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Status of the Fishery Resources Off the Northeastern United States for 1982

Resource Assessment Division,
Northeast Fisheries Center

U.S. DEPARTMENT OF COMMERCE
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INTRODUCTION

The Assessment Division of the Northeast Fisheries Center (NEFC) with headquarters 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 1982. 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 differences in data and need for assessment information. 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, butterfish 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 fishery 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 replaced the fishing effort by the foreign vessels, NEFC assessment scientists have recently had to rely more on research vessel survey information rather 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 of the stock. The ability to estimate discard quantities for these fisheries is crucial for the production of accurate assessments. Recently for some fisheries, e.g., yellowtail flounder, the discards have decreased due to the acceptance of the smaller fish in the market. The definitions of the market categories, in fact, have recently changed in many ports. Since our sampling for catch at age is based on these categories to a large extent, this change in market definition has also produced problems in maintaining continuity in the assessments.

Fishing pressure on some species-stocks comes almost entirely from recreational fishermen and a great many other 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 a long time series of catch snd 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 research vessel survey indices of abundance.

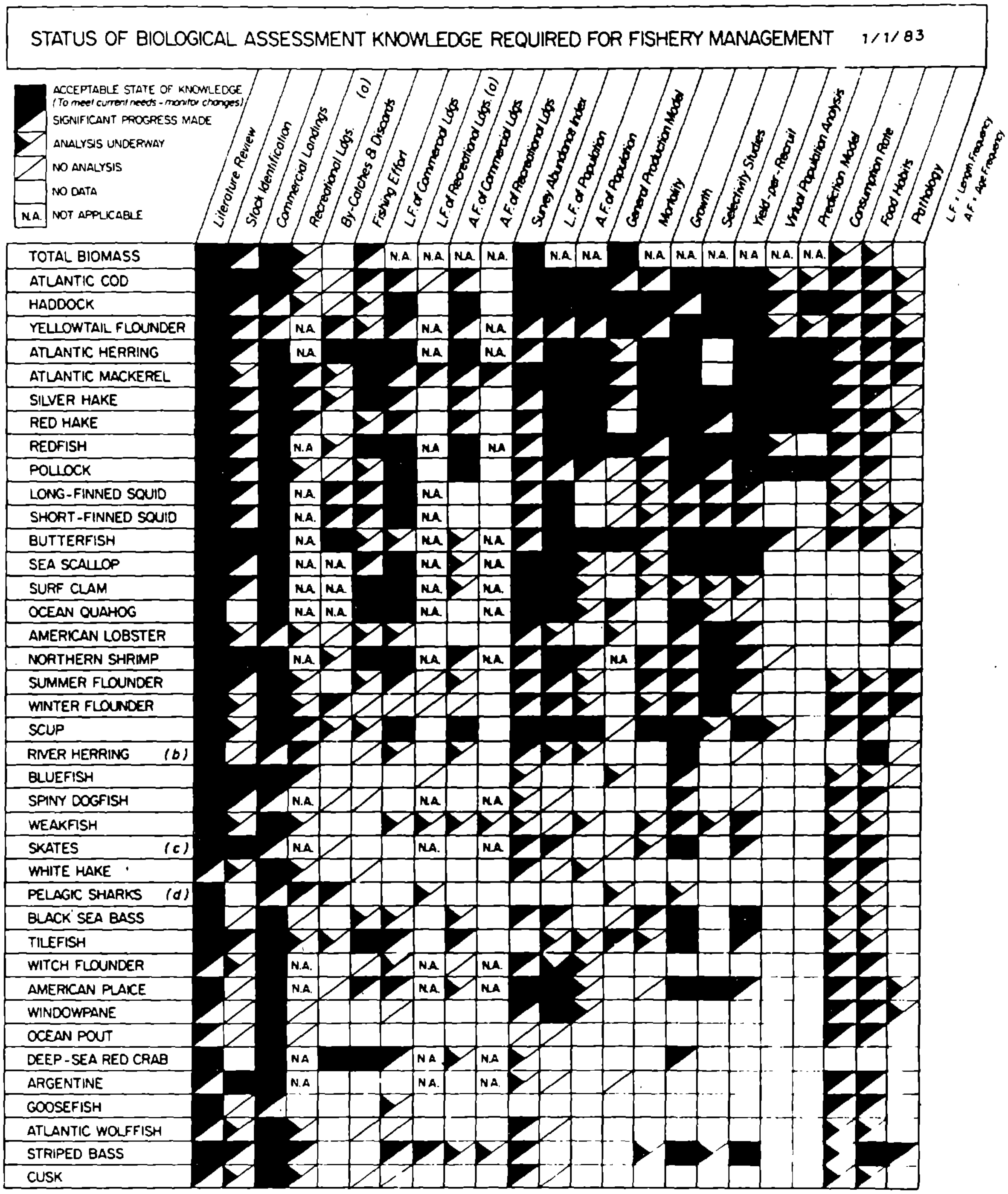
b) An assessment based on research vessel survey information, some biological knowledge concerning the species and general catch statistics.

c) Production models where stock size as a whole is estimated but the age composition of the catch 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 the items within the table still are not known. As fisheries become more intense, more of the categories will need to be filled in order to evaluate the effects of fishing on the resource, 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. Two columns in this table particularly address this situation, however. The assesment information is listed in Table 1 and in this report by single species generally. The first assessment--that of the total biomass, is an exception. Assessments are expressed by single species because many aspects such as biology, catch statistics,

Table 1.



(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

and population dynamics are best expressed in this way. Commercial catches for many of these species are caught, however, as part of a fishery for several species and management as well as assessments have to take this into consideration.

Certain assessment terms used throughout this document may not be familiar 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 equilibrium 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 regulated catch from a stock in a given time period, usually a year.

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. Instantaneous Total Mortality Rate (Z)
   It is the proportion of the population that die in a very small time interval but it is usually expressed on an annual basis. Instantaneous rates seem to be confusing but they are used in asssessments because they are

mathematically easy to use, e.g., they can be added directly while percentages cannot be. If 0.466% of a population dies each day all year long, for example, then the fishing mortality rate for that year is 0.00466 multiplied by 365 days or 1.7. The amount that dies each day differs 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. The proportion that actually dies during the year is, therefore, $1-e^{-1.7}$ or 0.8173.

8. Instantaneous Fishing Mortality Rate (F)

This is the instantaneous rate of death due to fishing, usually expressed over the entire year. If 0.411% of the population die each day from fishing, then 0.00411 multiplied by 365 days is the fishing mortality rate during the year, or in this case 1.5. If fishing were the only cause of death then 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 as the fishery that must be considered in calculating the number that die from fishing only. The number that die from fishing alone is the proportion that fishing is of the total mortality, multiplied by the number that die from all causes, i.e., F/Z multiplied by $(1-e^{-Z})$ multiplied by 1 million. If the total mortality rate is 1.7 as explained in item 7 above then this calculation is:

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

or

$$(0.8824) \quad (0.8173) \quad (1{,}000{,}000)$$

and

721,186 fish that die from fishing.

9. Instantaneous 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 and are of less immediate interest in themselves. The most important causes of natural death are predation, disease and cannibalism and are expressed separately when their rates of mortality are known. Following the examples given in items 7 and 8 above, M is equal to Z-F or 1.7-1.5 = 0.2. The number of fish that die during the year from natural causes is, therefore, the proportion of total mortality (Z) due to natural causes multiplied by the proportion that actually die multiplied by the population alive at the beginning of the year:

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

or

$$(0.1176)\ (0.8173)\ (1{,}000{,}000)$$

Therefore, 96,114 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 because some fish are caught by the fishery before they have the opportunity to die from predation etc. If the fishery did not exist, for example, an M of 0.2 applied over the year to 1 million fish would cause a mortality of $(1-e^{-0.2})$ multiplied by 1 million or 181,269 fish and 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. Recruitment

The addition of fish to the fishable population due to migration or to growth. Recruits are usually fish from one year class that have just grown large enough to be retained by the fishing gear.

12. 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.

13. $F_{0.1}$

The rate of fishing mortality for a given method of fishing at which the increase in yield per recruit for a small increase in fishing mortality results in only one-tenth the increase in yield per recruit for the same increase in fishing mortality from a virgin fishery.

12. Virtual Population Analysis (or Cohort Analysis)

An analysis of the catches from a given year class over its life in the fishery. If 10 fish were caught each year from the 1968 year class for 10 successive 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. Since 10 fish were caught during 1979, then 10 fish must have been alive at the beginning of that year. At the beginning of 1978 there must have been at least 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 at least 100 fish were alive at the beginnning 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 known in addition to the 10 fish caught per year in the fishery, then a virtual population 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 commercial catches for many species were not available in early 1983 when this was written. However, catches for 1982 were estimated by assessment scientists for most species and are presented in tables throughout this document.

The total international (domestic and foreign) commercial nominal catch of all species off the northeastern United States (Gulf of Maine to Cape Hatteras, North Carolina) decreased slightly from 1980 to 1981. The total catch was approximately 1.44 million metric tons (mt) in 1980 decreasing to 1.39 million mt in 1981 (Table 2). This decline is largely due to a 12% decrease in catch of finfish whereas the catch of invertebrates increased 2%.

Groundfish

Total groundfish commercial catches decreased 7% from 1980 to 1981 (Table 2). Catches of the principal groundfish (cod, haddock, redfish, red hake, silver hake, pollock) decreased 9% from 154,000 mt in 1980 to 140,000 mt in 1981. A decrease in cod, haddock, and redfish catches accounts for the majority of this decrease. Catch levels of silver hake, red hake, and pollock changed only slightly.

Flounder (flatfishes) nominal catches decreased 7,500 mt during the same one year period. Yellowtail and summer flounder were down 4,000 mt each, explaining the decline. Nominal catches for Atlantic halibut and windowpane flounders increased 18% and 33%, respectively.

Other groundfish catches increased 13% from 24,000 to 27,000 mt. Change was mainly due to a tripling of foreign cusk catches and a 58% increase in domestic white hake landings.

Pelagics

Nominal catches of principal pelagic species, herring and mackerel, decreased 15% in 1981 from the previous year (87,000 to 73,000 mt, Table 2). Mackerel catches by distant water fleets increased dramatically from 400 mt to 5,000 mt. The 1981 domestic herring catches decreased by 18,000 mt, from 83,000 to 65,000 mt. In 1981 domestic mackerel catches showed a minor increase.

Other pelagic species decreased approximately 7%, largely due to an 8% decrease in menhaden catches.

Other Finfish

The international nominal catch of other finfish decreased less than 4% (Table 2). Other finfish catches were about 44,000 mt in 1980, and 42,000 mt in 1981.

Invertebrates

The total domestic and foreign nominal catch of the invertebrate species increased 2% (16,000 mt), from 709,000 mt in 1980 to 725,000 mt in 1981 (Table 2). Foreign catches increased 3% (2,000 mt). There was a 53% increase in the Canadian sea scallop fishery but a 55% decrease in the foreign squid fishery. Domestic catches increased 14,000 mt, with 95% of this increase due to a 20,000 mt rise in surf clam catches and a 7,000 mt increase in sea scallop catches. Domestic squid catches decreased 34%. Other invertebrates remained relatively stable with only minor changes in nominal catch.

Table 2. Domestic and foreign nominal catches (metric tons) from the marine finfish and invertebrate resources off the northeastern United States (Gulf of Maine to the Middle Atlantic areas) for 1981 compared with 1980.

Species	FOREIGN 1981	FOREIGN (1980)	USA COMMERCIAL 1981	USA COMMERCIAL (1980)	TOTAL 1981	TOTAL (1980)
Principal Groundfish	21,785	(26,118)	117,773	(127,802)	139,558	(153,920)
Atlantic cod	9,107	(8,255)	46,382	(53,581)	55,489	(61,836)
Haddock	6,175	(10,304)	24,989	(24,782)	31,164	(35,086)
Redfish (Ocean perch)	19	(98)	7,899	(10,085)	7,918	(10,183)
Silver hake (Whiting)	2,382	(1,678)	16,237	(16,461)	18,619	(18,139)
Red hake	52	(149)	4,247	(4,988)	4,299	(5,137)
Pollock	4,050	(5,634)	18,019	(17,905)	22,069	(23,539)
Flounders	299	(512)	59,107	(66,382)	59,406	(66,894)
American plaice	17	(48)	12,881	(13,549)	12,898	(13,597)
Witch flounder	7	(19)	3,421	(3,374)	3,428	(3,393)
Yellowtail flounder	12	(81)	15,594	(19,385)	15,606	(19,466)
Greenland halibut	0	(2)	0	(0)	0	(2)
Atlantic halibut	118	(88)	80	(80)	198	(168)
Winter flounder	19	(44)	17,779	(17,384)	17,798	(17,428)
Summer flounder	41	(57)	7,958	(11,536)	7,999	(11,593)
Windowpane flounder	0	(0)	1,286	(966)	1,286	(966)
Flatfishes (unknown)	85	(173)	108	(108)	193	(281)
Other Groundfish	2,902	(1,514)	24,162	(22,187)	27,064	(23,701)
Cusk	2,071	(664)	1,857	(1,770	3,928	(2,434)
Scup	1	(16)	9,766	(8,497)	9,767	(8,513)
White hake	454	(307)	5,707	(3,596)	6,161	(3,903)
Atlantic wolffish	101	(153)	740	(896)	841	(1,049)
Groundfish (not specified)	275	(374)	6,092	(7,428)	6,367	(7,802)
Principal Pelagics	5,282	(407)	68,020	(86,146)	73,302	(86,553)
Atlantic herring	0	(1)	65,079	(83,463)	65,079	(83,464)
Atlantic mackerel	5,282	(406)	2,941	(2,683)	8,223	(3,089)
Other Pelagics	967	(988)	327,339	(353,795)	328,306	(354,783)
Bluefish	0	(5)	5,171	(4,694)	5,171	(4,699)
Atlantic butterfish	681	(800)	4,851	(5,356)	5,532	(6,156)
Atlantic menhaden	0	(0)	313,885	(340,421)	313,885	(340,421)
Pelagic (not specified)	286	(183)	3,432)	(3,324)	3,718	(3,507)
Other Finfish	2,645	(1,651)	39,296	(42,146)	41,941	(43,797)
River herring	10	(3)	3,162	(4,762)	3,172	(4,765)
Spiny dogfish	0	(224)	5,370	(4,170)	5,370	(4,394)
Skates	0	(73)	826	(881)	826	(954)
Finfish (not specified)	2,635	(1,351)	29,938	(32,333)	32,573	(33,684)
Invertebrates	83,353	(80,964)	641,825	(627,906)	725,178	(708,870)
Short-finned squid (Illex)	7,503	(17,529)	618	(335)	8,121	(17,864)
Long-finned squid (Loligo)	9,124	(19,750)	2,091	(3,744)	11,215	(23,494)
American lobster	175	(195)	17,512	(16,731)	17,687	(16,932)
Northern shrimp	0	(0)	1,031	(332)	1,031	(332)
Red crab	0	(0)	3,108	(2,548)	3,108	(2,548)
Surf clam	0	(0)	110,034	(90,338)	110,034	(90,338)
Ocean quahog	0	(0)	123,237	(125,341)	123,237	(125,341)
Sea scallops	66,551	(43,487)	97,845	(104,678)	164,396	(148,165)
Invertebrates (not specified)	0	(3)	286,349	(283,853)	286,349	(283,856)
Grand Total					1,394,755	(1,438,518)

Not specified indicates other species in this category not listed in this table.

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 fishing is a formidable task because sport fishing occurs 24 hours a day, seven days a week, 52 weeks a year in coastal rivers, bays, sounds, and the ocean. Sport anglers fish from private boats, party and charter boats, rented boats, and shore, and from man-made structures such as piers, bridges, and jetties.

National saltwater angling surveys were conducted in 1960, 1965, and 1970 as supplements to the national surveys of hunting and fishing. Relying on mail questionnaires, results from these surveys were of questionable accuracy because of, among other factors, the length of recall periods (up to one year) and the potential for species misidentification. In 1974 NMFS conducted surveys that were more regional in scope and that reduced the recall period to less than two months. Surveys were also conducted by the NEFC in the mid-1970's that focused on bluefish, summer flounder, and the party and charter boat fishery from New York to Maryland.

In 1979 a new survey methodology was introduced by NMFS that consisted of two complementary surveys (household survey and direct-intercept creel census). The new survey methodology was intended to avoid many of the problems of the earlier survey, particularly the recall period and poor response to questionnaires. Recently-discovered problems with the data reduction and analysis performed on the surveys in 1979, 1980, and 1981 have prevented the information from being made available for public use. These problems are expected to be resolved shortly, but not in time for publication of the results in this document. The 1979 methodology represents a radical change from previous methodologies; therefore, data from the 1979-1981 surveys will not be directly comparable to earlier survey results.

Since recreational fishery data are an important factor in determining the status of many stocks, the NMFS survey data, repesenting the only source of information, have to be used. Typically, the recreational catch between survey years has been derived by interpolation, using the relationship between the sport catch and other indices of stock abundance (commercial catch or NEFC bottom trawl survey indices) in the survey years. Interpolating between surveys that used different data collection techniques adds to the biases in the catch statistics. Therefore, use of the recreational survey data to monitor the status of these stocks should be done with caution and with other indices of stock abundance, such as pre-recruit survey data or total adult biomass indices.

TOTAL FINFISH AND SQUID BIOMASS

This group includes all commercially exploited 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, nominal commercial catches averged 1.2 million mt, substantially above the maximum sustained yield (MSY) level of 900,000 mt 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 nominal catches of over 90% since the early 1970's, while the total nominal catch declined by over 60% (Table 3, Figure 1). The sharp drop in recreational catch estimates for recent years appears to reflect different survey methodology rather than an actual decline in catches. Under extended jurisdiction the US nominal commercial catch increased from 266,300 mt in 1977 to 357,600 mt in 1980 (+34%), Canadian nominal catches have fluctuated without a definite trend, and catches by distant-water fleets have declined from 174,300 m in 1977 to only 42,300 mt in 1980 (-76%).

Catchability coefficients have been obtained for species-stocks within this group by dividing autumn survey catch-per-tow (weight) index values by corresponding stock biomass estimates for the beginning of the following year and averaging results over all years for which data were available. This provided an average coefficient to apply to survey index values for those years in which biomass estimates were missing. Annual biomass estimates were then obtained for 1964-1981 by applying these average coefficients to individual autumn survey index values by stock (including those for years for which biomass estimates were not available) and summing resulting biomass estimates over all stocks by year. Estimates of total biomass peaked at 8.0 million mt in 1968 and then declined to only 1.9 million mt in 1975 (Figure 1). Subsequent estimates increased to an average of 3,3 million mt for 1977-1978 and then rose sharply to 7.9 million mt in 1979, due primarily to anomalous survey catch per tow values for Atlantic herring and Atlantic mackerel. The 1980-1981 estimates, however, were virtually identical (3.4 million mt, Figure 1) and agreed closely with the 1977-1978 average. The 1982 estimate declined to 2.5 million mt. Taken together, available data suggest relatively constant biomass levels in recent years, with perhaps a slight decline evident in 1982.

Generally speaking, stock biomass estimates for groundfish, flounder, miscellaneous finfish species, and _Illex_ squid have increased since 1975, although corresponding estimates for herring and mackerel (which contributed about 50% of the total biomass during the 1960's) have fluctuated about a relatively low level compared to earlier years. Recovery to the level corresponding to MSY (4.0-4.5 million mt) 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. Nominal catches (thousand metric tons) and management information for total finfish and squids from the Gulf of Maine to Cape Hatteras, 1970-1982.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981[1]	1982[2]
US Recreational[3]	175.5	139.9	128.2	118.2	99.7	77.9	86.4	76.0	-
Commercial									
US	207.0	216.8	235.2	266.3	290.8	322.3	357.6	314.7	107.5
Canada	18.8	14.0	7.8	14.6	26.8	16.0	25.9	22.4	-
Other	824.8	628.0	419.9	174.3	48.7	39.0	42.3	18.1	-
Total nominal catch	1226.1	998.7	791.1	573.4	466.0	455.2	512.2	431.2	107.5
Total allowable catch[4]	923.9[5]	850.0	650.0	520.0[6]	-	-	-	-	-

Long-term potential catch = 900[7]
Importance of recreational fishery = Major
Status of management = None as a group
Status of exploitation = Underexploited as a group
Age at 50% maturity = N/A
Size at 50% maturity = N/A
M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1981} = Unknown

[1] Provisional (incomplete).
[2] Through June 30, 1982.
[3] Surveys performed in 1970, 1974, and 1979; remaining points estimated.
[4] Excludes recreational.
[5] For 1974.
[6] Recommended under ICNAF, but not implemented under extended jurisdiction.
[7] From analysis of commercial data.

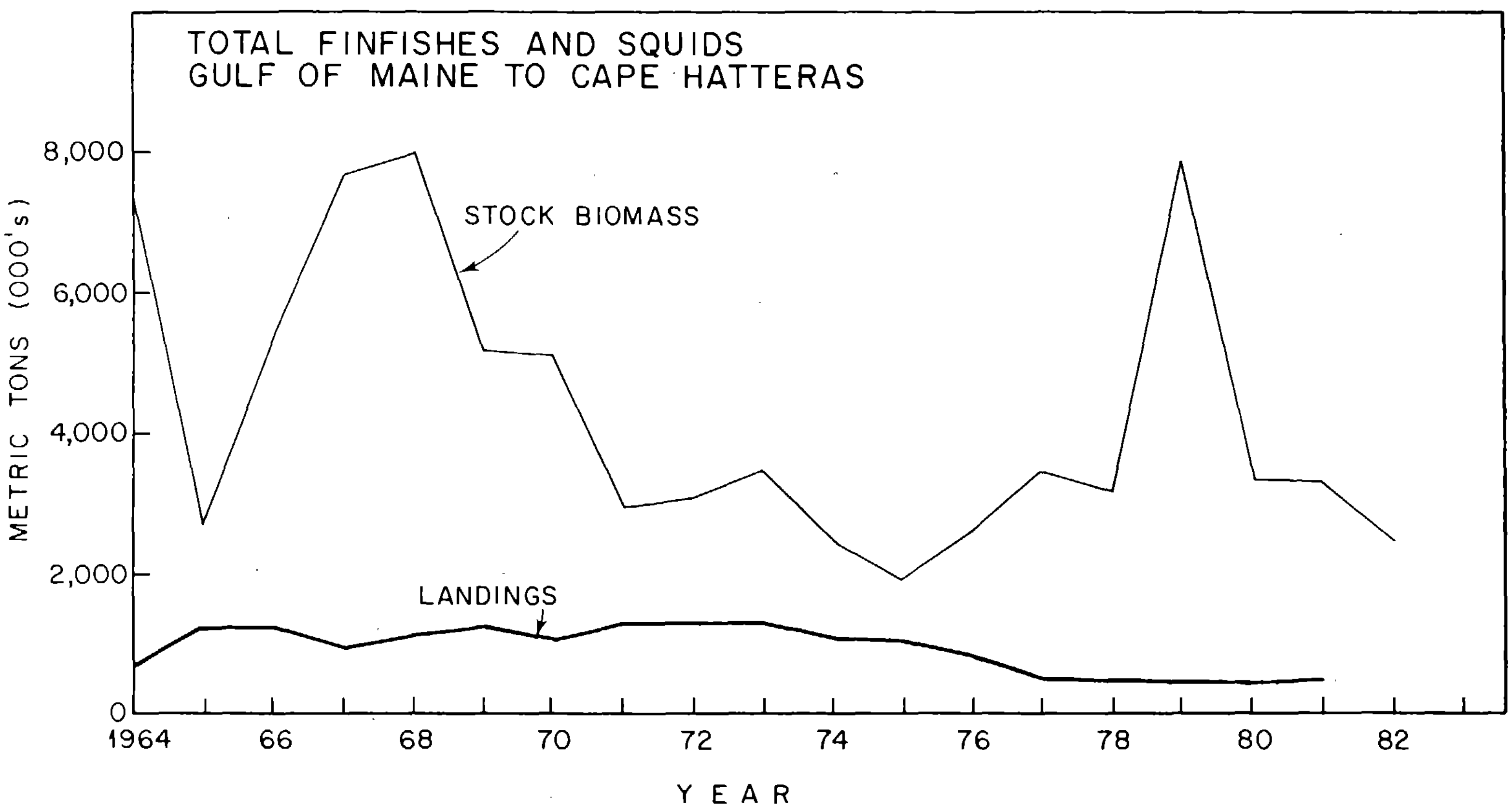


Figure 1. Nominal catches and stock biomass of finfish and squids from the Gulf of Maine to Cape Hatteras.

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 are omnivorous eating 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 among 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. These groups are presently managed as two units: Gulf of Maine, and Georges Bank and Southward. Important commercial and recreational fisheries occur in both units. The commercial fisheries are prosecuted year-round using otter trawls, line trawls, gill nets, pair trawls, Danish seines, hand lines, jigs and traps. Recreational fishing also occurs year-round, although peak activity occurs during the summer in the lower Gulf of Maine, and from late fall to early spring in inshore waters from Massachusetts southward. Party and charter boat fishing as well as shore-based and private boat angling comprise the major modes of recreational cod fishing.

Gulf of Maine

Commercial 1982 Gulf of Maine nominal cod catches (provisional) were 15,350 mt, 2,217 mt more than in 1981, and the highest annual catch ever. The USA 1982 commercial nominal catch was 14,000 mt, 12% greater than in 1981, and the second highest since domestic commercial landings have been maintained by stock area (i.e., 1932) (Table 4). Canadian 1982 catches were 1350 mt, a 751 mt increase from 1981. The 1982 USA recreational Gulf of Maine cod catch is unknown, although the summer party boat fishery was a good one. Party boat captains reported extremely good landings of 'market' cod during late spring and summer.

The 1982 NMFS offshore research vessel abundance and biomass indices were among the highest observed, indicative of continued high stock-size levels (Figure 2). Survey age composition data indicated that the 1977-1980 year-classes appear to be above average in strength. These four year-classes comprised nearly 83% of the 1982 Gulf of Maine population, by number, and in 1983 will account for the bulk of the spawning stock. The 1981 and 1982 year-classes presently appear to be average and below average in strength, respectively.

Market category composition of the 1981 USA commercial landings was similar to those observed during 1977-1980 in indicating continued dominance in the fishery of 'market' and 'large' cod. The 1977 and 1978 year-classes predominated in size frequency samples from USA landings. Otter trawl landings accounted for 64% of the 1981 USA commercial catch. Gill net landings comprised 33% of the 1981 USA total, the highest annual percentage recorded during 1965-1981.

Recent fishing mortality rates appear to have been relatively stable but have been higher than F_{max} (F_{max}=0.30) and higher than levels observed during the mid and late 1960's and early 1970's. Given current resource conditions, short-term annual commercial fishery yields of about 12,000 mt appear sustainable. However, both potential yield and total reproductive potential of the stock would be enhanced by reducing fishing mortality to the F_{max} level and delaying age at first capture in the fishery.

Table 4. Nominal catches (thousand metric tons) and management information for Atlantic cod from the Gulf of Maine.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982
US Recreational	-	-	-	-	-	0.8 [1]	-	-	-
Commercial									
US	7.1	8.9	10.2	12.4	12.4	11.7	13.5	12.5	14.0
Canada	0.1	0.1	*	0.1	0.4	0.4	0.2	0.6	1.4
Other	0.1	*	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total nominal catch	7.3	9.0	10.2	12.5	12.8	12.9	13.7	13.1	15.4
Total allowable catch		10.0	8.0	12.0	8.0	9.7	9.5	9.5	- [2]

Long-term potential catch = 10.0
Importance of recreational fishery = Major
Status of management = FMP in force since March 1977
Status of exploitation = Fully exploited
Age at 50% maturity = 4.2 yrs (males); 3.8 yrs (females)
Size at 50% maturity = 54 cm (21.3 inches) males; 50 cm (19.7 inches) females
$M = 0.20$ $F_{0.1} = 0.16$ $F_{max} = 0.30$ $F_{1981} = 0.38$

* Less than 0.1.
[1] Includes estimated recreational cod catch in Maine and New Hampshire
[2] Quota management was eliminated on 31 March 1982 with implementation of Interim Groundfish Plan.

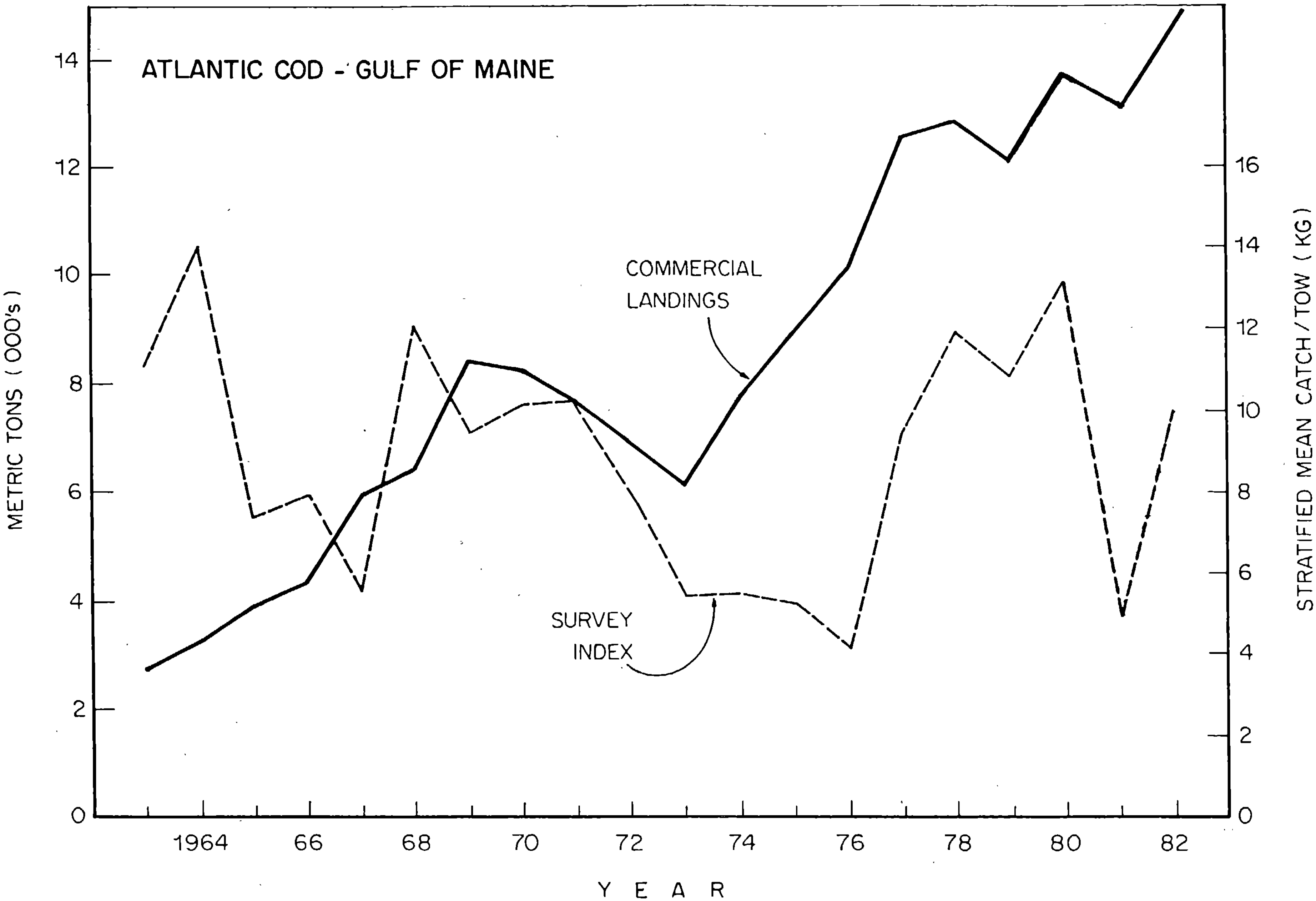


Figure 2. Nominal total commercial catches and indices of abundance from NMFS autumn research vessel bottom trawl surveys for Atlantic cod in the Gulf of Maine area.

Georges Bank and Southward

Total commercial 1982 nominal catch (provisional) was 57,730 mt, 36% higher than in 1981, and the highest annual commercial catch ever (Table 5). USA 1982 commercial catches were 39,850 mt, the second highest since 1907. Canadian 1982 catches were 17,880 mt, a record and more than double the 1981 landings of 8,508 mt. The 1982 USA recreational Georges Bank and Southward recreational landings are unknown; however, party boat reports described the spring 1982 cod fishery as 'exceptional' and much improved over preceding years.

NMFS autumn 1981 and spring 1982 research vessel catch-per-tow indices were among the upper third of recorded values. Abundance and biomass indices from the NMFS autumn 1982 survey, however, were near the lowest observed (Figure 3). There is some indication that these latter results reflect a reduced availability of cod since sharp declines were evident in almost cohorts, and were more pronounced than would be expected due solely to fishing mortality. Age composition data from the autumn 1981 and spring 1982 surveys indicate that the Georges Bank population is dominated by the 1978-1980 year-classes, all of which appear to be either above average or strong. These three year-classes accounted for 81% of the autumn 1981 total abundance index and 75% of the spring 1982 total abundance value. The relative strengths of the 1981 and 1982 year-classes, based on age 0 and 1 survey indices, appear to be strong and average, respectively.

The 1978 year-class was dominant in USA 1981 commercial landings, accounting for 37% of the fish landed, followed by the 1979 year-class (25%), the 1977 year-class (22%), and the 1975 year-class (11%). Otter trawl landings accounted for 86% of the 1981 USA commercial catch while gill nets accounted for 11% of the 1981 total.

Recent fishery mortality (1978-1981) has been higher than F_{max} (0.39 vs. 0.30) but has been lower than the levels observed in the mid-1960's and mid-1970's. Stock stability has been maintained at high levels through a succession of above average and strong year classes, moderate fishing mortality rates, and proportional harvesting of the stock relative to its age/size composition. Recruitment of the 1980 and 1981 year-classes, presently considered strong ones, will initially occur in the otter trawl fishery in the latter part of 1982 and 1983, respectively, thereby increasing harvestable biomass. If this good recruitment is realized, it is expected then annual total commercial landings of about 40,000 mt should be sustainable during the next 2-3 years. If, however, the 1982 record catch of 57,500 mt was accompanied by a marked increase in fishing mortality, some future potential yield may have already been lost.

For further information see:

Serchuk, F.M., R.S. Rak, and J. Penttila. 1982. Status of the Georges Bank and Gulf of Maine Atlantic cod stocks - 1982. Woods Hole Lab. Ref. 82-33, 46 p.

Table 5. Nominal catches (thousand metric tons) and management information for Atlantic cod from Georges Bank and Southward.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982
US Recreational		-	-	-	-	3.1[1]	-	-	-
Commercial									
US	15.8	16.0	14.9	21.1	26.6	32.6	40.0	33.9	39.9
Canada	2.5	1.8	2.3	6.2	8.9	6.0	8.1	8.5	17.9
Other	8.7	7.2	2.7	0.1	0.0	0.0	0.0	0.0	0.0
Total nominal catch	27.0	25.0	19.9	27.4	35.5	41.7	48.1	42.4	57.8
Total allowable catch		35.0	35.0	26.7	26.0	36.9	35.0	35.0	-[2]

Long-term potential catch = 35.0
Importance of recreational fishery = Major
Status of management = FMP in force since March 1977
Status of exploitation = Fully exploited
Age at 50% maturity = 2.6 yrs (males); 2.9 yrs (females)
Size at 50% maturity = 44 cm (17.3 inches) males; 51.5 in (20.3 inches) females
$M = 0.20$ $F_{0.1} = 0.15$ $F_{max} = 0.30$ $F_{1981} = 0.39$

[1] Includes estimated recreational cod catch from Massachusetts and southward.
[2] Quota management was eliminated on 31 March 1982 with implementation of Interim Groundfish Plan.

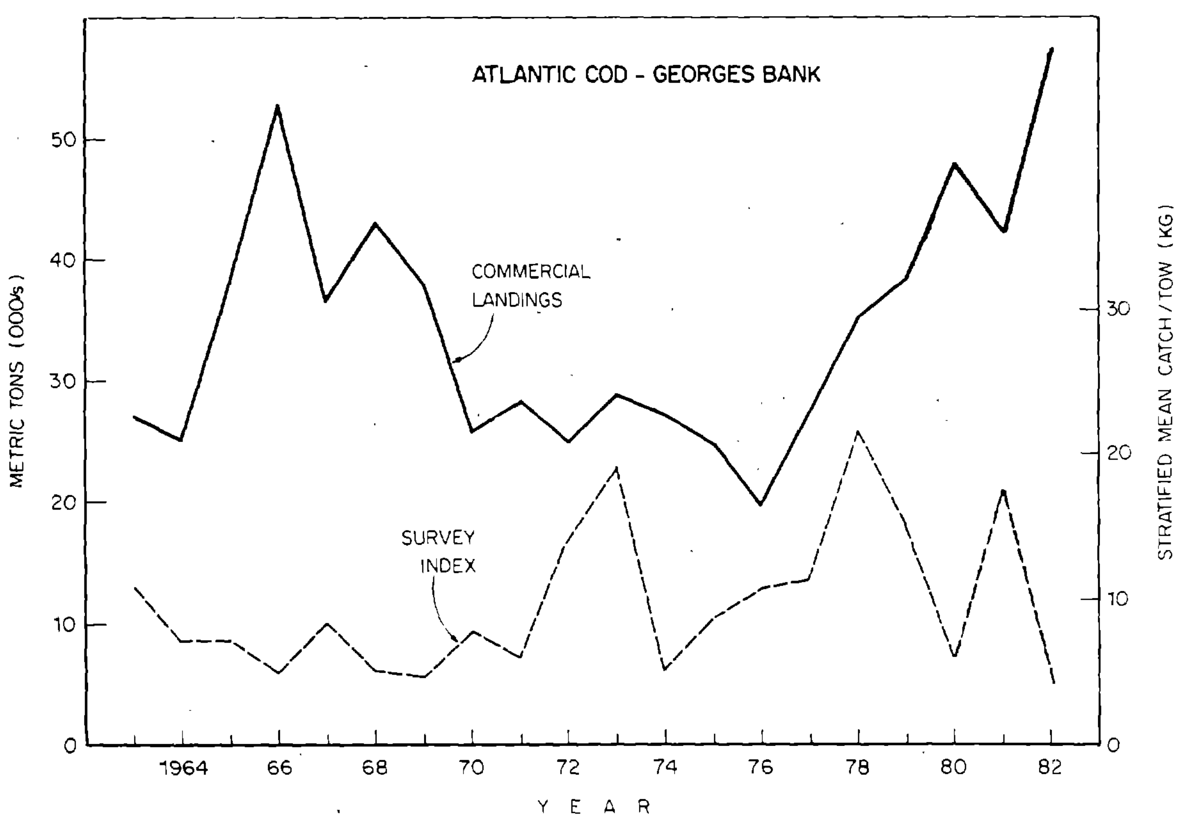


Figure 3. Nominal total commercial catches and indices of abundance from NMFS autumn research vessel bottom trawl surveys for Atlantic cod in the Georges Bank area.

