NOAA Technical Memorandum NMFS-F/NEC-42

Status of the Fishery Resources Off the Northeastern United States for 1985

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Center
Woods Hole, Massachusetts
August 1985

NOAA TECHNICAL MEMORANDUM NMFS-F/NEC

Under the National Marine Fisheries Service's mission to "Achieve a continued optimum utilization of living resources for the benefit of the Nation," the Northeast Fisheries Center (NEFC) is responsible for planning, developing, and managing multidisciplinary programs of basic and applied research to: (1) better understand the living marine resources (including marine mammals) of the Northwest Atlantic, and the environmental quality essential for their existence and continued productivity; and (2) describe and provide to management, industry, and the public, options for the utilization and conservation of living marine resources and maintenance of environmental quality which are consistent with national and regional goals and needs, and with international commitments.

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27. ***Pelagic Distributions of Marine Birds Off the Northeastern United States.*** By Kevin D. Powers. November 1983. xvi + 201 p., 116 figs., 5 tables, 9 app. NTIS Access. No. PB84-187871.

28. ***Food of Seventeen Species of Northwest Atlantic Fish.*** By Ray E. Bowman and William L. Michaels. January 1984. xx + 183 p., 2 figs., 61 tables, 19 app. NTIS Access. No. PB84-219195.

29. ***Status of the Fishery Resources Off the Northeastern United States for 1983.*** By Resource Assessment Division, Northeast Fisheries Center; Emory D. Anderson, ed. July 1984. iii + 132 p., 44 figs., 48 tables. NTIS Access. No. PB85-106847.

30. ***Recent Estimates of Adult Spawning Stock Biomass Off the Northeastern United States from MARMAP Ichthyoplankton Surveys.*** By Peter Berrien, Wallace Morse, and Michael Pennington. July 1984. ix + 111 p., 25 figs., 25 tables. NTIS Access. No. PB85-108991.

31. ***Evidence of Nearshore Summer Upwelling Off Atlantic City, New Jersey.*** By Merton C. Ingham and James Eberwine. November 1984. iii + 10 p., 5 figs.

(continued on inside back cover)

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Status of the Fishery Resources Off the Northeastern United States for 1985

Conservation & Utilization Division, Northeast Fisheries Center

U.S. DEPARTMENT OF COMMERCE
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Woods Hole, Massachusetts
August 1985

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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 1984. 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.

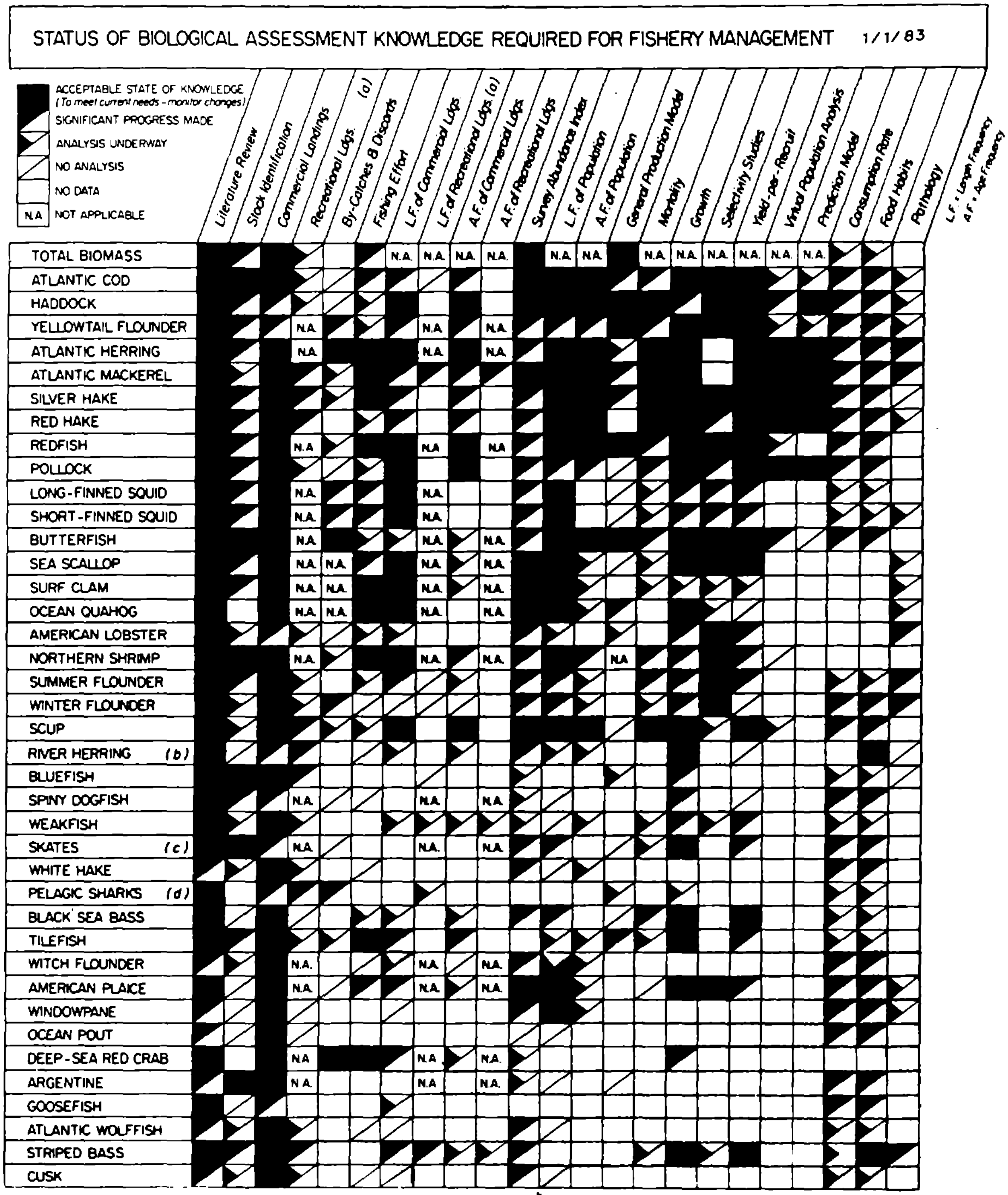
d) Catch statistics alone.

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.



(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 (J). 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 instan-taneous 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 10% from 1983 to 1984. The total catch decreased from 1.39 million metric tons (mt) in 1983 to 1.25 million mt in 1984 (Table 2). The catch of finfish decreased 16%, whereas the invertebrate catch decreased 5%.

Groundfish

Total groundfish commercial catches decreased 11% from 1983 to 1984 (Table 2). Catches of the principal groundfish (cod, haddock, redfish, red hake, silver hake, and pollock) decreased 10% from 127,927 mt in 1983 to 115,926 mt in 1984. Cod and haddock catches decreased 20% and 27% respectively, whereas silver hake (19%) and pollock (13%) catches increased.

Flounder catches decreased 15,600 mt from 1983 to 1984 (19% decrease). Yellowtail flounder catch decreased from 33,083 mt in 1983 to 17,819 mt in 1984 accounting for 98% of the total flounder catch decline.

Other groundfish catches increased by 6% from 1983 to 1984. This increase seems to be due to small increases in several groundfish species.

Pelagics

Nominal catches of the principal pelagics, herring and mackerel, increased 30% from 1983 (33,003 mt) to 1984 (47,454 mt) (Table 2). The USA herring catch increased 30% (about 10,000 mt) and USA mackerel catch increased by 16%. The distant-water-fleet mackerel catch increased 62% from 6,000 mt to 9,477 mt.

Catches of other pelagic species decreased 25% due to a 28% decrease in the menhaden catch. However, butterfish catch increased 127% from 1983 (5,466 mt) to 1984 (12,425 mt).

Other Finfish

The total international catch of other finfish decreased 7% from 1983 (34,456 mt) to 1984 (32,083 mt).

Invertebrates

The total USA and foreign catch of invertebrates decreased 5% from 728,135 mt in 1983 to 689,288 mt in 1984 (Table 2). Foreign catches decreased 24% due to a 29% decrease in the Canadian sea scallop catch. Domestic catch decreased only 11%.

Total squid catch decreased 14%. Foreign catches of short-finned squid (Illex) decreased 62% from 1983 (1,776 mt) to 1984 (676 mt), while long-finned squid (Loligo) decreased 6%. Most of the overall decrease in the total invertebrate catch is accounted for by decreases in sea scallop and inshore crab catches.

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 1983 and 1984. All catches are expressed as live weight.

Species	Foreign		USA Commercial		Total	
	1983	1984	1983	1984	1983	1984
Principal Groundfish	25,359	15,387	102,568	100,539	127,927	115,926
Atlantic cod	14,923	8,849	50,639	43,721	56,562	52,570
Haddock	5,215	2,708	14,286	11,603	19,501	14,311
Redfish (Ocean perch)	113	71	5,214	4,721	5,327	4,792
Silver hake (Whiting)	618	412	16,832	21,020	17,450	21,432
Red hake	107	57	2,167	2,273	2,274	2,330
Pollock	4,383	3,290	13,430	17,201	17,813	20,491
Flounders	550	219	80,715	65,481	81,265	65,700
American plaice	37	8	13,150	10,135	13,187	10,143
Witch flounder	45	14	5,837	6,532	5,882	6,546
Yellowtail flounder	46	4	33,037	17,815	33,083	17,819
Greenland halibut	0	0	0	0	0	0
Atlantic halibut	131	62	69	74	200	136
Winter flounder	19	5	15,335	14,680	15,354	14,685
Summer flounder	0	0	11,821	14,197	11,821	14,197
Windowpane flounder	0	0	1,257	1,830	1,257	1,830
Flatfishes (unknown)	272	126	209	218	481	344
Other Groundfish	1,805	2,199	22,100	23,240	23,905	25,439
Cusk	601	477	1,837	1,710	2,438	2,187
Scup	0	0	7,792	7,781	7,792	7,781
White hake	810	1,013	6,167	6,491	6,977	7,504
Atlantic wolffish	95	82	1,188	1,042	1,283	1,124
Groundfish (not specified)	299	627	5,116	6,216	5,415	6,843
Principal Pelagics	5,940	9,477	27,063	37,977	33,003	47,454
Atlantic herring	0	0	23,247	33,447	23,247	33,447
Atlantic mackerel	5,940	9,477	3,816	4,530	9,756	14,007
Other Pelagics	561	446	364,217	271,577	364,778	272,023
Bluefish	0	0	5,546	4,279	5,546	4,279
Atlantic butterfish	561	432	4,905	11,993	5,466	12,425
Atlantic menhaden	0	0	349,641	251,788	349,641	251,788
Pelagics (not specified)	0	14	4,125	3,517	4,125	3,531
Other Finfish	763	795	33,693	31,288	34,456	32,083
River herring	6	16	4,180	4,088	4,186	4,104
Spiny dogfish	8	2	4,856	4,390	4,864	4,392
Skates	0	5	3,583	4,129	3,583	4,134
Finfish (not specified)	749	772	21,074	18,681	21,823	19,453
Invertebrates	37,853	28,925	690,282	660,363	728,135	689,288
Short-finned squid (Illex)	1,776	676	9,812	9,307	11,588	9,983
Long-finned squid (Loligo)	11,720	11,031	13,762	10,825	25,482	21,856
American lobster	329	267	15,133	19,887	15,462	20,154
Shrimp (Pandalid)	0	0	1,574	3,227	1,574	3,227
Crab (nk)	0	1	80,943	57,921	80,943	57,922
Surf clams	0	0	133,611	168,038	133,611	168,038
Ocean quahogs	0	0	133,654	149,120	133,654	149,120
Sea scallops	24,028	16,950	72,478	64,468	96,506	81,418
Invertebrates (not specified)	0	0	229,315	177,570	229,315	177,570
Grand Total	72,831	57,448	1,320,638	1,190,465	1,393,469	1,247,913

--Not specified indicates that there are other species in this category which are not listed in the table.
--1984 landings are provisional.
--Catch Totals in Table 2 represent Gulf of Maine - Mid-Atlantic only. Catch Totals in Tables 10-49 may vary since they represent the specific stock assessment boundaries described. Recreational catches are also not included in Table 2.

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 1979-1982 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

NEW ENGLAND

The trend in the economic status of the New England fishing fleet over the period 1978 through 1984 has been the reverse of that of the national economy. Over the period many fish stocks declined, fuel and interest costs rose steeply, the number of vessels in the fisheries jumped sharply, and the level of imports increased. In addition, American fishermen were required to withdraw from the eastern side of the Gulf of Maine segment of the U.S.-Canadian maritime boundary. Most recently, as many costs of fishing have begun to stabilize, insurance costs have accelerated in many ports and access to an additional fishing area, a rich portion of the Georges Bank, was lost in the World Court settlement.

The total revenue received by vessels of five gross registered tons (GRT) or more has remained at approximately $150 million over the last seven years (Table 3)[1]. Total landings (live weight), which increased by over ten million pounds (mlb.) to 714 mlb. between 1978 and 1982, fell to 662 mlb. in 1984. The number of vessels in this category increased by almost 50% between 1978 and 1981, but has since remained fairly constant at approximately 1350 vessels. Consequently, landings-per-vessel and revenue-per-vessel have, with minor fluctuations, shown a downward trend over the period marked by the implementation of the M.F.C.M.A. The larger-than-normal profits to individual fishing vessels, which were made possible after enactment of the M.F.C.M.A. in 1977, have been diluted to a large extent by the growth in the fleet.

Otter Trawls and Scallop Dredges: For the 990 otter trawl vessels operating in 1984, total landings and total revenue were 360 million pounds and $92 million, respectively, down slightly from the 1983 level (Table 3). Deflated revenue-per-trawler has fluctuated around $94,000 in the eighties after a steep decline from the 1978 figure. Landings-per-trawler have likewise declined but less steadily. Both revenue and landings-per-trawler were at their lowest point in 1984 for the seven year period.

The New England scallop dredge fleet is comprised of approximately 210 vessels. The fleet harvested 83 million pounds (live weight) of sea scallops and some Icelandic scallops in 1984. This figure is significantly lower than the 148 million pounds brought on board in 1981 (Table 3). The 1984 landings brought $32 million to the fleet--a low for the period--and $10 million less than the year before. The average individual vessel received $150,000 for 388,000 pounds of live sea scallops dredged that year. This was the lowest value received and quantity landed in the seven year period.

In general, the decline in landings has not brought about an increase in prices to fishermen (Table 4). In some cases the size of the average fish became smaller as stocks came under stress. For some species, imports contributed to keeping prices from rising. The prices of most major species

[1] All value amounts--prices, revenues, costs, earnings, etc.-- have been adjusted for inflation ("deflated") using 1977 as the base year. In this way the purchasing power of a dollar is comparable between years.

Table 3. New England Landings and Revenue by Gear Types for Vessels 5 Gross Tons and Over.

Years	Number of Vessels	Total Revenue (000's $)	Total Landings (000's lbs)	Revenue Per Vessel (000's $)	Landings Per Vessel (000's lbs)	Number of Fishermen
			ALL GEAR			
1978	907	145431	612491	160	675	4160
1979	1145	155482	625444	135	546	5453
1980	1306	149881	699663	114	535	6498
1981	1343	152891	657694	113	489	6798
1982	1343	151339	714459	112	531	6492
1983	1592	162886	700051	102	439	7270
1984	1386	148733	662461	107	477	6872
			TRAWL GEAR ONLY			
1978	643	85964	320395	133	498	2703
1979	768	89254	336840	116	438	3177
1980	894	85245	366943	95	410	3792
1981	914	85913	354278	93	387	3956
1982	988	94426	398299	95	403	4404
1983	975	94101	396807	96	406	4354
1984	994	92021	358696	92	360	4517
			SCALLOP DREDGE GEAR ONLY			
1978	129	37685	132504	292	1027	937
1979	200	42999	125913	214	629	1599
1980	272	43408	128273	159	471	2259
1981	292	47315	148109	162	507	2472
1982	191	34092	121029	178	633	1660
1983	221	42518	105241	192	476	1743
1984	213	32133	82782	150	388	1750

NOTE: The revenue data are in deflated dollars (CPI index: 1977 = 100).

caught have been relatively stable over the period. Cod and redfish prices have changed very little. Those of pollock, whiting and the hakes have declined since 1979. Haddock, yellowtail flounder and winter flounder prices declined through 1981 but have risen slightly in the recent past. Scallop prices, which were stalled through 1982, increased by almost 50% the following year but fell by 10% in 1984.

The increase in foreign imports of cod, other groundfish and flatfish--principally from Canada--has helped to moderate the potential rise in fish prices resulting from declining U.S. catches (Table 5). The major increase in imports has been in cod, especially in the fresh product. Although 1984 imports to New England were less than those of 1983, Canadian cod imports were fully seven times the quantity of cod landed by the New England fleet. The mix of the different cod product forms has also changed and now competes more directly with New England landings.

Total scallop imports have been fluctuating but have shown a generally downward trend. Imports of sea scallops from Canada declined by about 5 million pounds (meat weight) between 1983 and 1984 and by 17 million pounds since 1977. Some of this slack has been taken up by other countries, most notably Iceland and Japan. Domestic supplies of presumably close substitutes for sea scallops--bay scallops and calico scallops from the South--have had a moderating impact on prices paid to New England sea scallopers. The jump in the 1983 average price was apparently influenced less by a small decline in total scallop supplies than by the general economic turnaround.

Table 4. New England prices and revenues for major species, 1978-1984[1,2].

