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Status of the Fishery Resources Off the Northeastern United States for 1983

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INTRODUCTION

The Resource 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 as needed to administrators, managers, the fishing industries, and the public. 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 1983. 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 distant-water fleets. 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 implementation of 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 fully replaced the fishing effort by the distant-water fleets, 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 (e.g., yellowtail flounder, butterfish), 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 and butterfish), there has been an acceptance of smaller fish in the market. The definitions of the market categories, in fact, have recently changed in many ports. Since our sampling of landings for length and age composition 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 lesser amounts of 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 fairly new, resulting from new management initiatives from the Councils and the accompanying need 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 other species (e.g., haddock, cod, mackerel, and herring) 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) 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).

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

d) Catch statistics alone.

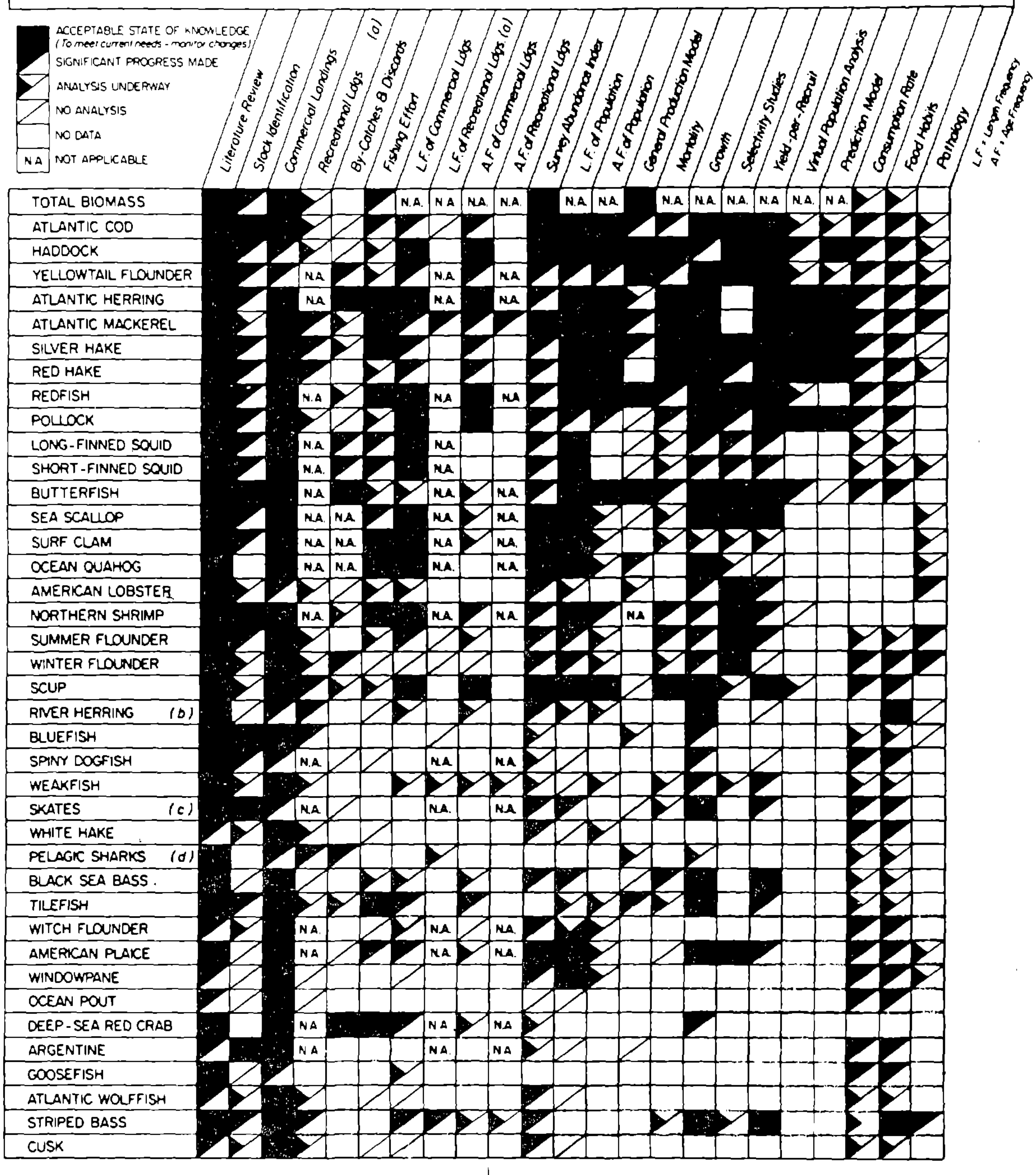
The status of the biological assessment knowledge required for fishery management at the Northeast Fisheries Center is given in Table 1. Although research on some of the species has been underway for years, many of the items within the table still are not known. As fisheries become more intense, more of the categories will need to be filled in order to evaluate the effects of fishing on the resource; 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 generally listed in Table 1 and in this report by single species, although the first assessment (total biomass) is an exception. Assessments are expressed by single species because many aspects such as biology, catch statistics, and population dynamics are best expressed in this way. Commercial catches for many of these species are taken, however, as part of a fishery for several species, and management, as well as assessments, has to take this into consideration.

Certain assessment terms used throughout this document may not be familiar to all. A brief explanation of some of these follows:

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

Table 1.

STATUS OF BIOLOGICAL ASSESSMENT KNOWLEDGE REQUIRED FOR FISHERY MANAGEMENT 1/1/83



(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

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.

TAC. Total Allowable Catch is the total regulated catch from a stock in a given time period, usually a year.

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

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 there is a need to follow the catches or abundance of this year class annually 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.

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). For example, if 720,000 fish were caught during the year from a population of 1 million fish present at the beginning of the year, the annual exploitation rate would be 0.72.

Instantaneous Total Mortality Rate (Z). This is the proportion of the population that dies in a very small time interval but which is usually expressed on an annual basis. Instantaneous rates seem to be confusing, but are used in assessments because they are mathematically easy to use (e.g., they can be added directly while percentages cannot be). If a year is divided into a large number (n) of equal time intervals, Z/n is the proportion of the population which dies during each time interval. If Z = 1.7 and a day represents the time interval, then approximately 1.7/365 or 0.466% of the population dies each day. The amount that dies each day differs because the population is declining, but the instantaneous rate is constant. Actually 0.465% of the population dies each day instead of 0.466% because a day only approximates an instantaneous time period. If hours were used, the approximation would be even closer. During the first day of the year, about 4,660 fish will die and 995,340 will survive out of a population of 1 million. The survival rate over the year is $e^{-1.7}$ (where e = 2.71828) or 0.1827. Multiplying 0.1827 by the number of fish alive at the beginning of the year (1 million) gives 182,684 fish that survive to the beginning of the next year. The proportion that actually dies during the year is, therefore, $1-e^{-1.7}$ or 0.8173. This is called the annual mortality rate (A) which, of course, can never exceed 1.0.

Instantaneous Fishing Mortality Rate (F). This is the instantaneous rate of death due to fishing, usually expressed over the entire year. If F = 1.5, then approximately 1.5/365 or 0.411% of the population dies each day from fishing. 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. The number that die from fishing 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 above, then this calculation is:

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

or (0.8824) (0.8173) (1,000,000)

or 721,186 fish that die from fishing.

Instantaneous Natural Mortality Rate (M). This is also an instantaneous rate expressed over the year and is equal to Z-F. All causes of death other than fishing are usually lumped under the category of "natural" for convenience 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 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 die from predation, etc. For example, if the fishery did not exist, 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.

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.

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.

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.

$F_{0.1}$. 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.

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 backwards year by year, one can be virtually certain that at least 100 fish were alive at the beginning of 1970. A virtual population analysis goes a step further and calculates the 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 was known in addition to the 10 fish caught per year in the fishery, then a virtual population analysis calculates the 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 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 (1979), and by calculating backwards year by year for the year class, a very precise estimate of the abundance can be determined by three or four years back in time (by 1976 or 1975). The accuracy depends on the rate of population decline and the correctness of the starting value of the fishing mortality rate (in the most recent year). This technique is used extensively in fishery assessments since the conditions for its use are so common: many fisheries are heavily exploited, the catches taken each year for a year class can be easily determined, and the natural mortality rate is known within a fairly small range and is low compared with the fishing mortality rate.

COMMERCIAL FISHERY TRENDS

Total Commercial Catch

The total international (USA and foreign) commercial nominal catch of all species off the northeastern United States (Gulf of Maine to Cape Hatteras, North Carolina) decreased slightly from 1982 to 1983. The total catch decreased from 1.39 million metric tons (mt) in 1982 to 1.33 million mt in 1983 (Table 2). The catch of finfish decreased less than 1%, whereas the invertebrate catch decreased 8%.

Groundfish

Total groundfish commercial catches decreased 4% from 1982 to 1983 (Table 2). Catches of the principal groundfish (cod, haddock, redfish, red hake, silver hake, and pollock) decreased 11% from 144,669 mt in 1982 to 128,047 mt in 1983. Decreases occurred in the catches of all the principal groundfish, but the bulk of the decrease was with cod and haddock.

Flounder catches increased 7,100 mt from 1982 to 1983 (10% increase). Yellowtail flounder catches increased 5,900 mt, explaining most of the increase. American plaice catches decreased about 2,000 mt from 1982 to 1983 (13% decrease).

Other groundfish catches decreased 14% from 27,611 mt in 1982 to 23,882 mt in 1983, due mainly to a decrease in the catch of scup.

Pelagics

Nominal catches of the principal pelagics, herring and mackerel, decreased 22% from 1982 (42,342 mt) to 1983 (32,998 mt) (Table 2). The USA herring catch decreased 28% from 32,329 mt in 1982 to 23,253 mt in 1983. The USA mackerel catch increased 13% from 1982 (3,368 mt) to 1983 (3,805 mt), whereas the distant-water-fleet catch decreased 11% from 6,644 mt to 5,940 mt.

Catches of other pelagic species increased 6%, largely due to a 7% increase in the menhaden catch (324,582 mt vs 348,186 mt). The butterfish catch, primarily by the USA, decreased 43% from 9,536 mt to 5,476 mt.

Other Finfish

The total international catch of other finfish decreased 5% from 1982 (35,184 mt) to 1983 (33,425 mt) (Table 2).

Invertebrates

The total USA and foreign catch of invertebrates decreased 8% from 722,708 mt in 1982 to 664,122 mt in 1983 (Table 2). Foreign catches decreased 41% (26,400 mt). Canadian sea scallop catches decreased 33% from 35,938 mt in 1982 to 24,028 mt in 1983. Foreign catches of long-finned squid (*Loligo*) decreased 25% from 1982 to 1983, whereas foreign catches of short-finned squid (*Illex*) decreased 86%. USA catches of *Illex* and *Loligo* increased 82% and 193%, respectively. Most of the overall decrease in the total invertebrate catch was accounted for by decreases in sea scallops and inshore species such as oysters and hard clams.

Table 2. USA commercial and foreign nominal catches (mt) from the marine finfish and invertebrate resources off the northeastern United States (Gulf of Maine - Mid-Atlantic) in 1982 and 1983. All catches are expressed as live weight.

Species	Foreign 1982	Foreign 1983	USA Commercial 1982	USA Commercial 1983	Total 1982	Total 1983
Principal Groundfish	31,973	25,359	112,696	102,688	144,669	128,047
Atlantic cod	19,231	14,923	52,918	50,737	72,149	65,660
Haddock	6,209	5,215	18,280	14,292	24,489	19,507
Redfish	168	113	6,735	5,215	6,103	5,328
Silver hake	957	618	16,831	16,840	17,788	17,458
Red hake	34	107	3,840	2,159	3,874	2,266
Pollock	5,374	4,383	14,092	13,445	19,466	17,828
Flounders	325	550	73,985	80,862	74,310	81,412
American plaice	27	37	15,125	13,159	15,152	13,196
Witch flounder	9	45	4,886	5,850	4,895	5,895
Yellowtail flounder	18	46	27,170	33,066	27,188	33,112
Greenland halibut	-	-	-	-	-	-
Atlantic halibut	116	131	85	71	201	202
Winter flounder	19	19	15,353	15,467	15,372	15,486
Summer flounder	5	-	10,146	11,780	10,151	11,780
Windowpane flounder	-	-	1,099	1,252	1,099	1,252
Flounders (not specified)	131	272	121	217	252	489
Other Groundfish	3,822	1,805	23,789	22,077	27,611	23,882
Cusk	1,162	601	1,825	1,836	2,987	2,437
Scup	-	-	9,759	7,815	9,759	7,815
White hake	766	810	5,989	6,168	6,755	6,979
Atlantic wolffish	189	95	885	1,184	1,074	1,279
Groundfish (not specified)	1,705	299	5,331	5,073	7,036	5,372
Principal Pelagics	6,645	5,940	35,697	27,058	42,342	32,998
Atlantic herring	1	-	32,329	23,253	32,330	23,253
Atlantic mackerel	6,644	5,940	3,368	3,805	10,012	9,745
Other Pelagics	455	561	342,612	362,323	343,067	362,884
Bluefish	4	-	5,706	5,037	5,710	5,037
Atlantic butterfish	450	561	9,086	4,915	9,536	5,476
Atlantic menhaden	-	-	324,587	348,186	324,582	348,186
Pelagics (not specified)	1	-	3,238	4,185	3,239	4,185
Other Finfish	978	763	34,206	32,662	35,184	33,425
River herring	-	6	5,796	4,141	5,798	4,147
Spiny dogfish	103	8	6,381	4,848	6,484	4,856
Skates	-	-	594	3,557	593	3,557
Finfish (not specified)	875	749	21,434	20,116	22,309	20,865
Invertebrates	64,340	37,928	658,368	626,194	722,708	664,122
Short-finned squid (Illex)	12,350	1,776	5,438	9,902	17,788	11,678
Long-finned squid (Loligo)	15,800	11,795	5,464	15,987	21,264	27,782
American lobster	252	329	19,545	20,027	19,797	20,356
Northern shrimp	-	-	2,064	1,574	2,064	1,574
Crab (not specified)	-	-	2,246	3,253	2,246	3,253
Surf clams	-	-	132,037	133,851	132,037	133,851
Ocean quahogs	-	-	135,947	133,654	135,947	133,654
Sea scallops	35,938	24,028	78,506	72,526	114,444	96,554
Invertebrates (not specified)	-	-	277,121	235,420	277,121	235,420
Grand Total	108,538	72,906	1,281,353	1,253,864	1,389,891	1,326,770

RECREATIONAL FISHERY TRENDS

The recreational landings of many species of fish and shell-fish 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, 7 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 12 months) 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 2 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: a household survey and a 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. The recreational fisheries of the Atlantic coast have been surveyed annually since 1979 by the new NMFS survey. Unfortunately, problems with data reduction and analysis have resulted in lengthy delays in making this information available to the public as well as to NEFC assessment scientists. Preliminary results from 1979-1980 have been incorporated into some of the species-stocks assessments summarized in this report. It is expected that results from succeeding surveys will be available for use in the near future. Since the new methodology represents a radical change from previous methodologies, data from the 1979-present 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.

AN ECONOMIC OVERVIEW OF FISHERIES IN THE NORTHEAST REGION

Aggregate Overview

The New England harvesting sector, once the mainstay for many coastal communities, has experienced several changes which have affected the industry since the mid-1960's. These changes include fluctuating fish stocks, heavy foreign fishing during the 1960's, highly competitive imports, and increased costs of operations (e.g., fuel, insurance, interest, food, and repairs). There has been an increase in the number of vessels[1] and fishermen without a commensurate increase in landings or value (Table 3) The fleet expanded from 594 vessels in 1965 to 1,344 vessels in 1981, a 126% increase. The number of fishermen increased from 3,404 to 6,798 individuals (100% increase) during the same period. Landings totalled 297,000 mt in 1965 and 298,000 mt in 1981. Total landed value increased from \$45.9 million to \$229.5 million. However, the value adjusted for inflation increased only 89% between 1965 and 1981. Average landings per vessel decreased by about 56% and average value per vessel (adjusted for inflation) fell by 16%.

The effects of these events have been partially concealed by the constant increases in ex-vessel prices which have generally increased at a higher rate than has inflation. Ex-vessel prices (unadjusted for inflation) for all fish increased by nearly 400% between 1965 and 1981; the general price level for all goods and services in the economy increased by only 200%. Groundfish prices increased by 400%, and sea scallop prices increased nearly 500%. The general price level for other species increased by about 200%.

Changes in landings, value, and prices are only partially indicative of fleet and fishery performance. The most important indicator is the profitability of operations which indicates whether or not firms will remain in business or make some alternative arrangements such as changing fisheries or borrowing money. Information on profitability or well-being of fishing firms is also useful for indicating possible reasons for increases or decreases in the financial status of vessels. A general overview is given of the economic performance of several major Northwest Atlantic fisheries with emphasis as to whether or not the economic performance has improved during the 1965-1982 period.

New England Otter Trawl Fishery

Major species harvested in the New England otter trawl fishery include cod, haddock, yellowtail flounder, and other flounders. In recent years, there has been a major shift away from haddock to cod. Other flounders have

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[1] Reported changes in landings, vessels, and employment are based only on vessels $\geq$5 gross registered tons landing in Maine, Massachusetts, and Rhode Island. Discussions with respect to a given gear-type relate vessel performance only to the associated gear in use. Gear switching by any group of vessels was not considered in evaluating the economic performance.

Table 3. Landings, value, vessels, and employment associated with vessels >5 gross registered tons landing in Maine, Massachusetts, and Rhode Island.

	All gears				Otter trawl		Scallop dredge		Other	
Year	Landings (000's mt)	Value (000's $)	No. of vessels	No. of fishermen	Landings (000's mt)	Value (000's $)	Landings (000's mt)	Value (000's $)	Landings (000's mt)	Valu (000's
1965	297	45,930	594	3,404	243	36,560	46	8,230	8	1,140
1966	284	47,047	619	3,435	231	38,513	41	5,397	12	3,137
1967	245	39,914	628	3,398	209	33,685	26	5,297	10	932
1968	246	43,371	610	3,231	203	33,724	29	8,642	14	1,005
1969	212	44,389	604	3,047	186	37,591	19	5,436	7	1,362
1970	202	48,799	608	2,911	172	41,448	16	5,757	14	1,594
1971	192	46,344	620	2,959	155	38,417	15	5,788	22	2,139
1972	175	55,285	655	3,161	135	42,112	13	6,857	27	6,316
1973	192	59,266	666	3,096	134	46,117	12	5,549	46	7,600
1974	191	64,755	695	3,157	123	48,308	16	6,423	52	10,024
1975	185	81,928	737	3,363	115	57,275	20	10,114	50	14,539
1976	211	98,423	783	3,581	118	64,694	39	19,209	54	14,520
1977	241	116,454	836	3,878	135	74,931	59	25,781	47	15,742
1978	278	156,630	907	4,160	145	92,584	60	40,587	73	23,459
1979	284	186,270	1,145	5,453	153	106,930	57	51,513	74	27,827
1980	317	203,839	1,308	6,498	166	115,933	58	59,036	93	28,870
1981	298	229,493	1,344	6,798	161	128,956	67	71,024	70	29,513

become increasingly important in terms of both landings and value. Landings of yellowtail flounder declined by nearly 60% from 1965 to 1981, but value increased by 146%. Cod, haddock, yellowtail flounder, and other flounders accounted for nearly 72% of the total landed value by otter trawls in 1965 compared to 78% in 1981. Total landed value per vessel (adjusted for inflation) declined by nearly 25% between 1965 and 1981, while corresponding average landings per vessel declined 63%.

Nominal prices of the major groundfish species have all increased. Yellowtail flounder displayed the largest increase from $0.09/lb in 1965 to $0.56/lb in 1981. The price of cod increased from $0.08/lb to $0.34/lb, haddock prices went from $0.10/lb to $0.41/lb, and other flounder prices increased from $0.11/lb in 1965 to $0.41/lb in 1981. Corresponding species landings (thousand mt) by trawl vessels were as follows: cod - 13.6(1965) vs 33.3(1981), haddock - 59.0(1965) vs 23.7(1981), yellowtail - 34.7(1965) vs 13.9(1981), and other flounders - 15.6(1965) vs 34.7(1981).

In spite of several unfavorable events, the otter trawl fleet has managed to maintain the same economic performance in 1982 which it had in 1965 (Table 4). Significant declines in landings of major groundfish and major increases in vessel operational costs have been partially offset by high ex-vessel prices. However, increasing levels of imports from Canada have been instrumental in preventing the industry from realizing any major gains in their economic status. The 500% increase in the value of landings since 1965 has kept pace with the cost per unit of landings.

The period of most profitable performance occurred during the first two years after the implementation of the MFCMA. By 1979, the heavy influx of additional vessels to this fleet and the resulting increase in fishing effort without a parallel increase in landings produced a reversal in the performance of the fleet. Increases in fuel and other costs induced a drop of 15% in the

Table 4. Indices of cost, price, effort, and health for the New England otter trawl fishery.

Year	Number of vessels[1]	Output cost index (cost/unit of landings)	Input price index	Average ex-vessel price index	Effort index (vessel days absent)	Health index (price/cost)
1965	512	100.00	100.00	100.00	100.00	1.00
1966	545	106.56	104.20	110.82	97.22	1.04
1967	559	119.93	105.90	107.13	97.40	0.89
1968	538	118.52	109.50	110.42	90.42	0.93
1969	550	134.13	115.60	134.33	88.81	1.00
1970	562	159.11	119.40	160.17	94.33	1.01
1971	566	167.07	118.80	164.74	89.70	0.99
1972	565	196.72	121.40	207.34	90.02	1.05
1973	553	210.39	135.20	228.75	85.81	1.09
1974	575	291.47	166.60	261.05	88.56	0.90
1975	587	355.96	177.20	331.04	95.07	0.93
1976	590	347.71	184.80	364.41	91.37	1.05
1977	594	313.61	196.00	368.92	88.89	1.18
1978	643	345.75	214.30	424.40	96.27	1.23
1979	768	425.31	246.10	464.53	108.81	1.09
1980	896	500.39	287.60	464.20	118.86	0.93
1981	914	551.57	321.90	532.38	113.53	0.97
1982	975	596.67	319.80	594.81	129.76	1.00

[1] Excludes vessels <5 gross registered tons.

economic performance between 1979 and 1980[2]. The economic performance of the fleet in 1982 was similar to the 1965 level.

New England Sea Scallop Dredge Fishery

The sea scallop fishery displayed a somewhat different trend than the trawl fishery between 1965 and 1981. Total sea scallop landings (live weight) increased from 46,000 mt in 1965 to 67,000 mt in 1981. Total value increased from $8.2 million to $71.0 million, a 766% increase. The corresponding price per pound (meat weight) increased nearly 500% from approximately $0.68/lb in 1965 to $4.01/lb in 1981. The number of vessels using a scallop dredge increased substantially from 60 in 1965 to 293 in 1981. However, average landed value per vessel (adjusted for inflation) declined by 32%, while landings per vessel declined by 70%.

Although landings by the sea scallop dredge fleet fluctuated substantially between 1965 and 1982 (Table 5), the fleet managed to do better economically in 12 of 18 years (1968 and 1971-1981) than it did in 1965. Total landings of sea scallops decreased from 46,000 mt in 1965 to a low of 12,000 mt in 1973 and then increased to 67,000 mt in 1981.

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[2] Economic performance is measured by a health index which is a ratio of the average ex-vessel price index and the output cost index in a given year compared to a base year.

Table 5. Indices of cost, price, effort, and health for the New England sea scallop dredge fishery.

Year	Output cost index (cost/unit of landings)	Input price index	Average ex-vessel price index	Effort index (vessel days absent)	Health index (price/cost)
1965	100.00	100.00	100.00	100.00	1.00
1966	100.03	104.20	72.74	86.59	0.73
1967	135.03	105.90	114.12	71.95	0.85
1968	157.41	109.50	165.14	91.46	1.05
1969	219.10	115.60	163.07	76.83	0.74
1970	208.80	119.40	200.77	60.98	0.96
1971	206.63	118.80	218.21	56.10	1.06
1972	247.49	121.40	296.59	57.32	1.20
1973	243.64	135.20	262.39	46.34	1.08
1974	209.21	166.60	229.73	42.68	1.10
1975	201.32	177.20	279.37	50.00	1.39
1976	170.20	184.80	275.53	78.05	1.62
1977	173.24	196.00	244.23	113.41	1.41
1978	197.61	214.30	376.81	120.73	1.91
1979	313.61	246.10	503.38	158.54	1.61
1980	503.29	287.60	565.99	221.95	1.12
1981	528.11	321.90	589.72	240.24	1.12
1982	626.57	319.80	611.24	217.07	0.98

Peak economic performance occurred in 1978 when the health index was about 90% above the 1965 level and effort was about 21% higher than in 1965.

Many vessels entered the sea scallop fishery in the late 1970's and early 1980's because of the healthy economic performance. In 1981, effort by the sea scallop dredge fleet was twice as high as in 1978, but the economic performance was 41% below the 1978 high. By 1982, the overall financial status of this fleet had declined 2% below the 1965 base year and 49% below the 1978 high. The recent decline in economic performance by this fishery was due to a substantial drop in landings and an increase in input cost whose combined effect was not matched by an increase in revenue.

Maine Lobster Fishery

The Maine lobster fishery has not done well financially over the 1965-1982 period. Only in four years (1972-1974 and 1976) was the economic performance of this fishery above the 1965 level (Table 6). During two of these four years, effort, as measured by the number of trap hauls, was about 10% below the base year. Fishing effort in 1982 was 16% above the base year, but the index of economic performance was 10% below the 1965 level even though landings were 20% above the 1965 level. A major factor for the decline in economic performance was the increased cost of production.

The deflated value per unit of landings was about the same in 1982 as in 1965. Cost increases on input prices, even after adjusting for inflation, were proportionally higher than revenues, which was due, in part, to the fact that increased imports from Canada had a depressing impact on the price level received by USA lobstermen. Imports of fresh and frozen lobsters from Canada during 1976-1982 were equivalent to 55-79% of the Maine landings.

Table 6. Indices of cost, price, effort, and health for the Maine lobster fishery.[1]

Year	Output cost index (cost/unit of landings)	Input price index	Average ex-vessel price index	Effort index (vessel days absent)	Health index (price/cost)
1965	100.00	100.00	100.00	100.00	1.00
1966	99.63	104.20	99.56	100.95	1.00
1967	111.96	105.90	107.76	92.43	0.96
1968	117.71	109.50	95.79	116.84	0.81
1969	122.22	115.60	107.76	111.18	0.88
1970	130.52	119.40	123.73	105.32	0.95
1971	141.89	118.80	130.38	111.18	0.92
1972	126.28	121.40	137.03	89.66	1.09
1973	161.47	135.20	170.29	108.21	1.05
1974	176.14	166.60	183.59	92.26	1.04
1975	228.57	177.20	214.58	116.38	0.94
1976	192.23	184.80	195.65	104.79	1.02
1977	238.50	196.00	207.87	119.27	0.87
1978	238.30	214.30	233.41	112.79	0.98
1979	256.00	246.10	246.37	122.07	0.96
1980	285.35	287.60	229.38	115.63	0.80
1981	296.57	321.90	260.85	110.55	0.88
1982	311.47	319.80	279.68	116.19	0.90

[1] Data from Maine Dept. of Marine Resources, Lobster Research Program, Lobster Informational Leaflet #12, July 1983.

Mid-Atlantic Surf Clam Fishery

The economic performance of the Mid-Atlantic surf clam fishery in 1982 was 17% below the base year of 1965 (Table 7), but was 48% above the low level experienced in 1980. The economic status in 1980 was 44% below the 1965 level. Significant fluctuation in availability of harvestable surf clams without corresponding changes in fishing effort was primarily responsible for the rather poor economic performance of the fishery in recent years.

During 1965-1981, landings of surf clams increased from 20,000 mt (live weight) in 1965 to 436,000 mt in 1974 and then collapsed to a low of 15,800 mt in 1979 before recovering somewhat to 22,500 mt in 1982.

The most significant element contributing to the recent decline in economic performance by this fishery was the rapid introduction of additional effort in the fishery. The weighted effort index increased from 301 in 1976 to 513 in 1977 without any significant increase in landings or values. This situation produced a 350% increase in the cost per unit of landings and only a 60% increase in revenues (as reflected by the average ex-vessel price index). It is unclear to what extent the recent growth in imports of fresh and frozen clams has contributed to moderating prices received by surf clam fishermen. Imports of fresh and frozen clams (mainly from Canada) increased over 340% from 967 mt (meat weight) in 1976 to 4,280 mt in 1982. Imports of fresh and frozen clams in 1976 were equivalent to less than 5% of the total surf clam landings, whereas in 1982, these imports represented 20% of the landings.

Table 7. Indices of cost, prices, effort, and health for the Mid-Atlantic surf clam fishery.

Year	Output cost index (cost/unit of landings)	Input price index	Average ex-vessel price index	Effort index (vessel days absent)	Health index (price/cost)
1965	100.00	100.00	100.00	100.00	1.00
1966	125.54	104.20	119.16	123.08	0.95
1967	170.81	105.90	134.43	165.93	0.79
1968	168.46	109.50	141.59	140.66	0.84
1969	150.13	115.60	165.34	146.15	1.10
1970	151.14	119.40	157.64	193.41	1.04
1971	198.00	118.80	180.74	197.80	0.91
1972	161.87	121.40	171.68	191.21	1.06
1973	140.83	135.20	165.54	194.51	1.18
1974	154.26	166.60	174.91	201.10	1.13
1975	182.68	177.20	199.77	205.49	1.09
1976	499.46	184.80	653.69	301.10	1.31
1977	852.17	196.00	713.04	513.19	0.84
1978	1,096.47	186.40	734.43	520.88	0.67
1979	1,280.00	192.00	761.77	540.66	0.60
1980	1,236.50	247.30	697.89	438.46	0.56
1981	858.33	206.00	702.20	425.27	0.82
1982	873.46	227.10	720.63	442.86	0.83

Other Fisheries

The remaining fisheries have experienced increases in both landings and value[3]. Landings increased from 8,000 mt in 1965 to 93,000 mt in 1980, but dropped to 70,000 mt in 1981 (Table 3). Total value increased from $1.1 million in 1965 to $29.5 million in 1981. Average price rose from $0.06/lb in 1965 to $0.19/lb in 1981. The number of vessels increased from 65 in 1965 to 360 in 1981. Average landings per vessel increased by nearly 55% over the period, and average revenue per vessel (adjusted for inflation) increased by approximately 67%.

For further information see:

Kirkley, J.E. 1981. The Northwest Atlantic commercial fisheries of the United States: a description and characterization. NMFS, NEFC, unpublished rept., 276 p.

Norton, V.J., M.M. Miller, and E. Kenney. 1984. Indexing the economic health of the U.S. fishing industry's harvesting sector. 8th Ann. Seminar, Center for Oceans Law and Policy, Univ. Virginia, Cancun, Mexico, Jan. 1984, 57 p.

[3] Other fisheries refers to those using vessels >5 gross registered tons, which excludes several fisheries such as the important small boat lobster fishery. Consequently, the description of trends for other fisheries grossly understates the importance of this category.

SUMMARY STATUS OF THE FISHERY RESOURCES

Groundfish

Atlantic cod. Nominal catches in the Gulf of Maine in 1983 were the highest ever at 16,700 mt. Stock abundance appears to be at a fairly high level due to above-average recruitment in recent years, although a slight decline occurred from 1982 to 1983. Catches of about 10,000-12,000 mt can probably be sustained in the near future. Fishing mortality has increased recently to above F_{max}, and potential yields would be enhanced by a reduction in fishing mortality. The catch from Georges Bank and South was 49,000 mt in 1983, 15% less than in 1982, but the third highest ever. High catches in recent years have been sustained by above-average year classes in most years since 1975. Catches of about 40,000 mt should be sustainable in 1984 and 1985. However, fishing effort has increased sharply and fishing mortality is well above F_{max}; if these increases continue, potential long-term yield will be reduced.

Haddock. Nominal catches (commercial and recreational) in the Gulf of Maine were higher than ever during 1980-1983 at an average of 7,300 mt per year. The 1979, 1980, and 1982 year classes appear to be moderate in strength, but total stock size declined 65% from 1979 to 1983. Fishing mortality has increased recently to above F_{max}. Catch and stock size should remain somewhat stable for the next year or two, but could decline if fishing mortality stays high or recruitment is poor. The Georges Bank catch in 1983 was 11,900 mt, a 35% drop from 1982 and a 57% drop from the recent peak in 1980. The fishery since 1977 has been supported primarily by the 1975 and 1978 year classes; all other year classes have been poor Stock biomass dropped 75% from 1980 to 1983. Fishing mortality is currently near F_{max}. Stock biomass will continue to decline given anticipated levels of fishing mortality and will remain at low levels until recruitment improves.

Redfish. The nominal catch of 5,200 mt in 1983 was the lowest since the fishery began in the early 1930's. Stock biomass declined 75% from 1969 to 1984. The fishery and stock are supported primarily by the 1971 year class. Except for moderate 1978 and 1979 year classes, recruitment prospects are poor. Current fishing mortality is above F_{max}. Stock biomass and catches will continue to decline.

Silver hake. Nominal commercial catches of silver hake in the Gulf of Maine - Mid-Atlantic area totalled about 17,400 mt in 1983: 11,400 mt in the southern New England - Mid-Atlantic area, 1,200 mt on Georges Bank, and 4,800 mt in the Gulf of Maine. Catches in 1983 in the Gulf were the highest since 1978, but were the lowest ever on Georges Bank and the lowest since 1961 in the southern New England - Mid-Atlantic area. Overall stock biomass of ages 2 and older in 1983 was an estimated 120,000 mt, well below the peak of 1.1 million mt in 1964. Biomass in the Gulf of Maine has been slowly increasing in recent years and is presently the highest since the late 1960's, but has been decreasing and is currently at record low levels in the other two areas. The 1982 year class appears to be strong in most areas. Current fishing mortality is well below $F_{0.1}$ in all areas. There is potential for increased catches in all areas.

Red hake. Nominal commercial catches of red hake in 1983 were only 113 mt on Georges Bank (a record low) and 1,332 mt in the southern New England - Mid-Atlantic area (second lowest ever). Stock biomass in both areas has been increasing steadily since a low in 1977 to a total of about 105,000 mt in 1983 (ages 2 and older). Increases in stock biomass have resulted primarily from very low catches as recruitment has been about average. Current fishing mortality is well below $F_{0.1}$. There is potential for increased catches in all areas.

Pollock. Nominal catches of pollock were 51,000 mt in 1983, down from a peak of 61,200 mt in 1981. Catches have increased to average 53,300 mt per year during 1978-1983. Stock biomass increased 83% from 1974 to 1981 and declined slightly to 296,000 mt (ages 2 and older) in 1983. Current fishing mortality is at $F_{0.1}$ and recent levels of catch are near the long-term level corresponding to $F_{0.1}$.

Yellowtail flounder. Nominal catches increased sharply in 1982-1983 to an overall total of about 33,100 mt in 1983, the highest level since 1972. The increase, largely in southern New England, was due mainly to increased abundance and the removal of catch quotas under the Interim Management Plan. Stock biomass in both the Georges Bank and southern New England areas increased from lows in the mid-1970's to higher levels in 1980-1982, but has since decreased. The 1979 and 1980 year classes were much stronger than preceding ones, but succeeding year classes appear to be relatively weak. Increased abundance in 1982-1983 was accompanied by relatively high discard rates on young fish in the southern New England area. Fishing mortality is currently above F_{max} in both areas. Stock biomass should continue to decline in both areas if fishing mortality remains high.

Summer flounder. Nominal commercial catches were 11,800 mt in 1983, 16% above the 1982 level but below the 1979 peak of 14,500 mt. Recreational catches are as great or greater than commercial catches. Stock biomass has been at a much higher level in the last 8-10 years than during the late 1960's - early 1970's, but appears to have undergone considerable fluctuations in the last 5 years. The current level of fishing mortality is probably in excess of F_{max}.

American plaice. Nominal catches in 1983 were 13,200 mt, 13% less than the record 1982 catch, but still the third highest ever. Current catch levels are fourfold higher than the 1960-1978 average. Stock biomass increased sharply from the mid-1970's until 1980 and, although it has subsequently declined, still remains at a relatively high level. The 1980 and 1981 year classes are among the strongest produced in recent years. Current catch levels should be sustainable for the next several years.

Witch flounder. Nominal catches increased from 1,850 mt in 1976 to 5,850 mt in 1983, the second highest ever. Concurrent with the increase in catches has been a decreasing trend in stock biomass. The fishery is probably fully exploited at the present time and current catch levels are likely not sustainable in view of the declining trend in stock biomass.

Winter flounder. The nominal commercial catch in 1983 was 15,500 mt, about the same as in 1982 and 13% below the peak in 1981. Recreational catches are at about the same level as commercial catches. Overall stock biomass has exhibited no major trend during 1976-1983, although it appears to have declined somewhat in 1982-1983 relative to the 1980-1981 level.

Scup. Nominal catches (commercial and recreational) were 11,300 mt in 1983, about the same as the 1974-1982 mean but down from the recent high of 13,800 mt in 1981. Stock biomass in the southern New England - Mid-Atlantic area decreased significantly from a fairly high level in 1981 to a relatively low level in 1982-1983. Fishing mortality is currently between $F_{0.1}$ and F_{max}. The stock, particularly in the Mid-Atlantic area, appears to be fully exploited.

