

SUMMARY OF STOCK ASSESSMENTS

AUGUST - 1978

by

Resource Assessment Division

National Marine Fisheries Service
Northeast Fisheries Center
Woods Hole Laboratory
Woods Hole, Massachusetts 02543

Laboratory Reference No. 78-40

29 August 1978

TABLE OF CONTENTS

	<u>Page</u>
INTRODUCTION.....	1
COMMERCIAL FISHERY TRENDS.....	1
Gulf of Maine, Georges Bank, and Southern New England.....	1
Middle Atlantic.....	2
RECREATIONAL FISHERY TRENDS.....	2
ATLANTIC COD.....	3
Georges Bank Stock.....	3
Gulf of Maine Stock.....	4
HADDOCK.....	5
REDFISH.....	6
SILVER HAKE.....	7
Gulf of Maine stock.....	7
Georges Bank Stock.....	7
Southern New England - Middle Atlantic Stock.....	8
RED HAKE.....	9
Georges Bank Stock.....	9
Southern New England - Middle Atlantic Stock.....	9
POLLOCK.....	10
YELLOWTAIL FLOUNDER.....	11
West of 69 ^o W Stock.....	11
East of 69 ^o W Stock.....	12
SUMMER FLOUNDER.....	12
FLOUNDERS EXCEPT YELLOWTAIL AND SUMMER FLOUNDER.....	13
ATLANTIC HERRING.....	14
Maine Juvenile Fishery.....	14
Gulf of Maine Adult Fishery.....	14
Georges Bank Adult Fishery.....	15
ATLANTIC MACKEREL.....	15

	<u>Page</u>
RIVER HERRING.....	16
SCUP.....	17
WEAKFISH.....	17
BUTTERFISH.....	18
BLUEFISH.....	19
WHITE HAKE.....	19
OTHER FINFISH.....	19
SQUID.....	20
TOTAL FINFISH AND SQUID.....	21
NORTHERN LOBSTER.....	22
NORTHERN SHRIMP.....	23
RED CRAB.....	23
SURF CLAMS.....	24
OCEAN QUAHOGS.....	25
SEA SCALLOPS.....	26

The following Resource Assessment Division personnel, listed alphabetically, assisted in the preparation of this report: Frank Almeida, Emory Anderson, Elizabeth Bevacqua, Bradford Brown, Thurston Burns, Steve Clark, Brian Hayden, Emma Henderson, Hillary Herring, Anne Lange, Ralph Mayo, Steve Murawski, William Overholtz, Fred Serchuk, Michael Sissenwine, and Gordon Waring.

INTRODUCTION

This report summarizes the current status of over 30 species-stocks of marine finfish and shellfish inhabiting the continental shelf waters of the Northwest Atlantic between the Gulf of Maine and Cape Hatteras. The assessments of these stocks were made by personnel of the Resource Assessment Division of the Northeast Fisheries Center and have incorporated the most recent commercial, recreational, and research vessel survey data available. Detailed assessment reports for many of these stocks are available at the Center in the form of Laboratory References. The primary purpose of the assessments is to provide advice and recommendations to management groups (e.g., New England and Mid-Atlantic Fishery Management Councils) relative to setting catch quotas and establishing other regulations. At the present time, many of the species-stocks included in this report are under management either through PMP's or FMP's.

COMMERCIAL FISHERY TRENDS

Gulf of Maine, Georges Bank, and Southern New England

The international commercial catch¹ of all species declined from 647,050 tons² in 1976 to 542,294 tons in 1977 (-19%). The international catch of groundfish species increased slightly from 197,662 tons in 1976 to 211,594 tons in 1977 (+7%). The greatest increase occurred in haddock (+136%), cod (+34%), flounders other than yellowtail (+31%), redfish (+28%), and pollock (+24%). All other groundfish species exhibited either declines or only slight increases. A notable decrease occurred in the red hake catch, which dropped from 20,568 tons in 1976 to 7,109 tons in 1977 (-65%), almost entirely a result of reduced USSR catches.

The international catch of pelagic species declined sharply from 249,146 tons in 1976 to only 76,176 tons in 1977 (-69%). The greatest share of this reduction is attributable to the catches of distant water fleets which dropped from 154,794 tons in 1976 to 8,398 tons in 1977 (-95%). The USA pelagic catch decreased 28%. The species which accounted for the largest share of this sharp decrease in catch are Atlantic mackerel (-95%), Atlantic herring (-43%), and Atlantic menhaden (-65%).

The international catch of other finfishes also declined from 20,780 tons in 1976 to 11,867 tons in 1977 (-43%), almost entirely as a result of the decline in the USSR dogfish catch from 12,359 tons in 1976 to 4,880 tons in 1977.

Overall, the total international finfish catch from this area dropped from 467,588 tons in 1976 to 299,637 tons in 1977 (-36%).

The international invertebrate catch increased from 177,648 tons in 1976 to 217,779 tons in 1977 (+23%). The major share of this is due to the sharp rise in the sea

¹Catches in this report refers to nominal catches defined as the live weight equivalent of landings.

²Tons in this report refers to metric tons (2,204.6 lbs).

scallop catch from 98,894 tons (live weight) in 1976 to 151,873 tons in 1977 (+54%). Offsetting this increase to some extent was a decline in the international squid catch from 24,043 tons in 1976 to 9,816 tons in 1977 (-59%).

Middle Atlantic

The international catch of all species declined from 900,061 tons in 1976 to 786,771 tons in 1977 (-13%). Catches of groundfish and other finfish remained close to the 1976 levels, while the pelagic fish catch dropped from 372,607 tons in 1976 to 305,613 tons in 1977 (-18%). A 54% drop in the mackerel catch contributed substantially to this decline.

Overall, the total international finfish catch in this area decreased from 447,691 tons in 1976 to 377,497 tons in 1977 (-16%).

The international invertebrate catch declined from 452,370 tons in 1976 to 409,274 tons in 1977 (-19%). A drop in the sea scallop catch (-11%) was offset by a 23% increase in the total squid catch. The American oyster catch also declined from 176,857 tons in 1976 to 131,099 tons in 1977 (-26%).

RECREATIONAL FISHERY TRENDS

One of the explicit purposes of the Fishery Conservation and Management Act of 1976 is to promote "...recreational fishing under sound conservation and management principles." The Act makes it mandatory that information on the quantity, effort expended, revenue, and seasonal and geographical distribution of the recreational catch be included in the development of any fishery management plan. Accurate annual catch statistics, coupled with other data, will facilitate management planning for optimum yield of fishery resources.

National saltwater angling surveys were conducted in 1960, 1965, and 1970 as supplements to the national surveys of fishing and hunting. Additionally, a regional survey was conducted in the northeastern coastal United States in 1974, and a local New Jersey party and charter boat recreational survey was performed by the NMFS Sandy Hook Laboratory during 1975-76; during spring and summer of 1977, this laboratory conducted a recreational party and charter boat survey in the Maryland - New York area to estimate recreational catches of mackerel and selected other species. Resource Assessment Division personnel at the Sandy Hook Laboratory are presently engaged in a survey, which began 15 April 1978 under contract to the Mid-Atlantic Fishery Management Council and in cooperation with personnel from Delaware, New Jersey, and New York, to estimate the recreational catch of Atlantic mackerel between Delaware and New York and also to gather information concerning the catch of bluefish and summer flounder.

Although methodologies and sampling techniques have differed among the various surveys, several trends in the overall marine angler harvest in Northwest Atlantic waters are discernable. The estimated number of finfish caught by marine anglers (Maine through Virginia) increased from 211.9 million in 1960 to 264.8 million in 1965 to 285.2 million in 1970 but declined to 139.5 million in 1974.

Similarly, the estimated weight of finfish caught by recreational fishermen in this region increased from 164,054 tons in 1960 to 201,654 tons in 1965 to 232,979 tons in 1970 but declined to 161,963 tons in 1974.

Interpretation of the angling survey results must be done with caution. First of all, the estimated catches are subject to considerable statistical variability. Secondly, the sampling procedures were similar for the 1960, 1965, and 1970 national surveys, but considerably different for the 1974 regional survey. The latter included a telephone survey of randomly-selected households to determine participation followed by the mailing of questionnaires at 2-month intervals to obtain data on participation, catch, effort, and expenditures. The earlier surveys were direct household interviews conducted on population subsamples by the Bureau of the Census which relied on memory recall for the entire year. Because of these basic differences in procedure, the estimated catches are not comparable. Whereas the increase in catch from 1960 to 1970 is probably true, it is likely that the reported decrease from 1970 to 1974 is, in fact, incorrect and is merely the result of the differences in sampling procedures.

Methodological studies under contract to the NMFS Washington Office to improve the reliability of survey data were completed in 1977. These analyses indicated that future survey approaches should include a combined telephone and on-site intercept survey; a random digit telephone survey to obtain participation and effort data, and an intercept (creel) survey to obtain the distribution of the total catch at the species level.