HADDOCK

The haddock (Melanogrammus aeglefinus) is a demersal gadoid species commonly attaining lengths of 75-80 cm (30-32 inches) and weights of up to 5 kg (11 lbs). In recent US nominal catches average lengths have ranged from 50-60 cm (20-24 inches), while average weights have ranged between 1.5-2.5 kg (3-5 lbs). Haddock mature sexually at ages 2-3, and ages of up to 18 years have been documented for Georges Bank, although ages in excess of 9 years are uncommon. The species is distributed on both sides of the North Atlantic and in the Northwest Atlantic ranges from West Greenland to Cape Hatteras; off the US coast, highest concentrations occur on northern and eastern Georges Bank and in the southwestern Gulf of Maine. Haddock are most common at depths of 45-135 m (25-75 fathoms) and temperatures of 2-10°C (36°-50°F). Georges Bank haddock appear to be relatively sedentary, although seasonal coastal movements occur in the western Gulf of Maine. Small invertebrates constitute the bulk of the diet.

Spawning occurs between January and June, with peak activity during late March and April; individual females may produce up to 3 million eggs. Major spawning concentrations occur on eastern Georges Bank; some spawning also occurs to the east of Nantucket Shoals and along the Maine coast. Juvenile haddock are pelagic in habit for several months and then settle to the bottom, where they remain for the rest of their lives.

Haddock on Georges Bank and in the Gulf of Maine were managed by the New England Fishery Management Council (NEFMC) under the Fishery Management Plan (FMP) for Atlantic Groundfish from March 15, 1977 to March 30, 1982. As amended, this plan provided for US commercial allocations of 17,675 mt for Georges Bank and 7,575 mt for the Gulf of Maine, a US recreational allocation of 2,000 mt, and a Canadian allocation of 5,250 mt, for a total OY of 32,500 mt during the 1979-1980 and 1980-1981 "fishing years" (October 1-September 30). Catch quotas for the US fishery for Calendar Years 1980 and 1981 were equivalent to these values since quarterly allocations corresponded to these totals. Nominal commercial catches during 1980 and 1981 under these OY's were 35,100 mt and 31,100 mt, respectively; the projected 1982 total is 24,500 mt. The current Interim Plan for Atlantic Groundfish redefines OY as the amount actually harvested by US fishermen in accordance with other plan provisions, which include mesh regulations by area, seasonal spawning area closures, minimum possession sizes and a voluntary data reporting system.

Gulf of Maine

During 1977-1981, US fishermen accounted for 94% of the nominal commercial catch of haddock from the Gulf of Maine, with the remainder being taken by Canada. During 1977-1981, 81% of the US catch was taken by otter trawls, and 17% was taken by gillnetting. Distinct peaks have generally been evident in US landings during spring and autumn, apparently attributable to seasonal migrations.

Nominal commercial catches for the Gulf of Maine increased from 600 mt in 1973 to 7,500 mt in 1980 (Figure 4). The provisional total for 1981 was 6,500 mt, and the projected catch for 1982, based on statistics through October, is comparable to the 1981 figure (Table 6). Since 1977, the fishery appears to have been supported primarily by the 1975 and 1978 year classes, although research vessel survey data indicate the 1978 year class to be much weaker than the 1975 year class. Estimated recreational catches for 1974 and 1979 totalled 200 mt and 400 mt, respectively.

NEFC spring and autumn survey indices (stratified mean catch per tow, kg) declined to minimal levels in the early to mid-1970's and then increased sharply, due primarily to recruitment and growth of the strong 1975 year class. Since 1978, the spring survey index has fluctuated without a definite trend, while the corresponding autumn survey index has declined (Figure 4). NEFC survey catch-per-tow-at-age data indicate the 1975 year class to have been far stronger than subsequent cohorts, with the possible exception of the 1976 year class. The 1981 year class appears to be very weak; the 1982 year class appears to be somewhat stronger, but still relatively weak compared to the 1975 and 1976 year classes.

Throughout most of the NEFC survey time series, trends in the NEFC autumn survey index have been consistent with commercial landings trends. Since 1978, however, the NEFC index has declined continually, while landings have remained at relatively high levels, suggesting that fishing mortality (F) has increased. Stock abundance estimates for 1982 and earlier years derived from analyses of survey and nominal catch data also indicate a declining trend, and, given the above evidence for poor recruitment prospects from the 1981 and 1982 year classes, it appears that no reversal of this trend can be expected prior to 1985.

Table 6. Nominal catches (thousand metric tons) and management information for Gulf of Maine haddock, 1970-1982.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981[1]	1982[2]
US Recreational[3]	0.7	0.3	0.4	0.5	0.4	0.4	0.6	0.5	0.6
Commercial									
US	0.9	1.2	1.9	3.3	4.5	4.6	7.3	6.0	6.5
Canada	0.1	0.1	0.1	0.0[4]	0.6	0.3	0.2	0.5	0.4
Other	0.0[4]	0.0[4]	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total nominal catch	1.7	1.6	2.4	3.8	5.5	5.3	8.1	7.0	7.5
Total allowable catch[5]	7.2	6.0	6.0	10.5	19.0[6]	8.2[7]	9.6[8]	9.6[8]	-

Long-term potential catch = 5.0
Importance of recreational fishery = Minor
Status of management = (Interim) FMP in force since March 31, 1982
Status of exploitation = Fully exploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 38 cm (15 inches)
$M = 0.2$ $F_{0.1} = 0.26$ $F_{max} = 0.55$ $F_{1981} => F_{max}$

[1] Provisional (incomplete).
[2] Preliminary.
[3] Values for 1970, 1974 and 1979 obtained from surveys; remaining points estimated
[4] Less than 0.05 (50 mt).
[5] Values for 1970-1978 are for Georges bank and the Gulf of Maine, inclusive; 1970-1976 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 allocation for the Gulf of Maine and total recreational allocation for Calendar Years 1980 and 1981 under Final Supplement #4 to the Fishery Management Plan (FMP) for Atlantic Groundfish (effective September, 1981).

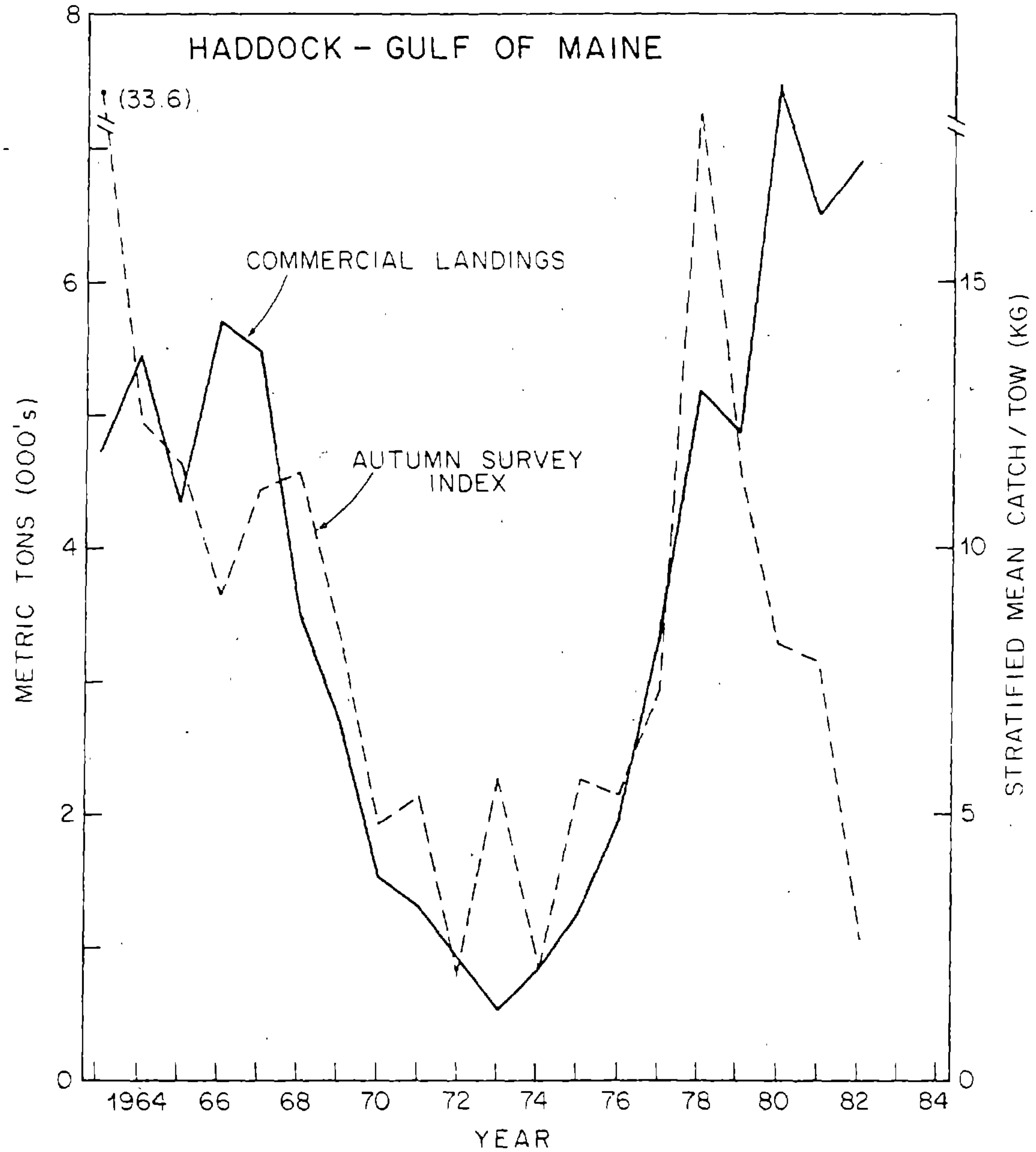


Figure 4. Nominal catches and index of abundance for Gulf of Maine haddock.

Georges Bank

US fishermen accounted for 68% of the nominal catch during 1977-1981, with practically all of the remainder being taken by Canada. Almost all of the US nominal catch has been taken by otter trawling. US catches have tended to increase somewhat in late spring and summer due to termination of seasonal spawning area closures, recruitment and improved weather conditions. This tendency has been most evident during years when recruiting year classes have been strong.

The Georges Bank nominal catch increased from an annual average of 4,700 mt during 1974-1976 to 27,600 mt in 1980; the provisional total for 1981 was 24,600 mt, and the projected total for 1982 (based on US and Canadian data through October) is 17,600 mt (Table 7, Figure 5). Recreational catches for this stock have been negligible. Since 1977, the Georges Bank fishery has been supported primarily by the 1975 and 1978 year classes. Research vessel survey data for 1981-1982 indicate the 1980 year class to be substantially below average in size, and the remaining year classes since 1975, including the 1982 year class, appear to be very weak. Since the 1975 year class is now much reduced, the Georges Bank fishery is at present primarily dependent on the 1978 year class.

The NEFC spring survey index for Georges Bank (stratified mean catch per tow, kg) rose from 5.4 kg per tow in 1975 to 35.7 kg in 1980, the highest value observed in the spring survey time series (which began in 1968). The corresponding autumn survey index rose from 2.6 kg in 1974 to 26.9 kg in 1979, the highest value observed since 1965. These increases resulted primarily from recruitment and growth of the 1975 and 1978 year classes. Since 1980, however, both indices have declined substantially; in particular, the autumn survey index declined precipitously from 11.8 kg in 1981 to 4.2 kg in 1982- a decline of over 60% (Figure 5). The 1982 young-of-year index for Georges Bank was also one of the lowest on record. NEFC survey data indicate that since 1977, fishing mortality (F) has substantially exceeded F_{max} (=0.55) following recruitment to commercial gear at age 2, followed by a decline to between $F_{0.1}$ (=0.26) and F_{max} at ages 3 and older. These results indicate substantial additional mortality from unreported catches at age 2, particularly for the 1975 and 1978 year classes.

Stock size estimates (age 2 and older) for 1982 are in the order of 40-50 million fish (63-70,000 mt) depending on assumptions made relative to the strength of the 1980 year class. These levels are substantially below the long-term (1935-1960) average of 140 million fish or 153,000 mt. These figures are comparable to those obtained from virtual population analysis for the late 1960's when recruitment was poor and stock size was declining rapidly. Catch and stock size projections for 1983-1984 indicate continued declines in abundance and biomass for levels of F anticipated in the immediate future. If recruitment remains poor, a return to the very low levels of abundance observed in the early-to-mid 1970's will occur by the mid-1980's.

For further information see:

Clark, S.H., R.K. Mayo and A. Green. MS 1982. Georges Bank and Gulf of Maine haddock stock status - 1982. Nat. Mar. Fish. Serv., Woods Hole, Lab. Ref. Doc. No. 82-32, 39 p.

Clark, S.H., W.J. Overholtz and R.C. Hennemuth. 1982. Review and assessment of the Georges Bank and Gulf of Maine haddock fishery. J. Northw. Atl. Fish. Sci. 3: 1-27.

Overholtz, W.J. MS 1982. Current status of the Georges Bank and Gulf of Maine haddock stocks, December, 1982. Nat. Mar. Fish. Serv., Woods Hole, Lab. Ref. Doc. No. 82-47, 4 p.

Table 7. Nominal catches (thousand metric tons) and management information for Georges Bank haddock, 1970-1982.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981[1]	1982[2]
US Recreational	-	-	-	-	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]
Commercial									
US	5.0	4.0	2.9	7.9	12.2	14.3	17.5	18.9	12.0
Canada	1.2	1.4	1.4	2.9	10.2	5.2	10.1	5.7	5.6
Other	1.3	0.1	0.0[3]	0.0	0.0	0.0	0.0	0.0[3]	0.0
Total nominal catch	7.5	5.5	4.4	10.8	22.4	19.5	27.6	24.6	17.6
Total allowable catch[4]	7.2	6	6	10.5	19.0[5]	22.1[6]	22.9[7]	22.9	-

Long-term potential catch = 47
Importance of recreational fishery = Insignificant
Status of management = (Interim) FMP in force since March 31, 1982
Status of exploitation = Fully exploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 38 cm (15 inches)
$M = 0.2$ $F_{0.1} = 0.26$ $F_{max} = 0.55$ $F_{1981} = 0.3$

[1] Provisional (incomplete).
[2] Preliminary.
[3] Less than 0.05 (50 mt).
[4] Values for 1970-1978 are for Georges Bank and the Gulf of Maine, inclusive; 1970-1976 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 allocation for Georges Bank and total Canadian allocation for Calendar Years 1980 and 1981 under Final Supplement #4 to the Fishery Management Plan (FMP) for Atlantic Groundfish (effective September, 1981).

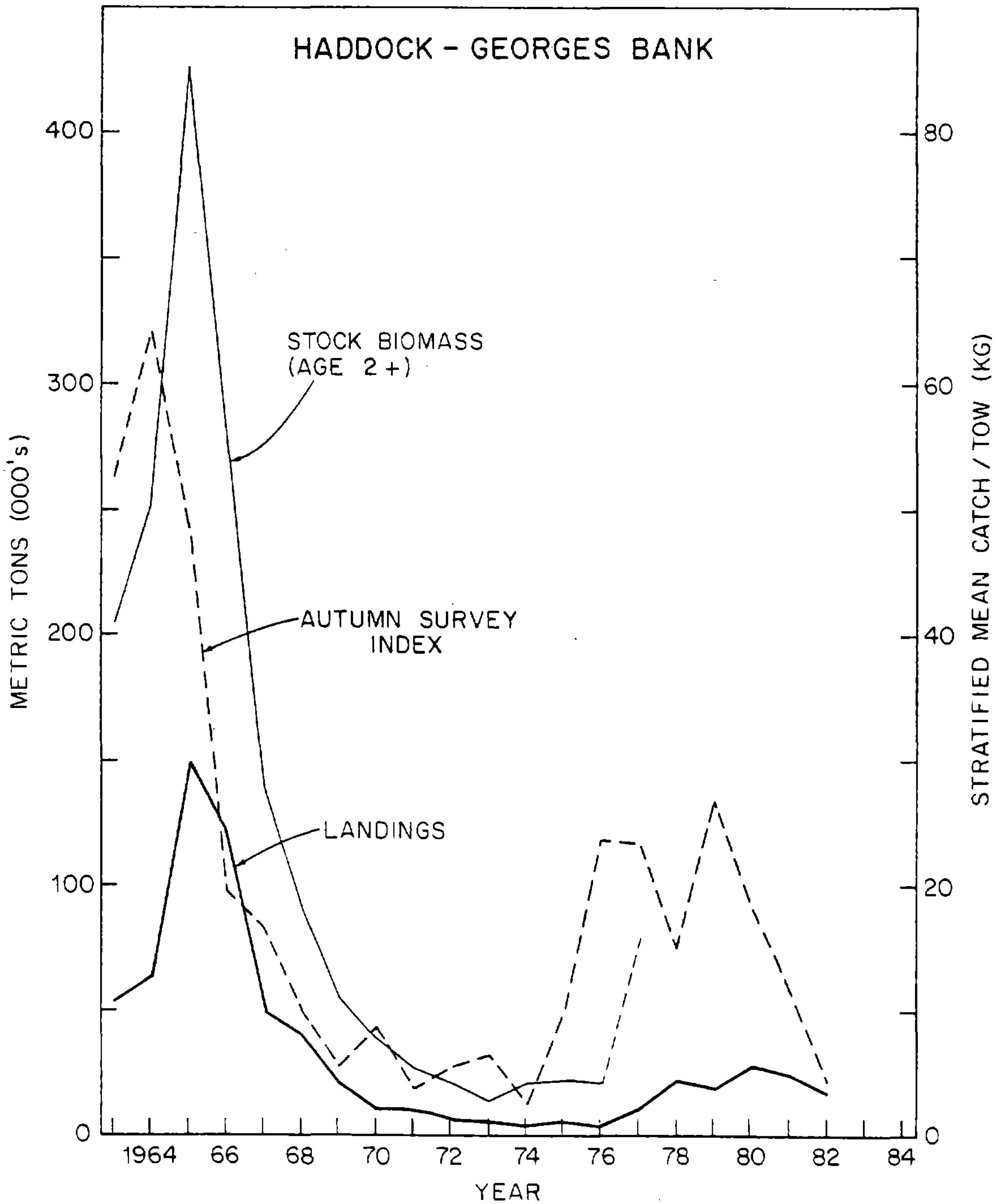


Figure 5. Nominal catches, stock biomass and index of abundance for Georges Bank haddock.

REDFISH

Redfish, Sebastes spp., are distributed throughout the North Atlantic from the coast of Norway to Georges Bank. Off New England, Sebastes fasciatus 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 in.) 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 to 9 in.). 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 nominal catches rapidly rose to a peak level of about 60,000 mt in 1942 followed by a gradual decline. Nominal catches in recent years increased from approximately 10,000-11,000 mt during 1974-1976 to 14,000-15,000 mt in 1978-1979 (Table 8, Figure 6). In 1980 and 1981, however, catches declined to 10,100 and 7,800 mt, the lowest annual figures 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 mt per day fished between 1975 and 1978, declined to 1.4 and 1.2 mt in 1980 and 1981, respectively (Figure 6). The NEFC survey index (stratified mean catch per tow) declined from an average of 122 fish per tow in 1967-68 to an average of 43 fish per tow in 1977-78. Recent autumn indices for 1980 and 1981 (21 and 20 fish per tow, respectively) are the lowest values observed since the beginning of the survey. Prior to this, redfish biomass in the Gulf of Maine had remained relatively constant for the previous 3-4 years because of continued growth and recruitment of 1971 year-class fish. However, declines since 1979 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 on 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 surplus production 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 considerably less than MSY as indicated by the sharp decline in 1980 and 1981 nominal catches 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. Nominal catches (thousand metric tons) and management information for redfish from the Gulf of Maine and Georges Bank area.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982 [1]
US Recreational	-	-	-	-	-	-	-	-	-
Commercial									
US	13.1	9.1	10.1	13.0	14.0	14.7	10.1	7.8	3.3
Canada	0.2	0.0 [2]	0.2	0.2	0.1	0.0	0.0	0.0	0.0
Other	3.5	1.4	0.4	0.0 [2]	0.0 [2]	0.0 [2]	0.0 [2]	0.0 [2]	0.0 [2]
Total nominal catch	16.7	10.6	10.7	13.2	14.1	14.7	10.2	7.8	3.3
Total allowable catch	30	25	17	9 [3]	-	-	-	-	-

Long-term potential catch = 14
Importance of recreational fishery = Insignificant
Status of management = None
Status of exploitation = Fully exploited
Age at 50% maturity = 8-9 yrs
Size at 50% maturity = 22-23 cm (8.5-9 inches)
M = 0.1 $F_{0.1}$ = 0.1 F_{max} = >1.0 F_{1981} = 0.2

[1] Through June 30, 1982.
[2] Less than 0.1.
[3] Recommended by ICNAF, but not implemented under extended jurisdiction.

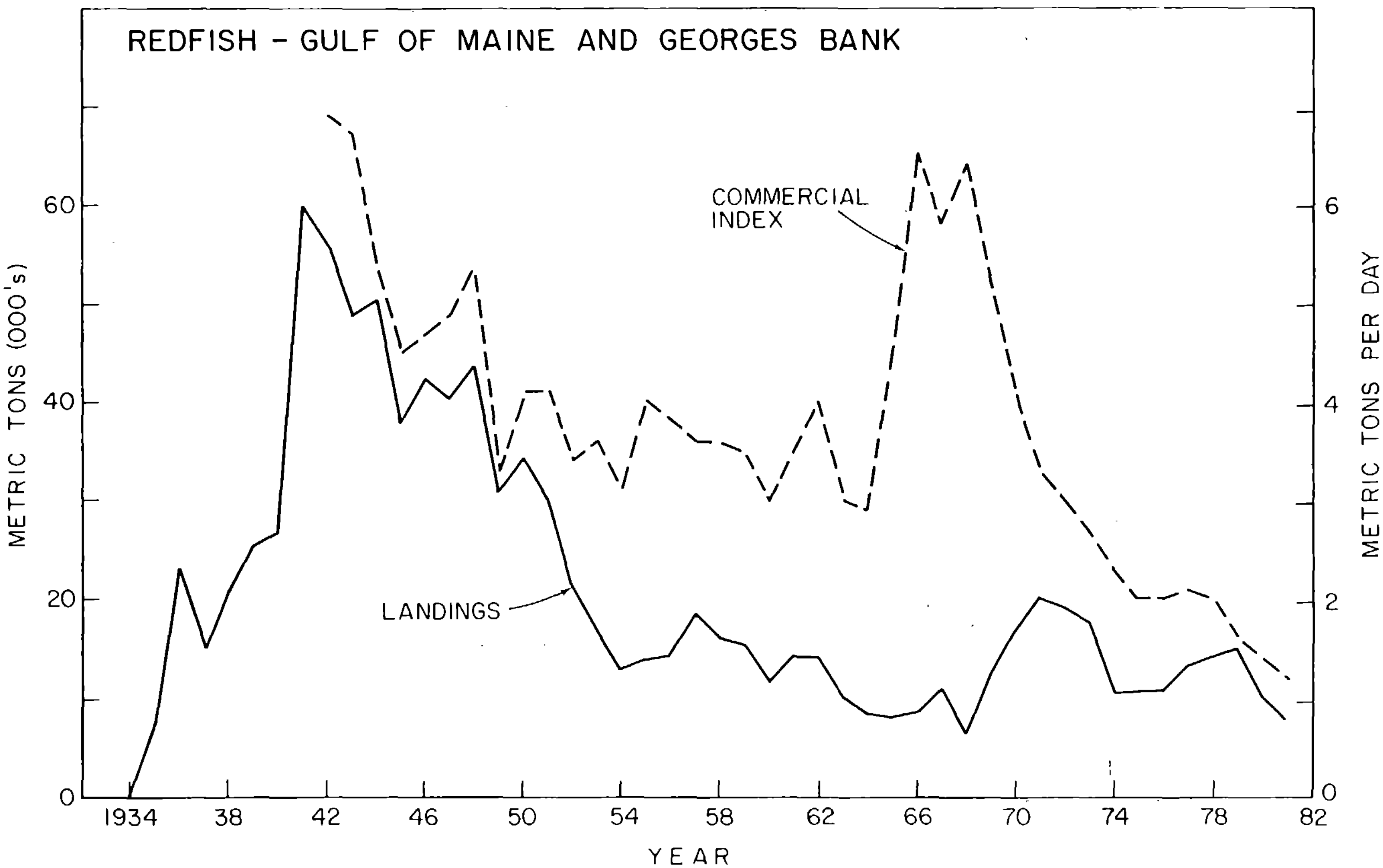


Figure 6. Nominal catches and index of abundance for Gulf of Maine and Georges Bank redfish.

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 outer 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 Island, southern and southeastern 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 older than about 8-10 years are rarely encountered.

Gulf of Maine Stock

The nominal catch of silver hake in 1981 was 3,787 mt, taken exclusively by the USA (Table 9, Figure 7). This level of catch represented a 44% increase over 1979, the lowest level in the 1955-1981 series, but was still the second lowest reported and substantially below catch levels in past years (83% lower than the 1960-1969 average of 22,000 mt and 53% lower than the 1970-1977 average of 8,100 mt). The commercial catch-per-effort index, after dropping sharply from 16.71 mt/day in 1976 to 6.44 mt/day in 1979, increased to 7.74 mt/day in 1980 and then dropped sharply to only 2.85 mt/day in 1981, the lowest level in the series.

Both the spring and autumn NEFC bottom trawl survey catch-per-tow indices have reflected similar 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, increasing in 1980, and then decreasing in 1981-1982. 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 and 1979 year classes were relatively weak in comparison to previous years, while the 1977 and 1978 cohorts were much stronger. The 1980-1981 year classes appear to be of at least average strength with the 1980 year class potentially being quite strong.

Due to low levels of catch during 1979-1981, 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 fishing mortality and stock size for 1980-1982 were derived based on projections utilizing estimated stock sizes at age at the beginning of 1979, known catches, and estimates of year class size from a relationship between spring survey catch per tow at age 1 and year class size from VPA.

Fishing mortality in 1978 was estimated to be 0.40 for ages 3 and older, approximately equal to the average F during 1973-1977. As a result of the decline in catch during 1979-1981, projected F values for those years were estimated to average 0.14. $F_{0.1}$ for this stock is estimated to be about 0.55.

Total stock biomass (ages 1 and older) averaged 179,400 mt during 1955-1966 but declined steadily to only 20,400 mt in 1971 before increasing to average 43,400 mt during 1975-1979. Spawning stock biomass (ages 2 and older), after maintaining high levels during 1955-1966 (averaging 157,000 mt), declined sharply to only 15,900 mt in 1971, but increased to average approximately 34,000 mt during 1975-1979 (Figure 7).

Projections of stock biomass during 1980-1982 indicated a generally increasing trend due to the low levels of catch reported since 1978, with estimates of total and spawning stock biomass reaching about 55,000 mt and 44,000 mt, respectively, in 1982. With continued low levels of catch and average year classes in 1980 and 1981, it is unlikely that this stock will undergo any major declines in 1983 if catches remain at or somewhat above the levels reported in recent years.

Table 9. Nominal catches (thousand metric tons) and management information for silver hake from the Gulf of Maine.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982[1]
US Recreational	-	-	-	-	-	-	-	-	-
Commercial									
US	7.6	8.0	9.8	8.7	6.2	2.6	3.8	3.8	2.1
Canada	-	-	-	-	-	-	-	-	-
Other	0.5	1.1	-	-	-	-	-	-	-
Total nominal catch	8.1	9.1	9.8	8.7	6.2	2.6	3.8	3.8	2.1
Total allowable catch		15.0	10.0	9.0	-[2]	-[2]	-[2]	-[2]	-[2]

Long-term potential catch = 26.3
Importance of recreational fishery = Insignificant
Status of management = FMP in preparation
Status of exploitation = Underexploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 23.3 cm (9.2 inches) males; 23.9 cm (9.4 inches) female
$M = 0.40$ $F_{0.1} = 0.55$ $F_{max} = >2.00$ $F_{1981} = 0.13$

[1] Estimated.
[2] Catches were unregulated during 1978-1982.

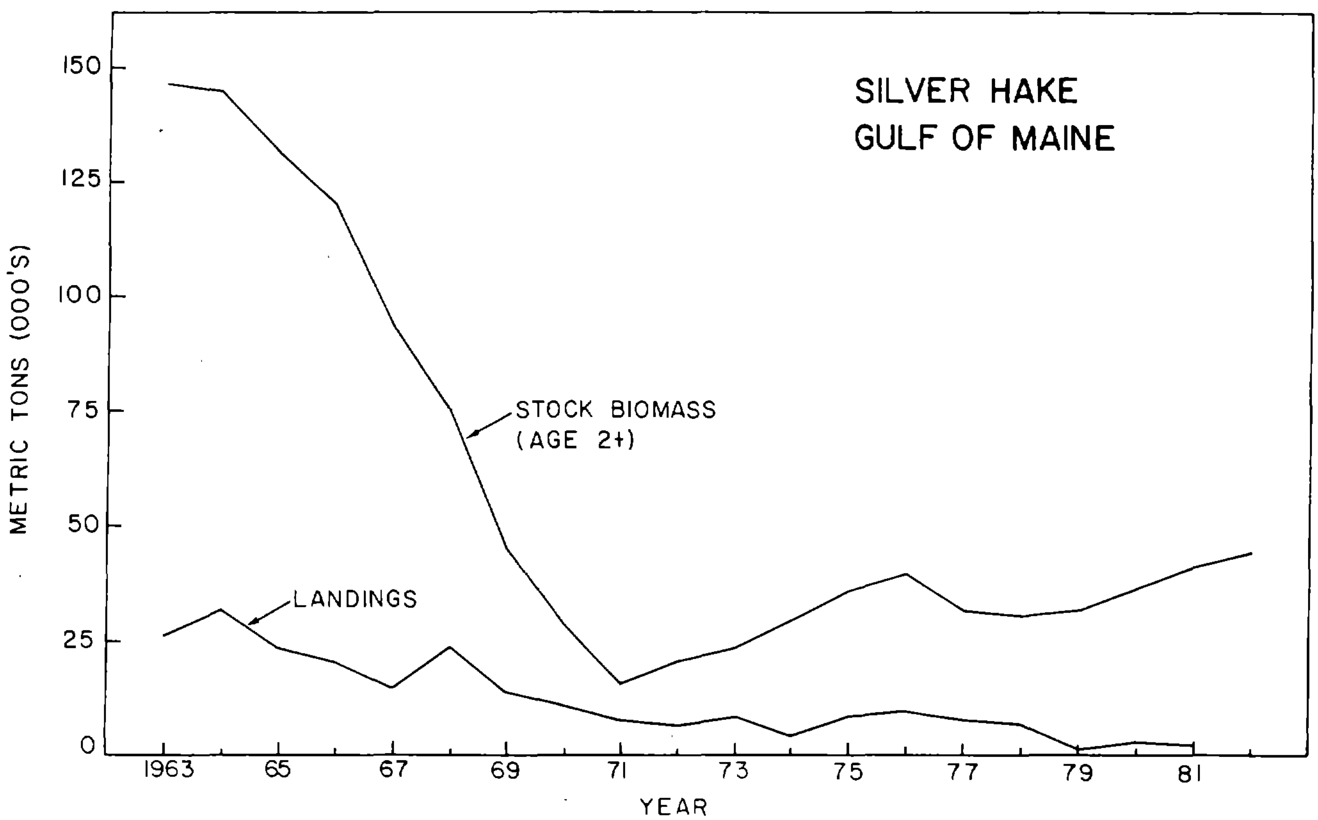


Figure 7. Nominal catch and estimates of stock biomass for silver hake from the Gulf of Maine.

Georges Bank Stock

The 1981 international nominal catch on Georges Bank was 1,489 mt (Table 10, Figure 8), the lowest catch reported in the 1955-1981 time series. Catches have declined steadily from 66,364 mt in 1974 largely due to a reduction in the foreign fishery. Distant-water-fleet catches were only 339 mt in 1981 compared to 1,022 mt in 1979 and 40,514 mt in 1977. The USA catch of 1,150 mt in 1981 was the third lowest since 1955. The USA commercial catch-per-day index, after reaching 46.1 mt in 1976, declined to 17.4 mt in 1979, increased slightly in 1980 to 21.0 mt, then decreased to 15.8 mt in 1981, the lowest level since 1974.

The NEFC autumn bottom trawl survey catch-per-tow index, after reaching a high level in 1976, dropped through 1979 before increasing in 1980 and again in 1981. The spring survey index, after reaching its highest level in the time series in 1981, dropped sharply in 1982 to its lowest level in the series. Survey catch-per-tow-at-age data indicate that the 1973 and 1974 year classes were quite strong and were the dominant year classes in the fishery through about 1978. Since 1975, no year classes of any substantial strength have appeared although the 1978 and 1980 cohorts appear to be stronger than the 1975-1977 year classes. The 1981 year class appears to be weak.

Fishing mortality in 1981 was estimated to be 0.14 for ages 3 and older based on a relationship between fishing effort and past fishing mortality from VPA. This level of F is a sharp drop from an average of 1.07 during 1971-1978.

Total stock biomass (ages 1 and older) in 1982 was estimated to be 26,600 mt, an approximate 6% decrease from the 1981 estimate and substantially below the levels maintained from 1966 through 1976 (average 213,000 mt). Spawning stock biomass (ages 2 and older) was estimated to be 21,500 mt at the beginning of 1982, a slight increase over the 1978-1980 average, but well below past levels which averaged about 167,000 mt during 1966-1976 (Figure 8).

A 1982 catch varying between 1,500 mt (equal to the 1981 catch) and 3,000 mt (the projected 1982 catch) would produce an F for fully recruited ages of 0.10 to 0.21. Resulting spawning stock biomass in 1983 would range between 21,600 mt (approximately equal to the 1982 biomass) and 23,000 mt (a 7% increase over 1982). Fishing at $F_{0.1}$ in 1983 (0.65) would result in catches between 8,400 mt and 9,000 mt and result in an average decrease in spawning stock biomass in 1984 of approximately 28%.

The low catches reported during 1979-1981 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 VPA. Accordingly, the estimates of current and projected stock size and catch levels must be interpreted with considerable caution.

Table 10. Nominal catches (thousand metric tons) and management information for silver hake from Georges Bank.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982[1]
US Recreational	-	-	-	-	-	-	-	-	-
Commercial									
US	3.2	4.6	3.8	3.7	6.4	0.9	1.2	1.2	3.0
Canada	-	-	-	-	-	-	-	-	-
Other	57.3	58.6	42.0	40.6	3.6	1.0	0.5	0.3	0.1
Total nominal catch	60.5	63.2	45.8	44.3	10.0	1.9	1.7	1.5	3.1
Total allowable catch		80.0	50.0	70.0	58.8	58.8	35.0	25.0	25.0

Long-term potential catch = 80.0
Importance of recreational fishery = Insignificant
Status of management = FMP in force since 1977
Status of exploitation = Underexploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 24.3 cm (9.6 inches) males; 26.1 cm (10.3 inches) female
$M = 0.40$ $F_{0.1} = 0.65$ $F_{max} = >2.00$ $F_{1981} = 0.14$

[1]Estimated.

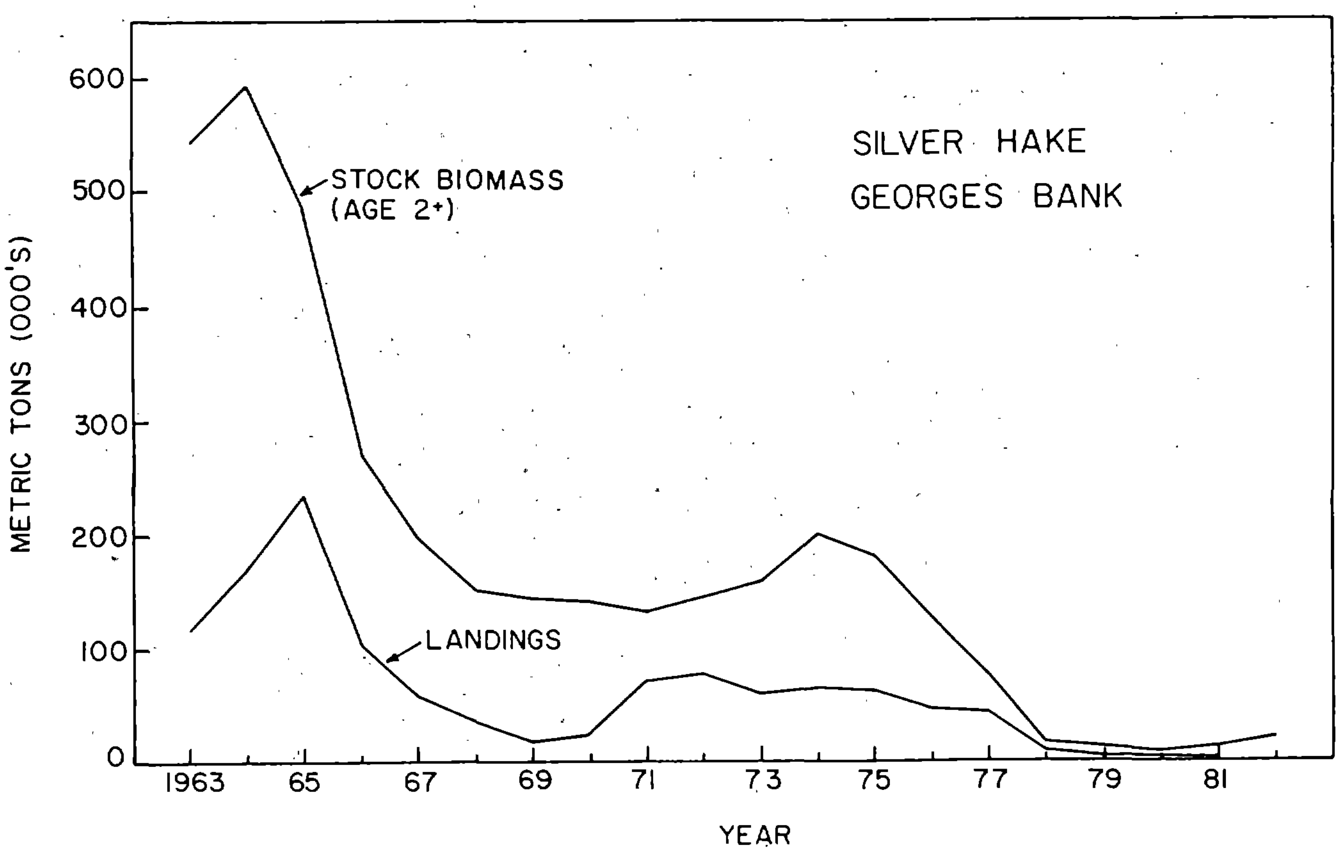


Figure 8. Nominal catch and estimates of stock biomass for silver hake in the Georges Bank area.

Southern New England - Middle Atlantic Stock

The 1981 international nominal catch was 16,900 mt, a slight increase over 1980, but continuing the low level of catches reported since 1979 (Table 11, Figure 9). The USA commercial catch in 1981 was 11,197 mt, down slightly from 11,483 mt in 1980 but well above levels reported in the early 1970's (average 5,700 mt during 1970-1973). The USA recreational catch was estimated to be 3,000 mt. The distant-water-fleet catch in 1981 was 2,703 mt, compared to 973 mt in 1980, but still well below levels reported before the inception of MFCMA when the DWF catch averaged 76% of the total. The DWF catch has averaged only 21% of the total catch since 1978.

The USA commercial catch-per-day index, after remaining relatively steady during 1976-1979, declined in 1980 and again in 1981 to a level approximately equal to those calculated in the early 1970's. The NEFC bottom trawl survey catch-per-tow indices for this stock have not indicated consistent trends in that while the autumn survey index has reflected basically the same trend as the commercial catch-per-effort index, remaining relatively steady during 1976-1980 and declining in 1981, the spring index has shown considerble fluctuation, recording its lowest level in the series in 1980, increasing in 1981 and declining in 1982. Survey catch-per-tow-at-age data indicate, as with the Gulf of Maine and Georges Bank stocks, that the 1973-1974 year classes were of superior strength compared to more recent years. Of the year classes produced since 1974, the 1976 and 1978 cohorts appear stronger than the others. The 1980 and 1981 year classes appear to be of average strength.

