake	4	11	15
Spiny dogfish	4	11	12
White hake	4	1	5
Pollock	4	1	4
Yellowtail flounder	5	12	11
Winter flounder	5	12	11
Ocean pout	5	12	11
Sea raven	5	12	11
Longhorn sculpin	5	12	11
Winter skate	7	12	12
Northern sandlance	7	1	12
Atlantic hagfish	12	1	5
Fourbeard rockling	12	1	14
Haddock	15	1	4
Southern Bank/slope			
Fourspot flounder	1	10	12
Butterfish	1	10	12
Spotted hake	1	10	15
Fawn cuskeel	1	10	15
Gulfstream flounder	1	10	15
Summer flounder	3	13	18
Scup	3	13	18
Northern (common) searobin	3	13	18
Smooth dogfish	3	13	16
Black seabass	3	14	18
Windowpane	7	9	12
Little skate	7	9	12

[1] The numbers in the columns show which species group the species had its highest loading on in the PCA (PC) (Table 6), the species cluster groups (SG) (Figure 11), and the grouping of species based on maximum relative abundance in the site cluster groups (CG) (Table 8). Horizontal lines separate species loading on different PCs.

Figure 16. Correpondence between sites scoring in the top 5% of PCA-determined assemblages and site cluster groups.[1]



[1]Shading indicates correspondence between sites occurring in a given PC group and site cluster group (CG), as determined by the ratio of observed to expected numbers of sites co-occurring in the PC and site cluster group pairs under a null hypothesis of no relationship. The following key is used.



2, and PC 11 with CG 3, the correspondence is nearly one-to-one. In other cases, such as PC1, PC3, and PC4, the sites are distributed over several CGs. For each PC, the chi-square statistic was used to test whether the distribution of sites in the cluster groups was significantly different from random, based on the total numbers of sites within each site cluster group. The differences from a random distribution were significant ($P < 0.01$) for every cluster group. Therefore, it is evident that PC site groups tend to correspond to particular site cluster groups, as would be expected if both analyses were providing different perspectives on the same assemblage distributions. However, it is also evident that the strength of this correspondence varies.

The geographic correspondence between PCs and site cluster groups is reflected in the distribution plots for the individual PC and site cluster groups (Figures 6, 9). The distribution of sites for PC17 and CG2, which both represent the shorthorn sculpin/lumpfish species pair, are very similar. PC2 and CGs 9 and 13 also correspond well, but there are many shallow sites in the CGs that are not seen in PC2. In contrast, PC4, which represents the South Temperate Bank/Slope group of silver hake, red hake, cusk, pollock, spiny dogfish, white hake, ocean pout, goosefish (Angler), haddock, and shortfin squid, is distributed over several CGs.

The PCA and site cluster analysis both provided information on the strength of species affinities for their assemblages. There is moderate agreement between the two approaches, in that the maximum species loadings on the PCs (Table 6) are correlated with log transformed maximum relative abundances (Table 8) ($r=0.48$, $P < 0.01$).

A brief description of the assemblages, based on their geographical, depth, and temperature distributions, is provided in Table 16. For this summary, the groupings from the PCA are used, and the main corresponding site cluster groups are given. This table indicates that, as several previous studies have found, depth and temperature play important roles in determining assemblage distributions (Overholtz and Tyler 1985; Murawski and Finn 1988; Mahon and Smith 1989; Gabriel 1992; Gomes *et al.* 1995).

The PCA revealed patterns of species association broadly consistent with previous studies of smaller regions (Table 17). Comparing the present study to previous, more localized studies is subjective owing to the different methodologies and species used. No study has yet defined assemblages for the northern Labrador Shelf. The assemblages found in the present study were most consistent with those reported by Gabriel (1992), for the area from Cape Hatteras north to the Scotian Shelf, and by Mahon (1995), for the Scotian Shelf and Bay of Fundy. The approach to assemblage definition taken by Gomes *et al.* (1992), and Guadalupe Villagarcia (1995) emphasized the absolute abundance of species in an assemblage, so their results are difficult to compare with those of this study. However, the combination of thorny skate, American plaice, and Atlantic cod emerged as a dominant group in their analyses.

The finding of a large number of sites without assemblages is not entirely consistent with previous studies in the area (e.g., Mahon and Sandeman 1985; Overholtz and Tyler 1985; Mahon and Smith 1989; Gabriel 1992; Gomes *et al.* 1995). However, the similarity of the results for the PCA and site cluster analysis in this study support this interpretation for the ECNASAP data set. For the PCA, 45.5% (17,612) of the sampled sites do not score in the top 5% of any PC. For the cluster analysis, 42.6% (16,474) of the sites are in the first cluster, which is interpreted as not having any characteristic assemblage. A total of 7,823 (i.e., somewhat less than half) of these are the same sites, which suggests that these two methods differed somewhat in determining which sites were not assignable to an assemblage. This discrepancy might be reduced with other distance indices or clustering methods, or by modifying the top 5% criterion for inclusion of a site in a PCA-defined assemblage.

Several factors could have contributed to this apparent lack of structure. The large spatial scale of the data set could mask relationships that exist in smaller regions or that vary spatially. Some of the lack of structure in the results could be due to the sampling gear, which integrates species occurring over a transect of 1.8 nautical miles, and may, therefore, integrate assemblages that do not occur in the same habitat. It could also be due to the use of data obtained from different sources, which employed different trawling gear and vessels. Using data from several months may also have been a factor. For this to be a cause, species associations would have to change seasonally, and seasonal differences in assemblage structure have been described in several studies (Colvocoresses and Musick 1984; Mahon and Smith 1989). Although analyzing the 20-year time period covered in the ECNASAP data set might have obscured relationships that occurred over shorter time periods, the similarity between the PCAs for the 1975-94 period and the five-year blocks suggests that the amount of time in the data set was not a major factor in limiting assemblage structure.

This apparent lack of structure could also be a reflection of the real nature of the existing demersal fish assemblages, which may not be highly structured into functional groups. The mobility of most fish species,

Table 16. Summary of characteristics of species assemblages derived from PCA of all years, with associated site cluster groups (CGs) having a ratio ≥ 5 in Figure 16.[1]

PC #	Associated CGs	Characteristics
1	7 12 **15** **16** 17 **18**	SOUTHERN, VERY WARM, SHALLOW-MIDDLE DEPTH, AGGREGATED The most southern assemblage, restricted to the Middle Atlantic Bight and southern Georges Bank. PC species: **Gulfstream flounder, Fourspot flounder, Fawn cusk-eel, Spotted hake, Butterfish,** Red hake, Goosefish (Angler)
2	**9** **13**	NORTHERN, COLD, VERY DEEP, AGGREGATED The deepest assemblage, occurring in the north, through the Laurentian channel, around the slope of the Grand Banks and Labrador Shelf, and around the Flemish Cap. PC species: **Blue hake, Rock (Roundnose) grenadier, Longnose (Slatjaw cutthroat) eel, Large-scale tapirfish, Roughhead grenadier,** Marlin-spike (Common grenadier)
3	7 12 **16** 17 **18**	SOUTHERN, WARM, SHALLOW-MIDDLE DEPTH, DISPERSED Primarily a southern assemblage, most commonly occurring on Georges Bank, in the Middle Atlantic Bight, in the mouth of the Bay of Fundy, but with scattered sites up to the Grand Banks. PC species: **Scup, Summer flounder, Northern (Common) searobin, Black sea bass, Smooth dogfish**
4	**4** 7 15 17	SOUTH-CENTRAL, WARM, SHALLOW-MIDDLE DEPTH, AGGREGATED Concentrated in the Gulf of Maine, on the southern Scotian Shelf, outer edges of Georges Bank, and the Middle Atlantic Bight. PC species: **Silver hake, Red hake, Cusk, Pollock, Spiny dogfish,** White hake, Ocean pout, Goosefish (Angler), Haddock, Shortfin squid
5	**11**	CENTRAL, MEDIUM TEMPERATURE, VERY SHALLOW, FRAGMENTED The shallowest assemblage, occurring on bank tops and some coastal areas in the middle of the study area (fragmented distribution). PC species: **Longhorn sculpin, Sea raven, Yellowtail flounder, Winter flounder,** Ocean pout
6	**5**	CENTRAL, MEDIUM TEMPERATURE, DEEP, LOCALISED Occurs primarily in the Laurentian Channel and into the mouth of the St. Lawrence River. PC species: **Marlin-spike (Common grenadier), Redfishes (*Sebastes* spp.), Witch flounder, Black dogfish,** Atlantic argentine, White hake, Longfin hake
7	11 **12**	SOUTHERN (GEORGES BANK), VERY WARM, SHALLOW, AGGREGATED Occurs most strongly on Georges Bank, and to a lesser extent on other banks. PC species: **Windowpane, Winter skate, Little skate,** Northern sand lance
8		NORTHERN, COLD, DEEP, AGGREGATED Occurs on the NE Newfoundland and southern Labrador shelves. PC species: **Spotted wolffish, Atlantic wolffish, Northern wolffish,** Roughhead grenadier, Atlantic cod, Greenland halibut, Redfishes (*Sebastes* spp.)

[1]The highest association of each site cluster group with a PC (in Figure 16) is typed in bold (see Tables 7 and 9 for depth and temperature information). In the PC species lists, species with loadings ≥ 0.5 are in bold type; species with loadings between 0.3 and 0.5 are in standard type.

Table 16. (continued)

PC #	Associated CGs	Characteristics
9	17	SOUTHERN WIDESPREAD, WARM, MEDIUM DEPTH Occurs in the deeper shelf areas of the Scotian Shelf and Gulf of Maine, and along the shelf slope from the SW Grand Banks to Cape Hatteras. PC species: **Blackbelly rosefish, Offshore hake, Shortnose greeneye**
10		NORTH CENTRAL, COOL, MEDIUM DEPTH, DISAGGREGATED Occurs on the NE Newfoundland Shelf, Grand Banks, Northern Scotian Shelf, and in the Gulf of St. Lawrence at medium to deep depths in cool water. PC species: **Thorny skate, American plaice,** Witch flounder, Atlantic cod, Smooth skate
11	3	NORTHERN, COLD, DEEP, AGGREGATED The coldest water assemblage, occurs on the NE Newfoundland and Labrador Shelves. PC species: **Arctic cod, Atlantic sea poacher,** Greenland halibut, Polar sculpin
12	14	CENTRAL, MEDIUM TEMPERATURE, MEDIUM DEPTH Occurs in the Northern Gulf of St. Lawrence and Gulf of Maine. PC species: **Fourbead rockling, Atlantic hagfish,** Smooth skate
13	8 14	CENTRAL, COOL, SHALLOW SCATTERED AGGREGATIONS Occurs at several scattered localities north of Cape Cod. PC species: **Moustache (Mailed) sculpin, Alligatorfish, Snowflake hookear sculpin**
14	5 10	CENTRAL, MEDIUM TEMPERATURE, DEEP, LOCALISED Concentrated in the Laurentian Channel and in the Gulf of St. Lawrence up to the mouth of the St. Lawrence River, and also along the slope of the Labrador and Scotian Shelves. PC species: **Roughnose grenadier, Longfin hake, Black dogfish**
15		CENTRAL, MEDIUM TEMPERATURE, MEDIUM DEPTH Occurs mainly on the outer banks of the Scotian Shelf, and on the SW edge of the Grand Banks into the NE Gulf of St. Lawrence. PC species: **Atlantic halibut, Haddock**
16		NORTHERN, COOL, DEEP Essentially a single species PC, concentrated on NE Newfoundland and Labrador slope, scattered into the Gulf of St. Lawrence, Gulf of Maine, and Georges Bank. PC species: **Polar sculpin**, Roughhead grenadier, Greenland halibut
17	2	NORTH CENTRAL, VERY COLD, MEDIUM DEPTH Localised on the shelf S of Newfoundland and around into the NE Gulf of St. Lawrence. PC species: **Lumpfish, Shorthorn sculpin,** Sea raven
18	8 11	SOUTHERN, WARM, SHALLOW Essentially a single species PC, occurs in the SW Gulf of St. Lawrence, Bay of Fundy, Georges Bank, and Middle-Atlantic Bight. PC species: **Cunner,** Winter flounder, Snake blenny

Table 17. Comparison of species groupings found in the PCA of the present study with groupings found in previous studies.[1]

This study (PCA)	Middle Atlantic Bight (Colvocoressess and Musick 1984)	Middle AtlanticBight/ Georges Bank/ Gulf of Maine (Gabriel 1992)	Scotian Shelf (Mahon and Smith 1989)	Scotian Shelf (Mahon 1995)
Gulfstream flounder **Fourspot flounder** **Fawn cusk eel** **Spotted hake** **Butterfish** Red hake Goosefish (Angler)	Red hake Silver hake Gulfstream flounder Spotted hake Butterfish Fourspot flounder	Spotted hake Fourspot flounder Butterfish	XXXX	XXXX
Blue hake **Rock (Roundnose) grenadier** **Longnose (slatjaw cutthroat) eel** **Large-scale tapirfish** **Roughhead grenadier** Marlin-spike (Common grenadier)	XXXX	XXXX	XXXX	XXXX
Scup **Summer flounder** **Northern (Common) searobin** **Black sea bass** **Smooth dogfish**	Scup Summer flounder Northern (Common) searobin Black sea bass Smooth dogfish	Scup Summer flounder Northern (Common) searobin Black sea bass	XXXX	XXXX
Silver hake **Red hake** **Cusk** **Pollock** **Spiny dogfish** White hake Ocean pout Goosefish (Angler) Haddock Shortfin squid		Red hake Silver hake Goosefish (Angler) Cusk Spiny dogfish Shortfin squid	Red hake Goosefish (Angler)	Red hake Silver hake Goosefish (Angler) Spiny dogfish
Longhorn sculpin **Sea raven** **Yellowtail flounder** **Winter flounder** Ocean pout	Longhorn sculpin Yellowtail flounder American plaice Little skate Windowpane Spiny dogfish	Sea raven Ocean pout	Longhorn sculpin Sea raven Winter flounder Yellowtail flounder Winter skate	Longhorn sculpin Sea raven Winter flounder Yellowtail flounder Winter skate Ocean pout
Marlin-spike (Common grenadier) **Redfishes (*Sebastes* spp.)** **Witch flounder** **Black dogfish** Atlantic argentine White hake Longfin hake	Witch flounder White hake Goosefish (Angler)	Redfishes Witch flounder White hake	Marlin-spike (Common grenadier) Longfin hake	Marlin-spike (Common grenadier) Redfishes (*Sebastes* spp.) Witch flounder White hake

[1]Species groups in previous studies have been placed next to the PC assemblage to which they appear most similar. In the PCA column, the species in bold type have loadings ≥ 0.5; the species in standard type have loadings between 0.3 and 0.5. XXXX indicates that none of the species in the present study's group were included in the previous study.

Table 17. (continued)

This study (PCA)	Middle Atlantic Bight (Colvocoressess and Musick 1984)	Middle AtlanticBight/ Georges Bank/ Gulf of Maine (Gabriel 1992)	Scotian Shelf (Mahon and Smith 1989)	Scotian Shelf (Mahon 1995)
Windowpane **Winter skate** **Little skate** Northern sand lance		Winter skate Windowpane Little skate		
Spotted wolffish **Atlantic wolffish** **Northern wolffish** Roughhead grenadier Atlantic cod Greenland halibut Redfishes (*Sebastes* spp.)	XXXX			
Blackbelly rosefish **Offshore hake** **Shortnose greeneye**	Blackbelly rosefish Offshore hake Shortnose greeneye	Blackbelly rosefish Offshore hake Longfin hake Gulfstream flounder	XXXX	
Thorny skate **American plaice** Witch flounder Atlantic cod Smooth skate		Thorny skate American plaice	Thorny skate American plaice Atlantic cod	Thorny skate American plaice
Arctic cod **Atlantic sea poacher** Greenland halibut Polar sculpin	XXXX	XXXX	XXXX	XXXX
Fourbeard rockling **Atlantic hagfish** Smooth skate			Pollock Spiny dogfish	Cusk Pollock Atlantic argentine
Moustache (Mailed) sculpin **Alligatorfish** **Snowflake hookear sculpin**	XXXX		Moustache (Mailed) sculpin	
Roughnose grenadier **Longfin hake** **Black dogfish**	XXXX		Longfin hake	
Atlantic halibut **Haddock**	XXXX	Atlantic halibut Atlantic wolffish	Atlantic halibut Haddock	Atlantic halibut Haddock Atlantic wolffish
Polar sculpin Roughhead grenadier Greenland halibut	XXXX	XXXX	XXXX	XXXX
Lumpfish **Shorthorn sculpin** Sea raven	XXXX	Lumpfish	XXXX	XXXX
Cunner Winter flounder Snake blenny	XXXX	Cunner	XXXX	XXXX

and their relatively large ranges, together with the migratory habits of many species, may preclude development of tight functional relationships among groups of more than two or three species. Because fishes change their ecological roles as they grow and size was not considered in the analyses conducted for this report, functional relationships among size classes of various species may have been masked. In addition, some naturally occurring functional assemblages may have been disrupted by fishing mortality.

RECOMMENDATIONS AND IMPLICATIONS FOR MANAGEMENT

The analyses described in this report merely scratch the surface of a large body of interesting investigations that could be undertaken with the ECNASAP/Cod Mortality Project data set. Based on the work to date, this section provides recommendations for further work, which will refine the analyses to gain a better understanding of demersal assemblages, and the roles of Atlantic cod, in the study area. The identification of biological and environmental systems and/or boundaries may enable development of management strategies that correspond more closely to the systems to which they are applied. Implications for management are briefly discussed; this topic obviously will warrant a fuller consideration when the results of more detailed analyses become available.

Recommendations for Further Work

The purpose of the suggestions that follow is not only to gain an improved understanding of the groundfish, but also to conduct analyses that will enable development of better management strategies in the future. Two areas are addressed: analytical methods and new analyses. Further development of the ECNASAP desktop systems is not discussed, as other forums for these discussions are more appropriate.

Most of the suggested work relies heavily on geographic information systems (GIS). The power of GIS enables distinct improvements over earlier methodologies for any analysis involving spatial, and spatial/temporal, relationships. For example, prior to the widespread use of GIS, biogeographic analyses had to rely on relatively primitive geographic techniques, such as projecting data onto axes parallel to the coast. This is not necessary with GIS, wherein actual maps can be analyzed. In addition, maps of other relevant data, such as temperature, depth, and fishing effort, can be combined with the species maps. Moreover, a temporal series of maps can be analyzed to investigate how relationships have changed through time.

Analytical methods. Two major issues involving analytical methods are addressed: interpretation and mapping of the assemblages identified through PCA; and approaches for analyzing relationships between assemblages and abundant, widespread species.

Interpreting PCA - To gain a better understanding of the relationship between PC scores and the assemblages that a PC is assumed to represent, it will be useful to examine how the species compositions of sites change as the site PC scores change. Species composition could be compared in sites falling within the top 5%, 10%, 15%, etc. of scores on a PC. In particular, it would be useful to determine the PC score level at which species with high loadings do not occur.

Alternative ways of mapping PC scores should be explored. Overplotting occurs when plotting large numbers of points in different range categories on a single map. Patterns evident on a map may be an artifact of which points are plotted last, and patterns in the underlying points may be obscured. Contouring PC scores and developing change maps (maps showing how abundance has changed over time) might provide more readily interpretable results.

Patterns of co-distribution and overlap of assemblages as defined by PCA should be explored, both statistically and by combining them on thematic maps showing overlapping assemblages. This would enable identification of assemblage "hot spots," where high levels of species interactions could be occurring. A statistical approach would be to determine the frequency with which sites have high scores (e.g., are in the top 5%) for more than one PC (Table 13). A mapping approach would be to create polygons for each assemblage, overlay them on a map, and determine the extent of overlap.

Because PC scores may show that an assemblage is present when one of the constituent species is not, an alternative approach to defining the assemblages, which would not use the site PC scores, could be explored. Each assemblage could be considered present at all sites where all the major species occurred at some specified level of abundance, (e.g. abundance > average catch/tow). A quantitative measure of the degree to which the assemblage is represented at each site could then be based on the combined relative catch/tow (i.e., relative to the species annual or long-term mean catch/tow) of the major species at the site. This *ad hoc* approach to assemblage definition would not permit an assemblage to be present at a site where one of its major species was absent. It would also allow abundance to be brought back into the analyses (see below).

Analyzing abundant species - Relationships between abundant, widespread (i.e., assemblage generalist) species (e.g., Atlantic cod) and the assemblages need to be addressed. Both PCA and cluster analysis are designed to detect unique patterns of covariation, and are not very effective at detecting lower levels of variation that occur ubiquitously. Several possible approaches involving cross tabulation of site groups and species are available for examining relationships among assemblages and ubiquitous species in more detail. It might be useful to examine species abundances in the assemblages identified by the PCA, as was done for PCs 10 and 11 (Table 14). Ubiquitous species, such as silver hake (PC 10) and American plaice (PC 11), were quite abundant in the trawls assigned to these PCs, which indicates that even though these species are not unusually abundant in these assemblages, there may be significant interactions between them and the assemblages.

Nodal analysis may be useful for investigating relationships between abundant species and the cluster groups (Boesch 1977; Stephenson *et al.* 1972). Indices of constancy and fidelity can be calculated and diagrammed to show patterns of association between species (or species groups) and site groups. Constancy is the ratio of observed to possible occurrences of a species in a group of sites. This indicates the extent to which the assemblage may occur without a particular species being present. In a diagnostic sense, a constancy of 1 means that if the species is not present, then the assemblage is not present either. Fidelity is the ratio of constancy of a species in a site group to its average constancy in all other site groups. Fidelity substantially greater than 1 indicates that the species is highly characteristic of the site group. Constancy and fidelity of a ubiquitous species would be expected to be moderate-to-low for a large number of site groups. These indices would be high in site groups in which species with limited distributions tend to co-occur, and low for these species in the remaining site groups.

A third possibility would be to simply develop tables of co-occurrence, where the species would be listed along the side and top of the table, and the frequency with which a species on the side of the table co-occurred in trawls with the species listed along the top would be calculated. In this approach, a ubiquitous species, such as Atlantic cod, might have a fairly low co-occurrence with many less abundant species, because cod may be caught in many areas beyond the ranges of any given less abundant species, yet the less abundant species would have a high co-occurrence frequency with cod, because wherever they are caught, cod is also frequently caught.

New analyses. Several suggestions for new analyses are provided, which are intended either to improve upon the existing analyses, or to provide additional insights into the structure and function of the groundfish community. The purpose of the suggestions is to enable a better characterization of the biological and environmental systems in which the groundfish, and fishing, occur.

Effects of different gear on the trawl data. As discussed in the methods section of this report, the analyses completed to date do not include any corrections of the data for the use of different gear by the different regional surveys. Based on the similarities between the results of this study and those of several others that utilized data from only one source, the assumption that strong signals in the data would be detectable, even in the presence of possible distortions caused by the use of different gears, appears justified. However, the mixture of gears may have contributed to the substantial amount of unexplained variance in the assemblage analyses of this study. The assemblage analyses could be repeated using gear-standardized data, which might provide more accurate information to analyze, and reduce the amount of unexplained variability.

Effects of spatial/temporal sampling bias. Variation in the spatial distribution of sampling over time may have introduced artificial spatial/temporal patterns into the apparent distribution of species and/or assemblages. The extent of this possible problem should be investigated. One approach could be to identify species that, because they are abundant in areas that were intermittently sampled, are likely to have been affected by the sampling variation. Data for the remaining species are not likely to have been affected by sampling variation. Selected analyses could be repeated using only species or subareas that were well sampled.

Size. The assemblage analyses conducted for this report do not include any consideration of size or age. However, size and age can influence distribution (e.g., Horne and Campana 1989) and species interactions. Therefore, analyzing distributional patterns and species associations using a size- or age-structured data set could provide more detailed information.

Distribution and Environment. Both fish distribution and environmental characteristics vary over a range of spatial and temporal scales. It is well-known that fish distribution is tied to environmental characteristics, but the extent to which biotic factors affect distribution is less well understood. A more comprehensive understanding of how these factors interact and/or covary is vital for developing fishery management strategies that correspond to biological and/or environmental systems.

Developing a more complete characterization of the spatial and temporal variability of fish distribution and abundance is a first step for identifying the biological systems existing in the study area. The analyses should include shifts in location and the area occupied, and changes in the species compositions of assemblages. Analyzing temporal trends in the species composition of assemblages would also provide insight into the interdependence among the assemblage species. Temporal trends in the distribution of species and assemblages could be examined using a GIS, or by a regression approach similar to that used by Murawski (1993) for the Middle Atlantic Bight/Georges Bank/Gulf of Maine area.

Analysis of the role of habitat in determining species and assemblage distributions could have important applications. It could enable development of distribution maps for areas lacking adequate sampling data, and support an in-depth understanding of the degree to which assemblages exist because of environmental requirements. It would also support strategic assessment and planning activities, especially exploration of the relative impacts of management scenarios involving fishing or competing uses, such as resource development. For example, potential impacts of environmental change, such as global warming, changes in freshwater inflow to estuaries, or offshore drilling activities, can be assessed when relationships among species/assemblage distributions and environmental conditions are known. This capability is now being developed by SEA Division in the Gulf of Maine (Gulf of Maine Project and SEA Division 1994), mid-Atlantic states (Monaco *et al.* in prep.), and Florida. Habitat suitability models can be used to infer species (or assemblage) distributions and relative abundances as a function of the habitat requirements of a species (or assemblage) and the environmental characteristics of the available habitat. The models are run using a GIS. If habitat characteristics change because of natural or anthropogenic causes, so too will distribution maps generated using the models.