A new marine recreational fisheries survey, employing the above procedures, will be conducted by NMFS, beginning in the autumn of 1978. Data will be collected by state for 10 specified geographical regions of the United States, and will provide detailed information on participation, finfish catches, and catches of selected species of shellfish. The survey is scheduled to be conducted on a continuing, annual basis.

ATLANTIC COD

Georges Bank Stock

Provisional reported USA commercial landings of cod (Gadus morhua) in 1977 were 19,750 tons, a 36% increase from 1976, and the highest domestic yearly catch since 1946. Canadian landings in 1977 totaled 5,430 tons, an increase of over 3,100 tons from 1976, and the highest since 1969. Reported international commercial catch increased from 19,926 tons in 1976 to 25,180 tons in 1977 (26% increase). Reported 1977 USA commercial landings are believed to underestimate the actual commercial catch since informal reports by fishermen suggest that considerable quantities of scrod cod were discarded in 1977. The exact amount of the 1977 USA recreational harvest is unknown, although, for 1978 assessment purposes, a catch of 10,000 tons was used, that being the estimated amount caught in 1974. Qualitative input from recreational fishery sources indicates that this amount is likely an overestimate for 1977.

Both USA bottom trawl survey and commercial length-frequency data indicate that within the present stock, the strong 1975 year-class is predominant. The autumn 1977 research bottom trawl survey indicated that the 1975-year class comprised 49% of the population, by number. USA commercial size/age frequency data in 1977 revealed that the 1975 year-class (age 2 fish) comprised 54% of the yearly catch in number (discard not considered). The distribution of USA commercial landings by market category further corroborated the presence of the strong 1975

year-class as the percent of scrod (by weight) landed doubled between 1976 and 1977 (18 vs 34%). Such dominance by one year-class in the fishery occurred previously since 1960 only with the 1966 and 1971 year-classes.

The 1977 autumn survey revealed two abundance changes within the stock: (1) the catch per tow (number) of fish age 2 and older (2+) increased sharply from 1976 to 1977 (3.196 vs 3.893), and was the highest since 1973; and (2) the catch per tow of fish of ages 0 and 1 markedly decreased from 1976 to 1977 (3.434 vs 0.483), and was the lowest value observed in the history of the autumn trawl survey. These patterns result from the strong 1975 year-class and the absence of significant recruitment from the 1976 and 1977 year-classes.

Total stock biomass (age 1+) increased from 66,300 tons in 1976 to about 80,000 tons in 1977, due to the growth-in-weight of the 1975 year-class. Spawning stock biomass (age 3+), which decreased by about 60% from 1965 to 1976, increased to about 56,500 tons in 1977. At the beginning of 1978, total stock biomass was reduced to 71,000 tons and spawning stock size to nearly 55,000 tons (assuming USA discards equalled 30% of the reported 1977 commercial catch).

A total catch of about 26,000 tons (including discards) in 1978 will likely maintain stock size at the beginning of 1979 at the 1978 level, and possibly result in a minor increase (<5%) in spawning stock size. However, if recreational catches were overestimated in former years, stock declines may ensue from a 1978 (commercial and recreational) harvest of 26,000 tons.

Fishing mortality values observed in 1977 and estimated for 1978 ($F=0.522$ for a catch of 26,000 tons) are above $F_{max} = 0.30$. Although the projected 1979 stock size would remain higher than those noted since 1972, it would still be considerably less than those observed during 1961-1971.

Gulf of Maine Stock

Provisional 1977 USA commercial landings were 10,291 tons, the highest in the fishery since 1945, and 4% higher than the 1976 commercial harvest of 9,878 tons. All annual commercial catches since 1974 have exceeded the annual long-term (1932-1975) mean of 6,200 tons. The 1977 catch exceeded the 1977 commercial OY by 106%.

USA bottom trawl survey and commercial market category size composition data indicate that one strong year-class (1971) and two moderately strong year-classes (1973 and 1974) have appeared in the fishery since 1970. Gulf of Maine cod are generally recruited to the commercial fishery at age 3, and hence both the 1973 and 1974 year-classes have already entered the fishery.

The autumn survey abundance indices (numbers and kg per tow) increased from 1976 to 1977; the catch-per-tow index (9.7 kg) was the highest since 1971. The catch-per-tow indices (numbers) of juvenile fish (ages 0, 1, and 2), however, were among the lowest in the survey time-series, and imply that the 1975, 1976, and

1977 year-classes are probably as poor or poorer than any observed since 1973. These results suggest that, although stock biomass has increased recently, the currently harvested year-classes will have to sustain the fishery through at least 1980.

Total stock biomass at the beginning of 1978 was estimated at about 27,600 tons. A catch in 1978 of 8,500 tons ($F=0.31$) would probably maintain the stock size in 1979 at the 1978 level. Catches of 10,500, 12,500, and 14,300 tons in 1978 would likely result in biomass declines of 10%, 18%, and 26%, respectively, assuming essentially no recruitment. Fishing mortality rates corresponding to these catches ($F=0.4, 0.5, \text{ and } 0.6$) are considerably higher than $F_{\max} = 0.3$, the mortality rate producing maximum yield per recruit. On a short term (1 year) basis, fishing at a level of F_{\max} or above may not result in a serious stock decline, although continued fishing at these levels will probably result in declines, as has been the case in other northern cod stocks fished at F_{\max} levels and above. It should be noted that here, as in all assessments, the relative declines from certain levels of fishing mortality are the critical consideration, not stock size. Certain factors affecting stock size accuracy such as unknown catch usually do not affect the percent declines.

The poor recruitment evident since 1975 is significant. Recent large annual catch levels (i.e., high F values) cannot be sustained for long if recruitment continues to be poor.

HADDOCK

Haddock (Melanogrammus aeglefinus) have been managed as a single unit in the Georges Bank - western Gulf of Maine area since 1970, although separate spawning stocks appear to exist on Georges Bank, off Nantucket Shoals, and in the western Gulf of Maine. An analytical assessment has been performed only for the Georges Bank stock.

Provisional statistics for 1977 indicate a catch of 14,121 tons, more than double the catch reported for 1976 (6,280 tons). Of this amount, 10,808 tons was taken from Georges Bank; the remainder (3,313 tons) was taken from the Gulf of Maine. This observed catch distribution was approximately the same between the two areas during 1975-1976 (i.e., the Gulf of Maine catch was 31% of the Georges Bank catch in 1977 and 33% of the Georges Bank catch during 1975-1976). The sharp increase in 1977 reflects the recruitment of the very strong 1975 year-class and occurred in spite of an incidental catch limitation of 6,000 tons for most of the year. The 1977 commercial catch was taken entirely by the USA (11,232 tons) and Canada (2,889 tons). The most recent recreational catch estimate available is 200 tons in 1974. Provisional commercial statistics for January-April 1978 indicate a Georges Bank - Gulf of Maine catch of 4,700 tons for the USA. Assuming increased USA catches in summer and autumn, and including projected Canadian and USA recreational catches, it appears likely that the 1978 catch will exceed 20,000 tons.

USA 1977 autumn and 1978 spring bottom trawl survey data indicate that the 1975 year-class (estimated to be approximately 169 million fish at the beginning of 1977) continues to dominate the population. This year-class constituted 81% of the mean catch-per-tow (number) of haddock in the 1977 autumn survey. The 1976

and 1977 year-classes both appear to be poor (10 million and 2 million fish, respectively) and should not increase stock abundance significantly in 1978 and 1979.

Assuming a 1975 year-class of 169 million fish at age 2, the Georges Bank haddock stock increased to 196 million fish (age 2+) at the beginning of 1977, substantially above the long-term (1935-1960) average for this stock (145 million fish). Stock biomass increased from 140,000 tons in 1977 to 192,000 tons at the beginning of 1978. Assuming a 1978 catch of 15,000 tons from Georges Bank (corresponding approximately to a Georges Bank - Gulf of Maine combined catch of 20,000 tons) stock biomass in 1979 would be approximately 193,000 tons. Preliminary calculations indicate that this level of catch should be sustainable at least through 1980 without a significant increase in fishing mortality or a significant reduction in spawning stock biomass below the long-term (1935-1960) level of 130,000 tons.

REDFISH

The international redfish (Sebastes marinus) catch in the Gulf of Maine- Georges Bank region increased from 10,696 tons in 1976 to 13,209 tons in 1977. The USA caught 13,005 tons and Canada accounted for the remaining 204 tons. The standardized commercial catch-per-effort index has been recalculated for each of the years from 1952 to 1977. This index, which had been declining from a 1968 high of 6.4 tons per standard day fished, increased slightly from 2.0 tons in 1975 and 1976 to 2.1 tons in 1977.

USA research vessel bottom trawl survey data from the Gulf of Maine - Georges Bank areas inhabited by redfish show a continued decline in both number and weight of redfish per tow in the offshore areas. Numbers and weight per tow for inshore areas increased in 1977, suggesting continued recruitment of the 1971 year-class.

