

SUMMARY OF STOCK ASSESSMENTS

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by

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INTRODUCTION

This report summarizes our knowledge on the current status of over 30 species-stocks of finfish and shellfish inhabiting the continental shelf waters of the Northwest Atlantic from the Gulf of Maine to Cape Hatteras. The assessment analyses have incorporated the most recent commercial, recreational, and research vessel survey data available. Detailed assessments of many of these species-stocks are available as Laboratory Reference Reports at the Woods Hole Laboratory and may be obtained upon request. These assessments constitute the basis for scientific advice and recommendations provided to the New England and Mid-Atlantic Fishery Management Councils and to the NMFS Regional and Washington Offices for management of the resource.

COMMERCIAL FISHERY TRENDS

Gulf of Maine, Georges Bank, and Southern New England

The international commercial catch¹ of all species declined slightly from 518,355 tons² in 1977 to 517,467 tons in 1978 (-0.2%). The international catch of groundfish species decreased from 211,594 tons in 1977 to 195,033 tons in 1978 (-8%). Increases in the international catch of haddock (+49%), pollock (+28%), cod (+18%), flounders other than yellowtail (+17%), and redfish (+6%) were more than offset by declines in the silver hake (-59%) and red hake (-58%) catches. Decreases in the catch of the latter two species were largely as a result of the decline in the USSR silver hake (-77%) and red hake (-65%) catches from 1977 to 1978.

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 lb).

The international catch of pelagic species increased substantially from 76,716 tons in 1977 to 102,509 tons in 1978 (+34%), chiefly in response to an increase in the USA menhaden catch (+68%). However, the catch of pelagic species by distant water fleets declined from 8,398 tons in 1977 to 1,347 tons in 1978 (-84%).

The international catch of other finfish declined from 11,867 tons in 1977 to 9,961 tons in 1978 (-16%). An increase in the USA catch (+35%) was more than offset by a decline in the USSR catch of dogfish from 4,880 tons in 1977 to 438 tons in 1978 (-91%).

Overall, the international finfish catch exhibited a slight increase from 299,637 tons in 1977 to 307,503 tons in 1978 (+3%).

The international invertebrate catch underwent a slight decline from 217,779 tons in 1977 to 209,412 tons in 1978 (-4%). A modest increase (+11%) in USA sea scallop catches was approximately offset by a similar decline (-7%) in the Canadian catch.

Middle Atlantic

The international catch of all species declined from 786,711 tons in 1977 to 739,212 tons in 1978 (-6%). The groundfish catch exhibited a moderate decline (-20%) while the catch of other finfish exhibited an increase (+11%).

The international catch of pelagic species decreased substantially from 305,613 tons in 1977 to 227,350 tons in 1978 (-26%). Decreases in the GDR, Polish, and USSR mackerel catches from 44,052 tons in 1977 to zero in 1978 and a decline in the USA menhaden catch from 248,821 tons in 1977 to 219,977 tons in 1978 (-12%) accounted for practically all of this drop.

Overall, the total international finfish catch in this area decreased from 377,497 tons in 1977 to 295,776 tons in 1978 (-22%).

The international invertebrate catch increased from 409,274 tons in 1977 to 444,122 tons in 1978 (+9%). Increases in the USA catch of ocean quahog (+63%), sea scallop (+32%), and oysters (+21%) were partially offset by a substantial decline in the surf clam catch (-26%). Overall, the USA invertebrate catch increased from 377,810 tons in 1977 to 419,184 tons in 1978 (+11%).

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 also conducted a recreational party- and charter-boat survey in the Maryland-New York area to estimate recreational catches of mackerel and other selected species. Resource Assessment Division personnel at the Sandy Hook Laboratory conducted a mackerel survey in 1978 under contract to the Mid-Atlantic Fishery Management Council and in cooperation with personnel from Delaware, New Jersey, and New York. They also collected

mackerel length-frequency and age data in the spring of 1979 to supplement the ongoing national survey. A survey of bluefish and summer flounder party-boat fisheries in New Jersey was conducted in 1978, and length and age samples are currently being collected for both these species.

Although methodologies and sampling techniques have differed among the various surveys, several trends in the overall marine angler harvest in Northwest Atlantic waters are discernible. 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 165,054 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 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.

A new national salt-water recreational fisheries survey, employing a combined telephone and on-site intercept survey (a random digit telephone survey to obtain participation and effort data, and an intercept survey to obtain the distribution of the total catch at the species level) began in November 1978. Data are being 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. These data will significantly increase our ability to monitor trends in recreational fisheries. Combined with collections of length and age samples, data from the survey will increase the accuracy of stock assessments for species with significant recreational harvests.

ATLANTIC COD

Georges Bank Stock

The provisional reported USA commercial catch of cod (Gadus morhua) in 1978 was 26,596 tons, a 26% increase from 1977 and the highest domestic annual catch since 1937. The Canadian catch in 1978 totaled 8,903 tons, an increase of over 2,800 tons from 1977, and the highest yearly catch since 1966. The total reported catch increased from 27,265 tons in 1977 to 35,499 tons in 1978 (30% increase). Due to alleged widespread discarding and unreporting, the reported USA commercial catch in 1978 (as in 1977) is believed to be an underestimate. The total 1978 recreational catch is unknown; however, the party and charter boat logbook records indicated a catch of 521 tons from that component of the recreational fishery.

The NMFS 1978 autumn bottom trawl survey catch-per-tow indices (both numbers and weight) were among the highest in the time series. Mean number per tow (6.97) was 58% higher than in 1977 (4.42); mean weight (lbs) per tow

was 47.3, 86% larger than the 1977 value of 25.4. The autumn 1978 number-per-tow data indicated that the relatively strong 1975 year class comprised nearly half (49%) of the population in number, and has not been reduced in size as rapidly as were either the strong 1966 or 1971 year classes. Recruitment of the 1977 year class appears better than had previously been expected based on the 1977 age 0 catch-per-tow results. The 1978 year class seems to be of average size based on the autumn 1978 age 0 survey catch-per-tow index.

Distribution of the reported 1978 USA commercial catch from Georges Bank by market category, indicated that "market cod" (2.5-10.0 lbs; 1.1-4.5 kg) comprised 61% of the domestic catch by weight. This is an increase of 20% in this category from 1977 and reflects the dominance of the 1975 year class in the fishery and the growth in weight of this cohort into "market" category size.

Fishing mortality in the past several years appears to be much lower than during the 1965-72 period. Actual fishing mortality rates in 1977 and 1978 are unknown because of the uncertainties in the catch statistics for these years.

The most recent assessment results indicate that the Georges Bank cod biomass is at a relatively high level. On a short-term basis, a harvest at the 1978 level appears to be sustainable at current population levels.

Gulf of Maine Stock

The provisional reported 1978 USA commercial catch of cod was 12,424 tons, a harvest almost identical to that taken in 1977 (12,427 tons). The Canadian catch in 1978 totaled 384 tons, an increase of 278 tons from 1977, and the highest annual Canadian catch since 1966. The total reported commercial catch in 1978 was 12,808 tons, a 2% increase from 1977, and the highest yearly catch in the history of the fishery. Total commercial catches in 1977 and

1978 represented the first time that successive annual commercial removals have exceeded 12,000 tons. The total 1978 recreational catch is not known; party- and charter-boat logbook records indicated a catch of 581 tons.

Autumn 1978 bottom trawl survey catch-per-tow indices (numbers and weight) were among the highest in the time series. Mean number per tow in 1978 (4.66) was 87% larger than in 1977 (2.49); mean weight (lbs) per tow was 26,2, a 27% increase from 1977 (20.7). Corresponding spring 1978 survey indices exhibited decreases from 1977 but the current values still indicated moderately high and stable abundance levels.

Recruitment of the 1977 year class as indicated by the autumn 1978 age 1 catch-per-tow index suggests that this year class may be reasonably strong, although the spring 1978 age 1 index implied the year class may be closer to average size. Catch-per-tow of age 0 cod in the autumn 1978 survey (0.157) suggests that the 1978 year class is probably of average strength.

