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Northeast Fishery Management Task Force

Definition of Management Units

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PREFACE

This document is the result of studies originating within the Northeast Fishery Management Task Force. The Task Force, organized in 1979 by the New England and Mid-Atlantic Fishery Management Councils and funded by the NMFS, seeks to promote discussion and dialogue on the major issues of fishery management and to explore the effects of various fishery management alternatives.

Composed of representatives from the fishing industry, Regional Fishery Management Councils, federal and state agencies, academic institutions, and general public, the Task Force will operate in three phases. The first phase will assemble background information for identifying and analyzing management options. The second phase will examine this background information to determine the data requirements, regulatory measures, administrative procedures, and enforcement methods associated with each management option. The third phase will critically review the various options for application to specific fisheries, particularly the Atlantic demersal finfish fishery.

This document is one of eight developed under Phase I operations, all of which are being issued in the *NOAA Technical Memorandum NMFS-F/NEC* series. This document and six others functionally serve as appendixes to the eighth and leading document for Phase I operations—"Overview Document of the Northeast Fishery Management Task Force, Phase I."

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NOAA Technical Memorandum NMFS-F/NEC series

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I. INTRODUCTION

Under the Fishery Conservation and Management Act of 1976 (FCMA), the United States assumed responsibility for the establishment of fishery management plans and policies for the fish stocks that are endemic to an area designated as the Fishery Conservation Zone (FCZ). Fishery management plans (FMP) prepared pursuant to the FCMA must carefully define the nature of the fishery which is expected to be subject to the provisions of the plan and the objectives which these provisions are expected to achieve. The FCMA, however, provides little specific guidance in determining the appropriate dimensions of a management unit, although National Standard 3 requires that to the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks shall be managed as a unit or in close coordination. This national standard requires management to recognize two aspects of a management unit: (1) species naturally co-occur on fishing grounds, and as such are subject to being jointly harvested; (2) species commonly interact at the harvesting, processing, and market levels, so that net benefits to the industry derive from a range of commercially and recreationally important species. The various dimensions of management units are discussed in the following sections.

II. RESOURCE DIMENSION OF MANAGEMENT UNITS

Determination of management units for fisheries in the U.S. Fishery Conservation Zone in the Northwest Atlantic should take into account the distribution and mixture of various species which vary by season, geographical zone, and water depth. Most fishing in the Northwest Atlantic for finfish species is conducted by means of bottom otter trawls which are non-selective except to the extent that they partially exclude fish below a certain size, depending on the cod end mesh employed in the net. Fishing for certain species may be successfully carried out with pelagic trawls or purse seines (e.g., pelagic species such as sea herring and Atlantic mackerel) resulting in pure or nearly pure catches of target species, but this component of the overall fishery in the Northwest Atlantic is presently much smaller than the traditional mixed species demersal finfish fishery.

The following is a generalized description of the "pure" pelagic fisheries and the seasonal and depth distribution of approximately two dozen principal commercial finfish and squid species in the (1) Gulf of Maine, (2) Georges Bank, (3) Southern New England, and (4) Middle Atlantic areas. This description is intended to illustrate the dimensions of the problem associated with fishery management in a multi-species fishery. Variations in seasonal, geographic, and depth distributions (Figure 1) must be considered in management units and suggest the possibility of area designations being the basic component of management units.

PELAGIC FISHERY RESOURCES

Sea herring, Atlantic mackerel, and river herring are schooling, pelagic, highly migratory species. In the Gulf of Maine, juvenile herring are available in summer and autumn in inshore areas. Adults are concentrated in late summer and autumn at spawning areas. Herring, which spawn in the Gulf and on Georges Bank, overwinter in Southern New England-Middle Atlantic waters generally inside 80 meters (40 fathoms) as far as Chesapeake Bay, but generally are not as tightly schooled then as during the later summer-early autumn spawning period. As warming begins in the spring, these fish begin migrating east and north towards the Northern Georges Bank-Nantucket Shoals area for autumn spawning. Gulf of Maine spawners overwinter in Long Island Sound and Southern New England waters and also return north, beginning in the spring.

Mackerel (both northern and southern components) overwinter along the edge of the continental shelf from Georges Bank to Cape Hatteras. In March-April they begin moving inshore and north and east. Prior to spawning during April-June primarily in the New York Bight (southern component), they are tightly schooled, but tend to be less concentrated during the summer as they distribute themselves along the coast of New England and to some extent on Georges Bank. The northern component spawns in the Gulf of St. Lawrence.

Both species undergo daily vertical migrations, being closer to the bottom during the day and nearer the surface at night; consequently there is some potential for catching additional species when using bottom trawls during daylight. In the past, the largest catches have occurred prior to spawning for both species: in late summer-early autumn for herring, and in the late winter-early spring for mackerel.

