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Northeast Fishery Management
Task Force

The Status of the Marine Fishery Resources of the Northeastern United States

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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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TABLE OF CONTENTS

Introduction 1
Synopses of Species 2

- Atlantic Cod 2
- Haddock 2
- Pollock 3
- Silver Hake 3
- Red Hake 3
- White Hake 3
- Atlantic Mackerel 3
- Redfish 4
- Yellowtail Flounder 4
- Winter Flounder 4
- Summer Flounder 4
- American Plaice 4
- Windowpane Flounder 4
- Witch Flounder 5
- Atlantic Herring 5
- River Herring 5
- Black Seabass 5
- Skates 5
- Scup 5
- Butterfish 6
- Spiny Dogfish 6
- Angler-goosefish 6
- Ocean Pout 6
- Northern Shrimp 6
- *Loligo* Squid 6
- *Illex* Squid 6
- Bluefish 7
- Tilefish 7
- Total Finfish and Squid 7

Description of Table 7

- Geographical Range and Stock Structure 7
- Growth 8
- Age Range in Fished Populations 8
- Recruitment 8
- Maturity 8
- Natural Mortality 9
- Fishing Mortality 9
- Abundance 9
- Maximum Sustainable Yield 10
- By-catch 10

Summary and Conclusions 10
Acknowledgements 11
Footnotes 11
Literature Cited 12
Figures 14
1 Major geographical areas off the Northeast coast of the United States 14
2 Relative percentages of recreational, foreign and U.S. commercial catch to the total catch for each species in the year 1970 15
3 U.S. and foreign commercial catch values (mean total annual catch 1969-1978) 16
4 Salt water angling effort: 1960, 1965 and 1970 17
Tables 18
1 1978 total catch (MT) North and Middle Atlantic Regions as shown in Fig. 1 18
2 Annual U.S. and foreign commercial landings for major species 1969-1978 for areas shown in Fig. 2 19
3 Resource summary table 20

INTRODUCTION

The fishery resource of the Northwest Atlantic from Georges Bank to Cape Hatteras has undergone dramatic changes in many respects during the course of its regularly recorded history. Inhabited by over 200 different species of fish, this region has been of major fisheries importance since the 15th century. A number of its fisheries (Figure 1) have been of great international consequence.

In the United States many species are of considerable importance for recreational fishing. These species either inhabit coastal waters for prolonged periods of their lives, or frequent such inshore areas seasonally. The relative percentages of recreational, foreign, and U.S. commercial catch contributing to the total catch for each species in the year 1970 are shown in Figure 2 (Duel 1973, ICNAF 1972a). Data from 1970 have been presented because it is the most recent year for which recreational catch estimates are available for all species. Recreational fishing effort appears to be increasing (Figure 3) (Clark 1962; Duel and Clark 1968; Duel 1973).

The waters of the Northwest Atlantic, from Georges Bank to Cape Hatteras are among the most productive in the world in terms of finfish biomass per unit area. The current estimate of maximum sustainable yield is 900,000 metric tons (T) for finfish and squid (Brown et al. 1976). The total average catch of each species in absolute values for 1969-1978 is given in Figure 4 and the basic commercial and recreational data are given in Table 1 and Table 2 respectively. The values in Figure 3 represent the sum of all recreational, foreign, and U.S. commercial catch (food and industrial), and indicate the magnitude of the fishery for each species relative to all others. Average landings totaled 900,000 T and there were 26 species for which individual averages were 3,000 T or greater.

The major function of fisheries research is to determine resource productivity, and to evaluate natural causes of population fluctuations and man's fishing impact. Natural changes in the environment are factors largely responsible for fluctuations in fish abundance. However, the intensity of man's fishing effort can be the overriding determinant and is the only controllable factor affecting abundance.

Fisheries management in the Northwest Atlantic essentially began in 1953, when the International Commission for the Northwest Atlantic Fisheries (ICNAF), then three years old, imposed mesh-sized regulations on some fisheries (ICNAF 1953). Prior to 1960, the area off the coast of the Northeastern United States was fished almost exclusively by a coastal fleet of small U.S. vessels of under 300 gross registered tons (GRT). Fishing effort was not sufficient to impair the productivity of the resource as a whole, although a few traditional groundfish stocks were near full exploitation.

Landings during the 1950's averaged less than 500,000 T; the total resource was quite stable, and many large stocks were virtually unexploited. This situation changed dramatically in 1961, when distant-water fleets began to fish Atlantic herring[1] on Georges Bank and in the course of this activity discovered large groundfish stocks. Subsequent fishing effort was directed towards groundfish in the 1960's, and catches of groundfish and squid rose to 700,000 T in 1965 (ICNAF 1967). Groundfish catches subsequently declined, and as a result, effort was again shifted towards herring and also mackerel, resulting in a peak catch of 670,000 T of principal pelagics in 1971 (ICNAF 1972a). Landings of other finfish rose to 215,000 T in 1969 (ICNAF 1971) and landings of squid rose to a 57,000 T peak in 1973 (ICNAF 1975) (Canada is the basic source of fishery statistics for this area). Landings for all species averaged about 1.2×10^6 MT for 1971-1973 (ICNAF 1972b; ICNAF 1974a; ICNAF 1975). This is substantially larger than the MSY of 900,000 MT estimated by Brown et al. (1976). Many of the stocks heavily fished during this period of expansion suffered dramatic declines in abundance in the early 1970's. By 1974, a comprehensive management regime had been instituted under ICNAF (ICNAF 1973, 1974b). Since passage of the Fisheries Management Conservation Act in 1976, overall fishing (predominantly distant-water fleets) has been even further reduced. While there have been considerable increases in the overall resources, some stocks have not yet recovered.

This paper reviews the recent history and current status of fisheries for 28 important species in the Northwest Atlantic plus total finfish and squid. Current estimates of biological conditions that reflect production potential are presented in Table 1. Both research survey and commercial data are used for these reviews. The survey indices are those from bottom trawl surveys made by the Northeast Fisheries Center of the National Marine Fisheries Service (see Grosslein 1969 and Clark, 1979 for description of survey).

SYNOPSES OF SPECIES

Atlantic Cod

Four major geographical groups of Atlantic cod have been recognized in the waters off the northeastern United States: Gulf of Maine, Georges Bank, Southern New England, and the New Jersey coast (Wise, 1962).[2] Studies indicate that intermingling between the Gulf of Maine and the other groups is minimal while mixing between the three southerly groups is more extensive, particularly between the three Southern New England and the New Jersey populations. South of Long Island, cod eggs and larvae have been routinely recorded although the virtual absence of juvenile cod in the southern area compared to the number of adults suggests that the New Jersey population may not be self-sustaining.[3] In addition to exchanges within these areas off the northeastern United States, there is also some movement of the Gulf of Maine fish into and out of the Bay of Fundy, and some minor exchanges across the Fundian Channel from Georges Bank, to the Scotian Shelf and Browns Bank. Cod have a long history of commercial fishing in the Northwest Atlantic; there was a considerable increase in the latter part of the 1960's due to expansion of USSR, Canadian, and Spanish effort on Georges Bank.[4] This increased effort and resultant catch followed an apparently modest increase in the Georges Bank population size. Following this heavy exploitation, the population declined and the fishery became more dependent on current recruitment than formerly. Concomitantly, cod became less abundant in more southerly areas in wintertime than before. Following the reduction in the fishing effort of the distant-water fleet and the entry of the 1971 and 1975 classes into the Georges Bank population, the catch increased. Presently, the 1975 year class is maintaining itself in the population longer than those year classes preceding it despite fishing effort slightly above that which might be expected to sustain the highest catch rate in the long term. This is an indication both of the size of the year class and the reduced mortality rate compared to that of the late 1960's and early 1970's. The Gulf of Maine catch has increased considerably in recent years following entry into the fishery of some good year classes. Year classes of cod in the areas considered in this paper, have not exhibited the extreme fluctuation found in many other species. Given the past history of lower catches in the Gulf of Maine, an area which has had a long history of fishing, concern has been expressed that cod may not be able to support catches at the current level for an extended period of time.[4, 5, 6]

Haddock

The haddock stock on Georges Bank has been a classic for fishery management. Catch history and scientific data in the period from 1930 to the early 1960's indicated a very stable population despite fluctuation in year-class size (a ratio of 6 to 1 in recruiting year-class size excluding the extremely abundant 1963 year-class and about 20 to 1 including it).[7, 8, 9] The number of year classes in the population to a large degree, stabilized the stock, so that yields averaged close to 50,000 metric tons throughout the period despite the year class variability. The stock collapsed in the 1960's, the result of a series of years with very low year class production. These came just before the extremely heavy removals by the foreign fleet in the mid-1960's lowered the spawning stocks to 10% of earlier years. Throughout the late 1960's and into the 1970's, spawning produced low year classes. Variability was greater than in the earlier periods (100 to 1 excluding 1975 and about 1,200 to 1 including it).[7, 8] This indicates that recruitment at low spawning stock levels has higher variability, considerably lower sized year classes on the average, and much less frequent good year classes. The 1975 year class was extremely strong ranking with the larger ones that occurred during the pre-1964 period. The fact that such good year classes occurred so infrequently in the latter period compared to earlier, supports the overall importance of maintaining an adequate spawning stock. The 1975 year class was followed by two poor year classes similar to those just preceding it. The entry of the 1975 year class increased the population by an order of magnitude.[8] Management attempted to hold back the removals which, at this population level, would easily have yielded more than 50,000 tons of fish similar to catches occurring during the 1950's. With the higher fishing mortality rates that the present fleet is capable of exerting, the consequences of completely uncontrolled fishing would have been even more severe. The New England Regional Fisheries Management Council's goals were to hold back fishing mortality allowing the 1975 year class to recruit to the spawning stock, maintaining it at as large a size as possible until other good year classes recruited. This was intended to result in a more stable spawning stock consisting of several year classes. The results of NEFC research survey indicate that the 1978 year class, the first spawned by the 1975 year class, is of a size typical of the 1930-1960 period.

The 1979 NEFC summer research survey gave preliminary indications that the 1979 year class may also fall into that range of values. If these levels of recruitment continue, the haddock and fishing mortality held to moderate levels will soon resemble in terms of the number of age groups, spawning stock, and total abundance, the conditions existing prior to entry of the foreign fleets. This would imply a continuing yield averaging between 40,000 and 50,000 T, if fishing effort is held at moderate levels. It should be realized that yearly catches will vary about these averages.

Haddock in the Gulf of Maine have appeared over the years to follow generally the same population trends as those on Georges Bank. If this pattern continues this stock will also be in a condition similar to former periods. Its yield, however, would be on the average about 10 to 20 percent of that on Georges Bank, given historical values.[4]

Pollock

Pollock is a transboundary stock found on Georges Bank, the Scotian Shelf, and in the Gulf of Maine. The primary spawning area appears to be in the southwestern Gulf of Maine (Clark et al. 1977). Both Canada and the United States have increased their pollock fishing in recent years. Indications are that pollock are now at a level of abundance slightly higher than a few years earlier although current catch statistics are questionable, making it difficult to indicate the predicted catch for a given level of effort. There is some indication that catch per unit effort in the commercial fishery may be declining slightly, this and certain biological considerations support a conclusion that a fishing mortality lower than currently existing in the fishery would result over time in maintaining a higher sustainable catch rate, a more abundant stock size, and greater stability in the fishery. Catch levels about 20% lower than at present[10] would be required to achieve this.

Silver Hake

Silver hake are found on the Nova Scotian Shelf south to the Middle Atlantic. General distribution studies indicate that the Nova Scotian, Georges Bank, Southern New England-Middle Atlantic, and the Gulf of Maine fish have some degree of stock separation, with the greatest degree of separation being with the Nova Scotian stock. Stock analyses (Anderson et al., 1980) indicate that trends in abundance in these three southern stocks have differed over the years. There are also morphometric studies (Conover et al. 1961) reporting stock differences indicating some degree of separation and differential response to fishing pressure.

Silver hake spawning stocks on Georges Bank increased about six-fold from the middle 1950's to a peak in the middle 1960's, then declined to somewhat lower levels as fishing mortality increased greatly with entry of the distant-water fleets. Following removal of that effort, the stock has recovered to levels approximately 1½ to 2 times that of the middle 1950's, but only to about ⅓ to ¼ of the peak period size (Anderson et al., 1980). The stock now appears to be stabilizing with recent recruitment at lower levels.