Market category distribution of the reported 1978 USA commercial catch from the Gulf of Maine indicated that "scrod" comprised 16% of the catch, "market" cod-44%, and "large" cod-34% (by weight). Since 1975, "market" cod have dominated the catch as a result of the entry of the strong 1971 year class into "market" size beginning in 1975, and the subsequent growth of the moderately strong 1973 and 1974 year classes into "market" sized fish in 1977 and 1978, respectively.

Since 1975, fishing mortality appears to have decreased annually as inferred from relative exploitation rates derived from reported catches. Due to uncertainties in the 1977 and 1978 catch statistics, however, the recent relative exploitation rates may be higher than calculated. If unreported catches of 5,000 tons occurred in both 1977 and 1978, the respective fishing mortalities would approximate the highest levels ever observed.

The most recent assessment results indicate that Gulf of Maine cod biomass is at about the highest level since the late 1960's-early 1970's, and that recent catch levels have not resulted in any discernible biomass reductions. A catch in 1979 at the same magnitude as in 1978 should not adversely affect short-term population biomass, although sustained yearly harvests at this level will probably not maintain the present biomass.

HADDOCK

Georges Bank haddock (Melanogrammus aeglefinus) have received intensive study. Trends in stock abundance have been documented by virtual population analysis (VPA) as far back as 1931; a substantial body of research vessel survey data is also available. The commercial data base for the Gulf of Maine is much less adequate and trends in that area have been monitored primarily by examination of survey data.

Three relatively distinct groups of haddock appear to exist in the Georges Bank - Gulf of Maine area. However, some degree of interchange exists between them, and historical trends in abundance appear to have been generally similar. Consequently, haddock in the Georges Bank - Gulf of Maine area were managed as a unit both under ICNAF and later under USA extended jurisdiction until July 1978, when the haddock resource was redefined into Georges Bank and Gulf of Maine components and quotas established on that basis. Optimum yield (OY) levels were raised repeatedly in 1978-79, culminating in a final OY of 28,254 tons for the 1978-79 fishing year (October 1 - September 30), and a further increase (to 32,500 tons) has been recommended for the 1979-80 fishing year.

Commercial catches from the combined areas have increased dramatically since 1976 (to 14,000 tons in 1977 and 27,500 tons in 1978; Canadian and USA catches in 1978 totalled 10,800 and 16,700 tons, respectively. An analytical

assessment is available only for Georges Bank. Virtual population analysis indicates a relatively constant stock size (age 2+) averaging 175,000 tons during 1935-60, with an average spawning stock size of 125,000 tons (age 3+) during the same period. Stock size increased to 433,000 tons in 1965 due to the recruitment of the strong 1962 and the outstanding year classes and then declined precipitously to an apparent all-time low of 23,000 tons in 1972 in response to overexploitation and poor recruitment. Abundance has recently increased dramatically due to the recruitment of the strong 1975 year class (estimated at 165 million fish at age 2 or more than double the long-term average of 65 million fish at age 2 for 1935-60). Age 3 estimates for this year class are, however, substantially lower (72-77 million fish). The rate of decline for this year class is not compatible with known removals in 1977 (6 million fish) but reflects discards and misreporting of catch and/or an overestimate of the size of this year class at age 2 (1977) possibly combined with an underestimate at age 3 (1978). The 1976 and 1977 year classes appear very weak (11 million fish and 1 million fish, respectively); however, the 1978 year class appears to be comparable to the above long-term average (71 million fish at age 2). This year class could augment spawning stock size in 1981 if not subjected to heavy fishing mortality in 1979 and 1980.

Due to the above recruitment pattern, stock size (age 2+) increased to above the long-term average in 1977 but has subsequently declined considerably; estimates for 1979 range from 109,000 to 116,000 tons. These trends in population size have been corroborated by trends in the NMFS spring and autumn bottom trawl survey indices (stratified mean catch per tow). The spring survey trawl index for Georges Bank declined from 23.1 kg in 1968 to 5.4 kg in 1975 and has since increased steadily to 20.7 kg in 1978. The autumn survey

index declined from 64.1 kg in 1964 to 2.6 kg in 1974 before increasing to an average of 23.4 kg in 1976-77; the 1978 index was 15.2 kg.

Management actions to date, and New England Fishery Management Council recommendations for the 1979-80 fishing year, imply a 1979 calendar year catch of about 22,500 tons, which would result in an estimated 18% reduction in spawning stock size in 1980. A similar catch level in 1980 should allow recovery in spawning stock biomass to above the long-term average of 125,000 tons in 1981 if the 1978 year class proves to be as strong as anticipated.

An analytical assessment has not been prepared for the Gulf of Maine. Trends in spring and autumn bottom trawl survey data have been essentially similar to those observed for Georges Bank. The spring survey index (stratified mean catch per tow) declined from 9.2 kg in 1968 to 0.7 kg in 1974 subsequently increased to 4.5 kg in 1977 before declining to 1.0 kg in 1978. The autumn survey index declined continually from 33.6 kg in 1963 to 2.2 kg in 1974 and has since steadily increased to 18.2 kg in 1978. Thus, available data are consistent with data for Georges Bank in indicating a significant improvement in stock biomass in recent years.

REDFISH

The international redfish (Sebastes marinus) catch in the Gulf of Maine - Georges Bank region increased from 13,225 tons in 1977 to 14,083 tons in 1978. The USA caught 13,991 tons and Canada accounted for the remaining 92 tons. The standardized catch-per-unit-effort (CPUE) index has remained essentially unchanged since 1975 at approximately 2.0 tons per standard day fished, although the catch has been steadily increasing. These CPUE values are the lowest on record.

NMFS 1978 bottom trawl survey data indicate a decline in abundance in the inshore sampling strata and a corresponding increase in the offshore strata. This may reflect the accelerated offshore movement of female members of the 1971 year class. Commercial length frequency data indicate that the 1971 year class accounted for over 50% of the catch in 1978. Recruitment of this year class to the fishery now appears to be complete.

Recruitment since the early 1960's has been extremely poor. Since 1963, the only strong year class to enter the fishery is the 1971 cohort. Prospects for improved future recruitment, also appear to be poor, as indicated by the latest bottom trawl survey results. Therefore, since the 1971 year class is now fully recruited to the fishery, the only short-term increase in fishable biomass will be through growth of these relatively young individuals.

The estimated fishing mortality rate on the 1971 year class as well as on those which have supported the fishery since the late 1960's, is considerably higher than the expected long-term average.

Equilibrium yield models indicate that maximum sustained yield (MSY) is about 14,000 MT. However, given the current low population abundance, catches should be held substantially below the MSY level to prevent further declines.

All of the evidence suggests that the Gulf of Maine redfish population will soon be dominated by the single 1971 year class, and that the fishery is becoming increasingly dependent on this year class. Given these conditions, it is evident that the current effort and fishing mortality rate will result in further stock declines.

SILVER HAKE

Gulf of Maine Stock

The silver hake (Merluccius bilinearis) catch in 1978 was 6,220 tons,

taken exclusively by the USA. This represents a decrease from the 1977 catch (8,730 tons) and the second lowest level in the 1955-78 time-series. The commercial catch-per-day index also dropped sharply from 15.9 tons in 1977 to 7.6 tons in 1978. The NMFS 1978 autumn catch-per-tow index was 6.20 kg, a continued decline from 10.87 kg in 1976. After recording very high spring catch-per-tow indices in 1975 (14.94) and 1976 (14.26), the index dropped to 0.68 in 1978 but increased again 2.92 kg in 1979.

The relationship between fishing effort and fishing mortality (F) indicates an F of 0.39 in 1978 for fully-recruited ages (4+) compared to $F_{0.1} = 0.50$. Spawning stock biomass (age 2+) in 1979 was estimated to be 61,300 tons, continuing a steady increase from a low of 16,000 tons in 1971. The highest level of biomass (age 2+) observed during 1955-78 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. Estimates of year-class strength from virtual population analysis indicate that recruitment has been relatively consistent since 1971, averaging 160 million fish at age 1. Although these estimates are higher than those in the late 1960's, they are still substantially lower than the levels of recruitment in the late 1950's which averaged approximately 580 million fish at age 1.

If the catch in 1979 varies between 1,000 and 10,000 tons, fishing at $F_{0.1}$ in 1980 would result in a catch of between 13,700 and 16,600 tons. Fishing at these levels would leave a spawning stock biomass (age 2+) in 1981 between 66,900 and 72,100 tons, close to the level estimated at the beginning of 1980.