White hake. Nominal catches have undergone an increasing trend since 1968, reaching a peak of 7,000 mt in 1983. Stock biomass has exhibited no major trend since 1969, and there is no evidence that the stock has been adversely affected by recent levels of catch.

Cusk. Nominal catches increased steadily from 1,400 mt in 1977 to a peak of 3,900 mt in 1981 and then dropped to 2,400 mt in 1983. Stock biomass appears to have followed the same pattern as catches.

Atlantic wolffish. Nominal catches increased steadily from 170 mt in 1970 to a peak of nearly 1,300 mt in 1983. Stock biomass has exhibited a declining trend throughout this period.

Tilefish. Nominal catches, after rising dramatically from 300-400 mt per year in 1967-1971 to a peak of 3,900 mt in 1979, dropped sharply to 1,800 mt in 1983. Fishing effort (primarily by longlines) increased substantially during the 1970's and remained at a relatively high constant level during 1979-1983. CPUE decreased about 80% from 1973 to 1983. Fishing mortality is currently estimated to be about twice F_{max}. Stock biomass has apparently undergone a substantial decrease in response to excessive fishing mortality exerted since the late 1970's.

Pelagics

Atlantic herring. Coastal Maine nominal catches (juveniles) dropped from about 48,200 mt in 1981 (the highest since 1963) to 18,200 mt in 1983 due to reduced availability of fish to the fixed gear fisheries and to decreased abundance. Western Gulf of Maine (Jeffreys Ledge) catches (adults) were about 4,300 mt in 1983, a 44% drop from 1982. Reduced market demand appears to have seriously influenced the 1983 catch. Stock biomass (ages 2 and older) in the Gulf of Maine declined 37% from 1979 to 1982 to 134,000 mt, the lowest stock level yet observed. The Georges Bank stock, as large as 1.2 million mt in 1967 (spawning stock of ages 4 and older), collapsed in 1977 and has not supported a fishery since.

Atlantic mackerel. Nominal catches (commercial and recreational) from Labrador to North Carolina were relatively stable during 1978-1983, averaging about 32,100 mt per year. The 1983 catch was 33,100 mt. The USA commercial catch in 1983 of 3,800 mt was the highest since 1970. Fishing mortality during 1978-1983 was low and quite stable, averaging a third of the $F_{0.1}$ level. The 1982 year class is the strongest to appear since 1974, followed by the 1980 and 1981 year classes. Total stock biomass (ages 1 and older) increased 90% from 1980 to 1984 to 676,000 mt, the highest level since 1976. There is considerable potential for increased catches from this stock. Projected catches for 1984 resulting from fishing mortality at $F_{0.1}$ are 132,000 mt.

Butterfish. Nominal catches dropped from 9,700 mt in 1982 to 5,500 mt in 1983. The USA catch, at a record high of 8,900 mt in 1982, was 4,900 mt in 1983. Stock biomass increased 45% from 1978 to 1982, dropped in 1983, but recovered again in 1984. Four of the last five year classes have been strong (1982 was relatively weak), with the 1983 year class being the strongest yet observed. Discard rates of age 0 and 1 butterfish (up to 50% of the landed catch) have been a serious problem since the last half of 1983. Annual discard was estimated to be 1,150 mt in 1983. Continued high discard of young fish will have an adverse impact on the stock and the fishery. Current levels of fishing mortality on ages 2 and older are well below $F_{0.1}$. Catches can probably be increased over present levels as long as they are comprised mainly of ages 1 and older.

Bluefish. Nominal catches (commercial and recreational) totalled an estimated 76,700 mt in 1983, the highest level observed. Recreational catches have averaged 93% of the total during 1960-1983. Based on trawl survey indices of recruitment which are strongly correlated with catches 2-4 years later, total catches should remain at the current high levels for at least the next several years, providing no significant changes occur in fishing effort.

Other Finfish

River herring. Nominal catches in 1983 were about 4,100 mt, down from 5,700 mt in 1982. Catches have steadily declined from an annual average of 24,800 mt during 1963-1969. Stock biomass has been depressed at a fairly stable low level since the late 1960's, although some increase has been evident in the Mid-Atlantic area since the mid-1970's.

American shad. Nominal commercial catches have declined steadily since the late 1960's to a low of about 500 mt in 1983. Recreational catches, although unknown, are considered to be very low at the present time. Excessive fishing has been blamed for the decline of American shad in most rivers. Restoration efforts are currently underway in several areas.

Black sea bass. Nominal commercial catches in 1983 were 1,500 mt, compared to 1,100 mt in 1981. Recreational catches have comprised 50-75% of the combined catch in years for which estimates are available. Stock abundance has undergone a rather sharp drop since 1977. It appears that the stock is fully exploited at the present time.

Striped bass. Nominal catches (commercial and recreational) in 1983 were only about 1,100 mt, the lowest in over 50 years. Catches have declined 98% from an estimated high of 43,300 mt in 1969. Estimated recreational catches currently account for less than 30% of the total compared to about 85% during the 1960's. Recruitment has generally been poor since 1970, although the 1982 year class was above average. Striped bass have been subject to intensive exploitation, and efforts are currently underway to sharply curtail fishing mortality.

Spiny dogfish. Nominal catches in 1983 were 4,900 mt, down from 6,000 mt in 1982. Minimum biomass estimates from NEFC spring survey catches were about 230,000 mt in 1983, close to the 1968-1982 geometric average. The USA fishery is selective for large females to satisfy market demands. There is a potential for rapid overexploitation of sharks such as spiny dogfish. Although optimal levels of annual harvest are currently not defined, they are likely above current catch levels.

Skates. Nominal catches were 3,600 mt in 1983, including 2,800 mt sold for bait. Since the bait catches were not reported prior to 1983, total catches in 1983 remained at about the 1981-1982 level. Stock biomass of all skates combined has exhibited a declining trend since the late 1960's.

Invertebrates

Short-finned squid. Nominal catches and abundance of *Illex illecebrosus* have declined drastically in recent years throughout the Northwest Atlantic. The fishery in Canadian waters has virtually collapsed, with catches dropping from 153,000 mt in 1979 to 408 mt in 1983. Although the USA catch increased markedly from about 300 mt in 1980 to a record 9,900 mt in 1983, the total international catch in USA waters was only 11,700 mt in 1983, the lowest since 1971. Stock abundance in USA waters is currently the lowest since 1974. Pre-recruit abundance in autumn 1983 was the lowest since 1970. Even though current stock abundance is low, it should be sufficient to support the present 30,000-mt OY in the 1984-1985 fishing year. However, further declines in stock abundance estimates would be cause for concern.

Long-finned squid. Nominal catches of *Loligo pealei* were about 27,800 mt in 1983, the highest since 1975. The USA catch in 1983 was 16,000 mt, the highest ever and about threefold higher than in 1982. Stock abundance is currently above the long-term average. The 1983 year class, if fished at the average 1978-1981 level of fishing mortality, should support catches during the 1984-1985 fishing year of at least twice the 1983 level.

American lobster. Nominal catches in 1983 totalled a record high 20,300 mt. Inshore catches from within 12 miles peaked in 1983 at 17,500 mt, while offshore catches (including Canadian catches on Georges Bank) in 1983 were about 2,800 mt. Stock biomass in offshore areas has remained relatively stable since the late 1970's. However, fishing mortality is currently well above F_{max} and, particularly in coastal areas, remains a source of serious concern.

Northern shrimp. Nominal catches in 1984 were about 3,000 mt, compared to about 1,500 mt in 1982-1983 and about 400 mt in 1979-1980. Fishing effort almost doubled from 1983 to 1984. Stock biomass has undergone an increase since the late 1970's, but still remains well below the levels observed during the late 1960's and early 1970's.

Red crab. The nominal catch in 1983 exceeded the estimated MSY for this resource by about 25%. This fishery is fully exploited at the present time.

Surf clams. Nominal catches (FCZ and state waters) in 1983 totalled about 25,400 mt (meats), the highest level since 1975. FCZ catches in 1983 were 20,500 mt, slightly greater than the annual quota of 18,900 mt. About 1,520 mt was taken in southern New England waters in 1983. Sufficient biomass exists in the Mid-Atlantic FCZ to sustain the fishery at current catch levels into the early 1990's. Since there do not appear to be additional strong year classes following the strong 1976 ~~and~~ 1977 year classes off New Jersey and the Delmarva Peninsula, the fishery will be supported almost exclusively by these two year classes for at least the next six years.

Ocean quahogs. Nominal catches in 1983 were 16,000 mt (meats), slightly less than the record high of 16,400 mt in 1981. More than 95% of the 1983 catch was from FCZ waters, with about 75% of that from off New Jersey. The total standing stock throughout the region is estimated to be 1.2 million mt. Current annual catches represent only 1.3% of the standing stock. If present catch levels persist, the stock and fishery in the New Jersey - Delmarva area should remain stable for the next 5-7 years, after which the fishery may shift northeasterly to more dense concentrations.

Sea scallops. Nominal catches in the Gulf of Maine - Mid-Atlantic area totalled 11,600 mt (meats) in 1983, a 56% decrease from the peak in 1978. Catches in the Gulf of Maine were 1,042 mt in 1983, up 50% from 1982 but less than the peak of 1,640 mt in 1980. USA CPUE dropped to record low levels in 1983; increased catches were achieved by a twofold increase in fishing effort. Catches on Georges Bank were 7,076 mt in 1983, down 35% from 1982 and the lowest since 1974. Fishing effort declined slightly in 1983 and CPUE was the lowest in the 1965-1983 time series. Biomass on Georges Bank is currently about 25% of the 1975-1979 level, as recent recruitment has been poor. Depressed stock conditions will continue until recruitment improves. Catches in the Mid-Atlantic area were 3,227 mt in 1983, 90% higher than in 1982 but only 37% of the recent high of 8,600 mt in 1978. Fishing effort doubled from 1982 to 1983, with much of it diverted from Georges Bank. Increased catches in 1983 resulted mainly from increased effort, as stock biomass continues to decrease. Conditions will continue to remain poor until recruitment improves.

TOTAL FINFISH AND SQUID BIOMASS

This group includes all commercially-exploited species of finfish and squid in the Gulf of Maine - 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 averaged 1.2 million mt, substantially above the maximum sustainable-yield (MSY) of 900,000 mt 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 8, Figure 1). The sharp drop in recreational catch estimates for recent years appears to reflect a different survey methodology rather than an actual decline in catches. Following extended jurisdiction, the USA nominal commercial catch increased from 266,300 mt in 1977 to 357,600 mt in 1980 (+34%) and declined steadily since then. Canadian nominal catches have fluctuated without a definite trend, but have generally increased since 1980. Catches by distant-water fleets declined from 174,300 mt in 1977 to only 6,900 mt in 1983 (-96%).

Catchability coefficients have been obtained for species-stocks within this group by dividing autumn survey catch-per-tow (weight) indices 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 indices for those years in which biomass estimates were missing. Annual biomass estimates were then obtained for 1964-1983 by applying these average coefficients to individual autumn survey indices 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 1983 estimate increased to 4.4 million mt, again due to inflated Atlantic herring and mackerel survey values. Taken together, available data suggest relatively constant biomass levels in recent years, with perhaps a slight increase evident in 1983.

Although stock biomass estimates for groundfish, flounder, miscellaneous finfish species, and short-finned squid were generally higher in 1983 than in 1975, they have declined since 1981. The mackerel stock appears to be recovering slowly, while herring have continued to remain at relatively low levels of abundance. These two species comprised about 50% of the total biomass in the 1960's. 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 8. Nominal catches (thousand metric tons) and management information for for total finfish and squid from the Gulf of Maine - Cape Hatteras area, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational[1]	159.6	128.2	118.2	99.7	77.9	79.0	72.7	69.3	68.3
Commercial									
USA	203.8	235.2	266.3	290.8	322.3	357.6	314.7	299.7	295.3
Canada	19.2	7.8	14.6	26.8	16.0	25.9	22.4	33.8	26.7
Other	848.8	419.9	174.3	48.7	39.0	42.3	18.1	16.7	6.9
Total nominal catch	1,231.4	791.1	573.4	466.0	455.2	504.8	427.9	419.5	397.2
Total allowable catch[2]	-	650.0	520.0[3]	-	-	-	-	-	-

Long-term potential catch = 900.0[4]
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_{1983} = Unknown

[1] Surveys performed in 1970, 1974, and 1979; remaining points estimated.

[2] Excludes recreational.

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

[4] From analysis of commercial data.

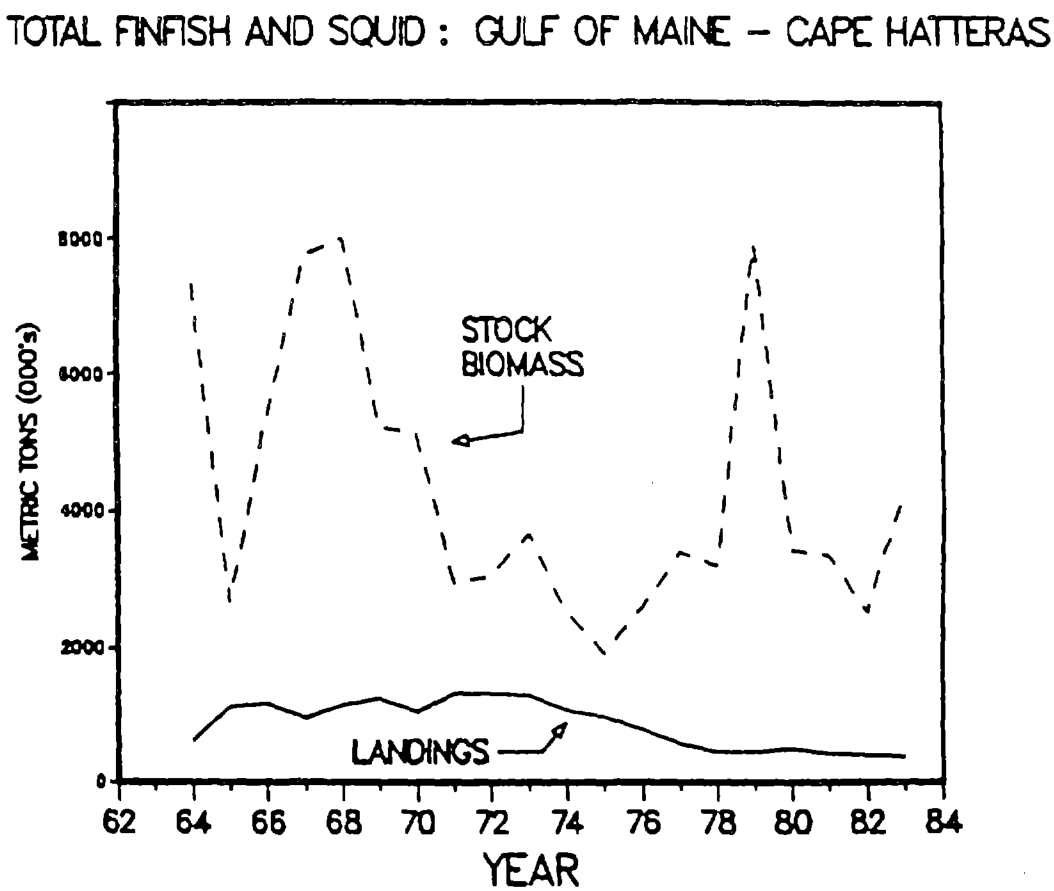

Figure 1. Total commercial and recreational landings and estimates of stock biomass of the total finfish and squid resource (less menhaden and large pelagics) from the Gulf of Maine to Cape Hatteras.

ATLANTIC COD

The Atlantic cod (Gadus morhua) is distributed in the Northwest Atlantic from Greenland to 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 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 - Mid-Atlantic. These groups are presently managed as two units: Gulf of Maine and Georges Bank and south. 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 autumn 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 1983 Gulf of Maine nominal cod catches were 16,733 mt, 1,782 mt more than in 1982, and the highest annual catch ever. The USA 1983 commercial catch was 13,980 mt, 3% greater than in 1982, and the second highest since domestic commercial landings have been maintained by stock area (i.e., 1932) (Table 9). Canadian 1983 catches were 2,750 mt, twice as large as in 1982. USA commercial CPUE indices in 1983 remained among the high values observed in recent years. The 1983 USA recreational Gulf of Maine cod catch is unknown, although the summer party boat fishery was "fair".

NMFS research vessel survey indices exhibited slight declines from 1982 to 1983 (Figure 2). The spring 1983 indices were among the upper third of recorded values, although the autumn indices were near the lowest observed. A recent decline in availability of cod in the autumn surveys appears to have occurred. Survey age composition data indicate that the 1977-1981 year classes are above average in strength. These five cohorts comprised 76% of the 1983 Gulf of Maine population by number and 86% by weight. The 1982 and 1983 year classes presently appear to be above average and average, respectively.

The 1983 USA commercial catch was dominated by the 1980 year class which accounted for 43% of the number landed and 28% of the total weight. The 1977-1979 year classes each contributed about 18% to the total 1983 yield. Otter trawl landings accounted for 72% of the 1983 USA total; gill net landings comprised 27% of the USA total.

Table 9. Nominal catches (thousand metric tons) and management information for Atlantic cod from the Gulf of Maine, 1971-1983.

Category	Year 1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	0.8[1]	-	-	-	-
Commercial									
USA	7.4	10.2	12.4	12.4	11.7	13.5	12.5	13.6	14.0
Canada	0.1	<0.1	0.1	0.4	0.4	0.2	0.6	1.4	2.7
Other	<0.1	-	-	-	-	-	-	-	-
Total nominal catch	7.5	10.2	12.5	12.8	12.9	13.7	13.1	15.0	16.7
Total allowable catch	-	8.0	12.0	8.0	9.7	9.5	9.5	-[2]	-[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

$M = 0.20$ $F_{0.1} = 0.16$ $F_{max} = 0.30$ $F_{1983} = 0.50$

[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.

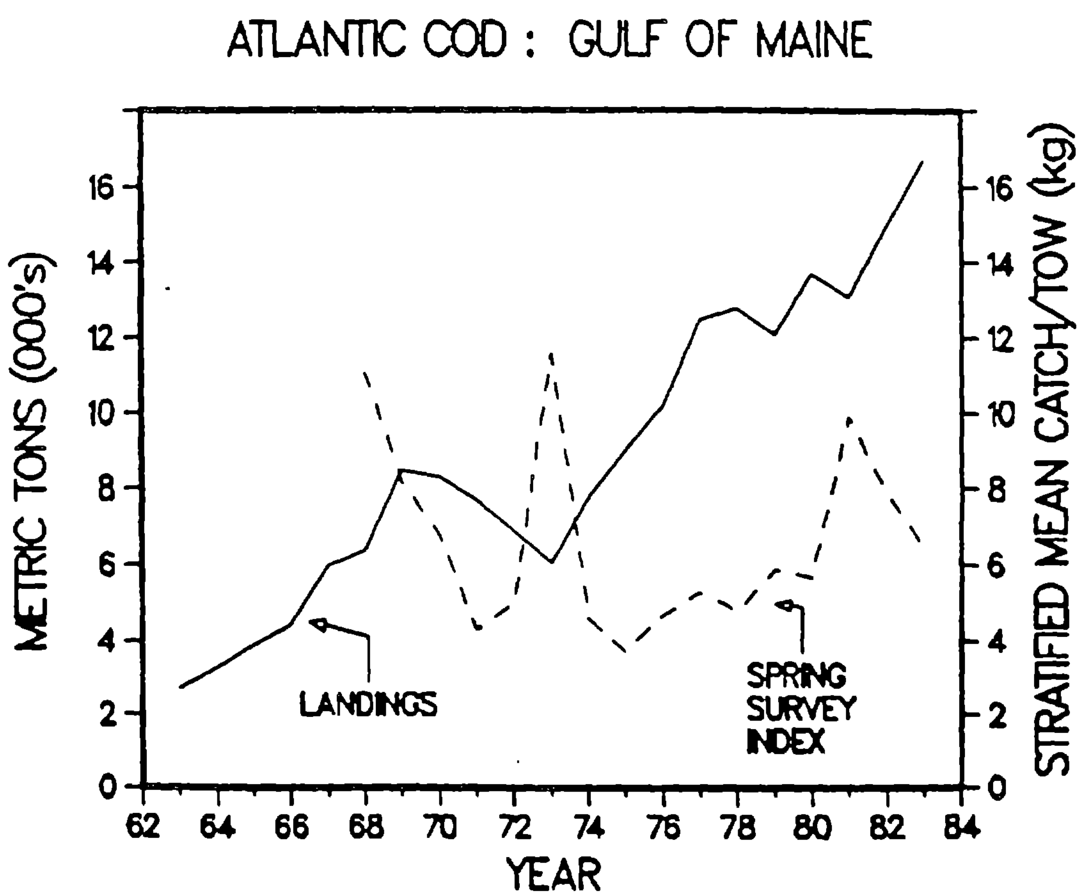

Figure 2. Total commercial landings and stock biomass indices from NEFC spring bottom trawl surveys of Atlantic cod in the Gulf of Maine.

Given the balance of age groups in the Gulf of Maine stock and the recent pattern of above-average recruitment, fishery yields of about 10,000-12,000 mt can probably be sustained in the near future. Recent fishing mortality, however, appears to have increased above F_{max}, and potential yields would be enhanced by a reduction in fishing mortality.

Georges Bank and South

Total commercial 1983 nominal catch was 48,890 mt, 15% less than in 1982, but still the third highest ever (Table 10). USA 1983 commercial landings were 36,760 mt, the third largest since 1907. Canadian 1983 catches were 12,130 mt, 32% lower than the record 1982 catch of 17,860 mt. The 1982 USA recreational catch from the Georges Bank and South cod stock is unknown; party boat reports described the spring 1983 cod fishery as "good."

NEFC spring and autumn 1983 research vessel survey indices were similar to those in 1982. The spring indices were among the upper third of recorded values (Figure 3), while the autumn indices were among the lowest. Large cod (> age 6) were virtually absent from autumn catches, suggesting a recent reduction in availability of these fish during the past two autumn surveys.

Survey age composition data indicate that the Georges Bank population is dominated by the 1978-1981 year classes, all of which appear to be either above average (1979, 1981) or strong (1978, 1980). These cohorts accounted for 84% of the spring 1983 total abundance index and 53% of the autumn 1983 index. Based on age 0 and 1 survey catch-per-tow indices, the 1982 and 1983 year classes appear to be average and strong, respectively.

The 1980 year class was dominant in the 1983 USA commercial catch, accounting for 45% of the fish landed and 37% of the total weight landed. The 1977-1979 and 1981 cohorts contributed about equally to fishery yields; each accounted for between 11 and 14% of the total catch weight. Otter trawl landings comprised 91% of the USA catch, while gill nets accounted for 5% of the total.

Recent fishing mortality rates have exceeded F_{max} and appear to have increased in 1983. Although USA commercial CPUE indices remained high in 1983, USA fishing effort was the highest recorded. The 1983 fishery was highly directed with 69% of the USA catch accounted for by trips in which cod comprised 50% or more of the trip catch weight. Fishery yields have been sustained by a succession of better-than-average year classes produced almost every year since 1975. Given this recruitment pattern, commercial landings of about 40,000 mt should be sustainable through 1984 and 1985 as the 1981 and 1983 year classes become fully recruited to the fishery. However, if fishing effort continues to increase, potential long-term yields will be further sacrificed since current fishing mortality levels are already higher than F_{max}.

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. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 82-33, 46 p.

Table 10. Nominal catches (thousand metric tons) and management information for Atlantic cod from Georges Bank and South, 1971-1983.

Category	Year 1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	3.1[1]	-	-	-	-
Commercial									
USA	16.0	14.9	21.1	26.6	32.6	40.0	33.9	39.3	36.8
Canada	2.4	2.3	6.2	8.9	6.0	8.1	8.5	17.9	12.1
Other	8.5	2.7	0.1	-	-	-	-	-	-
Total nominal catch	26.9	19.9	27.4	35.5	41.7	48.1	42.4	57.2	48.9
Total allowable catch	-	35.0	26.7	26.0	36.9	35.0	35.0	-[2]	-[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 cm (20.3 inches) females

$M = 0.20$ $F_{0.1} = 0.15$ $F_{max} = 0.30$ $F_{1983} = 0.50$

[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.

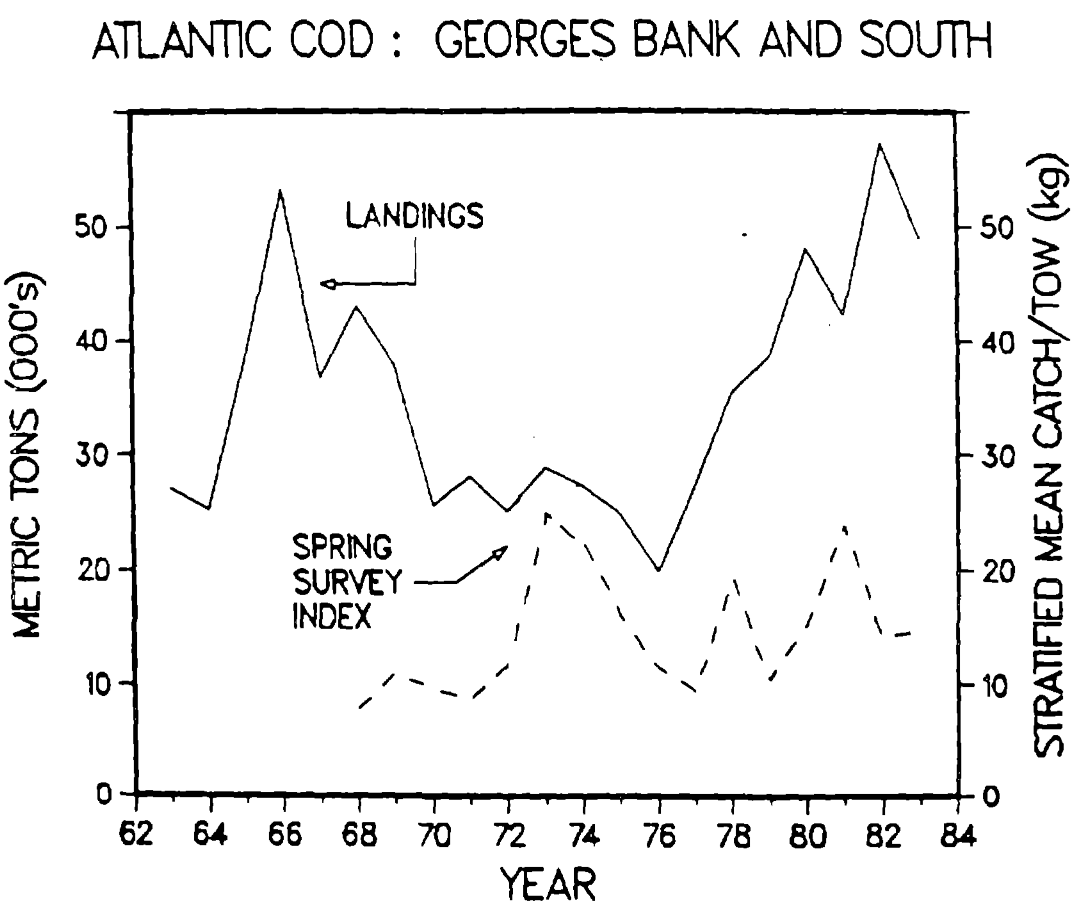

Figure 3. Total commercial landings and stock biomass indices from NEFC spring bottom trawl surveys of Atlantic cod in the Georges Bank and south area.

HADDOCK

The haddock (Melanogrammus aeglefinus) is a demersal gadoid species commonly attaining lengths of 75-80 cm (30-32 inches) and weights up to 5 kg (11 pounds). In recent USA nominal catches, average lengths have ranged from 50 to 60 cm (20-24 inches), while average weights have ranged between 1.5 and 2.5 kg (3-5 pounds). Haddock mature sexually at ages 2-3, and ages 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. Highest concentrations off the USA coast 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 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 15 March 1977 to 30 March 1982. As amended, this plan provided for USA commercial allocations of 17,675 mt for Georges Bank and 7,575 mt for the Gulf of Maine, a USA 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" (1 October - 30 September). Catch quotas for the USA 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 USA 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 1977-1982, USA fishermen accounted for 92% of the nominal commercial catch of haddock from the Gulf of Maine, with the remainder being taken by Canada. Nominal catches for the Gulf of Maine increased from 600 mt in 1973 to 5,640 mt in 1982 (Table 11, Figure 4). The provisional total for 1983 was 5,593 mt. Since 1977, the fishery has been supported primarily by the 1975 and 1978 year classes, although research vessel survey data and age compositions of commercial catches from 1982 suggest that the 1979 and 1980 year classes are at least moderately strong. Estimated recreational catches for 1974 and 1979 totalled 200 and 400 mt, respectively.

NEFC autumn survey indices have declined since 1978, while the spring indices have fluctuated without a definite trend (Figure 4). Survey catch-per-tow-at-age data indicate that the 1975 year class was by far the largest cohort in recent times. The 1978 year class was also strong, and the 1979 and 1980 cohorts appear to be at least moderate in strength. Bottom trawl surveys conducted by the NEFC and the Commonwealth of Massachusetts indicate that the 1982 year class is also at least moderate in strength.

Stock size estimates underwent a 65% decline from 1979 to 1983. This implies an increase in fishing mortality given the relative stability in commercial landings during this period. Landings and stock abundance for the near future will probably remain stable, although major reductions could occur if fishing mortality continues to increase or recruitment delines.

Table 11. Nominal catches (thousand metric tons) and management information for Gulf of Maine haddock, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational[1]	0.7	0.4	0.5	0.4	0.4	0.6	0.5	0.6	0.6
Commercial									
USA	0.9	1.9	3.3	4.5	4.6	7.3	5.7	5.6	5.6
Canada	0.1	0.1	<0.1	0.6	0.3	0.2	0.5	1.1	1.0
Other	<0.1	-	-	-	-	-	-	-	-
Total nominal catch	1.7	2.4	3.8	5.5	5.3	8.1	6.7	7.3	7.2
Total allowable catch[2]	-	6.0	10.5	19.0[3]	8.2[4]	9.6[5]	9.6[5]	-	-

Long-term potential catch	= 5.0
Importance of recreational fishery	= Minor
Status of management	= (Interim) FMP in force since 31 March 1982
Status of exploitation	= Fully exploited
Age at 50% maturity	= 2 yrs
Size at 50% maturity	= 38 cm (15 inches)

$M = 0.20$ $F_{0.1} = 0.26$ $F_{max} = 0.55$ $F_{1983} = >F_{max}$

[1] Values for 1970, 1974 and 1979 obtained from surveys; remaining points estimated.

[2] Values for 1971-1978 are for Georges Bank and the Gulf of Maine, inclusive; 1971-1976 figures relate to commercial catch only.

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

[4] Represents USA 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.

[5] Represents USA commercial allocation for the Gulf of Maine and total recreational allocation for Calendar Years 1980 and 1981 under Final Supplement No. 4 to the Fishery Management Plan (FMP) for Atlantic Groundfish (effective September 1981).

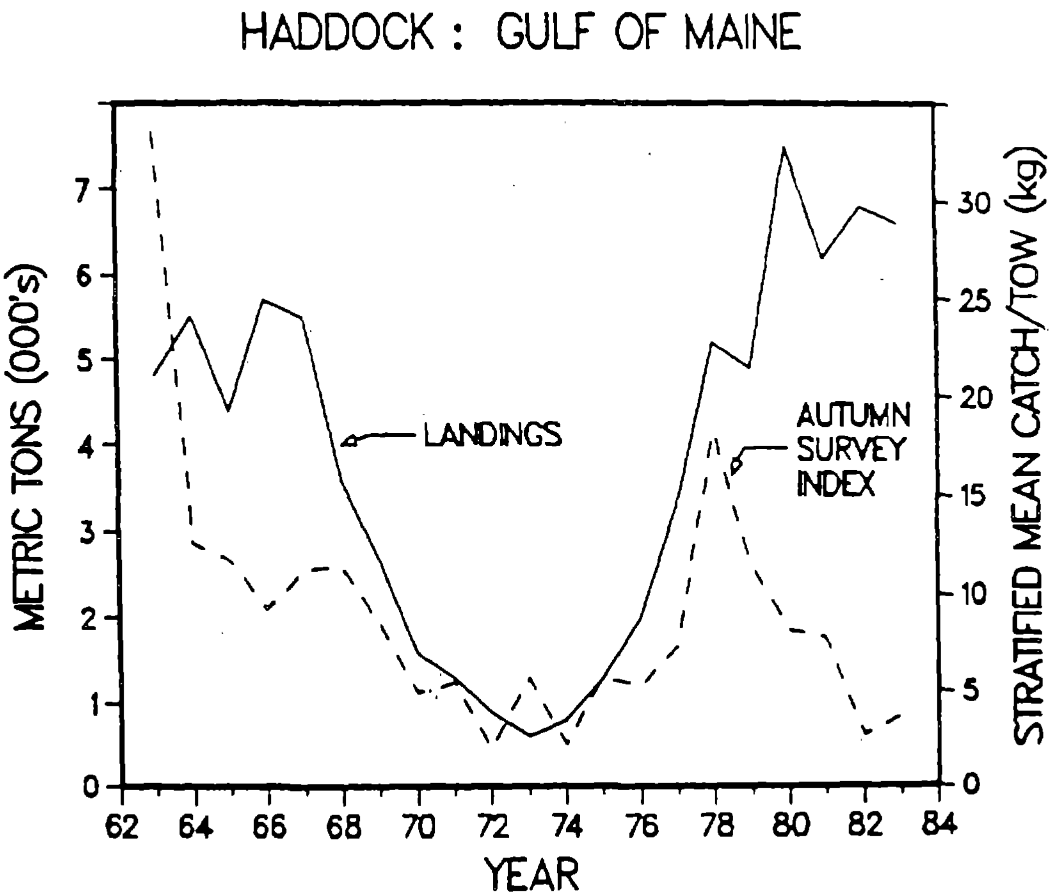

Figure 4. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of haddock in the Gulf of Maine.

Georges Bank

USA fishermen accounted for 68% of the nominal catch during 1977-1982, with practically all of the remainder being taken by Canada. Almost all of the USA nominal catch has been taken by otter trawling. USA catches have tended to increase somewhat each year 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 total for 1982 was 18,200 mt, and the provisional total for 1983 is 11,900 mt (Table 12, 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 1981-1983 indicate the 1980 year class to be well below average in size, and the remaining year classes since 1975, including the 1983 year class, appear to be weak. The abundance of 1975 year-class fish is currently low, and the fishery is highly dependent on the 1978 year class.

The NEFC spring survey index for Georges Bank rose from 5.4 kg/tow in 1975 to 35.7 kg/tow 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/tow in 1974 to 26.9 kg/tow 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/tow in 1981 to 4.2 kg/tow in 1982, a decline of over 60%. The 1982 and 1983 young-of-year indices for Georges Bank were two of the lowest on record. NEFC survey data indicate that since 1977, fishing mortality (F) at age 2 has exceeded F_{max} (0.55), and at ages 3 and older has declined to between $F_{0.1}$ (0.26) and F_{max}. These results indicate that additional mortality occurred from unreported catches at age 2, particularly for the 1975 and 1978 year classes. Estimated levels of unreported discard were 12.8 million fish from the 1975 year class and 21.0 million fish from the 1978 cohort at age 2 in 1977 and 1980, respectively.

Stock size estimates (age 2 and older) calculated from virtual population analysis declined from 91 million fish or 110,000 mt in 1980 to only 16 million fish or 28,000 mt in 1983 (Figure 5). Catch and stock size projections indicate continued declines in abundance and biomass since 1983. Current levels are well below the long-term (1935-1960) average of 140 million fish or 153,000 mt and appear comparable to those observed during the early to mid-1970's when recruitment was poor and stock size was low. If recruitment remains poor, the stock will continue to remain at low levels.

For further information see:

Clark, S.H., R.K. Mayo, and A. Green. 1982. Georges Bank and Gulf of Maine haddock stock status - 1982. NMFS, NEFC, 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., S.H. Clark, and D.Y. White. 1983. A review of the status of the Georges Bank and Gulf of Maine haddock stocks for 1983. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 83-23, 31 p.

Table 12. Nominal catches (thousand metric tons) and management information for Georges Bank haddock, 1971-1983.

Category	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial									
USA	4.1	2.9	7.9	12.2	14.3	17.5	19.2	12.6	8.7
Canada	1.1	1.4	2.9	10.2	5.2	10.1	5.7	5.6	3.2
Other	1.1	<0.1	-	-	-	-	<0.1	-	-
Total nominal catch	6.3	4.4	10.8	22.4	19.5	27.6	24.9	18.2	11.9
Total allowable catch[1]	-	6.0	10.5	19.0[2]	22.1[3]	22.9[4]	22.9[4]	-	-

Long-term potential catch = 47.0
Importance of recreational fishery = Insignificant
Status of management = (Interim) FMP in force since 31 March 1982
Status of exploitation = Fully exploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 38 cm (15 inches)

$M = 0.20$ $F_{0.1} = 0.26$ $F_{max} = 0.55$ $F_{1982} = 0.52$

[1] Values for 1971-1978 are for Georges Bank and the Gulf of Maine, inclusive; 1971-1976 figures relate to commercial catch only.

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

[3] Represents USA 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.

[4] Represents USA commercial allocation for Georges Bank and total Canadian allocation for Calendar Years 1980 and 1981 under Final Supplement No. 4 to the Fishery Management Plan (FMP) for Atlantic Groundfish (effective September 1981).