River herring (i.e. alewife, blueback, shad) at certain times of the year can be considered targets of a "pure" pelagic fishery. These species range throughout the entire area from the Middle Atlantic to the Gulf of Maine. Adults move inshore in the spring after overwintering

offshore to spawn in the rivers, at which time the traditional U.S. fishery has been conducted. Chesapeake Bay is the principal spawning area, but rivers along the entire coast support river herring spawning runs. After spawning, the adults return to the sea (fish spawning in the Middle Atlantic tend to move northward) and are loosely distributed throughout the continental shelf waters in summer and autumn. They move offshore to deep water during the winter and begin to concentrate before migrating inshore to spawn. These pre-spawning concentrations, particularly in the Middle Atlantic, have been vulnerable to otter trawl fisheries (e.g., distant water fleets in the late 1960's-early 1970's).

GULF OF MAINE FISHERY RESOURCES

This area, by virtue of its colder water temperatures, has some permanently residing boreal species but many summer migrants as well. Redfish are relatively sedentary and occupy primarily the deep waters down to 350-400 fathoms. Cod are distributed throughout most of the Gulf from the shore to 200-300 fathoms. Haddock are found mainly in the southwestern part of the Gulf in waters less than 100 fathoms. Pollock, which are found throughout the Gulf but most abundantly in the shallow areas (less than 80 fathoms), are migratory throughout the Northwest Atlantic, and are most available at spawning time in the southwestern part of the Gulf. Cusk are found in waters deeper than 10-15 fathoms, but prefer rocky ledges; ocean pout are common throughout the Gulf at moderate depths. American plaice and witch flounder are the two most common flounders, being found in waters greater than 20 fathoms. Winter flounder are common inside of 30 fathoms; and yellowtail are found primarily in the shallow southwestern part of the Gulf particularly off Cape Cod. Red hake and white hake are found in the Gulf throughout the year, preferring shoaler water during the summer and deeper water in the winter; white hake appear to be the more widely distributed of the two species and prefer deeper water. Silver hake are common in the summer months along the edge of the Gulf in shallow water; some retreat to deep water in the winter and others apparently migrate to Southern New England-Middle Atlantic waters to overwinter. Scup and butterfish migrate as far north as the southwestern part of the Gulf in summer. Short-finned *(Illex)* squid are found throughout the Gulf in summer but overwinter along the edge of the shelf. Long-finned *(Loligo)* squid are not common in the Gulf.

GEORGES BANK FISHERY RESOURCES

Georges Bank is a highly productive area, but undergoes substantial seasonal changes in species abundance and distribution. Cod and haddock are distributed all over the Bank but are most abundant on the eastern half. Cod range to about 250 fathoms whereas haddock are found in waters less than 100 fathoms. Pollock are found in the Georges Bank area during the entire year but are most prevalent in the northwestern part. Silver, red, and white hake overwinter in deep water around Georges Bank and move onto the Bank to shoaler water in the summer and autumn. Yellowtail and winter flounder are permanent residents of the Bank, and widely distributed in waters less than 50 fathoms, most abundantly on the central and western parts. American plaice are found along the northern part of Georges in deeper water. Sand flounder and four-spotted flounder are taken throughout the Bank with sand flounder found to depths of about 40 fathoms and four-spotted flounder to about 75 fathoms. Summer flounder are found on the southwestern part of the Bank, occurring in deep water (greater than 75 fathoms) in winter and spring and in shoal water in summer and autumn. Redfish are found in deep water around the perimeter of the Bank; tilefish are restricted to a narrow strip of shelf edge in water from 50 to 200 fathoms. *Loligo* and *Illex* squid are found in deep water along the edge of Georges in winter and move further inshore to shoal water in summer. Summer and autumn residents on Georges Bank (southwest part) include butterfish and scup.

SOUTHERN NEW ENGLAND FISHERY RESOURCES

The zone extending from Nantucket Shoals to Hudson Canyon marks the approximate northern limit for many of the warm water species which migrate northward in the summer. Fish north of here (Georges Bank-Gulf of Maine) consist mainly of boreal species. Hake and flounder species are generally the most prevalent year-round. Silver hake and red hake concentrate in deep water during winter and spring (although in winter they are found inshore in the Hudson Canyon area) and move inshore and northeasterly in summer. Yellowtail are distributed throughout the area out to about 50 fathoms. Winter flounder are also very abundant, their distribution extending into the estuaries. Sand and four-spotted flounder are also present. Summer flounder are found offshore (deeper than 75 fathoms) in the winter and inshore to the beach in the summer and autumn. Cod are found primarily on the Nantucket Shoals in the warm months but migrate west and south as far as New Jersey in the winter. Haddock are rarely found west of Nantucket Shoals. Pollock venture as far southwest as New York-New Jersey in winter but are not abundant there. Tilefish are found along the entire edge of the shelf in a narrow deep-water band. *Loligo* and *Illex* squid, scup, and butterfish are found in deep water (deeper than 75 fathoms) along the edge of the shelf during cold months and move inshore to shoaler water in the warm months. Black sea bass and weakfish are found along the inshore area during summer and autumn and overwinter offshore in the Middle Atlantic area.

