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

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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, it has been of major fisheries importance since the 15th century. A number of fisheries in this region (Figure 1) have been of great international consequence. In the United States many species are of great 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 US commercial catch to the total catch for each species in the year 1970 are shown in Figure 2. Data from 1970 has been presented because it is the most recent year for which recreational catch estimates are available for all species. However, recreational fishing effort appears to be increasing (Figure 3). 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 (MT) for finfish and squid. The total average catch of each species in absolute values for 1969-1978 is given in Figure 4 and 1978 preliminary values in Table 2 (recreational catch not available). Totals for individual years are given in Table 3 for foreign and US catches. The values in Figure 4 represent the sum of all recreational, foreign, and US commercial catch (food and industrial), and indicates the magnitude of the fishery for each species relative to all others. Average landings totaled 900,000 MT and there were 26 species for which individual averages were 3,000 MT 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 then three year old International Commission for the Northwest Atlantic Fisheries (ICNAF) imposed mesh-size regulations on some fisheries. (ICNAF, 1953). Prior to 1960, this area was fished almost exclusively by a coastal fleet of small US 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 MT, hence, 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 on Georges Banks (common names as in Bailey et al, 1970) 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 MT in 1965. Groundfish catches declined, and effort was again shifted towards herring and also mackerel, resulting in a peak catch of 670,000 MT of principal pelagics in 1971. Landings of other finfish rose to 215,000 MT in 1969 and landings of squid rose to a 57,000 MT peak in 1973, ICNAF Statistical Bulletins, ICNAF, Halifax, Nova Scotia, Canada, are the source of fishery statistics. Landings for all species averaged about 1.2×10^6 MT for 1971-1973. 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. Since the advent of 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 the Northeast Fisheries Center of the National Marine Fisheries Service bottom trawl surveys (see Grosslein 1969, Clark, 1979 for description of survey).

Synopses of Species

Atlantic Cod

Four major 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. 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 suggest that the New Jersey population may not be self-sustaining. 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; there are, as well, some minor exchanges across the Fundian Channel from Georges Bank, to the Scotian Shelf and Browns Bank. Cod has 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 the USSR, Canadian, and Spanish effort on Georges Bank. This increased effort and resultant catch followed an apparent 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. Concommittently cod became less abundant in more southerly areas in the wintertime than previously. Following the reduction in the fishing effort of the distant-water fleet and the entry of the 1971 and 1975 classes into Georges Bank population the catch increased. Presently the 1975 year class is maintaining itself in the population longer than those 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. Cod in the areas considered in this paper, has not exhibited the extreme fluctuation of year classes 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 the cod may not be able to support catches at the current level for an extended period of time.

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). The number of year classes in the population stabilized, to a large degree, 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 began 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). This indicates that recruitment at low spawning stocks 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 ranging with the larger ones that occurred during the earlier period. The fact that such good year classes occurred so infrequently in the latter period compared to the 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. Management attempted to hold back the removals which, at this population level, would have easily yielded more than 50,000 tons of fishing mortalities similar to those occurring during the 1950's. With the higher fishing mortality rates that the present fleet is capable of exerting, the result of completely uncontrolled fishing would have been even greater. The (New England Regional Fisheries Management Council's) management goals were to hold back the fishing mortality to allow the 1975 year class to recruit to the spawning stock and to maintain the spawning stock at as large a size as possible until other good year classes recruited. This would 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 the that range of values. If these levels of recruitment continue the haddock will soon be resembling both in number of age groups, spawning stock and in total abundance, the conditions existing prior to the entry of the foreign fleets. This would imply a continuing yeild averaging between 40,000 and 50,000 tons if fishing effort is held at moderate

levels. It should be realized that yearly catches will vary about these averages.

The haddock in the Gulf of Maine has appeared over the years to generally follow the same 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.

Pollock

Pollock is a transboundary stock found on Georges Bank, the Scotian Shelf, and the Gulf of Maine. The primary spawning area appears to be in the southwestern Gulf of Maine. Both Canada and the United States have increased their pollock fishing in recent years. Indications are that pollock is now at a level of abundance slightly higher than a few years earlier although current catch statistics are questionable, so it is 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 would support other general biological considerations that maintaining a fishing mortality lower than currently existing in the fishery would result over time in maintaining a higher catch rate, a more abundant stock size, and greater stability in the fishery. This would require moderately lower (about 20%) catch levels than at present.

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 apparently being with the Nova Scotian stock. Stock analyses indicate that the trends in abundance in these three southern stocks have differed over the years indicating some degree of separation and differential response to fishing pressure.

Silver hake spawning stocks on Georges Bank increased from the middle 1950's by a factor of about 6 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 the removal of that effort, the stock has recovered to levels approximately 1 1/2 to 2 times that of the middle 1950's, but only to about 1/3 to 1/4 of the peak period. The stock now appears to be leveling off with recent recruitment at lower levels.

The Southern New England-Middle Atlantic stock of silver hake was exploited by a US industrial fishery in the 1950's. The population increased 6-fold to a peak in the middle 1960's and then declined to levels slightly above that existing in the 1950's. With the 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 USA shrimp fishery with its associated bycatch 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. Since then, fishing mortality has been reduced, assisting in the recovery of the stock. The spawning

stock is now about one-third of that observed during peak levels, but about three times that observed at the lowest levels 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 abudnance suggest that the Southern New England-Middle-Atlantic fish are to some extent separate from those on Georges Bank. 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 dependent where sustained fishery effort on annual productivity. From the latter 1960's the spawning stock increased somewhat into the early 1970's. It has been reduced to slightly lower levels at the present time. The Southern New England-Middle Atlantic red hake stock has a longer history of fishing being an important component of USA industrial catches in the 1950's. It also had 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 part of the 1960's and the early part of the 1970's, when the size was about twice what is being observed at the present time. Indications are the recent year classes are somewhat larger then those in the preceding period.

White Hake

White hake may possibly be considered as a unit stock throughout the Scotian Shelf, Gulf of Maine, and Georges Bank area. Centers of abundance appears to lie in the deep areas of the Gulf of Maine. The catches have

increased considerably in the 1970's with Canada taking the largest proportion. NEFC bottom trawl surveys indicate that the stock has remained relatively constant since 1968 somewhat higher than earlier. The extent to which catches could be increased on a sustainable basis is not known.