Fishing mortality in 1981 was estimated to be 0.47 for ages 3 and older from a relationship between fishing effort and past fishing mortality from VPA. While this level of F is slightly above the 1980 estimate, it is approximately equal to the 1976-1980 average.

Total stock biomass (ages 1 and older) at the beginning of 1982 was estimated to be 79,100 mt. This level of biomass is approximately 29% below the average of 111,400 mt estimated for 1975-1979, and 77% below the 1962-1967 average (350,900 mt), the period of highest biomass for this stock. Spawning stock biomass (ages 2 and older) was estimated to be 64,100 mt, a slight increase over 1981, but still the third lowest level since 1971 (Figure 9).

A catch in 1982 varying between 8,000 (the projected 1982 catch) and 20,000 mt would produce a F of 0.18 to 0.51 and result in a spawning stock biomass in 1983 ranging from 60,300 mt (a 6% decrease from 1982) to 71,900 mt (a 12% increase). Fishing at $F_{0.1}$ in 1983 would produce catches ranging between 20,000 mt and 23,900 mt, and result in an average decrease in spawnig stock size of about 8% from 1983 to 1984.

For further information see:

Almeida, F.P. and E.D. Anderson. 1981. Status of the silver hake rsource off the Northest coast of the United States - 1981. NMFS, NEFC, Woods Hole Lab. Ref. No. 81-36, 78 p.

Table 11. Nominal catches (thousand metric tons) and management information for silver hake from Southern New England and the Middle Atlantic area.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982[1]
US Recreational[1]	0.9	0.2	1.7	3.9	4.0	3.0	3.0	3.0	3.0
Commercial									
US	6.0	8.3	9.5	9.5	11.4	13.0	11.5	11.2	4.0
Canada	-	-	-	-	-	-	-	-	-
Other	34.9	33.4	16.5	14.5	10.8	3.9	1.0	2.7	1.0
Total nominal catch	41.8	41.9	27.7	27.9	26.2	19.9	15.5	16.9	8.0
Total allowable catch		80.0	43.0	45.0	38.2	40.0	55.0	30.0	30.0

Long-term potential catch = 47.6
Importance of recreational fishery = Moderate
Status of management = PMP in force since 1977
Status of exploitation = Underexploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 25.1 cm (9.9 inches) males; 25.3 cm (9.9 inches) females
$M = 0.40$ $F_{0.1} = 0.55$ $F_{max} = >2.00$ $F_{1981} = 0.47$

[1] Estimated.

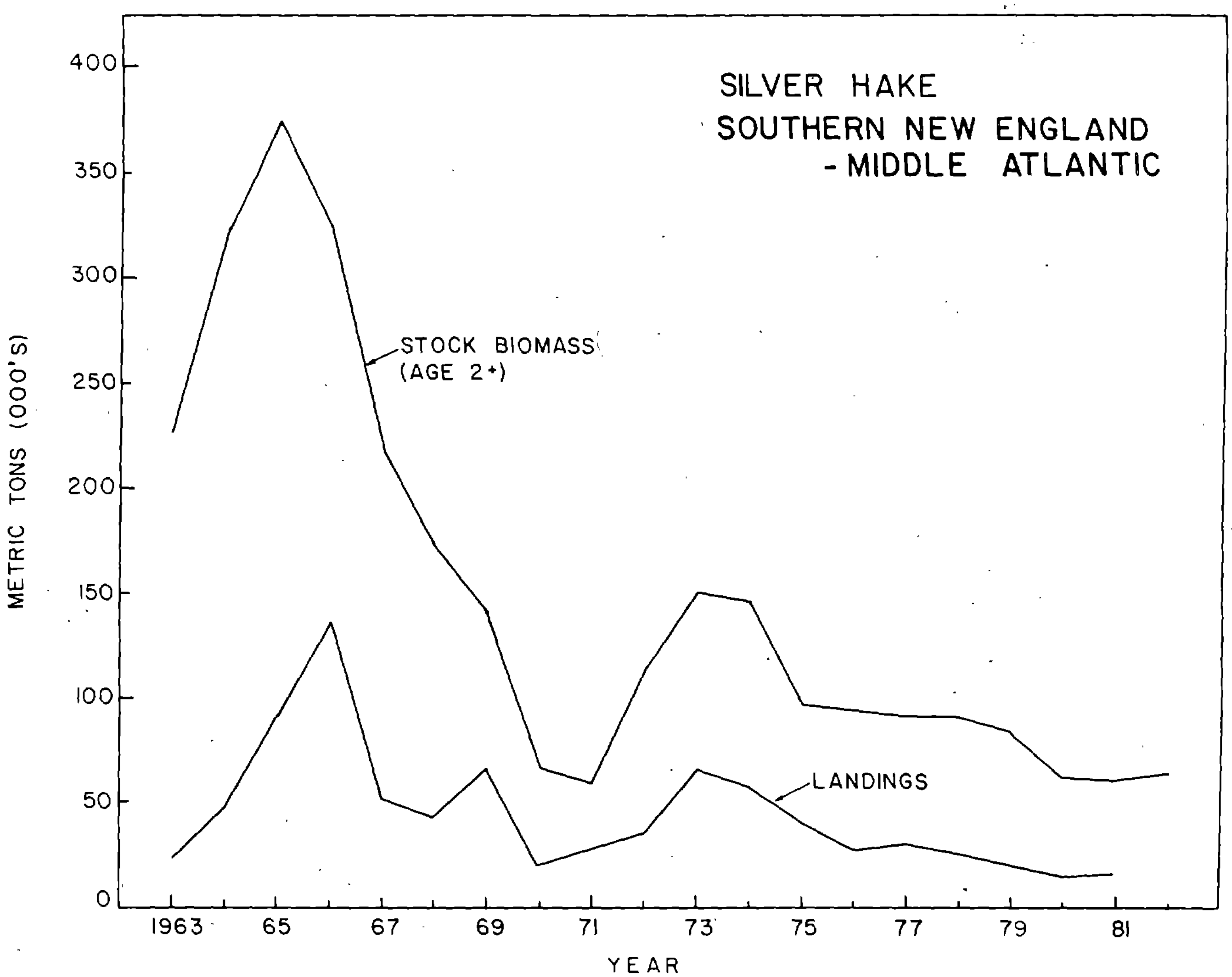


Figure 9. Nominal catch and estimates of stock biomass for silver hake in the Southern New England - Middle Atlantic area.

RED HAKE

The red hake, _Urophycis chuss_, is widely distributed 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 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 behavioral characteristic peculiar to red hake juveniles is the fact that many are found inside live sea scallop shells apparently using the shells as protection against predators.

Major spawning areas include the southwest part of Georges Bank and the southern New England area south of Montauk Point, 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 1981 international nominal catch of red hake on Georges Bank was 345 mt, a slight increase over 1980 but still the third lowest (after 1979 and 1980) in the 1960-1981 time series (Table 12, Figure 10). The USA catch was 311 mt, the highest since 1968. The major reason for the recent decline in total catch has been the sharp drop in distant-water-fleet catches since 1977; the 1981 catch was only 34 mt.

The NEFC spring bottom trawl survey catch-per-tow index, after increasing steadily during 1978-1981, dropped sharply in 1982 to its lowest level in the 1968-1982 time series. The autumn survey index, after remaining relatively steady during 1976-1980, dropped slightly in 1981. Survey catch-per-tow-at-age data indicate that the 1973-1974 year classes were quite strong when compared to other years, while the 1975 and 1976 year classes were weak. The cohorts produced since 1977 appear to be of average strength although the 1980 year class could potentially be quite strong.

Due to low levels of catch during 1979-1981 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 fishing mortality and stock size for 1979-1982 were derived based on projections utilizing estimated stock sizes at age at the beginning of 1978, known catches, and estimates of year-class size from a relationship between spring survey catch per tow at age 1 and year-class size at age 1 from VPA.

Fishing mortality for fully recruited ages has shown two distinct peaks, in 1972-1973 (average 1.10) and in 1976 (1.02). F dropped sharply to an estimated 0.17 in 1978. During 1979-1981, F was probably quite low (e.g., less than 0.10) as a result of the minimal catches in those years. $F_{0.1}$ for this stock has been calculated to be about 0.55.

Total stock biomass (ages 1 and older), after reaching a peak of 102,300 mt in 1971, declined steadily to 18,200 mt in 1977 before increasing slightly to 25,100 mt in 1978. Spawning stock biomass (ages 2 and older) reached a peak of 86,900 mt in 1971 before declining steadily to only 11,900 mt in 1977 and then increasing to 14,700 mt in 1978 (Figure 10).

With low levels of catch reported since 1978 and estimated year-class sizes of average strength, projections indicated generally increasing trends in stock biomass during 1979-1982 with estimates of total and spawning stock biomass reaching about 50,000 mt and 40,000 mt, respectively in 1982. It is unlikely that this stock will undergo major declines in biomass in 1983 if catches remain at or somewhat above the levels reported in recent years.

Table 12. Nominal catches (thousand metric tons) and management information for red hake from Georges Bank.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982[1]
US Recreational	-	-	-	-	-	-	-	-	-
Commercial									
US	0.1	0.1	+[2]	0.1	0.2	0.3	0.3	0.3	0.1
Canada	-	-	-	-	-	-	-	-	-
Other	17.4	14.9	17.1	2.8	0.8	+[2]	+[2]	+[2]	+[2]
Total nominal catch	17.5	15.0	17.1	2.9	1.0	0.3	0.3	0.3	0.1
Total allowable catch		20.0	26.0	16.0	16.0	16.0	6.0	6.0	6.0

Long-term potential catch = 15.5
Importance of recreational fishery = Insignificant
Status of management = FMP in force since 1977
Status of exploitation = Underexploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 28.1 cm (11.1 inches)
M = 0.40 $F_{0.1}$ = 0.55 F_{max} = Unknown F_{1981} = <0.10

[1] Estimated.
[2] Less than 0.1.

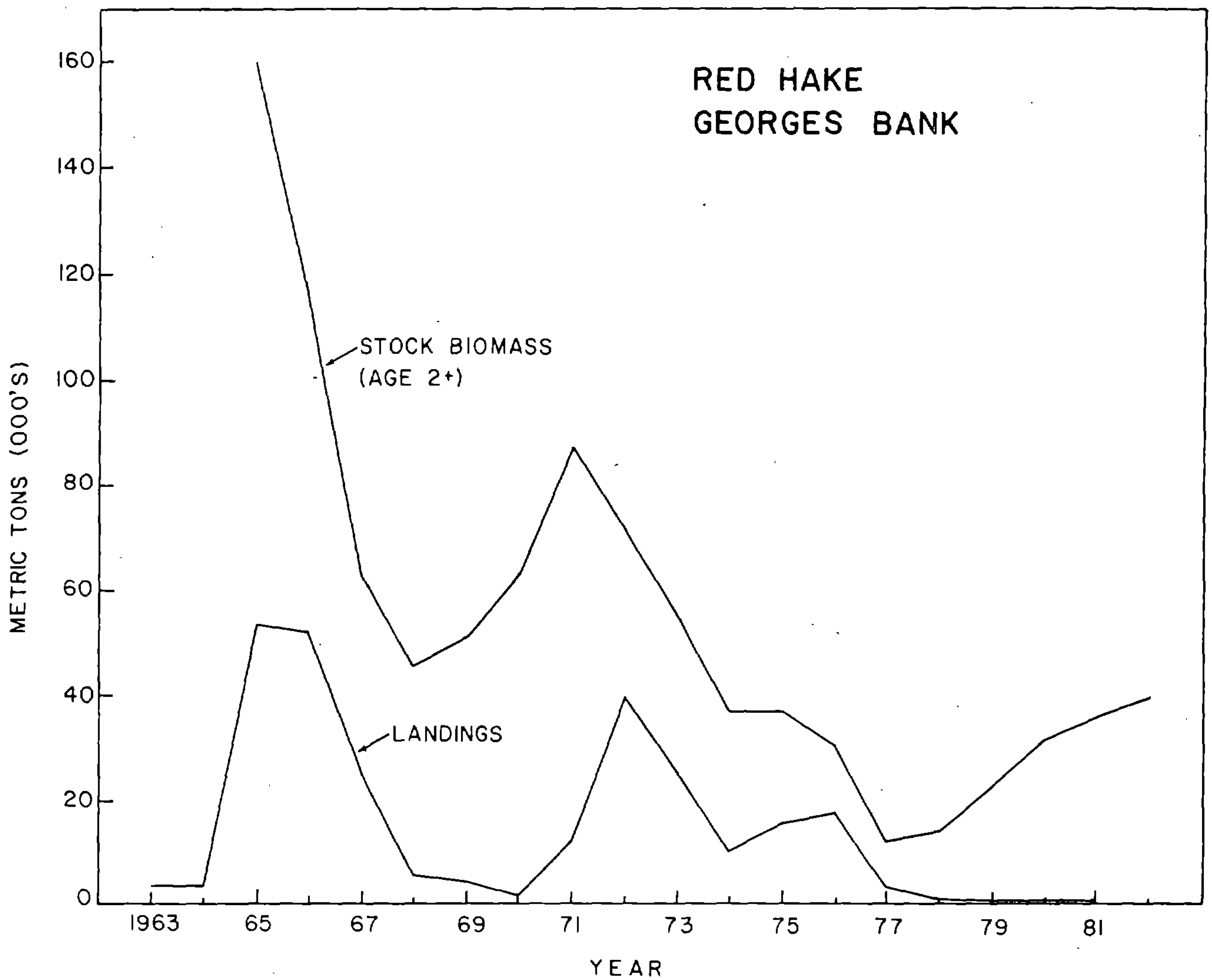


Figure 10. Nominal catch and estimates of stock biomass for red hake in the Georges Bank area.

Southern New England - Middle Atlantic Stock

The international nominal catch of red hake was 2,750 mt, a 39% decrease from 1980 and the lowest level reported in the 1960-1981 time series (Table 13, Figure 11). The reduction in total catch was primarily due to a decline in catches by the DWF which reported a catch of only 130 tons in 1981. DWF catches have dropped steadily from about 38,000 mt in 1973 to the present. The USA commercial catch in 1981 was 2,120 mt, a 45% decrease from 1980, but only slightly below the levels maintained during the early and mid-1970's. The USA recreational catch in 1981 was estimated to be 500 mt.

The NEFC spring bottom trawl survey catch-per-tow index, after increasing steadily from 1979 to 1981, declined somewhat in 1982. A similar trend was evident in the autumn survey index, increasing during 1978-1980 before declining in 1981. However, the declines in the most recent indices were to levels about equal to their long-term averages and may have been due to the variable availability of red hake to the research trawl net. Survey 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 particuarly poor. The 1980 and 1981 cohorts also appear to be of average strength.

Due to low levels of catch and limited sampling data available for 1981, it was not possible to determine catch at age in numbers necessary for updating the VPA for 1982. Estimates of fishing mortality and stock size for 1982 were derived based on projections utilizing estimated stock sizes at age at the beginning of 1981, known catches, and an estimated year-class size of average strength.

Fishing mortality for fully recruited ages, after averaging 0.81 during 1972-1976, dropped sharply to an average of 0.23 during 1977-1980 as a result of decreased catches in those years. In 1981, F was probably about 0.10. $F_{0.1}$ for this stock has been calculated to be approximately 0.45.

Total stock biomass (ages 1 and older) in 1981 was estimated to be 62,600 mt, about the same level as observed since the mid-1970's. Previous levels of total biomass were much higher (e.g., the 1963-1966 average was 195,000 mt). Spawning stock biomass (ages 2 and older) also underwent a similar pattern, declining from high levels in the early 1960's to its lowest level of 30,200 mt in 1977, before increasing to an estimated 48,800 mt at the beginning of 1981 (Figure 11).

With the low levels of catch reported in 1980 and 1981, average year classes in those years, and no sharp changes in the survey abundance indices, projected estimates of total and spawning stock biomass continued to increase in 1982 to about 70,000 mt and 58,000 mt, respectively. It is likely that this stock will not undergo any major declines in biomass in 1983 if catches remain at or somewhat above the levels reported in recent years.

For further information see:

Almeida, F.P. and E.D. Anderson. 1981. Status of the red hake resource off the Northeast coast of the United States - 1981. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 81-37, 49 p.

Table 13. Nominal catches (thousand metric tons) and management information for red hake from Southern New England and the Middle Atlantic area.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982[1]
US Recreational[1]	0.3	0.1	0.6	0.8	0.7	0.5	0.5	0.5	0.5
Commercial									
US	3.1	2.1	3.9	2.5	3.3	6.6	3.9	2.1	4.0
Canada	-	-	-	-	-	-	-	-	-
Other	24.8	11.1	7.2	2.4	1.4	1.0	0.1	0.2	+[2]
Total nominal catch	28.2	13.3	11.7	5.7	5.4	8.1	4.5	2.8	4.5
Total allowable catch		45.0	16.0	28.0	20.5	16.0	11.1	16.0	16.0

Long-term potential catch = 26.0
Importance of recreational fishery = Minor
Status of management = PMP in force since 1977
Status of exploitation = Underexploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 27.6 cm (10.9 inches)
$M = 0.40$ $F_{0.1} = 0.55$ F_{max} = Unknown $F_{1981} = 0.10$

[1] Estimated.
[2] Less than 0.1.

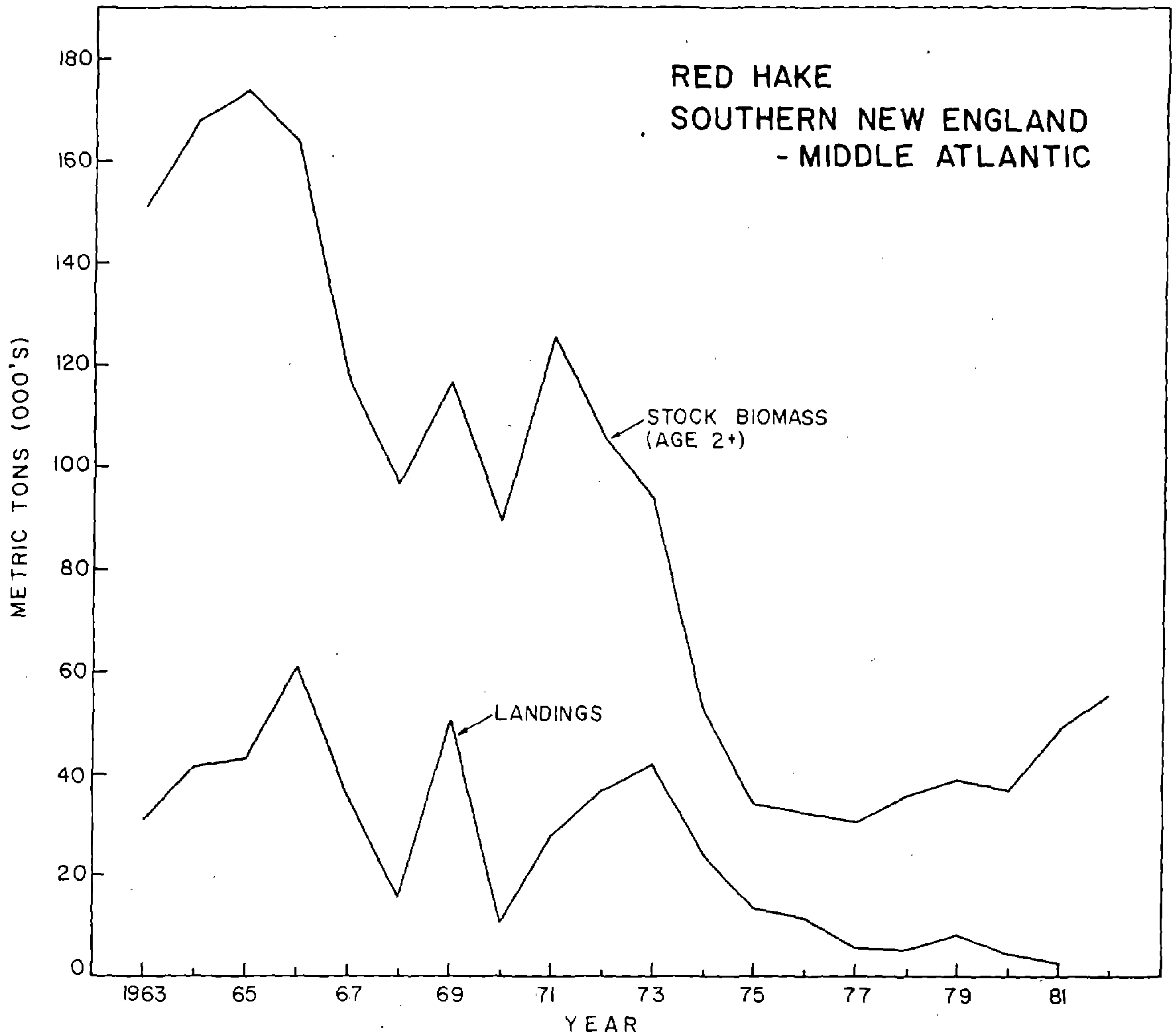


Figure 11. Nominal catch and estimates of stock biomass for red hake in the Southern New England - Middle Atlantic area.

POLLOCK

Pollock (Pollachius virens) occur on both sides of the North Atlantic; in the northwest Atlantic, they are most abundant on the southwestern Scotian Shelf and in the Gulf of Maine. One major spawning area is currently known to exist 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 areas as they grow older. Sexual maturity is essentially complete at age 6. Pollock may attain lengths of up to 110 cm (43 in.) 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 toward this species. Commercial catches remained relatively stable about an average of 38,200 mt from 1974-1977 and then increased to an average of 55,200 mt in 1980 and 1981, of which 36,100 mt was landed by Canada and 18,200 mt by the USA (Table 14). Canadian catches were relatively constant about an average of 25,400 mt during 1975-1978 and then increased sharply in 1980-1981; USA catches have increased more or less continually since 1973. Nominal catches by distant water fleets have declined from 9,900 mt in 1973 to an average of 900 mt during 1977-1981, almost all of which was taken by USSR vessels on the Scotian Shelf (Table 14). USA recreational catch estimates declined from 9,900 mt in 1960 to only 500 mt in 1974; the 1979 Marine Recreational Fishery Statistics Survey provided an estimate of 1,600 mt. Differences observed in recreational catch estimates appear to be more dependent upon differences in survey methodology than trends in abundance or fishing effort. No information is available on Canadian recreational harvest, although it appears to be of minor importance. The total nominal catch (including recreational) increased from an average of 26,100 mt during 1968-1970 to an average of 47,600 mt during 1978-1979. In 1980, total landings increased further to 57,400 mt, provisional statistics for 1981 indicate landings of 56,700 mt (Table 14, Figure 12). Canadian and USA comercial figures for recent years appear to have been biased upwards by misreporting of other species (e.g., haddock) as pollock to circumvent landings restrictions, although there 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 (mt per hour fished) increased sharply in 1979, and 1979-1980 averages for 150-499 GT and 500-999 GT trawlers (1.4 and 1.7 mt, respectively) are more than double corresponding 1972-1978 averages (0.5 and 0.8 mt). 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 (stratified mean catch per tow) declined from 4.5 fish per tow in 1970 to 1.6 in 1975 before rising sharply to 8.7 in 1977; the 1980 index value (12.4) was the highest observed in the time series. The USA spring survey index (retransformed stratified mean catch per tow) increased to a peak of 6.5 kg per tow in 1976 before declining to an averge of 3.5 kg in 1978-1980, comparable to the 1972-1974 average of 3.8 kg (Figure 12). Recent spring indices for 1981 (4.9 kg) and 1982 (3.3 kg) have fluctuated without any definite trend. 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. In 1981 and 1982, however, autumn survey indices declined futher to 1.4 and 0.9 kg respectively. USA summer survey data for 1977-1980 indicate substantially higher levels of abundance compared to the 1960's.

Virtual population analysis indicates an increase in stock size (age 2+) of from 99 million fish (162,000 mt) in 1974 to 133 million fish (210,000 mt) in 1977. Abundance subsequently declined to 107 million fish in 1981, although biomass increased to 220,000 mt. Equilibrium yield calculations indicate that fishing at $F_{0.1}$ would provide a long-term catch of 52,000 mt from a stock biomass of 350,000 mt, while fishing at F_{max} would provide a catch of 57,000 mt from a stock biomass of 240,000 mt. Harvests in 1980-81 appear to have generated fishing mortality levels approximately equal to F_{max}.

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.

Clark, S.H., L. O'Brien and R.K. Mayo. MS 1981. Scotian Shelf, Gulf of Maine, and Georges Bank Pollock Status - 1981. NMFS, NEFC, Woods Hole Laboratory Ref. Doc. No. 81-32, 38 p.

McGlade, J., K. Zwanenburg and J.J. Maguire. MS 1981. Assessment of the Division 4VWX and Subarea 5 Pollock Stock Complex CAFSAC Research Document No. 81/31, 50 p.

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

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982[1]
US Recreational[2]	2.0	0.5	0.6	1.3	1.8	1.6	1.9	1.9	-
Commercial									
US	5.9	9.3	10.9	13.1	17.1	15.5	18.3	18.1	5.0
Canada	18.5	26.5	23.6	24.7	26.8	30.0	36.0	36.2	-
Other	8.5	3.2	3.2	0.7	0.8	1.1	1.2	0.5	-
Total nominal catch	35.0	39.5	38.3	39.8	47.1	48.2	57.4	56.7	5.0
Total allowable catch	53	55	55	30[3]	-	-	-	-	-

Long-term potential catch = 52
Importance of recreational fishery = Minor
Status of management = FMP in preparation (USA fishery)
Status of exploitation = Fully exploited
Age at 50% maturity = 5 yrs
Size at 50% maturity = 61 cm (24 inches)
$M = 0.2$ $F_{0.1} = 0.25$ $F_{max} = 0.49$ $F_{1981} = 0.51$

[1] Through June 30, 1982.
[2] Data for 1974 and 1979 taken from recreational surveys; remaining points estimated.
[3] Recommended by ICNAF but not implemented under extended jurisdiction.

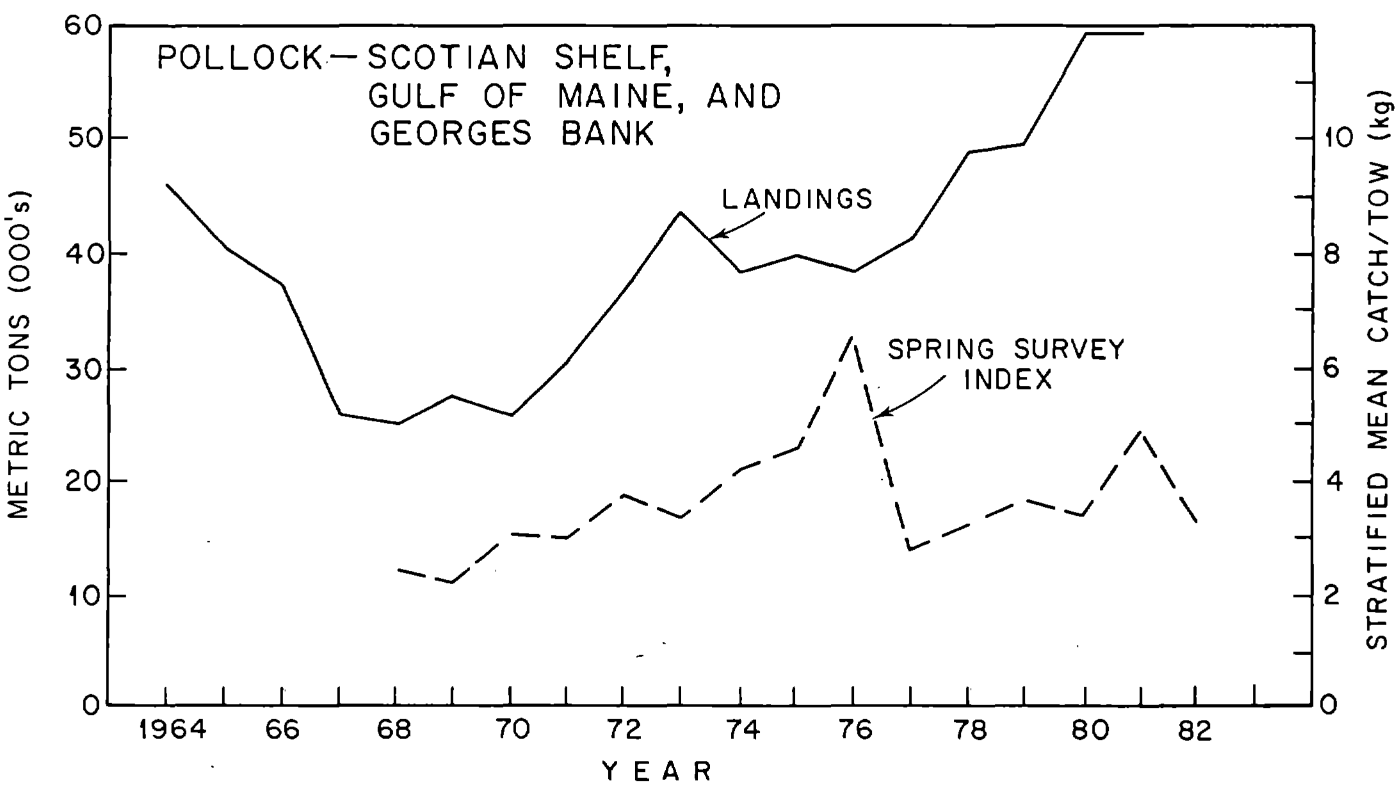


Figure 12. Nominal catches and index of abundance for Scotian Shelf, Gulf of Maine, and

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.

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 have been recognized in recent years: 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.

Nominal catches of yellowtail for Georges Bank (East of 69°W) and southern New England, Cape Cod, and the Mid-Atlantic (West of 69°W) dropped from 57,400 mt in 1969 to only 10,900 mt in 1978 under ICNAF and FCMA restrictions. Nominal catches subsequently averaged 16,100 mt during 1979-1981, and the projected total for 1982 is approximately 22,000 mt, the highest since 1974. The sharp increase observed for 1982 appears primarily attributable to increased landings for the southern New England grounds. Catches for the northern Gulf of Maine, although limited, have increased from an average of 100 mt in 1973-1974 to approximately 500 mt in 1980-1981. Enactment of optimum yields (OYS) and other restrictions under FCMA appear to have resulted in extensive misreporting (or nonreporting) of nominal catches and discard information for recent years is inadequate. Consequently, recent catch and effort data are not considered to be reliable. Age composition data indicate increased proportions of younger fish in nominal catches in recent years.

Georges Bank (East of 69°W)

Nominal catches declined precipitously from an average of 15,300 mt for 1970-1974 to only 4,600 mt in 1978; subsequent catches have increased slightly but are nowhere near levels observed in the early 1970's (Table 15, Figure 13). The commercial abundance index for Georges Bank (mt/day fished) suggests a similar trend. The 1977 and 1978 year classes predominated in the 1981 nominal catch. NEFC survey data indicate a pronounced decline in abundance and biomass between the late 1960's and the mid-to-late 1970's. The spring survey (weight) index has subsequently increased from an average of 1.3 kg per tow in 1977-1979 to 6.0 kg in 1980 and averaged 3.8 kg in 1981-1982; the NEFC autumn survey index increased from an average of 2.0 kg in 1977-1979 to 6.1 kg in 1980 and subsequently declined to only 1.9 kg in 1982 (Figure 13). The NEFC summer survey index increased more or less continually from 0.8 kg in 1977 to 4.6 kg in 1981. Thus, commercial and research vessel survey data are consistent in indicating a modest increase in abundance and biomass in recent years, although current levels appear to be well below those observed during the mid-to-late 1960's.

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 have been the strongest observed in recent years and contributed significantly to the observed increase 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. The 1979 year class may be comparable, based on 1981 spring and autumn survey data. Total mortality estimates calculated from NEFC spring and autumn survey data for 1978-1981 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 completely dependent upon incoming recruitment.

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

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981[1]	1982[2]
US Recreational	-	-	-	-	-	-	-	-	-
Commercial									
US	14.4	13.8	11.4	9.5	4.5	5.5	6.7	6.3	3.2
Canada	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.1	0.0[3]	0.1	0.0[3]	-
Other	0.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	-
Total nominal catch	15.3	13.9	11.4	9.5	4.6	5.5	6.8	6.3	3.2
Total allowable catch	16[4]	16	16	10	4.4	4.5[5]	5.0[6]	5.0[6]	-

Long-term potential catch = 16
Importance of recreational fishery = Insignificant
Status of management = Interim FMP in effect since March 31, 1982
Status of exploitation = Fully exploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 26 cm (10 inches)
M = 0.2 $F_{0.1}$ = 0.3 F_{max} = 0.5 F_{1981} =>Fmax

[1] Provisional (incomplete).
[2] Through June 30, 1982.
[3] Less than 0.05 (50 mt).
[4] For 1972-1974.
[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 Years 1980 and 1981 under Final Supplement No. 4 to the FMP for Atlantic Groundfish (effective September, 1981).

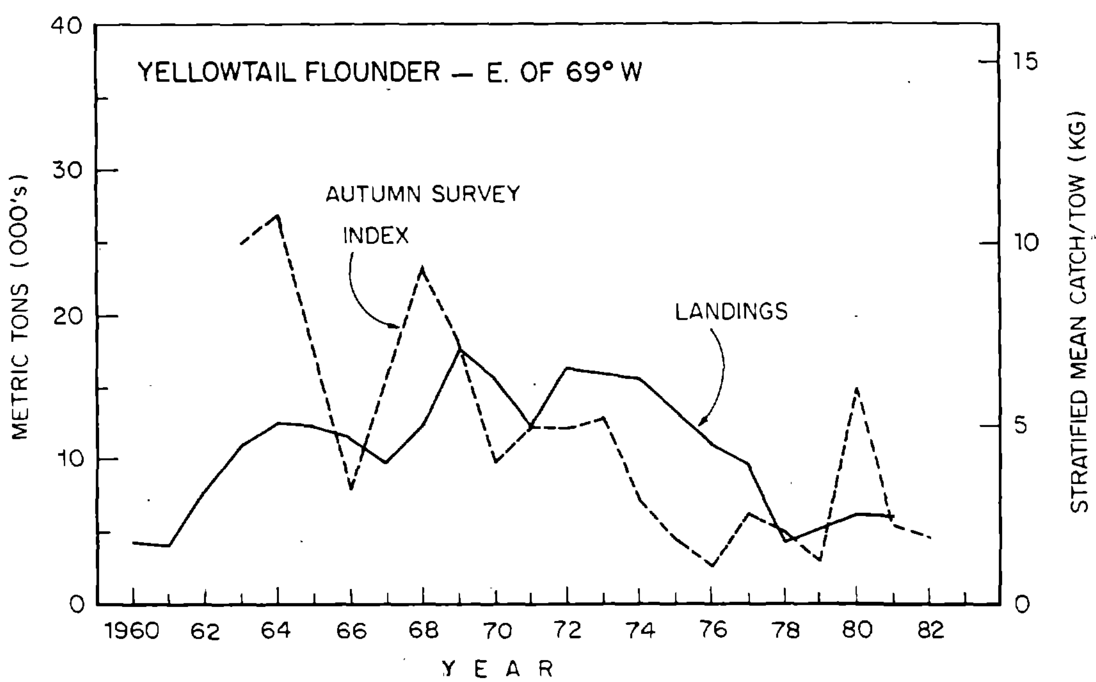


Figure 13. Nominal catch and indices of abundance from autumn research vessel surveys for yellowtail flounder from the area east of longitude 69°W.

Southern New England, Cape Cod, and Mid-Atlantic (West of 69^{o}W)

Nominal catches declined from an average of 17,700 mt during 1970-1974 to only 6,200 mt from 1975-1978. Subsequent catches have increased substantially, but again are nowhere near the 1970-1974 average (Table 16). Increased catches in 1982 appear to reflect elimination of quota restrictions under the Interim Plan and improving recruitment. The 1981 nominal catch was dominated by the 1978 year class.

NEFC survey data for southern New England indicate pronounced declines in abundance and biomass to minimal levels by the mid-1970's, followed by substantial increases in recent years. The spring survey (weight) index rose from an average of 2.1 kg during 1975-1977 to 8.6 kg in 1981-1982, while the corresponding autumn survey index rose from an average of 1.7 kg during 1975-1977 to 8.1 kg in 1982 (Figure 14). Recruitment has clearly improved since the mid-1970's, with the 1979 and 1980 year classes being perhaps the strongest in recent years. Instantaneous total mortality (Z) estimates obtained from NEFC spring and autumn survey data for 1978-1981 were 0.76 and 1.61, respectively, indicating that F has again exceeded F_{max} in recent years.

Results of cooperative surveys by the M/V FRIESLAND (1980), and M/V FORAGER (1981) agree with NEFC autumn survey data in indicating relatively high mortality, and also suggest that the 1979 year class may be a strong one. Stratified mean catch per tow values from these surveys 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.

The situation for the Mid-Atlantic area as evidenced by NEFC surveys appears comparable to that observed for southern New England. Again, abundance and biomass declined to minimal levels by the mid-1970's, followed by substantial increases in recent years. The NEFC spring survey (weight) index rose from an average of 1.2 kg for 1975-1977 to 9.9 kg in 1982, while the corresponding autumn survey index rose from an average of 0.1 kg in 1975-1977 to an average of 2.1 kg in 1981-1982 (Figure 14). Again, the 1979 and 1980 year classes appear to be the strongest in recent years. NEFC survey indices for Cape Cod yellowtail have fluctuated considerably although an increasing trend appears evident for recent years (Figure 14). 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.

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

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981[1]	1982[2]
US Recreational	0.0	0.0	0.0	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]
Commercial									
US	16.2	5.9	5.5	6.8	6.4	10.1	11.4	8.6	5.7
Canada	0.0[3]	0.0	0.0[3]	0.0	0.0[3]	0.0	0.0	0.0	-
Other	1.5	0.0[3]	0.0[3]	0.0[3]	0.0	0.0	0.0	0.0	-
Total nominal catch	17.7	5.9	5.5	6.8	6.4	10.1	11.4	8.6	5.7
Total allowable catch	10[4]	4.0	4.0	6.0	3.7	4.0[5]	5.0[6]	5.0[6]	-

Long-term potential catch = 23
Importance of recreational fishery = Insignificant
Status of management = Interim FMP in effect since March 31, 1982
Status of exploitation = Fully exploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 26 cm (10 inches)
$M = 0.2$ $F_{0.1} = 0.3$ $F_{max} = 0.5$ F_{1981} =>Fmax

[1] Provisional (incomplete).
[2] Through June 30, 1982.
[3] Less than 0.05 (50 mt).
[4] For 1972-1974, 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 Years 1980 and 1981 under Final Supplement No. 4 to the FMP for Atlantic Groundfish (effective September 1981).