The Southern New England-Middle Atlantic stock of silver hake was exploited by a U.S. industrial fishery in the 1950's. The population increased six-fold to a peak in the middle 1960's and then declined to levels slightly above those existing in the 1950's (Anderson et al., 1980). With reduction of fishing mortality and the occurrence of strong year classes, the stock is rebuilding and is now almost as large as it was during much of the 1960's.

Silver hake in the Gulf of Maine declined steadily during the latter half of the 1950's and throughout the 1960's, reaching low points in the 1970's. Poor year classes occurred during the latter 1960's. Since that time, year class strength has improved but not to the levels observed previously. The demise of the U.S.A. shrimp fishery with its associated by-catch of immature silver hake may be a factor in the improvement seen in this particular stock through 1978. Very high fishing rates occurred in the late 1950's and the very early 1960's (Anderson et al., 1980). Since then, fishing mortality has been reduced, assisting recovery of the stock. The spawning stock is now about one-third of that observed at peak levels, but about three times that observed at the lowest level of abundance.

Red Hake

Red hake are located primarily in the Georges Bank, and Southern New England-Middle Atlantic area. Distribution studies and following trends in abundance suggest that the Southern New England-Middle Atlantic fish are to some extent separate from those on Georges Bank.[11] The Georges Bank stock was essentially unfished until the middle 1960's entry of the distant-water fleets. The accumulated stock was harvested and reduced to a level at which the fishery depended on annual productivity. From the later 1960's, the spawning stock increased somewhat into the early 1970's. It has been reduced to slightly lower levels at the present time.[12] The Southern New England-Middle Atlantic red hake stock has a longer history of fishing being an important component of U.S.A. industrial catches in the 1950's. It also supported very high catches in the middle 1960's as a result of the entrance of the distant-water fleets. Fishing effort has since decreased. Abundance trends are available only for the more recent period. They indicate a relatively steady decline in abundance from peaks in the latter 1960's and the early 1970's, when the stock size was about twice that at the present time. Indications are that the recent year classes are somewhat larger than those in the early 1970's.[13]

White Hake

White hake may possibly be considered as a single stock throughout the Scotian Shelf, Gulf of Maine, and Georges Bank area.[14] Centers of abundance appear to lie in the deep areas of the Gulf of Maine. Catches have increased considerably in the 1970's, Canada taking the largest proportion. NEFC bottom trawl surveys indicate that the stock has remained relatively constant since 1968 somewhat more abundant than earlier.[14] The extent to which sustainable catches could be increased is not known.

Atlantic Mackerel

Atlantic mackerel range from Cape Hatteras to Newfoundland (Sette 1950; Anderson and Paciorkowski, in press). Stock biomass declined in 1977 to a low point about one-fifth of the 1969 peak, approximately to the level of the early 1960's; it has begun to recover since. Spawning stock has declined to a low level in 1979, but survey data indicate that it should begin to recover shortly.[15] The peak population resulted from recruitment of several very good year classes (Anderson and Paciorkowski, in press; Anderson 1979). The existence of stock recruitment relationships is not clearly evident, but it is probable that spawning stocks measurably smaller than in the early 1960's' stocks would produce fewer good year classes and more poor ones. There was a considerable restriction of distant-water fleet fishing during the late 1970's. The 1978 year class appears to be the largest in the past few years and will accelerate the rebuilding of the stock. The spawning stock can be expected to improve both in 1980 and 1981 based on entry of this year class.[15] This should bring the mackerel spawning stock significantly above the minimal levels observed at present, if harvest is maintained at the moderate levels of recent years. Restricted fishing in 1980 may not only increase the spawning potential, but should also increase yield per recruit.[15]

Redfish

The redfish stock is characterized by many year classes and very late recruitment to the fishery (Kelly and Wolf 1959; Mayo, in press).[16] In the Gulf of Maine the stock size is considerably lower than in earlier years. The fishery has become increasingly concentrated on a single year class (1971), compared to previous years in which individuals 20 to 30 years old have comprised significant portions of the catch. The 1971 year class is the only strong year class since 1963. It has now fully recruited to the fishery with apparently no significant recruitment following. Thus, to prevent further decline requires harvesting only very small catches compared to the earlier ones, which in part represented removals of accumulated stock that had built up over the years when fishing mortality was low. There are further indications that the redfish stock consists of separate groups or "pockets"; the fleet fishing a given area to low abundance, and then moving to another pocket. Presently, it appears that all "pockets" in the Gulf of Maine have been reduced in abundance (Mayo, in press).

Yellowtail Flounder

Yellowtail flounder stocks have been studied most extensively on Georges Bank and Southern New England; less is known about the Cape Cod and New York-Middle Atlantic area (Royce et al. 1959; Lux 1969; Sissenwine 1977).[17,18,19] The Cape Cod stock has been fished steadily for many years and appears to be maintaining itself at its current modest level, although recorded commercial catch-per-day is less than it was in the late 1960's.[17] The Georges Bank stock entered 1979 at very low levels, having declined considerably from the middle 1960's.[18,19] It would take several good year classes fished only moderately to rebuild this population. The Southern New England stock supported large yellowtail catches during the 1940's and again during the 1960's. Catches were low in the 1950's, as they have been recently. Pre-recruit indices indicated that these very low populations would increase in 1979; commercial fishery data confirm this.[19] The extent to which these recruits to the fishery will accumulate in the spawning stock remains to be seen. Commercial catch-per-day just prior to 1979 was quite low relative to earlier years. The present spawning stock level of yellowtail flounder may be low enough so that even with increasingly favorable environmental conditions, which seem to be occurring in Southern New England, a lower frequency of good year classes can be expected than with a larger spawning stock. Middle Atlantic catches and stock appear lower than they were in the early 1970's.

Winter Flounder

Winter flounder are distributed along the coast and out onto Georges Bank. They are fairly sedentary and there appear to be local populations along the coast. There does not seem to be an appreciable movement from Georges Bank to the inshore grounds.[20] Winter flounder in general appear to have been somewhat lower in abundance in the early 1970's than in the 1960's, possibly as a result of by-catch in the heavy offshore fishery.[20] Stock sizes in the 1970's, particularly on Georges Bank, have increased to about early 1960's levels. The commercial catch has also increased.

Summer Flounder

Summer flounder are found from Cape Hatteras to Cape Cod with the center of abundance in the Middle-Atlantic area. Populations south of Cape Hatteras may be distinct from those to the north (Wilk and Smith 1980). Commercial landings were high in the late 1950's and then declined throughout the 1960's. Summer flounders were subjected to the general increased fishing mortality in the mixed offshore fishery of the distant water fleet; with reduction of this mortality, U.S. catches have increased. Survey cruise abundance indices indicate increased abundance in the 1970's compared with the 1960's.[21]

American Plaice

American plaice are primarily found in the deeper waters of the Gulf of Maine. They are also located on the Scotian Shelf and are more important to the fisheries there than off the U.S. coast. American plaice appears to be a sedentary species; there is probably little mixture between areas. Populations appeared to decline in the latter 1960's and early 1970's and have since increased to early 1960 levels. Commerical catch is now higher than in the early 1960's.[20]

Windowpane Flounder

Windowpane flounder occur primarily in the Georges Bank and Southern New England areas. It has traditionally been a by-catch species but recently, commercial landings have increased, primarily on Georges Bank. Only the very largest individuals of this species are landed for food; others have been discarded or used for industrial purposes. On Georges Bank, the survey indices have been significantly higher during the 1970's than in the 1960's. The Southern New England indices, in contrast, indicate a slight decline from the earlier 1960's to the early 1970's followed by a modest recovery typical of many of the species which were subjected to the distant-water fleet fishery before its curtailment.[20]

Witch Flounder

Witch flounder, like American plaice, are also found in deeper water areas, predominantly in the Gulf of Maine. They appear to be relatively stationary fish and are unlikely to mix with witch flounder on the Scotian Shelf. Abundance has been fairly stable throughout the entire period. However, the lowest survey abundance indices occurred following the peak removals of the early 1970's, when total international effort approximately doubled previous levels.[20] The U.S. catch dropped after the early 1970's reaching a low point in 1976; however, in 1977 and 1978 catch and population both seemed to have recovered.

Atlantic Herring

Atlantic herring spawn in three major areas between Nova Scotia and Cape Hatteras: on northern Georges Bank, on the southwest part of the Gulf of Maine (Jeffreys Ledge) and off Nova Scotia (Lurchers Shoals). There have been fisheries for adults on the spawning grounds, and more recently on the over wintering and spring concentrations in which there appears to be some degree of intermixture between stocks. Furthermore, there is a juvenile fishery along the coasts of Maine and New Brunswick. All herring spawning stock levels are now considerably lower than in the 1960's (Anthony and Waring 1980, in press). The Georges Bank stock still appears to be extremely small as a result of the continued heavy fishing effort during a period of poor year-class production, with no firm indication as yet of rebuilding of this stock. The Jeffreys Ledge spawning area had a concentration in 1978 consisting of 1970 and 1973 year class fish. The 1976 year class appears reasonably strong and supported the bulk of the 1979 fishery in the first part of the year. The extent to which the spawning stocks rebuild depends on the degree that they are allowed to accumulate biomass. Three year olds do not often contribute greatly to the spawning stock on Jeffreys Ledge but have in certain years been major contributors on Georges Bank (Anthony and Waring, in press). When Atlantic herring stocks are very low they may remain low for a considerable period before good year classes recruit to rebuild the fishery.

River Herring

The river herring fishery is directed towards two species: alewife and blueback herring. The center of the fishery is in Virginia and North Carolina. This was entirely a U.S.A. inshore fishery until 1967 when the distant-water fleets began harvesting river herring in the offshore regions. At this time the stock declined precipitously. Despite cessation of the offshore fishery, spawning success in the major rivers has continued to be very low, and the stocks are now at historically low levels.[22] In the Gulf of Maine there has been, in contrast, a gradual but steady increase in recent years, probably due to improvement in stream conditions resulting from conservation measures.[23]

Black Sea Bass

Commercial catch statistics for black sea bass reflect a steady decline in abundance from a peak in the early 1950's. A general low was reached in the early 1970's. Recent catches have shown a modest increase but remain at about 25% of the early 1950's level. Black sea bass exhibit a sexual transformation generally between ages 2 and 5, beginning life as females and later transforming into males (Kendall 1977). Most of the exploited black sea bass consequently are males. It is postulated by Kendall and Mercer (in press) that heavy fishing pressure could cause an imbalance in the spawning population so favoring the number of females that the remaining males might not be sufficient for adequate reproduction. The recreational catch is thought to be consistently larger than the commercial, although data on the recreational catch is sketchy. In the 1970's the recreational catch comprised more than 75% of the total catch of black sea bass. Survey indices indicate that 1969 and 1974 were years of relatively high abundance. The 1978 abundance index was 44% less than the 1967-1978 average.

Skates

Skates have been taken frequently throughout the history of the U.S. trawl fishery; most of them have been discarded but some have been landed for industrial and food purposes. During the period of intense distant-water fleet fishing, skate catches also increased. The larger proportion of the catch consisted of big, little, and thorny skates. Skate abundance in trawl survey catches has declined in recent years. Increased U.S.A. trawling may to some degree be substituting for part of the distant-water fleet effort. Being a species of relatively low fecundity, skates can be expected to have a longer recovery time than more fecund species. Recruitment studies based on survey length frequency data indicate no evidence for the dominant year classes which serve to speed stock recovery in other species.[24]

Scup

Historical landings of scup reflect large fluctuations in population size (Morse 1978). Poor spawning success, increased fishing pressure (both distant-water fleets and domestic), and high discard levels of juveniles combined to reduce scup catches dramatically from the early 1960's to the early 1970's. Landings in the 1970's were about 20-22% of the peak in the 1960's and the catch in 1973 was 50% less than the 1929-1973 average. The 1976 survey abundance index was the largest in the 1967-1978 data series; the next largest value was in 1969: 36% of 1976.[23] A three-year running average for the survey indices shows an increase in 1976-1978 that more than doubles the average of previous years in the series.