Atlantic Mackerel

Atlantic mackerel range from Cape Hatteras to Newfoundland. Stock biomass declined in 1977 to a low point about one-fifth of the 1969 peak and approximately a level similar to that in the early 1960's and has begun to recover since. Spawning stock has declined to a low level in 1979, but survey data indicates that it should begin to recover shortly. The peak population resulted from the recruitment of several very good year classes. The existence of stock recruitment relationships is not clearly evident, however, it is probable that a spawning stock at a level considerably lower than the levels observed in the early 1960's would result in a lower frequency of good year classes and a higher frequency of poor ones. Hence, there was considerable restriction of distant-water fleet fishing during the latter part of the 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. This should bring the mackerel spawning stock significatnly above the minimal levels observed at the present, if harvest is maintained at moderate levels similar to those in recent years. Restricted fishing in 1980 may not only increase the spawning potential, but should also increase yield per recruit.

Redfish

The redfish stock is characterized by many year classes and very late recruitment to the fishery. 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 amounts compared to the earlier catches. Such catches were in part the result of removals of accumulated stock that had built up over the years when fishing mortality was low. There are further indications that this stock consists of separate groups or "pockets" with the fleet fishing a given area to low abundance, and then moving to another pocket (Mayo, 1978). Presently, it appears that all "pockets" in the Gulf of Maine have been reduced in abundance.

Yellowtail Flounder

Yellowtail flounder stocks have been studied most extensively on Georges Bank and Southern New England with a lesser information base for the Cape Cod and New York-Middle Atlantic areas. 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 for yellowtail flounder in this area is less than it was in the late 1960's. The Georges Bank stock entered 1979 at very low levels, having declined considerably from the middle 1960's. 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 well as recently. Pre-recruit indices indicate that these very low populations would be expected to increase in 1979, and commercial fishery data confirms this. 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 low spawning stocks of yellowtail flounder may be low enough so that even with increasingly favorable environmental conditions, which seem to be occurrring in Southern New England, a lesser frequency of good year classes would be expected than with a larger spawning stock. Middle-Atlantic catches and stock appear quite a bit lower than they did in the early 1970's.

Winter Flounder

Winter flounder are distributed along the coast and out onto Georges Bank. They are fairly sedentary and indications are that there are local populations along the coast. There does not seem to be an appreciable movement from Georges Bank to the inshore grounds. 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. 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 differ from those to the north (Wilk and Morse, 1978). Summer flounder 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 the reduction of this mortality US catches have again increased. Survey cruise abundance indices indicate an increased abundance in the 1970's compared with the 1960's.

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 US coast. American plaice appears to be a sedentary species and there is probably little mixture between areas. The populations did appear to decline in the latter 1960's and early 1970's and have since increased to early 1960 levels. Commercial catch is now higher than in the early 1960's.

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 fished industrially. 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 total overall distant-water fleet fishery.

Witch Flounder

Witch flounder, like American plaice is also found predominantly 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. The US 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, the southwest part of the Gulf of Maine (Jeffreys Ledge) and off Nova Scotia (Lurchers Shoals). There have been adult fisheries 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 the stocks. Furthermore, there is a juvenile fishery along the coast of Maine and New Brunswick. All herring spawning stocks are now considerably lower than in the 1960's. The Georges Bank stock still appears to be extremely small as a result of the continued high fishing effort during a period of poor year-class production. There is yet no firm indication of rebuilding of the Georges Bank stock. The Jeffreys Ledge spawning area had a spawning 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 that the spawning stocks rebuild

depends on the degree that the stock is allowed to accumulate spawning 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. Historical studies indicate that when Atlantic herring stocks are very low they may remain low for a considerable period of time 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 USA inshore fishery until 1967 when the distant-water fleets began harvesting river herring in the offshore regions. At this time the stock declined precipitiously. Despite the cessation of the offshore fishery, spawning success in the major rivers has continued to be very low and the stocks are at historically low levels (Johnson et al, 1979). In the Gulf of Maine there has been, in contrast, a gradual but steady increase in recent years, probably due to improvement in the stream conditions from conservation measures being put into effect.

Black Sea Bass

Commercial catch statistics for black sea bass reflect a steady decline in abundance from the 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. Most of the exploited black sea bass consequently are males. It is postulated by Kendall and

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 to sustain 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 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 US 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, the 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 USA trawling may to some degree be substituting for part of the distant-water fleet effort. Being a species of relatively low fecundity, skates would be expected to have a longer recovery time than more fecund species. Recruitment studies based on survey length frequency data indicate no evidence for dominant year classes, which serve to speed stock recovery in other species.

Scup

Historical landings of scup reflect large fluctuations in population size. Poor spawning success, increased fishing pressure (both distant-water fleets and domestic), and high discard levels of juveniles combined

to lead to dramatic reductions in scup 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 59% 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. A running average of three 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 US fishery prior to 1960; after which these were subjected to increased exploitation from the distant-water fleets. As a result, the population shifted to younger age groups. 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 indicies are slightly lower than the 1963-1978 average, as it is the recruitment index. Nevertheless, survey indices are still well within the range of values necessary to support a fishery observably larger than the now existing one.

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. 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 MT to 225,000 MT. 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 is below 1% of the total production of the fish (Soldat 1979). Recently, the USA has developed a small export market of about 2,000 MT of dogfish fillets with the European nations. 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. The 1978 survey index for spiny dogfish shows no appreciable change from the 1967-1978 average.

Angler Goosefish

Clark and Brown (1978) estimated the biomass of angler at 18,000 MT 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 USA 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 USSR 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 MT from 1935 to 1942. In 1943, attempts to market ocean pout as a food fish were frustrated by parasitic lesions casued by a protozoan, which proved to be a recurring problem. During the 1950's and 1960's US landings were almost entirely industrial. Ocean pout comprised a substantial part of the total US 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 MT. It declined to an average level of 5,600 MT from 1970 to 1974. Since 1974 the ocean pout fishery has been essentially USA 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, 1975). Total US landings in 1977 were 1,060 MT; more than 50% of this was marketed as food fish. The 1978 survey index is 51% greater than the 1967 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 MT in 1969 but has recently declined to essentially a non-existent state. 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 more than one (1) year class fishery, as opposed to being fished out immediately and reduced to very low levels. In latter years, fishery effort has concentrated on several age groups including small males prior to their transforming into females and spawning; whereas, the historical Maine winter fishery focused on egg-bearing females. At this time the fishery is closed due to regulations to allow the stock to accumulate when good reproduction occurs.

Loligo Squid

Loligo squid are a very volatile species with a short life span that has the potential for exhibiting drastic year to year changes. Although records of squid were not kept in the early years of the survey cruise

they were in relatively low abudnance during the most of the 1950's. In the late 1960's the population expanded rapidly and has continued this through the 1977 period. During this time an extensive fishery was developed by the distant-water fleets. 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. Thus, in terms of numbers, the abundance remains at the high levels observed over the last decade.