Georges Bank Stock

The 1978 international catch of 10,001 tons was the lowest catch in the 1955-78 time-series; the 1977 catch was 44,263 tons. The OY was 58,800 tons

for 1978. The USA catch was 6,394 tons, the highest level since 1968, but the distant water fleet catch of only 3,607 tons was the lowest since the fleet's introduction in 1962 and a 91% decrease from 1977. The USA commercial catch-per-day index continued to decline from 46.1 tons in 1976 to 20.2 tons in 1978. The autumn survey catch-per-tow index, after recording a time-series high of 4.42 kg in 1976, declined in 1977, but in 1978 increased again to 3.04, which is exceeded by only the 1976 and 1963 values. The spring survey index in 1979 declined to a level approaching the 1974-76 average after increasing sharply in 1977 and decreasing in 1978.

Fishing mortality (F) in 1979 was estimated to be 0.33 for ages 4 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, $F_{0.1} = 0.65$.

The 1973 and 1974 year classes were the strongest to appear since 1964. Since 1974, the year-class sizes have been smaller, and the 1977 cohort appears to be the lowest in the 1955-78 series.

Spawning stock biomass (age 2+) at the beginning of 1979 was estimated to be 202,000 tons, a 12% increase from 1978. The spawning stock has generally increased in recent years from a low of 132,000 tons in 1971 to average 182,000 tons during 1974-79. The highest spawning stock biomass in the 1955-78 series was 595,000 tons in 1964.

If the catch in 1979 varies between 5,000 and 15,000 tons (compared to an OY of 58,800 tons), fishing at $F_{0.1}$ in 1980 would result in a catch of between 50,900 and 54,500 tons. Fishing at these levels would leave a spawning stock biomass (age 2+) in 1981 between 237,800 and 241,600 tons, resulting in a decrease in biomass from 1980 of approximately 6%.

Southern New England - Middle Atlantic Stock

The 1978 total international catch was 26,169 tons continuing a recent decline from 66,000 tons in 1973; the 1977 catch was 27,880 tons. The 1978 OY was 33,200 tons, and was increased by 5,000 tons in mid-year. The USA commercial catch was 11,405 tons in 1978, the highest since 1965. The USA recreational catch in 1978 was estimated to be 4,000 tons or about the same as in 1977. The estimated recreational catch has ranged between 197 tons in 1975 and 4,000 tons in 1978 and averaged about 1,000 tons during 1966-76; the 1955-65 average was about 2,800 tons. The distant water fleet catch in 1978 was 10,764 tons, continuing a steady decline since 1973, and was the lowest catch since 1963 when the USSR caught 4,191 tons.

The USA commercial catch-per-day index increased from 7.65 tons in 1977 to 8.40 tons in 1978, the highest catch rate in the 1964-78 series. The 1978 NMFS autumn survey abundance index recorded its highest level since 1968, but the 1979 spring abundance index decreased to its lowest level since 1970.

Fishing mortality was estimated to be 0.46 in 1979 for ages 4 and older compared to $F_{0.1} = 0.55$. 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 year-class size at age 1 from virtual population analysis, the 1976 year class is estimated to be one of the strongest since 1965, with the 1977 and 1978 year classes also appearing to be good.

Stock biomass (age 2+) at the beginning of 1979 was estimated to be 254,000 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 catch in 1979 varies between 15,000 and 25,000 tons (compared to an OY of 40,000 tons), fishing at $F_{0.1}$ in 1980 would result in a catch of between 66,300 and 69,700 tons. Fishing at these levels would leave a spawning stock biomass (age 2+) in 1981 between 261,300 and 266,600 tons. resulting in a decrease in the biomass from 1980 of approximately 10%.

RED HAKE

Georges Bank Stock

The international catch of red hake (Urophycis chuss) in 1978 was only 964 tons, compared to 2,879 tons in 1977 and 17,124 tons in 1976. The 1978 OY was 16,000 tons. The 1978 catch was the lowest observed since the USSR fishery began in 1963, and the lowest since 963 tons in 1962. The USA catch in 1978 was 151 tons, the highest since 1972.

The NMFS autumn bottom trawl survey catch-per-tow index has remained relatively constant during 1976-78 averaging 4.7 kg. The spring index dropped from 1.3 kg per tow in 1975-76 to 0.2 kg in 1977-78, and increased to 0.8 kg in 1979. Catch per hour by USSR large stern trawlers decreased from 2.8 tons in 1976 to 1.1 tons in 1978.

Stock biomass is currently rather low compared to past levels. Total biomass (ages 1 and older) decreased from 175,000 tons in 1965 to 68,000 tons in 1969, recovered somewhat to 103,000 tons in 1971, and declined steadily to about 33,000 tons in 1977-78. Total biomass at the beginning of 1979 was estimated to be about 40,000 tons. Spawning stock biomass (ages 2 and older) exhibited a similar pattern, decreasing from 160,000 tons in 1965 to 45,000 tons in 1968, increasing to 87,000 tons in 1971, and then dropping to 18,000 tons in 1977. Spawning biomass in 1979 was estimated to be about 29,000 tons.

Fishing mortality at ages 3 and older has decreased in recent years from 1.24 in 1972 to an estimated 0.10 in 1978.

Recruitment has been below average in recent years. The 1967-69 year classes were the largest in the available time-series (1964-present) averaging 278 million fish at age 1. The 1973 year class at 170 million has been the strongest since 1970. The 1975 year class was estimated to be only about 50 million at age 1, whereas the 1976-78 cohorts are estimated to average about 100 million. These estimates are well below the 1964-75 mean of 190 million.

Projections suggest a 1979 catch between 300 ($F = 0.02$) and 1,000 tons ($F = 0.06$), compared to the 1979 OY of 16,000 tons, which will result in about a 25% increase in spawning stock biomass from 1979 (29,000 tons) to 1980 (37,000 tons). A catch in 1980 of 3,000-4,000 tons will maintain the 1981 spawning stock at the 1980 level. Fishing at $F_{0.1} = 0.55$ in 1980 will generate a catch of about 10,000 tons but reduce the spawning stock about 15% from 1980 to 1981.

Southern New England - Middle Atlantic Stock

The total international catch of red hake was 5,357 tons in 1978, the lowest since 1960, continuing a downward trend from 41,800 tons in 1973. The decline has been due to a steady reduction in distant-water-fleet catches. The 1978 OY was 20,500 tons. The USA commercial catch was 3,326 tons in 1978, up slightly from 1977, and the estimated recreational catch was 700 tons, approximately the same level as determined for 1976-77.

The NMFS autumn survey catch-per-tow index has declined steadily from 4.3 kg in 1975 to 2.1 kg in 1978. The spring index has fluctuated sharply in recent years and dropped abruptly from 10.8 kg per tow in 1978 to 2.6 kg in 1979, the lowest since 1969. Catch per hour by USSR large stern trawlers decreased from 3.5 tons in 1976 to only 1.5 tons in 1978.

This stock is presently low in abundance compared to previous levels. Total biomass (ages 1 and older) decreased from about 210,000 tons in 1963 to 43,000 tons in 1976 followed by an increase to an estimated 69,000 tons in 1979. Spawning stock biomass (ages 2 and older) declined from about 110,000 tons in 1964-66 to 34,000 tons in 1975-77 and improved to an estimated 64,000 tons in 1979.

Fishing mortality at ages 3 and older decreased from 0.94 in 1973 to an estimated 0.18 in 1978.

Recruitment in the 1970's has been substantially below the levels observed in the 1960's. Year-class size averaged 557 million fish at age 1 for the 1962-69 cohorts, but only 210 million for the 1970-75 year classes. The 1977 year class is estimated to be the strongest (240 million) since the 1970 year class, but the 1978 year class appears to be the poorest observed (70 million).

The 1979 catch is estimated at between 8,000 ($F = 0.20$) and 10,000 tons ($F = 0.26$) compared to an OY of 16,000 tons, and will reduce the spawning stock biomass about 10% from 1979 to 1980. A catch of about 8,000 tons in 1980 will hold the spawning biomass in 1981 at the 1980 level. Fishing at $F_{0.1} = 0.45$ in 1980 will generate a catch of about 16,000 tons but reduce the spawning stock about 15% from 1980 to 1981.