MIDDLE ATLANTIC FISHERY RESOURCES

The zone from Hudson Canyon to Cape Hatteras is characterized by an abundance of species in the

summer, but fewer in the winter. Principal year-round species include silver and red hake; summer, winter, and yellowtail flounder; squid; and scup, butterfish, and black sea bass. Red hake extend south to about Chesapeake Bay and are found primarily along the outer half of the shelf. Silver hake are found as far south as Cape Hatteras, but are more abundant off New Jersey; they tend to overwinter in deep water and move closer inshore during the warm months. Summer flounder migrate to deep, offshore waters during winter-spring and return to coastal waters during summer-autumn; they extend south to South Carolina. Winter flounder are found as far south as Chesapeake Bay and throughout the mid-portion of the shelf; they move more inshore during the cold months. The major area of yellowtail abundance extends to about New Jersey although some are found as far south as Chesapeake Bay. *Loligo* and *Illex* squid both overwinter along the edge of the shelf throughout the entire Middle Atlantic zone and move closer inshore during the summer. Scup, butterfish, weakfish, and black sea bass prefer the deeper, offshore waters during winter and move north and inshore during the summer. Cod are found in the Middle Atlantic primarily during winter-spring, some remain in cold water cells in the area east and north of Hudson Canyon, and the bulk migrate back to the Nantucket Shoals area for summer-autumn. Tilefish are found along the edge of the shelf from 50 to 200 fathoms.

III. ECONOMIC DIMENSIONS OF MANAGEMENT UNITS

In the previous section, discussion was focused on the commercial implications of the geographical/seasonal availability and the co-occurrence of important species off the Northeast coast of the United States. Many of the species mentioned are of recreational as well as commercial significance, while several other species, not noted, are primarily recreational. The following discussion of the economic dimensions of management units will again focus on commercial aspects of the important fisheries, drawing examples from New England and the Mid-Atlantic; the principles illustrated, however, can be extended to the recreational fishery as a special case.

Economic species interactions, in many cases, follow directly from species distribution and behavior. In general, three categories of economic interaction can be identified.

1) Joint harvesting relationships, often described as by-catch relationships, are common in the majority of New England and Mid-Atlantic trawl fisheries. They exist because trawl gear usually does not harvest individual species selectively. The extent to which species are harvested in conjunction with others is best illustrated in the New England mixed trawl fishery. Figure 2 shows that many species are harvested on trips where they account for less than half of the catch most of the time. For only a few species can the fishery clearly be called "directed," and even then there is significant by-catch. Thus, a large proportion of the total catch of a given species is often derived from small shares of the total catch on many individual trips. The implication for definition of management units is that concentration on "target" species in most fisheries is not an acceptable criterion because joint harvesting relationships imply management impacts on "by-catch" species as well.

2) The substitution among species which make up the total landings of a trip is another form of economic species interaction at the harvesting level. As a fisherman's expectation of net revenues increases from one species over another, he will shift his fishing effort toward the more profitable species. Such changes in relative expected species revenue are commonly associated with seasonal change in species abundance and availability. Seasonal switching of effort among species as a means of improving the economic returns to fishing is the rule rather than the exception in most trawl and fixed gear fisheries. Table 1 illustrates the annual dependence of certain New England ports on revenues from various species, while Figures 3 and 4 illustrate the seasonality of the species catches in two of these ports. Management measures focused on one or a group of seasonally co-harvested species may affect or constrain the switching behavior of fishermen, and consequently, economic returns to the industry. The implication for management unit definition is clear: these units must encompass or be sensitive to the range of species which, on an annual basis, contribute to the total expected net revenues of the fishery.

3) A third form of economic species interaction occurs at the market level. Many species are substitutes in various market sectors. Moreover, economic demand studies show that the price paid to fishermen for one species may depend on landings of another. This appears to be the case for the ex-vessel price of cod relative to the landings of haddock, and implies competition between these species at the market level. Clearly market effects have regional implications. For example, the ex-vessel price for sea scallop meats is a function of landings in the New England and Mid-Atlantic regions, imports, and the value of other competitive species (e.g., lobster). This implies that the expected revenue to one fleet sector from the harvesting of a species cannot be evaluated separately from the harvest of the same or competitive species by other fleet sectors. The scope of management transcends the multi-species harvesting practices of specific fleet sectors and includes the multi-species nature of fisheries from a regional perspective. Management units must reflect this. Species which to a large extent are harvested jointly, or which individually contribute

in a seasonal pattern to the earnings of various fleet sectors should be recognized as the resource basis for a management unit.

IV. MANAGEMENT IMPLICATIONS

The preceding sections discuss biological and economic considerations bearing upon management unit selection and suggest the desirability of defining management units as broadly as possible. However, various practical constraints exist upon the extent of the resource base which can be included within a management unit. These constraints may derive from the institutional structure for managing a broad range of regional fishery resources, from jurisdictional authority, and from practical limitations to operational management systems.