Thorough habitat analysis, or development and use of habitat suitability models, requires both detailed digital maps of environmental characteristics and a semi-quantitative understanding of relationships between abundance and environmental characteristics. Many of these resources are being developed in ECNASAP, or could be developed using ECNASAP products. Temperature and salinity maps will be available for the entire study area, as will sediment maps, at least for the region from Cape Hatteras to the eastern Scotian Shelf. Bathymetric maps are also available as ECNASAP products.

The trawl survey database developed for this project contains much of the information needed to develop habitat suitability models. Enough data should be available to relate abundance to temperature and depth. However, because less salinity data exist, and the little data available from the surveys on substrate has not been included in the ECNASAP data set, some information would have to be derived from the scientific literature. Several methods are available for determining species - environment relationships. Where quantitative data are available, cumulative distribution functions (Perry and Smith 1994; Smith *et al.* 1994), nonparametric density estimation methods (Rice 1993), or the Habitat Preference Index (Monaco *et al.* in prep.) may be appropriate. Discriminant analysis could be also used to identify environmental axes separating the various site groups or species (Horne and Campana 1989). For variables with less information, some judgment and experimentation would be required.

Future biogeographical work should be undertaken to better define faunal regions, and to associate faunal boundaries with environmental discontinuities. To improve upon earlier approaches (e.g., the band analysis of Mahon and Sandeman (1985)), GIS and spatial analysis techniques, perhaps combined with habitat suitability modeling, could be used. This would enable an integrated analysis, incorporating not only spatial and temporal variation in species and assemblage distributions, but also analysis of the impacts of variation in environmental conditions and/or habitat.

Species diversity, both richness and evenness, could also be mapped for the study area, as done by Mahon (1995). Diversity maps may indicate areas of high demersal finfish biodiversity, which could be candidates for conservation as reserves or protected areas. Temporal trends in diversity, within both high and low diversity areas, could be evaluated in relation to the distribution of fishing effort to determine possible effects of fishing on diversity, as done for the Scotian Shelf by Strong and Hanke (1995).

Fishing. The importance of accurately assessing the impacts of fishing mortality on fish distribution and abundance for developing credible management plans cannot be overstated. Fishing effort data are now being overlain with the trawl survey data for the Labrador Shelf and Grand Banks regions, but a comprehensive analysis requires information for the entire study area. Accurate temporal information will be needed to analyze cause and effect, as determining the extent to which changes in fishing mortality cause changes in abundance, and the extent to which changes in abundance cause changes in fishing effort is a highly sensitive issue in fishery management.

Implications for Management

The analyses described in this report may have some implications for fishery management. However, the present results are too preliminary to warrant an in-depth discussion. Further enhancements and analysis of the ECNASAP/Cod Mortality Project data base could provide the scientific basis for modernizing fishery management approaches. As the results of upcoming analyses become available, their management implications should be explored in much greater detail.

One primary question that could be addressed through detailed assemblage analysis is whether functional groupings exist that can be viewed as ecological entities (e.g., the assemblage production units of Tyler *et al.* (1982)). If assemblage production units exist, management strategies could be adapted to optimize harvest of assemblages, rather than harvest of single species. The analyses conducted to date indicate that the groundfish assemblages are rather loose, in that the assemblages explain only about 56% of the variance in total species distribution. This suggests that, in the context of all 66 species and the entire Cape Chidley-Cape Hatteras region, the assemblages may not have strong functional relationships. Additional analysis (e.g., focusing on trophic studies and habitat associations within assemblages) will be required to determine whether or not some groups have functional relationships within this overall framework.

Assemblage information may be useful for reducing bycatch of nontarget species. The assemblages detected are based on species co-occurrences, and they are persistent through time. Because of this persistence, management strategies could be developed to reduce bycatch by allocating fishing effort primarily to areas where nontarget species are rare, as is now being pursued by the NMFS management advisors at Woods Hole (see Garbiel's presentation in O'Boyle (1995)). This approach would be a real step beyond single-species models, and toward ecosystem management. It would not only reduce the impacts of trawling on nontarget species, but would also increase economic efficiency by minimizing trawling effort expended in the harvest of nontarget species.

The results of this study may have implications for the validity of most single species assessment and management models. These models are typically designed to operate on unit stocks, which are assumed to be closed populations contained in specific areas without immigration or emigration. Although fisheries management boundaries are static, this study has shown that the geographic limits of species distributions are variable over time, presumably as a function of variation in ocean climate. Therefore, running the models in static regions may violate basic model assumptions.

A related biogeographic issue is the extent to which the NAFO management areas fail to recognize important distributional features. If management boundaries split ecological regions, there is the possibility that conflicting or inappropriate management objectives may be applied to a single functional group. In this situation, reaching management objectives may be impossible.

The ECNASAP data set contains much information on species not currently exploited. With the decline of many traditionally harvested species along the east coast of North America, the fishing industry is turning more than ever toward new resources. For many species, the ECNASAP data set provides information on distribution, abundance, habitat characteristics, and species co-occurrences over a broad geographic range. This information is essential for developing sensible management schemes for these new species.

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APPENDIX 1: COMBINING TRAWL SURVEY DATA FROM CAPE HATTERAS TO CAPE CHIDLEY

The trawl survey data which were compiled were obtained from five sources. Data for the Labrador Shelf from Cape Chidley south, the Grand Banks of Newfoundland, the Flemish Cap, and the west coast of Newfoundland were obtained from the Canada Department of Fisheries and Oceans, North Atlantic Fisheries Centre, St. John's, Newfoundland (contact Bruce Atkinson). Data for the Northern Gulf of St. Lawrence were obtained from the Canada Department of Fisheries and Oceans, Marine Fish Division, Lamontagne Institute, Mon Joli, Quebec (contact Serge Labonte). Data for the Southern Gulf of St. Lawrence were obtained from the Canada Department of Fisheries and Oceans, Marine and Anadromous Fish Division, Gulf Fisheries Centre, Moncton, New Brunswick (contact Michael Chadwick). Data for the Scotian Shelf, the Bay of Fundy, and part of Georges Bank were obtained from the Canada Department of Fisheries and Oceans, Marine Fish Division, Scotia-Fundy Region, Bedford Institute of Oceanography, Dartmouth, Nova Scotia (contact Robert O'Boyle). Data for Georges Bank, the Gulf of Maine, and the Middle Atlantic Bight were obtained from the National Marine Fisheries Service (NMFS), Northeast Fisheries Science Center (NEFSC), Woods Hole, Massachusetts (contact Thomas Azarovitz).

Data Format and Codes

Original data. The format and codes of the original data have been documented in various publications. Sargent *et al.* (1985) describes the NMFS survey data set. The data from Newfoundland and Labrador, and the Northern Gulf of St. Lawrence are in the same format and use the same codes as described by Smith and Somerton (1981). The data from the Scotian Shelf, Bay of Fundy and Southern Gulf of St. Lawrence are in the same format as described by Strong and Gavaris (1993) and Hurlbut and Clay (1990).

The original format of the Canadian data has station and catch information stored on separate cards. There is one station card per tow, along with one catch card for each species. The U.S. data were obtained in two different formats: SVIMAGE for 1963-81 data and SVSTA/SVCAT for 1980-94 data. The SVIMAGE data consist of separate files for each year. These files contain records in five card-like formats, labeled by 1-5 in the 80th column. Station information and catch data were extracted from cards 1 and 5 respectively. The 1980-94 data are in two relational files per year. For each year, the SVSTA file contains station information, and the SVCAT file contains catch data.

ECNASAP/Cod Mortality Project format and codes. The data were converted to the most appropriate format for ecological analysis of trawl survey data; a sites times species format. Each site, or survey tow, is stored as a separate record (row), with the relevant site, environmental and catch information as variables in the columns. The catch of each species is a separate variable. Each data set was converted to this format, and then all were combined into one data set. The data are stored as an SPSS for Windows (release 6.1) file, TRWLNUM.SAV.

Data Selection and Correction

Data were provided in various degrees of preparation for the analysis to be undertaken. Therefore, some screening and selection of data were carried out.

Newfoundland and Northern Gulf of St. Lawrence data. Data records from these data sets were selected according to the following criteria: 'SET TYPE' categories 1 and 2, survey and sampling sets were selected; and 'OPERATION OF GEAR' categories 1 and 2, normal/no damage and normal/some damage to net, catch not affected, were selected (excluding categories 3, 4, and 5, which are unsuccessful sets and all instances in which operation of gear was missing).

Only sets in which standard survey gear was used were selected, including 'GEAR' codes 100-111, 152, 162, 170, 190, 192.

Sets were selected according to tow duration. Only sets with durations between 15 and 60 minutes were retained. The catch per set in numbers and weight were then standardized to a standard set distance of 1.8 nautical miles.

Northern Gulf of St. Lawrence data. All valid survey tows for the late summer and winter survey series were provided.

Southern Gulf of St. Lawrence data. The late summer survey series was provided. The following taxonomic errors communicated by Doug Swain were corrected:

- species 203 was recoded to 204 (winter skate),
- species 509 was recoded to 502,
- species 507 was recoded to 520,
- species 51 was recoded to 50.

Doug Swain and Tom Hurlbut (pers. comm.) expressed the view that the seasnails have not been reliably identified over the time series, and that they should be lumped to the genus level (*Liparis*). Therefore, species 503-506, 512 and 513 were combined with 500 as seasnails unspecified. For similar reasons, *Lycodes* 598, 619, 620, 627, 641, 643, and 647 were combined with 642 as genus *Lycodes*, and the barracudinas 674 and 712 were combined with 713 as barracudinas unspecified. For these three groups of species, both the combined and original codes have been included to retain the option of analysing the species separately.

Scotia-Fundy data. All valid survey tows for the summer, winter, and fall survey series were provided.

U.S. (NMFS) data. Valid tows were extracted from the SVIMAGE data sets using a list of survey cruises, which was provided by L. DePres. Approximately 100 tows in the SVIMAGE data were corrected by NMFS for nonstandard tow distances. Based on recommendations from NMFS, valid tows were extracted from the SVSTA data sets according to the following criteria: STATION_TYPE_CODE=1 (identifies survey tows); STRATUM_CODE=1 (offshore north of Cape Hatteras) or 05 (Scotian Shelf); HAUL≤3 (good tow/representative tow/problem tow may or may not be representative); and GEAR_CONDITION_CODE ≤6 (gear condition ranging from no damage to obstruction in trawl). All survey tows cover the standard distance in the SVSTA database, so no corrections were performed.

Data Standardization

Tow distance. For the data from Canadian sources, catch per tow was standardised to a tow distance of 1.8 nmi. The U.S. data were provided already standardised.

Taxonomy. The species lists from USA, Scotia-Fundy, and Newfoundland were combined into the single list represented in ALLSPP.XLS (Appendix 2), an Excel spreadsheet containing all the species occurring in the five source data sets. They were combined first on the basis of the scientific name. Subsequently, any duplicate common names with different scientific names were checked to see if one of the scientific names was old, or a synonym. The nomenclatural differences found were reconciled using Scott and Scott (1988). In each case below, the latter name was retained.

- *Molva byrkelange* (NFLD) was taken as synonymous with *M. dypterygia*,
- *Notocanthus nasus* (NFLD) was taken as synonymous with *N. chemnitzi*,
- *Eutremeus sadina* (NFLD) was taken as synonymous with *E. teres*,
- *Rhodogramma sherborni* (NFLD) was taken as synonymous with *Howella sherborni*,
- *Macdonaldia rostrata* (NFLD) was taken as synonymous with *Polyacanthonotus rissoanus*,
- *Poronotus triacanthus* (NFLD) was taken as synonymous with *Peprilus triacanthus*,
- *Lycodes turneri* (NFLD) was taken as synonymous with *L. polaris*,
- *Benthodesmus elongatus* (SF) and *B. simonyi* (NMFS) were both taken as *B. elongatus simonyi*.

The two codes for Blennioidei s.o. in the Scotia-Fundy codes list (605 and 644) were combined.

In the Newfoundland codes, *Eumicrotremus spinosus* and *E. spinosus variabilis* are given separate codes. Scott and Scott (1988) do not mention this distinction, so these species were combined.

Notolepis rissoi and *Notolepis rissoi kroyeri* have separate codes (727 and 712) in the Scotia-Fundy data set. According to Scott and Scott (1988), only subspecies *kroyeri* is in the western Atlantic, so these species were combined.

Four new variables were created, in which the species within genera were combined, due to identification problems as described above in the section for the Southern Gulf of St. Lawrence. These are: (1) REDALL, which includes all redfishes in the genus *Sebastes*; BARALL, which includes all barracudinas in the genus *Paralepis*; ELPALL, which includes all eelpouts in the genus *Lycodes*; and SSNALL, which includes all seasnails in the genus *Liparis*.

Alpha Codes

The alpha codes are the variable names used in the species times trawl sets data set developed in this project (Appendix 2). Alpha codes are prefixed with N (for numbers caught) in the data file. There are some duplicate alpha codes in the spreadsheet. These occur when the same species has been given more than one code (e.g. for different sexes or age groups) Original species codes for the data from Newfoundland and the Northern Gulf of St. Lawrence are provided by Akenhead and LeGrow (1981), and Lilly (1982).

The original species codes in Appendix 2 are listed as follows: USCD = NMFS species code, SFCD = Scotia-Fundy and Southern Gulf species code, and NFCD = Newfoundland/Labrador and Northern Gulf species code. Species occurrences in each original data set are coded by a "1" in the next set of fields (i.e., USOC for the U.S. data, SFOC for the Scotia-Fundy data, SGOC for the Southern Gulf data, NGOC for the Northern Gulf data, and NFOC for the Newfoundland/

Labrador data). For the ECNASAP/Cod Mortality Project data set, the variable KEPT = 1 indicates the species included in the data set, while KEPT = 0 indicates species that were excluded. All invertebrates, except shortfin squid, were excluded. All fish species or aggregate groups were included, with the following exceptions: species known to be strays from south of Cape Hatteras, and having fewer than five occurrences in the data set; and the categories, "all fish", "all demersal fish." Incomplete or ambiguous species identifications were also excluded.

In the TYPE field of Appendix 2, each fish species is classified as demersal (D), mesopelagic (M), or pelagic (P) on the basis of information provided by Scott and Scott (1988) and Bigelow and Schroeder (1953). Demersal species included all those known to live on, near, or in association with the substrate. When there was no information on habitat, the category was assigned on the basis of a congener. In some cases, the habitat was assumed on the basis of the species structure (e.g., all flatfishes were assumed to be demersal). Several cases could not be placed in a category; these are indicated by "?" in the TYPE field.

Description of Database Fields

The following is a brief description of the ECNASAP/Cod Mortality Project data base fields. The file name is TRWLNUM.SAV, which is in SPSS for Windows (version 6.0). Full details of the codes and values are not provided, because users are assumed to be familiar with the trawl survey data from at least one of the regions, and are referred to the various data description documents for details.

BSAL:	Bottom salinity (ppt)
BTEMP:	Bottom temperature (° C)
CRUISE:	Cruise number (assigned sequentially within each vessel)
DAY:	Day of the month (1-31)
DEPTH:	Average bottom depth (m)
DIST:	Tow distance (nmi)
GEAR:	Type of trawl gear used (as coded in the original data)
LATDEC:	Latitude at the start of the tow (decimal degrees)
LONDEC:	Longitude at the start of the tow (negative decimal degrees)
MONTH:	Month (1-12)
N??????:	Standardised number caught per tow for species with alpha code ??????.
SET:	Set number (assigned sequentially within each cruise)
SOURCE:	Source of the data. The value is 1 for NMFS data, 2 for Scotia-Fundy data, 3 for Southern Gulf data, 4 for Northern Gulf Data, and 5 for Newfoundland/Labrador data.
SSAL:	Surface salinity (ppt) (most are missing)
STEMP:	Surface temperature (° C)
STRAT:	Fishing stratum (as coded in the original data)
TIME:	Time of day (hours and minutes)
VESS:	Vessel code (as in the original data)
YEAR:	Year of the tow (2 digits)

Year, Vessel, Cruise, and Set are together the unique identifiers of each set.

A similar SPSS data set, TRWLWTS.SAV, was prepared for the catch per tow in weight. It includes only the following variables; other variables can be merged from TRWLNUM.SAV using the set identifiers.

CRUISE:	Cruise number
SET:	Set number
W??????:	Standardised weight (kg) per tow for species with alpha code ??????
VESS:	Vessel code
YEAR:	Year of the tow

Appendix 2. List of species and codes in the original data sets

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE [1]	TYPE [2]	KEPT	ORIGINAL CODES [3] USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET [4] USOC	SFOC	SGOC	NFOC	NGOC
Sergeant major	*Abudefduf saxatilis*	SERMAJ	D	1	669			1				
Blue tang	*Acanthurus coeruleus*	BLTANG	D	1	742			1				
Shortnosed sturgeon	*Acipenser brevirostrum*	SNSTRG	D	1		249			1			
Atlantic sturgeon	*Acipenser oxyrhynchus*	STURG	D	1	380	243		1	1			
Spotted eagle ray	*Aetobatus narinari*	SEGRAY	D	1	271			1				
Atlantic sea poacher	*Agonus decagonus*	ATSPCH	D	1		350	836		1	1	1	1
Bonefish	*Albula vulpes*	BONFSH	D	1		175			1			
Shortnosed lancetfish	*Alepisaurus brevirostris*	SHTLAN	D	1		731	324		1		1	
Longnose lancetfish	*Alepisaurus ferox*	LONLAN	D	1		710	325		1		1	
Baird's smoothhead	*Alepocephalus bairdii*	BAISHD	D	1		724	166		1		1	
Dotterel filefish	*Aluterus heudeloti*	DOTFIL	D	1	830			1				
Unicorn filefish	*Aluterus monoceros*	UNIFIL	D	1	831			1				
Orange filefish	*Aluterus schoepfi*	ORGFIL	D	1	832	1	933	1	1		1	
Scrawled filefish	*Aluterus scriptus*	SCRFIL	D	1	833			1				
American sandlance	*Ammodytes americanus*	AMSAND	D	1		599			1			
Northern sand lance	*Ammodytes dubius*	NLNCE	D	1	181	610	694	1	1	1	1	1
Northern wolffish	*Anarhichas denticulatus*	NORWLF	D	1		52	699		1	1	1	1
Atlantic wolffish	*Anarhichas lupus*	ATLWOL	D	1	192	50	700	1	1	1	1	1
Spotted wolffish	*Anarhichas minor*	SPTWLF	D	1		51	701		1		1	1
Three-eye flounder	*Ancylopsetta dilecta*	TEYFLD	D	1	774			1				
Ocellated flounder	*Ancylopsetta quadrocellata*	OCEFLD	D	1	775			1				
American eel	*Anguilla rostrata*	AMEEL	D	1	384	600	342	1	1		1	
Ogrefish	*Anoplogaster cornuta*	OGRFSH	D	1		774	500		1		1	
Daggertooth	*Anotopterus pharao*	DAGTTH	D	1		732	250		1		1	
Ocellated frogfish	*Antennarius ocellatus*	OCFROG	D	1		397			1			
Singlespot frogfish	*Antennarius radiosus*	SINFRG	D	1	446			1				
Yellowfin bass	*Anthias nicholsi*	YFNBAS	D	1	500	498		1	1			
Deepbody boarfish	*Antigonia capros*	DBBOAR	D	1	158			1				
Blue hake	*Antimora rostrata*	BLUHAK	D	1	81	113	432	1	1		1	
Fourspine sticklebac	*Apeltes quadracus*	FRST	D	1	488			1				
Black scabbardfish	*Aphanopus carbo*	BKSCAB	D	1		784	547		1		1	
Twospot cardinalfish	*Apogon psrudomaculatus*	TWSCAR	D	1	559			1				
Apristurus laurussoni	*Apristurus laurussoni*	APLAUR	D	1		947			1			
Shark deepsea cat	*Apristurus profundorum*	CATSHK	D	1		239	56		1		1	
Sheepshead	*Archosargus probatocephalus*	SHPHED	D	1		99			1			
Atlantic argentine	*Argentina silus*	ATLARG	D	1	46	160	193	1	1	1	1	1
Striated argentine	*Argentina striata*	STRARG	D	1	856	161	194	1	1		1	
Silver rag	*Ariomma bondi*	SILRAG	D	1	213			1				
Brown driftfish	*Ariomma melanum*	BRDRFT	D	1	891			1				
Spotted driftfish	*Ariomma regulus*	SPDRFT	D	1	748			1				
Bandtooth conger	*Ariosoma balearicum*	BONCON	D	1	389			1				
Atlantic hookear sculpin	*Artediellus atlanticus*	HKSCUL	D	1		880	811		1		1	1
Hookear sculpin uncl	*Artediellus sp.*	HSCUSP	D	1	159	323	810	1	1		1	1
Snowflake hookear sculpin	*Artediellus uncinatus*	SFSCUL	D	1		306	812		1	1	1	1
Alligatorfish	*Aspidophoroides monopterygius*	ALLIG	D	1	165	340	838	1	1	1	1	1

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Arctic alligatorfish	*Aspidophoroides olriki*	ARALIG	D	1		341	837		1	1	1	1
Scaled dragonfish (ns)	*Astronesthes sp.*	DRGNUI	D	1			235				1	
Northern stargazer	*Astroscopus guttatus*	NSTGZ	D	1	179			1				
Southern stargazer	*Astroscopus y-graecum*	SSTGAZ	D	1	699			1				
Trumpetfish	*Aulostomus maculatus*	TRUMP	D	1	119			1				
Silver perch	*Bairdiella chrysura*	SILPER	D	1	148			1				
Gray triggerfish	*Balistes capriscus*	GRYTRG	D	1	202	3		1	1			
Queen triggerfish	*Balistes vetula*	QTRIG	D	1		4			1			
Blacksmelt (ncn)	*Bathylagus benedicti*	BLSMLT	D	1			201				1	
Goitre blacksmelt	*Bathylagus euryops*	BKSMLT	D	1		176	202		1		1	
Deepsea smelt ncn	*Bathylagus sp.*	BATHSP	D	1		295	200		1		1	
Black herring	*Bathytroctes sp.*	BLKHER	D	1			167				1	
Shortfin searobin	*Bellator brachychir*	SHFNSR	D	1	760			1				
Streamer searobin	*Bellator egretta*	STRSR	D	1	761			1				
Horned searobin	*Bellator militaris*	HNSROB	D	1	762			1				
Goby flathead	*Bembrops gobioides. .dnu*	GOBYFL	D	1	178			1				
Frostfish	*Benthodesmus elongatus simon*	FRSFIS	D	1	239	714	548	1	1		1	
Arctic cod	*Boreogadus saida*	ARCOD	D	1		110	451		1	1	1	1
Peacock flounder	*Bothus lunatus*	PEAFLD	D	1	776			1				
Eyed flounder	*Bothus ocellatus*	EYEFLD	D	1	777	45		1	1			
Twospot flounder	*Bothus robinsi*	TSPFLD	D	1	873			1				
Cusk	*Brosme brosme*	CUSK	D	1	84	15	458	1	1		1	1
Saucereye porgy	*Calamus calamus*	SCEPOR	D	1	633			1				
Whitebone porgy	*Calamus leucosteus*	WHBPOR	D	1	634			1				
Knobbed porgy	*Calamus nodosus*	KNBPOR	D	1	635			1				
Spotfin dragonet	*Callionymus agassizi*	SPTDRG	D	1	735	637		1	1			
Pearlfish	*Carapus bermudensis*	PRLFIS	D	1	462			1				
Longfin seasnail	*Careproctus longipinnis*	LFNSNL	D	1		507	864		1		1	1
Seasnail ncn	*Careproctus ranula*	CARRAN	D	1	260	924	866	1	1		1	
Sea tadpole	*Careproctus reinhardi*	SEATAD	D	1		520	865		1	1	1	1
Seasnails (ns)	*Careproctus sp.*	SSNUI	D	1		515	863		1		1	1
Greenland manefish	*Caristius groenlandicus*	GRMFSH	D	1		97			1			
Atlantic goldeneye tilefish	*Caulolatilus chrysops*	ATGTIL	D	1	622			1				
Blackline tilefish	*Caulolatilus cyanops*	BLKTIL	D	1	562			1				
Gray tilefish	*Caulolatilus microps*	GRYTIL	D	1	621			1				
Alfonsino (ncn)	*Caulolepis longidens*	CAULON	D	1			514				1	
Cornish blackfish	*Centrolophus brittanicus*	CRNBFS	D	1			777				1	
Brown ruff	*Centrolophus medusophagus*	BRNRUF	D	1		786			1			
Black ruff	*Centrolophus niger*	BLKRUF	D	1		787			1			
Bank sea bass	*Centropristis ocyurus*	BKSBAS	D	1	526			1				
Rock sea bass	*Centropristis philadelphica*	RKSBAS	D	1	527			1				
Black sea bass	*Centropristis striata*	BLSBAS	D	1	141			1				
Black dogfish	*Centroscyllium fabricii*	BLKDOG	D	1	7	221	27	1	1	1	1	1
Portuguese shark	*Centroscymnus coelolepis*	PRTSHK	D	1		223	28		1		1	
Deepsea angler	*Ceratias holboelli*	DPSANG	D	1		401	981		1		1	1