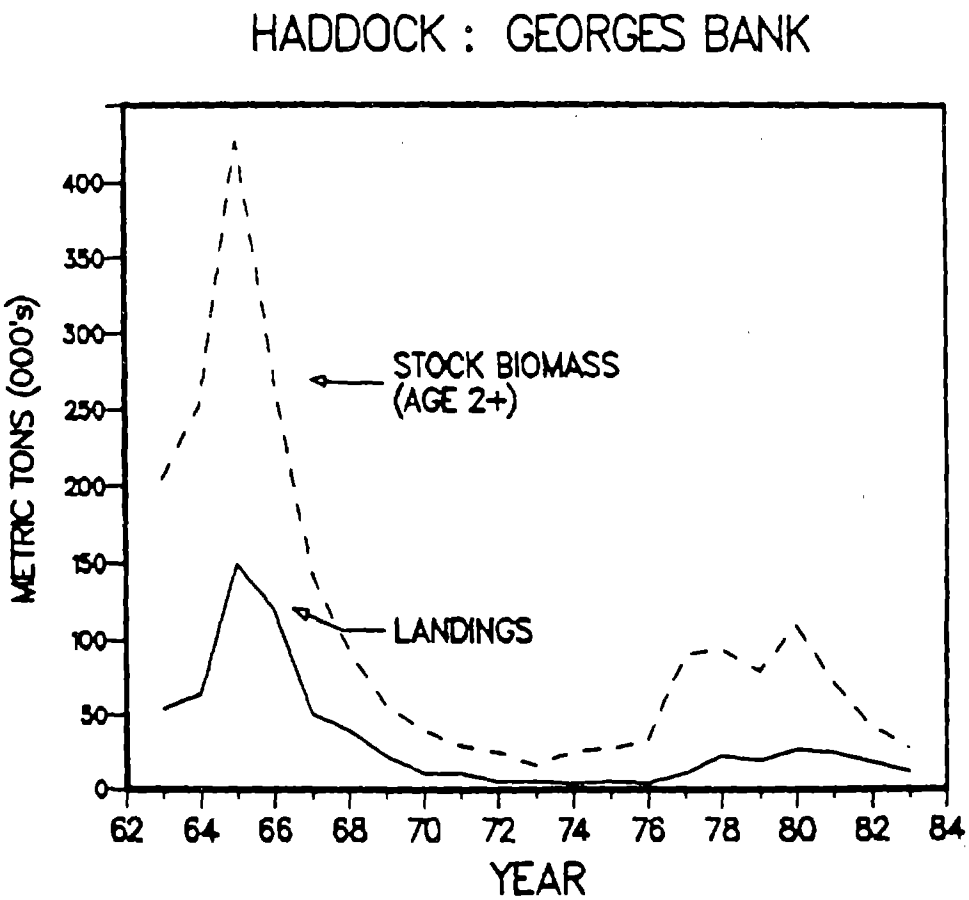

Figure 5. Total commercial landings and estimates of stock biomass of haddock on Georges Bank.

REDFISH

Redfish or ocean perch (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 inches) have been noted. In the Gulf of Maine, redfish reach maturity in about 8-9 years at an average length of 22-23 cm (8-9 inches). Females are viviparous, retaining eggs in the ovary after fertilization until yolk sac absorption. Mating takes place in autumn, with subsequent larval extrusion occurring the following spring and summer.

During the development phase of the Gulf of Maine fishery, USA 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 13, Figure 6). In 1982 and 1983, however, catches declined to 6,700 and 5,200 mt, respectively, the lowest annual figures since the directed fishery commenced in the early 1930's. 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 accounted for 63% of the numbers and 48% of the weight landed in the commercial fishery in 1980.

The standardized catch-per-unit-of-effort (CPUE) index declined from 6.1 mt/day in 1968 to approximately 2.4 mt/day between 1975 and 1978, and to 1.4 and 1.5 mt/day in 1981 and 1982, respectively (Figure 6). The NEFC survey index declined from an average of 122 fish/tow in 1967-1968 to an average of 43 fish/tow in 1977-1978. Recent autumn indices for 1982 and 1983 (9 fish/tow) are the lowest values observed since the beginning of the survey. Estimates of exploitable biomass (ages 5 and older) from virtual population analysis declined 61% from 134,000 mt in 1969 to 52,000 mt in 1980. Projections indicate a stock biomass in 1984 of 30,000-35,000 mt. Average fishing mortality during the 1970's was slightly greater than F_{max} (0.14) and twice the $F_{0.1}$ (0.07) level. In addition, the combination of declining overall stock size and increased fishing effort on the 1971 year class produced fishing mortality rates that were 50% above F_{max} and three times $F_{0.1}$ in the late 1970's.

Equilibrium surplus production models have indicated that maximum sustained yield (MSY) is about 14,000 mt. However, given the current low population abundance, surplus production in the near future will be considerably less than MSY as indicated by the sharp decline in 1982 and 1983 nominal catches.

The population is now in a severe state of disequilibrium and, with the present age structure and exploitation pattern, the fishery has become extremely dependent on recruitment. However, except for the moderate 1978 and 1979 year classes, recruitment prospects are poor; thus, declines in biomass are expected to continue.

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.

Mayo R.K., U.B. Dozier, and S.H. Clark. 1983. An assessment of the redfish, *Sebastes fasciatus*, stock in the Gulf of Maine - Georges Bank region. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 83-22, 55 p.

Table 13. Nominal catches (thousand metric tons) and management information for redfish from the Gulf of Maine and Georges Bank area, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	11.8	10.1	13.0	14.0	14.7	10.1	7.8	6.7	5.2
Canada	0.1	0.2	0.2	0.1	<0.1	0.1	<0.1	0.2	0.1
Other	3.6	0.4	<0.1	-	<0.1	-	-	<0.1	-
Total nominal catch	15.5	10.7	13.2	14.1	14.7	10.2	7.8	6.8	5.3
Total allowable catch	-	17.0	9.0[1]	-	-	-	-	-	-

Long-term potential catch = 14.0
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 (8.5-9.0 inches)

$M = 0.10$ $F_{0.1} = 0.07$ $F_{max} = 0.14$ $F_{1983} = 0.20$

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

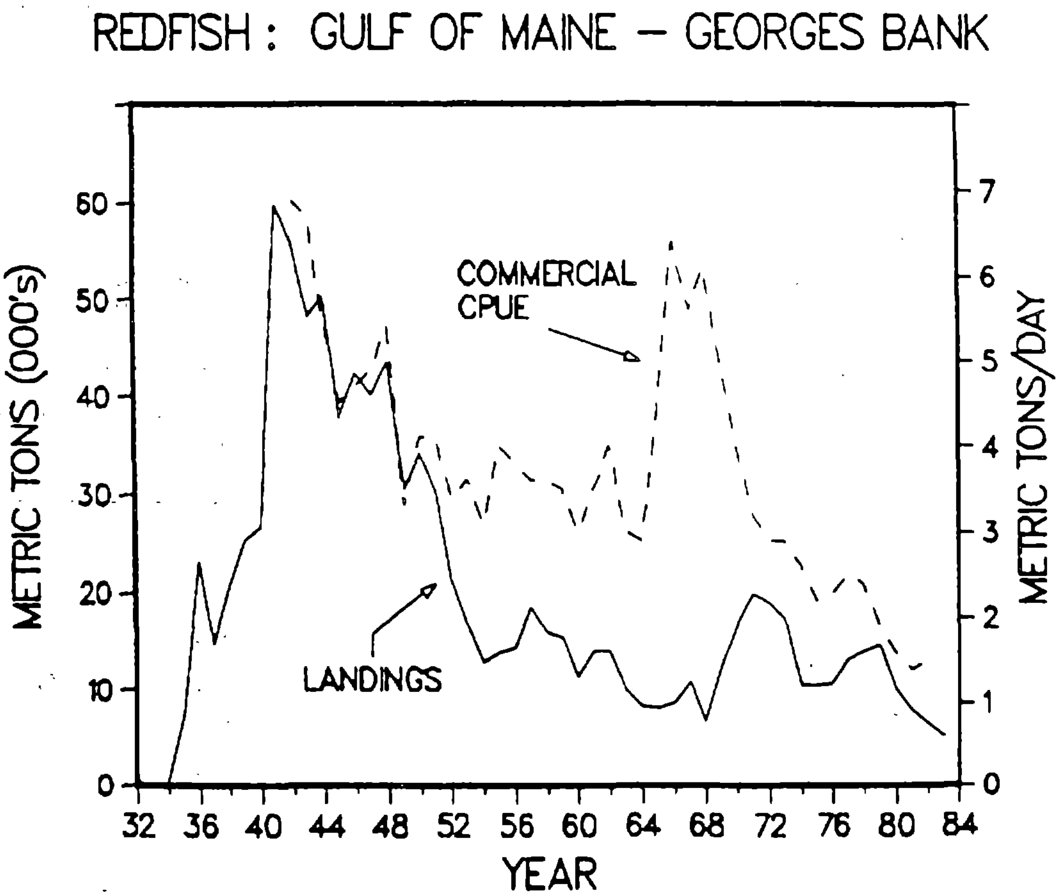

Figure 6. Total commercial landings and catch per unit effort of redfish in the Gulf of Maine - Georges Bank area.

SILVER HAKE

The silver hake or whiting (Merluccius bilinearis) is a widely distributed, slender, swiftly swimming fish with a range extending from Newfoundland 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 (25.6 inches). Ages of 15 years have been reported, although fish older than about 8-10 years are rarely encountered.

Gulf of Maine

The nominal catch of silver hake in 1983 was 4,800 mt, taken exclusively by the USA (Table 14, Figure 7). This catch represented a 48% increase from 1982, but was still the fifth lowest level in the 1955-1983 time series. Catches since 1979 have averaged only about 3,650 mt, substantially below catch levels in past years (83% lower than the 1960-1969 average of 22,000 mt and 55% lower than the 1970-1977 average of 8,100 mt). The commercial catch-per-effort index, after dropping from 16.7 mt/day in 1976 averaged 7.3 mt/day during 1978-1980, declined to its lowest level in 1981 (2.6 mt/day), but increased in 1982 and 1983 to 8.7 mt/day.

Both the spring and autumn NEFC bottom trawl survey indices have reflected similar trends as the commercial catch-per-effort index in recent years, exhibiting high levels in the mid-1970's, dropping to low levels in 1978-1979, increasing in 1980, and then decreasing in 1981-1983. 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, while the 1982 year may be quite strong.

Due to low levels of catch since 1979, 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 since 1979 were derived based on projections using 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 1979-1983, 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 1980-1983 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 58,000 mt and 48,000 mt, respectively, in 1984. With continued low levels of catch and average year classes, it is unlikely that this stock will undergo any major declines in 1984 if catches remain at or somewhat above the levels reported in recent years.

Table 14. Nominal catches (thousand metric tons) and management information for silver hake from the Gulf of Maine, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	7.0	9.8	8.7	6.2	2.6	3.8	3.8	3.2	4.8
Canada	-	-	-	-	-	-	-	-	-
Other	0.6	-	-	-	-	-	-	-	-
Total nominal catch	7.6	9.8	8.7	6.2	2.6	3.8	3.8	3.2	4.8
Total allowable catch	-	10.0	9.0	-	-	-	-	-	-

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) females

$M = 0.40$ $F_{0.1} = 0.55$ $F_{max} = >2.00$ $F_{1983} = 0.15$

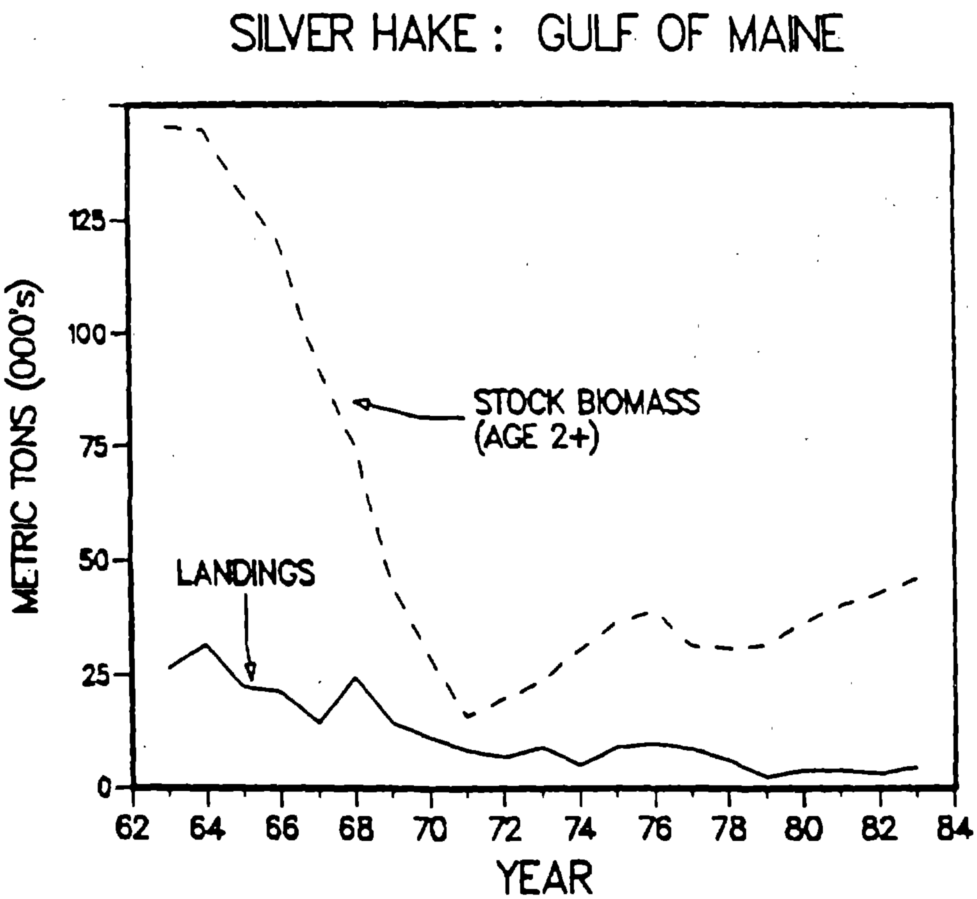

Figure 7. Total commercial landings and estimates of stock biomass of silver hake in the Gulf of Maine.

Georges Bank

The 1983 international nominal catch on Georges Bank was 1,234 mt (Table 15, Figure 8), the lowest catch reported in the 1955-1983 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 85 mt in 1983 compared to 1,022 mt in 1979 and 40,514 mt in 1977. The USA catch of 1,149 mt in 1983 was the third lowest since 1955. The USA commercial catch-per-day index, after reaching 46.1 mt/day in 1976, declined to average 18.6 mt/day during 1978-1981, increased in 1982, but then declined again in 1983 to 19.2 mt/day.

The NEFC autumn bottom trawl survey index, after reaching a high level in 1976, dropped through 1979 before increasing to its highest level in 1982. The spring survey index, after reaching its highest level in the time series in 1981, dropped sharply in 1982, but increased in 1983. 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 or 1981 year classes. The 1982 year class appears to be strong.

Fishing mortality in 1982 was estimated to be 0.13 for ages 2 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 1983 was estimated to be 44,000 mt, a sharp increase from the 1982 estimate, but substantially below the levels maintained from 1966 through 1976 (average 213,000 mt). Spawning stock biomass (ages 2 and older) was estimated to be 21,800 mt at the beginning of 1983, a slight decrease over the 1978-1980 average, but well below past levels which averaged about 167,000 mt during 1966-1976 (Figure 8).

The 1983 catch produced an F for fully-recruited ages of about 0.07, resulting in a spawning stock biomass in 1984 of 37,900 mt, a 75% increase from 1983 reflecting the strong 1982 year class. A catch in 1984 equal to the 1983 catch would result in a slight (3%) increase in spawning stock biomass in 1985. Fishing at $F_{0.1}$ in 1984 would result in a catch of about 12,400 mt and would decrease spawning stock biomass in 1985 by approximately 25%.

The low catches reported during 1979-1983 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 15. Nominal catches (thousand metric tons) and management information for silver hake from Georges Bank, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	3.3	3.8	3.7	6.4	0.9	1.2	1.2	3.0	1.1
Canada	-	-	-	-	-	-	-	-	-
Other	64.9	42.0	40.6	3.6	1.0	0.5	0.3	0.1	0.1
Total nominal catch	68.2	45.8	44.3	10.0	1.9	1.7	1.5	3.1	1.2
Total allowable catch	-	50.0	70.0	58.8	58.8	35.0	25.0	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) females

M = 0.40 $F_{0.1}$ = 0.65 F_{max} = >2.00 F_{1983} = 0.07

SILVER HAKE : GEORGES BANK

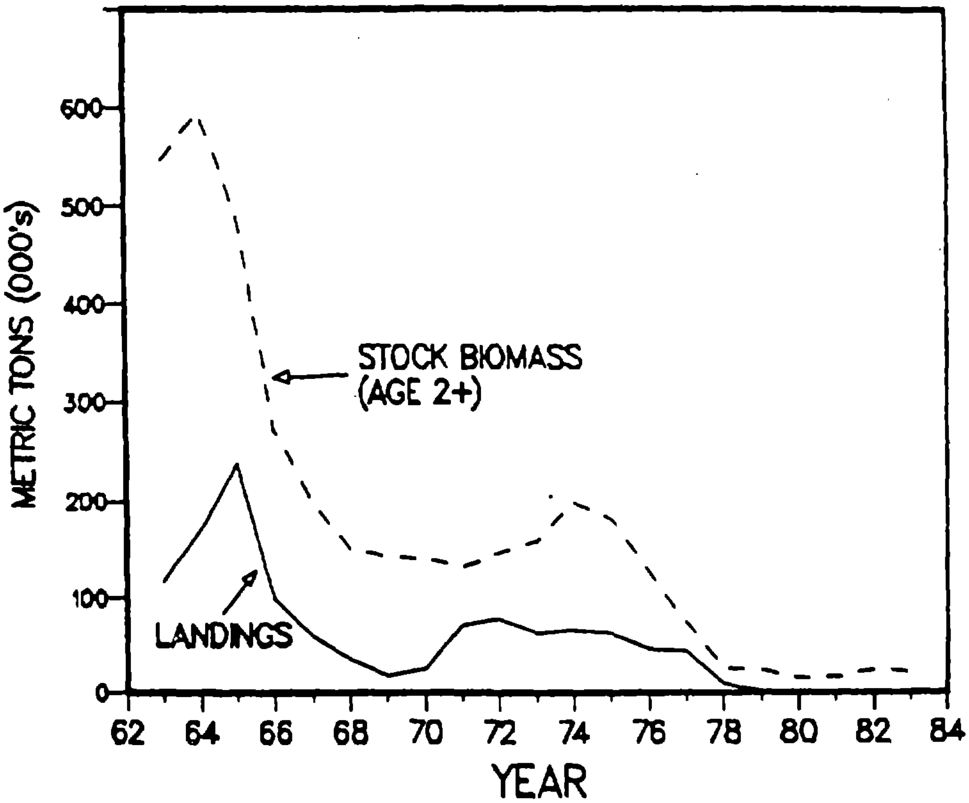

Figure 8. Total commercial landings and estimates of stock biomass of silver hake on Georges Bank.

Southern New England - Mid-Atlantic

The 1983 international nominal catch was 14,422 mt, a slight decrease from 1982, and continues the low level of catches reported since 1979 (Table 16, Figure 9). The USA commercial catch in 1983 was 10,887 mt, down slightly from 11,544 mt in 1982 but well above levels reported in the early 1970's (average 5,700 mt during 1970-1973). The USA recreational catch was assumed to be about 3,000 mt. The distant-water-fleet (DWF) catch in 1983 was 535 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 17% of the total catch since 1978.

The USA commercial catch-per-day index, after remaining relatively steady during 1976-1979, declined during 1980-1981 and then increased in 1982 and 1983 to a level approximately equal to that in the early 1970's. The NEFC bottom trawl survey indices for this stock have not indicated consistent trends; while the autumn survey index has reflected basically the same trend as the commercial catch-per-effort index, the spring index has shown considerable fluctuation, reaching its lowest level in the series in 1980, increasing in 1981, and declining in 1982 and 1983. 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 1980-1982 year classes appear to be of average strength.

Fishing mortality in 1982 was estimated to be 0.40 for ages 2 and older from a relationship between fishing effort and past fishing mortality from VPA. While this level of F is slightly above the 1981 estimate, it is approximately equal to the 1976-1980 average.

Total stock biomass (ages 1 and older) at the beginning of 1983 was estimated to be 79,800 mt. This level of biomass is approximately 28% 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) in 1983 was estimated to be 52,700 mt, a slight decrease from 1982 and the lowest level in the series (Figure 9).

The 1983 catch produced an F of about 0.39, with a resulting spawning stock biomass in 1984 of approximately 53,000 mt, virtually no change from 1983. A catch in 1984 equal to the 1983 catch would result in a spawning stock biomass of about 52,000 mt in 1985 (a 2% decrease). Fishing at $F_{0.1}$ in 1984 would produce a catch of about 19,000 mt and result in a decrease in biomass of about 10% from 1984 to 1985.

For further information see:

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

Table 16. Nominal catches (thousand metric tons) and management information for silver hake from the southern New England - Mid-Atlantic area, 1971-1983.

Category	Year 1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational[1]	0.7	1.7	3.9	4.0	3.0	3.0	3.0	3.0	3.0
Commercial									
USA	6.4	9.5	9.5	11.4	13.0	11.5	11.3	10.3	10.9
Canada	-	-	-	-	-	-	-	-	-
Other	39.2	16.5	14.5	10.8	3.9	1.0	2.6	2.3	0.5
Total nominal catch	46.3	27.7	27.9	26.2	19.9	15.5	16.9	15.6	14.4
Total allowable catch	-	43.0	45.0	38.2	40.0	55.0	30.0	30.0	30.0

Long-term potential catch = 47.6
Importance of recreational fishery = Moderate
Status of management = FMP 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

$M = 0.40$ $F_{0.1} = 0.55$ $F_{max} = >2.00$ $F_{1983} = 0.39$

[1] Estimated.

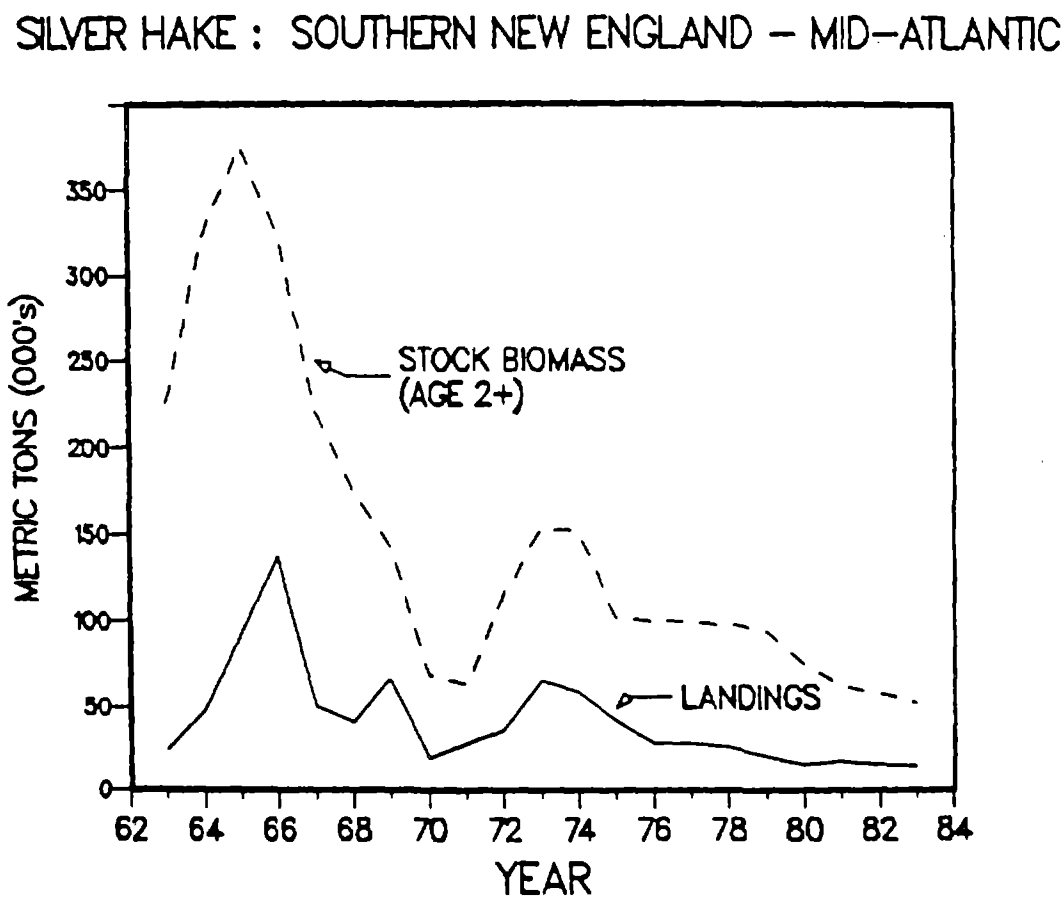

Figure 9. Total commercial and recreational landings and estimates of stock biomass of silver hake in the southern New England - Mid-Atlantic area.

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 (19.7 inches). 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

The 1983 international nominal catch of red hake on Georges Bank was 113 mt, the lowest level in the 1960-1983 time series (Table 17, Figure 10). The USA catch was 78 mt, which represented a 46% decrease from 1982 and the lowest catch since 1976. The distant-water-fleet (DWF) catch, primarily by-catch in the offshore squid fishery, was only 35 mt, a slight increase over 1982, but continues the series of low catches since 1977.

The NEFC spring survey index, after increasing steadily during 1978-1981, dropped sharply in 1982, but increased in 1983 to a level similar to that attained in the early 1970's. The autumn survey index, after remaining relatively steady during 1976-1980, dropped slightly in 1981 and 1982. Survey catch-per-tow-at-age data indicate that, since the strong 1973-1974 year classes, only the 1980 and 1981 cohorts appear to be above average.

Due to low levels of catch during 1979-1983 and 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 1979-1983 were derived based on projections using 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 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 25,200 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 13,900 mt in 1978 (Figure 10).

With low levels of catch reported since 1978 and estimated year-class sizes, projections indicate a generally increasing trend in stock biomass during 1979-1984 with estimates of total and spawning stock biomass reaching about 56,000 mt and 46,000 mt, respectively, in 1984. It is unlikely that this stock will undergo major declines in biomass in 1984 if catches remain at or somewhat above the levels reported in recent years.

Table 17. Nominal catches (thousand metric tons) and management information for red hake from Georges Bank, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	0.1	<0.1	0.1	0.2	0.3	0.3	0.3	0.2	<0.1
Canada	-	-	-	-	-	-	-	-	-
Other	20.0	17.1	2.8	0.8	<0.1	<0.1	<0.1	<0.1	<0.1
Total nominal catch	20.1	17.1	2.9	1.0	0.3	0.3	0.3	0.2	0.1
Total allowable catch	-	26.0	16.0	16.0	16.0	6.0	6.0	6.0	6.0

Long-term potential catch = 15.5
Importance of recreational fishery = Insignificant
Status of management = PMP 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 $F_{1983} = <0.10$

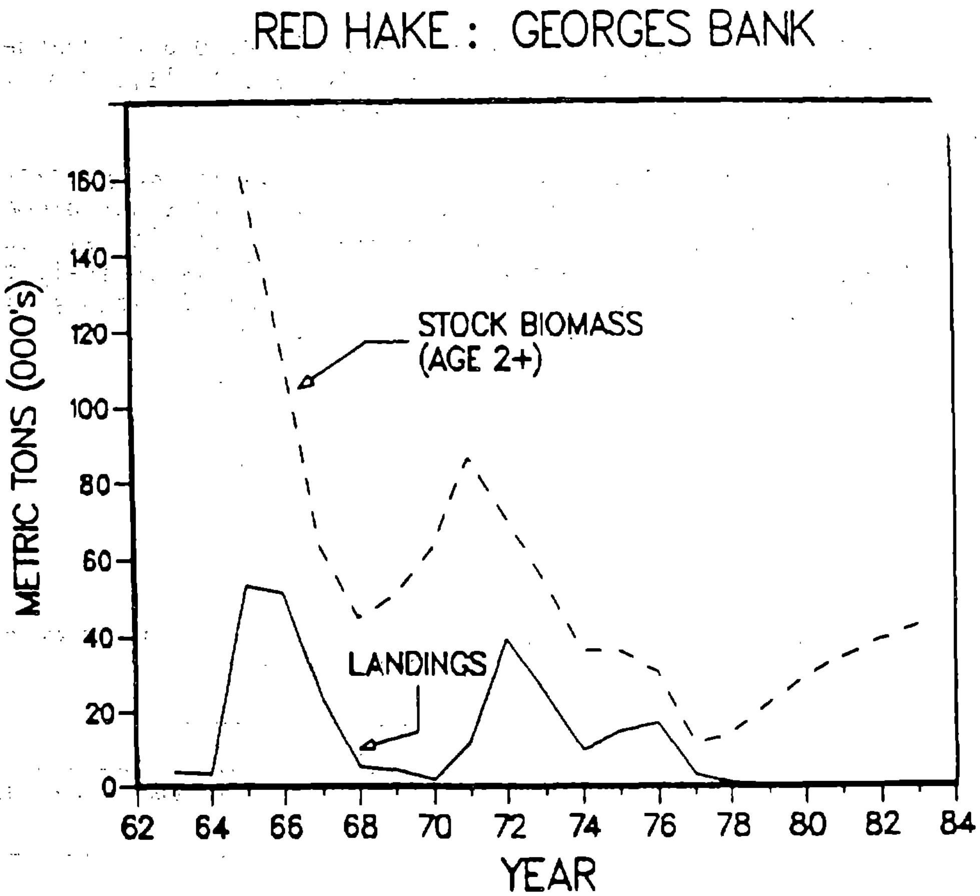

Figure 10. Total commercial landings and estimates of stock biomass of red hake on Georges Bank.

Southern New England - Mid-Atlantic

A total of only 1,832 mt of red hake was caught in 1983. This level of catch represented a 23% increase from 1982, but was still the second lowest catch in the 1960-1983 time series (Table 18, Figure 11). The USA commercial catch, after declining steadily from 6,600 mt in 1979 to a record low of 821 mt in 1982, increased to 1,262 mt in 1983. The USA recreational catch was assumed to be about 500 mt. The DWF catch in 1983 was only 70 mt, its lowest level since 1963, which represents a drastic decline from 38,000 mt in 1973. Since 1979, there has been no directed fishery for this species by the DWF; catches have come primarily as by-catch of the offshore squid fishery.

The NEFC spring survey index, after increasing from 1979 to 1981, declined during 1982-1983. The autumn survey index increased during 1978-1980, delined in 1981, but increased slightly in 1982. 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-data indicated that every fifth year since 1969 has produced a comparatively strong year class (e.g., 1969, 1974, and 1979 year classes). Other year classes have been average in strength with none being particularly poor. The 1981 and 1982 cohorts also appear to be of average strength.

Due to low levels of catch and limited sampling data available for 1981-1983, it was not possible to determine catch at age in numbers necessary for updating the VPA for 1983. Estimates of fishing mortality for 1983 and stock size for 1984 were derived based on projections using estimated stock sizes at age at the beginning of 1981, known catches, and estimated year-class sizes.

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 1983, F was probably less than 0.10. $F_{0.1}$ for this stock has been calculated to be approximately 0.45.

Total stock biomass (ages 1 and older) in 1983 was estimated to be 73,800 mt. 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 61,400 mt at the beginning of 1983 (Figure 11).

With the low levels of catch reported in 1980-1983, 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 1984 to about 77,000 mt and 64,000 mt, respectively. It is likely that this stock will not undergo any major declines in biomass in 1984 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 18. Nominal catches (thousand metric tons) and management information for red hake from the southern New England - Mid-Atlantic area, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational[1]	0.2	0.6	0.8	0.7	0.5	0.5	0.5	0.5	0.5
Commercial									
USA	2.6	3.9	2.5	3.3	6.6	3.9	2.1	0.8	1.3
Canada	-	-	-	-	-	-	-	-	-
Other	25.9	7.2	2.4	1.4	1.0	0.1	0.2	0.2	0.1
Total nominal catch	28.7	11.7	5.7	5.4	8.1	4.5	2.8	1.5	1.8
Total allowable catch	-	16.0	28.0	20.5	16.0	11.1	16.0	16.0	16.0

Long-term potential catch = 26.0
Importance of recreational fishery = Minor
Status of management = FMP in force since 1977
Status of exploitation = Underexploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 27.6 cm (10.9 inches)

$M = 0.40$ $F_{0.1} = 0.45$ F_{max} = Unknown $F_{1983} = <0.10$

[1] Estimated.

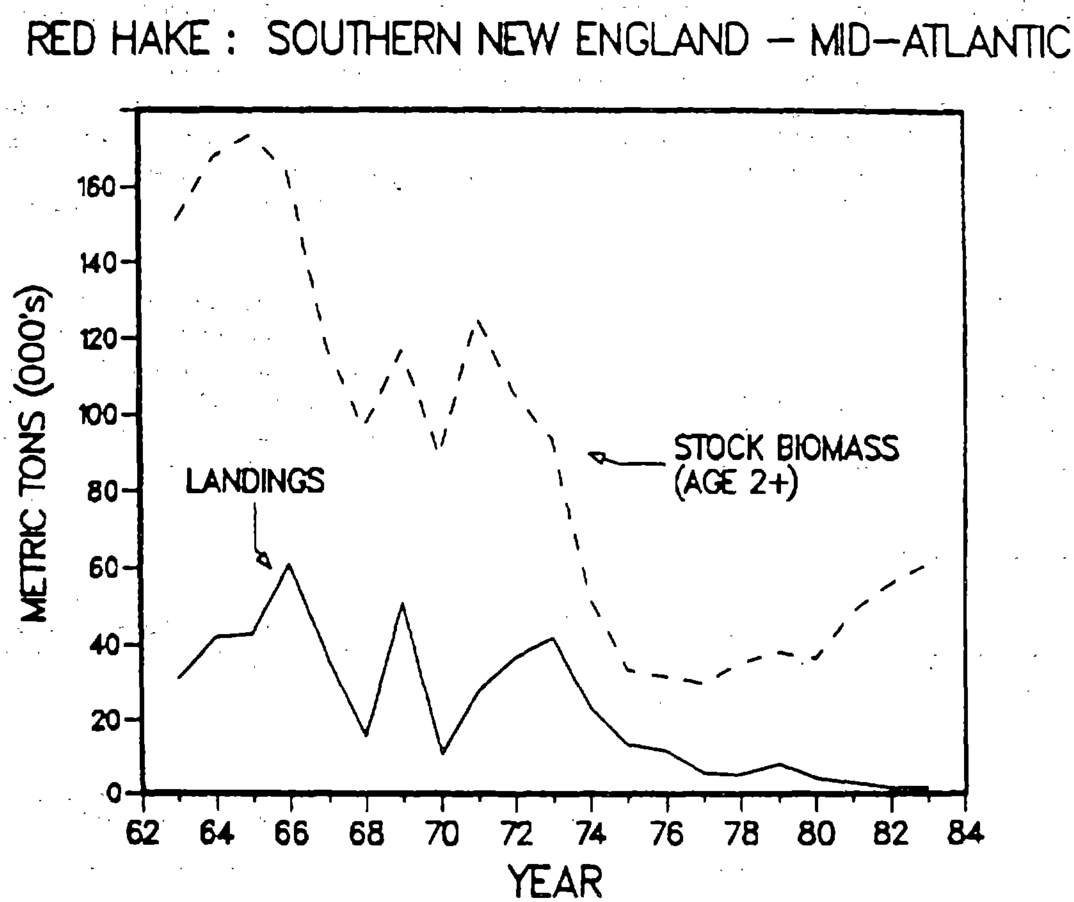

Figure 11. Total commercial and recreational landings and estimates of stock biomass of red hake in the southern New England - Mid-Atlantic area.

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 of pollock between the Gulf of Maine and the Scotian Shelf area. Accordingly, pollock from Cape Breton Island and south 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 up to 110 cm (43 inches) and weights of 16 kg (35 pounds).

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. Nominal commercial catches remained relatively stable about an average of 38,200 mt during 1974-1977 and then increased to an average of 57,200 mt in 1980 and 1981. Commercial catches have since declined to approximately 49,000 mt in 1983, of which 35,000 mt was taken by Canada and 14,000 mt by the USA (Table 19). 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 before declining in 1982 and 1983. Nominal catches by distant-water fleets have declined from 9,900 mt in 1973 to an average of 800 mt during 1977-1982, almost all of which was taken by USSR vessels on the Scotian Shelf (Table 19). USA recreational catch estimates declined from 9,800 mt in 1960 to only 500 mt in 1974; the 1980 Marine Recreational Fishery Statistics Survey provided an estimate of about 1,000 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 1967-1970 to an average of 47,700 mt during 1978-1979. In 1981, total catches increased further to 61,200 mt; provisional statistics for 1983 indicate catches of 51,000 mt (Table 19, Figure 12). Canadian and USA comercial figures for some 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/hour fished) increased sharply in 1979, and the 1981-1982 average for 501-999 GT trawlers (1.3 mt/hr) is twice the corresponding 1974-1977 average (0.7 mt/hr). The USA index for 51-500 GT trawlers, however, has fluctuated without a definite trend since the early 1970's. The Canadian summer survey index declined from 3.5 fish/tow in 1970 to 1.3 in 1975 before rising sharply to 6.8 in 1977. The 1980 index value (9.5 fish/tow) was the highest observed in the time series, although the 1981 and 1982 values declined to 2.1 and 4.7 fish/tow, respectively. The USA spring survey index increased to a peak of 6.5 kg/tow in 1976 before declining to an average of 3.5 kg/tow in 1978-1980, comparable to the 1972-1974 average of 3.8 kg/tow. The spring index declined steadily from 4.9 kg/tow in 1981 to 1.1 kg/tow in 1983. The USA autumn survey index peaked at 6.7 kg/tow in 1976 and then declined to an average of 3.5 kg/tow during 1978-1980, still relatively high compared to the time series as a whole. During 1981-1983, however, autumn survey indices declined further to 1.0 kg/tow. 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 biomass (ages 2 and older) from 176,000 mt in 1973-1974 to 322,000 mt in 1981 before declining to 296,000 mt in 1983 (Figure 12). Equilibrium yield calculations indicate that fishing at $F_{0.1}$ would provide a long-term catch of 56,000 mt from a stock biomass of 338,000 mt, while fishing at F_{max} would provide a catch of 61,000 mt from a stock biomass of 225,000 mt. Harvests in 1982-1983 appear to have generated fishing mortality levels approximately equal to $F_{0.1}$.