Butterfish

Butterfish were the basis of a very modest U.S. fishery prior to 1960; after which these were subjected to increased exploitation from the distant-water fleets (Murawski et al. 1975). As a result, the population became dominated by younger age groups (Murawski and Waring 1978). Recently, the reduction in the distant-water fleet catch has resulted in a decrease in fishing mortality rates and an increase in the average age of the fish in the population. Recent survey cruise total abundance indices are slightly lower than the 1963-1978 average, as is the recruitment index. Nevertheless, survey indices are still well within the range of values necessary to support a fishery larger than that now existing.[25]

Spiny Dogfish

In the Northwest Atlantic the spiny dogfish ranges from Newfoundland to North Carolina, and is common in continental shelf waters down to 200 m (Jensen 1965). It undergoes diel vertical migrations, with daytime catches considerably larger than those at night. The spiny dogfish is among the most numerous species in the Northwest Atlantic. The estimated range of total biomass for the New England area alone is from 170,000 T to 225,000 T.[26] Despite the large biomass of the species, the market (both food and industrial is very small. The catch of the species in the Northwest Atlantic in most years has been significantly below the total production of the fish.[27] Recently, the U.S.A. has developed a small export market of about 2,000 T of dogfish fillets with the European nations; this has increased in 1979. The reproductive potential of the dogfish is relatively low; it is unlikely that the stock could sustain a yield of over 20% of its size for a continued period of time (Holden 1968). The 1978 survey index for spiny dogfish shows no appreciable change from the 1967-1978 average.

Angler-Goosefish

Clark and Brown (1977) estimated the biomass of angler at 18,000 T based on survey data from 1968 to 1974 for Browns Bank, Nova Scotia, to Cape Hatteras. Both food and industrial use of goosefish is low. The U.S.A. is responsible for only 4% of the removals per year from Cape Hatteras to the eastern end of the Nova Scotian Shelf since 1966. The U.S.S.R. has taken most of the remaining 96%. Since 1966, landings for food have increased. The 1978 survey index is 31% greater than the 1967-1978 average, and the 1977 and 1978 values are the largest seen since 1972.

Ocean Pout

Knowledge of historical trends in the ocean pout fishery is somewhat obscure. In the New England area, commercial landings were negligible up to and during the 1930's and most of the catch was discarded. Landings fluctuated between 21 and 52 T from 1935 to 1942. In 1943, attempts to market ocean pout as a food fish were frustrated by parasitic lesions caused by a protozoan, which proved to be a recurring problem (Sheehy et al. 1974). During the 1950's, U.S.A. landings were almost entirely industrial. Ocean pout comprised a substantial part of the total U.S. industrial fishery between 1970 and 1974. Distant-water fleet vessels were involved in the fishery from 1966 to 1974, peaking in 1969 at 27,000 T. It declined to an average level of 5,600 T from 1970 to 1974. Since 1974 the ocean pout fishery has been essentially domestic only. Declines in relative abundance of 74% for Southern New England and 82% for Georges Bank have been reported for the period 1963 to 1974 (Clark and Brown 1977). Total U.S.A. landings in 1977 were 1,060 T; more than 50% of these were marketed as food fish. The 1978 survey index is 51% greater than the 1976 to 1978 average. Years with poor indices seem to be preceded by years of relatively heavy fishing.

Northern Shrimp

Landings of northern shrimp from the western Gulf of Maine peaked at 13,000 T in 1969 but have recently become essentially non-existent. Water temperatures are declining and may be more favorable now than in the recent past for production of good year classes to build a larger spawning stock and a single year class fishery. In latter years, fishery effort has concentrated on several age groups including small males prior to their transformation into female spawners; historically the Maine winter fishery focused on egg-bearing females (Anthony and Clark 1978; Clark and Anthony, in press; Dow 1977; Wigley 1973).[28,29] At this time the fishery is closed to allow the stock to recover to levels at which good reproduction can be expected more frequently.

Loligo Squid

Loligo squid populations are very volatile; the species has a short life span, and exhibits drastic year-to-year changes. Although records of squid were not kept in the early years of the survey cruises, they were relatively low in abundance during most of the 1950's. In the late 1960's, the population expanded rapidly and has continued to expand through the 1977 period (Lange and Sissenwine, in press). During this time, an extensive fishery was developed by the distant-water fleets. Since the implementation of the FMCA this fishery has continued but at lesser harvest levels. The U.S.A. fishery remains small. The 1978 fall survey index was low, but *Loligo* squid were abundant in the spring surveys at smaller lengths than usual, indicating that in 1978 there had been a late spawning.[30] Thus, in terms of numbers, abundance remains at the high levels observed over the last decade.

Illex Squid

Illex squid are a species with a short life span (about 1 year) which can also exhibit drastic changes in abundance from year to year. Since environmental conditions tend to be similar in adjacent years, abundant years tend to occur together, as do poorer years. In the last few years *Illex* has been extremely abundant relative to numbers observed earlier (Lange and Sissenwine, in press).[30] It is not known how long these high levels will continue, but it would certainly be expected that spawning would eventually result in lower stock sizes as observed previously. *Illex* is a wide ranging species from North Carolina to Newfoundland with extensive fisheries in Canadian waters. The extent to which fisheries in these areas may affect abundance in the Northeastern United States is not known.

Bluefish

Bluefish is a swift-swimming migratory pelagic species that is found in loosely aggregated feeding schools both inshore and offshore. Present knowledge of the distribution and abundance of bluefish is largely dependent on nearshore recreational and commercial catches with only supplemental data provided by bottom trawl catches of research vessels. Most information is, therefore, limited to the period bluefish spend in coastal and estuarine waters. However, there is evidence that their distribution extends farther out on the continental shelf than is generally believed, as indicated by the absence of both large and small individuals during winter in South Atlantic waters and by the sporadic catches made by offshore otter trawlers (Wilk 1977).

Bluefish is one of the most important recreationally-fished species for both food and sport, far exceeding the commercial catches. The North Atlantic and Middle Atlantic anglers' catch was estimated at 16,765 T in 1960 (Clark 1962). It rose to 35,932 T in 1965 (Duel and Clark 1968) and to 45,305 T in 1970 (Duel 1973). The commercial catch range (1950-1970) for the New York Bight was between 90 and 1,220 T per year with an average value of 635 T per year. For the period 1973-1975, commercial landings increased to over 2,000 T per year. Throughout the 1970's, research vessels have frequently caught bluefish in offshore waters of the Middle Atlantic and Georges Bank. The 1976-1978 average stratified mean weight per tow is 26% larger than the 1967-1969 average value. It has been observed that the age composition of the catches is also quite robust, with ages 4 and older being well represented. This would indicate that the condition of the stock is relatively stable, i.e., not dependent on one or two single year classes for continued recruitment.[31]

Tilefish

Bigelow and Schroeder (1953) estimated a potential sustainable yield of 1,000 to 1,500 T per year for tilefish off Southern New England, New York, and New Jersey, based on fishing reports of the 1900's. Landings since 1915 reveal that the harvest has fluctuated considerably, but it is difficult to translate this information into terms of relative abundance because market conditions have tended to dictate the level of landings more than abundance. Since the all-time high in 1916 of 4,500 T (when the U.S. Bureau of Fisheries first campaigned to promote a food fishery for tilefish), landings have fluctuated greatly, reaching a low of 32 T as recently as 1968. In 1977 about 2,000 T were reported; this increase was due largely to a rejuvenation of longlining out of New Jersey ports. Large party boats have contributed to a steady increase in the recreational fishery since 1969. However, recreational catch remains small relative to the commercial catch (Freeman and Turner 1977). Catches of tilefish in research surveys have been completely lacking in most years and extremely small in others, due to the habitat of the species which renders capture unlikely.

Total Finfish and Squid

Total finfish and squid refers to the biomass of all species with the exception of invertebrates other than squid, and also large pelagics (swordfish, sharks other than dogfishes, tunas) and certain other fishes such as menhaden, American eel, and white perch, which enter bottom trawl catches only infrequently. The decline in total biomass during the 1960's and early 1970's to an all-time low in 1975 was the strongest evidence of the extremely high overall fishing mortality generated by the distant-water fleets (Clark and Brown 1977, 1979). Since 1975, the resource has been increasing; present stock size is estimated to have approximately doubled the 1976-1978 average by weight. A large share of the increase is due to squid and most recently to herring and mackerel. The overall biomass is now approaching the levels that existed prior to the distant-water fleet fishing in the early 1960's.[32]

DESCRIPTION OF TABLE

In the examination and interpretation of the status of fishery resources, it is important to consider some basic parameters of the populations and the potential of these populations for interrelationships and interactions in the ecosystem. We are attempting to do this by outlining the state of our knowledge for a large number of species in the accompanying tables. The table headings outline these key characteristics and a brief discussion of these characteristics follows.

1) Geographical range and stock structure.

The range of a fish population and the extent that it exceeds the boundary of a management unit have important implications for fisheries management. For example, management requirements are quite different for *Loligo* squid, which ranges only as far north as the edges of Georges Bank, than for *Illex* squid, which moves to the area off Newfoundland.

Consideration of stocks within the area breakdowns is also useful information. The term "stock" is a very nebulous one in the literature of biology. It basically implies that there is a group that has a high degree of integrity in its breeding population and exhibits similar patterns of growth and mortality rates throughout its range. It does not imply that there is no intermixing. Intermixing must occur to at least some degree or else over time stocks would evolve into quite different species or subspecies. Intermixture between stocks can occur in a number of different ways. Stocks may separate during part of the year and be totally intermixed at other times. Sometimes this intermixture may be more or less random within the same schools, but at other times fish from different spawning stocks may occupy the same general area but exist in different schools. Furthermore, even within the area of greatest genetic integrity, that is within spawning concentrations, there may be a certain degree of mixture of fish from other areas. The important point is that there be enough separation among stocks so that interactions and effects on a stock from one area are not immediately seen in stocks from other areas.

Yellowtail flounder offer a classic example of stock structure. After a period of intense pulse fishing by the U.S.S.R. in the late 1960's, the Southern New England stock dropped drastically in abundance. If there were a large degree of intermixture with the stocks on Georges Bank, there would have been a rapid evening out of the available fish in both areas. However, this did not occur. The stock on Georges Bank maintained a higher level of abundance for several years after the decline in Southern New England.

Herring stocks are another example. Herring stocks on Georges Bank began to decline prior to those in the Nova Scotia area. The result of this decline was shown first in the lack of abundance of herring in the most southerly overwintering areas: that is, off Maryland and Virginia. Resident predator species in that area which depended on herring as forage shifted to other prey species instead of moving further north where herring were still abundant. This shows how stock structure may affect interactions between species. While this does not mean that management units must be based entirely on stock boundaries, it indicates that stock considerations may be important and that in evaluating the effects of management actions on the resource one needs to examine them.

2) Growth.

In the second column we list some of the basic biological parameters describing growth. The values given where available are:

(a) κ, which is a parameter from a von Bertalanffy growth equation (von Bertalanffy 1938), measures the rapidity of growth. The larger the κ the quicker the fish grow to $L\infty$. The species with the largest κ have the greatst potential for productivity, and also some of the greatest demands for food on the ecosystem.

(b) $L\infty$, from the same equation—the maximum length which an average fish would attain if it lived indefinitely. Individual fish may exceed that average.

(c) Maximum age, which indicates the length of time that an individual cohort is in the ecosystem and available to the fishery. This maximum age is not an extreme age, but only a rough indication of the oldest fish that have been observed. Fish of this age would not be expected to be abundant in stocks where fishing pressure is heavy.

3) Age range in fished populations.

The age range in fished populations is one of the most sensitive measures of the stability in stock biomass and its productivity. We use the term 'fished populations' to refer to populations that are undergoing moderate fishing. The age range is not what would occur in an unfished stock nor does it include the very rare older fish in the moderately fished stock. We also describe the current range in age distribution with an indication of predominant year-classes. The comparison of the present range of ages with the past gives a good indication of whether or not the stock is now more variable than would occur under more moderate fishing.

4) Recruitment.

This column lists the relative range of observed age at recruitment and the most recent trends. Recruitment is generally thought to be governed by an underlying stock-recruitment relationship that comes into play primarily when a stock is at an extremely low level. However, the relationship, which limits the amount of eggs produced in the system, is then acted on by a plethora of environmental forces, such that good recruitment can come from even small spawning stock sizes and very poor recruitment from large stock sizes. Spawning stock size has its impact on the frequency of distribution of recruitment size. There is a greater probability of good year classes when spawning stocks are above some minimal level. These minimal levels, however, are not well known.