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Atlantic spadefish	*Chaetodipterus faber*	ATLSPD	D	1	659			1				
Spotfin butterflyfish	*Chaetodon ocellatus*	SFNBUT	D	1	662	107		1	1			
Reef butterflyfish	*Chaetodon sedentarius*	REFBUT	D	1	663			1				
Viperfish	*Chauliodus sloani*	VIPFIS	D	1	240	169	227	1	1		1	1
Chauliodus sp.	*Chauliodus sp.*	CHAUSP	D	1		335			1			
Red anglerfish	*Chaunax pictus*	REDANG	D	1	862			1				
Gaper (ncn)	*Chaunax sp.*	CHAUNX	D	1		530			1			
Black swallower	*Chiasmodon niger*	BLSWAL	D	1		39	679		1		1	
Striped burrfish	*Chilomycterus schoepfi*	STRBUR	D	1	198			1				
Yarrell's, warbonnet blenny	*Chirolophus ascanii*	YBLEN	D	1		629			1			
Shortnose greeneye	*Chlorophthalmus agassizi*	SHTGEY	D	1	232	156		1	1			
Chlorophthalmus chalybeius	*Chlorophthalmus chalybeius. .dr*	CHLCHA	D	1	231			1				
Atlantic bumper	*Chloroscombrus chrysurus*	ATBUMP	D	1	573			1				
Yellowtail reeffish	*Chromis enchrysurus*	YCHROM	D	1	670			1				
Gulf stream flounder	*Citharichthys arctifrons*	GSTFLD	D	1	109	44		1	1			
Horned whiff	*Citharichthys cornutus*	HOWHIF	D	1	780			1				
Spotted whiff	*Citharichthys macrops*	SPWHIF	D	1	781			1				
Bay whiff	*Citharichthys spilopterus*	BYWHIF	D	1	782			1				
Longnose grenadier	*Coelorhynchus carminatus*	LNSGRN	D	1	93		482	1			1	
Saddled grenadier	*Coelorhynchus coelorhynchus*	SDGREN	D	1		413			1	1		
Conger eel	*Conger oceanicus*	CONEEL	D	1	63	608		1	1			
Bulleye	*Cookeolus boops*	BULEYE	D	1	616	78		1	1			
Rock, roundnose grenadier	*Coryphaenoides rupestris*	RKGREN	D	1		414	481		1	1	1	1
Polar sculpin	*Cottunculus micropes*	POSCUL	D	1		307	829		1	1	1	1
Deep sea sculpin	*Cottunculus sp.*	COTTSP	D	1			827				1	1
Pallid sculpin	*Cottunculus thompsoni*	PLSCUL	D	1		308	828		1	1	1	1
Wrymouth	*Cryptacanthodes maculatus*	WRYMTH	D	1	191	630	721	1	1	1	1	1
Lesser deepsea angler	*Cryptopsaras couesi*	LDPANG	D	1		402	982		1		1	1
Bigeye cigarfish	*Cubiceps athenae*	BIGCIG	D	1	876			1				
Spotfin flounder	*Cyclopsetta fimbriata*	SFNFLD	D	1	783	345		1	1			
Arctic lumpfish	*Cyclopteropsis macalpini*	ARCLMP	D	1			850				1	1
Lumpfish	*Cyclopterus lumpus*	LUMFIS	D	1	168	501	849	1	1	1	1	1
Veiled anglemouth	*Cyclothone microdon*	VANGLM	D	1		154	208		1			1
Weakfish	*Cynoscion regalis*	WKFIS	D	1	145		648	1			1	
Red dory	*Cyttopsis roseus*	REDDOR	D	1	899	595		1	1			
Flying gurnard	*dactylopterus volitans*	FLYGUR	D	1	175	806		1	1			
Southern stingray	*Dasyatis americanus*	STHRAY	D	1	29			1				
Roughtail stingray	*Dasyatis centroura*	RTLRAY	D	1	4	213		1	1			
Bluntnose stingray	*Dasyatis sayi*	BNSRAY	D	1	18			1				
Mackerel scad	*Decapterus macarellus*	MKSCAD	D	1	208	87	628	1	1		1	
Round scad	*Decapterus punctatus*	RDSCAD	D	1	211			1				
Neck eel	*Derichthys serpentinus*	NEKEEL	D	1		612			1			
Atlantic batfish	*Dibranchus atlanticus*	ATLBAT	D	1	199	742	969	1	1		1	
Balloonfish	*Diodon holocanthus*	BALFIS	D	1	849			1				
Porcupinefish	*Diodon hystrix*	PORPIN	D	1	850			1				

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Dwarf sand perch	*Diplectrum bivittatum*	DWSPER	D	1	529			1				
Sand perch	*Diplectrum formosum*	SANPER	D	1	530			1				
Silver porgy	*Diplodus argenteus*	SILPOR	D	1	638			1				
Spottail pinfish	*Diplodus holbrooki*	SPTPIN	D	1	639			1				
Spinyfin	*Diretmus argenteus*	SPIFIN	D	1		772	520		1		1	
Fourbeard rockling	*Enchelyopus cimbrius*	FBDROK	D	1	83	114	461	1	1	1	1	1
Red grouper	*Epinephelus morio*	RDGR	D	1	535	879		1	1			
Warsaw grouper	*Epinephelus nigritus*	WRGR	D	1	536			1				
Snowy grouper	*Epinephelus niveatus*	SNOGRP	D	1	537	698		1	1			
Jackknife-fish	*Equetus lanceolatus*	JAKNIF	D	1	648			1				
Cubbyu	*Equetus umbrosus*	CUBBYU	D	1	650			1				
Rough sagre	*Etmopterus princeps*	RGHSAG	D	1	8	224	26	1	1		1	
Fringed flounder	*Etropus crossotus*	FRINFL	D	1	785			1				
Smallmouth flounder	*Etropus microstomus*	SMMFLB	D	1	117	386		1	1			
4-line snake blenny	*Eumesogrammus praecisus*	FLBLEN	D	1		626	711		1	1	1	1
Leatherfin lumpsucker	*Eumicrotremus derjugini*	LTLSUK	D	1		509	846		1		1	1
Lumpfish (ns)	*Eumicrotremus sp.*	LMPUI	D	1			843				1	
Atlantic spiny lumpsucker	*Eumicrotremus spinosus*	ATLMSK	D	1	169	502	844	1	1	1	1	1
Spiny lumpsucker	*Eumicrotremus spinosus variablili*	SPLSUK	D	1			845				1	1
Pelican gulper	*Eurypharynx pelecanoides*	PELGUL	D	1			382				1	
Bluespotted cornetfish	*Fistularia tabacaria*	BLCORN	D	1	120	780		1	1			
Red cornetfish	*Fistularia villosa*	RDCORN	D	1	489			1				
Atlantic cod	*Gadus morhua*	ATLCOD	D	1	73	10	438	1	1	1	1	1
Greenland cod	*Gadus ogac*	GRCOD	D	1		118	439		1	1	1	1
Silver rockling	*Gaidropsarus argentatus*	SILROK	D	1		116	455		1		1	
Threebeard rockling	*Gaidropsarus ensis*	TBDROK	D	1	85	115	454	1	1		1	1
Rocklings (ns)	*Gaidropsarus sp.*	ROKUI	D	1		119	453		1	1	1	1
Threespine stickleback	*Gasterosteus aculeatus*	TSPSTK	D	1	115	361	426	1	1	1	1	1
Shrimp flounder	*Gastropsetta frontalis*	SHPFLD	D	1	787			1				
Big roughy	*Gephyroberyx darwini*	BIGROU	D	1	268			1				
Witch flounder	*Glyptocephalus cynoglossus*	WITFLD	D	1	107	41	890	1	1	1	1	1
Freckled stargazer	*Gnathagnus egregius*	FSTGAZ	D	1	725			1				
Naked goby	*Gobiosoma bosci*	NAKED	D	1	738			1				
Longtooth anglemouth	*Gonostoma elongatum*	GONELO	D	1	235	155	213	1	1		1	
Torpedo dragonfish	*Grammatostomias dentatus*	TORDRG	D	1		717			1			
Naked sole	*Gymnachirus melas*	NAKSOL	D	1	796			1				
Fishdoctor	*Gymnelis viridis*	FSHDOC	D	1		616	746		1	1	1	1
Arctic staghorn sculpin	*Gymnocanthus tricuspis*	ASSCUL	D	1		302	823		1	1	1	1
Spotted moray	*Gymnothorax moringa*	SPMORA	D	1	386			1				
Blackedge moray	*Gymnothorax nigromarginatus*	BLKMOR	D	1	387			1				
Spiny butterfly ray	*Gymnura altavela*	SPBRAY	D	1	375			1				
Smooth butterfly ray	*Gymnura micrura*	SMORAY	D	1	376			1				
Tomtate	*Haemulon aurolineatum*	TOMTAT	D	1	627			1				
White grunt	*Haemulon plumieri*	WHTGRT	D	1	629			1				
Striped grunt	*Haemulon striatum*	STRGRN	D	1	878			1				

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Dainty mora	*Halargyreus affinis*	HALAFF	D	1			433				1	
Mora (ncn)	*Halargyreus johnsonii*	HALJON	D	1			434				1	
Slippery dick	*Halichoeres bivittatus*	SLIPDK	D	1	677			1				
Pancake batfish	*Halieutichthys aculeatus*	PANBAT	D	1	449			1				
Longnose chimera	*Harriotta raleighana*	LNCHIM	D	1		247	120		1		1	
Blackbelly rosefish	*Helicolenus dactylopterus*	BBROSE	D	1	156	123	797	1	1	1	1	
Red barbier	*Hemanthias vivanus*	RDBARB	D	1	539			1				
Sea raven	*Hemitripterus americanus*	SEARAV	D	1	164	320	809	1	1	1	1	1
Atlantic footballfish	*Himantolophus groenlandicus*	ATFBAL	D	1		403	988		1		1	
Lined seahorse	*Hippocampus erectus*	LNSHRS	D	1	492		417	1			1	
American plaice	*Hippoglossoides platessoides*	AMPLC	D	1	102	40	889	1	1	1	1	1
Atlantic halibut	*Hippoglossus hippoglossus*	ATLHAL	D	1	101	30	893	1	1	1	1	1
Blue angelfish	*Holacanthus bermudensis*	BLUANG	D	1	665		669	1			1	
Queen angelfish	*Holacanthus ciliaris*	QUNANG	D	1	666			1				
Squirrelfish	*Holocentrus ascensionis*	SQRFIS	D	1	478			1				
Longspine squirrelfish	*Holocentrus rufus*	LSPSQR	D	1	480			1				
American lobster	*Homarus americanus*	AMLOB	D	1	301	2550	8154	1	1	1		1
Blackmouthed alfonsin	*Hoplostethus mediterraneus*	BLMALF	D	1	261			1				
Sherborn's cardinalfish	*Howella sherborni*	SHCARD	D	1	150	783	616	1	1		1	
Deepwater chimera	*Hydrolagus affinis*	DPCHIM	D	1		242	121		1		1	
Barrelfish	*Hyperoglyphe perciformis*	BARFSH	D	1	207	743		1	1			
Twohorn sculpin	*Icelus bicornis*	THSCUL	D	1		313	831		1	1	1	
Twohorn sculpin (ns)	*Icelus sp.*	ICELUI	D	1			830				1	
Spatulate sculpin	*Icelus spatula*	SPSCUL	D	1		314	832		1	1	1	1
Ribbon sawtailfish	*Idiacanthus fasciola*	RIBSAW	D	1		723	·246		1			1
Shortfin squid	*Illex illecebrosus*	SFSQD	D	1	502	4511	4753	1	1	1	1	1
Bermuda chub	*Kyphosus sectatrix*	BERCHB	D	1		106			1			
Hogfish	*Lachnolaimus maximus*	HOGFIS	D	1	682			1				
Honeycomb cowfish	*Lactophrys polygonia*	NONCOW	D	1	838			1				
Scrawled cowfish	*lactophrys quadricornis*	SCRCOW	D	1	839			1				
Trunkfish	*Lactophrys trigonus*	TNKFSH	D	1		794			1			
Smallscale mora	*Laemonema barbatulum*	LBARB	D	1	867	319		1	1			
Smooth puffer	*Lagocephalus laevigatus*	SMPUF	D	1	195			1				
Oceanic puffer	*Lagocephalus lagocephalus*	OCPUFF	D	1		792			1			
Pinfish	*Lagodon rhomboides*	PINFIS	D	1	640			1				
Banded drum	*Larimus fasciatus*	BANDRM	D	1	651			1				
Spot	*Leiostomus xanthurus*	SPOT	D	1	149			1				
Largeye lepidion	*Lepidion eques*	LEPEQU	D	1			435				1	
Fawn cusk-eel	*Lepophidium cervinum*	FNCEEL	D	1	194	650	761	1	1		1	
Mottled cusk-eel	*Lepophidium jeannae*	MTCEEL	D	1	457			1				
Blenny (ncn)	*Leptoclinus maculatus*	LEPMAC	D	1			713				1	
Yellowtail flounder	*Limanda ferruginea*	YTLFLD	D	1	105	42	891	1	1	1	1	1
Smooth flounder	*Liopsetta putnami*	SMFLD	D	1		140			1			
Seasnails (created)	*Liparis (all)*	NSSNALL	D	1								
Seasnail	*Liparis atlanticus*	SEASNL	D	1	170	503	858	1	1	1	1	1

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Gulf sea snail	*Liparis coheni*	GLFSSN	D	1		513			1	1		
Gelatinous snailfish	*Liparis fabricii*	GELSNL	D	1		505	859		1	1	1	1
Dusky snailfish	*Liparis gibbus*	DSKSSN	D	1		512	862		1	1	1	1
Inquiline snailfish	*Liparis Inquilinus*	INQSNL	D	1		508			1			
Striped seasnail	*Liparis liparis*	STRSSN	D	1	167	504	860	1	1	1	1	
Seasnails (ns)	*Liparis sp.*	LIPASP	D	1		500	857		1	1	1	1
Greenland snailfish	*Liparis tunicatus*	GRNSNL	D	1		506	861		1	1	1	1
Backfin tapirfish	*Lipogenys gillii*	BLKTAP	D	1		615	391		1		1	
Goosefish	*Lophius americanus*	GSEFIS	D	1	197	400	966	1	1	1	1	1
Tilefish	*Lopholatilus chamaeleonticeps*	TILFIS	D	1	151	25		1	1			
Slender eelblenny	*Lumpenus fabricii*	SLEELB	D	1		631	715		1	1	1	1
Snake blenny	*Lumpenus lumpretaeformes*	SNKBLN	D	1	182	622	716	1	1	1	1	1
Daubed shanny	*Lumpenus maculatus*	DBSHAN	D	1	183	623	717	1	1	1	1	1
Stout eelblenny	*Lumpenus medius*	STEELB	D	1		632	718		1	1	1	1
Red snapper	*Lutjanus campechanus*	REDSNP	D	1	589			1				
Lane snapper	*Lutjanus synagris*	LANSNP	D	1	592			1				
Silk snapper	*Lutjanus vivanus*	SLKSNP	D	1	593			1				
Kolthoff's wolfeel	*Lycenchelys kolthoffi*	KOWEEL	D	1			749					1
Common wolf eel	*Lycenchelys paxillus*	CMWEEL	D	1		617	750		1		1	1
Sar's wolf eel	*Lycenchelys sarsi*	SWEEL	D	1			751				1	
Wolf eel (ns)	*Lycenchelys sp.*	WELUI	D	1			747				1	
Wolf eelpout	*Lycenchelys verrillii*	WLFEPT	D	1	190	603	752	1	1	1	1	1
Eelpouts (created)	*Lycodes (all)*	NELPALL	D	1								
Atlantic eelpout	*Lycodes atlanticus*	ATEELP	D	1		964	734		1		1	1
Eelpout (ncn)	*Lycodes atratus*	LYCATR	D	1			735					1
Vachon's eelpout	*Lycodes esmarki*	VCEELP	D	1		643	727		1	1	1	1
Eelpout (ncn)	*Lycodes eudipleurostictus*	LYCEUD	D	1			736				1	
Eelpout (ncn)	*Lycodes frigidus*	LYCFRI	D	1			737				1	
Laval's eelpout	*Lycodes lavalaei*	LVEELP	D	1		620	728		1	1	1	1
Pale eelpout	*Lycodes pallidus*	PLEELP	D	1		627	740		1	1	1	1
Polar eelpout	*Lycodes polaris*	POEELP	D	1		628	731		1	1	1	
Arctic eelpout	*Lycodes reticulatus*	ARCEPT	D	1	189	641	729	1	1	1	1	1
Eelpouts (ns)	*Lycodes sp.*	EELPUI	D	1		642	726		1	1	1	1
Newfoundland eelpout	*Lycodes terraenova*	NFEELP	D	1		619	732		1	1	1	
Vahl's, checker eelpout	*Lycodes vahlii*	VLEELP	D	1		647	730		1	1	1	1
Eelpout (ncn)	*Lycodonus mirabilis*	EELPUI	D	1			743				1	
Grenadier (ncn)	*Macrourus aequalis*	MACAEQ	D	1			475				1	
Rough head grenadier	*Macrourus berglax*	RHDGRN	D	1	92	411	474	1	1		1	
Ocean pout	*Macrozoarces americanus*	OCPOUT	D	1	193	640	744	1	1	1	1	1
Straptail grenadier	*Malacocephalus occidentalis*	STGREN	D	1		409			1			
Tarpon	*Megalops atlanticus*	TARPON	D	1		167			1			
HaddockYy	*Melanogrammus aegelfinus yy*	HADDOK	D	1	71			1				
Haddock	*Melanogrammus aeglefinus*	HADDOK	D	1	74	11	441	1	1	1	1	1
Atlantic soft pout	*Melanostigma atlanticum*	ATLSPT	D	1	262	646	745	1	1	1	1	1
Bluenose dragonfish	*Melanostomias spilorhynchus*	BLUDRG	D	1		718			1			

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Southern kingfish	*Menticirrhus americanus*	SKING	D	1	652			1				
Northern kingfish	*Menticirrhus saxatilis*	NKFIS	D	1	146			1				
Offshore hake	*Merluccius albidus*	OFFHAK	D	1	69	19	448	1	1		1	
Silver hake	*Merluccius bilinearis*	SILHAK	D	1	72	14	449	1	1	1	1	1
Atlantic tomcod	*Microgadus tomcod*	TOMCOD	D	1		17			1	1		
Blue whiting	*Micromesistius poutassou*	BLUWHT	D	1		117	440		1		1	1
Atlantic croaker	*Micropogon undulatus*	ATLCRK	D	1	136			1				
Blue ling	*Molva dypterygia*	BLLING	D	1		56	456		1		1	
European ling	*Molva molva*	EULING	D	1		55	457		1		1	
Fringed filefish	*Monacanthus ciliatus*	FRNFIL	D	1	836	5		1	1			
Planehead filefish	*Monacanthus hispidus*	PLFLFS	D	1	201	6	938	1	1		1	
Deepwater flounder	*Monolene sessilicauda*	DPWFLD	D	1	110	385		1	1			
Striped bass	*Morone saxatilis*	STPBAS	D	1	139			1				
Red goatfish	*Mullus auratus*	RDGOAT	D	1	187	105		1	1			
Smooth dogfish	*Mustelus canis*	SMODOG	D	1	13	222	64	1	1		1	
Black grouper	*Mycteroperca bonaci*	BLKGRP	D	1	540			1				
Yellowmouth grouper	*Mycteroperca interstitialis*	YMTGRP	D	1	524			1				
Gag	*Mycteroperca microlepis*	GAG	D	1	541			1				
Scamp	*Mycteroperca phenax*	SCAMP	D	1	542			1				
Bullnose ray	*Myliobatis freminvillei*	BULRAY	D	1	19			1				
Grubby	*Myoxocephalus aenaeus*	GRUBBY	D	1	166	303	818	1	1		1	1
Longhorn sculpin	*Myoxocephalus octodecemspinc*	LHSCUL	D	1	163	300	820	1	1	1	1	1
Fourhorn sculpin	*Myoxocephalus quadricornis*	FHSCUL	D	1		315	821		1		1	1
Arctic sculpin	*Myoxocephalus scorpioides*	ARSCUL	D	1		316	822		1	1	1	1
Shorthorn sculpin	*Myoxocephalus scorpius*	SHSCUL	D	1	162	301	819	1	1	1	1	1
Ribbed sculpin	*Myoxocephalus sp.*	RISCUL	D	1			817				1	1
Blackbar soldierfish	*Myripristis jacobus*	BLKSOL	D	1	482			1				
Spotted spoon-nose eel	*Mystriophis intertinctus*	SSNEEL	D	1	394			1				
Atlantic hagfish	*Myxine glutinosa*	ATLHAG	D	1	1	241	12	1	1	1	1	1
Large-eyed argentine	*Nansenia groenlandica*	LEARG	D	1		162	195		1		1	
Lesser electric ray	*Narcine brasiliensis*	ELERAY	D	1	367			1				
Armoured grenadier	*Nematonurus armatus*	ARGREN	D	1		998	472		1		1	
Slender snipe eel	*Nemichthys scolopaceus*	SNPEEL	D	1	67	604	368	1	1		1	
Spinycheek scorpionfish	*Neomerinthe hemingwayi*	SPSCRP	D	1	751			1				
Duckbill oceanic eel	*Nessorhamphus ingolfianus*	DBLEEL	D	1		607	365		1		1	
Marlin-spike	*Nezumia bairdi*	COMGRN	D	1	91	410	478	1	1	1	1	1
Grenadier NCN	*Nezumia hildebrabdi*	GRNNCN	D	1			479					1
Emerald parrotfish	*Nicholsina usta*	EMPAR	D	1	685			1				
Large scale tapirfish	*Notocanthus chemnitzi*	LSCTAP	D	1		740	386		1		1	1
White barracudina	*Notolepis rissoi*	WHTBAR	D	1	246	727	320	1	1		1	1
White barracudina	*Notolepis rissoi kroyeri*	WHTBAR	D	1		712			1	1		
Yellowtail snapper	*Ocyurus chrysurus*	YLSNAP	D	1	594			1				
Sand tiger	*Odontaspis taurus*	SANTIG	D	1	12	215		1	1			
Shortnose batfish	*Ogcocephalus nasutus*	SHTBAT	D	1	450			1				
Roughback batfish	*Ogcocephalus parvus*	RGHBAT	D	1	451			1				

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Longnose batfish	*Ogcocephalus vespertilio*	LNSBAT	D	1	206			1				
Snake eel	*Omochelys cruentifer*	SNEEL	D	1			349				1	
Margined snake eel	*Ophichthus cruentifer*	MAREEL	D	1		609			1			
Palespotted eel	*Ophichthus ocellatus*	PSPEEL	D	1	396			1				
Longnose cusk-eel	*Ophidion beani*	LNCUEL	D	1	886			1				
Blotched cusk-eel	*Ophidion grayi*	BLCEEL	D	1	458			1				
Bank cusk-eel	*Ophidion holbrooki*	BKCEEL	D	1	459			1				
Oyster toadfish	*Opsanus tau*	OYTOAD	D	1	185			1				
Pigfish	*Orthopristis chrysoptera*	PIGFIS	D	1	142			1				
Bigeye soldierfish	*Ostichthys trachypomus*	BEYSOL	D	1	483			1				
Polka-dot cusk-eel	*Otophidium omostigmum*	PDCEEL	D	1	186			1				
Red porgy	*Pagrus sedecim*	REDPOR	D	1	641			1				
Seaweed blenny	*Parablennius marmoreus*	SWBLEN	D	1		586			1			
Barracudinas (created)	*Paralepis +*	NBARALL	D	1								
Duckbill barracudina	*Paralepis atlantica*	DUKBAR	D	1		711			1			
Short barracudina	*Paralepis brevis*	SHTBAR	D	1			318				1	1
Barracudina ncn	*Paralepis coregonoides*	PARCOR	D	1	245	674	319	1	1	1	1	1
Barracudinas (ns)	*Paralepis sp.*	BARRUI	D	1		565	317		1		1	1
Summer flounder	*Paralichthys dentatus*	SUMFLD	D	1	103	141		1	1			
Southern flounder	*Paralichthys lethostigma*	STHFLD	D	1	789			1				
Fourspot flounder	*Paralichthys oblongus*	FSTFLD	D	1	104	142	901	1	1		1	
Broad flounder	*Paralichthys squamilentus*	BRDFL	D	1	790			1				
Seasnail	*Paraliparis calidus*	SEASNA	D	1		868			1			
Blacksnout seasnail	*Paraliparis copei*	BLKSSN	D	1		511	856		1		1	1
Longnose greeneye	*Parasudis truculenta*	LNGGEY	D	1	242	149	329	1	1			1
Butterfish	*Peprilus triacanthus*	BUTTER	D	1	131	701	783	1	1	1	1	
Slender searobin	*Peristedion gracile*	SLSROB	D	1	763			1				
Armored searobin	*Peristedion miniatum*	ARSROB	D	1	173	331		1	1			
Sea lamprey	*Petromyzon marinus*	SEALAM	D	1	2	240	15	1	1	1	1	1
Gadoid NCN	*Phocaegadus megalops*	GADNCN	D	1			459					1
Banded gunnel	*Pholis fasciata*	BANGUN	D	1		633			1	1		
Rock gunnel	*Pholis gunnellus*	RKGUN	D	1	180	621	705	1	1	1	1	
Hakeling	*Physiculus fulvus*	HAKLIN	D	1	82			1				
Snake eel	*Pisoodonophis cruentifer*	SNKEEL	D	1	65			1				
Righteye flounder uncl	*Pleuronectidae sp*	RFLDUI	D	1	773	49	887	1	1		1	