Illex Squid

Illex squid are also a very volatile species with a short life span (about 1 year) that can exhibit drastic changes from year to year. Nevertheless, since environmental conditions tend to be more similar in adjacent years, abundant years tend to go together as do poorer years. In the last few years Illex has been extremely abundant relative to numbers observed earlier. 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 with extensive fisheries in Canadian waters. The extent that fisheries in these areas may effect abundance in the Northeastern United States is now 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.

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 angler catch was estimated at 16,765 MT in 1960. It rose to 35,932 MT in 1965 and to 45,305 MT in 1970. The commercial catch range (1950-1970) for the New York Bight was between 90 and 1,220 MT per year, with an average value of 635 MT per year. For the period 1973-1975, commercial landings increased to over 2,000 MT 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 value 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.

Tilefish

Bigelow and Schroeder (1953) estimated a potential sustainable yield of 1,000 to 1,500 MT 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, however 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 (when US Bureau of Fisheries first campaigned to promote a food fishery for tilefish) of 4,500 MT, landings have fluctuated greatly, reaching a low of 32 MT as recently as 1968. In 1977 about 2,000 MT 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. Catches of tilefish in research surveys have been completely lacking in most years and extremely small in others, due to 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 other invertebrates and also large pelagics (swordfish, sharks, other than dogfishes, tunas) and certain others such as menhaden, American eel, and white perch, which enter bottom trawl catches only very 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, 1978). Since, 1975, the resource has been increasing. Stock size is predicted to have approximately doubled the 1976-1978 average by age. 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.

Description of Table

In the examination and interpretation of the status of fishery resources, it is important to consider some basic parameters of the population and their potential 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 table. The table headings outline these key characteristics and a brief discussion of these characteristics follows.

The first heading is "Range and Stock Considerations". 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 implications are quite a different set of considerations, for *Loligo* squid, which ranges only as far north as the edge of Georges Bank, than for *Illex* squid which moves to the area off Newfoundland.

The stock considerations within the area breakdowns also give useful designations. 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 the similar patterns of growth and mortality rates throughout its range. It does not imply that there is no intermixing. Intermixing is a necessity 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 on a more or less random basis 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 the spawning concentrations, there may be a certain degree of mixture of fish from other areas. The important point is that there be enough separation in stocks so that interactions and effects on one stock are not immediately seen in the other areas.

Yellowtail flounder is a classic example of stock structure. After a period of intense pulse fishing by the USSR in the late 1960's the Southern New England stock dropped drastically in abundance. If there were a large degree of intermixture with the stock on Georges Bank, there would have been 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.

Another example can be illustrated with the herring stocks. 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. Obviously, some of the more resident fish in that area which depend on herring as forage shifted to other species as opposed to moving further north where herring was still abundant.

Thus, for interpreting the effects of various actions on the ecosystems, either man-made or natural (environmental), stock structure may be an important consideration of the analysis. This does not mean that management units should necessarily be based entirely on stock boundaries depending on the management objectives evaluating the effects of management actions on the resource one needs to look at the stock considerations.

In the second column we list some of the basic biological parameters

describing growth. The values given for many species are:

(1) 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.

(2) L_∞, which is a parameter from a von Bertalanffy growth equation--the maximum length which an average fish would attain if it lived indefinitely. Individual fish may exceed that average.

(3) κ, from the same equation, measures the rapidity of growth. The larger the κ the quicker the fish grow to L_∞. The species with the largest κ have the greatest potential for productivity, and also some of the greatest demands for food on the ecosystem.

In the next column is given the natural mortality rate (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 a size which can be recruited into the fishery. The higher the mortality rate the more rapidly the fish die, and the more rapidly, and at younger ages, one would expect to harvest them. The lower 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 from the population prior to being harvested.

Maturity is another important criterion, and is found in the next column. The more common factors given are the 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 and the weight at age (assumed proportional to fecundity) from growth curves. The length of the spawning season is also given. The implication of this, of course, is that those stocks with small areas and/or time spawning designations would be expected to have wider fluctuations due to environmental variations than a stock with a broader area and longer season. For certain specialized stocks such as dogfish, with very small numbers of young produced and spawning perhaps every other year, these pertinent items are noted.

The recruitment section lists the relative range of observed 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. The difference in the impact of spawning stock size is on the frequency of distribution of recruitment. 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 the sensitivity of it to various environmental factors. These range from quite stable, in terms of cod, where recruitment values observed have fluctuated by no more than a factor between 2 and 3, to those of haddock, where the ratio reaches almost 27,000-1. It should ge noted that the range for haddock during times of good population size is considerably less, roughly 20-1, and that the very high variability results by including the period of very low recruitment and spawning stock size. Not only was recruitment low when spawning stock size was low, but it was also more variable (1,200-1). The degree of variability is important when one considers that presently certain fisheries count almost entirely on production from entering year classes. The more variable the year class frequency the greater the fluctuation and thus the uncertainty in the size of the fishable population at any point in time when it is made up of very few year classes.

The next column lists some basic parameters of fishing; that is, the fishing mortality rate. F_{max} is a fishing mortality rate which would be 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 $F_{0.1}$ has been recommended for use in various management bodies such as ICNAF in its later years, the advice of the scientists to ICES, and the practice of the Canadian scientific committees after the 200-mile limit. This is a value less than F_{max} which will give almost as much yield as one would achieve by fishing at F_{max}, resulting 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 when available under 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 definition 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.

The next column (labeled abundance) 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 surveys data.

In order to obtain a crude index of the degree of confidence one has in the information given on abundance, a ranking scale was developed, ranging between 1 and 4. The difference here is between the previous and present state of the population. The scale reflects how confident we are

that the trends over time described in the abundance column have actually occurred in the population. A rating of 1 indicates that the relative difference is considered by the assessment group at Woods Hole to be measured with considerable precision and thus we are quite confident, a 2 would be considered to be measured with moderate precision, a 3 with poor precision, and a 4 would indicate only very modest improvement upon accepting the informationless state of assuming the range 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 our analytical methods. It is much easier to describe large fluctuations in abundance than it is to describe small ones.

It should be noted that these are very difficult kinds of evaluations to make. They are, in a sense, a gambler's judgment. It is obvious, since there is memory in the system, that there is a great deal of knowledge about certain stocks. That general knowledge about these stocks may provide, depending upon the management goal, adequate understanding. On the other hand, even the most precise knowledge does not pretend to estimate the exact stock size closely. Point estimates of the stocks are not intended to be an exact estimate of the stock they only provide guidelines which adhered to over time can help to achieve management goals. They can not be separated from management objectives but serve as necessary numerical values for developing management measures. The variance about any single point estimate can be large but the study of trends, overtime and biological unit characteristics provides significant information to make assessment of the stocks a valid description of relative conditions, and projects the longer term results of particular harvest strategies.