Application of bottom trawl survey age-length keys to the commercial length frequency data from 1975 to 1977 confirms the presence of the 1971 year-class in the commercial catch during these years. In 1977, approximately 38% of the total number of redfish caught from this region was from the 1971 year-class, compared to 31% in 1976 and 3% in 1975. Comparison of the 1977 commercial and survey length frequencies suggests that recruitment of the 1971 year-class was almost complete by the end of the 1977 fishing season. However, survey data do not indicate any strong year-classes after 1971.

Given the above evidence on recruitment and year-class strength, it appears that any increase in biomass during the next five years will have to come from growth of individuals of the 1971 year-class. If the fishery continues to be dependent on this single year-class for any extended amount of time, growth will no longer balance the effect of mortality, and a decrease in biomass can be expected.

SILVER HAKE

Gulf of Maine Stock

The 1977 silver hake (Merluccius bilinearis) catch of 8,710 tons, taken exclusively by the USA, decreased slightly from 1976 but still exceeded the 1971-1976 average of 7,996 tons. The commercial catch-per-day index decreased slightly from 16.7 tons in 1976 to 15.9 in 1977 but still exceeded the 1971-1976 average. The 1977 autumn survey catch-per-tow index was 7.19 kg, a decrease from 10.86 in 1976. After recording the two highest spring survey abundance indices in the series (1975 and 1976), the index dropped sharply in 1977 and again in 1978, possibly due to changes in distribution or availability since results of virtual population analysis indicate improving stock abundance and the commercial catch rate in 1977 decreased only slightly from 1976 but was higher than in the other years since 1971.

The relationship between fishing effort and fishing mortality (F) indicates an F of 0.30 in 1977 for fully-recruited ages (3+) compared to $F_{0.1}=0.50$. Spawning stock biomass (age 2+) in 1978 is estimated to be 58,000 tons, continuing a steady increase from a low of 16,000 tons in 1971. The highest level of biomass (age 2+) observed during 1955-1978 was about 185,000-195,000 tons in the mid-late 1950's.

Recent year-classes have been much stronger than those produced in the late 1960's. The 1976 year-class appears to be the strongest since 1964 followed in strength by the 1974 and 1975 year-classes. The 1977 year-class is estimated to be 136 million fish or about the size of the 1972 and 1975 year-classes.

If the catch in 1978 varies between 5,000 and 15,000 tons, fishing at $F_{0.1}$ in 1979 would result in a catch of between 13,400 and 17,000 tons. Fishing at these levels would leave a spawning stock biomass (age 2+) in 1980 between 54,200 and 59,800 tons, close to the level estimated at the beginning of 1978.

Georges Bank Stock

The 1977 international catch was 44,263 tons, continuing a recent steady decline from 77,512 tons in 1971, and was the lowest catch since 1970. The USA catch was 3,750 tons. The USA commercial catch-per-day index, after increasing sharply to 46.1 tons in 1976, the highest catch rate since 1959, decreased to 31.6 tons in 1977, but still remained higher than in any year since 1967 (excluding 1976). The USA autumn survey catch-per-tow index decreased in 1977 to a level similar to those in the past five years after a dramatic increase in 1976. The spring survey index, after increasing to its highest level in the 1968-1978 series in 1977 also decreased but remained higher than in any year since 1973.

Fishing mortality (F) in 1977 was estimated to be 0.40 for ages 3 and older based on a relationship between fishing effort (calculated using USA commercial catch-per-effort data) and fishing mortality from virtual population analysis (VPA). Based on current estimates of partial recruitment at age, $F_{0.1}=0.65$.

Autumn survey abundance indices at age 0 and spring survey indices at age 1 are not consistent with each other nor with year-class estimates at age 1 from the VPA. However, using the spring indices which have been most consistent in predicting year-class size, the 1973 and 1974 year-classes appear to be fairly strong, in fact, the strongest since 1964. Since 1974, the year-class sizes have decreased to a point where the 1977 estimate appears to be the lowest in the 1955-1978 series.

Spawning stock biomass (age 2+) at the beginning of 1978 was estimated to be 243,000 tons, a 15% decrease from 1977. The spawning stock has generally increased in recent years to average 272,000 tons during 1974-1978 from a low of 133,000 tons in 1971. The highest spawning stock biomass in the 1955-1978 series was 596,000 tons in 1964. If the 1978 catch varies between 9,000 and 19,000 tons, assuming a minimal foreign catch in the second half of the year, fishing at $F_{0.1}$ in 1979 would allow a catch between 70,500 and 74,400 tons and would result in a stock biomass (age 2+) between 233,000 and 237,000 tons in 1980, about the same level as estimated at the beginning of 1979 given the range of catch options in 1978.

Southern New England - Middle Atlantic Stock

The 1977 total catch was 27,800 tons continuing a recent decline in catches from 66,000 tons in 1973. The USA commercial catch was about 9,500 tons in both 1976 and 1977, the highest since 1966. The USA recreational catch in 1977 was estimated from a NEFC (Sandy Hook) marine angler survey to be 3,950 tons. Various angler surveys provided estimates for the 1960, 1965, 1970, and 1974-1977 recreational catches; catches in the remaining years in the 1955-1977 series were interpolated. The recreational catch has ranged from 200 tons in 1975 to 3,950 tons in 1977 and averaged about 1,000 tons during 1966-1976. The 1955-1965 average was about 2,800 tons.

The USA commercial catch-per-day index increased from 6.6 tons in 1976 to 7.7 tons in 1977, equalling the highest catch rate in the 1964-1977 series. The USA autumn survey abundance index, after increasing from 1974 to 1976, decreased slightly in 1977. However, the spring index declined from 1975 to 1977 but increased in 1978.

Fishing mortality was estimated to be 0.47 in 1977 for ages 3 and older compared to $F_{0.1}=0.65$. Recent year-classes have improved considerably over the low levels observed in the late 1960's based on the relationship between autumn survey catch-per-tow at age 0 and VPA year-class size at age 1. The 1976 year-class is estimated to be the strongest since 1964 followed in strength by the 1974 and 1977 year-classes.

Stock biomass (age 2+) at the beginning of 1978 was estimated to be 310,000 tons, the highest since 1966. The highest biomass observed previously was 376,000 tons in 1965. The stock has been rebuilding steadily from 63,400 tons in 1971, decreasing only in 1975. If the 1978 international

catch varies between 25,000 and 35,000 tons, assuming a minimal foreign catch in the second half of the year, fishing at $F_{0.1}$ in 1979 would result in a catch of between 71,200 and 75,100 tons but would decrease the 1980 age 2+ stock biomass by about 9% from 1979. Catches of about 45,000 - 47,000 tons in 1979 would maintain the same age 2+ stock biomass in 1980 as in 1979.

RED HAKE

Georges Bank Stock

The international catch of red hake (Urophycis chuss) in 1977 was 2,879 tons compared to 17,124 tons in 1976 and 15,004 tons in 1975. The USA catch in 1977 was only 96 tons. The 1978 optimum yield (OY) was set at 16,000 tons.

The USA autumn survey catch-per-tow index increased in 1975 to 7.63 kg after fluctuating between 1.01 and 3.02 (mean = 1.71) during 1968-1974. Catch-per-tow decreased to 4.42 in 1976 and increased slightly to 4.98 in 1977. Stock biomass of age 2+ fish from virtual population analysis (data base = 1968-1977) reached a high of 86,000 tons in 1971, decreased steadily to 35,000 tons in 1975, increased to 46,000 tons in 1976, declined to 32,000 tons in 1977, and increased slightly to 40,000 tons in 1978. The spring survey catch-per-tow index increased from 0.26 kg in 1968 to a high of 1.52 kg in 1971 and decreased to a low of 0.06 kg in 1978. The spring index and the results of the VPA agree very well in describing recent changes in stock size, except for the sharp decreases in the spring survey index in 1977 and 1978.

Fishing mortality in 1977 at ages 3+ was estimated as 0.89 compared with an average of 1.02 during 1972-1976 and a high of 1.55 in 1976.

The 1967-1969 year-classes were the largest, averaging 275 million fish at age 1. From 1970 to 1973, year class size (age 1) decreased steadily and averaged 162 million fish (a 41% decrease from 1967-1969). The 1974 year-class increased to 275 million fish, matching the high 1967-1969 average. The 1975 year-class decreased sharply to an estimated 108 million fish and the 1976 and 1977 estimates have continued to be poor with the 1977 level of 90 million fish being the poorest in the series.

Assuming a catch of 1,000 tons in 1978, fishing at $F_{0.1}=0.80$ would result in a catch of 10,000 tons in 1979 and a 3% increase in stock biomass (age 2+) in 1980 compared to 1979. If 11,300 tons are taken, an F of 0.987 will be generated, leaving the same stock biomass (age 2+) in 1980 as in 1979.