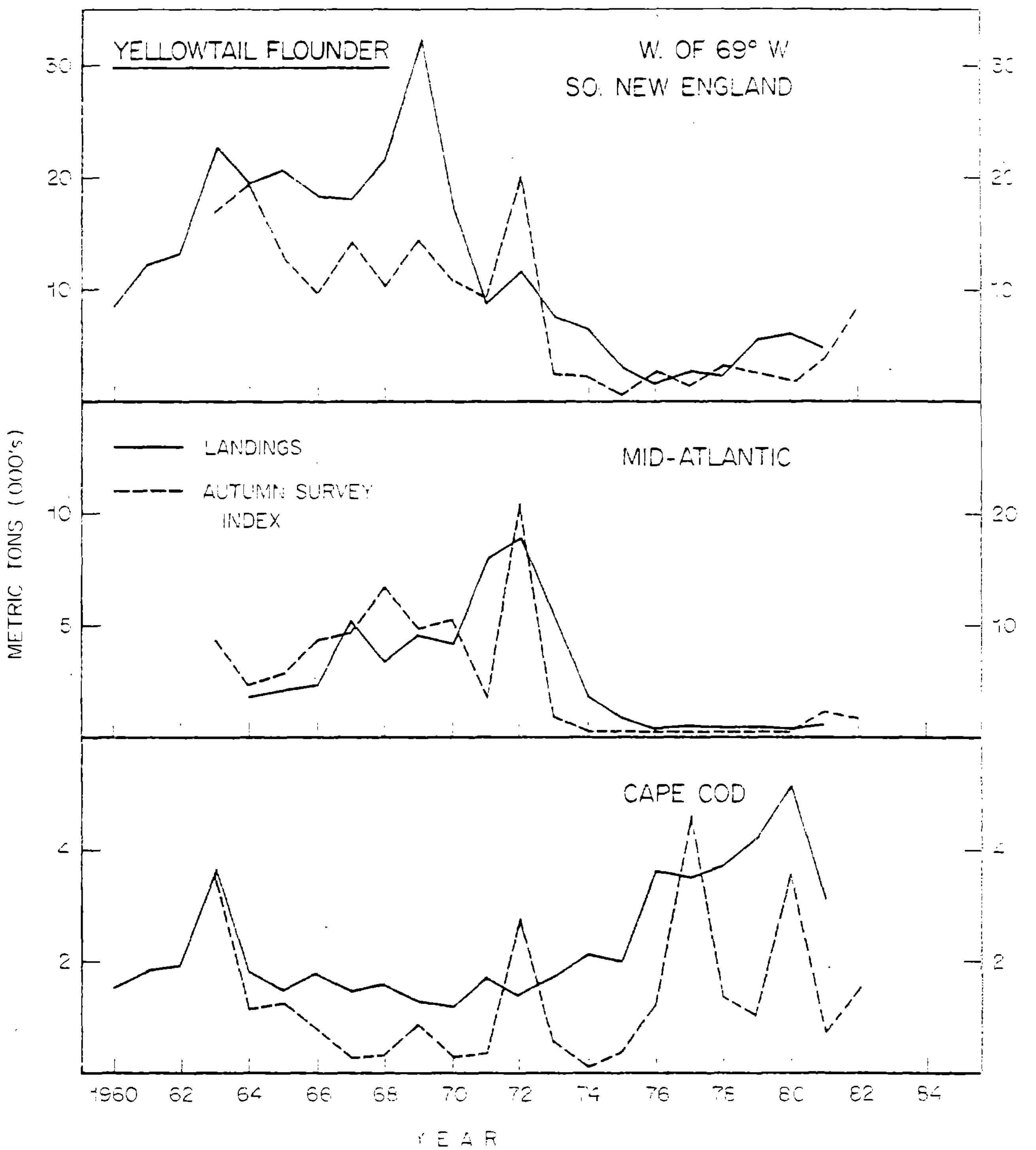


Figure 14. Nominal catch and indices of abundance from autumn research vessel surveys for yellowtail flounder from the areas west of 69° (Southern New England), Middle Atlantic and the Cape Cod areas.

SUMMER FLOUNDER

The summer flounder, Paralichthys dentatus, occurs from the southern Gulf of Maine to South Carolina. Important commercial and recreational fisheries for summer flounder exist within the Middle Atlantic Bight (Cape Cod to Cape Hatteras). Summer flounder are concentrated in coastal embayments and estuaries from late spring through early autumn. An offshore migration to the outer continental shelf is undertaken in autumn; larger individuals tend to move to more northerly locations. Spawning occurs during the offshore fall migration and the larvae are transported toward coastal areas by prevailing water currents. Development of post-larvae and juveniles occurs primarily within embayments and estuarine areas, notably Pamlico Sound and Chesapeake Bay. Growth rates differ appreciably between the sexes with females obtaining weights up to 11.8 kg. Female summer flounder may live up to 20 years, but males rarely exceed 7 years.

Nominal commercial catch of summer flounder averaged 8,300 mt during 1950-1960 and declined sharply to 1,700 mt in 1969. Yield subsequently recovered during 1974-1978 to an average of 8,600 mt. The US nominal catch in 1981 was 7,900 mt, a 31% decrease relative to the 1980 level of 11,500 mt and considerably below the peak 1979 catch of 14,500 mt (Table 17). The preliminary nominal catch during January-August 1982 was 5,020 mt, indicating a total 1982 catch similar to 1981. The estimated recreational catch of summer flounder in 1979 was 8,626 mt with an additional 2.13 million fish caught and released alive (weight not available). Since the inception of the MFCMA, nominal catches by foreign vessels have not exceeded 52 mt; an estimated 41 mt was taken by Japanese vessels in 1981.

The NEFC spring survey index (stratified mean catch per tow, kg) declined from 0.40 kg in 1980 to 0.25 kg in 1981 (Figure 15) but remained above the 1979 index value of 0.17 kg. The corresponding autumn survey index declined from 0.39 kg in 1980 to 0.21 kg in 1981. Decreases in both the 1981 spring and fall survey indices and commercial nominal catch during 1981 suggest a recent decline in abundance.

Recent evidence suggests that summer flounder are extremely susceptible to a hemoflagellate parasite and that large scale mortality of juvenile summer flounder may have occurred in Chesapeake Bay during 1981 as a result of parasite infestation.

For further information see:

Fogarty, M.J. MS 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. Nominal catches (thousand metric tons) and management information for summer flounder from the southern New England, Georges Bank, and Mid Atlantic area, 1970-1982.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981[1]	1982
US Recreational	15.8	-	-	-	-	-	8.6	-	-
Commercial									
US	4.0	7.6	10.8	8.9	8.5	14.5	11.5	7.9	5.0[2]
Canada									
Other	0.3	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]	-
Total nominal catch	4.3	7.6	10.8	8.9	8.5	14.5	11.5	7.9	
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = 15-20
Importance of recreational fishery = Major
Status of management = FMP in preparation
Status of exploitation = Fully exploited
Age at 50% maturity[4] = 2 yrs
Size at 50% maturity = 32 cm (12.6 inches)
$M = 0.2$ $F_{0.1} = 0.16$ $F_{max} = 0.19$ F_{1981} = Unknown

[1] Provisional.
[2] Through August, 1982.
[3] Less than 0.1.
[4] Females.

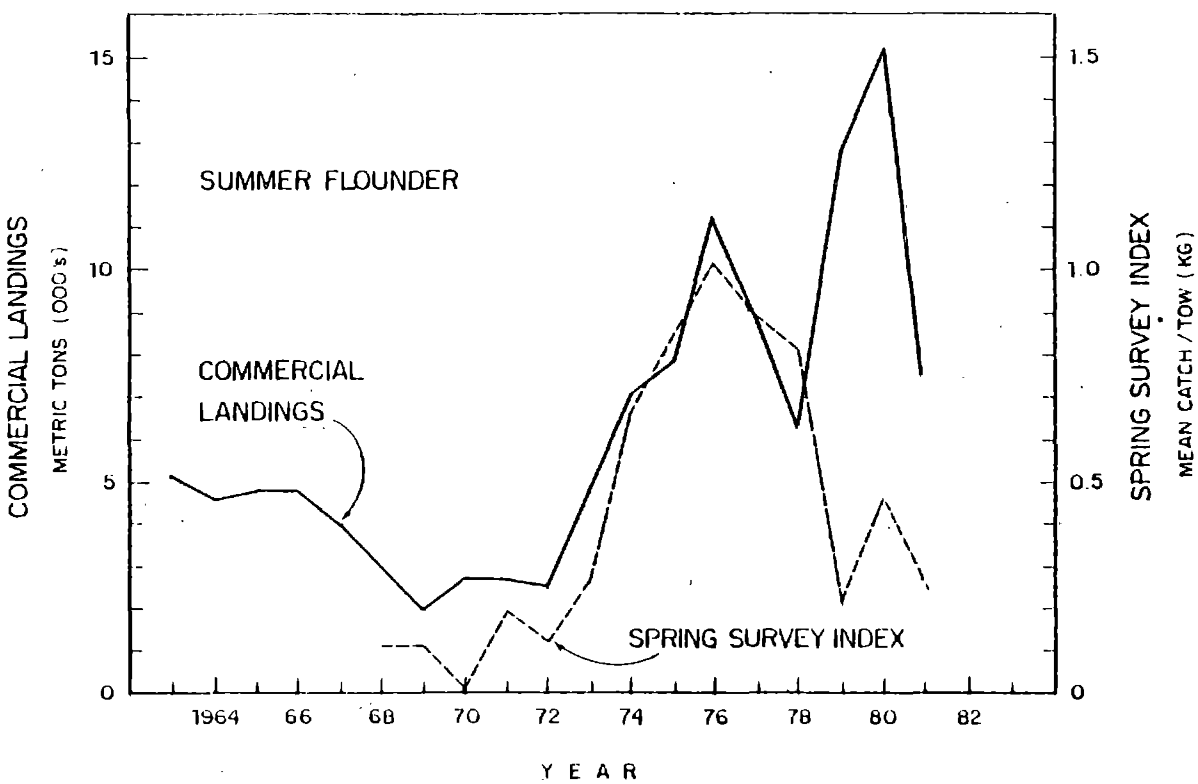


Figure 15. Nominal catches and research vessel abundance indices for summer flounder from the Georges Bank, southern New England and Middle Atlantic areas.

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 182 m (50-100 fm). Sexual maturity commences between ages 2 and 3; spawning occurs in spring, generally during March through May. Growth is rather slow; 3 year old fish are normally between 22-28 cm (9-11 in) in length and weigh between 90-190 g (0.2-0.4 lb). After age 4, females grow faster than males.

Gulf of Maine

Total nominal commercial catch (all but 1 ton taken by USA) in 1981 was 10,325 mt, a 7% decline from the record 1980 nominal catch (11,136 mt) but still the second highest ever (Table 18, Figure 16). Prior to 1981, Gulf of Maine nominal catches had successively increased annually during each of the preceding ten years.

Before 1975, Gulf of Maine catches accounted for less than 50% of the total annual USA nominal catches, comprising only 33% of the total USA plaice catch during 1960-1974. Subsequently, however, annual Gulf of Maine nominal catches have exceeded those from Georges Bank. In 1981, Gulf of Maine catches accounted for 80% of the USA total plaice catch and were 4.1 times greater than those from Georges Bank.

Trends in nominal catch have generally paralleled trends in NMFS offshore autumn research survey bottom trawl weight per tow indices (Figure 16). Although the 1981 survey index was slightly less than 1980 value (10.0 vs. 11.1 kg/tow), it was still the second highest in the survey time series implying that biomass is at a near record-high level.

Table 18. Nominal catches (thousand metric tons) and management information for American plaice from the Gulf of Maine.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982
US Recreational	-	-	-	-	-	-	-	-	
Commercial									
US	0.7	1.5	2.6	5.6	7.2	8.8	11.1	10.3	- [1]
Canada	+ [2]	-	-	-	+ [2]	-	-	+ [2]	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	0.7	1.5	2.6	5.6	7.2	8.8	11.1	10.3	- [1]
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = Unknown
Importance of recreational fishery = Insignificant
Status of management = FMP in planning stage
Status of exploitation = Becoming fully exploited
Age at 50% maturity = 3.2 yrs (males); 3.8 yrs (females)
Size at 50% maturity = 25.6 cm (10.1 in) males; 29.7 cm (11.7 in) females
$M = 0.20$ $F_{0.1} = 0.17$ $F_{max} = 0.34$ F_{1981} = Unknown

[1] Not yet available.
[2] Less than 0.1.

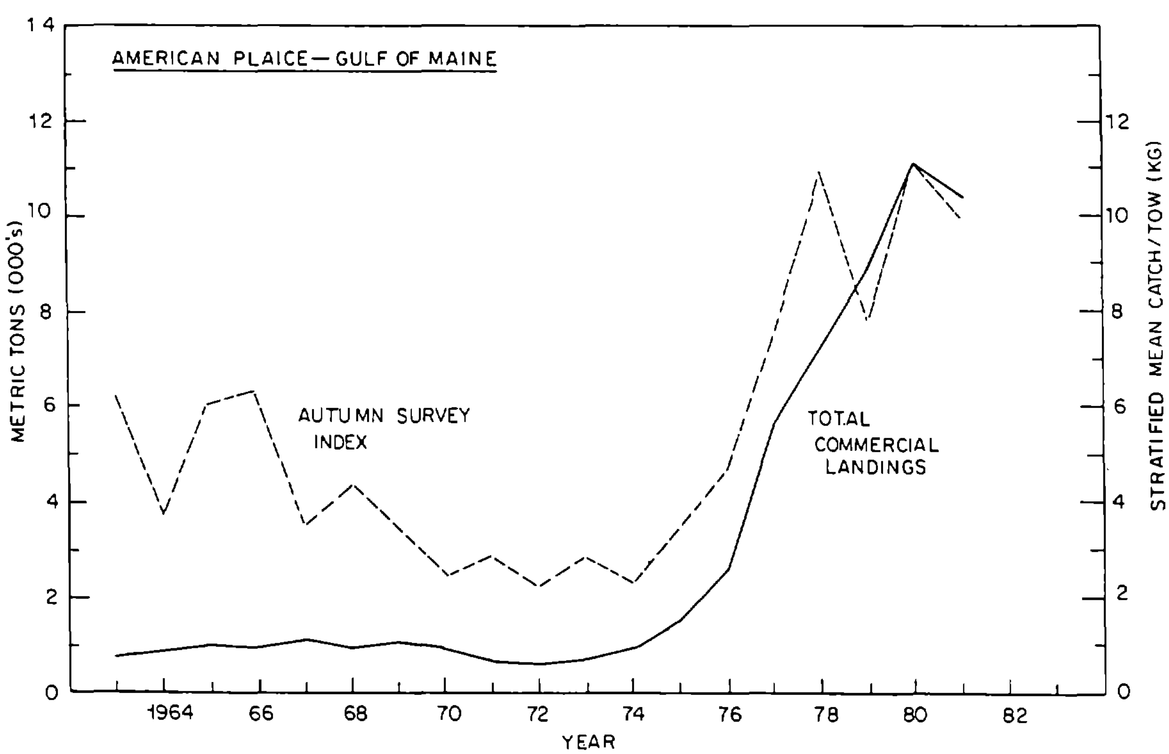


Figure 16. Nominal total commercial landings and indices of abundance from NMFS autumn research vessel bottom trawl surveys for American plaice in the Gulf of Maine area.

Georges Bank

Total nominal commercial catch in 1981 was 2,526 mt, 66 mt more than in 1980, and the second highest annual catch since 1970 (Table 19 and Figure 17). Only 15 mt were taken by foreign (Canadian) effort in 1981. Although total annual nominal catches doubled between 1974 and 1981, the 1981 nominal catch remained below the peak catches observed during 1964-1970 which were accompanied by declines in relative abundance and yield.

NMFS autumn bottom trawl survey indices have generally trended upward since 1974. The 1981 index declined from the 1980 value (2.1 v. 3.2 kg/tow), but was still the third highest since 1966 (Figure 17). The NMFS spring 1982 index (4.0 kg/tow) was the highest in that time series. In toto, the survey data suggest continued improvement in the population of American plaice on Georges Bank, with current abundance and biomass approaching historically high levels.

For further information see:

Sullivan, L.F. 1982. American plaice, _Hippoglossoides platessoides_, in the Gulf of Maine. MA Thesis., Univ. of Rhode Island, Kingston, R.I., 96 p.

Table 19. Nominal catches (thousand metric tons) and management information for American plaice from Georges Bank.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982
US Recreational	-	-	-	-	-	-	-	-	
Commercial									
US	1.3	0.9	1.0	1.4	2.2	2.5	2.4	2.5	- [1]
Canada	+ [2]	+ [2]	+ [2]	+ [2]	0.1	+ [2]	+ [2]	+ [2]	-
Other	0.7	0.1	+	0.1	-	+ [2]	+ [2]	-	-
Total nominal catch	2.0	1.0	1.0	1.5	2.3	2.5	2.4	2.5	- [1]
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = Unknown
Importance of recreational fishery = Insignificant
Status of management = FMP in planning stage
Status of exploitation = Becoming fully exploited
Age at 50% maturity = 3.2 yrs (males); 3.8 yrs (females)
Size at 50% maturity = 25.6 cm (10.1 in) males; 29.7 cm (11.7 in) females
$M = 0.20$ $F_{0.1} = 0.17$ $F_{max} = 0.34$ F_{1981} = Unknown

[1] Not yet available.
[2] Less than 0.1.

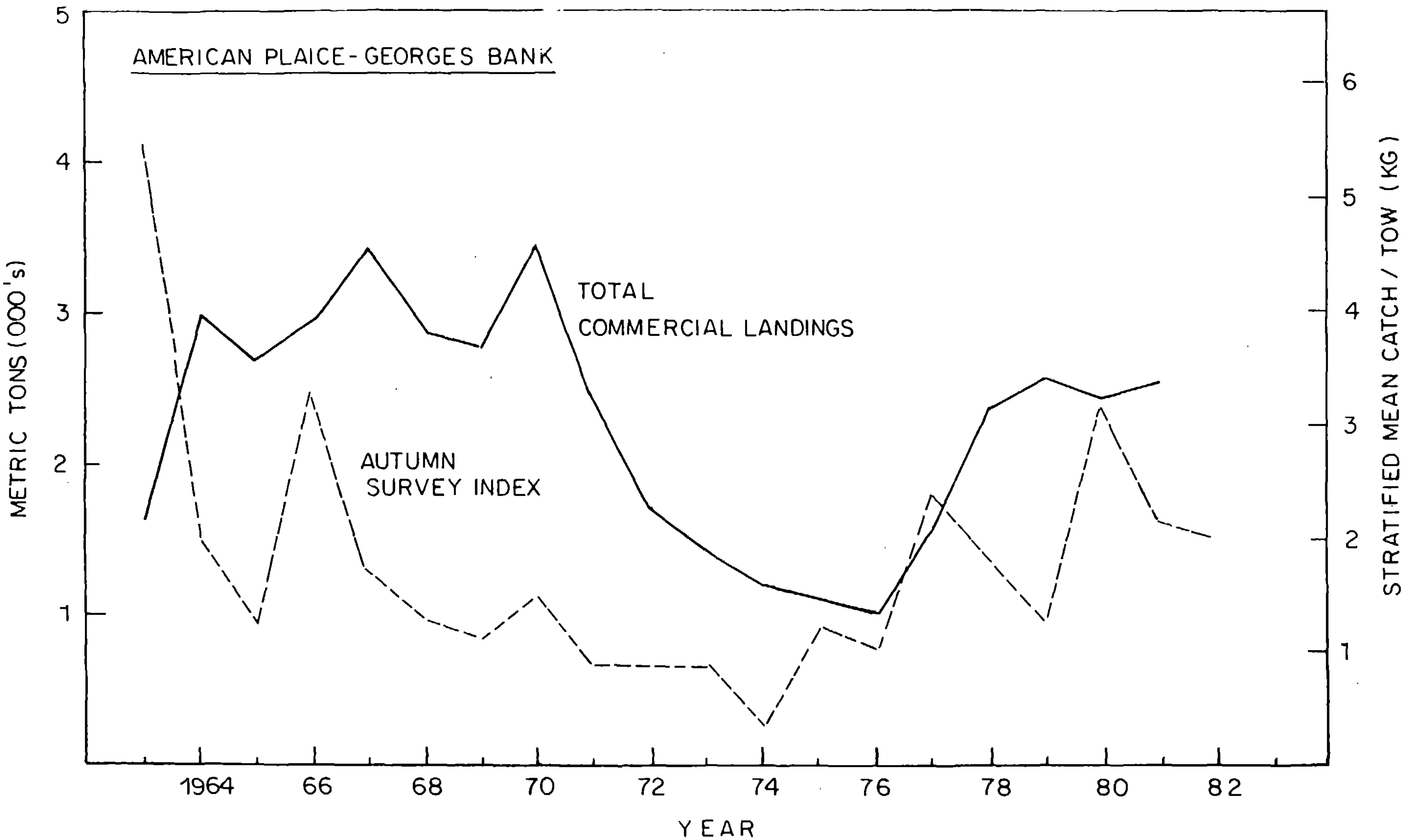


Figure 17. Nominal total commercial landings and indices of abundance from NMFS autumn research vessel bottom trawl surveys for American plaice in the Georges Bank area.

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 27 m (15 fathoms) and most are caught between 110-275 m (60-150 fathoms). Spawning occurs in late spring and summer. Witch flounder attain lengths upwards of 60 cm (24 inches) and weights of approximately 2 kg (4.5 lbs).

Since 1960, the US nominal catch has been distributed almost evenly between Georges Bank and the Gulf of Maine, although in recent years most of the US catch has come from the latter area. No recreational catches have been reported for this stock. Canadian nominal catches from both areas have been minor (less than 50 mt annually since 1970). Distant water fleet catches on Georges Bank averaged 2,600 mt in 1971-72, but subsequently declined sharply and have been negligible since 1977. The total Georges Bank - Gulf of Maine nominal catch increased from 1,000 mt in 1961 to an annual average of 5,700 mt in 1971-1972 and subsequently declined to 1,800 mt in 1976 (Table 20, Figure 18). Nominal catches for 1978-1981 averaged 3,300 mt. The US catch through June 30, 1982 totalled 2,400 mt.

NEFC spring and autumn survey indices both suggest a declining trend in abundance and biomass, followed by an increase, during the 1970's. The NEFC autumn survey index (stratified mean catch per tow, kg) declined from an average of 4.2 kg in 1969-1970 to only 1.1 kg in 1975-76; index values for 1977-1981 averaged 2.6 kg, although the 1982 index value dropped to 1.0 kg (Figure 18).

For further 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. Nominal catches (thousand metric tons) and management information for witch flounder from the Gulf of Maine and Georges Bank, 1970-1982.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981[1]	1982[2]
US Recreational	-	-	-	-	-	-	-	-	-
Commercial									
US	2.6	2.1	1.8	2.5	3.5	3.0	3.4	3.3	2.4
Canada	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]	-
Other	1.3	0.1	0.0[3]	0.0	0.0[3]	0.0	0.0	0.0	-
Total nominal catch	3.9	2.2	1.8	2.5	3.5	3.0	3.4	3.3	2.4
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = Unknown
Importance of recreational fishery = Insignificant
Status of management = None
Status of exploitation = Unknown
Age at 50% maturity = Unknown
Size at 50% maturity = 33 cm (13 inches)
M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1981} = Unknown

[1] Provisional (incomplete).
[2] As of June 30, 1982.
[3] Less than 0.05 (50 mt).

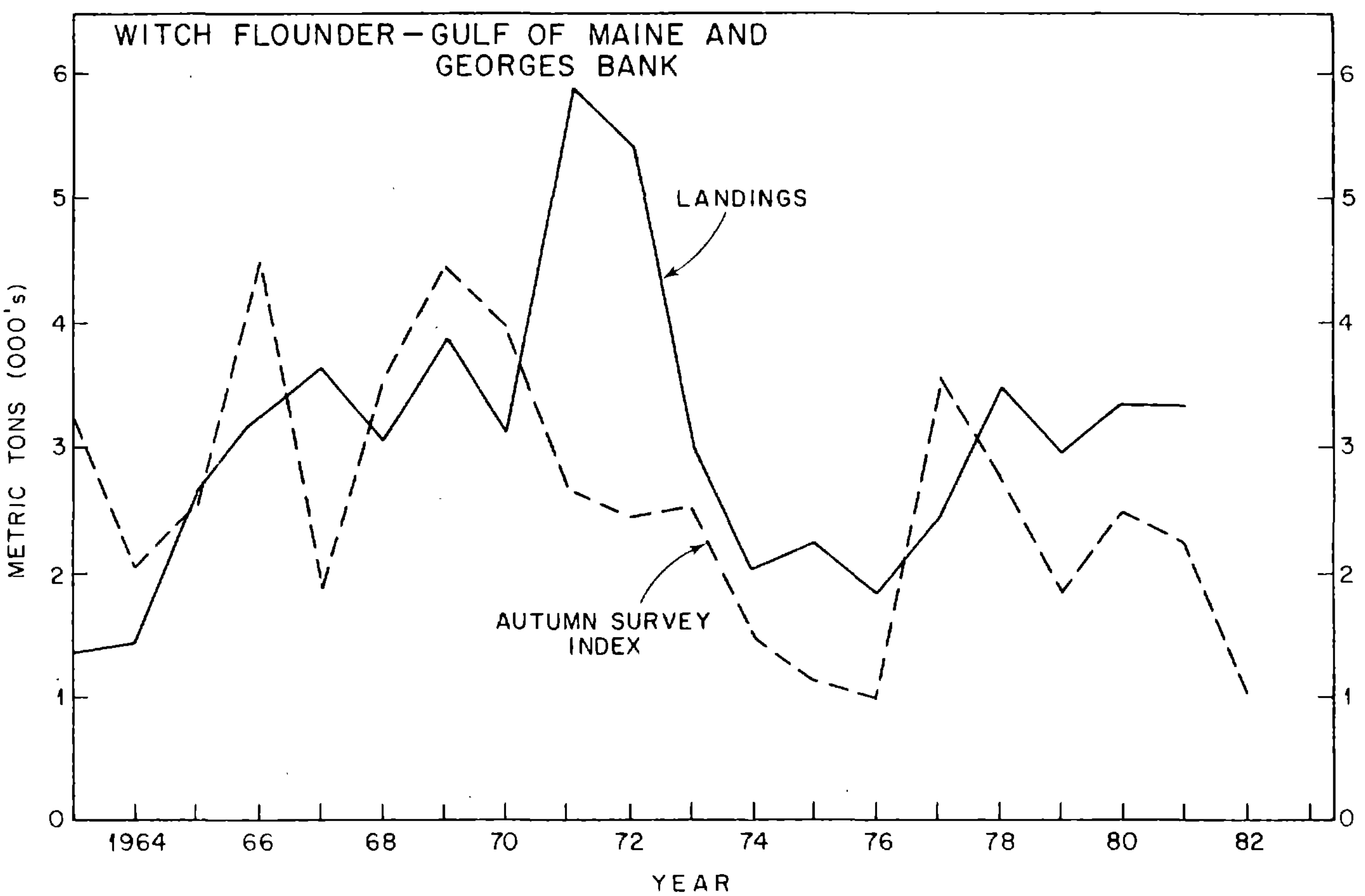


Figure 18. Nominal catches and index of abundance for Gulf of Maine and Georges Bank witch flounder.

WINTER FLOUNDER

The winter flounder, Pseudopleuronectes americanus, is distributed in the Northwest Atlantic from Labrador to Georgia. Abundance appears to be highest from the Gulf of St. Lawrence to Chesapeake Bay. Winter flounder may attain sizes of up to 58 cm (23 inches) total length. The diet consists primarily of benthic invertebrates. Movement patterns of winter flounder are generally localized with small scale seasonal movements. Winter flounder migrate during winter to estuaries, embayments and salt ponds to spawn and move from these locations to deeper water during summer. There is evidence that winter flounder tend to return to the same spawning locations in consecutive years. Restricted movement patterns, and differences in meristic and morphometric characteristics, suggest that relatively discrete local groups exist. Winter flounder are typically exploited in coastal locations, although offshore shoal areas, particuarly Georges Bank and Nantucket Shoals, support important winter flounder fisheries.

The US nominal commercial catch of winter flounder has increased substantially in recent years (Table 21, Figure 19). The US nominal catch of winter flounder in 1981 was 17,800 mt, a slight increase over the 1980 level. The preliminary nominal catch during January-August 1982 was 8,136 mt. The 1977-1979 average commercial yield of 11,800 mt is comparable to that sustained during 1965-71, a period of relatively high yield. The nominal catch of winter flounder by foreign vessels in 1981 was 19 mt, taken entirely by Canada. Landings by foreign vessels have been sharply reduced since the implementation of MFCMA. The estimated recreational catch of winter flounder in 1979 was 7,500 mt, a marked reduction from the estimated 1974 level of 15,800 mt. Due to a change in recreational survey methodology, the 1979 figure is not directly comparable to previous estimates.

The NEFC spring survey index (stratified mean catch per tow, kg) remained virtually constant during 1980-81 at a level considerably above the 1979 value. The corresponding autumn survey index has declined slightly since 1979.

For further information see:

Lange, A.M.T. and F.E. Lux. MS 1978. Review of 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 21. Nominal catch (thousand metric tons) and management information for winter flounder from the Gulf of Maine, Georges Bank, Southern New England, and Mid-Atlantic areas.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981[1]	1982[2]
US Recreational	15.8	-	-	-	-	7.5	-	-	-
Commercial									
US	10.0	8.7	6.7	10.6	12.4	12.2	17.4	17.8	8.1
Canada	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]	-
Other	1.3	0.6	0.0[3]	0.0[3]	0.0	0.0	0.0	0.0	-
Total nominal catch[4]	11.3	9.3	6.7	10.6	12.4	12.2	17.4	17.7	8.1
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = Unknown
Importance of recreational fishery = Major
Status of management = None
Status of exploitation = Unknown
Age at 50% maturity = 2 yrs
Size at 50% maturity = 25 cm (9.8 inches) males; 26 cm (10.2 inches) females
M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1981} = Unknown

[1] Provisional (incomplete).
[2] Through August 1982.
[3] Less than 0.05 (50 mt).
[4] Commercial only.

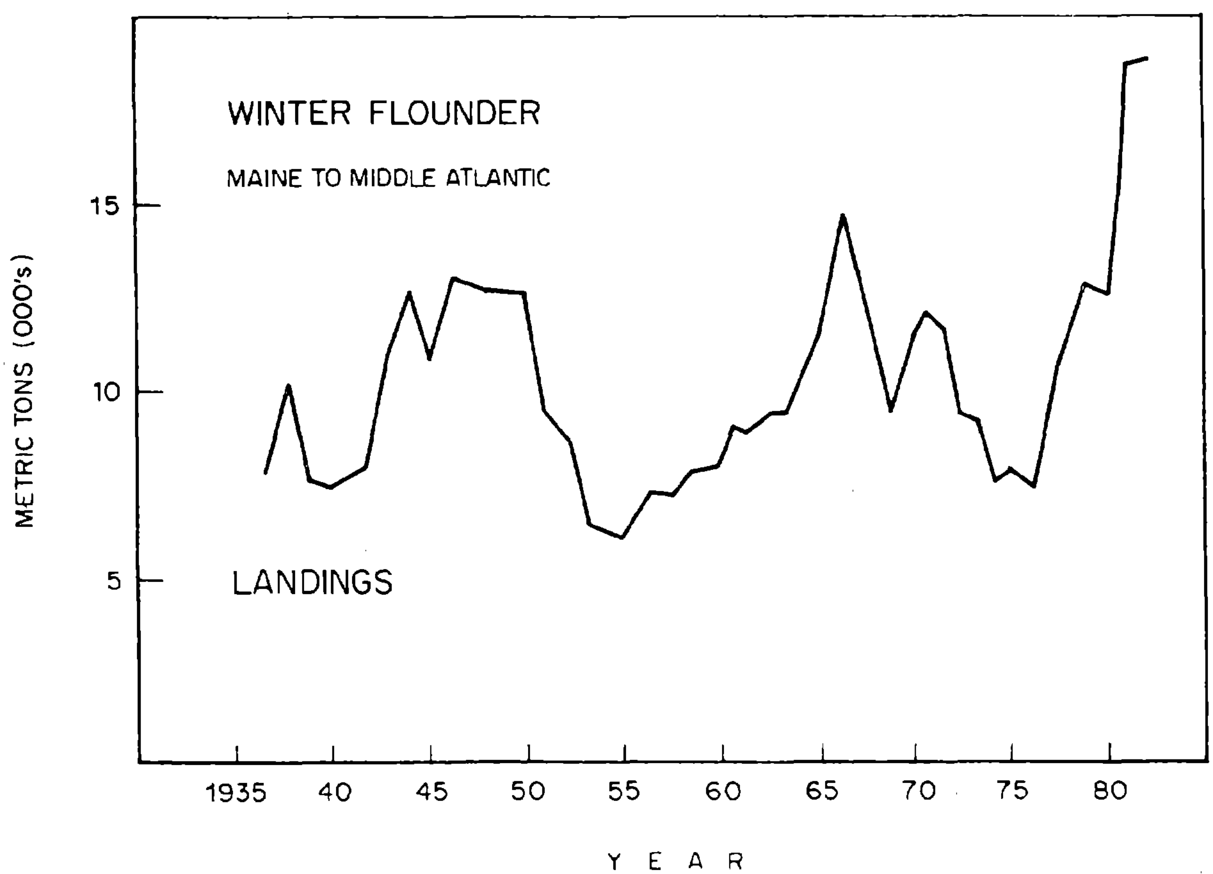


Figure 19. Nominal catches of winter flounder from the Gulf of Maine to Middle Atlantic areas.

ATLANTIC HERRING

The Atlantic herring (Clupea harengus) is widely distributed in continental shelf waters from Labrador to Cape Hatteras. Important commercial fisheries for juvenile herring (age groups 1-3) have been in existence since the last century along the coasts of Maine and New Brunswick. Development of large scale fisheries for adult herring is comparatively recent, primarily occurring in the western Gulf of Maine and on Georges Bank and the Scotian Shelf. The Georges Bank stock collapsed during 1976-77 and no evidence of stock recovery has been noted to date. Gulf of Maine herring migrate from feeding grounds along the Maine coast during autumn to the southern New England-Mid Atlantic region during winter with larger individuals tending to migrate further distances. Tagging experiments have provided evidence of intermixing of Gulf of Maine-Scotian Shelf herring during different phases of the annual migration.

Spawning in the Gulf of Maine occurs during late August-October, beginning in northern locations and progressing southward. Atlantic herring are not fully mature until ages 4-5. Recent evidence suggests a density dependent effect on growth and maturation, indicating that the average age at maturity may vary annually. The eggs are demersal and are typically deposited on rock or gravel substrates. Primary spawning locations off the northeastern United States occur on Jeffreys Ledge and Nantucket Shoals; Georges Bank formerly supported an extensive spawning ground. Incubation is temperature dependent but usually requires 7-10 days. Larvae metamorphose by late spring into juvenile "brit" herring which may form large aggregations in coastal waters during summer. Juvenile herring are fully vulnerable to the coastal fixed gear fisheries (stop seines and weirs) by age 2.

Gulf of Maine

Coastal Maine nominal catches averaged 57,000 mt during 1950-65, subsequently declining to an average of 23,000 mt during 1966-79. With the exception of the strong 1970 year class, recruitment estimates during this period remained below average. Nominal catches increased to an average of 45,000 mt during 1979-1981 with recruitment of a succession of strong year classes (1976, 1977, 1979). The 1981 yield of 48,245 mt was the highest since 1963. The 1982 nominal catch was approximately 24,000 mt. The reduction in 1982 appears to be related to reduced availability to the fixed gear fisheries, although reduced abundance cannot be discounted. A marked shift in gear type (from fixed gear to mobile gear) during 1982 further supports the inference that changes in availability have influenced catch rates. The nominal catch by mobile gear is projected to comprise in excess of 50% of the 1982 total for coastal Maine, but comprised just 7% of the 1981 total.

The 1981 nominal catch of 15,321 mt in the western Gulf of Maine mobile gear fishery represented a 58% decline relative to the 1980 level of 36,175 mt. Reduced demand in the export market appears to have influenced the 1981 yield considerably. The projected 1982 nominal catch is approximately 8,000 mt, reflecting continued market constraints. The fishery was primarily dependent on the 1976 and 1977 year classes during 1982, since the 1978 year class was among the weakest on record and the strong 1979 year class is not fully recruited to the western Gulf of Maine fishery.

Spawning stock size (age 4+) for the total Gulf of Maine region (Coastal Maine and western Gulf of Maine) averaged 150,000 mt during 1965-1970 before declining to an estimated 30,000 mt in 1973 (Figure 20). Recruitment of the strong 1970 year class to the spawning stock increased biomass levels to 110,000 mt during 1974-1975. Estimated spawning stock biomass in 1981 was 80,000 mt. A recent history of landings and catch restrictions is provided in Table 22.

Table 22. Nominal catches (thousand metric tons) and management information for Atlantic herring from the Gulf of Maine (coastal Maine and the western Gulf of Maine).

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982[1]
US Recreational	-	-	-	-	-	-	-	-	-
Commercial									
US	30.0	32.0	49.4	50.2	48.4	63.8	82.1	63.6	33.0
Canada	10.6	4.5	0.9	-	-	-	-	-	-
Other	7.1	0.2	-	-	-	-	-	-	-
Total nominal catch[2]	47.7	36.7	50.3	50.2	48.4	63.8	82.1	63.6	33.0
Total allowable catch[3]	25	25	16	7	7	8	12	12	12

Long-term potential catch = 20
Importance of recreational fishery = Insignificant
Status of management = FMP withdrawn in 1982
Status of exploitation = Fully exploited
Age at 50% maturity = 3 yrs
Size at 50% maturity = 26 cm (10.2 inches)
$M = 0.20$ $F_{0.1} = 0.24$ F_{max} = None $F_{1981} = 0.75$

[1] Preliminary.
[2] Age groups 1 and older.
[3] Age groups 3 and older.

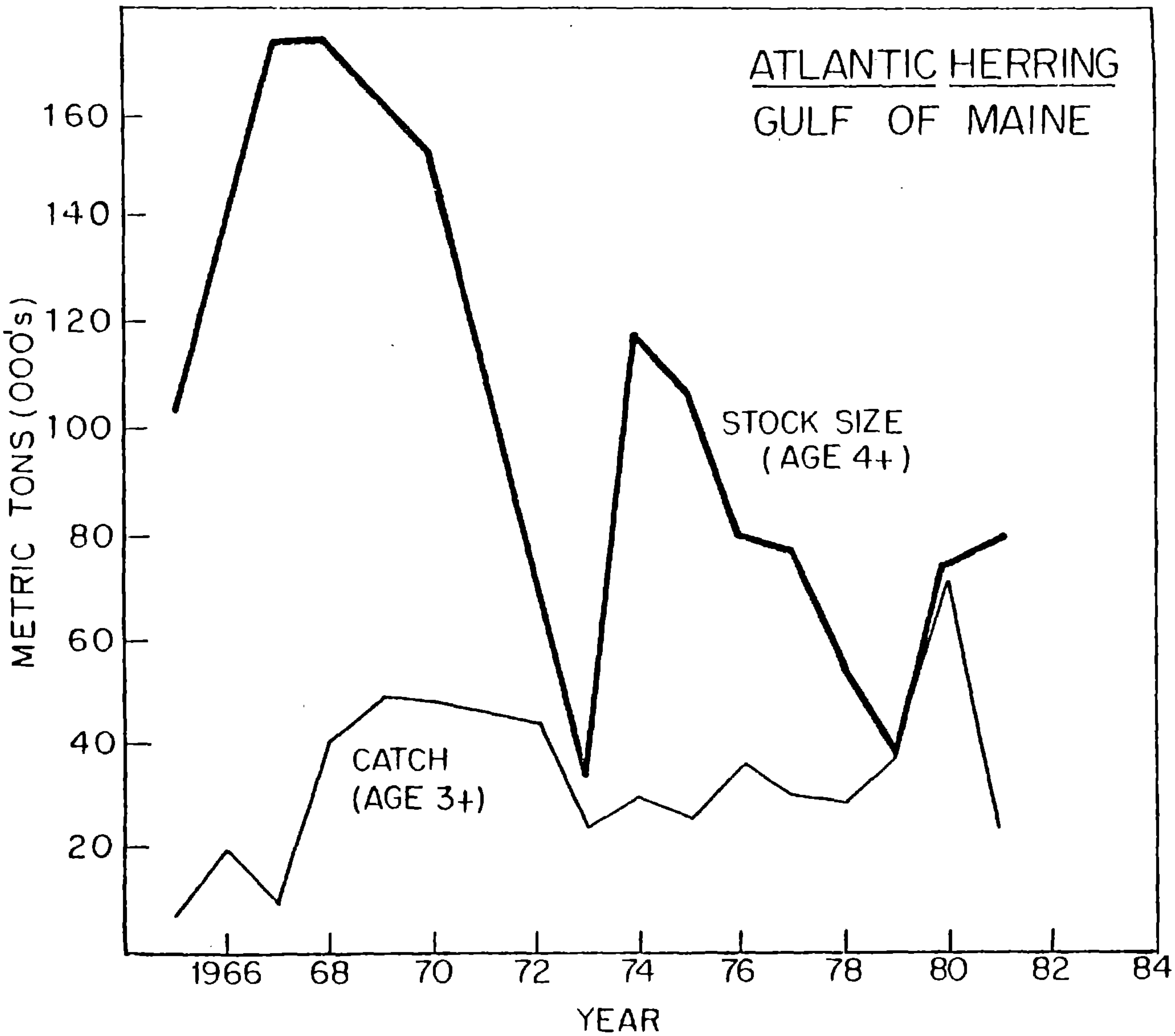


Figure 20. Nominal catches (age 3 and older) and estimates of stock size (age 4 and older) of Atlantic herring from the Gulf of Maine.