POLLOCK

The pollock (Pollachius virens) fishery in the Northwest Atlantic has increased considerably in importance in recent years. Historically, pollock were taken primarily as by-catch in directed fisheries for other groundfish species, but since 1970 more effort appears to have been directed towards this species and catches have almost doubled since that year. Available biological evidence suggests the existence of one major spawning area (in the western

Gulf of Maine), and, accordingly, pollock from the Scotian Shelf to the Southern New England area have been assessed as a unit since 1973. This fishery was managed by means of annual total allowable catches implemented by ICNAF during 1973-76, but since extended jurisdiction by the USA and Canada, there have been no catch limitations. A Fishery Management Plan for the USA fishery is currently in the process of being prepared.

The reported commercial catch for this stock totalled 45,300 tons in 1978, the highest since 1960, of which 26,800 tons (59%) was taken by Canada and 17,700 tons (39%) was taken by the USA. However, these figures are likely erroneous due to alleged misreporting of haddock as pollock in both the USA and Canadian fisheries. The USA catch for the first five months of 1979 (when a haddock OY of 20,000 tons for the Georges Bank - Gulf of Maine area was in effect) was 25% lower than during the same period in 1978 (when the haddock OY ranged from 5,000 to 8,000 tons); there is no evidence of a corresponding decline in stock abundance. Reported catches by other nations have decreased sharply since 1976 (i.e. from 3,200 tons in 1976 to only 800 tons in 1978).

There is no evidence that this stock is declining under current catch levels although catches of 45,000 tons, if actually taken, would correspond approximately to the F_{max} level at present levels of abundance and would likely not be sustainable for an extended period. The commercial abundance index for USA trawlers of 0-50 GT increased from 6.9 tons per day fished in 1977 to 7.2 tons per day in 1978, while that for 51-500 GT vessels declined slightly (from 8.2 to 7.3 tons per day fished). The Canadian commercial index for 500-999 GT otter trawlers also declined slightly (from 1.0 to 0.9 tons per hour fished). The NMFS spring bottom trawl survey index (stratified mean

catch per tow) increased from 3.4 kg in 1977 to 7.1 kg in 1978 and was the highest observed since 1972. However, the NMFS autumn survey index declined from 8.0 to 5.8 kg, while the Canadian summer survey index (stratified mean catch per tow in numbers) declined from 6.3 to 2.7. These values were, however, still among the highest observed in the history of these surveys. Recruitment appears to have been reasonably good in recent years. The 1968 and 1971 year classes appear to have been strong ones, and the 1973-74 year classes appear to have been average in size. Subsequent (1975-77) year classes may be somewhat weaker.

Cohort analysis performed under the assumption of a 45,300-ton catch in 1978 indicates an increase in stock size (age 2+) from 171,100 tons in 1973 to 219,400 tons in 1976, followed by a decline to 189,300 tons at the beginning of 1979. Assuming an average level of recruitment in 1980 and 1981 and a catch of 37,000 tons in 1979 (projected from available USA and Canadian catch data), fishing at $F_{\max} = 0.37$ in 1980 would result in a catch of 50,200 tons and a stock size of 203,400 tons in 1981. Fishing at $F_{0.1} = 0.20$ would generate a catch of 29,200 tons, with a 1981 stock size of 224,600 tons.

YELLOWTAIL FLOUNDER

Yellowtail flounder (Limanda ferruginea) are managed as two separate units east and west of 69°W . longitude. Four populations are considered for assessment purposes: Georges Bank, Southern New England, Cape Cod, and the Middle Atlantic area.

East of 69°W Stock

Georges Bank catch levels have declined during the 1970's to a present level of 42% below the long-term average (1935-78). The total catch (USA

food landings plus discard) dropped from 9,700 tons in 1977 to 4,600 tons in 1978. In both years, the catch corresponded closely to optimum yield. Catch per standard day fished remains at the same all-time-low level as in 1977 (1.4 tons per day), compared to an average of 3.8 tons per day during 1943-78.

NMFS bottom trawl survey data indicate that population size did not improve in 1979. The pre-recruit index increased from 0.8 in 1977 to 4.3 in 1978, but represents only a tentative improvement. A comparable increase in 1975 was followed by a continued population decline, although the catch was higher during 1975-77 than at the present time.

West of 69°W Stock

The Cape Cod stock has supported a modest, but stable fishery since the early 1940's, never exceeding 5,000 tons, although catches have increased in recent years. The 1978 catch of 3,683 tons represents a 6% drop from 1977, but still exceeds the long-term (1943-78) average by 79%. Catch per standard day fished has been declining throughout the 1970's, with no increase shown in 1978.

The Southern New England stock provided the bulk of the yellowtail catch during the 1940's and the 1960's. These periods were followed by poor catches during the 1950's and the 1970's. The 1978 catch underwent further decline to only 18% of the long-term (1935-78) average. The catch quota of 4,400 tons (for the area west of 69°W) in 1978 was restrictive. Recruitment has been poor throughout the 1970's. The 1978 pre-recruit index increased 100% from 1977 but was still 63% below the long-term (1963-78) average. The catch per standard day fished value remained low in 1978 dropping 29% from the 1977 level.

Catches in the Middle Atlantic peaked in the early 1970's at 8,900 tons, but have since declined to less than 10% of that amount. The catch dropped

from 560 tons in 1977 to 431 tons in 1978. Stock abundance, as reflected by survey indices, has dropped precipitously in the 1970's and shows no indication of improved recruitment at the present time.

SUMMER FLOUNDER

Summer flounder (Paralichthys dentatus) are distributed from Cape Cod and Georges Bank to south of Cape Hatteras. The mean size of summer flounder captured on Georges Bank and the Southern New England area is larger than those captured in the Middle Atlantic area. Summer flounder are harvested throughout their range in both commercial and recreational fisheries. Commercial fisheries follow the seasonal migrations, with winter fisheries primarily offshore in the Middle Atlantic region and summer fisheries in coastal waters.

The estimated recreational catch of summer flounder has exceeded the commercial catch in all years. The last recreational survey (1974) indicated a catch of 15,830 tons, whereas a commercial catch of 6,738 tons was reported for the same year. The preliminary estimate of commercial catch for 1978 is 6,000 tons, 32% lower than 1977 and 45% lower than the peak year of catch in 1976. The average domestic commercial catch from 1950 to 1978 was 6,365 tons.

NMFS autumn and spring bottom trawl surveys indicate that the abundance of summer flounder has generally been higher during the 1970's than during the 1960's. The abundance on Georges Bank is generally lower than in the Middle Atlantic and Southern New England areas. The 1978 autumn survey indicated a significant decrease in catch per tow for these latter regions.

FLOUNDERS EXCEPT YELLOWTAIL AND SUMMER FLOUNDER

The 1978 commercial catch of all major flounders, including winter flounder (Pseudopleuronectes americanus), American plaice (Hippoglossoides platessoides),

witch flounder (Glyptocephalus cynoglossus), and windowpane flounder (Scophthalmus aquosus) from Cape Hatteras to the Gulf of Maine totaled 29,979 tons, a 36% increase over the 1977 level. USA catches accounted for 99% of the total (29,725 tons). In addition, the 1974 regional angler survey indicated substantial recreational catches of winter flounder (18,884 tons) from Maine to Virginia. If a similar amount was taken in the 1978 recreational fishery, the total catch of these species would be about 49,000 tons.

The 1978 NMFS spring bottom trawl survey mean catch-per-tow indices for winter flounder in the Southern New England and Georges Bank areas were above the 1968-77 average, while indices from the autumn survey were comparable to the long-term average. The 1978 USA commercial catch of winter flounder (12,310 tons) was the highest since 1971 and greater than the 1960-69 average.

NMFS spring bottom trawl survey catch-per-tow indices for windowpane flounder in 1978 were below average, while autumn indices were comparable to the long-term mean. The commercial catch of this species, taken only by the USA, was about the same in 1978 (1,824 tons) as in 1977 (1,880 tons).