Southern New England - Middle Atlantic Stock

Total international catches (commercial plus estimated recreational) declined steadily from 41,803 tons in 1973 to 5,680 tons in 1977. Recreational catch, estimated from

marine angler surveys, was about 750 tons in 1977 and averaged 428 tons for 1960, 1965, 1970, and 1974-1977. The USA commercial catch was 2,514 tons in 1977, declining 1,390 tons from the 1976 commercial catch of 3,904 tons which was the highest since 1970. An OY of 20,500 tons was set for 1978.

The USA autumn bottom trawl survey catch-per-tow index fluctuated considerably during 1963-1977. Recently it has declined from 4.3 kg in 1975 to 3.2 kg in 1977. The spring survey index increased from 1.6 kg in 1968 to 5.6 kg in 1972 and then decreased to 1.4 kg in 1975. The 1976 and 1978 indices were relatively high averaging 3.6 kg, whereas the 1977 index was only 1.0 kg. Neither set of abundance indices corresponds well with stock biomass estimates calculated from virtual population analysis, although of the two, the spring index exhibits a better relationship.

Stock biomass (age 2+) declined from 125,000 tons in 1971 to a low of 26,500 tons in 1976, and increased to 44,000 tons in 1978.

Fishing mortality (F) was estimated to be 0.40 in 1977 for ages 3+. Fishing mortality increased sharply from 0.25 in 1968 to 0.98 in 1969, dropped to 0.35 in 1971, then increased to 0.97 in 1973-1974. F averaged 0.90 during 1974-1976 and dropped to an estimated 0.40 in 1977.

The 1971-1977 year-classes have been, on the average, about 2.6 times smaller than the 1967-1970 year-classes. The 1973 and 1974 year-classes were the poorest observed, whereas the 1977 year-class is estimated to be the strongest since 1970.

An estimated catch of 6,000 tons in 1978, assuming a minimal foreign catch in the second half of the year, would require an F of 0.25 for ages 3 and older, and was used in projecting options of catch in 1979 and stock size levels in 1980. Fishing at $F_{0.1}=0.65$ in 1979 would result in a catch of about 17,400 tons and would allow the spawning stock biomass in 1980 to increase by 1% from 1979. A catch of 18,200 tons ($F=0.685$) could be taken in 1979 and still maintain the same spawning stock biomass in 1980 as in 1979.

POLLOCK

Pollock (Pollachius virens) in the Scotian Shelf, Georges Bank, and Gulf of Maine areas have been assessed as a unit stock since 1973. Provisional statistics for 1977 indicate a catch of 38,100 tons, the approximate 1974-1976 average. As in previous years, Canada has accounted for the largest portion of the catch (25,000 tons) compared to an allocation of 20,975 tons. The USA catch has increased steadily since 1968, and in 1977 was the highest recorded (13,100 tons) for any year since 1959. A management plan has not been developed for the USA fishery; consequently, USA catches were unregulated in 1977. The distant-water-fleet catch for 1977 declined sharply to less than 700 tons

compared to 3,200 tons in 1976. USA recreational catch estimates are not available since 1974 (500 tons). Canadian recreational data are not available, although these catches appear to be insignificant. Until recently, both Canadian and USA pollock catches have been primarily by otter trawl. However, the proportion of the total catch taken by gillnets has increased substantially for both countries in recent years. Canadian gillnet catches increased from 2% of the total in 1973 to 21% in 1976, while the USA catch by gillnet increased from 7% in 1970 to 37% in 1977. Catch by both countries has also been primarily incidental to other species although recently more effort appears to have been directed towards pollock. The percentage of the total catch from USA trips in which pollock was landed has doubled since the mid-1960's.

The USA autumn bottom trawl survey catch-per-tow index and the Canadian summer bottom trawl survey index both increased sharply in 1976-1977, following general declines. However, the USA 1977 spring bottom trawl survey index was the lowest observed since 1968. Commercial catch-per-effort indices calculated for Canadian 501-900 GT otter trawlers and for USA 0-500 GT otter trawlers also increased sharply in 1977 following previous declines. These results appear to indicate a recent increase in abundance, although changes in availability may also have occurred.

Cohort analysis was performed for 1973-1977 which indicated an increase in stock biomass (age 2+) from 200,300 tons in 1973 to 247,100 tons in 1976, followed by a decline to 228,300 tons in 1977. Stock biomass was estimated to be 235,400 tons at the beginning of 1978. Spawning stock biomass (25% of age 4, 75% of age 5, and 100% of age 6+) increased during the same period from 90,200 tons in 1973 to 136,800 tons in 1978. Assuming a catch of 40,000 tons in 1978, fishing at $F_{max}=0.37$ in 1979 would result in a catch of 51,600 tons and a 1% decrease in stock size in 1980. Fishing at $F_{0.1}=0.20$ in 1979 would result in a catch of 30,000 tons and a 9% increase in stock size.

YELLOWTAIL FLOUNDER

Yellowtail flounder (Limanda ferruginea) have been assessed as four stocks although three of these stocks have been combined for management purposes. The Cape Cod, Southern New England and Mid-Atlantic stocks have been managed as one stock west of 69°W and the Georges Bank stock has been managed separately east of 69°W. The degree of mixing between the Southern New England and Mid-Atlantic stocks is unknown. There is evidence that the other three stocks are relatively isolated from each other.

West of 69°W Stock

A small stock off Cape Cod has supported catches of about 2,000 tons per year since the early 1940's, although the catch has increased in recent years. The 1977 catch was 3,469 tons. The commercial catch-per-standard-day-fished has declined steadily throughout the 1970's.

The Southern New England stock was the mainstay of the fishery from the 1930's until recently. However, the 1977 catch was only 2,871 tons. Catches have been regulated since 1971 and were limited to 4,000 tons in 1975-1977 (area west of 69°W). There has been poor recruitment throughout the 1970's. During the 1970's, the pre-recruit index calculated from USA autumn bottom trawl survey catch data has not exceeded 15% of the mean value prior to 1970. A population size index (based on autumn survey data) indicates that the stock has stabilized at about 10% of the peak level observed in 1968. The commercial catch-per-standard-day-fished remained at less than 50% of the average during the 1960's.

In the area west of Block Island, a small fishery existed until 1972 and 1973 when the catch doubled from that in the preceding years reaching about 9,000 tons. By 1975, the fishery had collapsed resulting in a catch of less than 1,000 tons. The 1977 catch was 361 tons. The abundance of the stock, as indicated by autumn bottom trawl survey catch-per-tow (weight) declined over 90% from 1972 to 1973 and remains at a very low level (less than 1% of the level typically observed earlier).

East of 69°W Stock

The Georges Bank fishery has been the largest of the two yellowtail fisheries in recent years. The 1977 catch was 9,445 tons. Catch has declined steadily from a peak of about 16,000 tons in 1973. The available evidence indicates that recruitment and stock size has also declined (although more rapidly than catch) in recent years.

The commercial catch-per-standard-day-fished on Georges Bank has been less than 2 tons since 1975. It ranged from 2 to 10 tons per standard day fished during 1943-1974, averaging 4.2 tons per standard day fished.

The mean catch per tow (kg) during each of the last four USA autumn bottom trawl surveys on Georges Bank was lower than in any of the previous 11 surveys. The mean catch per tow during 1974-1977 was about 33% of the 1963-1973 level. The pre-recruit indices during the last two surveys averaged only 8% of those during the previous 13 surveys.

SUMMER FLOUNDER

Summer flounder (Paralichthys dentatus) are harvested from Cape Hatteras to the Gulf of Maine. The major offshore fishery operates during the spring and autumn inshore-offshore migrations, whereas the major recreational fishery is during the summer feeding period when the stock is dispersed inshore.

The USA commercial catch (Maine - Virginia) averaged about 8,100 tons per year during 1950-1962, about 3,500 tons during 1963-1973, and 8,500 tons per year during 1974-1977. The catch reached a period low of 1,782 tons in 1969 and then increased steadily to a high of 10,862 tons in 1976; the 1977 catch was 8,757 tons.

Marine angler surveys in 1960, 1965, 1970, and 1974 indicated an average recreational catch of 12,500 tons per year or about 70% of the combined commercial and recreational catch. Assuming this level of recreational catch in the non-surveyed years, total international catch during 1950-1977 averaged about 18,900 tons per year, ranging from 11,400 tons in 1970 to 23,400 tons in 1976; the 1977 estimated total was 21,300 tons. Foreign catch during 1965-1977 was relatively insignificant, averaging only 1% of the total.

USA bottom trawl survey catch-per-tow indices indicate that stock size has increased steadily since a low in 1970. Localized shifts in abundance occur and may be due to changing migratory behavior, variations in recruitment, or changes in fishing pressure. The survey indices show that the 1978 adult stock should be similar to 1977, but that recruitment will be lower (at the 1975 level). The USA commercial catch has followed the same general trend as the survey indices. Provisional statistics for New England indicate that the January - May catch in 1978 is about 20% less than in 1977.