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Pollock	*Pollachius virens*	POLLOK	D	1	75	16	443	1	1	1	1	1
Shortspine tapirfish	*Polycanthonotus rissoanus*	SHTTAP	D	1		739	387		1		1	
Beardfish	*Polymixla lowei*	BDFIS	D	1	263	771	508	1	1		1	
Stout beardfish	*Polymixla nobilis*	SBDFIS	D	1	264	744		1	1			
Longspine scorpionfish	*Pontinus longispinis*	LSSCOR	D	1	154			1				
Atlantic midshipman	*Porichthys porosissimus*	ATLMID	D	1	444			1				
Bigeye	*Priacanthus arenatus*	BIGEYE	D	1	134			1				
Northern, common searobin	*Priondius carolinus*	NSROB	D	1		330			1			
Spiny searobin	*Prionotus alatus*	SPSROB	D	1	764			1				
Northern searobin	*Prionotus carolinus*	NSROB	D	1	171		800	1			1	
Striped searobin	*Prionotus evolans*	SSROB	D	1	172	332	801	1	1		1	
Bandtail searobin	*Prionotus ophryas*	BTSROB	D	1	765			1				
Gulf searobin	*Prionotus paralatus*	GLSROB	D	1	274			1				
Bluespotted searobin	*Prionotus roseus*	BSSROB	D	1	766			1				
Blackwing searobin	*Prionotus salmonicolor*	BWSROB	D	1	768			1				
Leopard searobin	*Prionotus scitulus*	LPSROB	D	1	769			1				
Shortwing searobin	*Prionotus stearnsi*	SWSROB	D	1	871			1				
Bighead searobin	*Prionotus tribulus*	BHSROB	D	1	770			1				
Short bigeye	*Pristigenys alta*	SHTBEY	D	1	557			1				
Wenchman	*Pristipomoides aquilonaris*	WNECH	D	1	595			1				
Longsnout butterflyfish	*Prognathodes aculeatus*	LSNBFL	D	1	864			1				
Streamer bass	*Pronotogrammus aureorubens*	STRBAS	D	1	546			1				
Winter flounder	*Pseudopleuronectes americanus*	WINFLD	D	1	106	43	895	1	1	1	1	1
Spotted goatfish	*Pseudupeneus maculatus*	SPGOAT	D	1	656			1				
Ninespine stickleback	*Pungitius pungitius*	NSPSTB	D	1			428					1
Clearnose skate	*Raja eglanteria*	CNSSKT	D	1	24	206		1	1			
Little skate	*Raja erinacea*	LITSKT	D	1	26	203	93	1	1		1	1
Round skate	*Raja fyllae*	RNDSKT	D	1		207	94		1		1	1
Rosette skate	*Raja garmani*	ROSSKT	D	1	25	967		1	1			
Arctic skate	*Raja hyperborea*	ARCSKT	D	1		210	95		1		1	
Jensen's skate	*Raja jenseni*	JENSKT	D	1		209	96		1		1	1
Barndoor skate	*Raja laevis*	BRNSKT	D	1	22	200	97	1	1	1	1	1
Freckled skate	*Raja lentiginos*	FRKSKT	D	1		969			1			
White skate	*Raja lintea*	WHTSKT	D	1		217	98		1		1	
Soft skate	*Raja mollis*	SFTSKT	D	1		208	99		1		1	1
Winter skate	*Raja ocellata*	WNTSKT	D	1	23	204	100	1	1	1	1	1
Thorny skate	*Raja radiata*	THNSKT	D	1	28	201	90	1	1	1	1	1
Smooth skate	*Raja senta*	SMOSKT	D	1	27	202	91	1	1	1	1	1
Spinytail skate	*Raja spinicauda*	SPTSKT	D	1		205	102		1		1	1
Greenland halibut	*Reinhardtius hippoglossoides*	GRNHAL	D	1	99	31	892	1	1	1	1	1
Knifenose chimera	*Rhinochimera atlantica*	KNCHIM	D	1		248	122		1		1	
Cownose ray	*Rhinoptera bonasus*	CAWRAY	D	1	270			1				
Vermilion snapper	*Rhomboplites aurorubens*	VERSNP	D	1	596			1				
Striped cusk-eel	*Rissola marginata*	STCEEL	D	1	188			1				
Freckled soapfish	*Rypticus bistrispinus*	FRSOAP	D	1	555			1				

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Spotted soapfish	*Rypticus subbifrenatus*	SPSOAP	D	1	895			1				
Beans blueback	*Scopelogadus beanii*	BNSBBK	D	1		795			1			
S. Lepidus	*Scopelosaurus lepidus*	SLEPID	D	1		588			1			
Scopelosaurus (ns)	*Scopelosaurus sp.*	SCOPUI	D	1			301				1	
Windowpane	*Scophthalmus aquosus*	WINPAN	D	1	108	143	907	1	1	1	1	1
Longfin scorpionfish	*Scorpaena agassizi*	LFSCRP	D	1	753			1				
Barbfish	*Scorpaena brasiliensis*	BRBFIS	D	1	754			1				
Smoothhead scorpionfish	*Scorpaena calcarata*	SMSCRP	D	1	755			1				
Chain dogfish	*Scyliorhinus retifer*	CHNDOG	D	1	14			1				
Redfishes (created)	*Sebastes (all)*	NREDALL	D	1								
Acadian redfish	*Sebastes fasciatus*	ACARED	D	1	155	283		1	1			
Golden redfish	*Sebastes marinus*	GOLRED	D	1		20	793		1		1	1
Deepwater redfish	*Sebastes mentella*	DPWRED	D	1		21	794		1		1	1
Redfishes (ns)	*Sebastes sp.*	REDUI	D	1		23	792		1	1	1	1
Small redfish	*Sebastes sp.*	REDUI	D	1			997				1	1
Large redfish	*Sebastes sp.*	REDUI	D	1			998				1	
Bigeye scad	*Selar crumenopthalmus*	BESCAD	D	1	209	89		1	1			
Atlantic moonfish	*Selene setapinnis*	MOONFS	D	1		94			1			
Lookdown	*Selene vomer*	LKDOWN	D	1	133	91		1	1			
Blackear bass	*Serranus atrobranchus*	BERBAS	D	1	549			1				
Tattler	*Serranus phoebe*	TATLER	D	1	552			1				
Stout sawpalate	*Serrivomer beani*	STSWPL	D	1		613	369		1		1	1
S. Brevidentatus	*Serrivomer brevidentatus*	SBREV	D	1		638			1			
Slime eel	*Simenchelys parasiticus*	SLMEEL	D	1	64	601	359	1	1		1	
Marbled puffer	*Sphoeroides dorsalis*	MARPUF	D	1	843			1				
Northern puffer	*Sphoeroides maculatus*	NPUF	D	1	196	746	955	1	1		1	
Southern puffer	*Sphoeroides nephelus*	STHPUF	D	1	844			1				
Bandtail puffer	*Sphoeroides spengleri*	BTLPUF	D	1	845			1				
Northern sennet	*Sphyraena borealis*	NSENN	D	1	694			1				
Spiny dogfish	*Squalus acanthias*	SPIDOG	D	1	15	220	24	1	1	1	1	1
Atlantic angel shark	*Squatina dumerili*	ATANSHK	D	1	16		32	1			1	
Longspine porgy	*Stenotomus caprinus. .dnu*	LSPPOR	D	1	642			1				
Scup	*Stenotomus chrysops*	SCUP	D	1	143	102		1	1			
Arctic shanny	*Stichaeus punctatus*	ARSHAN	D	1		624	710		1			1
Boa dragonfish	*Stomias (boa) ferox*	BOADRG	D	1	228	159	230	1	1		1	
Butterfish uncl	Stromateidae sp.	BUTTUI	D	1	750	951	781	1	1		1	1
Channel flounder	*Syacium micrurum*	CHNFLD	D	1	792			1				
Dusky flounder	*Syacium papillosum*	DSKFLD	D	1	793			1				
Slatjaw cutthroat eel	*SyNaphobranchus kaupi*	CUTEEL	D	1		602			1			
Offshore tonguefish	*Symphurus civitatus*	OFTONG	D	1	797			1				
Spottedfin tonguefish	*Symphurus diomedianus*	SPTONG	D	1	798			1				
Slender tonguefish	*Symphurus marginatus*	SLTNG	D	1	821		884	1			1	
Blackcheek tonguefish	*Symphurus plagiusa*	BCTONG	D	1	825			1				
Northern tonguefish	*Symphurus pusillus*	NTONG	D	1	826			1				
Spottail tonguefish	*Symphurus urospilus*	SLTONG	D	1	827			1				

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Blackmouth bass	*Synagrops bella*	BLMBAS	D	1	114			1				
Blackmouth bass	*Synagrops bella. .dnu*	BLMBAS	D	1	560			1				
Synagrops spinosa	*Synagrops spinosa*	SYSPIN	D	1	137			1				
Longnose eel	*Synaphobranchus kaupi*	LNSEEL	D	1			373				1	1
Northern pipefish	*Syngnathus fuscus*	NPIPE	D	1	116			1				
Inshore lizardfish	*Synodus foetens*	INSLIZ	D	1	435			1				
Sand diver	*Synodus intermedius*	SANDIV	D	1	436			1				
Offshore lizardfish	*Synodus poeyi*	OFFLIZ	D	1	437			1				
Red lizardfish	*Synodus synodus*	REDLIZ	D	1	438			1				
Tautog	*Tautoga onitis*	TAUTOG	D	1	177	53		1	1			
Cunner	*Tautogolabrus adspersus*	CUNNER	D	1	176	122	672	1	1	1	1	
Atlantic torpedo	*Torpedo nobiliana*	ATLTOR	D	1	21	216		1	1			
Snakefish	*Trachinocephalus myops*	SNKFIS	D	1	439			1				
Common pompano	*Trachinotus carolinus*	COMPOM	D	1		261			1			
Rough scad	*Trachurus lathami*	RGSCAD	D	1	212			1				
Rough scad	*Trachurus lathami. .dnu*	RGSCAD	D	1	122			1				
Roughnose grenadier	*Trachyrhynchus murrayi*	RGGRN	D	1		412	483		1		1	1
Atlantic cutlassfish	*Trichiurus lepturus*	ATLCUT	D	1	126			1				
Moustache sculpin	*Triglops murrayi*	MSSCUL	D	1	161	304	814	1	1	1	1	1
Bigeye sculpin	*Triglops nybelini*	BESCUL	D	1		305	815		1		1	1
Ribbed sculpin	*Triglops pingeli*	RBSCUL	D	1		317	816		1		1	
Mailed sculpins (ns)	*Triglops sp.*	SCULFM	D	1			813				1	1
Threelight dragonfish	*Trigonolampa miriceps*	TLTDRG	D	1		721			1			
Norway pout	*Trisopterus esmarki*	NWAYPT	D	1			460				1	
Radiated shanny	*Ulvaria subbifurcata*	RDSHAN	D	1	184	625	712	1	1	1	1	1
Dwarf goatfish	*Upeneus parvus*	DWGOAT	D	1	657			1				
Longfin hake	*Urophycis chesteri*	LFNHAK	D	1	79	112	444	1	1	1	1	1
Red hake	*Urophycis chuss*	REDHAK	D	1	77	13	445	1	1	1	1	1
Carolina hake	*Urophycis earlli*	CARHAK	D	1	454			1				
Southern hake	*Urophycis floridanus*	STHHAK	D	1	455			1				
Spotted hake	*Urophycis regius*	SPTHAK	D	1	78	111	446	1	1		1	
White hake	*Urophycis tenuis*	WHIHAK	D	1	76	12	447	1	1	1	1	1
American straptail grenadier	*Ventrifossa occidentalis*	AMSGRN	D	1	280			1				
Atlantic gymnast	*Xenodermichthys copei*	ATLGYM	D	1		725	168		1		1	
Buckler dory	*Zenopsis conchifera*	BUKDOR	D	1	112	704		1	1			
John dory	*Zenopsis ocellata*	JONDOR	D	1			530				1	
Slickhead	*Conocara salmonea*	SLIKHD	?	1		749			1			
E. denticulatus	*Epigonus denticulatus*	EDENT	?	1		677			1			
Epigonus pandionis	*Epigonus pandionis*	EPIPAN	?	1	144	587		1	1			
Silver jenny	*Eucinostomus gula*	JENNY	?	1	599			1				
Pearly razorfish	*Hemipteronotus novacula*	PRLRAZ	?	1	681			1				
Lancer stargazer	*Kathetostoma albigutta*	LSTGAZ	?	1	726			1				
Spiny lebbeid	*Lebbeus groenlandicus*	SPILEB	?	1	293			1				
Jambeau	*Parahollardia lineata*	JAMB	?	1	829			1				
Conejo	*Promethichthys prometheus*	CONEJO	?	1	127			1				

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Uraleptus maraldi	*Uraleptus maraldi*	URAMAR	?	1	70			1				
Silver hatchetfish	*Argyropelecus aculeatus*	SILHAT	M	1	250	700		1	1			
Horned lanternfish	*Ceratoscopelus maderensis*	HRNLAN	M	1	54	163	287	1	1		1	
Headlight fish	*Diaphus dumerilii*	HLFIS	M	1	210	152		1	1			
Cocco's lanternfish	*Gonichthys coccoi*	COLANT	M	1			288				1	
Gonostoma atlanticum	*Gonostoma atlanticum*	GONATL	M	1	234			1				
Hygophum taaningi	*Hygophum taaningi*	HYGTAN	M	1	57	467		1	1			
Lightless loosejaw	*Malacosteus niger*	LGHLSJ	M	1		177	304		1		1	
Pearlsides	*Maurolicus muelleri*	MUEPRL	M	1	229	158	214	1	1			1
Pearlsides	*Maurolicus pennanti. .dnu*	PENPRL	M	1	230			1				
Lanternfishes (ns)	*Myctophidae*	LANTUI	M	1			272				1	1
Humboldts lanternfish	*Myctophum humboldti*	HUMLAN	M	1	53			1				
Spotted lanternfish	*Myctophum punctatum*	SPTLAN	M	1	55	180		1	1			
Black snake mackerel	*Nealotus tripes*	NLTRIP	M	1		28			1			
Kroyer's lanternfish	*Notoscopelus elongatus kroyerii*	KRYLAN	M	1		182	275		1		1	
Common lanternfish (ns)	*Notoscopelus sp.*	LANTUI	M	1			273				1	1
Hatchetfish	*Polyipnus asteroides*	HATFIS	M	1	251		222	1				1
P. Asteroides	*Polyipnus asteroides*	POLAST	M	1		708			1			
Polymetme corytheola	*Polymetme corythaeola*	POLCOR	M	1	237			1				
Transparent hatchetfish	*Sternoptyx diaphana*	TRNHAT	M	1		709			1			
Largescale lanternfish	*symbolophorus veranyi*	LGSLAN	M	1		184	293		1		1	
Flat needlefish	*Ablennes hians*	FLNDFS	P	1	68			1				
African pompano	*Alectis crinitus*	AFPOMP	P	1	568			1				
Thresher shark	*Alopias vulpinus*	THRSHK	P	1		234			1			
Blueback herring	*Alosa aestivalis*	BBKHER	P	1	34	165		1	1			
Hickory shad	*Alosa mediocris*	HKSHAD	P	1	37			1				
Alewife	*Alosa pseudoharengus*	ALEWIF	P	1	33	62	151	1	1	1	1	1
American shad	*Alosa sapidissima*	AMSHAD	P	1	35	61	152	1	1	1	1	1
Striped anchovy	*Anchoa hepsetus*	STANCH	P	1	44	58		1	1			
Dusky anchovy	*Anchoa lyolepis*	DSANCH	P	1	859			1				
Bay anchovy	*Anchoa mitchilli*	BYANCH	P	1	43			1				
Longnose anchovy	*Anchoa nasuta*	LNANCH	P	1	890			1				
Atlantic pomfret	*Brama brama*	ATLPOM	P	1		95			1			
Atlantic menhaden	*Brevoortia tyrannus*	ATLMEN	P	1	36	164		1	1			
Ocean triggerfish	*Canthidermis sufflamen*	OCTRIG	P	1		826			1			
Yellow jack	*Caranx bartholomaei*	YELJAK	P	1	569			1				
Blue runner	*Caranx crysos*	BLURUN	P	1	129	85		1	1			
Crevalle jack	*Caranx hippos*	CRVJAK	P	1		86			1			
Horse-eye jack	*Caranx latus*	HEYJAK	P	1	571			1				
Blacknose shark	*Carcharhinus acronotus*	BNSESH	P	1	354			1				
Whitetip shark	*Carcharhinus longimanus*	WTPSHK	P	1		244			1			
Sandbar shark	*Carcharhinus milberti*	SANSHK	P	1	9			1				
Dusky shark	*Carcharhinus obscurus*	DUSSHK	P	1	3	246		1	1			
White shark	*Carcharodon carcharias*	WHTSHK	P	1		232			1			
Basking shark	*Cetorhinus maximus*	BASSHK	P	1	6	233	48	1	1		1	1

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Atlantic herring	*Clupea harengus*	ATLHER	P	1	32	60	150	1	1	1	1	1
Dolphin	*Coryphaena hippurus*	DOLPH	P	1	584	747		1	1			
Margined flyingfish	*Cypselurus cyanopterus*	MARFLY	P	1	463			1				
Atlantic flyingfish	*Cypselurus melanurus*	ATLFLY	P	1	465			1				
Pelagic stingray	*Dasyatis violacea*	PELRAY	P	1		218			1			
Sharksucker	*Echeneis naucrates*	SHKSUK	P	1		82			1			
Silver anchovy	*Engraulis eurystole*	SVANCH	P	1	865			1				
Round herring	*Etrumeus teres*	RNDHER	P	1	31	166	157	1	1		1	
Little tunny	*Euthynnus alletteratus*	LITTUN	P	1		173			1			
Sargassumfish	*Histrio histrio*	SARFIS	P	1	448	399		1	1			
Halfbeak	*Hyporhamphus unifasciatus*	HALFBK	P	1	66	737		1	1			
Shortfin mako	*Isurus oxyrinchus*	SHTMAK	P	1	352	238	52	1	1		1	
Skipjack tuna	*Katsuwonus pelamis*	SKJTUN	P	1		172			1			
Porbeagle shark	*Lamna nasus*	PRBSHK	P	1		230	51		1		1	
Opah	*Lampris guttatus*	OPAH	P	1		778			1			
Escolar	*Lepidocybium flavobrunneum*	ESCOL	P	1	824	27		1	1			
Longspine snipefish	*Macrorhamphosus scolopax*	LSPSNP	P	1	111			1				
Capelin	*Mallotus villosus*	CAPLIN	P	1	38	64	187	1	1	1	1	1
Atlantic manta	*Manta birostris*	ATLMAN	P	1		225	111		1			1
Atlantic silverside	*Menidia menidia*	ALTSIL	P	1	113	770		1	1	1		
Ocean sunfish	*Mola mola*	OCSUN	P	1		730			1			
Pilotfish	*Naucrates ductor*	PILFIS	P	1	576	88		1	1			
Man-of-war fish	*Nomeus gronovii*	MOWFSH	P	1		788			1			
Atlantic thread herring	*Opisthonema oglinum*	ATTHER	P	1	428			1				
Rainbow smelt	*Osmerus mordax*	RSMELT	P	1	45	63	188	1	1	1	1	
Bluefish	*Pomatomus saltatrix*	BLUFIS	P	1	135	81		1	1			
Blue shark	*Prionace glauca*	BLUSHK	P	1	17	231	65	1	1		1	
Cobia	*Rachycentron canadum*	COBIA	P	1	563			1				
Spearfish remora	*Remora brachyptera*	SPREM	P	1		83			1			
Remora	*Remora remora*	REMORA	P	1	567	84		1	1			
Atlantic sharpnose shark	*Rhizoprionodon terraenovae*	ASHSHK	P	1	360	235		1	1			
Oilfish	*Ruvettus pretiosus*	OILFSH	P	1		29			1			
Atlantic salmon	*salmo salar*	ATLSAL	P	1	894	65	173	1	1	1	1	
Arctic char	*Salvelinus alpinus*	ARCHAR	P	1		76			1			
Brook trout	*Salvelinus fontinalis*	BRKTRT	P	1			178					1
Striped bonito	*Sarda orientalis*	STRBON	P	1	938			1				
Atlantic bonito	*Sarda sarda*	ATLBON	P	1	123	188		1	1			
Spanish sardine	*Sardinella anchovia*	SPNSAR	P	1	429			1				
Chub mackerel	*Scomber japonicus*	CHBMAK	P	1	124	170		1	1			
Atlantic mackerel	*Scomber scombrus*	ATLMAK	P	1	121	70	572	1	1	1	1	1
Atlantic saury	*Scomberesox saurus*	ATLSAU	P	1	205	720	398	1	1	1	1	1
King mackerel	*Scomberomorus cavalla*	KINMAK	P	1	744	189		1	1			
Spanish mackerel	*Scomberomorus maculatus*	SPNMAK	P	1	745	171		1	1			
Atlantic moonfish	*Selene setapinnis*	ATLMON	P	1	132			1				
Greater amberjack	*Seriola dumerili*	GTAMBJ	P	1	203			1				

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Almaco jack	*Seriola rivoliana*	ALJK	P	1	578			1				
Banded rudderfish	*Seriola zonata*	BANRUD	P	1	204	74		1	1			
Greenland shark	*Somniosus microcephalus*	GRNSHK	P	1		237	20		1		1	1
Scalloped hammerhead	*Sphyrna lewini*	SCAHAM	P	1	362			1				
Sm. Hammerhead shark	*Sphyrna zygaena*	HAMSHK	P	1		236			1			
Bigscale pomfret	*Taractichthys longipinnis*	BSCPOM	P	1		96			1			
Spotted tinselfish	*Xenolepidichthys dalgleishi*	SPTINS	P	1	617			1				
Swordfish	*Xiphias gladius*	SWDFIS	P	1	700	72		1	1			
Swordfish	*Xiphias gladius. .dnu*	SWDFIS	P	1	290			1				
Arrow squid	*Loligo plei*	ARRSQD		0	505			1				
Daggertoothfishes (ns)	*Anotopteridae*	DAGGUI	D	0			249				1	
Pipefish seahorse uncl	*Syngnathidae sp.*	SHRSUI	D	0	421		416	1			1	
Shrimp	*Acanthephyra pelagica*	ACSHR1		0			8040				1	
Shrimp	*Acanthephyra sp.*	ACSHR2		0			8039				1	
Wahoo	*Acanthocybium solanderi*	WAHOO		0		830			1			
Sturgeons (ns)	*Acipenseridae f.*	STRGUI		0		272			1			
Sea anemone	*Actinaria*	ACTIN		0			2165				1	1
Ns)sea poachers, alligatorfishe	*Agonidae f.*	SPCHUI		0		351	835		1		1	1
Lancetfishes (ns)	*Alepisauridae*	LANCUI		0			323				1	
Slickhead species	*Alepocephalid species*	SKHDSP		0	39	968	164	1	1		1	
Sand lance (ns)	*Ammodytes sp.*	SLNCUI		0		611			1			
Sandlances (ns)	*Ammodytidae f.*	SLANUI		0		590	693		1		1	1
Wolffishes (ns)	*Anarhichadidae f.*	WFLUI		0		59	698		1		1	
Eels (ns)	*Anguillidae f.*	EELUI		0		648			1			
Unidentified eels	*Anguilloidei s.o.*	EELUI		0		634			1			
Segmented worms	*Annelida p.*	ANNUI		0		3000			1			
Ogrefishes (ns)	*Anoplogasteridae*	OGREUI		0			499				1	
Frogfishes (ns)	*Antennariidae f.*	FROGUI		0		398			1			
Sea anemone	*Anthozoa c.*	ANEM		0		8300			1	1		
Sea mouse	*Aphrodita hastata*	SEAMSE		0		3200			1			
Aphrodita sp.	*Aphrodita sp.*	APHRUI		0		3212			1	1		
Cardinalfish uncl	*Apogonidae sp*	CARDUI		0	138	697		1	1			
Cardinalfish uncl	*Apogonidae sp. .dnu*	CARD		0	561			1				
Purple sea urchin	*Arabacia punctulata*	PURCH		0		6421			1			
Squid	*Architeuthis dux*	SQD1		0			4709				1	
Ocean quahog (live)	*Arctica islandica*	OCQUA		0	409	4304		1	1	1		
Argentines (n.s.)	*Argentinidae f.*	ARGUI		0		288	192		1		1	
Tunicate, sessile	Ascidiacea	TUNUI		0			8680				1	1
Asterias sp.	*Asterias sp.*	ASTUI		0		6110			1	1		
Purple starfish	*Asterias vulgaris*	PASTER		0		6111			1	1		
Starfish uncl	Asteriidae sp.	STRFIS		0	332			1				
Starfishes (ns)	Asteroidea s.c.	STARUI		0		6100	8390		1	1	1	1
Astronesthidae	Astronesthidae	ASTRUI		0		966			1			
Silverside uncl	Atherinidae sp.	SILVU		0	423			1				
Frigate mackerel	*Auxis thazard*	FRGMAK		0		187			1			