American plaice and witch flounder are taken primarily in the Gulf of Maine. Autumn survey indices for American plaice continued to increase in 1978 to the highest level in the time-series (1963-78), while spring indices were also above average. The 1978 USA commercial catch (9,511 tons) was the highest on record, representing a 36% increase over the previous high in 1977. Spring and autumn survey indices for witch flounder declined from 1977 to 1978. However, the autumn index remained above the level observed in the early 1970's. The USA 1978 commercial catch (3,520 tons) was the highest since 1960, although the international catch was below that taken in the early 1970's.

ATLANTIC HERRING

The management of and catch allocations for Atlantic herring (Clupea harengus harengus) fisheries within the USA Fishery Conservation Zone were changed from a calendar year to a fishing year beginning July 1978. The Georges Bank allocation was 13,500 tons for July-November 1978 and 2,500 tons for December 1978 - June 1979, allocated entirely to domestic fishermen. The USA catch for 1978 from the Georges Bank - Southern New England area totaled 2,041 tons. This was considerably greater than the 1977 catch (261 tons) but slightly below the 1965-78 average (2,535 tons). The allocation for the Gulf of Maine adult fishery was 4,000 tons for each of the two fishing periods indicated above. There was no distant water fleet allocation for the 1978-79 fishing season. The 1978 catch for this fishery totaled 18,558 tons, a 4% increase from 1977. The catch from the Gulf of Maine juvenile fishery declined 8% from 32,300 tons in 1977 to 29,857 tons in 1978.

Maine Juvenile Fishery

The 1978 catch was dominated by the 1976 year class (age 2) which accounted for 12,398 tons. The catch of age 4 and older fish was 9,177 tons, the highest recorded in the history of this fishery.

Gulf of Maine Adult Fishery

The 1970 year class (5,977 tons) and the 1973 year class (5,209 tons) were dominant in the 1978 catch. The winter-spring fishery, conducted primarily by pair trawlers, accounted for 11,487 tons or 63% of the catch. The summer-autumn fishery, conducted principally by purse seiners, caught 7,070 tons for a 44% increase from the 1977 catch. First quarter 1979 catches totaled 6,480 tons of which the 1976 and 1975 year classes accounted for 1,586 and 1,829 tons, respectively.

Georges Bank Adult Fishery

There was no commercial fishery in operation during autumn 1978 on the Georges Bank spawning stock. Historically, this was the period/area when the distant water fleets took the bulk of their catches. NMFS and FRG autumn 1977 and 1978 bottom trawl and larval surveys on Georges Bank failed to locate any concentrations of spawning herring. This supports the hypothesis that the abundance of herring on Georges Bank is severely depressed relative to a few years ago when a large fishery flourished. Spring 1979 research vessel surveys caught primarily 1975 year-class (age 4) and 1976 year-class (age 3) herring. The size of the spawning stock in 1979 will depend on the extent to which 1976 year-class fish mature at age 3.

Current Assessment

A holistic approach to the analysis of the sea herring fisheries in the Northwest Atlantic from Cape Hatteras to Southwest Nova Scotia was conducted in March 1979. The results indicated that the current stock biomass for the entire region is probably significantly below average size, but that the 1976 year class, which will begin recruiting to the offshore (primarily adult) fisheries in 1979, is probably one of the largest year classes observed. Recruitment of the 1976 year class will likely result in some significant recovery of population size.

ATLANTIC MACKEREL

The international catch of Atlantic mackerel (Scomber scombrus) in the Northwest Atlantic decreased from 78,120 tons in 1977 to 33,450 tons in 1978, continuing a sharp decline from 431,606 tons in 1972. In 1978, the USA catch was 8,175 tons (1,604 - commercial, 6,571 - recreational), the Canadian catch

was 24,444 tons, and other countries caught only 831 tons. Of the total taken in 1978, 8,537 tons (26%) was from USA waters, including 362 tons by distant water fleets.

Fish from the 1974 (age 4) and 1973 (age 5) year classes comprised 51% of the total 1978 catch (mainly Canadian), with the catch of age 1-3 mackerel being very low in comparison to other years. The 1978 and 1979 spring recreational catch differed considerably in age composition from the Canadian catch; approximately half of the recreational catch in both years consisted of 1969 and 1967 year-class fish.

The NMFS bottom trawl survey autumn catch-per-tow index increased markedly from 0.03 kg in 1977 to 0.19 kg in 1978; however, the spring index, after increasing from 0.20 kg in 1977 to 0.45 kg in 1978, decreased to 0.22 kg in 1979. The decrease in 1979 is not indicative of stock decline, but was associated with warmer water temperatures at the time of the survey which likely stimulated an early migration of mackerel out of the survey area into Canadian waters.

Catches from the commercial fishery as well as spring and autumn survey data indicate weak 1975-77 year classes. Recent survey data suggest, however, a strong 1978 year class (the strongest since the 1969 year class), which should begin recruiting to the fishery in 1979. The 1973 and 1974 year classes have supported the fishery since 1975, averaging about 50% of the catch in weight each year.

Total stock biomass (ages 1 and older) declined from an estimated 2,515,000 tons in 1969 to 485,000 tons in 1977 and has since begun rebuilding to about 631,000 tons at the beginning of 1979. Spawning stock biomass (50% of age 2 and 100% of ages 3 and older) declined from around 1,900,000 tons in 1970-72

to only 358,000 tons in 1979. Fishing mortality at ages 3 and older, after increasing steadily from 0.04 during 1962-64 to 0.67 in 1976, decreased to 0.34 in 1977 and to an estimated 0.15 in 1978 (ages 4 and older), the lowest level observed since 1969.

Catch projections for 1979 varying between 30,000 and 100,000 tons would generate a fishing mortality rate (ages 4 and older) of 0.103 to 0.380 and leave spawning stock biomass levels ranging from 488,000 tons (36% increase from 1979) to 421,000 tons (18% increase from 1979) at the beginning of 1980.

Projected catches for 1980 vary from 17,600 tons ($F = 0.05$) to 150,700 tons ($F = 0.50$), assuming a 1979 catch of 30,000 tons, and from 15,000 tons ($F = 0.05$) to 128,900 tons ($F = 0.50$), assuming a 1979 catch of 100,000 tons. Resultant spawning stock biomass in 1981 would increase under this multiplicity of options 32-84% compared to 1979 and 6-41% compared to 1980.

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. The USA catch averaged 24,831 tons annually between 1964 and 1966, and over 87% of this was taken from the Middle Atlantic. Recently, however, USA catches declined to only 6,472 and 5,730 tons in 1977 and 1978, respectively. The distant water fleets accounted for 20,000 - 36,000 tons annually between 1968 and 1971; over 73% of these catches were taken from the Georges Bank - Southern New England area, and the remainder off Chesapeake Bay. The distant-water-fleet harvest has also declined substantially in recent years to 189 and 21 tons in 1977 and 1978, respectively.

An MSY estimate of 23,000-28,000 tons was determined for river herring by scientists at the Virginia Institute of Marine Science. However, stock size appears to have been depressed considerably below the level necessary to support MSY in recent years. 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 1974-77 suggest that recruitment in the immediate future may be poor although juvenile abundance increased from 1976 to 1977 in both Virginia and North Carolina.

NMFS spring bottom trawl surveys indicate continued low levels of abundance of river herring in the Middle Atlantic area through 1978. In the Southern New England - Georges Bank region, the spring survey indices appear to have been relatively stable between 1968 and 1978, while a gradual, but consistent, increase in abundance is indicated in the Gulf of Maine, especially since 1971.

The smaller alewife fisheries in coastal waters of the Gulf of Maine do not appear to have been affected by distant-water-fleet 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 9,413 tons in 1978. However, present levels of catch are well below the 18,000-20,000-ton catches of the 1950's. The distant-water-fleet catch declined drastically from 1,783 tons in 1973 to only 2 tons in 1978. A recreational catch estimate was not available for 1978, but if the recreational catch was 30% of the total scup catch as observed previously, then the total catch increased from about 12,000 tons in 1977 to about 13,500 tons in 1978.

Catch per unit effort in the New England otter trawl fishery (using trips for which landings consisted of at least 80% scup) increased steadily between 1964 and 1977. However, the index declined slightly from 7.79 tons per day in 1977 to 7.22 tons in 1978. The catch-per-tow index from the NMFS autumn bottom trawl survey in the Southern New England area also decreased slightly from 3.09 kg in 1977 to 3.01 kg in 1978. The survey has indicated a general increasing trend in abundance in the Southern New England area since 1971.