Fish appear to be recruited to the offshore fishery at age 2-3 and to the inshore fishery at age 1-2. Age at first maturity is 3 years.

FLOUNDERS EXCEPT YELLOWTAIL AND SUMMER FLOUNDER

The 1977 international commercial catch of all major flounders, including winter flounder (Pseudopleuronectes americanus), American plaice (Hippoglossoides platessoides), witch flounder (Glyptocephalus cynoglossus), and windowpane flounder (Scophthalmus aquosus), totaled 22,069 tons, a 53% increase over 1976. USA catches accounted for 99.7% of the total (22,010 tons). In addition, recent angler surveys from Maine to Virginia have indicated substantial recreational catches of winter flounder (18,884 tons in 1974). If this amount is assumed for the 1977 recreational catch, the total 1977 catch of these species would be about 41,000 tons.

The USA 1977 autumn bottom trawl survey indicated increases in winter flounder abundance from 1976 in the Southern New England and Gulf of Maine areas. The Gulf of Maine catch-per-tow index was the greatest since 1963, but the Southern New England index was still well below those observed in the mid-1960's. Georges Bank winter flounder abundance appears to have remained at stable levels since the mid-1960's. The 1977 USA commercial catch of winter flounder (10,551 tons) was the highest since 1971, but still below the level of the 1960's.

Commercial catches of windowpane flounder decreased 16% from 1976 to 1977 (2,243 to 1,880 tons). USA spring bottom trawl survey catch-per-tow indices also decreased from the 1976 and the 1968-1976 average levels in all areas except Georges Bank, while autumn indices were comparable to past levels in all areas.

The two most abundant flounders in the Gulf of Maine are American plaice and witch flounder. Survey abundance indices for American plaice in 1977 in both spring and autumn were the highest on record (80% of the survey catch was taken in the Gulf of Maine). Witch flounder survey indices in the Gulf of Maine in 1977 increased in the autumn to a level comparable to that in the late 1960's. USA commercial catches (2,474 tons) were similar to those reported in the 1960's while the absence of foreign catches kept the total 1977 catch below earlier levels.

ATLANTIC HERRING

The total allowable catch for the 1977 Georges Bank herring (Clupea harengus harengus) fishery was 33,000 tons of which 21,000 tons was allocated to foreign fleets. The foreign fishery took only 1,465 tons from 1 January to 28 February 1977, prior to extended jurisdiction, and an additional 301 tons was taken after 28 February. The major portion of the TAC was not caught due to the failure of the international herring fleet to find concentrations of herring in the "herring window" during September - October 1977. The USA catch from the Georges Bank - Southern New England area totalled only 361 tons, the lowest since 1963 (322 tons). The catch from the adult fishery (17,891 tons) in the Gulf of Maine was 12% lower than the 1976 catch (20,204 tons) and 17% lower than the 1975 catch (21,500 tons), but was comparable to the catch in 1974 (18,000 tons). The catch from the Gulf of Maine juvenile fishery increased slightly from 30,200 tons in 1976 to 32,300 tons in 1977.

Maine Juvenile Fishery

The 1977 catch was dominated by the 1975 year-class (age 2) which accounted for 18,500 tons. The catches of the 1976 year-class at age 1 (1,300 tons) and the 1975 year-class at age 2 (18,500 tons) were the highest recorded since 1,900 tons for the 1970 year-class at age 1 and 21,000 tons for the 1966 year-class at age 2.

Gulf of Maine Adult Fishery

The 1973 year-class (3,940 tons) and the 1970 year-class (8,714 tons) were dominant in the 1977 catch. Since the introduction of pair trawling in 1975, catches from the winter-spring component of this fishery have steadily increased to 5,435, 7,932, and 12,973 tons in 1975, 1976, and 1977, respectively.

Catches in the summer-autumn fishery (taken principally by purse seines) have gradually declined during the same period to 10,974, 10,472, and 4,918 tons in 1975, 1976, and 1977, respectively. The 1978 catch is expected to equal the 1977 level. There is no foreign allocation for 1978.

Surplus production by this stock is almost totally dependent on recruitment. The surplus yield has equalled observed catch in recent years (about 20,000 tons) only when strong year-classes have recruited. Therefore, a trend of declining abundance is expected unless catch is reduced.

Georges Bank Adult Fishery

Recent (winter-spring 1978) research vessel bottom trawl surveys have indicated that the 1970 year-class has, for practical purposes, apparently been fished out of the Georges Bank stock. The surveys also indicate that the 1971 and 1972 year-classes are extremely weak. The fact that these three year-classes only accounted for 2% of the fish captured in the 1978 surveys may explain in part the total failure of the autumn 1977 Georges Bank fishery. The 1978 research vessel surveys indicate that about 73% of the offshore herring stock (in numbers) in the Georges Bank - Middle Atlantic region is comprised of 1975-1976 year-class fish. These young fish would not have contributed to the 1977 autumn spawning ground fishery.

The current evidence indicates that the 1975 year-class and possibly also the 1976 year-class are probably stronger than average. If catches are held to minimal levels in 1978, some recovery of the stock is likely. Also, unless there is an unusually rapid expansion in the USA fishery, the domestic fishery on Georges Bank is unlikely to have a significant impact on the stock in 1979.

Evidence from tagging studies and age composition data indicates that the Pt. Judith fishery in Southern New England waters may be more heavily dependent on the Gulf of Maine stock than present assessment and management practices indicate. For assessment and management purposes this fishery was considered as part of the Georges Bank stock by ICNAF. An unusual occurrence of 1977 year-class fish was observed in southern Cape Cod estuaries during the spring and early summer of 1978. The significance of this to the future fishery is unknown.

ATLANTIC MACKEREL

The international catch of Atlantic mackerel (Scomber scombrus) in the Northwest Atlantic was about 78,100 tons in 1977, a sharp decrease from 246,000 tons in 1976. The foreign catch was 76,222 tons in 1977, the USA commercial catch was 1,376 tons, and the estimated USA recreational catch was 545 tons. Provisional data for 1978 indicate a foreign catch of about 431 tons in USA waters through May, a USA commercial catch of 694 tons through May, and an annual recreational catch of about 4,000 tons based on the spring recreational fishery in the Mid-Atlantic area.

The USA spring bottom trawl survey catch-per-tow index declined continuously from 1968 to 1977 and then increased from 0.20 kg in 1977 to 0.45kg in 1978. This increase reflects the absence of the large foreign fishery which, before 1978, was conducted in Southern New England - Middle Atlantic waters during the winter and early spring.

Results from the 1978 spring survey suggest that the 1975, 1976, and 1977 year-classes are poor, as previously assumed. The 1974 year-class was the strongest produced since 1969, followed by the 1973 year-class.

Stock size (age 1+) has continuously declined from 2,400,000 tons in 1969 to a low of 517,000 tons in 1978. Spawning stock biomass (50% of age 2 and 100% of age 3 and older) also declined from a high of 1,800,000 tons in 1970-1972 to a low of 405,000 tons in 1978. Fishing mortality at ages 3 and older increased steadily from 0.04 in 1962-1964 to 0.85 in 1976 before decreasing to 0.36 (ages 4 and older) in 1977, the lowest level observed since 1972.

The level of catch in 1978 is currently uncertain. Various options of 1978 catch were considered which assumed USA commercial and recreational catches ranging between 4,000 and 14,000 tons, a foreign catch in USA waters of 1,200 tons, and a Canadian catch ranging between 25,000 and 100,000 tons. Estimated catches, therefore, may vary from about 40,000 to 115,000 tons. Assuming a 1978 catch of 55,000 tons (best estimate), about 65,000 tons could be caught in 1979 ($F = 0.20$) and maintain the spawning stock biomass in 1980 at the 1978 level. Various other combinations of 1978 and 1979 catches could maintain stock size or result in rebuilding.

RIVER HERRING

The river herring fishery, primarily for alewife (*Alosa pseudoharengus*) and blueback herring (*A. aestivalis*), is one of the oldest in North America, and was exclusively a USA inshore fishery until 1967 when distant-water fleets began catching river herring in offshore areas. As foreign fishing intensified, USA catches declined and by 1971 were reduced to approximately half the 1969 level, although USA fishing effort remained relatively constant. The USA catch averaged 10,700 tons per year during 1973-1975 but then declined sharply to an all-time low of 6,482 tons in 1976. Provisional statistics indicate a USA catch of 6,472 tons in 1977. Total international catches declined from 61,544 tons in 1969 to 6,661 tons in 1977. The USSR, GDR, and Poland accounted for most of the distant-water catch.