The range for average recruitment gives some indication of the variability of the stock and its sensitivity to various environmental factors. Recruitment rates range from quite stable, as in the case of cod, where observed recruitment values have fluctuated by no more than a factor between 2 and 3, to those of haddock, where the ratio reaches almost 2,700 to 1. It should be noted that the range for haddock during times of good population size is considerably less, roughly 20 to 1, and that the very high variability mentioned above reflects the fact that a period of very low recruitment and spawning stock size was included. Not only was recruitment low when spawning stock size was low, but it was also more variable (1,200 to 1).[9] The degree of variability is important when one considers that at present certain fisheries count almost entirely on production from entering year classes. The more variable the year class, the greater the uncertainty in the size of a fishable population at a given time when it is made up of very few year classes.

5) Maturity.

The table shows age at the onset of maturity, and the size at maturity. This does relate somewhat to the effects of harvesting at younger ages. Obviously when harvesting is done prior to maturity, a lower rate of harvest is required to allow the same spawning potential as when harvest begins at older ages. However, since in most cases the number of eggs produced relates to the weight of the fish and thus the age of the fish, there is, in general, an increase in potential egg production with increasing size. To get an indication of the meaning of this, we calculate the age at which, under a nonfishing situation, the maximum egg production would occur for a given year class. This is a product of the number at age from mortality rate curves for the mature component of the population, the weight at age (assumed proportional to fecundity) from growth curves, and the fecundity at weight relationships. The length of the spawning season is also given. The implication of this, of course, is that those stocks with small spawning areas and/or times would be expected to have wider fluctuations due to environmental variations than stocks with broader spawning areas and longer spawning seasons. For certain specialized stocks such as dogfish, which produce very small numbers of young and spawn perhaps every other year, such pertinent items are noted.

6) Natural mortality (M).

Natural mortality rates are one of the most difficult parameters of fish populations to estimate. Many of the values here are only approximations. They all apply to fish of sizes which can be recruited into the fishery, and larger. The higher the mortality rate the more rapidly the fish die, and the more rapidly, at younger ages, one would expect to harvest them. Low mortality rates imply a stock that would maintain itself for a considerably longer period of time. For example, at a mortality rate point of 0.2 and no fishing, one would expect 18% of the population at the beginning of the year to die of natural causes over the year, whereas in a population where M = 0.4, 33% would be expected to die during the year. Since, to a certain extent, harvesting replaces natural mortality with fishing mortality, (by catching some fish that would die naturally) the higher the natural mortality the more fish that can be harvested in a given year. When this is combined with growth, however, greater yields may come over time from individuals with lower mortality rates and an opportunity to accumulate more growth in weight in the population prior to being harvested.

7) Fishing mortality.

F_{max} is a fishing mortality rate which would result in the maximum possible yield being obtained from harvesting a given cohort or year class. Fishing at the F_{max} level has been shown in a number of cases to result in very low spawning stock sizes. Hence, an alternative value $F_{0.1}$ (Gulland and Boerma 1973) has been recommended by ICNAF in its later years, by scientific advisers to ICES, and by Canadian scientific committees after the 200-mile limit. This is a value less than F_{max} which gives almost as much yield as one would achieve by fishing at F_{max} but which results in a considerably higher stock size and a much greater catch per unit effort for individual vessels.

F_{max} and $F_{0.1}$ are given in the table when available, for both conditional and optimal cases. The conditional case assumes that the present age at entry into the fishery will remain constant, and chooses the best fishing mortality rate according to the definitions of F_{max} and $F_{0.1}$. The other F values given refer to the overall maximum, i.e., when age at entry into the fishery is included in the maximizing procedure.

Finally, an estimate of current F is presented. Where F is considerably above F_{max} and $F_{0.1}$, reductions in F will give a higher yield per recruit, a larger spawning stock, and in many cases an overall total increase in yield along with a greater catch per unit of effort. Where it is considerably below $F_{0.1}$, room for expansion is indicated.

8) Abundance.

This column lists the condition of the current stock size relative to historic levels in terms of population size. The information in the column is based on both fishery and research vessel survey data.

A simple index was devised to suggest what confidence we can place in estimates of population size trends. A rating of 1 indicates that the relative change in population size with time is considered by the assessment group at the Northeast Fisheries Center, National Marine Fisheries Service, NOAA, to be measured with considerable precision. Ratings of 2 and 3 are considered moderate or poor, while a rating of 4 indicates that the information available gives only very modest improvement over accepting the informationless state of assuming the size to be within the historic range of observed values for the stocks. Our level of confidence is influenced by the level of variability in the resource as well as by our analytical methods; it is much easier to describe large fluctuations in abundance than small ones.

It should be noted that these are very difficult kinds of ratings to make; they are, in a sense, gamblers' hunches. There is a great deal of knowledge about certain stocks, and this may be adequate, depending upon the management goal. On the other hand, even the most precise estimates of stock size possible do not pretend to estimate the stock size exactly. Estimates at any moment can only provide guidelines which adhered to over time can help to achieve management goals. They cannot be separated from management objectives but serve as necessary numerical values for developing management measures. The variance about any single point estimate may be large but the study of trends and biological characteristics provides significant information to make assessment of the stocks a valid description of relative conditions and projections of longer term results of particular harvest strategies.

The present condition of a stock relative to its historic condition is the point about the assessment which is the most valid and the most useful for decision making. When stocks are abundant, they are fairly robust against a very large number of socioeconomically oriented management objectives; i.e., management goals can be flexible. If the stocks are not in good condition, management strategies aimed at short-term ends can have quite different long-term effects. In any case, it is the relative condition of the stock which can be reliably assessed, not the yearly stock size.

9) Maximum sustainable yield.

This measure (MSY) provides a useful guide to the long-range biological productivity of the stocks, provided that the limitations of MSY are kept in mind. The maximum sustainable yield given here is based in some cases on analytical models, and in other cases it is based on observations of long-range historical catch averages. It gives an indication, not of what might be taken in any given year, but of what might be taken on the average over time, with some years being above average and some years below. That is, MSY permits potential productivity of stocks to be compared in a general way.

Year-to-year variations are due to fluctuations in environmental conditions and condition of the stock. In some cases, depending upon the history of the fishery, the year-to-year variation is greatly affected by previous fishing practices. In general, there has been no attempt to calculate an MSY that could actually be harvested on the average over time. It should be kept in mind that if one were to hold catch at the MSY level, the stock would likely decrease and the resulting average catch would be lower than the MSY value that initiated the action. In certain cases this also holds true for effort being fixed at the levels of harvest for MSY (Doubleday 1977; Sissenwine 1978). Nevertheless, the comparison of the values given here do give rough indications of the differences between stocks and their general long-range productivity.

10) By-catch.

The final column lists by-catch and distribution. One of the most important considerations in mixed fisheries is that a unit of effort may be directed at several species at the same time. Furthermore, a unit of effort directed primarily at one species will catch, less effectively, species that are associated with it in the environment. Finally, in the mixed fishery situation even if a fisherman is capable of directing effort to a relatively pure species catch, when other species of value are located close by, the trip often consists of directed effort at several species; to make an economically viable trip, fishing is directed at several species. This column lists the historically-observed by-catches, where data are available, and also makes inferences from the seasonal, horizontal and vertical distribution patterns of various species. For example, certain species which migrate through the water column may yield relatively pure catches when they are high in the water column, but when they are on the bottom during other parts of the day they become components of the mixed trawl fishery. Other species occupy seasonally quite separate areas, so that the by-catch at different periods of the year may be quite different both in amount and in species composition.

Basic life history data in this table follows Bigelow and Schroeder (1953) and Grosslein and Azarovitz (in press). Spawning times are based primarily on Colton et al. (1979). Information is taken from the documents cited in the text as augmented by unpublished data in the files of the Northeast Fisheries Center.

In summary, the information in the table furnishes important background information upon which decisions regarding resource utilization can be realistically made.

SUMMARY AND CONCLUSIONS

During the last twenty-five years, the fishery resources of the waters off the coast of the Northeastern United States underwent a large increase in fishing mortality. The fishery changed from one concentrated on relatively few stocks to a wide-based industry directed at the total finfish and squid biomass. Total resource abundance declined as a result and the annual harvest exceeded total productivity. Since 1975, the trend has been reversed, overall fishing effort has declined and the stocks have begun to recover, now approaching levels that existed prior to entry of the distant-water fleets. Certain components of the resources (e.g. haddock) were fully exploited prior to the entry of the distant-water fleets and continue to be so today; in these stocks conditions still exist such that the potential fishing effort can harvest in excess of annual productivity. Some stocks with a low capacity to rebuild, such as redfish, yellowtail flounder, and haddock, suffered extremely heavy fishing mortality imposed by distant-water fleets over and above that already existing from domestic harvesters. Yellowtail in the offshore areas are still below abundance levels of earlier times. Haddock, although recovered in total abundance, do not yet have the stable structure of a population capable of consistently sustaining high harvests. Nevertheless, indications of future recruitment give hope for achieving this goal within the foreseeable future.

Of the larger offshore stocks fished primarily by distant-water fleets, only Atlantic herring on Georges Bank have not yet demonstrated a start towards recovery to earlier levels. Even here, however, the potential for a good incoming year class currently exists and if such a year class contributes significantly to the spawning stock for a period of time, even the offshore herring stocks could approach values observed historically prior to consistent heavy fishing. As the total resource builds to a level at which annual productivity is maximized, or in some cases beyond that level, the concept of stability must be considered only as an average over all the resources using the energy flow in the system.

Yearly environmental fluctuations create wide ranges of abundance within particular species. These fluctuations can be dampened or accelerated depending on the fishery management practices pursued, but they will continue to be a major feature of fishery resources now as in the past.

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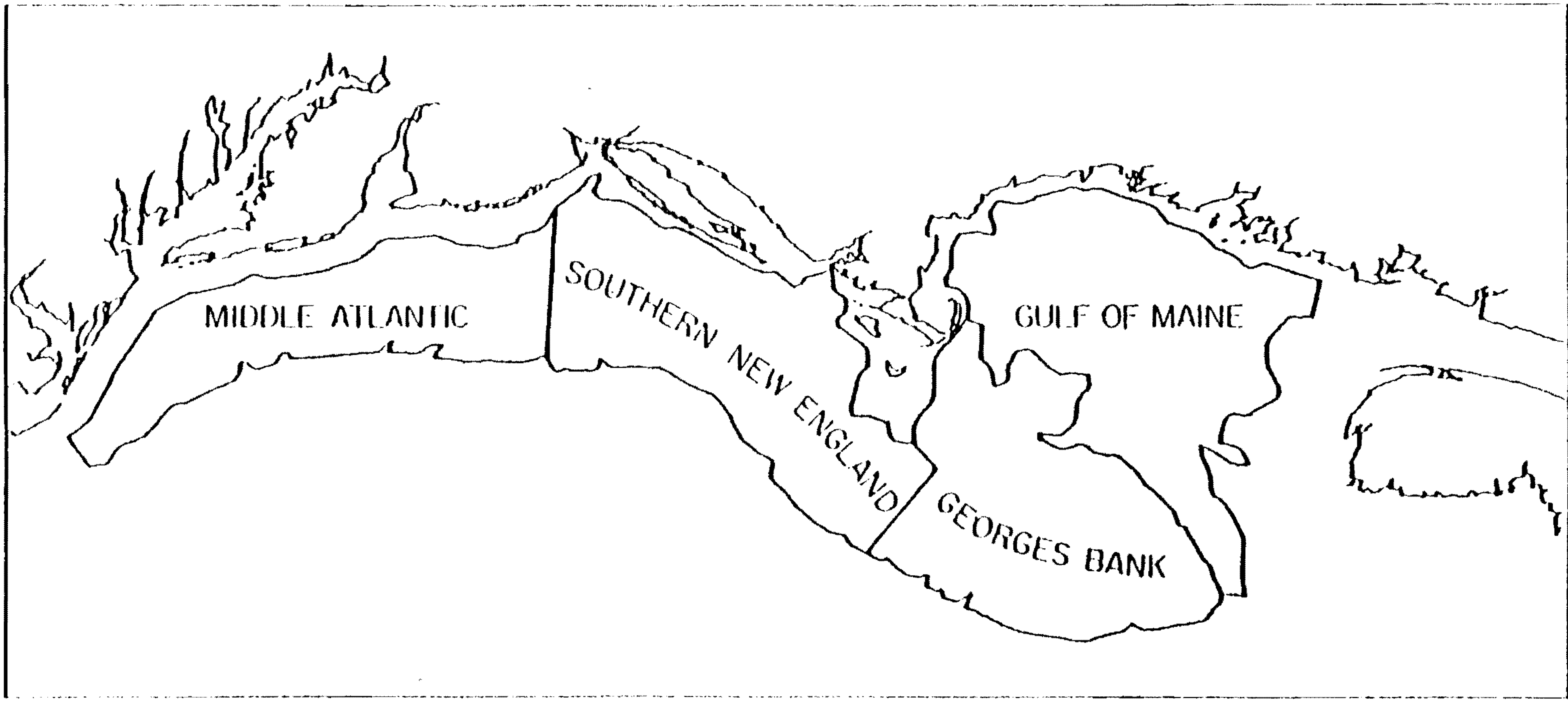

Figure 1. Major geographical areas off the Northeast coast of the United States.