Year	Cod Revenue	Cod Price	Haddock Revenue	Haddock Price	Pollock Revenue	Pollock Price	Redfish Revenue	Redfish Price	Winter Flounder Revenue	Winter Flounder Price
1978	$16.7	$0.23	$11.4	$0.30	$5.3	$0.16	$ 5.6	$0.16	$10.1	$0.43
1979	20.3	0.25	14.2	0.35	4.7	0.17	6.0	0.17	8.1	0.35
1980	20.0	0.25	14.7	0.29	4.5	0.14	4.0	0.17	9.1	0.26
1981	20.1	0.23	14.8	0.27	4.9	0.15	3.5	0.19	10.3	0.29
1982	22.4	0.21	13.4	0.32	3.7	0.13	3.1	0.17	9.0	0.30
1983	20.8	0.21	11.2	0.36	3.0	0.11	2.1	0.16	9.5	0.32
1984	18.2	0.22	10.4	0.41	3.3	0.10	2.0	0.17	11.5	0.41

Year	Yellowtail Revenue	Yellowtail Price	Whiting Revenue	Whiting Price	Hake Revenue	Hake Price	Scallop Meats Revenue	Scallop Meats Price
1978	$13.5	$0.57	$ 4.3	$0.12	$1.5	$0.17	$37.6	$2.37
1979	14.2	0.42	2.3	0.14	1.4	0.17	42.3	2.84
1980	13.8	0.35	2.1	0.12	1.3	0.14	43.4	2.82
1981	11.9	0.38	2.2	0.11	1.7	0.12	47.7	2.66
1982	17.3	0.32	2.9	0.12	1.6	0.10	34.3	2.33
1983	20.0	0.31	2.2	0.09	1.5	0.09	42.4	3.45
1984	15.0	0.43	2.4	0.08	1.6	0.09	31.8	3.26

[1]By all vessels over 5 GRT, regardless of year.
[2]Price per pound and revenue in millions deflated by CPI: 1977=100.

The costs of the various inputs used in fishing--fuel, labor, and interest on capital--have, with the exception of insurance costs, stabilized in the last two years after having risen sharply in 1979-1982. Currently, substantial and, in some cases, prohibitively expensive hull and liability rates exist in particular ports and for vessels in particular fisheries because of abnormally large numbers of sinkings, large liability settlements or because of the advanced age of a fleet.

The landings per unit of capital and labor used in fishing have been declining, reflecting changes in the state of the fish and scallop stocks. On the basis of mandays-at-sea or vesseldays-at-sea, otter trawl landings have declined since 1977 and were at a low for all tonnage classes of trawlers in 1984. For example, the landings per vesselday-at-sea for the largest class of trawler (greater than 150 GRT) were 65% of what they were in 1978. For all but the smallest scallop dredges, the decline in returns to vesseldays-at-sea has been even more severe. The landings per vesselday for the largest scallop dredges in 1984 were only 28% of its 1978 level.

Even if fishing costs were assumed constant, the declining returns to capital and labor inputs result in an increasing cost-per-pound of landed product. For those affected by the insurance market readjustment, this cost is rising much more rapidly. Given increasing costs of landings and constant revenue per pound, net earnings have been declining in both real and nominal (undeflated) terms. For example, by the end of 1983 a selection of New Bedford scallop dredge vessels showed that the earnings of the captain, an individual crew member, and the owner gave them less than half the purchasing power they had received in 1978 (Figure 1). For a selected group of trawlers, the impact of these trends in the fishery have been similar (Figure 2).

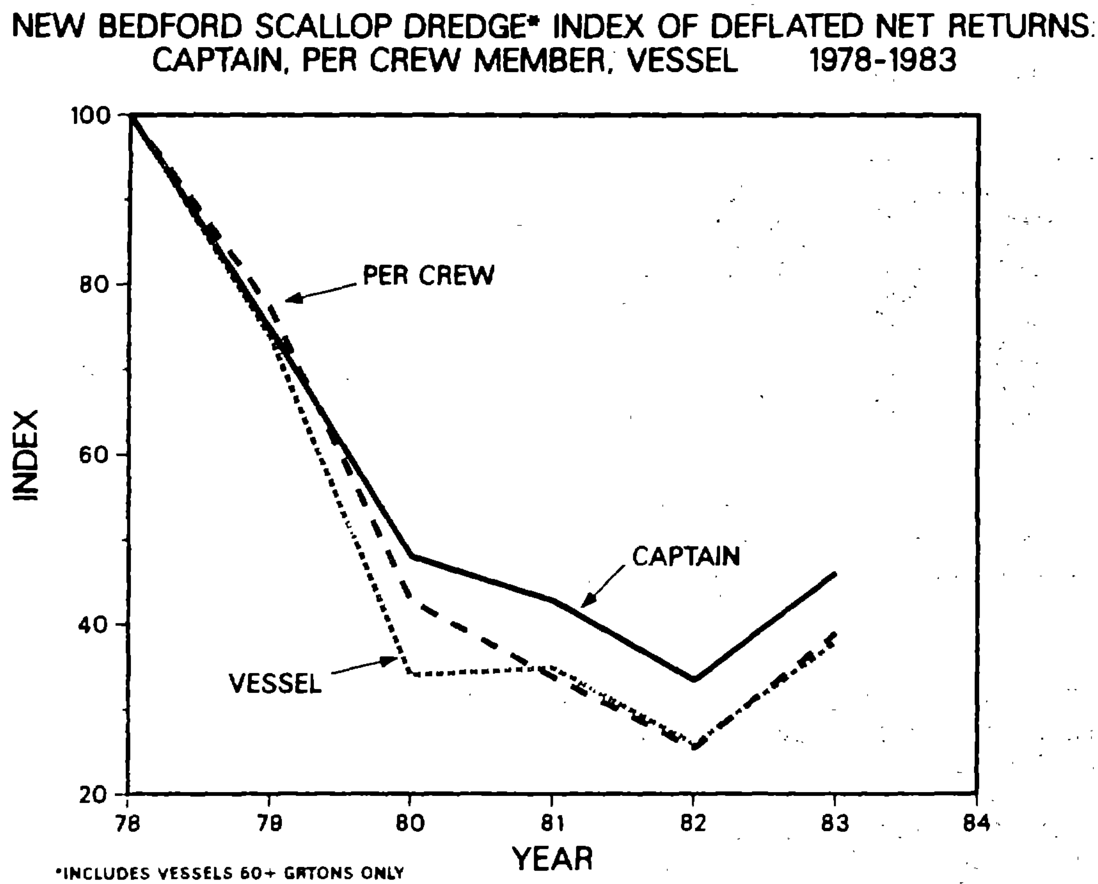


Figure 1. Index of deflated net returns to a captain, an individual crew member and to the vessel for a representative, full-time scallop dredge firm based in New Bedford 1978-1983.

In 1984 the average trawl or scallop dredge firm was operating much closer to the point where its financial returns from fishing would not exceed what could be earned elsewhere. The surplus profit or resource rent has been severely diminished as a buffer to the effects of resource variability, increasing costs, imports and other domestic market competition. Furthermore, the vulnerability of the average New England firm has undoubtedly been increased by the loss of access to part of the rich Georges Bank fishing ground as a result of the World Court decision in October, 1984. Some firms on the less efficient end of the scale can be expected to exit the groundfish and scallop fisheries for more profitable pursuits.

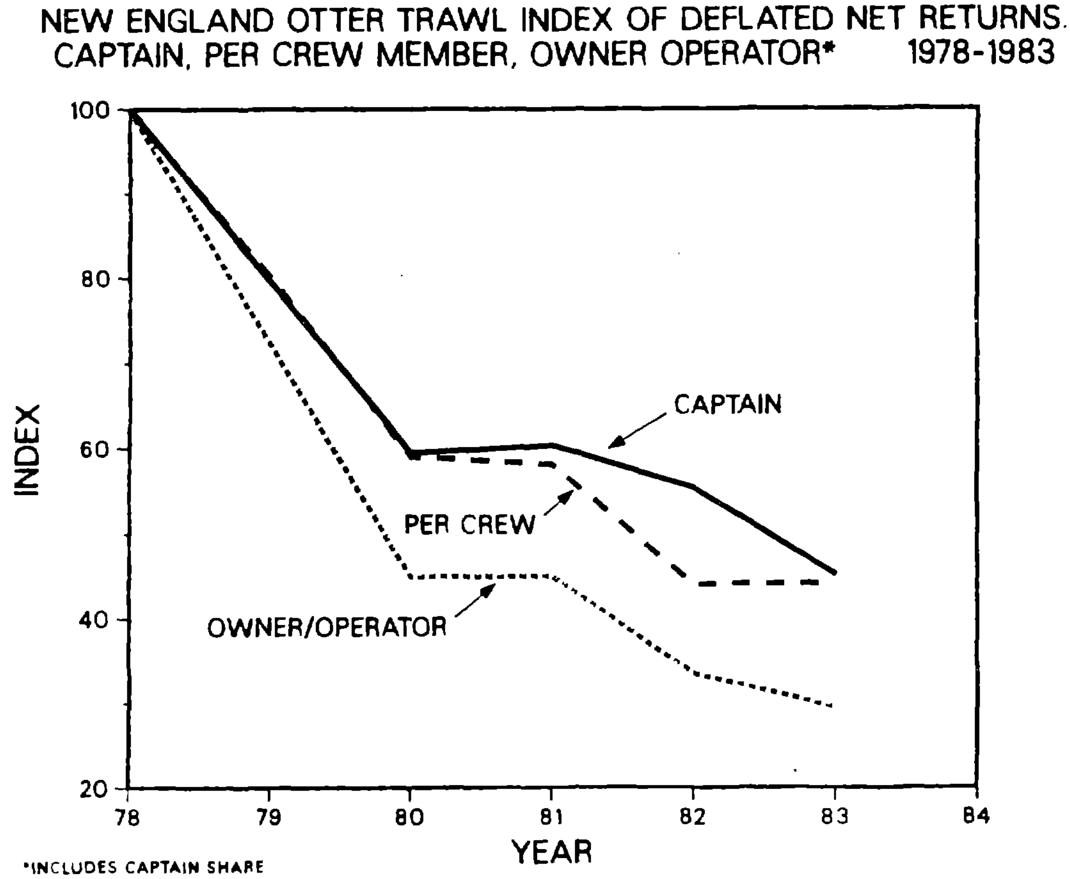


Figure 2. Index of deflated net returns to a captain, an individual crew member and to the owner/operator for a representative, full-time, New England otter trawl firm 1978-1983. Note that owner/operator returns include those of the captain.

<u>The Lobster Fishery</u>: Approximately 95% of lobster catches in the Northeast are landed in New England. Maine reports over 47% of these. New England landings grew from 32.8 million pounds in 1978 to a peak of 42 mlb. in 1983, and fell slightly in 1984 to 41.5 mlb. (Table 6). Total revenue from these catches has risen only slightly over the period, from $56.7 million to $62.4 million. Prices initially fell, reached a low in 1982 and gained only slightly in 1984.

The inshore lobster fishery accounts for over 87% of the landings and slightly less than 84% of the revenue generated by this species. It is carried out by boats of less than 5 GRT in the territorial waters of each of the New England states. No total count of the number of boats or traps in the region is available. A few states, most notably Maine, keep detailed records on the fishery. Maine landings have declined somewhat since the high in 1982 of 23.9 mlb. The 1984 landings, 19.5 mlb., are similar in magnitude to those of 1978.

The offshore lobster fishery involves vessels of over 5 GRT principally out of ports in Massachusetts and Rhode Island. These vessels use traps, pots and lobster trawls. Many otter trawl vessels also land lobsters as incidental catches in the groundfish fishery. Since 1979 reported New England offshore lobster catches have risen from 3.7 to 5.3 mlb.

Table 5. Imports to New England from Canada of selected fishery products, 1977-1984[1].

Year	Cod	Other Groundfish[2]	Flatfish	Total	Scallops
			(1,000 pounds)		
1977	283.1	50.5	174.6	508.2	25.6
1978	333.8	76.3	189.8	599.9	23.6
1979	450.3	79.9	191.4	721.6	18.4
1980	439.2	82.6	154.3	676.1	14.5
1981	492.2	131.4	208.0	831.6	18.6
1982	559.7	98.9	154.6	813.2	14.6
1983	640.2	92.5	127.0	859.7	12.9
1984	615.8	79.2	144.2	839.2	8.4

[1]Scallop expressed in meat weight; all others in live weight equivalent.
[2]Cusk, hake, haddock, and pollock.

Table 6. New England lobster landings, revenue, and prices, 1978-1984[1].

Year	Landings (000's lbs)	Revenue (000's Dollars)	Price (Per Pound[2])
1978	32,825	57,756	1.73
1979	35,545	57,091	1.61
1980	35,596	52,813	1.48
1981	35,904	54,700	1.52
1982	37,265	53,331	1.43
1983	42,078	61,265	1.46
1984	41,507	62,412	1.50

[1]Prices and revenues are adjusted for inflation using the Consumer Price Index with 1977 as the base year.

[2]Live weight.

Table 7. New England imports of lobsters and lobster meat, 1978-1984.

Year	Live (000's lb)	Fresh and Frozen Meat (000's lb)
1978	12,159	1,046
1979	14,331	1,827
1980	12,000	2,354
1981	15,209	1,981
1982	16,897	1,877
1983	20,136	5,109
1984	23,348	6,714

Since 1981, the nation's principal source of lobster meat has been foreign imports. The vast majority of this imported product comes into New England. New England imports of live lobsters increased from 12 mlb. to 23 mlb. between 1978 and 1984 (Table 7). Almost all of the live lobster imports come from Canada. Imports of fresh and frozen lobster meat have increased over six-fold in the seven year period from 1.0 mlb. to 6.7 mlb. Since 1980 over 90% of this flow has come from Canada with the majority of the remainder from Iceland.

MID-ATLANTIC

The Surf Clam and Ocean Quahog Fishery: The Mid-Atlantic surf clam and ocean quahog fishery is conducted principally by a fleet landing in New Jersey, Maryland and Virginia (Table 8). These vessels, which contribute the majority of U.S. supplies of these products, has been relatively stable in number over the past four years. In 1984, 138 vessels of 5 GRT or more received $24 million for combined catches of over 613 million pounds live weight. Both revenue-per-vessel and landings-per-vessel for 1984 were at a six year high of $176,000 and 4.4 million pounds live weight, respectively.

Significant quantities of quahogs were not landed until 1977. Since then, quahog landings have stabilized the total combined yield and compensated for the declining surf clam catch which peaked in the mid seventies. In 1975, surf clams were ninety-nine percent of combined landings, while in 1984 they were sixty-two percent. The ex-vessel price per pound of surf clams reached a peak of 52 cents in 1977 and has since been on a slow and steady decline. The average price per pound of meats in 1984 was twenty-nine cents. Ocean quahog prices have been relatively constant for several years in the neighborhood of eighteen cents per pound of meats.

Landings per manday-at-sea and vesselday-at-sea have risen significantly since 1979; an average 1984 manday returned 415% and a vesselday 438% of the yield they produced in 1979. With fishing costs, especially fuel costs, having leveled out recently, the variable costs of landings have decreased. However, the age of the mid-Atlantic surf clam fleet has put upward pressure on insurance premiums. Consequently fixed costs of production are quite high. The disparity between quahog and surf clam prices and the trend toward increased landings of quahogs is expected to continue.

For further information see:

Fisheries of the United States, Current Fishery Statistics No. 8360, National Marine Fisheries Service, Washington, D.C., April 1985.

Table 8. Mid-Atlantic landings and revenue. Gear Type: surf clam and ocean quahog dredge. Area Fished: all waters. All vessels 5 gross tons and over.

Year	Number of Vessels	Total Revenue (000's $)	Total Landings (000's lbs)	Revenue Per Vessel (000's $)	Landings Per Vessel (000's $)	Number of Fishermen
1979	90	11433	87939	127	977	348
1980	64	8369	232802	130	3637	243
1981	135	13620	333868	100	2473	564
1982	132	20736	498297	157	3774	564
1983	128	18872	517115	147	4039	550
1984	138	23846	613329	172	4444	604

Note: The revenue data are in deflated dollars (CPI index: 1977=100).

SUMMARY STATUS OF THE FISHERY RESOURCES

Groundfish

Atlantic cod. Nominal catches in the Gulf of Maine were 12,200 mt, 27% lower than in 1983, and the lowest since 1979. Stock biomass has declined due to record fishing effort. Recent fishing mortality rates are the highest in over 20 years and are much above F_{max}. At these levels, stock biomass and landings will continue to decline. The 1984 nominal catch from Georges Bank and South was 38,700 mt, 21% less than in 1983, and the lowest since 1979. Fishing effort in 1984 attained a record-high and CPUE fell to a record-low. The 1983 year class is above average and scrod abundance during 1985 should be higher than at any time since 1982. Recent fishing mortality rates are the highest observed since 1964 and about twice as high as F_{max}. At these high fishing mortality levels, stock biomass and landings are expected to decline, despite the improved recruitment by the 1983 year class.

Haddock. Nominal catch (commercial and recreational) in the Gulf of Maine averaged 6,800 mt from 1981-1983, but dropped to only 4,000 mt in 1984. The fishery is presently being supported by the remainder of the 1978 year class. Research vessel surveys indicated that the 1979, 1980 and 1982 year class were reasonably strong, but information from 1984 suggests that these cohorts have been much reduced by fishing and stock biomass is low. The Georges Bank catch was 10,200 mt in 1984, a 14% drop over 1983. The 1978 year class is supporting the fishery and all year classes since 1978 have been very poor. Stock biomass dropped to very low levels in 1984 and is expected to decline even further since fishing fortality is near or above F_{max} and recent year classes are among the smallest on record.