In the Middle Atlantic area, the autumn bottom trawl survey catch-per-tow index increased from 1.69 kg in 1975 to 15.87 kg in 1976 and then decreased to 0.87 kg in 1977. The high 1976 value was probably an anomaly as the 1975 and 1977 indices were similar to those observed during 1970-74. There were no scup caught in the 1978 autumn bottom trawl survey in the Middle Atlantic.

The steady increase in the commercial catch-per-effort index since 1971 coincided with the appearance of a number of relatively strong year classes as indicated by the bottom trawl surveys in the Southern New England area between 1969 and 1977.

WEAKFISH

Although the geographical range of the weakfish (Cynoscion regalis) extends from New Hampshire to Florida, evaluations of racial studies and tagging information suggest the existence of a discrete stock from Cape Hatteras northward. Commercial catches from Massachusetts through North Carolina have historically undergone considerable fluctuations declining from 19,000 tons in 1945 to 1,338 tons in 1967, but increasing since. The 1978 commercial catch was 9,713 tons, 15% greater than in 1977, and the highest recorded since the mid-1940's. Recreational catches have exhibited the same general trend as commercial catches, increasing from an estimated 1,027 tons

in 1965 to 9,137 tons in 1974. Commercial and recreational catches have been approximately equal in recent years. During 1978, most of the commercial catch was landed in North Carolina, Virginia, New Jersey, and New York.

Weakfish are partially recruited to the fishery in their first year, nevertheless strong year classes indicated by inshore NMFS trawl surveys during the mid-1970's should continue to support catches for the next several years. Yield-per-recruit analyses indicate that an increase in minimum age at first capture from 1 to 2 years would result in a 29-32% increase in yield in weight per recruit at F_{\max} .

BUTTERFISH

The distant-water-fleet butterfish (Peprilus triacanthus) catch declined from 2,846 tons in 1977 to 1,324 tons in 1978. This is the second consecutive year of declining catch, which is attributed in part to reduced catch allocations for distant water fleets as a result of extended jurisdiction. However, only 34% of the distant-water-fleet allocation (3,911 tons) was taken. The USA catch more than doubled from 1,447 tons in 1977 to 3,563 tons in 1978 (48% of 1978 total).

The NMFS autumn bottom trawl survey catch-per-tow index declined from 6.87 kg in 1977 to 4.59 kg in 1978 and was below the 1968-78 average of 5.65. The recruitment index (number per tow at age 0) in the autumn 1978 survey (48.73) was above the 1977 value (33.60) but below the 1968-78 average (85.01). Average weight (g) per fish declined in the 1978 spring and autumn surveys, but the spring 1979 weight was the third highest observed since 1968. This probably reflects a decrease in fishing mortality rate since 1976.

The distant-water-fleet catches in 1978 were dominated by age 1 fish as indicated by USA observer length-frequency samples. The USA industrial fishery

harvested primarily age 0 (1978 year class) fish while age 2 fish were dominant in the food fishery. This difference is attributed to the smaller mesh size in the industrial fishery (66 mm) versus the food fishery (114 mm).

The autumn 1978 and spring 1979 survey data indicate that butterfish abundance is still within the range of values used earlier to calculate maximum average yield (16,000 tons), and the total mortality rate of the population has been drastically reduced. The sharp decline in total catch in 1977 and 1978 should have a positive effect on spawning potential.

BLUEFISH

Bluefish (Pomatomus saltatrix) has become the most important recreational species along the Atlantic coast of the USA. Total catches (commercial and estimated recreational) from Florida to Maine increased from about 22,400 tons in 1961 to 103,400 tons in 1978. During this period, the estimated recreational catch averaged about 94% of the annual total. USA commercial catches increased from about 1,300 tons in 1960 to 4,900 tons in 1978, with over half during 1973-78 coming from the New Jersey - North Carolina region. Precise levels of recreational catch are uncertain. However, estimates based on national saltwater angler surveys indicate an increase from about 23,000 tons in 1960 to about 54,000 tons in 1970. Extrapolations based on 1974-75 regional surveys and ratios between commercial and recreational catches indicate a continued increase in recreational catch to an estimated 98,600 tons in 1978.

The recreational fishery for bluefish is most important, in terms of the amount caught, in the New York - New Jersey area. The fishery is conducted in the bays, surf, and along the coast extending offshore 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, except mainly for spawners and young-of-the-year, tend to intermingle.

Relative abundance indices (catch per tow, kg) for bluefish calculated from NMFS autumn bottom trawl survey results increased sharply from an average of 0.08 kg in 1967-70 to 1.54 kg in 1974. Aside from the abrupt rise in 1974 and a sharp drop to 0.48 kg in 1976, the index has remained relatively steady since 1971, averaging 0.78 kg.

Maximum sustainable yield estimates using a generalized stock production model averaged about 88,000 tons, indicating that current levels of harvest are at or above MSY, may not be sustainable, and if continued may result in a decline in abundance.

WHITE HAKE

Available NMFS and Canadian bottom trawl survey data suggest that white hake (Urophycis tenuis) in the Scotian Shelf, Gulf of Maine, and Georges Bank area should be considered as a unit for assessment and management purposes. The center of abundance appears to be in the deeper areas of the Gulf of Maine, which is consistent with available literature indicating that this species prefers a deep, muddy bottom habitat. The total catch increased steadily from 1,800 tons in 1968 to 9,600 tons in 1974 before declining to an annual average of 7,200 tons during 1975-77; the total catch in 1978 was 7,700 tons. Canada and the USA have accounted for 59% and 39% of the total catch, respectively, since 1967.

This resource currently appears to be in good condition. NMFS autumn bottom trawl surveys indicate increases in abundance during the mid-1960's to relatively constant biomass levels from 1969 to 1973. The NMFS autumn

survey index (mean catch per tow) averaged 2.4 kg and 16.4 kg for Georges Bank and the Gulf of Maine, respectively, during this period. Survey indices for both areas declined slightly during 1974-75 but increased in 1978 to approximately the 1969-73 average (3.7 and 14.5 kg, respectively). This resource does not appear to be adversely affected by current catch levels.

SKATES

Skates (family Rajidae) are harvested from the Chesapeake Bay to the Gulf of Maine. The fishery is composed of two components: the Southern New England industrial trawl fishery in which skates are reduced to meal, and the food fishery in which only the "wings" are landed for a limited fresh food market. The species composition of the food fishery is unknown, while the industrial fishery species composition is available since 1969.

The USA skate catch for food averaged 303 tons yearly during 1905-64. The major portion of the catch during this period was landed in the Southern New England States with New York, New Jersey, and Delaware accounting for the remaining component. Since 1965, when skate catches were first reported by distant water fleets, USA food catches have averaged 207 tons per year, which represents a 32% decline from the historical average.

The principal species taken for the industrial trawl fishery are little skate (Raja erinacea) and big skate (R. ocellata). The little skate has averaged 77% of the skate catch in this fishery. Catches averaged 1,352 tons per year during 1969-78, and were the highest in 1969 (3,021 tons); since 1975, yearly catches have remained below 1,000 tons.

NMFS bottom trawl survey catch-per-tow indices (all skate species) indicate that stock size has declined since 1971. However, indices for individual

species have fluctuated since 1971. Recruitment, based on survey length-frequency data, appears low for all species, and there is no evidence of dominant year classes.

Based on length-frequency data from the industrial fishery and research vessel age samples, little skates are recruited to the fishery as early as age 2 (19-27 cm), but the largest component is age 4+ (>40 cm). The maximum size for little skates is 54 cm. Males attain sexual maturity beginning at age 3+ and females at age 4+. Similar data are lacking for the other skate species.

OTHER FINFISH

The "Other Finfish" resource consists of over 60 species groups (excluding menhaden, American eel, white perch, billfishes, tunas, and pelagic sharks) usually taken either incidentally or in mixed industrial catches (e.g., dogfish, cusk, ocean pout, wolffish, goosefish, sea robins, etc. although some (e.g., argentine) have been subject to directed fisheries. Many are also of considerable recreational importance (e.g., striped bass). This category was originally conceived within ICNAF to include those species for which individual assessments were lacking or available only in preliminary form. Many of the species originally included in this group are described separately in this report (e.g., river herring, scup, weakfish, butterfish, bluefish, skates, and white hake). However, catch statistics described below include these species.