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Birds	Aves c.	BIRDUI		0		9410			1			
Triggerfish filefish uncl	Balistidae sp.	BALUI		0	820			1				
Deepsea (ns) smelts	Bathylagidae	SMLUI		0			199				1	
Octopus	*Bathypolypus arcticus*	OPOD1		0			4879				1	
Octopus	*Bathypolypus sp.*	OPOD2		0			4878				1	
Skates and rays (ns)	Batoidei o.	SKTUI		0		219			1			
Glacier lanternfish	*Benthosema glaciale*	GLCLAN		0		157			1			
Lanternfish	*Benthosema suborbitale*	LANTAA		0		473			1			
Bivalvia c.	bivalvia c.	BIVUI		0		4300			1	1		
Combtooth blenny uncl	Blenniidae sp.	CBLNUI		0	733			1				
Blennies, shannies, gunnels	Blennioidei s.o.	BLENUI		0		605	697		1		1	
Blennies, shannies, gunnels	Blennioidei s.o.	BLENUI		0		644			1			
Lanternfish	*Bolinichthys photothorax*	LANTT		0		292			1			
Sea potato	*Boltenia sp.*	SEAPOT		0		1823			1	1		
Bighead (ns) dragonfishes	*Borostomias sp.*	DRGUID		0		949			1			
Lefteye flounder uncl	Bothidae sp.	LFLDUI		0	795	196	898	1	1		1	1
Squid	Brachioteuthidae	SQD3		0			4741				1	
Crabs (ns)	Brachyura s.o.	CRBUI		0		2510	8203		1	1	1	1
Bryozoans ectoprocta p.	bryozoans ectoprocta p.	BRYOZ		0		1920			1	1		
Whelk	Buccinidae	WHLKUI		0			3515				1	
Whelk eggs (ns)	Buccinidae eggs	WLKEGG		0		1510			1	1		
Whelks (ns)	Buccinum sp.	WHLKUI		0		4210	3516		1	1	1	1
Common wave whelk	Bucinum undatum	WHEL		0		4211			1	1		
Channeled whelk	*Busycon canaliculatum*	CHNWHK		0	336			1				
Blue crab	*Callinectes sapidus*	BLUCRB		0	314	2512		1	1			
Callionymus sp.	*Callionymus sp.*	CALLSP		0		657			1			
Jonah crab	*Cancer borealis*	JONCRB		0	312	2511	8207	1	1	1	1	
Rock crab	*Cancer irroratus*	ROKCRB		0	313	2513	8206	1	1	1		1
Cancer crab uncl	Cancridae sp.	CCRBUI		0	311	2524		1	1			
Jack pompano uncl	Carangidae sp.	JKPOMP		0	582			1				
Greencrab	*Carcinus maenas*	GRCRB		0		2531			1			
Cockles (ns)	Cardiidae f.	COCKUI		0		4340			1	1		
Loggerhead turtle	*Caretta caretta*	LOGTRT		0	950			1				
Manefishes (ns)	Caristiidae	MANEUI		0			516				1	
Lanternfish	*Centrobranchus nigroocellatus*	LANTA		0		124			1			
Cephalopod	Cephalopoda	CEPH1		0			4545				1	1
Octopus uncl	Cephalopoda sp.	OCTUI		0	510			1				
Sea devils (ns)	Ceratiidae	SDEVUI		0			980				1	1
Lanternfish	*Ceratoscopelus warmingii*	LANTZ		0		468			1			
Basking (ns) sharks	Cetorhinidae	BSHKUI		0			47				1	
Butterflyfish uncl	Chaetodontidae sp.	BFLYUI		0	855	328		1	1			
Viperfishes (ns)	Chauliodontidae	VIPUI		0			226				1	1
Turtles (ns)	Chelonia o.	TURTUI		0		9430			1			
Swallowers (ns)	Chiasmodontidae f.	SWALUI		0		38			1			
Chimaeras (ns)	Chimaeridae	CHIMUI		0			118				1	

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Snow crab	*Chionectes opilio*	SNWCRB		0	325	2526	8213	1	1	1	1	1
Spider (queen, snow) unid.	Chionoecetes sp.	SCRBUI		0		2522			1	1		
Iceland scallop (cla	*Chlamys islandica (clapper)*	ICELAN		0	341	4322	4167	1	1	1	1	1
Iceland scallop (live)	*Chlamys islandica (live)*	ICSCAL		0	340			1	?			
Scallop	*Chlamys sp.*	SCALUI		0			4166				1	
Greeneye uncl	Chlorophthalmid sp.	GNEYSP		0	47	593		1	1			
Squid uncl	Chrondrophora sp.	SQDUI		0	501			1				
Whiff uncl	Citharichthys sp.	WHIFUI		0	866			1				
Herring uncl	Clupeidae sp.	HERRU		0	30	336	149	1	1		1	
Sand dollars	Clypeasteroida o.	SDOLUI		0		6500	8370		1	1	1	
Cnidaria	Cnidaria			0			1340					1
Coelenterata p.	Coelenterata p.	COELUI		0		8200			1	1		
Conger eel uncl	Congridae sp.	CNELUI		0	390	431		1	1			
Sculpin uncl	Cottidae uncl	SCULUI		0	160	312	808	1	1	1	1	1
Squid	Cranchiidae	SQD4		0			4808				1	
Sevenspine bay shrimp	*Crangon septemspinosa*	SEVSHP		0	287			1				
Crangon sp.	*Crangon sp.*	CRANUI		0		2416			1	1		
Shrimp	Crangonidae	SHR1		0			8117				1	1
Crustaceans (ns)	Crustacea c.	CRUSUI		0		2000			1	1		
Mud star	*Ctenodiscus crispatus*	MUDSTR		0		6115			1	1		
Comb-jelly	Ctenophora	CJELL		0			2250				1	1
Lumpfish snailfish uncl	Cyclopteridae sp.	SNAILU		0	249		842	1			1	1
Anglemouth (ns)	Cyclothone sp.	ANGMUI		0		755	206		1		1	
Hooded seal	*Cystophora cristata*	HDSEAL		0			1089				1	
Ray uncl	Dasyatidae myliobatidae sp	RAYUI		0	5			1				
Sea cucumber	Dendrochirotida	CUCUI		0			8291				1	
Lanternfish	*Diaphus effulgens*	LANTB		0		125			1			
Lanternfish	*Diaphus mollis*	LANTD		0		128			1			
Lanternfish	*Diaphus perspicillatus*	LANTC		0		126			1			
Lanternfish	*Diaphus rafinesquii*	LANTE		0		129			1			
Headlightfish uncl	*Diaphus sp.*	HLFSUI		0	61			1				
Lanternfish	*Diaphus taaningi*	LANTCC		0		540			1			
Lanternfish	*Diaphus termophilus*	LANTF		0		130			1			
Bristled longbeak	*Dichelopandalus leptocerus*	BRILBK		0	296			1				
Porcupinefishes (ns)	Diodontidae f.	PORCUI		0		692			1			
Lanternfish	*Diogenichthys atlanticus*	LANTY		0		466			1			
Hermit crab uncl	Diogenidae/paguridae sp.	HERCRB		0	335			1				
Spinyfins (ns)	Diretmidae	SPINUI		0			519				1	
Sand dollar	*Echinarachnius parma*	SDOL1		0			8373				1	
Sand dollar	*Echinarachnius sp.*	SDOL2		0			8372				1	
Echinoderms (ns)	Echinodermata p.	ECHUI		0		6000	8260		1	1	1	1
Sea urchin	Echinoida	SEAURC		0			8361				1	1
Sand dollar uncl	Echinoidae sp.	SANDOL		0	330		8360	1			1	1
Sea urchin uncl	Echinoidae sp.	SEAURC		0	331			1				
Eel uncl	Eel uncl	EELENK		0	60			1				

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Lanternfish	*Electrona risso*	LANTG		0		131			1			
Anchovy uncl	Engraulidae sp.	ANCHUI		0	851			1				
Etropus uncl	Etropus sp.	ETROSP		0	794			1				
Krill shrimp	euphausiacea o.	KRILUI		0		2600	7991		1	1		1
Flyingfishes (ns)	Exocoetidae f.	FLYUI		0		748			1			
Finfishes (ns)	Finfishes (ns)	FISHUI		0		100			1			
Cornetfish uncl	Fistularia sp.	CORNUI		0	490			1				
Flounder uncl	Flounder uncl. .dnu	FLNDUI		0	100			1				
foreign articles, garbage	foreign articles, garbage	GARBUI		0		9400			1	1		
Gadoids (ns)	Gadidae f.	GADUI		0		251	436		1		1	
Galatheid sp	Galatheid sp.	GALASP		0	319			1				
Stickleback unid.	Gasterosteidae f.	STIKUI		0		360	422		1			1
Snails and slugs	Gastropoda o.	GASTUI		0		4200			1	1		
Snake mackerel uncl	Gempylidae sp.	SNMACU		0	822	296		1	1			
Mojarra uncl	Gerreidae sp.	MOJAUI		0	625			1				
Red crab	*Geryon quinquedens*	REDCRB		0	310	2532		1	1	1		
Atl. Pilot whale	*Globicephala melaena*	PILWAL		0		921			1			
Goby uncl	Gobiidae sp.	GOBYU		0	739			1				
Arctic squid	*Gonatus fabricii*	ARCSQD		0			4770				1	
squid	Gonatus sp.	SQD5		0			4769				1	
Lightfish uncl	Gonostomatidae sp	LFISUI		0	887	745	205	1	1		1	
Basket stars	*Gorgonocephalidae, asteronychi*	GORGUI		0		6300			1	1		
Basslet uncl .	Grammidae sp.	BASTUI		0	618			1				
Octopus	Graneledone sp.	OPOD5		0			4913				1	
Green moray	*Gymnothorax funebris*	GRNMOR		0		606			1			
Hake uncl	Hake uncl. .dnu	HAKUI		0	80	18		1	1			
Sea peach	*Halocynthla pyriformis*	SEAPCH		0		1827			1	1		
Halosaurus (ns)	Halosauridae	HALOUI		0			394				1	
Blood star	*Henricia sanguinolenta*	BLDSTR		0		6119			1	1		
Bivalve	Heterodontida	BIVUI		0			4225				1	
Sea snails	Heteropoda s.o.	HETUI		0		3600			1			
Squid	Histioteuthidae	SQD6		0			4712				1	
Squid	*Histioteuthis bonnelli*	HISBON		0			4714				1	
Squid	Histioteuthis sp.	SQD7		0			4713				1	
Squirrelfish uncl	Holocentridae sp.	SQRUI		0	485			1				
Sea cucumbers	Holothuroidea c.	HOLOUI		0		6600	8290		1	1	1	1
Toad crab	*Hyas araneus*	TDCRB1		0		2527	8217		1		1	1
Toad crab	*Hyas coarctatus*	TDCRB2		0			8218				1	1
Toad crab unid.	*Hyas sp.*	TCRBUI		0		2520	8216		1	1	1	1
Hydrozoan	Hydrozoa	HYDUI		0			1341				1	1
Lanternfish	Hygophum hygomii	LANTH		0		135			1			
North. bottlenose whale	*Hyperoodon ampullatus*	BTNWAL		0		922			1			
Squids (ns)	*Illex sp*	SQDUI		0		4515	4751		1		1	1
Invertebrates (ns)	Invertebrata p.	INVERT		0		1701	1100		1	1	1	1
Atlantic sailfish	*Istiophorus platypterus*	ATLSLF		0		255			1			

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Wrasse uncl	Labridae sp.	WRSUI		0	683	36		1	1			
White-sided dolphin	*Lagenorhynchus acutus*	WHSDOL		0		933			1			
White beaked dolphin	*Lagenorhynchus albirostris*	WHBDOL		0		932			1			
Mackerel (ns) sharks	Lamnidae	LAMNUI		0			50				1	1
Lanternfish	*Lampadena luminosa*	LANTI		0		137			1			
Mirror lanternfish	*Lampadena speculigera*	MIRLAN		0		138			1			
Lanternfish	*Lampanyctus ater*	LANTR		0		284			1			
Jewel lanternfish	*Lampanyctus crocodilus*	JEWLAN		0		144			1			
Lanternfish	*Lampanyctus festivus*	LANTJ		0		145			1			
Lanternfish	*Lampanyctus intricarius*	LANTW		0		460			1			
Lanternfish	*Lampanyctus macdonaldi*	LANTK		0		146			1			
Lanternfish	*Lampanyctus photonotus*	LANTX		0		465			1			
Lanternfish	*Lampanyctus pusillus*	LANTL		0		147			1			
Lanternfish	*Lepidophanes guentheri*	LANTQ		0		228			1			
Limanda beanii	*Limanda beanii*	LIBEAN		0	98			1				
Horseshoe crab	*Limulus polyphemus*	HORCRB		0	318	2514		1	1			
Seasnails (ns)	Liparidae	LIPAFM		0			853				1	1
Northern stone crab	*lithodes maja*	NSTCRB		0	324	2523	8196	1	1	1	1	1
Spiny (ns) crabs	*Lithodes/neolithodes f.*	PCRBUI		0		2525	8195		1		1	
Spiny crab	Lithodidae	LITHUI		0			8194				1	1
Periwinkles	Littorinidae f.	PWINK		0		4250			1			
Lanternfish	*Lobianchia gemellarii*	LANTM		0		178			1			
Squids (ns)	*Loliginidae/ommastrephidae f.*	SQIDUI		0		4514			1	1		
Longfin squid	*Loligo pealei*	LFSQD		0	503	4512	4598	1	1			1
Loligo sp.	*Loligo sp.*	LOLIGO		0		4541	4595		1			1
Brief squid	*Lolliguncula brevis*	BRFSQD		0	504			1				
Anglerfishes (ns)	Lophiiformes o.	ANGFUI		0		298	964		1		1	
Shanny unid.	Lumpenidae f.	SHANUI		0		645			1	1		
Blennys (ns)	*Lumpenus sp.*	BLENUI		0		946	714		1		1	1
Moonshell	*Lunatia heros*	MOONSH		0		4221			1	1		
Snapper uncl	Lutjanidae sp.	SNPUI		0	597			1				
Grenadier uncl	Macrouridae uncl	GRENUI		0	90	416	471	1	1		1	
Grenadiers (ns)	Macrouriformes	GRENUI		0			470				1	
Grenadiers (ns)	*Macrourus sp.*	GRENUI		0			473				1	
Shrimp (ns)	Macrura s.o.	SHRUI		0		2100	8141		1			1
Spider crab uncl	Majidae sp.	SCRBUI		0	317	2519	8211	1	1		1	
White marlin	*Makaira albida*	WHTMAR		0		32			1			
Blue marlin	*Makaira nigricans*	BLUMAR		0		33			1			
Loosejaws (ns)	Malacosteidae f.	LJAWUI		0		819	303		1		1	
Melamphaes sp.	*Melamphaes sp.*	MELAM		0		686			1			
Scaleless dragonfishes (ns)	Melanostomiatidae f.	DRAGUI		0		665			1			
Whiting uncl	*Merluccius sp.*	WHITUI		0	86	35		1	1			
Horse mussel	*Modiolus modiolus*	HORMUS		0	342	4332		1	1			
Mollusks (ns)	Mollusca p.	MOLLUI		0		4000	3110		1	1	1	
Mora uncl	Moridae sp.	MORAUI		0	88	194	431	1	1		1	

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Mullets (ns)	Mugilidae f.	MULLUI		0		265			1			
Malacostracan	*Munidopsis curvirostra*	MALUI1		0			8164				1	
Moray uncl	Muraenidae sp.	MORAYU		0	388	425	344	1	1		1	
Softshell clam	*Mya arenaria*	SFCLM		0		4318			1			
Metalic lanternfish	Mycotophum affine	METLAN		0		179			1			
Sea basses	Mycteroperca sp.	MPERUI		0		664			1			
Lanternfish uncl	Myctophid sp.	LANTSP		0	56			1				
Lanternfish uncl	Myctophidae uncl. . dnu	LANTUI		0	220	150		1	1	1		
Lanternfish	*Myctophum asperum*	LANTU		0		327			1			
Lanternfish	*Myctophum selenops*	LANTDD		0		559			1			
Myctophum sp.	Myctophum sp.	LANTV		0		370			1			
Clam	Myidae	MYIDUI		0			4425				1	
Mussels (ns)	Mytilidae f.	MUSUI		0		4330			1	1		
Common mussel	*Mytilus edulis*	COMMUS		0		4331	4122		1	1		1
Hagfishes (ns)	Myxinide	HAGUI		0			11				1	1
Hagfishes (ns)	Myxiniformes	HAGUI		0			10				1	1
Dog whelks	Nassariidae or thaisidae f.	WHLKDG		0		4235			1	1		
Shrimp uncl	Natantia sp.	SHPUI		0	305		8020	1			1	1
Moon snail uncl	Naticidae sp.	MONSNL		0	338			1				
Snipe (ns) eels	Nemichthyidae	SEELUI		0			367				1	1
Ridged eel	*Neoconger mucronatus*	RDGEEL		0		472			1			
Spiny spider crab	*Neolithodes grimaldi*	SSCRB		0		2528			1	1		
Nereidae f.	Nereidae f.	NEREUI		0		3150			1	1		
Grenadier (ns)	Nezumia sp.	GRENUK		0			477				1	
Unknown invert code	No code	UNK1		0			4321				1	
Unknown invert code	No code	UNK2		0			8539				1	
Unknown invert code	No code	UNK3		0			8550				1	
Unknown invert code	No code	UNK4		0			9851				1	
Unknown invert code	No code	UNK5		0			9852				1	
Water haul	No fish but good tow	WATHAU		0	300	9600		1	1	1		
Driftfishes	Nomeidae f.	DRFFSH		0		821			1			
Spiny (ns) eels	Notacanthiformes	SEELUI		0			384				1	1
Spiny (ns) eels	Notocanthidae f.	SEELUI		0		662	385		1		1	1
Lanternfish	*Notolychnus valdiviae*	LANTN		0		181			1			
Lanternfish	*Notoscopelus bolini*	LANTS		0		287			1			
Lanternfish	*Notoscopelus caudispinosus*	LANTBB		0		478			1			
Lanternfish	*Notoscopelus resplendens*	LANTO		0		183			1			
Sea slugs	Nudibranchia o.	SLUGUI		0		4400			1	1		
Octopus (ns)	Octopoda o.	OCTOUI		0		4521	4846		1	1	1	1
Octopus	Octopodidae	OPOD7		0			4877				1	
Octopus	Octopus sp.	OPOD8		0			4894				1	1
Whales (ns)	Odontoceit s.o.	ODONUI		0		920			1			
Dolphin (ns) (mammal)	Odontoceit s.o.	ODONUI		0		930			1			
Batfish uncl	Ogcocephalidae sp	BATUI		0	452	694	968	1	1		1	1
Omnastrephes sp.	Omnastrephes sp.	OMMSP		0		4513			1	1		

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Squid	Omnastrephidae	SQDB		0			4747				1	
Snake eel uncl	Ophichthyidae sp	SEELUI		0	425			1				
Brotulid uncl	Ophidiidae sp	BRTULU		0	424		760	1			1	
Cusk-eel uncl	Ophidiidae sp	CEELUI		0	461			1				
Cusk eels (ns)	Ophidioidei s.o.	CKELUI		0		660			1			
Brittlestars (ns)	Ophiuroidea s.c.	BRITUI		0		6200	8530		1	1	1	1
Smelts/capelins (ns)	Osmeridae f.	SMLTUI		0		337			1			
Pastel swimming crab	*Ovalipes guadalupensis*	PSWCRB		0	321			1				
Lady crab	*Ovalipes ocellatus*	LADCRB		0	322			1				
Calico crab uncl	*Ovalipes sp.*	CALCRB		0	315			1				
Hermit (ns) crabs	Paguridae f.	HCRBUI		0		2559	8177		1		1	1
Paguroidea s.f.	Paguroidea s.f.	HRCBUI		0		2560			1	1		
Pagurus sp.	*Pagurus sp.*	PGCBUI		0		2561	8178		1			1
Pandalidae f.	Pandalidae f.	PANDUI		0		2200	8105		1	1	1	
Northern shrimp	*Pandalus borealis*	NORSHP		0	306	2211	8111	1	1	1	1	1
Aesop shrimp	*Pandalus montagui*	AESSHP		0	297	2212	8112	1	1	1	1	1
Pandalus propinquus	*Pandalus propinquus*	PANPRO		0	298	2213	8113	1	1			1
Shrimps (ns)	*Pandalus sp.*	SHRUI		0		2210	8110		1	1	1	1
Barracudina uncl	Paralepidae sp.	BARCUI		0	896	713	316	1	1	1	1	1
Seasnail (ns)	Paraliparis sp.	SNUI		0			854				1	1
Pink glass shrimp	*Pasiphaea multidentata*	PGLSHP		0	292	2021		1	1			
P. Multidentata	*Pasiphea multidentata*	PASMUL		0		2221	8057		1	1		1
Scallops (ns)	Pectinidae f.	SCALUI		0		4320	4165		1	1	1	1
Sea pen	*Pennatula borealis*	SEAPEN		0		8318			1	1		
Peristedion sp.	*Peristedion sp.*	PERISP		0		580			1			
Lampreys (ns)	Petromyzontiformes	LAMPUI		0			14				1	
Harp seal	*Phoca groenlandica*	HRSEAL		0			1085				1	
Seal (ns)	*Phoca sp.*	SEALUI		0			1082				1	
Seals (ns)	Phocidae f.	SEALUI		0		900			1			
Fish (unidentified)	Pisces p.	FISHUI		0		90	999		1		1	1
Sea scallop (live)	*Placopecten magelanicus (live)*	SESCAL		0	401	4321		1	1	1		
Bristle worms	Polychaeta c.	POLYUI		0		3100	4950		1	1		1
Chitons	Polyplacophora c.	CHITON		0		4700			1	1		
Damselfish uncl	Pomacentridae sp.	DAMSUI		0	619			1				
Grunt uncl	Pomadasyidae sp.	GRTUI		0	630			1				
Bluefishes (ns)	Pomatomidae	BFSHUI		0			622				1	
Sponges (ns)	Porifera p.	SPONUI		0		8600	1101		1	1	1	1
Swimming crab uncl	Portunid sp.	WCRBUI		0	320			1				
Bigeyes (ns)	Priacanthidae	BEYEUI		0			609				1	
Clams (ns)	Prionodesmata/teleodesmata	CLMUI		0		4310			1	1		
Searobin	*Prionotus sp.*	SROBUI		0			799				1	
Lanternfish	*Protomyctophum arcticum*	LANTP		0		226			1			
Winter flounder eggs	*Pseudopleuronectes americanus*	FLDEGG		0		1253			1			
Bivalve	Pteroconchida	BIVUI		0			4120				1	
Sea spider	Pycnogonida sp.	SPIDUI		0		5100	5951		1	1	1	1

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Skate unid.	Raja eggs	SKTEGG		0		1224			1	1		
Skate uncl	**Raja sp.**	SKTUI		0	20		89	1			1	1
Skates (ns)	Rajidae	SKTUI		0			88				1	1
Skates, rays, etc.	Rajiformes	SKTUI		0			80				1	1
Cephalopod	*Rossia sp.*	CEPH2		0			4557				1	
Cephalopod	Rossiinae	CEPH3		0			4556				1	
Tusk shell	Scaphopoda	TUSK		0			3975				1	
Parrotfish uncl	Scaridae sp.	PARUI		0	688			1				
Drum uncl	Sciaenidae sp.	DRUMUI		0	858			1				
Shrimp	*Sclerocrangon boreas*	SHR2		0			8119				1	1
Mackerel tuna uncl	Scombridae sp.	MKTNUI		0	860		556	1			1	
Scopelosaurus (ns)	Scopelosauridae	SCOPUI		0			300				1	
Rockfishes (ns)	Scorpaena sp.	ROKFUI		0		278			1			
Scorpionfish uncl	Scorpaenidae sp	SCRPUI		0	759	280	791	1	1		1	
Rockfishes (ns)	Scorpaeniformes	ROKORD		0			790				1	
Cat (ns) sharks	Scyliorhinidae	CSHKFM		0			55				1	
Spanish slipper lobster	*Scyllarides aequinoctialis*	SSLLOB		0	303			1				
Ridged slipper lobster	*Scyllarides nodifer*	RSLLOB		0	302			1				
Jellyfishes (ns)	Scyphosoa c.	JELUI		0		8500	2040		1	1	1	1
North Gulf Inverts	see Nfld codes			0			9995					1
North Gulf Inverts	see Nfld codes			0			8019					1
North Gulf Inverts	see Nfld codes			0			8055					1
North Gulf Inverts	see Nfld codes			0			8138					1
North Gulf Inverts	see Nfld codes			0			8092					1
North Gulf Inverts	see Nfld codes			0			8093					1
North Gulf Inverts	see Nfld codes			0			6930					1
North Gulf Inverts	see Nfld codes			0			8261					1
North Gulf Inverts	see Nfld codes			0			8077					1
North Gulf Inverts	see Nfld codes			0			9987					1
North Gulf Inverts	see Nfld codes			0			8135					1
North Gulf Inverts	see Nfld codes			0			4852					1
North Gulf Inverts	see Nfld codes			0			8037					1
North Gulf Inverts	see Nfld codes			0			6580					1
North Gulf Inverts	see Nfld codes			0			8085					1
North Gulf Inverts	see Nfld codes			0			8128					1
North Gulf Inverts	see Nfld codes			0			6980					1
North Gulf Inverts	see Nfld codes			0			8087					1
North Gulf Inverts	see Nfld codes			0			8157					1
North Gulf Inverts	see Nfld codes			0			4554					1
North Gulf Inverts	see Nfld codes			0			4951					1
North Gulf Inverts	see Nfld codes			0			6760					1
North Gulf Inverts	see Nfld codes			0			8075					1
North Gulf Inverts	see Nfld codes			0			8079					1
North Gulf Inverts	see Nfld codes			0			8080					1
North Gulf Inverts	see Nfld codes			0			8084					1

