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Status of the Fishery Resources off the Northeastern United States for 1981

by

Resource Assessment Division

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INTRODUCTION

The Assessment Division of the Northeast Fisheries Center (NEFC) with the majority of personnel located at the Woods Hole Laboratory in Woods Hole, Massachusetts, annually updates its finfish and shellfish assessments and presents detailed information to administrators, managers, the fishing industries, and the public as needed. This report summarizes the general status of the major finfish and shellfish resources off the northeast coast of the United States from Cape Hatteras to Nova Scotia through 1980. Many of these assessments are available as Laboratory Reference Documents at the Woods Hole Laboratory and may be obtained upon request. The most recent reports for each species-stock are listed under each species-stock throughout the document.

The assessment information contained in this report varies among the species-stocks because of the difference in available data. In some cases, recent deterioration of the fisheries data base has severely limited the use of some valuable time series in assessing the status of the stocks.

Some species-stocks such as mackerel, Georges Bank herring, silver hake, red hake, and squid were fished most heavily in the past decade by foreign nationals. Before 1977 biological and catch-effort data collected by foreign scientists provided most of the basic information used for assessing the status of these stocks. Since the Magnuson Fishery Conservation and Management Act of 1976, the levels of foreign fishing have been greatly reduced. Because fishing effort by the United States has not completely replaced the fishing effort by the foreign vessels NEFC assessment scientists have recently had to rely more on research survey information than on both commercial catch and survey information for assessing the status of these stocks. While this weakens the analysis, the assessment information may not be so critical for these stocks, since the fishing pressure and the demand for achieving maximum harvest from these stocks has been greatly reduced. Assessment information is important for these stocks, however, in management activities designed to rebuild the stocks at a given rate and in providing information for fisheries development interests.

For some fisheries the discarding of small fish is a very significant proportion of the total mortality on the stock. The estimation of discard levels at each age determines the accuracy of the assessment in the year that these fish would have recruited to the fishable biomass to the degree that these fish would have contributed to the overall abundance of the harvestable stock.

Fishing pressure on some species-stocks comes almost entirely from recreational fishermen and a great many species receive some fishing pressure from recreational fishermen. Catch and effort information has been especially poor for the recreational harvesting sector although significant progress in collecting this information is now being made.

Many of the species assessments herein are new, resulting from new management initiatives from the Councils, and, thus, the request for assessment information. The newer assessments may only involve an examination of harvest levels, biology and survey abundance indices for recent years, while the assessments of such species as haddock, cod, mackerel, and herring, for example, reflect the benefit of long time series of catch and survey information.

The assessments can be grouped into four categories:

a) An analytical assessment based on detailed analysis of the age structure of the population and catches over time. The basic data for these assessments include detailed catch data, biological samples for length and age of catches, fishery and/or survey indices of recruitment levels and independent survey indices of abundance.

b) An assessment based on research survey information, some biological knowledge concerning the species and general catch statistics.

c) Production models where stock size as a whole is estimated but the age composition of the catches and stock are not available (these models incorporate to some degree trends in recruitment and interaction with other species that have been observed over time).

d) General biological knowledge, research survey and catch statistics.

The status of the biological assessment knowledge required for fishery management at the Northeast Fisheries Center is given in Table 1. Although research on some of the species has been underway for years, many of items within the table still are not known. As fisheries become more intense, more of the categories will need to be filled in in order to evaluate the effects of fishing on the resources, and efforts are being made in this direction. The interactive knowledge required in addressing the multispecies and multitrophic relationships is not immediately obvious from this table. The last two columns particularly address this situation, however.

Certain assessment terms used throughout this document may not be familar to all. A brief explanation of some of them, therefore, follows:

1. Nominal Catch — The sum of catches that have been reported as live weight equivalent of the landings. Nominal catches do not include such catches as unreported discards or unidentified young fish put into fish meal.

2. Sustainable Yield — The catch by weight from a fish stock when it is in equilibruim with fishing of a given intensity, and (apart from effects of environmental variation) its biomass is not changing from year to year.

3. TAC — Total Allowable Catch is the total permitted catch from a stock in a given year.

Table 1.

STATUS OF BIOLOGICAL ASSESSMENT KNOWLEDGE REQUIRED FOR FISHERY MANAGEMENT 9/1/80

ACCEPTABLE STATE OF KNOWLEDGE
SIGNIFICANT PROGRESS MADE
ANALYSIS UNDERWAY
NO ANALYSIS
NO DATA
N.A. NOT APPLICABLE

	Literature Review	Stock Identification	Commercial Landings	Recreational Lndgs (a)	By-Catches & Discards	Fishing Effort	* L.F. of Commercial Lndgs	* L.F. of Recreational Lndgs (a)	○ A.F. of Commercial Lndgs	○ A.F. of Recreational Lndgs	Survey Abundance Index	L.F. of Population	A.F. of Population	General Production Model	Mortality	Growth	Selectivity Studies	Yield-per-Recruit	Virtual Population Analysis	Prediction Model	Consumption Rate	Food Habits
TOTAL BIOMASS							N.A.	N.A.	N.A.	N.A.		N.A.	N.A.		N.A.	N.A.	N.A.	N.A.	N.A.	N.A.		
ATLANTIC COD																						
HADDOCK																						
YELLOWTAIL FLOUNDER				N.A.				N.A.		N.A.												
ATLANTIC HERRING				N.A.				N.A.		N.A.												
ATLANTIC MACKEREL																						
SILVER HAKE																						
RED HAKE																						
REDFISH																						
POLLOCK																						
LONG-FINNED SQUID				N.A.				N.A.														
SHORT-FINNED SQUID				N.A.				N.A.														
BUTTERFISH				N.A.				N.A.		N.A.												
SEA SCALLOP				N.A.	N.A.			N.A.		N.A.												
SURF CLAM				N.A.	N.A.			N.A.		N.A.												
OCEAN QUAHOG				N.A.	N.A.			N.A.		N.A.												
AMERICAN LOBSTER																						
NORTHERN SHRIMP				N.A.				N.A.		N.A.												
SUMMER FLOUNDER																						
WINTER FLOUNDER																						
SCUP																						
RIVER HERRING (b)																						
BLUEFISH																						
SPINY DOGFISH				N.A.				N.A.		N.A.												
WEAKFISH																						
SKATES (c)				N.A.				N.A.		N.A.												
WHITE HAKE																						
PELAGIC SHARKS (d)																						
BLACK SEA BASS																						
TILEFISH																						
WITCH FLOUNDER				N.A.				N.A.		N.A.												
AMERICAN PLAICE				N.A.				N.A.		N.A.												
WINDOWPANE																						
OCEAN POUT																						
DEEP-SEA RED CRAB				N.A.				N.A.		N.A.												
ARGENTINE				N.A.				N.A.		N.A.												
GOOSEFISH																						
ATLANTIC WOLFFISH																						
STRIPED BASS																						
CUSK																						

* L.F. = Length Frequency
○ A.F. = Age Frequency

(a) A COMPREHENSIVE RECREATIONAL FISHERIES SURVEY BEGAN IN 1979 UNDER A NATIONAL MARINE FISHERIES SERVICE CONTRACT. SUITABILITY OF THE RESULTING CATCH AND LENGTH-FREQUENCY DATA FOR BIOLOGICAL ASSESSMENTS WILL BE DETERMINED WHEN THE DATA BECOME AVAILABLE TO THE NORTHEAST FISHERIES CENTER.

(b) COMBINED ALEWIFE AND BLUEBACK HERRING.

(c) COMBINED LITTLE SKATE, WINTER SKATE, BARNDOOR SKATE, SMOOTH SKATE, ROSETTE SKATE, AND CLEARNOSE SKATE.

(d) ALL SHARKS EXCEPT DOGFISH SHARKS.

4. Quota — A regulated portion of a TAC as distinct from an allowance or estimated catch.

5. Year-Class (or cohort) — This term refers to a group of fish which were born in a particular year and are referred to throughout their life by their year of birth. It is a very useful term because occasionally fish born in a particular year are extremely abundant or extremely scarce and one has a unique name for following the catches of this year class by year as the fish get older. Fish born in 1978, therefore, are of the 1978 year class and are age 2 in 1980, age 3 in 1981, age 5 in 1983, etc.

6. Exploitation Rate (μ) — The proportion of a population at the beginning of a given time period that is caught during that time period (usually expressed on a yearly basis) If 720,000 fish were caught during the year from a population of 1 million fish present at the beginning of the year, for example, the annual exploitation rate would be 0.72.

7. Total Mortality Rate (Z) — This is an instantaneous rate. It is the proportion of the population that die in a very small time interval but it is usually expressed on an annual basis. If 0.466% of a population dies each day all year long, for example, then the fishing mortality rate for the year is 0.00466 multiplied by 365 days or 1.7. The amount that dies each day is different because the population is declining but the instantaneous rate is constant. If the time limit of 1 day is small enough to represent an instantaneous period then the survival rate over the year is $e^{-1.7}$ where e = 2.71828. In this case 1 million fish at the beginning of the year multiplied by $e^{-1.7}$ or 0.1827 gives 182,684 for the number of fish that survive and 817,316 for the number that die.

8. Fishing Mortality Rate (F) — This is the instantaneous rate of death due to fishing expressed over the entire year. If 0.411% of the population die each day then 0.00411 multiplied by 365 is the fishing mortality rate during the year, or in this case 1.5. If fishing were the only cause of death than the number of fish that survive the fishery over the year from a population of 1 million alive at the beginning of the year is 1 million multiplied by $e^{-1.5}$ or 223,130 fish. There are other causes of death, however, that are also acting on the population of fish at the same time that must be considered in calculating the number that die from fishing only. The number that die from fishing only is the proportion of the total mortality due to fishing multipdied by the total number that die from all causes,

i.e. $\frac{F}{Z}$ multiplied by $(1-e^{-Z})$ times 1 million. If the total mortality rate is 1.7 as explained in 7 above than this calculation is:

$$\frac{1.5}{1.7} \; (1-e^{-1.7}) \; (1{,}000{,}000)$$

or

$$(882) \; (.8123) \; (1{,}000{,}000)$$

and

$$(.720873) \; (1{,}000{,}000)$$

and 720,873 fish that die from fishing

9. Natural Mortality Rate (M)

This is also an instantaneous rate expressed over the year and is equal to Z-F. All causes of death other than fishing are usually lumped under the category of "natural" for convenience purposes since these causes of mortality are usually much smaller than the mortality due to fishing which is of most immediate interest. The most important causes of natural death are predation, disease and cannabolism and are expressed separately when their rates of mortality are known. Following the examples given in 7 and 8 above, M is equal to Z-F or 1.7-1.5 or 0.2. The number of fish that die during the year from natural causes is therefore:

$$\frac{M}{Z} \; (1-e^{-Z}) \; (1 \text{ million})$$

or

$$(.1176) \; (.8173) \; (1{,}000{,}000)$$

and 96,153 fish or 9.6% of the population die from natural causes during the year when the fishing mortality rate is 1.5. If fishing mortality were less more fish would die from natural causes cause some fish are caught by the fishery before they die from predation etc. If the fishery did not exist, for example, an M if 0.2 applied over the year to 1 million fish would cause a mortality of 181,269 from or 18.1% of the beginning population.

10. MSY

The maximum sustainable yield of a fish stock is the largest average annual harvest in weight which could be removed from the stock year after year, under existing environmental conditions, while maintaining the stock size.

11. F_{max}

The rate of fishing mortality for a given method of fishing which maximizes the harvest in weight taken from a single year-class of fish over its entire lifespan.

12. $F_{0.1}$ — The rate of fishing mortality for a given method of fishing at which the increase in catch per effort (vessel) for a small increase in fishing mortality is only one-tenth the increase in catch per effort (vessel) for the same increase in fishing mortality from a virgin fishery.

13. Virtual Population Analysis (or cohort analysis) — An analysis of the catches of a given year class over its life in the fishery. If 10 fish were caught each year from the 1968 year class for 10 succession years from 1970 to 1979 (age 2 to age 11) then 100 fish would have been caught from the 1968 year class during its life in the fishery. If 10 fish were caught during 1979, then 10 fish must have been alive at the beginning of that year. Of this we can be virtually certain. At the beginning of 1978 there must have been 20 fish alive because 10 were caught in 1978 and 10 more were caught in 1979. By working back year by year we are virtually certain that 100 fish were alive at the beginning of 1970. A virtual population analysis goes a step further and calculates the minimum number of fish that must have been alive if some fish also died from causes other than fishing. For example, if the instantaneous natural mortality rate were 0.20 per year in addition to the 10 fish caught per year in the fishery, then a cohort analysis calculates the minimum number that must have been alive each year to produce a catch of 10 fish each year in addition to those that died from natural causes.

If one also knows the fishing mortality rate during the last year for which catch data are available (in this case 1979) then the exact abundance of the year class can be determined in each and every year. If the fishery removes a large proportion of the stock each year so that the population declines quite rapidly over time then an approximate fishing mortality rate can be used in the last year (here in 1979) and by calculating backwards year by year for the year class, a very precise estimate of the abundance can be determined by three or four years back in time (by 1976 or 1975). The accuracy depends on the rate of population decline and the correctness of the starting value of the fishing mortality rate (in the most recent year).

This technique is used extensively in fishery assessments since the conditions for its use are so common: many fisheries are heavily exploited, the catches taken each year for a year class can be easily determined and the natural mortality rate is known within a fairly small range and is low compared with the fishing mortality rate.

COMMERCIAL FISHERY TRENDS

Total Commercial Catch

The total international (domestic and foreign) commercial nominal catch (line weight equivalent of the landings) of all species (including invertebrates) in these areas decreased less than one percent from 1979 to 1980. The total nominal landing was approximately 1.43 million metric tons (MT) in 1979 decreasing to 1.42 million MT in 1980. The slight change is due largely to an 8 percent decrease in the catch of invertebrate species.

Principal Groundfish and Flounders

The international nominal catch of the principal groundfish species (cod, haddock, redfish, red hake, silver hake, and pollock) increased about 11 percent from 1979 (278,000 MT) to 1980 (307,000 MT), a rise of about 15 thousand MT. An increase in cod, haddock, and pollock nominal catches accounts for this increase. Both the USA and Canada had a dramatic increase in haddock catches during 1980. The USA haddock nominal catches increased 43 percent, up 6 thousand MT over the previous year, and Canadian haddock nominal catches increased 89 percent, up 5 thousand MT from 1979. Nominal cod catches for the USA and Canada increased 22 and 29 percent respectively; pollock nominal catches increased 28 and 85 percent respectively.

Flounder (flat fishes) nominal catches increased approximately 8 thousand MT from 1979 to 1980. American plaice nominal catches increased over 2 thousand MT; yellowtail nominal catches went up about 3 thousand MT; winter flounder nominal catches increased 5 thousand MT over the previous year. Summer flounder nominal catches declined 3 thousand MT and all the other flounder nominal catches, e.g., witch, Atlantic halibut, windowpane, etc. fluctuated a few hundred MT.

Pelagics

The nominal catch of pelagic species increased 8 percent from 1979 to 1980, from 408.5 thousand MT in 1979 to 441.1 thousand MT in 1980. The nominal catch by distant water fleets was only 1.3 thousand MT. The catches were comprised mainly of five species - herring, mackerel, menhaden, butterfish, and bluefish. USA herring catches increased 18.4 thousand MT during 1980; about 28 percent over 1979. Mackerel and bluefish catches, although relatively low increased about 700 MT each. Menhaden catches increased 10 thousand MT and USA butterfish catches increased over 85 percent from 2.8 to 5.3 thousand MT.

Other Finfish

The international nominal catch of other finfish decreased from 71 thousand MT in 1979 to 67 thousand MT in 1980. This decline in catch is not due entirely to any one particular species in this category but reflects the fluctuation of several catches by a few hundred MT.

RECREATIONAL FISHERY TRENDS

The recreational landings of many species of fish and shellfish caught in the coastal waters of the northeastern United States are equivalent to or exceed the commercial landings. Notable examples are mackerel, striped bass, bluefish, weakfish, and pelagic sharks. Obtaining detailed records on recreational landings is a formidable task because sport fishing occurs 24 hours a day, 7 days a week, 52 weeks a year in coastal rivers, sounds, bays, and the ocean. Sport anglers fish from private boats, party and charter boats, rented boats, shore, and from man-made structures such as piers, bridges, and jetties. Obtaining data, even within a small geographic area, is a costly and time-consuming process.

National saltwater angling surveys were conducted in 1960, 1965, and 1970 as supplements to the national surveys of fishing and hunting. These surveys relied on fishermen recalling their catch up to one year prior to the mail questionnaire interview, and results certainly contained some misidentified species and bias as to amounts caught. In 1974 NMFS conducted surveys that were more regional in scope and reduced the recall period to a maximum of two months. Additionally 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, the Sandy Hook 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. A survey of bluefish and summer flounder party-boat fisheries in New Jersey was also conducted in 1978. 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 inter vals. The earlier surveys were direct household interviews conducted on population 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 directly comparable.

In 1979 a new survey methodology was introduced by NMFS that consisted of two complementary surveys (household survey and direct-intercept creel census). The 1979 survey design avoided many of the problems of the previous surveys which included low response rates to questionnaires, inability to recall the number of fish caught, and other similar types of research design obstacles. The 1979 approach was a significant departure from the other NMFS surveys; therefore, the data collected in 1979 are also not directly comparable with the previous surveys.

Although methodologies and sampling techniques have differed among the various surveys, an increasing trend in the overall marine angler harvest in Northwest Atlantic waters is apparent. The estimated number of finfish caught by marine anglers (Maine through Virginia) increased from 212 million in 1960 to 265 million in 1965 to 285 million in 1970 but declined to 140 million in 1974 and 122 million in 1979 (probably due to sampling techniques).

Although the data are difficult to obtain and interpret, they must be collected if we are to monitor the status of the stocks. Recreational catches are not only extremely important in that they provide a very significant economic use of the resource, but they affect the abundance substantially and in many cases are the greatest source of fishing mortality on the stock.

TOTAL FINFISH AND SQUID BIOMASS

This group includes all species of finfish and squids in the Gulf of Maine to Cape Hatteras area with the exception of highly migratory species such as billfishes, tunas, and large sharks, and inshore species such as menhaden, American eel, and white perch. Various stocks within this group were heavily exploited by distant-water fleets from the mid-1960's to the early 1970's. During 1971-1973, commercial landings averaged 1.2 million metric tons, substantially above the maximum sustained yield (MSY) level of 950,000 tons as determined from analysis of commercial fishery data. Increasingly restrictive management under ICNAF (International Commission for the Northwest Atlantic Fisheries) and subsequent restrictions on foreign effort imposed under extended jurisdiction, have resulted in a decline in foreign landings of over 95% since 1973, while total commercial landings have declined by almost 70% (Table 3). The sharp drop in recreational catch estimates observed for 1977-1980 compared to former years appears to reflect different survey methodology rather than an actual decline in catches. Under extended jurisdiction US commercial landings and estimated recreational catches increased from 345,800 tons in 1977 to 464,200 tons in 1980 (+34%), Canadian landings have fluctuated without a definite trend, and landings by distant-water fleets have declined from 174,300 tons in 1977 to only 35,500 tons in 1980 (-80%).

Catchability coefficients have been obtained for species-stocks within this group by dividing autumn survey catch-per-tow (weight) index values by the corresponding stock size estimates for the beginning of the following year and averaging results over 1964-1975. Total annual biomass estimates were then obtained for 1964-1981 by applying these coefficients to individual autumn survey catch per tow index values by stock and summing resulting biomass estimates over all stocks by year. Estimates peaked at 8.0 million metric tons in 1968 and subsequently declined to only 1.9 million tons in 1975. Subsequent estimates increased to an average of 3.3 million tons for 1977-1978 and then rose sharply to 7.9 million tons in 1979; the 1980-1981 estimates were virtually identical (3.4 million tons, Figure 1). The increase observed in 1979 can be attributed primarily to an apparent increase in biomass of Atlantic herring and Atlantic mackerel caused by anomalous increases in 1978 autumn survey catch per tow values in one or two sampling strata. The 1980-1981 estimates agree closely with the 1977-1978 average, suggesting relatively constant biomass levels in recent years.

Generally speaking, individual stock biomass estimates for groundfish, flounders, miscellaneous finfish species, and Illex squid have increased since 1975, although estimates for herring and mackerel (which contributed about 50% of the total biomass during the 1960's) have fluctuated without a definite trend. Recovery to the level corresponding to MSY (4.0-4.5 million tons) appears to be dependent upon a significant improvement in abundance of herring and mackerel.

For further information, see:

Clark, S.H., and B.E. Brown. 1977. Changes in biomass of finfishes and squids from the Gulf of Maine to Cape Hatteras, 1963-1974, as determined from research vessel survey data. Fish. Bull., U.S., 75:1-21.

Clark, S.H., and B.E. Brown. 1979. Trends in biomass of finfishes and squids in ICNAF Subarea 5 and Statistical Area 6, 1964-1977, as determined from research vessel survey data. Investigacion Pesquera, 43:107-122.

Table 3. Landings (thousand metric tons) and management information for total finfish and squids from the Gulf of Maine - Georges Bank area and south to Cape Hatteras.

	YEAR							
	1973	1974	1975	1976	1977	1978	1979[1]	1980[1]
US recreational landings[2]	150.9	152.8	162.0	175.8	79.5	86.8	96.3	106.7
Commercial landings								
US	201.9	204.5	216.8	235.2	266.3	290.8	322.3	357.4
Canada	16.8	11.0	14.0	7.8	14.6	26.8	16.0	25.9
Other	936.6	724.9	628.1	419.9	174.3	48.7	39.0	35.5
Total landings	1306.2	1093.2	1020.9	838.7	534.7	453.2	473.6	525.5
Total allowable catch	---	923.9	850.0	650.0	520.0[3]	---	---	---

Long-term potential catch	=	950.0[4]
Importance of recreational fishery	=	Major
Status of management	=	None as a group
Status of exploitation in 1980	=	Underexploited as a group

[1]Provisional (incomplete)

[2]Data for 1974 as obtained in NMFS Northeast Regional Survey; data for 1979 as obtained in NMFS Marine Recreational Fishery Statistics Survey of the Atlantic and Gulf Coasts. Remaining points estimated.

[3]Recommended under ICNAF, but not implemented under extended jurisdiction.

[4]Based on analysis of commercial data.

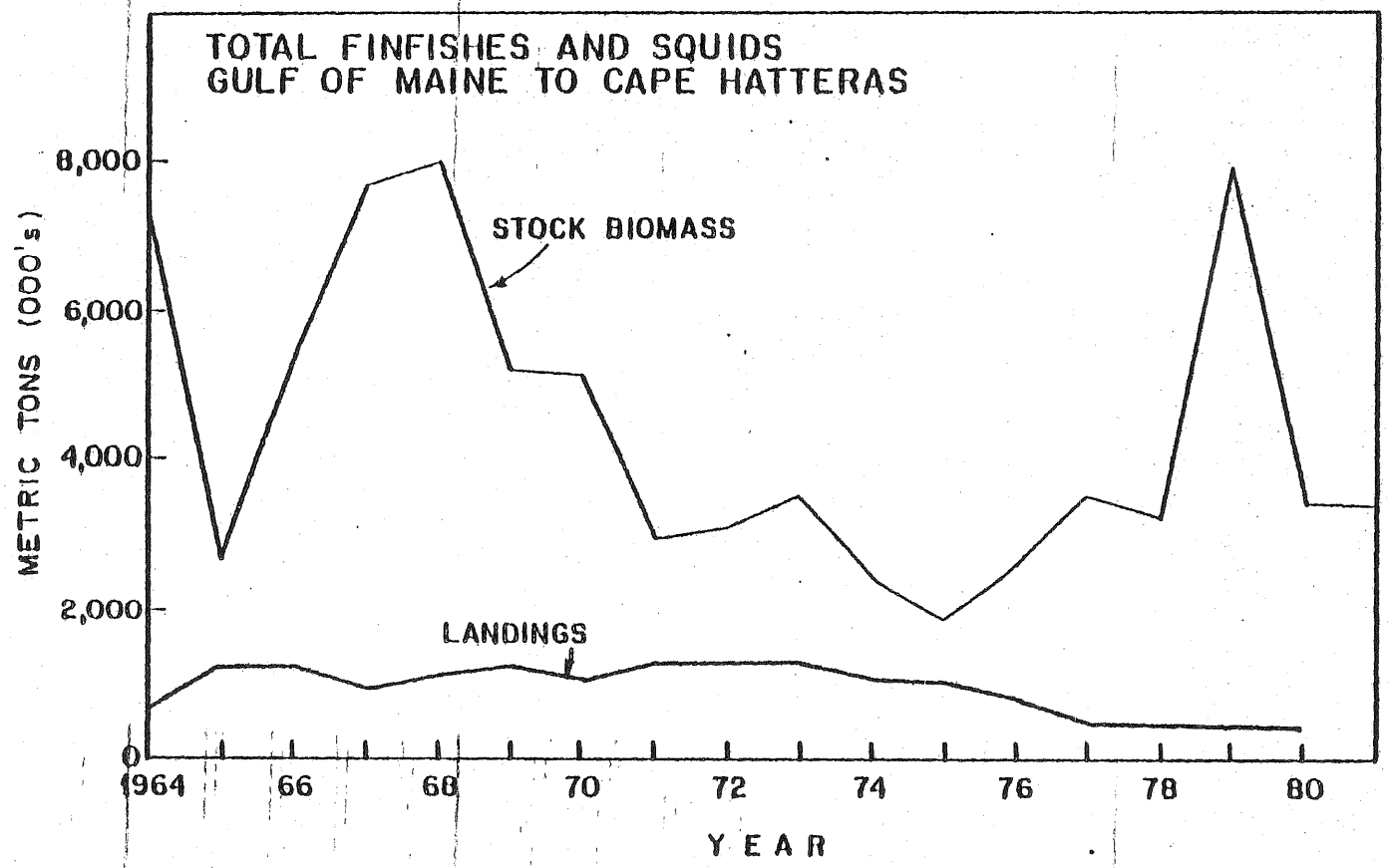

Figure 1. Stock biomass and landings of all finfish and squids for the North Atlantic area from Cape Hatteras to Nova Scotia.

ATLANTIC COD

The Atlantic cod, Gadus morhua, is distributed in the Northwest Atlantic from Port Burwell, West Greenland to Cape Hatteras, North Carolina. It is a heavy-bodied, bottom-dwelling, cold-water species found from near-shore surf areas to depths exceeding 200 fathoms. Cod eat a wide variety of mollusks, crustaceans, and fishes. Spawning occurs during winter and early spring, normally at water temperatures between 5-7°C (41-45°F). A large mature female may produce between 3-9 million eggs. Growth varies between geographical regions but is generally slower in the more northerly portions of the range. The maximum age is probably in excess of 20 years.

In USA Atlantic waters, three groups of cod occur: Gulf of Maine, Georges Bank, and southern New England-Middle Atlantic. Presently, these groups are managed as two units: The Gulf of Maine unit and the Georges Bank and southern New England-Middle Atlantic unit. Important commercial and recreational fisheries exist in both units. The commercial fisheries occur year-round using otter trawls, line trawls, gill nets, pair trawls, Danish seines, hand lines, jiggers, and traps. Recreational fishing also occurs throughout the year, although peak activity occurs during the summer in the lower Gulf of Maine, and in late fall and winter in inshore waters from Massachusetts southward. Party- and charter-boats as well as shore- and private-boats angling comprise the recreational fisheries.

Gulf of Maine

The total reported commercial landings in 1980 was 13,689 t, 1,630 t more than in 1979, and the second highest annual catch ever. USA 1980 commercial landings were 13,528 t, 16% greater than 1979, and the second highest since domestic commercial landings have been classified by stock area (Table 3). Canadian landings declined in 1980 to 161 t from 379 t in 1979. As in the past three years, the 1980 USA reported commercial landings are considered to underestimate commercial catches due to misreporting and non-reporting. The 1980 recreational catch is unknown. The 1979 NMFS Marine Recreational Fishery Statistics Survey estimated that 3,857 t of cod were taken by USA recreational anglers from Maine to New Jersey.

The 1980 NMFS offshore spring and autumn bottom trawl survey weight-per-tow indices were among the highest observed as were almost all weight-per-tow values in the 1980 NMFS and State of Massachusetts inshore bottom trawl surveys (Figure) Survey age composition data indicate that the 1979 and 1978 year classes are above average and may be relatively strong. The 1980 and 1977 year classes appear be of at least average strength.

Distribution of the reported 1980 USA commercial landings by market category was similar to those in 1978 and 1979 in indicating continued dominance in the fishery of "market" and "large" cod, presumably a result of the continued importance of the 1971, 1973 and 1974 year classes. Otter trawl landings accounted for 67.6% of the 1980 USA commercial landings. Gillnet landings comprised 29.3% of the 1980 USA commercial total, the highest annual percentage during 1965-1980.

Since 1975, annual relative exploitation indices (relationship of annual commercial landings to autumn research survey catch per tow indices) for the Gulf of Maine fishery have sequentially declined. The 1980 index was the lowest since 1972. Even if the 1980 value is conservative due to unreported catches, fishing mortality in 1980 did not appear to generate a reduction in population biomass from the relatively high 1979 level.

Recruitment of the 1978 and 1979 year classes into the commercial fishery in 1981 and 1982, respectively, should result in increased harvestable biomass if these year classes remain as strong as current survey indices imply. Given this good recruitment, continued annual harvests of about 12,000 t should not decrease average population biomass.

Table 4. Commercial landings (thousand metric tons) and management information for Atlantic cod from the Gulf of Maine, 1973-1980.

	YEAR							
Commercial Landings	1973	1974	1975	1976	1977	1978	1979	198
USA	6.1	7.6	8.9	10.2	12.4	12.4	11.7	13.
Canada	*	0.1	0.1	*	0.1	0.4	0.4	0.
Other	*	*	*	0.0	0.0	0.0	0.0	0.
Total	6.1	7.7	9.0	10.2	12.5	12.8	12.1	13.
Total allowable catch (commercial)	10	10	10	8	12	8	9.7	9.

Long-term potential catch	=	10
Importance of recreational fishery	=	Major
Status of management	=	FMP in force since March, 1977
Status of exploitation in 1980	=	Fully exploited

*Less than 0.1

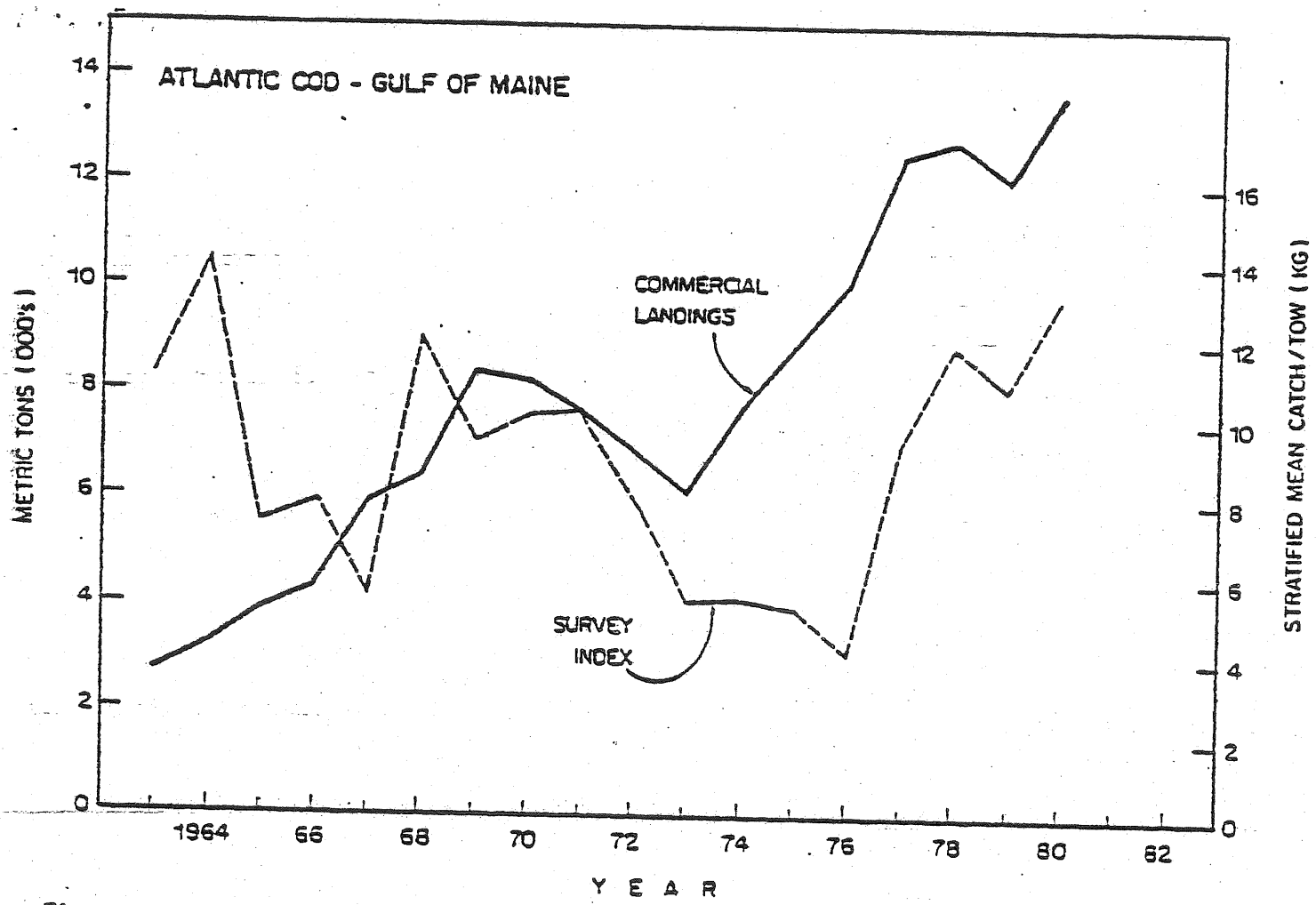

Figure 2. Commercial landings and index of abundance from research vessel surveys for Atlantic cod in the Gulf of Maine area.

Georges Bank and Southward

Total reported 1980 commercial landings were 48,147 t, 25% higher than in 1979, and the highest annual commercial landings in 14 years (Table 4). USA 1980 commercial landings were 40,053 t, a 23% increase over the 32,645 t reported in 1979, and the highest annual level since commercial landings have been maintained by stock area (beginning in 1932). Canadian commercial landings in 1980 USA commercial landings data are believed to underestimate the actual commercial catch as was true during 1977-1979. The total 1980 recreational catch from the Georges Bank and South stock is unkown, although charter- and party-boat records submitted to NMFS from all areas in the Northwest Atlantic FCZ indicated total landings of 669 t of cod. The logbook data grossly underestimate actual charter boat and party boat catches, however, due to incomplete compliance with logbook record keeping and submission requirements.

Research vessel bottom trawl survey catch-per-tow indices in 1980 showed disparate patterns; spring and summer offshore and inshore indices were generally higher than in 1979 but all of the 1980 autumn survey values were significantly lower than in 1979 or 1978. The 1980 NMFS autumn offshore numbers and weight indices were among the lower third of values in the autumn survey time-series, and were the lowest since 1974 (Figure 3). Survey catch-at-age data indicate that the 1978 year class is above average in abundance, although less than the strong 1975 year class in size. Both the 1977 and 1980 year classes appear average in strength while the 1979 year class appears relatively weak.

Composition of the 1980 USA commercial landings was dominated by "market" and "large" cod suggesting that the 1975 year class is still important in the fishery. Otter trawl landings accounted for 84.3% of the 1980 USA commercial catch. USA gill net landings increased sevenfold from 1979 and comprised 12% of the 1980 U.S.A. commerical landings. Commercial catch per effort indices remained high in 1980 but these data are difficult to evaluate because of management constraints on catch per trip.

In 1979 and 1980, relative exploitation indices (relationship of annual commercial landings to autumn research survey catch per tow indices) for the Georges Bank fishery have annually increased. The 1980 index was about twice as high as in 1977 or 1978, and was the highest since 1970. Because reported USA commercial landir are believed to underestimate the actual 1980 catch, the actual 1980 relative exploit tion index may be considerably higher than that calculated suggesting that recent fishing mortality may have increased to the levels observed during 1964-1970 when stock declines ensued.

If the recent declines in the autumn catch-per-tow indices are indicative of declines in stock biomass, continuation of current annual harvests (about 48,000 t) in the near future will further reduce population size. Although continued recruitment of the above average 1978 year class into the commercial fishery during 1981 may ameliorate the extent of these reductions, the 1979 and 1980 year classes curren appear no better than average in strength, and will not support fishing at current levels through 1983 without stock reduction.

For additional information see:

Serchuk, F.M., and P.W. Wood, Jr. 1981. Assessment and status of the Georges Bank and Gulf of Maine Atlantic cod stocks - 1981. Woods Hole Lab. Ref. 81-06, 67 p.

Serchuk, F.M., S.H. Clark, and B.E. Brown. 1981. Implications of the 1981 Georges Bank and Gulf of Maine cod and haddock assessments for future management strategies. Woods Hole Lab. Ref. 81-09, 7p.

Table 5. Commercial landings (thousand metric tons) and management information for Atlantic cod from Georges Bank, 1973-1980.

Commercial Landings	YEAR 1973	1974	1975	1976	1977	1978	1979	1980
USA	16.2	18.4	16.0	14.9	21.1	26.6	32.6	40.0
Canada	3.2	1.4	1.8	2.3	6.2	8.9	6.0	8.1
Other	9.5	7.6	7.1	2.7	*	0.0	0.0	0.0
Total	28.9	27.4	24.9	19.9	27.3	35.5	38.6	48.1
Total allowable catch (commercial)	35	35	35	35	25.65[1]	26[1]	36.92[1]	35.0

Long-term potential catch	=	35
Importance of recreational fishery	=	Major
Status of management	=	FMP in force since March, 1977
Status of exploitation	=	Fully exploited

[1]Calendar year OY includes 4,000 mt quota to Canada. Reflects OY amendments to Fishery Management Plan (FMP) on 3 November 1977 and 19 July 1978, and OY revisions proposed in Draft Amendment No. 4 to the FMP.

*Less than 0.1

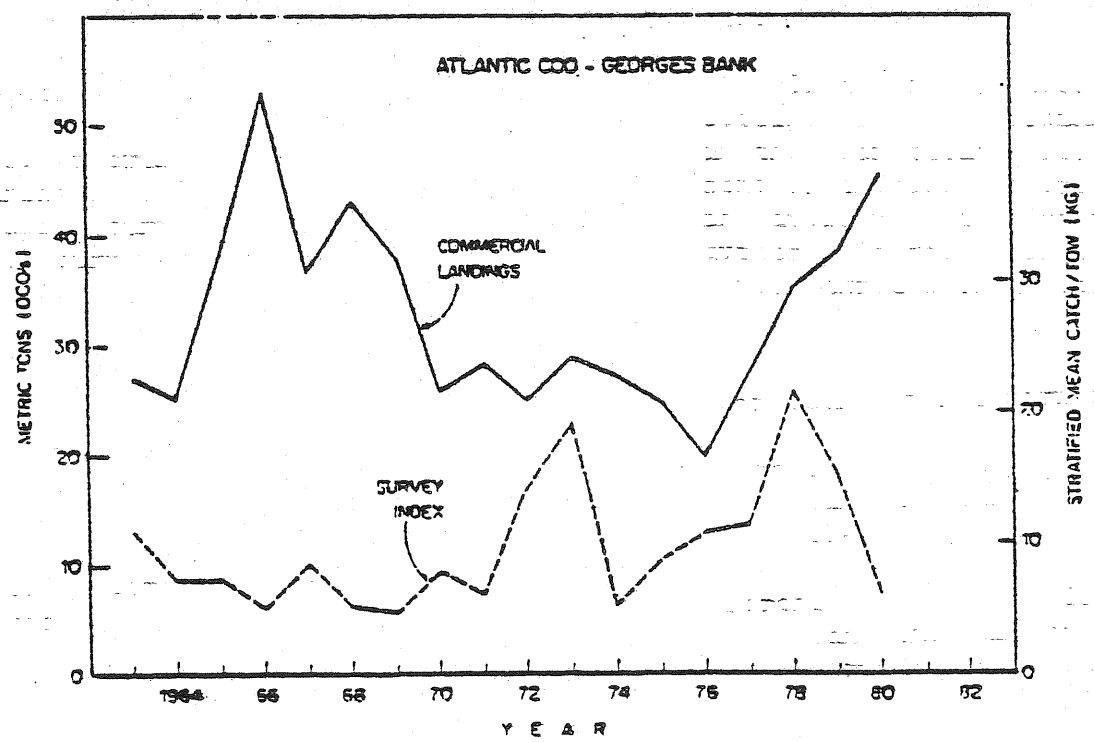

Figure 3. Commercial landings and index of abundance from research vessel surveys for Atlantic cod from the Georges Bank area.