The commercial catch of "Other Finfish" was 84,500 tons in 1977 and 75,600 tons in 1978; 85% of the total for these years was taken by the USA and 8% by the USSR. The average for 1977-78 (80,100 tons) was 46% lower than the 1964-76 average (147,700 tons). Total recreational catches of "Other Finfish" species

have been significant (125,600 tons, 138,800 tons, and 106,500 tons in 1965, 1970, and 1974, respectively) and may have increased in recent years. Important commercial species during 1977-78 included scup (11% of the total), croaker (9%), weakfish (8%), alewife (8%), butterfish, (6%), dogfish (6%), and white hake (5%). Estimated recreational catches in 1974 were dominated by bluefish (54%) and striped bass (17%).

There is no evidence that these species, as a unit, are declining under current catch levels. Since 1969, total catch (commercial and estimated recreational) appears to have been well below the estimated MSY value of 275,000 tons. Total catch values for 1977 and 1978 (estimated by applying the 1974 ratio between estimated recreational catch and USA commercial catch to USA commercial catches for 1977-78 and adding the result to the above commercial totals) averaged 200,500 tons. The linear abundance index for this group (stratified mean catch per tow, kg) calculated from NMFS autumn bottom trawl survey data increased from 28.0 kg in 1974 to 63.5 kg in 1977; the 1978 value was 53.7 kg. An additional index, obtained by logarithmic transformation of the data and retransformation of the calculated values; was 39.4 kg, 77.7 kg, and 79.3 kg, respectively for 1974, 1977, and 1978. Trends for individual species have also been generally upward. In summary, available evidence suggests that this group has been generally increasing in abundance in recent years in response to declining levels of exploitation by distant-water fleets.

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

International squid catches have continued to decrease to about 28,340 tons in 1978, 32% less than the 1977 catch of 41,908 tons. USA catches remained at traditional low levels, totaling about 1,861 tons (1,476-Loligo and 385-Illex), while distant-water-fleet Loligo catches dropped about 36% to 9,356

tons, and Illex catches declined about 19% from the 1977 level to about 17,123 tons. The distant-water-fleet fishery took only 46% and 77% of their 1978 Loligo and Illex allocations, respectively, although this may have been due in part to restrictions on by-catch of butterfish.

The 1978 NMFS autumn bottom trawl survey abundance index (mean number per tow) for Loligo was well below the 1968-77 average, with the second lowest value of the time-series. This was due primarily to a 70% reduction in the number of pre-recruit individuals which suggested a significant reduction in the Loligo population, even though the index for recruited Loligo was slightly above the 1971-77 average. However, the 1979 spring abundance index (in weight) was slightly above the 1977 value and consisted of 85% pre-recruit squid. Also, the mean length in the spring survey dropped from a long-term average of about 16 cm to about 6 cm, indicating the appearance of young squid not caught during the previous autumn survey. These individuals will probably be available to the fishery throughout the winter of 1979-80.

The 1978 autumn survey abundance index for Illex was well above historic levels and comparable to the high 1976 value. There was also a large increase in the abundance of pre-recruit Illex second only to the 1975 level which preceded the great abundance of 1976. If there is a relationship between this index and availability to the fishery, Illex may be very abundant in 1979. In fact, catches to date in 1979 are running above historic levels.

TOTAL FINFISH AND SQUID

Catchability coefficients calculated for all stocks from the Gulf of Maine to Cape Hatteras were applied to NMFS autumn bottom trawl survey abundance indices (mean catch per tow) for 1964-78 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, with these coefficients then applied to the autumn bottom trawl survey data. 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 relatively steady increase. The 1979 estimate was approximately double the 1976-78 average. Biomass estimates calculated from linear data declined continually from an average of 7.3 million tons in 1966-68 to 1.8 million tons in 1975, followed by an increase to an average of 2.7 million tons in 1976-78. The estimated biomass at the beginning of 1979 was 4.6 million tons. Estimates based on retransformed data declined from an average of 7.4 million tons in 1966-68 to 1.9 million tons in 1975, followed by an increase to an average of 3.1 million tons in 1976-78. The estimated biomass at the beginning of 1979 was 7.9 million tons. The dramatic increase observed for both data sets in 1979 can be attributed primarily to an apparent increase in biomass of Atlantic herring and Atlantic mackerel (estimates were inflated by anomalous increases in 1978 autumn survey catch-per-tow values in one or two sampling strata). Survey catches of Illex squid have also risen substantially since 1975; since catchability for this species is uncertain, estimates have been calculated based on minimum biomass estimates from USSR summer surveys in 1975 and 1976 which suggest a more modest rate of increases than indicated by the USA survey. A more accurate evaluation does not appear possible for this species until additional information is obtained relative to catchability.

NORTHERN LOBSTER

The USA commercial offshore lobster (Homarus americanus) fishery is conducted beyond 19 km from shore, primarily in continental shelf and upper slope areas from Georges Bank to North Carolina. A small offshore fishery was recently initiated in the Gulf of Maine, and although effort appears to be increasing in this area, catches are still insignificant (14 tons in 1978). The offshore fishery is currently centered in the Georges Bank - Southern New England region off Massachusetts and Rhode Island; 84% and 83% of the total offshore catch in 1977 and 1978, respectively, was landed in these two states.

Annual offshore catches increased gradually from 87 tons in 1951 to 801 tons in 1960. Catches by 1969 increased substantially to 3,139 tons, peaked at 3,982 tons in 1972, and subsequently declined to 2,618 tons in 1973. Catches during 1974-78 stabilized at approximately 2,600 tons per year with the bulk of the catch (60%) taken in Southern New England waters and Georges Bank accounting for most of the remainder (32%). Catches were relatively constant during 1974-78 in the Southern New England and Middle Atlantic areas but increased sharply on Georges Bank from 383 tons in 1977 to 741 tons in 1978, apparently reflecting an eastward shift in trap effort. Statistics for the offshore fishery do not accurately reflect the true catch due to the alleged non-reporting of substantial amounts of lobsters.

A Canadian offshore lobster fishery began on Georges Bank in 1971, with catches relatively stable at about 200 tons during 1972-75. The catch declined to 133 tons in 1976 and subsequently increased to 305 tons in 1978. Recent Canadian effort on Georges Bank has been concentrated on the southeast edge in the vicinity of Corsair Canyon.

The USA commercial trap index declined from 1.64 kg per trap haul set over day (THSOD) in 1969 to a low of 0.19 kg per THSOD in 1977 and then rose slightly to 0.29 kg per THSOD in 1978. The commercial otter trawl index declined from 680 kg per day in 1964 to 397 kg per day in 1973 and subsequently increased gradually to 508 kg per day in 1977; the 1978 index value was 445 kg per day. Both indices reveal a general decline in abundance.

The NMFS spring bottom trawl catch-per-tow index for Southern New England declined from an average of 0.94 kg in 1968-70 to an average of only 0.28 kg during 1976-78, while the corresponding autumn survey index declined from an average of 2.28 kg in 1964-66 to an average of 0.75 kg in 1976-78. For the Middle Atlantic area, the spring survey index declined from an average of 0.35 kg in 1968-70 to an average of 0.17 kg in 1976-78, while the autumn index declined from an average of 0.90 kg in 1967-69 to an average of 0.36 kg in 1976-78. For Georges Bank, spring survey data do not reveal a clear trend; however, the autumn survey index declined from an average of 2.74 kg in 1964-66 to an average of 1.20 kg in 1973-75 but then increased to an average of 2.34 kg during 1976-78, which was comparable to the level observed in the mid-1960's. The survey results agree very well with available commercial data relative to the distribution of fishing effort in recent years.

Yield-per-recruit analyses indicate that current age at entry to the fishery is too low and substantial increases in yield could be realized by reducing fishing mortality. The continued expansion of this fishery, indicated by substantial increases in the number of traps fished in recent years, may result in continued declines in stock abundance.