The relative condition of the stock, present to historic, is the point about the assessments that is not only the most valid but also the most relevant in decision making. Flexibility in terms of management goals relates a great deal to the condition of the stocks. When stocks are in fairly good condition, i.e., a relatively high level of abundance, they are fairly robust against a very large number of socioeconomically oriented management objectives. Where the stocks are not in good condition, then various management strategies involving different catch levels with only short-term consideration can have quite different long-term effects. In any case, it should be noted that is is the relative condition of the stock for which the assessments have significant reliability, not the estimates of yearly stock size.

The column giving maximum sustainable yield provides a useful guideline to the long-range biological productivity of the stocks, provided that it is taken within the context of the limitations of MSY. The maximum sustainable yield given here is based in some cases on anlytical models, and in other cases it is based on observations of long-range historical catch averages. It does give 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 and some years being below average. Therefore, it does give a general idea of comparing different stocks with regard to their differences in potential productivity. The year-to-year variations, are due to environmental conditions and the 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 is 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. Nevertheless, the comparison of the values given here do give rough indications of the differences between stocks and their general long-range productivity.

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, to a lesser degree of effectiveness, species that are associated with it in the environment. And finally, in the mixed fishery situation, even when 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 speceis. Thus, to make an economically viable trip, fishing is directed at several species. This column lists the historically observed by-catches, where available, and also notes particular inferences from the distribution patterns, both horizontally and vertically, through the seasons. For example, certain species which migrate through the water column may be fished with relative purity when they are high in the water column, but when they are on the bottom during other parts of the day they form the components of the mixed trawl fishery. Other species occupy seasonally quite separate areas, thus the by-catch in a different period of the year may be quite different both in amount and in species composition. These points are noted where pertinent in this table.

In summary, the information on the table can be used as important background information upon which decisions for utilizing the resources can be realistically made.

Geographical range; stock breakdown	Growth	Age range in fished populations	Recruitment	Maturity
COD				
From Port Burwell, W. Greenland, to Cape Lookout, NC 1) Geo. Bank 2) Gulf of ME 3) So. New England and So. Channel 4) Mid-Atlant. coast	Geo.B GulfME SNE-MA κ=0.120 0.116 0.257 L∞=148.1 146.5 112.9 Max. age = 22 yr Max. length = 183 cm	2-15+ yr Gulf ME: Presently 1971, 1973, 1974 yr classes dominate. Geo. Bank: 1978 catch dominated by 1975 yr class (49%). 1966, 1971 also good.	Geo.B. GulfME Mean age: 2 3 Geo.B: better than avg GulfME: better than avg Ratio 2.42-1 for 1960-1975	50% mature at 3 yr. Spawn chiefly in winter Max egg production: age 12
HADDOCK				
From W. Greenland to Cape Hatteras 1) Geo. Bank 2) Gulf of ME	Gulf ME Geo. Bank κ=0.352 κ=.376 L∞=72.91 cm L∞=73.80 Max. age = 18 yr Max. length = 112 cm	2-9+ yr In 1978: Over 80% fishable stock is 1975 year class. Historically ages 2-4 dominate catch.	Geo. B Gulf ME 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 Geo. Bank. Max egg production: age 6
POLLOCK				
From Labrador - West Greenland to Cape Hatteras. 1) Nova Scotia, GulfME, to SNE	κ=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) Geo. Bank 2) Gulf ME 3) So. New England-Mid-Atlant.	Geo. Bank GulfME SNE-MA κ=0.246 0.182 0.416 L∞=50.72 65.41 46.08 Max. age = 12 ♀; 6 ♂ Max. length = 66 cm	2-12+ yr Gulf ME: 1971 saw a shift toward younger fish; ages 2-3 dominated catch. In 1975-1977, age 3 made up 44% of catch. Geo. Bank: 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 Geo. Bank and Central Gulf ME, earlier on SNE Max egg production: age 4.
RED HAKE				
From Gulf St. Lawr. and Grand Bank Newf. to No. Carolina 1) Geo. Bank 2) So. New England-Mid-Atlant. 3) Gulf ME (small)	κ=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 Geo. Bank 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 Geo. Bank	κ L∞ { Not available. Max. age = ≈23 yr Max. length = 122 cm	Not known.	Not known.	Spawn on Continental Slope of Mid-Atlant. Bight in summer.

Natural Mortality	Fishing Mortality	Abundance	MSY	By-catch/ Distribution
COD (cont.)				
M=0.2	GulfME Geo. B $F_{0.1}$=0.16 0.15 F_{max}=0.3 0.3 (7.5 yr)	Rank 2 Both GulfME and Geo.B cod seem at abundant population condition. Geo.B 1978 autumn index is 123% greater than 1963-1978 average (1978 increased 86% over 1977). GulfME 1978 autumn index is 38% greater than 1963-1978 average (1978 27% over 1977).	GulfME = 8,000 MT Geo.B = 35,000 MT	Haddock, pollock, yellowtail, other flounders, groundfish. Demersal Geo.B 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. Geo. B 1978 fall index 23% less than 1963-1978 average. GulfME 1978 fall index 88% greater than 1963-1978 average.	Geo.B = 40-50,000 MT	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 Geo.B 1977 fall index 82% greater than 1963-1977 average. GulfME 1977 fall index 81% greater than 1963-1977 average. Scotian Shelf 1977 fall index 21% less than 1963-1977 average.	42,000 MT for Nova Scotia Shelf, GulfME, Geo.B., So. New England	Herring (fall only), groundfish when fishing on bottom. Pelagic/Demersal Seasonal spawning movements to western GulfME, Scotian Shelf
SILVER HAKE (cont.)				
M=0.4	$F_{0.1}$ Fcurrent Geo.B=0.65 0.33 GulfME=0.5 0.39 SNE-MA=0.55 0.461 F_{max} not a calculable value.	Rank 3. GulfME stock recovering, remains less than peak, early 50's. Geo.B and So. New England stock in good condition but less than peak abundance. Geo.B 1977 fall index 3% greater than 1963-1977 average. GulfME 1977 fall index 11% greater than 1963-1977 average. SNE-MA 1977 fall index 22% less than 1963-1977 average.	Geo.B = 55,000 MT GulfME = 17,000 MT SNE-MA = 35,000 MT	Red hake, mackerel, other ground Demersal/Pelagic Densest offshore; migrates shoreward spring, summer. NY Bight f migrate East to SNE waters in summer.
RED HAKE (cont.)				
M=0.4	$F_{0.1}$ Fcurrent Geo.B. =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. Geo.B 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.	Geo.B = 13,000 MT SNE-MA = 26,000 MT	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 MT GulfME = 3,000 MT	Red hake, other groundfish. Demersal Inshore movement in GulfME and So. New England in autumn.