For further information see:

McGlade, J., M.C. Annand, and D. Beanlands. 1983. Stock status of pollock in NAFO Division 4VWX and Subarea 5. CAFSAC Res. Doc. 83/34, 33 p.

Mayo, R.K., and S.H. Clark. 1984. An assessment of the pollock (Pollachius virens L.) stock in the Scotian Shelf, Gulf of Maine, and Georges Bank region. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 84-13, 42 p.

Table 19. Nominal catches (thousand metric tons) and management information for pollock from the Gulf of Maine, Georges Bank, and Scotian Shelf area, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational[1]	1.6	0.6	2.7	1.8	1.8	2.1	2.3	2.0	2.0
Commercial									
USA	7.0	10.9	13.1	17.7	15.5	18.3	18.2	14.4	14.0
Canada	21.7	23.6	24.7	26.8	30.0	36.0	40.3	38.0	35.0
Other	7.5	3.2	0.7	0.8	1.1	1.2	0.5	0.4	-
Total nominal catch	37.8	38.3	41.2	47.1	48.4	57.6	61.2	54.8	51.0
Total allowable catch	-	55.0	30.0[2]	-	-	-	-	-	-

Long-term potential catch = 56.0
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)

$M = 0.20$ $F_{0.1} = 0.25$ $F_{max} = 0.49$ $F_{1983} = 0.26$

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

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

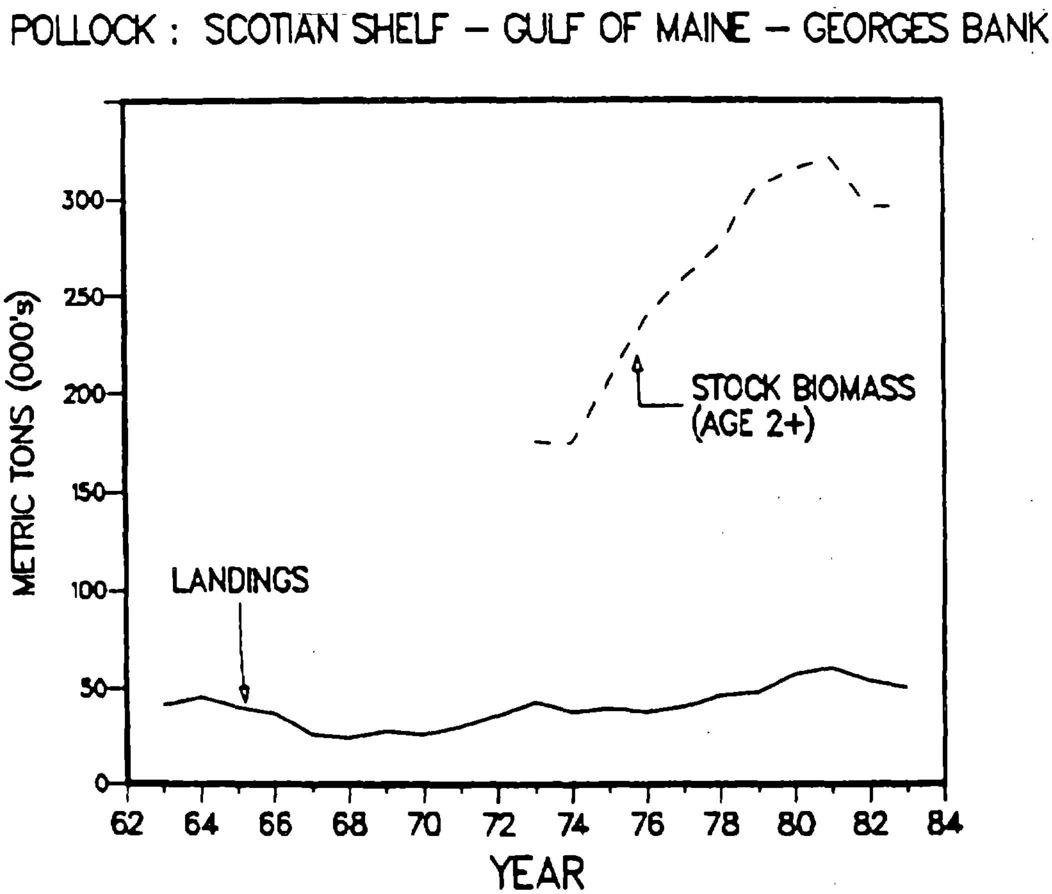

Figure 12. Total commercial and recreational landings and estimates of stock biomass of pollock in the Gulf of Maine, Georges Bank, and Scotian Shelf area.

YELLOWTAIL FLOUNDER

The yellowtail flounder (Limanda ferruginea) ranges from Labrador to Chesapeake Bay and, off the USA coast, occurs in commercially important concentrations on Georges Bank, off Cape Cod, and off southern New England, generally at depths of 37-73 m (20-40 fathoms). Yellowtail commonly attain lengths up to 47 cm (18.5 inches) and weights 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.

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 are also fished commercially in the Mid-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 the Cape Cod, southern New England, and Mid-Atlantic unit (west of 69°W).

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 MFCMA restrictions. Nominal catches subsequently averaged 16,100 mt during 1979-1981, but rose to 25,000 mt in 1982 and to 33,066 mt in 1983, the highest since 1972. The sharp increase observed during 1982-1983 appears to be due to increased landings primarily from the southern New England grounds and to a removal of quotas under the Interim Management Plan. Nominal catches for the northern Gulf of Maine, although limited, increased from an average of 100 mt during 1973-1974 to approximately 470 mt during 1980-1982; preliminary 1983 landings total 324 mt.

Implementation of optimum yields (OY's) and other restrictions under MFCMA resulted in extensive misreporting (or nonreporting) of landings; discard information for recent years is also inadequate. In response to these and other problems, the Atlantic Demersal Finfish Plan (ADF) is currently being developed. An Interim Management Plan was implemented on 31 March 1982. The Interim Plan redefined OY for yellowtail flounder as the amount actually harvested by USA fishermen in accordance with other Plan provisions which include mesh regulations by area, a minimum possession size of 28 cm (11 inches), and a voluntary data reporting system.

Georges Bank (East of 69°W)

Nominal catches declined precipitously from an average of 15,300 mt during 1970-1974 to only 4,600 mt in 1978; subsequent catches have increased steadily. The preliminary value for 1983 (11,440 mt) is the largest since 1976, but remains 25% lower than the average value observed in the early 1970's (Table 20, Figure 13). The commercial abundance index for Georges Bank (mt/day fished) increased slightly in the 1982-1983, but remained comparable to the relatively low values observed during the early 1970's. The 1980 and 1979 year classes dominated landings in 1982 (53% and 29% of the total number, respectively). Reported trip discard rates for Georges Bank were as high as 30% (by weight) in 1982, but appeared to decline somewhat in 1983. NEFC spring and autumn survey indices declined throughout the 1970's, but increased substantially in 1980 (Figure 13). Subsequent indices have been conflicting; the spring 1980-1983 data suggest higher levels of abundance and biomass than in the late 1970's, but autumn data indicate no improvement. Recent indices have been substantially below the levels observed in the late 1960's and early 1970's. Survey catch-per-tow-at-age data suggest that most recent year classes have been relatively weak. Fishing mortality appears to have exceeded F_{max} in recent years.

Table 20. Nominal catches (thousand metric tons) and management information for yellowtail flounder from the Georges Bank area (east of 69°W), 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	14.1	11.4	9.5	4.5	5.5	6.7	6.4	10.6	11.4
Canada	<0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	0.1
Other	0.8	-	-	-	-	-	-	-	-
Total nominal catch	14.9	11.4	9.5	4.6	5.5	6.8	6.4	10.6	11.4
Total allowable catch	-	16.0	10.0	4.4	4.5[1]	5.0[2]	5.0[2]	-	-

Long-term potential catch = 16.0
Importance of recreational fishery = Insignificant
Status of management = Interim FMP in effect since 31 March 1982
Status of exploitation = Fully exploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 26 cm (10 inches)

$M = 0.20$ $F_{0.1} = 0.30$ $F_{max} = 0.50$ $F_{1983} = >F_{max}$

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

[2] Represents USA allocations for Calendar Years 1980 and 1981 under Final Supplement No. 4 to the FMP for Atlantic Groundfish (effective September 1981).

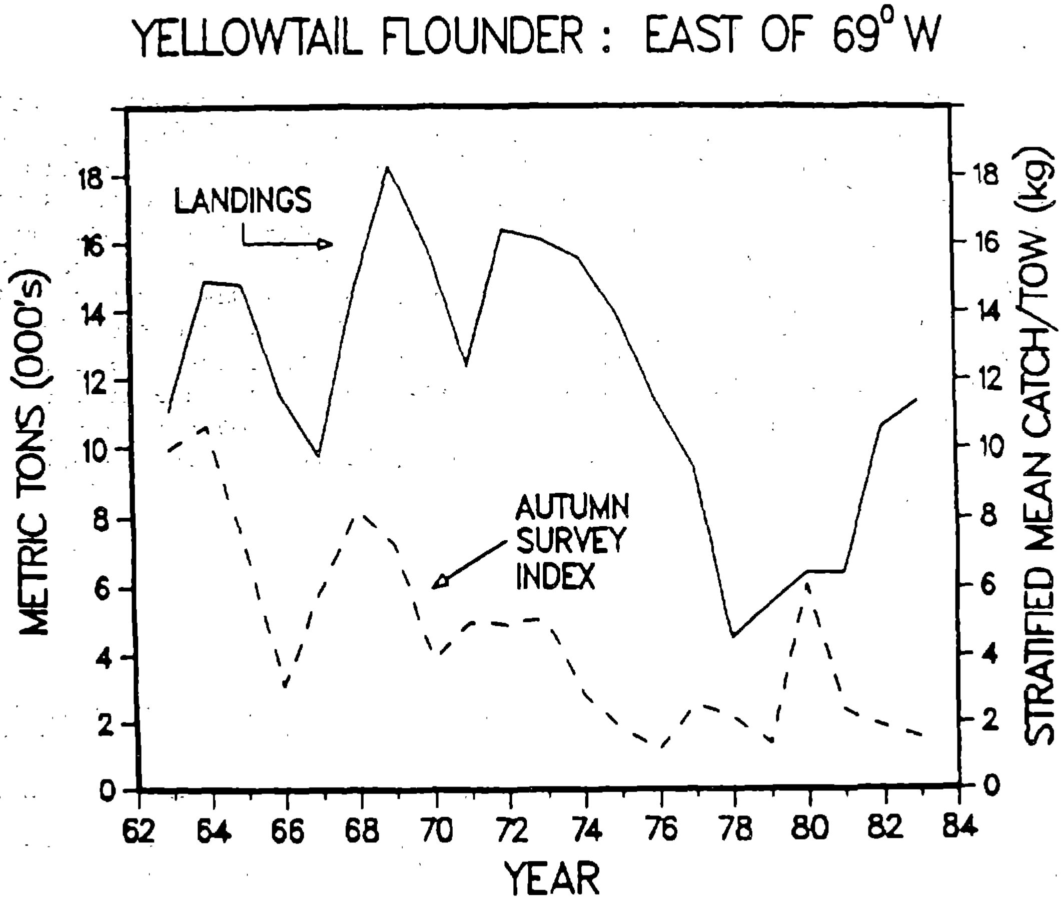

Figure 13. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of yellowtail flounder on Georges Bank east of 69°W longitude.

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

Nominal catches declined from an average of 17,700 mt during 1970-1974 to only 6,200 mt during 1975-1978. Subsequent catches increased substantially in 1982-1983 (21,363 mt in 1983), particularly for southern New England (Table 21, Figures 14-16). Increased catches in 1982-1983 appear to be related to the elimination of quota restrictions under the Interim Plan and recruitment of the strong 1980 year class which comprised over 54% (by number) of the southern New England 1982 landings. Discard levels increased substantially in 1982 as reported trip discard rates ranged from 25 to 80% (by weight), but appeared to decline somewhat in 1983.

NEFC survey data for southern New England indicate pronounced declines in abundance and biomass to minimal levels in the mid-1970's, followed by substantial increases in recent years (Figure 14). The offshore spring biomass index rose from 2.2 kg/tow in 1979 to 10.4 kg/tow in 1982; similarly, the autumn index increased from 2.0 kg/tow in 1980 to 8.1 kg/tow in 1982. While survey indices for 1982 were substantially above those observed during the low in the mid-1970's, they remained below the peak levels observed in the mid-late 1960's. Spring 1983-1984 and autumn 1983 indices declined, however. Recruitment has improved since the mid-1970's, with the 1979 and 1980 year classes being perhaps the strongest in recent years; however, year classes subsequent to 1980 do not appear as strong. The 1980 year class appears to have been severely reduced in number by heavy fishing in 1982. Fishing mortality has exceeded F_{max} in recent years.

Stratified mean catch per tow of yellowtail flounder from surveys conducted cooperatively by the Rhode Island Division of Fish and Wildlife and the NEFC remained approximately constant in 1980 and 1981 and then increased sharply in 1983. This survey also indicated that the 1979 and 1980 year classes were the strongest observed in recent years, with the 1980 year class being the strongest. These results are generally consistent with those from NEFC surveys.

The situation for the Mid-Atlantic area (Figure 15) appears comparable to that observed for southern New England. NEFC spring and autumn survey indices declined to minimal levels by the mid-1970's and then increased somewhat during 1980-1982. Since 1982, however, these indices have declined. The 1979 and 1980 year classes also appear to have been the strongest in recent years.

NEFC survey indices for Cape Cod yellowtail have fluctuated considerably, indicating no clear trends (Figure 16). Abundance and biomass indices were quite low during the mid-1970's. There were subsequent increases evident through 1982, but indices since then have declined. Despite low survey indices, the Cape Cod fishery has typically been more stable than those from southern New England or Georges Bank. There is no evidence to suggest that total catches of 2,000-3,000 mt (the approximate 1960-1982 average) would adversely affect this resource.

For further information see:

McBride, M.M., and S.H. Clark. 1983. Assessment status of yellowtail flounder (Limanda ferruginea) stocks off the northeast United States, 1983. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 83-32, 23 p.

Table 21. Nominal catches (thousand metric tons) and management information for yellowtail flounder from the southern New England, Cape Cod, and Mid-Atlantic areas (west of 69°W), 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	<0.1	-	-	-	-
Commercial									
USA	13.3	5.5	6.8	6.4	10.1	11.4	8.7	13.8	21.4
Canada	<0.1	<0.1	-	<0.1	-	-	-	-	-
Other	0.7	<0.1	<0.1	-	-	-	-	-	-
Total nominal catch	14.3	5.5	6.8	6.4	10.1	11.4	8.7	13.8	21.4
Total allowable catch	-	4.0	6.0	3.7	4.0[1]	5.0[2]	5.0[2]	-	-

Long-term potential catch = 23.0
Importance of recreational fishery = Insignificant
Status of management = Interim FMP in effect since 31 March 1982
Status of exploitation = Fully exploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 26 cm (10 inches)

$M = 0.20$ $F_{0.1} = 0.30$ $F_{max} = 0.50$ $F_{1983} = >F_{max}$

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

[2] Represents USA allocations for Calendar Years 1980 and 1981 under Final Supplement No. 4 to the FMP for Atlantic Groundfish (effective September 1981).

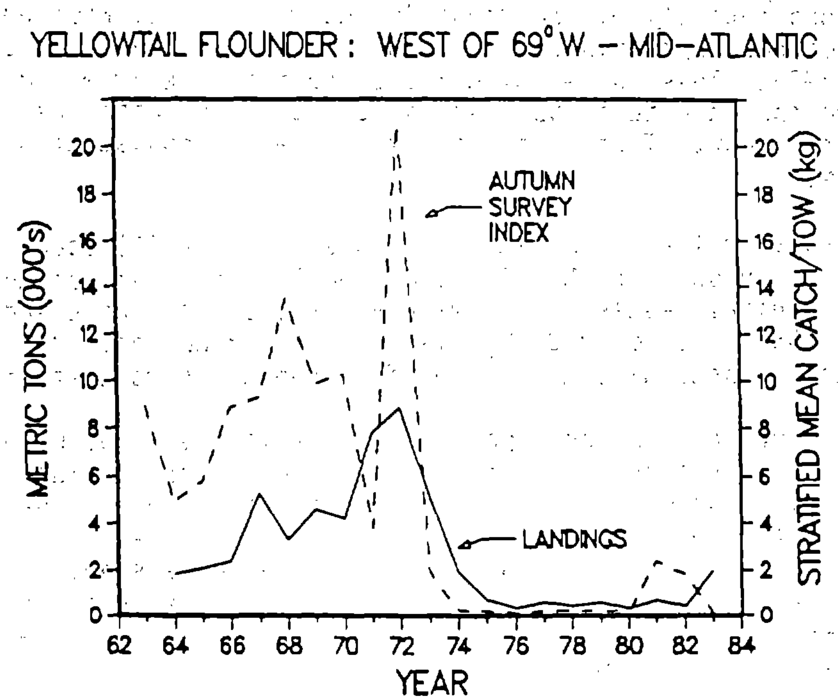

Figure 14. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of yellowtail flounder west of 69°W longitude (southern New England).

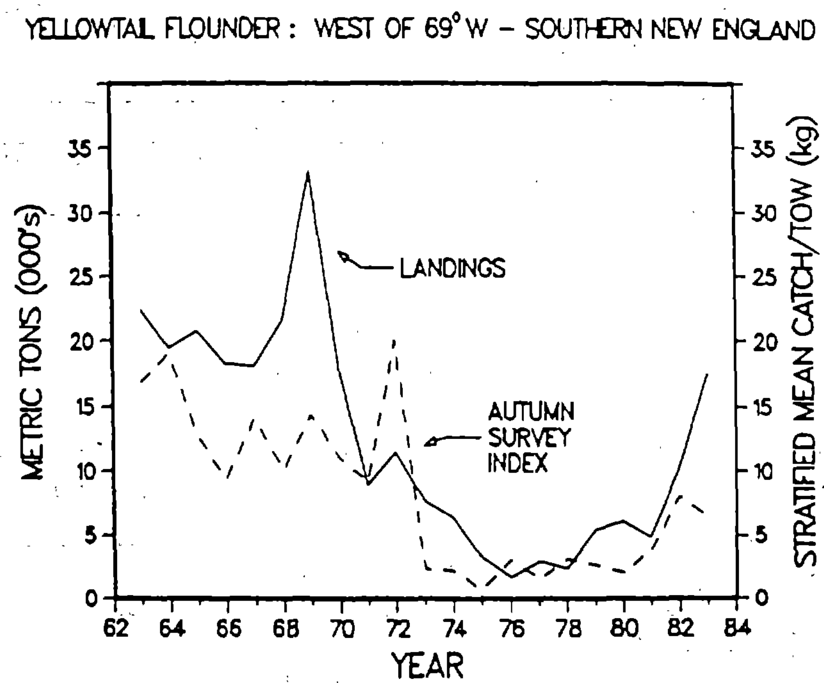

Figure 15. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of yellowtail flounder west of 69°W longitude (Mid-Atlantic).

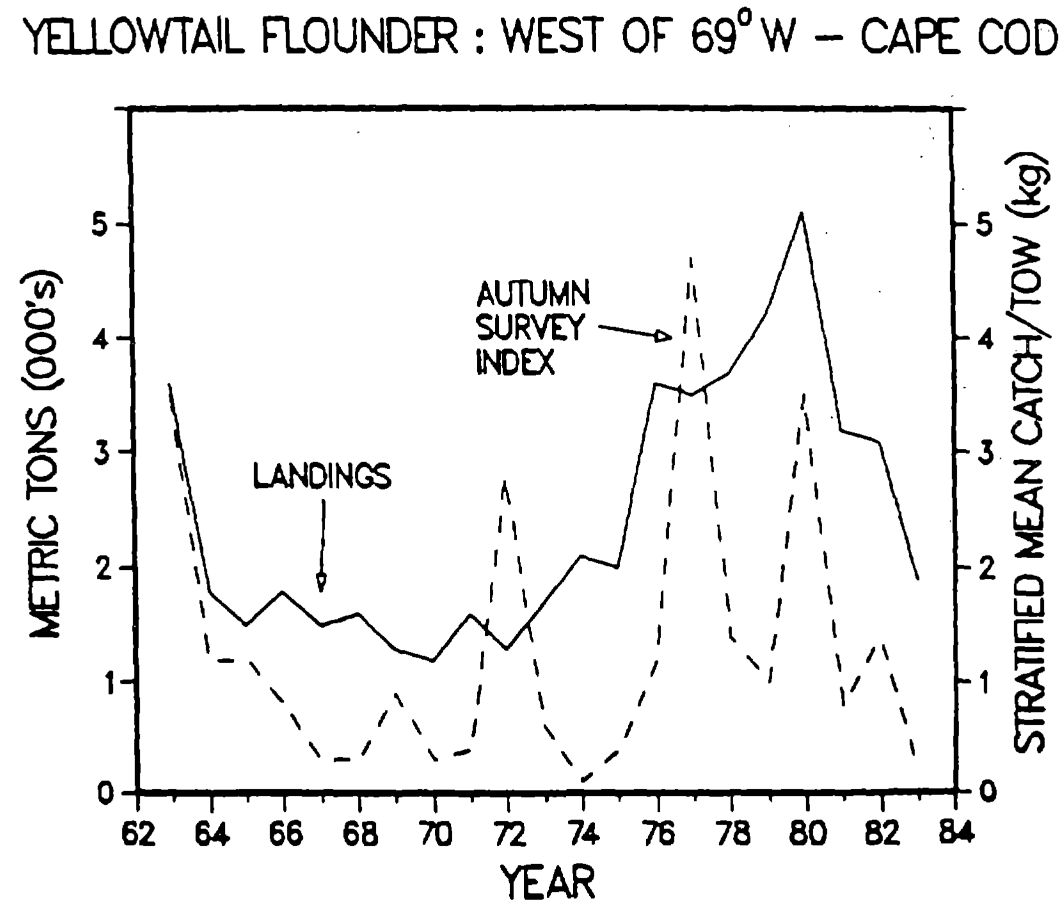

Figure 16. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of yellowtail flounder west of 69°W longitude (Cape Cod).

SUMMER FLOUNDER

The summer flounder or fluke (Paralichthys dentatus) occurs from the southern Gulf of Maine to South Carolina. Important commercial and recreational fisheries for summer flounder exist within the Mid-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 autumn 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 attaining weights up to 11.8 kg. Female summer flounder may live up to 20 years, but males rarely exceed 7 years.

Nominal commercial catches 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 USA nominal catch in 1983 was 11,780 mt, a 16% increase relative to the 1982 level of 10,150 mt and considerably below the peak 1979 catch of 14,500 mt (Table 22). 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). The 1980 recreational catch estimate was 14,700 mt, with an additional 4.62 million fish caught and released alive. Since the inception of the MFCMA, nominal catches by foreign vessels have not exceeded 52 mt; Japanese vessels reported taking 41 mt in 1981 and 5 mt in 1982.

Stock biomass is currently at a higher level than during the late 1960's - early 1970's, based on NEFC survey indices. The spring survey index rose from 0.06 kg/tow in 1970 to a peak of 0.99 kg/tow in 1976 (Figure 17). Following a sharp drop to 0.17 kg/tow in 1982, the index again increased to 0.79 kg/tow in 1982, but fell to 0.44 kg/tow in 1983. Catch curve analysis of survey and commercial age composition data collected during 1976-1979 indicated fishing mortality rates of about 0.8, well in excess of F_{max}. Although mortality estimates are not available for the last several years, they are assumed to still be above F_{max}. Analyses indicate that yield per recruit and long-term yield can be increased significantly by increasing the minimum size of fish caught and reducing fishing mortality.

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

Lange, A.M.T. 1984. Long-term effects of change in mesh size on yield of summer flounder. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 84-04, 14 p.

Table 22. Nominal catches (thousand metric tons) and management information for summer flounder from the Georges Bank - Mid-Atlantic area, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational[1]	15.8[2]	-	-	-	8.6	14.7	-	-	-
Commercial									
USA	5.0	10.8	8.9	8.5	14.5	11.5	7.9	10.2	11.8
Canada	-	-	-	-	-	-	-	-	-
Other	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total nominal catch[3]	5.3	10.8	8.9	8.5	14.5	11.5	7.9	10.2	11.8
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = 15.0-20.0
Importance of recreational fishery = Major
Status of management = FMP in preparation
Status of exploitation = Fully exploited
Age at 50% maturity = 2 yrs (females)
Size at 50% maturity = 32 cm (12.6 inches)

$M = 0.20$ $F_{0.1} = 0.16$ $F_{max} = 0.19$ F_{1983} = Unknown

[1] Estimates available only for 1979 and 1980.

[2] 1974 estimate.

[3] Commercial only.

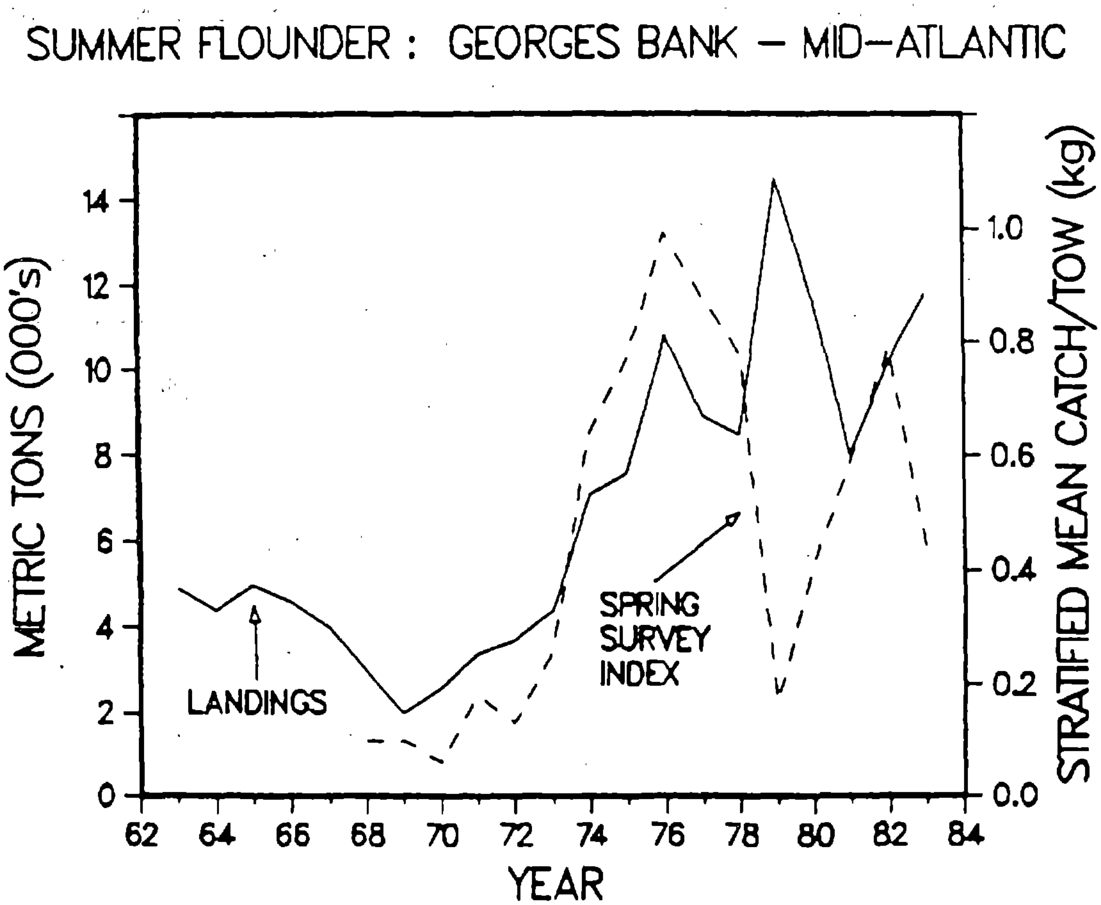

Figure 17. Total commercial landings and stock biomass indices from NEFC spring bottom trawl surveys of summer flounder in the Georges Bank - Mid-Atlantic area.

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, the greatest commercial concentrations exist between 90 and 182 m (50-100 fathoms). Sexual maturity begins 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 and 28 cm (9-11 inches) in length and weigh between 90 and 190 g (0.2-0.4 pounds). After age 4, females grow faster than males.

Total 1983 commercial landings of American plaice from the Gulf of Maine - Georges Bank region were 13,160 mt, 13% less than the record 1982 catch, but still the third highest ever (Table 23, Figure 18). Since 1979, annual landings have averaged 13,250 mt, about fourfold higher than the 1960-1978 annual average of 3,550 mt. USA commercial CPUE indices sharply increased in 1977 and have subsequently remained at historically high levels. Recent commercial landings have been dominated by the 1976 and 1977 year classes, with age groups 4-9 well represented in the catch.

Prior to 1975, most USA landings were from deepwater areas along the northwest edge of Georges Bank. Subsequently, however, landings by small vessels from the west-central Gulf of Maine have exceeded those by larger vessels fishing on Georges Bank. In 1983, Gulf of Maine catches accounted for 69% of the USA total plaice catch and were 2-3 times greater than those from Georges Bank.

Landings trends have generally paralleled trends in NEFC autumn survey indices (Figure 18). The 1983 spring and autumn survey indices were higher than in 1982 and were among the upper third of values in both the spring and autumn series. Survey age composition data indicate that a number of strong year classes have been produced since 1975, with the 1980 and 1981 year classes among the strongest in recent years.

Despite record annual landings, stock abundance has remained relatively high due to improved recruitment. Given these conditions, annual landings near present levels should be sustainable during the next few years.

For further information see:

Sullivan, L.F. 1982. American plaice, Hippoglossoides platessoides, in the Gulf of Maine. MA Thesis, Univ. of Rhode Island, Kingston, RI, 96 p.

Table 23. Nominal catches (thousand metric tons) and management information for American plaice from the Gulf of Maine - Georges Bank area, 1971-1983.

Category	Year 1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	2.0	3.5	7.1	9.5	11.4	13.5	12.9	15.1	13.2
Canada	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other	0.4	<0.1	0.2	<0.1	0.1	-	<0.1	-	-
Total nominal catch	2.4	3.5	7.3	9.6	11.5	13.6	12.9	15.2	13.2
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 inches) males; 29.7 cm (11.7 inches) female

$M = 0.20$ $F_{0.1} = 0.17$ $F_{max} = 0.34$ F_{1983} = Unknown

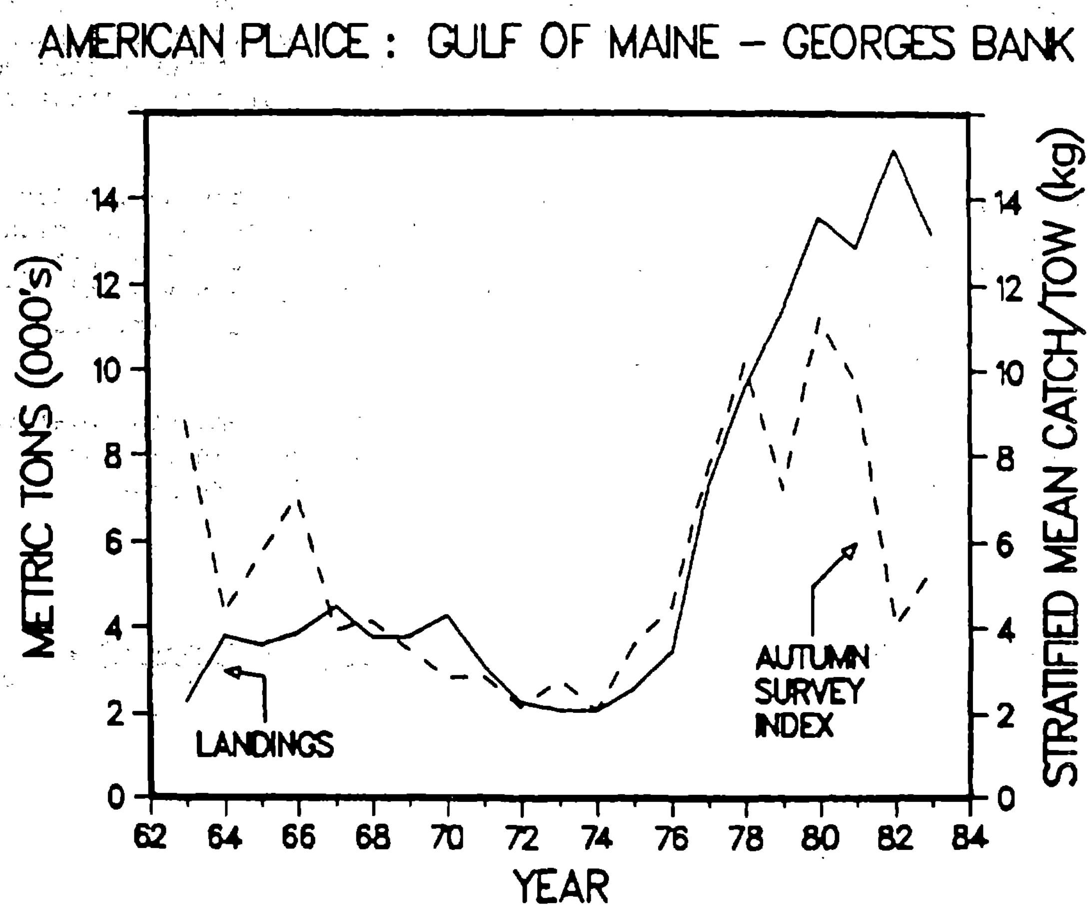

Figure 18. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of American plaice in the Gulf of Maine - Georges Bank area.

WITCH FLOUNDER

The witch flounder or gray sole (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 areas; few fish are taken shoaler than 27 m (15 fathoms) and most are caught between 110 and 275 m (60-150 fathoms). Spawning occurs in late spring and summer. Witch flounder attain lengths up to 60 cm (24 inches) and weights of approximately 2 kg (4.5 pounds).

Since 1960, the USA nominal catch has been distributed almost evenly between Georges Bank and the Gulf of Maine, although in recent years most of the USA catch has come from the latter area. No recreational catches have been reported for this species. 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 1971-1972, 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 24, Figure 19). Nominal catches for 1978-1981 averaged 3,300 mt, but rose sharply to 5,100 mt in 1982 and 5,800 mt in 1983.

NEFC autumn survey indices seem to accurately reflect trends in biomass (Figure 19). Heavy exploitation by distant-water fleets in 1971-1972 was followed by a decline in the autumn index from an average of 3.6 kg/tow in 1966-1970 to 1.0 kg/tow in 1976. The stock recovered somewhat in 1977-1978, but a declining trend has since been evident. Given this trend, it is unlikely that recent catch levels can be sustained.

For further information see:

Burnett, J., and S.H. Clark. 1983. Status of witch flounder in the Gulf of Maine - 1983. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 83-36, 31 p.

Table 24. Nominal catches (thousand metric tons) and management information for witch flounder from the Gulf of Maine - Georges Bank area, 1971-1983.