HADDOCK

The haddock (Melanogrammus aeglefinus) is a demersal species commonly attaining lengths of 75-80 cm (30-32 inches) and weights of up to 5 kg (11 pounds). Off the USA coast, highest concentrations occur on eastern Georges Bank, generally at depths of 50-150 meters (27-82 fathoms); small invertebrates constitute the bulk of the diet. Georges Bank haddock are relatively sedentary, although seasonal coastal movements have been documented in the western Gulf of Maine. Spawning occurs from January to June, although peak spawning activity occurs in March and April. Juveniles are pelagic in habit for several months and then settle to the bottom, where they remain for the rest of their lives. Haddock mature sexually at ages 2-3.

Haddock on Georges Bank and in the Gulf of Maine have been managed separately since July of 1978. Optimum yield (OY) levels have been raised repeatedly since 1976 (Tables 5 and 6); currently, the fishery is being administered under a fishing year (October 1 - September 30) OY of 32,500 tons, of which 25,250 tons has been designated for USA commercial harvest (17,675 tons, Georges Bank; 7,575 tons, Gulf of Maine), 5,250 tons are allocated to Canada, and 2,000 tons are designated for recreational harvest. During 1977-1979, USA fishermen accounted for 65% of the reported commercial landings for Georges Bank and 93% of the reported total for the Gulf of Maine, with the remainder being taken by Canada. The actual USA haddock catch appears to have been much higher during this period due to discard and/or misreporting, but there is no basis for estimating the magnitude of the resulting bias. Recreational surveys for 1974 and 1979 indicate annual catches of 200 tons and 400 tons, respectively, almost all of which appears to have been taken in the western Gulf of Maine.

Georges Bank

Commercial landings for Georges Bank increased from an average of 4,700 tons during 1974-1976 to 10,800 tons in 1977 and to 22,300 tons in 1978 with recruitment of the strong 1975 year class; provisional statistics for 1979 indicate landings of 19,500 tons, and preliminary statistics for 1980 indicate landings of 27,500 tons, 17,400 tons of which were taken by the US (Table 6, Figure 4). This increase reflects recruitment and growth of the strong 1975 and 1978 year-classes, increased USA and Canadian effort and changes in OY's and USA vessel class allocations. During 1977-1979, the 1975 year class accounted for 70% of the total number landed, while in 1980 the 1978 year class provided an estimated 54% of the total number landed. The 1975 year class is now much reduced and the population is now dominated by the 1978 year class (which, however, appears to have been appreciably reduced by landings and discard in 1980).

The NEFC spring survey index for Georges Bank increased from 5.4 kg per tow in 1975 to 20.7 kg in 1978; the spring 1980 index value (35.7 kg) was the highest observed in the NEFC spring survey time series. The NEFC autumn survey index increased from 2.6 kg per tow in 1974 to an average of 23.4 kg in 1976-1977;

index values for 1978, 1979, and 1980 were 15.2 kg, 26.9 kg, and 18.5 kg, respectively. Both sets of data (and more limited summer survey data) are consistent in indicating a substantial increase in stock abundance in recent years, and index values for 1977-1980 are generally comparable to or higher than values observed during the late 1960's. During 1977-1979, the 1975 year class accounted for 85% of the total catch in number of age 2 and older fish in NEFC spring and autumn surveys. The 1978 year class appears comparable to the 1975 year class, and the 1980 year class appears to be at least of average size, although the 1976, 1977, and 1979 year classes appear to be weak. Consequently, the Georges Bank fishery should continue to be dominated by a single year class at least until late 1982.

Current assessment results indicate a total 1981 stock biomass (age 2 and older) of approximately 110,000 tons; the corresponding spawning stock size estimate is 105,000 tons. These values are comparable to those observed in the late 1960's (1967-1968 averages were 118,000 tons and 116,000 tons, respectively) and are also intermediate between the corresponding long term (1935-1960) averages of 153,000 tons and 131,000 tons and the very low levels observed during the early to mid-1970's as determined from virtual population analysis or VPA (Figure 4). Fishing at $F_{0.1}$ in 1981 would provide a catch of 25,100 tons; fishing at F_{max} would provide a catch of 46,700 tons. Assuming recruitment of 61 million fish (the long-term average) at age 2 in 1982, resulting stock sizes in 1982 would be 139,100 tons and 115,800 tons, respectively.

Table 6. Landings (thousand metric tons) and management information for Georges Bank haddock, 1974-1980.

	Year							
	1973	1974	1975	1976	1977	1978	1979[1]	1980[2]
US recreational landings	-	-	-	-	-	-	-	-
Commercial landings								
US	2.3	2.4	4.0	2.9	7.9	12.2	14.3	17.4
Canada	1.6	0.3	1.3	1.4	2.9	10.2	5.2	10.1
Other	1.0	1.4	0.1	0.0[3]	0.0	0.0	0.0	0.0
Total landings	5.3	4.3	5.4	4.3	10.3	22.3	19.5	27.5
Total allowable catch[4]	6	0	6	6	10.3	19.0[5]	22.1[6]	22.9[7]

Long-term potential catch = 47

Importance of recreational fishery = Insignificant

Status of management = FMP in force since March, 1977

Status of exploitation in 1980 = Fully exploited

[1] Provisional (incomplete).

[2] Preliminary.

[3] Less than 0.1.

[4] Values for 1973-1978 are for Georges Bank and the Gulf of Maine, inclusive; 1973-1976 figures relate to commercial catch only.

[5] Represents total US commercial allocations for Quarters 1-3 of 1978 and Quarter 1 of the 1978-1979 fishing year and total Canadian and US recreational allocations for Calendar Year 1978.

[6] Represents US commercial allocations for Georges Bank for Quarters 2-4 of the 1978-1979 fishing year and Quarter 1 of the 1979-1980 fishing year and total Canadian allocation for Calendar Year 1979.

[7] Represents US commercial and total Canadian allocations for Georges Bank for Calendar Year 1980 under the proposed September, 1979 OY of 22,500 tons.

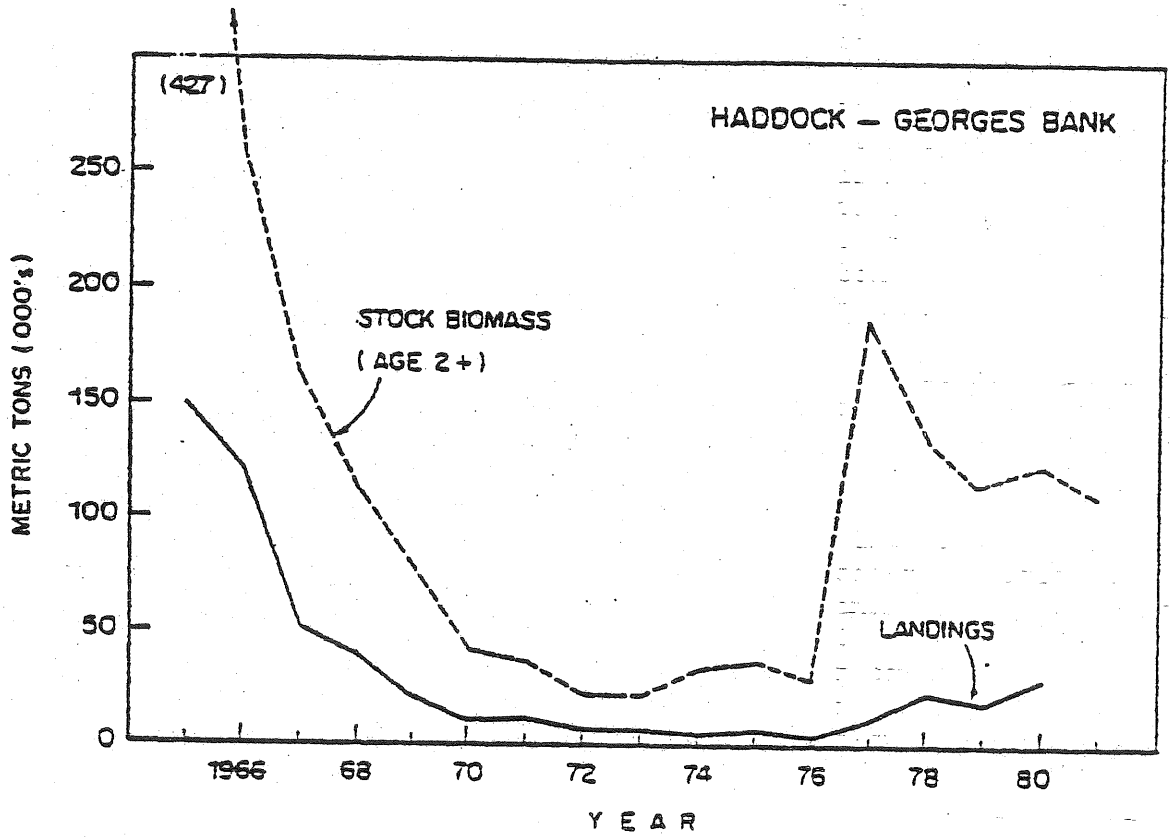

Figure 4. Landings and estimates of stock biomass of haddock from the Georges Bank area.

Gulf of Maine

Commercial landings for the Gulf of Maine increased from 600 tons in 1973 to 5,200 tons in 1978; provisional statistics for 1979 indicate landings of 4,900 tons, and preliminary statistics for 1980 indicate landings of 7,400 tons, 7,300 tons of which were reported by US vessels (Table 7, Figure 5). The 1975 year class again appears to have supported the fishery from 1977-1979, but in contrast to Georges Bank, recruitment from the 1978 year class does not appear to have been significant in 1980.

The NEFC spring survey index increased from 0.7 kg per tow in 1974 to 4.5 kg in 1977 before declining to 1.0 kg in 1978; spring 1979 and 1980 index values were 3.2 and 2.2 kg, respectively. The autumn survey index increased from 2.2 kg per tow in 1974 to 18.2 kg in 1978 before declining to 8.2 kg in 1980. The summer survey index has fluctuated without a definite trend since 1977. The 1975 year class generally appears to have been the strongest in recent years in all three surveys, although catch per tow of young-of-year haddock during the 1980 autumn survey was the highest observed since 1963. NEFC inshore summer survey results are generally comparable although catch per tow increased from an average of 2.7 kg in 1978-1979 to 6.6 kg in 1980. Massachusetts inshore survey data also suggest an increase in abundance since 1978.

Assuming that stock size in 1981 has declined 30% below the assumed 1964-1968 average of 16,600 tons as indicated by 1980 autumn survey results, fishing at F_{max} in 1981 would provide a catch of 5,200 tons; fishing at $F_{0.1}$ would provide a catch of 2,800 tons. Thus, landings in the order of 6,000 tons (the 1978-1980 average) may result in fishing mortality levels in excess of F_{max} and may not be sustainable, particularly if the 1980 year class proves to be weaker than anticipated.

For additional information see:

Clark, S.H., and R.J. Essig. MS 1980. Georges Bank and Gulf of Maine haddock assessment update. Nat. Mar. Fish. Serv., Woods Hole, Lab. Ref. Doc. No. 80-06, 33 p.

Clark, S.H., R.K. Mayo, and E. Faulk. MS 1981. Georges Bank and Gulf of Maine haddock stock status - 1981. Nat. Mar. Fish. Serv., Woods Hole, Lab. Ref. Doc. No. 81-05, 47 p.

Table 7. Landings (thousand metric tons) and management information for Gulf of Maine haddock, 1974-1980.

	Year							
	1973	1974	1975	1976	1977	1978	1979[1]	1980[2]
US recreational landings[3]	0.2	0.2	0.4	0.4	0.3	0.4	0.4	0.6
Commercial landings								
US	0.5	0.6	1.2	1.9	3.3	4.5	4.6	7.3
Canada	0.0[4]	0.2	0.1	0.1	0.0[4]	0.7	0.3	0.2
Other	0.0	0.0[4]	0.0[4]	0.0	0.0	0.0	0.0	0.0
Total landings	0.8	1.0	1.7	2.4	3.6	5.6	5.3	8.0
Total allowable catch[5]	6	0	6	6	10.3	19.0[6]	8.2[7]	9.6[8]

Long-term potential catch = 5

Importance of recreational fishery = Insignificant

Status of management = FMP in force since March, 1977

Status of exploitation in 1980 = Fully exploited

[1] Provisional (incomplete).

[2] Preliminary.

[3] Values for 1974 and 1979 obtained from surveys; remaining points estimated.

[4] Less than 0.1.

[5] Values for 1973-1978 are for Georges Bank and the Gulf of Maine, inclusive; 1973-1976 figures relate to commercial catch only.

[6] Represents total US commercial allocations for Quarters 1-3 of 1978 and Quarter 1 of the 1978-1979 fishing year and total Canadian and US recreational allocations for Calendar Year 1978.

[7] Represents US commercial allocations for the Gulf of Maine for Quarters 2-4 of the 1978-1979 fishing year and Quarter 1 of the 1979-1980 fishing year and total USA recreational allocation for Calendar Year 1979.

[8] Represents US commercial and total recreational allocations for the Gulf of Maine for Calendar Year 1980 under the proposed September, 1979 OY of 32,500 tons.

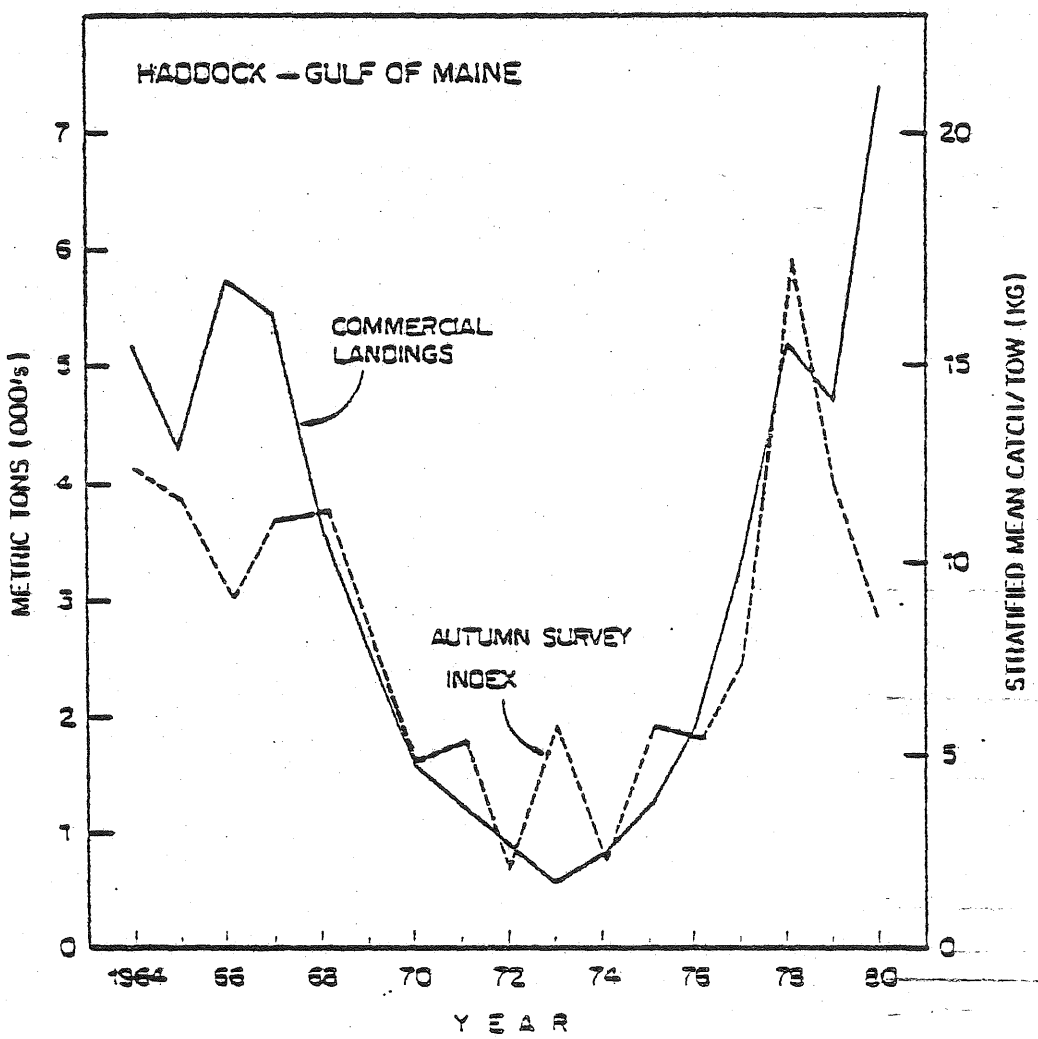

Figure 5. Commercial landings and index of abundance from autumn research vessel surveys for haddock from the Gulf of Maine area.

REDFISH

Redfish, Sebastes marinus (L.), are distributed throughout the North Atlantic from the coast of Norway to Georges Bank. Off New England, redfish are most common in deep waters of the Gulf of Maine to depths of 300 m (975 feet). Redfish are slow growing, long-lived animals; hence, the natural mortality rate is quite low. Ages in excess of 50 years and maximum sizes of 45-50 cm (18-20 inches) have been noted. In the Gulf of Maine, redfish reach maturity in about 8-9 years at an average length of 22 to 23 cm (8.5 to 9 inches). Females are viviparous, retaining eggs in the ovary after fertilization until yolk sac absorption. Mating takes place in autumn with subsequent larval extrusion occurring the following spring and summer.

During the development phase of the Gulf of Maine fishery, USA catches rapidly rose to a peak level of about 60,000 metric tons in 1942 followed by a gradual decline. The total commercial catch increased from approximately 10,000-11,000 tons during 1974-1976 to 14,000-15,000 tons in 1978-1979 (Table 8, Figure 6). In 1980, USA landings declined by 33% to less than 10,000 tons, the lowest annual figure since 1975. Available evidence indicates that the Gulf of Maine redfish population is now dominated by the 1971 year class and that the fishery is increasingly dependent on this year class. The 1971 year class has accounted for over 50% of the numbers landed in the commercial fishery since 1978.

The standardized catch per unit of effort (CPUE) index, after temporarily stabilizing at approximately 2.0 tons per day fished between 1975 and 1978, declined to 1.6 and 1.4 tons per day fished in 1979 and 1980, respectively (Figure 6). This contrasts with the late 1960's when the CPUE index varied between 5.2 and 6.5 tons per day fished. NMFS bottom trawl surveys also indicate a substantial decline in relative abundance in 1979 and 1980. Prior to this, redfish biomass in the Gulf of Maine had remained relatively constant for the past 3-4 years because of continued growth and recruitment of 1971 year-class fish. However, declines in relative abundance and biomass in 1979 and 1980 suggest that growth and recruitment of the 1971 year class are no longer compensating for mortality. The estimated fishing mortality rate on the 1971 year class is in the order of 0.3 to 0.4 ($F_{0.1}$ = 0.1 to 0.15), which appears high considering the long life span of the species and the low frequency of strong year classes which support the fishery. Recruitment of other year classes since the early 1960's has been extremely poor and future prospects also appear poor as indicated by the latest bottom trawl survey results; thus, declines in biomass are expected to continue in the near future.

Equilibrium yield models indicate that maximum sustained yield (MSY) is about 14,000 tons. However, given current low population abundance, surplus production in the near future will be less than MSY as indicated by the sharp decline in 1980 landings after three years averaging about the MSY level.

For further information see:

Mayo, R.K. 1980. Exploitation of redfish, Sebastes marinus (L.), in the Gulf of Maine - Georges Bank region, with particular reference to the 1971 year class. J. Northw. Atl. Fish. Sci. 1:21-38.

Table 8. Landings (thousand metric tons) and management information for redfish from the Gulf of Maine and Georges Bank area.

	Year							
	1973	1974	1975	1976	1977	1978	1979	1980
US recreational landings	-	-	-	-	-	-	-	-
Commercial landings								
US	11.9	8.7	9.1	10.1	13.0	14.0	14.7	9.3
Canada	0.0[1]	0.0[1]	0.0[1]	0.2	0.2	0.1	0.0[1]	0.0
Other	5.4	1.7	1.4	0.4	0.0[1]	0	0	0
Total landings	17.4	10.4	10.6	10.7	13.2	14.1	14.7	9.3
Total allowable catch	30	30	25	17	9[2]	-[2]	-[2]	-[2]

Long-term potential catch = 14

Importance of recreational fishery = Insignificant

Status of management = None

Status of exploitation in 1979 = Fully exploited

[1] Less than 0.1.

[2] TAC of 9,000 tons was adopted by ICNAF in 1977 but not enforced due to US implementation of FCMA. Since 1977, no regulations have been adopted.

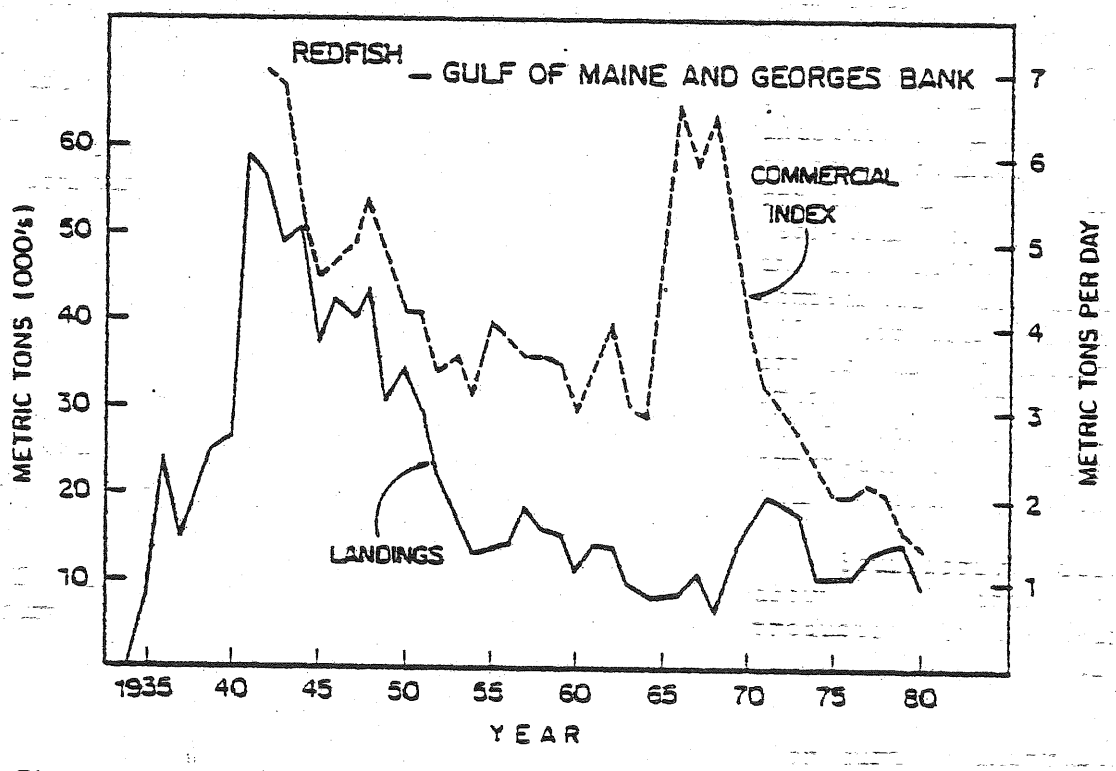

Figure 6. Landings and index of abundance from the commercial fishery for redfish from the Gulf of Maine and Georges Bank area.

SILVER HAKE

The silver hake, Merluccius bilinearis, Mitchell is a widely distributed slender, swiftly swimming fish with a range extending from the Newfoundland Banks to South Carolina, but most abundant off the New England coast. Research vessel bottom trawl surveys have indicated that silver hake have wide areal and depth ranges throughout the year, with only major concentrations of fish varying from season to season. In response to major seasonal changes in hydrographic conditions, availability of food, and spawning requirements, adult silver hake undergo extensive migrations, overwintering in the deep waters of the Gulf of Maine and along the continental shelf and slope, south and west of Georges Bank, and moving to shallower waters during March-November to spawn.

Major spawning areas for silver hake include the coastal region of the Gulf of Maine from Cape Cod to Grand Manan Is., shoal areas and the southeastern and southern slopes of Georges Bank, and the southern New England area south of Martha's Vineyard.

Silver hake grow to a maximum length of approximately 65 cm and ages of 15 years have been reported, although fish of ages older than about 8-10 years are rarely found.

Gulf of Maine Stock

The commercial catch of silver hake in 1980 was 3,812 tons, taken exclusively by the US (Table 9, Figure 7). This level of catch represented a 45% increase over 1979 but was still the second lowest reported in the 1955-1980 time series and substantially below catch levels in past years (83% lower than the 1960-1969 average of 22,900 tons and 53% lower than the 1970-1977 average of 8,100 tons. The commercial catch-per-effort index after dropping sharply from 16.71 tons/day in 1976 to a low of 6.44 tons/day in 1979, increased to 7.74 tons/day in 1980 a level approximately equal to the 1970-75 average. Both the spring and autumn NEFC research vessel trawl survey catch-per-tow indices have reflected the same trends as the commercial catch-per-effort index in recent years, recording high levels in the mid 1970's, dropping to low levels in 1978-1979, and increasing in 1980. The autumn survey index after reaching 10.87 kg in 1976, dropped to 6.20 kg in 1978, and then increased to 7.67 kg in 1980. The spring survey catch-per-tow index dropped from 14.23 kg in 1976 to 1.36 kg in 1978, increased to 6.79 kg in 1980, but dropped to 3.73 kg in 1981.

Spring and autumn survey catch-per-tow-at-age data indicate that the 1972-1974 year classes were quite strong with 1974 being the strongest. These year classes were also well represented in the commercial landings-at-age data. The 1975-1976 year classes appear to be relatively weak in comparison to previous years, while the 1977 and 1978 year classes are much stronger than the 1975-1976 year classes. The 1979 and 1980 year classes appear to be of at least average strength with the 1980 year class potentially being quite strong. These estimates, however, should be considered only provisional since neither the spring nor autumn survey year class estimates have shown any significant correlations with each other or with estimates calculated by virtual population analysis (VPA).

Due to low levels of catch in both 1979 and 1980, as well as very limited sampling of the catch in those years, it was not possible to determine the catch-at-age in numbers necessary for performing a VPA. Consequently, estimates of stock size from VPA are not available after 1978. Estimates of stock size after 1978 were derived utilizing relationships between VPA estimates and abundance indices from commercial fishery and research vessel survey data.

Fishing mortality in 1978 was estimated to be 0.40 for ages 3 and older compared to 0.61 in 1975 and 0.33 in 1977. In 1979 and 1980, F was probably 0.2-0.3 because of the reduction in catch.

Spawning stock biomass (ages 2 and older), after maintaining high levels during 1955-1966 (averaging 157,000 tons), declined sharply to only 15,900 tons in 1971, but increased in recent years to average approximately 34,900 tons during 1975-1980. The 1980 estimate was 36,300 tons (Figure 7).

Although this stock has remained at a low level of abundance during the 1970's compared to the 1950's and 1960's, estimates of relative abundance from both the commercial fishery and research vessel surveys have increased in recent years indicating some rebuilding of the stock.

Table 9. Landings (thousand metric tons) and management information for silver hake from the Gulf of Maine, 1974-1980.

	YEAR						
	1974	1975	1976	1977	1978	1979	1980
US recreational landings	-	-	-	-	-	-	-
Commercial landings							
US	4.6	8.0	9.3	8.7	6.2	2.6	3.3
Other	0.6	1.1	-	-	-	-	-
Total landings	5.2	9.1	9.3	8.7	6.2	2.6	3.3
Total allowable catch	10.0	15.0	10.0	9.0	*	*	*

Long-term potential catch	=	26.3
Importance of recreational fishery	=	Insignificant
Status of management	=	FMP in preparation
Status of exploitation in 1980	=	Underexploited

*Landings were unregulated in 1978-1980

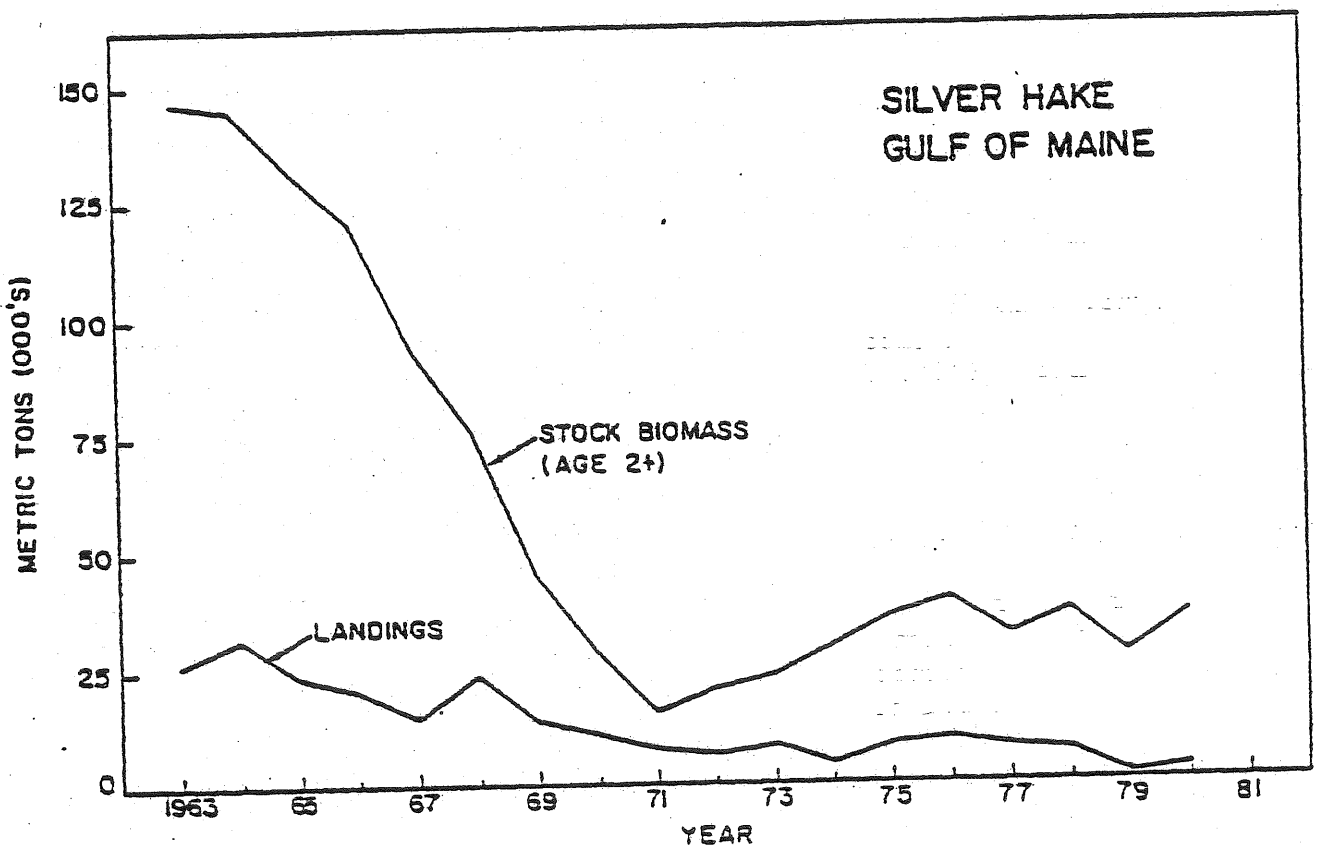

Figure 7. Landings and estimates of stock biomass for silver hake from the Gulf of Maine area.

Georges Bank Stock

The 1980 international catch on Georges Bank was only 1,664 tons (Table 10, Figure 8), the lowest catch in the 1955-1980 time series and slightly less than the 1979 catch (1,915 tons). Catches have declined sharply from 66,364 tons in 1974 largely due to a reduction in the foreign fishery. Distant-water-fleet catches were only 498 tons in 1980 compared to 1,022 tons in 1979 and 40,514 tons in 1977. The USA catch of 1,166 tons in 1980, although a slight improvement over 1979 (893 tons) was the third lowest since 1955. The USA commercial catch-per-day index, after reaching 46.1 tons in 1976, declined to 17.4 tons in 1979, and increased slightly in 1980 to 21.0 tons, which is roughly equivalent to levels observed during the early 1970's.

The NEFC spring bottom trawl survey catch-per-tow index, after reaching a high of 7.84 kg in 1977, dropped to only 2.08 kg in 1979, but rose sharply in 1980 and reached 8.76 kg in 1981, its highest level in the 1968-1981 time series. The autumn survey index, although showing more variability than the spring survey, also recorded a high level in 1976 (4.42 kg), dropped until 1979 (1.66 kg) and increased in 1980 to 2.11 kg.

Spring and autumn research vessel survey catch-per-tow-at-age data indicate that both the 1973 and 1974 year classes were quite strong and were the dominant year classes in the fishery through about 1978. Since 1973, no year classes of any substantial strength have appeared although the 1978 and 1980 year classes appear to be stronger than the 1975-1977 or 1979 year classes.

Total stock biomass (ages 1 and older) in 1981 was estimated to be 47,400 tons approximately a 16% increase over the 1980 estimate but still substantially below the levels maintained from 1966 through 1976 (average 213,000 tons). Spawning stock biomass (ages 2 and older) was estimated to be 32,300 tons at the beginning of 1981 (Figure 8), about the same as during 1978-1980 but well below past levels which peaked at about 595,000 tons in 1964.

Fishing mortality in 1980 was estimated to be 0.12 for ages 3 and older based on a relationship between fishing effort and past fishing mortality from virtual population analysis. This level of F is a sharp decrease from an average of 1.00 during 1971-1978.

A projected 1981 catch of 2,000 tons would generate an F of 0.09 and result in a increase in spawning stock biomass of 32% from 1981 to 1982. Fishing at $F_{0.1}$ in 1982 (0.65) would result in a catch of about 13,200 tons and decrease the spawning stock biomass in 1983 by approximately 1%.

The extremely low catches in 1979 and 1980 together with only limited amounts of catch sampling data has weakened the data base from which stock size and fishing mortality estimates are determined by virtual population analysis. Accordingly, the estimates of current and projected stock size and projected catch levels must be interpreted with considerable caution.

Table 10. Landings (thousand metric tons) and management information for silver hake from Georges Bank, 1974-1980.

	YEAR						
	1974	1975	1976	1977	1978	1979	1980
US recreational landings	-	-	-	-	-	-	-
Commercial landings							
US	2.3	4.6	3.8	3.7	6.4	0.9	1.2
Other	64.1	58.6	42.0	40.6	3.6	1.0	0.5
Total landings	66.4	63.2	45.8	44.3	10.0	1.9	1.7
Total allowable catch	80.0	80.0	50.0	70.0	58.3	58.3	33.0

Long-term potential catch = 80

Importance of recreational fishery = Insignificant

Status of management = FMP in force since 1977

Status of exploitation in 1980 = Underexploited

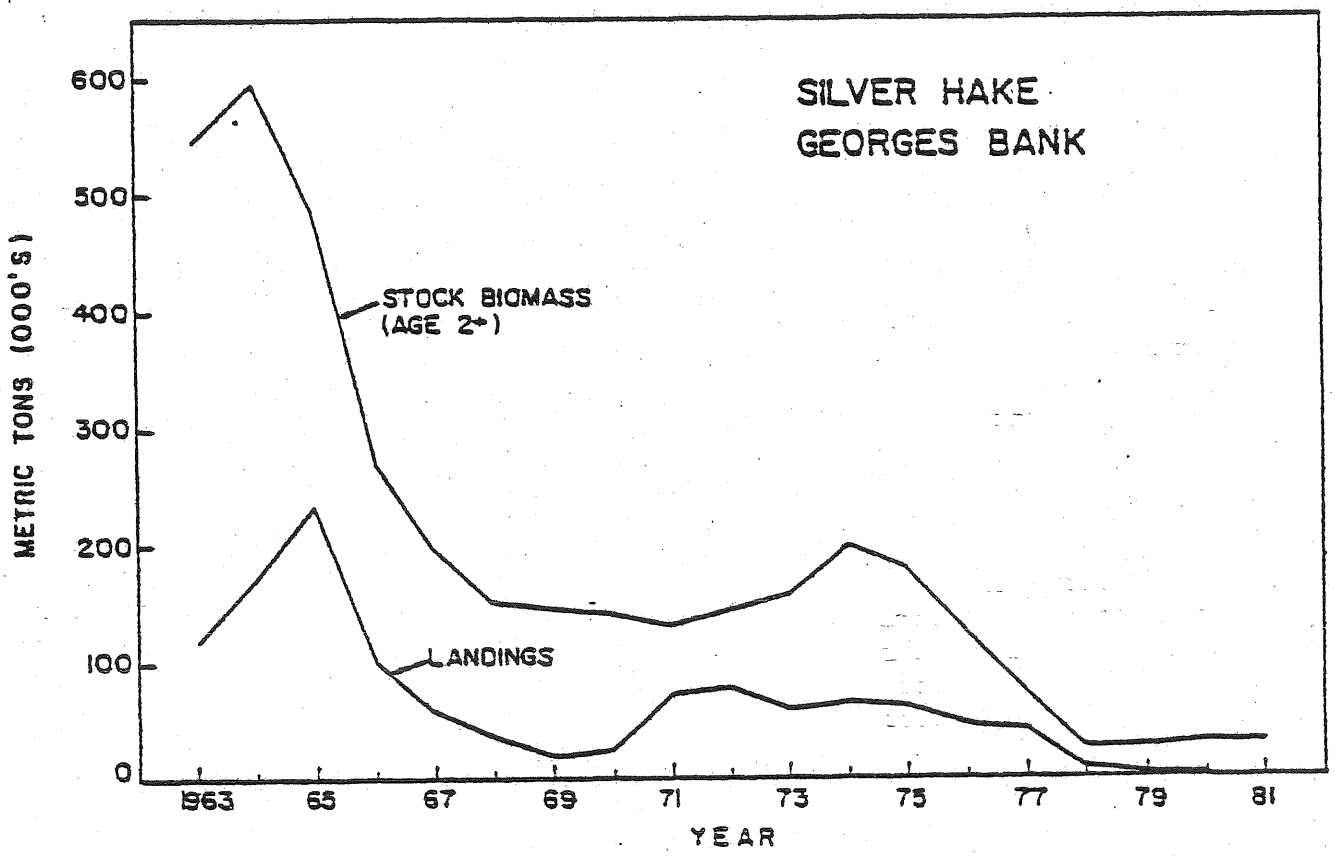

Figure 8. Landings and estimates of stock biomass for silver hake in the Georges Bank area.

Southern New England - Middle Atlantic Stock

The 1980 international catch was 15,456 tons compared to 16,862 tons in 1979, continuing a steady decline from 66,000 tons in 1973, the lowest level reported since the introduction of the distant-water-fleet in 1963 (Table 9, Figure 11). The USA commercial catch in 1980 was 11,483 tons, down slightly from 12,974 tons in 1979 but well above levels reported in the early 1970's (average 5,700 tons during 1970-1973). The USA recreational catch was estimated to be 3,000 tons. The distant-water-fleet catch in 1980 was 973 tons, compared to 3,888 tons in 1979, and by far, its lowest level since 1963.

The USA commercial catch-per-day index, after recording its highest level of 8.40 tons in 1978, decreased to 5.98 tons in 1980. The NEFC autumn bottom trawl survey catch-per-tow index, after reaching its highest level since 1968 in 1978 (4.63 kg), declined to 3.07 kg in 1980. The spring survey, after recording its lowest level in the 1968-1981 series in 1981 (3.92 kg), increased in 1981 to 6.35 kg.

Spring and autumn survey catch-per-tow-at-age data indicate as in the Gulf of Maine and Georges Bank stocks, that the 1973-1974 year classes were of superior strength compared to other years since 1973. Of the year classes produced since 1974, the 1976 and 1978 year classes appear stronger than the others. The 1980 year class appears to be of average strength.