Geographical range; stock breakdown	Growth	Age range in fished populations	Recruitment	Maturity
MACKEREL				
From Black Is.,Labrador, to Beaufort, NC 1) Considered as one stock on present evidence. (Winter concentrations off US mid-Atlant./So. Atlant. coast. Summer GulfME, Geo.B, 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 G Spawn on Western Gulf Maine and Cape Cod Bay in spring and early summer. Peak May-June Stock also spawns in Gu St. Lawr. Max egg production: ag
REDFISH				
From W. Greenland to New Jersey (2 species) 1) GulfME is range of S. marinus off US. S. mentella not found this far south.	κ =0.104 L∞=37.80 Max. age = >50 yr Max. length = 45-50 cm	6-25+ yr Usually 12-25 age range. 1977 introduced age 6'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 = 6.	Mature at age 8-9 (viviparous). Spawn on Scotian Shelf and Central Gulf ME. Peak late June to earl July.
YELLOWTAIL				
From South coast of Labrador to Chesapeake Bay 1) Gulf Maine 2) Geo. Bank 3) SNE 4) Mid-Atlant. 5) Cape Cod	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 Geo. Bank 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: ag
WINTER FLOUNDER				
From Labrador to Georgia 1) Georges Bank-59% 2) SNE-13% 3) GulfME-22% 4) Local inshore populations found %'s are of total catch.	Ford-Walford Growth Equation used: Geo.B 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 NE pre-recruit index up 173% over 1974-76 average. 1977 Geo.B 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 Geo.B.
SUMMER FLOUNDER				
From Cape Cod to Cape Hatteras 1) Geo.B 2) SNE 3) Mid-Atlantic	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 Sho and south Sept-Apr in north to south progres Early Sept for GM. Max egg production: ag
AMERICAN PLAICE				
From Labrador to south of Cape Cod offshore from New York 1) GulfME-area of conc. 2) Geo.B 3) New England	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 Vineyard March-June. Peaks Apr-May.

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, Geo.B, MA = 210,000-230,000 MT	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.	GulfME, Geo.B= =14,020 MT At current abundance, fishing at MSY effort would yield 5,200 MT	Relatively pure fishery; 85% pure between 1968 and 1978. However redfish are taken in mixed ground fisheries and GulfME shrimp fishe 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 considerably below peak periods. SNE 1978 index is 70% lower than 1967-1979 average. Geo.B 1979 index is 56% lower than 1964-1978 average. MA 1978 index is 89% lower than 1963-1978 average.	Geo.B = 16,000 MT SNE-MA = 23,000 MT	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.)				
(probably) M=0.27 So. of Cape Cod	So. of Cape Cod F = 0.27	Rank 3 Abundance has increased in recent years but not to peak levels. Recruitment appears to be good. 1978 Geo.B 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 extensiv
SUMMER FLOUNDER (cont.)				
M=0.2	F=0.3 in 1977	Rank 3 Abundance levels appear to be low relative to recent years. Geo.B 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 wit 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 ground Demersal No significant migrations.

Geographical range; stock breakdown	Growth	Age range in fished populations	Recruitment	Maturity
WINDOWPANE				
From Gulf St. Lawr. to So. Carolina 1) SNE-MA 2) Geo.B	Largest individuals found on Geo.B 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 Geo.B and Nantucket Shoals and South Apr-Jun. Peaks in May. Begins again in late fa
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 Cape Cod.	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 Cape Cod to Delaware Bay in late spring - summer. Peaks Jul-Aug.
ATLANTIC HERRING				
From polar ice in Greenland and Labrador to Cape Hatteras 1) Geo.B 2) Nova Scotia 3) Coastal ME	L_∞ / κ Geo.B 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 Geo.B and Nantucket Shoals - SW GulfME, smaller spawing 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 Cape Cod 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) Geo.B 2) NY Bight	8-10 cm/yr for 1st & 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 specie Peaks for Little Skate Nov-Jan and Jun-Jul. Probably about 30 egg cases per yr most speci

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 deep water in coldest months short annu 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 Geo. B. 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 MT SNE, Geo.B, MA= 120,000 MT; Scotian Shelf=90,104,000 MT Pelagic Total MSY probably less than sum of individuals due to stock interactions.	When caught in purse-seines, 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 Geo.B, Jeffrey's Ledge in autumn then migrate to NY Bight ar to overwinter. Migrate back in spr
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 MT	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 Geo.B-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 Big Skate 23,000 Cape Hatteras to Geo.B spring surveys provide best estimate. 1978 survey index is 25% greater than 1967-1978 average	Not available	Demersal Seasonal movements in response to changing water temperature; Long Island spring & fall, shelf off Chesapeake Bay - winter.

Geographical range; stock breakdown	Growth	Age range in fished populations	Recruitment	Maturity
SCUP				
From Cape Hatteras to Cape Cod Two subpopulations 1) SNE 2) New Jersey	Reach 60% of maximum size by age 3 κ = .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 κ = .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 Mid-Atl. to SW Geo.B 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 κ = } 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 Ovovivipasus 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) Geo.B 3) GulfME	10 cm/yr Long lived κ = } 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) Cape Cod So.	Slower in northerly areas κ = } 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 GulfME 1) GulfME (western)	κ = } 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 M

Natural Mortality	Fishing Mortality	Abundance	MSY	By-catch/ Distribution
SCUP (cont.)				
M=0.8	F=.15	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 MT	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 MT 1976 stock size - 32,000 MT, 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 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 MT/yr catch since 1972 1978 survey index shows no significant change from 1967-1978 average	40,000 MT	Pelagic/Semi-demersal Spawn offshore in winter, begin southward migration in Oct, return north in late spring Often caught and discarded in summ bottom trawl fisheries
ANGLER (GOOSEFISH),(cont.)				
Not known	Not known	Rank 4 18,000 MT 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% Geo.B 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 migrati Seasonal change in local distribut 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 GulfME