The rationale for defining a management unit in terms of an extended resource base is that management objectives and measures focusing on one or a group of species within a fishery can be expected to affect other species supporting the fishery at several operational levels. Broad definition of a management unit requires that management strategies be (1) simultaneously determined for those species requiring regulation, and (2) sensitive to impacts on commercially-important, non-regulated species and species which are likely candidates for fishery development. Tradeoffs will probably be necessary in selecting species for inclusion within a management unit. It is important to recognize, however, that even though relatively few species may be chosen for regulation, a broad management unit requires any management system to be evaluated in terms of its overall impacts on the multi-species fishery.

In fisheries which are characteristically directed at a single species, such as the scallop fishery, the management unit may only need to address the range of regional fisheries. However, it should be recognized that for some fleet sectors, the directed species (scallops) may supply only a portion of the annual revenues. Where management measures directed at scallops do not affect other fishing activities or options, management units may reasonably be defined independently.

The inclusion of various regional fleet sectors within a fishery management unit should not imply diminished flexibility in establishing management strategies consistent with the unique characteristics of each component fishery. The unique characteristics of a given fleet sector, including traditional patterns of operation, may clearly justify the establishment of a management system for that sector which is distinct from all others. Nevertheless, the attributes of each component management system within the management unit will have to be considered with reference to all others in evaluating the overall prospects for achieving the management objectives.

Many of the species which support the fisheries of New England and the Mid-Atlantic may be found both within state territorial seas and the FCZ. Management units for these species must transcend jurisdictional boundaries; although management plans developed under the FCMA may initially be enforced only in the FCZ, the plans must be designed to be responsive to the entire management unit. Where the management unit extends into state territorial seas, it is reasonable to expect states to cooperate with the regional management system, implementing complementary management measures.

V. CONCLUSION

In general, three conclusions may be drawn with respect to management unit definition.

1) Management units must be sensitive to the seasonal and geographical distribution of the fishery resources which are the focus of the various regional commercial and recreational fishing interests. The co-occurrence of these species must be recognized and the resultant by-catch implications considered.

2) The multiple-species focus of most New England and Mid-Atlantic commercial fishing operations must be reflected in the choice of management units. In many cases these multiple species operations are carefully designed to generate the maximum net revenue from a set of geographically and seasonally available species. The management unit needs to consider all of these complementary species in order to insure that the management system has minimum impact on the flexibility and profitability of such fisheries.

3) The management unit must extend over the natural geographic range in which a species is available to the fishery. Where appropriate, the management unit must transcend jurisdictional boundaries; institutional arrangements must be made to ensure effective implementation of the management system in all areas.