Redfish. The nominal catch of 4,700 mt in 1984 was the lowest since the fishery began in the early 1930's. Stock biomass has declined by over 80% since the late 1960's and commercial and research vessel survey indices suggest a continuing downward trend in recent years. The fishery continues to be strongly dependent upon recruitment and as recruitment prospects are poor, declines in stock biomass are expected to continue. Current fishing mortality levels are well above those corresponding to F_{max} and $F_{0.1}$.

Silver hake. Nominal catches in the Gulf of Maine - Middle Atlantic area totalled about 23,400 mt in 1984: 8,300 mt from the Gulf of Maine - northern Georges Bank stock, and 15,100 mt from the southern Georges Bank - Middle Atlantic stock. Catches from the northern stock were the highest since 1978, but are still well below past levels. In the southern area, the 1984 catch was the lowest reported since 1960. Estimates of biomass for silver hake are currently not available due to a change in their stock boundary definition; analytical assessments are in preparation. While survey indices have remained fairly steady or declined slightly during the past few years, very little fishing pressure has been exerted on the stocks. Current fishing mortality is assumed to be well below $F_{0.1}$ in all areas. There is potential for increased catches in all areas.

Red hake. Nominal catches totalled only 2,800 mt in 1984, continuing a series of very low catches reported since about 1978. In the Gulf of Maine - northern Georges Bank area, catches were about 1,000 mt while the southern Georges Bank - Middle Atlantic stock reported catches of about 1,800 mt. Estimates of biomass for red hake are currently not available due to a change in their stock boundary definition; analytical assessments are in preparation. Survey indices have remained fairly steady or have increased slightly in recent years. Current fishing mortality is assumed to be well below $F_{0.1}$ and there is potential for increased catches in all areas.

Pollock. Nominal catches from the Scotian Shelf, Gulf of Maine and Georges Bank region totalled 52,000 mt in 1984, down from a peak of 59,700 mt in 1981. Stock biomass increased from 176,000 mt in 1973-1974 to 322,000 mt in 1981, and has since declined to an average of 304,000 mt in 1983-1984. The 1979 year class is clearly a strong one and there are also preliminary indications that the 1982 year class is also strong. Fishing mortality appears to have approximated the $F_{0.1}$ level in recent years.

Yellowtail flounder. Nominal catches declined 46% in 1984 (17,800 mt) from the 1983 total (33,100 mt). This reflects reduction of the strong 1980 year class by fishing and poorer recruitment from more recent year classes. This fishery is now almost completely dependent upon incoming recruitment. The 1983 year class appears to be relatively weak suggesting poor recruitment to the fishery in 1985. Commercial and research vessel survey indices of abundance have declined sharply and in most cases Autumn 1984 survey index values were at or near historic lows. Fishing mortality (F) has been substantially above F_{max} during recent years.

Summer flounder. Nominal commercial catches were 14,164 mt in 1984, 21% below the 1983 level and 21% 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 1984 were 10,150 mt, 23% less than in 1983, and the lowest since 1978. Stock biomass has declined to its lowest level since the mid-1970's. Fishing mortality is currently too high to sustain the present level of catch.

Witch flounder. Nominal catches increased from 1,850 mt in 1976 to 6,500 mt in 1984, the highest ever. Stock biomass, after declining steadily since 1977, increased in 1983 and has remained comparable to the long-term average. There is no consistent evidence that current levels of exploitation are adversely affecting the resource, although historical trends seem to preclude sustainable harvests above 6,000 mt.

Winter flounder. The nominal commercial catch in 1984 was 14,700 mt, about the same as in 1983 and 17% below the peak in 1981. Recreational catches are at over one-half the level of commercial catches. Overall stock biomass has exhibited no major trend during 1976-1983, although it appears to have declined in 1983-1984 relative to the 1980-1981 level.

Scup. Nominal catches (commercial and recreational) remained stable at 10,600 mt in 1984, slightly below the 1977-1983 mean. 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, but increased to levels just below the long-term average in 1984. The stock, particularly in the Mid-Atlantic area, appears to be fully exploited.

Ocean Pout. Nominal catches, after averaging 560 mt from 1975-1983, increased to over 1,300 mt in 1984. Stock biomass rose sharply in 1980 and has since fluctuated around historic peak levels. It would appear that increased catches are sustainable for this developing fishery.

White hake. Nominal catches have increased steadily since 1968, reaching a peak of 7,500 mt in 1984. Stock biomass has exhibited a declining trend since 1980, and it appears unlikely that current harvest levels will be sustainable over the long term.

Cusk. Nominal catches of 2,200 mt in 1984 continued the trend of declining catches since 1981. However, stock biomass appears to be increasing, and catches comparable to the long-term average of 2,200 mt seem sustainable for 1985.

Atlantic wolffish. Nominal catches increased steadily from 170 mt in 1970 to a peak of nearly 1,300 mt in 1983, and decreased slightly to 1,100 mt in 1984. Stock biomass, while fluctuating considerably, has generally 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. Landings in 1984 were up slightly from the previous year to 1,900 mt. 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 19,500 mt in 1984. Western Gulf of Maine (Jeffreys Ledge) catches (adults) were about 12,300 mt in 1984, nearly triple the 1983 level. An increasing amount of the adult herring catch has been used for reduction rather than human consumption. 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) for this stock was 38,000 mt in 1984, a 16% increase over 1983. The USA commercial catch has increased slowly in every year since 1970, reaching 4,400 mt in 1984. Fishing mortality remained stable from 1978-1984 at a level much lower than $F_{0.1}$. The stock underwent rapid increases in numbers and biomass with recruitment of the strong 1980, 1981, and 1982 year classes. Total stock biomass jumped from about 480,000 in 1980 to 950,000 mt in 1984, a 98% increase. The 1984 year class also appears to be strong. The projected catch in 1985 would be about 270,000 mt, resulting from fishing the stock at $F_{0.1}$.

Butterfish. Nominal catches increased 127% from 5,500 mt in 1983 to 12,400 mt in 1984. The USA catch reached a record high level of 11,993 mt. Increased USA landings in 1984 were due to a strong export market and the development of a new "supersmall" market category in response to an abundance of small butterfish. Additionally, the 1984 fishery was beset by high discard rates which averaged 30% by weight of the landed catch. Stock abundance is currently above the long-term average. However, continued high rates of discard can be expected to have an adverse effect on the fishery and the stock.

Bluefish. Nominal commercial catches totalled an estimated 4,200 mt in 1984. Recreational catches have averaged close to 90% of the total catch of bluefish along the Atlantic Coast. 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 1984 were about 4,100 mt, down from 4,200 mt in 1983. 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 700 mt in 1983. Recreational catches, although unknown, are considered to be very low at the present time. Excessive fishing dams and pollution have 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 1984 were 1,500 mt, compared to 1,100 mt in 1981. Recreational catches have comprised 50-85% of the combined catch in years for which estimates are available. Stock abundance seems to have undergone a rather sharp drop since 1977. It appears that the stock is fully exploited at the present time.

Striped bass. Nominal commercial catches in 1984 were only about 1,200 mt. 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 1984 were 4,400 mt, down from 4,900 mt in 1983. Minimum biomass estimates from NEFC spring survey catches were about 240,000 mt in 1984, slightly above 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 4,100 mt in 1984, the highest ever recorded for this fishery. 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 under 100 mt in 1984. Although the USA catch increased markedly from about 300 mt in 1980 to a record 9,900 mt in 1983 and 9,300 mt in 1984, the total international catch in USA waters was only 10,000 mt in 1984, the lowest since 1971. (USA catches include prorated amounts of squid landed with no specific species and total landings are therefore somewhat greater than in Table 2.) Stock abundance in USA waters is currently the lowest since 1974. Pre-recruit abundance in autumn 1984 was the second lowest since 1970. Current stock abundance is low and may not be sufficient sufficient to support the present 30,000 mt OY in the 1985-1986 fishing year. Further declines in stock abundance estimates would be additional cause for concern.

Long-finned squid. Nominal catches of *Loligo pealei* were about 22,400 mt in 1984, 19% below the 1983 catch. The USA catch in 1984 was 11,400 mt, the second highest ever, but about 29% below the catch in 1983. (USA catches include prorated amounts of squid landed with no specific species and total landings are therefore somewhat greater than in Table 2.) Stock abundance is currently below the long-term average. The 1984 year class, if fished at the average 1978-1981 level of fishing mortality, should support catches during the 1985-1986 fishing year at about the 1983 level.

American lobster. Nominal catches in 1984 were 19,800 mt, a slight decline relative to 1983 levels. Inshore catches from within 12 miles in 1984 were 16,400 mt, while offshore catches (including Canadian catches on Georges Bank) in 1984 were about 3,200 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 the 1984-1985 season were about 3,900 mt, the highest observed in a decade. Abundance has increased substantially in recent years although levels remain substantially below those observed during the late 1960's and early 1970's. Research vessel survey results suggest relatively low levels of exploitation in 1983-1984.

Red crab. The nominal catch in 1984 exceeded the estimated MSY for this Resource. The resource is presently fully exploited.

Surf clams. Nominal landings (FCZ and state waters) in 1984 totalled about 32,200 mt (meat weight), representing a 27% increase over 1983 landings, and the fourth highest total on record. FCZ landings in 1984 were 23,500 mt, an increase of 15% over the previous year. About 3,200 mt was taken on Georges Bank and off Southern New England, indicative of the significant northward extension of the FCZ fishery from traditional offshore fishing areas in the Middle Atlantic. Sufficient stock biomass exists in the Middle-Atlantic and Georges Bank regions to sustain the fishery at current landings levels into the early early 1990's. 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 (a localized abundance of 1983 year class clams off New Jersey is currently too small to accurately evaluate). The FCZ fishery will thus be supported almost exclusively by the 1976 and 1977 year classes for at least the next six years.

Ocean quahogs. Nominal landings in 1984 were 19,200 mt (meats), representing a record total for the species and a 20% increase over the previous year. More than 90% of the 1984 landings 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 1.6% of the standing stock, but drastic increases in the exploitation rate are not warrented due to the very slow growth rate and extreme longevity of the species. 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 from the entire Gulf of Maine, Georges Bank and Mid-Atlantic area were 9,800 mt (meats), 16% lower than in 1983, and the lowest since 1974. Catches in 1984 declined in the Gulf of Maine (775 mt; -26%), on Georges Bank (5,000 mt);-29%), and in Southern New England (165 mt; -36%), but increased in the Mid-Atlantic fishery (3,825 mt; +19%). USA CPUE values declined in all areas in 1984 with the Georges Bank and Mid-Atlantic values the lowest in the 1965-1984 time series. Apart from the eastern section of the Northeast Peak of Georges Bank where localized recruitment of the 1981 year class was exceptional, stock biomass of scallops in almost all offshore regions continues to decline. Conditions will 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 1972-1976, nominal commercial catches averaged 1.1 million mt. 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 9, Figure 3). 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 has averaged 304,600 mt since then. Canadian nominal catches averaged about 27,600 mt from 1980-1983 and have since declined; nominal catches by distant water fleets averaged 43,800 mt from 1978-1982, but recent catches have been lower.

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 1964-1984 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 3). 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. Since 1980, estimates have fluctuated about an average of 3.3 million mt. Taken together, available data suggest relatively constant overall biomass levels in recent years, with declines in some groundfish stocks in 1984.

Although some stock biomass estimates for groundfish, flounder, miscellaneous finfish species, and short-finned squid are generally higher in 1984 than in 1975, several have declined since 1981. The mackerel stock appears to be recovering, 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 continued increases in the mackerel stock as well as improvements in traditional groundfish species and squids.

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 9. Nominal catches (thousand metric tons) and management information for for total finfish and squid from the Gulf of Maine - Cape Hatteras area, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational[1]	149.8	131.0	118.3	104.7	131.8	96.0	91.3	91.9	92.3
Commercial									
USA	208.7	266.3	290.8	325.5	357.6	315.4	298.9	301.3	302.7
Canada	13.4	14.6	26.8	16.0	25.9	22.6	33.8	28.0	13.0
Other	748.8	188.9	75.5	54.6	68.2	70.0	75.6	40.9	26.2
Total nominal catch	1,105.1	586.2	484.6	484.9	557.6	481.4	456.8	434.1	421.2
Total allowable catch[2]	-	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

[1]Surveys performed in 1974, and 1979-1982; remaining points estimated.

[2]Excludes recreational.

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

[4]From analysis of commercial data.

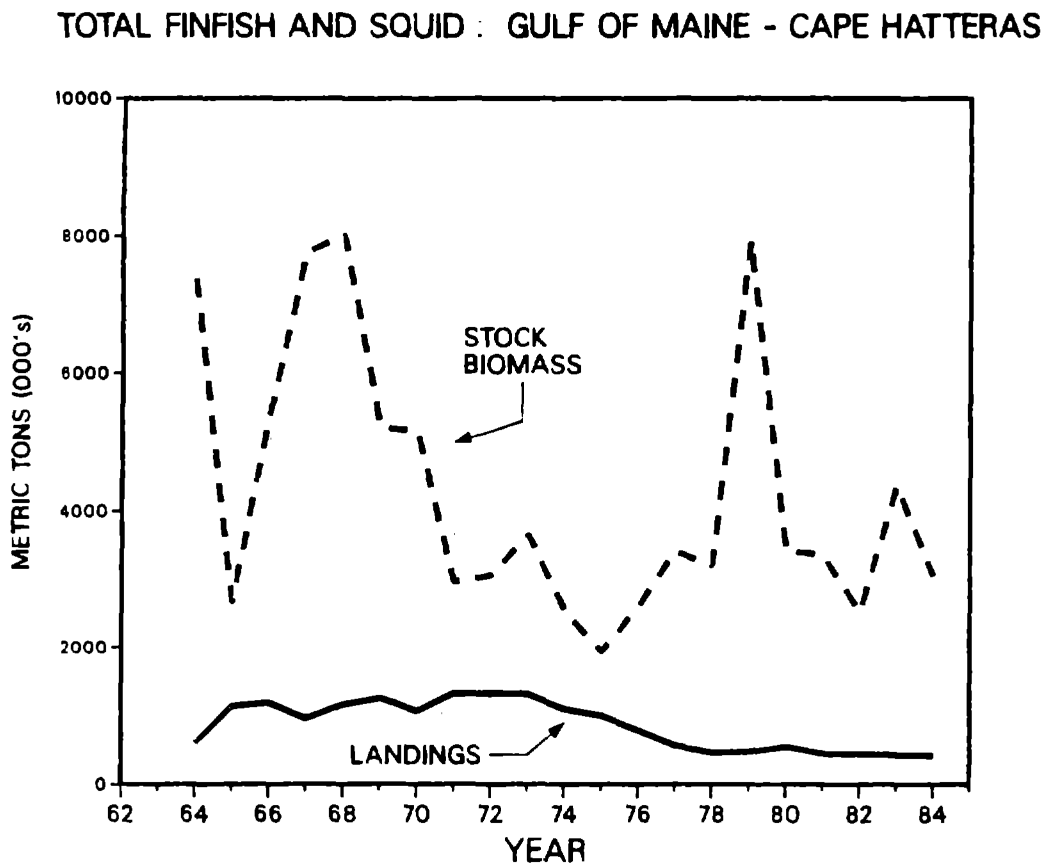


Figure 3. Total commercial and recreational landings and estimates of stock biomass of the total finfish and squid resource (less menhaden and large pelagics) from the Gulf of Maine to Cape Hatteras.

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 Gulf of Maine cod landings in 1984 were 12,210 mt, a 27% decline from 1983, and the lowest annual catch since 1979 (Table 10). The 1984 USA catch of 10,806 mt was the lowest since 1976 and was 23% less than in 1983. Canadian 1984 landings landings totaled 1,404 mt, half as large as in 1983, although substantial misreporting of Scotian Shelf landings as Gulf of Maine catch is believed to have occurred in 1983 and preceding years.

Commercial fishing effort in 1984 was a record high. USA commercial CPUE indices, however, declined by 35% from 1983 values. The 1984 CPUE index for directed cod trips (trips in which cod comprised 50% or more of trip weight) was the third lowest since 1965 and was lower than any value since 1973.

NMFS research vessel survey indices in 1984 declined for the fourth consecutive year (Figure 4). Both spring and autumn 1984 survey catch per tow values were among the lowest observed. Survey age composition data indicate the 1980-1982 year classes comprise 86% of the Gulf of Maine cod population by number and 71% by weight. The 1983 and 1984 year classes currently appear to be average and below average, respectively.

The 1984 USA commercial catch was dominated by the 1980 year class which accounted for 43% of the cod landed and 38% of the total weight. The 1979 and 1981 year classes each contributed about 18% to the total 1984 yield. Otter trawl landings accounted for 62% of the 1984 USA catch. Gill net landings comprised 37% of the USA total, the highest annual percentage recorded during 1965-1984.

Table 10. Nominal catches (thousand metric tons) and management information for Atlantic cod from the Gulf of Maine, 1972-1984.

Category	Year 1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	0.8[1]	-	-	-	-	
Commercial									
USA	7.9	12.4	12.4	11.7	13.5	12.5	13.6	14.0	10.8
Canada	0.1	0.1	0.4	0.4	0.2	0.6	1.4	2.7	1.4
Other	<0.1	-	-	-	-	-	-	-	-
Total nominal catch	8.0	12.5	12.8	12.9	13.7	13.1	15.0	16.7	12.2
Total allowable catch	-	12.0	8.0	9.7	9.5	9.5	-[2]	-[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

$M = 0.20$ $F_{0.1} = 0.16$ $F_{max} = 0.30$ $F_{1984} = 0.80$

[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.