Category	Year 1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	2.5	1.8	2.5	3.5	3.0	3.4	3.3	5.1	5.8
Canada	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other	1.3	<0.1	-	<0.1	-	-	-	-	-
Total nominal catch	3.7	1.8	2.5	3.5	3.0	3.4	3.3	5.1	5.8
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = Unknown
Importance of recreational fishery = Insignificant
Status of management = None
Status of exploitation = Fully exploited
Age at 50% maturity = 5 yrs (males); 6-7 yrs (females)
Size at 50% maturity = 29 cm (11.4 inches) males; 36 cm (14.2 inches) females

M = 0.20 $F_{0.1}$ = Unknown F_{max} = Unknown F_{1983} = Unknown

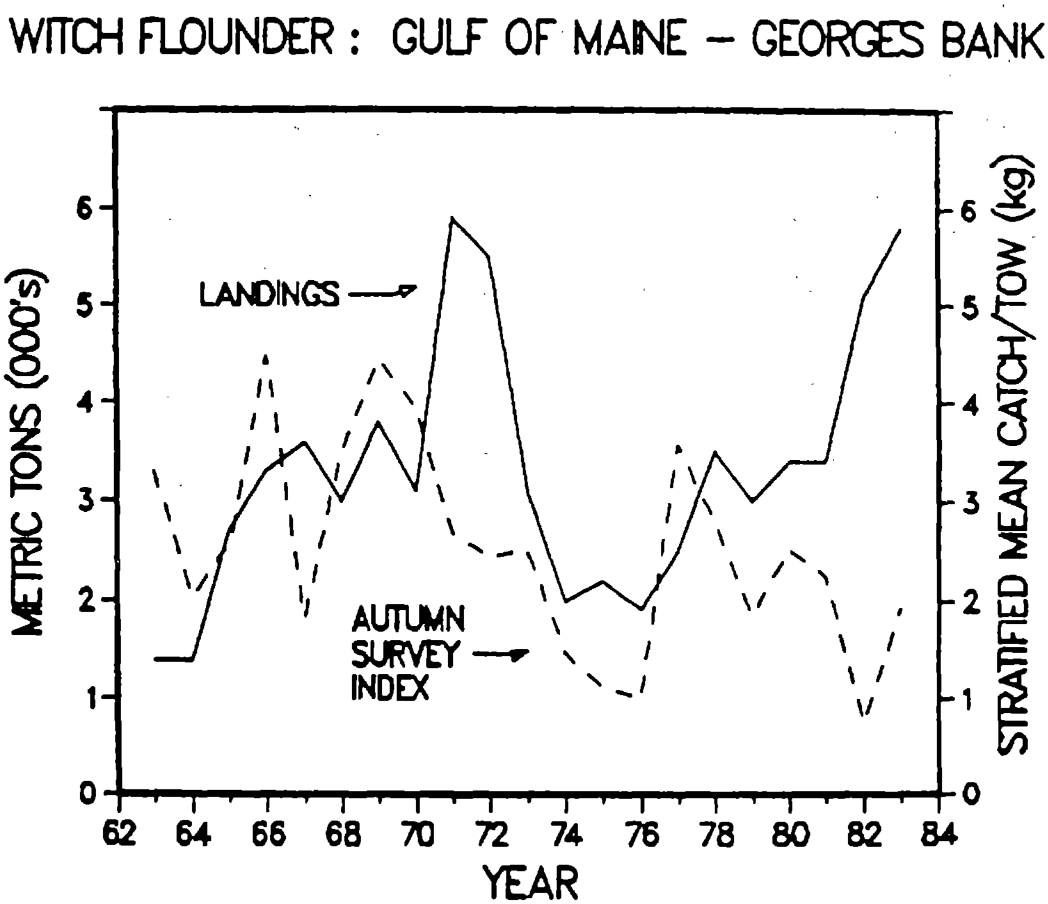

Figure 19. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of witch flounder in the Gulf of Maine - Georges Bank area.

WINTER FLOUNDER

The winter flounder, blackback, or lemon sole (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 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-waters 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.

For descriptive purposes, the winter flounder resource and fishery has been divided into four geographic groups which may comprise approximate boundaries to various local distributions: Gulf of Maine, Georges Bank, southern New England, and Mid-Atlantic. Winter flounder are typically exploited in coastal locations, although offshore shoal areas, particularly Georges Bank and Nantucket Shoals, support important winter flounder fisheries.

The USA nominal commercial catch of winter flounder has increased substantially in recent years (Table 25, Figure 20). The USA nominal catch of winter flounder has remained at around 15,500 mt between 1982 and 1983, somewhat below the record high landings of about 17,500 mt during 1980-1981. The 1977-1979 average commercial yield of 11,800 mt is comparable to that sustained during 1965-1971, a period of relatively high yield. The nominal catch of winter flounder by foreign vessels in 1982 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 10,300 mt, a 35% reduction from the estimated 1974 level of 15,800 mt. Due to a change in recreational survey methodology, however, the 1979 estimate is not directly comparable to previous estimates.

The 1983 NEFC autumn survey index (2.1 kg/tow) was within the range of values observed after 1976 (1.4-2.8 kg/tow), but below the recent high in 1981 (2.8 kg/tow) (Figure 20). Between 1971 and 1975, the index was generally lower than during any other time.

In the Gulf of Maine, commercial landings declined from a peak of 2,800 mt in 1982 to about 2,100 in 1983. Commercial landings had previously been increasing steadily from a low in 1975 of 1,200 mt. Catch per unit effort in 1982-1983 was somewhat lower than during 1980-1981. NEFC spring survey indices have exhibited a steadily increasing trend since 1975, but autumn indices indicate a potential decline in stock abundance in 1982-1983 compared to relatively high levels in 1980-1981.

On Georges Bank, commercial landings have remained at fairly high levels since 1980 and were about 3,900 mt in 1983. Catch per unit effort in 1982-1983 was slightly lower than in 1980-1981, but higher than the low levels observed during 1975-1976. Survey indices declined from the late 1970's until 1980, increased somewhat in 1981 and 1982, with no clear trend in 1983. Recent fishing effort has increased.

In southern New England, commercial landings declined from a peak in 1981 of over 11,000 mt to 9,300 mt in 1983. Recent catches had increased from 1975-1979 levels (3,700-5,800 mt). Catch per unit effort peaked during 1980-1981, but declined somewhat in 1982-1983. Both spring and autumn survey indices increased from low levels in 1975 to high levels in 1981; 1982 and 1983 indices were below the median, however. Current stock abundance appears to be much lower than several years ago. The proportion of large market category fish in the landed catch has been declining steadily since 1975, while the proportions of small and "peewee" fish have been increasing. Directed fishing effort has been increasing.

In the Mid-Atlantic region, reported commercial landings have fluctuated about low levels, with only 60 mt reported in 1983. Survey indices were relatively high in 1967-1969, dropped to low levels between 1975 and 1978, and increased to marginally higher levels between 1979 and 1983. Since this region constitutes the southern-most extent of the range of winter flounder, abundance and catch levels would be expected to be rather low.

For further information see:

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

Table 25. Nominal catches (thousand metric tons) and management information for winter flounder from the Gulf of Maine - Mid-Atlantic area, 1971-1983.

Category	Year 1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	8.6	-	-	-	10.3	7.5	-	-	-
Commercial									
USA	9.0	6.7	10.6	12.3	12.2	17.4	17.7	15.4	15.5
Canada	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other	1.4	<0.1	<0.1	-	-	-	-	-	-
Total nominal catch[1]	10.4	6.7	10.6	12.4	12.2	17.4	17.7	15.4	15.5
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_{1983} = Unknown

[1] Commercial only.

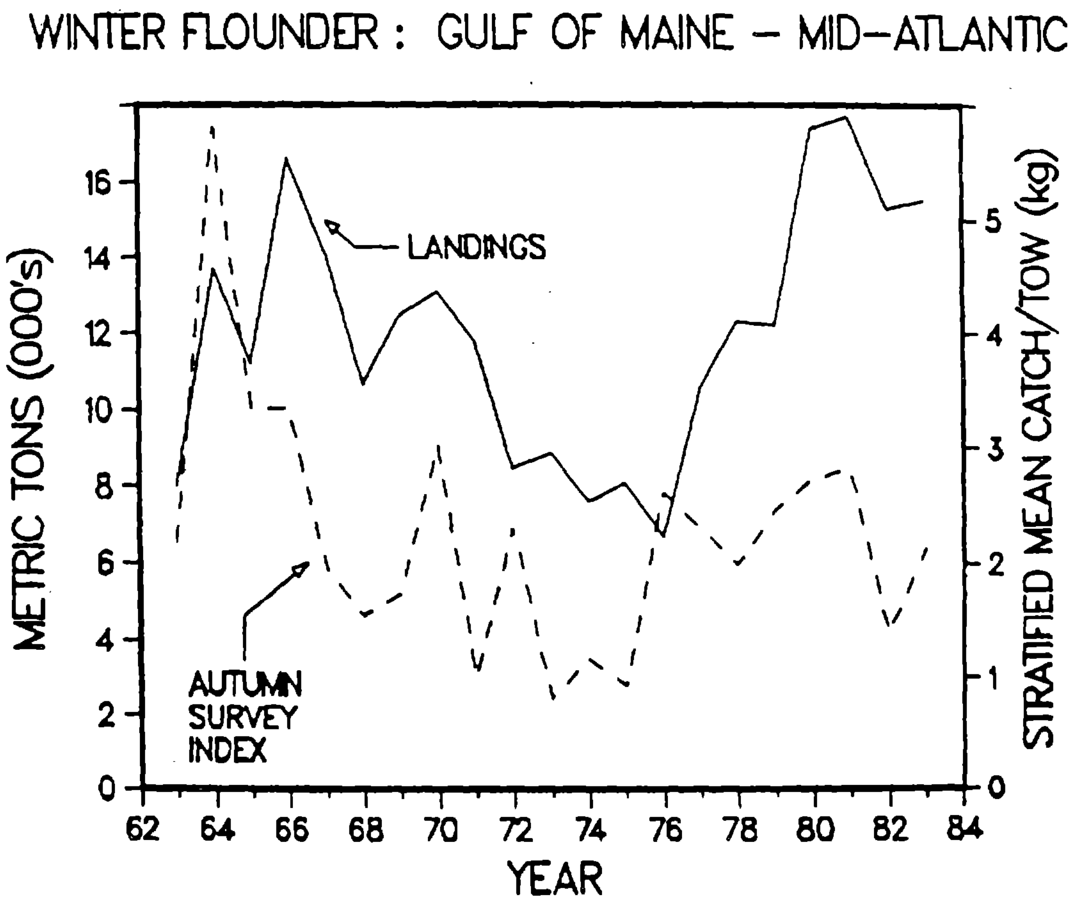

Figure 20. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of winter flounder in the Gulf of Maine - Mid-Atlantic area.

SCUP

Scup or porgy (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 (8 inches); spawning occurs during summer months. Although ages up to 20 years have been reported, recent catches have been dominated by age 2-3 fish. Scup attain a maximum length of about 40 cm (16 inches). 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 26, Figure 21). Nominal catches by distant-water fleets peaked at 5,900 mt in 1963, but declined to less than 100 mt per year after 1975. Estimated recreational catches declined from 7,500 mt in 1960 to 2,800 mt in 1974; the 1980 estimate was 3,900 mt. In general, the estimated recreational catch represents approximately 20-40% of the total nominal catch in those years for which comparisons are available. Assuming that recreational catches in years lacking survey estimates were in about the same proportion to commercial catches as in years when survey estimates were available, total catches (commercial and recreational) during 1974-1980 were fairly steady at around 11,000 mt per year. After increasing to about 13,800 mt in 1981, total estimated catches declined to 12,800 mt in 1982 and 11,300 mt in 1983.

Since the early 1970's, the USA nominal commercial catch has steadily increased and has exceeded 8,000 mt nearly every year since 1977. The 1982 and 1983 catches were 8,700 and 7,800 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 that 500 mt per year; the 1983 nominal catch was 500 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/day fished in 1971 to 6.2 mt/day in 1977 and 1979. Recent values have ranged from 5.5 mt/day in 1981 to 5.0 mt/day in 1983. Age composition data indicate that the 1975, 1977, and 1979 year classes have dominated recent landings. The NEFC autumn survey index (ages 1 and older) increased sharply from 1979 to the second highest value in the time series in 1981, but dropped markedly in 1982 and 1983 to some of the lowest levels observed (Figure 21). In recent years, stock abundance appears to have been considerably lower in the Mid-Atlantic area than in the southern New England area.

Instantaneous fishing mortality (F) in the southern New England area was estimated to be about 0.3 in 1981. Estimates have not been made for 1982 or 1983. Relative exploitation rates declined throughout the 1970's in the southern New England area, but increased substantially in the Mid-Atlantic region. All available evidence indicates that this resource is being fully exploited, particularly in the Mid-Atlantic region.

For further information see:

Mayo, R.K. 1982. An assessment of the scup, Stenotomus chrysops (L.), population in the southern New England and Mid-Atlantic regions. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 82-46, 59 p.

Table 26. Nominal catches (thousand metric tons) and management information for scup from the southern New England - Mid-Atlantic area, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational[1]	2.2	2.4	2.8	2.5	2.3	3.9	4.0	4.1	3.4
Commercial									
USA	5.6	7.3	8.3	8.9	8.0	7.9	9.8	8.7	7.8
Canada	-	-	-	-	-	-	-	-	-
Other	1.2	0.1	<0.1	<0.1	-	<0.1	<0.1	-	-
Total nominal catch	9.0	9.8	11.2	11.4	10.3	11.8	13.8	12.8	11.3
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = 10.0-15.0
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_{1983} = Unknown

[1] Estimates for 1971-1973 determined by applying interpolated ratios of recreational/commercial catch between 1970 and 1974 to commercial catches; estimates for 1975-1978 determined by applying interpolated ratios between 1974 and 1979 to commercial catches; estimates for 1981-1983 determined by applying the 1980 ratio to commercial catches.

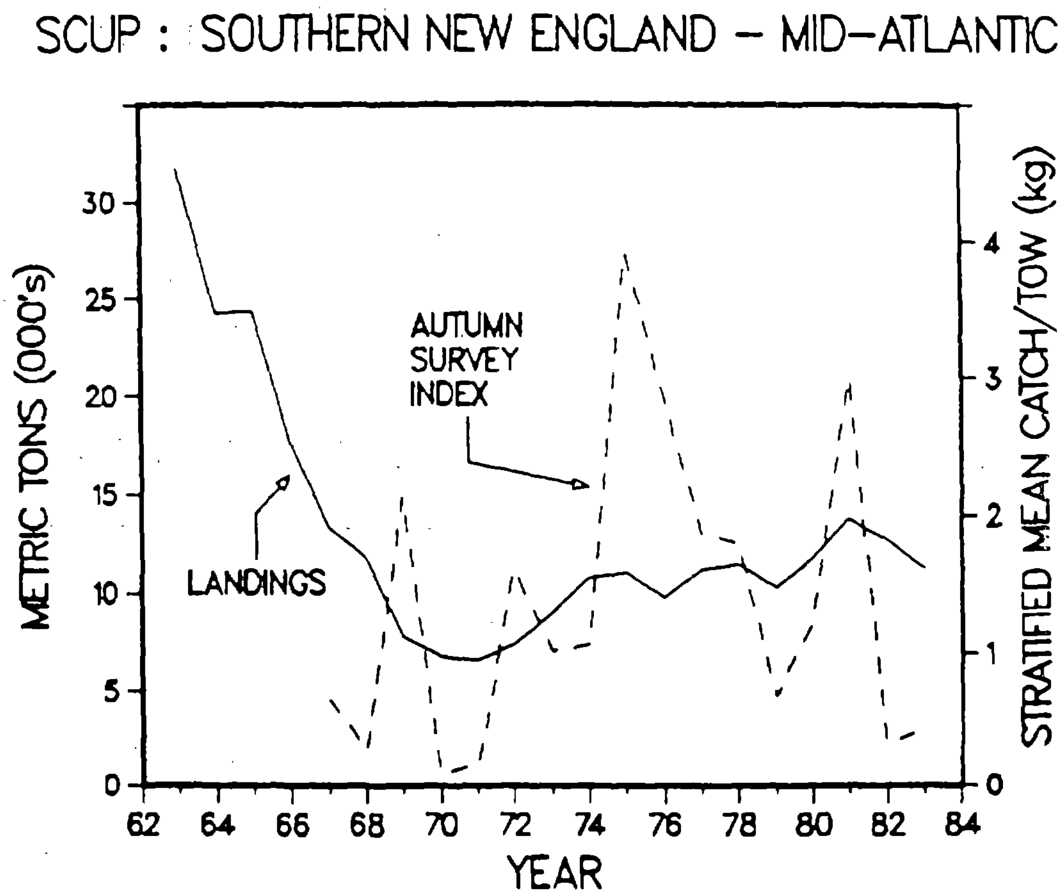

Figure 21. Total commercial and recreational landings and stock biomass indices from NEFC autumn bottom trawl surveys of scup in the southern New England - Mid-Atlantic area.

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 up to 120 cm (47 inches) and weights up to 18 kg (40 pounds).

The USA nominal catch has been taken primarily in the western Gulf of Maine both incidentally to directed operations for other demersal species and as an intended component in mixed fishery situations. During 1968-1983, USA 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 but then rose sharply to 6,100 mt in 1981, 6,800 mt in 1982, and 7,000 mt in 1983 (Table 27, Figure 22). 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 1969, the NEFC autumn survey index has fluctuated around an average of 11.4 kg/tow without any definite trend (Figure 22), while landings have risen to the present high level.

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.

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 27. Nominal catches (thousand metric tons) and management information for white hake from the Gulf of Maine - Georges Bank area, 1971-1983.

Category	Year 1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial									
USA	3.2	3.1	3.9	3.8	3.1	3.6	5.6	6.0	6.2
Canada	0.1	0.2	0.2	0.2	0.3	0.3	0.5	0.8	0.8
Other	0.1	-	0.2	<0.1	<0.1	<0.1	-	-	-
Total nominal catch	3.4	3.3	4.3	4.0	3.4	3.9	6.1	6.8	7.0
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 (16.5 inches)

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1983} = Unknown

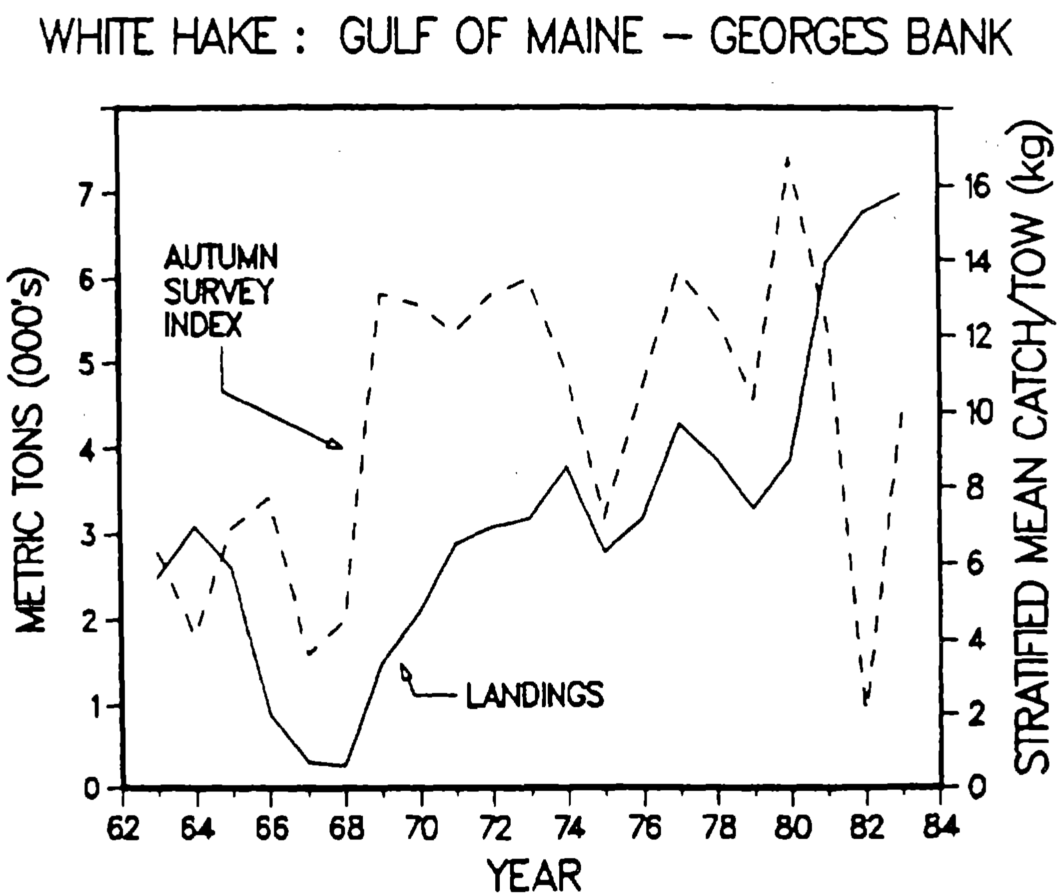

Figure 22. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of white hake in the Gulf of Maine - Georges Bank area.

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 up to 80 cm (32 inches) and weights up to 4.5 kg (10 pounds). Little is known relative to stock structure.

The bulk of the USA 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 USA, with almost all of the remainder being taken by Canada. The 1974 recreational fishery survey provided a catch estimate of 100 mt; however, the 1980 survey indicated a recreational catch of less than 50 mt. The total nominal catch for the Georges - Gulf of Maine area averaged 1,800 mt from 1971 to 1980, but rose sharply to 3,900 mt in 1981, due primarily to a sharp increase in Canadian catches on Georges Bank (Table 28, Figure 23). Landings in 1982-1983 have dropped to under 3,000 mt.

NEFC spring and autumn survey indices have fluctuated considerably, but are consistent in indicating trends in abundance and biomass. The autumn survey index increased from 0.5 kg/tow in 1974 to 2.1 kg/tow in 1980, but has averaged only 0.9 kg/tow since 1980 (Figure 23). This decline parallels decreased commercial landings since 1981.

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.

Table 28. Nominal catches (thousand metric tons) and management information for cusk from the Gulf of Maine - Georges Bank area, 1971-1983.

Category	Year 1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial									
USA	1.1	1.2	1.2	1.5	1.7	1.8	1.8	1.8	1.8
Canada	0.6	0.3	0.2	0.4	0.5	0.6	2.1	1.2	0.6
Other	<0.1	<0.1	-	-	-	-	-	-	-
Total nominal catch	1.7	1.6	1.4	1.9	2.2	2.4	3.9	3.0	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 = Unknown

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1983} = Unknown

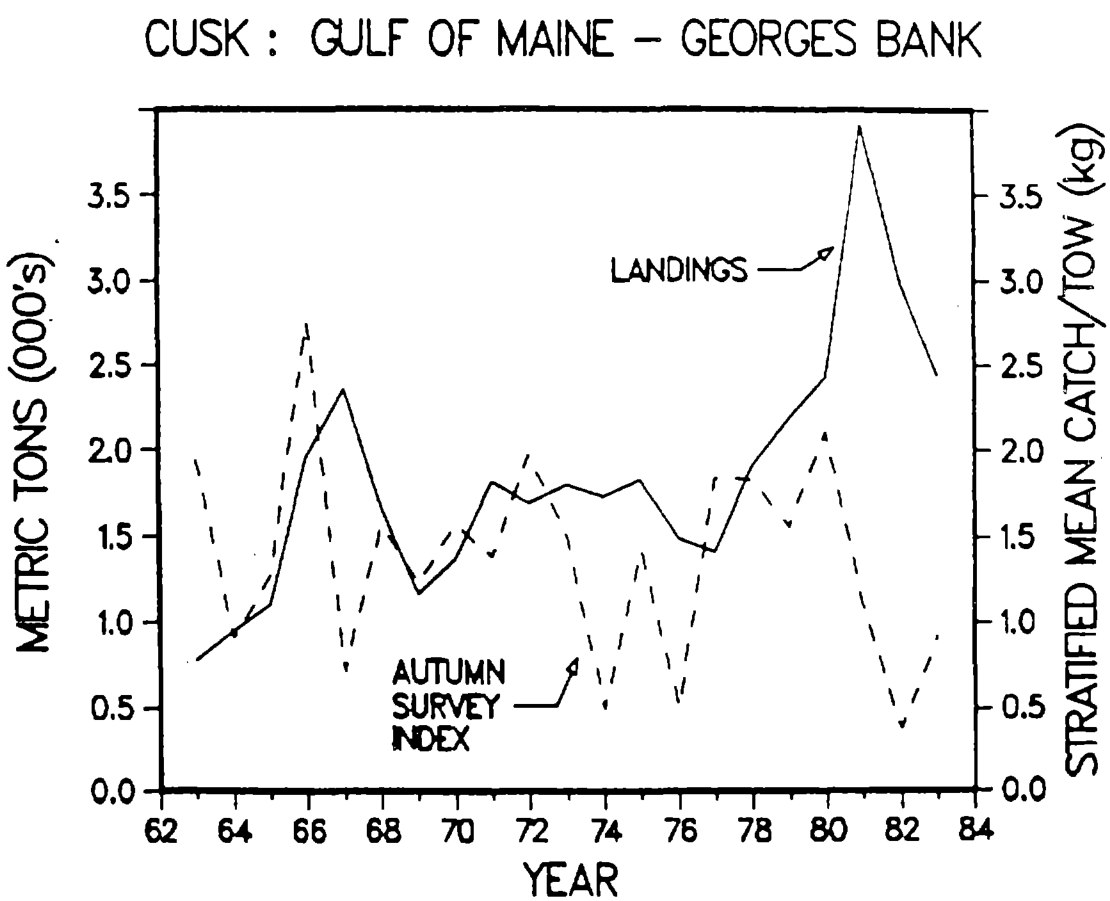

Figure 23. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of cusk in the Gulf of Maine - Georges Bank area.

ATLANTIC WOLFFISH

The wolffish or catfish (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 Jeffreys 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 pounds). They are significant predators of shellfish species.

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 USA nominal commercial catch has been about evenly divided between Georges Bank and the Gulf of Maine. In the last two decades, USA vessels have taken over 75% of the total Georges Bank - Gulf of Maine catch, with most of the remainder taken by Canadian fishermen. Recreational catches since 1978 have averaged 60 mt per year. The total Georges Bank - Gulf of Maine nominal catch increased from 170 mt in 1969 to an average of 1,040 mt in 1980-1982 and a peak of nearly 1,300 mt in 1983 (Table 29, Figure 24). The NEFC spring survey index has fluctuated considerably while exhibiting a downward trend (Figure 24), 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. Fish. Bull., U.S., 53(74):1-577.

Table 29. Nominal catches (thousand metric tons) and management information for Atlantic wolffish from the Gulf of Maine - Georges Bank area, 1971-1983.

Category	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	<0.1	<0.1	<0.1	0.1	0.1	0.1	0.1	0.1	0.1
Commercial									
USA	0.3	0.4	0.4	0.6	0.7	0.9	0.7	0.9	1.2
Canada	<0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1
Other	<0.1	-	-	-	-	-	-	-	-
Total nominal catch	0.4	0.5	0.5	0.9	0.9	1.1	0.9	1.1	1.3
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_{1983} = Unknown

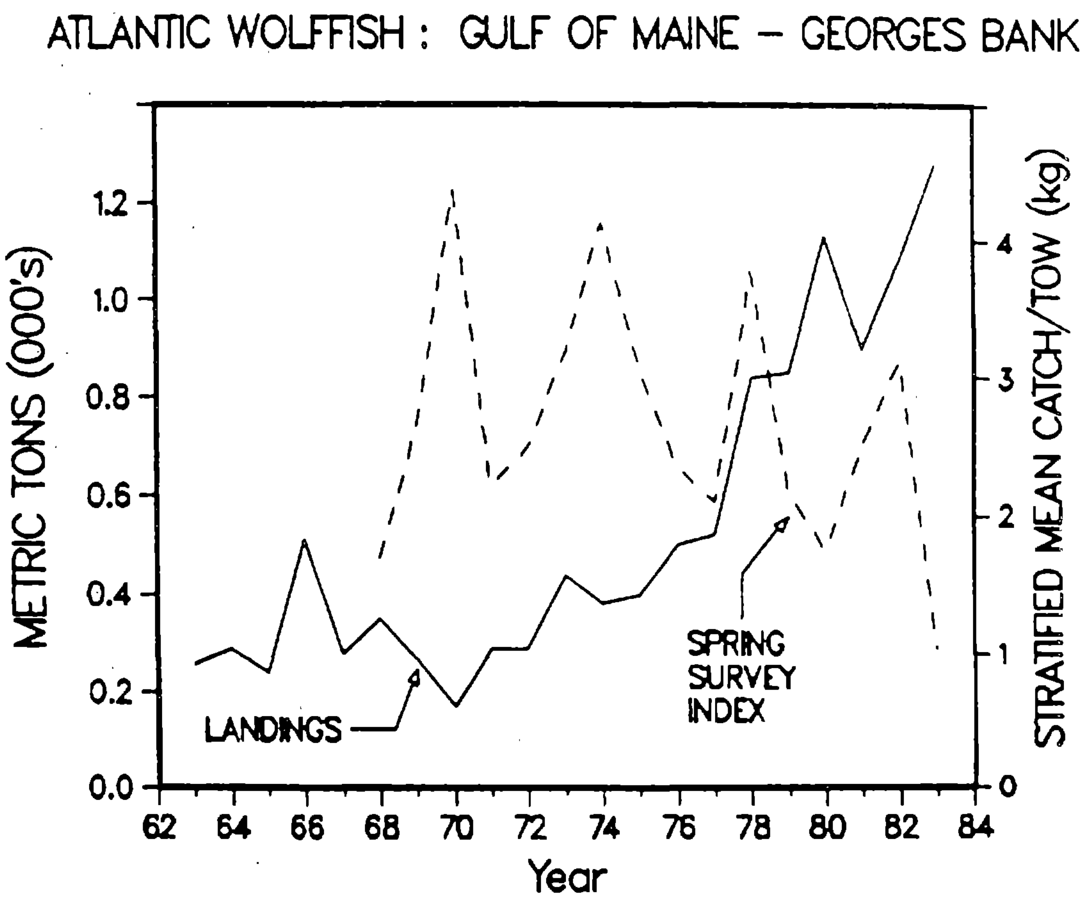

Figure 24. Total commercial landings and stock biomass indices from NEFC spring bottom trawl surveys of Atlantic wolffish in the Gulf of Maine - Georges Bank area.

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 - Mid-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, USA catches increased from about 30 mt in 1968-1969 to 3,840 mt in 1979 (Table 30, Figure 25). Catches declined steadily to about 3,400 mt in 1981 and to approximately 1,800 mt in 1983.

Longlines were the predominant gear used by the USA 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 USA 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 1981-1983. Fishing effort, expressed as standardized tubs of longline (1 tub = 225 hooks and 0.5 mile of line), increased from 2,300 tubs in 1973 to an estimated 44,600 tubs in 1979 and has remained at about that level since. Catch per unit effort (CPUE) decreased from 218.5 kg/tub in 1973 to 46.7 kg/tub in 1983 (Figure 25).

Estimates of fishing mortality (F) derived from virtual population analysis increased from 0.20 (mean F at ages 7 and older) in 1977 to 0.74 in 1981 (M = 0.15), with a slight decrease to 0.65 in 1982. Since fishing effort in 1983 was about the same as in 1982, F in 1983 probably remained at about 0.65. Yield-per-recruit analysis based on an age at first capture of 4 years produced an estimate of $F_{0.1} = 0.17$ and $F_{max} = 0.27$.

Maximum sustainable yield (MSY) for tilefish was estimated from a generalized stock production model to be about 2,400 mt. Fishing effort at MSY was estimated to be approximately 30,700 tubs or about 75% of the present effort.

Available data and analyses indicate clearly that tilefish have been overexploited in recent years. Total catches during 1977-1981 exceeded the MSY level by as much as 60% (1979). Fishing effort during 1979-1983 exceeded the MSY level by as much as 45% (1979). Estimated fishing mortality in 1981 exceeded the $F_{0.1}$ and F_{max} levels by 335% and 174%, 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.

Turner, S.C., and C.B. Grimes, Department of Horticulture and Forestry, Cook College, Rutgers University, New Brunswick, NJ, personal communication.

Table 30. Nominal catches (thousand metric tons) and management information for tilefish from the Georges Bank - Mid-Atlantic area, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial									
USA	0.4	1.1	2.1	3.4	3.8	3.7	3.4	2.0	1.8
Canada	-	-	-	-	-	-	-	-	-
Other	0.3	0.3	0.3	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total nominal catch	0.7	1.4	2.4	3.6	3.9	3.7	3.4	2.0	1.8
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = 2.4
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

$M = 0.15$ $F_{0.1} = 0.17$ $F_{max} = 0.27$ $F_{1983} = 0.65$

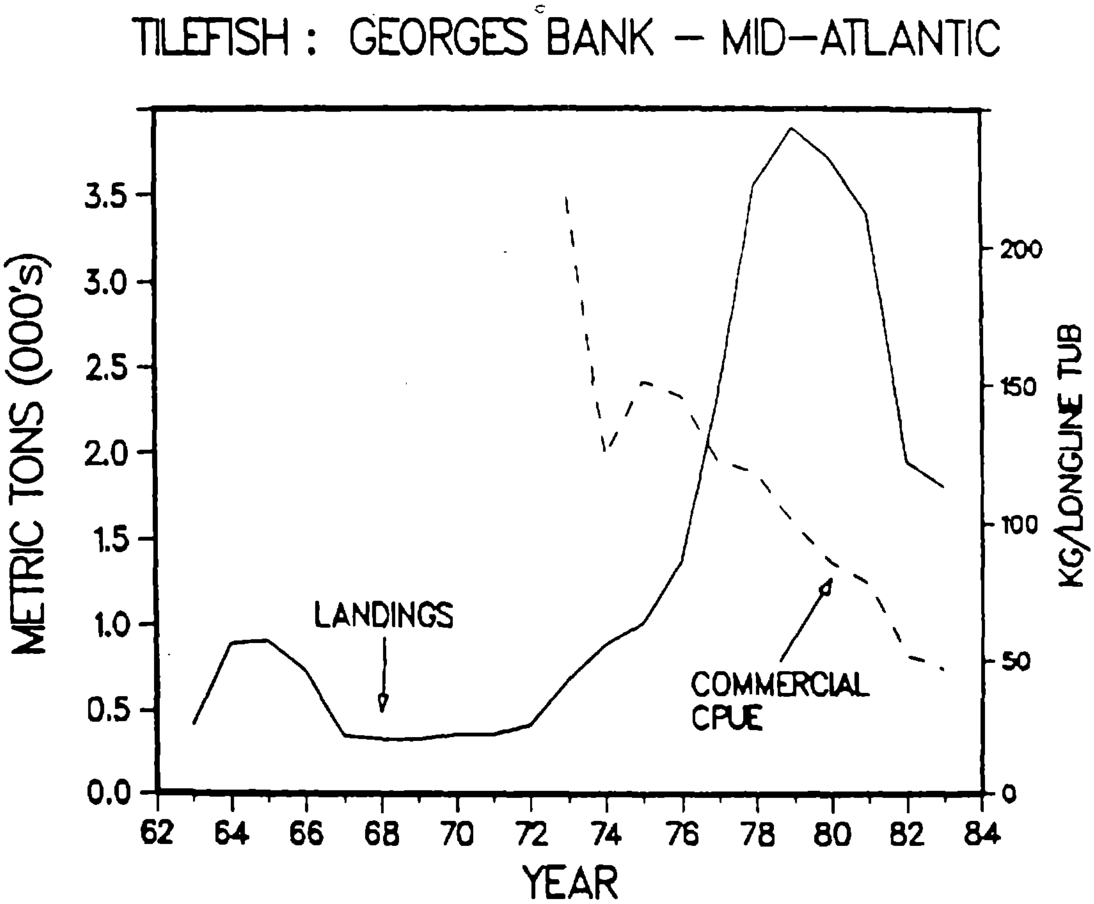

Figure 25. Total commercial landings and catch per unit effort of tilefish in the Georges Bank - Mid-Atlantic area.

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 (ages 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, on Georges Bank, and on the Scotian Shelf. The Georges Bank stock collapsed during 1976-1977, and only recently has any indication of stock recovery been noted. 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 1950-1965, subsequently declining to an average of 23,000 mt during 1966-1979. With the exception of the strong 1970 year class, recruitment 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 and 1983 nominal catch levels declined successively to 24,007 and 18,187 mt, respectively. The reduction in 1982 and 1983 appears to be related to reduced availability to the fixed gear fisheries and reduced abundance as measured by NEFC and Commonwealth of Massachusetts survey indices. Steady declines in survey indices have been noted in recent years. The 1982 indices were the lowest on record.

The 1983 nominal catch of 4,280 mt in the western Gulf of Maine (Jeffreys Ledge) mobile gear fishery represented a 44% decline relative to the 1982 level of 7,663 mt. Reduced demand in the export market appears to have influenced the 1983 yield considerably. 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 1979 year class was not fully recruited to the western Gulf of Maine fishery. In 1983, the fishery was dominated by the

1979 and 1980 year classes (30% and 24% by weight, respectively), while the 1976 and 1977 year classes contributed 18% and 16% by weight to the total.

Stock biomass (ages 2 and older) for the total Gulf of Maine region (coastal Maine and western Gulf of Maine) averaged 257,000 mt during 1965-1970 before declining to an estimated 146,000 mt in 1971 (Figure 26). Stock biomass remained fairly constant during 1971-1978 at about 150,000 mt per year. After increasing to 213,000 mt in 1979, stock biomass declined steadily to an estimated 134,000 mt in 1982, the lowest level yet observed. A recent history of landings and catch restrictions is provided in Table 31.

Table 31. Nominal catches (thousand metric tons) and management information for Atlantic herring from the Gulf of Maine (coastal Maine and the western Gulf of Maine), 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	43.8	49.4	50.2	48.4	63.7	82.1	63.6	31.7	22.5
Canada	8.0	0.9	-	-	-	-	-	-	-
Other	5.4	-	-	-	-	-	-	-	-
Total nominal catch[1]	57.2	50.3	50.2	48.4	63.7	82.1	63.6	31.7	22.5
Total allowable catch[2]	-	16.0	7.0	7.0	8.0	12.0	12.0	12.0	-

Long-term potential catch = 20.0
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 $F_{1982} = 0.40$

[1] Age groups 1 and older.

[2] Age groups 3 and older.