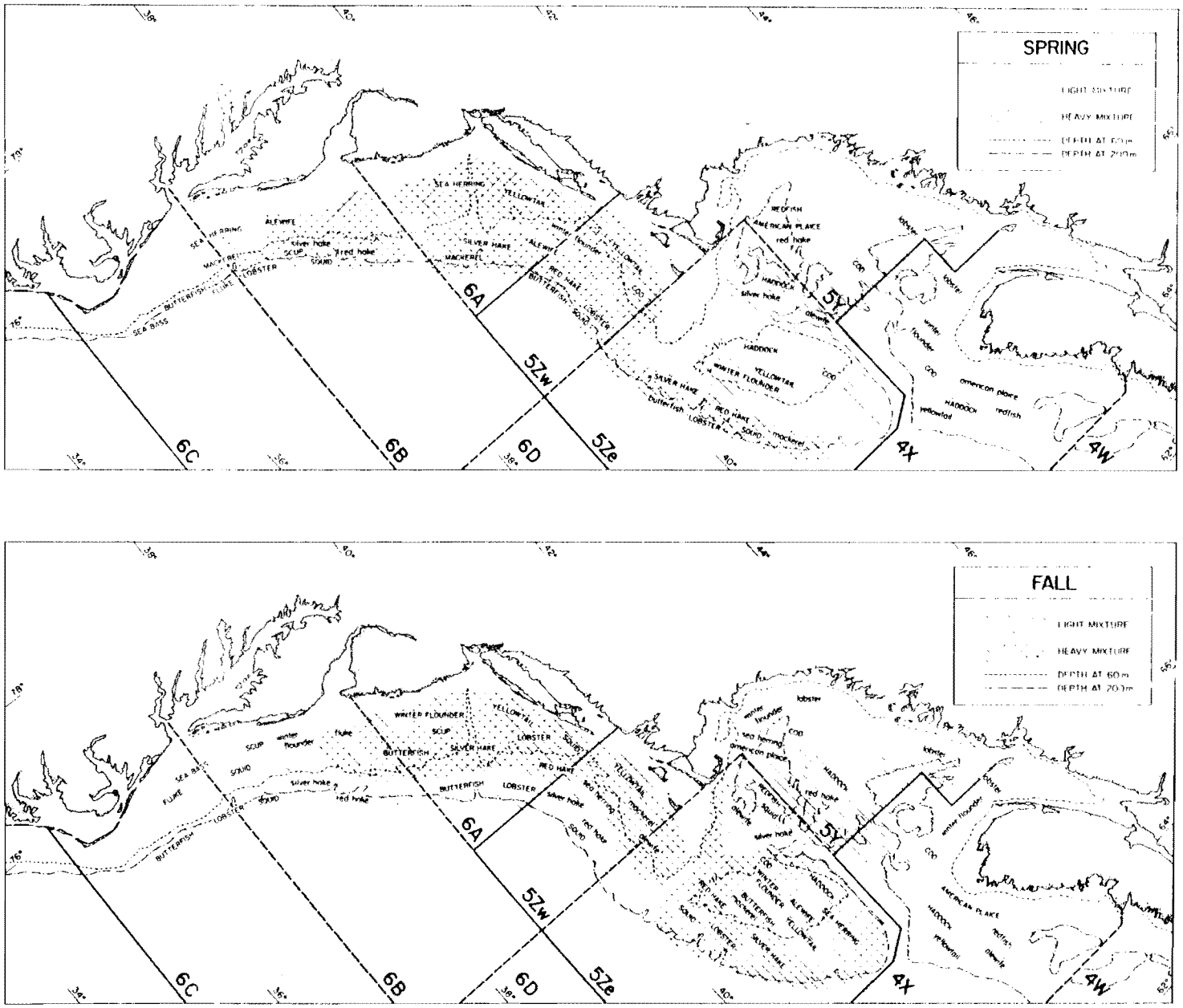


Figure 1. Generalized diagram of mixture of important species vulnerable to bottom trawling—based on plots of individual catches of bottom trawl surveys (from Grosslein and Bowman 1973).

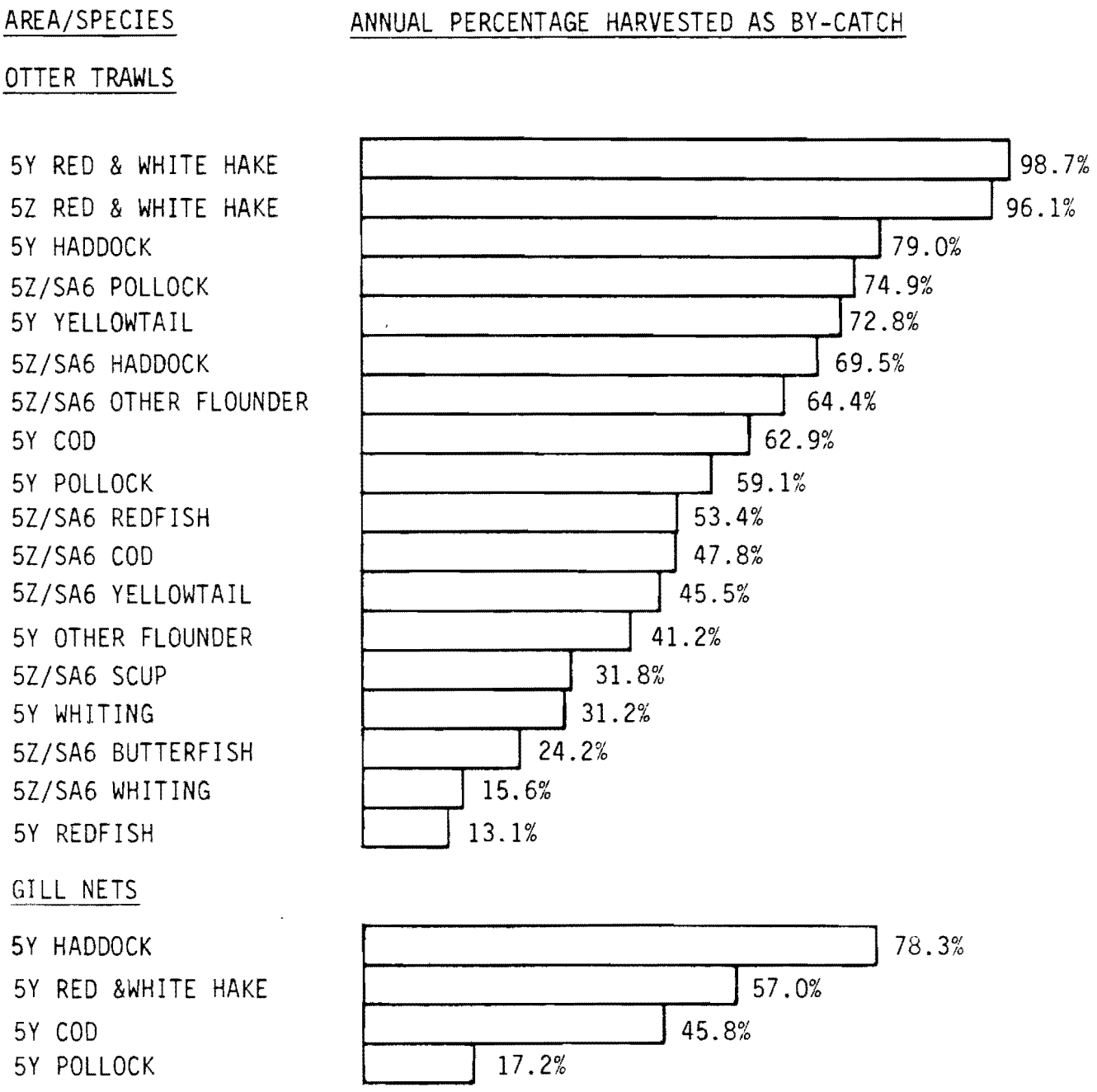


Figure 2. Percentages of total annual catch, in major fishing areas, of various groundfish species taken as "by-catch" by otter trawl and gillnet (i.e.: species making up 50% or less of individual trip catch; 1978).