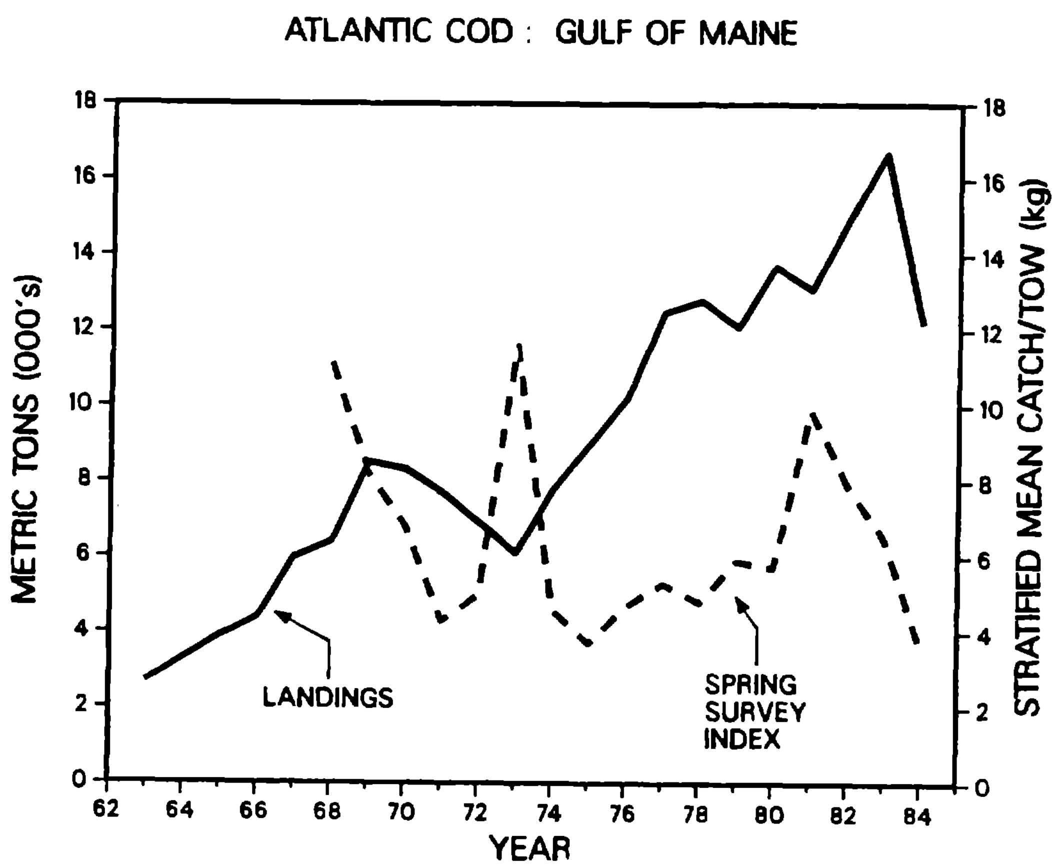


Figure 4. Total commercial landings and stock biomass indices from NEFC spring bottom trawl surveys of Atlantic cod in the Gulf of Maine.

Since 1981, fishing mortality has quadrupled on Gulf of Maine cod. Recent fishing mortality rates are the highest in over 20 years and are much in excess of those producing maximum yield. Should fishing pressure remain at current levels, further declines in Gulf of Maine cod abundance and landings are expected.

Georges Bank and South

Total commercial 1984 landings were 38,676 mt, 21% less than in 1983, and the lowest annual catch since 1979 (Table 11). The 1984 USA catch of 32,915 mt, also the lowest since 1979, declined 11% from 1983. Canadian 1984 landings totaled 5,761 mt, 53% lower than in 1983, and lower than any annual catch since 1976.

USA fishing effort increased in 1984 for the third consecutive year and surpassed the record-high level of 1983. USA commercial CPUE in 1984 markedly declined from 1983 (-30%). The 1984 CPUE index for directed trips (which accounted for 60% of the USA landings) was the lowest in the 1965-1984 time series.

NMFS spring 1984 research vessel survey indices were among the lowest ever obtained (Figure 5). The autumn 1984 survey indices were slightly higher than the low 1983 values due to high catches of cod from the 1983 year class. The autumn data indicate that the 1983 year class is above average and imply that abundance of scrod cod on Georges Bank during 1985 will be higher than at any time since 1982.

Survey age composition data reveal that the 1980 and 1981 year classes continue to dominate the Georges Bank cod population, accounting in 1984 for about 50% of the harvestable fish by number, and 41% by weight.

Both the 1980 and 1981 cohorts were dominant in the 1984 USA commercial catch. Together these year classes accounted for 71% by number and 58% by weight of the 1984 USA Georges Bank cod landings. In the 1984 fishery, otter trawl landings comprised 87% of the USA catch while gill net catches constituted 9% of the total.

Increased fishing effort during the past three years has produced a twofold increase in fishing mortality. Recent fishing mortality rates are the highest observed since 1964 and about twice as high as the F_{max} level producing maximum yield per recruit. The increased mortality has presumably resulted from increased fishing pressure on cod due to declines in abundance of other groundfish resources (haddock, redfish, yellowtail flounder). Despite improved recruitment by the 1983 year class in the 1985 fishery, declines in abundance and landings are expected if fishing mortality remains at present levels.

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 11. Nominal catches (thousand metric tons) and management information for Atlantic cod from Georges Bank and South, 1972-1984.

Category	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	-	3.1[1]	-	-	-	-
Commercial									
USA	15.8	21.1	26.6	32.6	40.0	33.9	39.3	36.8	32.9
Canada	2.3	6.2	8.9	6.0	8.1	8.5	17.9	12.1	5.8
Other	7.2	0.1	-	-	-	-	-	-	-
Total nominal catch	25.3	27.4	35.5	41.7	48.1	42.4	57.2	48.9	38.7
Total allowable catch	-	26.7	26.0	36.9	35.0	35.0	-[2]	-[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

$M = 0.20$ $F_{0.1} = 0.15$ $F_{max} = 0.30$ $F_{1984} = 0.65$

[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.

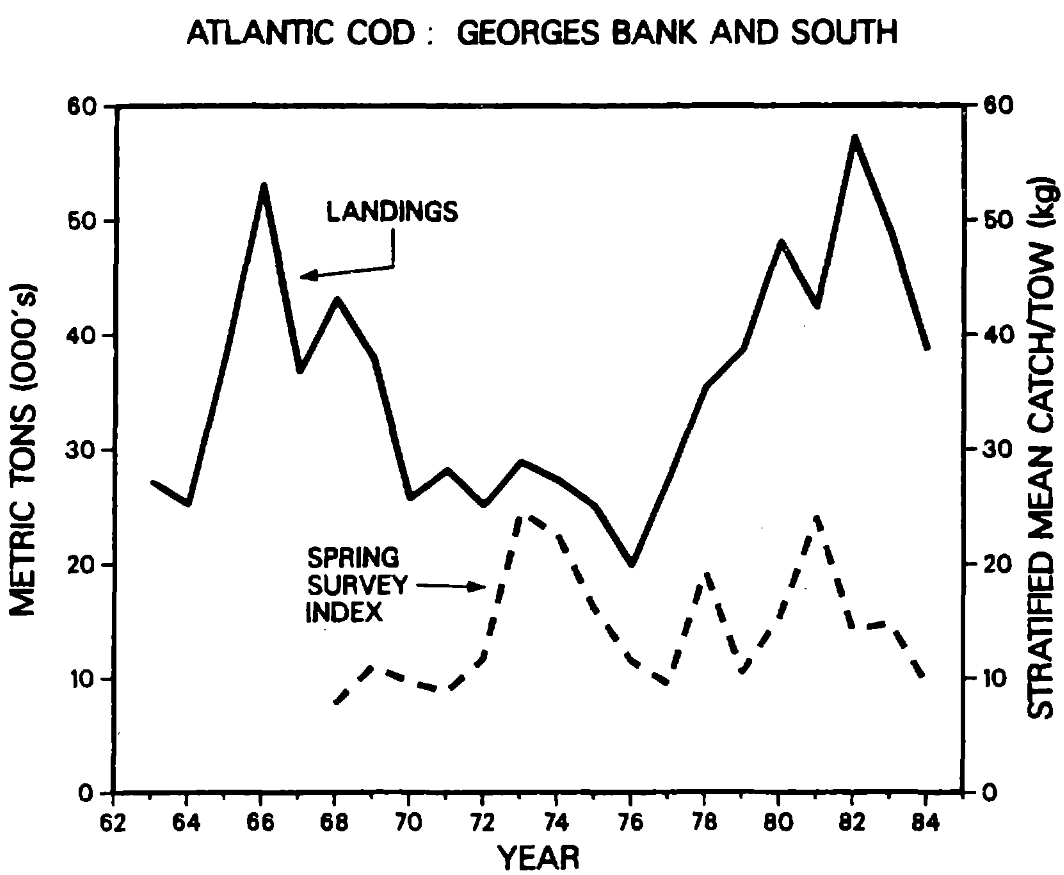


Figure 5. Total commercial landings and stock biomass indices from NEFC spring bottom trawl surveys of Atlantic cod in the Georges Bank and South area.

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 separately 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. This plan provided for optimal yield or OY management to be achieved by spawning catch quotas, seasonal spawning area closures, codend mesh size regulations and mandatory data reporting requirements. The current Interim Plan for Atlantic Groundfish became effective on 31 March 1982. It redefined OY as the amount actually harvested by USA fishermen in accordance other Plan provisions, excluding catch quotas. This plan will in turn be replaced by the Northeast Multispecies Fishery Management Plan currently in preparation and scheduled for implementation in late 1985.

Gulf of Maine

During 1977-1983, USA fishermen accounted for 87% of the nominal commercial catch of haddock from the Gulf of Maine, with the remainder being taken by Canada. Nominal commercial catches for the Gulf of Maine increased from 500 mt in 1973 to 7,500 mt in 1980, averaged 6,800 mt from 1981-1983, and then dropped sharply to 4,000 mt in 1984 (Table 12, Figure 6). 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 landings suggest that the 1979 and 1980 year classes were also relatively strong. Estimated recreational catches have declined from 1,700 mt in 1979 to less than 50 mt in 1981-1982.

Stock size estimates calculated from a modified DeLury analysis have declined 65% from 1979 to 1983. The NEFC autumn survey index has declined in nearly every year since 1978 (Figure 6) while spring index values have shown a downward trend since 1981. Spring and autumn index values for 1984 were among the lowest on record and autumn survey catch per tow in numbers was the lowest in the 22 year time series. Although recent surveys indicated that the 1979, 1980 and 1982 year classes were reasonably strong, data for 1984 suggest that these year classes have been much reduced by fishing and that the stock is now in extremely poor condition.

Table 12. Nominal catches (thousand metric tons) and management information for Gulf of Maine haddock, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational[1]	0.2	1.0	1.0	1.7	0.2	<0.1	<0.1	<0.1	<0.1
Commercial									
USA	0.8	3.3	4.5	4.6	7.3	5.7	5.6	5.6	2.8
Canada	0.1	<0.1	0.6	0.3	0.2	0.5	1.1	2.0	1.2
Other	<0.1	-	-	-	-	-	-	-	-
Total nominal catch	1.3	4.3	6.1	6.6	7.7	6.2	6.7	7.6	4.0
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)

$M = 0.20$ $F_{0.1} = 0.26$ $F_{max} = 0.55$ $F_{1984} = >F_{max}$

[1]Values for 1974 and 1979-1982 obtained from surveys; remaining points estimated.

[2]Values for 1972-1978 are for Georges Bank and the Gulf of Maine, inclusive; 1972-1976 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

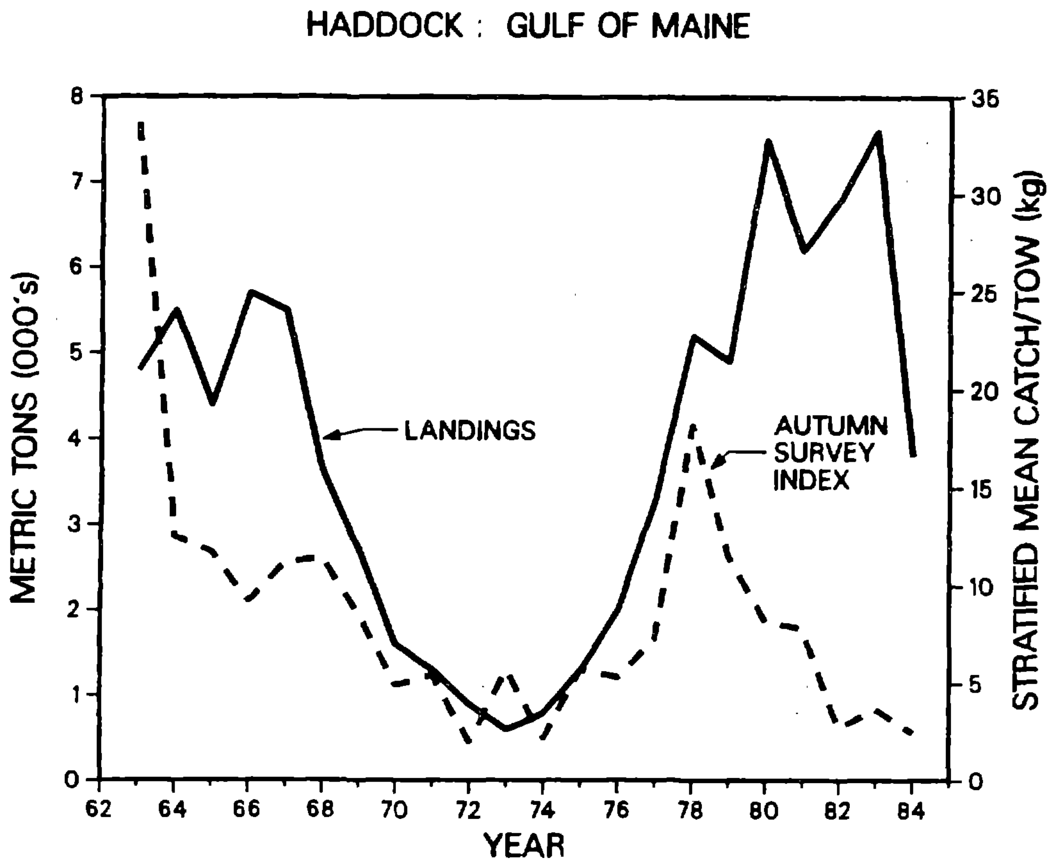


Figure 6. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of haddock in the Gulf of Maine.

Georges Bank

USA fishermen accounted for 68% of the nominal catch during 1977-1983, 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 4,900 mt during 1974-1976 to 27,600 mt in 1980; the total for 1983 was 11,900 mt, and the provisional total for 1984 is 10,200 mt (Table 13, Figure 7). 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 1979-1984 indicate a succession of weak year classes. The fishery is highly dependent on the 1978 year class at the present time.

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 both indices have declined; the autumn survey index dropped from 11.8 kg/tow in 1981 to 2.9 kg/tow in 1984.

The 1981, 1982 and 1984 young-of-year indices for Georges Bank were among the lowest on record. Indices for the 1983 year class suggest that it may be comparable to the 1972 year class in size, however, high fishing mortality and discarding in 1984 have already reduced this cohort.

Stock size estimates (age 2 and older) calculated from virtual population analysis or VPA have declined from 91 million fish or 110,000 mt in 1980 to very low levels in 1984 (Figure 7). Current levels are well below the long-term (1935-1960) average of 140 million fish or 153,000 mt and appear comparable to the record lows observed during the early to mid-1970's when recruitment was poor. The stock is expected to decline even further in the near future.

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 13. Nominal catches (thousand metric tons) and management information for Georges Bank haddock, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial									
USA	3.2	7.9	12.2	14.3	17.5	19.2	12.6	8.7	8.8
Canada	1.1	2.9	10.2	5.2	10.1	5.7	5.6	3.2	1.4
Other	0.6	-	-	-	-	<0.1	-	-	-
Total nominal catch	4.9	10.8	22.4	19.5	27.6	24.9	18.2	11.9	10.2
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)

$M = 0.20$ $F_{0.1} = 0.26$ $F_{max} = 0.55$ $F_{1984} = >F_{max}$

[1]Values for 1972-1978 are for Georges Bank and the Gulf of Maine, inclusive; 1972-1976 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).