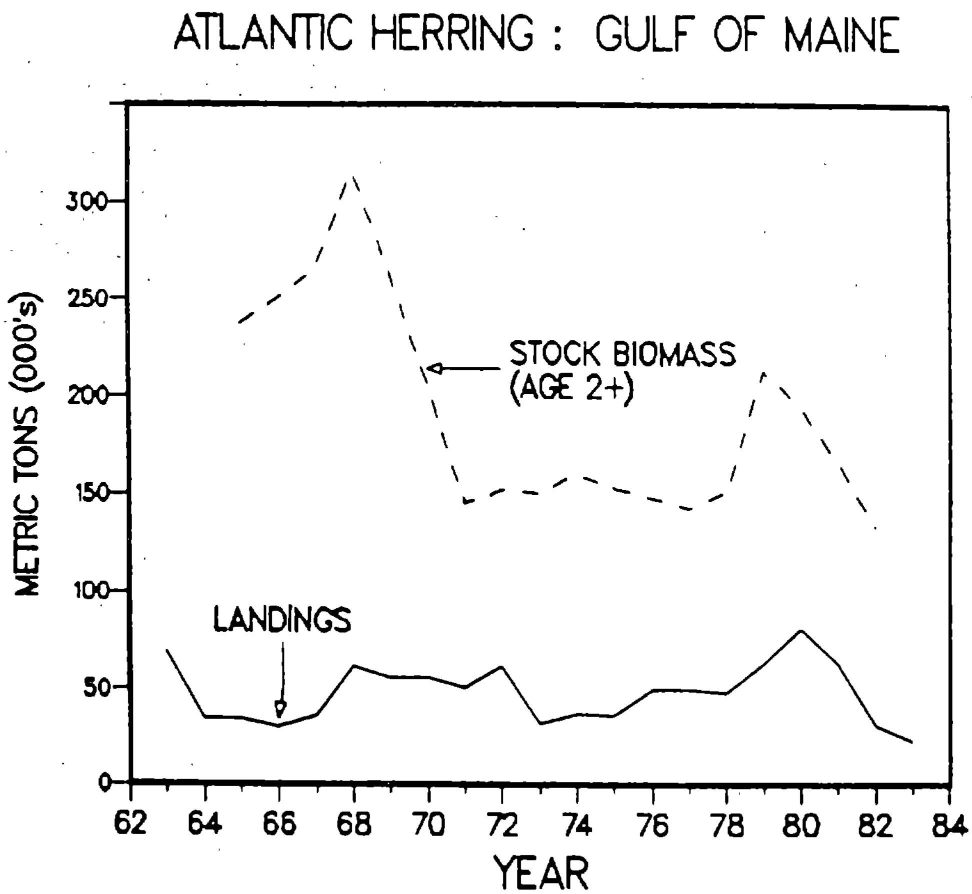

Figure 26. Total commercial landings and estimates of stock biomass of Atlantic herring in the Gulf of Maine.

Georges Bank

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 biomass (ages 4 and older) increased from 300,000 mt in 1961 to nearly 1.2 million mt in 1967 and subsquently declined steadily to extremely low levels. There has been no fishery for Atlantic herring on Georges Bank in recent years. Indication of some level of recovery has been obtained based on larval surveys and bottom trawl surveys conducted during 1984. Prospects for redevelopment of the fishery are currently unknown. Recent landings and catch restrictions are provided in Table 32.

For further information see:

Fogarty, M.J., and S.H. Clark. 1983. Status of herring stocks in the Gulf of Maine region for 1983. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 83-46, 33 p.

Table 32. Nominal catches (thousand metric tons) and management information for Atlantic herring from the Georges Bank area[1], 1971-1983.

Category	Year 1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	3.8	0.7	0.4	2.1	1.1	1.7	0.7	1.0	0.1
Canada	3.6	-	-	-	-	-	-	-	-
Other	180.4	42.8	1.8	-	-	-	-	-	-
Total nominal catch	187.8	43.5	2.2	2.1	1.1	1.7	0.7	1.0	0.1
Total allowable catch	-	60.0	33.0	8.0	15.0	15.0	15.0	-	-

Long-term potential catch = 100.0
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 $F_{1983} = <0.01$

[1] Includes landings for the southern New England 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°, 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 pounds 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. USA commercial catches have occurred mainly during January-May in southern New England - Mid-Atlantic coastal waters and during May-December in coastal Gulf of Maine waters. USA 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 USA 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 decreased slightly from 31,600 mt in 1981 to 30,400 mt in 1982 (Table 33). Catches remained fairly stable during 1978-1982, averaging 31,900 mt annually, and were taken largely by Canadian and USA 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 (Figure 27).

The USA accounted for 24% of the 1982 international catch, including about 3,300 mt commercial and an estimated 4,000 mt recreational, a slight increase from 1981. The Canadian catch declined from 19,294 mt in 1981 to 16,379 mt in 1982, 54% of the total. The distant-water-fleet catch increased from 5,361 mt in 1981 to 6,647 mt in 1982. About 4,400 mt of the 1982 catch was taken by Poland in a research fishery with the NEFC.

The international catch in 1983 increased to an estimated 33,100 mt because of a marked increase in Newfoundland catches relative to 1982 and an increase in the USA commercial catch.

Fish from the 1980 year class (age 2) comprised 21% of the international catch in numbers in 1982. The 1978 year class (age 4) with 18% and the 1974 year class (age 8) with 17%, were also important contributors to the 1982 international catch. The 1982 Canadian catch consisted of 17% 1978 year-class and 17% 1974 year-class fish. The USA commercial catch was 50% 1980 year-class fish (age 2) followed by 18% 1978 year-class fish and 10% 1974 year-class fish. The distant-water-fleet catch in 1982 (principally Polish) consisted primarily of the 1974 (21%) and 1978 (20%) year classes. A February-May 1983 Polish research catch of about 4,300 mt was comprised mainly by the 1981 (30%) 1974 (18%), 1978 (13%), and 1982 (10%) year classes.

The catch-per-tow indices for mackerel from the NEFC spring and autumn bottom trawl surveys declined sharply from 1982 to 1983. These changes appear to be the result of seasonal distributional changes causing a decrease in availability to the trawl surveys and are also a reflection of the inherent variability of mackerel in survey catches. Marked changes in the timing of seasonal migrations and in the seasonal distribution of mackerel throughout their range have been observed in the last several years and appear to be related to water temperture. USA commercial catch-per-day for ages 3 and older increased about 25% from 1981 to 1982 reflecting the recent increase in biomass of age 3 and older fish.

Fishing mortality (F) at ages 3 and older in 1982 was estimated to be 0.11; natural mortality (M) = 0.20. Separable virtual population analysis was used to estimate the exploitation pattern (proportion of F at age relative to the mean F at ages 3 and older) for the fishery in 1982. Results of this analysis indicated a dome-shaped pattern increasing from 53% at age 3 to 227% at age 6 and decreasing to 46% at age 12. This general pattern has been evident since 1978. 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 0.65 in 1976 and then dropped to an average of 0.10 during 1978-1982. An estimated catch of 33,100 mt in 1983 will generate an F of 0.07. $F_{0.1}$ for mackerel at the current pattern of exploitation in the fishery is 0.30.

The 1975-1983 year classes are all estimated to be below average in strength, with the 1982 year class appearing to be nearly twice as strong as any of the others. The 1976, 1977, 1979, and 1983 year classes are extremely weak. Next to the 1982 year class, the 1980 and 1981 year classes are the strongest since the 1974 year class.

Total stock biomass (ages 1 and older) increased from around 300,000 mt in 1962-1965 to 1.9 million mt in 1970-1971 before dropping to an estimated 355,000 mt in 1980 (Figure 27). Since 1980, the total stock increased about 90% in weight to about 676,000 mt at the beginning of 1984. Spawning stock biomass (50% of age 2 fish and 100% of ages 3 and older) increased from about 297,000 mt in 1981 to an estimated 563,000 mt at the start of 1984.

Rebuilding of the mackerel stock has been aided by relatively low catches during 1978-1983 (average of 32,100 mt) as well as markedly improved recruitment from the 1980-1982 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 1984 can be increased substantially without reducing spawning stock biomass from 1984 to 1985. Management measures recommended by the Mid-Atlantic Fishery Management Council for the 1 April 1984 - 31 March 1985 fishing year and adopted by NMFS include an allowable biological catch

(ABC) of 87,000 mt (USA waters only), an OY of 83,500 mt, a DAH of 26,500 mt, a TALFF of 28,500 mt, and a Reserve of 28,500 mt. These recommendations are based on a projected catch of 132,000 mt for the total international mackerel fishery in the Northwest Atlantic resulting from fishing mortality at $F_{0.1}$ = 0.30.

For further information see:

Anderson, E.D. 1983. Status of the Northwest Atlantic mackerel stock - 1983. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 83-40, 44 p.

Table 33. Nominal catches (thousand metric tons) and management information for Atlantic mackerel from Labrador to North Carolina, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	11.1	4.2	0.5	6.6	3.3	3.9	4.0	4.0	4.0
Commercial									
USA	1.8	2.7	1.4	1.6	2.0	2.7	2.9	3.3	3.8
Canada	16.6	15.7	20.4	25.4	30.2	22.1	19.3	16.4	19.3
Other	347.5	223.3	56.1	0.8	0.4	0.6	5.4	6.6	5.9
Total nominal catch	377.0	245.9	78.3	34.4	36.0	29.3	31.6	30.4	33.1
Total allowable catch[1,2]	-	310.0	105.0	15.5	15.5	30.0	30.0	30.0	101.7

Long-term potential catch = 120.0[3]
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 $F_{0.1}$ = 0.30 F_{max} = 0.77 F_{1983} = 0.07

[1] Fishery Conservation Zone only for 1978 and later.

[2] 1 April - 31 March fishing year for 1980 and later.

[3] Assuming constant recruitment at level of geometric mean of 1961-1983 year classes and fishing mortality at $F_{0.1}$.

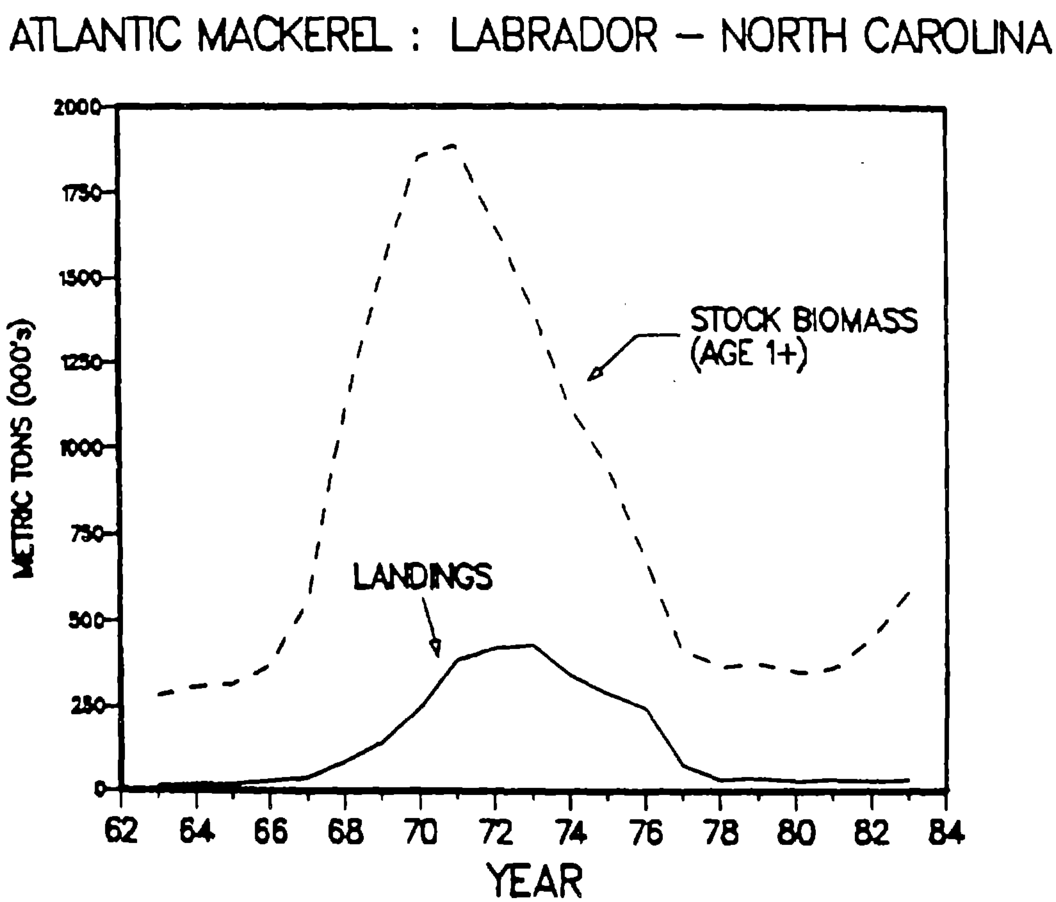

Figure 27. Total commercial and recreational landings and estimates of stock biomass of Atlantic mackerel in the Labrador - North Carolina area.

BUTTERFISH

The butterfish (Peprilus triacanthus) 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.

The international nominal catch declined 43% from 9,699 mt in 1982 to 5,545 mt in 1983 (Table 34, Figure 28). The international catch peaked in 1973 at 19,500 mt, most of which was taken by distant-water fleets (DWF) in conjunction with their squid fisheries. The USA nominal catch declined 45% from a record high of 8,905 mt in 1982 to 4,915 mt in 1983. Decreased USA landings in 1983 were due to a reduction in abundance of large, marketable fish (ages 1 and older) rather than a decline in demand; the export market for butterfish presently remains strong. The DWF nominal catch declined slightly from 794 mt in 1982 to 630 mt in 1983.

During the latter half of 1983, the USA fishery was beset by a large influx of small, unmarketable (1983 year class, age 0) butterfish. As a result, estimated annual discard rates of 10% in the butterfish trawl fishery increased to 50% during August-December 1983. Annual discard (primarily age 0 fish) increased from an estimated 107 mt in 1977 to 1,150 mt in 1983. The high discard rates observed during the last part of 1983 have continued into early 1984 (30-50% discard). This continued high discard has resulted from the presence of a strong 1983 year class coupled with decreased abundance of older fish. Market demand for butterfish has led to the recent development of a new "supersmall" market category, which has encouraged the intense fishery on small butterfish.

Based on NEFC autumn survey indices, the 1983 year class was the strongest observed in the 16-year time series for butterfish. This represents the fourth strong year class since 1979; the 1982 year class was the weakest observed since 1977.

Estimates of fishing mortality (F) on fully-recruited fish (ages 2 and older), as determined by virtual population analysis, dropped from 2.14 in 1976 to 0.91 in 1977 and then underwent a gradual increase to 1.04 in 1981. Mean F on ages 2 and older dropped sharply to 0.77 in 1982 and declined further to an estimated 0.67 in 1983. The increase in total catch (landings plus discard) from 6,250 mt in 1981 to 10,480 mt in 1982 was due largely to heavy catches of age 0 and 1 fish and relatively high levels of F at those ages. F on ages 0 and 1 in 1982 was three times higher than the 1977-1981 average.

Stock biomass of age 1 and older butterfish increased 45% from 1978 to 1982 (Figure 28), but declined 35% from 15,800 mt in 1982 to 10,400 mt in 1983. This drop was caused by the relatively high levels of fishing mortality at ages 0 and 1 in 1982 and recruitment of a relatively weak 1982 year class. Because of the drop in catch and F from 1982 to 1983 and the recruitment of a strong 1983 year class, stock biomass at the beginning of 1984 was estimated to be 25% higher than in 1983.

Projections indicate that a catch (landings plus discard) in 1984 of 7,100 mt (F = 0.84 on ages 2 and older) would result in no change in stock biomass from 1984 to 1985 (assuming an average 1984 year class). Fishing at $F_{0.1}$ = 1.60 in 1984 would produce a catch of 11,500 mt, but would decrease the stock about 20% from 1984 to 1985.

Continued high rates of discard on age 0 fish can be expected to have an adverse effect on the fishery and the stock. Because butterfish have a short life span (about 4 years) and a relatively high natural mortality rate (M = 0.8), the fishery should concentrate primarily on age 1 and 2 fish to maximize yield per recruit. Delaying fishing beyond age 1 will result in a loss in yield due to the high M, but excessive levels of fishing mortality at age 0 will result in lost yield as well as reduced recruitment to the spawning stock.

For further information see:

Waring, G.T., and E.D. Anderson. 1983. Status of the Northwestern Atlantic butterfish stock - 1983. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 83-41, 39 p.

Table 34. Nominal catches (thousand metric tons) and management information for butterfish from the Gulf of Maine - Mid-Atlantic area, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	1.7	1.5	1.4	3.7	2.8	5.4	4.9	8.9	4.9
Canada	-	-	-	-	-	-	-	-	-
Other	9.9	9.9	3.2	1.3	0.8	0.9	0.9	0.8	0.6
Total nominal catch	11.6	11.4	4.7	5.0	3.7	6.3	5.8	9.7	5.5
Total allowable catch	-	-	18.0	18.0	18.0	11.0[1]	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 = 0.80 $F_{0.1}$ = 1.60 F_{max} = >2.50 F_{1983} = 0.67

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

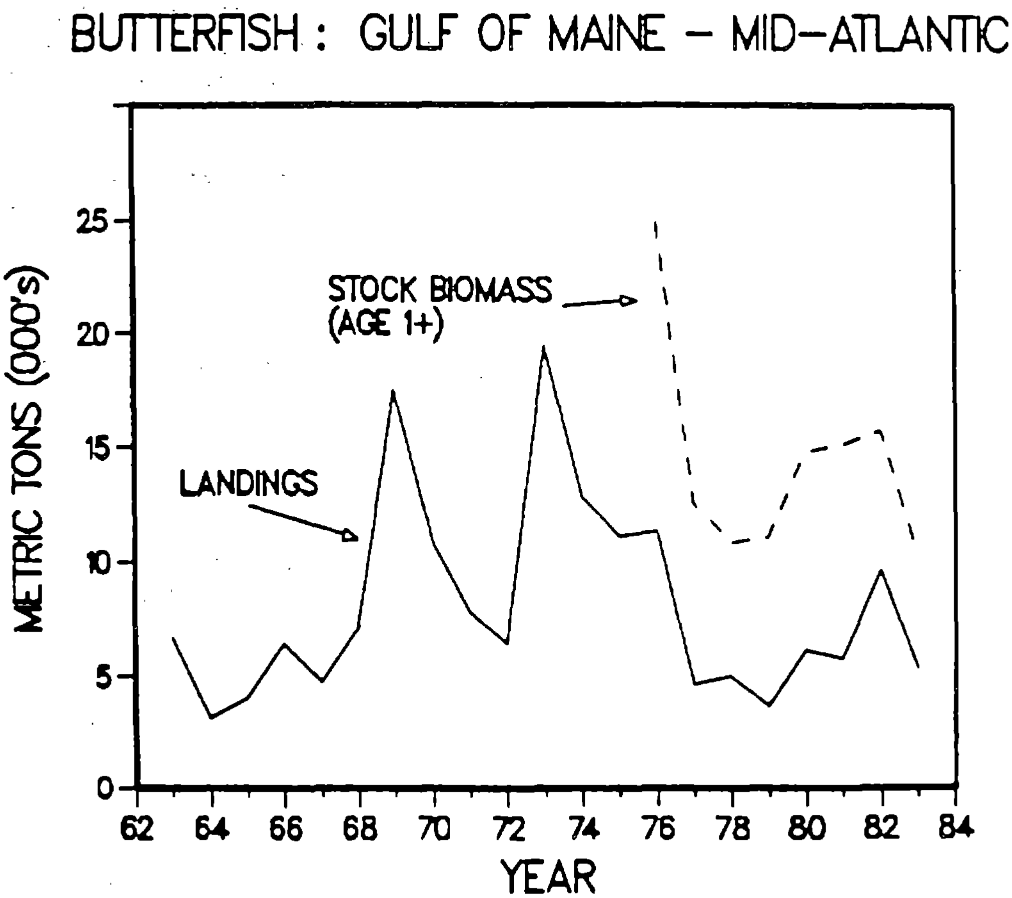

Figure 28. Total commercial landings and estimates of stock biomass of butterfish in the Gulf of Maine - Mid-Atlantic area.

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, bluefish are found from Nova Scotia to Texas, moving northward in the spring and southward in the autumn 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 pounds) in weight.

The bluefish has become perhaps the most important species to the marine recreational fishery along the Atlantic coast of the USA in recent years. Total nominal catches of bluefish (commercial and recreational) from Maine to Florida increased from about 24,200 mt in 1960 to an estimated 76,700 mt in 1983 (Table 35, Figure 29). During this period, recreational landings averaged about 93% of the total nominal catch. USA commercial catches steadily increased from 1,251 mt in 1960 to 7,600 mt in 1983, with over 50% of the 1973-1983 catch coming from the Mid-Atlantic region (New Jersey - Cape Hatteras).

The stratified mean number of bluefish per tow in the NEFC autumn inshore survey from Cape May to Cape Cod is used as an index of recruitment. Over 90% of the bluefish caught in this survey are age 0 (<30 cm in length). The index rose abruptly between 1974 and 1977 and has since fluctuated between 10 and 20 fish/tow (Figure 29). Since this index exhibits a strong correlation with nominal catch two, three and four years later, catch is expected to remain at its current high level at least through 1986, assuming that no significant changes occur in fishing effort.

A coastwide management plan for bluefish has recently been submitted to NMFS by the Mid-Atlantic Fishery Management Council. The Plan allocates 20% of the total projected bluefish catch for a given year to the commercial fishery, 10% of which will be allocated to the New England area, 50% to the Mid-Atlantic area, and 40% to the South Atlantic area. Control measures such as trip limits, individual vessel quotas, time limits, and/or gear limitations will be used as necessary to insure that allocations in any given year are not exceeded.

For further information see:

Boreman, J. 1983. Status of bluefish along the Atlantic coast, 1982. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 83-28, 35 p.

Table 35. Nominal catches (thousand metric tons) and management information for bluefish from the Atlantic coast (Maine-Florida), 1971-1983.

Category	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	53.4	51.7	52.0	49.9	53.9	59.7	65.1	62.7	69.1
Commercial									
USA	3.8	4.5	4.9	4.9	5.6	6.5	7.2	7.4	7.6
Canada	-	-	-	-	-	-	-	-	-
Other	0.1	<0.1	<0.1	-	-	<0.1	-	-	-
Total nominal catch	57.3	56.2	56.8	54.8	59.5	66.2	72.2	70.1	76.7
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = Unknown
Importance of recreational fishery = Major
Status of management = FMP in preparation
Status of exploitation = Possibly fully exploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 35 cm (13.8 inches)

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1983} = Unknown

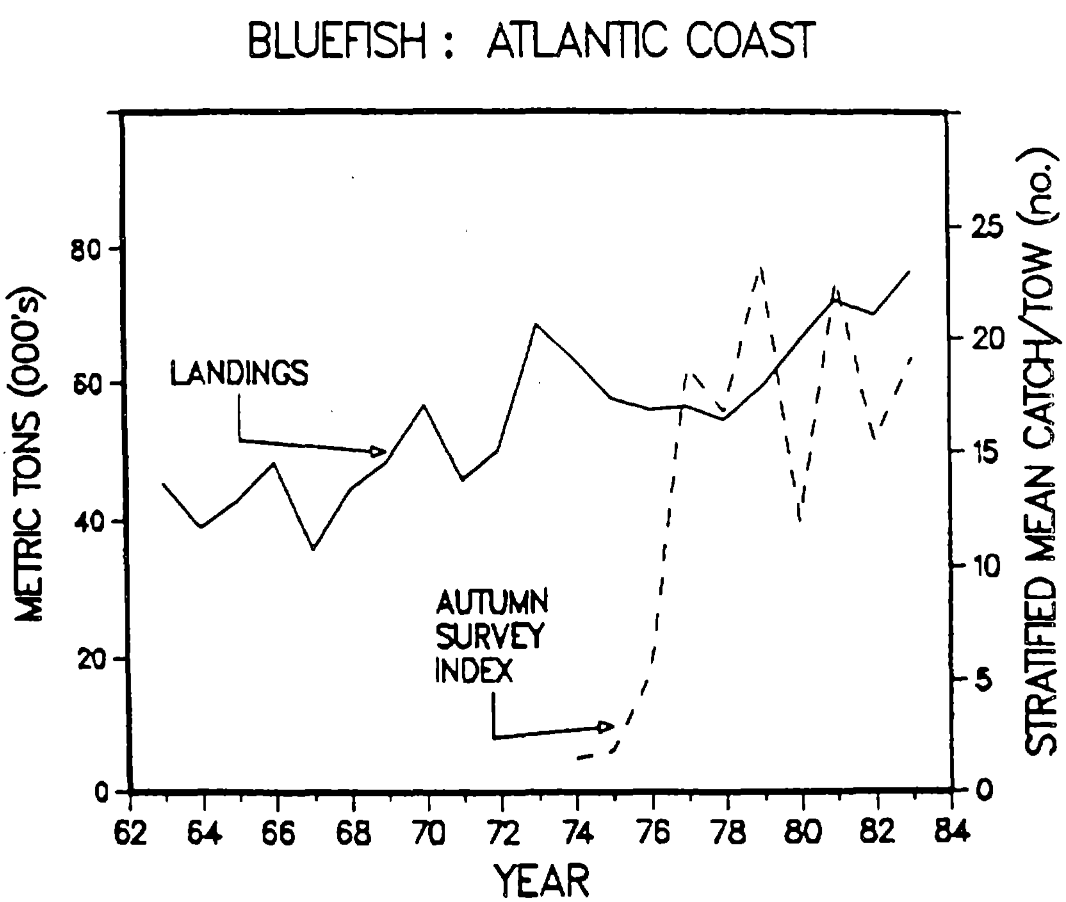

Figure 29. Total commercial and recreational landings and recruitment indices from NEFC autumn bottom trawl surveys of bluefish along the Atlantic coast.

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 alewives 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. Alewives may live as long as 10 years and reach a size of 36 cm (14 inches) in length; blueback herring live for about 7 or 8 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 3-5 with age 4 being dominant.

River herring have been subjected to intensive exploitation along the Atlantic coast. Nominal catch has declined considerably in the last 10 years (Figure 30), 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 USA inshore fishery until the late 1960's, when distant water fleets began fishing for river herring off the Mid-Atlantic coast. The USA nominal catch averaged 24,800 mt annually between 1963 and 1969. Since 1969, the nominal catch has exhibited a downward trend (Table 36).

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 (Hoagman et al. 1973). However, stock biomass in recent years has 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 NEFC 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 biomass since 1975.

In response to the observed decline in nominal catch and the lack of a coastwide increase in stock biomass, 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. Doc. 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.

Richkus, W.A., and G. DiNardo. 1984. Current status and biological characteristics of the anadromous alosid stocks of eastern United States: American shad, hickory shad, alewife, and blueback herring. Martin Marietta Environmental Center, prepared for the Atlantic States Marine Fisheries Commission, Washington, DC.

Table 36. Nominal catches (thousand metric tons) and management information for river herring (alewife and blueback herring) from the Gulf of Maine - Mid-Atlantic area, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	11.5	6.5	6.1	5.4	4.2	4.7	3.2	5.7	4.1
Canada	-	-	-	-	-	-	-	-	-
Other	10.2	1.8	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total nominal catch	21.7	8.3	6.3	5.4	4.2	4.7	3.2	5.7	4.1
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = Unknown
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 (11.0 inches)

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1983} = Unknown

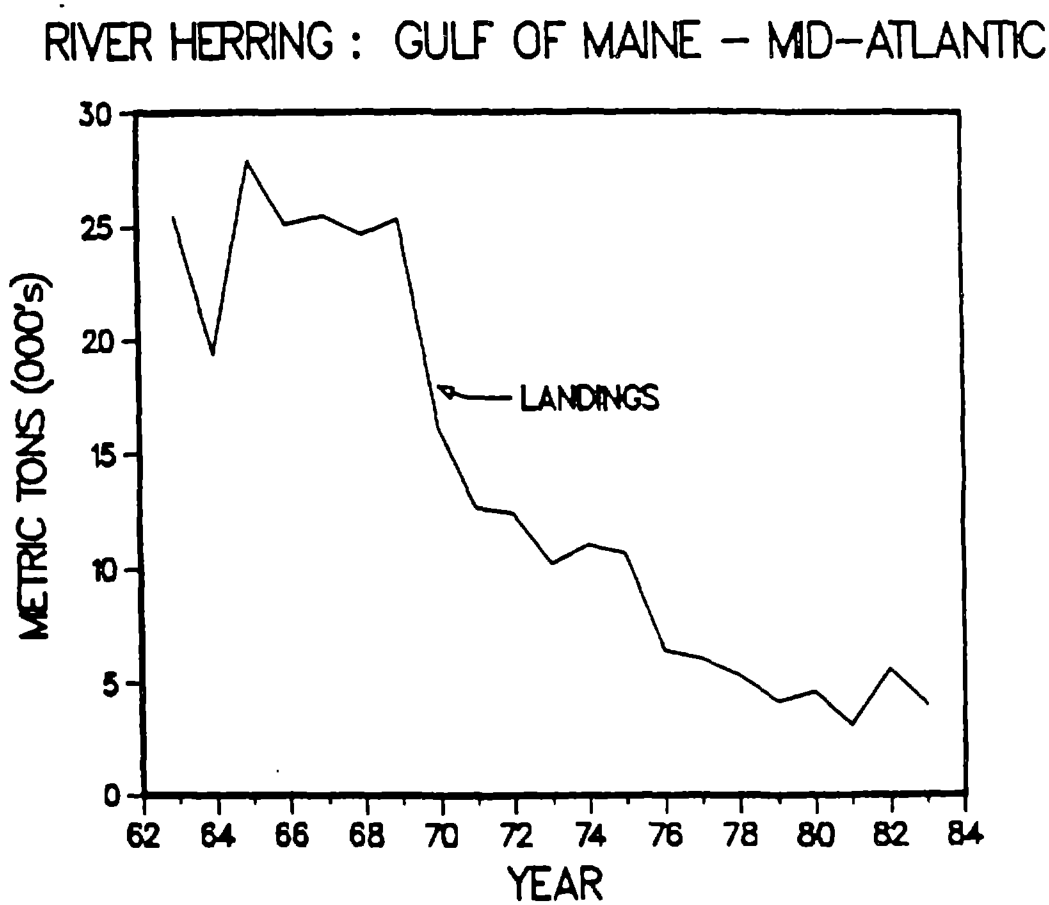

Figure 30. Total commercial landings of river herring (alewife and blueback herring) in the Gulf of Maine - Mid-Atlantic area.

AMERICAN SHAD

The American shad (<u>Alosa sapidissima</u>) 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 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 1,000 mt per year. Excessive fishing 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. 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 has been the lowest on record (Table 37, Figure 31), although some restoration efforts (particularly in the Delaware system) are apparently starting to be effective.

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 has closed its recreational (and commercial) fishery since 1980 to protect the stock, which is at an extremely low level. Since the marine recreational fishing surveys conducted by the NMFS and its predecessor agency 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. Doc. No. 81-40. 21 p.

Richkus, W.A., and G. DiNardo. 1984. Current status and biological characteristics of the anadromous alosid stocks of eastern United States: American shad, hickory shad, alewife, and blueback herring. Martin Marietta Environmental Center, prepared for the Atlantic States Marine Fisheries Commission, Washington, DC.

Table 37. Nominal catches (thousand metric tons) and management information for American shad from the Gulf of Maine - Mid-Atlantic area, 1971-1983.

Category	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	1.5	0.9	1.2	1.2	0.8	0.9	0.7	0.9	0.5
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	1.5	0.9	1.2	1.2	0.8	0.9	0.7	0.9	0.5
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 yrs (varies by latitude)
Size at 50% maturity = 40 cm (15.8 inches)

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1983} = Unknown

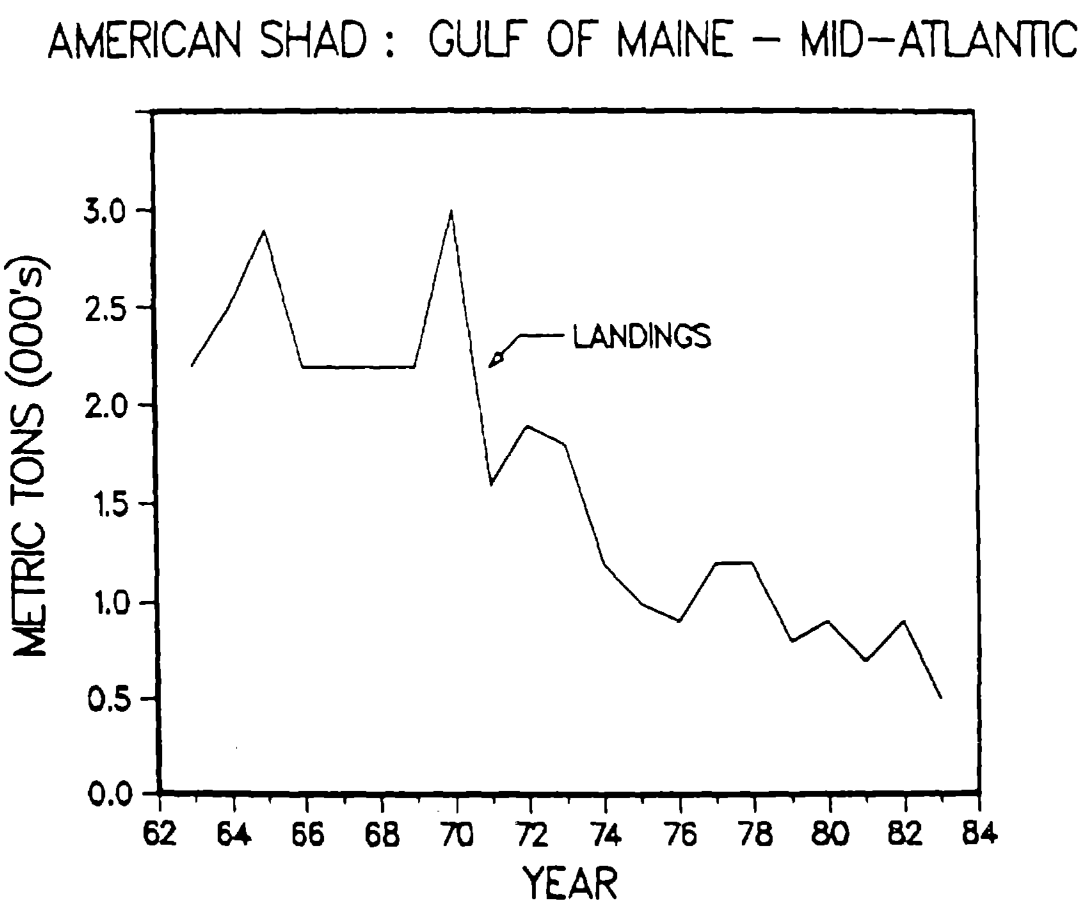

Figure 31. Total commercial landings of American shad in the Gulf of Maine - Mid-Atlantic area.

BLACK SEA BASS

Black sea bass (Centropristis striata) occur off the northeast United States along the entire Atlantic coast, with the greatest concentrations found off Cape May. Black sea bass overwinter along the 100-meter isobath off Virginia and Maryland, then migrate north and west into the major coastal bays and become associated with live bottom habitat (reefs, oyster beds, wrecks, etc.). Spawning begins in June off Virginia and occurs progressively later (until October) further north. Black sea bass are protogynous hermaphrodites (i.e., some fish function first as females and then transform into males). As a result, females generally mature earlier (age 2, 16.3 cm or 6.4 inches, standard length) than males (age 3, 21.3 cm or 8.4 inches). Females are rarely found older than 8 years (>35 cm or 13.8 inches), while males may live up to 20 years (>60 cm or 23.6 inches). Black sea bass are opportunistic omnivores, feeding on crustaceans, molluscs, echinoderms, fish, and plants.

Nominal commercial catch fluctuated around 2,600 mt from 1887 to 1948, then increased to over 6,900 mt. After reaching a peak of 9,883 mt in 1952, catch steadily declined to 614 mt in 1971. Since then, catch increased to 2,424 mt in 1977, but dropped to 1,481 mt in 1983 (Table 38, Figure 32). The only reported catch by distant-water fleets was 1,494 mt in 1964. Estimated recreational catches also show a downward trend from 5,398 mt in 1960 to 1,366 mt in 1980. In general, the estimated recreational catch represents 50-75% of the total nominal catch in those years for which comparisons are available.

Catch per unit effort of the Mid-Atlantic and Chesapeake pot/trap fishery declined from 78.9 kg/trap in 1953 to 10.0 kg/trap in 1968. The most recent (1979) CPUE value is 26.2 kg/trap. NEFC spring offshore bottom trawl survey data indicate an increase in abundance from 1970 (0.3 fish/tow) to 1977 (18.2 fish/tow) followed by a precipitous decline to 0.6 fish/tow in 1982 (Figure 32).

Size composition data from commercial landings indicate that black sea bass fully recruit to the trap and trawl fishery by ages 2 and 3, respectively. The optimum (biologically) age for harvesting black sea bass, based on yield-per-recruit analysis, is 6 years. Evidence indicates that black sea bass north of Cape Hatteras are being fully exploited.

Connecticut, New York, and New Jersey have imposed restrictions on the buying or selling of black sea bass less than 8 inches (20.3 cm) in length. The remaining Atlantic coastal states from Maine to North Carolina do not have any regulations pertaining to black sea bass. The Mid-Atlantic Fishery Management Council is considering the management of black sea bass either as a single species or together with other commonly associated species.