NORTHERN SHRIMP

Catches of northern shrimp (Pandalus borealis) in the western Gulf of Maine peaked at 12,800 tons in 1969, declined to an annual average of 11,000 tons from 1970 to 1972, and subsequently declined precipitously to 387 tons in 1977. The fishery was closed from May 15, 1977 to early 1979 when a catch of 440 tons was taken during February and March. The fishery has since been closed indefinitely.

Available data indicates a decline to a very low level of abundance in recent years. Both the Maine summer trawl survey index and the NMFS spring and autumn bottom trawl survey indices declined over 90% between 1968 and 1977. The NMFS spring 1978 index was the lowest ever observed although the 1978 Maine summer and NMFS autumn indices increased slightly from 1977. The commercial catch-per-day-fished index has also declined continually since 1969. Stock size estimates, obtained using annual catch data and mortality and exploitation rates determined from Maine surveys, declined from 25,000 tons in 1969-70 to only 1,000 tons at the beginning of 1977. Abundance appeared to stabilize in 1977-78, but recruitment prospects remain poor and, accordingly, there appears to be minimal probability of a significant improvement in stock size in the immediate future.

RED CRAB

Directed commercial fishing for 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 from Georges Bank - Southern New England waters increased from 636 tons in 1976 to 1,034 tons in 1978, the highest in the short history of the fishery. The catch in 1977 from the Mid-Atlantic, where a small fishery has been recently operative, was 322 tons but decreased in 1978 to 214 tons. This latter fishery has developed off Chesapeake Bay in the Norfolk Canyon area. 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 46% 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 CLAM

Offshore surf clam (Spisula solidissima) populations in the Middle Atlantic have been managed since November 17, 1977 by a Fishery Management Plan (FMP) developed by the Mid-Atlantic Fishery Management Council. A principal objective

of the FMP is to first stabilize the abundance of recently-declining Middle Atlantic surf clam populations and then to rebuild these populations to levels that would sustain total annual harvests of 23,000 tons of shucked meat. To achieve this objective, the FMP established a variety of regulations including an annual total catch quota of 1.8 million bushels (approximately 13,600 tons of meat). Middle Atlantic surf clam catches from the FCZ accordingly declined 27% from 19,501 tons in 1977 to 14,240 tons in 1978.

Approximately 92% of the FCZ catch of surf clams during 1978 were taken off the Delmarva Peninsula, with 8% off New Jersey and about 0.2% from Southern Virginia - North Carolina. Relative abundance indices from the NMFS January and December surveys indicated no significant declines in commercial-sized (≥ 12 cm shell length) surf clams in any of the three major offshore fishery areas (Northern New Jersey, Southern New Jersey, Delmarva) during the year. Commercial quarterly mean catch-per-effort indices derived from the required logbooks varied only slightly within offshore areas throughout 1978 further suggesting relative resource stability.

Survey catch-per-tow indices for intermediate-sized surf clams (9-11 cm shell length) have not fluctuated greatly since 1976, particularly off Southern New Jersey and Delmarva. Hence, average recruitment to the fishery should be maintained during the next several years. Accordingly, if the distribution and level of Middle Atlantic offshore catches in 1979 and 1980 approximate those of 1978, the commercially-exploitable biomass should not change markedly in the immediate future. However, if total catches greatly exceed the 13,600-ton level in 1979 or 1980, accelerated declines in the abundance of clams (≥ 12 -cm shell length) will probably result. Growth rate analyses imply that the widespread pre-recruit resources indicated during the December 1978 and January 1979 research vessel surveys off Delmarva and northern New Jersey will recruit to the fishery by 1981 and 1982. Significant increases in popu-

lation size of harvestable clams should occur in these years if natural mortality remains constant and fishing mortality remains minimal on these pre-recruit clams in 1979 and 1980. Future monitoring of the relative abundance of pre-recruits in 1980-81 should establish more precisely the relative size and impact of these surf clam beds on the abundance of the harvestable resource.

OCEAN QUAHOG

Commercial utilization of Middle Atlantic (Cape Cod to Cape Hatteras) ocean quahog (Arctica islandica) populations has increased rapidly in recent years. The total USA catch in 1977 was 8,412 tons, a 235% increase from 1976 and 12-fold greater than the 1967-76 average of 687 tons. Catches from the Fishery Conservation Zone (FCZ) during 1978 were about 9,163 tons, a 26% increase from 1977. Prior to 1976, virtually all USA catches were derived from a small fishery off Rhode Island. The development of a fishery off New Jersey in 1976 and the Delmarva Peninsula in 1977 resulted in a sharp increase in catches. The contribution from these areas comprised 0% of the USA total in 1975 but 87% in 1977. Declines in surf clam abundance, exacerbated in 1976 by a massive kill of the clam stocks in the traditional New Jersey fishing grounds, stimulated increased exploitation of ocean quahogs. Implementation of management measures enacted to conserve and rebuild dwindling offshore surf clam stocks encouraged continued expansion of the ocean quahog fishery.

Abundance and size composition estimates of Middle Atlantic ocean quahog populations were derived from seven BCF/NMFS dredge surveys conducted from Cape Cod to Cape Hatteras during 1965-77. Minimum population sizes in numbers

and biomass (meat weight) were calculated using mean quahog densities (1965-77) expanded by strata areas. Within the area from Long Island through Delmarva, a standing crop of 56.6 billion ocean quahogs was estimated, having a biomass of 1.5 million tons. The largest proportion of the resource (46%) was located off Long Island, with 44% off New Jersey and 10% off the Delmarva Peninsula.

Maximum sustainable yield (MSY) estimates of the ocean quahog resource from Long Island through Delmarva were generated with a surplus production model incorporating minimum stock size calculations and assumptions of the instantaneous natural mortality rate (M) of the species. If $M \leq 0.05$ for quahogs (implying $\geq 0.7\%$ survive to 100 years), then MSY for the Long Island-Delmarva area is probably less than 23,000 tons. Further refinement of MSY estimates will be possible as additional information on age and growth, breakage of unharvested quahogs, and catch-per-effort data become available. However, it should be noted that the model used to compute MSY implies maximum production will occur when the standing stock is reduced to 50% of the virgin level. Therefore, harvests above MSY in the initial fishing years should not cause irreparable harm to the resource. If, however, subsequent evidence suggests rapid resource depletion and little concurrent recruitment to the population, appropriate constraints on the fishery should be considered.

SEA SCALLOPS

The USA sea scallop (Placopecten magellanicus) catch rose 29% from 11,068 tons (meat weight) in 1977 to 13,710 tons in 1978 (the highest USA annual catch). The Georges Bank catch increased from 4,805 tons in 1977 to 5,569 tons in 1978 (+16%) while the Middle Atlantic catch went from 5,869 tons in 1977 to 7,877 tons in 1978 (+34%). Canadian catches on Georges Bank did not change significantly: 13,034 tons in 1977 and 12,189 in 1978 (-6%). Total sea scallop

catches from the Georges Bank - Middle Atlantic area increased from 24,102 tons in 1977 to 25,907 tons in 1978 (+7%) and, for the second successive year, a new record for annual level of catch.

The 1978 NMFS sea scallop survey indicated that the 1972 year class was still the predominant year class present. The domestic fishery continues to be highly dependent on this cohort.

The 1978 survey abundance indices show that, with the exception of the Northern Edge and Peak of Georges Bank and the Virginia - North Carolina region of the Middle Atlantic, recruitment continues to be poor from the 1973, 1974, and 1975 year classes. With catches continuing to remain at historically high levels in 1979 and immediate recruitment prospects poor, fishing mortality will continue to rise. This is particularly true in the Middle Atlantic and the South Channel area of Georges Bank. Decreasing abundance in the latter two areas may occasion a shift in USA effort to the eastern half of Georges Bank resulting in increased catches from that area. Since the Northern Edge and Peak has exhibited more consistent annual recruitment than any other region, the biological risks associated with increased future exploitation on these scallop grounds, appear relatively moderate.

In most regions on Georges Bank and in the Middle Atlantic, sea scallops have been harvested in recent years at a size less than that producing maximum yield per recruit. Increasing age at first capture and decreasing fishing mortality will be beneficial in increasing the potential long-term yield from the resource.