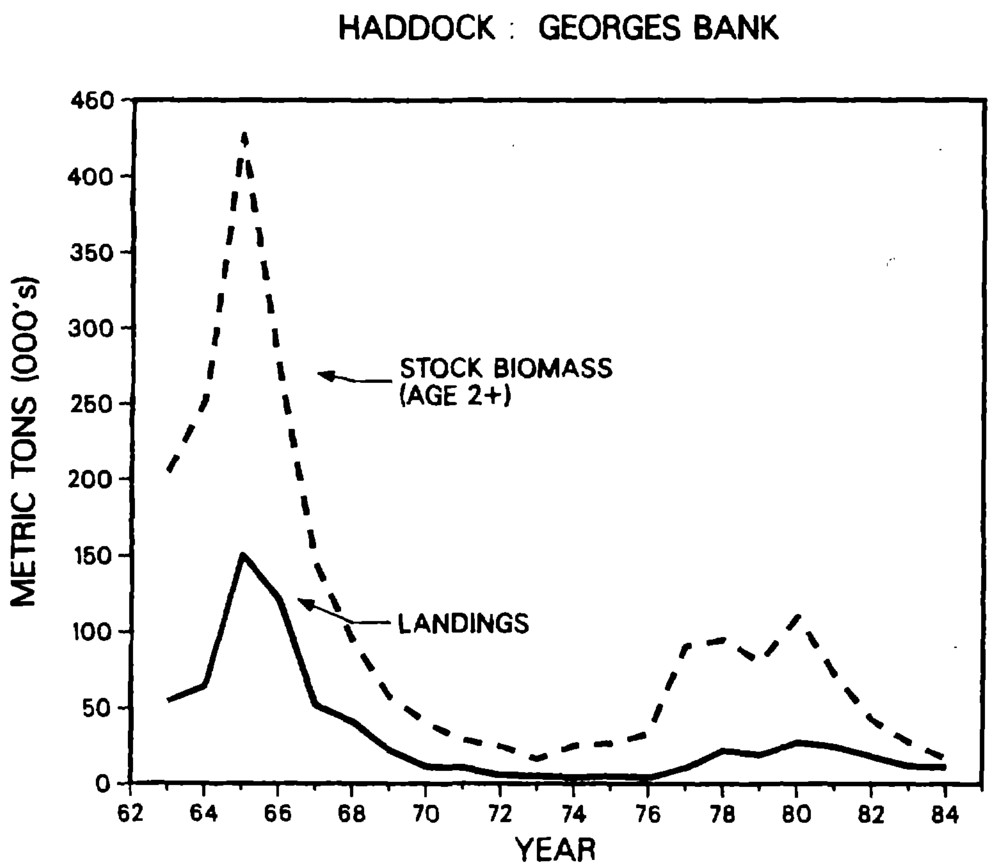


Figure 7. Total commercial landings and estimates of stock biomass of haddock on Georges Bank.

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 with an extremely low natural mortality rate. 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 14, Figure 8). In 1983 and 1984, however, catches declined to 5,200 and 4,700 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 dominated by the 1971 year class and that the fishery continues to depend on this year class. The 1971 year class accounted for 61% of the numbers and 52% of the weight landed in the commercial fishery between 1980 and 1984.

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 1.2 and 1.1 mt/day in 1983 and 1984, respectively (Figure 8). 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 through 1984 (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 for 1985 indicate a stock biomass of 25,000-30,000 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. The current level of fishing mortality is well above the calculated F_{max} and $F_{0.1}$ values (Table 14).

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 1983 and 1984 nominal catches.

The population remains in a severe state of disequilibrium and, with the present age structure and exploitation pattern, the fishery continues to be 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 14. Nominal catches (thousand metric tons) and management information for redfish from the Gulf of Maine and Georges Bank area, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	10.6	13.0	14.0	14.7	10.1	7.8	6.7	5.2	4.7
Canada	0.1	0.2	0.1	<0.1	0.1	<0.1	0.2	0.1	0.1
Other	2.9	<0.1	-	<0.1	-	-	<0.1	-	-
Total nominal catch	13.6	13.2	14.1	14.7	10.2	7.8	6.8	5.3	4.8
Total allowable catch	-	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)

$M = 0.05$ $F_{0.1} = 0.07$ $F_{max} = 0.14$ $F_{1984} = 0.20$

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

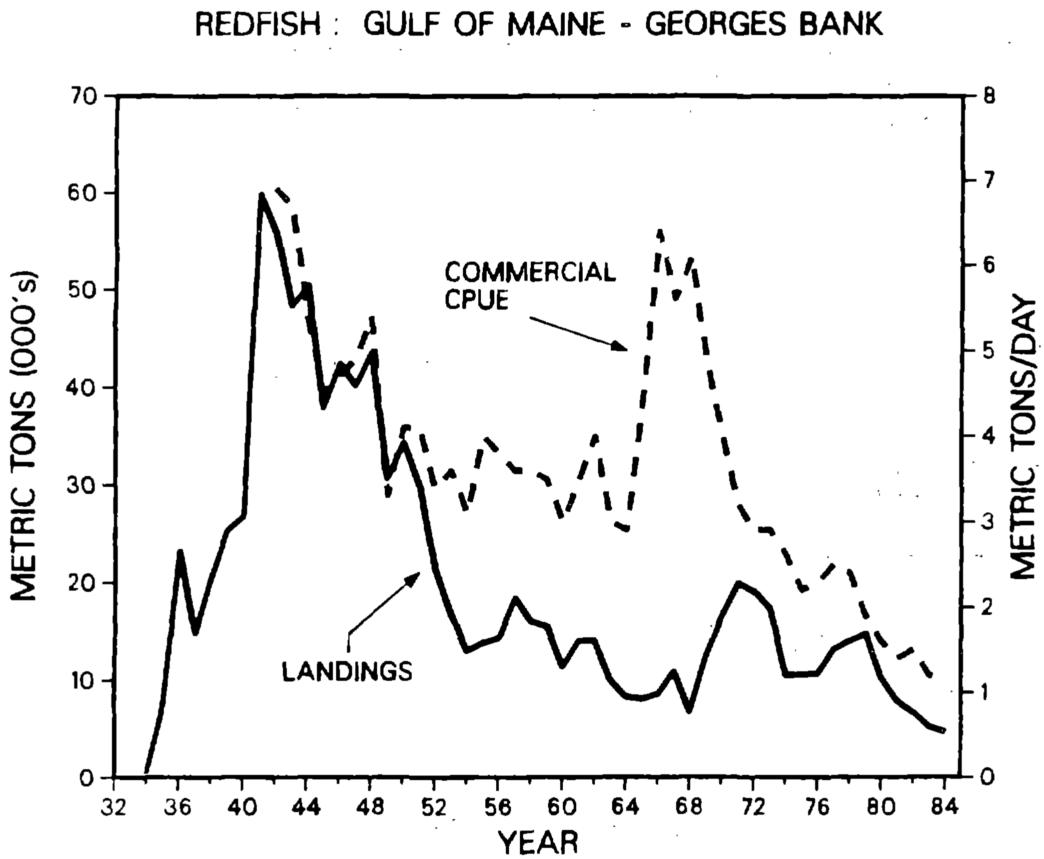


Figure 8. Total commercial landings and catch per unit effort of redfish in the Gulf of Maine - Georges Bank area.

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.

The following summaries of the status of silver hake stocks represent a departure from the three stock assessments performed in the past. Recently completed stock delineation studies have indicated that silver hake should be assessed as two stocks. These are a northern stock including fish from the Gulf of Maine and northern Georges Bank, and a southern stock made up of silver hake inhabiting southern Georges Bank south to Cape Hatteras. For more information regarding the stock identification studies see Almeida (1985). Analytical assessments of the silver hake stocks are in preparation.

Gulf of Maine-Northern Georges Bank Stock

The nominal catch of silver hake in 1984 was 8,289 mt, taken exclusively by the US (Table 15, Figure 9). While this catch represented a 56% increase over 1983 and was the highest level reported since 1978, this level is still well below those reported in the past. Total catches from this area averaged approximately 49,100 mt during 1955-1961. With the introduction of the distant water fleet in 1962, catches rose sharply to a high of 94,500 mt in 1964, then dropped and averaged 27,700 mt from 1969 to 1974. Catches then increased to 41,200 mt in 1975, decreased to average about 13,300 mt during 1976-1978, then dropped sharply to only 3,400 mt in 1979. During 1980-1982, catches averaged only about 4,600 mt before increasing in both 1983 and 1984. Prior to the inception of the MFCMA, the distant-water-fleet catch averaged about 49% of the total ranging from 21% in 1967 to 75% in 1972. During 1969-1974, the DWF catch averaged 16,100 mt, increased to 28,600 mt in 1975, then declined to only 2 mt in 1977 before the fleet was excluded from these waters in 1978. During this same period, US catch remained relatively constant averaging 12,000 mt during 1969-1978. However, after 1978 catches declined and have remained at a reduced level.

Both the spring and autumn NEFC bottom trawl survey catch-per-tow indices reached high levels in 1976 and then declined through about 1982. In 1983, the spring index increased only slightly; however, in the autumn the index increased sharply to its highest level since 1976 due primarily to a strong 1982 year class. In 1984, both surveys declined. Survey catch-per-tow-at-age data indicate that the 1973-1974 year classes were quite strong with 1974 being the strongest. These year classes supported the increase in commercial catch in 1975. The 1977-1978 and 1981-1982 year classes were also strong in comparison to other years in the 1973-1984 time series. The 1983 year class was quite weak, recording its lowest and second lowest indices in the spring and autumn surveys, respectively. The 1984 year class appears to be of at least average strength.

With continued low levels of catch and average year classes, it is unlikely that this stock will undergo any major declines in 1985 if catches remain at or slightly above the levels reported in recent years.

Table 15. Nominal catches (thousand metric tons) and management information for silver hake from the Gulf of Maine - northern Georges Bank stock, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	10.7	12.4	12.6	3.4	4.7	4.4	4.7	5.3	8.3
Canada	-	-	-	-	-	-	-	-	-
Other	16.2	-	-	-	-	-	-	-	-
Total nominal catch	26.9	12.4	12.6	3.4	4.7	4.4	4.7	5.3	8.3
Total allowable catch	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]

Long-term potential catch = Unknown
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 = 23.8 cm (9.4 inches) males; 25.0 cm (9.8 inches) females

M = 0.40 $F_{0.1}$ = Unknowwn F_{max} = >2.00 F_{1984} = Unknown

[1]Past TAC's not applicable to this stock grouping.

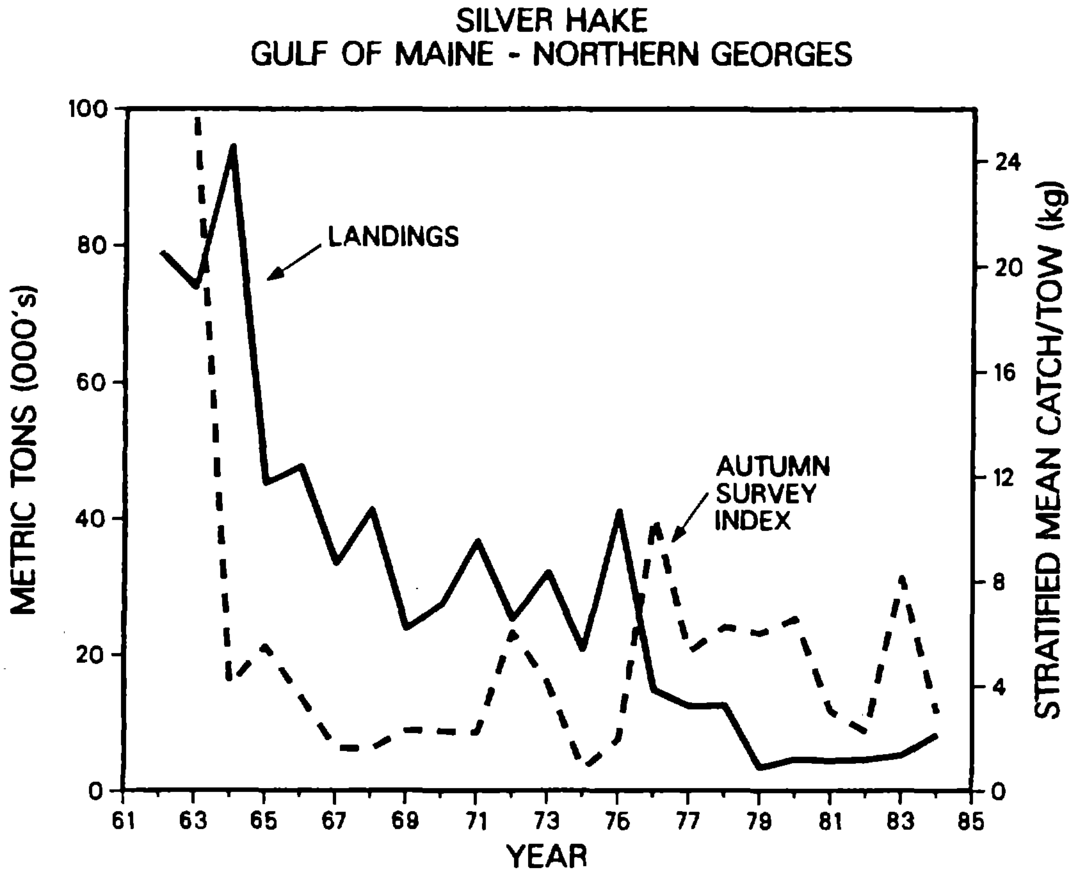


Figure 9. Total commercial landings and stock biomass indices for the Gulf of Maine - northern Georges Bank stock of silver hake.

Southern Georges Bank-Middle Atlantic Stock

The international nominal catch of silver hake in 1984 was 15,143 mt (Table 16, Figure 10). This level of catch was the lowest reported since 1960. The US catch in 1984 was 14,731 mt, the second highest level since 1965 and maintaining the fairly constant level of catches which have averaged about 14,000 mt during 1977-1983. Distant-water-fleet catch was only 412 mt, the lowest level reported since their introduction to the fishery in 1962. The DWF catch, from 1963 to the inception of MFCMA, dominated the catch from this stock averaging 87% annually. Recreational catch in 1984 was assumed to be about 2,000 mt.

Total catches from this stock increased from an average of 15,500 mt during 1955-1961 before increasing sharply with the introduction of the DWF to 308,500 mt in 1965 before decreasing to only 28,000 mt in 1970. Catches subsequently increased to about 110,000 mt in 1974, then dropped steadily to 61,300 mt in 1977. Restrictions placed on the foreign fleet in 1978 caused further decreases in total catch to a point where present catch levels, averaging 15,800 mt, are similar to those prior to 1963. The DWF catch of silver hake is now taken primarily as by-catch in the squid fishery.

The NEFC autumn bottom trawl survey catch-per-tow index has reflected trends similar to those in commercial catch statistics. The index increased to a high in 1965 and declined steadily thereafter to a low level in 1969. The index then increased and remained fairly constant during 1970-1973, but dropped sharply to its lowest level in 1974. After increasing steadily through 1978 the index then dropped again during 1979-1981, and then increased again in 1982 and 1983. However, in 1984, the index dropped to its 1981 level. Survey catch-per-tow-at-age data indicate that, like the northern stock of silver hake, the 1973-1974 year classes were strong in comparison to other years in the time series. Year-class strength since 1975, with the exception of the 1977 cohort, has appeared to be of only average strength although the 1982 year class may be stronger than others.

Since 1978, this stock has been under very little fishing pressure when compared to 1963-1977 when the fishery was dominated by the DWF. However, biomass, as indicated by the NEFC bottom trawl survey, has not increased substantially. With catch levels remaining at their present level and average year classes, it is unlikely that this stock will undergo any major declines in 1985.

For further information see:

Almeida, F.P. 1985. An analysis of the stock structure of silver hake, Merluccius bilinearis, off the northeast coast of the United States. MS Thesis. Oregon State University, Corvallis, Oregon. 141 p.

Table 16. Nominal catches (thousand metric tons) and management information for silver hake from the southern Georges Bank - Middle Atlantic stock, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	0.9	3.9	2.0	2.3	2.0	2.0	2.1	2.0	2.0
Commercial									
USA	7.4	9.5	11.4	13.1	11.7	11.7	11.9	11.5	12.7
Canada	-	-	-	-	-	-	-	-	-
Other	82.1	47.9	14.4	4.9	1.7	3.0	2.4	0.6	0.4
Total nominal catch	90.4	61.3	27.8	20.3	15.4	16.7	16.4	14.1	15.1
Total allowable catch	-[1]	-[1]	-[1]	-[1]	-1	-[1]	-[1]	-[1]	-[1]

Long-term potential catch = Unknown
Importance of recreational fishery = Minor
Status of management = FMP in preparation
Status of exploitation = Underexploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 24.7 cm (9.7 inches) males; 25.7 cm (10.1 inches) females

M = 0.40 $F_{0.1}$ = Unknown F_{max} = >2.00 F_{1984} = Unknown

[1] Past TAC's not applicable to this stock grouping.

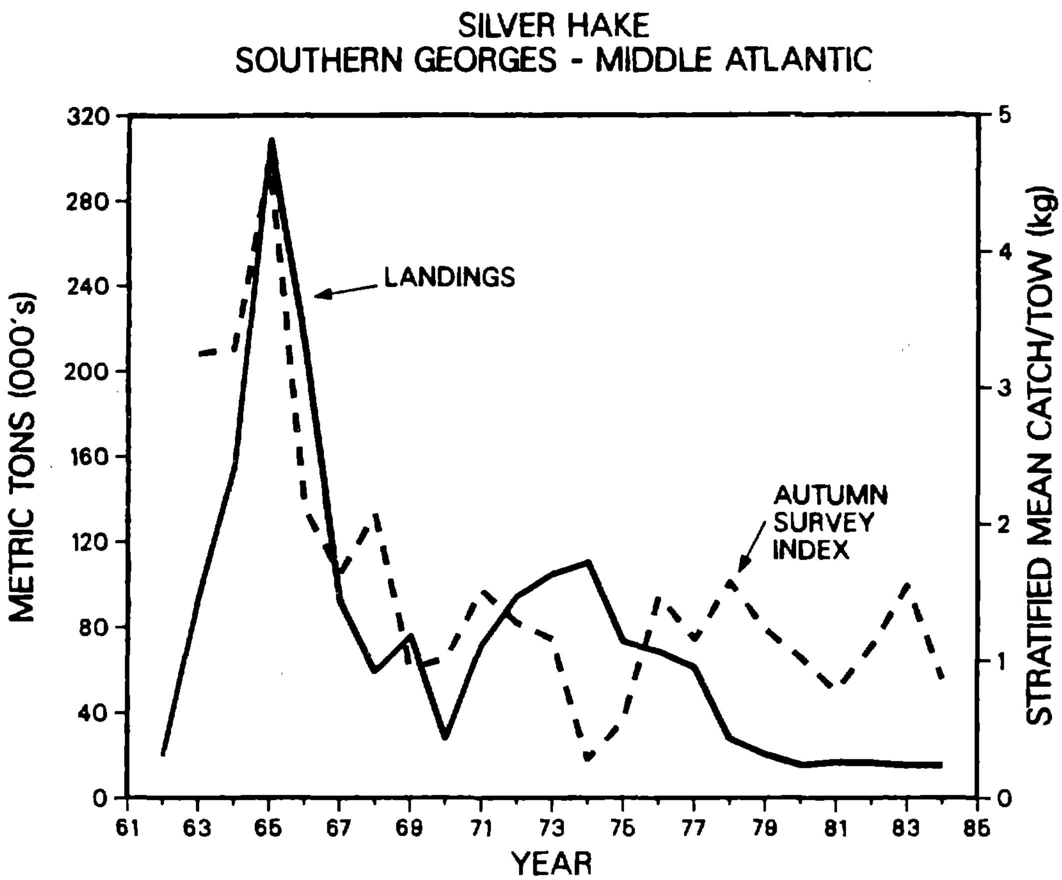


Figure 10. Total commercial landings and stock biomass indices for the southern Georges Bank - Middle Atlantic stock of silver hake.