Table 38. Nominal catches (thousand metric tons) and management information for black sea bass from the Gulf of Maine - Mid-Atlantic area, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	2.6	3.1	4.0	3.1	2.4	1.4	-	-	-
Commercial									
USA	1.1	1.7	2.4	2.1	1.9	1.3	1.1	1.2	1.5
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	3.7	4.8	6.4	5.2	4.3	2.7	1.1	1.2	1.5
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = Unknown
Importance of recreational fishery = Major
Status of management = Some state regulations; FMP being planned
Status of exploitation = Fully exploited
Age at 50% maturity = 3 yrs
Size at 50% maturity = 27.2 cm (10.7 inches)

M = 0.27 $F_{0.1}$ = Unknown F_{max} = Unknown F_{1983} = Unknown

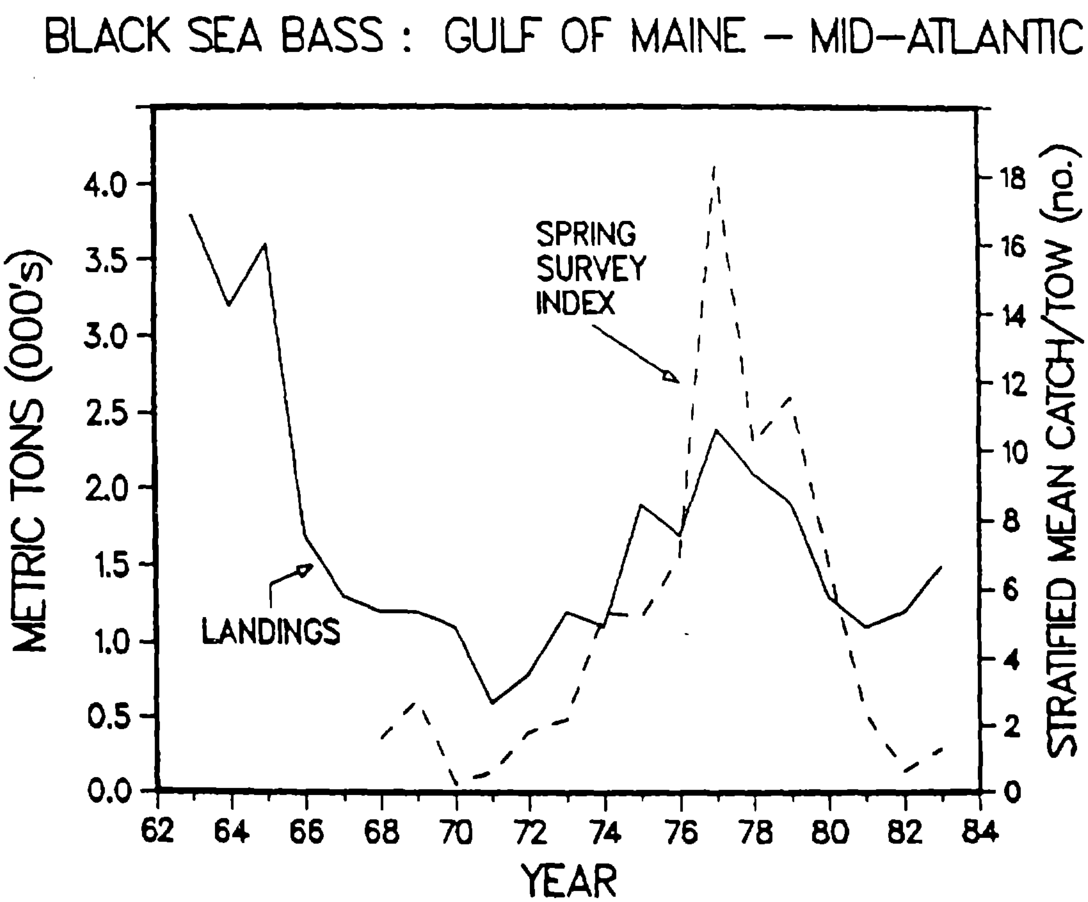

Figure 32. Total commercial landings and stock abundance indices from NEFC spring bottom trawl surveys of black sea bass in the Gulf of Maine - Mid-Atlantic area.

STRIPED BASS

The striped bass (Morone saxatilis) is an anadromous species distributed along the Atlantic coast from northern Florida to the St. Lawrence estuary, along the Pacific coast from Ensenada, Mexico to British Columbia, and in numerous inland lakes and reservoirs. Striped bass 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°C to 23°C; peak spawning activity is observed between 15°C and 20°C. Larvae range from 2.0 to 3.7 mm in total length at hatching and initiate feeding after 4-10 days. At about 13 mm in length, larval striped bass form small schools and move inshore; juvenile striped bass move downriver into higher salinity waters during their first summer or autumn.

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. Coastal migratory behavior appears to be limited to 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 dominant year classes. The last such year class in Chesapeake Bay, the largest in the past 30 years, occurred in 1970 and resulted in peak commercial 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 33), 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 below the level produced in the late 1960's and early 1970's. In 1983, the indices for the Roanoke River and Chesapeake Bay stocks were close to the lowest in their 30-year time series, while the index for the Hudson River stock was one of the highest in its 15-year time series.

Nominal catch of striped bass in the commercial fisheries from Maine to North Carolina averaged 2,700 mt between 1929 and 1983. Gill nets, haul seines, pound nets, and handlines account for over 80% percent of the commercial catch. The nominal commercial catch from Maine to North Carolina in 1983 (800 mt) (Table 39) was the lowest since 1931. Estimated recreational catches of striped bass in the same region for 1980 (the most recent data available) were also 800 mt, representing a drop of 98% from the 1970 estimate (33,200 mt). Recreational catches comprised about 85% of the total during the 1960's, but less than 30% since 1980.

A coastwide management plan for striped bass was recommended by the Atlantic States Marine Fisheries Commission (ASMFC) in 1981. The plan requested that states enforce a 14-inch total length (35.6 cm) minimum size limit on striped bass in nursery rivers and bays, and a 24-inch total length

(61.0 cm) minimum size limit on the coastal fisheries. The plan also suggested that fishing in spawning rivers be banned during the spawning season. The coastal states are currently in the process of adopting the measures suggested by the ASMFC. Due to the continued decline in abundance and landings since 1981, the ASMFC is currently recommending an additional 55% reduction in fishing mortality.

Findings of the Emergency Striped Bass Study (ongoing since 1980) link the decline in abundance of the Chesapeake Bay stock to a combination of factors including contaminant toxicity, exploitation, climatic events, and larval nutrition. The Study findings also indicate that the decline in commercial and recreational catch since 1974 may have cost the Northeast approximately 7,000 jobs and over $220 million in economic activity in 1980.

Table 39. Nominal catches (thousand metric tons) and management information for striped bass from the Gulf of Maine - Mid-Atlantic area, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	22.1	8.4	5.6	3.3	1.7	0.8	0.7	0.4	0.3
Commercial									
USA	4.7	2.9	2.5	2.1	1.7	2.0	1.8	1.0	0.8
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	26.8	11.3	8.1	5.4	3.4	2.8	2.5	1.4	1.1
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = Unknown
Importance of recreational fishery = Major
Status of management = FMP in effect
Status of exploitation = Overexploited
Age at 50% maturity = 2 yrs (males); 4 yrs (females)
Size at 50% maturity = 29.7 cm (11.7 inches) males; 47.0 cm (18.5 inches) females

M = 0.10-0.20 $F_{0.1}$ = Unknown F_{max} = Unknown F_{1983} = Unknown

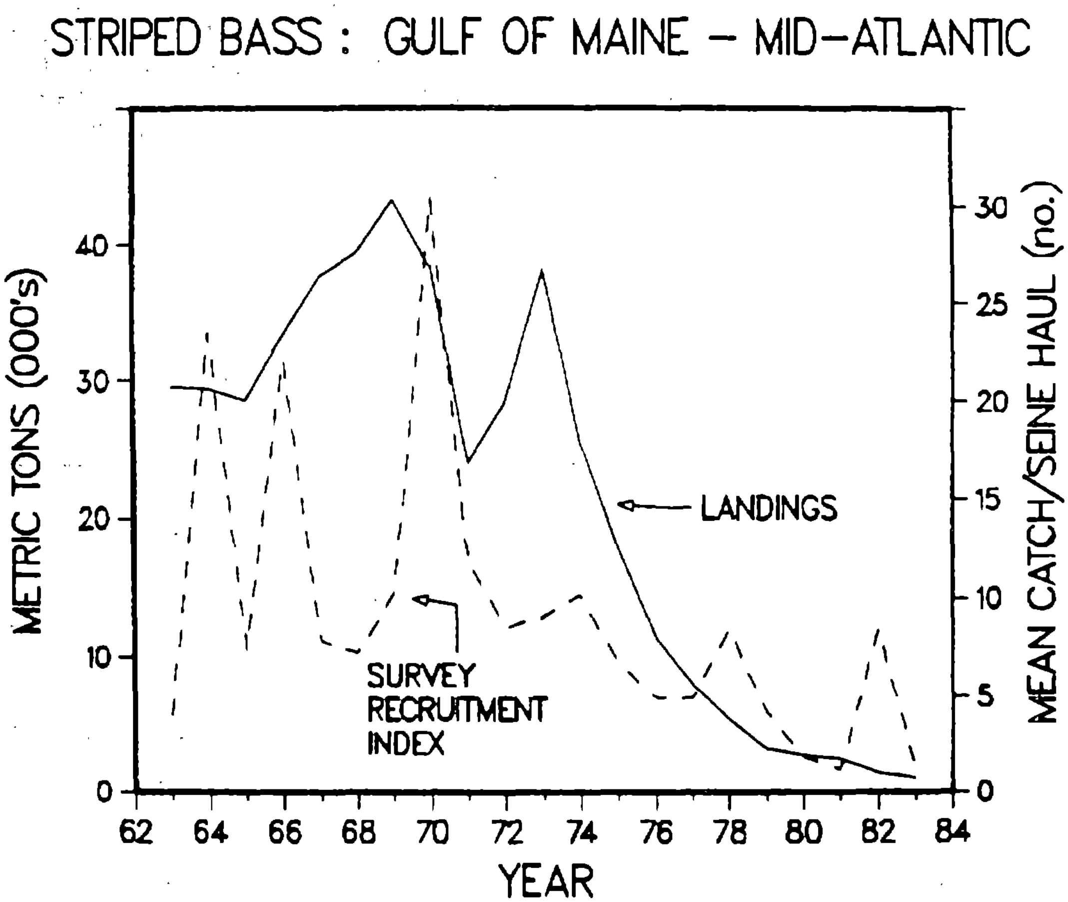

Figure 33. Total commercial and recreational landings and recruitment indices from Maryland seine surveys in Chesapeake Bay of striped bass in the Gulf of Maine - Mid-Atlantic area.

SPINY DOGFISH

Spiny dogfish (Squalus acanthias) 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 40, Figure 34). Distant-water fleets consistently accounted for virtually all of the reported catches. The reported USA nominal catch declined from 5,400 mt in 1982 to 4,900 mt in 1983. The principal fishing season extends from June to October in the Gulf of Maine. During this period, large concentrations of marketable-sized dogfish are found in the vicinity of and on Stellwagen Bank. Attempts at fishing during November to May have met with limited success.

Minimum biomass estimates of spiny dogfish based on NEFC spring bottom trawl survey catches decreased from 899,000 mt in 1982 to 229,000 mt in 1983, close to the 1968-1982 geometric average of 240,000 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 USA fishery for dogfish is similar in nature to the European fisheries in being selective for large individuals [>2.3 kg (5.1 pounds), 83 cm (33 inches)], 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 by-catch 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. Optimal levels of annual harvest in USA waters are currently unknown, but are likely above present catch levels.

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 40. Nominal catches (thousand metric tons) and management information for spiny dogfish from the Gulf of Maine - Mid-Atlantic area, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	0.1	0.5	0.5	0.9	4.8	4.2	6.9	5.4	4.9
Canada	-	-	-	-	-	-	-	-	-
Other	14.6	13.8	6.5	0.6	-	0.2	0.3	0.6	-
Total nominal catch	14.7	14.3	7.0	1.5	4.8	4.4	7.2	6.0	4.9
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) females

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1983} = Unknown

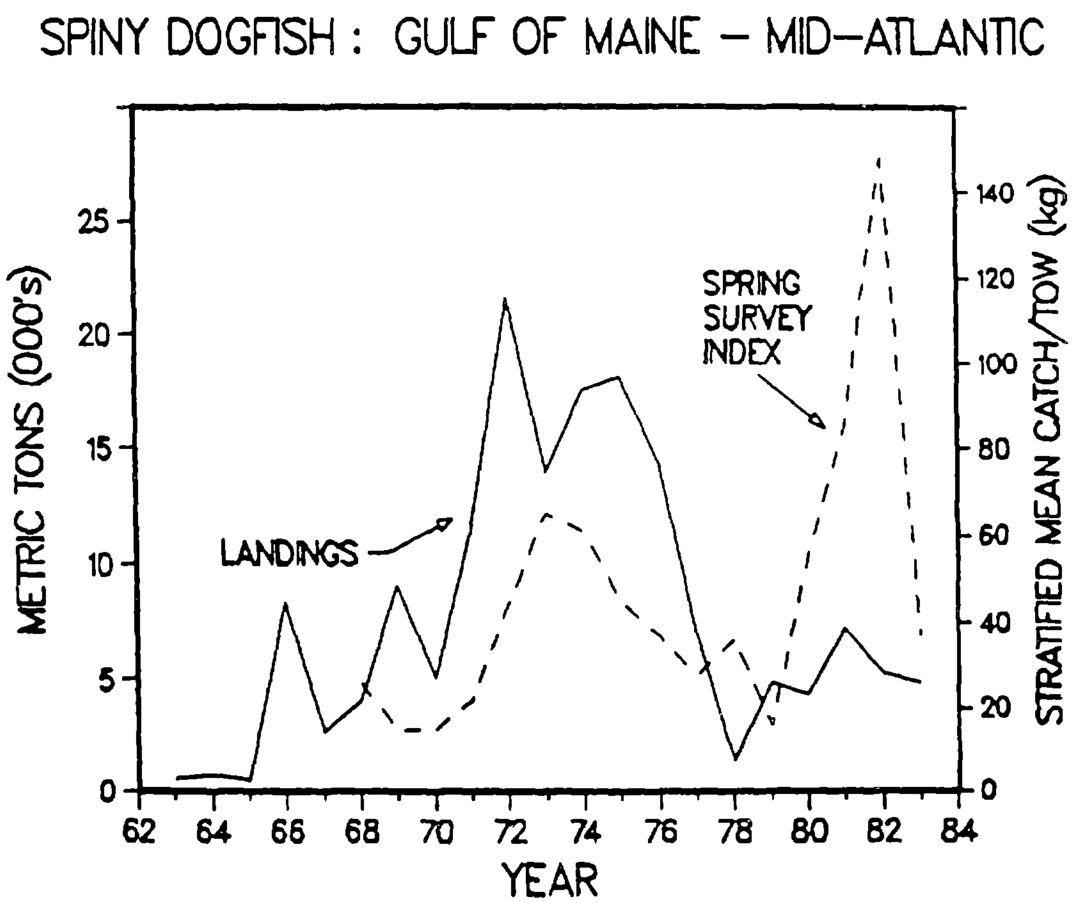

Figure 34. Total commercial landings and stock biomass indices from NEFC spring bottom trawl surveys of spiny dogfish in the Gulf of Maine - Mid-Atlantic area.

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_ occurring along the North Atlantic coast of the USA: 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 during 1975-1982 were less than 2,000 mt annually (Table 41). Most of the domestic catch has traditionally been discarded at sea. The reported USA nominal catch increased 260% from 1,000 mt in 1982 to 3,600 mt in 1983. However, a significant portion (2,800 mt or 78%) of the increase represents skate catches which were sold for bait. This data was unavailable prior to 1983. Therefore, excluding the bait figures, nominal catches have remained at about the 1981-1982 level. The decline since 1980 is largely attributed to the elimination of the southern New England industrial trawl fishery. The nominal catch in the industrial trawl fishery averaged 570 mt during 1975-1980.

The species composition of the 1983 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 - Mid-Atlantic area determined from NEFC bottom trawl survey data declined from 103,000 mt in 1980 to 87,000 mt in 1981 (Figure 35). 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, compared to 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 41. Nominal catches (thousand metric tons) and management information for skates (all species) from the Gulf of Maine - Mid-Atlantic area, 1971-1983.

Category	Year 1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	1.1	1.1	1.3	1.5	1.6	2.0	0.8	1.0	3.6
Canada	<0.1	-	-	-	-	-	-	-	-
Other	5.0	0.9	0.2	-	-	-	-	-	-
Total nominal catch	6.1	2.0	1.5	1.5	1.6	2.0	0.8	-1.0	3.6
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = Unknown
Importance of recreational fishery = Insignificant
Status of management = None
Status of exploitation = Underexploited
Age at 50% maturity = 4 yrs[1]
Size at 50% maturity = 40 cm (15.8 inches)[1]

$M = 0.40$[1] $F_{0.1} = 0.49$[1] $F_{max} = 1.00$[1] F_{1983} = Unknown

[1] Pertains to the little skate (*Raja erinacea*).

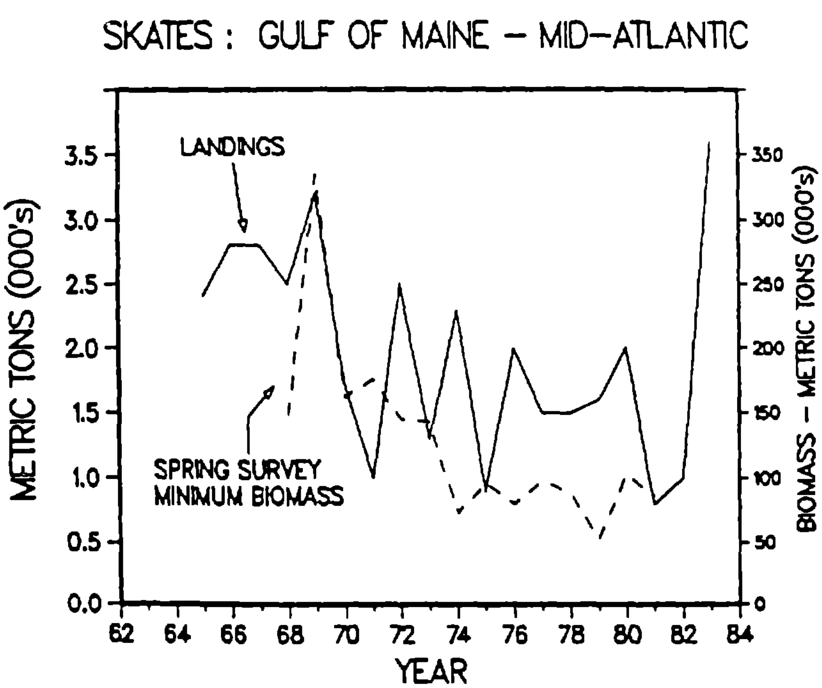

Figure 35. Total commercial landings and estimates of minimum stock biomass from NEFC spring bottom trawl surveys of skates in the Gulf of Maine - Mid-Atlantic area.

SHORT-FINNED SQUID

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 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 USA are comprised mainly of 10-28 cm (4-11 inch) individuals which are probably 8-24 months of age.

Total catches decreased from 17,788 mt in 1982 to 11,678 mt in 1983, compared to the 1974-1981 mean of 19,600 mt. The USA nominal catch increased from 5,438 mt in 1982 to an estimated 9,902 mt in 1983 (Table 42). The 1983 USA catch represented almost a sixfold increase over the 1977-1982 average and included about 8,344 mt taken in joint ventures. Distant-water-fleet catches during 1983 were 1,776 mt, a 86% decrease from 1982 (12,350 mt), and 90% below the 1974-1982 mean catch of 18,270 mt.

The reported catch in Canadian waters in 1983 was only 408 mt, indicating a collapse of the fishery which has seen catches decline from a high of 153,000 mt in 1979. The 1982 catch was about 9,000 mt.

The NEFC autumn survey index for Illex decreased 53% from 1982 to 1983 and was 85% below the 1967-1982 mean (Figure 36). Minimum abundance off the USA coast was estimated to be 10 million individuals in 1983 compared to 21 million in 1982. This was the lowest estimate since abundance began an upward trend in 1974. Pre-recruit (<10 cm) abundance in 1983 equalled the previous low recorded in 1970 and was 84% below the 1967-1982 average (excluding the high 1975 value). The pre-recruits sampled in the 1983 autumn survey will comprise the bulk of the catch in the 1984-1985 fishery.

For further information see:

Lange, Anne M.T. 1983. Status of the short-finned squid (Illex illecebrosus) off the Northeastern USA, October 1983. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 83-30, 20 p.

Table 42. Nominal catches (thousand metric tons) and management information for the short-finned squid (Illex) from the Gulf of Maine - Mid-Atlantic area, 1971-1983.

Category	Year 1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	0.3	0.2	1.0	0.4	1.6	0.3	0.6	5.4	9.9
Canada	-	-	-	-	-	-	-	-	-
Other	11.8	24.7	23.8	17.3	16.3	19.6	14.9	12.4	1.8
Total nominal catch	12.2	24.9	24.8	17.7	17.9	17.9	15.4	17.8	11.7
Total allowable catch	-	30.0	30.0	35.0	30.0[1]	30.0[1]	30.0[1]	30.0[1]	30.0[1]

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 (7.9 inches) dorsal mantle length

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1983} = Unknown

[1] 1 April - 31 March fishing year.

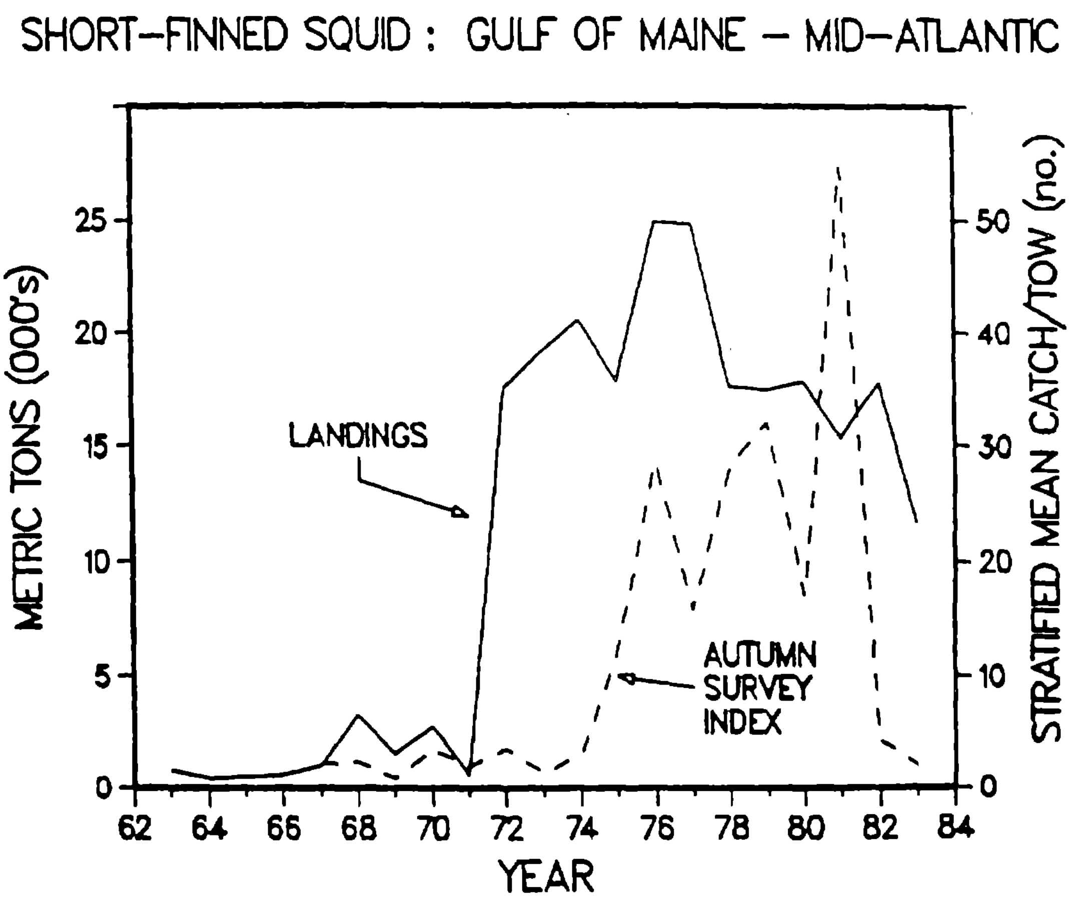

Figure 36. Total commercial landings and stock abundance indices from NEFC autumn bottom trawl surveys of short-finned squid in the Gulf of Maine - Mid-Atlantic area.

LONG-FINNED SQUID

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. An extended spawning season 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 inches) and 8-14 months.

Total catches increased from 21,269 mt in 1982 to 27,782 mt in 1983 (Table 43) and were 20% above the 1970-1982 average (23,300 mt). The USA nominal catch increased from 5,464 mt in 1982 to 15,987 mt in 1983, the highest level yet recorded. This increase was due, in part, to joint venture catches which accounted for 2,332 mt. Distant-water-fleet catches during 1983 were 11,795 mt compared with 15,800 mt in 1982. The 1983 catches were 45% below the 1970-1982 mean (21,480 mt).

The NEFC autumn survey index for 1983 increased 6% from 1982 and was 21% above the 1967-1982 average (Figure 37). The 1983 pre-recruit index was 13% less than in 1982 and 4% below the 1967-1982 mean. Minimum abundance was estimated to be 4.7 billion individuals during the time of the 1983 autumn survey, with 68% (3.2 billion) being of pre-recruit size (<8 cm or <3 inches). Recruitment from the 1983 year class should be 2.1-4.6 billion individuals assuming 100%-45% catchability of Loligo to the survey net. Yield-per-recruit analyses indicate that potential yields from this level of recruitment would be about 54,000 mt with the present fishery.

For further information see:

Lange, Anne M.T. 1983. Status of the long-finned squid, Loligo pealei, stocks off the Northeastern USA, November 1983. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 83-38, 27 p.

Table 43. Nominal catches (thousand metric tons) and management information for long-finned squid (Loligo) from the Gulf of Maine - Mid-Atlantic area, 1971-1983.

Category	Year 1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	1.3	3.6	1.1	1.3	4.3	4.0	2.3	5.4	16.0
Canada	-	-	-	-	-	-	-	-	-
Other	29.5	21.7	15.6	9.4	13.1	19.8	20.2	15.9	11.8
Total nominal catch	30.8	25.3	16.7	10.6	17.3	23.7	22.5	21.3	27.8
Total allowable catch	-	44.0	44.0	44.0	44.0[1]	44.0[1]	44.0[1]	44.0[1]	44.0[1]

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 (6.3 inches) dorsal mantle length

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1983} = Unknown

[1] 1 April - 31 March fishing year.

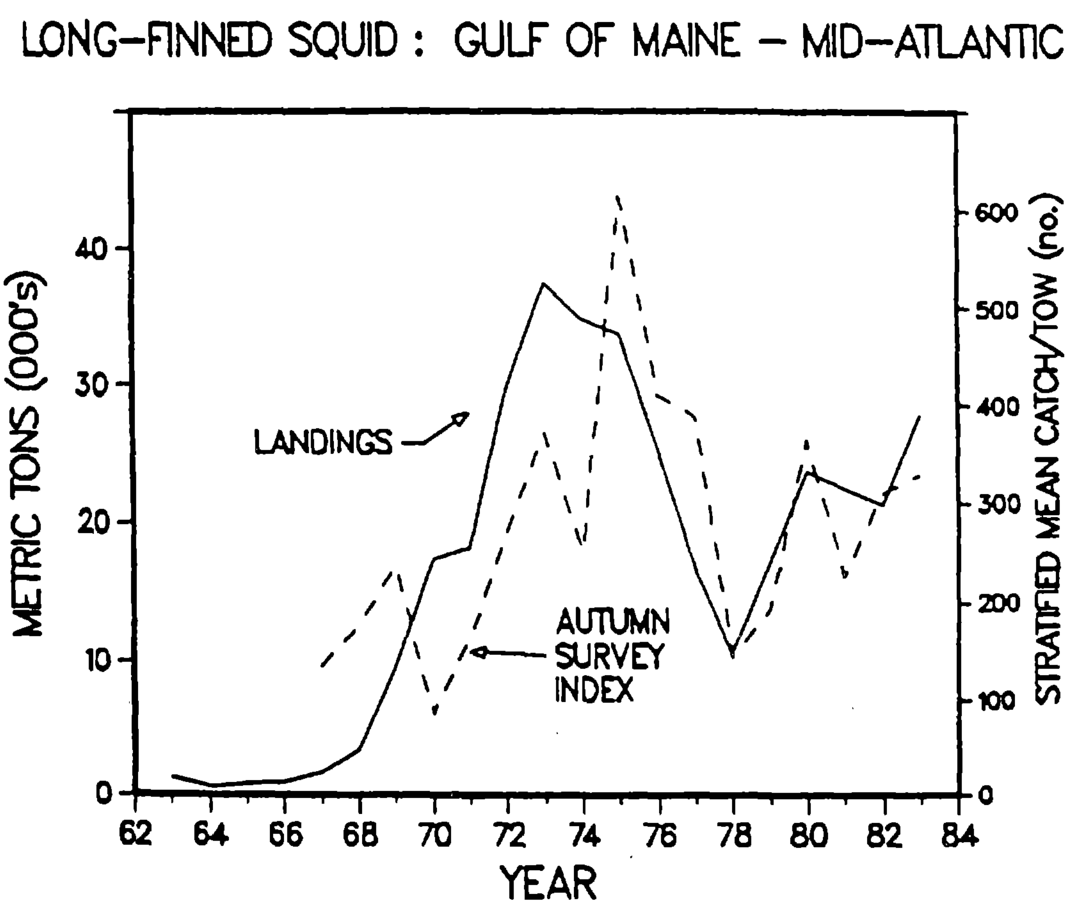

Figure 37. Total commercial landings and stock abundance indices from NEFC autumn bottom trawl surveys of long-finned squid in the Gulf of Maine - Mid-Atlantic area.

AMERICAN LOBSTER

The American lobster (Homarus americanus) is distributed in the Northwest Atlantic from Labrador to Cape Hatteras at depths 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 movements of small lobsters 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 1979-1981, averaging 15,500 mt and peaking in 1983 at 17,500 mt (Table 44). Nominal catches for the offshore lobster 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; landings during 1982-1983 averaged 2,400 mt. The offshore trawl fishery averaged 1,900 mt per year during 1965-1974 and then decreased steadily to only 200 mt in 1981; landings during 1982-1983 averaged 300 mt. Total offshore landings have declined in recent years relative to levels of the mid-1970's (Figure 38), but recovered slightly during 1982-1983.

The NEFC autumn survey biomass index declined steadily from 1.33 kg/tow in 1964 to 0.51 kg/tow in 1970, averaged 0.65 kg/tow during 1971-1976, and then increased to an average of 0.97 kg/tow during 1977-1980 (Figure 38). The autumn index decreased slightly to 0.86 kg/tow in 1981, but increased to 0.90 kg/tow during 1982-1983. The commercial CPUE index (kg-per-trap-haul-set-over-day or kg/THSOD) also indicated sharp declines in stock biomass during the 1970's, dropping from 1.74 kg/THSOD in 1969 to only 0.41 kg/THSOD in 1972. This index subsequently increased to 0.79 kg/THSOD in 1974 before dropping to a relatively stable level (0.40 kg/THSOD) during 1975-1982. Thus, trends in offshore commercial landings, commercial CPUE, 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 in more recent years. 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. 1982. Assessment of the USA offshore American lobster (*Homarus americanus*) fishery. ICES, C.M. 1982/K:14, 21 p.

Table 44. Commercial and recreational landings (metric tons, live weight) of American lobster from the Gulf of Maine - Mid-Atlantic area, 1971-1983.

Category		Year								
		1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational										
State waters[1]		-	-	-	-	-	-	-	-	-
Commercial										
USA:	Offshore[2]	3.8	3.9	3.0	3.3	2.5	2.2	1.8	2.2	2.5
	Inshore[3]	10.1	10.5	11.4	12.4	15.0	15.3	15.8	15.7	17.5
Canada:	Georges Bank	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.3	0.3
	Other	-	-	-	-	-	-	-	-	-
Total nominal catch		14.1	14.6	14.7	16.0	17.7	17.7	17.8	18.2	20.3
Total allowable catch		-	-	-	-	-	-	-	-	-

Long-term potential catch = 3.4
Importance of recreational fishery = Insignificant
Status of management = FMP in preparation
Status of exploitation = Fully exploited
Size at 50% maturity = 10 cm (3.9 inches) carapace length

$M = 0.10$ $F_{0.1}$ = Unknown F_{max} = 0.18 (males) 0.23 (females) $F_{1983} = >F_{max}$

[1] Unknown.

[2] Outside 12 miles.

[3] Within 12 miles.

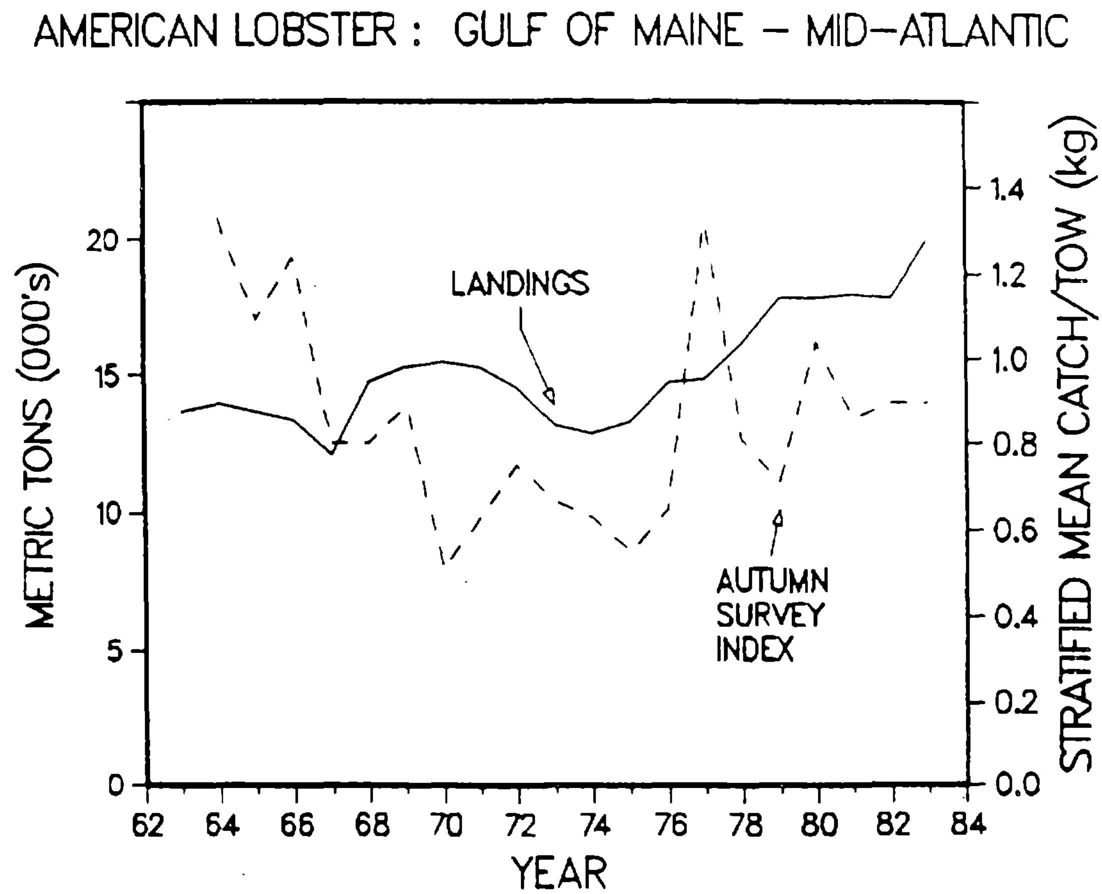

Figure 38. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of American lobster in the Gulf of Maine - Mid-Atlantic area.

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 largely attributable to environmental conditions. This stock collapsed during the mid-1970's in response to high exploitation and poor recruitment; some recovery has been evident in recent years, but abundance remains considerably below peak levels observed during the late 1960's.

Northern shrimp are protandric hermaphrodites, maturing first as males (generally at 2 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 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 Marine 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 45). 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 1982-1983, the fishing season was from 15 December to 15 May, and during 1983-1984, the season was from 15 December to 30 April.

Historically, effort has been directed primarily towards ovigerous females in inshore areas during the winter, although during the early 1970's, substantial quantities of all age groups were also harvested further offshore during the summer. 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.

Nominal catches peaked at 12,800 mt in 1969, averaged approximately 10,000 mt during 1970-1974, and then declined precipitously to only 400 mt in 1977 (Table 45, Figure 39). Nominal catches have since increased from an average of 400 mt in 1979-1980 to an average of approximately 1,500 mt in 1982-1983. The catch for the 1983-1984 season increased to 3,000 mt.

Recent assessments suggest a gradual increase in abundance since the late 1970's. Both the State of Maine summer survey index and NEFC spring and autumn (Figure 39) survey indices have increased in recent years. The Maine 1983 summer survey index at age 1 was the highest observed since the early 1970's. Nevertheless, all index values remain considerably below levels observed during the late 1960's and early 1970's. The increase in nominal catch observed in 1983-1984 is believed attributable both to increased abundance and to a substantial increase in fishing effort. The number of fishing trips directed toward shrimp almost doubled from the previous season. Prospects for continued recovery will be enhanced by management measures designed to restrict mortality on ovigerous females during the winter and on offshore concentrations of all age groups during the summer.