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 1967 at 373,600 mt and subsequently declined to only 43,500 mt in 1976; the stock collapsed in 1977. Spawning stock size (age 4+) increased from 300,000 mt in 1961 to nearly 1,200,000 mt in 1967 and subsquently declined steadily to extremely low levels (Figure 21). There has been no fishery for Atlantic herring on Georges Bank in recent years. Recent landings and catch restrictions are provided in Table 23.

For further information see:

Fogarty, M.J. and V.C. Anthony. 1982. Status of herring stocks in the Gulf of Maine region for 1982. Nat. Mar. Fish. Serv., Woods Hole, Lab. Ref. Doc. No. 82-34, 30 p.

Table 23. Nominal catches (thousand metric tons) and management information for Atlantic herring from the Georges Bank region.[1]

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982[2]
US Recreational	-	-	-	-	-	-	-	-	-
Commercial									
US	3.3	4.5	0.7	0.4	2.1	1.1	1.7	0.7	1.0
Canada	3.6	-	-	-	-	-	-	-	-
Other	200.9	141.5	42.8	1.8	-	-	-	-	-
Total nominal catch	207.8	146.0	43.5	2.2	2.1	1.1	1.7	0.7	1.0
Total allowable catch	-	150	60	33	8	15	15	15	-

Long-term potential catch = 100
Importance of recreational fishery = Insignificant
Status of management = FMP withdrawn in 1982
Status of exploitation = Not exploited
Age at 50% maturity = 3 yrs
Size at 50% maturity = 26.4 cm (10.4 inches)
$M = 0.20$ $F_{0.1} = 0.36$ F_{max} = None $F_{1981} = 0.0$

[1] Includes landings for the southern New England area.
[2] Provisional.

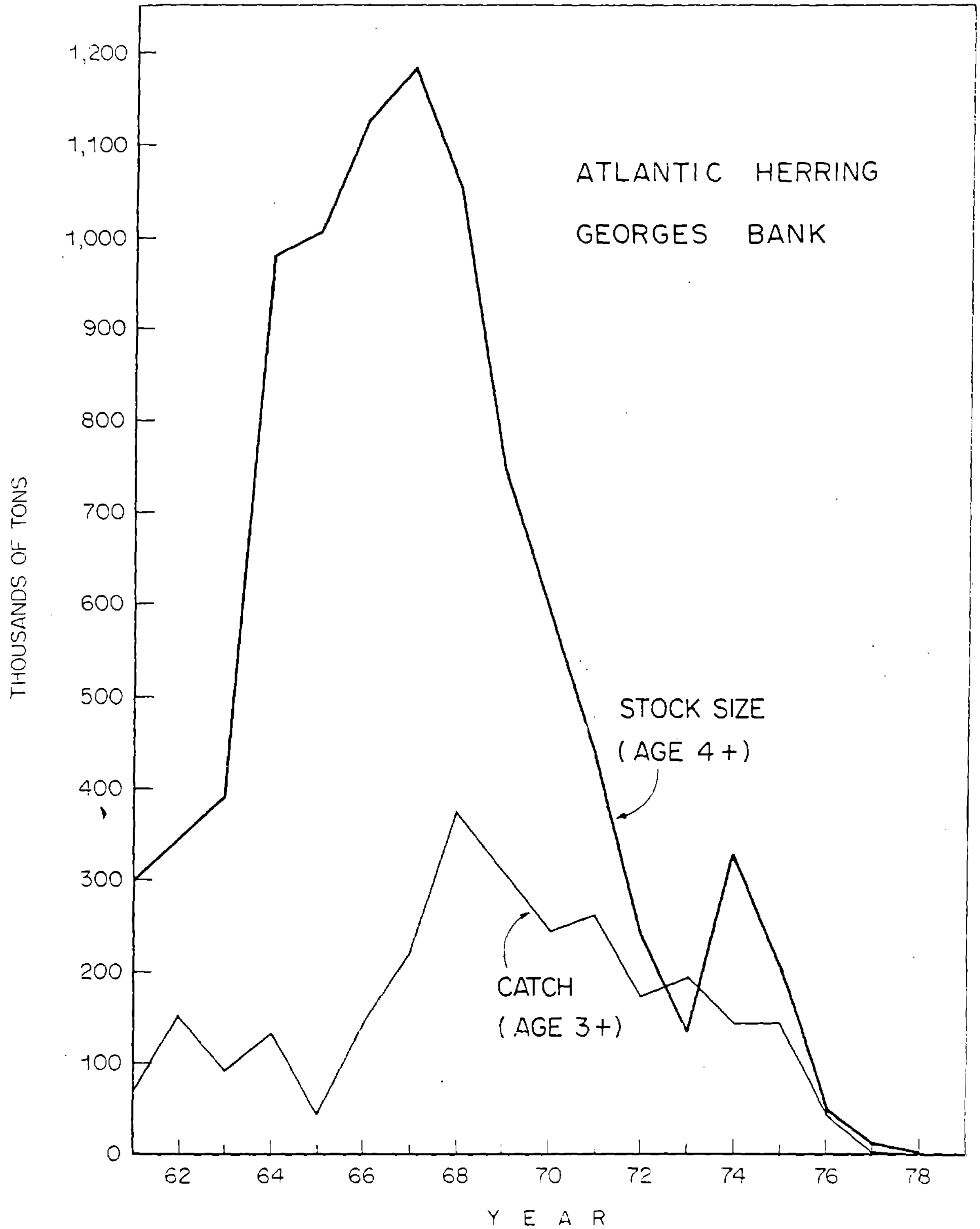


Figure 21. Nominal catches (age 3 and older) and estimates of stock size (age 4 and older) of Atlantic herring from the Georges Bank area.

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 Mid-Atlantic Bight during April-May and a northern group which spawns in the Gulf of St. Lawrence in June-July. Both groups overwinter between Sable Island (off Nova Scotia) and Cape Hatteras in waters generally warmer than 7^{o}, with extensive northerly (spring) and southerly (autumn) migrations to and from spawning and summering grounds. Maximum observed size in recent years is about 47 cm or 18.5 inches (fork length) and 1.3 kg or 2.85 lbs in weight. Sexual maturity begins at age 2 and is usually complete by age 3. Maximum age is about 20 years.

Mackerel are subjected to seasonal fisheries, both commercial and recreational, throughout most of their distributional range. US commercial catches have occurred mainly during January-May in Southern New England - Middle Atlantic coastal waters and during May-December in coastal Gulf of Maine waters. US recreational catches occur mainly during April-October in areas of seasonal occurrence. Catches in Canadian waters off Nova Scotia and Newfoundland have typically been during May-November. Catches by other countries, principally during the intensive fishery conducted during 1968-1977, occurred mainly during December-April between Georges Bank and Cape Hatteras.

Mackerel in the Northwest Atlantic were managed by nationally-allocated catch quotas during 1973-1977 by ICNAF. Since implementation of the MFCMA on 1 March 1977, mackerel in US waters have been managed by the NMFS, initially by a PMP and since February 1980 by an FMP developed by the Mid-Atlantic Fishery Management Council.

The international nominal catch of mackerel in the Northwest Atlantic increased slightly from 29,300 mt in 1980 to 31,600 mt in 1981 (Table 24). Catches remained fairly stable during 1978-1981, averaging 32,800 mt annually, and were taken largely by Canadian and US fishermen. The recent fishery is in sharp contrast to the intensive fishery conducted during 1968-1977 by vessels from 13-14 nations when reported catches peaked at 430,400 mt in 1973.

The US accounted for 22% of the 1981 international catch, including nearly 3,000 mt commercial and an estimated 4,000 mt recreational, both amounts representing slight increases from 1980. The Canadian catch declined from 22,136 mt in 1980 to 19,284 mt in 1981, 61% of the total. The distant-water-fleet catch increased sharply from 566 mt in 1980 to 5,368 mt in 1981. Nearly 4,000 mt of the 1981 catch was taken by Poland.

The international catch in 1982 dropped to an estimated 25,000 mt because of a marked decrease in Newfoundland catches caused by a general absence of mackerel in that area in 1982.

Fish from the 1974 year class (age 7) comprised 21% of the international catch in numbers in 1981, denoting the sixth consecutive year that this has been the dominant year class in the catch. The 1980 year class (age 1) with 17%, the 1978 year class (age 3) with 14%, and the 1975 year class (age 6) with 13% were also important contributors to the 1981 international catch. The 1981 Canadian catch consisted of 28% 1974 year-class, 20% 1975 year-class, 14% 1978 year-class, and 12% 1973 year-class fish. The US commercial catch was 61% 1980 year-class fish (age 1) followed by 24% 1979 year-class fish. The distant-water-fleet catch in 1981 (principally Polish) consisted primarily of the 1974 (28%) and 1978 (27%) year classes. A January-April 1982 Polish research catch of nearly 4,400 mt was also comprised mainly by the 1974 (23%) and 1978 (22%) year classes, followed by the 1980 (13%) and 1981 (9%) year classes.

The catch-per-tow index for mackerel from the NEFC spring bottom trawl survey dropped from 1.84 kg in 1981 to 0.88 kg in 1982. In spite of a 52% decrease from 1981 to 1982, the 1982 value was the second highest (next to 1981) since 1972. The autumn survey catch-per-tow index climbed sharply from 0.02 kg in 1981 to 0.13 kg in 1982, the highest value observed since 1969. The US commercial catch-per-day index declined from 1.42 mt in 1980 to 1.09 mt in 1981, but was still the second highest (next to 1980) since 1971. The high indices exhibited by the spring and autumn surveys and by the US commercial fishery in the last several years are indicative of an increasing trend in mackerel stock biomass. US commercial catch-per-day for ages 3 and older declined from 0.57 mt in 1980 to 0.42 mt in 1981 reflecting the gradual decline of age 3 and older fish and indicating that the increasing trend in recent years in total biomass is due to improved recruitment.

Natural mortality (M), previously assumed to be 0.30, was estimated to be 0.20 in the most recent assessment. Fishing mortality (F) at ages 4 and older in 1981 was estimated to be 0.15. Results from virtual population analysis indicate that mean F at ages 3 and older increased from 0.06 in 1962-1964 to a high of 0.74 in 1976 and then dropped to an average of 0.12 during 1978-1980. An estimated catch of 25,000 mt in 1982 will generate an F of 0.11. $F_{0.1}$ for mackerel at the current pattern of exploitation in the fishery is 0.40.

The 1975-1981 year classes are all estimated to be below average in strength, with the 1980 year class appearing to be the strongest among these. The 1976 and 1977 year classes appear to be particularly weak. The 1978 year class appears to be weaker than estimated in the 1981 assessment. The 1982 year class appears to be above average in strength based on results from the 1982 NEFC autumn survey. However, this single index is insufficient to reliably predict the size of that year class; an improved estimate will be available following completion of the 1983 NEFC spring survey.

Total stock biomass (ages 1 and older) increased from around 300,000 mt in 1962-1965 to 1.8 million mt in 1970-1971 before dropping to an estimated 323,000 mt in 1978 (Figure 22). Since 1978, the total stock has increased almost 75% in weight to about 560,000 mt at the beginning of 1983. Spawning stock biomass (50% of age 2 fish and 100% of ages 3 and older) increased from about 290,000 mt in 1980 to an estimated 470,000 mt at the start of 1983.

Rebuilding of the mackerel stock has been aided by relatively low catches during 1978-1982 (average of 31,300 mt) as well as some improvement in the size of recent year classes. In addition, higher mean weights at age in recent years resulting from improved growth rates have also influenced the upward trend in stock biomass. Projections indicate that the international catch in 1983 can be increased to 75,000-80,000 mt without reducing spawning stock biomass from 1983 to 1984. Management measures recommended by the Mid-Atlantic Fishery Management Council for the 1 April 1983 - 31 March 1984 fishing year include an OY of 58,800 mt (US waters only), a DAH of 22,900 mt, a TALFF of 15,450 mt, a Reserve of 15,450 mt, and a research catch of 5,000 mt. These recommendations are based on a projected catch of 103,800 mt for the total international mackerel fishery in the Northwest Atlantic resulting from fishing mortality at $F_{0.1}$ = 0.40.

For further information see:

Anderson, E.D. 1982. Status of the Northwest Atlantic mackerel stock - 1982. NMFS, NEFC Woods Hole Lab. Ref. Doc. No. 82-44, 45 p.

Table 24. Nominal catches (thousand metric tons) and management information for Atlantic mackerel from Cape Hatteras to Labrador, 1970-1982.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982
US Recreational	13.3	5.2	4.2	0.5	6.6	3.3	3.9	4.0	4.0
Commercial									
US	2.2	2.0	2.7	1.4	1.6	2.0	2.7	3.0	3.0
Canada	17.0	13.5	15.7	20.4	25.4	30.2	22.1	19.3	11.6
Other	335.4	271.7	223.3	56.1	0.8	0.4	0.6	5.4	6.4
Total nominal catch	367.9	292.4	245.9	78.3	34.4	36.0	29.3	31.6	25.0
Total allowable catch	- [1]	355.0[2]	310.0[3]	105.0[3]	15.5[4]	15.5[4]	30.0[5]	30.0[5]	30.0[5]

Long-term potential catch = 152
Importance of recreational fishery = Moderate
Status of management = FMP in force since 1979
Status of exploitation = Underexploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 32.7 cm (12.9 inches) fork length
$M = 0.20$ $F_{0.1} = 0.40$ $F_{max} = 1.78$ $F_{1981} = 0.15$

[1] 450.0 in 1973 for Gulf of Maine, Georges Bank, and south; in 1974, 304.0 for Gulf of Maine, Georges Bank, and south, and 55.0 for Nova Scotian shelf.
[2] 285.0 for Gulf of Maine, Georges Bank, and south; 70.0 for Nova Scotia - Newfoundland.
[3] Cape Hatteras - Newfoundland.
[4] Fishery Conservation Zone only.
[5] April 1 - March 31 fishing year.

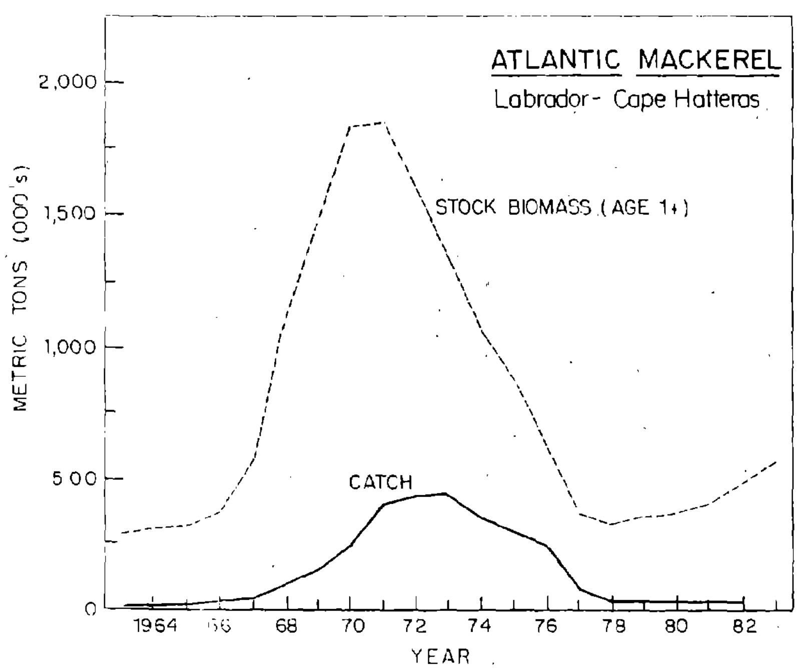


Figure 22. Nominal catches and estimates of stock biomass of Atlantic mackerel from the northwest Atlantic from Cape Hatteras to Labrador.

RIVER HERRING

River herring is a term applied collectively to alewife (*Alosa pseudoharengus*) and blueback herring (*Alosa aestivalis*). The coastal range of the blueback herring is from Nova Scotia to Florida; the coastal range of alewife is farther north, from Labrador to South Carolina. In coastal rivers where the ranges overlap, the fisheries for the two species are mixed. Both species are anadromous and undergo upriver spawning migrations during spring. Alewife may live as long as 10 years and reach a size of 36 cm (14 inches) in length; blueback herring live for about seven or eight years and reach a maximum length of about 32 cm (13 inches).

Alewives spawn earlier in the spring than blueback herring, when water temperatures are between 16°C and 19°C; blueback herring spawn when water temperatures are about 5°C warmer. Fecundity and age-at-maturity for both species are similar. Egg production is between 60,000 and 300,000 eggs per female and maturity is reached at ages three through five with age four dominant.

River herring have been subjected to intensive exploitation along the Atlantic coast. Nominal catch has declined considerably in the last ten years (Figure 23), parallel to a decline in the nominal catch of American and hickory shad. The river herring fishery is one of the oldest in North America, and was exclusively a US inshore fishery until the late 1960's, when distant water fleets began fishing for river herring off the middle Atlantic coast. The US nominal catch averaged 24,800 mt annually between 1964 and 1969. Since 1969 the catch has been in a downward trend (Table 25).

An MSY estimate of 23,000-28,000 mt has been determined for the river herring resource extending from the Gulf of Maine to Cape Hatteras by Hoagman et al. (1973). However, stock size in recent years may have been depressed to a point where the calculated MSY level is no longer applicable. Although fishing pressure on the resource has eased considerably, especially since the foreign catch was restricted in 1976, a recovery is not evident. Data from the NMFS spring and autumn bottom trawl surveys from the Gulf of Maine to northern New Jersey indicate that stock levels have been relatively stable since 1968. Data from the spring bottom trawl surveys between northern New Jersey and Cape Hatteras indicate an increase in abundance since 1975.

In response to the observed decline in nominal catch and the lack of a coastwide increase in stock abundance, the Mid-Atlantic Fishery Management Council has recommended that a comprehensive, coastwide management plan be prepared for shad and river herring. The plan is being prepared through the Atlantic States

Marine Fisheries Commission with the participation of all coastal states between Maine and Florida.

For further information see:

Boreman, J. 1981. River herring stocks along the Atlantic coast. NMFS, NEFC, Woods Hole Lab. Ref. No. 81-35. 23 p.
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 Rept.

Table 25. Nominal catches (thousand metric tons) and management information for river herring (alewife and blueback herring) from Maine to North Carolina.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982[1]
US Recreational[1]	-	-	-	-	-	-	-	-	
Commercial									
US	12.4	10.8	6.5	6.5	5.7	4.4	4.8	3.2	
Canada	-	-	-	-	-	-	-	-	
Other	13.4	3.8	1.8	0.2	+[2]	+[2]	+[2]	0.0	
Total nominal catch	25.8	14.6	8.3	6.7	5.7	4.4	4.8	3.2	
Total allowable catch	-	-	-	-	-	-	-	-	

Long-term potential catch = 23-28
Importance of recreational fishery = Minor
Status of management = Local (state, county or municipality, depending on area)
Status of exploitation = Fully exploited
Age at 50% maturity = 2-4 (varies by latitude)
Size at 50% maturity = 28 cm (11 inches)
M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1981} = Unknown

[1] Unavailable.
[2] Less than 500 mt.

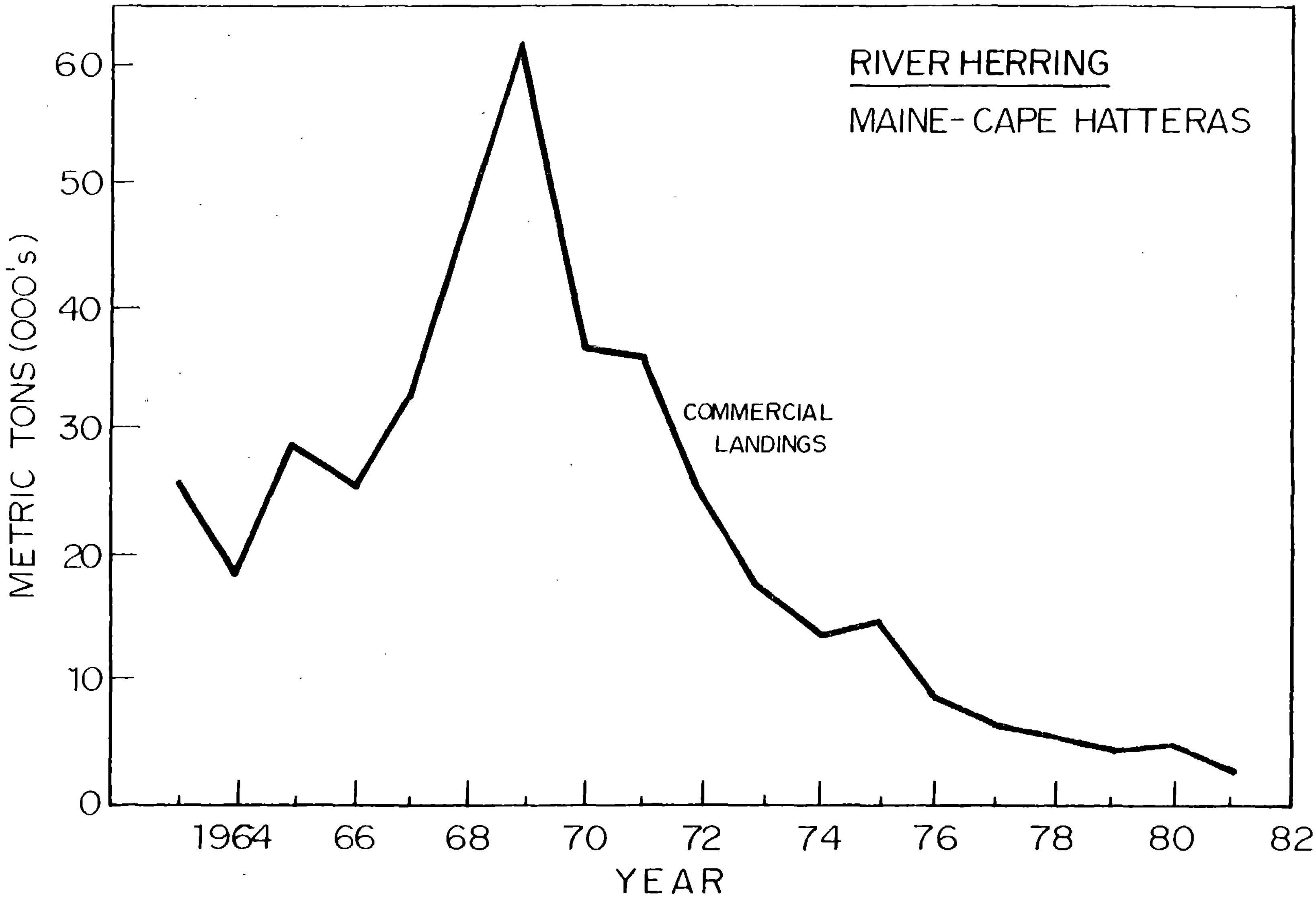


Figure 23. Nominal commercial landings of river herring (blueback herring and alewives) in the northeastern United States.

AMERICAN SHAD

The American shad (Alosa sapidissima) is an anadromous member of the family Clupeidae (herrings). Along the Atlantic coast, its range extends from southern Labrador to northern Florida. Virtually every major coastal river along the Atlantic seaboard has, at one time, supported a stock. American shad were successfully introduced on the Pacific coast in the late 1800's and are now established from Alaska to southern California.

American shad have been the subject of intensive exploitation for their flesh and roe. Nominal commercial catch along the Atlantic coast exceeded 22,000 mt in 1896, but currently averages less than 1,500 mt per year. Overfishing has been blamed for the decline in the Hudson River, the Connecticut River, in Maryland rivers, in North Carolina rivers, and in Florida. Dams along the Susquehanna River have led to an almost complete disappearance of what was once a major fishery; and pollution in the lower Delaware has been cited as the cause for the decline in the fishery in that system. Recent nominal commercial catch reported for states along the Atlantic coast have been the lowest on record, although some restoration efforts (particularly in the Delaware system) are apparently starting to take hold.

Recreational landings, like commercial landings, have declined in recent years. Rhode Island, Delaware, and Maryland reported to the Atlantic States Marine Fisheries Commission that recreational harvests have declined to virtual non-existence since 1970. In fact, Maryland closed its recreational (and commercial) fishery in 1980 and 1981 to protect the stock, which is at an extremely low level. Since the marine recreational fishing surveys conducted by the NMFS and its predecessor did not include American shad as a distinct species, data relevant to the nominal recreational catch along the eastern seaboard during the past two decades are not available. The American shad, however, is a popular sport fish in many states.

Management of the American shad is done at the state level. Interstate cooperative management programs have been established to help coordinate shad restoration in the Connecticut River, the Delaware River, and the Merrimac River. The Atlantic States Marine Fisheries Commission is currently preparing a coastwide management plan for American shad and river herring.

For further information see:

Boreman, J. 1981. American shad stocks along the Atlantic coast. NMFS, NEFC, Woods Hole Lab. Ref. No. 81-40. 21 p.

Table 26. Nominal catches (thousand metric tons) and management information for American shad from Maine to North Carolina.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982[1]
US Recreational[2]	-	-	-	-	-	-	-	-	-
Commercial									
US	1.9	1.0	0.9	1.2	1.2	0.8	0.9	0.7	0.2
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	1.9	1.0	0.9	1.2	1.2	0.8	0.9	0.7	0.2
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = Unknown
Importance of recreational fishery = Major
Status of management = Local (state, county or municipality, depending on area
Status of exploitation = Fully exploited
Age at 50% maturity = 2-4 (varies by latitude)
Size at 50% maturity = 40 cm (16 inches)
M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1981} = Unknown

[1] Jan - Aug (preliminary, excludes NC, DE, NY, CT).
[2] Statistics unavailable.

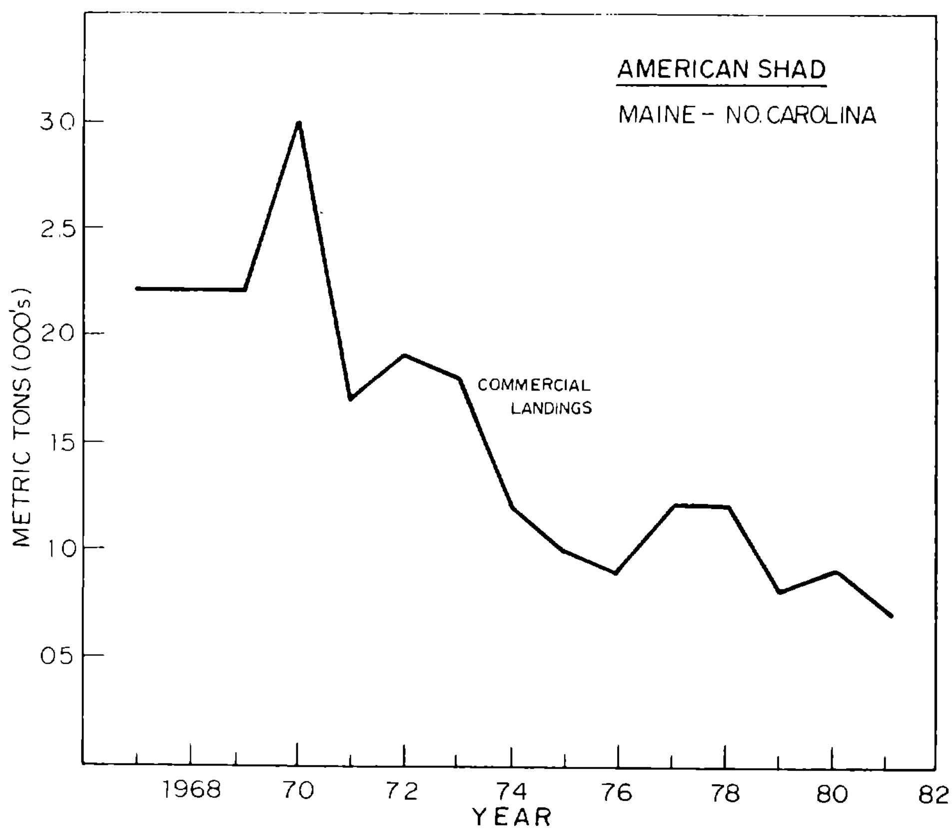


Figure 24. Nominal commercial landings of American shad in the northeastern United States.

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 by age 2 at a total length of 21 cm (9 in); spawning occurs during summer months. Although ages up to 20 years have been documented, recent catches have been dominated by age 2-3 fish. Scup attain a maximum length of about 40 cm (16 in). Tagging studies have indicated the possibility of a southern New England stock and another stock extending south from New Jersey.

Nominal commercial catches by USA vessels fluctuated between 18,000 and 22,000 mt annually during 1953-1963, but declined to 4,000-5,000 mt during the early 1970's (Table 27 and Figure 25). Nominal catches by distant-water fleets peaked at 5,900 mt in 1963, but declined to less than 100 mt after 1975. Estimated recreational catches declined from 7,600 mt in 1960 to 2,800 mt in 1974; the 1979 estimate was 2,300 mt. In general, the estimated recreational catch represents approximately 20-40% of the total nominal catch in those years for which comparisons are available.

Since the early 1970's, the USA nominal commercial catch has steadily increased and has exceeded 8,000 mt each year since 1977. The 1980 and 1981 catches equalled 7,900 and 9,100 mt respectively. Most of the recent increase is attributable to increased fixed gear and otter trawl catches in the southern New England-New Jersey area. The Virginia winter trawl fishery, which had previously produced nominal catches in excess of 5,000 mt annually has recently yielded less than 500 mt per year; the 1981 nominal catch equalled 1000 mt. The proportion taken by the Virginia fishery has declined from 40-60% of the total 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 mt prior to 1964, is now non-existent, and the pound net fishery, which formerly produced about 1,000 mt per year, is now negligible.

Catch per unit effort of southern New England otter trawlers increased from 2.2 mt per day fished in 1971 to 6.2 mt in 1977 and 1979 and 6.7 mt in 1981. Age composition data indicate that the 1975 and 1977, and 1979 year classes have dominated recent landings. NMFS autumn bottom trawl surveys also indicate increased abundance in the Southern New England area in recent years. The 1981 autumn Southern New England index is the second highest index ever recorded, although the 1982 index declined.

In the Middle Atlantic area, spring survey indices suggest an overall decline in scup abundance, particularly since 1974.

Instantaneous fishing mortality (F) in the Southern New England area in 1981 equalled 0.3. Relative exploitation rates have declined throughout the 1970's in the Southern New England area, but have increased substantially in the Middle Atlantic region. All available evidence indicates that this resource is being fully exploited, particularly in the Middle Atlantic region.

For further information see:

Mayo, R.K. MS 1982. An assessment of the scup, Stenotomus chrysops, population in the Southern New England and Middle Atlantic regions. NMFS, NEFC, Woods Hole Laboratory Ref. Doc. No. 82-46, 59 p.

Table 27. Nominal catches (thousand metric tons) and management information for scup from Cape Cod to Cape Hatteras.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982 [1]
US Recreational [2]	2.0	3.0	2.9	3.4	3.7	2.4	2.2	2.1	-
Commercial									
US	5.0	7.6	7.2	8.5	9.3	8.7	7.8	9.1	4.9
Canada	-	-	-	-	-	-	-	-	-
Other	1.1	0.7	0.1	0.0 [3]	0.0 [3]	0.0 [3]	0.0 [3]	0.0 [3]	0.0 [3]
Total nominal catch	8.1	11.3	10.2	11.9	13.0	11.1	9.9	11.2	4.9
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = 10-15
Importance of recreational fishery = Major
Status of management = None
Status of exploitation = Fully exploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 21 cm (9 inches)
M = 0.20 $F_{0.1}$ = 0.20 F_{max} = 0.35 F_{1981} = 0.34

[1] Through June 30, 1982.
[2] 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, and 1970.
[3] Less than 0.1.

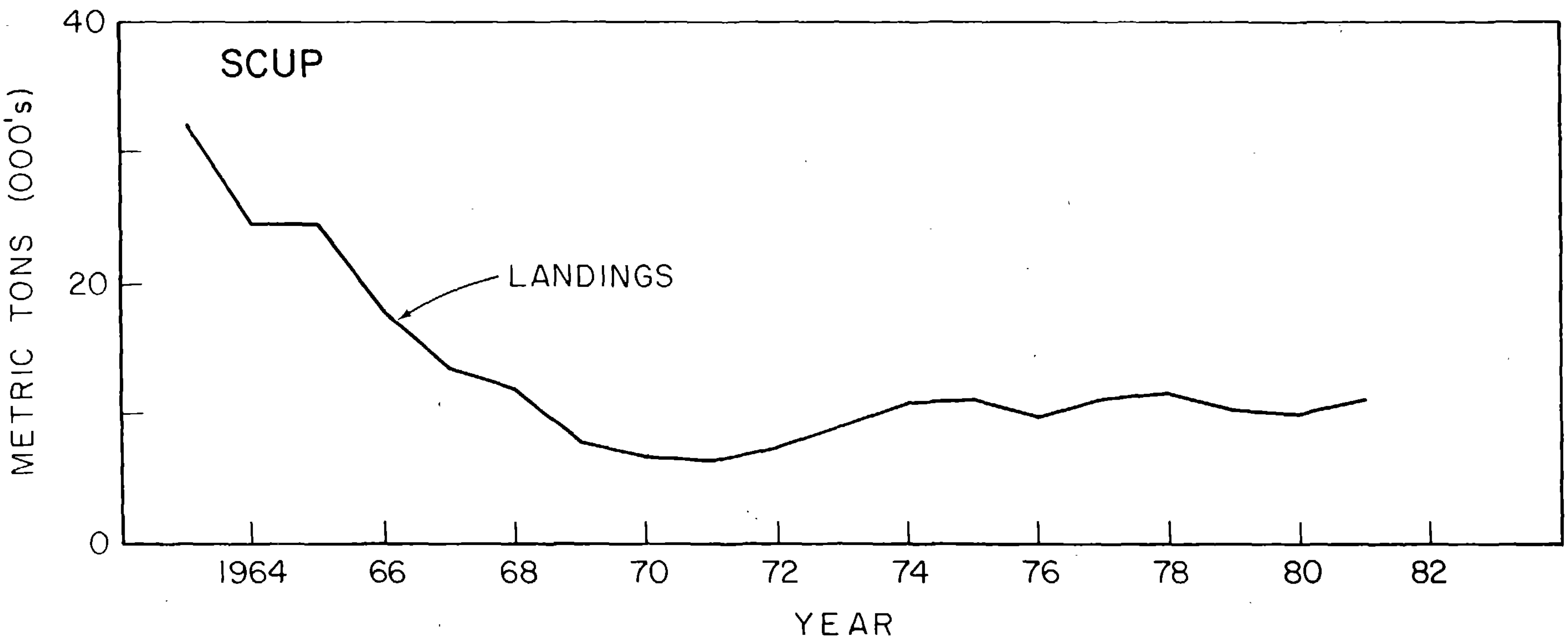


Figure 25. Nominal catches of scup from the Gulf of Maine to Cape Hatteras.

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 first 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 nominal catch increased 44% from 5,760 mt in 1981 to 8,304 mt in 1982 (Table 28). The international nominal catch peaked at 19,500 mt in 1973, most of which was taken by distant-water-fleets (DWF) in conjunction with their squid fisheries. The US nominal catch increased 63% from 4,801 mt in 1981 to a high of about 7,800 mt in 1982. The DWF nominal catch declined from 959 mt in 1981 to 500 mt in 1982.

The catch-per-tow index (all ages) from the NEFC autumn bottom trawl survey declined 33% from 1981 (7.0 kg) to 1982 (4.7 kg), continuing the decline from the high in 1980 (15.2 kg) (Figure 26). Likewise, the recruitment index (number per tow at age 0) from the 1982 autumn survey (82) declined 64% from the 1981 index (230). This decline follows three consecutive years of strong recruitment indices (1979-1981).

Based on the 1982 autumn survey data, butterfish abundance and biomass has declined sharply despite indications of strong recruitment in 1980 and 1981. The 1982 indices (numbers and weight), however, are comparable to values observed during 1973-1976 when nominal catches from the international fishery were high (11,200-19,500 mt), and suggest that sufficient fish are available to support a catch up to the maximum (16,000 mt) currently allowed by the FMP.

Since 1977, following implementation of the MFCMA, domestic fishermen have accounted for most of the butterfish catch, reversing the pattern observed during 1968-1977 when the DWF accounted for most of the catch. The US fishery should continue to expand due to increasing export markets.

For further information see:

Waring, G.T., and E.D. Anderson. 1982. Status of the Northwestern Atlantic butterfish stock - 1982. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 82-45, 20 p.