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.

The following summaries of the status of the red hake stocks represent a departure from the three stock assessments performed in the past. Based upon evidence obtained from an examination of the distributional patterns from research vessel bottom trawl surveys and their general similarity to silver hake, red hake are now considered to populate two stocks. These include a northern stock, with fish from the Gulf of Maine and northern Georges Bank, and a southern stock made up of individuals inhabiting southern Georges Bank south to Cape Hatteras. Analytical assessments of these stocks are in preparation.

Gulf of Maine - Northern Georges Bank Stock

The nominal catch of red hake in 1984 was 1,059 mt, taken exclusively by the US (Table 17, Figure 11). While this catch was a modest 18% increase over 1983, it represented a continuation of the low levels reported since 1977. Trends in total catch from this stock have shown three distinct periods. The first period, from the early 1960's through 1971 was characterized by relatively low catches ranging from about 1,000 to 5,000 mt. The second period during 1972-1976 showed a sharp rise in catches ranging from 6,300 to 15,300 mt. During this period, large catches averaging approximately 93% of the total annual catch, were taken by the distant-water-fleet on northern Georges Bank. Total catch then dropped sharply and has averaged only 1,100 mt from 1977 to the present, due primarily to the displacement of the distant-water fleet from the waters inhabited by this stock.

The NEFC spring bottom trawl survey index increased from low levels in the late 1960's and reached a peak in 1975 before dropping sharply through 1979. The index then increased dramatically in 1980 and recorded a series high in 1982. After a decline in 1982, the survey index increased in 1983 and again in 1984. The 1984 value was the second highest recorded in the series. The autumn survey reflected a trend similar to that in the spring, but has demonstrated more variability in recent years. The index also increased from low levels in the 1960's and early 1970's and has maintained a relatively high average value during the 1980's. Survey catch-per-tow-at-age data indicate that, like silver hake, the 1973 and 1974 year classes were the strongest since 1970. Year classes produced during 1975-1980 were of average strength with the exception of a weak 1977 cohort. The 1981 year class appeared to be above average while the 1983 year class appeared to be weak in comparison to other years. Preliminary estimates of the 1984 cohort indicate that it is of average strength.

The combination of minimal fishing pressure, combined with average to above average year classes produced since about 1980 have resulted in an apparent increase in stock size as indicated from the NEFC bottom trawl survey. It is unlikely that this stock will undergo any major declines in 1985 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 the Gulf of Maine - northern Georges Bank stock, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	0.5	0.9	1.2	1.5	1.0	1.2	1.2	0.9	1.1
Canada	-	-	-	-	-	-	-	-	-
Other	9.9	-	-	-	-	-	-	-	-
Total nominal catch	10.4	0.9	1.2	1.5	1.0	1.2	1.2	0.9	1.1
Total allowable catch	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]

Long-term potential catch = Unknown
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 = 28.1 cm (11.1 inches)

M = 0.40 $F_{0.1}$ = Unknown F_{max} = >2.00 F_{1984} = Unknown

[1]Past TAC's not applicable to this stock grouping.

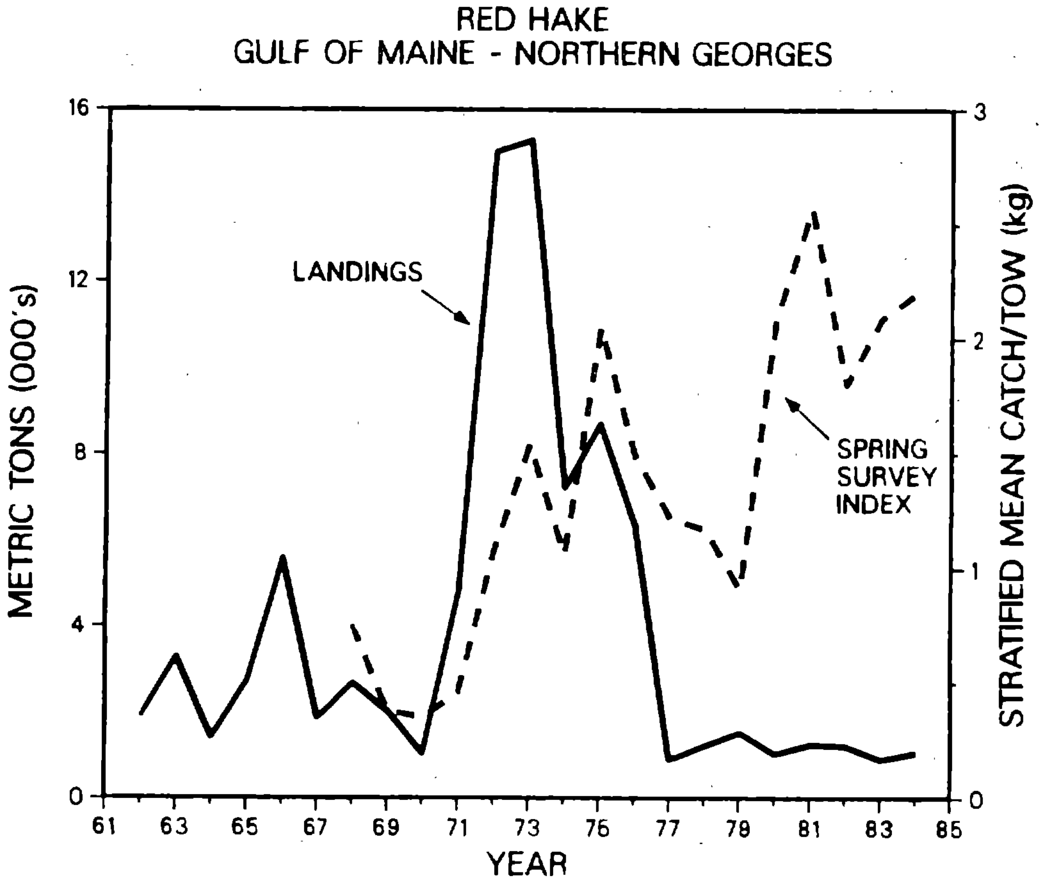


Figure 11. Total commercial landings and stock biomass indices for the Gulf of Maine - northern Goerges Bank stock of red hake.

Southern Georges Bank-Middle Atlantic Stock

The international nominal catch of red hake in 1984 was 1,771 mt, the lowest catch reported in the 1960-1984 time series and continuing a trend of decreasing catches which began in 1977 (Table 18, Figure 12). The US catch in 1984 was 1,214 mt, and the distant-water-fleet catch was reported to be only 57 mt. Recreational catch was assumed to be about 500 mt.

Total catches from this stock rose dramatically with the introduction of the DWF, from 4,600 mt in 1960 to a high of 108,000 mt in 1966. Catches subsequently declined to only 11,900 mt by 1970 before increasing to 61,400 in 1972. Since 1972, there has been a steady decline in total catch, initially due to modest declines in DWF catch and then, because of a sharp decline in DWF catch; from 18,600 mt in 1976 to an average of only 130 mt during 1980-1984. During the period of 1965-1976 the fishery was dominated by the DWF, which averaged 83% of the total annual catch. Since 1978, the DWF catch has averaged only 10% of the total annual catch due to restrictions placed on the fleet after the inception of MFCMA. The DWF catch of red hake is currently taken as by-catch in the foreign squid fishery.

US commercial catch increased from 4,300 mt in 1960 to a series high of 32,600 mt in 1964 and then began a steady decline to 4,700 mt in 1970. US catch has remained relatively steady during the 1970's and 1980's. With the exception of 1979 which saw a US catch of 6,600 mt, catches have ranged between 3,900 mt in 1980 and 1,214 mt in 1984 and have averaged 2,600 mt.

The NEFC autumn bottom trawl survey index declined steadily from high levels in the mid-1960's and then remained fairly constant during 1968-1973 before dropping to a series low in 1974. The index increased sharply in 1975 before declining slightly and again remaining fairly steady during 1976-1983 at a level similar to that during 1968-1973. In 1984, the index dropped sharply to the second lowest level in the series. Survey mean catch-per-tow-at-age indices indicated that the 1974, and 1979-1981 year classes were stronger than other years in the series with the 1974 cohort being the strongest. Other year classes since 1970 appeared to be of only average strength with the exception of the 1983 year class which appeared to be week.

As with the northern stock of red hake, there has been minimal fishing pressure exerted on this stock in recent years, allowing the age structure to remain fairly stable with 3-4 year classes contributing to the catch. It is unlikely that any major declines will be effected in 1985 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 Georges Bank - Middle Atlantic stock, 1972-1984.

Category	Year 1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational[1]	0.3	0.8	0.7	0.5	0.5	0.5	0.5	0.5	0.5
Commercial									
USA	2.8	2.5	3.3	6.6	3.9	2.1	3.0	1.3	1.2
Canada	-	-	-	-	-	-	-	-	-
Other	33.6	4.5	2.1	1.0	0.2	0.2	0.2	0.1	0.1
Total nominal catch[1]	36.7	7.8	6.1	8.1	4.6	2.8	3.7	1.9	1.8
Total allowable catch[2]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]

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

$M = 0.40$ $F_{0.1}$ = Unknown F_{max} = >2.00 F_{1984} = Unknown

[1]Past TAC's not applicable to this stock grouping.

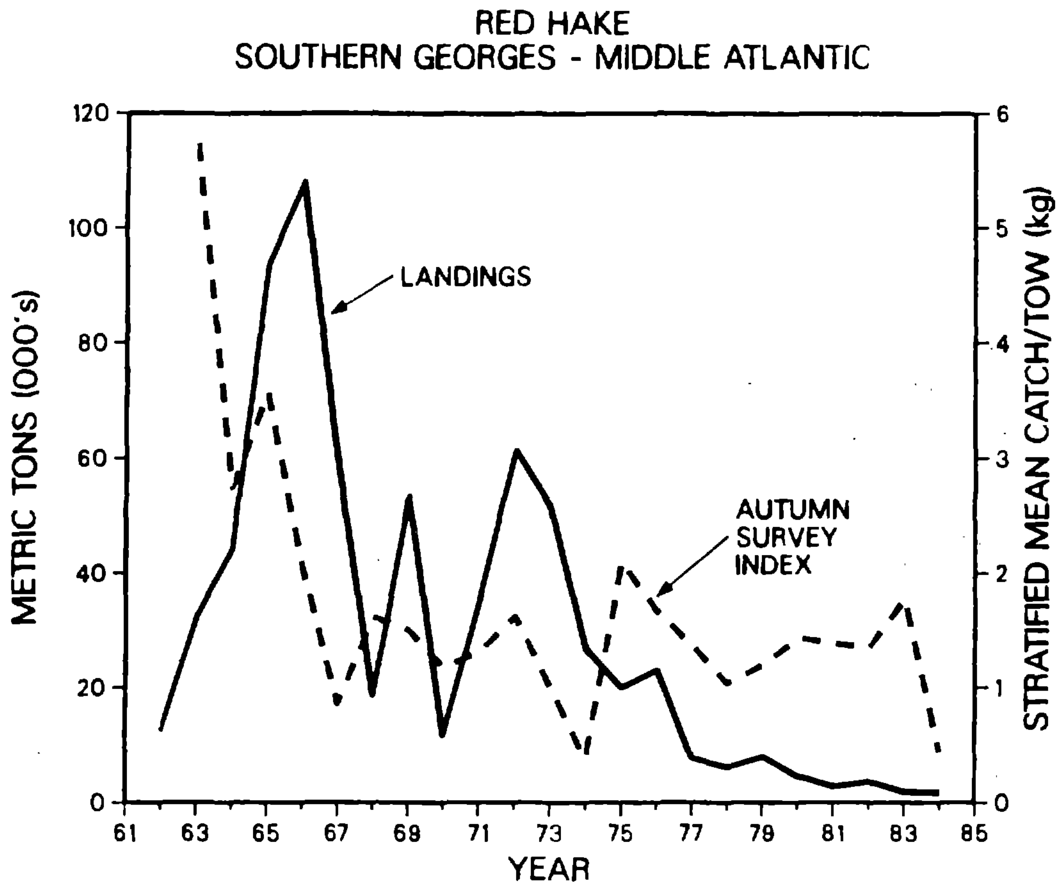


Figure 12. Total commercial and recreational landings and stock biomass indices for the southern Georges Bank - Middle Atlantic stock of red hake.

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).

Pollock have generally been taken as by-catch although in recent years directed effort appears to have increased. Nominal commercial catches from the entire Scotian Shelf, Gulf of Maine and Georges Bank region increased from 38,200 mt during 1972-1976 to 59,000 mt in 1981, but have since declined. The 1984 total was 51,000 mt, of which 33,100 mt was taken by Canada and 17,800 mt by the USA (Table 19). Nominal catches for Canada increased steadily from 24,700 mt in 1977 to 40,300 mt in 1981, but have since declined; USA catches have increased from an average of 8,200 mt during 1972-1976 to over 14,000 mt annually since 1978, peaking at over 18,000 mt in 1980 and 1981. Nominal catches by distant-water fleets have declined from an average of 6,000 mt during 1972-1976 to only 400-500 mt during 1981-1983. Most of this catch has been taken by USSR vessels on the Scotian Shelf. Estimated USA recreational catches have fluctuated between 700 and 1,300 mt since 1979. No information is available for Canadian recreational harvest, although it appears to be of minor importance. The total nominal catch, including recreational, peaked at almost 60,000 mt in 1981; the 1984 total was 52,000 mt.

Total stock size appears to be relatively high at present. Canadian commercial abundance indices (mt/hour fished) increased sharply in 1979, and the 1979-1983 average for 501-999 GT trawlers (1.2 mt/hour) is almost twice the corresponding 1974-1977 average (0.7 mt/hour). Indices for USA 51-500 GT trawlers have also doubled since the early 1970's. Abundance indices derived from Canadian summer and NEFC spring and autumn bottom trawl surveys also increased during the 1970's, but have declined sharply since 1981. Virtual population analysis indicates an increase in age 2+ stock biomass from 176,000 mt in 1973-1974 to 322,000 mt in 1981. Biomass subsequently declined to 296,000 mt in 1983, but has since increased to 312,000 mt in 1984 (Figure 13).

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. Since 1980, fishing mortality levels appear to have approximated $F_{0.1}$.

For further information see:

McGlade, J., M.C. Annand, and D. Beanlands. 1984. Assessment of pollock (Pollachius virens) in Divisions 4VWX and Subarea 5. CAFSAC Res. Doc. 84/77, 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 for pollock from the Gulf of Maine, Georges Bank, and Scotian Shelf area, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational[1]	1.1	2.7	1.8	0.7	1.0	0.7	1.3	1.0	1.0
Commercial									
USA	8.2	13.1	17.7	15.5	18.3	18.2	14.4	14.0	17.8
Canada	24.0	24.7	26.8	30.0	36.0	40.3	38.0	32.7	33.1
Other	6.0	0.7	0.8	1.1	1.2	0.5	0.4	0.5	0.1
Total nominal catch	39.3	41.2	47.1	47.3	56.5	59.7	54.1	48.2	52.0
Total allowable catch	-	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 = 3.1 yrs
Size at 50% maturity = 50 cm (20 inches)

$M = 0.20$ $F_{0.1} = 0.25$ $F_{max} = 0.49$ $F_{1984} = 0.27$

[1]Data for 1974 and 1979-82 taken from recreational surveys; remaining points estimated.