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
North Gulf Inverts	see Nfld codes			0			8094					1
North Gulf Inverts	see Nfld codes			0			8167					1
North Gulf Inverts	see Nfld codes			0			8172					1
North Gulf Inverts	see Nfld codes			0			8205					1
North Gulf Inverts	see Nfld codes			0			8222					1
North Gulf Inverts	see Nfld codes			0			8293					1
Sea bass uncl	Serranidae sp.	SBASUI		0	554	715	591	1	1		1	
Shark uncl	Shark uncl	SHKUI		0	11	592	18	1	1		1	
Rock shrimp	*Sicyonia brevirostris*	ROKSHP		0	316			1				
Propeller clam	*Siliqua patula*	PCLM		0		4312			1			
Razor (ns) clams	*Siliqua sp.*	RCLMUI		0		4315			1	1		
Snubnose (ns) eels	Simenchelyidae	SIMFM		0			358				1	1
Purple sunstar	*Solaster endeca*	PURSTR		0		6121			1	1		
Sun star	*Solaster papposus*	SUNSTR		0		6123			1	1		
Porgy uncl	Sparidae sp.	PORUI		0	643	326	661	1	1		1	
Barracuda uncl	Sphyraenidae sp.	BARRU		0	620			1				
Stimpson's surf clam	*Spisula polynyma*	SSCLM		0		4355			1			
Surf clam (live)	*Spisula solidissima (live)*	SRFCLM		0	403	4317		1	1	1		
Dogfishes (ns)	Squalidae f.	DOGFUI		0		274			1			
Octopus	Stauroteuthidae	OPOD10		0			4851				1	
Ogrefishes (ns)	Stephanoberyciformes	OGRORD		0			498				1	
Malacostracan	*Stereomastic sculpta*	MALUI2		0			8145				1	
Hatchetfishes (ns)	Sternoptychidae	HATFAM		0	252	741	220	1	1		1	
Pricklebacks (ns)	Stichaeidae f.	PBAKUI		0		639	709		1		1	
Mantis shrimp	Stomatopod sp.	MANSHP		0	323			1				
Scaled dragonfishes (ns)	Stomias sp.	DRGUI		0		756			1			
Scaly dragonfish uncl	Stomiatidae sp.	SCADRG		0	248	151	229	1	1		1	
stones and rocks	stones and rocks	ROCKUI		0		9200	9982		1	1	1	
Conchs (ns)	*Strombus/busycon sp.*	CONCUI		0		4335			1			
Sea urchins	*Stronglocentrotus sp.*	URCHUI		0		6400	8363		1	1	1	1
Sea urchin	Strongylocentrotidae	URCH1		0			8362				1	1
Sea urchin	*Strongylocentrotus droebachien:*	ORCH2		0			8364				1	1
Tonguefish Uncl	*Symphurus sp.*	TONGUI		0	221	805		1	1			
Cutthroat (ns) eels	Synaphrobranchidae	CUTEFM		0			372				1	
Pipefish (ns)	*Syngnathus sp.*	PIPEUI		0		759			1			
Lizardfish uncl	Synodontidae sp	LIZUI		0	852			1				
Puffer uncl	Tetraodontidae sp.	PUFUI		0	861			1				
Squid	Teuthoidea	SQD2		0			4591				1	1
seaweed, (algae), kelp	Thallophyta c.	WEEDUI		0		9300			1	1		
Albacore tuna	*Thunnus alalunga*	ABLTUN		0		190			1			
Yellowfin tuna	*Thunnus albacares*	YFTUN		0		191			1			
Bigyey tuna	*Thunnus obesus*	BGETUN		0		192			1			
Tunas (ns)	Thunnus sp.	TUNAUI		0		321			1			
Bluefin tuna	*Thunnus thynnus*	BLFTUN		0		71			1			
Cutlassfishes (ns)	Trichiuridae f.	CUTLUI		0		689	546		1		1	

Appendix 2. (continued)

COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE	TYPE	KEPT	ORIGINAL CODES USCD	SFCD	NFCD	OCCURS IN ORIGINAL DATA SET USOC	SFOC	SGOC	NFOC	NGOC
Searobin Uncl	Triglidae uncl	SROBUI		0	174	329	798	1	1	1	1	
Tunicata s.p.	Tunicata sp.	TUNICU		0		1810			1	1		
Bottlenose dolphin	*Tursiops truncatus*	BOTDOL		0		931			1			
unid. remains	unid remains, digested	REMAIN		0		9000			1	1		
North Gulk Unknown	Unknown	NGUNK4		0			1001					1
North Gulk Unknown	Unknown	NGUNK6		0			1003					1
North Gulk Unknown	Unknown	NGUNK8		0			1005					1
North Gulk Unknown	Unknown	NGUNK9		0			1007					1
North Gulk Unknown	Unknown	NGUNK5		0			1002					1
North Gulk Unknown	Unknown	NGUNK7		0			1004					1
North Gulk Unknown	Unknown	NGUNK10		0			315					1
North Gulf Unknown	Unknown	NGUNK3		0			960					1
North Gulf Unknown	Unknown	NGUNK2		0			720					1
Shrimp (pink)	Unknown	PNKSHP		0	307			1				
Unknown	Unknown	UNKSPP		0	153			1				
Unknown invert code	Unknown code	UNKSPP3		0		6120			1	1		
Unknown invert code	Unknown code	UNKSPP4		0		7086			1			
Unknown species	Unknown species	UNKSPP2		0	0			1				
Stargazer uncl	Uranscopidae sp.	STGZUI		0	857			1				
Ling uncl	*Urophycis sp.*	LINGUI		0	87	193		1	1			
Quahaug	*Venus mercenaria*	QHAUG		0		4311			1			
Dories, etc.	Zeiformes	ZEIFORD		0			528				1	
Eelpout uncl	Zoarcidae sp.	EELPOU		0	267	598	725	1	1	1	1	1
Invertebrate eggs		INVEGG		0			9985				1	

1Species codes are given in Appendix 2; the N prefix indicates numbers of individuals. Aggregate groups are italicized.
2SOURCES: NMFS-NEFSC = National Marine Fisheries Service, Northeast Fisheries Science Center, USA; DFO-SF = Department of Fisheries and Oceans, Scotia-Fundy Region, Canada; DFO-SG = Department of Fisheries and Oceans, Southern Gulf of St. Lawrence, Canada; DFO-NG = Department of Fisheries and Oceans, Northern Gulf of St. Lawrence, Canada; DFO-NFLD = Department of Fisheries and Oceans, Newfoundland-Labrador Region, Canada

Appendix 3. Numbers of individuals and frequency of occurrence of demersal species in the original trawl survey data sets.

SPECIES			NUMBERS OF INDIVIDUALS							FREQUENCY	
			SOURCE[2]								
COMMON NAME	SCIENTIFIC NAME	ECNASAP CODE[1]	NMFS-NEFSC	DFO-SF	DFO-SG	DFO-NG	DFO-NFLD	TOTAL	% OF TOTAL	# OF SETS	% OF SETS
Redfishes (created)	*Sebastes (all)*	*NREDALL*	178,808	825,697	168,131	1,651,875	7,526,105	10,350,616	39.38	22733	41.30
American plaice	*Hippoglossoides platessoides*	NAMPLC	90,610	167,813	701,487	61,014	1,873,920	2,894,845	11.01	36381	66.10
Atlantic cod	*Gadus morhua*	NATLCOD	47,452	230,407	360,974	333,460	1,470,833	2,443,127	9.29	34727	63.09
Silver hake	*Merluccius bilinearis*	NSILHAK	627,080	547,131	352	3,184	53,749	1,231,496	4.68	16033	29.13
Butterfish	*Peprilus triacanthus*	NBUTTER	1,164,593	13,643	98	0	2	1,178,336	4.48	4564	8.29
Spiny dogfish	*Squalus acanthias*	NSPIDOG	719,652	237,069	7,100	209	7,627	971,657	3.70	9703	17.63
Haddock	*Melanogrammus aeglefinus*	NHADDOK	172,872	444,193	1,981	5,887	117,533	742,466	2.82	12090	21.96
Northern sand lance	*Ammodytes dubius*	NNLNCE	411,445	40,103	94	9	170,614	622,264	2.37	2763	5.02
Yellowtail flounder	*Limanda ferruginea*	NYTLFLD	77,483	155,763	75,536	344	276,042	585,168	2.23	11762	21.37
Greenland halibut	*Reinhardtius hippoglossoides*	NGRNHAL	5	1,142	3,058	37,832	424,779	466,816	1.78	15577	28.30
Shortfin squid	*Illex illecebrosus*	NSFSQD	170,888	205,247	12,589	5,078	63,509	457,311	1.74	10021	18.21
Arctic cod	*Boreogadus saida*	NARCOD	0	0	11	1,318	427,363	428,693	1.63	4627	8.41
Thorny skate	*Raja radiata*	NTHNSKT	14,773	44,750	8,778	14,771	195,137	278,208	1.06	30479	55.37
Longhorn sculpin	*Myoxocephalus octodecemspinosus*	NLHSCUL	106,770	124,025	25,681	283	13,332	270,091	1.03	10226	18.58
Witch flounder	*Glyptocephalus cynoglossus*	NWITFLD	20,623	33,205	5,468	47,370	148,336	255,002	0.97	19913	36.18
Atlantic spiny lumpsucker	*Eumicrotremus spinosus*	NATLMSK	18	356	505	200,617	4,095	205,591	0.78	1665	3.02
White hake	*Urophycis tenuis*	NWHIHAK	43,712	62,690	36,956	15,620	32,780	191,757	0.73	13749	24.98
Northern (Common) searobin	*Priondius carolinus*	NNSROB	189,051	1,502	0	0	0	190,553	0.72	1723	3.13
Red hake	*Urophycis chuss*	NREDHAK	164,995	25,509	1	2	3	190,510	0.72	8143	14.79
Scup	*Stenotomus chrysops*	NSCUP	188,997	5	0	0	0	189,002	0.72	1020	1.85
Little skate	*Raja erinacea*	NLITSKT	158,879	16,282	0	4	5	175,169	0.67	6345	11.53
Winter flounder	*Pseudopleuronectes americanus*	NWINFLD	29,903	20,960	111,837	39	22	162,760	0.62	4994	9.07
Atlantic argentine	*Argentina silus*	NATLARG	8,742	43,972	3	14,907	77,737	145,361	0.55	3507	6.37
Black dogfish	*Centroscyllium fabricii*	NBLKDOG	121	2,661	9,520	64,052	68,968	145,322	0.55	3000	5.45
Spotted hake	*Urophycis regius*	NSPTHAK	126,352	25	0	0	0	126,377	0.48	2259	4.10
Pollock	*Pollachius virens*	NPOLLOK	21,000	80,655	407	4,065	4,828	110,954	0.42	6517	11.84
Fourspot flounder	*Paralichthys oblongus*	NFSTFLD	92,393	3,903	0	0	0	96,296	0.37	4598	8.35
Rock (Roundnose) grenadier	*Coryphaenoides rupestris*	NRKGREN	0	174	3	642	94,514	95,334	0.36	987	1.79
Marlin-spike (Common grenadier)	*Nezumia bairdi*	NCOMGRN	637	4,566	2,371	19,734	55,532	82,840	0.32	6999	12.72
Winter skate	*Raja ocellata*	NWNTSKT	47,589	27,870	2,204	1,582	1,092	80,337	0.31	5565	10.11
Eelpouts (summed group)	*Lycodes spp.*	*NELPALL*	15	6,904	10,434	3,054	56,007	76,413	0.29	12333	22.41
Lumpfish	*Cyclopterus lumpus*	NLUMFIS	212	416	177	4,575	58,638	64,018	0.24	5263	9.56
Longfin hake	*Urophycis chesteri*	NLFNHAK	5,953	40,069	1,209	16,081	0	63,313	0.24	2831	5.14
Windowpane	*Scophthalmus aquosus*	NWINPAN	47,320	8,712	3,608	66	60	59,767	0.23	3780	6.87
Roughhead grenadier	*Macrourus berglax*	NRHDGRN	15	67	0	0	57,251	57,332	0.22	5448	9.90
Ocean pout	*Macrozoarces americanus*	NOCPOUT	37,028	8,581	811	62	273	46,756	0.18	5437	9.88
Atlantic wolffish	*Anarhichas lupus*	NATLWOL	3,407	5,063	305	1,981	34,772	45,528	0.17	10095	18.34
Moustache (Mailed) sculpin	*Triglops murrayi*	NMSSCUL	18,307	10,148	5,366	808	8,652	43,282	0.16	3408	6.19
Gulfstream flounder	*Citharichthys arctifrons*	NGSTFLD	37,434	929	0	0	0	38,363	0.15	2517	4.57
Sea raven	*Hemitripterus americanus*	NSEARAV	11,505	7,653	2,050	890	7,446	29,544	0.11	8562	15.56
Spot	*Leiostomus xanthurus*	NSPOT	22,011	0	0	0	0	22,011	0.08	58	0.11
Round scad	*Decapterus punctatus*	NRDSCAD	20,892	0	0	0	0	20,892	0.08	122	0.22

Appendix 3. (continued)

SPECIES			NUMBERS OF INDIVIDUALS							FREQUENCY	
		ECNASAP	SOURCE						% OF	# OF	% OF
COMMON NAME	SCIENTIFIC NAME	CODE	NMFS-NEFSC	DFO-SF	DFO-SG	DFO-NG	DFO-NFLD	TOTAL	TOTAL	SETS	SETS
Smooth skate	*Raja senta*	NSMOSKT	3,228	5,787	961	2,575	7,254	19,805	0.08	7696	13.98
Goosefish	*Lophius americanus*	NGSEFIS	11,240	3,914	56	515	2,209	17,934	0.07	7644	13.89
Blackbelly rosefish	*Helicolenus dactylopterus*	NBBROSE	13,367	2,695	6	0	7	16,075	0.06	1383	2.51
Black sea bass	*Centropristis striata*	NBLSBAS	15,794	0	0	0	0	15,794	0.06	813	1.48
Fawn cusk-eel	*Lepophidium cervinum*	NFNCEEL	14,372	282	0	0	0	14,654	0.06	1150	2.09
Northern wolffish	*Anarhichas denticulatus*	NNORWLF	0	59	35	95	13,681	13,869	0.05	4566	8.30
Longspine porgy	*Stenotomus caprinus. . .dnu*	NLSPPOR	13,464	0	0	0	0	13,464	0.05	57	0.10
Threespine stickleback	*Gasterosteus aculeatus*	NTSPSTK	125	13	13,075	130	2	13,345	0.05	217	0.39
Mailed sculpins (ns)	*Triglops sp.*	*NSCULFM*	0	0	0	15	12,260	12,275	0.05	2480	4.51
Atlantic croaker	*Micropogon undulatus*	NATLCRK	11,617	0	0	0	0	11,617	0.04	64	0.12
Roughnose grenadier	*Trachyrhynchus murrayi*	NRGGRN	0	126	0	7,352	1,569	9,046	0.03	684	1.24
Fourbeard rockling	*Enchelyopus cimbrius*	NFBDROK	3,151	1,146	770	2,942	940	8,949	0.03	2737	4.97
Summer flounder	*Paralichthys dentatus*	NSUMFLD	8,722	174	0	0	0	8,896	0.03	1678	3.05
Blue hake	*Antimora rostrata*	NBLUHAK	0	64	0	0	8,664	8,728	0.03	840	1.53
Spotted wolffish	*Anarhichas minor*	NSPTWLF	0	37	0	183	7,910	8,130	0.03	3741	6.80
Offshore hake	*Merluccius albidus*	NOFFHAK	6,014	1,315	0	0	561	7,890	0.03	865	1.57
Alligatorfish	*Aspidophoroides monopterygius*	NALLIG	1,360	1,068	3,168	62	1,566	7,225	0.03	2148	3.90
Planehead filefish	*Monacanthus hispidus*	NPLFLFS	7,013	4	0	0	0	7,017	0.03	200	0.36
Atlantic halibut	*Hippoglossus hippoglossus*	NATLHAL	882	2,712	44	396	2,719	6,752	0.03	3742	6.80
Atlantic sea poacher	*Agonus decagonus*	NATSPCH	0	261	377	66	5,017	5,721	0.02	2003	3.64
Smooth dogfish	*Mustelus canis*	NSMODOG	5,437	0	0	0	2	5,439	0.02	376	0.68
Cusk	*Brosme brosme*	NCUSK	2,463	2,741	0	2	129	5,335	0.02	2247	4.08
Atlantic hagfish	*Myxine glutinosa*	NATLHAG	1,631	820	145	1,280	1,387	5,263	0.02	2024	3.68
Daubed shanny	*Lumpenus maculatus*	NDBSHAN	3,587	302	564	136	504	5,092	0.02	621	1.13
Tomtate	*Haemulon aurolineatum*	NTOMTAT	4,785	0	0	0	0	4,785	0.02	30	0.05
Cunner	*Tautogolabrus adspersus*	NCUNNER	1,573	631	2,440	0	0	4,643	0.02	615	1.12
Shorthorn sculpin	*Myoxocephalus scorpius*	NSHSCUL	227	47	550	94	3,567	4,484	0.02	1517	2.76
Atlantic soft pout	*Melanostigma atlanticum*	NATLSPT	869	64	136	3,034	225	4,329	0.02	569	1.03
Beardfish	*Polymixia lowei*	NBDFIS	3,895	6	0	0	0	3,901	0.01	113	0.21
Barracudinas (created)	*Paralepis +*	*NBARALL*	5	713	125	2,147	777	3,767	0.01	1101	2.00
Snowflake hookear sculpin	*Artediellus uncinatus*	NSFSCUL	0	1,645	860	956	230	3,691	0.01	804	1.46
Hookear sculpin uncl	*Artediellus sp*	*NHSCUSP*	0	0	0	77	3,601	3,678	0.01	1452	2.64
Longnose eel	*Synaphobranchus kaupi*	NLNSEEL	0	0	0	1	3,532	3,533	0.01	833	1.51
Striped searobin	*Prionotus evolans*	NSSROB	3,384	0	0	0	0	3,384	0.01	280	0.51
Polar sculpin	*Cottunculus micropes*	NPOSCUL	0	40	9	41	2,923	3,012	0.01	1538	2.79
Seasnails (created)	*Liparis (all)*	*NSSNALL*	244	131	776	187	1,475	2,814	0.01	1076	1.95
Shortnose greeneye	*Chlorophthalmus agassizi*	NSHTGEY	2,489	304	0	0	0	2,793	0.01	326	0.59
Large scale tapirfish	*Notocanthus chemnitzi*	NLSCTAP	0	60	0	10	2,718	2,787	0.01	824	1.50
Clearnose skate	*Raja eglanteria*	NCNSSKT	2,668	9	0	0	0	2,677	0.01	373	0.68
4-line snake blenny	*Eumesogrammus praecisus*	NFLBLEN	0	79	2,089	112	279	2,559	0.01	491	0.89
Rough scad	*Trachurus lathami*	NRGSCAD	2,483	0	0	0	0	2,483	0.01	129	0.23
Snake blenny	*Lumpenus lumpretaeformes*	NSNKBLN	354	741	650	264	450	2,460	0.01	804	1.46

Appendix 3. (continued)

SPECIES			NUMBERS OF INDIVIDUALS							FREQUENCY	
		ECNASAP	SOURCE						% OF	# OF	% OF
COMMON NAME	SCIENTIFIC NAME	CODE	NMFS-NEFSC	DFO-SF	DFO-SG	DFO-NG	DFO-NFLD	TOTAL	TOTAL	SETS	SETS
Inshore lizardfish	*Synodus foetens*	NINSLIZ	2,212	0	0	0	0	2,212	0.01	90	0.16
Vermilion snapper	*Rhomboplites aurorubens*	NVERSNP	2,166	0	0	0	0	2,166	0.01	34	0.06
Boa dragonfish	*Stomias (boa) ferox*	NBOADRG	44	1,185	0	0	679	1,908	0.01	345	0.63
Goitre blacksmelt	*Bathylagus euryops*	NBKSMLT	0	42	0	0	1,554	1,596	0.01	158	0.29
Spinytail skate	*Raja spinicauda*	NSPTSKT	0	5	0	47	1,538	1,590	0.01	1206	2.19
Viperfish	*Chauliodus sloani*	NVIPFIS	61	375	0	1	1,070	1,507	0.01	534	0.97
Greenland cod	*Gadus ogac*	NGRCOD	0	3	638	105	657	1,404	0.01	463	0.84
Smallmouth flounder	*Etropus microstomus*	NSMMFLB	1,337	0	0	0	0	1,337	0.01	149	0.27
Radiated shanny	*Ulvaria subbifurcata*	NRDSHAN	874	166	192	3	91	1,326	0.01	290	0.53
Rosette skate	*Raja garmani*	NROSSKT	1,271	2	0	0	0	1,273	0.00	302	0.55
Armored searobin	*Peristedion miniatum*	NARSROB	1,094	40	0	0	0	1,134	0.00	333	0.60
Deep sea sculpin	*Cottunculus sp.*	*NCOTTSP*	0	0	0	9	1,119	1,128	0.00	624	1.13
Black herring	*Bathytroctes sp.*	NBLKHER	0	0	0	0	1,091	1,091	0.00	74	0.13
Slender snipe eel	*Nemichthys scolopaceus*	NSNPEEL	271	576	0	0	119	966	0.00	286	0.52
Offshore lizardfish	*Synodus poeyi*	NOFFLIZ	959	0	0	0	0	959	0.00	37	0.07
Bigeye scad	*Selar crumenopthalmus*	NBESCAD	901	0	0	0	0	901	0.00	25	0.05
Wrymouth	*Cryptacanthodes maculatus*	NWRYMTH	222	249	266	68	89	893	0.00	488	0.89
Stout sawpalate	*Serrivomer beani*	NSTSWPL	0	145	0	3	594	741	0.00	285	0.52
Grubby	*Myoxocephalus aenaeus*	NGRUBBY	599	33	0	1	1	634	0.00	72	0.13
Tattler	*Serranus phoebe*	NTATLER	617	0	0	0	0	617	0.00	34	0.06
Snakefish	*Trachinocephalus myops*	NSNKFIS	605	0	0	0	0	605	0.00	71	0.13
Conger eel	*Conger oceanicus*	NCONEEL	575	5	0	0	0	580	0.00	304	0.55
Buckler dory	*Zenopsis conchifera*	NBUKDOR	519	60	0	0	0	579	0.00	244	0.44
Bank sea bass	*Centropristis ocyurus*	NBKSBAS	469	0	0	0	0	469	0.00	45	0.08
Threebeard rockling	*Gaidropsarus ensis*	NTBDROK	31	34	0	59	343	467	0.00	188	0.34
Slatjaw cutthroat eel	*Symaphobranchus kaupi*	NCUTEEL	0	458	0	0	0	458	0.00	80	0.15
Chain dogfish	*Scyliorhinus retifer*	NCHNDOG	455	0	0	0	0	455	0.00	197	0.36
Bank cusk-eel	*Ophidion holbrooki*	NBKCEEL	444	0	0	0	0	444	0.00	37	0.07
Red porgy	*Pagrus sedecim*	NREDPOR	413	0	0	0	0	413	0.00	59	0.11
Atlantic midshipman	*Porichthys porosissimus*	NATLMID	388	0	0	0	0	388	0.00	34	0.06
Spiny lumpsucker	*Eumicrotremus spinosus variablilis*	NSPLSUK	0	0	0	160	228	387	0.00	117	0.21
Barndoor skate	*Raja laevis*	NBRNSKT	182	184	8	2	7	383	0.00	204	0.37
Spiny searobin	*Prionotus alatus*	NSPSROB	361	0	0	0	0	361	0.00	19	0.03
Atlantic angel shark	*Squatina dumerili*	NATANSHK	359	0	0	0	0	359	0.00	163	0.30
Atlantic hookear sculpin	*Artediellus atlanticus*	NHKSCUL	0	0	0	303	55	358	0.00	92	0.17
Blackmouth bass	*Synagrops bella*	NBLMBAS	349	0	0	0	0	349	0.00	49	0.09
Chlorophthalmus chalybeius	*Chlorophthalmus chalybeius. . Dnu*	NCHLCHA	349	0	0	0	0	349	0.00	56	0.10
Round skate	*Raja fyllae*	NRNDSKT	0	14	0	30	302	346	0.00	294	0.53
Twospot cardinalfish	*Apogon pseudomaculatus*	NTWSCAR	337	0	0	0	0	337	0.00	11	0.02
Mackerel scad	*Decapterus macarellus*	NMKSCAD	305	0	0	0	0	305	0.00	47	0.09
Weakfish	*Cynoscion regalis*	NWKFIS	282	0	0	0	0	282	0.00	65	0.12
Striped grunt	*Haemulon striatum*	NSTRGRN	279	0	0	0	0	279	0.00	10	0.02

Appendix 3. (continued)