Geographic range; stock breakdown	Growth	Age range in fished populations	Recruitment	Maturity
LOLIGO				
From New Brunswick to Georgia 1) Main fishable stock winters offshore Mid-Atlant. 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 equa. to maximum age of indi vidual Spawns May-Sep inshore
ILLEX				
From Greenland, Labrador, and Newfoundl. to FL Stock structure uncertain, some appear to migrate thru Geo.B to summer conc. off Newfoundl; some summer on Geo.B-GulfME	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-Ju in deep water offshore areas.
BLUEFISH				
From MA to FL 1) MA to New Jersey 2) New Jersey 3) Delmarva Peninsula 4) Chesapeake Bay to Cape Lookout, No. Carolina 5) Cape Lookout to GA 6) Both coasts of Florida	Fast growing Max. age = 14 yrs Max. length = 114 cm	1-8 yrs 1-3 yr olds were bulk of sampled fish	Young of year have accounted for 20-90% of entire recreational catch taken from shore. Ratio not known	Mature at age 2-5 Spawns May-Jun
TILEFISH				
From Nova Scotia to Florida Mainly found at edge of shelf	Slow growth rate κ = ; L_∞ = not available Max. age = 40-50 yrs Max. length = 125 cm	No available data	No available data	Age of 1st maturity betw 5-13 yrs Spawn from Mar-Sep
Total FINFISH and SQUID				
NW Atlant. Primarily offshore, Gulf Maine, Geo.B, SNE, Mid-Atlant.	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.

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 Population size range: 1,100-4,800 million individuals (lowest since 1971).	SNE, Geo.B, MA = 44,000 MT	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 every wt/tow was 39% less than in 1976 indicating smaller individuals (second highest since 1968).	GulfME, SNE, Geo.B, MA = 30,000 MT Gulf of St. Lawr. and Grand Bank of Newfoundl. = 120,000 MT	Intensive by-catch both offshore and inshore. Mixtures of groundf. species taken when fished near bottom. Pelagic Move offshore in autumn into deepe warmer water.
BLUEFISH (cont.)				
M=0.2	Current levels of catch are at about MSY level Catches averaged 1975-1978 = 88,200 tons	Rank 4 1978 survey index is 13% greater than 1967-1978 average. Increased since the 1960's stable level in the 1970's	89,000 MT	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 wi little trawl commercial catch thei 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 MT (1976)	N/A

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 being concentrated on relatively few stocks to being eclectic over the total finfish and squid biomass. Total resource abundance declined and the annual harvest exceeded the total productivity. Since 1975, the trend has been reversed, overall fishing effort has declined and the stocks have begun to recover and are now approaching the 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. It is in these stocks which conditions still exist such that the potential fishing effort can harvest in excess of annual productivity. Some of these are stocks with a low capacity to rebuild, such as redfish, others like 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, does not yet have a stable structure that would denote a population capable of consistently sustaining high harvests. Nevertheless, the 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 has not yet demonstrated a start towards a recovery to earlier levels. Even here, however, the potential for a good incoming year class does currently exist and if this year class can contribute significantly to the spawning stock for a period of time, then

even the offshore herring stocks may be on their way toward approaching values observed historically prior to the consistent heavy fishing. As the total resource builds to a level at which productivity on an annual basis 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.

Environmental fluctuations on a yearly basis create wide ranges of abundance within particular species. These ranges 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.

Acknowledgements

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Table 2. 1978 Total Catch (MT)

North and Middle Atlantic Regions

	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 3

Annual US and foreign commercial landings (Metric tons) from ICNAF statistical areas 5 and 6, for major species in the decade 1969-1978.

Species	1969		1970		1971		1972		1973		1974		1975		1976		1977		1978	
	US	F	US	F	US	F	US	F	US	F	US	F	US	F	US	F	US	F	US	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	2900	8500	3668	4779	1891	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	58734	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	3818	195
Mackerel	4364	103990	4049	195930	2406	346338	2006	385358	1336	379828	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	8458	2539	8909	1533	7565	215	8135	577	6739	12	10583	25	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	19089	12804	23027	1228	12574	10310	6757	11109	5245	10797	3775	6482	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	458	1143	262	1595	226
Scup	4740	460	4514	198	3157	1049	3440	1647	4135	1703	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	2285	1070	3095	2730	3249	483	274	3	678	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	3189	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