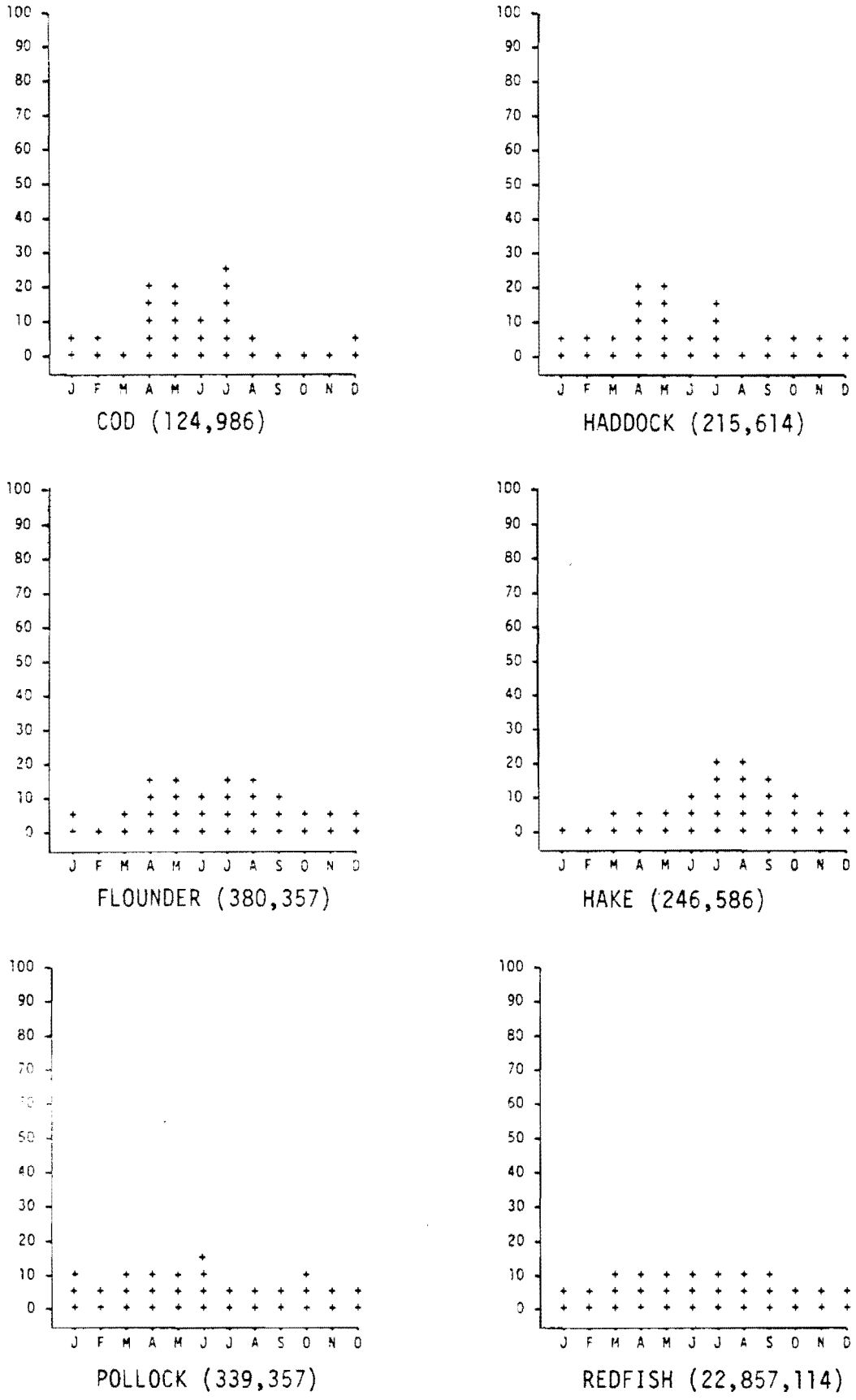
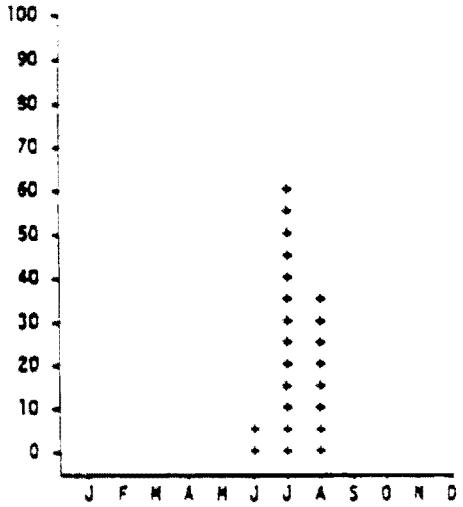


Figure 3. Monthly percentage distribution of otter trawl landings of selected species by port of landings, 1970-1976. (Number in parenthesis is the average annual landings for the seven year period in pounds.)