SPECIES			NUMBERS OF INDIVIDUALS							FREQUENCY	
		ECNASAP	SOURCE						% OF	# OF	% OF
COMMON NAME	SCIENTIFIC NAME	CODE	NMFS-NEFSC	DFO-SF	DFO-SG	DFO-NG	DFO-NFLD	TOTAL	TOTAL	SETS	SETS
Wolf eelpout	*Lycenchelys verrillii*	NWLFEPT	215	43	1	1	4	265	0.00	131	0.24
Northern pipefish	*Syngnathus fuscus*	NNPIPE	261	0	0	0	0	261	0.00	106	0.19
Longnose greeneye	*Parasudis truculenta*	NLNGGEY	217	22	0	1	0	240	0.00	36	0.07
Blue whiting	*Micromesistius poutassou*	NBLUWHT	0	1	0	1	233	235	0.00	102	0.19
Dusky flounder	*Syacium papillosum*	NDSKFLD	226	0	0	0	0	226	0.00	39	0.07
Epigonus pandionis	*Epigonus pandionis*	NEPIPAN	206	1	0	0	0	207	0.00	14	0.03
Slime eel	*Simenchelys parasiticus*	NSLMEEL	22	86	0	0	99	207	0.00	104	0.19
Spatulate sculpin	*Icelus spatula*	NSPSCUL	0	0	42	32	133	206	0.00	71	0.13
Short barracudina	*Paralepis brevis*	NSHTBAR	0	0	0	56	150	206	0.00	95	0.17
Sand perch	*Diplectrum formosum*	NSANPER	202	0	0	0	0	202	0.00	47	0.09
Northern puffer	*Sphoeroides maculatus*	NNPUF	196	1	0	0	0	197	0.00	41	0.07
Shortspine tapirfish	*Polycanthonotus rissoanus*	NSHTTAP	0	22	0	0	174	196	0.00	68	0.12
Bigeye	*Priacanthus arenatus*	NBIGEYE	182	0	0	0	0	182	0.00	37	0.07
Shortnosed lancetfish	*Alepisaurus brevirostris*	NSHTLAN	0	0	0	0	176	176	0.00	66	0.12
Slender tonguefish	*Symphurus marginatus*	NSLTNG	1	0	0	0	174	175	0.00	2	0.00
Bullnose ray	*Myliobatis freminvillei*	NBULRAY	160	0	0	0	0	160	0.00	40	0.07
Snake eel	*Pisoodonophis cruentifer*	NSNKEEL	151	0	0	0	0	151	0.00	97	0.18
Roughtail stingray	*Dasyatis centroura*	NRTLRAY	150	0	0	0	0	150	0.00	77	0.14
Tilefish	*Lopholatilus chamaeleonticeps*	NTILFIS	143	3	0	0	0	146	0.00	91	0.17
Seasnail ncn	*Careproctus ranula*	NCARRAN	1	1	0	0	144	146	0.00	96	0.17
Longnose grenadier	*Coelorhynchus carminatus*	NLNSGRN	140	0	0	0	6	146	0.00	38	0.07
Longtooth anglemouth	*Gonostoma elongatum*	NGONELO	7	126	0	0	6	139	0.00	48	0.09
Sand diver	*Synodus intermedius*	NSANDIV	136	0	0	0	0	136	0.00	33	0.06
Striated argentine	*Argentina striata*	NSTRARG	136	0	0	0	0	136	0.00	16	0.03
Pallid sculpin	*Cottunculus thompsoni*	NPLSCUL	0	17	1	4	113	135	0.00	95	0.17
Rock gunnel	*Pholis gunnellus*	NRKGUN	100	14	1	0	6	121	0.00	63	0.11
Cubbyu	*Equetus umbrosus*	NCUBBYU	119	0	0	0	0	119	0.00	21	0.04
Bigeye sculpin	*Triglops nybelini*	NBESCUL	0	0	0	2	115	117	0.00	25	0.05
Bluntnose stingray	*Dasyatis sayi*	NBNSRAY	115	0	0	0	0	115	0.00	34	0.06
Conejo	*Promethichthys prometheus*	NCONEJO	107	0	0	0	0	107	0.00	22	0.04
Sea tadpole	*Careproctus reinhardi*	NSEATAD	0	25	9	53	14	101	0.00	49	0.09
Atlantic batfish	*Dibranchus atlanticus*	NATLBAT	50	41	0	0	8	99	0.00	62	0.11
Atlantic tomcod	*Microgadus tomcod*	NTOMCOD	0	96	1	0	0	97	0.00	7	0.01
Deepbody boarfish	*Antigonia capros*	NDBBOAR	97	0	0	0	0	97	0.00	38	0.07
Yellowtail reeffish	*Chromis enchrysurus*	NYCHROM	97	0	0	0	0	97	0.00	7	0.01
Sea lamprey	*Petromyzon marinus*	NSEALAM	80	0	5	2	9	96	0.00	81	0.15
Shortwing searobin	*Prionotus stearnsi*	NSWSROB	95	0	0	0	0	95	0.00	9	0.02
Whitebone porgy	*Calamus leucosteus*	NWHBPOR	95	0	0	0	0	95	0.00	20	0.04
John dory	*Zenopsis ocellata*	NKNBPOR	85	0	0	0	0	85	0.00	11	0.02
White grunt	*Haemulon plumieri*	NWHTGRT	85	0	0	0	0	85	0.00	19	0.03
Arctic skate	*Raja hyperborea*	NARCSKT	0	0	0	0	84	84	0.00	31	0.06
Longnose batfish	*Ogcocephalus vespertilio*	NLNSBAT	83	0	0	0	0	83	0.00	50	0.09

Appendix 3. (continued)

SPECIES			NUMBERS OF INDIVIDUALS							FREQUENCY	
		ECNASAP	SOURCE						% OF	# OF	% OF
COMMON NAME	SCIENTIFIC NAME	CODE	NMFS-NEFSC	DFO-SF	DFO-SG	DFO-NG	DFO-NFLD	TOTAL	TOTAL	SETS	SETS
Slender eelblenny	*Lumpenus fabricii*	NSLEELB	0	9	3	66	4	82	0.00	36	0.07
Lancer stargazer	*Kathetostoma albigutta*	NLSTGAZ	80	0	0	0	0	80	0.00	31	0.06
Eyed flounder	*Bothus ocellatus*	NEYEFLD	76	0	0	0	0	76	0.00	22	0.04
Longspine scorpionfish	*Pontinus longispinis*	NLSSCOR	74	0	0	0	0	74	0.00	19	0.03
Pancake batfish	*Halieutichthys aculeatus*	NPANBAT	72	0	0	0	0	72	0.00	18	0.03
Smoothhead scorpionfish	*Scorpaena calcarata*	NSMSCRP	71	0	0	0	0	71	0.00	21	0.04
Gray triggerfish	*Balistes capriscus*	NGRYTRG	69	1	0	0	0	70	0.00	33	0.06
Fishdoctor	*Gymnelis viridis*	NFSHDOC	0	5	24	7	34	70	0.00	46	0.08
Arctic alligatorfish	*Aspidophoroides olriki*	NARALIG	0	5	4	1	59	68	0.00	18	0.03
Marbled puffer	*Sphoeroides dorsalis*	NMARPUF	68	0	0	0	0	68	0.00	28	0.05
Rock sea bass	*Centropristis philadelphica*	NRKSBAS	68	0	0	0	0	68	0.00	21	0.04
Black swallower	*Chiasmodon niger*	NBLSWAL	0	19	0	0	48	67	0.00	50	0.09
Rough sagre	*Etmopterus princeps*	NRGHSAG	62	5	0	0	0	67	0.00	13	0.02
Spiny lebbeid	*Lebbeus groenlandicus*	NSPILEB	65	0	0	0	0	65	0.00	11	0.02
Silver rag	*Ariomma bondi*	NSILRAG	64	0	0	0	0	64	0.00	37	0.07
Atlantic torpedo	*Torpedo nobiliana*	NATLTOR	60	3	0	0	0	63	0.00	61	0.11
Blackmouthed alfonsin	*Hoplostethus mediterraneus*	NBLMALF	60	0	0	0	0	60	0.00	17	0.03
Barbfish	*Scorpaena brasiliensis*	NBRBFIS	58	0	0	0	0	58	0.00	11	0.02
Baird's smoothhead	*Alepocephalus bairdii*	NBAISHD	0	0	0	0	55	55	0.00	13	0.02
Atlantic cutlassfish	*Trichiurus lepturus*	NATLCUT	55	0	0	0	0	55	0.00	25	0.05
Blotched cusk-eel	*Ophidion grayi*	NBLCEEL	55	0	0	0	0	55	0.00	26	0.05
Striped cusk-eel	*Rissola marginata*	NSTCEEL	55	0	0	0	0	55	0.00	32	0.06
Hakeling	*Physiculus fulvus*	NHAKLIN	54	0	0	0	0	54	0.00	7	0.01
White skate	*Raja lintea*	NWHTSKT	0	0	0	0	54	54	0.00	7	0.01
Shortnose batfish	*Ogcocephalus nasutus*	NSHTBAT	52	0	0	0	0	52	0.00	16	0.03
Silver rockling	*Gaidropsarus argentatus*	NSILROK	0	0	0	0	51	51	0.00	17	0.03
Ribbed sculpin	*Myoxocephalus sp.*	NRISCUL	0	0	0	21	28	49	0.00	8	0.01
Saddled grenadier	*Coelorhynchus coelorhynchus*	NSDGREN	0	33	16	0	0	48	0.00	11	0.02
Spiny butterfly ray	*Gymnura altavela*	NSPBRAY	48	0	0	0	0	48	0.00	27	0.05
Ocellated flounder	*Ancylopsetta quadrocellata*	NOCEFLD	47	0	0	0	0	47	0.00	5	0.01
Saucereye porgy	*Calamus calamus*	NSCEPOR	47	0	0	0	0	47	0.00	11	0.02
Leatherfin lumpsucker	*Eumicrotremus derjugini*	NLTLSUK	0	0	0	5	41	45	0.00	23	0.04
Grenadier (ncn)	*Macrourus aequalis*	NMACAEQ	0	0	0	0	44	44	0.00	2	0.00
Arctic staghorn sculpin	*Gymnocanthus tricuspis*	NASSCUL	0	0	1	4	38	43	0.00	18	0.03
Deepwater flounder	*Monolene sessilicauda*	NDPWFLD	40	1	0	0	0	41	0.00	27	0.05
Blackcheek tonguefish	*Symphurus plagiusa*	NBCTONG	41	0	0	0	0	41	0.00	24	0.04
Arctic sculpin	*Myoxocephalus scorpioides*	NARSCUL	0	3	3	5	29	39	0.00	33	0.06
Margined snake eel	*Ophichthus cruentifer*	NMAREEL	0	39	0	0	0	39	0.00	4	0.01
Horned searobin	*Bellator militaris*	NHNSROB	39	0	0	0	0	39	0.00	9	0.02
Yellowfin bass	*Anthias nicholsi*	NYFNBAS	38	1	0	0	0	39	0.00	7	0.01
Longnose chimera	*Harriotta raleighana*	NLNCHIM	0	15	0	0	24	39	0.00	22	0.04
Fourhorn sculpin	*Myoxocephalus quadricornis*	NFHSCUL	0	0	0	31	5	36	0.00	16	0.03

Appendix 3. (continued)

SPECIES			NUMBERS OF INDIVIDUALS							FREQUENCY	
		ECNASAP	SOURCE						% OF	# OF	% OF
COMMON NAME	SCIENTIFIC NAME	CODE	NMFS-NEFSC	DFO-SF	DFO-SG	DFO-NG	DFO-NFLD	TOTAL	TOTAL	SETS	SETS
Red goatfish	*Mullus auratus*	NRDGOAT	36	0	0	0	0	36	0.00	17	0.03
Channel flounder	*Syacium micrurum*	NCHNFLD	35	0	0	0	0	35	0.00	13	0.02
Short bigeye	*Pristigenys alta*	NSHTBEY	35	0	0	0	0	35	0.00	23	0.04
Arctic shanny	*Stichaeus punctatus*	NARSHAN	0	0	0	35	0	35	0.00	2	0.00
Twohorn sculpin	*Icelus bicornis*	NTHSCUL	0	13	9	0	10	32	0.00	16	0.03
Duckbill oceanic eel	*Nessorhamphus ingolfianus*	NDBLEEL	0	30	0	0	1	31	0.00	5	0.01
Common wolf eel	*Lycenchelys paxillus*	NCMWEEL	0	8	0	3	20	31	0.00	25	0.05
Pigfish	*Orthopristis chrysoptera*	NPIGFIS	31	0	0	0	0	31	0.00	6	0.01
Smooth puffer	*Lagocephalus laevigatus*	NSMPUF	31	0	0	0	0	31	0.00	12	0.02
Jensen's skate	*Raja jenseni*	NJENSKT	0	7	0	6	18	31	0.00	23	0.04
Tautog	*Tautoga onitis*	NTAUTOG	30	0	0	0	0	30	0.00	16	0.03
Pinfish	*Lagodon rhomboides*	NPINFIS	29	0	0	0	0	29	0.00	5	0.01
Blacksnout seasnail	*Paraliparis copei*	NBLKSSN	0	0	0	27	0	27	0.00	13	0.02
Shark deepsea cat	*Apristurus profundorum*	NCATSHK	0	1	0	0	26	27	0.00	16	0.03
Blacksmelt (ncn)	*Bathylagus benedicti*	NBLSMLT	0	0	0	0	26	26	0.00	10	0.02
Longspine squirrelfish	*Holocentrus rufus*	NLSPSQR	26	0	0	0	0	26	0.00	3	0.01
Reef butterflyfish	*Chaetodon sedentarius*	NREFBUT	26	0	0	0	0	26	0.00	10	0.02
Spotted goatfish	*Pseudupeneus maculatus*	NSPGOAT	25	0	0	0	0	25	0.00	5	0.01
Squirrelfish	*Holocentrus ascensionis*	NSQRFIS	25	0	0	0	0	25	0.00	3	0.01
Bigeye cigarfish	*Cubiceps athenae*	NBIGCIG	24	0	0	0	0	24	0.00	14	0.03
Duckbill barracudina	*Paralepis atlantica*	NDUKBAR	0	24	0	0	0	24	0.00	9	0.02
Cownose ray	*Rhinoptera bonasus*	NCAWRAY	21	0	0	0	0	21	0.00	3	0.01
Hogfish	*Lachnolaimus maximus*	NHOGFIS	21	0	0	0	0	21	0.00	13	0.02
Jackknife-fish	*Equetus lanceolatus*	NJAKNIF	20	0	0	0	0	20	0.00	15	0.03
Leopard searobin	*Prionotus scitulus*	NLPSROB	20	0	0	0	0	20	0.00	5	0.01
Orange filefish	*Aluterus schoepfi*	NORGFIL	19	0	0	0	1	20	0.00	10	0.02
Spinycheek scorpionfish	*Neomerinthe hemingwayi*	NSPSCRP	19	0	0	0	0	19	0.00	6	0.01
Atlantic spadefish	*Chaetodipterus faber*	NATLSPD	18	0	0	0	0	18	0.00	6	0.01
Polka-dot cusk-eel	*Otophidium omostigmum*	NPDCEEL	18	0	0	0	0	18	0.00	8	0.01
Red cornetfish	*Fistularia villosa*	NRDCORN	18	0	0	0	0	18	0.00	12	0.02
Longfin seasnail	*Careproctus longipinnis*	NLFNSNL	0	4	0	7	7	18	0.00	13	0.02
American straptail grenadier	*Ventrifossa occidentalis*	NAMSGRN	17	0	0	0	0	17	0.00	10	0.02
Northern kingfish	*Menticirrhus saxatilis*	NNKFIS	17	0	0	0	0	17	0.00	10	0.02
Spotfin butterflyfish	*Chaetodon ocellatus*	NSFNBUT	17	0	0	0	0	17	0.00	10	0.02
Twospot flounder	*Bothus robinsi*	NTSPFLD	17	0	0	0	0	17	0.00	3	0.01
American el	*Anguilla rostrata*	NAMEEL	5	12	0	0	0	17	0.00	11	0.02
Bandtail searobin	*Prionotus ophryas*	NBTSROB	16	0	0	0	0	16	0.00	7	0.01
Pearlfish	*Carapus bermudensis*	NPRLFIS	16	0	0	0	0	16	0.00	3	0.01
Scamp	*Mycteroperca phenax*	NSCAMP	16	0	0	0	0	16	0.00	9	0.02
Sergeant major	*Abudefduf saxatilis*	NSERMAJ	16	0	0	0	0	16	0.00	2	0.00
Deepwater chimera	*Hydrolagus affinis*	NDPCHIM	0	2	0	0	13	15	0.00	11	0.02
Spottail pinfish	*Diplodus holbrooki*	NSPTPIN	15	0	0	0	0	15	0.00	4	0.01

Appendix 3. (continued)

SPECIES			NUMBERS OF INDIVIDUALS							FREQUENCY	
		ECNASAP	SOURCE						% OF	# OF	% OF
COMMON NAME	SCIENTIFIC NAME	CODE	NMFS-NEFSC	DFO-SF	DFO-SG	DFO-NG	DFO-NFLD	TOTAL	TOTAL	SETS	SETS
Spinyfin	*Diretmus argenteus*	NSPIFIN	0	13	0	0	2	15	0.00	9	0.02
Spotfin dragonet	*Callionymus agassizi*	NSPTDRG	10	4	0	0	0	14	0.00	13	0.02
Stout beardfish	*Polymixia nobilis*	NSBDFIS	6	8	0	0	0	14	0.00	10	0.02
Blackedge moray	*Gymnothorax nigromarginatus*	NBLKMOR	14	0	0	0	0	14	0.00	12	0.02
Deepsea angler	*Ceratias holboelli*	NDPSANG	0	4	0	2	9	14	0.00	13	0.02
Knobbed porgy	*Calamus nodosus*	NKNCHIM	0	10	0	0	3	13	0.00	9	0.02
Lined seahorse	*Hippocampus erectus*	NLNSHRS	13	0	0	0	0	13	0.00	12	0.02
Slender searobin	*Peristedion gracile*	NSLSROB	13	0	0	0	0	13	0.00	4	0.01
Southern stingray	*Dasyatis americanus*	NSTHRAY	13	0	0	0	0	13	0.00	10	0.02
Streamer bass	*Pronotogrammus aureorubens*	NSTRBAS	13	0	0	0	0	13	0.00	8	0.01
Grenadier NCN	*Nezumia hildebrabdi*	NGRNNCN	0	0	0	13	0	13	0.00	1	0.00
Longnose lancetfish	*Alepisaurus ferox*	NLONLAN	0	3	0	0	10	13	0.00	12	0.02
Backfin tapirfish	*Lipogenys gillii*	NBLKTAP	0	10	0	0	2	12	0.00	5	0.01
Bandtail puffer	*Sphoeroides spengleri*	NBTLPUF	12	0	0	0	0	12	0.00	5	0.01
Gag	*Mycteroperca microlepis*	NGAG	12	0	0	0	0	12	0.00	8	0.01
Lookdown	*Selene vomer*	NLKDOWN	12	0	0	0	0	12	0.00	11	0.02
Peacock flounder	*Bothus lunatus*	NPEAFLD	12	0	0	0	0	12	0.00	3	0.01
Red lizardfish	*Synodus synodus*	NREDLIZ	12	0	0	0	0	12	0.00	5	0.01
Frostfish	*Benthodesmus elongatus simonyi*	NFRSFIS	5	2	0	0	4	11	0.00	11	0.02
Armoured grenadier	*Nematonurus armatus*	NARGREN	0	0	0	0	11	11	0.00	3	0.01
Blackwing searobin	*Prionotus salmonicolor*	NBWSROB	11	0	0	0	0	11	0.00	4	0.01
Pearly razorfish	*Hemipteronotus novacula*	NPRLRAZ	11	0	0	0	0	11	0.00	8	0.01
Red snapper	*Lutjanus campechanus*	NREDSNP	11	0	0	0	0	11	0.00	3	0.01
Roughback batfish	*Ogcocephalus parvus*	NRGHBAT	11	0	0	0	0	11	0.00	10	0.02
Scrawled cowfish	*lactophrys quadricornis*	NSCRCOW	11	0	0	0	0	11	0.00	7	0.01
Southern kingfish	*Menticirrhus americanus*	NSKING	11	0	0	0	0	11	0.00	2	0.00
Arctic lumpfish	*Cyclopteropsis macalpini*	NARCLMP	0	0	0	5	6	11	0.00	5	0.01
Brown driftfish	*Ariomma melanum*	NBRDRFT	10	0	0	0	0	10	0.00	5	0.01
Scrawled filefish	*Aluterus scriptus*	NSCRFIL	10	0	0	0	0	10	0.00	8	0.01
Snowy grouper	*Epinephelus niveatus*	NSNOGRP	10	0	0	0	0	10	0.00	3	0.01
Uraleptus maraldi	*Uraleptus maraldi*	NURAMAR	10	0	0	0	0	10	0.00	7	0.01
Atlantic gymnast	*Xenodermichthys copei*	NATLGYM	0	4	0	0	5	9	0.00	7	0.01
Bluespotted searobin	*Prionotus roseus*	NBSSROB	9	0	0	0	0	9	0.00	8	0.01
Red barbier	*Hemanthias vivanus*	NRDBARB	9	0	0	0	0	9	0.00	3	0.01
Beans blueback	*Scopelogadus beanii*	NBNSBBK	0	9	0	0	0	9	0.00	1	0.00
Smallscale mora	*Laemonema barbatulum*	NLBARB	4	4	0	0	0	8	0.00	3	0.01
Red dory	*Cyttopsis roseus*	NREDDOR	6	2	0	0	0	8	0.00	8	0.01
Atlantic sturgeon	*Acipenser oxyrhynchus*	NSTURG	5	3	0	0	0	8	0.00	8	0.01
Longnose cusk-eel	*Ophidion beani. Dnu*	NLNCUEL	8	0	0	0	0	8	0.00	5	0.01
Soft skate	*Raja mollis*	NSFTSKT	0	0	0	1	7	8	0.00	6	0.01
Shortfin searobin	*Bellator brachychir*	NSHFNSR	8	0	0	0	0	8	0.00	4	0.01
Slippery dick	*Halichoeres bivittatus*	NSLIPDK	8	0	0	0	0	8	0.00	4	0.01

Appendix 3. (continued)

SPECIES			NUMBERS OF INDIVIDUALS							FREQUENCY	
		ECNASAP	SOURCE						% OF	# OF	% OF
COMMON NAME	SCIENTIFIC NAME	CODE	NMFS-NEFSC	DFO-SF	DFO-SG	DFO-NG	DFO-NFLD	TOTAL	TOTAL	SETS	SETS
Spottail tonguefish	*Symphurus urospilus*	NSLTONG	8	0	0	0	0	8	0.00	4	0.01
Spotted whiff	*Citharichthys macrops*	NSPWHIF	8	0	0	0	0	8	0.00	3	0.01
Apristurus laurussoni	*Apristurus laurussoni*	NAPLAUR	0	8	0	0	0	8	0.00	4	0.01
Blue ling	*Molva dypterygia*	NBLLING	0	0	0	0	7	7	0.00	7	0.01
Barrelfish	*Hyperoglyphe perciformis*	NBARFSH	6	1	0	0	0	7	0.00	7	0.01
Honeycomb cowfish	*Lactophrys polygonia*	NNONCOW	7	0	0	0	0	7	0.00	5	0.01
Palespotted eel	*Ophichthus ocellatus*	NPSPEEL	7	0	0	0	0	7	0.00	4	0.01
Sand tiger	*Odontaspis taurus*	NSANTIG	7	0	0	0	0	7	0.00	4	0.01
Big roughy	*Gephyroberyx darwini*	NBIGROU	6	0	0	0	0	6	0.00	3	0.01
Bluespotted cornetfish	*Fistularia tabacaria*	NBLCORN	6	0	0	0	0	6	0.00	6	0.01
Blackbar soldierfish	*Myripristis jacobus*	NBLKSOL	6	0	0	0	0	6	0.00	2	0.00
Dotterel filefish	*Aluterus heudeloti*	NDOTFIL	6	0	0	0	0	6	0.00	5	0.01
Fringed filefish	*Monacanthus ciliatus*	NFRNFIL	6	0	0	0	0	6	0.00	5	0.01
Southern flounder	*Paralichthys lethostigma*	NSTHFLD	6	0	0	0	0	6	0.00	4	0.01
Synagrops spinosa	*Synagrops spinosa*	NSYSPIN	6	0	0	0	0	6	0.00	2	0.00
Ogrefish	*Anoplogaster cornuta*	NOGRFSH	0	1	0	0	5	6	0.00	5	0.01
Straptail grenadier	*Malacocephalus occidentalis*	NSTGREN	0	6	0	0	0	6	0.00	4	0.01
Lesser deepsea angler	*Cryptopsaras couesi*	NLDPANG	0	0	0	1	4	5	0.00	6	0.01
Dainty mora	*Halargyreus affinis*	NHALAFF	0	0	0	0	5	5	0.00	4	0.01
Sherborn's cardinalfish	*Howella sherborni*	NSHCARD	1	1	0	0	3	5	0.00	5	0.01
Banded drum	*Larimus fasciatus*	NBANDRM	5	0	0	0	0	5	0.00	1	0.00
Blackear bass	*Serranus atrobranchus*	NBERBAS	5	0	0	0	0	5	0.00	3	0.01
Bighead searobin	*Prionotus tribulus*	NBHSROB	5	0	0	0	0	5	0.00	3	0.01
Red anglerfish	*Chaunax pictus*	NREDANG	5	0	0	0	0	5	0.00	5	0.01
Spotfin flounder	*Cyclopsetta fimbriata*	NSFNFLD	5	0	0	0	0	5	0.00	5	0.01
Singlespot frogfish	*Antennarius radiosus*	NSINFRG	5	0	0	0	0	5	0.00	4	0.01
Daggertooth	*Anotopterus pharao*	NDAGTTH	0	0	0	0	4	4	0.00	4	0.01
Black scabbardfish	*Aphanopus carbo*	NBKSCAB	0	0	0	0	4	4	0.00	4	0.01
Bay whiff	*Citharichthys spilopterus*	NBYWHIF	4	0	0	0	0	4	0.00	3	0.01
Mottled cusk-eel	*Lepophidium jeannae*	NMTCEEL	4	0	0	0	0	4	0.00	2	0.00
Northern sennet	*Sphyraena borealis*	NNSENN	4	0	0	0	0	4	0.00	4	0.01
Northern stargazer	*Astroscopus guttatus*	NNSTGZ	4	0	0	0	0	4	0.00	4	0.01
Spotted eagle ray	*Aetobatus narinari*	NSEGRAY	4	0	0	0	0	4	0.00	2	0.00
Spotted driftfish	*Ariomma regulus*	NSPDRFT	4	0	0	0	0	4	0.00	2	0.00
Striped bass	*Morone saxatilis*	NSTPBAS	4	0	0	0	0	4	0.00	2	0.00
Deepsea smelt ncn	*Bathylagus sp.*	NBATHSP	0	4	0	0	0	4	0.00	1	0.00
Banded gunnel	*Pholis fasciata*	NBANGUN	0	1	2	0	0	3	0.00	3	0.01
Gadoid NCN	*Phocaegadus megalops*	NGADNCN	0	0	0	3	0	3	0.00	1	0.00
Alfonsino (ncn)	*Caulolepis longidens*	NCAULON	0	0	0	0	3	3	0.00	3	0.01
Dwarf goatfish	*Upeneus parvus*	NDWGOAT	3	0	0	0	0	3	0.00	3	0.01
Dwarf sand perch	*Diplectrum bivittatum*	NDWSPER	3	0	0	0	0	3	0.00	3	0.01
Emerald parrotfish	*Nicholsina usta*	NEMPAR	3	0	0	0	0	3	0.00	1	0.00