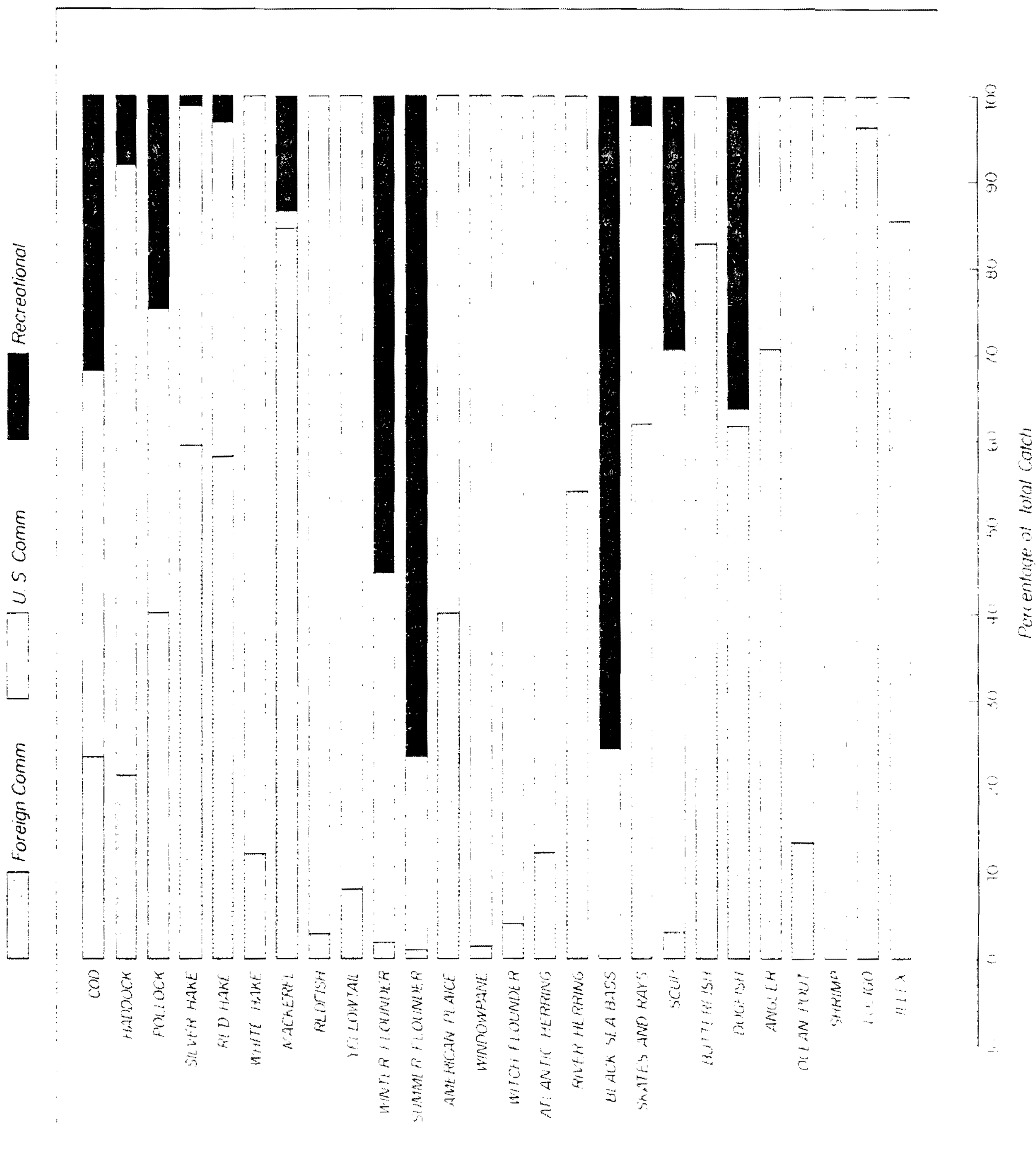

Figure 2. Relative percentages of recreational, foreign and U.S. commercial catch to the total catch for each species in the year 1970 for areas shown in Fig. 1.

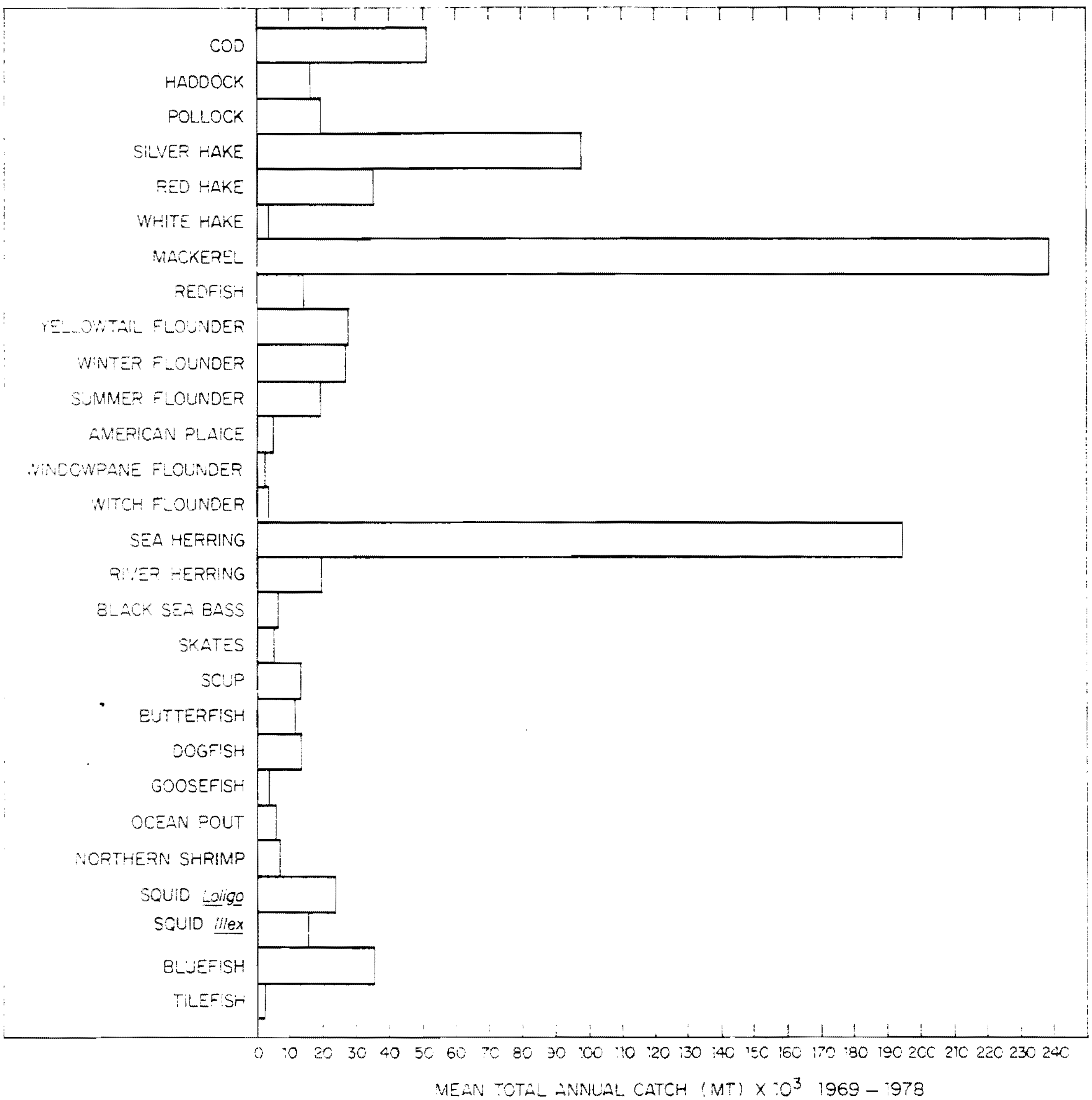

Figure 3. U.S. and foreign commercial catch values (mean total annual catch 1969-1978) and mean recreational catch from the 1960, 1965 and 1970 *Saltwater Angler* survey area shown in Fig. 1

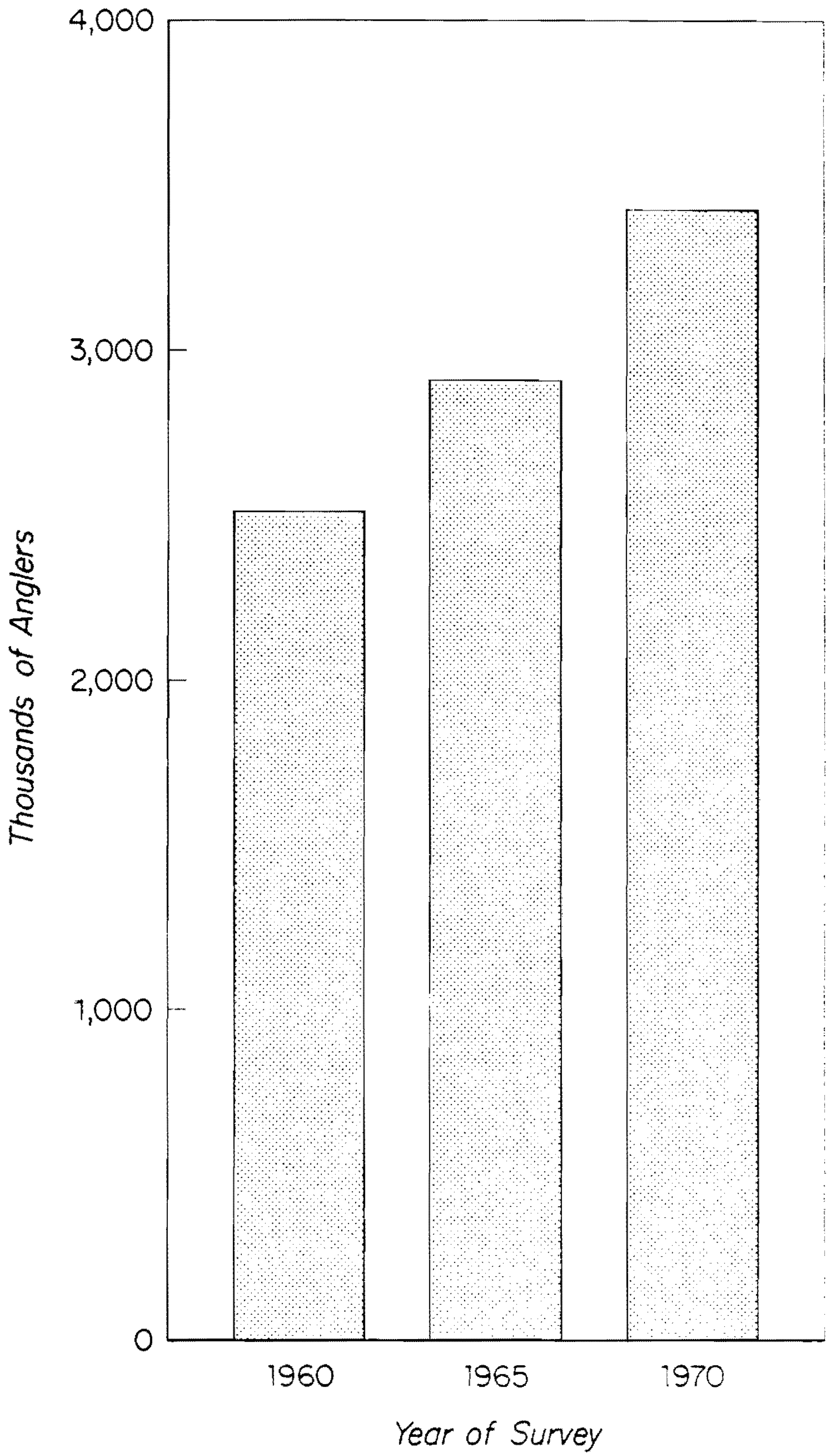

Figure 4. Salt water angling effort: 1960, 1965 and 1970.