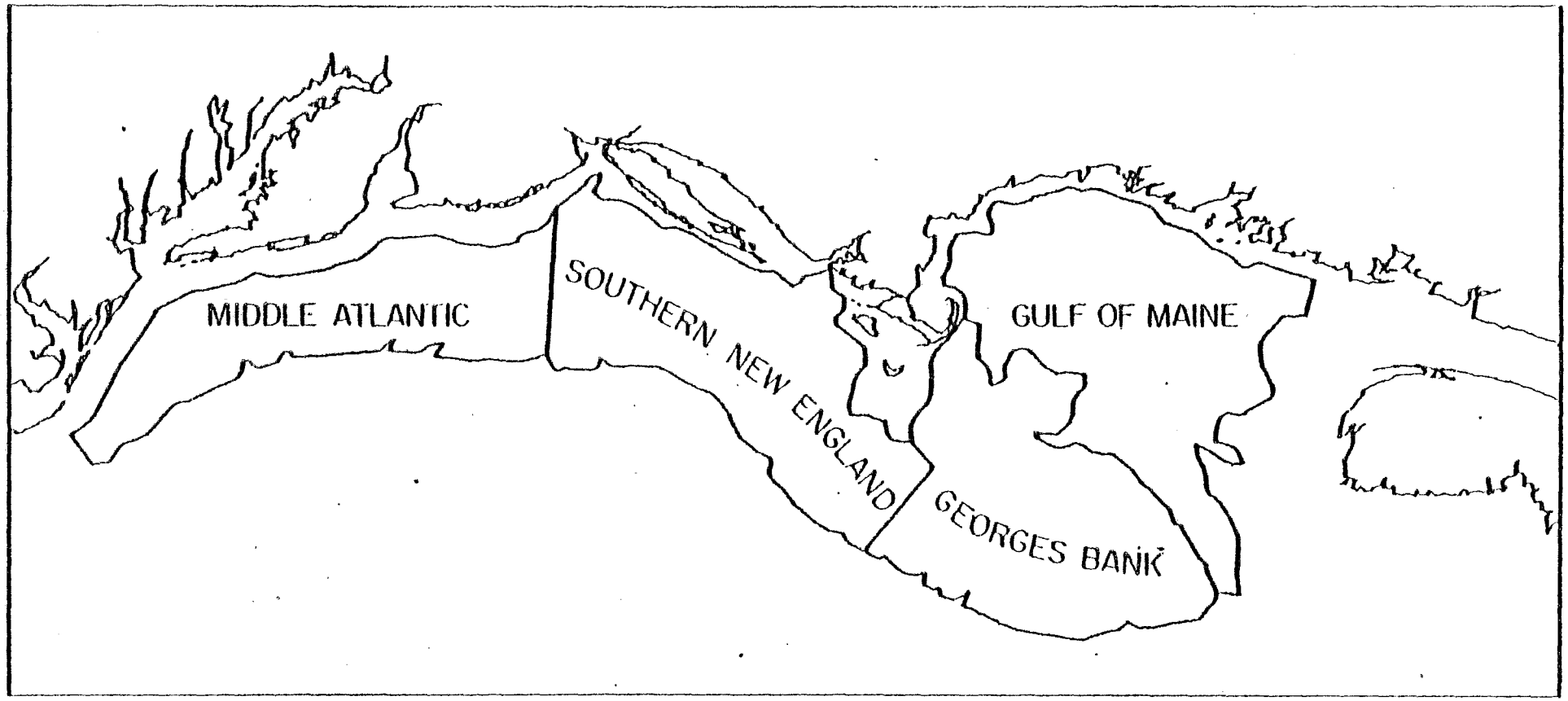

Figure 1. Major geographical areas off the Northeast coast of the United States.

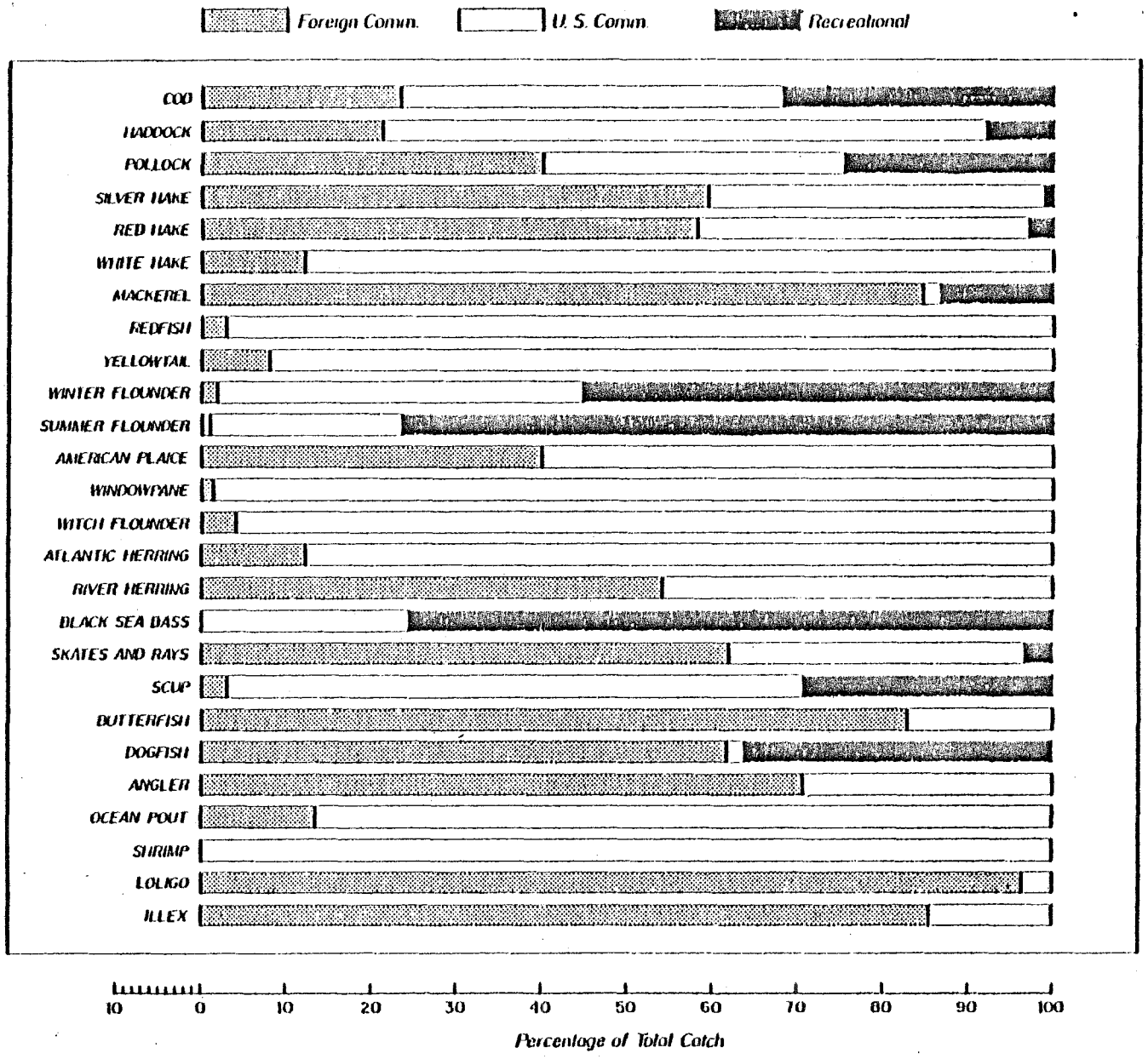

Figure 2. Relative percentages of recreational, foreign, and US commercial catch to the total catch for each species in the year 1970.