Fishing mortality in 1980 was estimated to be 0.45 for ages 3 and older from a relationship between fishing effort and past fishing mortality from VPA. Total stock biomass (ages 1 and older) at the beginning of 1981 was estimated to be 82,900 tons, approximately equal to the 1980 level (82,100 tons). This level of biomass is approximately 26% below the average of 111,400 tons estimated for the period 1975 to 1979, and 76% below the 1962-1967 average, the period of highest biomass for this stock (350,900 tons). Spawning stock biomass (ages 2 and older) at the beginning of 1981 was estimated to be 60,900 tons, which represents a slight increase over 1980 but still the second lowest level since 1971 (Figure 11).

A projected 1981 catch of 15,000 tons would generate an F of 0.37 and result in a spawning stock biomass of approximately 69,200 tons at the beginning of 1982, a 12% increase over 1981. Fishing at $F_{0.1}$ in 1982 (0.55) would produce a catch of 23,500 tons and result in an increase in spawning stock size of 25% from 1982 to 1983.

For additional information see:

Almeida, F.P. and E.D. Anderson. 1981. Status of the silver hake resource off the Northeast coast of the United States - 1981. NMFS, NEFC, Woods Hole Lab. Ref. No. 81-36, p.

Table 11. Landings (thousand metric tons) and management information for silver hake from Southern New England and the Middle Atlantic area, 1974-1980.

	YEAR						
	1974	1975	1976	1977	1978	1979	1980
US recreational landings[1]	1.1	0.2	1.7	3.9	4.0	3.0	3.0
Commercial landings							
US	7.2	8.3	9.3	9.5	11.4	13.0	11.3
Other	51.2	33.4	16.3	14.3	10.8	3.9	1.0
Total landings	59.5	41.9	27.7	27.9	26.2	19.9	15.3
Total allowable catch	80.0	80.0	43.0	45.0	38.2	40.0	33.0

Long-term potential catch = 47.6

Importance of recreational fishery = Moderate

Status of management = FMP in force since 1977

Status of exploitation in 1980 = Underexploited

[1]Estimated

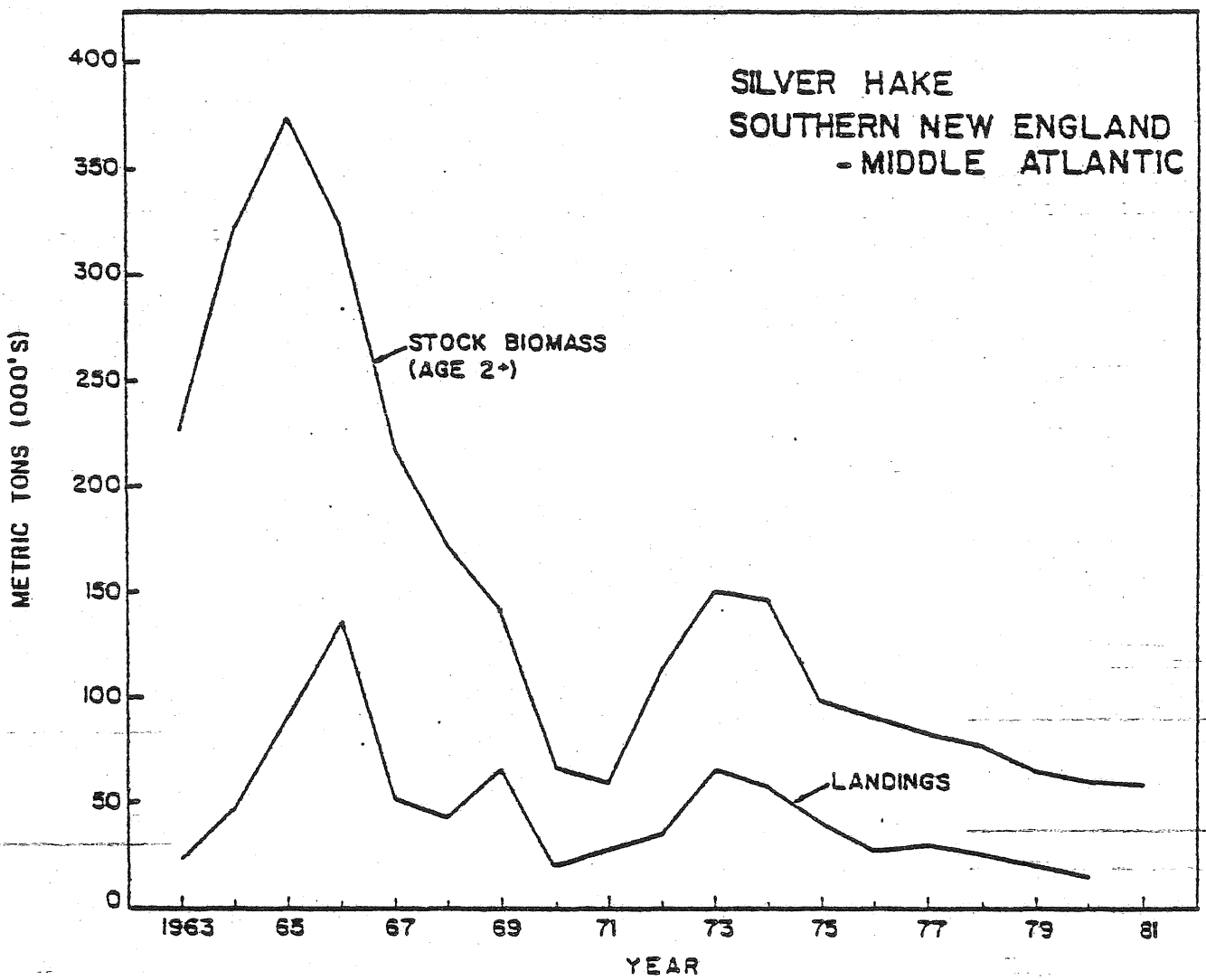

Figure 9. Landings and estimates of stock biomass for silver hake from the Southern New England and Middle Atlantic area.

RED HAKE

The red hake, Urophycis chuss, is a widely distributed fish with a range extending from the Gulf of St. Lawrence to North Carolina, but found in greatest numbers between Georges Bank and New Jersey. Like the silver hake, their general migration patterns indicated by research vessel survey data show overwintering areas to be in the deep waters of the Gulf of Maine and along the outer continental shelf and slope south and southwest of Georges Bank. During their spawning period from May through November, red hake are found in the warmer shoal and inshore waters. A characteristic pattern peculiar to red hake juveniles is the fact that many are found inside live sea scallops shells apparently using the shells for protection against predators.

Major spawning areas include the southwest slopes of Georges Bank and the Southern New England area south of Montauk Pt., Long Island. The maximum length achieved by red hake is approximately 50 cm and the maximum age is reported to be about 12 years although fish of age 8-10 are rarely seen in the commercial catch.

Georges Bank Stock

The 1980 international catch of red hake on Georges Bank was 280 tons, a very slight drop form 1979 but the lowest in the 1960-80 time series (Table 12, Figure 10). The USA catch was 240 tons, slightly lower than 1979 with both years being the highest since 1968. The major reason for the decline in total catch has been the sharp drop in distant-water-fleet catches beginning in 1977; the 1980 catch was only 40 tons.

Catch-per-tow indices from both the spring and autumn NEFC bottom trawl surveys increased from 1979 to 1980, following decreases from the mid-1970's. The 1980 values are close to the long-term means for the respective time-series.

Spring and autumn research vessel survey catch-per-tow-at-age data indicate that the 1973 and 1974 year classes were quite strong when compared to other years, but that recent year classes have been weaker.

Due to the low levels of catch in both 1979 and 1980 as well as very limited sampling of the catch in those years, it was not possible to determine the catch at age in numbers necessary for performing a virtual population analysis (VPA). Estimates of stock size after 1978 were derived utilizing a relationship between VPA-generated stock size and survey abundance indices.

Fishing mortality in 1979 and 1980 was probably quite low (e.g. less than 0.10) as a result of minimal catches in those years. In 1978, F was estimated to be 0.16 for ages 3 and older compared to 1.02 in 1976. $F_{0.1}$ for this stock has been calculated to be about 0.55.

Stock biomass (ages 1 and older), after reaching a peak of 102,300 tons in 1971, declined steadily to a low of 34,900 tons in 1976, but recovered to an estimated 65,800 tons at the beginning of 1981, the highest recorded since 1973. Spawning stock biomass (ages 2 and older) has followed a similar trend, reaching a peak in 1971 (86,900 tons) and declining to only 11,900 tons in 1977. Since 1977, biomass increased to an estimated 34,300 tons at the beginning of 1981 (Figure 10).

Table 12. Landings (thousand metric tons) and management information for red hake from Georges Bank, 1974-1980.

	YEAR						
	1974	1975	1976	1977	1978	1979	1980
Commercial landings							
US	0.1	0.1	-[1]	0.1	0.2	0.3	0.3
Other	9.4	14.9	17.1	2.8	0.8	-	-
Total landings	9.5	15.0	17.1	2.9	1.0	0.3	0.3
Total allowable catch	20.0	20.0	26.0	16.0	16.0	16.0	6.0

Long-term potential catch = 15.3

Importance of recreational fishery = Insignificant

Status of management = FMP in force since 1977

Status of exploitation in 1980 = Underexploited

[1] Less than 0.1

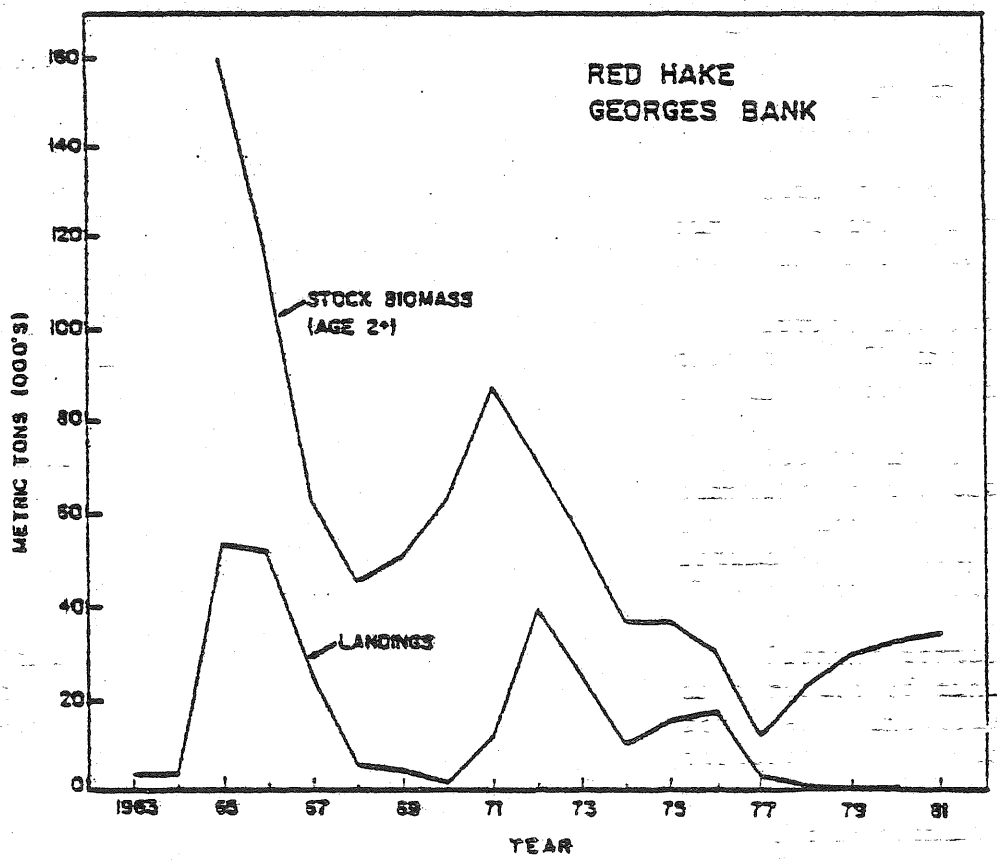

Figure 10. Landings and estimates of stock biomass for red hake from the Georges Bank area.

Southern New England-Middle Atlantic Stock

The 1980 international catch of red hake was 4,481 tons, a 45% decrease from 1979 and the lowest level reported in the 1960-80 series (Table 13, Figure 11). The reduction in catch was primarily due to a decline in catches by the distant-water-fleet (DWF) which reported a catch of only 106 tons in 1980, the lowest level since 1963. DWF catches have dropped steadily from about 38,000 tons in 1973 to the present time. The USA commercial catch in 1980 was 3,873 tons, a sharp decline from 1979 (6,622 tons) but still higher than the 1969-1978 average (3,290 tons). The USA recreational catch in 1980 was estimated to be 500 tons.

Catch-per-tow indices from both the spring and autumn NEFC bottom trawl surveys increased from 1979 to 1980. The 1980 autumn index was the highest observed since 1972 and was slightly above the 1963-1980 average. The 1980 spring index, although higher than in 1979, was about 30% below the 1968-1980 average.

Spring and autumn research vessel catch-per-tow-at-age data indicate that every fifth year since 1969 has produced a strong year class in comparison to other years, (e.g. 1969, 1974 and 1979 year classes). Other year classes have been average in strength with none being particularly poor. The 1980 year class also appears to be of average strength.

Fishing mortality in 1980 for ages 3 and older was estimated to be 0.23, continuing a series of low F's (averaging 0.23) since 1976. The 1980 estimate was determined from a relationship between relative exploitation (ration between international catch and the NEFC autumn survey catch-per-tow index) and past fishing mortality from virtual population analysis.

Total stock biomass (ages 1 and older) at the beginning of 1981 was estimated to be 49,300 tons, about the same low level as observed since the mid-1970's. Previous levels of total biomass were much higher (e.g. 1963-1966 average = 195,000 tons). Spawning stock biomass (ages 2 and older) has also undergone a similar pattern declining from high levels in the early 60's to its lowest level of 30,200 tons in 1977, but has increased to 38,000 tons at the beginning of 1981 (Figure 11).

A projected 1981 catch of 3,500 tons would generate and F of 0.13 and leave a spawning stock of about 54,300 tons at the beginning of 1982, a 43% increase over 1981. Fishing at $F_{0.1}$ in 1982 (0.45) would produce a catch of 16,800 tons and result in an increase in spawning stock size of 57% from 1982 to 1983.

For additional information:

Almeida, F.P. and E.D. Anderson. 1981. Status of the red hake resource off the Northeast Coast of the United States. NMFS, NEFC, Woods Hole Lab Ref. No. 81-37, p.

Table 13. Landings (thousand metric tons) and management information for red hake from the Southern New England and Middle Atlantic area, 1974-1980.

	YEAR						
	1974	1975	1976	1977	1978	1979	1980
US recreational landings[1]	0.2	0.1	0.6	0.8	0.7	0.5	0.5
Commercial landings							
US	2.2	2.1	3.9	2.5	3.3	6.6	3.9
Other	21.3	11.1	7.2	2.4	1.4	1.0	0.1
Total landings	23.7	13.3	11.7	5.7	5.4	8.1	4.5
Total allowable catch	50.0	45.0	16.0	28.0	20.5	16.0	11.0

Long-term potential catch = 26

Importance of recreational fishery = Minor

Status of management = FMP in force since 1977

Status of exploitation in 1980 = Underexploited

[1]Estimated

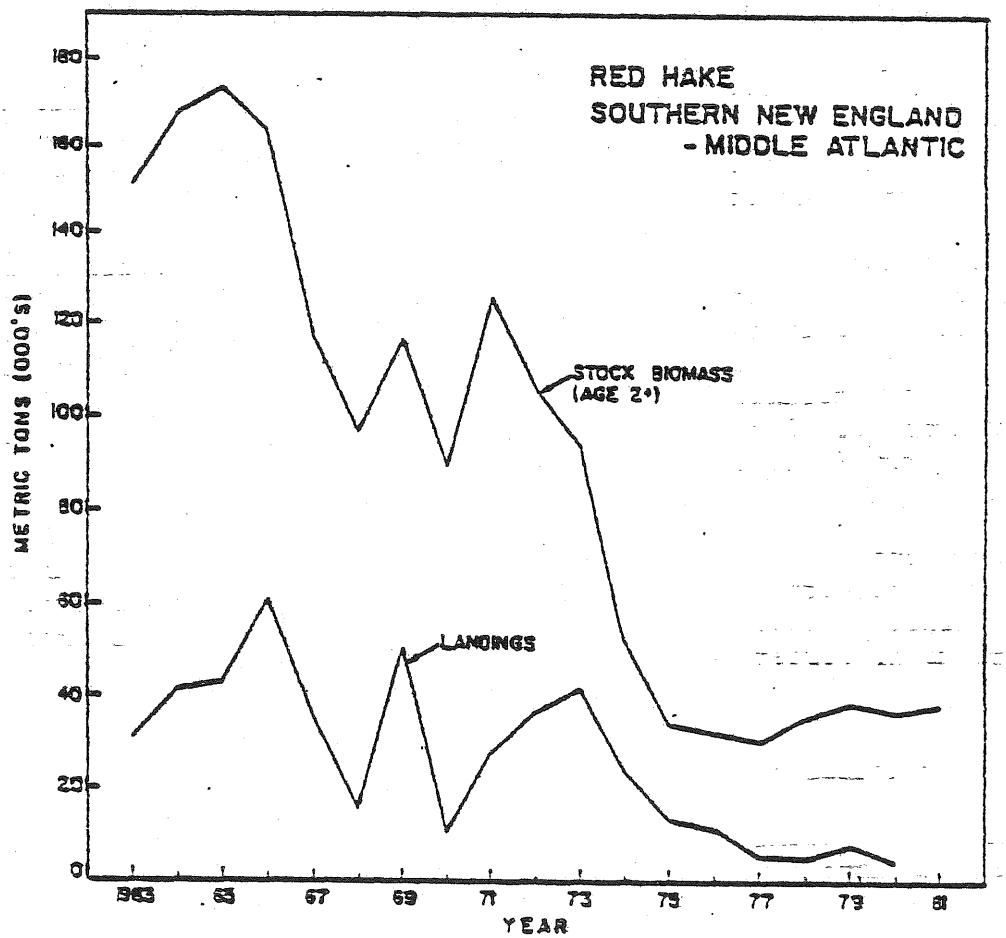

Figure 11. Landings and estimates of stock biomass for red hake from the Southern New England and Middle Atlantic area.

POLLOCK

The pollock (Pollachius virens) occurs on both sides of the North Atlantic; in the Northwest Atlantic, it is most abundant on the southwestern Scotian Shelf and in the Gulf of Maine. One major spawning area is currently known (in the western Gulf of Maine) and ancillary evidence suggests the potential for significant interchange between the Gulf of Maine and the Scotian Shelf area; accordingly, pollock from Cape Breton Island southward have been assessed as a unit. Spawning occurs in winter; juvenile "harbor" pollock are common in inshore areas but frequent more offshore situations as they grow older (sexual maturity is essentially complete at age 6). Pollock may attain lengths of up to 110 cm and weights of 16 kg.

Traditionally, pollock have been taken primarily as by-catch in directed fisheries for other groundfish species, but in recent years more effort has been directed towards this species and exploitation has increased considerably. Total commercial landings were relatively stable about an average of 38,200 tons from 1974-1977 and then increased to a total of 55,400 tons in 1980, of which 36,000 tons was landed by Canada and 18,300 tons by the USA (Table 14). Canadian landings were relatively constant about an average of 25,600 tons during 1973-1978 and then increased sharply in 1979-1980; USA landings have increased more or less continually since 1973. Catches by distant water fleets have declined from 9,900 tons in 1973 to an average of 900 tons during 1977-1980, almost all of which was taken by USSR vessels on the Scotian Shelf (Table 14). The USA recreational catch declined from 9,900 tons in 1960 to only 500 tons in 1974; the 1979 Marine Recreational Fishery Statistics Survey provided an estimate of 3,200 tons. Differences observed in recreational survey estimates appear to be more dependent upon differences in methodology than trends in abundance or fishing effort. No information is available on Canadian recreational harvest, although it appears to be of minor importance. Total landings including recreational catch estimates increased from an average of 26,100 tons during 1968-1970 to an average of 49,400 tons during 1978-1979; provisional statistics for 1980 indicate landings of 59,200 tons (Table 14, Figure 12). It should be noted that Canadian and USA commercial landings figures for recent years may have been biased upwards to an unknown degree by misreporting of other species (e.g., haddock) as pollock to circumvent landings restrictions; however, there is is no basis for quantifying actual amounts involved in either case.

Total stock size appears to be relatively high at present. Canadian commercial abundance indices (tons per hour fished) increased sharply in 1979, and 1979-1980 averages for 150-499 GT and 500-999 GT trawlers (1.4 tons and 1.7 tons, respectively) are more than double the corresponding 1972-1978 averages (0.5 tons and 0.8 tons). The USA index for 51-500 GT trawlers, however, has fluctuated without a definite trend since the early 1970's. The Canadian summer survey index declined from 4.5 fish per tow in 1970 to 1.6 fish in 1975 before rising sharply to 8.7 fish in 1977; the 1980 index value (12.4 fish) was the highest observed in the time series. The USA spring survey index increased to a peak of 6.5 kg per tow in 1976

before declining to an average of 3.5 kg in 1978-1980, comparable to the 1972-1974 average of 3.8 kg (Figure). The 1981 index value (4.9 kg) was the second highest observed in this time series. The USA autumn survey index peaked at 6.7 kg in 1976 and then declined to an average of 3.5 kg during 1978-1980, still relatively high compared to the time series as a whole. Available USA summer survey data for 1977-1980 indicate substantially higher levels of abundance than observed during the 1960's. Taken together, commercial and survey data provide no evidence that this stock has been adversely affected by recent increases in exploitation.

For further information, see:

Clark, S.H., L. Cleary, and T.S. Burns. 1978. A review of the northwest Atlantic pollock resource. ICES C.M. 1978/G:61, 31 p.

Cleary, L. MS 1980. Assessment of 4VWX-5-6 pollock. CAFSAC Res. Doc. 80/1, 37 p.

Table 14. Landings (thousand metric tons) and management information for pollock from the Gulf of Maine, Georges Bank, and Scotian Shelf area.

	YEAR							
	1973	1974	1975	1976	1977	1978	1979[1]	1980[1]
US recreational landings[2]	0.4	0.5	0.5	0.6	2.7	3.7	3.2	3.8
Commercial landings								
US	6.3	8.7	9.3	10.9	13.1	17.7	15.5	18.3
Canada	27.0	25.0	26.5	23.6	24.7	26.8	30.0	36.0
Other	9.9	4.1	3.2	3.2	0.7	0.3	1.1	1.2
Total landings	43.6	38.3	39.5	38.3	41.2	49.0	49.3	59.3
Total allowable catch	50	55	55	55	50[3]	---	---	---

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Minor
Status of management	=	FMP in preparation (USA fishery)
Status of exploitation in 1980	=	Fully exploited

[1] Provisional (incomplete).

[2] Data for 1974 and 1979 taken from recreational surveys; remaining points estimated.

[3] Recommended by ICNAF but not implemented under extended jurisdiction.

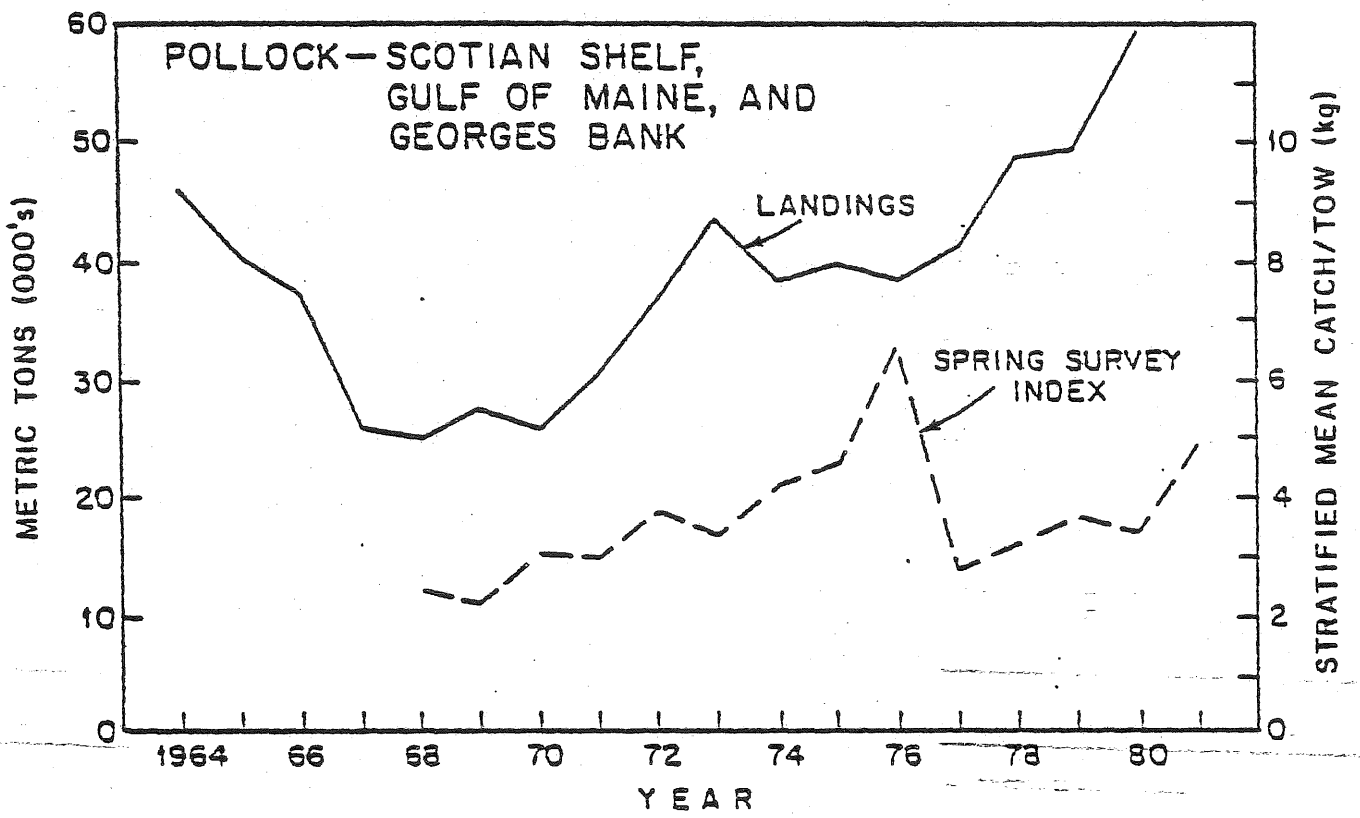

Figure 12. Landings and indices of abundance from spring research vessel surveys for pollock from the Scotian Shelf, Gulf of Maine and Georges Bank area.

YELLOWTAIL FLOUNDER

The yellowtail flounder (Limanda ferruginea) ranges from Labrador to Chesapeake Bay and off the USA coast occurs in commercially important concentrations on Georges Bank, off Cape Cod and off southern New England, generally at depths of from 37-73 m (20-40 fathoms). Yellowtail commonly attain lengths of up to 47 cm (18 inches) and weights of up to 1.0 kg (2.2 pounds) although commercial catches tend to be dominated by smaller fish. They appear to be relatively sedentary in habit although seasonal movements have been documented. Spawning occurs during spring and summer, peaking in May; larvae drift for a month or more, after which they assume adult characteristics and become demersal in habit. Yellowtail mature sexually at ages 3-4.

Previous tagging studies and other information indicate that southern New England, Georges Bank, and Cape Cod yellowtail form relatively discrete groups although some intermingling does occur. (Yellowtail have also been fished commercially in the Middle Atlantic and in the northern Gulf of Maine, but relationships to the above groups are unknown at present.) Two management units are currently recognized: the Georges Bank (East of 69°W) unit and a second unit (West of 69°W) which includes the Cape Cod, southern New England, and Mid-Atlantic groups.

Reported yellowtail landings for Georges Bank (East of 69°W) and southern New England, Cape Cod, and the Mid-Atlantic (West of 69°W) dropped from 57,500 MT in 1969 to only 10,900 MT in 1978 under ICNAF and FCMA restrictions; provisional statistics for 1979 indicate landings of 15,600 MT, and preliminary data for 1980 indicate landings of 18,700 MT (Tables 15 and 16, Figures 13 and 14). Landings for the northern Gulf of Maine, although limited, have increased more or less continually in recent years, from an average of approximately 100 tons in 1973-1974 to 400 tons in 1979-1980. Enactment of catch quotas and landings restrictions under FCMA appears to have resulted in extensive misreporting (or even nonreporting) of food landings, and discard information for recent years (particularly 1978-1980) is inadequate; consequently, recent landings and total catch data are not reliable. Age composition data for commercial food landings indicate that during the mid-1960's the fishery was supported by several age groups, although in recent years landings have been increasingly dominated by younger fish. The 1976 and 1977 year-classes have been well represented in recent commercial landings. Commercial abundance indices have declined substantially since the mid-1960's; recent data indicate slight improvement, but are highly suspect due to discard and reporting uncertainties.

Georges Bank (East of 69°W)

NEFC survey results indicate a pronounced decline in abundance to very low levels in the mid to late 1970's. The NEFC spring survey index has subsequently increased from an average of 1.3 kg per tow in 1977-1979 to 6.0 kg in 1980, while the NEFC autumn survey index increased from an average of 2.0 kg in 1977-1979 to 6.1 kg in 1980 (Figure 13). The NEFC summer survey index has

gradually increased from 0.8 kg in 1977 to an average of 1.5 kg in 1979-1980. Stratified mean catch per tow at age data indicate that year classes produced during the 1970's have been generally weaker than earlier ones; the 1977 and 1978 year classes appear to have been the strongest observed in recent years and contributed significantly to the observed increases in NEFC spring and autumn survey index values in 1980. However, the magnitude of the increase observed in catch per tow for both of these year classes in 1980 compared to 1979 values suggests that these observed increases resulted from increased availability rather than an actual increase in abundance. Total mortality estimates calculated from NEFC spring and autumn survey data for 1977-1979 exceeded 1.0, indicating that fishing mortality has substantially exceeded $F_{max} = 0.5$ in recent years. Equilibrium yield calculations indicate that under constant recruitment, increasing F from 0.5 to 1.0 would result in a slight (4%) increase in equilibrium yield and a 40% decline in stock size, and higher levels of mortality would result in the fishery becoming almost completely dependent upon incoming recruitment.

Table 15. Landings (thousand metric tons) and management information for yellowtail flounder from the Georges Bank area (East of 69°W).

	Year							
	1973	1974	1975	1976	1977	1978	1979[1]	1980[2]
US recreational landings	-	-	-	-	-	-	-	-
Commercial landings								
US	15.9	14.6	13.8	11.4	9.5	4.5	5.5	6.7
Canada	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0	0.0[3]
Other	0.2	1.0	0.1	0.0	0.0	0.0	0.0	0.0
Total landings	16.1	15.6	13.9	11.4	9.5	4.5	5.5	6.7
Total allowable catch	16	16	16	16	10	4.4	4.5[4]	5[5]

Long-term potential catch = 16

Importance of recreational fishery = None

Status of management = FMP in force since March, 1977

Status of exploitation in 1980 = Fully exploited

[1] Provisional (incomplete).

[2] Preliminary.

[3] Less than 0.1.

[4] Represents US allocations for Quarters 2-4 of the 1978-1979 fishing year and Quarter 1 of the 1979-1980 fishing year.

[5] Represents US allocations for Calendar Year 1980 under the proposed September, 1979 OY of 5,000 tons.

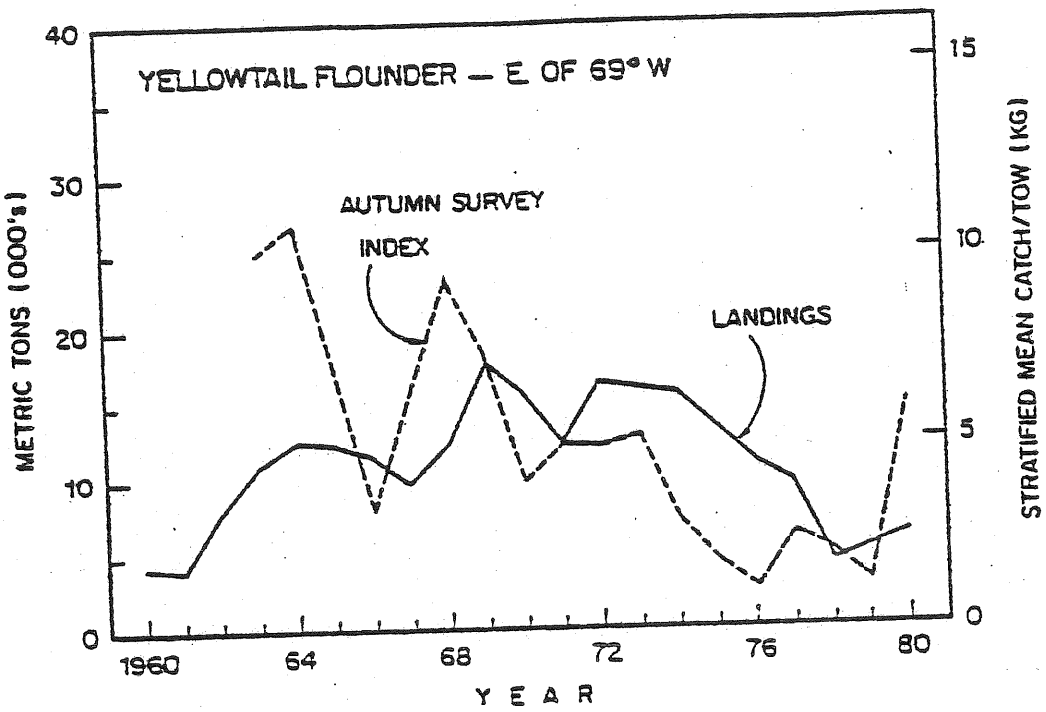

Figure 13. Landings and indices of abundance from autumn research vessel surveys for yellowtail flounder from the area east of longitude 69°W.

Southern New England, Cape Cod, and Mid-Atlantic (West of 69°W)

NEFC survey data for southern New England indicate a pronounced decline in abundance between the mid-to-late 1960's and the mid-1970's, with only slight, if any, improvement in subsequent years (Figure 14). Catches of age 1 and 2 fish have been substantially lower during 1977-1980 than observed previously. The 1976 and 1977 year classes generally appear stronger than other recent year classes, although no consistent differences are evident. Total mortality estimates for 1977-1979 obtained from spring and autumn survey data were 0.78 and 1.03, indicating that F has again exceeded F_{max} in recent years.

Results of cooperative surveys by the M/V FRIESLAND and M/V FORAGER agree with NEFC autumn survey data in indicating relatively constant abundance and biomass and high mortality ($Z \geq 1.4$) during 1980; however, a pronounced shift in size and age composition of survey catches was noted, due primarily to a decline in abundance of 1977 year-class fish and recruitment of 1979 year-class fish in 1981. The 1979 year class, however, does not appear to be appreciably stronger than other recent year classes based on results of NEFC surveys. Stratified mean catch per tow values from cooperative surveys for 1980-1981 would correspond to commercial index values of 4.4 and 3.9 MT per day fished, similar to those observed in the mid to late 1960's when total commercial landings were averaging about 22,000 tons, although catch rates expanded from these surveys are not directly comparable to commercial catch rates due to survey design and other factors. Equilibrium yield calculations again imply the potential for reductions in abundance and, if mortality levels are as high (and current recruitment levels as low) as recent NEFC and cooperative survey results indicate, the fishery would be expected to become dependent almost completely on incoming recruitment.

NEFC offshore spring and summer survey indices for Cape Cod yellowtail have fluctuated without a definite trend, although autumn survey data suggest increased abundance since the mid-1970's. NEFC and Massachusetts inshore survey results indicate relatively constant levels of abundance during 1978-1980. Recent year classes appear to have been comparable. All data are consistent in indicating a more stable situation than for southern New England or Georges Bank, and there is no evidence to suggest that total catches in the order of 2-3,000 tons (the approximate 1960-1976 average) would adversely affect this resource. The situation for the Mid-Atlantic area as evidenced by NEFC surveys appears comparable to that observed for southern New England, i.e., continued low abundance and recruitment in recent years, although abundance for the Gulf of Maine appears to have increased.

For further information see:

Clark, S.H., L. O'Brien, and R.K. Mayo. MS 1981. Yellowtail flounder stock status - 1981. Nat. Mar. Fish. Serv., Woods Hole, Lab. Ref. Doc. No. 81-10, 47 p.

Table 16. Landings (thousand metric tons) and management information for yellowtail flounder from the Cape Cod, southern New England, and Mid-Atlantic areas (West of 69°W).

	Year							
	1973	1974	1975	1976	1977	1978	1979[1]	1980[2]
US recreational landings	0.0	0.0	0.0	0.0	0.0[3]	0.0[3]	0.0[3]	0.0[3]
Commercial landings								
US	14.1	10.4	5.9	5.5	6.8	6.4	10.1	12.0
Canada	0.0	0.0[3]	0.0	0.0[3]	0.0	0.0[3]	0.0	0.0
Other	0.4	0.1	0.0[3]	0.0[3]	0.0[3]	0.0	0.0	0.0
Total landings	14.5	10.5	5.9	5.5	6.8	6.4	10.1	12.0
Total allowable catch	10[4]	10[4]	4	4	6	3.7	4.0[5]	3[6]

Long-term potential catch = 25

Importance of recreational fishery = Insignificant

Status of management = FMP in force since March, 1977

Status of exploitation in 1980 = Fully exploited

[1] Provisional (incomplete).

[2] Preliminary.

[3] Less than 0.1.

[4] Pertains to southern New England and Cape Cod only.

[5] Represents US allocations for Quarters 2-4 of the 1978-1979 fishing year and Quarter 1 of the 1979-1980 fishing year.

[6] Represents US allocations for Calendar Year 1980 under the proposed September, 1979 OY of 5,000 tons.

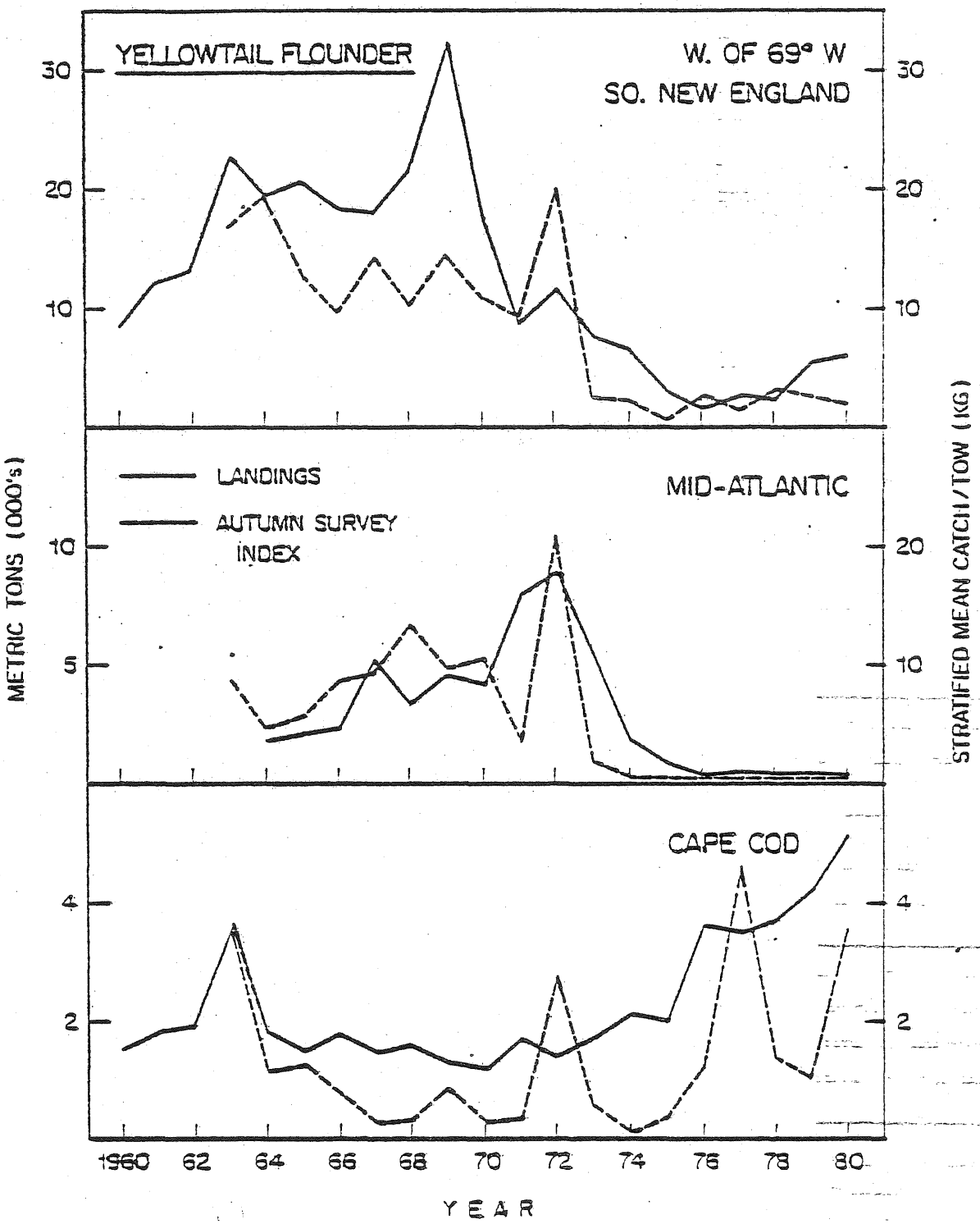

Figure 14. Landings and indices of abundance from autumn research vessel surveys for yellowtail flounder from the areas west of 69° (Southern New England) the Middle Atlantic and the Cape Cod areas.