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

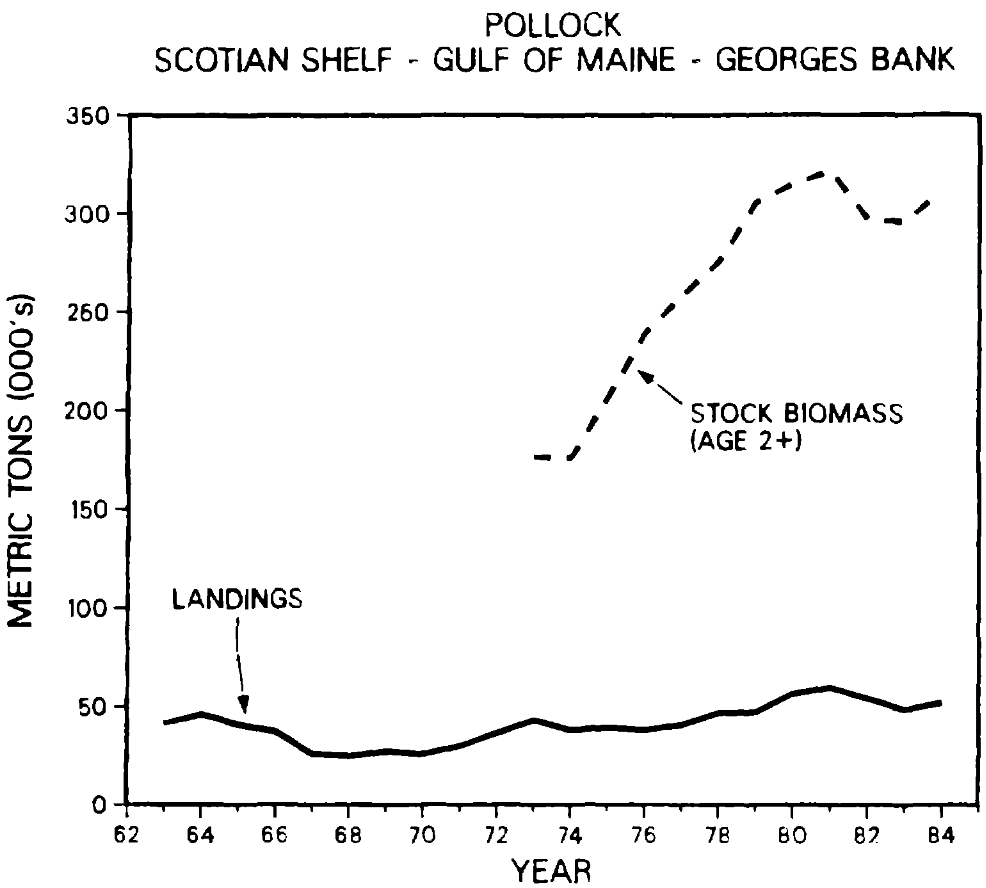


Figure 13. Total commercial and recreational landings and estimates of stock biomass of pollock in the Gulf of Maine, Georges Bank, and Scotian Shelf area.

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 11,000 mt in 1978 under ICNAF and MFCMA restrictions. Nominal catches averaged 16,200 mt during 1979-1981, and then rose to 33,100 mt in 1983, the highest since 1972. Landings for 1984 totalled 17,700 mt. The sharp increase observed during 1982-1983 appears to be due to improved recruitment and to removal of catch restrictions under the Interim Management Plan. Nominal catches for the northern Gulf of Maine increased from 100 mt during 1973-1974 to approximately 500 mt during 1980-1982 and then declined to 200 mt in 1984.

Georges Bank (East of 69°W)

Nominal catches declined from an average of 14,700 mt during 1972-1976 to only 4,600 mt in 1978. Landings increased gradually from 1979-1981 and then rose sharply to 11,400 mt in 1983, the highest since 1976 (Table 20, Figure 14). In 1984, however, landings dropped to only 5,800 mt. The 1980 year class dominated commercial landings in 1982 and 1983; the 1984 decline reflects reduction of this year class by fishing and poorer recruitment from the 1981 and 1982 year classes. Discard rates on a per-trip basis were as high as 30% of the landed total by weight in 1982, but have since declined somewhat.

The commercial abundance index (mt/day fished) for Georges Bank declined to minimal levels in the late 1970's and then increased with improving recruitment; values for 1982-1983 were the highest observed in recent years, but remained considerably below peak levels observed during the early to mid-1960's. NEFC spring and autumn (Figure14) survey results also suggest an increasing trend into the early 1980's; but since 1982 indices have declined substantially. Spring 1984 abundance and biomass index values are again comparable to the very low values observed in the late 1970's, while those for the 1984 autumn survey were the lowest in that time series. Survey catch-per-tow at age data indicate that recent year classes have been relatively weak; and in particular, catches of Age 1 (1983 year class) yellowtail in autumn of 1984 were among the lowest on record, suggesting that the current declining trend will continue. Fishing mortality has considerably exceeded the F_{max} level 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), 1972-1984.

Category	Year: 1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	14.0	9.5	4.5	5.5	6.4	6.4	10.6	11.4	5.8
Canada	<0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
Other	0.7	-	-	-	-	-	-	-	-
Total nominal catch	14.7	9.5	4.6	5.5	6.5	6.4	10.6	11.4	5.8
Total allowable catch	-	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)

$M = 0.20$ $F_{0.1} = 0.30$ $F_{max} = 0.50$ $F_{1984} = >F_{max}$

[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).

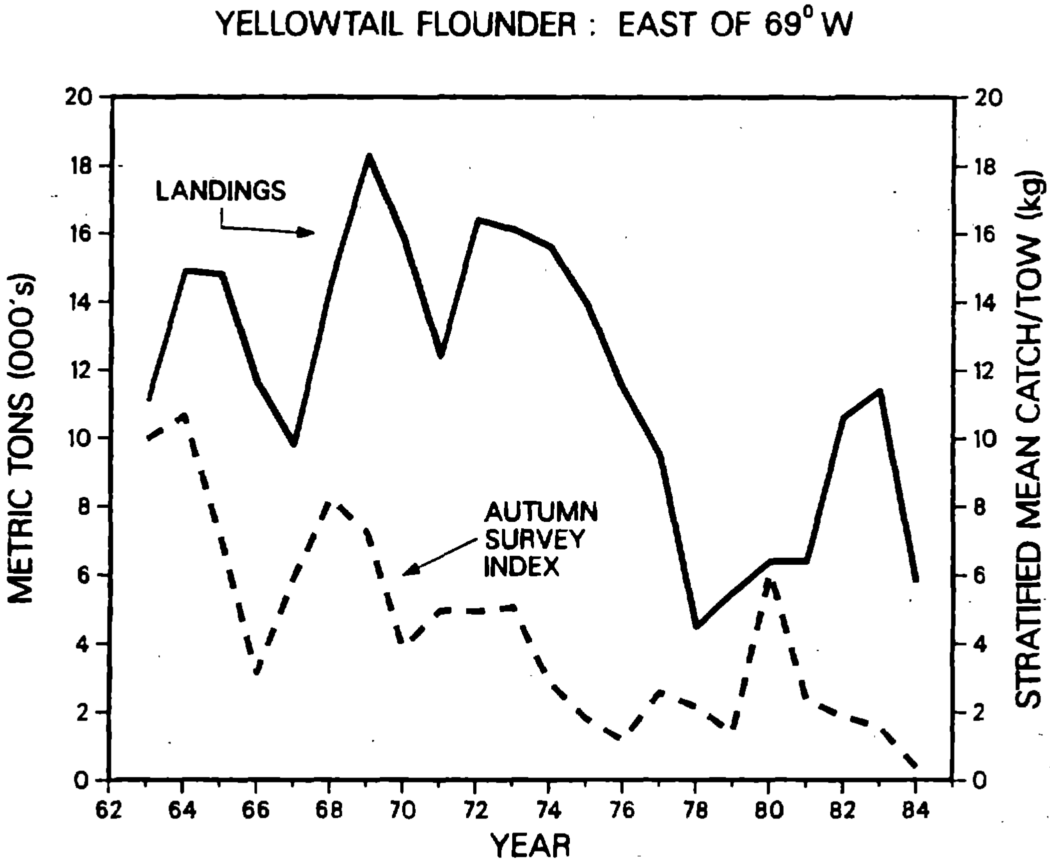


Figure 14. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of yellowtail flounder on Georges Bank east of 69°W longitude.

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

Nominal catches declined from an average of 11,600 mt during 1972-1976 to 6,400 mt in 1978; landings then rose to 13,800 mt in 1982 and to 21,300 mt in 1983 before declining sharply to 11,700 mt in 1984 (Table 21). Again, the 1980 year class predominated in 1982-1983 landings, and the 1984 decline reflects both reduction of this year class by fishing and poorer recruitment from subsequent year classes. Reported trip discard levels ranged from 25-80% of the landed total by weight in 1982; since that year, discard appears to have declined somewhat.

For southern New England, commercial and survey indices declined to very low levels in the mid-1970's; indices then increased gradually until 1982 and then rose sharply with recruitment of the 1980 year class. Since that year abundance has declined sharply and now appears to be at or near historic lows (Figure 15). The 1979 and 1980 year classes appear to have been the strongest in recent years, with subsequent year classes being much weaker. Research vessel survey catches of age 1 (1983 year class) yellowtail in spring and autumn of 1984 were the lowest on record. Results of a directed survey for yellowtail on the southern New England grounds in winter of 1985 also suggest very low levels of abundance and poor recruitment prospects. The 1980 year class has been severely reduced by fishing and is not expected to contribute appreciably to the fishery in the future. Fishing mortality has again substantially exceeded F_{max} in recent years.

Trends for the Mid-Atlantic have been generally similar to those observed for southern New England. NEFC spring and autumn (Figure 16) survey indices declined to very low levels in the mid-1970's, followed by a sharp increase in 1981-1982. Since 1982, abundance has again declined sharply; the increase in nominal catch in 1984 over 1983 levels reflects an increase in fishing effort.

The Cape Cod yellowtail fishery has generally been more stable than those for other areas. Nominal catch averaged between 1,000-2,000 mt from 1960 through 1975 and then increased to over 5,000 mt in 1980; since that year, landings have declined steadily to only 1,100 mt in 1984. Commercial and NEFC research vessel survey indices increased somewhat during the late 1970's and early 1980's; more recent data again indicate a declining trend (Figure 17).

For further information see:

Clark, S.H., M.M. McBride and B. Wells. 1984. Yellowtail flounder assessment update - 1984. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 84-39, 30 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), 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	10.9	6.8	6.4	10.1	11.4	8.7	13.8	21.3	11.7
Canada	<0.1	-	<0.1	-	-	-	-	-	-
Other	0.7	<0.1	-	-	-	-	-	-	-
Total nominal catch	11.6	6.8	6.4	10.1	11.4	8.7	13.8	21.3	11.7
Total allowable catch	-	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)

$M = 0.20$ $F_{0.1} = 0.30$ $F_{max} = 0.50$ $F_{1984} = >F_{max}$

[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).

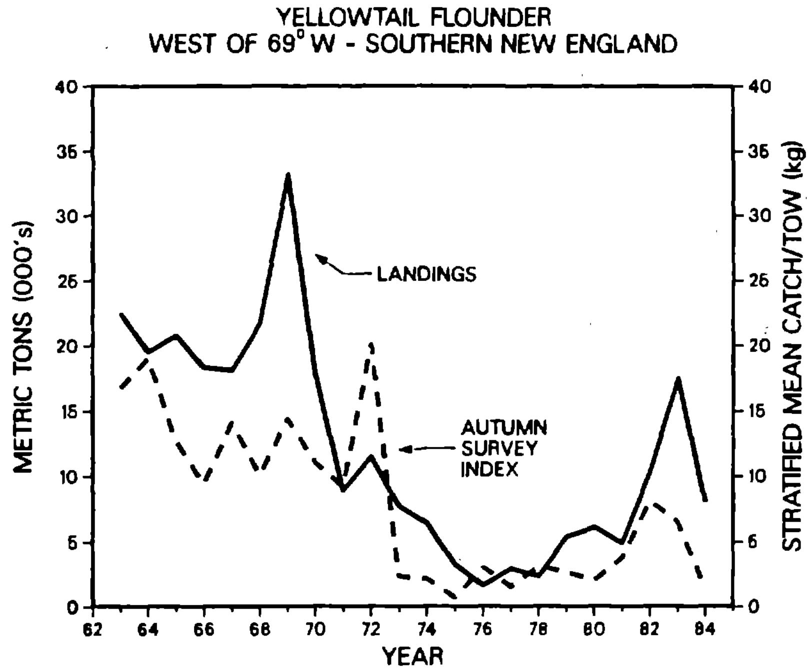


Figure 15. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of yellowtail flounder west of 69°W longitude (southern New England).

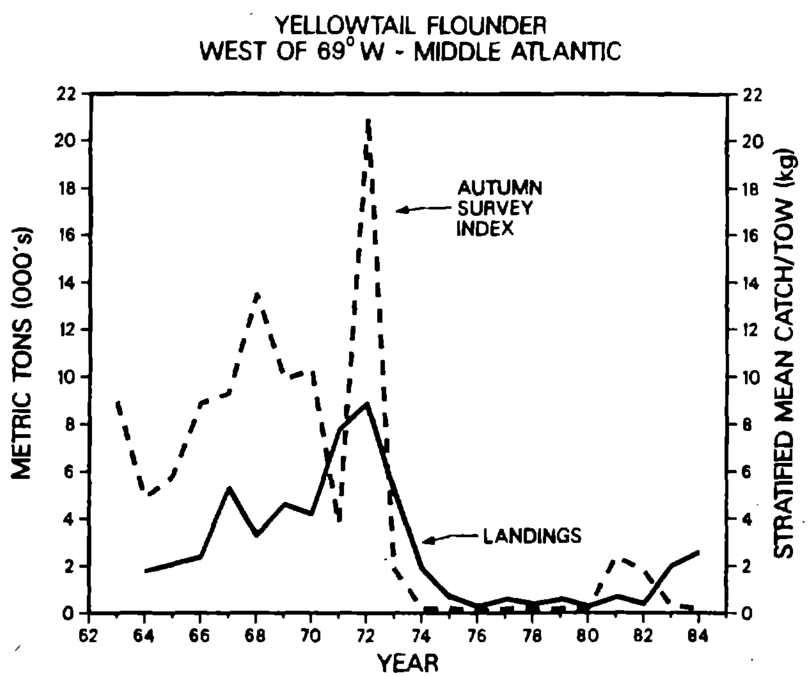


Figure 16. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl survey of yellowtail flounder west of 69°W longitude (Mid-Atlantic).

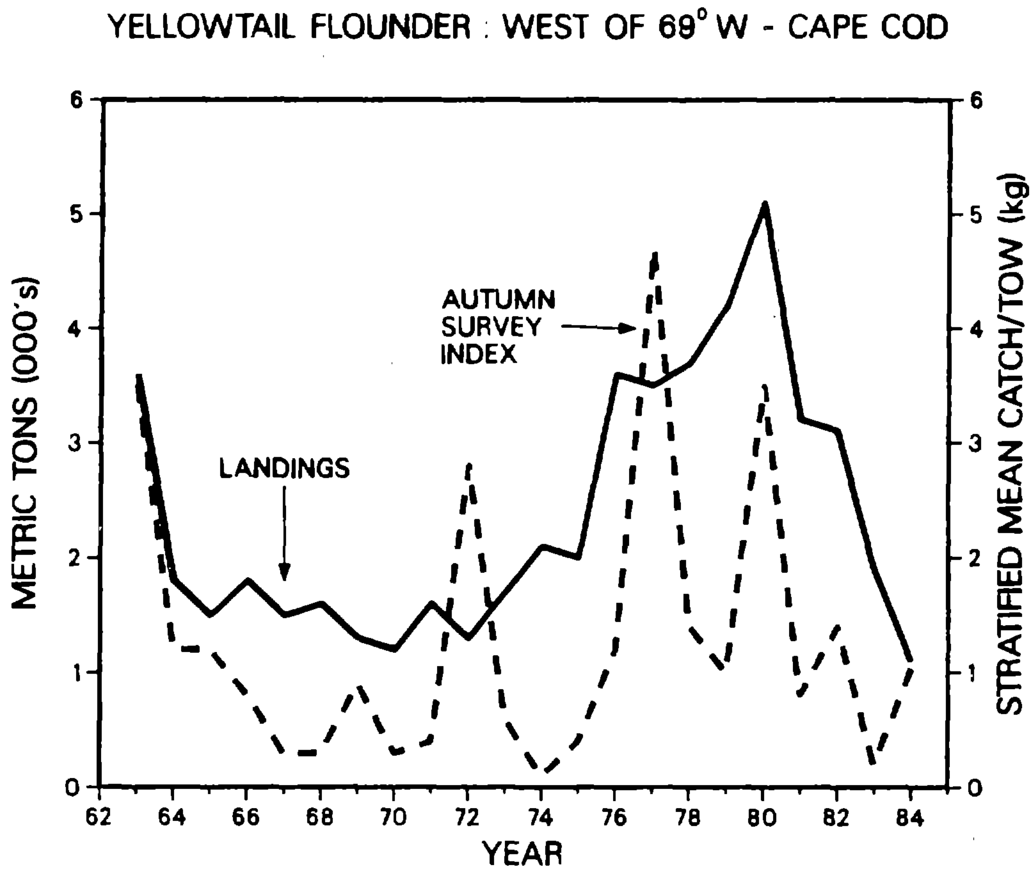


Figure 17. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of yellowtail flounder west of 69°W longtitude (Cape Cod).

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 1984 was 14,164 mt, a 20% increase relative to the 1983 level of 11,821 mt and near the peak 1979 catch of 14,500 mt (Table 22). The estimated recreational catch of summer flounder ranged from 6,500 to 21,200 mt (in 1984) during 1979-1984. An additional 2-4 million fish were caught and released alive (weight not available). 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 18). 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 0.26 kg/tow in 1984. 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.

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, 1972-1984.

Category	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational[1]	15.8[2]	-	-	7.1	17.2	6.5	10.3	-	21.2
Commercial									
USA	6.6	8.9	8.5	14.5	11.5	7.9	7.9	11.8	14.2
Canada	-	-	-	-	-	-	-	-	-
Other	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Total nominal catch[3]	6.6	8.9	8.5	14.5	11.5	7.9	7.9	11.8	14.2
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_{1984} = Unknown

[1]Estimates available only for years shown.

[2]1974 estimate.

[3]Commercial only.