For further information see:

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

Northern Shrimp Technical Committee. 1983. Gulf of Maine northern shrimp stock status - 1983. Report to Northern Shrimp Section of Atlantic States Marine Fisheries Commission, November 1983, 20 p.

Table 45. Nominal catches (thousand metric tons) and management information for Gulf of Maine northern shrimp, 1971-1983.

Category	Year 1971-1975 average	1976	1977	1978[1]	1979	1980	1981	1982[2]	1983[3]
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	9.0	1.0	0.4	<0.1	0.5	0.3	1.0	1.5	1.4
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	9.0	1.0	0.4	<0.1	0.5	0.3	1.0	1.5	1.4
Total allowable catch	-	-	1.6	-	-	-	-	-	-

Long-term potential catch = Unknown
Importance of recreational fishery = Insignificant
Status of management = Jointly by participating states[4]
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_{1983} = Unknown

[1] Fishery closed during 1978.

[2] 1 January - 15 April 1982.

[3] 15 December 1982 - 15 May 1983.

[4] Under Amendment No. 1 to the Atlantic States Marine Fisheries Compact.

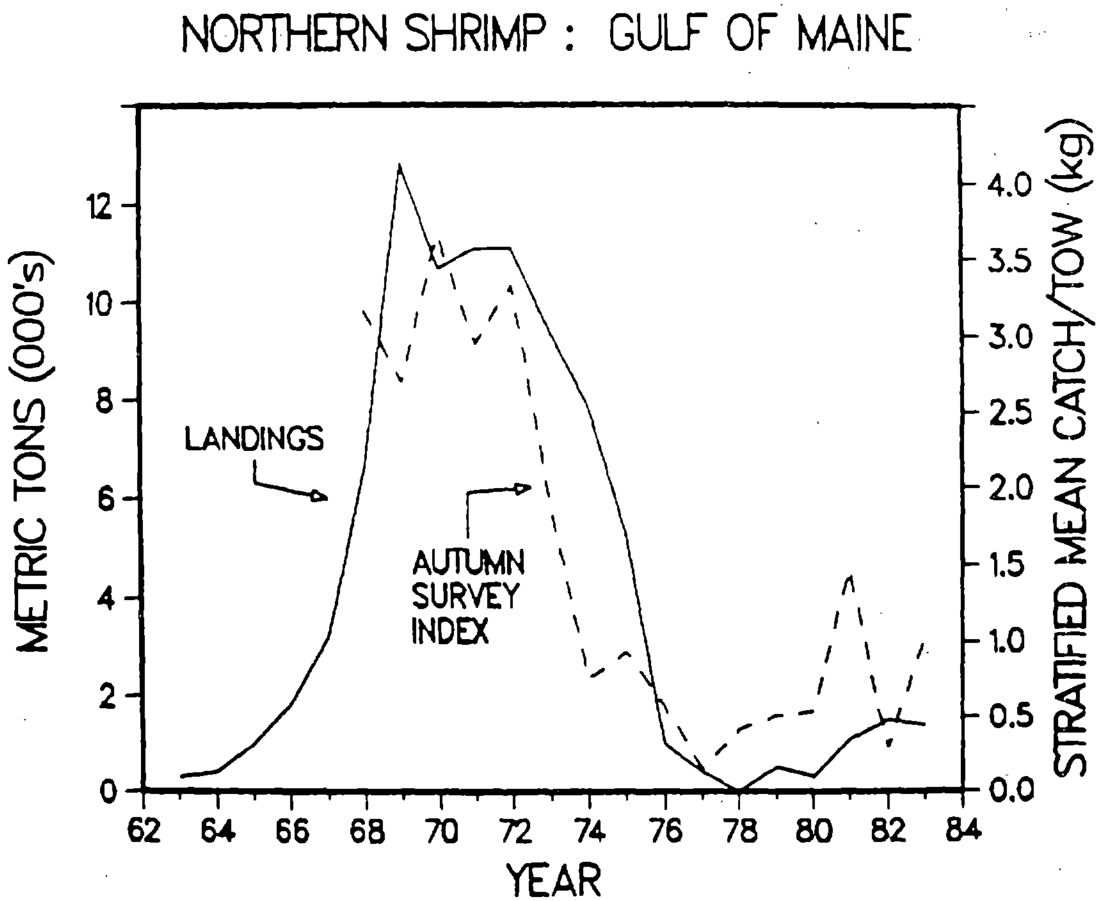

Figure 39. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of northern shrimp in the Gulf of Maine.

RED CRAB

The deep-sea red crab (Geryon quinquedens) is a relatively deep water crustacean distributed along the continental slope of the Northwest Atlantic, generally in depths from 100 to 1500 m (60-800 fathoms). The largest red crabs (males) may attain a carapace width of 178 mm (7 inches) and weigh about 1.36 kg (3 pounds). Growth rate of adult crabs is slow, and molting may not occur more frequently than at 2- to 3-year intervals. Maturity occurs at about 80-91 mm (3.2-3.6 inches) 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.

Estimates of standing crop biomass of commercial-sized [>4½ inches (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 concentrations of commercial biomass were off southern New England (46% of total) and Georges Bank (31% of total). Densities of red crab in the Norfolk Canyon area determined from research surveys 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.

Annual maximum sustained yield for the red crab resource between Georges Bank and offshore Maryland has been estimated to be 2,700 mt (5.9 million pounds). The 1983 nominal catch from this region exceeded 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. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 77-23, 15 p.

SURF CLAMS

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 Mid-Atlantic region, surf clams are found from the beach zone to a depth of about 60 m; beyond 40 m, however, abundance is low. Growth rates are relatively rapid, with clams reaching harvestable size (14 cm or 5 1/2 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 planktonic larval period of about 3 weeks (at 22°C).

Atlantic surf clam populations inhabiting offshore (Fishery Conservation Zone) waters of the USA east coast have been managed since November 1977 under provisions of the Magnuson Fishery Conservation and Management Act. Prior to enactment of the comprehensive management plan, stock abundance and total commercial landings in the Mid-Atlantic Bight fell dramatically; landings declined from 46,300 mt of shucked meats in 1974 to 22,300 mt in 1976. Regulation of the fishery has proceeded with one objective being the re-building of Mid-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 and Mid-Atlantic) are identified in the management plan reflecting the different status of resources and fisheries within these areas. A separate quota of 100,000 bushels (800 mt) was in effect in the southern New England region during 1983; this quota was raised to 200,000 bushels for 1984.

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, the New Jersey resources supported the fishery 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 46 and Figure 40). Average catches in these three years of 40,100 mt (meats) were 50% greater than the 1965-1977 average of 27,000 mt. The southern Virginia - North Carolina fishery collapsed during 1976; most vessels returned to more northern ports. During 1983, 41% of FCZ surf clam landings were taken off New Jersey, 42% off the Delmarva Peninsula, and 16% from the southern Virginia - North Carolina region. Total FCZ landings in 1983 were 20,500 mt, slightly greater than the annual quota. Landings off southern New England were about 1,520 mt in 1983, most of which were taken during January-June, necessitating a fishery closure for a substantial portion of the year.

Synoptic research vessel surveys of Mid-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 the survey gear. Indices of biomass were adjusted to reflect differences in the dimensions of the gear and the operational procedures employed.

Biomass indices from research vessel surveys generally parallel trends in landing statistics from various portions of the management area (Figure 40). Stock biomass 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 the summer of 1976 reduced the abundance of commercial-sized clams to extremely low levels. Subsequent surveys of the area (1978-1983) have indicated the existance of a substantial 1976 year class in the area subjected to the clam kill. Growth to harvestable size of this single year class off northern New Jersey resulted in an increasing proportion of total Mid-Atlantic nominal catches from that area. Much of the 1976 year class is yet to recruit to the exploitable stock, and depressed growth rates in high density areas off Atlantic City may result in some clams failing to reach the 14-cm size limit.

Biomass 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 that the biomass of commercial sizes has remained relatively low, although a significant pre-recruit resource (1977 year class) presently exists off Delmarva. Based on growth rate projections, increasing proportions of the 1977 year class will reach harvestable size during 1984 and 1985.

Surf clam resources in the southern New Jersey and southern Virginia - North Carolina 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. The increased surf clam landings from the southern New England FCZ during 1983 was also a result of the intensive culling necessary to land legal-sized clams from other regions.

Resource surveys and commercial fishery data suggest that sufficient surf clam resources exist in the Mid-Atlantic FCZ to sustain the fishery at current landings levels into the early 1990's. However, there does not appear to be additional strong cohorts following the 1976 and 1977 year classes off New Jersey and the Delmarva Peninsula. Thus, for at least the next six years, the fishery will be based virtually on these two year classes.

For further information see:

Murawski, S.A., and F.M. Serchuk. 1984. Assessment update for Mid-Atlantic surf clam, Spisula solidissima, populations - Winter 1983-1984. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 84-07, 42 p.

Murawski, S.A., and F.M. Serchuk. 1983. An assessment of the surf clam resource in FCZ waters off southern New England - Spring 1983. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 83-20, 21 p.

Table 46. Nominal catches (thousand metric tons) and management information for surf clams from the New England - Mid-Atlantic area, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA:									
FCZ waters	26.9	19.3	19.5	14.2	13.2	15.7	16.9	16.7	20.5
State waters	7.7	3.0	3.7	3.6	2.6	1.4	4.0	5.9	4.9
Total	34.6	22.3	23.2	17.8	15.8	17.1	20.9	22.5	25.4
Total allowable FCZ catch	-	-	-	13.6	13.6	13.6	18.1	18.1	18.9[1]

Long-term potential catch = 23.0
Importance of recreational fishery = Insignificant
Status of management = FMP in force since November 1977
Status of exploitation = Fully exploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 5 cm (2.0 inches)

$M = 0.20$ $F_{0.1}$ = Unknown F_{max} = Unknown F_{1983} = Unknown

[1]Includes 0.8 for southern New England area.

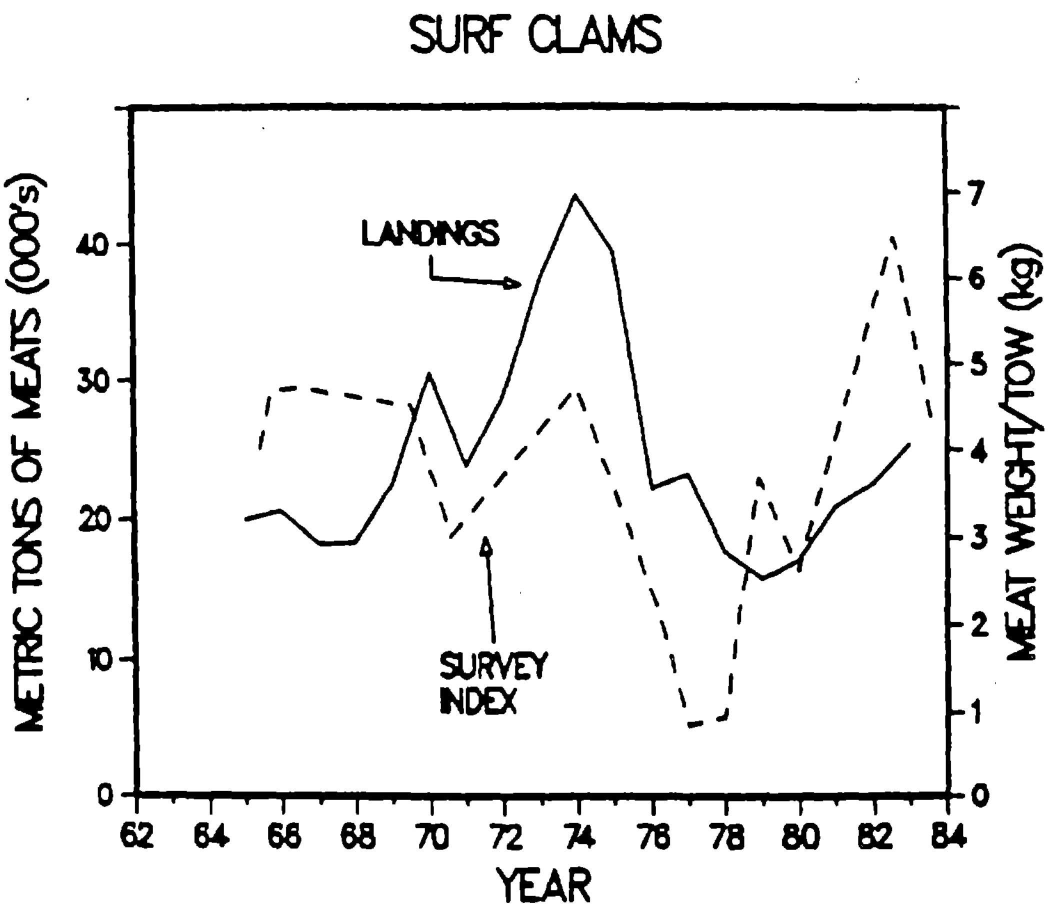

Figure 40. Total commercial landings and stock biomass indices from NEFC dredge surveys of surf clams in the Mid-Atlantic area.

OCEAN QUAHOGS

The ocean quahog (Arctica islandica) is found in temperate and boreal waters on both sides of the North Atlantic. Distribution in the Western Atlantic ranges from Newfoundland to Cape Hatteras in depths from 8 to 256 m. Quahogs are rarely found where bottom water temperatures exceed 16°C and occur progressively further offshore between Cape Cod and Cape Hatteras. Highest densities in the Mid-Atlantic region are in depths between 40 and 60 m; few quahogs have been found in excess of 100 m. Results of recent age and growth studies indicate that 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 1,000 mt 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. Total ocean quahog landings increased dramatically during 1976-1979 from 2,500 to 15,800 mt of meats per year. Landings have since stabilized at about 16,000 mt per year (Table 47, Figure 41). Landings in 1983 were 16,000 mt, of which more than 95% was from FCZ waters. Most of the FCZ landings were from off New Jersey (75%) and the Delmarva Peninsula (25%). Small quantities of quahogs were also landed from state waters off Rhode Island and Maine.

The FCZ fishery has been regulated since 1977 under provisions of the Surf Clam and Ocean Quahog Fishery Management Plan (FMP) developed by the Mid-Atlantic Fishery Management Council. The primary management measure has been an annual landings quota: 13,600 mt of meats in 1978 and 1979, 15,900 mt in 1980, and 18,100 mt in 1981-1984.

Resource surveys for ocean quahogs in the Georges Bank - Cape Hatteras region have been conducted by the NEFC since 1965. Biomass indices for six assessment areas in the region were extremely stable during 1965-1982, indicating little fluctuation in biomass. Total standing stock of quahogs in the region is estimated to be 1.2 million mt of meats. The majority of the resource occurs on Georges Bank (29%) and off southern New England (26%), with smaller amounts off Long Island (19%), New Jersey (19%), Delmarva (7%), and southern Virginia - North Carolina (<1%).

Trends in fishery performance during 1979-1983 were evaluated using mandatory logbook data submitted by each permitted vessel (Figure 41). The offshore ocean quahog fishery is conducted primarily with dredging vessels greater than 100 GRT. Average catch per hour for the large vessels varied little during the period, although average catch rates were significantly higher for the Delmarva area (152 bushels/hour) than off New Jersey (121 bushels/hour). The catch is primarily composed of quahogs 65-105 mm shell length. Little size selectivity by the fishery is apparent as the size composition of landings is similar to that from resource surveys.

Although annual landings are currently only 1.3% of the total estimated stock, annual landings considerably in excess of 18,000 mt are not warranted due to the extremely slow growth rate and poor annual recruitment exhibited by the populations. Annual landings off New Jersey and the Delmarva Peninsula are currently about 5% of the total resource in these areas. If current harvest levels and patterns are maintained, the quahog resource and fishery in the New Jersey - Delmarva area should remain stable for the next 5-7 years, after which the fishery will probably shift northward and to the east to take advantage of higher marginal catch rates.

For further information see:

Murawski, S.A., and F.M. Serchuk. 1983. An assessment of the ocean quahog, Arctica islandica, resource and fishery in FCZ waters off the Northeastern USA - Autumn 1983. NMFS,NEFC, Woods Hole Lab. Ref. Doc. No. 83-25. 31 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 47. Nominal catches (thousand metric tons) and management information for ocean quahogs from the New England - Mid-Atlantic area, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA:									
FCZ waters	-	1.9	7.3	9.2	14.3	13.9	16.0	15.6	15.3
State waters	0.7	0.7	1.1	1.2	1.4	1.5	0.4	0.2	0.7
Total	0.7	2.5	8.4	10.4	15.8	15.3	16.4	15.8	16.0
Total allowable FCZ catch	-	-	-	13.6	13.6	15.9	18.1	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 = Fully exploited in some areas
Age at 50% maturity = 8 yrs (males); 11 yrs (females)
Size at 50% maturity = 50 mm (2.0 inches) shell length

M = 0.01-0.10 $F_{0.1}$ = Unknown F_{max} = Unknown F_{1983} = Unknown

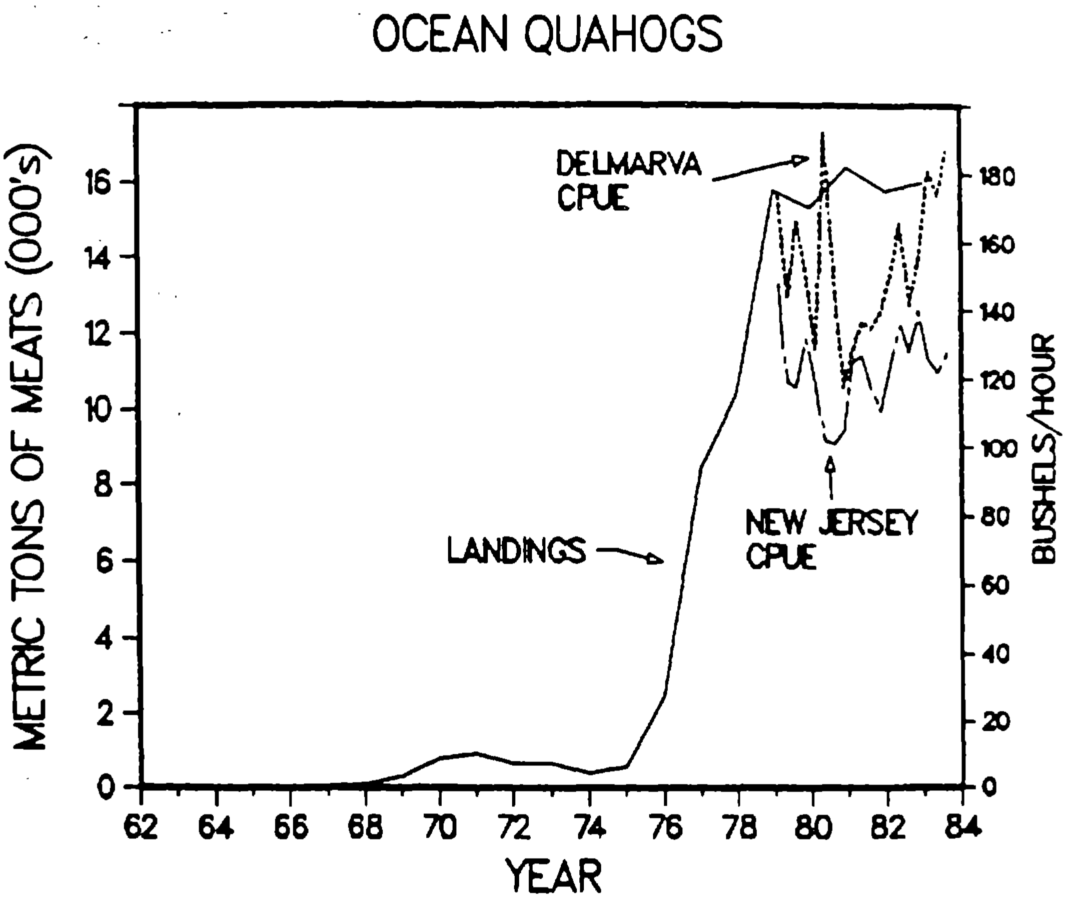

Figure 41. Total commercial landings of ocean quahogs in the New England - Mid-Atlantic area and commercial catch per unit effort in the New Jersey and Delmarva ocean quahog dredge fisheries.

SEA SCALLOPS

Sea scallops (Placopecten magellanicus) are distributed in western North Atlantic continental shelf waters from Newfoundland to North Carolina. North of Cape Cod, scattered concentrations may occur in shallow water less than 20 m (11 fathoms), but in more southerly and in offshore areas, scallops normally are found at depths between 40 and 200 m (22-110 fathoms). Commercial concentrations generally exist between 40 and 100 m (22-55 fathoms) in waters cooler than 20°C. Principal USA commercial fisheries are conducted in the Gulf of Maine, on Georges Bank, and in the Mid-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. Maximum size is about 23 cm (9.0 inches), but scallops larger than 17 cm (6.7 inches) 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

Commercial 1983 nominal catches were 1,042 mt (meat weight), 350 mt more than in 1982, and the third highest annual catch ever (Table 48, Figure 42). Both USA and Canadian landings (895 and 147 mt, respectively) were sharply higher than in 1982 (670 and 23 mt, respectively). Unlike 1980-1982 patterns, most (58%) of the 1983 USA catch was from inshore territorial waters along the coast of Maine. During 1970-1979, landings from territorial waters accounted for 84% of the total Gulf of Maine sea scallop catch.

Total effort in the Gulf of Maine fishery attained record levels in 1983. USA 1983 commercial CPUE declined to historically low levels for all vessel classes implying that the 34% increase in USA landings between 1982 and 1983 resulted from a twofold increase in fishing effort. Record ex-vessel prices in 1983 presumably stimulated this increase.

During August 1983, NEFC conducted a sea scallop research vessel survey in nine different offshore areas in the Gulf of Maine. Significant densities of scallops were observed in survey tows on Fippennies Ledge and Jeffreys Ledge, although most scallops were small with meat counts in excess of 50-100 per pound. No important beds were located in any of the five deep-water (>60 fathoms) areas surveyed.

Both the survey results and performance patterns in the commercial fishery suggest that the Gulf of Maine fishery will become more dependent on inshore, territorial beds in the future than in recent years.

Table 48. Nominal catches (thousand metric tons, meat weight) and management information for sea scallops from the Gulf of Maine, Georges Bank, and the Mid-Atlantic areas, 1971-1983.

Category	Year								
	1971-1975 average	1976	1977	1978	1979	1980	1981	1982	1983
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
Gulf of Maine									
USA	0.5	0.4	0.3	0.2	0.4	1.6	1.3	0.7	0.9
Canada	-	-	-	-	-	<0.1	<0.1	<0.1	0.1
Total	0.5	0.4	0.3	0.2	0.4	1.6	1.3	0.7	1.0
Georges Bank									
USA	1.0	1.8	4.8	5.6	6.7	5.8	8.5	6.7	4.6
Canada	5.2	9.8	13.1	12.2	9.2	5.2	8.0	4.3	2.8
Total	6.2	11.6	17.9	17.8	15.9	11.0	16.5	11.0	7.4
Mid-Atlantic									
USA	1.5	6.6	5.9	8.6	7.2	5.1	1.9	1.7	3.2
Total nominal catch	8.2	18.6	24.1	26.6	23.5	17.7	19.7	13.4	11.6
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch
- Gulf of Maine = 0.3 (territorial waters)
- Georges Bank = 10.0
- Mid-Atlantic = 3.0

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 yrs (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) $F_{1983} = \gg F_{max}$ in all areas

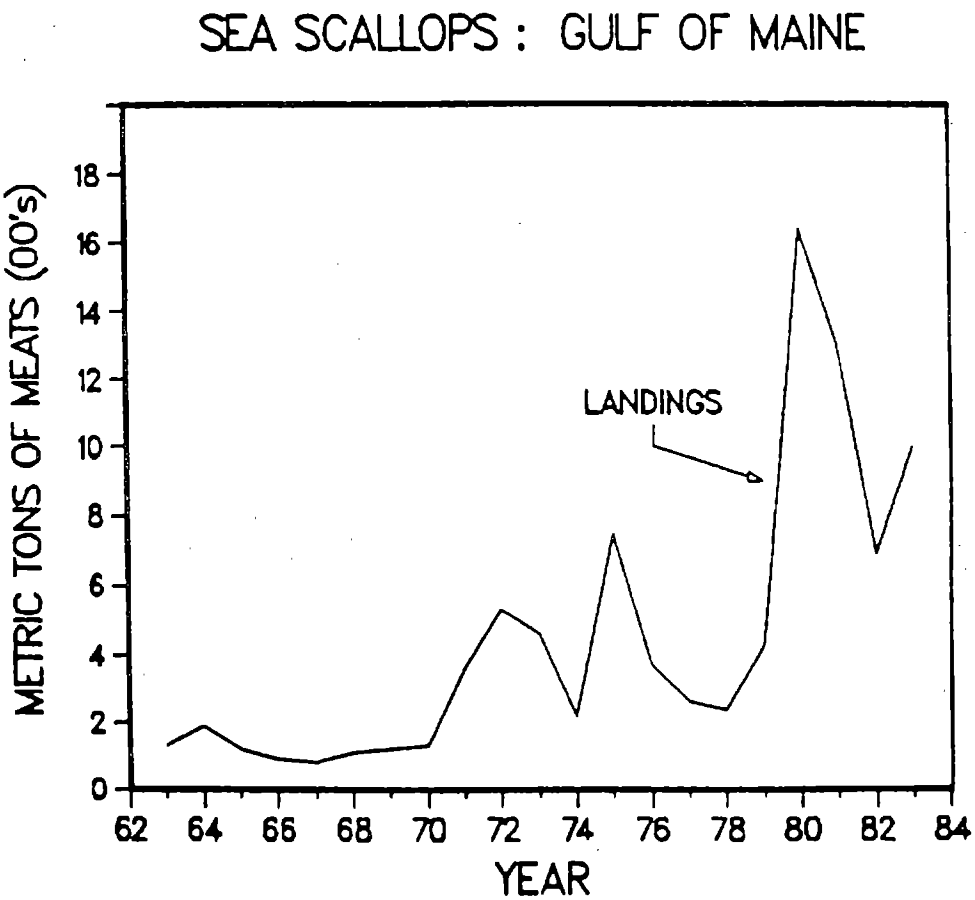

Figure 42. Total commercial landings of sea scallops in the Gulf of Maine.

Georges Bank

Total international (USA and Canada) 1983 commercial landings from Georges Bank were 7,076 mt, 35% less than in 1982, and the lowest annual catch since 1974 (Table 48, Figure 43). The 1983 USA catch (4,328 mt) was the lowest since 1976, while the 1983 Canadian catch (2,748 mt) was the lowest since 1959. About 59% of the total 1983 Georges Bank catch was from the Northern Edge and Peak region of the Bank, although most of the USA catch (56%) was from the South Channel fishery. Declines in 1983 landings were observed in all three principal fishery regions on Georges Bank (South Channel, Southeast Part, Northern Edge and Peak). The largest declines occurred on the Northern Edge and Peak where USA landings decreased 43% and Canadian landings declined 36% from 1982 to 1983. As in 1978-1982, all of the 1983 Canadian Georges Bank landings were taken from the Northern Edge and Peak.

Total USA effort in the 1983 Georges Bank fishery declined slightly (9%) from the near-record 1982 level. USA commercial CPUE was 27% lower in 1983 than in 1982 and was the lowest in the 1965-1983 time series. Canadian CPUE in 1983 was also among the lowest ever recorded. Due to declines in resource abundance, particularly in the Northern Edge and Peak region, the USA fleet shifted effort to the Mid-Atlantic region in 1983. Canadian effort in 1983 was also partially redirected towards Scotian Shelf and Grand Banks scallop resources.

Catch-per-tow indices from the NEFC 1983 Georges Bank sea scallop survey were the lowest observed in the 1975-1983 time series (Figure 43). The current survey values indicate that scallop abundance and biomass are between 33% and 25% of the levels observed during 1975-1979. Sequential annual declines in survey indices have now been observed for the past three years on Georges Bank.

Survey data indicated that recruitment in all regions of Georges Bank remains low. The 1980 year class is not strong in any area of the Bank. The exceptionally abundant 1979 year class, localized primarily in the South Channel region, has been substantially reduced in numbers more rapidly than anticipated due to presumed "mixing" of these small-sized scallops in the commercial landings.

Depressed resource conditions are likely to continue in the Georges Bank area through 1984 and 1985, with recovery of the population expected only when recruitment improves.

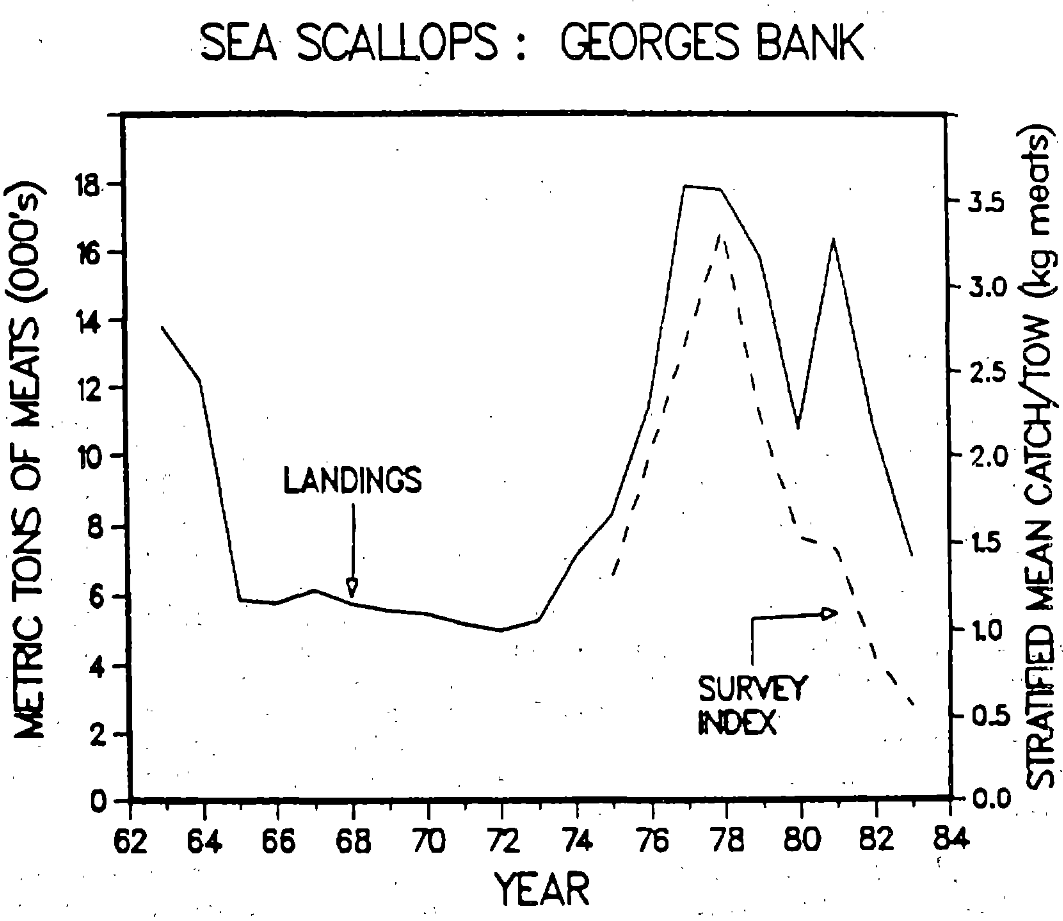

Figure 43. Total commercial landings and stock biomass indices from NEFC dredge surveys of sea scallops on Georges Bank.

Mid-Atlantic

Commercial 1983 landings (exclusively USA) from the Mid-Atlantic area were 3,227 mt, 90% higher than in 1982 (1,702 mt), and the highest annual catch since 1980 (Table 48, Figure 44). Mid-Atlantic scallop landings comprised 37% of the total 1983 USA sea scallop catch, about twice the proportional representation in the 1982 USA fishery (19%). Virtually all (90%) of the 1983 Mid-Atlantic catch was from the New York Bight region (off Long Island and New Jersey) where landings increased by a factor of 2.2 from 1982. Catches in the more southerly scallop regions (Delmarva and Virginia - North Carolina) declined 17% and 52%, respectively, between 1982 and 1983.

Total effort in 1983 was about twice as great as in 1982, and approached historically high levels. Effort and effort increases were highest in the New York Bight region where a record effort was generated in 1983. High ex-vessel prices and low abundance of scallops on Georges Bank prompted effort shifts to the Mid-Atlantic beds during spring 1983. Mid-Atlantic commercial CPUE in 1983 was slightly higher than in 1982 (0.47 vs 0.43 mt/day) although still far below the CPUE values observed during 1976-1978 (1.10-1.24 mt/day). The marginal increase in CPUE between 1982 and 1983 implies that elevated landings in 1983 primarily reflected fishing effort increases rather than improved resource conditions.

Abundance and biomass indices from the 1983 NEFC Mid-Atlantic research vessel survey were the lowest in the 1975-1983 time series (Figure 44). The 1983 decline in total catch per tow represented the fourth consecutive year in which reductions have occurred. Although pre-recruit indices in all Mid-Atlantic regions were slightly higher in 1983 than in 1982, the 1980 year class is not strong and is highly localized in a depth band between 25 and 40 fathoms off Virginia - North Carolina and Delmarva and between 15 and 30 fathoms in the New York Bight.

Given poor recruitment, record low survey indices, and high commercial effort, resource conditions in the Mid-Atlantic area will continue to remain poor in the near future.

For further information see:

Serchuk, F.M. 1983. Results of the 1983 USA sea scallop research vessel survey: Distribution and abundance of sea scallops in the Georges Bank, Mid-Atlantic and Gulf of Maine regions and biological characteristics of Iceland scallops off the coast of Massachusetts. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 83-37, 54 p.

Serchuk, F.M. 1984. Fishing patterns and management measures regulating size of capture in the Georges Bank sea scallop fishery: A brief historical review. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 84-11, 10 p.

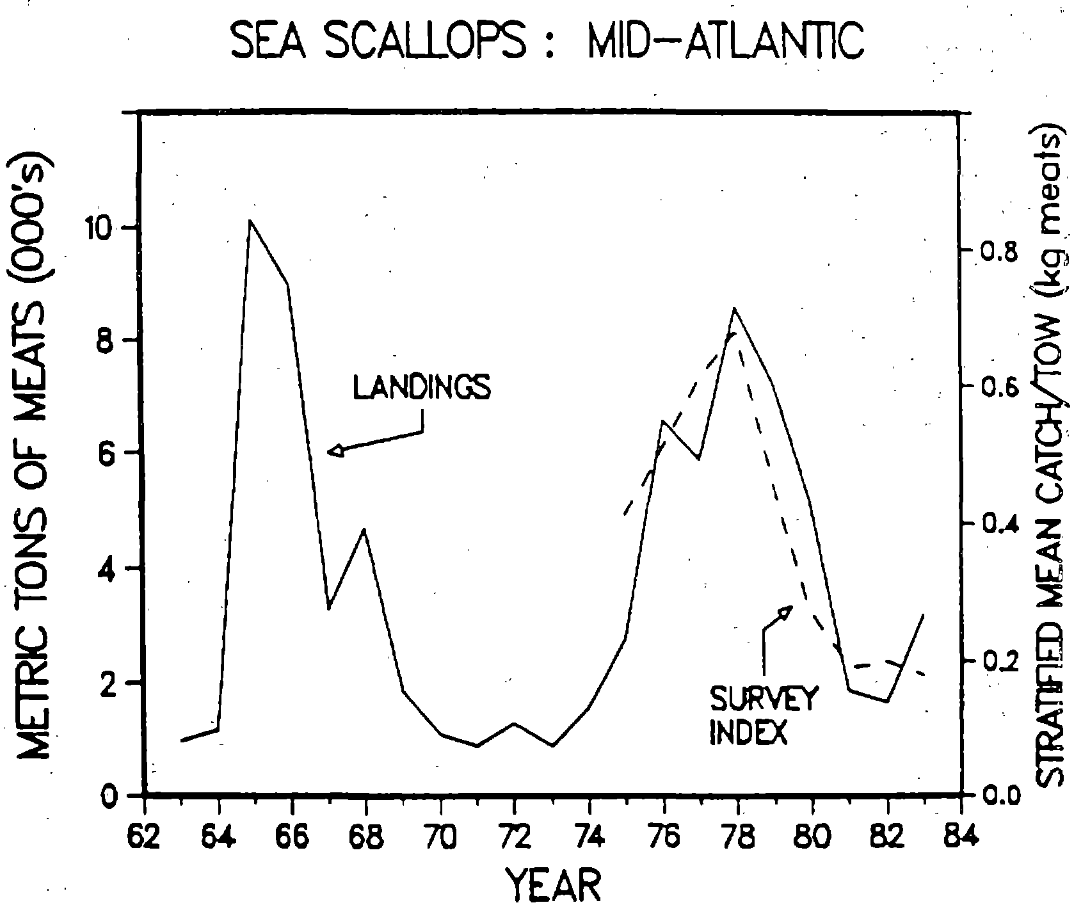

Figure 44. Total commercial landings and stock biomass indices from NEFC dredge surveys of sea scallops in the Mid-Atlantic area.