SUMMER FLOUNDER

The summer flounder, *Paralichthys dentatus*, is distributed in the Northwest Atlantic from the Gulf of Maine to South Carolina with the center of abundance in the Middle Atlantic (Cape Cod to Cape Hatteras) region. Closely related species, *P. lethostigma* and *P. albigutta* occur primarily south of Cape Hatteras. Important commercial and recreational fisheries for summer flounder are prosecuted within the Middle Atlantic Bight. Summer flounder are concentrated in coastal embayments and estuaries from late spring through early autumn; a migration to the outer continental shelf (≈200 m depth) is undertaken in fall with spawning occurring during this period. Larvae are transported to coastal locations by prevailing water currents and develop within estuarine areas. Principal nursery areas include Pamlico Sound and Chesapeake Bay. Females attain greater sizes than males and are longer lived.

US commercial landings in NAFO Statistical Areas 5 and 6 in 1980 was 11,500 mt, a 21% decrease over the 1979 level of 14,500 mt (Table 17). Summer flounder landings averaged 8,317 mt during 1950-1960 and subsequently declined to 1800 mt in 1969. Landings recovered during 1974-78 to an average of 8,600 mt. The substantial increase in yield noted in 1979 may be due to a large-scale increase in effort in the southern winter trawl fishery.

Estimated recreational landings of summer flounder in 1979 were 8,626 mt; an additional 2.13×10^6 summer flounder were caught and released alive (weight not available). Reported landings of summer flounder by foreign vessels in 1980 were 57 mt under by-catch provisions of the FCMA.

The NMFS spring groundfish survey biomass index increased in 1980 to 0.40 kg/tow over the 1979 stratified mean catch of 0.71 kg/tow but remained below the 1974-1979 mean index of 0.71 kg/tow. In contrast, the 1980 autumn biomass index decreased from the 1979 level of 0.51 kg/tow to 0.39 kg/tow. The 1980 autumn index represented a 49% decline from the 1974-1979 mean catch of 0.76 per standard tow. Conflicting trends in spring and autumn biomass indices for recent years may simply reflect variability due to sampling error and changes in availability of summer flounder as a result of annual variations in the timing of migratory activity. Both spring and autumn indices reflect a general recovery during the mid-1970's from low population levels noted during the latter part of the 1960's; relative abundance subsequently declined slightly during the latter part of the last decade (Figure 15).

An index of relative abundance based on catch-per-unit effort (mt per day) for tonnage class 2 vessels (<50 GRT) in southern New England increased slightly in 1980 to 0.862 mt/day over the 1979 estimate of 0.848 mt/day. The commercial CPUE index declined from 0.667 mt/day in 1967 to 0.440 mt/day in 1970; CPUE subsequently increased to 1.202 mt/day in 1974 and declined slightly during 1975-1980 to an average of 0.876 mt/day.

Estimates of total mortality based on analysis of age composition of survey and commercial catches during 1976-1979 approximated Z = 1.0 (Fogarty 1981). Assuming an instantaneous rate of natural mortality of 0.2, current levels of fishing mortality are on the order of F = 0.80. Fishing mortality rates providing maximum yield per recruit were 0.19 and 0.31 for females and males respectively with M = 0.2 and an age at entry to the fishery of 2 years). At a recruitment level of 40 x 10^6 fish, equilibrium yield ranged from 12,000 mt (F = 0.80) to 17,000 mt (F = 0.19).

For further information see:

Fogarty, M.J. 1981. Review and assessment of the summer flounder (*Paralichthys dentatus*) in the Northwest Atlantic. NMFS, NEFC, Woods Hole Lab. Ref. No. 80-22, 57 pp.

Table 17. Landings (thousand metric tons) and management information for summer flounder from the southern New England, Georges Bank, and Mid-Atlantic area.

	YEAR							
	1973	1974	1975	1976	1977	1978	1979	1980
US recreational landings	-	15.8	-	-	-	-	6.5	-
Commercial landings								
US	4.4	6.7	7.6	10.8	8.9	8.5	14.5	11.5
Other	0.0[1]	-	0.0[1]	0.0[1]	0.0[1]	0.0[1]	0.0[1]	0.0[1]
Total Commercial	4.4	6.7	7.6	10.8	8.9	8.5	12.3	14.5

Long term potential catch	=	15-20
Importance of recreational fishery	=	Major
Status of management	=	FMP in preparation
Status of exploitation	=	Fully exploited

[1] Less than 0.1

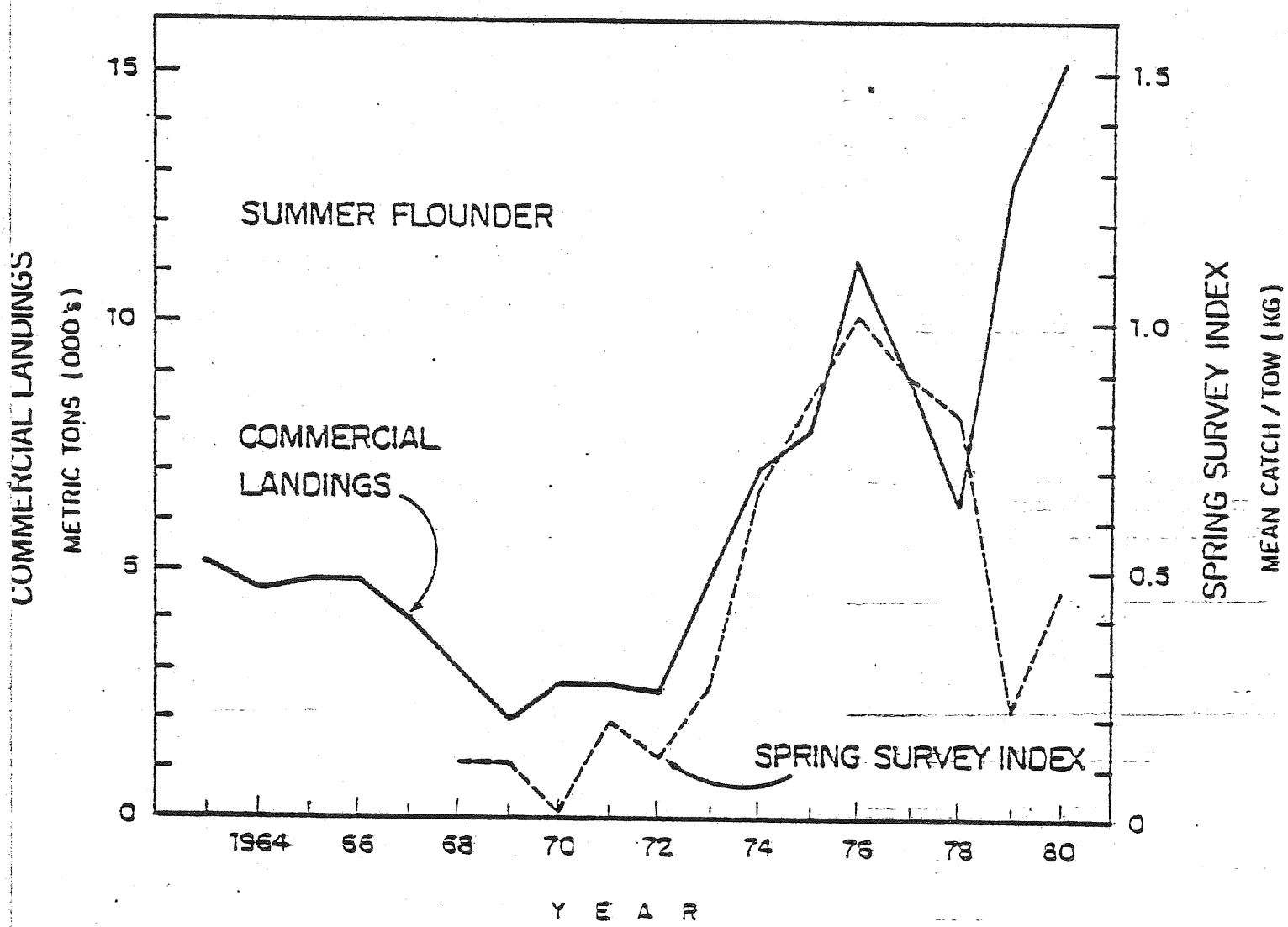

Figure 15. Commercial landings and indices of abundance from spring research vessel surveys for summer flounder from the southern New England Georges Bank and Mid Atlantic areas.

AMERICAN PLAICE

The American plaice or dab, Hippoglossoides platessoides, is a large-mouthed, "right-handed" flounder distributed along the Northwest Atlantic continental shelf from southern Labrador to Rhode Island in relatively deep waters. Off the USA coast greatest commercial concentrations exist between 90 to 128 meters (50-100 fathoms). Sexual maturity commences between ages 2 and 3; spawning occurs in spring, generally between March through May. Growth is rather slow; 3 year old fish are normally between 22-28 cm (9-11 inches) and roughly between 90-190 g (0.2-0.4 pounds). After age 4, females grow faster than males.

Gulf of Maine

Total nominal commercial catch in 1980 was 11,134 t, a 26% increase from 1979 (8,835 t), and the highest annual harvest on record (Table 18; Figure 16). USA commercial landings comprised 100% of the 1980 total nominal catch. Since 1972, Gulf of Maine landings have successively increased annually (Figure 16).

Prior to 1975, Gulf of Maine catches comprised less than 50% of the total USA annual American plaice landings, and accounted for only 32.8% of the total USA plaice landings during 1960-1974. Subsequently, however, annual landings from the Gulf of Maine have greatly exceeded those from Georges Bank; in 1980, Gulf of Maine catches comprised 82.2% of the USA total and were 4.6 times greater than those from Georges Bank (Tables 18 and 19).

Trends in the nominal catch have generally paralleled trends in the NMFS offshore autumn research survey bottom trawl weight per tow indices (Figure 16). Since 1974, the autumn indices have tended to annually increase. The 1980 index of 11.07 kg/tow is the highest in the 18-year survey time series implying that Gulf of Maine American plaice biomass is at a record-high level.

Table 18. Commercial landings (metric tons, live weight) of American plaice from the Gulf of Maine, 1973-1980.

Commercial Landings	YEAR 1973	1974	1975	1976	1977	1978	1979	1980
USA	687	945	1507	2550	5647	7228	8835	11134
Canada	-	2	-	-	-	30	-	-
Other	-	-	-	-	-	-	-	-
Total	687	947	1507	2550	5647	7258	8835	11134

Long-term potential catch = Unknown
Importance of recreational fishery = Insignificant
Status of management = FMP in planning stage
Status of exploitation in 1980 = Becoming fully exploited

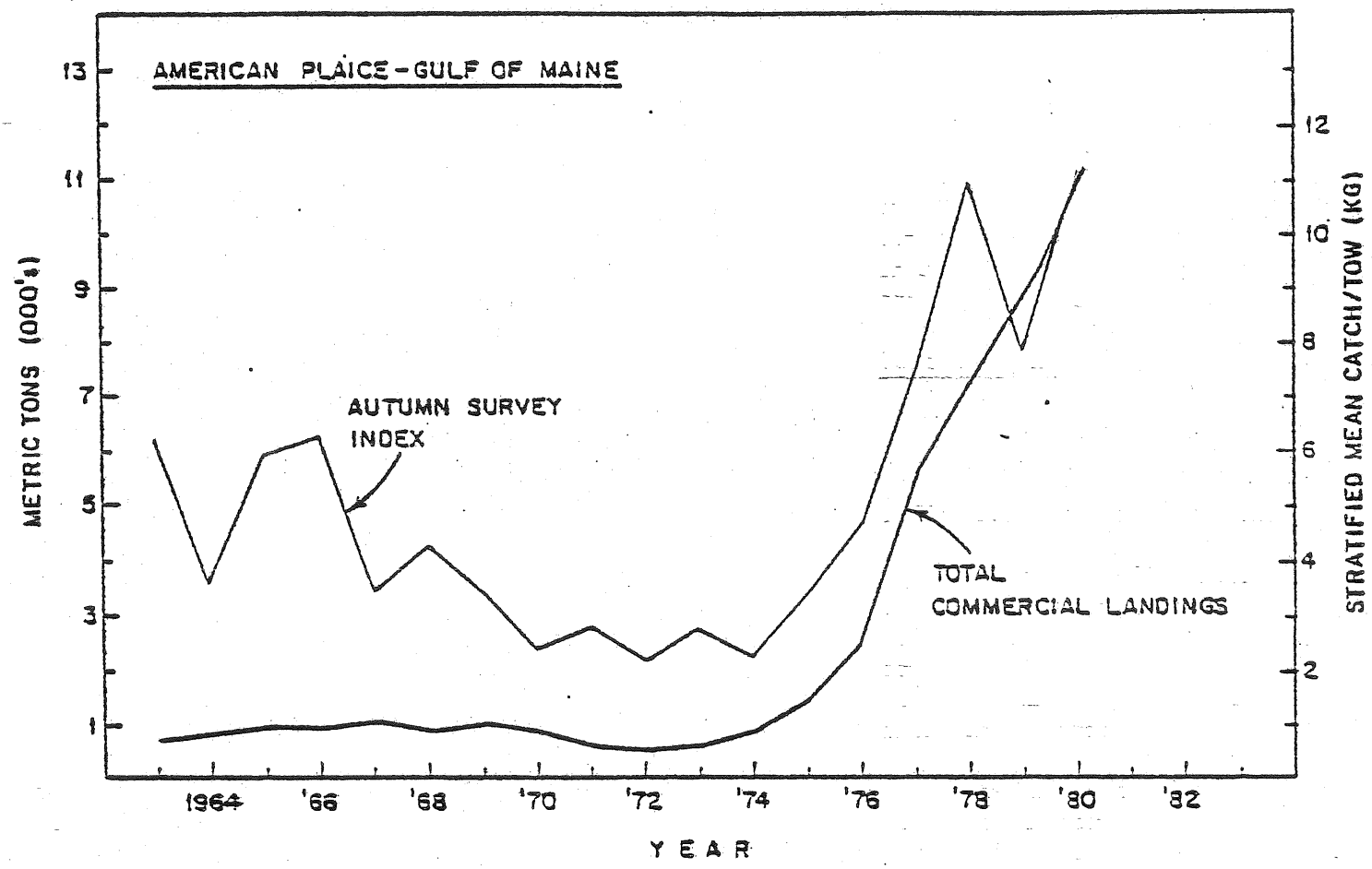

Figure 16. Commercial landings and indices of abundance from autumn research vessel surveys for American plaice from the Gulf of Maine area.

Georges Bank

Total nominal commercial catch in 1980 was 2,458 t, 63 t less than in 1979 (Table 19), and the second highest annual catch since 1970 (Figure 17). Less than 50 t were taken by foreign effort in 1980. Although total annual landings doubled between 1974 and 1980, the 1980 nominal catch remained below the peak catches observed during 1964 through 1970 which were followed by declines in both relative abundance and yield (Figure 17).

Autumn bottom trawl survey indices since 1974 have trended upward. The 1980 index of 3.2 kg/tow is the third largest value in the survey time series and the highest observed since 1966 (Figure 17). The survey data suggest that American plaice abundance on Georges Bank has markedly improved in recent years and is currently approaching historically high levels.

Table 19. Commercial landings (metric tons, live weight) of American plaice from Georges Bank, 1973-1980.

Commercial Landings	YEAR 1973	1974	1975	1976	1977	1978	1979	1980
USA	315	1131	916	953	1414	2208	2491	2411
Canada	38	27	25	24	33	77	23	43
Other	447	22	148	3	129	-	7	4
Total	1400	1180	1089	985	1577	2285	2521	2458

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Insignificant
Status of management	=	FMP in planning stages
Status of exploitation in 1980		Becoming fully exploited

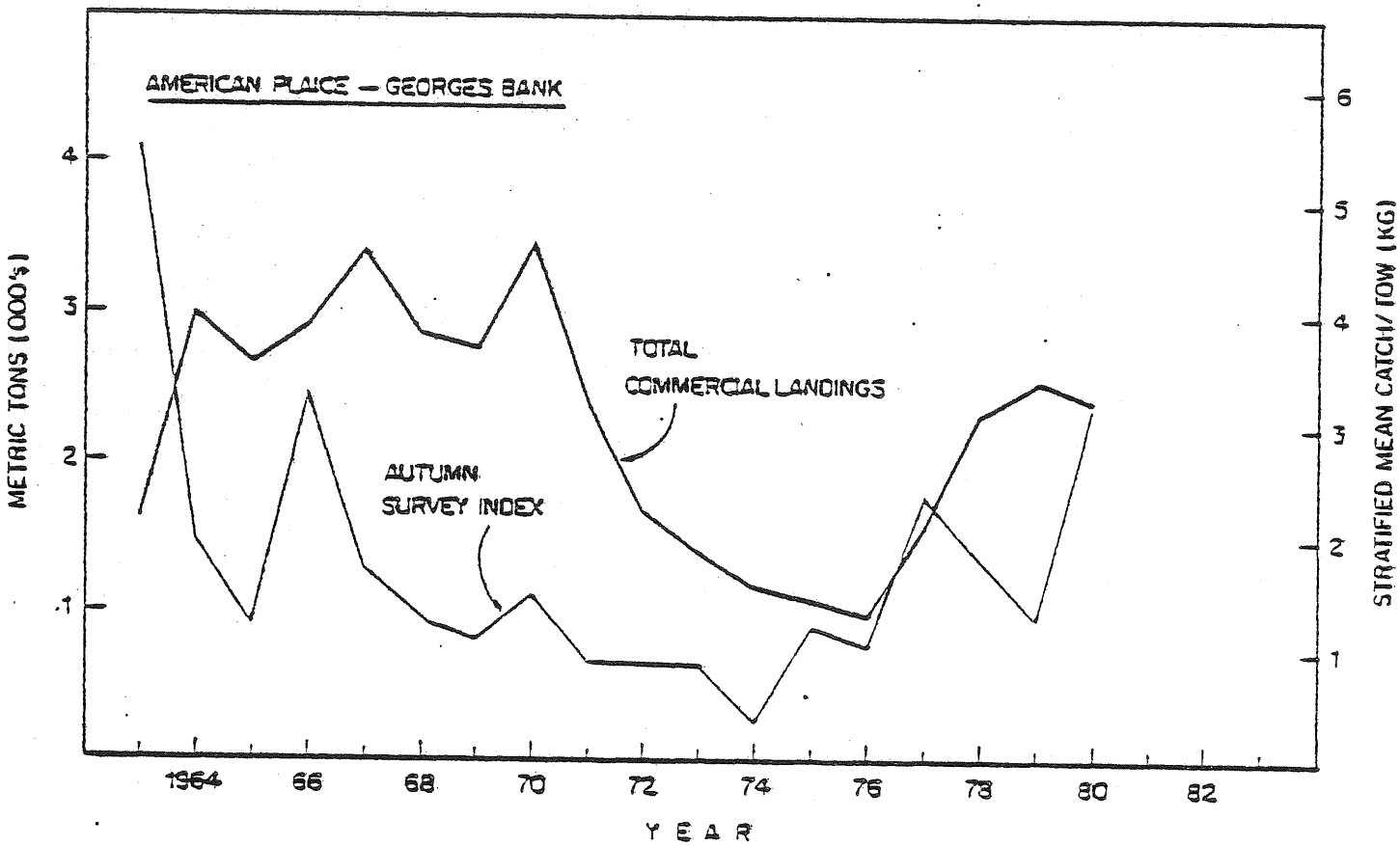

Figure 17. Commercial landings and indices of abundance from autumn research vessel surveys for American plaice from the Georges Bank area.

WITCH FLOUNDER

The witch flounder (Glyptocephalus cynoglossus) is common throughout the Gulf of Maine and also occurs in deeper areas on and adjacent to Georges Bank and along the shelf edge as far south as Cape Hatteras. Research vessel survey data suggest that the Gulf of Maine population may be relatively discrete from populations in other areas. Witch flounder appear to be sedentary in habit, preferring moderately deep situations; few fish are taken shoaler than 30 m and most are caught between 90-275 m. Spawning occurs in late spring and summer. Witch flounder attain lengths upwards of 60 cm and weights of approximately 2 kg.

Since 1960, the USA catch has been distributed almost evenly between Georges Bank and the Gulf of Maine, although in recent years most of the USA catch has come from the latter area. Canadian landings from both areas have been minor (<100 tons annually). Distant-water fleets occasionally made significant catches on Georges Bank (averaging 2,600 tons in 1971-1972) but since implementation of FCMA in 1977 distant-water fleet catches have been negligible. The total Georges Bank - Gulf of Maine catch increased from 1,000 tons in 1961 to an annual average of 5,700 tons in 1971-1972 and subsequently dropped to 1,800 tons in 1976 (Table 20 and Figure 18). Since that year, landings have fluctuated around an average of 3,100 tons. There is no recreational fishery for this species.

Both spring and autumn survey indices suggest declines in abundance during the early to mid-1970's, i.e. the spring index declined from 6.2 kg in 1973 to 2.8 kg in 1975, while the autumn index declined from an average of 4.2 kg in 1969-1970 to 1.0 kg in 1976. Subsequent spring index values have increased more or less continually from 1.88 kg in 1977 to 6.2 kg in 1981; the autumn survey index increased sharply to 3.6 kg in 1977 and subsequently averaged 2.4 kg (Figure 18).

For additional information, see:

Lange, A.M.T., and F.E. Lux. MS 1978. Review of the other flounder stocks (winter flounder, American plaice, witch flounder and windowpane flounder) off the Northeast United States, August 1978. Nat. Mar. Fish. Serv., Woods Hole, Lab. Ref. Doc. No. 78-44, 53 p.

Table 20. Landings (thousand metric tons) and management information for witch flounder from Georges Bank and the western Gulf of Maine.

	YEAR							
	1973	1974	1975	1976	1977	1978	1979[1]	1980[1]
US recreational catch	---	---	---	---	---	---	---	---
Commercial landings								
US	2.4	1.8	2.1	1.3	2.5	3.5	3.0	3.4
Canada	0.0[2]	0.0[2]	0.0[2]	0.0[2]	0.0[2]	0.0[2]	0.0[2]	0.0[2]
Other	0.6	0.3	0.1	0.0[2]	0.0	0.0[2]	0.0	0.0
Total Landings	3.0	2.1	2.2	1.3	2.5	3.5	3.0	3.4

Long-term potential catch	=	3.4
Importance of recreational fishery	=	None
Status of management	=	None
Status of exploitation in 1980	=	Fully exploited

[1] Provisional (incomplete)

[2] Less than 0.1

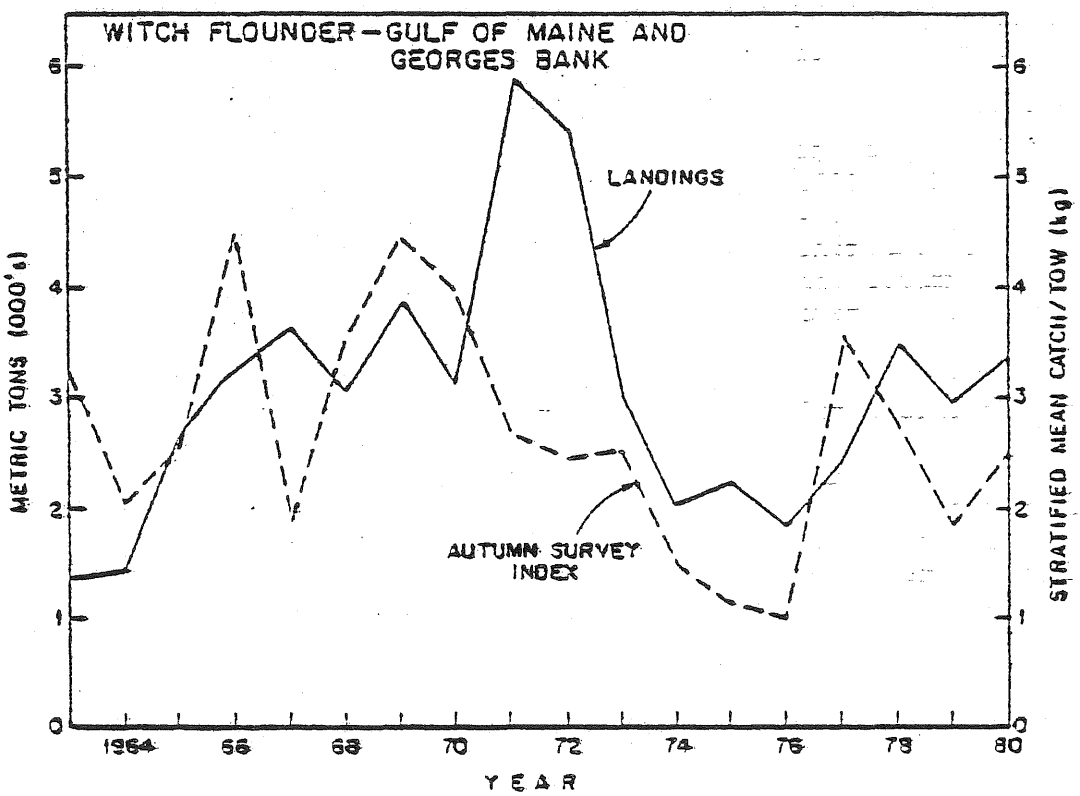

Figure 18. Landings and indices of abundance from autumn research vessel surveys for witch flounder from the Gulf of Maine and Georges Bank areas.

WINTER FLOUNDER

The winter flounder, Pseudopleuronectes americanus, is distributed along the Atlantic coast of North America from Labrador to Georgia and is most abundant from the Gulf of St. Lawrence to Chesapeake Bay. Winter flounder are typically exploited in coastal waters and offshore shoal areas, particularly Georges Bank and Nantucket Shoals. Migration patterns of winter flounder are generally localized, however, small scale seasonal movements do occur. Analyses of meristic characteristics also indicate that discrete winter flounder groups may exist. Spawning occurs in shallow estuarine waters from mid-winter to early spring with fish tending to return to the same spawning locations in consecutive years. There is evidence that spawning activity on Georges Bank coincides with reproduction in coastal locations and that the Georges Bank group is self-sustaining.

The US commercial catch of winter flounder was 17,400 MT in 1980 (Table 21). Landings have recently increased after a period of low yield from 1972-1976 (Figure 19). The 1977-1979 average yield of 11,800 tons indicates a recovery to the catch levels sustained during 1965-1971, a period of relatively high yield. Estimated foreign landings of winter flounder in 1980 was 44 tons, taken entirely by Canadian vessels. Landings of winter flounder by foreign vessels have been nominal since the inception of the FCMA. The estimated recreational catch of winter flounder in 1979 was 7,500 tons, in sharp contrast to the 1974 recreational fishing survey estimate of 15,831 tons. The lower estimate for the recent recreational survey may be due to improved sampling design; accordingly previous estimates of recreational catch should be treated with caution.

The spring bottom trawl survey index for winter flounder increased in 1980 to 0.84 kg over the 1979 index of 0.42 kg. The 1980 autumn survey index remained constant at 1.70 kg from 1.69 kg in 1979. Survey indices indicate a general increase in relative abundance during 1976-1978 following a period of low apparent abundance during 1970-1975.

Recent estimates of fishing mortality from commercial information are also not available. Howe and Coates (1975) provided an estimate of F = 0.27 based on tag return data for winter flounder marked and released from 1964-1966 off Massachusetts.

Prior to 1979, winter flounder were assessed collectively with American plaice, witch flounder, and windowpane flounder (Lange and Lux 1978). Attempts are currently being made to assess each species separately and to improve the data base available.

For additional information see:

Howe, A.B., and P.G. Coates. 1975. Winter flounder movements, growth and mortality of Massachusetts. Trans. Am. Fish. Soc. 104: 13-29.

Lange, A.M.T., and F.E. Lux. 1978. Review of the other flounder stocks (winter flounder, American plaice, witch flounder, and windowpane flounder) off the Northeast United States, August 1978. NMFS, Northeast Fisheries Center, Woods Hole Laboratory. Laboratory Reference No. 78-44.

Table 21. Landings (thousand metric tons) and management information for winter flounder from the Gulf of Maine, Georges Bank, Southern New England, and Mid-Atlantic areas.

	YEAR							
	1973	1974	1975	1976	1977	1978	1979	1980
US recreational Landings	---	15.3	---	---	---	---	7.5	---
Commercial Landings								
US	3.9	7.6	3.1	6.7	10.5	12.4	12.2	17.4
Canada	0.0[1]	0.0[1]	0.0[1]	0.0[1]	0.0[1]	0.0[1]	0.0[1]	0.0[1]
Other	1.5	0.2	0.6	0.0[1]	0.0[1]	---	---	---

Long term potential catch	=	Unknown
Importance of recreational fishery	=	Major
Status of management	=	None
Status of exploitation in 1980	=	Unknown

[1]Less than 0.1

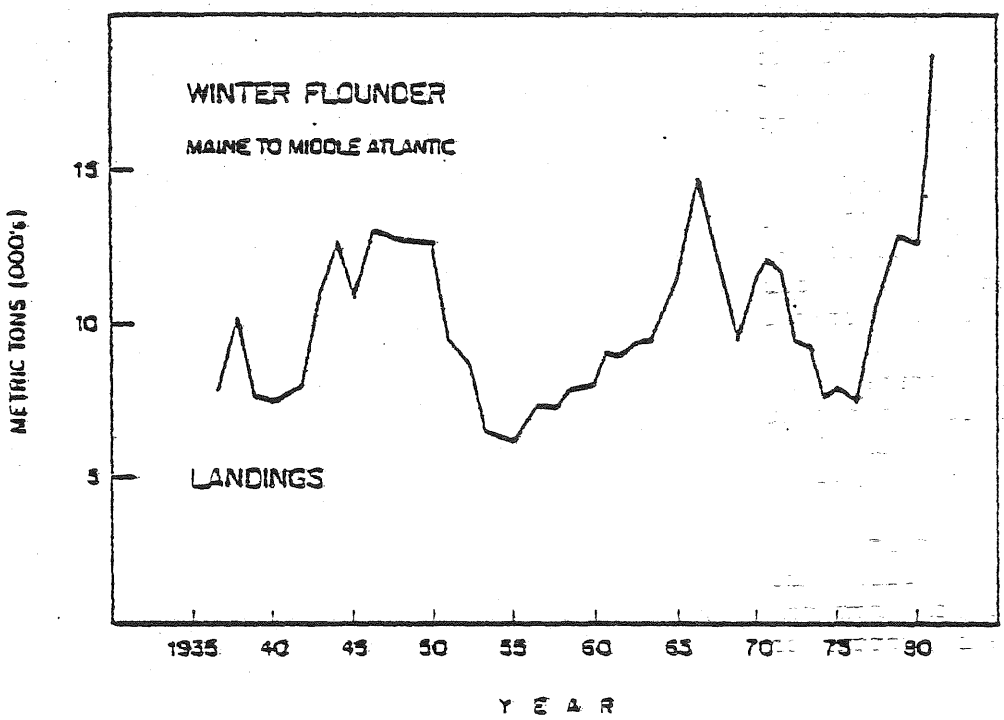

Figure 19. Landings of winter flounder from the Gulf of Maine to Middle Atlantic areas.

ATLANTIC HERRING

The Atlantic herring, Clupea harengus harengus, is a pelagic schooling species distributed in the Northwest Atlantic from Cape Hatteras to Labrador. Adult Atlantic herring undertake extensive seasonal movements although migratory pathways have not been totally defined. Juveniles (ages 1-3) move inshore in spring and are vulnerable to coastal fisheries along the coasts of Maine and New Brunswick through late autumn. An offshore fall migration occurs with some evidence of a general southwesterly dispersal. Differences in meristic counts, relative frequencies of parasite infestation, and enzyme frequencies have been used to identify stock components. Recent tagging experiments have demonstrated intermixture of stocks among areas. Herring begin to mature at age 3, however, most are not sexually mature until age 4-5. Spawning principally occurs during late August in the northern Gulf of Maine and in October in the southern Gulf and Georges Bank. The eggs are demersal and typically are located on gravel/rock substrates. Primary spawning locations off the northeast coast of the U.S. include Jeffreys Ledge in the southwestern Gulf of Maine, Georges Bank, and Nantucket Shoals. A sardine fishery for juvenile herring has operated along the Maine coast since 1875; predominate gear types in this fishery are stop seines and weirs. Fisheries for adult (age 4+) herring underwent significant development in the western Gulf of Maine and Georges Bank during the latter part of the 1960's. These fisheries were regulated under ICNAF during 1972-77 and by the New England Fisheries Management Council since 1977.

Maine Coastal Fishery

Herring landings along the Maine coast averaged 63,500 MT during 1950-60 and declined during 1964-75 to 15,000 MT. Except for the 1970 year class, nearly all year classes were below average in abundance over this period. Landings subsequently increased to 40,200 MT in 1979 and 45,900 MT in 1980 due to the good 1976 and 1977 year classes. The 1980 yield was the highest since 1963. The 1977 year class comprised 58% of total landings in the Maine coast fishery in 1980. In contrast, the 1978 year class contributed 20% to total yield; the coastal fishery is typically selective for age 2 herring. Fixed gear (stop seines and weirs) accounted for 78% of the 1980 yield along the Maine coast.

Western Gulf of Maine Fishery

Landings from the Western Gulf of Maine and NAFO Subareas 5Z and 6 peaked in 1972 at 45,700 MT and subsequently declined to a mean level of 21,700 MT during 1973-79 before increasing to 37,700 MT in 1980. The 1976 and 1977 year classes contributed 53% and 13% respectively to total landings in this fishery in 1980. Spawning stock size (age 4+), determined by virtual population analysis, decreased from an average of 146,000 MT, during 1967-71 to 40,400 MT in 1979 (Figure 20). With recruitment of the strong 1976 year class, estimated spawning stock biomass increased to 85,00 MT in 1980. Year classes 1977 and 1979 appear to be better than average in abundance which provides further optimism for stock recovery. A recent history of landings and management is provided in Table 22.

Table 22. Landings (thousand metric tons) and management information for Atlantic sea herring from the western Gulf of Maine area.

	YEAR							
	1973	1974	1975	1976	1977	1978	1979	1980
US recreational landings	-	-	-	-	-	-	-	-
Commercial landings								
US	5.2	10.2	16.4	19.2	17.9	13.6	23.3	37.7
Canada	4.1	4.0	4.5	0.9	-	-	-	-
Other	6.6	3.8	0.2	-	-	-	-	-
Total landings	16	18	21	20	18	19	24	38
Total allowable catch	25	25	16	7	7	8	13	

Long-term potential catch = 20

Importance of recreational fishery = Insignificant

Status of management = FMP in force since 1978

Status of exploitation in 1980 = Fully exploited

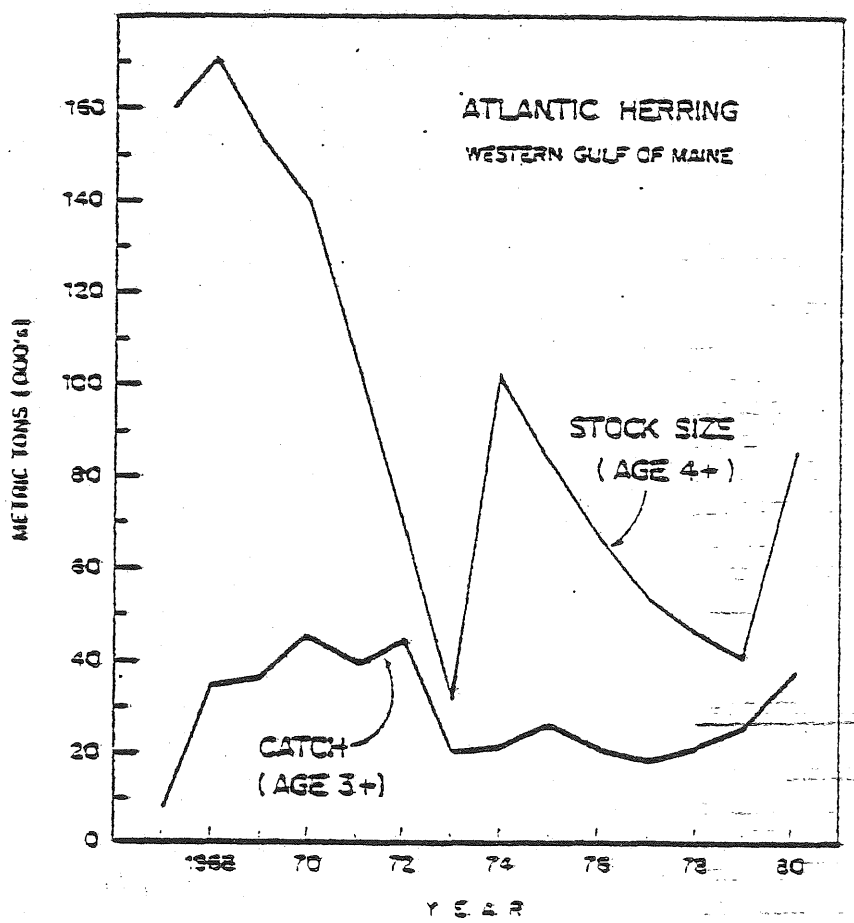

Figure 20. Catches (age 3 and older) and estimates of stock size (age 4 and older) of Atlantic herring from the Western Gulf of Maine area.

Georges Bank Fishery

The fishery for herring on Georges Bank was initiated in 1961 with increased foreign fishing activity off the northeast coast of the United States. Landings peaked in 1968 at 373,600 MT and subsequently declined during 1970-76 to 43,500 MT with a complete stock collapse in 1977. Spawning stock size (age 4+) increased from 300,000 MT in 1961 to nearly 1,200,000 MT in 1967. Spawning stock size declined steadily during 1967-77 to extremely low levels (Figure 21). There has been no fishery for Atlantic herring on Georges Bank since this collapse. Interrelationships among stocks have not been clearly resolved. Recent landings and management information are provided in Table 23.

For further information see:

Anthony, V.C., G.T. Waring and M.J. Fogarty. 1981. Status of herring stocks of the Gulf of Maine area for 1981. National Marine Fisheries Service, Northeast Fisheries Center, Woods Hole Laboratory, Woods Hole, MA. Laboratory Reference Document No. 81-20.

Anthony, V.C. and G.T. Waring. 1980. A review of the herring fisheries, their assessment and management in the Georges Bank-Gulf of Maine area. Proceedings of the Alaska Herring Symposium Alaska Sea Grant Report 80-4 pp 115-177.

Table 23. Landings (thousand metric tons) and management information for Atlantic sea herring from Georges Bank.