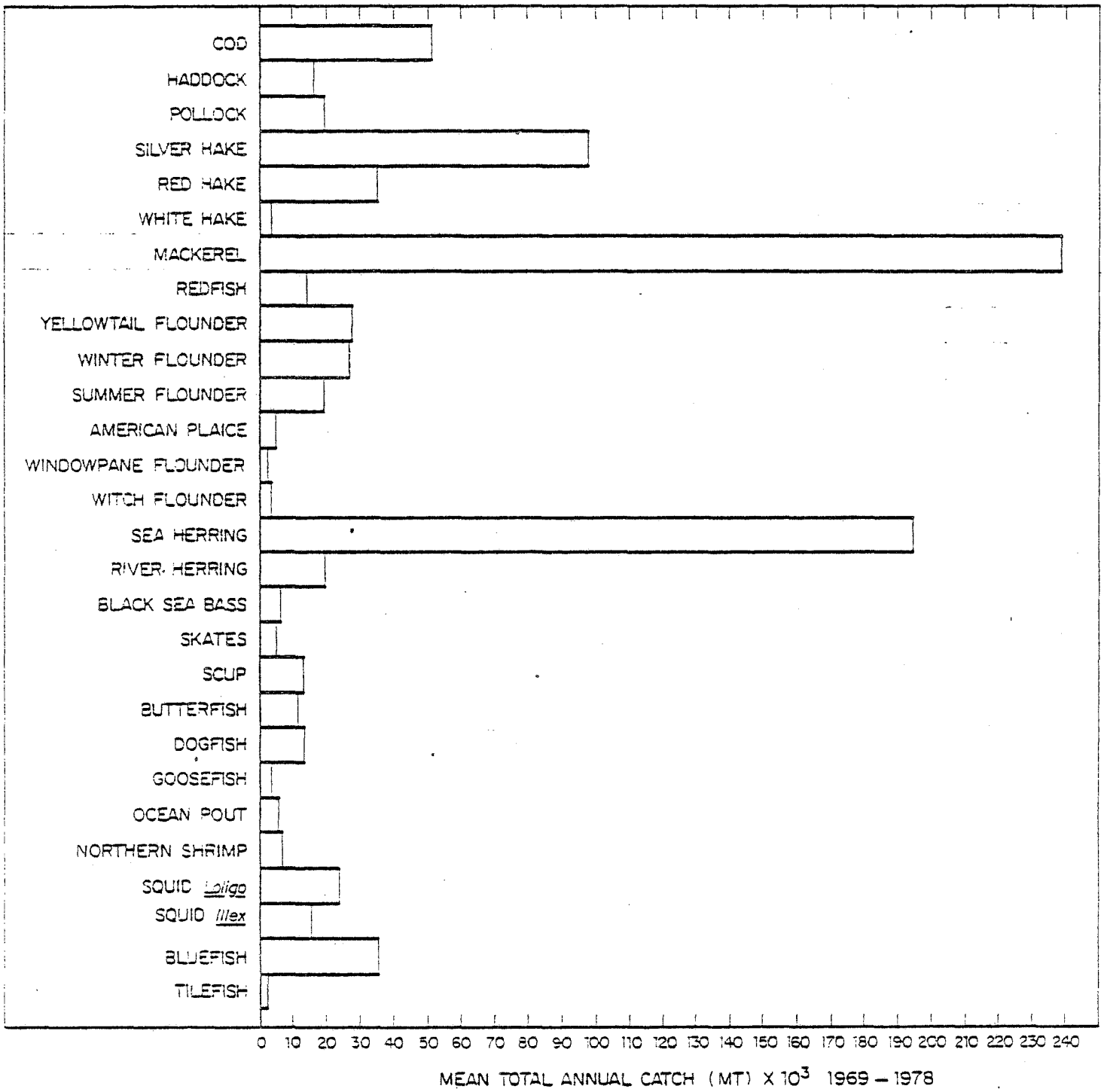

Figure 3. U.S. and foreign commercial catch values are taken from the ICNAF Statistical Bulletins. Recreational catch averaged from the 1960, 1965, and 1970 Saltwater Angling Surveys.

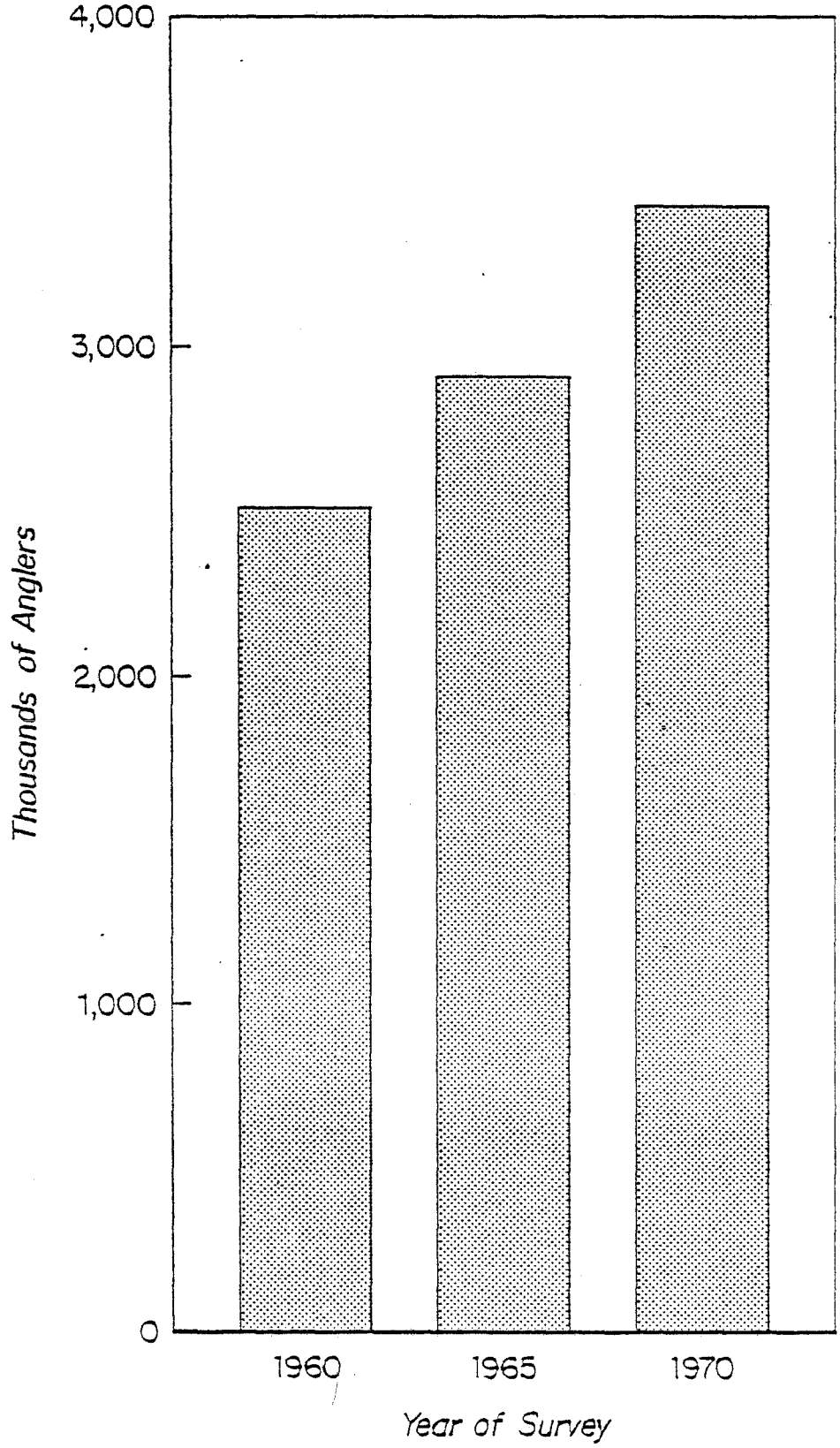

Figure 4. Saltwater angling effort for three years of survey as reflected by number of anglers.