Table 1
1978 Total Catch (MT) North and Middle Atlantic Regions as shown in Fig. 1

	US	Foreign	Total
Atlantic Cod	39,020	26,495	65,515
Haddock	16,695	10,821	27,516
Pollock	17,542	4,754	22,296
Silver Hake	23,151	14,475	37,626
Red Hake	2,192	2,155	4,347
White Hake	3,818	195	4,013
Atlantic Mackerel	1,604	370	1,974
Redfish	13,991	170	14,161
Yellowtail Flounder	11,454	59	11,513
Winter Flounder	12,246	64	12,310
Summer Flounder	8,451	12	8,463
American Plaice	9,511	209	9,720
Windowpane Flounder	1,824	0	1,824
Witch Flounder	3,520	18	3,538
Atlantic Herring	50,516	585	51,101
River Herring	5,789	32	5,821
Black Sea Bass	2,112	0	2,112
Skates	1,595	226	1,821
Scup	9,413	2	9,415
Butterfish	3,664	1,236	4,900
Dogfish	1,192	558	1,750
Angler (Goosefish)	1,808	39	1,847
Ocean Pout	330	0	330
Northern Shrimp	4	0	4
Loligo	1,476	4,777	6,253
Illex	385	21,458	21,843
Bluefish	3,751	0	3,751
Tilefish	3,413	1	3,414

Table 2
Annual U.S. and Foreign Commercial Landings for Major Species 1969-1978
for areas shown in Fig. 1

Species	1969 US	1969 F	1970 US	1970 F	1971 US	1971 F	1972 US	1972 F	1973 US	1973 F	1974 US	1974 F	1975 US	1975 F	1976 US	1976 F	1977 US	1977 F	1978 US	1978 F
Cod	24939	21468	22711	11165	23558	12283	20182	11794	22271	12798	26016	9079	24920	9103	25078	5036	33566	6200	39020	26495
Haddock	18079	6073	9872	2980	8500	3668	4779	1091	3289	2603	3018	2103	5169	1515	4771	1511	11233	2899	16695	10821
Pollock	3507	4120	3592	4067	5613	9590	5243	7770	5731	7345	8050	4343	8577	5294	10244	3138	12729	3453	17542	4754
Silver Hake	23521	74382	21627	32499	16321	91587	8330	107207	20143	116075	14118	115887	20908	93120	23063	50734	21929	54985	23151	14475
Red Hake	5685	49150	4940	7349	4001	35936	2520	73687	3956	62685	2739	30792	2515	26162	4559	24244	3412	5201	2192	2155
White Hake	1483	40	1845	268	2715	314	2925	199	3104	122	3657	232	2713	146	3071	195	3945	475	3018	195
Mackerel	4364	103990	4049	195930	2406	346338	2006	385350	1336	379820	1042	293883	1974	249005	2712	205956	1376	53274	1604	370
Redfish	11702	339	15534	424	16267	3767	13158	5944	11954	5429	8677	1834	9076	1720	10131	643	13012	213	13991	170
Yellowtail	36900	19094	35970	3094	29208	2125	32974	5537	30031	638	25050	269	19529	97	17154	10	16591	37	11454	59
Winter Fldr.	12475	6797	13092	531	11841	2122	8450	2539	8909	1533	7565	215	8135	577	6739	12	10583	75	12246	64
Summer Fldr.	1547	0	2471	11	2470	904	3288	393	4360	22	7051	0	7623	26	10757	15	8868	5	8451	12
American Plaice	3302	480	2586	1720	2170	882	1795	463	1603	485	2076	66	2427	207	3509	27	7070	247	9511	209
Windowpane	-	-	-	-	-	-	-	-	-	-	-	-	1983	0	2242	0	1880	0	1824	0
Witch Fldr.	2513	1330	2959	123	3220	2869	2934	2581	2434	639	1767	301	2106	230	1853	11	2479	23	3520	18
Sea Herring	32365	278901	31192	228008	35313	283050	40978	195628	26293	208433	32741	154005	36175	146762	50142	43684	50653	2852	50516	585
River Herring, Alewife, Blueback	25390	35527	16351	19009	12804	23027	1228	12574	10310	6757	11109	5245	10797	3775	6402	1774	6472	189	5789	32
Blk Sea Bass	1179	0	1067	0	583	0	720	0	1146	0	977	0	1852	0	1686	0	2425	0	2112	0
Skates	3045	6417	1437	2545	900	5220	866	7957	1191	6772	2026	1625	752	3216	754	450	1143	262	1595	226
Scup	4740	460	4514	198	3157	1049	3440	1647	4135	1783	7110	958	7611	672	7228	87	8469	10	9413	2
Butterfish	2438	11092	1869	9025	1570	6280	819	5657	1557	17897	2528	10334	2088	8959	1528	10280	1447	2641	3664	1236
Dogfish	112	9012	0	4954	0	11516	0	21526	0	13876	102	17584	168	18197	548	13933	930	6566	1192	558
Goosefish	194	2069	201	477	88	3649	242	4102	425	6818	444	727	831	2551	852	341	1322	251	1808	39
Ocean Pout	6537	20516	5851	895	4126	3741	2205	1070	3095	2730	3249	483	274	3	670	0	1060	0	330	0
Northern Shrimp	12818	0	10667	0	11127	0	11008	8	9339	0	7964	0	5300	7	1022	4	387	17	4	0
Loligo	899	8643	653	16732	727	17442	725	29009	1105	36508	2274	32576	1621	32180	3602	21682	1088	15586	1476	4777
Illex	562	975	408	2418	455	6159	472	17169	530	18625	148	20480	107	17819	229	24707	1024	23771	385	21458
Bluefish	1152	0	1648	0	1718	23	1690	18	2970	214	3109	99	3576	103	3452	1	3272	4	3751	0
Tilefish	26	0	136	0	61	0	120	1	390	0	606	0	750	5	1009	6	2046	0	3413	1

Table 3
Resource Summary Table

Geographical range; stock structure	Growth	Age range in fished populations	Recruitment	Maturity
COD From Port Burwell, W. Greenland, to Cape Lookout, NC 1) GB 2) GM 3) SNE and So. Channel 4) MA coast	GB GM SNE-MA K=0.120 0.116 0.257 L_∞=148.1 146.5 112.9 Max. age = 22 yr Max. length = 183 cm	2-15+ yr. GM: Presently 1971, 1973, 1974 yr classes dominate. GB: 1978 catch dominated by 1975 yr class (49%). 1966, 1971 also good.	GB GM Mean age: 2 3 GB: better than avg GM: better than avg Ratio 2.42-1 for GB 1960-1975	50% mature at 3 yr. Spawn chiefly in winter. GM-GB Max egg production: age 12
HADDOCK From W. Greenland to Cape Hatteras 1) GB 2) GM	GM GB K=0.352 K=.376 L_∞=72.91 cm L_∞=73.80 Max. age = 18 yr Max. length = 112 cm	2-9+ yr In 1978: Over 60% fishable stock is 1975 year class. Historically ages 2-4 dominate catch.	GB GM Mean age: 2.3 2.7 Improving. Ratio 19.3-1 for 1931-1965; 1,200-1 for 1966-1978; 2,700-1 for 1931-1978.	Some mature at age 2; almost all mature by age 3. Spawn Feb-May. Peak in Mar-Apr on GB Max egg production: age 6
POLLOCK From Labrador - West Greenland to Cape Hatteras. 1) Nova Scotia, GM to SNE	K=0.215 L_∞=97.77 cm Max. age = 23 yr Max. length = 106 cm	2-13+ yr Catch dominated by age 3-5 fish in recent years. Strong 1968, 1971 year classes.	Mean age: 3.5 Ratio 1.8-1 for 1971-1978 (age 2). 11.6-1 for 1961-1978 North Atlantic	75% mature by age 5. Spawn in Massachusetts Bay, Stellwagen, and So. Channel, Nov-Mar. Peak late Dec.
SILVER HAKE From Newfoundland Banks to So. Carolina 1) GB 2) GM 3) SNE-MA	GB GM SNE-MA K=0.246 0.182 0.416 L_∞=50.72 65.41 46.08 Max. age = 12 ♀; 6 ♂ Max. length = 66 cm	2-12+ yr GM: 1971 saw a shift toward younger fish; ages 2-3 dominated catch. In 1975-1977, age 3 made up 44% of catch. GB: 89% of 1977 catch age 3-4.	Mean age: 2 Ratio 12.1-1 for 1955-1978.	First spawn 2-3 yr Spawn Jun-Sep, principally Jul, Aug, on NE GB and Central GM, earlier on SNE Max egg production: age 4.
RED HAKE From Gulf St. Lawr. and Grand Bank Newf. to No. Carolina 1) GB 2) SNE-MA 3) GM (small)	K=0.37 L_∞=42.6 cm { Not for total population, but for small sample. Max. age = 12 yr Max. length = 75 cm	2-10+ yr In nearly all years, ages 2-3 have dominated catch, composing 75% of catch in 1975-1976. Shift toward 3-4-yr-olds in 1977, when they made up 81% of GB catch.	Mean age: 3 Related to size of sea scallop population due to symbiotic relationship in juvenile stage. Ratio 2.14-1 for 1968-1978.	First spawn ~2 yr. Spawn in summer on So. Georges and Nantucket Shoals.
WHITE HAKE From Gulf St. Lawr. and Grand Bank Newf. to Virginia 1) Scotian Shelf to GB	K, L_∞ { Not available. Max. age = ~23 yr Max. length = 122 cm	Not known.	Not known.	Spawn on Continental Slope of MA Bight in summer.

KEY
GB = Georges Bank
SNE = Southern New England
MA = Middle Atlantic
GM = Gulf of Maine
CC = Cape Cod

(cont'd)

Table 3. cont'd

Natural Mortality	Fishing Mortality	Abundance	MSY	By-catch/ Distribution
COD (cont.)				
M=0.2	GM GB $F_{0.1}$=0.16 0.15 F_{max}=0.3 0.3 (7.5 yr)	Rank 2 Both GM and GB cod seem at abundant population condition. GB 1978 autumn index is 123% greater than 1963-1978 average (1978 increased 86% over 1977). GM 1978 autumn index is 38% greater than 1963-1978 average (1978 27% over 1977).	GM = 8,000 T GB = 35,000 T	Haddock, pollock, yellowtail, other flounders, groundfish. Demersal GB stock migrates southwest in autumn.
HADDOCK (cont).				
M=0.2	$F_{0.1}$=0.26 F_{max}=0.55 F_{msy}=0.5-0.55 F for fully recruited ages has approx. 0.2 since 1973.	Rank 1 Recent dramatic increase due to 1975 year class. Tot. pop. abundance reaching range of 1930-1960, but overbalanced toward a single year class. GB 1978 fall index 23% less than 1963-1978 average. GM 1978 fall index 88% greater than 1963-1978 average.	GB = 40-50,000 T	Cod, yellowtail, other flounders, other groundfish. Demersal Move inshore off New England between Jan and June.
POLLOCK (cont.)				
M= 0.2	$F_{0.1}$=0.20, recent yrs F_{max}=0.37 Fcurrent 0.32 during 1973-1977	Rank 3. Relatively strong abundance GB 1977 fall index 82% greater than 1963-1977 average. GM 1977 fall index 81% greater than 1963-1977 average. Scotian Shelf 1977 fall index 21% less than 1963-1977 average.	42,000 T for Nova Scotia Shelf, GM, GB, SNE	Herring (fall only), groundfish when fishing on bottom. Pelagic/Demersal Seasonal spawning movements to western GM, Scotian Shelf
SILVER HAKE (cont.)				
M=0.4	$F_{0.1}$ Fcurrent GB = 0.65 0.33 GM = 0.5 0.39 SNE-MA = 0.55 0.461 F_{max} not a calculable value.	Rank 3. GM stock recovering, remains less than peak, early 50's. GB and SNE stock in good condition but less than peak abundance. GB 1977 fall index 3% greater than 1963-1977 average. GM 1977 fall index 11% greater than 1963-1977 average. SNE-MA 1977 fall index 22% less than 1963-1977 average.	GB = 55,000 T GM = 17,000 T SNE-MA = 35,000 T	Red hake, mackerel, other groundf. Demersal/Pelagic Densest offshore; migrates shoreward spring, summer. NY Bight fish migrate East to SNE waters in summer.
RED HAKE (cont.)				
M=0.4	$F_{0.1}$ Fcurrent GB = 0.85 0.10 SNE-MA = 0.45 0.18 F_{max} not a calculable value.	Rank 3 In general, stock appears in low condition. GB 1977 fall index 71% greater than 1963-1977 average. SNE-MA 1977 fall index 23% less than 1963-1977 average; has fluctuated considerably since 60's.	GB = 13,000 T SNE-MA = 26,000 T	Silver hake, assorted flounders, groundfish. Demersal During autumn adults are both inshore/offshore, but in winter and early spring they aggregate in deeper, offshore areas.
WHITE HAKE (cont.)				
Not known; probably low.	Not available.	Rank 4 1978 survey index equal to 1969-1978 average.	Nova Scotia = 8,000 T GM = 3,000 T	Red hake, other groundfish. Demersal Inshore movement in GM and SNE in autumn.