	YEAR							
	1973	1974	1975	1976	1977	1978	1979	1980
US recreational landings	-	-	-	-	-	-	-	-
Commercial landings								
US	4.6	3.4	4.6	0.7	0.4	2.1	1.1	1.0
Canada	3.1	0.2	-	-	-	-	-	-
Other	192.3	146.4	141.4	43.3	1.6	-	-	-
Total landings	202	150	146	44	2	2	1	
Total allowable catch	150	150	150	60	33	3	15	

Long-term potential catch = 100

Importance of recreational fishery = Insignificant

Status of management = FMP in force since 1978

Status of exploitation in 1980 = Not exploited

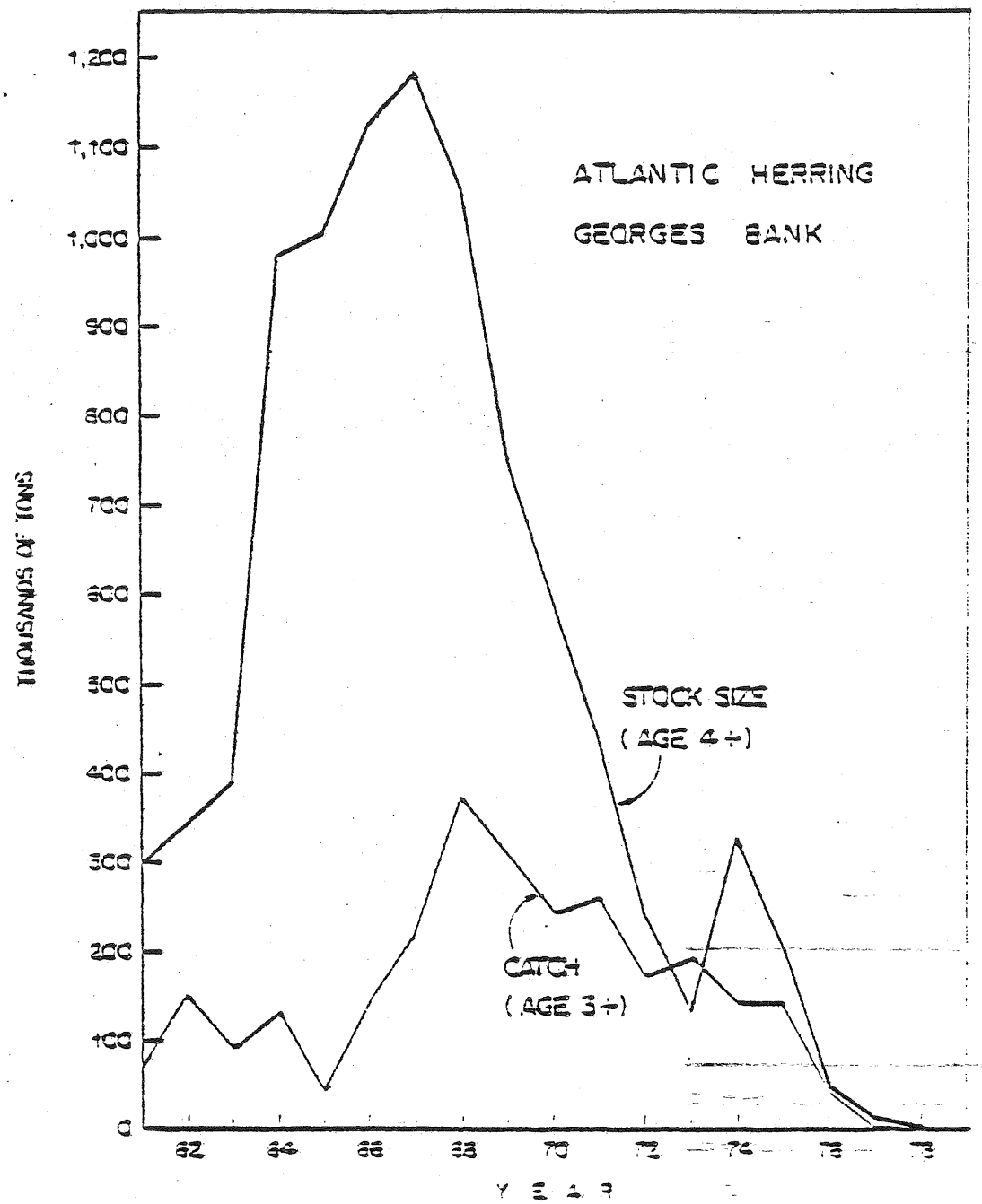

Figure 21. Catches (age 3 and older) and estimates of stock sizes (age 4 and older) of Atlantic herring from the Georges Bank area.

ATLANTIC MACKEREL

Atlantic mackerel, (Scomber scombrus), is a fast swimming, pelagic, schooling species distributed in the Northwest Atlantic between Labrador and North Carolina. There are two major spawning components of this population, a southern group which spawns primarily in the New York Bight in April-May and a northern group which spawns in the Gulf of St. Lawrence during June-July. Overwintering and apparent mixing of both groups occurs between Sable Island (off Nova Scotia) and Cape Hatteras with extensive northerly inshore spring and southerly offshore fall migrations to and from spawning and summering grounds. Maximum length is about 41 cm (fork length) although larger individuals are occasionally observed. Sexual maturity begins at age 2 and is generally completed by age 3. Maximum age is approximately 20 years. The mackerel resource in the Northwest Atlantic, after being fished heavily in the early 1970's by distant-water fleets and declining sharply in abundance, has been increasing slowly since 1978.

The international catch of mackerel in the Northwest Atlantic decreased from 36,000 t in 1979 to an estimated 29,300 t in 1980 (Table 24). The 1980 catch was only about 7% of the peak harvest of 430,400 t reported in 1973 (Figure 22). US commercial landings increased about 35% from 1,990 t in 1979 to 2,683 t in 1980, the highest since 1970. The US recreational catch was estimated to be about 3,900 t, compared to 3,315 t in 1979. Canadian landings decreased 27% from 30,244 t in 1979 to 22,136 t in 1980, and accounted for about 76% of the international total. Most of the decrease in the Canadian catch occurred in the Newfoundland area, due primarily to the lack of marketing and processing capacity. The distant-water-fleet catch in 1980 was 559 t, compared to 440 t in 1979 and a high of 396,800 t in 1973.

Fish from the 1974 year class (age 6) comprised 28% of the international catch in numbers in 1980, followed by the 1978 year class (age 2) with 22%, the 1975 year class (age 5) with 14%, and the 1973 year class (age 7) with 10%. The 1980 Canadian catch consisted of 36% 1974 year-class, 18% 1975 year-class, 15% 1978 year-class, and 12% 1973 year-class fish. The US commercial catch was 66% 1978 year-class fish, whereas the US recreational catch contained a higher proportion of older fish than any of the commercial catches, with the 1969 (age 11) and 1967 (age 13) year classes contributing 26% and 18%, respectively.

During January-March 1981, Polish vessels caught about 4,000 t of mackerel in the New York Bight. Fish from the 1974 and 1978 year classes comprised 28% and 27% of that catch, respectively, followed by the 1973 year class with 11% and the 1975 year class with 9%.

The catch-per-tow index for mackerel from the NEFC spring bottom trawl survey increased from 0.35 kg in 1980 to 1.84 kg in 1981, the highest index since 1971. The autumn survey catch-per-tow index remained unchanged from 1979 to 1980; both years were above the levels of the mid-1970's. The US commercial catch-per-day index increased markedly from 0.69 t in 1979 to

1.42 t in 1980; however, over 50% of the 1980 value was due to the 1978 year class which was estimated to be only 10% recruited to the fishery. US catch per day on ages estimated to be 100% recruited to the fishery declined from 0.65 t in 1979 to 0.54 t in 1980.

Fishing mortality (F) at ages 100% recruited to the fishery in 1980 (ages 4 and older) was estimated to be 0.07. Results from virtual population analysis, assuming natural mortality (M) of 0.30, indicate that F at fully-recruited ages increased from 0.04 in 1962-1964 to 0.44 in 1976 and then decreased to 0.06 in 1978. F decreased slightly from 0.08 in 1979 to 0.07 in 1980. $F_{0.1}$ for mackerel is 0.40.

Commercial fishery and research vessel bottom trawl survey data indicate weak 1975-1977 and 1979 year classes and an average 1978 year class which presently appears to be about the same strength as the 1973-1974 year classes. The 1980 year class, although presently estimated to be about half the size of the 1978 year class, is about 4 times larger than the mean of the weak 1975-1977 and 1979 year classes.

Total stock biomass (ages 1 and older) declined from an estimated 2,800,000 t in 1970-1971 to about 580,000 t in 1978 and subsequently improved to 780,000 t at the beginning of 1981. Spawning stock biomass (50% of age 2 and 100% of ages 3 and older) decreased from about 2,300,000 t in 1971 to 470,000 t in 1979 followed by an increase to 650,000 t in 1981.

A 1981 catch varying between 30,000 and 100,000 t would result in a fishing mortality rate (ages 4 and older) of 0.06 to 0.22 and leave a spawning stock biomass in 1982 ranging from 659,000 (2% increase from 1981) to 597,000 t (8% decrease from 1981).

Projected catches for 1982 at an F of 0.05 would vary from 28,500 (assuming a 1981 catch of 30,000 t) to 25,700 t (assuming a 1981 catch of 100,000 t) and leave a spawning stock biomass in 1983 ranging from 3% higher to 5% lower than in 1981 and from 1 to 3% higher than in 1982. Fishing mortality at the $F_{0.1}$ level (0.40) in 1982 would produce catches ranging from 197,000 (assuming a 1981 catch of 30,000 t) to 178,000 t (assuming a 1981 catch of 100,000 t) and reduce the spawning stock biomass 20-26% from 1981 to 1983 and 20-22% from 1982 to 1983.

For additional information see:

Anderson, E.D. 1981. Status of the Northwest Atlantic mackerel stock - 1981. NMFS, NEFC, Woods Hole Lab. Ref. No. 81-38, p.

Table 24. Landings (thousand metric tons) and management information for Atlantic mackerel from Cape Hatteras to Labrador, 1974-1980.

	YEAR						
	1974	1975	1976	1977	1978	1979	1980
US recreational landings	7.6	3.2	4.2	0.5	6.6	3.3	3.9
Commercial landings							
US	1.0	2.0	2.7	1.4	1.6	2.0	2.7
Canada	16.7	13.5	15.7	23.4	25.4	30.2	22.1
Other	321.8	271.7	223.3	36.1	0.3	0.4	0.6
Total landings	347.2	292.4	245.9	73.3	34.4	36.0	29.3
Total allowable catch	339.0[4]	353.0[2]	310.0	105.0	15.5[3]	15.5[3]	30.0[3,4]

Long-term potential catch = 224

Importance of recreational fishery = Major

Status of management = FMP in force since 1979

Status of exploitation in 1980 = Underexploited

[1]304.0 for Gulf of Maine, Georges Bank, and south; 35.0 for Nova Scotian shelf.

[2]235.0 for Gulf of Maine, Georges Bank, and south; 70.0 for Nova Scotia - Newfoundland.

[3]For Fishery Conservation Zone only.

[4]For April 1, 1980 - March 31, 1981 fishing year.

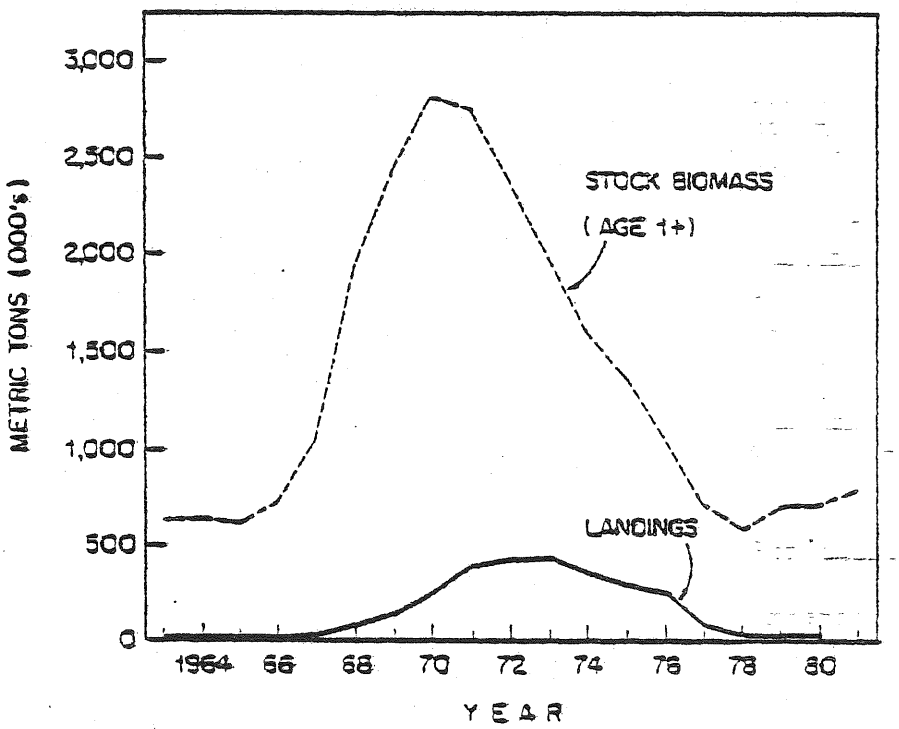

Figure 22. Landings and estimates of stock biomass (age 1 and older) of Atlantic mackerel from the Northwest Atlantic area from Cape Hatteras to Labrador.

RIVER HERRING

The river herring fishery is based primarily on two species, alewife, (Alosa pseudoharengus) and blueback herring (A. aestivalis). Alewives occur from Nova Scotia to North Carolina; the range of blueback herring extends from Nova Scotia to Florida. Both species are anadromous, undergoing upstream spawning migrations during spring, and both species become mature at ages III through V, with age IV dominant. Alewives have been reported to live up to 10 years, reaching a maximum (total) length of 36 cm; blueback herring live for about 7 or 8 years, reaching a maximum length of between 31 and 33 cm.

This fishery is one of the oldest in North America, and was exclusively a USA inshore fishery until 1967. The USA nominal catch averaged 24,800 tons annually between 1964 and 1969, and over 87% of this was taken from the Middle Atlantic area. USA nominal catches subsequently declined greatly following entrance of distant-water fleets, and this trend has continued in recent years (Table 25 and Figure 23). USA nominal catches in 1979 and 1980 were 4,400 and 4,800 tons, respectively. Nominal catches by foreign vessels ranged from 20,000-36,000 tons annually between 1968 and 1971; over 73% of the total was taken from the Georges Bank - Southern New England area, and the remainder was taken off Chesapeake Bay. The distant-water-fleet harvest has been neglible since 1976.

The recreational catch of river herring is presumed to be of minor importance compared to the commercial harvest, although data on this aspect of the fishery are lacking.

An MSY estimate of 23,000-28,000 tons has been determined for the river herring resource extending from the Gulf of Maine to Cape Hatteras by scientists at the Virginia Institute of Marine Science (Hoagman et al. 1973). However, stock size in recent years appears to have been depressed considerably below the MSY level. The USA fishery has become increasingly dependent on a smaller number of year-classes. Historically, age 3-5 fish were usually well represented in USA nominal catches, but in 1974 and 1975 the USA fishery became increasingly dependent upon 3 year old fish. Since then, however, recruitment of 3 year old fish has been very poor although juvenile abundance increased from 1977 to 1978 in both Virginia and North Carolina. A consequence of recent low recruitment levels has been a gradual increase in mean age of adult river herring in the Virginia area (Johnson et al. 1979).

NMFS spring bottom trawl surveys indicate an increase in abundance in the Middle Atlantic area since 1975. In the Southern New England-Georges Bank region, spring survey indices have been relatively stable between 1968 and 1980, while a gradual, but consistent, increase in abundance appears evident for 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 reported in many rivers in recent years.

For additional information see:

Hoagman, W.J., J.V. Merriner, R. St. Pierre, and W.L. Wilson. 1973. Biology and Management of River Herring and Shad in Virginia. Virginia AFC 7-1 to 7-3, Completion Report.

Johnson, H.B. et al. 1979. Biology and Management of Mid-Atlantic Anadromous Fishes Under Extended Jurisdiction. North Carolina-Virginia AFCS 9-2.

Walton, C.J. 1980. Population Biology and Management of the Alewife (Alosa pseudoharengus) in Maine. Maine AFC-21-1.

Table 25. Landings (thousand metric tons) and management information for river herring (alewife and blueback herring) from the Gulf of Maine to Cape Hatteras.

	YEAR							
	1973	1974	1975	1976	1977	1978	1979	1980
US recreational landings	---	---	---	---	---	---	---	---
Commercial landings								
US	10.2	11.1	10.8	6.5	6.3	5.7	4.1	4.3
Canada	---	---	---	---	---	---	---	---
Others	6.4	5.2	3.8	1.8	0.2	0.0[1]	0.0[1]	0.0[1]
Total Landings	16.6	16.3	14.6	8.3	6.7	5.7	4.1	4.3
Total allowable catch	---	---	---	---	---	---	---	---

Long-term potential catch	=	25
Importance of recreational fishery	=	Minor
Status of Management	=	Local (by state, county, or municipality, depending upon area)
Status of exploitation in 1980	=	Fully exploited

[1]Less than 0.1

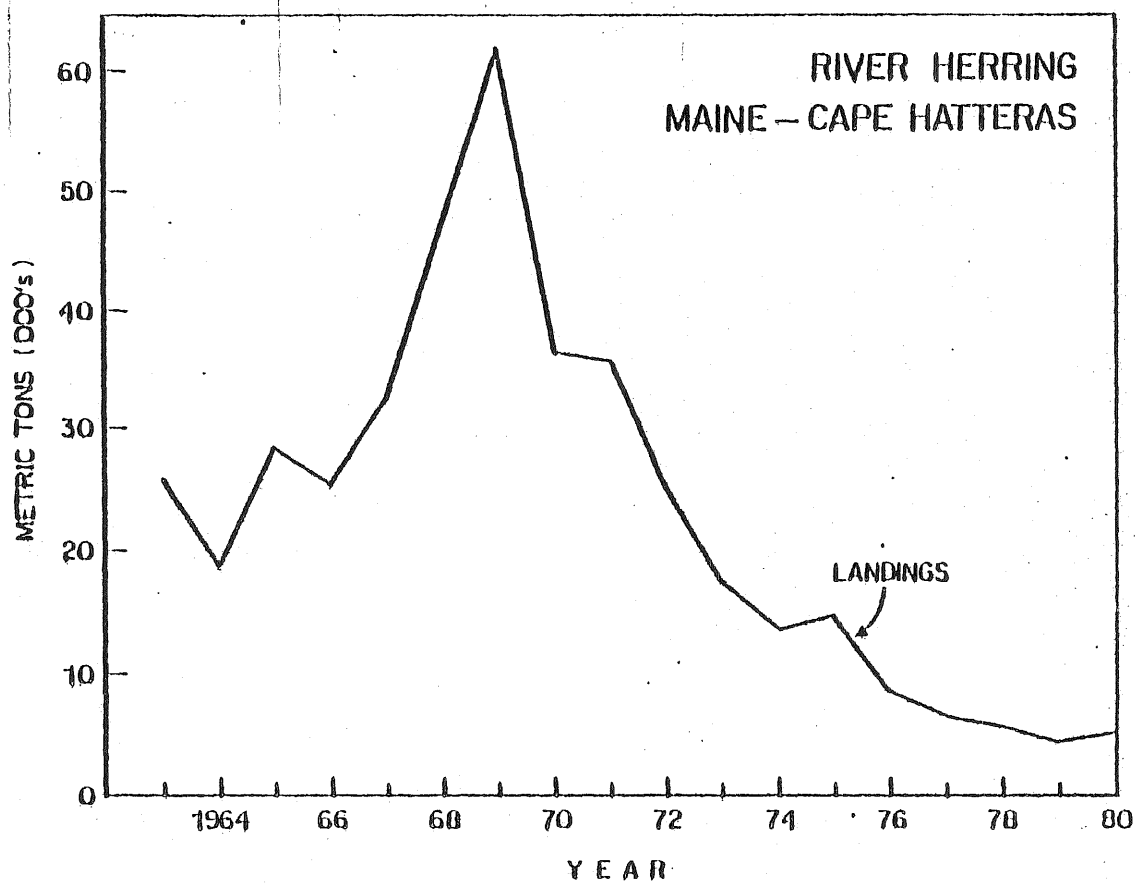

Figure 23. Landings of river herring (alewives and blueback herring) from the Gulf of Maine area to Cape Hatteras.

SCUP

Scup, Stenotomus chrysops, occur primarily in the Mid-Atlantic Bight from Cape Cod to Cape Hatteras. Seasonal migrations occur during spring and autumn; in summer, scup are common in inshore waters from Massachusetts to Virginia, while in winter scup are found in offshore waters between Hudson Canyon and Cape Hatteras at depths ranging from 70 to 180 m. Sexual maturity is essentially complete at age 2; spawning occurs during summer months. Although scup of 15-20 years of age have been recorded, recent catches have been dominated by age 2-3 fish. Scup attain a maximum length of about 40 cm. Tagging studies have indicated the possibility of a southern New England stock and another stock extending south from New Jersey.

The total annual commercial nominal catch fluctuated between 18,000 and 22,000 tons during 1953-63, but declined to 4,000-5,000 tons during the early 1970's (Table 26 and Figure 24). Reported nominal catches by distant-water fleets peaked at 5,900 tons in 1963, but declined to less than 100 tons after 1975. The recreational catch also declined from an estimated 7,600 tons in 1960 to 2,800 tons in 1974; an estimate of 2,425 tons has been obtained for 1979. In general, the estimated recreational catch represents approximately 20-40% of the reported total catch in those years for which comparisons are available.

Since the early 1970's, the USA nominal catch has steadily increased and has exceeded 8,000 tons each year since 1977. The 1979 and 1980 nominal catch equalled 8,700 and 8,500 tons respectively. Most of the recent increase is attributable to increased fixed gear and otter trawl landings in the southern New England-New Jersey area. The Virginia winter trawl fishery, which has previously produced landings in excess of 5,000 tons annually, now yields less than 500 tons per year. The proportion of the total scup nominal catch taken by the Virginia fishery has declined from 40-60% prior to 1967 to less than 15% since 1973. Although the amount of effort expended in this fishery has continued to rise, scup landings have remained at historically low levels. In New Jersey, the purse seine fishery, which annually accounted for up to 2,500 tons prior to 1964, is now non-existent, and the pound net fishery, which formerly produced about 1,000 tons per year, is now negligible.

Catch per unit effort of southern New England otter trawlers increased from 2.4 tons per day in 1971 to 8.0 tons in 1979 but declined to 6.4 tons in 1980. Age composition data indicate that the 1975 and 1977 year classes have dominated recent landings. NMFS autumn bottom trawl surveys also indicate increased abundance in the southern New England area in recent years. In the Middle Atlantic area, spring surveys show very little change in relative abundance since 1968. However, no data are available for earlier years when scup was a major component of the winter trawl fishery in the Middle Atlantic.

Preliminary estimates based on survey data indicate an increase in total mortality from the mid-1960's to the late 1960's - early 1970's followed by a decrease in the mid-late 1970's. Available evidence seems to indicate that the overall scup resource is probably being fully exploited, with the southern stock more so than the northern stock.

For additional information see:

Mayo, R.K. 1981. An assessment of the scup, Stenotomus chrysops, stocks in the southern New England and Middle Atlantic regions. NMFS, NEFC, Woods Hole Lab. Ref. No. 81- (In preparation).

Table 25. Landings (thousand metric tons) and management information for scup from Cape Cod to Cape Hatteras.

	YEAR							
	1973	1974	1975	1976	1977	1978	1979	1980
US recreational landings[1]	2.0	2.8	3.0	2.9	3.4	3.7	2.4	2.3
Commercial landings								
US	5.0	7.1	7.6	7.2	8.5	9.3	8.7	8.5
Canada	-	-	-	-	-	-	-	-
Others	1.3	0.9	0.7	0.1	0.0[2]	0.0[2]	0.0[2]	0.0[2]
Total landings	8.3	10.3	11.3	10.2	11.9	13.0	11.1	10.8
Total allowable catch	-	-	-	-	-	-	-	-

Long-term potential catch = 10 - 15

Importance of recreational fishery = Major

Status of management = None

Status of exploitation in 1980 = Fully Exploited

[1] Estimates for all years except 1974 and 1979 are based on the average ratio of US recreational estimates to US commercial landings for the years 1960, 1965, 1970, and 1974.

[2] Less than 0.1.

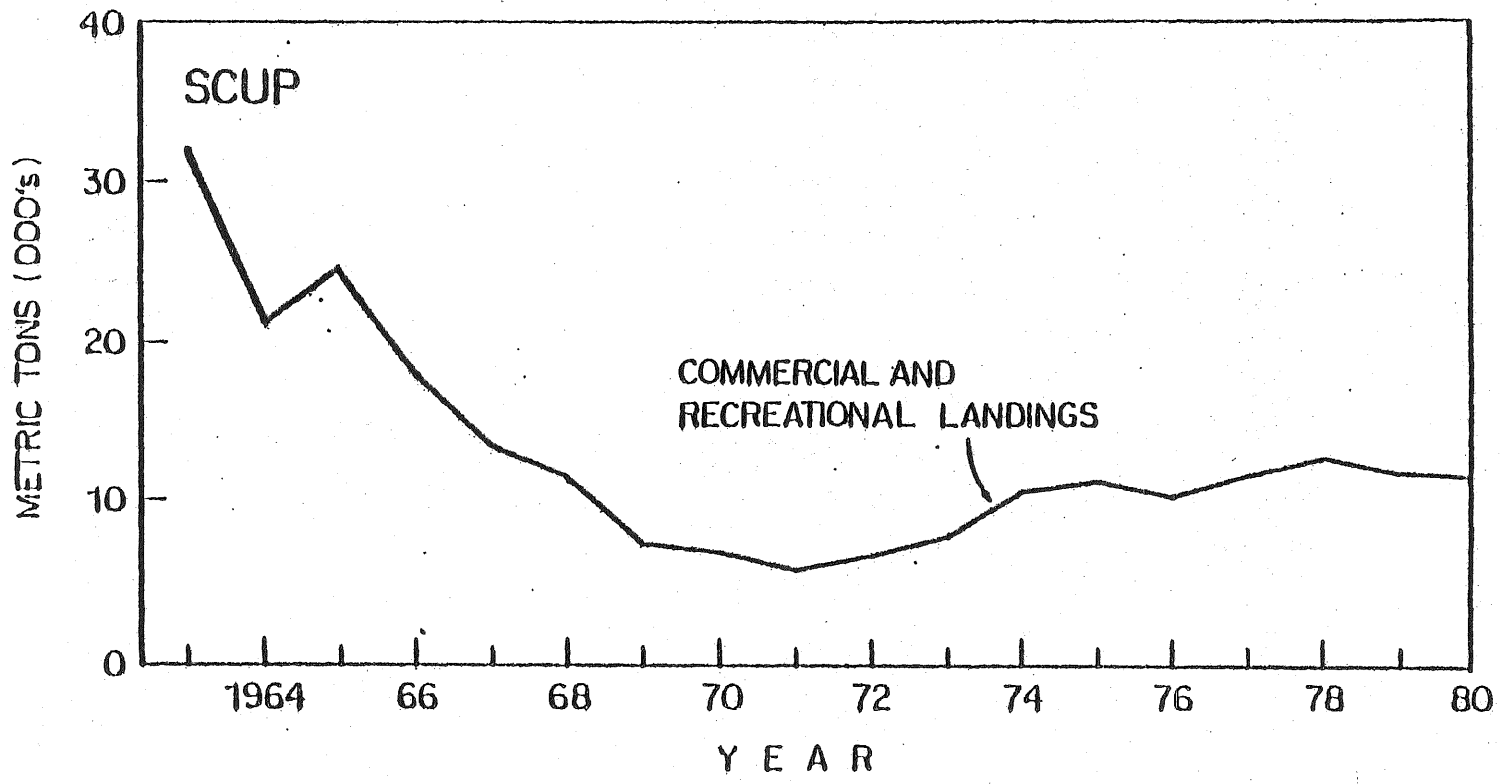

Figure 24. Landings of scup from the area north of Cape Hatteras.

BUTTERFISH

The butterfish, Peprilus triacanthus (Peck), is found along the Atlantic coast of North America from Newfoundland to Florida, and is commercially important between Cape Hatteras and Southern New England. North of Cape Hatteras, butterfish migrate inshore and northward during the summer and offshore to the edge of the continental shelf in late autumn as northern inshore waters cool.

Spawning takes place chiefly during the summer months, with the peak in July. Butterfish begin recruiting to the spawning stock at the end of their second year. The maximum recorded age for this species is 6 years, but few fish are seen beyond age 3. Natural mortality is considered to be high (M = 0.8).

The reported international catch increased from 3,676 t in 1979 to 6,062 t in 1980 (Table 27). The international catch was as high as 19,500 t in 1973, most of it taken by distant-water-fleets in conjunction with their squid fisheries. US landings increased nearly 86% from 2,831 t in 1979 to 5,262 t in 1980, the highest catch ever reported by the US. The distant-water-fleet catch decreased slightly from 845 t in 1979 to 800 t in 1980.

The catch-per-tow index (all ages) from the NEFC autumn bottom trawl survey increased 16% from 17.8 kg in 1979 to 20.6 kg in 1980, the highest index observed in the time-series (Figure 25). This increase reflects the recruitment of the strong 1979 and 1980 year classes. The recruitment index (number per tow at age 0) from the 1980 autumn survey (223) was 44% less than the 1979 index (393), but was still the second highest index in the time-series (1968-1980).

Distant-water-fleet catches in 1980 were dominated by age 0 fish, whereas US catches contained largely age 1 and older fish. Survey results indicate that the butterfish stock is presently at a relatively high level of abundance due to the presence of the strong 1979 and 1980 year classes. Because of the estimated high natural mortality rate for this species (M = 0.8), these two year classes will contribute substantially to the catch only through 1983.

For additional information see:

Waring, G.T., and E.D. Anderson. 1981. Status of the Northwestern Atlantic butterfish stock, August 1981. NMFS, NEFC, Woods Hole Lab. Ref. No. 81-27, 25 p.

Table 27. Landings (thousand metric tons) and management information for butterfish from Nova Scotia to Cape Hatteras, 1974-1980.

	YEAR						
	1974	1975	1976	1977	1978	1979	1980
US recreational landings	-	-	-	-	-	-	-
Commercial landings							
US	2.3	2.1	1.3	1.4	3.7	2.3	3.3
Canada	-	-	-	-	-	-	-
Other	10.3	9.1	9.9	3.2	1.3	0.3	0.8
Total landings	12.3	11.2	11.4	4.7	5.0	3.7	4.1
Total allowable catch	-	-	-	-	11.0	11.0[1]	11.0[1]

Long-term potential catch = 16

Importance of recreational fishery = Insignificant

Status of management = FMP in force since 1979

Status of exploitation in 1980 = Underexploited

[1]For April 1 - March 31 fishing year.

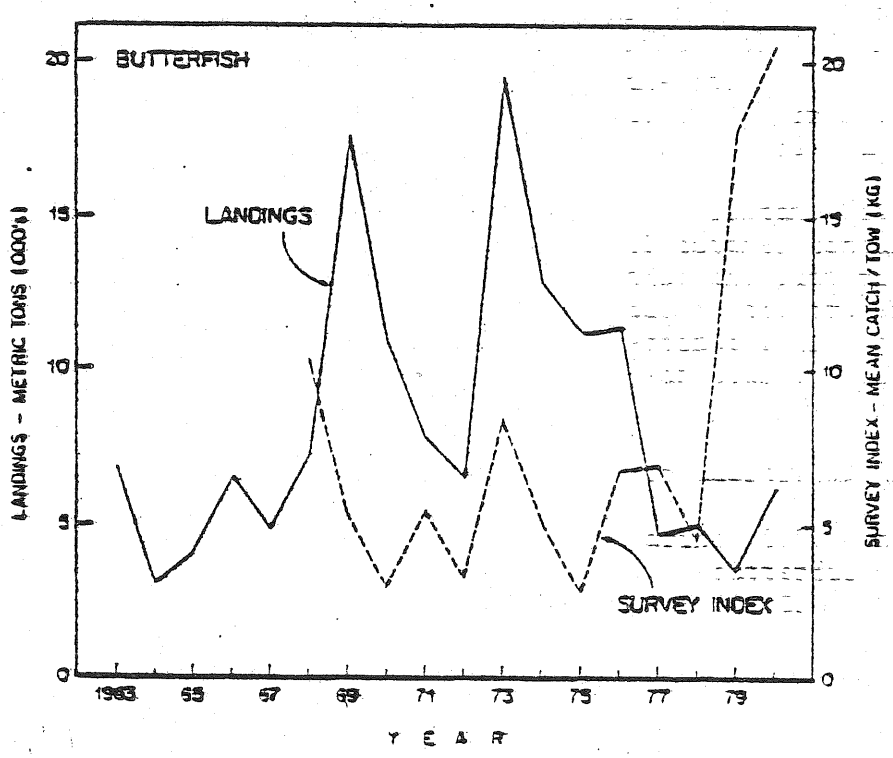

Figure 25. Landings and indices of abundance from the autumn research vessel surveys for butterfish for the area north of Cape Hatteras.

BLUEFISH

The bluefish (Pomatomus saltatrix) is a migratory, pelagic species found throughout the world in most temperate and warm temperate coastal regions except the eastern Pacific. Along the Atlantic coast of the US, bluefish are found from Nova Scotia to Texas, moving northward in the spring and summer and southward in the autumn and winter. Based on results from various studies, two and possibly more separate stocks exist along the Atlantic coast. Bluefish are ferocious predators, feeding on a wide variety of fish and invertebrates, and reaching ages of about 15 years and sizes in excess of 100 cm in length and 12 kg in weight.

Bluefish has become perhaps the most important species to the marine recreational fishery along the Atlantic coast of the US in recent years for various reasons, including the decreased abundance of other desired species such as striped bass (Morone saxatilis). Total catches (commercial and estimated recreational) from Maine to Florida increased from about 12,700 t in 1960 to 49,300 t in 1979 (Table 28 and Figure 26). During this period, estimated recreational catches comprised about 89% of the total annual catch. US commercial catches increased from 1,251 t in 1960 to 6,500 t in 1980, with over 50% during 1973-1980 coming from the Middle Atlantic area (New Jersey - Cape Hatteras). Precise levels of annual recreational catch are uncertain, although estimates obtained from national and regional saltwater angler surveys indicate a pronounced increase since 1960. The estimated recreational catch for 1979 was about 43,800 t, with about 43% coming from the North Atlantic area (Maine to New York) and 41% from the Middle Atlantic.

Relative abundance indices for bluefish calculated from NEFC autumn bottom trawl surveys for the area from Georges Bank to Cape Hatteras underwent a sharp increase from an average of 0.08 kg per tow in 1967-1970 to an average of 0.82 kg per tow during 1971-1980. During the latter period, the index varied between 0.43 kg in 1980 to 1.54 kg in 1974. The abundance index declined 60% from 1979 (1.08 kg) to 1980 (0.43 kg), the latter being the lowest since 1970. The increase in the index since the late 1960's coincided with a general warming trend north of Cape Hatteras, so it is unclear whether bluefish increased in absolute abundance along the entire Atlantic coast or merely underwent a northerly shift in distribution from south to north of Cape Hatteras in response to increased water temperatures. The decrease in the survey abundance index from 1979 to 1980 may reflect a drop in abundance, a shift in distribution or merely the usual year-to-year variability of the survey catches. Nevertheless, the decrease may be cause for concern.

Maximum sustainable yield estimates for bluefish along the entire Atlantic coast obtained from generalized stock production model analysis averaged 49,600 t. Considering the limitations and imprecise nature of the data utilized in that analysis, the MSY estimate must be regarded as approximate. The 1978-1980 estimates of total catch were near the MSY level, indicating that the stock may be fully exploited. Stock size may, therefore, decline in response to increased fishing pressure given the present level of recruitment, and the observed decline in the abundance index in 1980 may be indicating the beginning of such a decline.

For additional information see:

Anderson, E.D. 1980. A preliminary assessment of the status of bluefish (Pomatomus saltatrix) along the Atlantic coast of the United States. NMFS, NEFC, Woods Hole Lab. Ref. No. 80-30, 29 p.

Table 28. Landings (thousand metric tons) and management information for bluefish from the Gulf of Maine to Florida, 1974-1980.

	YEAR						
	1974	1975	1976	1977	1978	1979	1980
US recreational landings[1]	31.2	31.8	30.5	32.3	43.4	43.8	-[3]
Commercial landings							
US	4.5	4.4	4.5	4.8	4.9	5.6	6.3
Canada	-	-	-	-	-	-	-
Other	0.1	0.1	-[2]	-	-	-	-
Total landings	35.8	36.3	35.1	38.1	48.4	49.3	-[3]
Total allowable catch	-	-	-	-	-	-	-

Long-term potential catch	=	43-56
Importance of recreational fishery	=	Major
Status of management	=	FMP in preparation
Status of exploitation in 1980	=	Possibly fully exploited

[1] Estimated

[2] Less than 0.1

[3] Not available at the time of this report

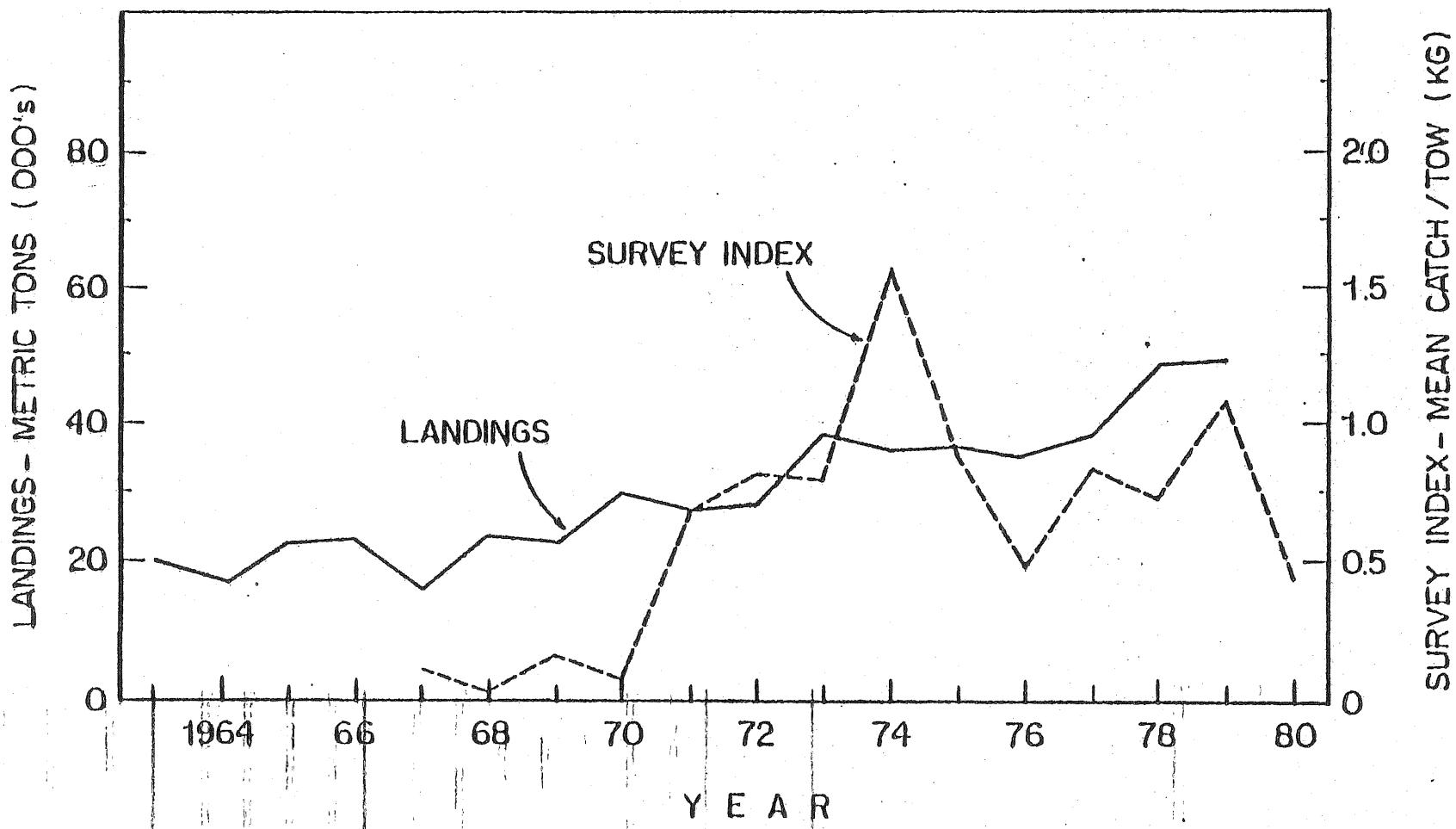

Figure 26. Landings of bluefish from Maine to Florida and indices of abundance from the autumn research vessel surveys for the area from Georges Bank to Cape Hatteras.