(cont'd)

Figure 3 (cont'd)

ROCKLAND COUNTY



WHITING (219,986)

A mark at the zero level represents a percentage of landings greater than 0 but less than 2.5 percent.

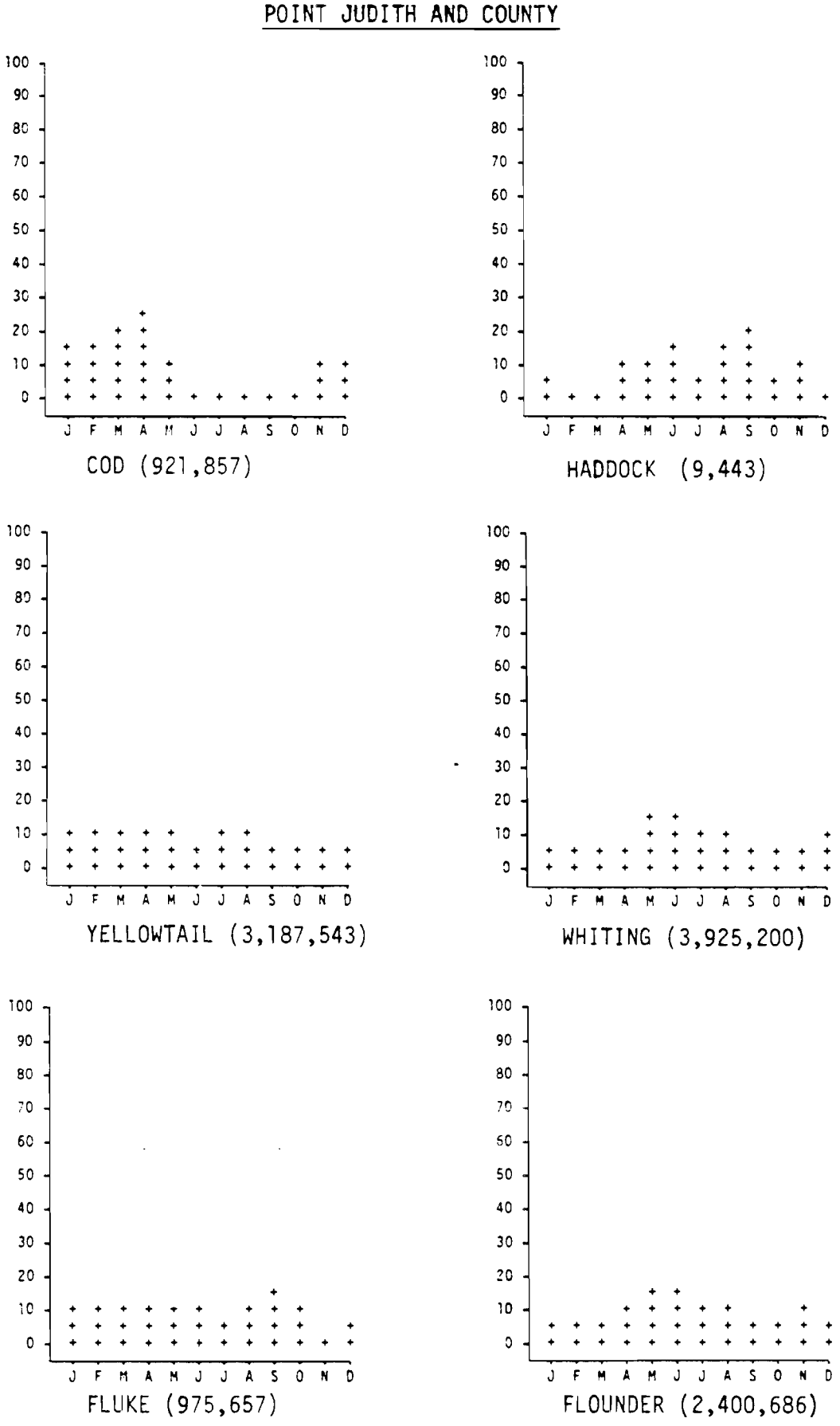
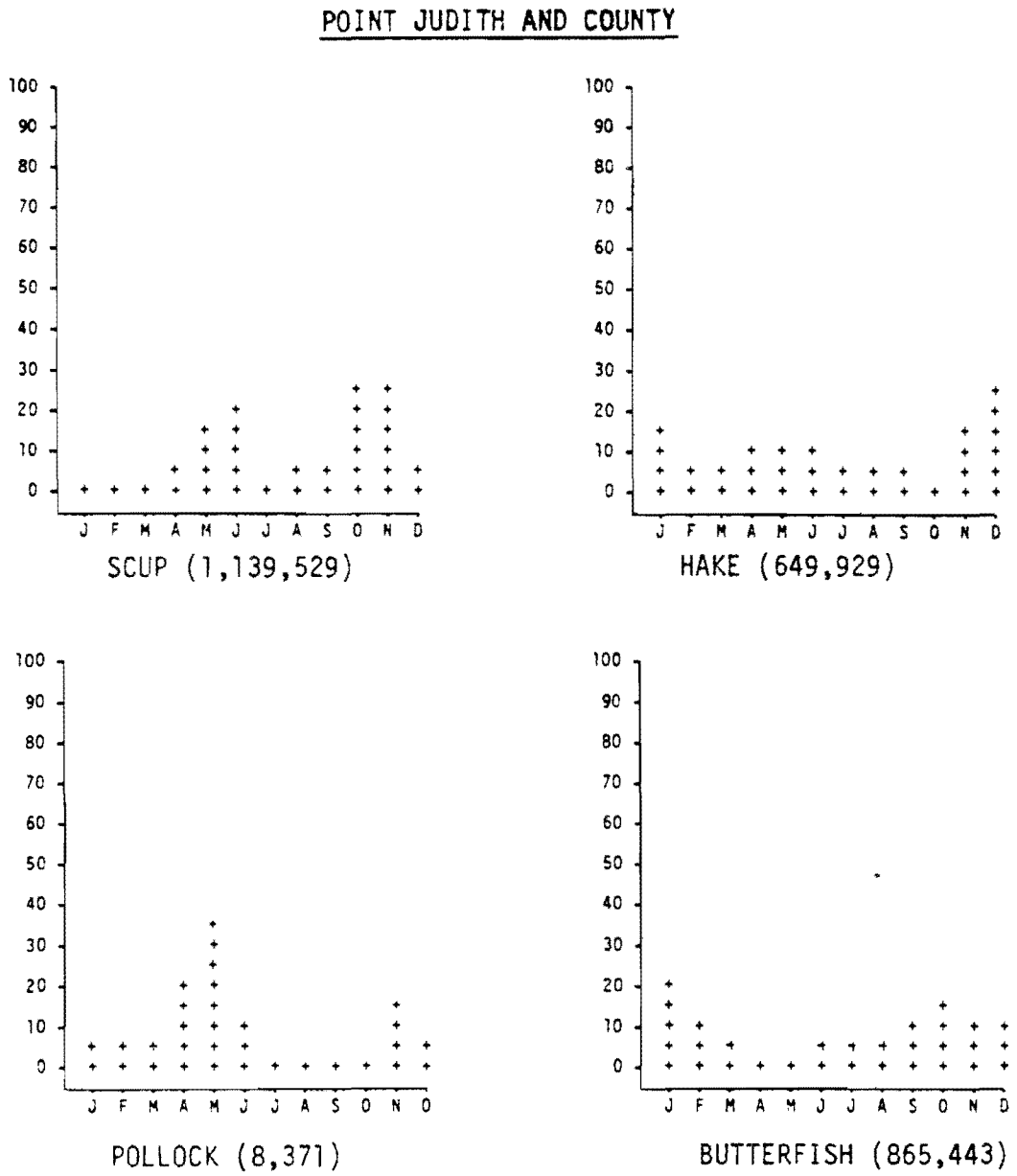