Table 28. Nominal catches (thousand metric tons) and management information for butterfish from Nova Scotia to Cape Hatteras, 1970-1982.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982
US Recreational	-	-	-	-	-	-	-	-	-
Commercial									
US	1.7	2.1	1.5	1.4	3.7	2.8	5.3	4.8	7.8
Canada	-	-	-	-	-	-	-	-	-
Other	9.8	9.1	9.9	3.2	1.3	0.8	0.8	1.0	0.5
Total nominal catch	11.5	11.2	11.4	4.7	5.0	3.7	6.1	5.8	8.3
Total allowable catch	-	-	-	18.0	18.0	18.0	11.0[1]	11.0[1]	11.0[1]

Long-term potential catch = 16.0
Importance of recreational fishery = Insignificant
Status of management = FMP in force since 1979
Status of exploitation = Underexploited
Age at 50% maturity = 1.5 yrs
Size at 50% maturity = 14.0 cm (5.5 inches) fork length
$M = 0.8$ $F_{0.1} = 1.01$ $F_{max} = >2.5$ F_{1981} =Unknown

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

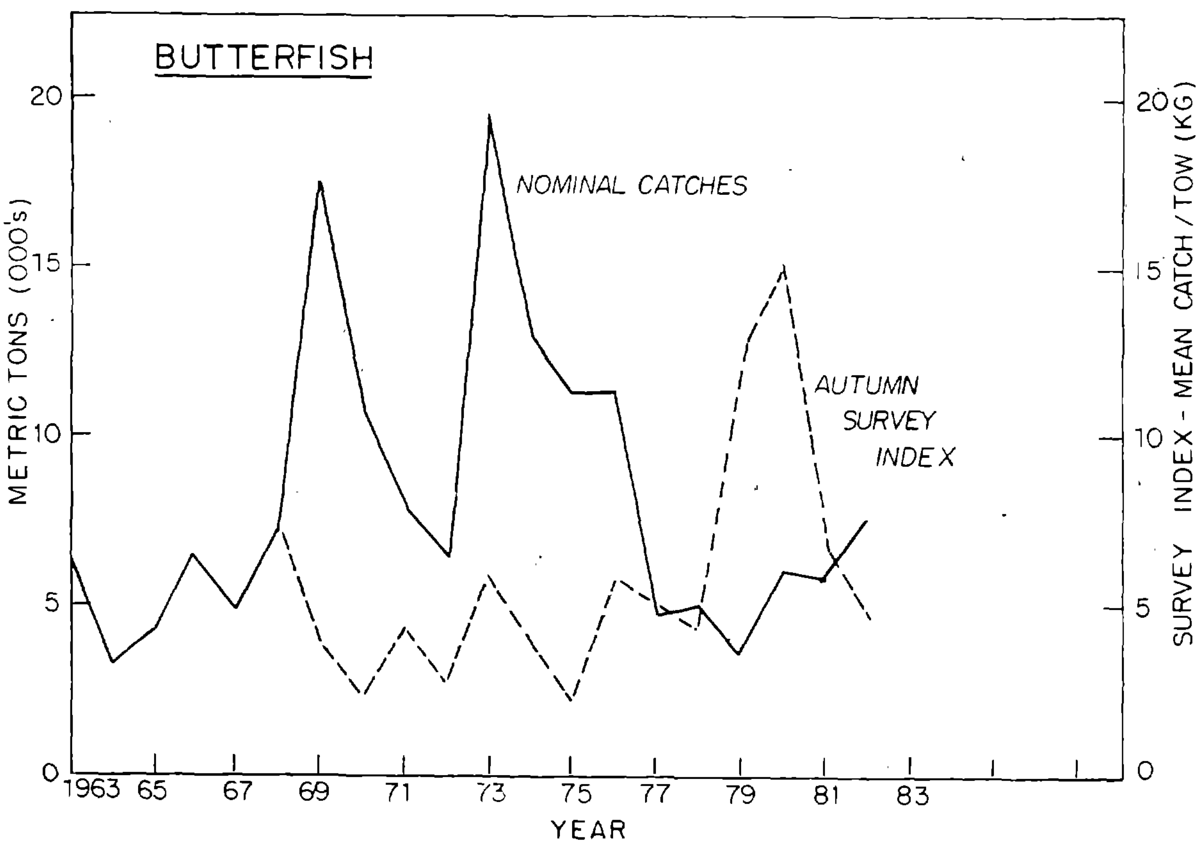


Figure 26. Nominal catches and indices of abundance from autumn research vessel surveys for butterfish for the area north of Cape Hatteras.

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 southward in the fall and winter. Based on various studies, two and possibly more distinct stocks exist along the Atlantic coast. Bluefish are ferocious predators that feed on a wide variety of fish and invertebrates. They may reach ages of about 15 years and sizes in excess of 100 cm (39 inches) in length and 12 kg (26 lbs) in weight.

The bluefish has become perhaps the most important species to the marine recreational fishery along the Atlantic coast of the US in recent years. Total nominal catches of bluefish (commercial and recreational) from Maine to Florida increased from about 12,700 mt in 1960 to an estimated 63,300 mt in 1981 (Figure 27, Table 29). During this period, recreational landings comprised about 90% of the total nominal catch. US commercial catch increased from 1,251 mt in 1960 to 5,700 mt in 1981, with over 50% of the 1973-1981 catch coming from the middle Atlantic region (New Jersey - Cape Hatteras).

Relative abundance indices for bluefish, calculated from NEFC autumn bottom trawl surveys for the areas 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 0.86 kg per tow in 1970-1981. The abundance index increased from 0.43 kg per tow in 1980 to 1.32 kg per tow in 1981; the former index being the lowest since 1970. NEFC inshore surveys, conducted on a comparative basis from Cape Cod to Cape Hatteras since 1974, have shown an increase in the relative abundance of young-of-the-year bluefish. Waters north of Cape Hatteras also have shown a warming trend since the late 1960's, 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 warmer water temperatures.

Maximum sustainable yield estimates for bluefish along the entire Atlantic coast, obtained from a generalized stock production model analysis, average 75,400 - 95,100 mt. Considering the limitations and imprecise nature of the data used in that analysis, and the sensitivity of the analysis results to a few data points, the MSY estimate must be regarded as provisional. Nonetheless, the total nominal catch during the past few years appears to be below the MSY level. This observation is supported by the increase in the relative abundance of young-of-the-year bluefish in recent years.

Table 29. Nominal catches (thousand metric tons) and management information for bluefish from the Gulf of Maine to Florida.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982 [1]
US Recreational	55.3	66.4	57.3	48.8	51.6	52.8	- [1]	- [1]	
Commercial									
US	3.4	4.4	4.5	4.8	4.9	5.6	6.6	7.2	
Canada	-	-	-	-	-	-	-	-	
Other	0.1	0.1	+ [2]	+ [2]	-	-	-	-	
Total nominal catch	58.8	70.9	61.8	53.6	56.5	58.4	-	-	
Total allowable catch	-	-	-	-	-	-	-	-	

Long-term potential catch = 75-95
Importance of recreational fishery = Major
Status of management = FMP in preparation
Status of exploitation = Possibly underexploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 35 cm (14 inches)
M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1981} = Unknown

[1] Unavailable.
[2] Less than 500 mt.

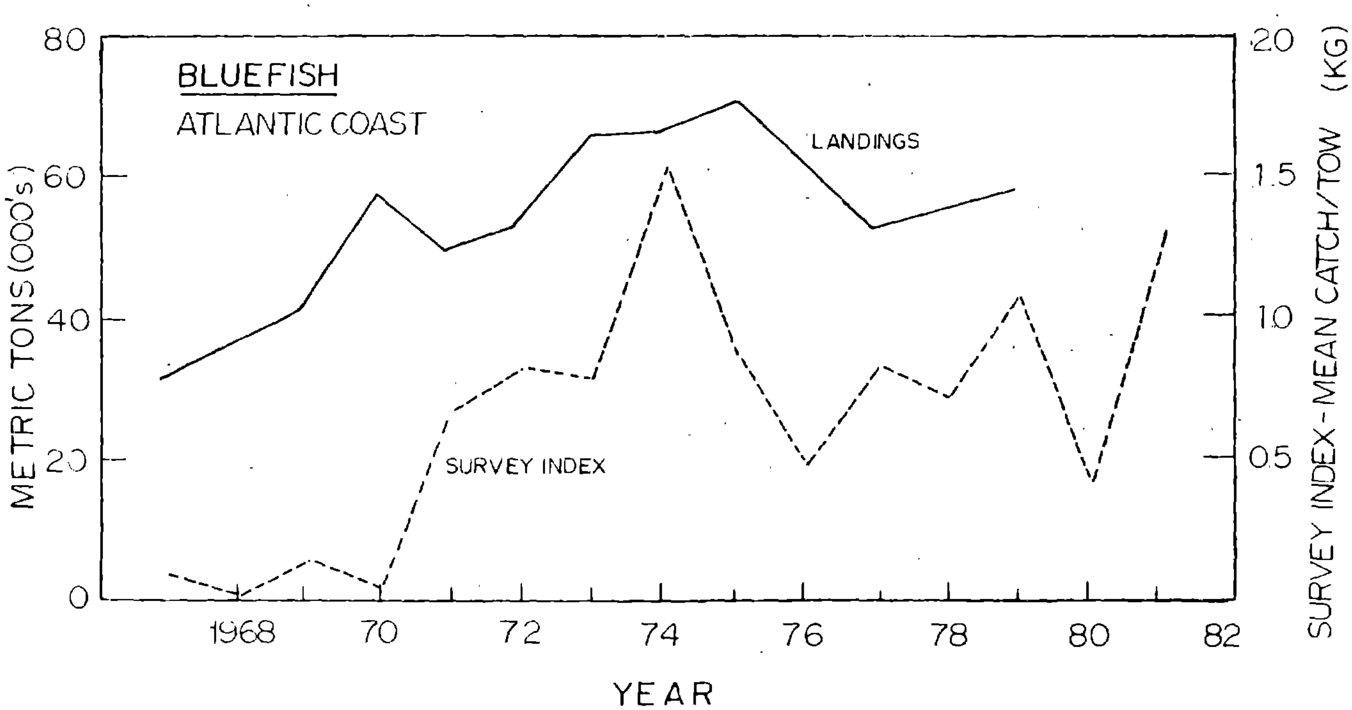


Figure 27. Estimated total landings of bluefish along the Atlantic coast and stock abundance indices based on NEFC fall bottom trawl surveys.

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 Pacific coast from Ensenada, Mexico, to British Columbia, Canada, and in numerous inland lakes and reservoirs. Striped bas spawn in mid-February in Florida and late June or July in Canada, and from mid-March to late July in California. Spawning occurs at or near the surface in fresh or slightly brackish waters at temperatures ranging from $10^{\circ}C$ to $23^{\circ}C$; peak spawning activity is observed between $15^{\circ}C$ and $20^{\circ}C$. Larvae range from 2.0-3.7 mm TL (total length) at hatching, and initiate feeding after 4 to 10 days. At about 13 mm TL, larval striped bass form small schools and move inshore; juvenile striped bass move downriver into higher salinity waters during their first summer or fall.

Most striped bass along the Atlantic coast are involved in two types of migration: an upriver spawning migration in late winter - early spring, and an offshore migration which is apparently not associated with spawning activity. Offshore migrations may be quite extensive; striped bass tagged in Chesapeake Bay have been captured in the Bay of Fundy, Canada. Coastal migratory behavior appears to be limited to coastal stocks north of Cape Hatteras and appears to be related to sex and age of the fish.

The coastal migratory stock of striped bass is largely maintained by the formation of dominant year classes. The last such year class in Chesapeake Bay, the largest in 26 years, occurred in 1970 and resulted in peak landings in the coastal states in 1973. The decline in landings since 1973 is largely the result of low levels of recruitment, as evidenced by annual young-of-the-year surveys conducted in the Maryland portion of Chesapeake Bay (Figure 28), coupled with intensive exploitation of the adult stock. Young-of-the-year indices for the populations that contribute to the coastal migratory stock (Roanoke River, Chesapeake Bay, and Hudson River) were all better than average in 1982, but not at the level of the late 1960's and early 1970's.

Nominal catch of striped bass in the commercial fisheries from Maine to North Carolina averaged 2,800 mt between 1929 and 1981; and 3,400 mt between 1970 and 1981. Gill nets, haul seines, pound nets, and handlines account for over 80 percent of the commercial catch. Recreational catch from Maine to North Carolina averaged an estimated 8,500 mt between 1970 and 1979 (Table 30), more than double the nominal commercial catch during the same time period. In the 1979 recreational fishing survey conducted by NMFS, striped bass ranked fifth in a tabulation of species groups sought by fishermen in the North Atlantic subregion (Maine to Connecticut) and fourth in the Mid-Atlantic subregion (New York to Virginia).

A coastwide management plan for striped bass has been recommended by the Atlantic States Marine Fisheries Commission (ASMFC). The plan requests that states enforce a 14-inch TL (35.6 cm) minimum size limit on striped bass in nursery rivers and bays, and a 24-inch TL (61 cm) minimum size limit on the coastal fisheries. The plan also suggests that fishing in spawning rivers should be banned during the spawning season. The coastal states are currently in the process of adopting the measures suggested by the ASMFC.

The decline in productivity of striped bass from Maine to North Carolina is currently being investigated through provisions of an amendment to PL 96-118 (Anadromous Fish Conservation and Management Act), which established an Emergency Striped Bass Study. In addition to studying causes for the decline in productivity, the Emergency Study is establishing a coordinated program among the coastal states to monitor the status of the coastal migratory stock. A third objective of the Emergency Study is to determine the impact of the commercial and recreational fisheries for striped bass on the coastal communites. The first objective (productivity studies) is the responsibility of the US Fish and Wildlife Service, the second objective (monitoring studies) is the responsibility of the NMFS, and the third objective (economic studies) is the joint responsiblity of both agencies and is being met through the cooperation of the Office of Sea Grant (NOAA).

Table 29. Nominal catches (thousand metric tons) and management information for bluefish from the Gulf of Maine to Florida.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982 [1]
US Recreational	55.3	66.4	57.3	48.8	51.6	52.8	- [1]	- [1]	
Commercial									
US	3.4	4.4	4.5	4.8	4.9	5.6	6.6	7.2	
Canada	-	-	-	-	-	-	-	-	
Other	0.1	0.1	+ [2]	+ [2]	-	-	-	-	
Total nominal catch	58.8	70.9	61.8	53.6	56.5	58.4	-	-	
Total allowable catch	-	-	-	-	-	-	-	-	

Long-term potential catch = 75-95
Importance of recreational fishery = Major
Status of management = FMP in preparation
Status of exploitation = Possibly underexploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 35 cm (14 inches)
M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1981} = Unknown

[1] Unavailable.
[2] Less than 500 mt.

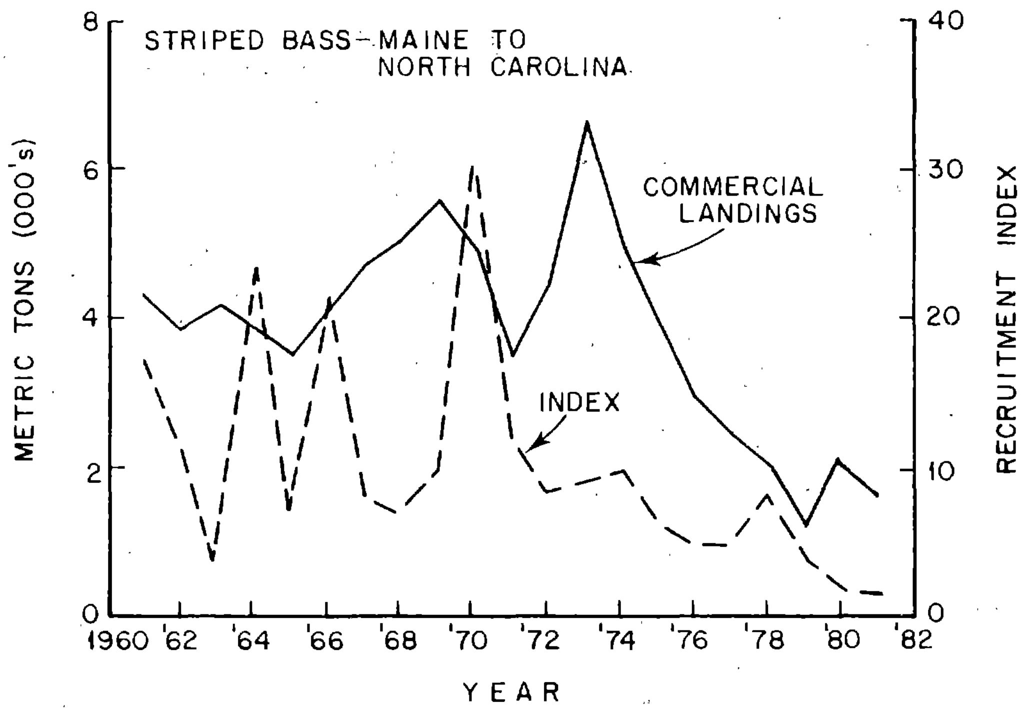


Figure 28. Nominal commercial landings for striped bass in the northeastern United States, and juvenile abundance indices, expressed as average catch per seine haul, for the Maryland stock.

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 110 m (60 fathoms). 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 (47 inches) and weights of up to 18 kg (40 lbs).

The US nominal 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, US vessels accounted for approximately 95% of the Gulf of Maine - Georges Bank white hake catch. Total nominal catch averaged 3,600 mt during 1975-1980 and then rose sharply to 6,100 mt in 1981 (Table 31, Figure 29) US catches through June, 1982 totalled 1,200 mt. Recreational catches for this species have been negligible. Small individuals are difficult to distinguish from red hake (Urophycis chuss), resulting in an unknown degree of bias in reported nominal catches.

There is no evidence that this stock is being adversely affected by current levels of exploitation. Since 1971, commercial landings have generally ranged between 3-4,000 tons, with a gradual upward trend. The NEFC spring survey index (stratified mean catch per tow, kg) 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 1982 index value was 8.8 kg. The corresponding autumn survey index has fluctuated without a definite trend since the late 1960's, although the index dropped sharply in 1982.

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.

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 31. Nominal catches (thousand metric tons) and management information for white hake from the Gulf of Maine and Georges Bank, 1970-1982.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981[1]	1982[2]
US Recreational	0.0	0.0	0.0	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]
Commercial									
US	2.8	2.7	3.1	3.9	3.8	3.1	3.6	5.6	1.2
Canada	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.5	-
Other	0.1	0.0	0.0	0.2	0.0[3]	0.0[3]	0.0[3]	0.0	-
Total nominal catch	3.0	2.8	3.3	4.3	4.0	3.4	3.9	6.1	1.2
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = Unknown
Importance of recreational fishery = Insignificant
Status of management = None
Status of exploitation = Unknown
Age at 50% maturity = Unknown
Size at 50% maturity = 42 cm
M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1981} = Unknown

[1] Provisional (incomplete).
[2] As of June 30, 1982.
[3] Less than 0.05 (50 mt).

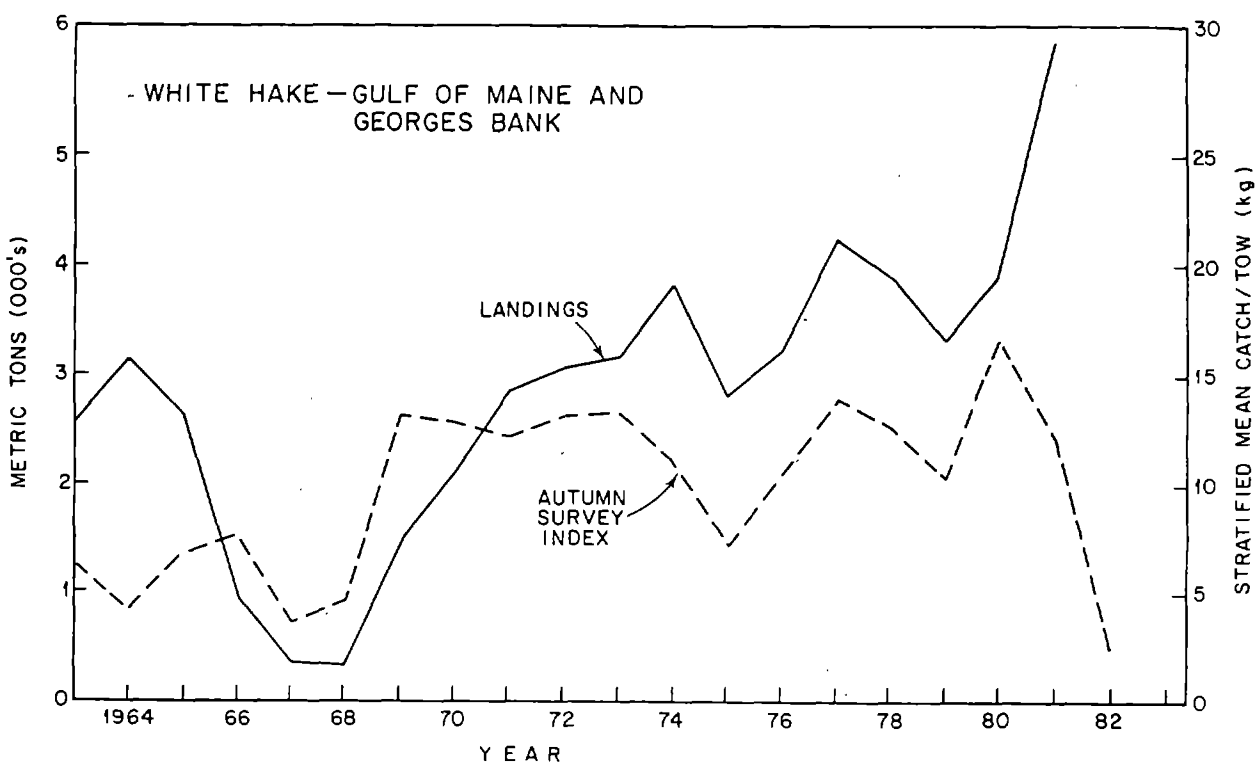


Figure 29. Nominal catches and index of abundance for Gulf of Maine and Georges Bank white hake.

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 183 m (100 fathoms). Spawning occurs in spring and early summer; eggs rise to the surface, where hatching and larval development occur. Juveniles move to the bottom at about 5 cm (2 inches) in length, where they become sedentary and rather solitary in habit. Individuals commonly attain lengths of up to 80 cm (32 inches) and weights of up to 4.5 kg (10 lbs). Little is known relative to stock structure.

The bulk of the US nominal commercial catch has been taken in the Gulf of Maine (65% of the 1960-1980 total). During that period 64% of the total Georges Bank - Gulf of Maine catch was taken by the US, with almost all of the remainder being taken by Canada. The 1974 recreational fishery survey provided an estimate of 100 mt; however, the 1979 survey indicated a recreational catch of less than 50 mt. The total nominal catch for the Georges - Gulf of Maine area averaged 1,700 mt from 1970-1977, increased to an average of 2,300 mt in 1979-1980, and then rose sharply to 3,900 mt in 1981, due primarily to a sharp increase in Canadian catches on Georges Bank (Table 32, Figure 30). The US nominal catch through June of 1982 totalled 700 mt.

NEFC spring and autumn survey indices have fluctuated considerably, but are consistent in indicating an increase in abundance and biomass in recent years. The NEFC spring survey index (stratified mean catch per tow, kg) 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 the time series). The corresponding autumn survey index has generally increased since the mid-1970's (Figure 30). The spring survey index, however, declined sharply to 1.4 kg in 1982, while the autumn survey index dropped from 1.1 kg in 1981 to 0.4 kg in 1982.

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. Nominal catches (thousand metric tons) and management information for cusk from the Gulf of Maine and Georges Bank, 1970-1982.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981[1]	1982[2]
US Recreational	0.0[3]	0.1	0.1	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.0[3]	-
Commercial									
US	0.9	1.4	1.2	1.2	1.5	1.7	1.8	1.8	0.7
Canada	0.7	0.4	0.3	0.2	0.4	0.5	0.6	2.1	-
Other	0.0[3]	0.0	0.0[3]	0.0	0.0	0.0	0.0	0.0	-
Total nominal catch	1.7	1.9	1.6	1.4	1.9	2.2	2.4	3.9	0.7
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = Unknown
Importance of recreational fishery = Insignificant
Status of management = None
Status of exploitation = Unknown
Age at 50% maturity = Unknown
Size at 50% maturity = Unknown
M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1981} = Unknown

[1] Provisional (incomplete).
[2] As of June 30, 1982.
[3] Less than 0.05 (50 mt).

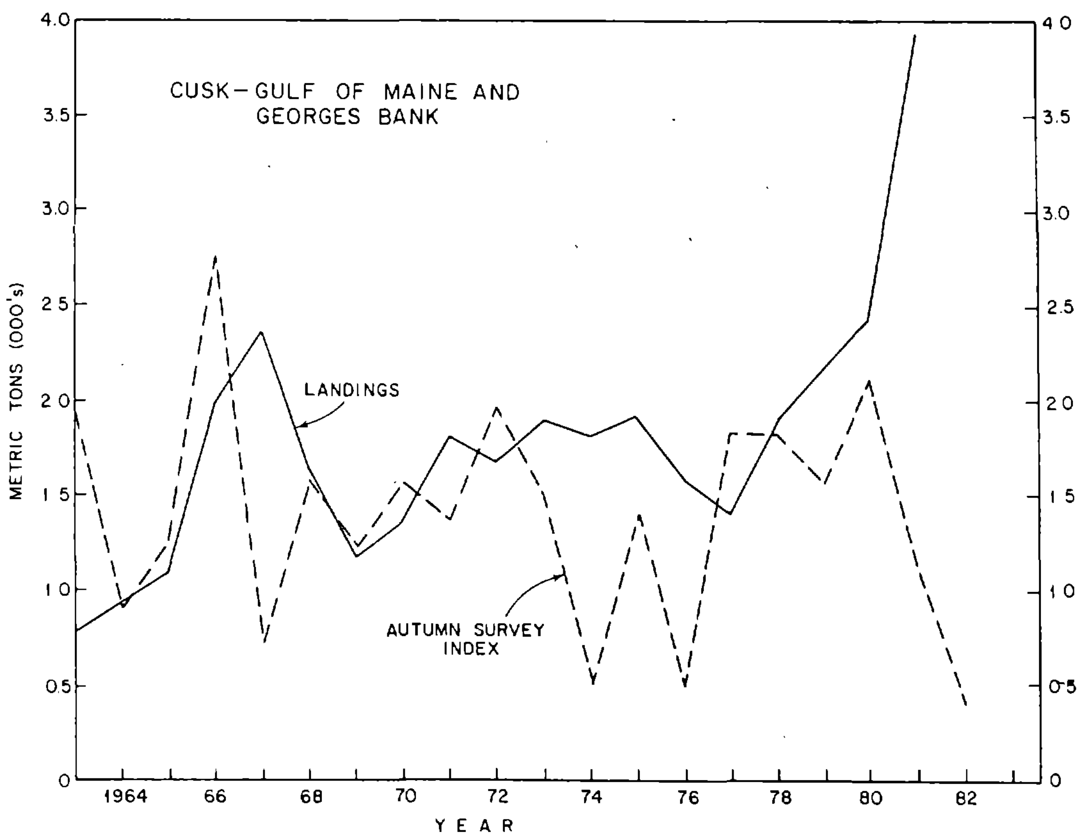


Figure 30. Nominal catches and index of abundance for Gulf of Maine and Georges Bank cusk.

ATLANTIC WOLFFISH

The wolffish (Anarhichas lupus) is a coldwater species of relatively minor importance in Gulf of Maine fisheries. NEFC research vessel surveys indicate that populations on Georges Bank and in the western Gulf of Maine are 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 (45-65 fathoms). Wolffish are sedentary and rather solitary in habit and populations tend to be rather localized. Little is known about the biology of this species. Individuals may attain lengths of 150 cm (59 inches) and weights of perhaps 18 kg (40 lbs). They are a significant predator of lobster.

Wolffish have been caught primarily as by-catch, although the species may also be an intended component of the catch in some mixed fishery situations. Since 1970, the US nominal commercial catch has been about evenly divided between Georges Bank and the Gulf of Maine. In the last two decades US vessels have taken over 75% of the total Georges Bank - Gulf of Maine catch, with most of the remainder going to Canada. The estimated recreational catch in 1979 totalled 60 mt. The total Georges Bank - Gulf of Maine nominal catch increased from 200 mt in 1970 to an average of 1,000 mt in 1980-1981 (Table 33, Figure 31). Through June, 1982, the US catch totalled 600 mt. The NEFC spring survey index (stratified mean catch per tow, kg) has fluctuated considerably without a definite trend (Figure 31), as has the corresponding autumn survey index.

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 33. Nominal catches (thousand metric tons) and management information for wolffish from the Gulf of Maine and Georges Bank, 1970-1982.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981[1]	1982[2]
US Recreational	0.0[3]	0.0[3]	0.0[3]	0.0[3]	0.1	0.1	0.1	0.1	-
Commercial									
US	0.2	0.3	0.4	0.4	0.6	0.7	0.9	0.7	0.6
Canada	0.0[5]	0.0[3]	0.1	0.1	0.2	0.1	0.1	0.1	-
Other	0.0[3]	0.0[3]	0.0	0.0	0.0	0.0	0.0	0.0	-
Total nominal catch	0.3	0.4	0.5	0.5	0.9	0.9	1.1	0.9	0.6
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = Unknown
Importance of recreational fishery = Insignificant
Status of management = None
Status of exploitation = Unknown
Age at 50% maturity = Unknown
Size at 50% maturity = Unknown
M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1981} = Unknown

[1] Provisional (incomplete).
[2] As of June 30, 1982.
[3] Less than 0.05 (50 mt).

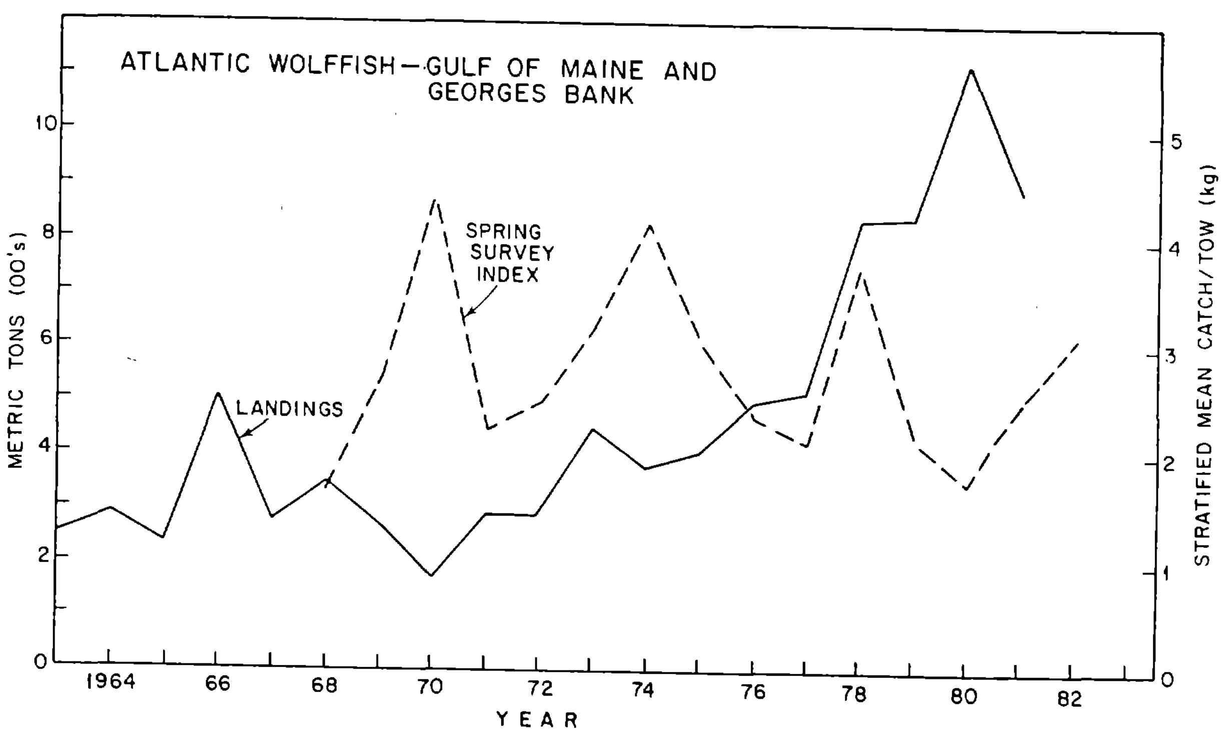


Figure 31. Nominal catches and index of abundance for Gulf of Maine and Georges Bank wolffish.

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 80-440 m (44-240 fathoms), 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 fork length in excess of 110 cm (43 inches) and a maximum observed age of 33 years. Sexual maturity is completed by about age 6 for females and age 9 for males.

Nominal catches were first recorded in 1915 (148 mt); 4,500 mt were taken in 1916 (the largest annual catch to date), but only 5 mt were reported in 1920. The fishery has since undergone several cycles with catches increasing to a peak and then declining. Most recently, US catches increased from about 30 mt in 1968-1969 to 3,840 mt in 1979 (Table 34 and Figure 32). Catches declined steadily to about 3,400 mt in 1981, and to approximately 2,000 mt in 1982 (preliminary estimate).

Longlines were the predominant gear used by the US fishery until the early 1940's. Bottom trawls were the most commonly used gear from then until the early 1970's, after which longlines were again predominant. Since 1972, New Jersey has averaged about 70% of the annual catch, 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 apparently reached no higher than about 100 mt (1974), and have been insignificant since the mid-1970's.

Reported catches of tilefish by distant-water fleets have been small, with the highest being about 150 mt in 1978. However, unreported catches prior to MFCMA may have reached 300 mt annually.

Fishing effort on tilefish by US longliners has increased substantially since the early 1970's. The number of active vessels from New Jersey and New York increased from five in 1973 to 31 in 1979 and then declined to 25 in 1981. Fishing effort, expressed as standardized tubs of longline (1 tub = 210 hooks and 0.5 mile of line), increased from 5,300 tubs in 1973 to an estimated 76,100 tubs in 1981. Catch per unit effort (CPUE) decreased continuously from 143.6 kg/tub in 1974 to 44.7 kg/tub in 1981. Preliminary information indicates that CPUE may have declined an additional 25% from 1981 to 1982.

Estimates of total mortality (Z) derived from catch curve analysis were 0.46 in 1978 and 0.55 in 1980. Assuming a natural mortality rate (M) of 0.10, fishing mortality (F) would have been 0.36 and 0.45 in those years. Assuming a constant relationship between fishing effort and fishing mortality during 1978-1981 would indicate that F in 1981 was about 0.49. Yield-per-recruit analysis based on conditions in the 1980 fishery (age at first capture of 5 years) produced an estimate of $F_{0.1}$ = 0.11 and F_{max} = 0.15.

Maximum sustainable yield (MSY) for tilefish was estimated from a generalized stock production model to be about 3,100 mt. Fishing effort at MSY was estimated to be approximately 44,000 tubs or about half the present effort.

Available data and analyses indicate clearly that tilefish have been overexploited in recent years. Total catches during 1978-1981 exceeded the MSY level by as much as 25% (1979). Fishing effort during 1979-1981 (and possibly in 1982) exceeded the MSY level by as much as 73% (1981). Estimated fishing mortality in 1981 exceeded the $F_{0.1}$ and F_{max} levels by 345% and 227%, respectively. The rapidly declining catch rate and particularly the sharp drop in catch from 1981 to 1982 indicates that stock abundance has decreased substantially in response to the excessive levels of fishing mortality exerted since the late 1970's.

For further information see:

Turner, S.C., C.B. Grimes, and K.W. Able. 1983. Report to Mid-Atlantic Fishery Management Council on Rutgers University preliminary tilefish stock assessment.

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, 18 p.

Table 34. Nominal catches (thousand metric tons) and management information for tilefish from the Southern New England - Middle Atlantic area, 1970-1982.

	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982[1]
	YEAR								
US Recreational	+	+	+	+	+	+	+	+	+
Commercial									
US	0.2	0.7	1.1	2.1	3.4	3.8	3.7	3.4	2.0
Canada	-	-	-	-	-	-	-	-	-
Other	0.3	0.3	0.3	0.3	0.1	+	+	+	+
Total nominal catch	0.6	1.1	1.4	2.4	3.6	3.9	3.7	3.4	2.0
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = 3.1
Importance of recreational fishery = Insignificant
Status of management = FMP in preparation
Status of exploitation = Overexploited
Age at 50% maturity = 5 yrs (females) 8 yrs (males)
Size at 50% maturity = 55 cm (21.6 inches) females; 65 cm (25.6 inches) males
$M = 0.10$ $F_{0.1} = 0.11$ $F_{max} = 0.15$ $F_{1981} = 0.49$

+ = less than 100 mt.
[1] Estimated catch.

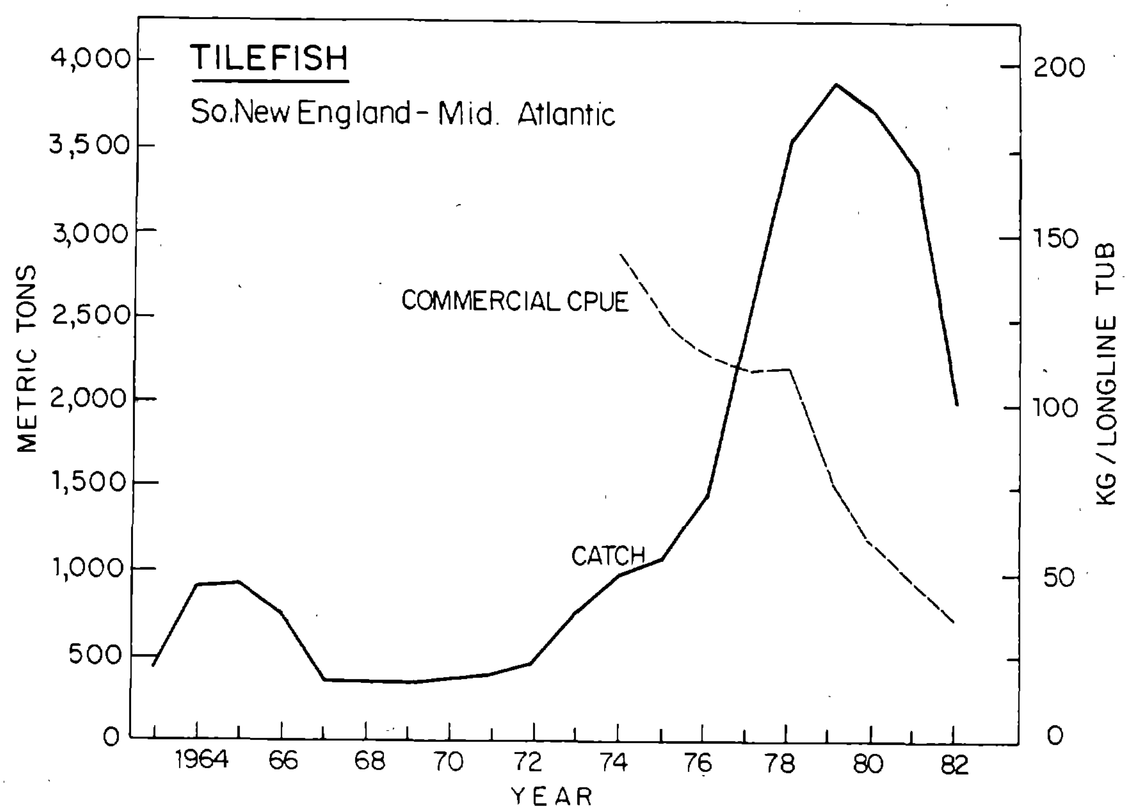


Figure 32. Nominal catches and commercial catch per effort (catch per standardized tub of longline) for tilefish from the Southern New England and Middle Atlantic areas.

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. In the Northwest Atlantic, the maximum ages reported for males and females are 35 and 40 years, respectively. The species bears live young, with a gestation period of about 18-22 months producing 2-15 pups or an average of 6.

Reported international nominal catches peaked at about 21,000 mt in 1972 and declined sharply from 1975 to 1978 (Table 35 and Figure 33). Distant-water-fleets consistently accounted for virtually all of the reported catches. The reported US nominal catch increased from 4,200 mt in 1980 to 6,900 mt in 1981 due to a strong European market. The fishing season extends from June to October in the Gulf of Maine and November to February in the Mid-Atlantic region. Attempts at fishing during May-June, when dogfish are migrating northward, have met with limited success. The domestic dogfish catch can be expected to remain near recent levels of 4,000-7,000 mt given current market conditions.