STRIPED BASS

The striped bass (Morone saxatilis) is an anadromous species distributed along the Atlantic coast from northern Florida to the St. Lawrence Estuary, Canada; along the Gulf of Mexico from western Florida to eastern Louisiana; and along the Pacific coast from Ensenada, Mexico, to British Columbia, Canada. Populations have been established in numerous inland reservoirs and lakes. Striped bass spawn from mid-February in Florida until June or July in Canadian waters, and from mid-March to late July in California waters. Spawning occurs at or near the surface in fresh or nearly fresh waters at temperatures from 10° to 23°C; peak spawning usually occurs between 15° and 20°C. Yolk-sac larvae (pro-larvae) range from 2.0 to 3.7 mm TL (total length) at hatching. Larval feeding is usually initiated from 4 to 10 days after hatching. At about 13 mm TL, larval striped bass form small schools and move inshore; during their first summer, juvenile fish move downstream into higher salinity waters in many areas. Most estuarine stocks of striped bass along the Atlantic coast are involved in two types of migration: the upstream spring spawning migration and the offshore coastal migrations which apparently are not associated with spawning activity. Male striped bass reach sexual maturity at an earlier age than females; most males are mature in their second year and females in their fourth or fifth year.

Commercial landings of striped bass in the northeastern United States (Maine to North Carolina) averaged 2,800 MT between 1929 and 1980, and 3,500 MT between 1970 and 1980. Gill nets, haul seines, and pound nets accounted for over 80 percent of the commercial landings during this period. Recreational landings from Maine to North Carolina averaged an estimated 8,500 MT between 1970 and 1979 (Table 29). In 1979 striped bass ranked number five in a tabulation of species groups sought by recreational fishermen in the North Atlantic subregion (Maine to Connecticut) and number four in the mid-Atlantic subregion (New York to Virginia).

The coastal migratory stock of striped bass in the Northeast is largely maintained by periodic formation of dominant year classes. The last such year class, the largest in 26 years, occurred in 1970 and resulted in peak landings in 1973. The rapid decline in landings since 1973 is largely the result of low levels of recruitment, as evidenced by the annual young-of-the-year abundance surveys in Maryland waters of the Chesapeake Bay (Figure 27).

The perceived decline in the coastal striped bass stocks from Maine to North Carolina stimulated inclusion of an amendment to P.L. 96-118 (Anadromous Fish Conservation Act) which established an Emergency Striped Bass Study. The study has two objectives: (1) to assess the current status of the stocks in the Northeast, including the levels of exploitation; and (2) to determine the possible causes for the decline in landings since 1973. The National Marine Fisheries Service is primarily responsible for the first objective and the U.S. Fish and Wildlife Service is primarily responsible for the second. Besides in-house studies, the Emergency Striped Bass Study is conducting investigations through state agencies and universities.

Table 15. Landings (thousand metric tons) and management information for striped bass from Maine to North Carolina.

	YEAR							
	1973	1974	1975	1976	1977	1978	1979	1980
US recreational landings[1]	14.4	9.0	6.4	4.2	3.1	2.2	1.1	1.2
Commercial landings								
US	6.7	5.0	4.0	3.0	2.5	2.1	1.3	1.4
Canada	---	---	---	---	---	---	---	---
Other	---	---	---	---	---	---	---	---
Total landings	21.1	14.0	10.4	7.2	5.6	4.3	2.4	2.6
Total allowable catch	---	---	---	---	---	---	---	---

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Major
Status of management	=	FMP in preparation
Status of exploitation	=	Unknown

[1]Estimated

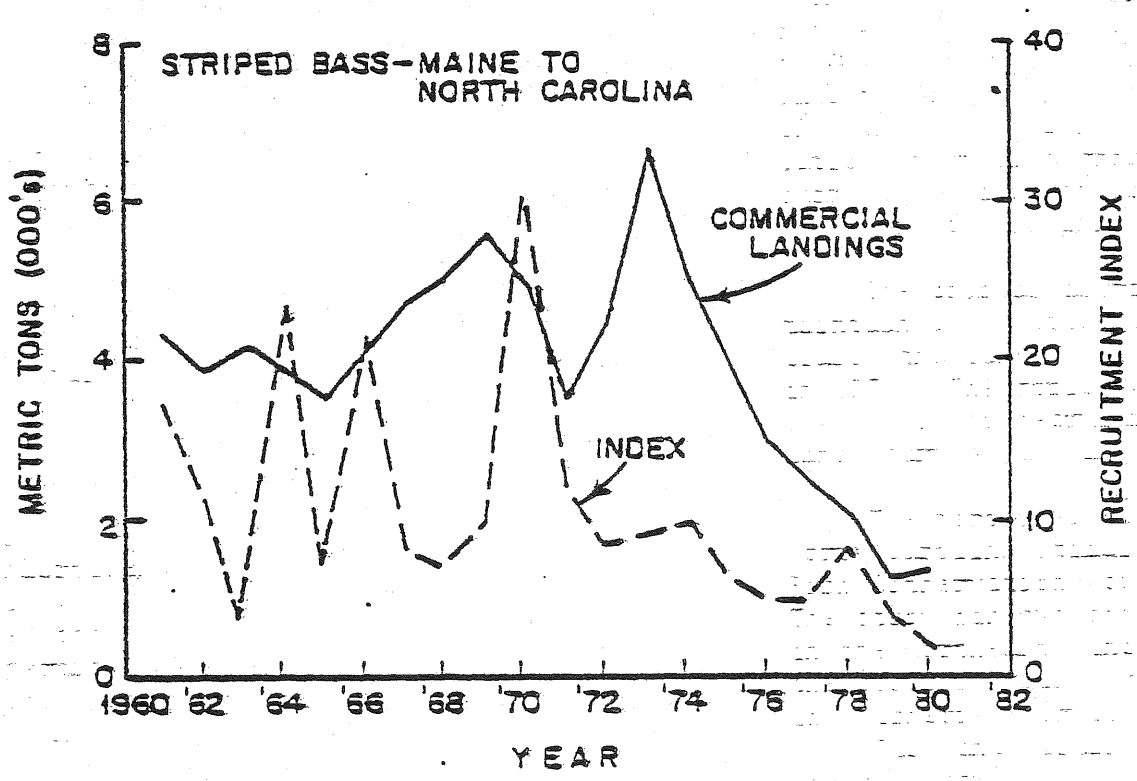

Figure 27. Landings of striped bass from Maine to North Carolina and indices of abundance as calculated from young of the year surveys in Maryland waters within Chesapeake Bay.

WHITE HAKE

The white hake (Urophycis tenuis) is a boreal species which is common in muddy bottom situations throughout the Gulf of Maine. Stock boundaries are uncertain, although research vessel survey data indicate the Gulf of Maine population to be more or less discrete from populations further east. Juveniles may be found in shallow areas, but adults are most common at depths exceeding 120 m (they may, however, move into shoaler areas for spawning in late winter and spring and inshore movement in autumn has also been reported). Adults attain lengths of up to 120 cm and weights of up to 18 kg.

The USA white hake catch has been taken primarily in the western Gulf of Maine (both incidentally to directed operations for other groundfish species and as an intended component in mixed fishery situations). During 1968-1980, USA vessels accounted for approximately 95% of the Gulf of Maine - Georges Bank white hake catch. Total landings increased from an annual average of 300 tons during 1967-1968 to 4,200 tons in 1977-1978 (Table 30 and Figure 28). Provisional statistics for 1979 and 1980 indicate landings of 3,400 tons and 3,900 tons, respectively. Recreational catches of white hake have been negligible. Smaller individuals are difficult to distinguish from red hake (Urophycis chuss), resulting in an unknown degree of bias in reported landings data.

There is no evidence that this stock is being adversely affected by current levels of exploitation. Since 1971, commercial landings from Georges Bank and the Gulf of Maine have generally ranged between 3-4,000 tons, with a gradual upward trend. The NEFC spring survey index fluctuated about an average of 13.1 kg from 1973-1977, declined to 5.0 kg in 1979, and then increased very sharply to 19.9 kg in 1981; the NEFC autumn survey index averaged 12.9 kg during 1969-1973; declined to 7.2 kg in 1975, and subsequently rose to 16.7 kg in 1980, the highest observed in the time series (Figure 28).

For additional information see:

Bigelow, H.B., and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. U.S. Fish Wildl. Serv., Fish Bull. 53, 576 p.

Musick, J.A. 1974. Seasonal distribution of sibling hakes, Urophycis chuss and U. tenuis (Pisces, Gadidae) in New England. Fish. Bull., U.S., 72: 481-495.

Table 30. Landings (thousand metric tons) and management information for white hake from the Gulf of Maine and Georges Bank.

	YEAR							
	1973	1974	1975	1976	1977	1978	1979[1]	1980[1]
US recreational landings	---	---	---	---	0.0[2]	0.0[2]	0.0[2]	0.0[2]
Commercial landings								
US	3.1	3.6	2.7	3.1	3.9	3.3	3.1	3.6
Canada	0.1	0.2	0.1	0.2	0.2	0.2	0.3	0.3
Other	0.0[2]	0.0	0.0	0.0	0.2	0.0[2]	0.0[2]	0.0[2]
Total landings	3.2	3.8	2.8	3.3	4.3	4.0	3.4	3.9
Total allowable catch	---	---	---	---	---	---	---	---

Long-term potential catch = Unknown

Importance of recreational fishery = Insignificant

Status of management = None

Status of exploitation in 1980 = Unknown

[1]Provisional (incomplete).

[2]Less than 0.1.

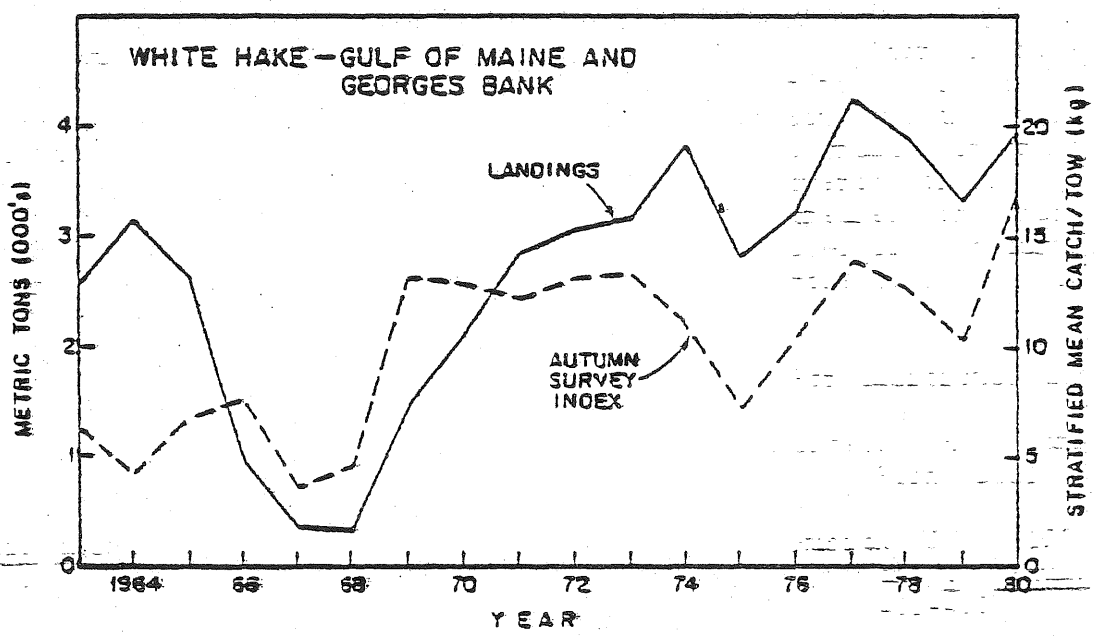

Figure 28. Landings and indices of abundance from autumn research vessel surveys of white hake from the Gulf of Maine and Georges Bank areas.

CUSK

The cusk (Brosme brosme) is a deepwater species which is found in rocky, hard bottom areas throughout the Gulf of Maine, generally at depths exceeding 200 m. Spawning occurs in spring and early summer; juveniles move to the bottom at about 5 cm in length, where they become sedentary and rather solitary in habit. Individuals commonly attain lengths of up to 80 cm and weights of up to 4.5 kg. Little is known relative to stock structure.

The bulk of the USA catch in the Georges Bank - Gulf of Maine area has been taken in the Gulf of Maine (65% of the 1960-1980 total). Canada accounted for 35% of the total catch during this period, practically all of which was taken on Georges Bank. Catches by distant-water fleets have been negligible. Recreational catches totalled approximately 100 tons in the 1974 recreational fishery survey; however, the 1979 survey indicated a recreational catch of only 40 tons. Total landings for the Georges Bank - Gulf of Maine area have been in the order of 1-2,000 tons annually since the mid-1960's; since 1977, landings have steadily increased (Table 31 and Figure 29). The NEFC spring survey index increased more or less continually from an average of 1.6 kg in 1975-1976 to 4.3 kg in 1981 (the highest value in this time series); the NEFC autumn survey index has fluctuated considerably although since 1976 values have generally increased (Figure 29).

For additional information, see:

Bigelow, H.B., and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. U.S. Fish Wildl. Serv., Fish. Bull. 53, 576 p.

Table 31. Landings (thousand metric tons) and management information for cusk from the Gulf of Maine and Georges Bank.

	YEAR							
	1973	1974	1975	1976	1977	1978	1979[1]	1980[1]
US recreational landings	0.1	0.1	0.1	0.1	0.0[2]	0.0[2]	0.0[2]	0.0[2]
Commercial landings								
US	1.2	1.2	1.4	1.2	1.2	1.5	1.7	1.3
Canada	0.6	0.5	0.4	0.5	0.2	0.4	0.5	0.7
Other	0.0	0.0	0.0	0.0[2]	0.0	0.0	0.0	0.0
Total landings	1.9	1.8	1.9	1.6	1.4	1.9	2.2	2.3
Total allowable catch	---	---	---	---	---	---	---	---

Long-term potential catch = Unknown

Importance of recreational fishery = Insignificant

Status of management = None

Status of exploitation in 1980 = Unknown

[1] Provisional (incomplete)

[2] Less than 0.1

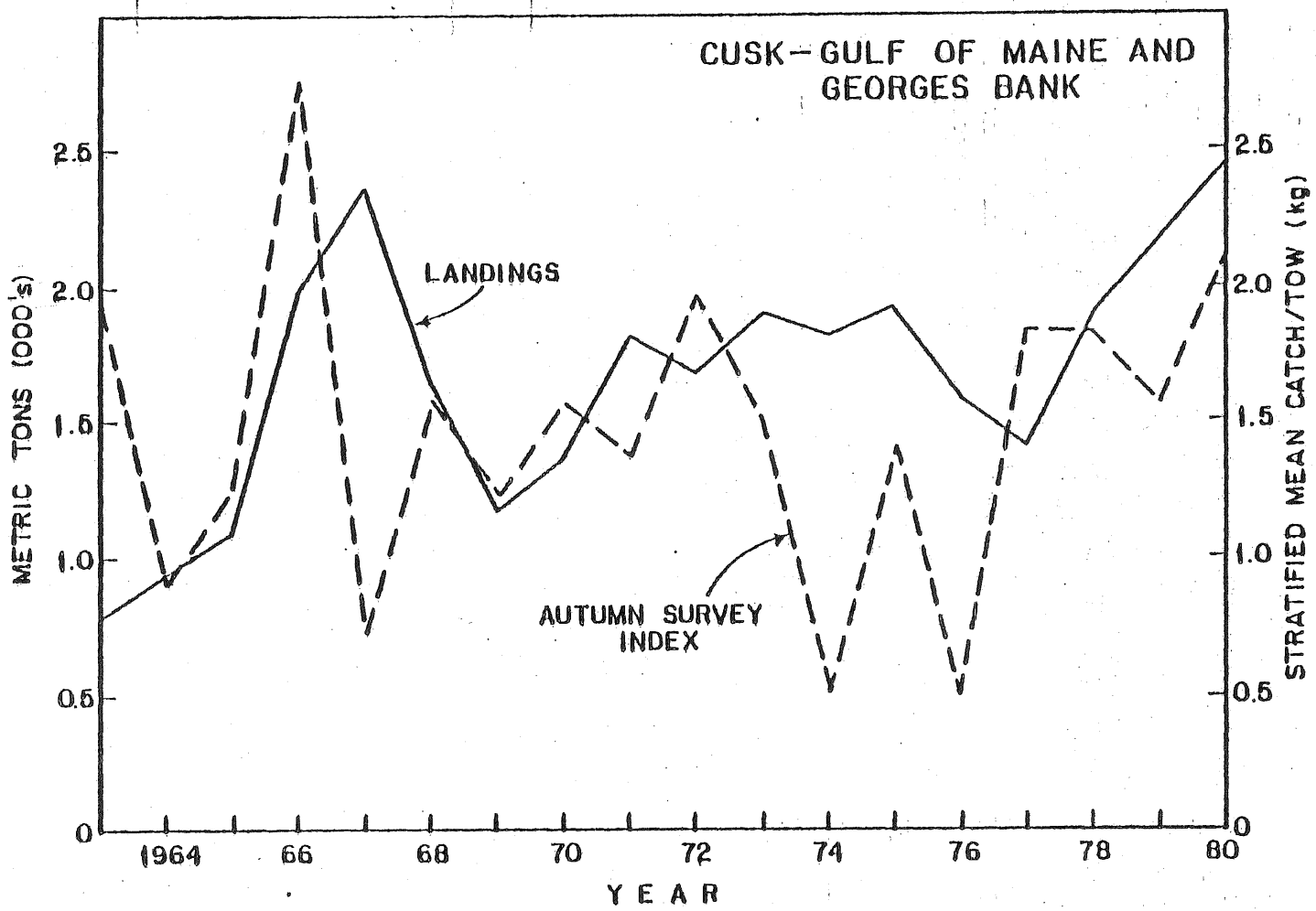

Figure 29. Landings and indices of abundance from autumn research vessel surveys of cusk from the Gulf of Maine and Georges Bank areas.

ATLANTIC WOLFFISH

The wolffish (Anarhichas lupus) is a coldwater species of relatively minor importance in the Gulf of Maine. NEFC surveys indicate populations on Georges Bank and in the western Gulf of Maine to be discrete from groups in the Browns Bank - Scotian Shelf area. West of the Scotian Shelf, abundance appears to be highest in the southwestern portion of the Gulf of Maine from Jeffrey's Ledge to the Great South Channel at depths of 80-120 m. Wolffish are sedentary and rather solitary in habit and populations tend to be rather localized. Little is known relative to the biology of this species. Individuals may attain lengths of 150 cm and weights of perhaps 18 kg.

Wolffish have been taken primarily as by-catch, although the species may also be an intended component of the catch in certain mixed fishery situations. Increased landings in recent years suggest that commercial interest in this species may be increasing. In the last two decades USA vessels have taken 77% of the total Georges Bank - Gulf of Maine catch, with most of the remainder going to Canada. Total landings from the Georges Bank - Gulf of Maine area increased from less than 200 tons in 1970 to 1,200 tons in 1980 (Table 32 and Figure 30). Research vessel survey indices have fluctuated without a definite trend in recent years.

For further information, see:

Bigelow, H.B., and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. U.S. Fish Wildl. Serv., Fish. Bull. 53, 576 p.

Table 32. Landings (thousand metric tons) and management information for wolffish from the Georges Bank - Gulf of Maine area.

	YEAR							
	1973	1974	1975	1976	1977	1978	1979[1]	1980[1]
US recreational landings	0.0[2]	0.0[2]	0.0[2]	0.0[2]	0.0[2]	0.1	0.1	0.1
Commercial landings								
US	0.2	0.3	0.3	0.4	0.4	0.6	0.7	0.9
Canada	0.0[2]	0.0[2]	0.0[2]	0.1	0.1	0.2	0.1	0.2
Other	0.2	0.0[2]	0.0[2]	0.0	0.0	0.0	0.0	0.0
Total landings	0.4	0.4	0.4	0.5	0.5	0.9	0.9	1.2
Total allowable catch	---	---	---	---	---	---	---	---

Long-term potential catch = Unknown

Importance of recreational fishery = Insignificant

Stamus of management = None

Stamus of exploitation in 1980 = Unknown

[1] Provisional (incomplete)

[2] Less than 0.1

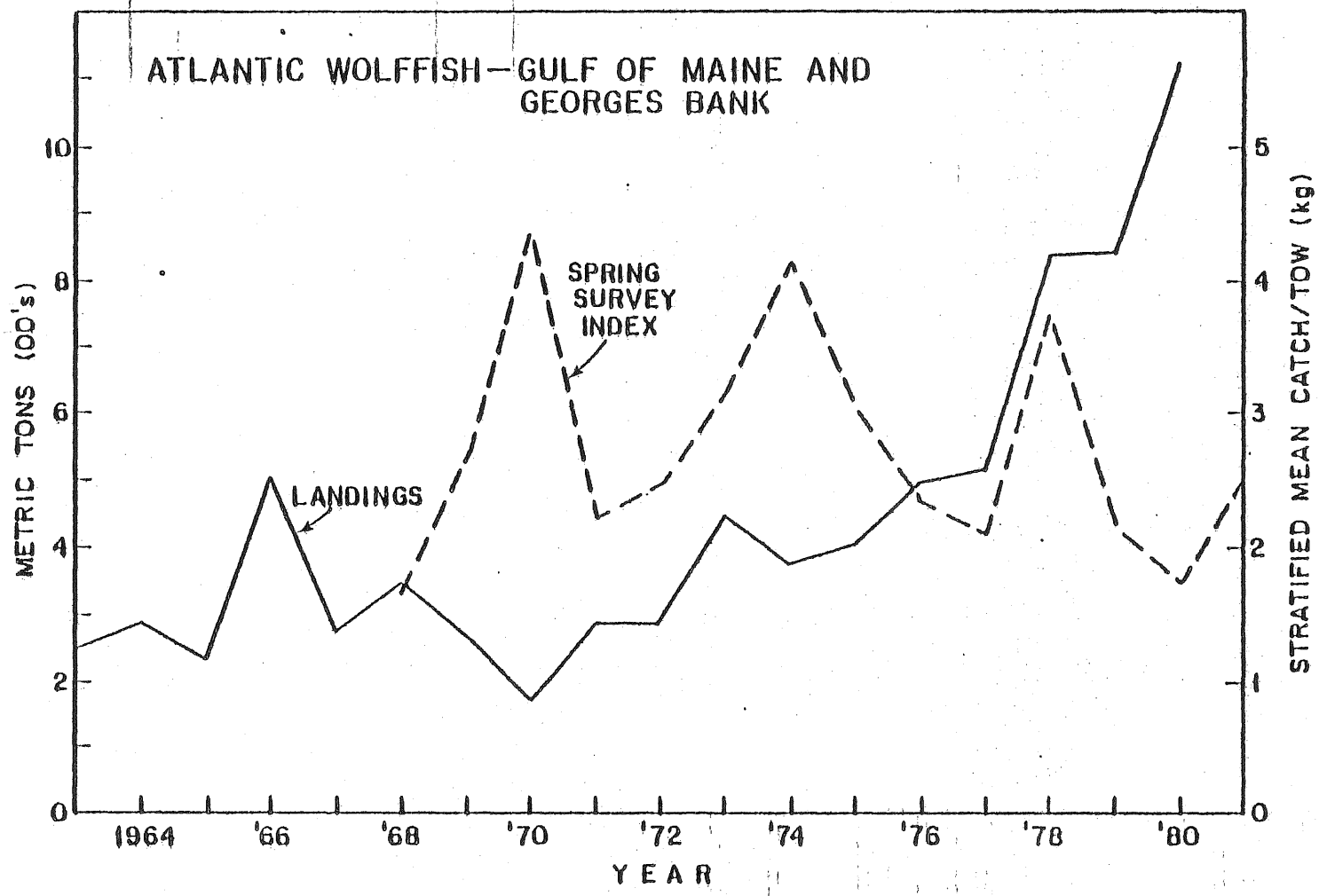

Figure 30. Landings and indices of abundance from spring research vessel surveys of Atlantic wolffish from the Gulf of Maine and Georges Bank areas.

TILEFISH

Tilefish (Lopholatilus chamaeleonticeps) are found along the outer continental shelf from Nova Scotia to South America. They are relatively abundant in the Southern New England-Middle Atlantic area, occurring at depths of 80 to 440 m, and are generally found in and around the submarine canyons where they occupy burrows in the substrate. Tilefish are relatively slow growing and long lived, with a maximum observed length in excess of 110 cm and a maximum observed age of 33 years. Sexual maturity occurs at about age 6, with spawning from March to August.

Commercial landings were first recorded in 1915 (148 t); 4,500 t were taken in 1916 (the largest annual catch to date), but only 5 t were reported in 1920. The fishery has undergone several cycles since that time with catches increasing to a peak and then declining. Most recently, US landings increased from about 30 t in 1968-1969 to 3,800 in 1979 (Table 33 and Figure 31). Landings decreased slightly to about 3,700 t in 1980. Longlines were the predominant gear used until the early 1940's; bottom trawls were the most commonly-used gear from then until the early 1970's, after which longlines again were predominant. Since 1972, New Jersey has averaged about 70% of the annual landings, followed by New York and Rhode Island.

A recreational fishery for tilefish developed in the Mid-Atlantic area in the late 1960's. Annual catches were estimated to have reached a high of several hundred tons in the early 1970's, but declined sharply in the late 1970's. The NMFS Marine Recreational Fishery Statistics Survey indicated no catch north of Cape Hatteras in 1979.

Reported catches of tilefish by distant-water fleets have been small, never exceeding 12 t per year. However, recent information from the NMFS Foreign Fisheries Observer Program indicates that tilefish were taken as bycatch in 1978-1979, with annual catches possibly as high as 50-150 t.

Fishing effort by domestic longliners has increased substantially on tilefish since the early 1970's. The number of vessels operating out of New York and New Jersey increased from five in 1974 to about 30 in 1980. In addition, the amount of gear fished per vessel also increased. Catch-per-unit-effort declined from 1.0 kg/hook in 1975 to 0.3 kg/hook in 1978. Although analyses are not complete, indications are that catch-per-unit-effort continued to decline in 1979 and 1980.

Average size of the fish in the catch declined from 1974 and the percentage of immature fish increased.

Reduction in catch rate and size of fish are expected when a fishery initially develops on a stock. Since the data base necessary for assessing the status of this stock is presently limited, the implications and consequences of these reductions cannot be determined. However, the increasing

trend in catch and fishing effort and a decrease in catch-per-unit-effort and average fish size are cause for concern. Continued collection of statistics and sampling data are necessary before a comprehensive assessment of this stock will be possible.

For further information see:

Turner, S.C., E.D. Anderson, and S.J. Wilk. 1981. A preliminary analysis of the status of the tilefish population in the Southern New England-Middle Atlantic region. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 81-03, 18p.

Table 33. Landings (thousand metric tons) and management information for tilefish from Southern New England and the Middle Atlantic area, 1974-1980.

	YEAR						
	1974	1975	1976	1977	1978	1979	1980
US Recreational Landings[1]	0.2	-	-	-	-	-	-
Commercial Landings							
US	0.6	0.7	1.1	2.1	3.4	3.8	3.7
Other	-	-	-	-	-	0.1	0.1
Total Landings	0.8	0.7	1.1	2.1	3.4	3.9	3.8
Total Allowable Catch	-	-	-	-	-	-	-

Long-term potential catch	Unknown
Importance of recreational fishery	Currently insignificant
Status of management	FMP in preparation
Status of exploitation in 1980	Unknown

[1] Estimated.

- = less than 100 t.

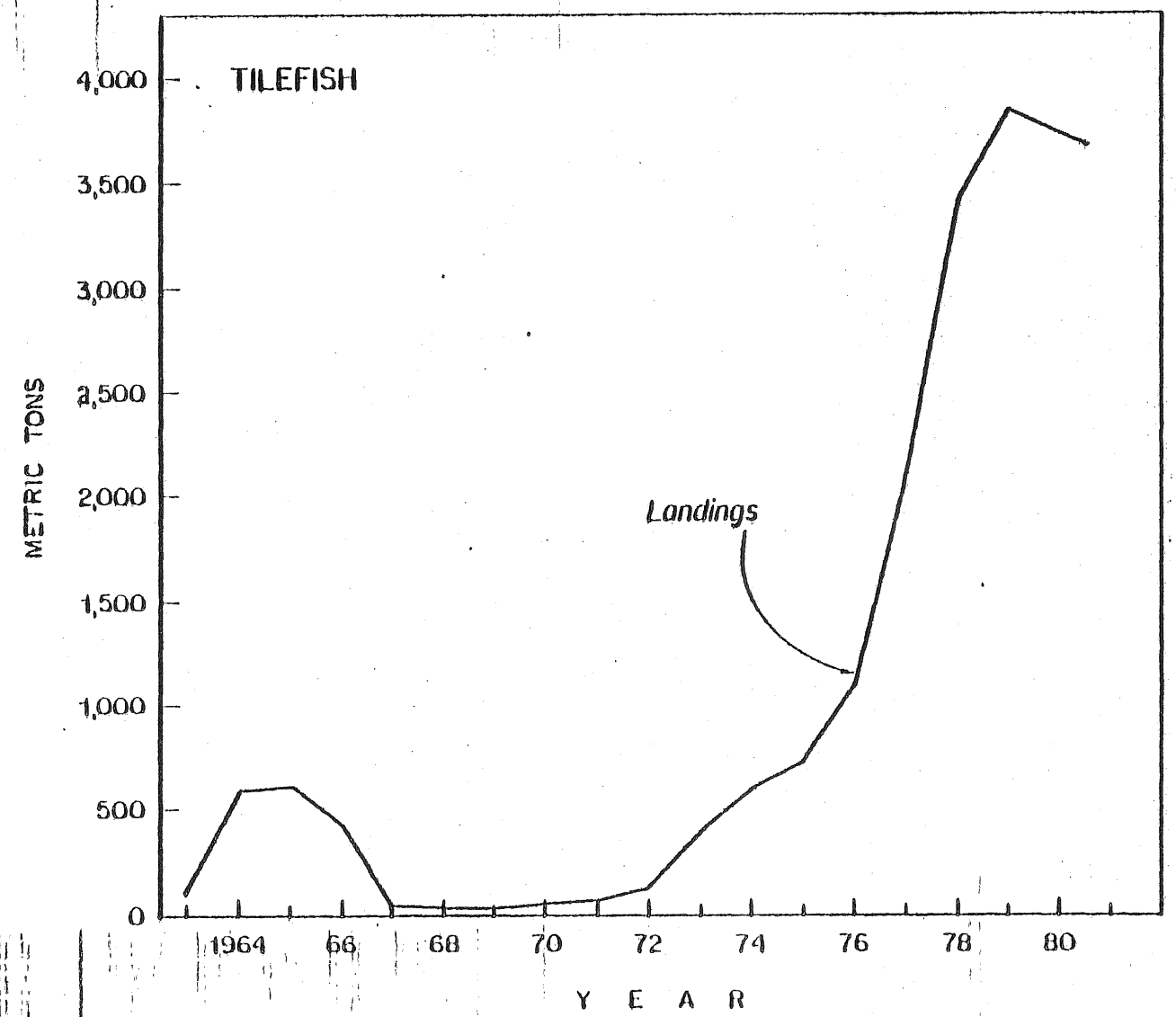

Figure 31. Landings of tilefish from the Southern New England and Mid Atlantic areas.

SPINY DOGFISH

Spiny dogfish, Squalus acanthias L., are distributed in the western North Atlantic from Georgia to Newfoundland. During spring and autumn they are found along the coastal waters between North Carolina and Southern New England. Dogfish are chiefly a summer visitor to the Gulf of Maine (including Georges Bank) and more northern waters, and in winter are distributed primarily in deeper waters along the edge of the continental shelf. They tend to school by size and, for large mature individuals, by sex. Dogfish are voracious feeders and are known to attack schools of herring and mackerel, as well as concentrations of haddock, cod, and other species. They will also tear at commercial fishing nets during fishing operations. The species bears live young, with a gestation period of about 18-22 months producing about 8 pups.

Commercial landings include the spiny dogfish, the smooth dogfish, Mastelus conis and dogfish (unspecified). Based on NEFC bottom trawl survey data, the spiny dogfish is more abundant than the smooth dogfish in this region, and thus probably accounts for the bulk of the landings. Therefore, in this document landings of dogfish that are unspecified are reported as spiny dogfish. Dogfish have generally been caught incidentally in fishing operations directed towards other species, and the catch has traditionally been discarded at sea. Reported international landings peaked at about 21,000 t in 1972 and declined sharply from 1975 to 1978 (Table 34 and Figure 32). Distant-water-fleets consistently accounted for virtually all of the reported landings. Reported US landings rose sharply from about 900 t in 1978 to 4,800 t in 1979 due to the availability of a European export market. However, US landings dropped back to about 4200 t in 1980 as the European market failed to hold. There remains a strong interest in dogfish by several US processors, and improvements in handling and processing should enhance market opportunities and stimulate increased US landings.

Minimum biomass estimates of spiny dogfish based on NEFC bottom trawl survey catches increased from 156,000 t in 1979 to 497,000 t in 1980, 71% above the 1968-1980 average of 290,000 t. Since dogfish school, there tends to be rather high variability among the random survey catches which results in large fluctuations in the annual biomass estimates.

The potential for rapid overexploitation of sharks has been observed in European fisheries. This results from low growth and fecundity rates, schooling of large mature individuals by sex, and direct stock-recruitment relationships. Any significant expansion of the US fishery for dogfish should, therefore, be done with caution.

For further information see:

Bigelow, H.B., and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. Fish. Bull., U.S. 53:1-595.

Colvocoresses, J.A., and J.A. Musick. 1980. A preliminary evaluation of the potential for a shark fishery in Virginia. Va. Inst. Mar. Sci. Spec. Rpt. Appl. Mar. Sci. Ocean. Engineering No. 234:37 p.

Holden, M.J. 1973. Are long-term sustainable fisheries for elasmobranchs possible? Rapp. p.-v. Réun. Cons. int. Explor. Mer. 164:360-367.

Table 34. Landings (thousand metric tons) and management information for spiny dogfish from Maine to Cape Hatteras, 1974-1980.

	YEAR						
	1974	1975	1976	1977	1978	1979	1980
US recreational landings	-	-	-	-	-	-	-
Commercial landings							
US	0.1	0.2	0.5	0.5	0.9	4.8	0.9
Canada	-	-	-	-	-	-	-
Other	17.6	18.0	13.8	6.5	0.6	-	-
Total landings	18	18	14	7	2	5	1
Total allowable catch	-	-	-	-	-	-	-

Long term potential catch = 65

Importance of recreational fishery = Insignificant

Status of management = None

Status of exploitation in 1980 = Unknown

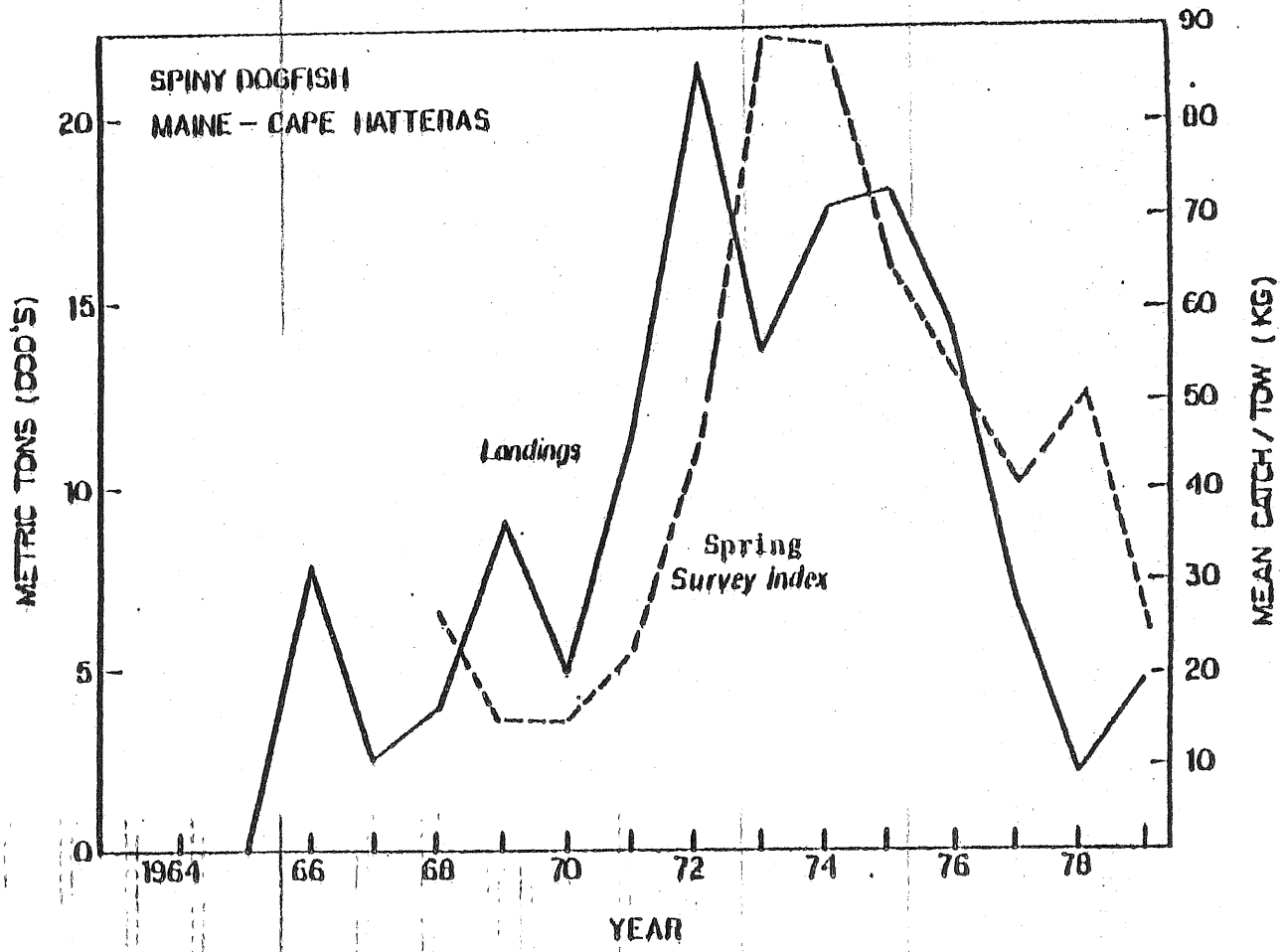

Figure 32. Landings and indices of abundance from the spring research vessel surveys for spiny dogfish from the Maine to Cape Hatteras areas.

PELAGIC SHARKS

Pelagic sharks (defined here as all sharks except dogfish) are distributed throughout the world's oceans. Many different species are included in this group, and discrete stocks are not confined to waters of the US Fishery Conservation Zone (FCZ) in the Atlantic and Gulf of Mexico. Sharks differ from the bony fishes in that they have a cartilaginous skeleton, attain considerable size (maximum length of largest species is in excess of 10 m), and have a very low reproductive potential (giving birth to 1-80 young instead of releasing large numbers of eggs - up to several million as in the case of cod). Limited data indicate that the life span of sharks ranges from 15 to 30 years.

Sharks are harvested in a variety of fisheries, primarily as by-catch, but very little of the shark catch is landed and accounted for in reported statistics. Consequently, the level of harvest is based predominantly on estimates from a variety of fisheries.

The total estimated catch in the Atlantic and Gulf of Mexico FCZ has increased from about 12,000 in 1967 to about 20,000 in 1978 (Table 35 and Figure 33). The US share of the total catch has varied from an average of 53% during 1965-1966 to 73% during 1967-1971 to 84% during 1972-1978. The estimated US recreational catch averaged about half of the total during 1965-1978. Most of the remainder of the US catch has been from by-catch in the swordfish long-line fisher (mainly north of Cape Hatteras) and in the Gulf of Mexico shrimp fishery. Most of the catch by other countries has been from the Japanese tuna longline fishery.

Reliable measures of relative abundance are generally lacking for sharks. Catch per effort determined from Japanese longline effort statistics and from catches of sharks as reported to FAO underwent a steady decline from 1973 to 1978. Annual estimated shark catches in the entire Western North Atlantic averaged about 23,600 during 1965-1978, of which about 15,100 or 65% was taken in the US FCZ. An estimate of MSY for the Western North Atlantic was determined from a generalized stock production model to be approximately 25,000. Based on the proportion of estimated catches attributed to the FCZ, about 65% or 16,000 of this MSY could be attributed to the FCZ. A further division of this estimate, on the basis of catches, into Atlantic and Gulf of Mexico components would suggest values of 9,000 and 7,000, respectively.