Figure 4. Monthly percentage distribution of otter trawl landings of selected species by port of landings, 1970-1976. (Number in parenthesis is the average annual landings for the seven year period in pounds.) (cont'd)

Figure 4 (cont'd)



A mark at the zero level represents a percentage of landings greater than 0 but less than 2.5 percent.

Table 1
Recent Annual Species Revenues (%) to Otter Trawls by Port

New Bedford	1978	1976	Newport	1978	1976	Pt. Judith	1978	1976
Yellowtail	30.0	44.0	Yellowtail	25.3	33.1	Butterfish	27.0	5.9
Flounder	28.2	19.5	Flounder	22.5	11.0	Flounder	16.8	9.6
Cod	24.0	18.6	Fluke	19.9	30.2	Fluke	15.1	32.2
Haddock	11.2	4.6	Cod	10.5	44.4	Whiting	10.2	10.3
Lobster	2.3	1.6	Loster	6.3	12.8	Yellowtail	9.0	9.5
Fluke	1.7	5.2	Haddock	5.1	1.7	Scup	4.9	9.0

Rockland	1978	1976	Portland	1978	1976	Gloucester	1978	1976
Redfish	57.7	73.0	Flounder	39.2	16.2	Flounder	20.3	12.9
Flounder	21.4	10.6	Redfish	29.6	46.5	Cod	19.3	25.0
Haddock	6.4	5.6	Haddock	13.2	10.5	Haddock	18.9	10.9
Cod	4.8	2.9	Cod	8.2	11.4	Whiting	14.5	16.3
Pollock	3.8	2.8	Pollock	3.4	3.2	Pollock	7.7	6.8
Hake	2.3	1.6	Hake	2.4	2.8	Redfish	7.5	9.4

*U.S. GOVERNMENT PRINTING OFFICE: 1981 — 700-692/320