A preliminary MSY estimate of 23,000-28,000 tons has been obtained for river herring by scientists at the Virginia Institute of Marine Science. However, stock size appears to have been depressed considerably below the MSY level in recent years. In addition, the USA fishery has become increasingly dependent on a smaller number of year-classes. Historically, three year-classes were usually well represented in USA catches, but in 1974 and 1975 the USA fishery moved strongly towards dependence on a single year-class. Sampling data from Virginia for 1974-1977 also suggests

that recruitment in the immediate future may be poor, although juvenile abundance increased from 1976 to 1977 in both Virginia and North Carolina. USA autumn bottom trawl survey data indicate a decline in alewife abundance from 1967 to 1974, followed by a gradual increase.

The smaller alewife fisheries in coastal waters of the Gulf of Maine do not appear to have been affected by foreign fishing, and increased abundance has been evident in many rivers in recent years.

SCUP

Commercial scup (Stenotomus chrysops) catches by the USA have increased steadily from 4,000 tons in 1971 to 8,500 tons in 1977. However, present levels of catch are well below the 18,000-20,000 ton catches of the 1950's. The foreign catch declined drastically from 1,783 tons in 1973 to only 10 tons in 1977. A recreational catch estimate was not available for 1977, but if the recreational catch was about 30% of the total scup catch as observed previously, then the total catch increased from 10,300 tons in 1976 to 12,100 tons in 1977.

Catch-per-effort for the New England otter trawl fishery during 1967-1977 (using trips for which landings consisted of at least 80% scup) indicates a steady increase in abundance. The 1977 index was 7.79 tons per day compared to 5.57 tons per day in 1976. This increase was also evident in the catch-per-tow index from the USA autumn bottom trawl survey in the Southern New England area which increased from 1.8 kg in 1976 to 2.6 kg in 1977. The survey has indicated a general increasing trend in abundance in the Southern New England area since 1971.

In the Mid-Atlantic area the autumn bottom trawl survey catch-per-tow index increased from 1.6 kg in 1975 to 14.8 kg in 1976 and then decreased to 0.8 kg in 1977. However, the high 1976 value was probably an anomaly as the 1975 and 1977 indices were similar to those observed during 1970-1974.

WEAKFISH

The range of the weakfish (Cynoscion regalis) extends from Massachusetts to Florida. Commercial catches from Massachusetts to North Carolina have historically undergone considerable fluctuation. Catch declined from 19,000 tons in 1945 to 1,338 tons by 1967 but subsequently rose to 9,249 tons in 1976; catch in 1977 declined slightly to 8,437 tons. Estimates of recreational catch (obtained from recreational surveys in 1960, 1965, 1970, and 1974 and interpolated for the remaining years) paralleled the dramatic increases in the commercial fishery since 1967. Total USA catch (commercial and estimated recreational) increased from 2,837 tons in 1967 to 18,498 tons in 1976. Most commercial catch comes from North Carolina, Virginia, and New Jersey, while the majority of the recreational catch occurs in New Jersey, Delaware, and New York.

The average length of fish taken during inshore surveys has increased; nevertheless, a strong 1976 year-class was evident in the 1976 autumn bottom trawl survey. Length frequency analysis of trawl survey data and creel census information indicate that young-of-year fish are only partially recruited to the recreational fishery. Total mortality rates (Z) calculated for fish of age 4 and older ranged from 0.47 to 0.75. A yield-per-recruit analysis was conducted assuming natural mortality rates (M) of 0.2, 0.3, and 0.4, which indicated that an increase from age 1.0 to 2.0 in the minimum age of the catch would result in a 29-32% increase in yield in weight per recruit at F_{max} .

BUTTERFISH

The international butterfish (Peprilus triacanthus) catch in 1977 (3,439 tons) was 78% less than in 1976 (15,857 tons). This large decrease is attributed to reduced catch allocations for foreign fleets as a result of extended jurisdiction. The USA catch (1,364 tons) was 40% of the 1977 total and about 10% below the USA catch in 1976 (1,513 tons).

The USA autumn bottom trawl survey abundance indices (kg/tow) declined in 1977 from the 1976 level but was above the 10-year (1968-1977) average. The recruitment index (number of age 0 fish per tow) in the autumn 1977 survey was the third lowest observed since 1968.

The age distribution of the commercial catch remained stable during 1970-1972, with age 1+ individuals dominating the catch. A considerable proportion of the fish caught in 1973 were those spawned the previous summer. During 1974-1976, age 0 and 1 fish were essentially co-dominant in the samples. Thus, a trend of decreasing age at recruitment is evident since 1970. Age composition data for the 1977 fishery is currently not yet available.

Stock size varied from 31,900 tons in 1976 to 70,600 tons in 1973, averaging 53,800 tons. Biomass estimates from expanded survey catch-per-tow data averaged 61,400 tons for 1969-1973. The average year-class size at age 0 during 1968-1975 was approximately 1138.5×10^6 fish. The large year-classes indicated by the VPA were 1972, 1968, 1971, and 1973, while smaller cohorts were 1975, 1967, 1970, and 1974.

Maximum catch at $F_{0.1}=1.01$, given constant average recruitment, was calculated to be 21,600 tons at a mesh size of 82 mm. Substantial decreases in total yield, however, are evident when mesh sizes smaller than 82 mm are used. Yield per recruit at $F_{0.1}$ is also reduced if the nets are larger than 82 mm. Presently, the bottom trawls used by foreign fleets must be at least 60 mm, and pelagic trawls must be 45 mm. Projected average annual catch based on yield per recruit studies and $F_{0.1}$ values was 14,500 tons for a 30-mm mesh net ($t_c = 0.275$ yr) and 18,900 tons for a 60-mm net ($t_c = 0.767$ yr).

BLUEFISH

Commercial catches of bluefish (Pomatomus saltatrix) increased steadily from 792 tons in 1964 to 3,090 tons in 1974 and remained relatively constant during 1975-1977 averaging 3,469 tons. The recreational fishery has shown a greater increase than the commercial fishery with estimated catch increasing from 16,765 tons in 1960 to 57,952 tons in 1974. The bluefish fishery is predominantly a recreational fishery with commercial catch accounting for only 4% of the total. The largest catches have been taken in the New York - New Jersey area. The recreational fishery occurs in the bays, surf, and along the coast extending offshore beyond the 3-mile zone generally as far as boats and weather conditions permit.

Separate racial groups of bluefish exist along the Atlantic coast and have seasonal inshore-offshore movements, but tend to mix, except primarily for spawners and young-of-the-year, making management by individual stocks difficult.

Relative abundance indices of bluefish calculated from USA autumn bottom trawl survey catches since 1967 show an increasing trend which was rather stable during 1972-1977 except for a sharp increase in 1974. At the present level of harvest there is no evidence to indicate a decline in this stock.

WHITE HAKE

Commercial catches of white hake (Urophycis tenuis) have increased substantially in the Georges Bank and western Gulf of Maine region in recent years. The international catch in 1977 was 4,025 tons, of which 3,817 tons was caught by the USA. USA catches accounted for 94% of the total during 1967-1977; Canada, Japan, and Spain accounted for the remaining 6%. Canadian catches, however, have shown an increase in recent years. The bulk of the USA catch has been taken from the Gulf of Maine while the bulk of the Canadian catch has come from Georges Bank.

On the basis of all the information currently available, including USA and Canadian survey results, it appears that white hake in the Gulf of Maine-Georges Bank area should be considered as a single stock.

Relative abundance indices of white hake calculated from USA autumn bottom trawl surveys indicate an increasing trend in abundance since 1968, suggesting that increases in commercial catch since 1968 may have resulted more from increased abundance than shifts in fishing effort. There is no evidence to indicate that this stock is declining under current harvest levels.

OTHER FINFISH

The "other finfish" category from the Gulf of Maine to Cape Hatteras consists of a variety of species (excluding menhaden, American eel, white perch, billfishes, tunas, and large sharks) which are usually taken incidentally to other

species or in mixed industrial catches (e.g., dogfish, scup, ocean pout, angler, and skates) although some (e.g., argentine and alewife) have been subject to intensive directed fisheries. Many are also of considerable recreational importance (e.g., bluefish, weakfish, striped bass).

Provisional statistics indicate an international commercial catch of 82,825 tons in 1977, of which 64,892 tons were taken by the USA. The USSR accounted for the bulk of the distant-water catch (11,078 tons). Bulgaria, Canada, Cuba, GDR, Italy, Japan, Poland, Romania, and Spain also reported catches of "other finfish" species in 1977 (6,855 tons). The international commercial catch averaged 144,400 tons during 1964-1976, of which 74,300 tons was taken by the USA. Estimated USA recreational catches were 125,600, 139,800, and 106,500 tons in 1965, 1970, and 1974, respectively. Assuming the same ratio of commercial catch to recreational catch for the USA in 1977 as in 1974, total catch (including recreational catch) by all countries for 1977 was 197,700 tons. Scup, butterfish, alewife, dogfish, and weakfish have been the most significant species commercially since 1972. Estimated USA recreational catches of "other finfish" in 1974 were dominated by bluefish, striped bass, and weakfish.