Minimum biomass estimates of spiny dogfish based on NEFC spring bottom trawl survey catches increased from 743,000 mt in 1981 to 899,000 mt in 1982, 177% above the 1968-1981 average of 325,000 mt. 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 US fishery is similar in nature to the European fisheries in being selective for large individuals [>2.3 kg (5.1 lb), 83 cm (33 in)], which are mainly mature females, to meet processing and marketing requirements. However, during certain times of the year, smaller individuals, consisting of both mature and immature males as well as immature females, are taken as bycatch and discarded. Additionally, since this species bears live young, a directed fishery on mature females directly impacts on recruits. 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.

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.

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. Reun. Cons. int. Explor. Mer. 164: 360-367.

Nammack, M.F. 1982. Life history and management of spiny dogfish, _Squalus acanthias_, off the northeastern United States. MA Thesis. The College of William and Mary, 63 p.

Table 35. Nominal catches (thousand metric tons) and mangement information for spiny dogfish from Maine to Cape Hatteras, 1970-1981.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982[1]
US Recreational	-	-	-	-	-	-	-	-	
Commercial									
US	0.9	0.2	0.5	0.5	0.9	4.8	4.2	6.9	
Canada	-	-	-	-	-	-	-	-	
Other	13.9	18.0	13.8	6.5	0.6	-	0.2	0.3	
Total nominal catch	14.8	18.2	14.3	7.0	1.5	4.8	4.4	7.2	
Total allowable catch	-	-	-	-	-	-	-	-	

Long-term potential catch = 65.0
Importance of recreational fishery = Insignificant
Status of management = None
Status of exploitation = Underexploited
Age at 50% maturity = 6 yrs (males); 12 yrs (females)
Size at 50% maturity = 60.1 cm (23.4 inches) males; 80.7 cm (31.8 inches) femal
M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1981} = Unknown

[1] Not available.

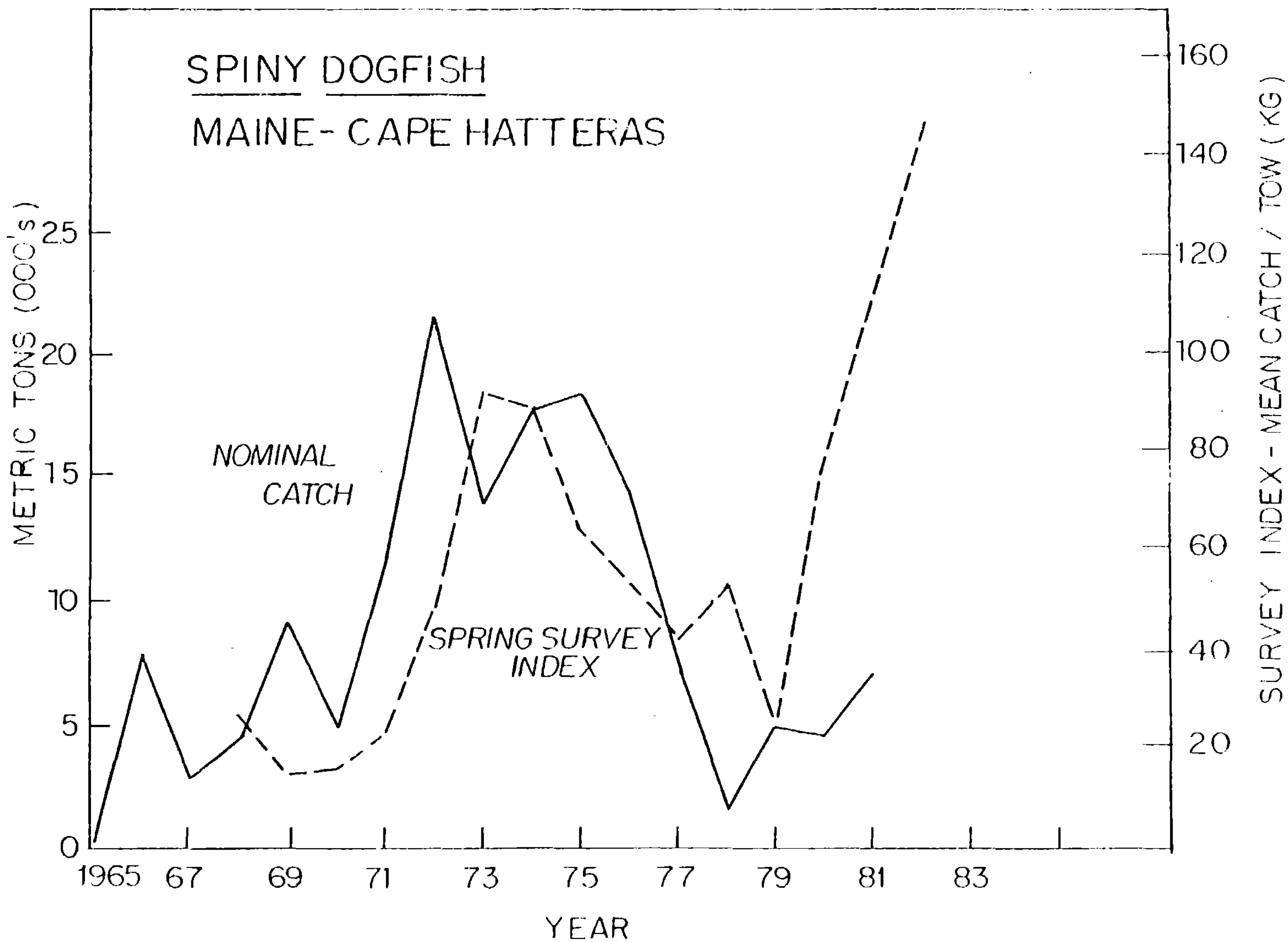


Figure 33. Nominal catches and indices of abundance from the spring research vessel surveys for spiny dogfish from Maine to Cape Hatteras areas.

SKATES

Skates, Family Rajidae, are distributed throughout the Northwest Atlantic from near 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*; barndoor skate, *R. laevis*; thorny skate, *R. radiata*; 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, barndoor, 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 changes in water temperature, 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 nominal catches since 1975 have been less than 2,000 mt annually (Table 36). Most of the domestic catch has traditionally been discarded at sea. The reported U.S. nominal catch in 1981 (does not include industrial catch which has not been estimated for 1981) was 50% below the 1980 level. Thus, the decline is largely attributed to a reduction in total fishing effort in 1981 in the Southern New England industrial trawl fishery. The nominal catch in the industrial trawl fishery averaged 550 mt during 1975-1981. The species composition of the 1981 catch of skates for human consumption was unknown since only the pectoral fins or "wings" are landed. Nominal catches are not expected to markedly increase in the near future unless the limited domestic market expands or an export market develops.

Minimum biomass estimates (mt) for all skates combined in the Gulf of Maine-Cape Hatteras area determined from NEFC bottom trawl survey data declined from 103,000 mt in 1980 to 87,000 mt in 1981 (Figure 34). The 1981 estimate was about 36% less than the 1968-1980 average of 136,000 mt. Since 1974, the total skate biomass estimate has remained at about or below 100,000 mt, which reversed the trend observed during 1968-1973 when yearly biomass estimates ranged from 143,000 to 335,000 mt.

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. Nominal catches (thousand metric tons) and management information for skates (all species) from the Gulf of Maine and Georges Bank areas south to Cape Hatteras, 1970-1982.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982
US Recreational	-	-	-	-	-	-	-	-	-
Commercial									
US	1.8	0.9	1.1	1.3	1.5	1.6	2.0	0.8	1.0
Canada	-	-	-	-	-	-	-	-	-
Other	4.5	3.1	0.9	0.2	-	-	-	-	-
Total nominal catch	6.3	4.0	2.0	1.5	1.5	1.6	2.0	0.8	1.0
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = Unknown
Importance of recreational fishery = Insignificant
Status of management = None
Status of exploitation = Underexploited
[1]Age at 50% maturity = 4 yrs
[1]Size at 50% maturity = 40 cm (15.8 inches)
[1]$M = 0.4$ [1]$F_{0.1} = 0.49$ [1]$F_{max} = 1.0$ F_{1981} = Unknown

[1]Pertains to the little skate (_Raja erinacea_).

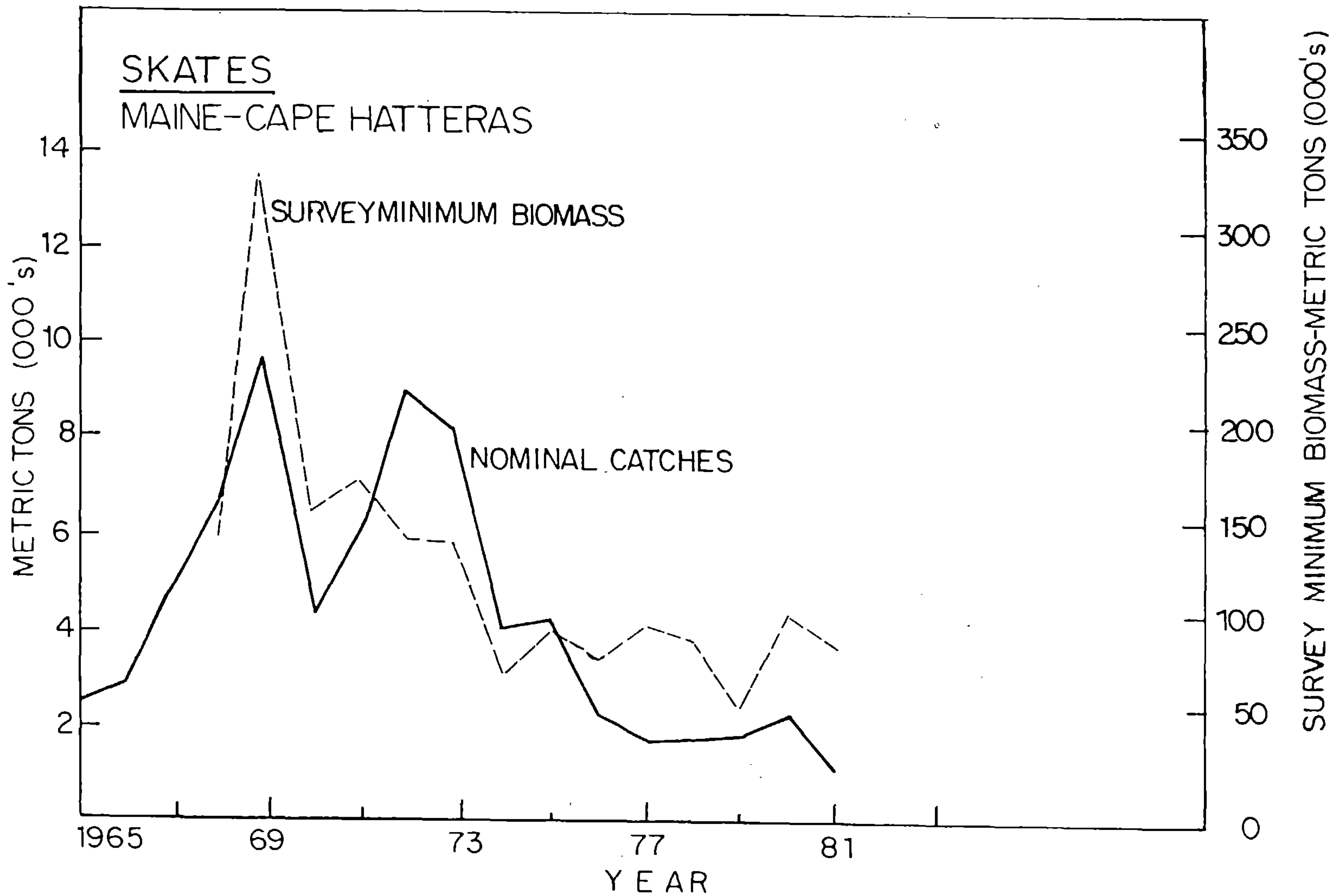


Figure 34. Nominal catches and indices of abundance from spring research vessel surveys for skates from Maine to Cape Hatteras areas.

SHORT-FINNED SQUID (*Illex illecebrosus*)

The short-finned squid (*Illex illecebrosus*) is found in commercial quantities between Cape Hatteras and Newfoundland. Based on present scientific information, this range represents the major distribution of a single stock. *Illex* undergo seasonal migrations onto the continental shelf during summer, and off the edge of the shelf in winter to spawn. Results of recent larval and juvenile surveys indicate that spawning probably occurs somewhere south of Cape Hatteras, in or near the Gulf Stream. Larvae and juveniles are assumed to be transported north and east by the Gulf Stream. In some years, the spawning season of *Illex* is prolonged so that two cohorts (winter and late spring) are produced. These cohorts tend to vary in relative importance from year to year. *Illex* grow to a maximum length of about 35 cm (14 inches, dorsal mantle length) and live about 12-24 months. Commercial catches off the US are comprised mainly of 10-28 cm (4-11 inch) individuals which are probably 8-24 months of age.

Total *Illex* catches increased from 15,354 mt in 1981 to 19,400 mt (preliminary) in 1982, comparable to the 1974-80 mean (19,592 mt). The US nominal catch of *Illex* increased from 600 mt in 1981 to an estimated 5,900 mt in 1982 (Table 37). The 1982 catch represented almost a 4 fold increase over the previous annual high in 1979, and included about 2,338 mt taken in joint ventures. Distant-water-fleet catches during 1982 were 13,500 mt, down 9% from 1981 (14,900 mt). The 1982 catch was 15% below the 1974-1981 mean catch of 11,800 mt. Through December 1982, the distant water fleets took 10,621 mt or 76% of their April 1, 1982 - March 31, 1983 fishing year allocation.

The reported catch in Canadian waters in 1982 was only about 9,000 mt during January-October, indicating a continuing decline from a high of 153,000 mt in 1979. The 1981 catch was 32,500 mt.

The abundance index (mean number per tow) for *Illex* from the NEFC 1982 autumn bottom trawl survey decreased 92% from the 1981 record high and was 66% below the 1967-81 mean (Figure 35). Minimum abundance off the US coast was estimated to be 21.4 million individuals in 1982 compared with 219.1 million in 1981. This was the lowest estimate since abundance began an upward trend in 1974. However, pre-recruit (<10 cm) abundance was 2.1 times higher than in 1981 and only 15% below the 1967-81 average (excluding the high 1975 value). The pre-recruits sampled in the 1982 autumn survey will comprise the bulk of the catch in the 1983-84 fishery.

For further information see:

Lange, Anne M.T. 1982. Status of the squid (Loligo pealei and Illex illecebrosus) populations off the Northeastern USA. NMFS, NEFC, Woods Hole Lab. Ref. No. 82-27, 19 p.

Table 37. Nominal catches (thousand metric tons) and management information for the short-finned squid (Illex) from the Middle Atlantic to the Gulf of Maine, 1970-1982.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982[3]
US Recreational	-	-	-	-	-	-	-	-	-
Commercial									
US	0.4	0.1	0.2	1.0	0.4	1.6	0.3	0.6	5.7
Canada	-	-	-	-	-	-	-	-	-
Other	11.8	17.8	24.7	23.8	17.3	16.3	19.6	14.9	13.5
Total nominal catch	12.2	17.9	24.9	24.8	17.7	17.9	17.9	15.4	19.2
Total allowable catch[1]	-	-[2]	30.0	30.0	35.0	30.0	30.0	30.0	30.0

Long-term potential catch = 30.0
Importance of recreational fishery = Insignificant
Status of management = FMP in force since 1979
Status of exploitation = Underexploited
Age at 50% maturity = 18 months
Size at 50% maturity = 20 cm (8 inches) dorsal mantle length
M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1981} = Unknown

[1] Total allowable catch is for the 1 April - 31 March fishing year.
[2] Total allowable catch of 71,000 tons for Loligo and Illex combined for 1974 and 1975.
[3] Catches estimated.

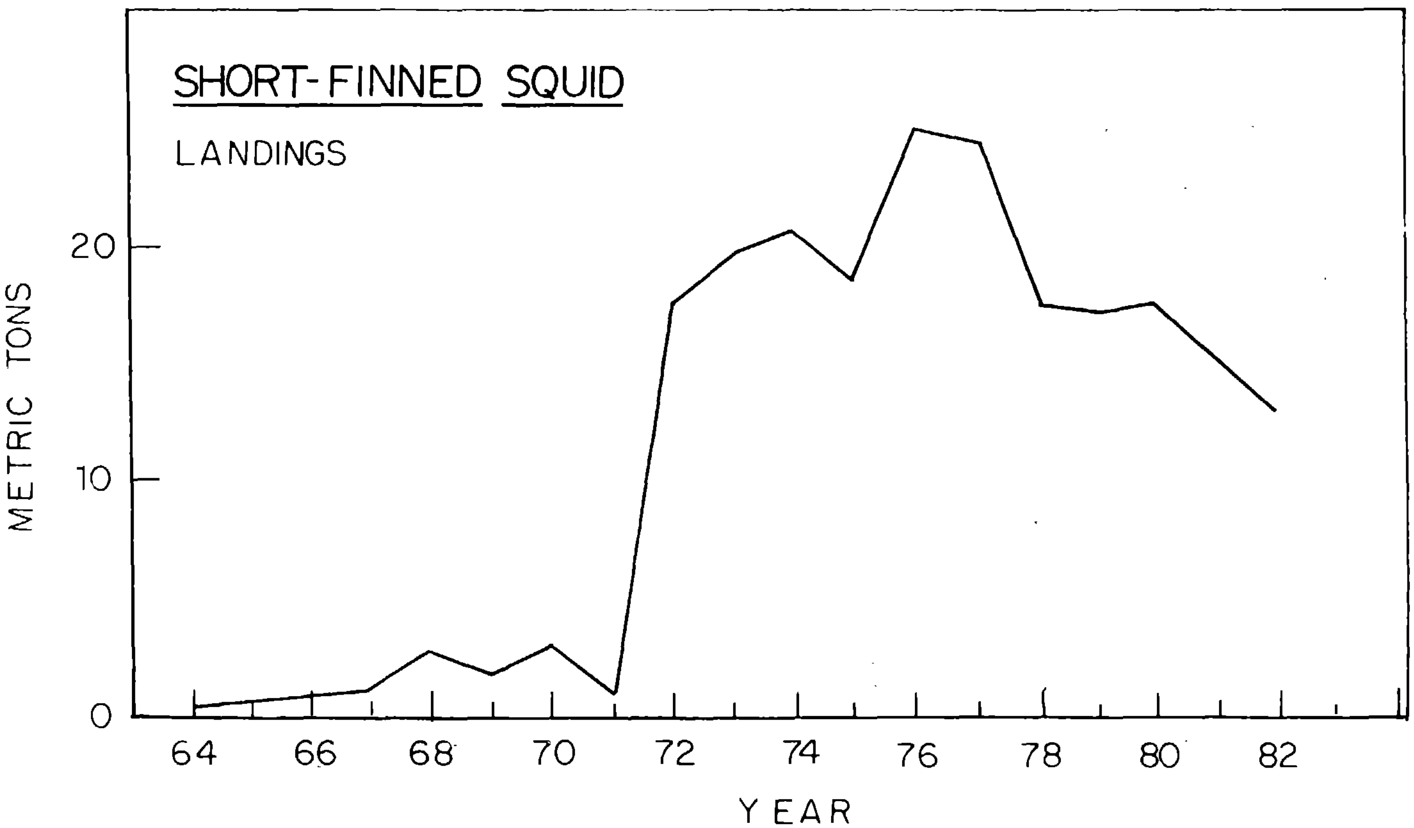


Figure 35. Nominal catches of the short-finned squid from the Gulf of Maine - Mid Atlantic area.

LONG-FINNED SQUID (*Loligo pealei*)

The long-finned squid (*Loligo pealei*) is found in commercial quantities from Cape Hatteras to southern Georges Bank. *Loligo* undergo seasonal migrations, moving into shallow inshore waters from southern Cape Cod to the Chesapeake Bay in spring and summer to spawn. In late autumn they begin to move offshore to the edge of the continental shelf, where the distant water fishery occurs in winter. The extended spawning season for *Loligo* results in two cohorts, with the early (spring) cohort generally more important than the late summer cohort, although this importance may vary from year to year. *Loligo* reach lengths of over 40 cm (16 inches, dorsal mantle length) and ages of about 3 years, but most individuals taken in commercial catches are 8-20 cm (3-8 in) and 8-14 months.

Total *Loligo* catches increased from 15,882 mt in 1981 to 20,500 mt (preliminary) in 1982 (Table 38), but were still 12% below the 1970-1981 average (23,425 mt). The U.S. nominal catch increased from 2,316 mt in 1981 to an estimated 4,500 mt in 1982, the highest level yet recorded. This increase was due, in part, to joint venture catches which accounted for about 1,100 mt. Distant-water-fleet catches during 1982 were 16,000 mt (preliminary) compared with 13,600 mt in 1981. The 1982 catches, however, were 26% below the 1970-1981 mean (21,500 mt). Through December 1982, the distant water fleets took 6,500 mt or 36% of their 1982-1983 fishing year (April 1- March 31) allocation.

The abundance index (mean number per tow) from the NEFC 1982 autumn bottom trawl survey increased 37% from 1981 and was 15% above the 1967-1981 average (Figure 36). The 1982 pre-recruit index was 56% greater than in 1981 and 9% above the 1967-1981 mean. Minimum abundance was estimated to be 3.7 billion individuals during the time of the 1982 autumn survey, with 81% (3.0 billion) being of pre-recruit size (< 8cm or 3 in). Monthly estimates of natural mortality (M) range between 0.08 and 0.14, and assuming that most individuals would be recruited to the fishery by December 1982, an estimated 2.8-3.2 billion individuals or 140,000-158,000 mt (at 50 g per individual) should be available at that time. This compares with an estimated 2.6-2.9 billion individuals or 128,000-144,000 mt, available in December 1981.

For further information see:

Lange, Anne M.T. 1982. Status of the squid (*Loligo pealei* and *Illex illecebrosus*) populations off the Northeastern USA. NMFS, NEFC, Woods Hole Lab. Ref. No. 82-27, 19 p.

Table 38. Nominal catches (thousand metric tons) and management information for long-finned squid (Loligo) from the Middle Atlantic to the Gulf of Maine, 1970-1982.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982[3]
US Recreational	-	-	-	-	-	-	-	-	-
Commercial									
US	1.1	1.6	3.6	1.1	1.3	3.9	3.9	2.3	4.5
Canada	-	-	-	-	-	-	-	-	-
Other	26.5	32.2	21.7	15.6	9.4	13.2	19.8	13.6	16.0
Total nominal catch	27.6	33.8	25.3	16.7	10.7	17.1	23.7	15.9	20.5
Total allowable catch[1]	-	-[2]	44.0	44.0	44.0	44.0	44.0	44.0	44.0

Long-term potential catch = 44.0
Importance of recreational fishery = Insignificant
Status of management = FMP in force since 1979
Status of exploitation = Underexploited
Age at 50% maturity = 12 months
Size at 50% maturity = 16 cm (6 inch) dorsal mantle length
M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1981} = Unknown

[1] Total allowable catch is for the 1 April - 31 March fishing year.
[2] Total allowable catch of 71,000 tons for Loligo and Illex combined in 1974 and 1975.
[3] Catches estimated.

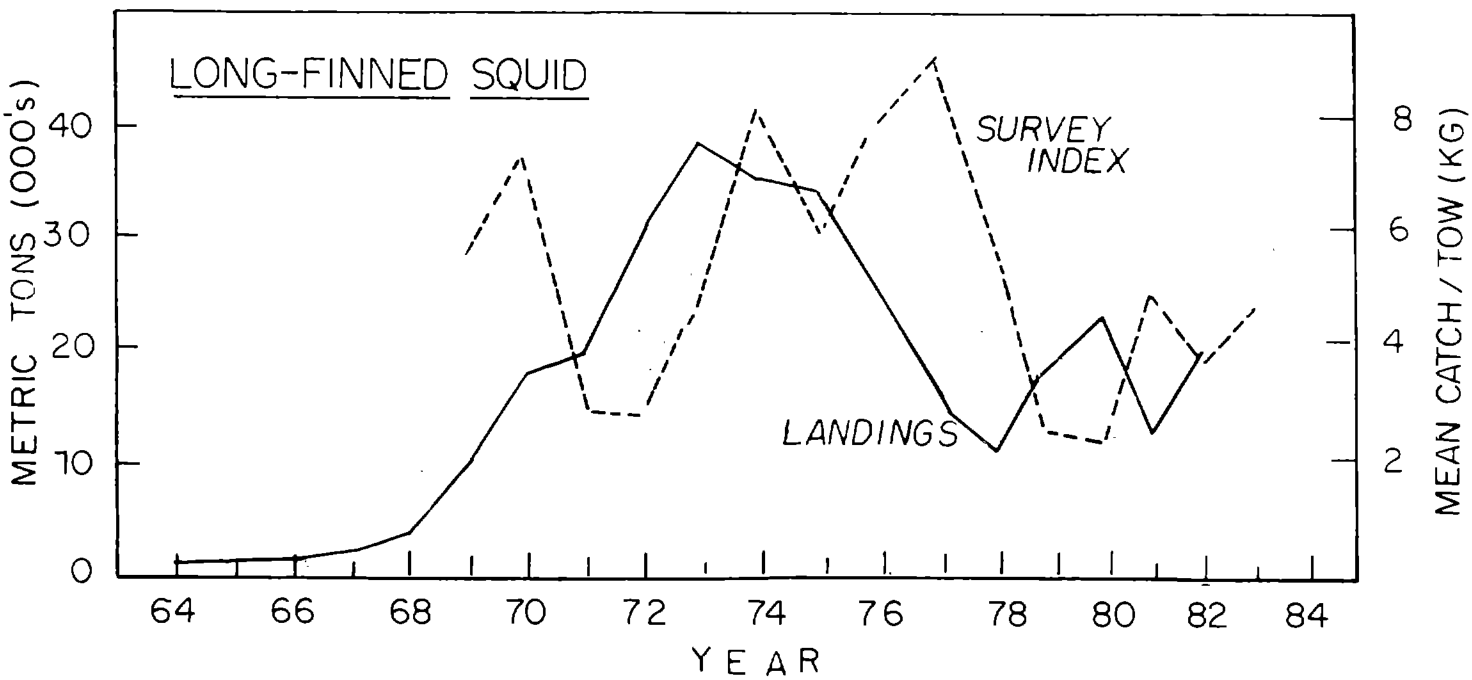


Figure 36. Nominal catches and indices of abundance from autumn research vessel surveys for long-finned squid from the Gulf of Maine - Mid Atlantic area.

AMERICAN LOBSTER

The American lobster (Homarus americanus) is distributed in the Northwest Atlantic from Labrador to Cape Hatteras at depths of up to 700 m (380 fathoms). Lobsters are locally abundant in coastal areas within the Gulf of Maine and off Southern New England, decreasing in abundance in more southerly locations. Coastal lobsters are primarily concentrated in rocky areas where shelter is readily available, although occasional high densities occur in offshore mud substrates suitable for burrowing. Offshore lobsters are most abundant in the vicinity of submarine canyons along the edge of the continental shelf. Tagging experiments in coastal waters suggest that for small lobsters movements are rather limited, although there is evidence that larger individuals may travel extensively. In contrast, offshore lobsters undertake well-defined shoalward migrations during spring, travelling up to 300 km (186 miles) and commonly migrating up to 80 km (50 miles), and a return migration occurs during autumn. Lateral movements along the shelf edge have also been demonstrated.

Lobsters exhibit a complex life cycle in which mating occurs following molting of the female; the eggs (7,000-80,000) are carried under the female's abdomen during the 10-11 month incubation period. Hatching occurs during late spring-early summer and the pelagic larvae undergo four molts before attaining adult characteristics and settling to the bottom. Lobsters molt approximately 20 times before reaching the minimum legal size at 5-7 years of age. Nearly all lobsters caught inshore are juveniles.

Nominal catches in the USA inshore (within 12 miles) trap fishery remained relatively stable during 1965-1975, ranging from 10,300 to 12,200 mt and averaging 11,100 mt. The nominal inshore catch subsequently increased to record levels during 1979-81, averaging 15,400 mt (Table 39). Nominal catches for the offshore trap fishery increased rapidly following its inception in 1969, from 50 mt in 1969 to 2,900 mt in 1973. Yield remained relatively stable at approximately 2,000 mt during 1975-1978, but subsequently declined to 1,200 mt during 1981. The offshore trawl fishery averaged 1,900 mt during 1965-1974 and then decreased steadily to only 200 mt in 1981. Total offshore catch has declined in recent years (Figure 37). Preliminary data for January-August of 1982 (inshore statistics for several states not included) indicate a USA catch of 5,900 mt.

The NEFC autumn survey biomass index (stratified mean catch per tow, kg) declined steadily from 1.33 kg per tow in 1964 to 0.51 kg in 1970, averaged 0.65 kg during 1971-76, and then increased to an average of 0.97 kg during 1977-1980. The autumn index decreased slightly to 0.86 kg in 1981. The corresponding spring survey index averaged 1.03 kg during 1968-72, declined to 0.48 kg in 1975, and subsequently increased to 0.71 kg in 1981.

The commercial index (kg-per-trap-haul-set-over-day or kg per THSOD) also indicated sharp declines in stock biomass during the 1970's, from 1.74 kg in 1969 to only 0.41 kg in 1972. This index subsequently increased to 0.79 kg in 1974 and then dropped to a relatively stable level (0.40 kg per THSOD) during 1975-1981. Thus, trends in offshore commercial landings and commercial and research vessel survey indices are generally consistent in indicating a reduction in stock biomass following the development of the offshore trap fishery and stabilization at reduced levels during the latter 1970's. High fishing mortality rates, particularly in coastal locations, remain a source of serious concern for this extremely valuable resource.

For further information see:

Fogarty, M.J., R.A. Cooper, J.R. Uzmann and T.S. Burns. MS 1982. Assessment of the USA offshore American lobster (_Homarus americanus_) fishery. ICES, C.M. 1982/K:14, 21 p.

Table 39. Commercial and recreational landings (metric tons, live weight) of American lobster from the Northwest Atlantic (Maine to North Carolina), 1970-1982.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982
US Recreational									
State Waters	-	-	.2	.2	.2	.2	.2	.2	.2
Commercial									
US: Offshore	3.4	3.4	3.9	3.0	3.3	2.5	2.2	1.8	-
Inshore (within 12 miles)	10.8	9.7	10.5	11.4	12.4	15.0	15.3	15.8	5.7[1]
Canada: Georges Bank	.2	.2	.2	.3	.3	.2	.2	.2	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	14.3	13.3	14.8	14.9	16.2	17.9	17.9	18.0	5.9
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
Size at 50% maturity = 10 cm (3.9 inches) carapace length
M = .10 $F_{0.1}$ = N/A F_{max} = 0.18 (males) 0.23 (females) F_{1981} = >F_{max}

[1] Based on preliminary data for January-August.

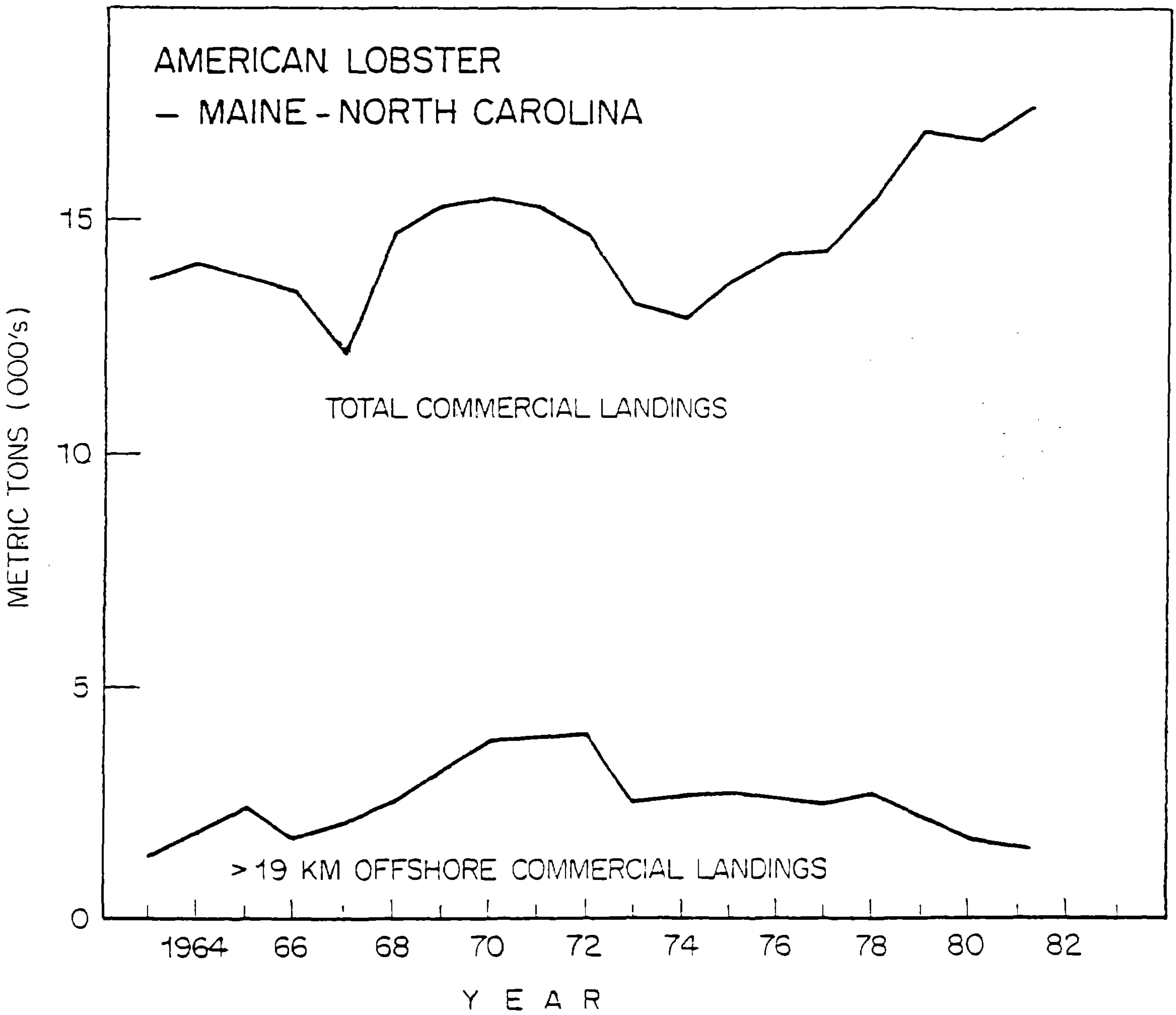


Figure 37. Nominal catches of American lobster from Maine to North Carolina compared with catches in the offshore (greater than 19 km or 12 miles) area.

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 changes in distribution appear to correlate well with localized temperature trends. Historical trends in abundance also appear attributable in large measure to environmental conditions, although the relative impact of apparently unfavorable temperatures during the early to mid-1970's 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 $2\frac{1}{2}$ years of age); they then pass through a series of transitional stages and mate again as females the following summer at age $3\frac{1}{2}$. During autumn and winter, egg bearing (ovigerous) females migrate into inshore areas, where the eggs hatch. These females may survive to spawn in subsequent years, although natural mortality appears to increase sharply after first hatching at age 4.

The Gulf of Maine northern shrimp fishery is managed jointly by the participating states (Maine, New Hampshire, and Massachusetts) under the auspices of the Atlantic States Maine Fisheries Commission (ASMFC). Under this arrangement regulations are posted and enforced in the name of the Commission; however, enforcement authority remains vested with the individual states. Since management originated in 1973, regulations have included minimum mesh sizes and seasonal closures. A quota of 1,600 mt (3.5 million pounds) was also imposed in 1977 (Table 40). Recent assessments 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 per recruit. Since 1975, directed fishing has been restricted to winter and spring; in 1982, the fishing season extended from January 1-April 15, and a December 15 to April 30 season has been established for 1982-83.

Historically, effort has been directed primarily towards ovigerous females in inshore areas in wintertime, although during the early 1970's substantial quantities of all age groups were also harvested further offshore during the summer months. Otter trawls have been the primary gear used. A limited pot fishery was initiated during the early 1970's, but nominal pot catches have never exceeded 2% of the total catch.

Nominal catches peaked at 12,800 mt in 1969, averaged approximately 10,000 mt from 1970-74, and then declined precipitously to only 400 mt in 1977 (Table 40, Figure 38). Nominal catches have since increased from an average of 400 mt in 1979-1980 to 1,500 mt in 1982. The Maine summer survey index declined from 45.8 kg per tow in 1968 to only 1.6 kg in 1977 and has since shown slight, if any, improvement. NEFC spring and autumn survey indices (stratified mean catch per tow, kg) similarly declined by over 90% during 1968-1977 but have since increased substantially, and NEFC summer survey data also suggest an increase during 1977-1980.

For further information see:

Clark, S.H. MS 1982. Assessment and management of the Gulf of Maine northern shrimp (Pandalus borealis) fishery. ICES C.M. 1982/K:13, 20 p.

Table 40. Nominal catches (thousand metric tons) and management information for Gulf of Maine northern shrimp.

	YEAR								
	1970-1974 average	1975	1976	1977	1978[1]	1979	1980	1981[2]	1982[3]
US Recreational	-	-	-	-	-	-	-	-	-
Commercial									
US	10.0	5.3	1.0	0.4	0.0[4]	0.5	0.3	1.0	1.5
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	10.0	5.3	1.0	0.4	0.0	0.5	0.3	1.0	1.5
Total allowable catch	-	-	-	1.6	-	-	-	-	-

Long-term potential catch = N/A
Importance of recreational fishery = Insignificant
Status of management = Jointly by participating states [5]
Status of exploitation = Fully exploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 9 cm (3.5 inches)
M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1981} = Unknown

[1] Fishery closed during 1978.
[2] Provisional (incomplete).
[3] Preliminary.
[4] Less than 0.05 (50 mt).
[5] Under Amendment One to the Atlantic States Marine Fisheries Compact.