(cont'd)

Table 3. cont'd

Geographical range; stock structure	Growth	Age range in fished populations	Recruitment	Maturity
MACKEREL				
From Block Is., Labrador, to Beaufort, NC 1) Considered as one stock for management on present evidence. (Winter concentrations off US MA/So. Atlant. coast. Summer GM, GB, Gulf St. Lawr.)	κ=0.257 L_∞=41.43 Max. age = 18-20 yr Max. length = 56 cm	2-6+ yr At this time, 2 principal year classes in fishery: 1973 and 1974. 1978 is largest year class to enter fishery since 1969.	Mean age: 3 (70%) Ratio 18.2-1 for 1962-1978.	First spawn 2-3 yr (50% mature at age 2). Spawn in NY Bight and GB Spawn on Western GM and CC Bay in spring and early summer. Peak May-June. Stock also spawns in Gulf St. Lawr. Max egg production: age 4
REDFISH				
From W. Greenland to New Jersey (2 species) 1) GM is range of S. mentella off US. Both S. mentella and S. marinus found further north.	κ =0.104 L_∞=37.80 Max. age = >50 yr Max. length = 45-50 cm	6-25+ yr Usually 12-25 age range. 1976 introduced age 5's into fishery from 1971 year class.	Since 1963, only 1971 year class shows above-average strength. Other dominant year classes: 1953, 1963, 1971. Age at 1st recruitment = 5.	Mature at age 8-9 (viviparous). Spawn on Scotian Shelf and Central GM Peak late June to early July.
YELLOWTAIL				
From South coast of Labrador to Chesapeake Bay 1) GM 2) GB 3) SNE 4) MA 5) CC	κ =.335 L_∞=50.0 cm Max. age = 14+ yrs Max. length = 55 cm ♀	2-12+ yr in 1977 ages 2-3 dominated catches in fishery. Prior to entrance of foreign fleets in latter 1960's ages 3 & 4 dominated catch.	SNE offers more favorable temp. regime. Mean age 2 yrs improving recruitment in SNE. Ratio is 1.96-1 for GB 1963-1975. Ratio is 11.5-1 for SNE 1963-1975.	First spawn 2-3 yrs. Spawns March thru August on Browns Bank. Max egg production: age 7
WINTER FLOUNDER				
From Labrador to Georgia 1) GB-59% 2) SNE-13% 3) GM-22% 4) Local inshore populations found (%'s are of total catch.)	Ford-Walford Growth Equation used: GB Cape & No. Cape & So. E. κ =.67 .69 .75 L_∞=57.8 45.5cm 48.2 ♀ + ♂ averaged Max. age = 12+ yrs Max. length = 62 cm	2-12+ yr Modal distribution of catch would most likely be in 1st half of this range.	1977 SNE pre-recruit index up 173% over 1974-76 average. 1977 GB pre-recruit index shows improvement from 1976 but is 61% down from 1975 peak. 1977 GM pre-recruit index is larger in 1963-1977 series.	Mature 2-3 yrs. Occurs later in more northern waters. Spawns Apr thru June on GB
SUMMER FLOUNDER				
From CC to Cape Hatteras 1) GB 2) SNE 3) MA	κ =.209 L_∞=92.24 Max. age = 20 yrs Max. length = 95 cm	2-7 yrs Survey catches mostly 3 and 4 yr olds	Recruitment begins at age 1 or 2 with full recruitment at age 3 or 4.	Mean age = 3 yrs 50% mature at 35 cm. Spawns on Nantucket Shoals and south Sept-Apr in a north to south progression. Early Sept for GM. Max egg production: age 7.
AMERICAN PLAICE				
From Labrador to south of CC offshore from New York 1) GM-area of conc. 2) GB 3) SNE	Rather slow growth rate. κ = } not known L_∞= Max. age = not known Max. length = 83 cm	1-9 yrs	Not available.	Spawns south of Martha's Vineyard March-June. Peaks Apr-May.

(cont'd)

Table 3. cont'd

Natural Mortality	Fishing Mortality	Abundance	MSY	By-catch/ Distribution
MACKEREL (cont.)				
M=0.15-0.3	$F_{0.1}$=0.4 F_{max}=1.0-1.6 Fcurrent = 0.15 (ages 4+) 1962-1978 data	Rank 2 Increased 30% beginning 1979 from 1977 low which was 82% below 1969 peak. Increase in near future dependent on 1978 year class.	Newf., SNE, GB, MA = 210,000-230,000 T	While pelagic, can be caught with bottom trawls, and at that time will have other groundfish as by-catch, i.e., herring, hakes. Generally inshore, then NE migration in spring for spawning. Tagging shows extensive movement.
REDFISH (cont.)				
M=0.1	$F_{0.1}$=0.14 F_{max}=0.5-1.0 in excess F=0.2 average all year classes, 1933-1963. F=0.4 for more recent year classes, 1955-1963. $F_{current}$=0.5, 1976-1977.	Rank 2 Increasingly dependent on 1971 year class. 1978 survey index 22% less than 1963-1978 average. Population much lower than during peak catches in 1940's.	GM, GB = 14,020 T At current abundance, fishing at MSY effort would yield 5,200 T	Relatively pure fishery; 85% pure between 1968 and 1978. However redfish are taken in mixed groundf. fisheries and GM shrimp fishery Demersal Nonmigratory
YELLOWTAIL (cont.)				
M=0.2	GB / SNE-MA $F_{0.1}$ 0.3 / 0.3 F_{max} 0.5 / 0.5 Fcurrent for 1978 1.03 / 0.37	Rank 1 Yellowtail abundance is estimated at below peak periods. SNE 1978 index is 70% lower than 1967-1979 average. GB 1979 index is 56% lower than 1964-1978 average. MA 1978 index is 89% lower than 1963-1978 average.	GB = 16,000 T SNE-MA = 23,000 T	Cod, haddock, other groundf. and flounders. Demersal Annual migration to SNE-Nantucket Shoals area moves west in winter and east in summer.
WINTER FLOUNDER (cont.)				
So. of CC (Probably) M=0.27	F = 0.27	Rank 3 Abundance has increased in recent years but not to peak levels. Recruitment appears to be good. 1978 GB survey index is 26% greater than 1963-1978 average; 1978 SNE survey index is 30% less than 1963-1978 average; 1978 GM survey index is 33% less than 1963-1978 average.	Not available	Cod, haddock, and other groundf. Demersal Winter spawning migrations into bays and estuaries - not extensive.
SUMMER FLOUNDER (cont.)				
M=0.2	F=0.3 in 1977	Rank 3 Abundance levels appear to be low relative to recent years. GB 1978 survey index is 13% greater than 1973-1978 average; SNE 1978 index is 9% less than 1963-1978 average; MA 1978 index is 95% less than 1967-1978 average.	20,000-22,000 MT	Mixed groundf., winter flounder, Loligo, scup, etc. Demersal Autumn migrations to offshore wintering grounds where it mixes with loligo.
AMERICAN PLAICE (cont.)				
No estimates available. Life history would indicate M=0.2	Not known	Rank 3 GM indices increasing since 1973 and greater in 1977 than any year since 1966.	Not available	Other flounders, and other groundf. Demersal No significant migrations.

(cont'd)

Table 3. cont'd

Geographical range; stock structure	Growth	Age range in fished populations	Recruitment	Maturity
WINDOWPANE				
From Gulf St. Lawr. to So. Carolina 1) SNE-MA 2) GB	Largest individuals found on GB κ = } not known L_∞ = } Max. age = not known Max. length = 38 cm	Mean age of individuals decreased from about 4-5 yrs (1968-1970) to 3 yrs (1971) to 2 yrs (1972) 5 yr olds most abundant in 1975 landings	Enter fishery at approximately 4 yrs.	Mature at age 2-4. Spawns on GB and Nantucket Shoals and South Apr-Jun. Peaks in May. Begins again in late fall.
WITCH FLOUNDER				
From Newfound. to Cape Hatteras 1) GM-area of conc. 2) Nova Scotia Spawning areas are GM, Nova Scotia, coastal ME They overwinter primarily south of CC	Slow growth rate 18-20 yrs old at 60 cm κ = } not known L_∞= } Max. age = not known Max. length = 63 cm	Not known.	Not available	Spawns from CC to Delaware Bay in late spring - summer. Peaks Jul-Aug.
ATLANTIC HERRING				
From polar ice in Greenland and Labrador to Cape Hatteras 1) GB 2) Nova Scotia 3) Coastal ME	L_∞ / κ GB 34.5 / 0.34 N. Scotia 39.0 / 0.179 Coastal ME: Western 35.1 / 0.335 Eastern 38.0 / 0.277 Max. age = 18 yrs Max. length = 43.5 cm	1-12 yr The very strong 1970 year class provided 73% of catch from 1973 to 1976.	Age 1 juvenile fishery Age 3 adult fishery Ratio is 10.6-1 for these stocks 1965-77. Ratio is 131-1 (Atlanto Scandia) 1965-77.	Mature at age 3-4. Spawns Sep-Nov on GB and Nantucket Shoals - SW GM, smaller spawning stock along eastern coast of ME
RIVER HERRING, ALEWIFE, BLUEBACK HERRING				
From Nova Scotia to FL - Blueback From Newf. to NC - Alewife 1) Major populations in rivers Chesapeake Bay region and northern NC Spawning runs also found along coast.	Alewife κ = .634 L_∞= 32.5 Max. age = 11 yrs Max. length = 33 cm Bluebacks slower and grow to a smaller size	1-9 yr Average age of alewives has declined in recent yrs. Alewife dominant ages in catch are 4, 5 & 6.	Alewife Becoming more dependent on a single year class recruited at time of 1st spawning.	Alewife mature between 3-5 yrs. Blueback ♂'s spawn 3-4 yrs ♀'s spawn 4-5 yrs *Repeat spawning 4-5 times. Spawning: Alewife - spring Blueback - late spring
BLACK SEA BASS				
From CC to Cape Canaveral 1) North of Cape Hatteras 2) South of Cape Hatteras	κ =.088 L_∞= 62.5 Max. age = 20 yrs Max. length = 61 cm+	2-12 yr Only available literature states that in 1946 populations was dominated by age 4-7 fish.	No available data	Hermaphroditic Begins life as ♀, transforms into ♂ Mature between 2-3 yrs Larvae caught Jun-Nov
SKATES				
From northern NC to So. side of Gulf of St.Lawr. Several species; Big & Little Skates, Thorny Skates important in fisheries. No stock studies but areas of concentration are: 1) GB 2) NY Bight	8-10 cm/yr for 1st 3 3rd yr 2-3 cm/yr after age 5 B. Skate / L. Skate κ = .312 / .352 L_∞= 98.9 / 52.7 Max. age: Not known / 8 yrs Max. length: 107 cm / 53 cm	2-8 yr Catch is dominated by age 4-8 yr fish.	Little Skate partial recruitment at 2 yr No available data for other species	Little Skates mean age 3-4 yr All year spawnings with peak periods all species. Peaks for Little Skate Nov-Jan and Jun-Jul. Probably about 30 egg cases per yr most species

(cont'd)