The international catch for "other finfish" has, since 1973, been substantially below the estimated MSY level of 275,000 tons, and research vessel survey data indicate a continued increase in abundance since 1974. The autumn bottom trawl survey catch-per-tow index for "other finfish" species increased substantially over the 1975-1976 average (i.e., from 51.1 kg in 1975-1976 to 63.5 kg in 1977). Most indices for individual species were comparable to or higher than values calculated for 1975-1976.

Other sections of this report specifically discuss the status of river herring, scup, weakfish, butterfish, bluefish, and white hake. The statistics reported for "other finfish" in this section include these species.

SQUID (Short-finned Illex and Long-finned Loligo)

The international squid catch continued to decrease from a peak of 56,770 tons in 1973 to 39,970 tons in 1977. USA catches for both species remained at traditionally low levels, while foreign Loligo catches decreased substantially. The 1977 foreign Loligo catch was 16,045 tons, a 43% decrease from the 1970-1976 average. The decline may have resulted in part from the closure of traditional grounds during portions of the fishing season. Foreign Illex catches (21,389 tons) in 1977 increased 78% over the 7-year average. USA catch-per-effort decreased 36% for Loligo in Southern New England waters, and 59% for Illex in the Gulf of Maine from 1976 to 1977. Increased interest in Loligo in 1977 was evident from an 88% increase in the number of Loligo trips, defined as those wherein the Loligo catch was 50% or more of the total.

The 1977 USA bottom trawl survey abundance index for Illex was 2.7 times the 1967-1976 average, but only 55% of the high 1976 value. The 1977 pre-recruit index was 37.5% greater than the 1968-1976 average (excluding the exceptionally high 1975 value). The 1977 autumn survey minimum biomass estimate of 21,747 tons

was 2.1 times the previous 9-year average, but only about half of the 1976 estimate. The autumn abundance index (in numbers) for Loligo was 43% greater and the pre-recruit index was 20% greater than the 10-year average. However, the overall biomass estimate was 24% less than the 10-year average and 47% less than the 1976 estimate, including smaller average weights per individual. Decreases in Loligo mean weight at length in 1977 samples were also evident from preliminary analysis of length-weight data from 1975, 1976, and 1977 surveys.

Spring 1978 survey abundance indices for Loligo were above 1977 levels but below the 1968-1977 average in the Southern New England and Middle Atlantic areas, while on Southern Georges Bank this index was below all past levels. Illex abundance in Southern New England was greater than in past years while in the Middle Atlantic and on Southern Georges Bank the indices were considerably below past levels. However, since spring surveys are conducted prior to major inshore movements of Illex, variability in these indices may reflect differences in distribution rather than in abundance.

The downward trend in Loligo biomass as reflected by (1) the USA 1977 autumn bottom trawl survey index and commercial catch-per-effort, (2) the trend toward smaller individuals (which probably suffer high natural mortality) in the recruited portion of the stock, and (3) continued low levels of abundance in spring may indicate that catches at a level of 44,000 tons may not be sustainable at these lower stock sizes.

Although Illex abundance based on the USA 1977 autumn survey index and foreign catches appears to be at an adequate level to maintain the current level of catch in USA waters, the rapid expansion of the Illex fishery in Canadian waters from 17,760 tons in 1975 to 80,630 tons in 1977 may adversely affect the population in USA waters, which is presently considered to be, at least in part, a component of the stock fished in Canadian waters. Therefore, a conservative management strategy may also be necessary for this species.

TOTAL FINFISH AND SQUID

Catchability coefficients calculated for all stocks from Georges Bank to the Middle Atlantic using USA commercial and autumn bottom trawl survey data were applied to USA autumn bottom trawl survey data (stratified mean catch-per-tow values) for 1964-1977 to obtain total annual biomass estimates. Some of the effects of non-normal distribution of the survey catches were reduced by logarithmic transformation of the data and retransformation of the calculated values. Linear (untransformed) values were also calculated for comparative purposes. Catchability coefficients were calculated by relating autumn survey data to stock size estimates at the beginning of the following year and then the coefficients were applied to autumn bottom trawl survey data; consequently, computed estimates are considered to represent stock size at the beginning of the year following the survey.

Results indicate a decline in total biomass to an apparent all-time low at the beginning of 1975, followed by a substantial increase in 1976-1977. The 1978

estimates are approximately equal to the 1976-1977 average. Biomass estimates based on linear survey data declined continually from an average of 7.0 million tons in 1966-1968 to 1.8 million tons in 1975, followed by an increase to an average of 2.7 million tons in 1976-1977. The estimated biomass at the beginning of 1978 was 2.6 million tons. Estimates based on retransformed data declined from an average of 7.1 million tons in 1966-1968 to 1.9 million tons in 1975, followed by an increase to 3.0 million tons in 1976-1977. The estimated biomass at the beginning of 1978 was 3.2 million tons. Catches of Illex squid have risen substantially since 1975 compared to previous years. Since catchability for this species is uncertain, estimates for Illex have been calculated based on minimum biomass estimates from USSR summer surveys in 1975 and 1976 which indicate a more modest rate of increase. Thus, the potential exists for a greater increase in total biomass in recent years than indicated by the above data. A more complete evaluation does not appear possible until additional information is obtained relative to the catchability of Illex.

NORTHERN LOBSTER

Lobsters (Homarus americanus) of the outer continental shelf region are rather mobile, exhibiting lateral movement along the shelf edge as well as seasonal shoalward migrations in spring and summer with a return to deeper water in autumn and winter. Lobsters move from offshore canyon areas (Hudson, Block, Atlantis, Veatch) into the inshore fishing grounds southwest of Cape Cod where they are caught in the coastal fisheries during spring and summer.

The USA offshore lobster fishery (>12 miles seaward of the coast) is presently being conducted from Georges Bank to Virginia and is centered off Massachusetts and Rhode Island with approximately 82% of the 1976 catch and 84% of the 1977 catch being landed in these two states. Commercial catches of offshore lobsters were first reported in 1950 (136 tons) and during the following decade reported catches increased gradually to 544 tons in 1960. The reported annual catch by 1969 had increased to 3,138 tons. Catches peaked at 3,983 tons in 1972 and have since declined to 2,497 tons in 1977. However, substantial quantities of offshore lobsters are taken as "shack" in the otter trawl fisheries and are not reported; therefore, exact landings statistics are uncertain. There is no recreational fishery for offshore lobsters.

Stratified mean catch-per-tow values (in numbers and weight) from USA research vessel bottom trawl surveys were averaged for 1964-1966 (Southern New England, Georges Bank) and 1967-1969 (Middle Atlantic) and compared with corresponding values for 1975-1977. Mean catch-per-tow (kg) declined 76%, 50%, and 70% for Southern New England, Georges Bank, and the Middle Atlantic, respectively, while mean catch-per-tow (numbers) declined 70%, 22%, and 55%, respectively. Commercial indices also indicate a decline in offshore lobster abundance. Catch-per-effort for lobster pots has declined from 1.64 kg/trap haul set-over-day (THSOD) in 1969 to 0.19 kg/THSOD in 1977, and the otter trawl catch rate declined from 680 kg/day fished in 1964 to 523 kg/day fished in 1977.

A State-Federal lobster assessment workshop in 1976 concluded that fishing mortality rates were excessive and that minimum size limitations were too low to achieve maximum yield-per-recruit. Preliminary MSY estimates were obtained for the offshore fishery (Georges Bank to Virginia) based on generalized stock - production modeling. Estimates were calculated independently by gear using effort data derived from the above commercial abundance indices. An estimated MSY value of 3,180 tons was obtained based on the trap haul set-over-day index, while an MSY of 3,511 tons was calculated based on the otter trawl index. For the purpose of these analyses, the assumption was made that lobsters in offshore areas are not affected by fishing in inshore areas. Based on the pot index, results suggest that the 1977 level of effort (13.3 million THSOD) is substantially greater than that necessary to achieve the MSY (4.3 million THSOD) and that effort must be reduced if the stock is to be rebuilt to the MSY level.

NORTHERN SHRIMP

The northern shrimp (Pandalus borealis) fishery of the western Gulf of Maine expanded dramatically during the 1960's and reached a peak in 1969, when 12,822 tons were landed. Since that time, catches have declined drastically and totalled only 385 tons in 1977. Since 15 May 1977, this fishery has been closed to promote the objective of stock rebuilding.

Stock size estimates calculated from commercial and research vessel survey data and NMFS and Maine survey abundance indices indicate a decline in stock abundance of over 90% since 1969. The NMFS autumn bottom trawl survey catch-per-tow index declined from 2.3 kg in 1969-1970 to 0.2 kg in 1977, while the NMFS spring bottom trawl survey index declined from 3.9 kg in 1969-1970 to 0.7 kg in 1977. Similarly, the Maine summer survey catch-per-tow index declined from 36.0 kg in 1969-1970 to 1.9 kg in 1977. Stock size estimates declined from 25,000 tons in 1969-1970 to about 1,000 tons in 1977. Recovery potential appears very limited due to poor recruitment prospects and by-catch in the Gulf of Maine silver hake fishery.