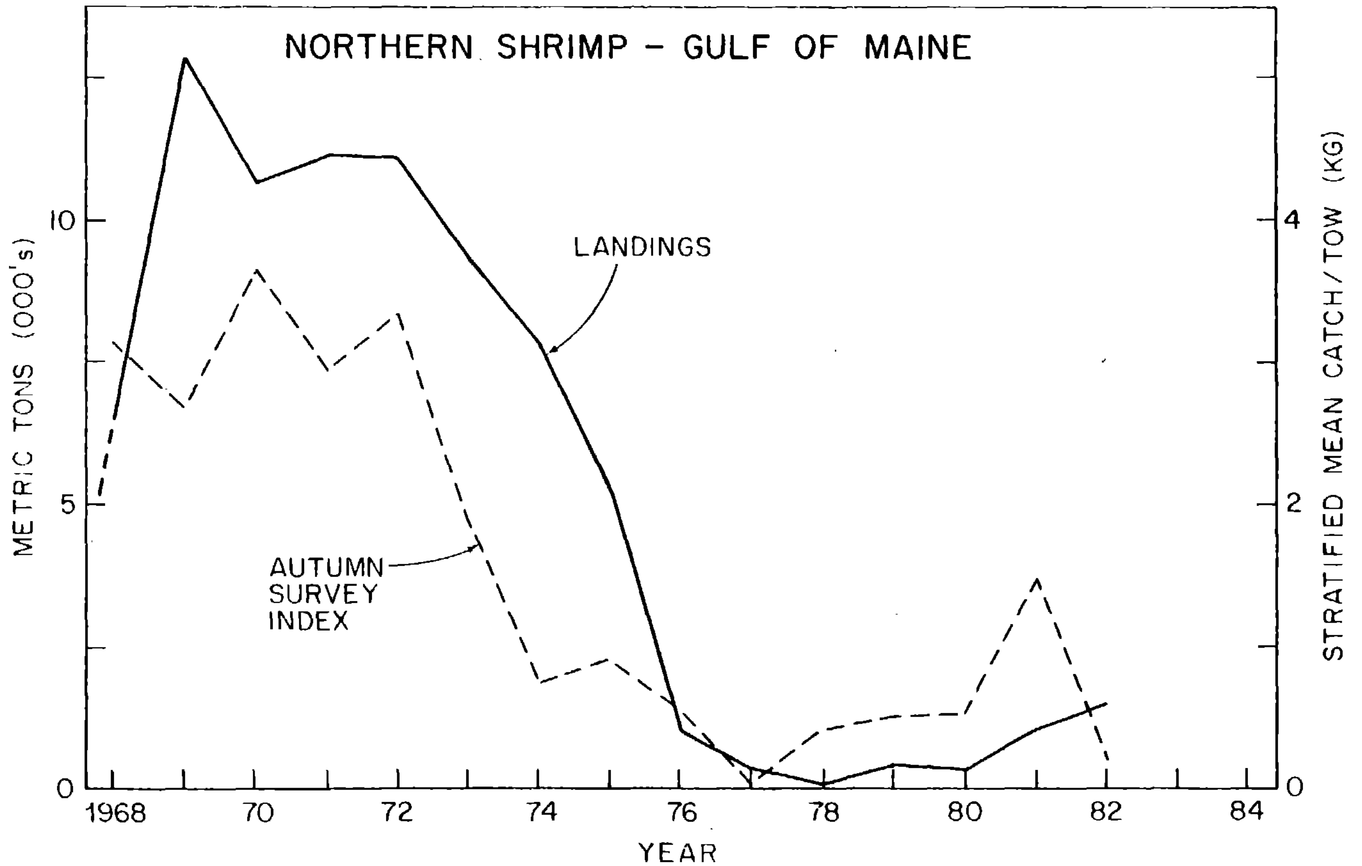


Figure 38. Nominal catches and index of abundance for Gulf of Maine northern shrimp.

RED CRAB

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

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

USA nominal catch in 1981 was 3,108 mt, 560 mt more than in 1980, and a record high for the fishery (Table 41 and Figure 39). Mid-Atlantic catches (2,108 mt) accounted for 68% of the total 1981 harvest; the remaining 32% or 1000 mt was derived from Georges Bank - Southern New England waters.

Estimates of standing crop biomass of commercial-sized (>4½ in. (11.4 cm) carapace width) red crabs in the offshore areas between eastern Georges Bank and northern Maryland, derived from a 1974 research vessel survey, indicated that approximately 26,700 mt of red crab existed within the surveyed regions. Greatest concentration 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 conducted 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 2,700 mt (5.9 million pounds). The 1981 nominal catch from this region (3,000 mt) approximates 111% of the estimated MSY.

For further information see:

Gerrior, P. 1981. The distribution and effects of fishing on the deep sea red crab, Geryon quinquedens Smith, off Southern New England. MA Thesis, Southeastern Massachusetts Univ., North Dartmouth, MA., 130 p.

Serchuk, F.M. 1977. Assessment of red crab (Geryon quinquedens) populations in the Northwest Atlantic, September 1977. Woods Hole Lab. Ref. 77-23, 15 p.

Table 41. Nominal catches (metric tons, live weight) and management information for red crab from the Northeast coast of the United States.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982
US Recreational	-	-	-	-	-	-	-	-	-
Commercial									
US	264	313	702	1,245	1,432	1,216	2,548	3,108	-[1]
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	264	313	702	1,245	1,432	1,216	2,548	3,108	-[1]
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = 2700
Importance of recreational fishery = Insignificant
Status of management = None
Status of exploitation = Fully exploited
Age at 50% maturity = Unknown
Size at 50% maturity = 85 mm (3.3 inch) carapace width (females)
M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1981} = Unknown

[1] Not yet available.

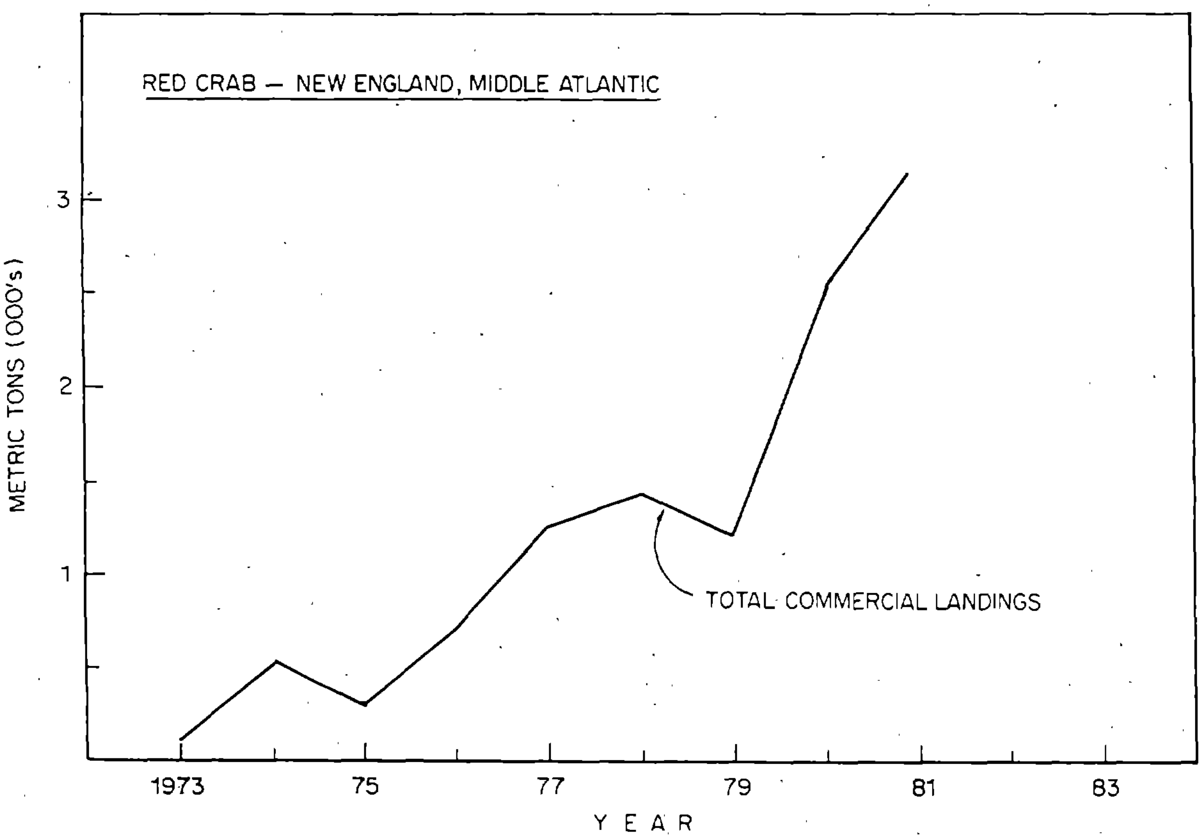


Figure 39. Nominal total landings of red crab from the Northeast Coast of the United States.

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 and off the Virginia Capes. In the Middle Atlantic regions 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 harvestable size (14 cm or 5½ inches, by Federal regulation) in about 6-7 years. Maximum size is about 22.5 cm (8 7/8 inches) but clams larger than 20 cm (7 7/8 inches) 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 their second year. Eggs and sperm are shed directly into the water column; recruitment to the bottom occurs after a plantonic larval period of about 3 weeks (at 22°C).

Atlantic surf clam populations inhabiting offshore (Fishery Conservation Zone) waters of the United States East Coast have been managed since November 1977 under provisions of the Magnuson Fishery Conservation and Management Act (MFCMA). Prior to enactment of the comprehensive management plan, stock abundance and total commercial landings in the Middle Atlantic Bight Region fell dramatically: landings declined from 46.3 thousand metric tons of shucked meats in 1974 to 22.3 thousand metric tons in 1976. Regulation of the fishery has proceeded with one objective being the re-building of Middle Atlantic stocks. Various regulatory devices to effect this and other objectives have included landings quotas, a moratorium on new vessel entrants, closure of areas to protect pre-recruit sized clams, effort restrictions, and, most recently, a minimum clam size. Two distinct management units (Southern New England, Middle Atlantic) are identified in the Management 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 40.1 thousand tons (meats) were 50% greater than the 1965-1977 average of 27 thousand tons. The southern Virginia-North Carolina fishery collapsed during 1976; most vessels returned to more northern ports.

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 (1978-1982) have indicated the existance of substantial 1976 year class in the area subjected to the clam kill. Growth to harvestable size of the single year class off Northern New Jersey resulted in an increasing proportion of total Middle Atlantic nominal catches derived from that area. During 1981 and 1982, the Northern New Jersey region accounted for 48 and 40% respectively of total Middle Atlantic landings. The bulk of the 1976 year class off Northern New Jersey will likely reach the minimum harvestable size during 1983.

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 1976-1980 resulted in declining stocks of commercial sizes. Recent surveys indicate the abundance of commercial sizes has remained relatively low although significant pre-recruit resources (1977 year class) presently exist off Delmarva. Based on growth rate projections, it is likely that a small proportion of the 1977 year class will reach harvestable size during 1983, with the bulk growing to legal size during 1984.

Surf clam resources in the southern New Jersey and southern Virginia-North Carolina assessment areas remain at relatively low levels, although fishing activity in the two regions increased during the latter half of 1982. The slight increase in activity in the two areas was primarily due to the fact that the predominance of small clams in catches off Northern New Jersey and Delmarva necessitated laborious culling of the catch to land only legal-sized clams.

For further information see:

Murawski, S.A., and F.M. Serchuk. 1982. Assessment and current status of offshore surf clam, *Spisula solidissima* populations off the Middle Atlantic Coast of the United States - Autumn 1982. Woods Hole Lab. Ref. 82-43.

Table 42. Nominal catches (thousand metric tons) and management information for surf clams from USA Northwest Atlantic Waters, 1970-1982.

	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982[1]
USA: FCZ Waters	24.2	20.1	19.3	19.5	14.2	13.2	15.7	16.9	15.8
USA: State Waters	8.6	19.3	3.0	3.7	3.6	2.6	1.4	4.0	6.0
USA: Total	32.8	39.4	22.3	23.2	17.8	15.8	17.1	20.9	21.8
Total allowable FCZ catch	-	-	-	-	13.6	13.6	13.6	18.1	18.1

Long-term potential catch = 23
Importance of recreational fishery = Insignificant
Status of management = FMP in force since November 1977
Status of exploitation in 1982 = Fully exploited
Age at 50% maturity = 2 yrs.
Size at 50% maturity = 5 cm (2 inches)
M = 0.2 $F_{0.1}$ = Unknown F_{max} = Unknown F_{1981} = Unknown

[1]Estimated based on FCZ logbook data through 12/82, and projections of catches from state waters.

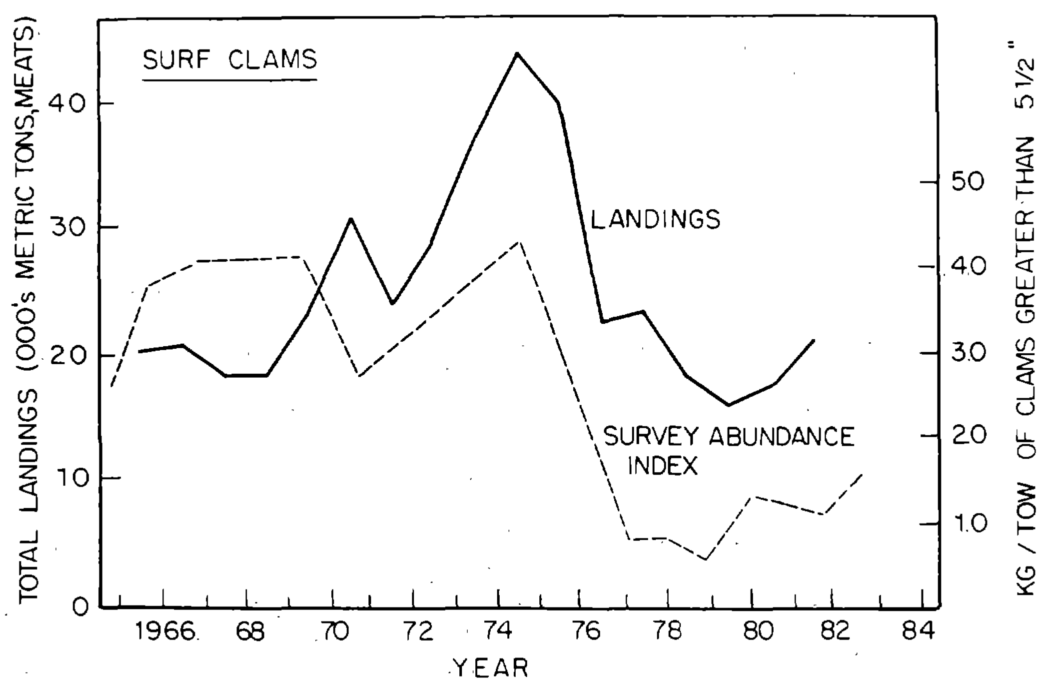


Figure 40. Total landings (metric tons of shucked meats) and relative abundance of surf clam populations in the Middle Atlantic Bight, 1965-1982.

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 (3 inches, shell length) marked off Long Island during 1978, grew about 0.6 mm in one calendar year and 1.2 mm in two years. 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 thousand metric tons 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 95% of the 1981 total of 16.4 thousand metric tons (Table 43, 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 as 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 and 1982. 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 1976-1982 comprised about 5% of the estimated acccumulated 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 further 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.

Murawski, S.A., J.W. Ropes, and F.M. Serchuk. 1982. Growth of the ocean quahog, _Arctica islandica_ in the Middle Atlantic Bight. Fish. Bull. (U.S.) 80(1): 21-34.

Table 43. Nominal catches (thousand metric tons) and management information for ocean quahogs from USA Northwest Atlantic Waters, 1970-1982.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982[1]
USA: FCZ Waters	-	-	1.9	7.3	9.2	14.3	13.9	16.0	15.0
USA: State Waters	0.7	0.6	0.7	1.1	1.2	1.4	1.5	0.4	0.5
USA: Total	0.7	0.6	2.5	8.4	10.4	15.8	15.3	16.4	15.5
Total allowable FCZ catch	-	-	-	-	13.6	13.6	15.9	18.1	18.1

Long-term potential catch = Unknown
Importance of recreational fishery = Insignificant
Status of management = FMP in force since November 1977
Status of exploitation in 1982 = Fully exploited in some areas
Age at 50% maturity = 8 yrs. (males); 11 yrs. (females)
Size at 50% maturity = 50 mm (2 inches shell length)
M = 0.01-0.10 $F_{0.1}$ = Unknown F_{max} = Unknown F_{1981} = Unknown

[1]1982 data are projected annual totals

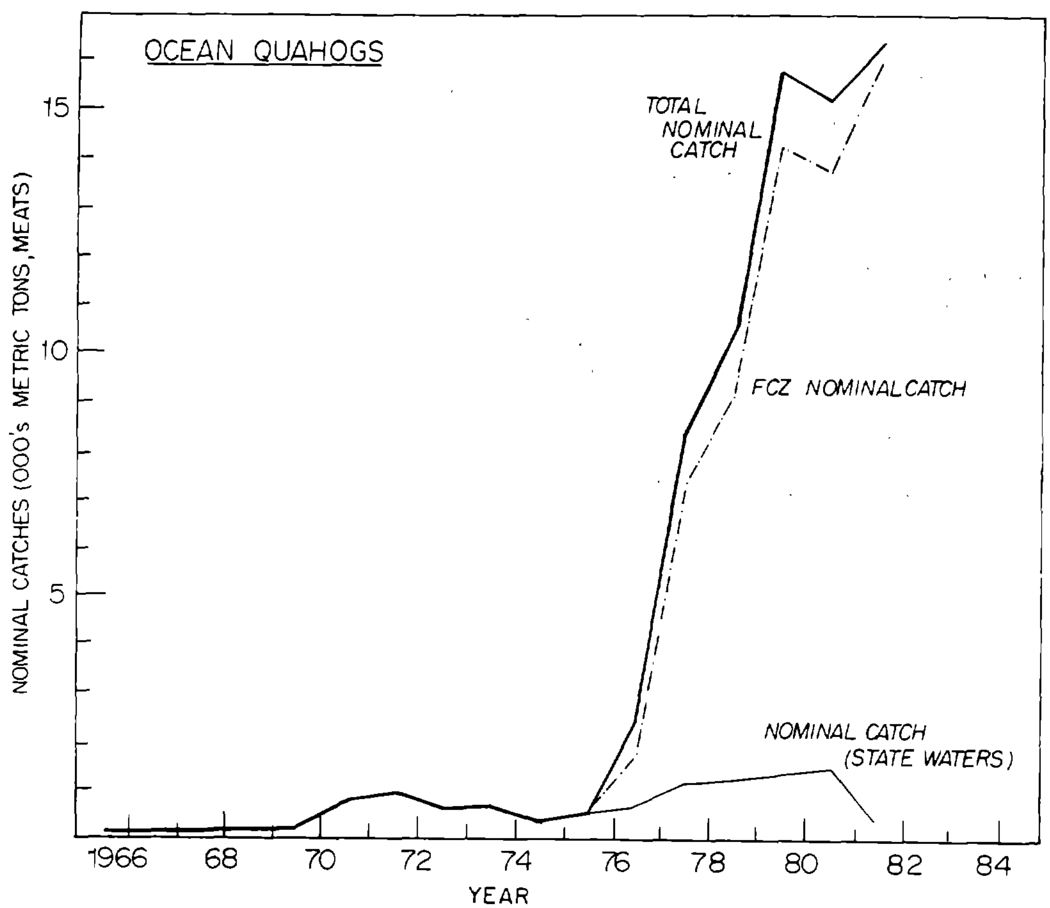


Figure 44. Total nominal catches (metric tons of shucked meats) of ocean quahogs from the Northeast Coast of the United States 1965-1982. Data are presented for state and FCZ waters separately.

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 (11 fms), but in more southerly and in offshore areas, scallops normally are found between 40 and 200 m depths (22-110 fms). Commercial concentrations generally exist between 40-100 m (22-55 fms) 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 3 1/2 years. Maximum size is about 23 cm (9.0 in) but scallops larger than 17 cm (6.7 in) 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

Estimated 1982 commercial Gulf of Maine landings (exclusively USA) were 475 tons, 830 tons less (-64%) than in 1981, and the lowest annual catch since 1979 (Table 44; Figure 42). Gulf of Maine landings accounted for 6% of the total 1982 USA sea scallop catch, about half of the proportional representation in the 1980 and 1981 landings (i.e., 13% and 11%, respectively). As in the two previous years, most of the 1982 catch (>50%) was derived from offshore waters in the Fishery Conservation Zone (FCZ). However, the 1982 FCZ landings were largely derived from beds much further northeastward (Jonesport, Machias, Grand Manan waters) than those exploited in 1980 (Jeffreys Basin, Cashes Ledge, Fippennies Ledge). Reliance of the Gulf of Maine fishery on offshore populations is a recent phenomenon. During 1970-1979, inshore territorial water landings accounted for 84% of the total Gulf of Maine nominal sea scallop catch.

Total effort in the Gulf of Maine fishery in 1981 declined slightly from the record 1980 level. Effort in 1982 was estimated to be less than in 1981, although most of this reduction was due to decreased vessel activity by larger vessels (>50 GRT).

During August 1982, NMFS conducted a sea scallop research vessel dredge survey in the Gulf of Maine to obtain biological data on growth and shell size-meat weight relationships of scallops, particularly those populations supporting the Jonesport FCZ fishery. Survey size frequency data indicated that the Jonesport beds are primarily comprised of scallops larger than 85 mm shell height (3.3 in); 94% of the 2,700 scallops obtained in the Jonesport sampling (42 tows) were >85 mm shell height. The average shell height of scallops in the Jonesport beds was 101 mm (4.0 in); average meat size was 11.3 grams, equivalent to a meat count of 40 per pound. Scallops as large as 137 mm shell height (5.5 in) and meats as great as 33.3 grams (14 count) occurred in the Jonesport samples. Most female scallops greater than 80 mm shell height (3.1 in) were sexually mature.

Apart from the Jonesport beds, most other Gulf of Maine areas sampled (56 stations) in the 1982 survey yielded few scallops with two exceptions: on Jeffreys Ledge, one tow caught 2,900 scallops (mean shell height = 64 mm; average meat count = 96) and on Fippenies Ledge, two tows caught a total of 1,700 scallops (mean shell height = 33 mm; average meat count = 368).

Sustained high yields from the offshore Gulf of Maine beds currently being fished appear improbable since exploitation has generated high fishing mortality rates effecting rapid declines in abundance. Unless additional high density beds of harvestable sized scallops are located, scallop landings from the Gulf of Maine fishery during 1983 and 1984 are not likely to exceed 300-500 tons annually.

Table 44. Nominal catches (thousand metric tons, meat weight) and management for sea scallops from the Gulf of Maine, Georges Bank, and the Mid-Atlantic areas.

	YEAR								
	1970-1974 average	1975	1976	1977	1978	1979	1980	1981	1982
US Recreational	-	-	-	-	-	-	-	-	-
Commercial									
Gulf of Maine (Area 5Y)									
US	0.3	0.7	0.4	0.3	0.2	0.4	1.6	1.3	0.5
Canada	-	-	-	-	-	-	<0.1	<0.1	-
Georges Bank (Area 5Z)									
US	1.1	0.9	1.8	4.8	5.6	6.7	5.8	8.5	6.2
Canada	4.5	7.5	9.8	13.1	12.2	9.2	5.2	8.0	4.3
Total	5.6	8.4	11.6	17.9	17.8	15.9	11.0	16.5	10.5
Mid-Atlantic (Area 6)									
US	1.1	2.8	6.6	5.9	8.6	7.2	5.1	1.9	1.3
Total nominal catch	7.0	11.9	18.6	24.1	26.6	23.5	17.7	19.7	12.3
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch
- Gulf of Maine = 250 mt (territorial waters)
- Georges Bank = 10,000 mt
- Mid-Atlantic = 3,000 mt

Importance of recreational fishery = Insignificant
Status of management = FMP in force since May 1982
Status of exploitation in 1981 = Fully exploited
Age at 50% maturity = 3-4 (GB and MA)
Size at 50% maturity = 60-90 mm shell height (GB and MA)
$M = 0.10$ $F_{0.1}$ =0.14(GM), 0.15(GB), 0.14(MA). F_{max} =0.22(GM), 0.26(GB), 0.25(MA). $F_{1981} = >>F_{max}$ in all areas.

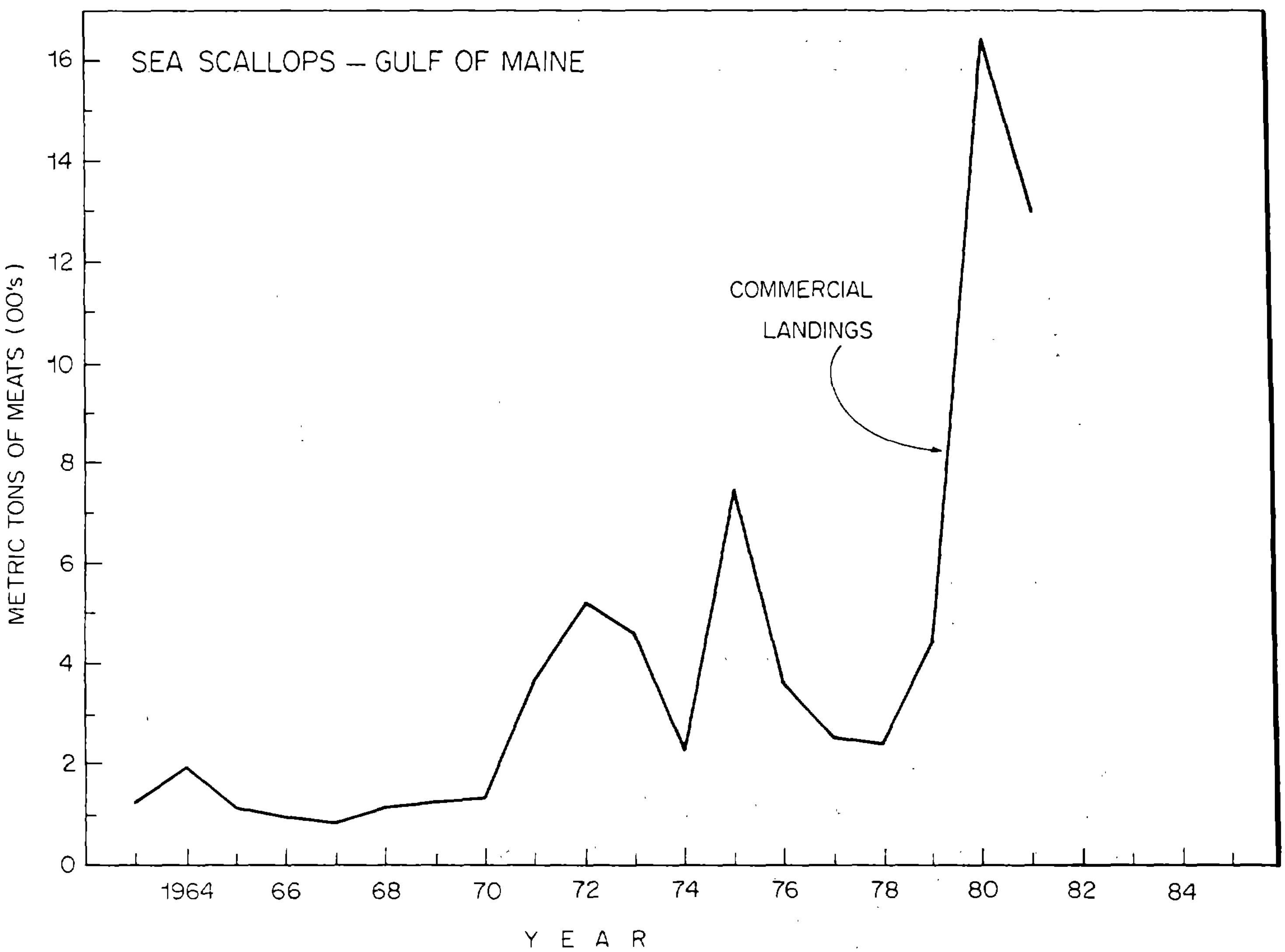


Figure 42. Nominal total commercial landings of sea scallops from the Gulf of Maine area.

Georges Bank

Total estimated international (USA and Canada) commercial landings in 1982 were 10,307 tons, a decrease of 6,127 tons (-37%) from 1981, and the lowest annual yield since 1976 (Table 44; Figure 43). The USA and Canada accounted for 58% (6,000 tons) and 42% (4,307 tons) of the 1982 catch, respectively. Both countries landed significantly less scallops in 1982 than in 1981 (USA: 6,000 vs. 8,421 tons; Canada: 4,307 vs. 8,013 tons). About 63% of the combined 1982 catch was derived from the Northern Edge and Peak region of Georges Bank. USA 1982 landings from this region were 2,107 tons, a 56% decline from 1981, and accounted for 36% of the USA Georges Bank catch. As in 1981, all of the 1982 Canadian Georges Bank landings were derived from the Northern Edge and Peak.

Shell height frequency distributions from 1982 USA commercial sea scallop samples indicated that the 1977 and 1978 year-classes were the most important in contributing to fishery yield. However, both cohorts have experienced a significant decline in abundance due to high exploitation rates. The mean size of scallops in the 1982 USA commercial samples from each principal fishing region on Georges Bank (South Channel, Southeast Part, Northern Edge and Peak) was larger than in 1981; concomitantly, average meat counts in the 1982 landings were lower than in 1981. The implementation of the USA Fishery Management Plan for Atlantic Sea Scallops on May 15, 1982, established a maximum average meat count of 40 meats per pound prompting an apparent increase in the cull size in the commercial fishery.

Total effort in the 1982 Georges Bank fishery declined from the record-high 1981 level. Preliminary analyses of commercial catch per unit of effort (CPUE) indicate a reduction in average vessel performance between 1981 and 1982. Due to declines in resource abundance, particularly in the Northern Edge and Peak region, the USA fleet shifted effort from the Northern Edge and Peak to the South Channel area during 1982.

Catch per tow indices in the 1982 USA Georges Bank sea scallop survey indicated marked declines in abundance and biomass from 1981 in both the Northern Edge and Peak and Southeast Part regions of the Bank. The 1982 survey values for each of these regions were the lowest obtained in the 1975-1982 time series and were about 50% lower than the previously lowest values observed. On the Northern Edge and Peak, both USA and Canadian 1982 survey size composition data indicated that the formerly abundant 1977 and 1978 year-classes have been greatly reduced. USA 1982 survey indices for the South Channel region were significantly higher than in 1981; the pre-recruit (< 70 mm shell height) and total number per tow values were the highest observed in the survey series. The survey data indicated that the 1979 year-class is outstanding in abundance in the South Channel and should provide exceptional recruitment to the fishery in this region in late 1983 and during 1984. To the extent, however, that scallops from this cohort are "mixed" together with larger-sized scallops in the spring and summer 1983 fishery landings, potential yield from this year-class will be diminished.

Given the current disparity in scallop abundance among the three principal fishery regions on Georges Bank, it is probable that the South Channel region will become increasingly more important to the USA fleet in the near future. On the Northern Edge and Peak, the absence of significant recruitment and reduced population abundance levels should result in much lower near-term yields from this region than those obtained during 1977-1981.

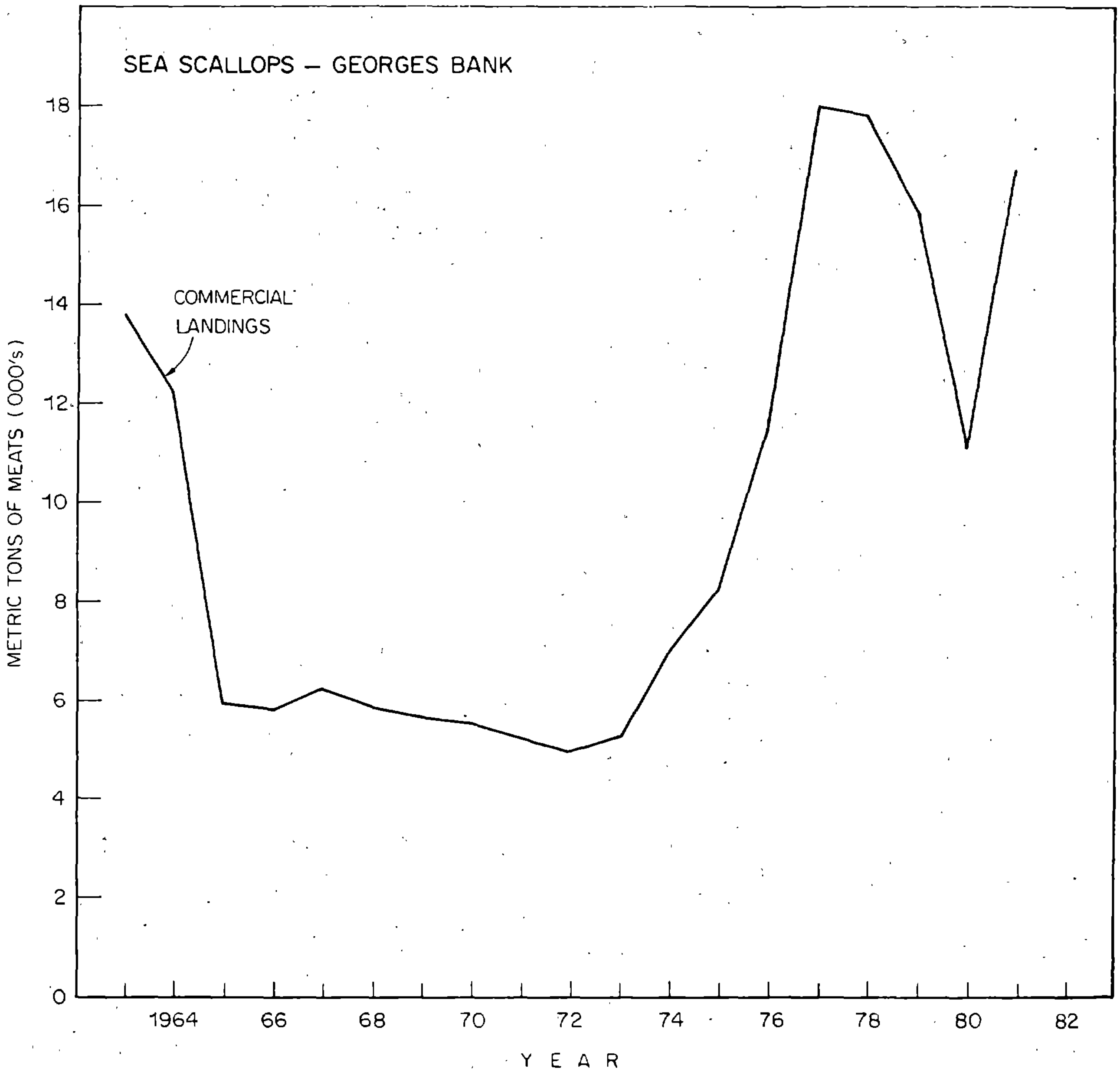


Figure 43. Nominal total commercial landings of sea scallops from the Georges Bank area.

Mid-Atlantic

Total estimated 1982 commercial landings (exclusively USA) were 1,325 tons, 565 tons less than in 1981, and the lowest annual catch since 1973 (Table 44; Figure 44). Since 1978 both commercial landings and commercial CPUE hve sequentially declined annually. In 1981, commercial CPUE was 20% lower than in 1980, 71% lower than the peak 1977 index and the lowest value in the 1965-1981 USA catch rate time series. CPUE in 1982 (data for full year not presently available) is expected to be as low or lower than the 1981 values.

In response to declines in catch and CPUE, effort in the Mid-Atlantic area successively declined in 1981 and 1982. Many Mid-Atlantic vessels have transferred fishing operations to the Georges Bank grounds or left the sea scallop fishery completely.

Commercial 1982 size frequency sampling data indicate a continued dependence in the fishery on larger-sized scallops (> 100 mm shell height). Since historically meat counts for the Mid-Atlantic area have rarely exceeded 40 count, the 1982 commercial size frequency data reflect the lack of significant recent recruitment in the fishery rather than implementation of the 40 meat count provision of the Fishery Management Plan.

USA research survey catch per tow indices in 1982 indicated that scallop abundance in all Mid-Atlantic regions (New York Bight, Delmarva, and Virginia-North Carolina) continues to remain relatively low with little improvement from 1981 conditions. No evidence of above average recruitment was observed in survey results from any region.

For further information see:

Serchuk, F.M., P.W. Wood, Jr., and R.S. Rak. 1982. Review and assessment of the Georges Bank, Mid-Atlantic and Gulf of Maine Atlantic sea scallop (Placopecten magellanicus) resources. Woods Hole Lab. Ref. 82-06, 132 p.

Serchuk, F.M., and Robert S. Rak. 1983. Status of the Georges Bank, Mid-Atlantic and Gulf of Maine Atlantic sea scallop resources - 1983. Woods Hole Lab. Ref. 83-05 (Summary Only), i-iv.

Serchuk, F.M., and Robert S. Rak. 1983. Biological characteristics of offshore Gulf of Maine sea scallop populations: size distributions, shell height-meat weight relationships and relative fecundity patterns. Woods Hole Lab. Ref. 83-07, 42 p.

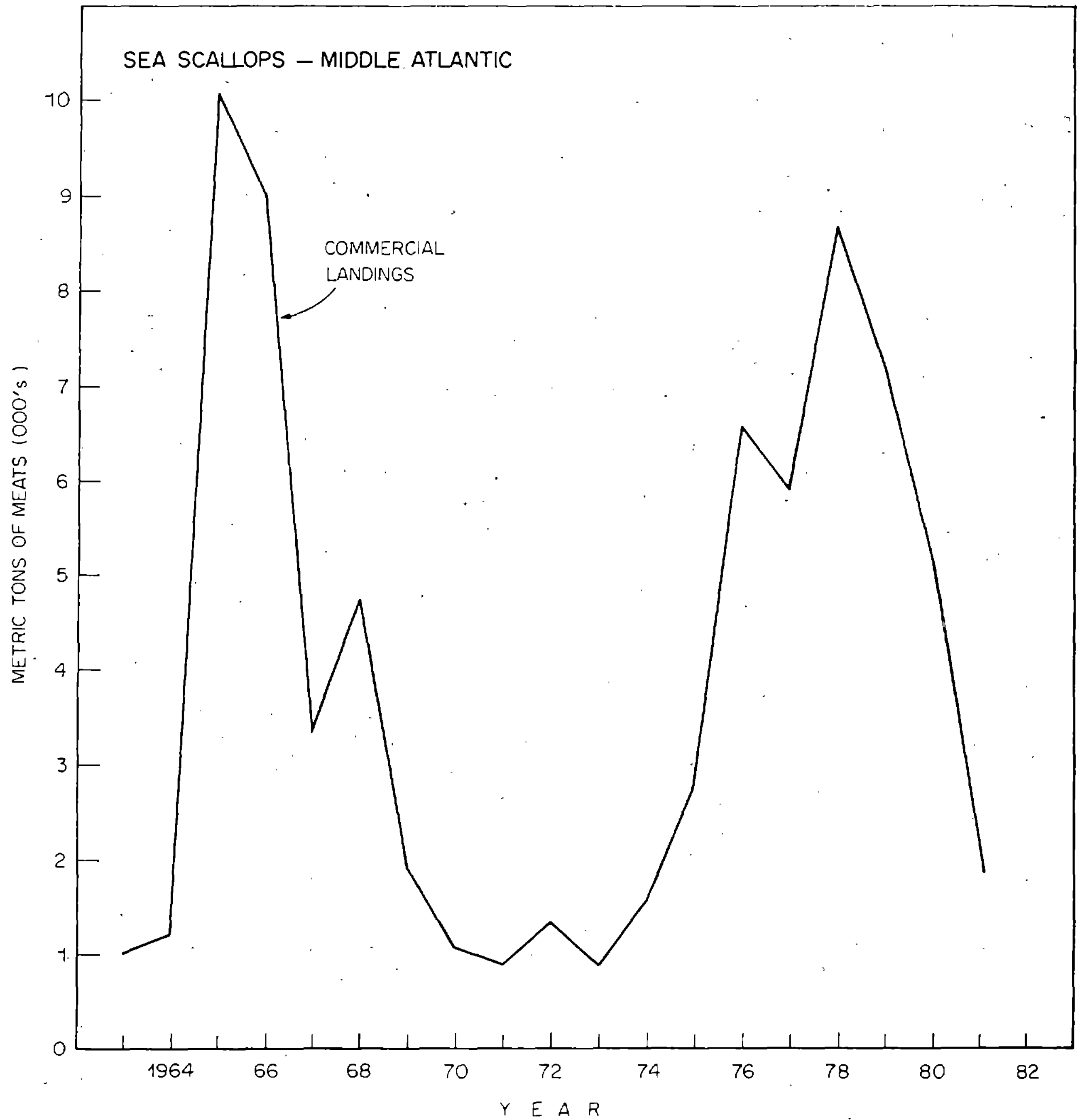


Figure 44. Nominal total commercial landings of sea scallops from the Mid-Atlantic area.