Comparison of estimated catch levels for 1978 with the above MSY estimates indicates that current levels of catch are considerably in excess of MSY in the Atlantic and somewhat less than MSY in the Gulf of Mexico. The extreme vulnerability of sharks to fishing has been well documented for several species in various parts of the world. Consequently, the increasing trend in estimated catches and the apparently excessive current level of harvest in the Atlantic FCZ may, if continued, result in a decline in shark abundance.

For additional information see:

Anderson, E.D. 1980. Analysis of various sources of pelagic shark catches in the Northwest and Western Central Atlantic Ocean and Gulf of Mexico. NMFS, NEFC, Woods Hole Lab. Ref. No. 79-56, 37 p.

Anderson, E.D. 1980. MSY estimates of pelagic sharks in the Western North Atlantic. NMFS, NEFC, Woods Hole Lab. Ref. No. 80-18, 13 p.

Table 33. Landings (thousand metric tons) and management information for pelagic sharks for the Atlantic coast and Gulf of Mexico areas, 1974-1980.

	YEAR						
	1974	1975	1976	1977	1978	1979[3]	1980[3]
US recreational landings	7.6	7.3	8.5	9.1	9.3		
Commercial landings[1]							
US	4.0	3.7	6.3	3.1	7.8		
Canada	-	-[2]	-	-	-		
Other	2.2	2.3	3.5	1.4	2.6		
Total landings	13.8	13.3	18.3	13.6	20.1		
Total allowable catch	-	-	-	-	6.2	6.2	6.2

Long-term potential catch	=	16
Importance of recreational fishery	=	Major
Status of management	=	FMP in force since 1978
Status of exploitation in 1980	=	Fully exploited in the Atlantic; under exploited in the Gulf of Mexico

[1] Includes estimated unreported by-catch

[2] Less than 0.1

[3] Catch data not yet available

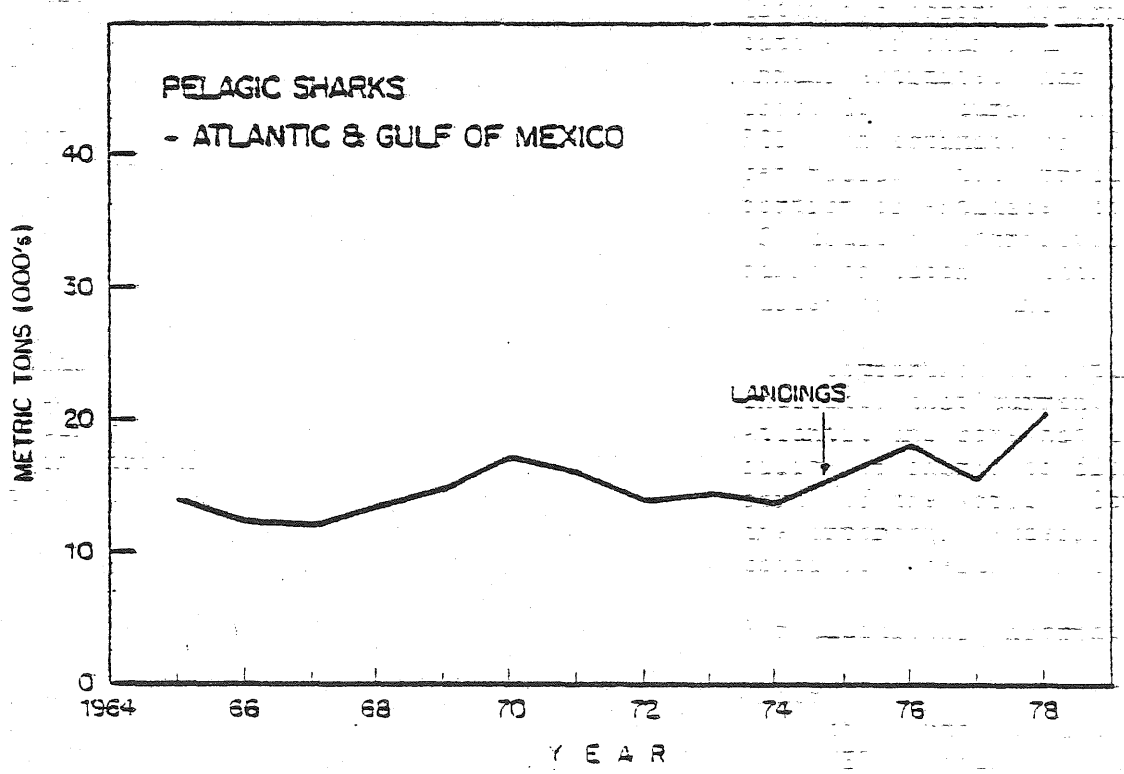

Figure 33. Landings of pelagic sharks from the Atlantic coast and Gulf of Mexico areas.

SKATES

Skates, family Rijidae, are distributed throughout the Northwest Atlantic from close to the tide line to depths exceeding 700 m. Members of this family lay eggs which are enclosed in a hard leathery case, commonly called a "mermaid's purse." Incubation time is 6-12 months, with the young having the adult form at the time of hatching. There are seven species of Raja occuring along the North Atlantic coast of the US: little skate, Raja erinacea; winter skate, R. ocellata; barn-door skate, R. laevis; thorny skate, R. rudiate; brier skate, R. eglanteria; leopard skate R. garmani; and smooth-tailed skate, R. senta. The center of distribution for the little and winter skates is Georges Bank and Southern New England. The thorny, barn-door, smooth-tailed, and leopard skates are commonly found in the Gulf of Maine. The brier skate is a southern species, located primarily in the Chesapeake Bight. Skates are not known to undertake large-scale migrations, but they do move inshore and offshore in response to seasonal water temperature changes, generally offshore in the summer and early autumn and vice versa during the winter-spring period.

There is no directed fishery for skates, and total landings since 1975 have been less than 2,000 t annually (Table 36). Most of the domestic catch has traditionally been discarded at sea. Reported US landings increased slightly from 1,600 t in 1979 to 2000 t in 1980. Landings in the Southern New England industrial trawl fishery in 1980 accounted for 23% (450 t) of the total. The principal skate species taken in this fishery are little and winter skates. The remainder (77%) of the US catch was for human consumption, with only the pectoral fins or "wings" landed. The species composition of the catch landed as "wings" is unknown. In this document landings from the food fishery were converted to nominal landings using the factor 2.27. Future landings are not expected to increase markedly unless the limited domestic market expands or an export market develops.

Minimum biomass estimates for the Gulf of Maine-Cape Hatteras area determined from NEFC bottom trawl survey catches increased from 56,000 t in 1979 to 103,000 t in 1980 (Figure 34). However, the 1980 estimate was still about 27% less than the 1968-1980 average of 131,000 t.

For further information see:

Bigelow, H.B., and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. Fish. Bull., U.S. 53(74):1-577.

Holden, M.J. 1973. Are long-term sustainable fisheries for elasmobranchs possible? Rapp. P.-v. Reun. Cons. int. Explor. Mer. 164:360-367.

Waring, G.T. 1980. A preliminary stock assessment of the little skate Raja erinacea, in the Northwest Atlantic. MA Thesis. Bridgewater State College, 122 p.

Table 36. Landings (thousand metric tons) and management information for skates (all species) from the Gulf of Maine, and Georges Bank areas south to Cape Hatteras, 1974-1980.

	YEAR						
	1974	1975	1976	1977	1978	1979	1980
US recreational landings	-	-	-	-	-	-	-
Commercial landings							
US	2.3	0.9	1.1	1.3	1.3	1.6	-
Canada	-	-	-	-	-	-	-
Other	1.7	3.1	0.9	0.2	-	-	-
Total landings	4	4	2	2	2	2	-
Total allowable catch	-	-	-	-	-	-	-

Long-term potential catch	= Unknown
Importance of recreational fishery	= Insignificant
Status of management	= None
Status of exploitation in 1980	= Moderately exploited

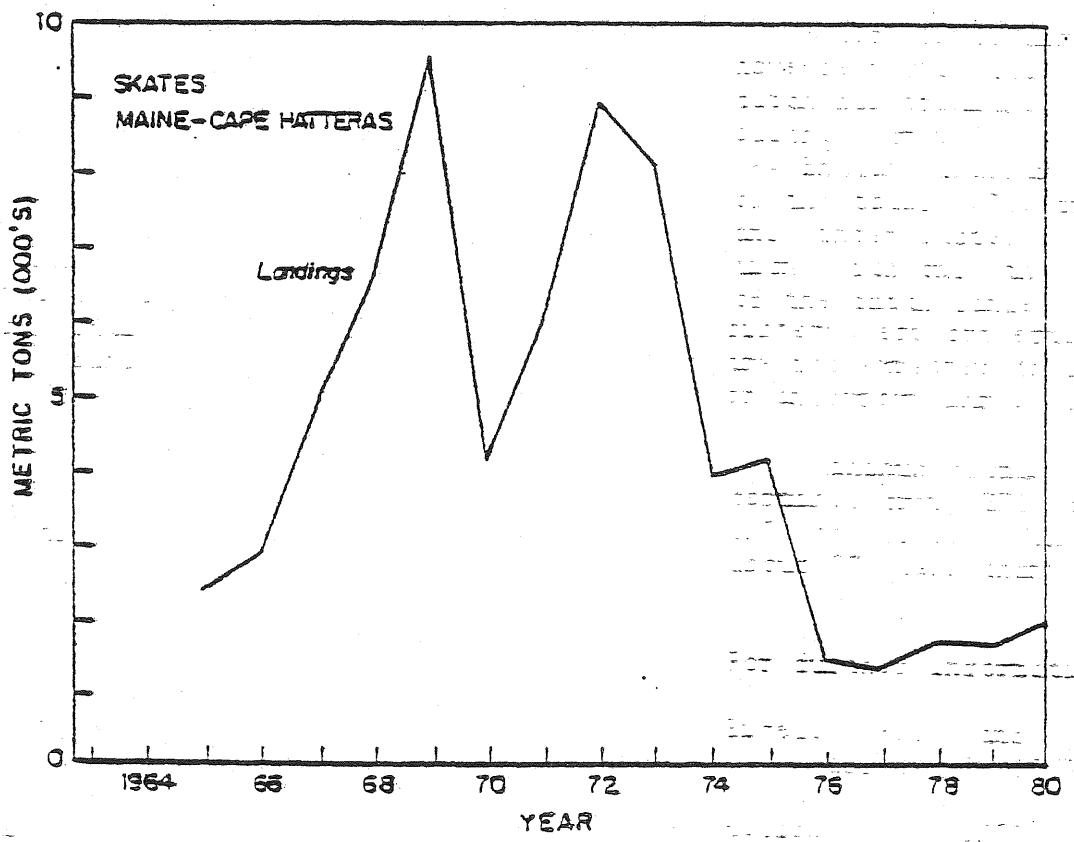

Figure 34. Landings of skates from the Gulf of Maine to Cape Hatteras areas.

SHORT-FINNED SQUID (ILLEX ILLECEBROSUS)

The short-finned squid (Illex illecebrosus) is found in commercial quantities from about Cape Hatteras to Newfoundland. This species undergoes seasonal migrations onto the continental shelf during summer, and off the edge of the shelf in winter, to spawn in unknown areas. Illex reach about 30 cm in dorsal mantle length, and about 18-24 months of age. Commercial catches, however, are comprised mainly of 14-20 cm individuals which are probably 8-12 months of age.

Reported international landings of Illex for the Gulf of Maine - Middle Atlantic area were lower in 1980 (15,222 t) than in 1979 (17,901 t) (Table 37 and Figure 35). US landings decreased from 1,593 t in 1979 to 333 t in 1980, while distant-water-fleet catches (southern Georges Bank to Middle Atlantic) decreased about 9% from 16,308 t in 1979 to 14,889 t in 1980. During the 1980-1981 fishing year (April 1 - March 31), the distant-water-fleet took 18,619 t or about 75% of their allocation.

The abundance index (mean number per tow) from the NEFC autumn bottom trawl survey declined 47% from 1979 to 1980. In spite of this decrease, the 1980 index was only slightly below the mean for the recent period of high abundance (1975-1979) and well above the historic average. The pre-recruit abundance index declined 73% from 1979 to 1980 to a level less than 40% of the long-term average. This decrease suggests a possible decline in the stock for the 1981-1982 fishing year.

For further information see:

Lange, Anne M.T. 1981. Stock status and estimates of potential yields of squid (Loligo pealei and Illex illecebrosus) populations off the Northeastern USA. NMFS, NEFC, Woods Hole Lab. Ref. No. 81-29, 21 p.

Table 37. Landings (thousand metric tons) and management information for the short-finned squid (Illex) from the Middle Atlantic to the Gulf of Maine, 1974-1980.

	YEAR						
	1974	1975	1976	1977	1978	1979	1980
US recreational landings	-	-	-	-	-	-	-
Commercial landings							
US	0.1	0.1	0.2	1.0	0.4	1.6	0.3
Canada	-	-	-	-	-	-	-
Other	20.5	17.8	24.7	23.3	17.3	16.3	14.9
Total landings	20.6	17.9	24.9	24.3	17.7	17.9	15.2
Total allowable catch	(1)	(1)	30.0	33.0	30.0	30.0	30.0

Long-term potential catch = 30

Importance of recreational fishery = Insignificant

Status of management = FMP in force since 1979

Status of exploitation in 1980 = Underexploited

(1) Total allowable squid (Loligo and Illex combined) catch of 71,000 tons.

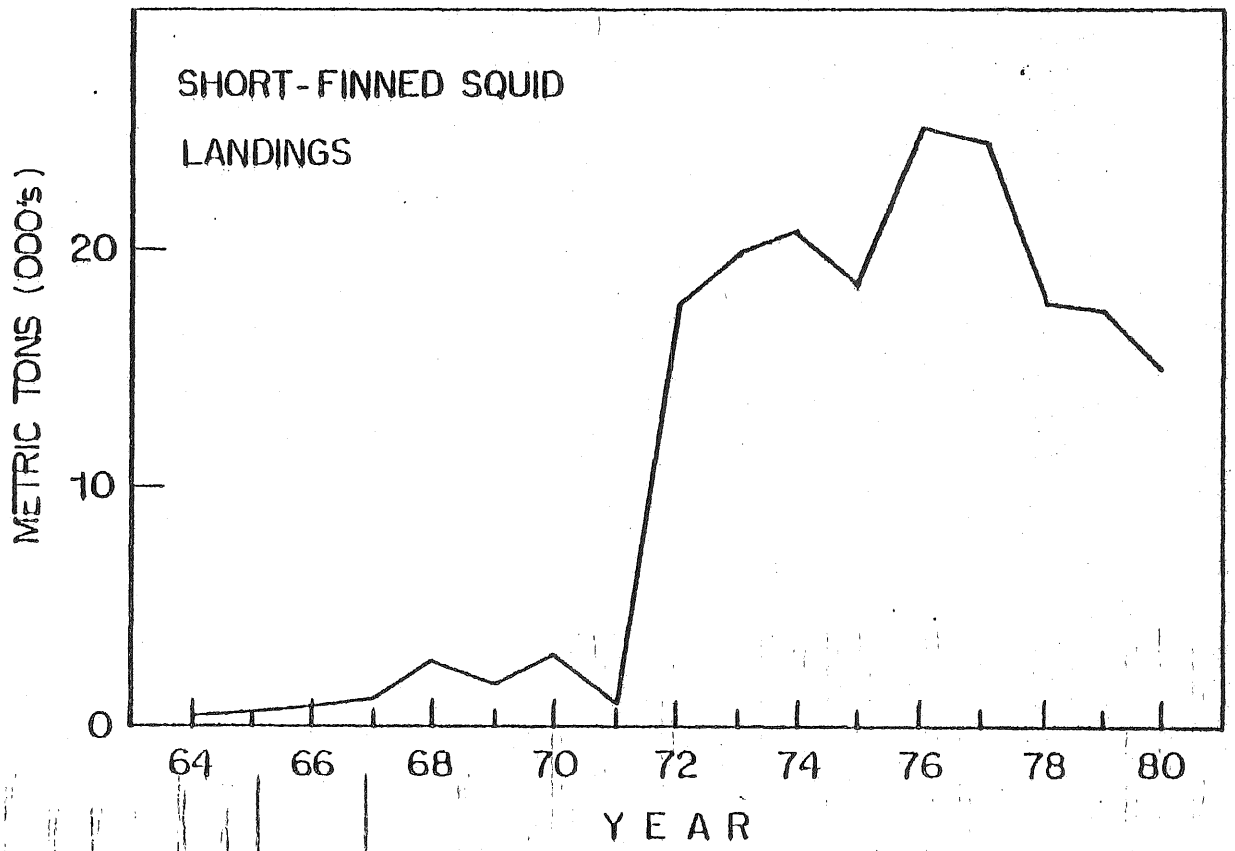

Figure 35. Landings of short-finned squid from the Gulf of Maine-Mid Atlantic area.

LONG-FINNED SQUID (*LOLIGO PEALEI*)

The long-finned squid (*Loligo pealei*) is found in commercial quantities from Cape Hatteras to southern Georges Bank, and, like *Illex*, undergoes seasonal migrations. *Loligo* move into shallow inshore waters in summer to spawn, and move to the edge of the shelf, where the distant-water fishery occurs, in winter. *Loligo* reach lengths of over 40 cm (dorsal mantle length), and ages of about 3 years, but most individuals taken in commercial catches are 10-20 cm and 8-14 months.

Reported international landings of *Loligo* increased about 15% from 17,078 t in 1979 to 19,701 t in 1980 (Table 38 and Figure 36). US landings were similar in 1980 (3854 t) to 1979 (3,896 t), whereas distant-water-fleet catches increased 20% from 13,182 t in 1979 to 15,847 t in 1980. During the 1980-1981 fishing year (April 1-March 31), the distant-water-fleets caught 20,043 t or 57% of their allocation.

The abundance index (mean number per tow) from the NEFC autumn bottom trawl survey increased 88% from 1979 to 1980 to about the 1977 level and 37% above the 1968-1979 average. The pre-recruit abundance index increased 79% from 1979 to 1980 and was 20% above the long-term average. Based on these results, the stock during the 1981-1982 fishing year should be at a relatively high level of abundance.

For further information see:

Lange, Anne M.T. Stock status and estimates of potential yields of squid (*Loligo pealei* and *Illex illecebrosus*) populations off the Northeastern USA. NMFS, NEFC, Woods Hole Lab. Ref. No. 81-29, 21 p.

Table 38. Landings (thousand metric tons) and management information for the long-finned squid (*Loligo*) from the Middle Atlantic to the Gulf of Maine, 1974-1980.

	YEAR						
	1974	1975	1976	1977	1978	1979	1980
US recreational landings	-	-	-	-	-	-	-
Commercial landings							
US	2.3	1.6	3.6	1.1	1.3	3.9	3.9
Canada	-	-	-	-	-	-	-
Other	32.6	32.2	21.7	15.6	9.4	13.2	15.3
Total landings	34.9	33.8	25.3	16.7	10.7	17.1	19.7
Total allowable catch	(1)	(1)	44.0	44.0	44.0	44.0	44.0

Long-term potential catch = 44

Importance of recreational fishery = Insignificant

Status of management = FMP in force since 1979

Status of exploitation in 1980 = Underexploited

(1) Total allowable squid (*Loligo* and *Illex* combined) catch of 71,000 tons.

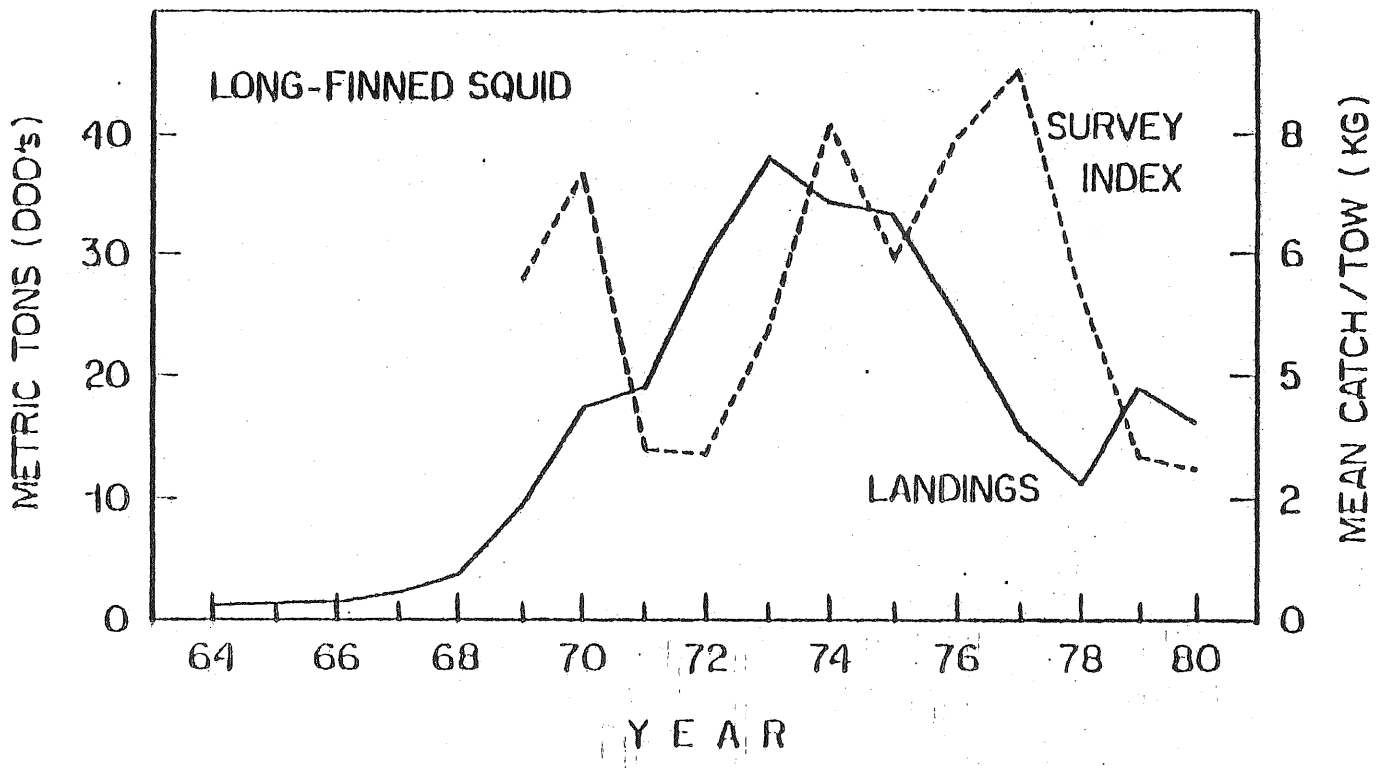

Figure 36. Landings and indices of abundance from the autumn research vessel surveys for long-finned squid from the Gulf of Maine to Mid Atlantic areas.

AMERICAN LOBSTER

The American lobster (Homarus americanus) occurs along the east coast of North America from Labrador to Cape Hatteras, North Carolina from the surf zone to the Continental slope waters 700 m deep. In US coastal waters (≤19 km) lobsters are most abundant from Maine to New Jersey while the heaviest offshore (>19 km from shore) concentrations occur in the Georges Bank-southern New England region. Smaller concentrations occur off southwest Nova Scotia, in the Gulf of Maine, and south of Hudson Canyon. Tagging studies have generally indicated only localized movements of lobsters, in coastal areas, although the localized recoveries may be due to the size of the lobsters and heavy fishing pressure. There is evidence that larger lobsters tend to undertake more extensive migrations than smaller lobsters. Offshore lobsters in the outer shelf region of Georges Bank and southern New England appear to be rather mobile, exhibiting both lateral movement along the shelf edge and shoalward migrations in spring with a return to deeper waters in the autumn. Interrelationships between inshore and offshore lobster populations have not been resolved. Relatively little is known concerning larval distribution, abundance, and recruitment, particularly the relationship between offshore lobsters and inshore recruitment.

Recent (1973-1979) recreational and commercial lobster landings for the US and Canada from Maine to North Carolina averaged 14,672 metric tons (Table 34). Total US commercial landings averaged 12,488 MT during 1950-60 and increased to 15,500 MT by 1970. Landings decreased to 13,000 MT in 1974 and subsequently increased to 16,700 in 1980 (Figure 37). No foreign fishery exists for lobsters and recreational catches are relatively minor, averaging 203 MT during 1976-79 (Table 39).

The US commercial offshore lobster fishery is conducted 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 relatively minor. The offshore fishery is currently centered in the Georges Bank-southern New England region off Massachusetts and Rhode Island. From 1974-79 the bulk of the catch (58%) was taken in southern New England waters, and Georges Bank accounted for most of the remainder (34%).

Annual offshore (beyond 19 km or 12 miles) catches increased gradually from 87 tons in 1951 to 801 tons in 1960. Catches by 1969 increased substantially to 3,139 tons by 1969, peaked at 3,982 tons in 1972, and subsequently declined to 2,618 tons in 1973. Offshore catches during 1974-78 stabilized at approximately 2,600 tons per year but declined from 2,704 tons in 1978 to 2,000 tons (preliminary) in 1980, the lowest catch since 1967 (Figure 37). Statistics for the offshore and inshore fisheries may 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 remaining relatively stable at about 200 tons during 1972-75. The

catch increased to 240 mt in 1979 and declined slightly to 195 mt in 1980. Recent Canadian effort on Georges Bank has been concentrated on the southeast edge in the vicinity of Corsair Canyon.

The NMFS spring bottom trawl survey catch-per-tow index declined from an average of 0.50 kg in 1976 to an average of only 0.25 kg during 1978-80, while the corresponding autumn survey index declined from 1.75 kg in 1976 to an average of 0.60 kg in 1978-80.

Recent analyses indicate that a substantial increase in yield could be achieved by reducing fishing mortality and increasing age at entry to the fishery. The value of F_{max} is estimated to be between 0.06 and 0.12 for the offshore fishery depending on estimated natural mortality. Estimated instantaneous fishing mortality rates based on length composition samples collected in 1979 range from 0.47 to 1.54 depending on the area and sex. The continued expansion of this fishery, indicated by increasing numbers of traps fished in recent years, may result in continued declines in stock abundance.

For additional information see:

Anthony, V.C., and J.F. Caddy (editors). 1980. Proceedings of the Canada-US workshop on status of assessment science for N.W. Atlantic lobster (Homarus americanus) stocks (St. Andrews, N.B., Oct. 24-26, 1978).

Burns, T.S., S.H. Clark, V.C. Anthony, and R.J. Essig. 1979. Review and assessment of the USA offshore lobster fishery. ICES CM 1979/K:25, 31 p.

Table 39. Commercial and recreational landings (metric tons, live weight) of American lobster from the Northwest Atlantic (Maine to North Carolina)[1], 1973-1979.

	YEAR							
	1973	1974	1975	1976	1977	1978	1979	1980
US recreational landings								
State Waters	--	--	--	.2	.2	.2	.2	.2
Commercial landings								
US: FCZ	2.7	3.5	3.4	3.9	3.0	3.3	2.4	2.0
State Waters	10.5	9.3	9.7	10.5	11.4	12.4	14.5	14.7
Canada: Georges Bank	.2	.1	.2	.2	.3	.3	.3	.2
Other	--	--	--	--	--	--	--	--
Total Catch	13.4	12.9	13.3	14.8	14.9	16.2	17.4	17.1
Total allowable catch	--	--	--	--	--	--	--	--

Offshore (greater than 12 miles)

Long term potential catch	=	3,400 tons
Importance of recreational fishery	=	insignificant
Status of management	=	FMP in preparation
Status of exploitation in 1980	=	fully exploited

[1] Source of landings data: 1973-1980 - Fisheries of the United States (1973-1979); 1976-1980 - Unpublished state recreational landings data.

[2] Landings include all states except Maine and New Jersey, where recreational landings are unknown but considered insignificant (less than 10% of the respective state landings). Thomas J., pers. comm., ME Dept. of Mar. Res., West Boothbay Harbor, ME, 24 Sept., 1980; Andrew, W.D., pers. comm., NJ Dept. of Envir. Protection, Absecon, NJ, 23 July 1980.

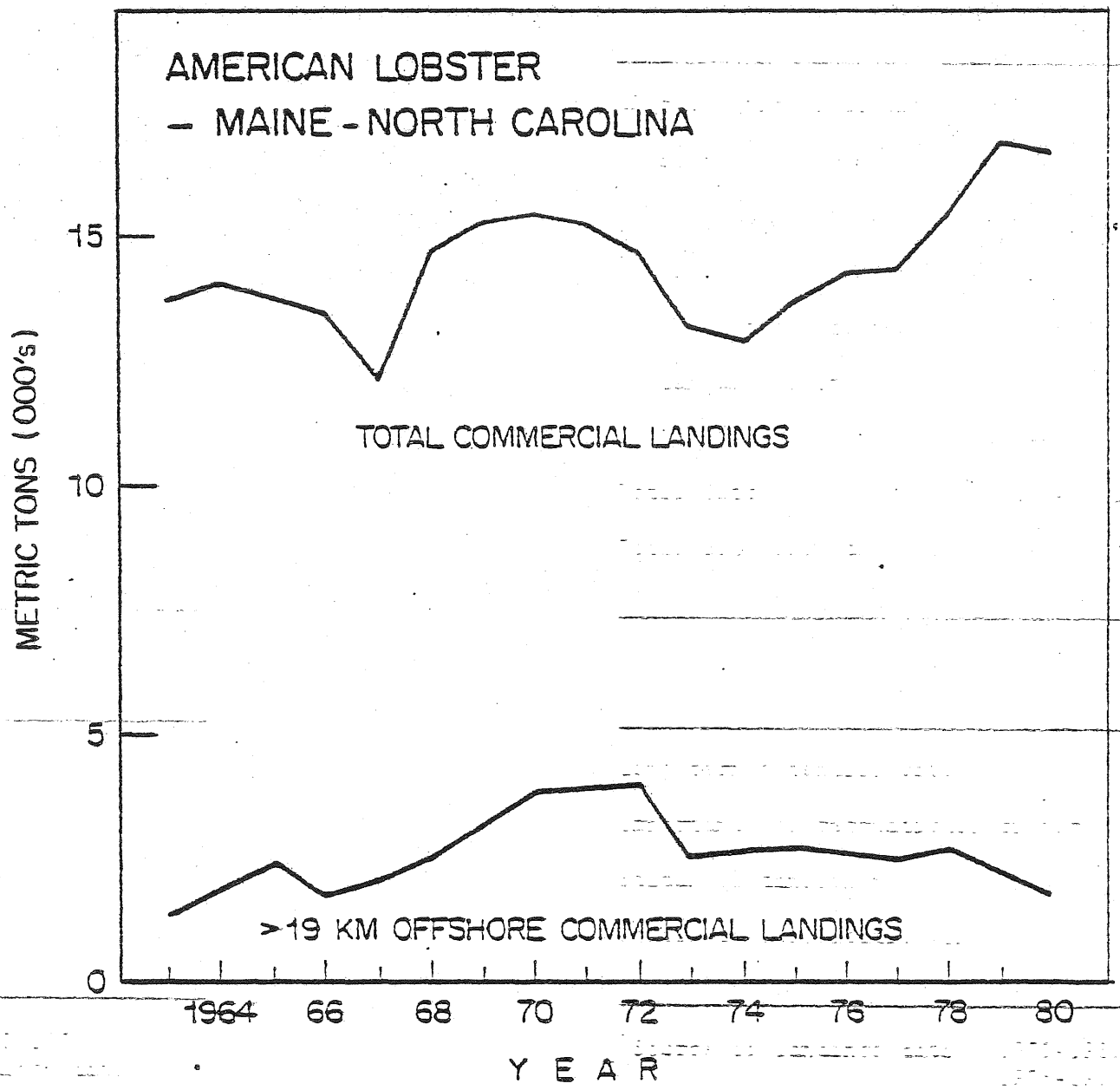

Figure 37. Total landings of American lobster from Maine to North Carolina compared with landings of lobsters in the offshore (greater than 19 km or 12 miles) area.

NORTHERN SHRIMP

The northern shrimp (Pandalus borealis) supports important commercial fisheries in the North Atlantic and the North Pacific; the Gulf of Maine marks the southernmost extent of its Atlantic range. Distribution within the Gulf appears to be governed in large measure by temperature conditions; highest concentrations occur in the southwestern corner of the Gulf of Maine where temperatures are coolest, and seasonal shifts in abundance appear to correlate well with localized temperature trends. Historical trends in abundance also appear attributable in large measure to environmental conditions, although the impact of apparently unfavorable temperatures in recent years is difficult to quantify due to high levels of fishing effort. This population appears to be discrete from other groups and there is no evidence to indicate significant movement into or out of the Gulf of Maine.

Northern shrimp are protandric hermaphrodites, maturing first as males (generally at 2½ years of age); they then pass through a series of transitional stages and mate as females the following summer at age 3½. During autumn and winter, egg bearing (ovigerous) females migrate into inshore areas, where the eggs hatch. These shrimp may survive to spawn in subsequent years, although natural mortality appears to increase sharply after first hatching.

Since 1974, the fishery has been managed by indefinite seasonal closures and mesh size regulations; a quota of 1,600 tons (3.5 million pounds) was also imposed in 1977 (Table 40). Available biological data and yield per recruit studies indicate that a late winter-early spring fishery employing 4.5 cm (1.75 inch) mesh trawls would enhance prospects for recruitment and for achieving maximum yield.

Commercial landings peaked at an all-time high of 12,800 tons in 1969, averaged approximately 11,000 tons from 1970-1972, and then declined precipitously to only 400 tons in 1977 (Table 40 and Figure 38); landings in 1979 totalled approximately 500 tons, and preliminary statistics for 1980 indicate landings of approximately 300 tons. The Maine summer survey index declined from 45.8 kg per tow in 1968 to 1.6 kg in 1977 before increasing to 4.4 kg in 1979; the 1980 index value was 2.7 kg. NEFC spring and autumn survey data indicate declines in abundance of over 90% between the late 1960's and 1977-1978; subsequently, the spring survey index increased from 0.3 kg per tow in 1978 to an average of 0.9 kg in 1979-1980, while the NEFC autumn survey index increased from 0.2 kg in 1977 to 0.5 kg in 1979-1980. NEFC summer survey data also indicate an increasing trend during 1977-1980. Nevertheless, recent index values are substantially below those observed in the late 1960's and early 1970's. Stock biomass estimates (age 2+) calculated from annual landings data and mortality and exploitation rates determined from Maine summer survey data declined from an average of 21,000 tons in 1969-1970 to an average of only 1,000 tons during 1977-1979.

For further information see:

Clark, S.H., R.J. Essig, and D. Hansford. MS 1979. Gulf of Maine northern shrimp - current states and future outlook. Nat. Mar. Fish. Serv., Woods Hole, Lab. Ref. Doc. No. 79-51, 31 p.

Northern Shrimp Scientific Committee. MS 1980. Gulf of Maine northern shrimp stock status - 1980, 26 p.

Table 40. Landings (thousand metric tons) and management information for northern shrimp from the Gulf of Maine area.

	Year							
	1973	1974	1975	1976	1977	1978[1]	1979[2]	1980[3]
US recreational landings	-	-	-	-	-	-	-	-
Commercial landings								
US	9.4	7.9	5.3	1.0	0.4	-	0.3	0.3
Canada	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-
Total landings	9.4	7.9	5.3	1.0	0.4	-	0.3	0.3
Total allowable catch	-	-	-	-	1.6	-	-	-

Long-term potential catch = N/A

Importance of recreational fishery = Insignificant

Status of management = Jointly by participating states under Amendment One, ASMFC Compact

Status of exploitation in 1980 = Fully exploited

[1]Fishery closed during 1978.

[2]Provisional (incomplete).

[3]Preliminary.

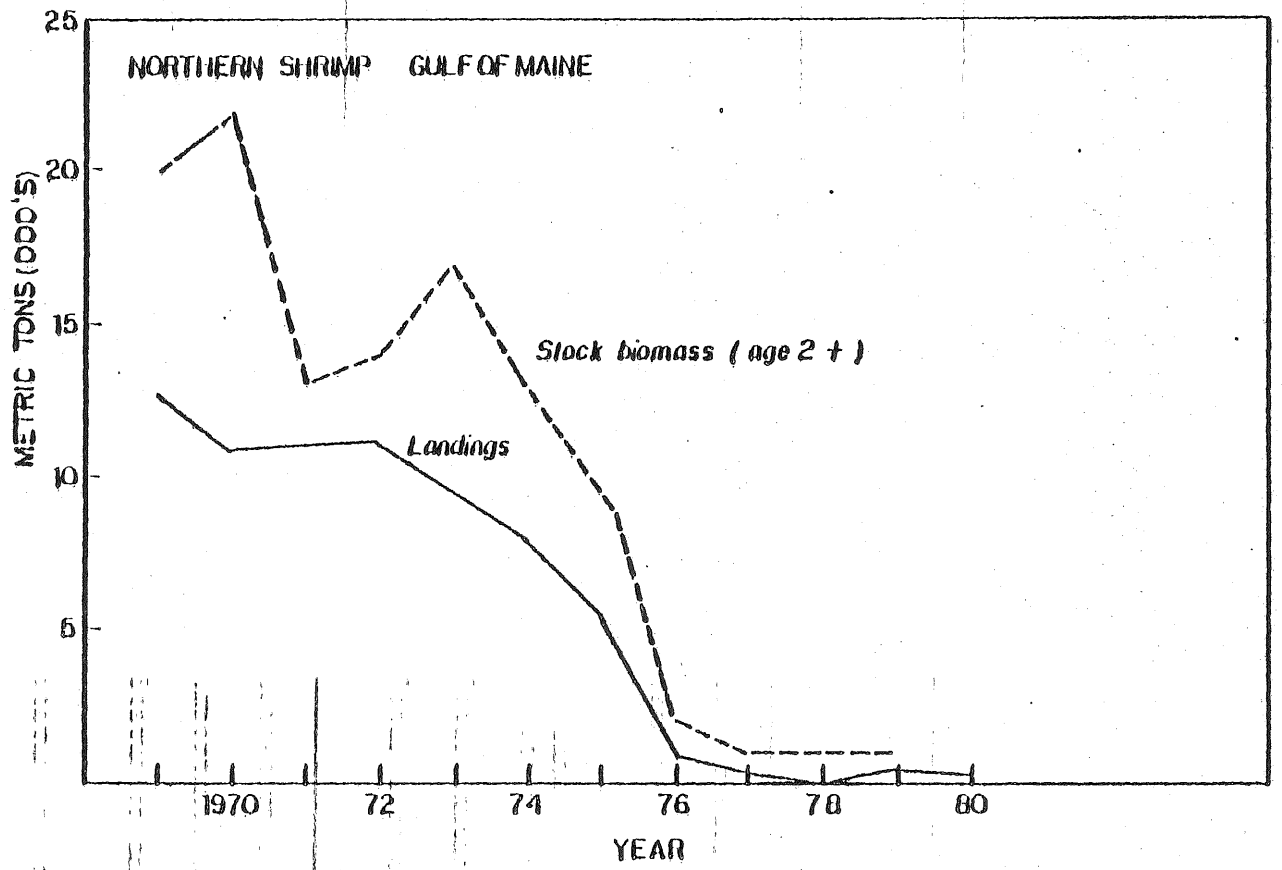

Figure 38. Landings and estimates of stock biomass for northern shrimp from the Gulf of Maine area.

RED CRAB

The deep-sea red crab, Geryon quinquedens is a relatively large deep water crustacean distributed along the continental slope of the Northwest Atlantic ocean generally in depths from 100 to 1500 meters (60-800 fathoms). The largest red crabs (males) may attain a carapace width of 178 mm (7 inches) and weigh about 1.36 kg (3 pounds); growth rate of adult crabs is slow and molting may not occur more frequently than at two to three year periods. Maturity occurs at about 80-91 cm (3.2-3.6 inches) carapace width for females, after which molting ceases or becomes quite infrequent.

The directed commercial fishery for red crab began in 1973 in response to declines in the offshore lobster fishery and fishery development efforts directed toward improving the harvesting, processing, and marketing of this species.

Landings in 1980 were 2547 t over twice as large as in 1979, and a record high for the fishery (Table 41 and Figure 39). Catches from Georges Bank - Southern New England waters accounted for 62% of the 1980 USA harvest; the remaining 33% or 836 t was derived from the Middle Atlantic region. This latter fishery, initiated in 1977, had developed primarily in the Baltimore and Norfolk Canyon areas. Foreign fishing for red crab is not authorized since this species is identified as a continental shelf fishery resource.