RED CRAB

Directed commercial fishing of the red crab (Geryon quinquedens) began in 1973 in response to declines in the offshore lobster fishery and intensive fisheries development efforts aimed at improving the harvesting, processing, and marketing of this species.

The catch of red crab in New England doubled from 635 tons in 1976 to 1,270 tons in 1977, the highest in the short history of the fishery. The catch in 1977 from the Mid-Atlantic, where a small fishery recently began, is currently unknown but may have been as high as 450 tons. This latter fishery has developed off Chesapeake Bay in the Norfolk Canyon area due to dwindling supplies of surf clams and variabilities associated with blue crab harvests.

Estimates of standing crop biomass of commercial-sized ($>4\frac{1}{2}$ inches carapace width) red crabs between offshore Maryland and eastern Georges Bank, derived from a research survey performed during June-July 1974 using an otter trawl and a sled-mounted photographic system, indicated that approximately 26,800 tons of red crab existed within the surveyed areas. Greatest concentrations of commercial biomass were found off Southern New England (46% of the total) and on Georges Bank (31% of the total).

MSY was estimated to be about 2,700 tons annually. Since the instantaneous rate of natural mortality (M) is unknown, it was assumed to be 0.20.

Preliminary results from a NMFS red crab tagging program initiated in May-June 1974 suggest that growth rate is relatively slow. Many of the crabs recaptured had not molted in 2 years, and some had not molted in 3 years.

The current catch levels of red crab approximate 47-63% of the estimated MSY. If resource availability or economic constraints do not limit future participation in the fishery, moderate increases in fishing effort could result in fishing mortality rates in excess of that required to fully exploit the resource.

SURF CLAMS

The catch of surf clams (Spisula solidissima) increased 5% from 22,268 tons (meats) in 1976 to 23,311 tons in 1977. At present, stock size appears to have been depressed considerably below levels which would sustain this level of harvest, and a Fishery Management Plan has been prepared by the Mid-Atlantic Fishery Management Council in an attempt to rebuild the populations to the point at which an annual harvest of around 22,700 tons could be sustained. Data are currently unavailable to assign the 1977 catch to inshore and offshore regions, and therefore, the 1977 catch cannot be related yet to the most recent NMFS research vessel survey results.

Since 1965, NMFS has conducted 12 shellfish resource assessment surveys to monitor the distribution and relative abundance of surf clam populations in Mid-Atlantic waters. The most recent surveys were performed in January-March 1977 and January-February 1978. Similar to previous analyses, indices of relative abundance (catch-per-tow in number) were determined from these surveys for populations in offshore northern New Jersey, offshore southern New Jersey, and offshore Delaware. Additionally, pre-recruit indices were obtained for each of the offshore regions for surf clams of pre-commercial size (90-119 mm).

In New Jersey waters, the survey trends have paralleled the drastic decline in offshore catches noted since 1965. The 1977 and 1978 survey indices (2.65 and 1.20 clams/tow for the northern New Jersey offshore area; 7.92 and 11.30 clams/tow for the southern New Jersey offshore area) are among the lowest in the time-series and are well below the survey catch-per-tow levels observed during 1965-1967. Pre-recruit indices (110-119 mm size group) derived from the 1977 and 1978 surveys indicate that the relative abundance of recruiting surf clams in both the northern and southern offshore New Jersey area is low compared to previous years.

The survey indices from the offshore Delmarva region remained stable between 1965 and 1976. Pre-recruit indices also appeared relatively constant during this period implying steady recruitment. Results of the 1977 and 1978 surveys, however, indicate significant decreases in catch-per-tow values in this region (12.5 and 8.0 clams/tow in 1977 and 1978, respectively). These indices are lower than any of the former survey values; the 1978 index is about 33% of the mean catch-per-tow during 1965-1976. Correspondingly, the 1978 pre-recruit abundance index is the lowest observed in the history of the survey. These data suggest that the present levels of harvest of clams from Delmarva (presently not available for 1977) may not be sustainable in the near future.

OCEAN QUAHOGS

The catch of ocean quahogs (*Arctica islandica*) increased from 2,585 tons (meats) in 1976 to 8,073 tons in 1977 (211% increase). Much of this increase was attributable to the continued development of the New Jersey fishery, which experienced a 233% gain in catch between 1976 and 1977 (1,859 tons vs 6,213 tons). Quahog catches in the traditional Rhode Island fishery rose to 1,270 tons in 1977, an increase of 73% from 1976. Both the New Jersey and Rhode Island harvests were record levels. Ocean quahogs were also landed in Maryland and Virginia during 1977 (635 tons). The accelerated development of the ocean quahog fishery in the Mid-Atlantic is a consequence of the dwindling supplies of surf clams and recent technological advances in the processing of quahog meats. Significant fishing effort in 1977 was transferred from the surf clam fishery to the ocean quahog resource. To prevent overfishing of quahogs, the Mid-Atlantic Fishery Management Council prepared a Fishery Management Plan in 1977 to regulate quahog harvests. This plan, implemented on 17 November 1977 restricts the annual ocean quahog catch to 3 million bushels (about 13,600 tons). The precautionary harvest level was based on an estimated MSY of 49,000 tons (from Long Island to Virginia) and preliminary estimates of high dredge mortality to unharvested quahogs. Uncertainties in growth and natural mortality rates and age at maturity were additional factors in implementing an optimum yield for quahogs of 3 million bushels.

To evaluate quahog growth rates, NMFS has initiated a field study to mark and redistribute quahogs. Recapture of marked specimens in dredges and by divers will provide information on shell growth and annular mark formation. Additionally, quahogs are currently being collected for analysis of size at maturity and condition factor.

Distribution and relative abundance data of ocean quahog populations, monitored during the shellfish resource assessment cruises accomplished since 1965, are currently being analyzed.

SEA SCALLOPS

The USA catch of sea scallops (Placopecten magellanicus) rose 25% from 8,722 tons (meat weight) in 1976 to 10,900 tons in 1977 (the highest annual catch since 1962). Georges Bank catches nearly tripled from 1,770 tons in 1976 to 4,805 tons in 1977, while Mid-Atlantic catches declined 11% from 6,576 to 5,826 tons. Canadian catches from Georges Bank increased sharply from 9,726 tons in 1976 to 13,053 tons in 1977 (the highest Canadian catch in the history of the scallop fishery). Total sea scallop catches from the Northwest Atlantic (ICNAF Subarea 5 and Statistical Area 6) in 1977 were 23,953 tons, a 30% increase from the 1976 catch of 18,467 tons, and the highest annual level of catch ever reported.

Sea scallop research vessel surveys conducted in 1975 and 1977 indicate that recruitment of the 1972 year-class was exceptional in all the major fishing grounds on both Georges Bank and in the Mid-Atlantic, and was the strongest year-class observed in nearly 10 years. Analysis of USA commercial length frequency data reveals that the domestic fishery was highly dependent on the 1972 year-class in both 1976 and 1977. The relative absence of older age-groups of scallops in the catch is striking since these were well represented in earlier years.

The 1977 research survey abundance indices (number-per-tow) indicate that the current relative abundance of the recruited (or commercially exploitable) segment of the scallop populations for almost all areas, other than the Northern Edge and Peak of Georges Bank, is similar to that observed in 1975, but that the pre-recruit (less than about 70 mm) indices have drastically declined. These results imply that recruitment of the 1973 and 1974 year-classes (first observed in the survey dredge at age 3) was fair and poor, respectively. Since catches between 1975 and 1977 doubled or tripled in most of the major fishing areas and recruitment prospects are poor, the present high catch levels cannot be sustained without greatly increasing fishing mortality. This is particularly true in the Mid-Atlantic and in the South Channel area of Georges Bank. Abundance can be expected to decline sharply in these regions as the 1972 and 1973 year-classes are fished out. Because of recent good recruitment on the Northern Edge, catches at the current level should keep fishing mortality relatively stable in the immediate future.

Preliminary analyses of overall fishing mortality on scallop populations on Georges Bank and in the Mid-Atlantic indicate that between 1975 and 1977, fishing mortality rates (F) in both areas were in excess of $F = 0.85$. Maximum yield-per-recruit occurs at an F of 0.2-0.4 (depending on age at first capture). Hence, no gain in yield is realized by permitting F to exceed 0.4, and, in fact, potential yield actually decreases at higher fishing mortality rates.

Stock-recruitment relationships for sea scallop populations are unknown. Currently, the domestic sea scallop fishery is dependent on only one or two year-classes. Since strong recruitment is characteristically irregular for sea scallops, there is a high probability of poor recruitment in the immediate future.