Table 3. cont'd

Natural Mortality	Fishing Mortality	Abundance	MSY	By-catch/ Distribution
WINDOWPANE (cont.)				
No estimates available. Life history would indicate M=0.2-0.3	Not known	Rank 3 Survey indices significantly higher since 1972 (1963-1971) = 3.70. Since 1972 = 19.92 mean/tow.	Not available.	Spiny dogfish, little skate, silver hake, red hake, scup, butterfish, yellowtail, squid, winter flounder. Demersal Relatively sedentary found in deeper water in coldest months short annual inshore-offshore migration.
WITCH FLOUNDER (cont.)				
No estimates available. Life history would indicate M=0.1-0.2	Not known.	Rank 3 1978 GM survey index is 9% greater than 1963-1978 average; 1978 NS survey index is 37% less than 1963-1978 average. Large fluctuation is seen during this time series.	Not available.	Thorny skates, cod, haddock, silver hake, pollock, white hake, redfish, Am. Plaice. Demersal Rather stationary No directed fishery.
ATLANTIC HERRING (cont.)				
Age/Mortality (range) 5 0.15-0.32 6 0.30-0.43 7 0.47-0.55 8 0.54-0.82 for average in mature populations M=0.2 has been used.	F= 1.0 in 1973 F= 0.55 in 1974 An F of 0.6 on long-term basis will provide 95% of yield per recruit realized from an F of 1.6. $F_{0.1}$ ranges from 0.3 to 0.38.	Rank 2 There was an 87% reduction in stock abundance by weight from 1967 to 1973. After 1974 abundance of GB herring is not clear however catch declined in 1976 and there was almost no catch in 1977. Entry of 1976 year class is rapidly increasing abundance.	GM = 16,000 T SNE, GB, MA = 120,000 T; Scotian Shelf = 90,000 - 104,000 T Pelagic Total MSY probably less than sum of individuals due to stock interactions.	Catches in purse-seines and pelagic trawls are relatively pure. When caught in spring in bottom trawl fishery, mixed groundf. also taken. Pelagic Distribution differs by size & age. Spawn on GB, Jeffrey's Ledge in autumn then migrate to NY Bight area to overwinter. Migrate back in spring.
RIVER HERRING, ALEWIFE, BLUEBACK HERRING (cont.)				
M=0.2 Prior to spawning Alewife - 36% of spawning adults die during fresh water phase.	Annual mortality between 50% & 60% 1965-1969 39% in 1975 $F_{0.1}$=0.38	Rank 4 Blueback appear less abundant than alewife in NY Bight. Alewife - virgin fish comprise greater portion of population. Decline in stock abundance since 1969. 1978 survey index is 11% less than 1967-1978 average.	23,000-28,000 T	Same as sea herring. Catch in spring spawning runs is relatively pure. Pelagic Anadromous. Spawns on Chesapeake Bay in Apr on Nova Scotia in Jun. Autumn spent on GB-GM area.
BLACK SEA BASS (cont.)				
Not known	Not known	Rank 4 Landings have declined steadily since early 1950's from >20 million lbs in 1950's to >5 million lbs in mid-1970's. 1978 survey index is 44% less than 1967-1978 average	Not available	Demersal Northern populations migrate seasonally inshore north in spring offshore south in autumn
SKATES (cont.)				
Little Skates M=0.3 Not known for others	Not known	Rank 4 Minimum biomass estimate 1968-1978; little skate 88,000 T big skate 23,000 T Cape Hatteras to GB spring surveys provide best estimate. 1978 survey index is 25% greater than 1967-1978 average.	Not available	Demersal Little skates movements in response to changing water temperature: Long Island spring & fall, shelf off Chesapeake Bay - winter

(cont'd)

Table 3. cont'd

Geographical range; stock structure	Growth	Age range in fished populations	Recruitment	Maturity
SCUP				
From Cape Hatteras to CC Two subpopulations 1) SNE 2) New Jersey	Reach 60% of maximum size by age 3 k = .195 .216 L_∞= 40.79 39.58 Max. age = 19 yr Max. length = 43 cm	2-15 yr Catch dominated by 2-3 yr fish	No available data	Mature at age 2 Spawns May-Aug, Peaks May-mid-Jul
BUTTERFISH				
From Newfoundl. to FL 1) So. of Cape Hatteras 2) No. of Cape Hatteras	Fastest in 1st yr & decreases in each following yr k =.861 L_∞=21 cm Max. age = 6 yr Max. length = 30 cm	1-6 yr During 1974-1976 age group - 0+ and 1+ fish dominated catch.	Recruitment lower than average; trend of decreasing age at recruitment since 1970; 1971 yr class was most abundant Age at entry = 0+	Mature at age 1-2 Spawns MA to SW GB May-Aug. Peaks in Jul
SPINY DOGFISH				
From Labrador to FL Evidence of movement across Fundian Channel; No.-So. migrations	Rate ~ 3.2 cm/yr k = } not available L_∞= Max. age = 30 yr Max. length = 110 cm	No information available Range - not known May sustain moderate fishing mortality rates Primarily by-catch	No available data	Mature at age 9+ Young born Nov-Jan Ovoviviparus Young born Nov-Jan 2 yr cycle
ANGLER (GOOSEFISH)				
From Grand Banks of Newfoundl & Gulf of St. Lawr. to NC Stock breakdown not available but areas of conc. are: 1) Nantucket Shoals 2) GB 3) GM	10 cm/yr Long lived k = } not available L_∞= Max. age = 30 yr Max. length = 122 cm	No available data	No available data	Mature at age 4 ♂ (5 ♀ Spawn spring, summer, and early autumn according to latitude
OCEAN POUT				
From Labrador So. to Delaware Bay 1) Bay of Fundy 2) CC So.	Slower in northerly areas k = } not available L_∞= Max. age = 18 yr Max. length = 98 cm	4-10 yr Dominant ages not available	No available data	♀'s between 5-9 yr ♂s between 2-3 yr Spawns Sep-Oct
NORTHERN SHRIMP				
Circumpolar - No. Atlant. area, from Barents sea westward to Baffin Island and southward to GM 1) GM (western)	k = } not available L_∞= Max. age = 6-7 yr Max. length = 31.0 mm (carapace)	In 1977 age 3+ shrimp dominated catch	Estimate decline over 95% during 1969-1977 Enter fishery at 1 yr Recruitment seems to be related to both temperature and to removals of parent spawning stocks.	Hermaphroditic ♂ - ♀ ♂'s mature age 2 ♀'s mature age 3 Peak hatching occurs in late Feb - early Mar

(cont'd)

Table 3. cont'd

Natural Mortality	Fishing Mortality	Abundance	MSY	By-catch/ Distribution
SCUP (cont.)				
Current data not available		Rank 4 Historical fluctuations in populations size Dramatic reduction from 1960-1970. Increased landings since 1970 indicates resurgence, however 1978 survey index is 36% less than 1967-1978 average.	Minimum sustainable yield estimated at 15,000 T	Demersal Extensive seasonal migrations from inshore summer grounds to offshore winter grounds
BUTTERFISH (cont.)				
M=0.8	F increased from .21 in 1968 to .87 in 1974 and had dropped since then due to the reduction of the foreign fishing	Rank 3 Autumn surveys indicate 20% decline from 1967-1974 Minimum biomass 1969-1973 = 61,000 T 1976 stock size - 32,000 T, lowest observed for 1968-1976 period 1978 survey index is 15% less than 1967-1978 average but still in MSY range	Max. catch at $F_{0.1}$ is 14,500-21,500 T depending on age at entry into fishery	Loligo offshore; mixed groundf. inshore Pelagic / demersal Move offshore in late autumn and somewhat south inshore migration in Apr
SPINY DOGFISH (cont.)				
Low because dogfish have few natural enemies and abundance remains high despite low reproductive rate	Not known	Rank 4 Range of biomass: from 150,000-225,000 with ~ 20,000 T/yr catch since 1972 1978 survey index shows no significant change from 1967-1978 average	40,000 T	Pelagic/Semi-demersal Spawn offshore in winter, begin southward migration in Oct, return north in late spring Often caught and discarded in summer bottom trawl fisheries
ANGLER (GOOSEFISH) (cont.)				
Not known	Not known	Rank 4 18,000 T standing crop estimate based on 1968-1974 data 1978 survey index is 31% greater than 1967-1978 average	Not known	Other groundf. Demersal Non-migratory
OCEAN POUT (cont.)				
Not known	Not known	Rank 4 Declines in survey abundance of 80% from SNE area & 83% GB from 1963-1974. However, 1978 index is 43% greater then 1967-1978 average and landings have increased since 1975.	Not available	Parasitic lesions have caused decrease in commercial value. Demersal No evidence of significant migration Seasonal change in local distribution do occur
NORTHERN SHRIMP (cont.)				
M=0.25 Appear to increase significantly after 1st hatching	Average of approx. 1.5 during 1973-1977.	Rank 2 Has declined over 90% since late 1960's and currently remains at very depressed level	Not known	Demersal Females move to coastal waters in winter to spawn - males & females found in deeper waters offshore in GM

(cont'd)

Table 3. cont'd

Geographic range; stock structure	Growth	Age range in fished populations	Recruitment	Maturity
LOLIGO				
From New Brunswick to Georgia 1) Main fishable stock winters offshore MA Species south of NC questionable	1.0-1.5 cm/month Few fish found over 2 yrs Max. age = 3 yrs Max. length = 40 cm	6 mo - 2 yrs 1 yr olds predominate catch	70% decline in pre-recruit individuals (autumn 1978) (5-6 mos) Ratio is 17-1 for 1969-1974	Spawners die afterwards so age at maturity is about equal to maximum age of individual Spawns May-Sep inshore
ILLEX				
From Greenland, Labrador, and Newfoundl. to FL Stock structure uncertain, some appear to migrate thru GB to summer conc. off Newfoundl; some summer on GB-GM	Faster growing than loligo shorter lived 2.0 cm/mo Few fish found over 1 yr Max. age = 2 yrs Max. length = 40 cm	6-18 mos 1 yr olds predominate catch	Improved over last few years, pre-recruits for 1978 was second highest in time series. (5-12 cm) Ratio is 5.46-1 for 1968-1974; probably minimal due to short time series.	Same as loligo Assumed: spawns Dec-Jul in deep water offshore areas.
BLUEFISH				
From MA to FL	Fast growing Max. age = 14 yrs Max. length = 114 cm	1-8 yrs 1-3 yr olds were bulk of sampled fish	No available data	Mature at age 2-5 Spawns May-Jun
TILEFISH				
From Nova Scotia to Florida Mainly found at edge of shelf	Slow growth rate K = , L_∞ = } not available Max. age = 40-50 yrs Max. length = 125 cm	No available data	No available data	Age of 1st maturity between 6-13 yrs Spawn from Mar-Sep
Total FINFISH and SQUID				
NW Atlant. Primarily offshore, GM, GB, SNE, MA	N/A	On overall basis the bulk of the yields are taken of animals 2-5 yrs of age	On the average recruitment probably occurs at age 2.	Not available.

(cont'd)

Table 3. cont'd

Natural Mortality	Fishing Mortality	Abundance	MSY	By-catch/ Distribution
LOLIGO (cont.)				
M=1.6 High mortality after spawning.	Not known	Rank 2 Autumn surveys from 1967 indicated general increase, but trend has been downward in 1977-1978. Minimum biomass range: 14,000-52,000 T Population size range: 1,100-4,800 T million individuals (lowest since 1971).	SNE, GB, MA = 44,000 T	Intensive by-catch both offshore and inshore mixtures. Butterfish is the major by-catch. Basically pelagic, but frequents near-bottom waters Migrate inshore each spring to spawn and offshore in winter
ILLEX (cont.)				
M=1.56 Heavy post spawning mortality after 1 yr of age.	Not known	Rank 3 Survey indices were well below 10 yr average in all but SNE area - increased in 1978 to 1976 level of high abundance by number, however wt/tow was 39% less than in 1976 indicating smaller individuals (second highest since 1968).	GM, SNE, GB, MA = 30,000 T Gulf of St. Lawr. and Grand Bank of Newfoundl. = 120,000 T	Intensive by-catch both offshore and inshore. Mixtures of groundf. species taken when fished near bottom. Pelagic Move offshore in autumn into deeper, warmer water.
BLUEFISH (cont.)				
M=0.2	Current levels of catch are at about MSY level Catches averaged 1975-1978 = 88,200 T	Rank 4 1978 survey index is 13% greater than 1967-1973 average. Increased since the 1960's stable level in the 1970's	89,000 T	Not significantly fished commercially Pelagic Aggregations travel northward in spring and summer, southward in fall and winter
TILEFISH (cont.)				
Not available	Not available	Rank 4 Not available	Not available	Lobster and summer flounder, but with little trawl commercial catch their numbers would not be significant Demersal Do not migrate extensively
Total FINFISH and SQUID (cont.)				
For bulk of fishery biomass M=0.25 would be appropriate average	Probably about 0.4	Rank 2 Biomass declined up to 59% 1963-1974 Since 1975, total biomass levels appear to have increased significantly	900,000 T (1976)	N/A

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