Appendix 3. (continued)

SPECIES			NUMBERS OF INDIVIDUALS							FREQUENCY	
		ECNASAP	SOURCE						% OF	# OF	% OF
COMMON NAME	SCIENTIFIC NAME	CODE	NMFS-NEFSC	DFO-SF	DFO-SG	DFO-NG	DFO-NFLD	TOTAL	TOTAL	SETS	SETS
Silver jenny	*Eucinostomus gula*	NJENNY	3	0	0	0	0	3	0.00	1	0.00
Longsnout butterflyfish	*Prognathodes aculeatus*	NLSNBFL	3	0	0	0	0	3	0.00	2	0.00
Naked sole	*Gymnachirus melas*	NNAKSOL	3	0	0	0	0	3	0.00	3	0.01
Pelican gulper	*Eurypharynx pelecanoides*	NPELGUL	0	0	0	0	3	3	0.00	3	0.01
Porcupinefish	*Diodon hystrix*	NPORPIN	3	0	0	0	0	3	0.00	3	0.01
Silver perch	*Bairdiella chrysura*	NSILPER	3	0	0	0	0	3	0.00	2	0.00
Spotted spoon-nose eel	*Mystriophis intertinctus*	NSSNEEL	3	0	0	0	0	3	0.00	3	0.01
Southern stargazer	*Astroscopus y-graecum*	NSSTGAZ	3	0	0	0	0	3	0.00	2	0.00
Southern hake	*Urophycis floridanus*	NSTHHAK	3	0	0	0	0	3	0.00	1	0.00
Three-eye flounder	*Ancylopsetta dilecta*	NTEYFLD	3	0	0	0	0	3	0.00	3	0.01
Stout eelblenny	*Lumpenus medius*	NSTEELB	0	0	2	1	0	3	0.00	3	0.01
S. Lepidus	*Scopelosaurus lepidus*	NSLEPID	0	2	0	0	0	2	0.00	2	0.00
Sar's wolf eel	*Lycenchelys sarsi*	NSWEEL	0	0	0	0	2	2	0.00	2	0.00
Chauliodus sp.	*Chauliodus sp.*	NCHAUSP	0	2	0	0	0	2	0.00	1	0.00
Atlantic bumper	*Chloroscombrus chrysurus*	NATBUMP	2	0	0	0	0	2	0.00	2	0.00
Carolina hake	*Urophycis earlli*	NCARHAK	2	0	0	0	0	2	0.00	2	0.00
Lesser electric ray	*Narcine brasiliensis*	NELERAY	2	0	0	0	0	2	0.00	2	0.00
Freckled soapfish	*Rypticus bistrispinus*	NFRSOAP	2	0	0	0	0	2	0.00	2	0.00
Largeye lepidion	*Lepidion eques*	NLEPEQU	0	0	0	0	2	2	0.00	2	0.00
Longfin scorpionfish	*Scorpaena agassizi*	NLFSCRP	2	0	0	0	0	2	0.00	2	0.00
Ninespine stickleback	*Pungitius pungitius*	NNSPSTB	0	0	0	2	0	2	0.00	1	0.00
Northern tonguefish	*Symphurus pusillus*	NNTONG	2	0	0	0	0	2	0.00	1	0.00
Oyster toadfish	*Opsanus tau*	NOYTOAD	2	0	0	0	0	2	0.00	2	0.00
Shrimp flounder	*Gastropsetta frontalis*	NSHPFLD	2	0	0	0	0	2	0.00	2	0.00
Spotted soapfish	*Rypticus subbifrenatus*	NSPSOAP	2	0	0	0	0	2	0.00	2	0.00
Southern puffer	*Sphoeroides nephelus*	NSTHPUF	2	0	0	0	0	2	0.00	1	0.00
Striped burrfish	*Chilomycterus schoepfi*	NSTRBUR	2	0	0	0	0	2	0.00	2	0.00
Unicorn filefish	*Aluterus monoceros*	NUNIFIL	2	0	0	0	0	2	0.00	2	0.00
Wenchman	*Pristipomoides aquilonaris*	NWNECH	2	0	0	0	0	2	0.00	2	0.00
Trunkfish	*Lactophrys trigonus*	NTNKFSH	0	1	0	0	0	1	0.00	1	0.00
Freckled skate	*Raja lentiginos*	NFRKSKT	0	1	0	0	0	1	0.00	1	0.00
S. Brevidentatus	*Serrivomer brevidentatus*	NSBREV	0	1	0	0	0	1	0.00	1	0.00
Seaweed blenny	*Parablennius marmoreus*	NSWBLEN	0	1	0	0	0	1	0.00	1	0.00
Torpedo dragonfish	*Grammatostomias dentatus*	NTORDRG	0	1	0	0	0	1	0.00	1	0.00
Atlantic footballfish	*Himantolophus groenlandicus*	NATFBAL	0	0	0	0	1	1	0.00	1	0.00
Atlantic goldeneye tilefish	*Caulolatilus chrysops*	NATGTIL	1	0	0	0	0	1	0.00	1	0.00
Balloonfish	*Diodon holocanthus*	NBALFIS	1	0	0	0	0	1	0.00	1	0.00
Bigeye soldierfish	*Ostichthys trachypomus*	NBEYSOL	1	0	0	0	0	1	0.00	1	0.00
Black grouper	*Mycteroperca bonaci*	NBLKGRP	1	0	0	0	0	1	0.00	1	0.00
Blackline tilefish	*Caulolatilus cyanops*	NBLKTIL	1	0	0	0	0	1	0.00	1	0.00
Blue tang	*Acanthurus coeruleus*	NBLTANG	1	0	0	0	0	1	0.00	1	0.00
Blue angelfish	*Holacanthus bermudensis*	NBLUANG	0	0	0	0	1	1	0.00	1	0.00

Appendix 3. (continued)

SPECIES			NUMBERS OF INDIVIDUALS							FREQUENCY	
		ECNASAP	SOURCE						% OF	# OF	% OF
COMMON NAME	SCIENTIFIC NAME	CODE	NMFS-NEFSC	DFO-SF	DFO-SG	DFO-NG	DFO-NFLD	TOTAL	TOTAL	SETS	SETS
Bandtooth conger	*Ariosoma balearicum*	NBONCON	1	0	0	0	0	1	0.00	1	0.00
Broad flounder	*Paralichthys squamilentus*	NBRDFL	1	0	0	0	0	1	0.00	1	0.00
Bulleye	*Cookeolus boops*	NBULEYE	1	0	0	0	0	1	0.00	1	0.00
Gaper (ncn)	*Chaunax sp.*	NCHAUNX	0	1	0	0	0	1	0.00	1	0.00
Flying gurnard	*dactylopterus volitans*	NFLYGUR	1	0	0	0	0	1	0.00	1	0.00
Fringed flounder	*Etropus crossotus*	NFRINFL	1	0	0	0	0	1	0.00	1	0.00
Fourspine sticklebac	*Apeltes quadracus*	NFRST	1	0	0	0	0	1	0.00	1	0.00
Freckled stargazer	*Gnathagnus egregius*	NFSTGAZ	1	0	0	0	0	1	0.00	1	0.00
Gray tilefish	*Caulolatilus microps*	NGRYTIL	1	0	0	0	0	1	0.00	1	0.00
Mora (ncn)	*Halargyreus johnsonii*	NHALJON	0	0	0	0	1	1	0.00	1	0.00
Horned whiff	*Citharichthys cornutus*	NHOWHIF	1	0	0	0	0	1	0.00	1	0.00
Jambeau	*Parahollardia lineata*	NJAMB	1	0	0	0	0	1	0.00	1	0.00
Lane snapper	*Lutjanus synagris*	NLANSNP	1	0	0	0	0	1	0.00	1	0.00
Large-eyed argentine	*Nansenia groenlandica*	NLEARG	0	0	0	0	1	1	0.00	1	0.00
Blenny (ncn)	*Leptoclinus maculatus*	NLEPMAC	0	0	0	0	1	1	0.00	1	0.00
Naked goby	*Gobiosoma bosci*	NNAKED	1	0	0	0	0	1	0.00	1	0.00
Offshore tonguefish	*Symphurus civitatus*	NOFTONG	1	0	0	0	0	1	0.00	1	0.00
Portuguese shark	*Centroscymnus coelolepis*	NPRTSHK	0	0	0	0	1	1	0.00	1	0.00
Queen angelfish	*Holacanthus ciliaris*	NQUNANG	1	0	0	0	0	1	0.00	1	0.00
Ribbed sculpin	*Triglops pingeli*	NRBSCUL	0	0	0	0	1	1	0.00	1	0.00
Red grouper	*Epinephelus morio*	NRDGR	1	0	0	0	0	1	0.00	1	0.00
Seasnail	*Paraliparis calidus*	NSEASNA	0	1	0	0	0	1	0.00	1	0.00
Silver porgy	*Diplodus argenteus*	NSILPOR	1	0	0	0	0	1	0.00	1	0.00
Slickhead	*Conocara salmonea*	NSLIKHD	0	1	0	0	0	1	0.00	1	0.00
Silk snapper	*Lutjanus vivanus*	NSLKSNP	1	0	0	0	0	1	0.00	1	0.00
Smooth butterfly ray	*Gymnura micrura*	NSMORAY	1	0	0	0	0	1	0.00	1	0.00
Spotted moray	*Gymnothorax moringa*	NSPMORA	1	0	0	0	0	1	0.00	1	0.00
Spottedfin tonguefish	*Symphurus diomedianus*	NSPTONG	1	0	0	0	0	1	0.00	1	0.00
Streamer searobin	*Bellator egretta*	NSTRSR	1	0	0	0	0	1	0.00	1	0.00
Warsaw grouper	*Epinephelus nigritus*	NWRGR	1	0	0	0	0	1	0.00	1	0.00
Yellowtail snapper	*Ocyurus chrysurus*	NYLSNAP	1	0	0	0	0	1	0.00	1	0.00
Yellowmouth grouper	*Mycteroperca interstitialis*	NYMTGRP	1	0	0	0	0	1	0.00	1	0.00
E. denticulatus	*Epigonus denticulatus*	NEDENT	0	1	0	0	0	1	0.00	1	0.00
Kolthoff's wolfeel	*Lycenchelys kolthoffi*	NKOWEEL	0	0	0	1	0	1	0.00	1	0.00
		TOTALS	5,252,018	3,482,272	1,587,169	2,535,273	13,429,636	26,286,369		55,043	

[1]Species codes are given in Appendix 2; the N prefix indicates numbers of individuals. Aggregate groups are italicized.
[2]SOURCES: NMFS-NEFSC = National Marine Fisheries Service, Northeast Fisheries Science Center, USA; DFO-SF = Department of Fisheries and Oceans, Scotia-Fundy Region, Canada; DFO-SG = Department of Fisheries and Oceans, Southern Gulf of St. Lawrence, Canada; DFO-NG = Department of Fisheries and Oceans, Northern Gulf of St. Lawrence, Canada; DFO-NFLD = Department of Fisheries and Oceans, Newfoundland-Labrador Region, Canada

APPENDIX 4A. Species loadings on VARIMAX-rotated principal components for 1975-79.[1]

Species	Loadings
PC1	
Little skate	0.797
Windowpane	0.791
Winter skate	0.749
Spiny dogfish	0.634
Winter flounder	0.446
Longhorn sculpin	0.346
Northern sand lance	0.330
Red hake	0.313
Fourspot flounder	0.305
PC2	
Blue hake	0.849
Rock (Roundnose) grenadier	0.820
Longnose eel	0.743
Large-scale tapirfish	0.665
Roughnose grenadier	0.519
Black dogfish	0.394
Roughhead grenadier	0.331
PC3	
Roughhead grenadier	0.687
Spinytail skate	0.591
Greenland halibut	0.585
Northern wolffish	0.529
Redfishes (Sebastes spp.)	0.402
Polar sculpin	0.383
Marilin-spike (Common grenadier)	0.369
Large-scale tapirfish	0.309
PC4	
Sea raven	0.748
Longhorn sculpin	0.739
Yellowtail flounder	0.594
Winter flounder	0.453
Ocean pout	0.411
Haddock	0.361
PC5	
Red hake	0.692
Silver hake	0.660
Goosefish (Angler)	0.564
Ocean pout	0.496
White hake	0.441
Fourspot flounder	0.399
PC6	
Gulfstream flounder	0.731
Fawn cusk eel	0.727
Spotted hake	0.593
Fourspot flounder	0.573
Butterfish	0.508
PC7	
Black sea bass	0.844
Northern (Common) searobin	0.819
Scup	0.631
Spotted hake	0.326
Fourspot flounder	0.311
PC8	
Atlantic wolffish	0.779
Spotted wolffish	0.691
Atlantic cod	0.535
Northern wolffish	0.459
PC9	
Arctic cod	0.789
Atlantic sea poacher	0.718
Greenland cod	0.637
Shorthorn sculpin	0.389
Greenland halibut	0.339
Northern wolffish	0.320
PC10	
Atlantic hagfish	0.695
Fourbeard rockling	0.667
Black dogfish	0.554
Marlin-spike (Common grenadier)	0.503
Witch flounder	0.397
Redfishes (Sebastes spp.)	0.311
PC11	
Atlantic argentine	0.618
White hake	0.492
Redfishes (Sebastes spp.)	0.458
Marilin-spike (Common grenadier)	0.451
Longfin hake	0.398
Witch flounder	0.357
Atlantic halibut	0.337
PC12	
Blackbelly rosefish	0.813
Offshore hake	0.764
Shortnose greeneye	0.644
PC13	
Smooth dogfish	0.859
Summer flounder	0.813
Scup	0.501
PC14	
Pollock	0.738
Cusk	0.734
Haddock	0.470
PC15	
American plaice	0.620
Thorny skate	0.567
Witch flounder	0.326
Atlantic cod	0.306
Atlantic halibut	-0.372
Haddock	-0.317
Shortfin squid	-0.309
PC16	
Moustache (Mailed) sculpin	0.796
Alligatorfish	0.724
PC17	
Smooth skate	0.575
Snowflake hookear sculpin	0.541
Polar sculpin	0.493
PC18	
Atlantic halibut	0.344
Lumpfish	-0.780
Shorthorn sculpin	-0.409
PC19	
Cunner	0.676
Snake blenny	0.397

APPENDIX 4B. Species loadings on VARIMAX-rotated principal components for 1980-84.

Species	Loadings
PC1	
Blue hake	0.858
Longnose (Slatjaw cutthroat) eel	0.754
Large-scale tapirfish	0.715
Rock (Roundnose) grenadier	0.688
Marlin-spike (Common grenadier)	0.497
Roughhead grenadier	0.472
Northern wolffish	0.336
PC2	
Fawn cusk eel	0.784
Spotted hake	0.780
Gulfstream flounder	0.730
Fourspot flounder	0.631
Butterfish	0.596
Shortfin squid	0.341
PC3	
Summer flounder	0.767
Scup	0.754
Northern (Common) searobin	0.744
Black sea bass	0.627
Smooth dogfish	0.513
Windowpane	0.305
PC4	
Red hake	0.763
Silver hake	0.666
Ocean pout	0.559
Goosefish (Angler)	0.520
Fourspot flounder	0.455
Gulfstream flounder	0.412
Longhorn sculpin	0.340
Little skate	0.313
PC5	
Winter skate	0.793
Windowpane	0.779
Little skate	0.756
Spiny dogfish	0.356
PC6	
Winter flounder	0.695
Sea raven	0.677
Longhorn sculpin	0.620
Cunner	0.552
Yellowtail flounder	0.392
Ocean pout	0.336
PC7	
Witch flounder	0.595
Greenland halibut	0.560
Smoother skate	0.550
Roughhead grenadier	0.532
Polar sculpin	0.524
Spinytail skate	0.518
Redfishes (Sebastes spp.)	0.321
PC8	
Atlantic wolffish	0.764
Spotted wolffish	0.661
Northern wolffish	0.536
Atlantic cod	0.506
Greenland halibut	0.304
PC9	
Blackbelly rosefish	0.826
Offshore hake	0.757
Shortnose greeneye	0.692
PC10	
Roughnose grenadier	0.754
Black dogfish	0.684
Longfin hake	0.615
Witch flounder	0.307
PC11	
Cusk	0.738
Pollock	0.648
Spiny dogfish	0.446
Haddock	0.389
PC12	
Thorny skate	0.651
Yellowtail flounder	0.568
American plaice	0.505
Northern sand lance	0.477
PC13	
Atlantic halibut	0.721
Atlantic argentine	0.462
White hake	0.396
Redfishes (Sebastes spp.)	0.369
Haddock	0.389
Marlin-spike (Common grenadier)	0.312
Goosefish (Angler)	0.302
PC14	
Arctic cod	0.722
Atlantic sea poacher	0.550
Greenland halibut	0.435
Greenland cod	0.364
Northern wolffish	0.355
PC15	
Fourbeard rockling	0.709
Atlantic hagfish	0.669
Marlin-spike (Common grenadier)	0.370
White hake	0.396
PC16	
Moustache (Mailed) sculpin	0.781
Alligatorfish	0.671
PC17	
Lumpfish	0.758
Shorthorn sculpin	0.651
Sea raven	0.333
PC18	
Snake blenny	0.730
Greenland cod	0.542
Atlantic cod	0.303
PC19	
Snowflake hookear sculpin	0.625

APPENDIX 4C. Species loadings on VARIMAX-rotated principal components for 1985-89.

Species	Loadings
PC1	
Gulfstream flounder	0.812
Fourspot flounder	0.787
Fawn cusk eel	0.782
Spotted hake	0.702
Butterfish	0.517
Red hake	0.347
Little skate	0.344
Goosefish (Angler)	0.339
PC2	
Blue hake	0.826
Longnose (Slatjaw cutthroat) eel	0.822
Rock (Roundnose) grenadier	0.811
Large-scale tapirfish	0.622
Roughhead grenadier	0.471
PC3	
Black sea bass	0.833
Northern (Common) searobin	0.786
Scup	0.770
Summer flounder	0.712
PC4	
Silver hake	0.700
Red hake	0.651
Spiny dogfish	0.621
Cusk	0.560
Ocean pout	0.395
Pollock	0.375
Shortfin squid	0.372
White hake	0.321
PC5	
Longhorn sculpin	0.781
Winter flounder	0.667
Sea raven	0.595
Yellowtail flounder	0.592
Ocean pout	0.462
Alligatorfish	0.367
Winter skate	0.342
PC6	
Atlantic argentine	0.695
Redfishes (Sebastes spp.)	0.566
White hake	0.537
Marlin-spike (Common grenadier)	0.537
Pollock	0.436
Witch flounder	0.414
Goosefish (Angler)	0.372
PC7	
Roughnose grenadier	0.867
Longfin hake	0.707
Black dogfish	0.662
Witch flounder	0.430
Redfishes (Sebastes spp.)	0.325
PC8	
Winter skate	0.694
Little skate	0.673
Windowpane	0.668
Northern sand lance	0.516
PC9	
Fourbeard rockling	0.757
Atlantic hagfish	0.676
Smooth skate	0.532
Marlin-spike (Common grenadier)	0.381
White hake	0.319
Redfishes (Sebastes spp.)	0.305
PC10	
Spotted wolffish	0.679
Atlantic wolffish	0.665
Northern wolffish	0.602
Atlantic cod	0.407
Roughhead grenadier	0.361
Greenland halibut	0.312
PC11	
Offshore hake	0.825
Blackbelly rosefish	0.741
Shortnose greeneye	0.727
PC12	
Thorny skate	0.678
American plaice	0.642
Atlantic cod	0.363
Witch flounder	0.301
Shortfin squid	-0.323
PC13	
Moustache (Mailed) sculpin	0.700
Snowflake hookear sculpin	0.647
Alligatorfish	0.560
PC14	
Polar sculpin	0.680
Greenland halibut	0.500
Roughhead grenadier	0.495
Greenland cod	-0.395
PC15	
Arctic cod	0.763
Atlantic sea poacher	0.679
Greenland cod	0.384
Greenland halibut	0.331
PC16	
Atlantic halibut	0.750
Haddock	0.654
PC17	
Lumpfish	0.779
Shorthorn sculpin	0.596
Sea raven	0.465
PC18	
Cunner	0.630
Winter flounder	0.402
Snake blenny	0.364
PC19	
Smooth dogfish	0.745
Summer flounder	0.310
Northern sand lance	-0.405

APPENDIX 4D. Species loadings on VARIMAX-rotated principal components for 1990-94.

Species	Loadings
PC1	
Blue hake	0.810
Longnose (Slatjaw cutthroat) eel	0.783
Rock (Roundnose) grenadier	0.749
Roughhead grenadier	0.698
Large-scale tapirfish	0.486
Northern wolffish	0.484
Spinytail skate	0.385
Greenland halibut	0.372
Marlin-spike (Common grenadier)	0.367
PC2	
Black dogfish	0.790
Marlin-spike (Common grenadier)	0.766
Longfin hake	0.694
Redfishes (Sebastes spp.)	0.647
Witch flounder	0.634
White hake	0.476
Greenland halibut	0.305
PC3	
Black sea bass	0.842
Northern (Common) searobin	0.838
Summer flounder	0.784
Scup	0.779
Smooth dogfish	0.507
PC4	
Gulfstream flounder	0.814
Fourspot flounder	0.796
Fawn cusk eel	0.749
Spotted hake	0.688
Butterfish	0.500
Little skate	0.351
Red hake	0.319
PC5	
Longhorn sculpin	0.807
Sea raven	0.655
Yellowtail flounder	0.648
Winter flounder	0.645
Ocean pout	0.499
Haddock	0.348
PC6	
Silver hake	0.721
Red hake	0.692
Goosefish (Angler)	0.679
White hake	0.544
Ocean pout	0.428
Spiny dogfish	0.397
PC7	
Windowpane	0.751
Winter skate	0.725
Little skate	0.695
Fourspot flounder	0.309
PC8	
Moustche (Mailed) sculpin	0.714
Alligatorfish	0.675
Greenland cod	0.540
Snowflake hookear sculpin	0.517
Snake blenny	0.404
PC9	
Cusk	0.773
Pollock	0.670
Atlantic argentine	0.455
Spiny dogfish	0.362
PC10	
Shortnose greeneye	0.753
Offshore hake	0.748
Blackbelly rosefish	0.747
PC11	
Atlantic wolffish	0.735
Spotted wolffish	0.733
Northern wolffish	0.418
PC12	
Thorny skate	0.768
American plaice	0.620
Smooth skate	0.456
Atlantic cod	0.369
Witch flounder	0.325
PC13	
Atlantic sea poacher	0.799
Arctic cod	0.788
Greenland halibut	0.404
PC14	
Atlantic hagfish	0.680
Fourbeard rockling	0.670
Smooth skate	0.335
Snowflake hookear sculpin	0.311
PC15	
Atlantic halibut	0.718
Haddock	0.657
PC16	
Lumpfish	0.755
Shorthorn sculpin	0.648
Sea raven	0.371
PC17	
Cunner	0.681
Butterfish	0.416
PC18	
Roughnose grenadier	0.765
Polar sculpin	-0.374
PC19	
Northern sand lance	0.766

[1]Species with loadings $\geq$ 0.5 are printed in bold type; species with loadings between 0.3 and 0.5 are printed in standard type.