Estimates of standing crop biomass of commercial-sized (≥4½ inches carapace width) red crabs in the offshore areas between eastern Georges Bank and northern Maryland, derived from a research survey performed in 1974, indicated that approximately 26,700 t of red crab existed within the surveyed regions. Greatest concentrations of commercial biomass were off Southern New England (46% of total) and Georges Bank (31% of total). Densities of red crab in the Norfolk Canyon area determined from research surveys in 1975 and 1976 by the Virginia Institute of Marine Science were 50-95% lower than those observed for the more northeasterly continental shelf and slope regions.

Average annual maximum sustained yield for the red crab resources between Georges Bank and offshore Maryland has been initially estimated to be about 2,700 t (5.9 million pounds). The 1980 USA total catch approximates 94% of the estimated MSY.

For further information see:

Serchuk, F.M. 1977. Assessment of red crab (Geryon quinquedens) populations in the Northwest Atlantic, September 1977. Northeast Fisheries Center, Woods Hole Laboratory, Lab. Ref. Doc. No. 77-23, 15 p.

Table 41. Commercial landings (metric tons, live weight) of red crab from the Northeast Coast of the United States.

Commercial Landings	YEAR 1973	1974	1975	1976	1977	1978	1979	1980
USA	112	520	313	702	1,245	1,432	1,216	2,347
Total	112	520	313	702	1,245	1,432	1,216	2,347

Long-term potential catch = 2700

Importance or recreational fishery = None

Status of management = None

Status of exploitation in 1980 = Becoming fully exploited

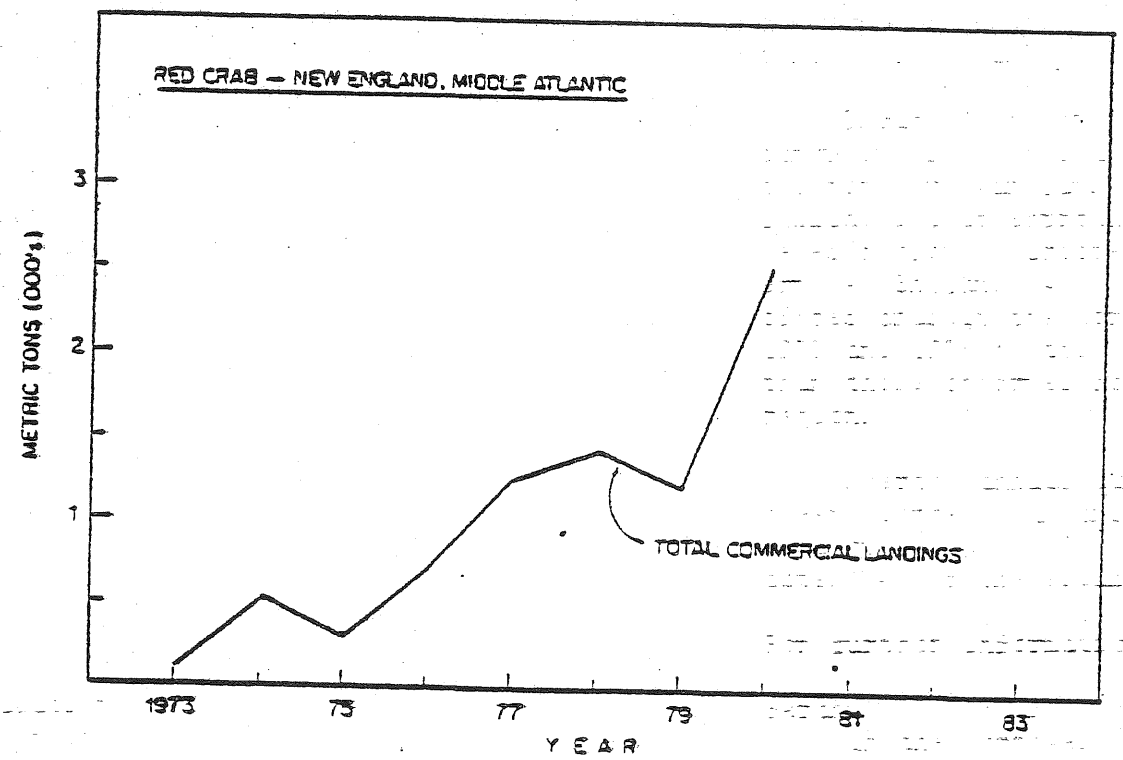

Figure 39. Landings of red crab from the Gulf of Maine to Middle Atlantic areas.

SURF CLAM

Surf clams, Spisula solidissima, are distributed in western North Atlantic waters from the southern Gulf of St. Lawrence to Cape Hatteras. Commercial concentrations are found primarily off New Jersey and the Delmarva Peninsula although some fishable quantities exist in southern New England waters. In the Middle Atlantic region surf clams are found from the beach zone to a depth of about 60 m; beyond 40 m, however, abundance is low. Growth rates are relatively rapid with clams reaching commercial size (≥12 cm shell length) in about 5 years. Maximum size is about 22.5 cm but clams larger than 20 cm are rare. Surf clams are capable of reproduction at the end of their first year of life, however, most do not spawn until the end of the second year. Eggs and sperm are shed directly into the water column; recruitment to the bottom occurs after a planktonic larval period of about 3 weeks (at 22°C).

Resources in the US FCZ (3-200 n. miles from the coast) are regulated under an FMP developed by the Mid-Atlantic Fishery Management Council, effective November 1977. An annual quota equivalent to 14,000 t of shucked meats is supplemented by a moratorium on new vessel entrants to the fishery (ca. 160 vessels), weekly effort limitations, and limited closures of areas to protect dense sets of pre-recruit sized clams. Two distinct management units (Southern New England, Middle Atlantic) are identified in the plan reflecting the different status of resources and fisheries within these areas.

Intensive fishing for surf clams was initiated during the post-World War II era in response to increased demand and dwindling supplies of traditional clam species. Almost all of these early landings were taken off Long Island and northern New Jersey. Extensive offshore beds were discovered and developed off Pt. Pleasant during the 1950's; combined with inshore beds near Cape May - Wildwood, New Jersey resources supported the fisheries until the early 1970's. Declining productivity of New Jersey fishing areas prompted a shift of effort to the south during the early 1970's. New beds off southern Virginia and North Carolina contributed to a tremendous increase in total landings during 1973-1975 (Table 42 and Figure 40). Average catches in these three years of 40,100 t (meat) were 50% greater than the 1965-1977 average of 27,000 t. The southern Virginia - North Carolina fishery collapsed during 1976 and most vessels moved to the ports of Chincoteague, Virginia, and Ocean City, Maryland where the fishery is currently centered.

Synoptic research vessel surveys of Middle Atlantic surf clam resources have been conducted intermittently since 1965. In all cases commercial-type hydraulic clam dredges, modified to retain pre-recruit sizes, were used as survey gear. Indices of abundance were adjusted to reflect differences in the dimensions of gear and operational procedures employed.

Abundance indices from research vessel surveys generally parallel trends in landing statistics from various portions of the management area. The stock abundance and landings of surf clams declined steadily off the Northern

New Jersey Coast from the mid-1960's to 1977. A mass-mortality of clams in the northern New Jersey area during summer 1976 reduced commercial-sized clams to extremely low levels. Subsequent surveys of the area during 1978, 1979, and 1980 have indicated the existence of a large pre-recruit resource (1976 year class) in the area subjected to the clam kill. Estimates of modal size groups present in the population and previous growth rate studies suggest these clams will reach exploitable sizes (≥12 cm) during 1981.

Abundance off the Delmarva Peninsula was maintained until the return of the fleet from southern Virginia - North Carolina during 1976. Concentration of the offshore fishery in Delmarva waters during 1976-1977 resulted in declining stocks of commercial sizes. Recent surveys indicate the abundance of commercial sizes has remained low although significant pre-recruit resources (1977 year class) presently exist off Delmarva. However, modal sizes, imply that recruitment to the exploitable population (≥12 cm) will not occur until 1982.

For additional information see:

Serchuk, F.M., and S.A. Murawski. 1980. Assessment and status of surf clam *Spisula solidissima* (Dillwyn) populations in offshore Middle Atlantic waters of the United States. NMFS, Woods Hole Lab. Ref. 80-33, 46 p.

Table 42. USA commercial landings (metric tons, meat weight) of surf clams from USA Northwest Atlantic waters, 1973-1980.

	YEAR							
Landings	1973	1974	1975	1976	1977	1978	1979	1980
USA: beyond 3 miles	32,922	33,761	20,081	19,304	19,490	14,240	13,186	15,748
USA: less than 3 miles	4,441	9,834	19,362	2,983	3,660	3,558	2,650	1,369
Total	37,363	43,595	39,443	22,287	23,150	17,798	15,836	17,117
Total Allowable Catch: beyond 3 miles (FCZ)	--	--	--	--	---	14,000	14,000	14,000

Long term potential catch: ~23,000

Importance of recreational fishery: Insignificant

Status of Management: FMP in force since November 1977

Status of exploitation in 1980: Fully exploited

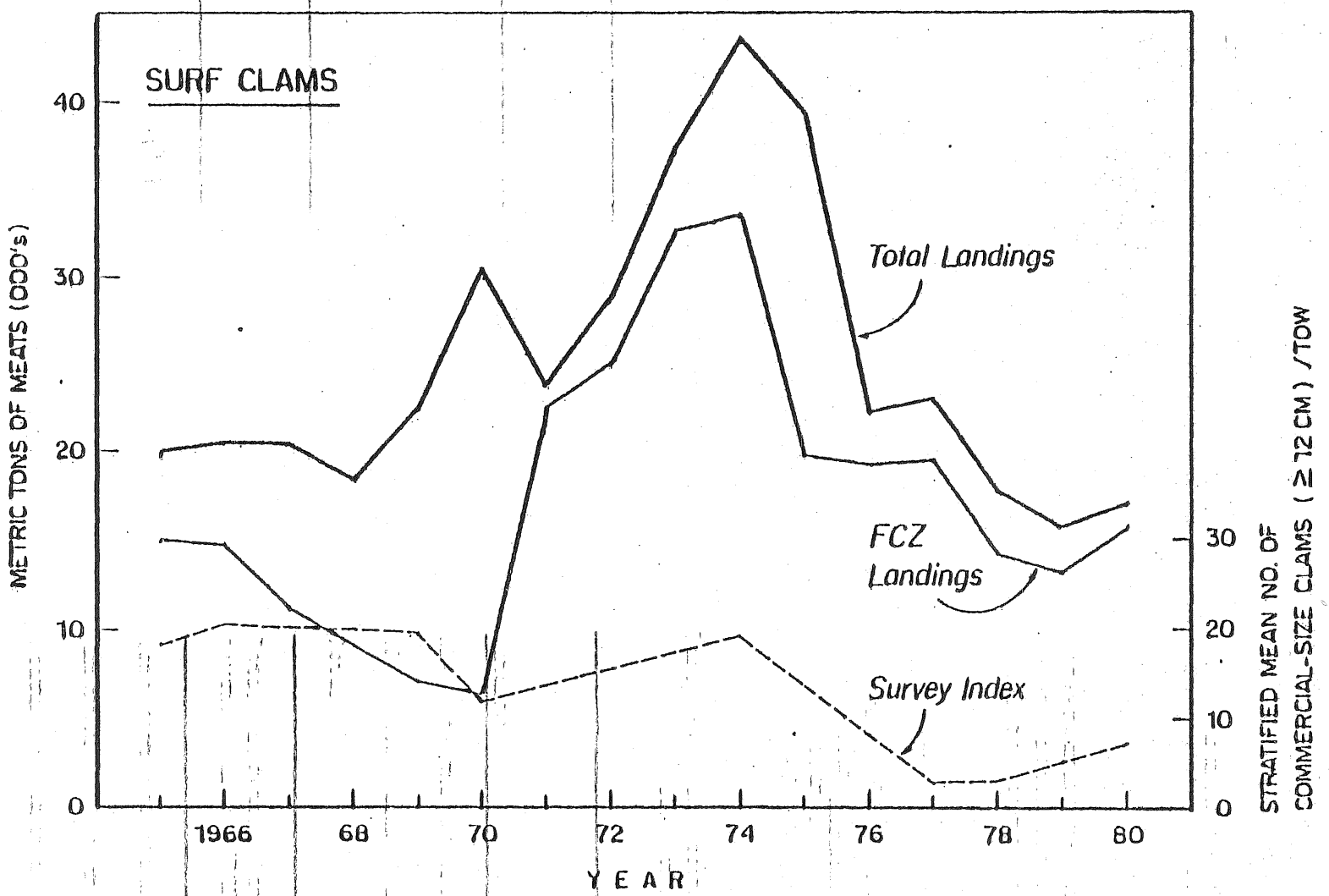

Figure 40. Total landings, landings from the Fisheries Conservation Zone and indices of abundance from research vessel surveys for surf clams from the Gulf of Maine to the Middle Atlantic areas.

OCEAN QUAHOG

The ocean quahog, Arctica islandica, is found in temperate and boreal waters on both sides of the North Atlantic Ocean. Distribution ranges from Newfoundland to Cape Hatteras in depths from 8 to 256 m in the western Atlantic. Quahogs are rarely found where bottom water temperatures exceed 16°C and thus occur progressively further offshore between Cape Cod and Cape Hatteras. Highest densities in the Middle Atlantic region are between 40 and 60 m depths; few quahogs have been found in the Mid-Atlantic in excess of 100 m. Results of recent age and growth studies indicate ocean quahogs are extremely slow growing and long-lived compared to other continental shelf pelecypods. Specimens averaging 77 mm (shell length) marked off Long Island during 1978, grew about 0.5 mm in one calendar year. Analyses of a series of length frequency data, and examination of banding patterns of small individuals corroborate slow growth rates impled from mark-recapture studies. Spawning apparently occurs over a protracted interval from summer through autumn; little is known of larval and juvenile life history.

Harvesting of ocean quahogs was initiated during World War II off Rhode Island. Total landings, however, never exceeded 1,000 t of shucked meats until 1976 when offshore exploitation began off New Jersey and Maryland. Steady declines in offshore surf clam stocks combined with the massive kill of clams off New Jersey in 1976 stimulated fishing for the deeper dwelling ocean quahog. Landings off New Jersey and the Delmarva Peninsula accounted for more than 90% of the 1980 total of 15,346 t (Table 43 and Figure 41). The fishery is currently most intensively prosecuted from the ports of Cape May, New Jersey, and Ocean City, Maryland.

A series of seven research vessel surveys conducted by the NMFS during 1965-1977 has been used to map distribution and estimate size composition and abundance in the Middle Atlantic region. Commercial type hydraulic clam dredges have been used as sampling gear during all the surveys. Gear dimensions and durations of tows varied somewhat and were thus standardized to assess relative abundance over time. Indices of relative abundance and minimum densities were computed for 20 m depth intervals in three areas where most sampling activity occurred: Long Island, New Jersey, and the Delmarva Peninsula.

The most striking feature of the abundance data is its stability over time. In general, quahog abundance in any particular area/depth stratum did not change significantly during the 13-year study period. Depths from 40 to 60 m generally exhibited the highest indices and greatest proportion of tows successfully capturing quahogs (>90%). Quahog biomass was greatest off Long Island followed by New Jersey and Delmarva. Estimates of absolute abundance are minimal to the extent survey dredges were less than 100% efficient in sampling. Average population size for the survey area was 1.5×10^6 MT of meat; 46% off Long Island, 44% off New Jersey, and 10% off Delmarva.

Estimates of maximum sustainable yield for the Middle Atlantic ocean quahog resource range from 3,000-45,000 MT depending on natural mortality

rate (M) and the dredge mortality on unharvested quahogs. If M = 0.027 (equivalent to 0.7% of the population surviving to an age of 100 years), MSY is 15,000 to 23,000 t for Middle Atlantic stocks.

Annual quotas established under the surf clam-ocean quahog management plan were 13,600 t in 1978 and 1979, 15,876 t in 1980, and 18,144 t for 1981. These values thus reflect average MSY's considering the range of population parameters used. Fishing effort is currently highly disproportionate to stock biomass; virtually all offshore landings are from New Jersey and Delmarva. Localized declines in quahog abundance will probably result from current harvest patterns although the long-term impacts from these reductions are speculative. On-going monitoring programs should establish if declines in stock density enhance recruitment and result in accelerated growth rates. Cumulative annual FCZ landings during 1976-1980 comprised about 3% of the estimated accumulated stock biomass in the region from Long Island through Delmarva. Thus, even if growth and recruitment remain poor, large declines in total stock abundance are not expected in the immediate future.

For additional information see:

Serchuk, F.M., and S.A. Murawski. 1980. Evaluation and status of ocean quahog, Arctica islandica (Linnaeus), populations off the Middle Atlantic coast of the United States. Woods Hole Lab. Ref. 80-32, 7 p.

Table 45. USA commercial landings (metric tons, meat weight) of ocean quahogs from USA Northwest Atlantic waters, 1973-1980.

Landings	1973	1974	1975	YEAR 1976	1977	1978	1979	1980
USA: beyond 3 miles (FCZ)	--	--	--	1,355	7,296	9,199	14,347	13,388
USA: less than 3 miles	661	365	369	656	1,118	1,218	1,404	1,458
Total	661	365	369	2,311	8,414	10,417	15,751	15,346
Total Allowable Catch:	--	--	--	--	--	13,600	13,600	15,376

Long term potential catch = Unknown

Importance of recreational fishery = Insignificant

Status of management = FMP in force since November 1977

Status of exploitation in 1980 = Fully exploited in some areas

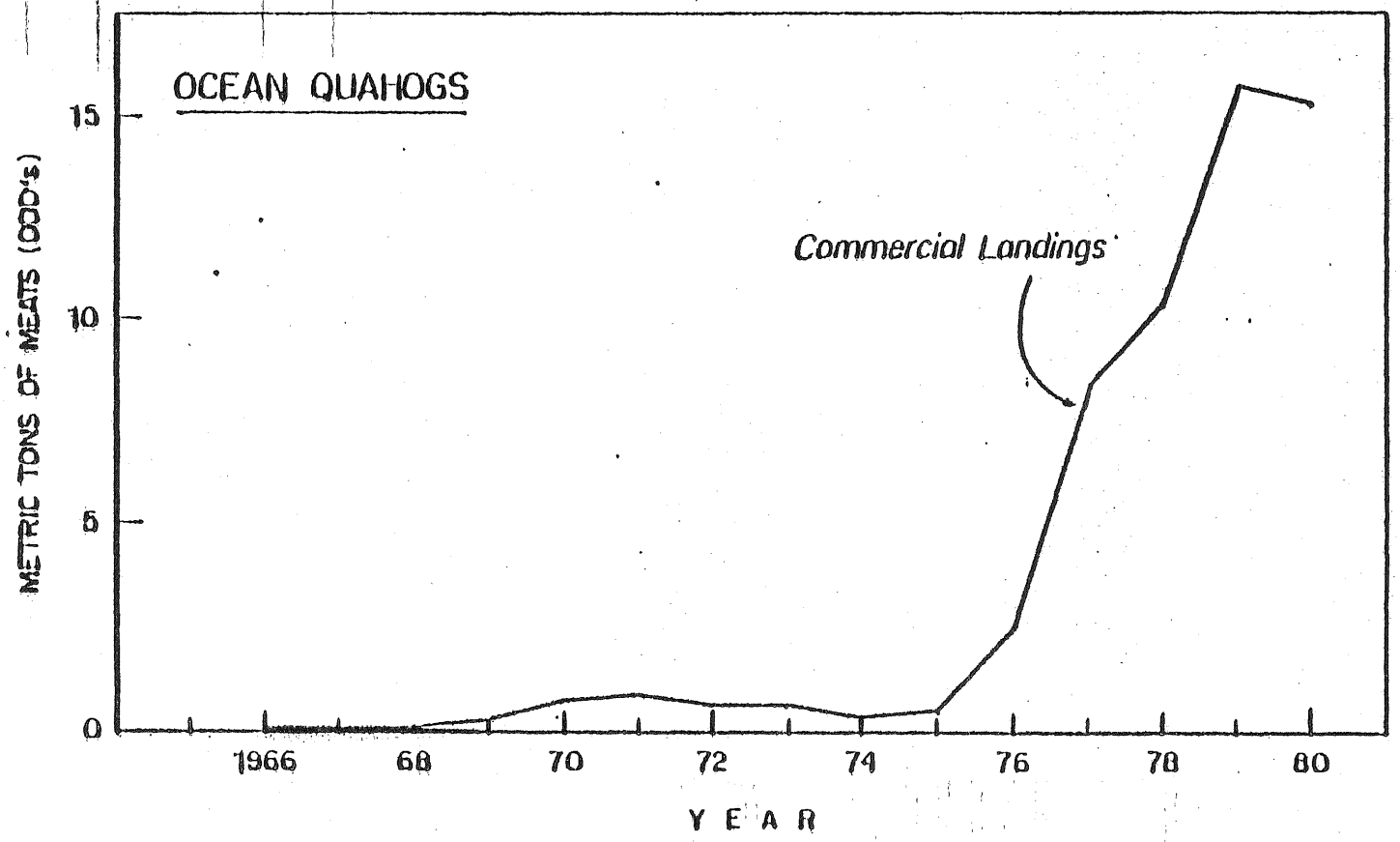

Figure 41. Landings of ocean quahogs from Southern New England and the Mid Atlantic area.

SEA SCALLOPS

Sea scallops (Placopecten magellanicus) are distributed in western North Atlantic continental shelf waters from the Strait of Belle Isle, Newfoundland, to Cape Hatteras, North Carolina. North of Cape Cod, scattered concentrations may occur in shallow water less than 20 m, but in more southerly and in offshore areas, scallops normally are found between 40 and 200 m depths. Commercial concentrations generally exist between 40-100 m in waters cooler than 20°C. Principal USA commercial fisheries are conducted in the Gulf of Maine, on Georges Bank, and in the Middle Atlantic offshore region. Recreational fishing is insignificant occurring primarily in Maine where shallow water scallop beds frequently exist.

Scallops grow rapidly during the first several years of life. Between ages 3 and 5, scallops commonly increase 50-80% in shell height and quadruple in meat weight. During this time span, the number of meats per pound is reduced from greater than 100 to about 23. Commercial size (≥70 mm shell height) is normally attained in about 3½ years. Maximum size is about 23 cm but scallops larger than 17 cm are rare. Sexual maturity commences at age 3 but scallops less than age 4 probably contribute little to total egg production due to their presumed low fecundity. Spawning occurs in late summer and early autumn, varying slightly between years and areas. Eggs are buoyant and larvae remain in the water column for 4-6 weeks until spatfall occurs.

Gulf of Maine

USA commercial landings of sea scallops from the Gulf of Maine in 1980 were 1,637 t, 1,203 t greater than in 1979, and a record catch in the fishery (Table 44; Figure 42). Approximately 70% of the 1980 landings were derived from the Fishery Conservation Zone (FCZ: >3 miles from shore) from newly discovered beds. Traditionally, the Gulf of Maine scallop fishery has exploited scallops inhabiting territorial waters. During 1973-1978, territorial water landings accounted for 91% of the total Gulf of Maine commercial catch.

USA spring and autumn offshore bottom trawl survey indices of scallops in the Gulf of Maine indicate differential scallop abundance in waters between 30-60 fm and 61-100 fm. In the 30-60 fm offshore region, catch per tow indices have been relatively stable since 1974. The 1980 and 1981 surveys indicate that the 1975 and 1976 year classes are dominant in the population. Most of the 1980 FCZ fishery is believed to have transpired on scallop beds in the 30-60 fm depth zone. In the 61-100 fm region, catch per tow indices in 1980 and 1981 markedly increased from former years, particularly during the spring surveys. The 1980 spring index was 33 scallops per tow; the 1981 index was 98 scallops per tow. During 1975-1979, the mean catch per tow value was 3 scallops per tow. Survey height frequency distributions in 1980 and 1981 indicate that recent increases in abundance are due to above average recruitment of the 1974-1976 year classes. Since little, if any, exploitation has occurred on the scallop beds in the 61-100 fm region, the long term productivity of these populations is not known. The extremely high survey indices during 1980 and 1981, however, suggest that current scallop densities may be sufficient to support development of commercial harvesting.

Table 44. Commercial landings (metric tons, meat weight) of sea scallops from Georges Bank, Mid-Atlantic, and the Gulf of Maine.

Commercial Landings	Year 1973	1974	1975	1976	1977	1978	1979	1980
Georges Bank (Area 5Z)								
USA	1,083	930	907	1,770	4,941	5,598	6,666	5,839
Canada	4,208	6,115	7,387	9,745	13,044	12,189	9.208	5,239
Total	5,291	7,045	8,294	11,515	17,985	17,787	15,874	11,078
Mid-Atlantic (Area 6) USA	857	1,569	2,769	6,576	5,904	8,641	7,156	5,090
Gulf of Maine (Area 5Y)	460	223	746	366	258	243	434	1,637
Grand Total	6,608	8,836	11,809	18,457	24,146	26,671	23,464	17,805
Total allowable catch	---	---	---	---	---	---	---	---

Long-term potential catch:

Georges Bank: 10,000 t
Mid-Atlantic: 5,000 t
Gulf of Maine: 250 t (territorial waters)

Importance of recreational fishery: Insignificant except in Gulf of Maine

Status of management: FMP in preparation

Status of exploitation in 1980: Fully exploited.

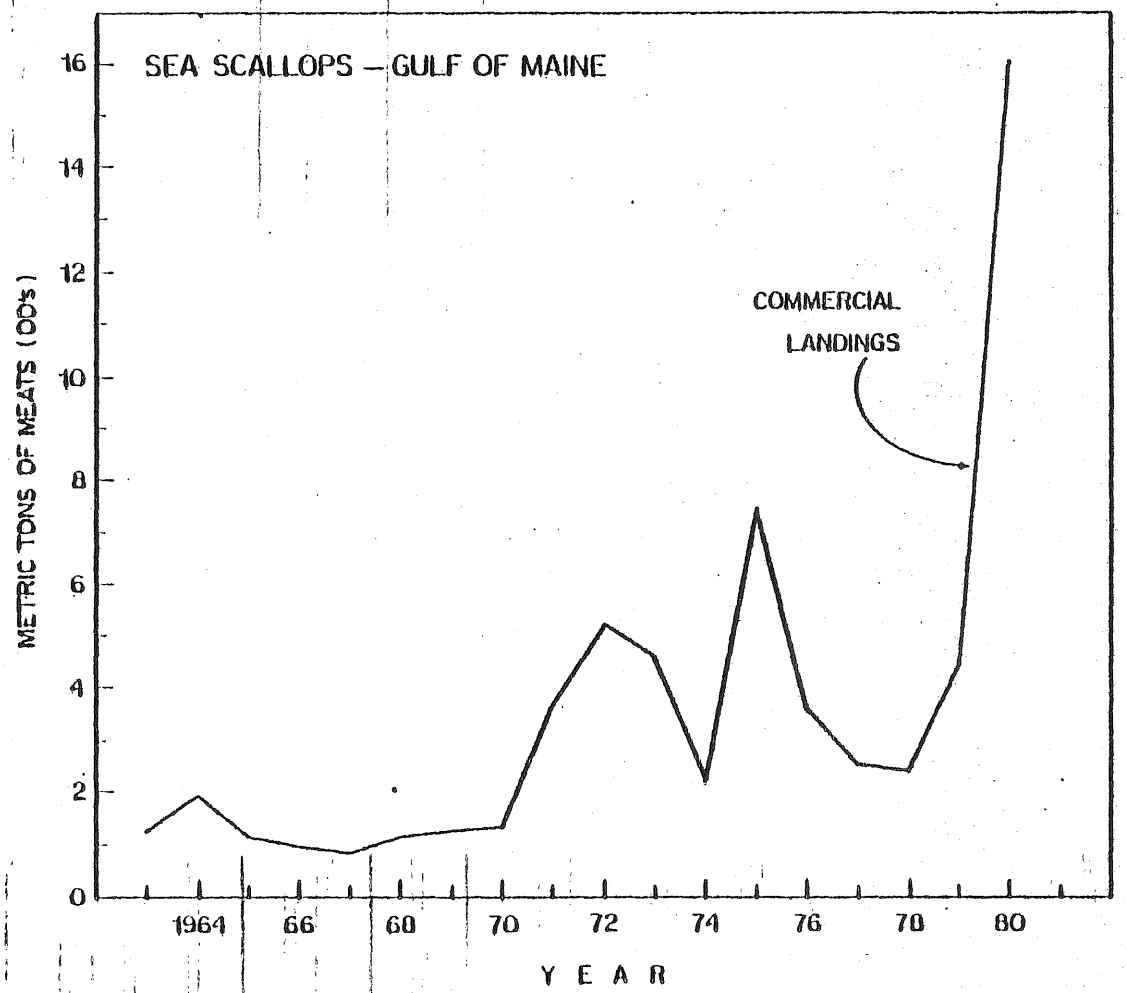

Figure 42. Landings of sea scallops from the Gulf of Maine area.

Georges Bank

Total international commercial landings in 1980 were 11,078 t (meat weight), 30% lower than in 1979, and the lowest annual catch since 1975 (Table 44; Figure 43). USA 1980 landings were 5,839 t, a decline of 12% from 1979. Canadian landings in 1980 were 5,239 t, 43% less than in 1979. Both USA and Canadian 1980 commercial catch per effort indices were about 28% lower than in 1979, and were nearly 50% less than the peak values achieved in the recent fishery during 1977. Since 1977, annual catch per effort indices in both fleets have sequentially declined implying a concomitant reduction in harvestable biomass.

The 1980 USA and Canadian sea scallop survey catch per tow indices of commercial sized scallops ($\geq$70 mm shell height) in the South Channel and Northern Edge and Peak areas of Georges Bank exhibited marked declines from 1979 (66% less for the South Channel; 50% less for the Northern Edge and Peak). Pre-recruit indices (<70 mm, shell height), however, were much higher in all areas during 1980 than in 1979 suggestive of very good to exceptional recruitment from the 1977 year class.

Both the USA and Canadian fleets began exploiting this year class in early 1981. Total landings for the first six months of 1981 were about 2,400 t higher than for the same time interval in 1980. Meat counts (number of scallops per pound) increased in 1981 as cull sizes were reduced in harvesting the 1977 year class, particularly on the Northern Edge and Peak. USA effort continued to shift toward the Northern Edge and Peak where densities of the 1977 year class were highest on the Bank.

The 1981 sea scallops survey indices indicated that total abundance of scallops in the South Channel and Southeast Part regions declined by greater than 50% from 1980. Total catch per tow values for each of these areas were the lowest in the 1975-1981 time series. Pre-recruit indices in both areas were also relatively low implying low level recruitment from the 1978 year class. The 1981 survey total catch per tow index on the Northern Edge and Peak declined from 1980 (-6%). The 1978 year class, however, appears to be above average in strength in this region.

The differential resource status of scallop populations in the three principal fishery regions on Georges Bank suggests that the Northern Edge and Peak region will become increasingly more important in sustaining the total Georges Bank scallop fishery. Since total combined USA and Canadian effort in 1980 was the highest on record, it is likely that fishing mortality will continue to remain high despite recent improved recruitment. Moreover, relatively poor resource conditions in the Mid-Atlantic sea scallop fishery will likely result in a continued displacement of USA fishing effort to the Georges Bank region. Without significantly improved recruitment in areas other than the Northern Edge and Peak, overall scallop abundance should further decline unless reduction in fishing effort are effected.

Mid-Atlantic

The 1980 commercial catch of Mid-Atlantic sea scallops, taken exclusively by the USA, was 5,090 t, a 29% decrease from 1979 and the lowest annual harvest since 1975 (Table 44; Figure 44). The commercial catch per day index of dredge vessels was 33% lower than in 1979, 63% lower than the peak 1977 index,

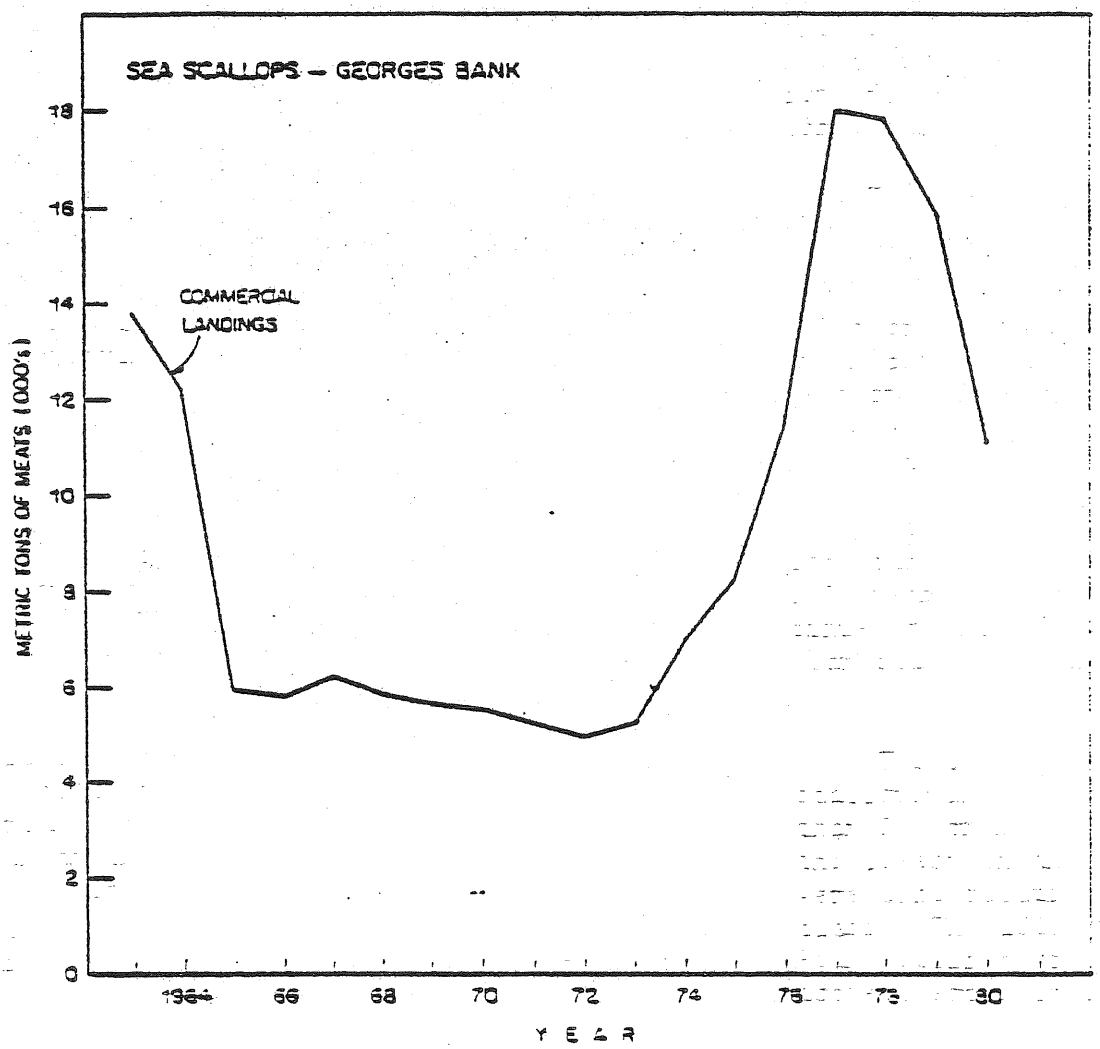

Figure 45. Landings of sea scallops from the Georges Bank area.

and the third lowest value in the 1965-1980 time series. Despite this decline in commercial catch rate, effort in the Mid-Atlantic fishery during 1980 was greater than 11,000 days fished, a record level.

Catch per tow indices from both the 1980 and 1981 USA sea scallop research surveys exhibited similar trends. In the Delmarva and Virginia-North Carolina regions, survey values have sequentially declined; the 1981 indices for both areas are the lowest in the 1975-1981 survey time series. Recruitment of the 1977 and 1978 year classes is relatively low in Delmarva and poor in Virginia-North Carolina offshore waters. No evidence of successful recruitment of the 1979 year class was observed in survey tows in either area. Survey total catch per tow indices in the New York Bight region were similar in 1980 and 1981, being about half of the 1975 index and among the lowest values in the 1975-1981 time series. Pre-recruit indices in both surveys suggest low to moderate recruitment from the 1977 and 1978 year classes. Recruitment of the 1979 year class may be better than these preceding cohorts since scallops from this year class were taken in the 1981 survey. Normally, two-year old scallops are seldom captured in survey tows.

The absence of significant recent recruitment throughout the Mid-Atlantic area in conjunction with high effort levels in the Mid-Atlantic fishery will continue to impede improvement of resource abundance in the near future.

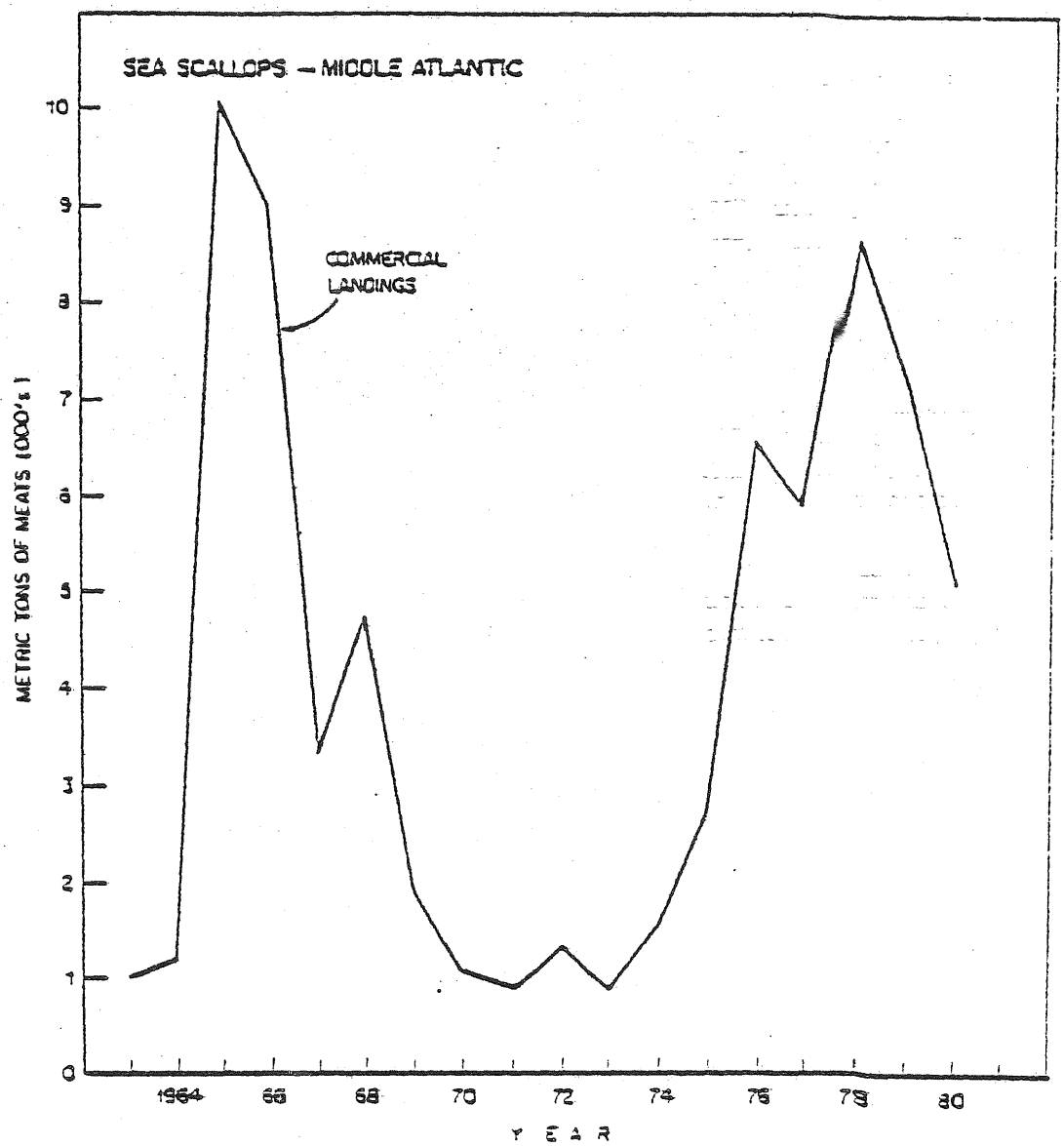

Figure 44. Landings of sea scallops from the Middle Atlantic area.