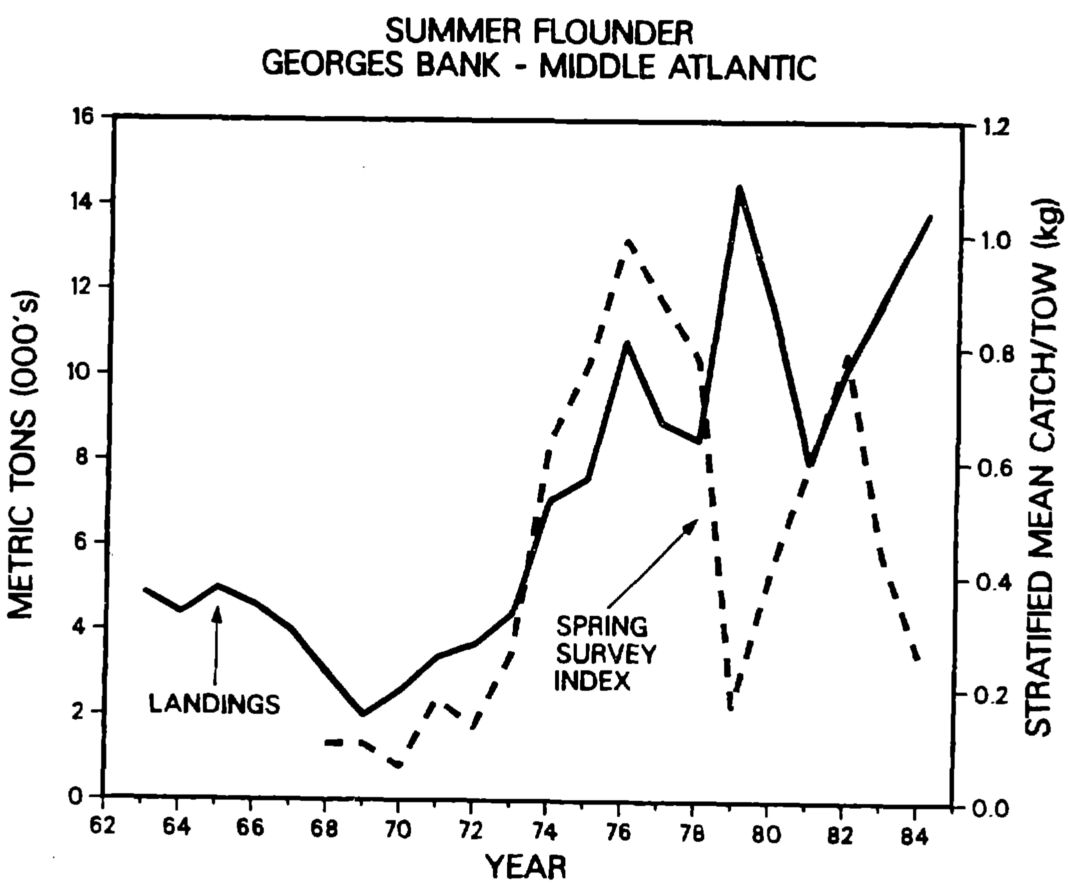


Figure 18. Total commercial landings and stock biomass indices from NEFC spring bottom trawl surveys of summer flounder in the Georges Bank - Mid-Atlantic area.

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.

Commercial 1984 landings of American plaice from the Gulf of Maine - Georges Bank region were 10,150 mt, 23% less than in 1983, and the lowest annual catch since 1978 (Table 23, Figure 19). Annual landings during 1979-1984 have averaged 12,740 mt, about 3.5 fold higher than the 1960-1978 annual mean (3,550 mt). USA commercial CPUE indices were relatively stable during 1964-1969, declined in the early 1970's, and sharply increased in 1977 when total landings doubled. CPUE indices in the Gulf of Maine peaked in 1981 while Georges Bank CPUE values peaked in 1983; in these years, record CPUE values were attained. Subsequently, annual CPUE indices have sequentially declined. The 1984 indices in both areas were the lowest since the mid-1970's. Effort in 1984, however, was a record high.

During 1960-1974, 67% of USA landings were from deepwater areas on Georges Bank. Since then, Gulf of Maine landings have exceeded those from Georges Bank. The 1984 Gulf of Maine catch (6,840 mt) was twice as large as than from Georges Bank (3,300 mt). In both areas, however, shifts in landings by vessel class have recently occurred. In 1984, for the first time ever in the Gulf of Maine, plaice landings by small vessels (Class 2: 5-50 GRT) accounted for less than half of the Gulf of Maine catch. Class 3 (51-150 GRT) and Class 4 (151-500 GRT) vessels accounted for 42% and 12% respectively of the 1984 total Gulf of Maine landings, record percentages for these tonnage categories. On Georges Bank, Class 3 vessels accounted for 64% of the 1984 catch, the lowest percentage ever, while landings by Class 4 vessels comprised 31% of the Georges Bank total, near the record high of 32% obtained in 1983.

In both the Gulf of Maine and Georges Bank regions, the American plaice fisheries became highly directed during 1981 and 1982. In 1981, 70% of the total Gulf of Maine catch was taken by trips in which plaice comprised more than 50% of the trip catch. In 1982, 29% of the Georges Bank landings was taken in such trips. Since then, "directed trips" have become much less important in accounting for yield. In 1984, "directed trips" accounted for only 25% of the Gulf of Maine catch and only 14% of the Georges Bank catch.

Landings trendings have generally paralleled trends in NEFC autumn indices (Figure 19). The 1984 autumn survey weight per tow index was the lowest since the mid-1970's (1974). The declining trend in survey values since 1980 is consistent with that observed in CPUE values.

American plaice abundance, high in the late 1970's, has now been markedly reduced. Due to increased effort, fishing mortality is now too high to sustain annual landings at their present levels. Given these conditions, abundance is expected to remain low during 1985 and 1986 accompanied by a continued decline in landings.

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, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	2.3	7.1	9.5	11.4	13.5	12.9	15.1	13.2	10.1
Canada	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other	0.2	0.2	<0.1	0.1	-	<0.1	-	-	-
Total nominal catch	2.5	7.3	9.6	11.5	13.6	12.9	15.2	13.2	10.1
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = Unknown
Importance of recreational fishery = Insignificant
Status of management = FMP in planning stage
Status of exploitation = Becoming fully exploited
Age at 50% maturity = 3.2 yrs (males); 3.8 yrs (females)
Size at 50% maturity = 25.6 cm (10.1 inches) males; 29.7 cm (11.7 inches) females

$M = 0.20$ $F_{0.1} = 0.17$ $F_{max} = 0.34$ F_{1984} = Unknown

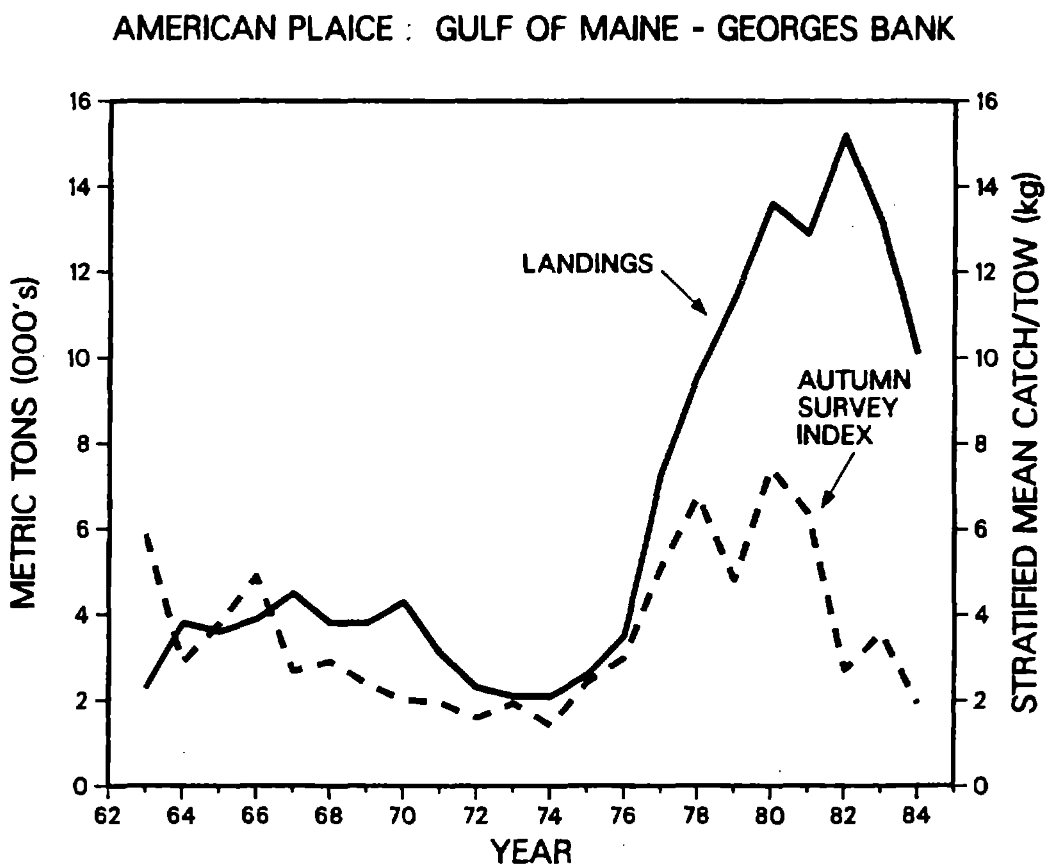


Figure 19. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of American plaice in the Gulf of Maine - Georges Bank area.

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 20). Nominal catches have since increased more or less continually to 6,500 mt in 1984.

NEFC autumn survey catches seem to accurately reflect trends in biomass (Figure 20). 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. Abundance increased sharply in 1977-1978; subsequent indices have been lower, although 1983 and 1984 values were comparable to the long-term average. Spring 1985 catch levels were also comparable to the long-term NEFC spring survey average. There is therefore no consistent evidence to indicate that this resource is being adversely affected by current levels of exploitation. It remains questionable whether harvests of 6,000 mt or more can be sustained over the long term given historical trends.

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, 1972-1984.

Category	Year 1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	2.2	2.5	3.5	3.0	3.4	3.4	4.8	5.8	6.5
Canada	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other	0.7	-	<0.1	-	-	-	-	-	-
Total nominal catch	2.9	2.5	3.5	3.0	3.4	3.4	4.8	5.8	6.5
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_{1984} = Unknown

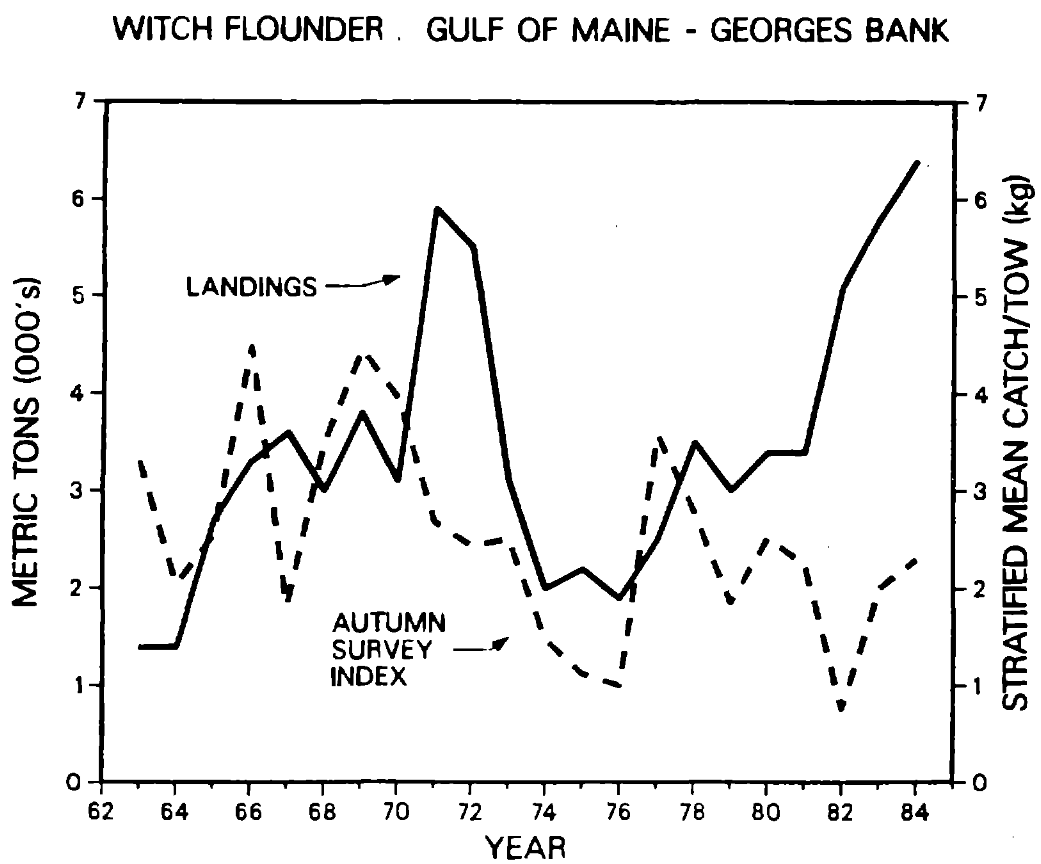


Figure 20. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of witch flounder in the Gulf of Maine - Georges Bank area.

WINTER FLOUNDER

The winter flounder, blackback, or lemon sole (Pseudopleuronectes americanus) is distributed in the Northwest Atlantic from Labrador to Georgia. Abundance is 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-water 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.

Total commercial landings in 1984 were 14,700 mt, about 17% below the record high landings of around 17,500 mt in 1980-1981, but almost equal to 1983 landings (Table 25, Figure 21). Preliminary estimates indicate a small increase in landings from Georges Bank and decreases in landings from the Gulf of Maine, Southern New England and Middle Atlantic areas. Total USA commercial landings increased rapidly from an average of 7,960 mt between 1972-1976 to levels comparable to the late 1960's in 1977 and 1979 (12,000 mt). The nominal catch of winter flounder by foreign vessels in 1983 was 19 mt, taken entirely by Canada. Landings by foreign vessels have been sharply reduced since the implementation of the MFCMA. The estimated recreational catch of winter flounder in 1982 was 8,600 mt, a 17% reduction from the 1979 high of 10,300 mt, but nearly equal to catches in 1981. Due to change in recreational survey methodology, however, the 1979 estimate is not directly comparable to previous estimates.

The 1984 NEFC autumn survey index (1.2 kg/tow) declined relative to 1983 (2.1 kg/tow), approaching the low levels of the mid-1970's (0.9 kg/tow in 1975) (Figure 21).

In the Gulf of Maine, commercial landings declined from a peak of 2793 mt in 1982 to 1698 mt in 1984. USA commercial catch per unit effort (CPUE) indices declined from peaks in 1980-1981 to 1984 levels near or below the lowest previously observed (since 1975). In 1984, the NEFC spring offshore survey index decreased significantly for the first time (from 7.4 to 1.9 kg/tow) after increasing from a 1975 low. The fall offshore index (2.0 kg/tow) was approximately the same as in 1983 (1.6 kg/tow) below 1980-1982 indices (5.8-2.4 kg/tow). The fraction of small (<28 cm, 11") winter flounder in the commercial catch has been increasing in 1983 and 1984; the fishery is landing more sexually immature fish.

For the Georges Bank area, 1984 commercial landings approximately equalled those of 1983 (3928 mt, 3894 mt, respectively) above 1982 landings (2962.2 mt) and close to the 1981 peak (4055.1 mt). CPUE indices in 1984 were the lowest since 1975 and 1976 (the earliest years for which data were available) however, and arose from increased effort. The NEFC autumn survey index fluctuates widely, but has trended downward from 1976-1982, from 7.1 to 1.9 kg/tow, respectively. Although the 1983 and 1984 preliminary estimates (3.2-3.9 kg/tow) are higher than in 1982, they are still below average (4.7 kg/tow).

In Southern New England, commercial landings declined from a peak of 11,134 mt in 1981 to 9134 mt in 1983 and 8838 mt in 1984. Landings in 1984 still exceeded landings in any year before 1980, however. CPUE indices have declined rapidly from a peak in 1981 to near or below historical low levels (since 1975-1976) in 1984. NEFC offshore survey indices also declined from local peak values in 1981 (2.7 kg/tow, spring survey) to stable levels in 1982-1984 (0.8 kg/tow in 1984) which are below the long term (1963-1984) average (1.1 kg/tow).

In the Mid-Atlantic, commercial landings are typically low. In 1984, 44 mt were landed, similar to landings in 1981 and 1982, but below 1983 (59 mt). CPUE cannot be calculated because most of the catch is by fyke nets, for which no effort data are available. Both spring and fall NEFC offshore survey indices have shown overall increases since lows in 1978-1979 (which followed record high commercial landings of 115 mt in 1978).

Based on recent and often sharp declines in CPUE and declining or below average survey indices in most areas, it appears that winter flounder are fully exploited and current catch levels are unlikely to be sustained.

For further information see:

Foster, K. L. and Gabriel, W.L. Manuscription in preparation. The status of the winter flounder (Pseudopleuronectes americanus) stocks from the Gulf of Maine to the Middle Atlantic regions.

Table 25. Nominal catches (thousand metric tons) and management information for winter flounder from the Gulf of Maine - Mid-Atlantic area, 1972-1984.

Category	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	8.6	-	-	10.3	7.5	8.7	8.6	-	-
Commercial									
USA	8.0	10.6	12.3	12.2	17.4	17.7	15.4	15.3	14.7
Canada	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other	1.0	<0.1	-	-	-	-	-	-	-
Total nominal catch[1]	9.0	10.6	12.4	12.2	17.4	17.4	15.4	15.3	14.7
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_{1984} = Unknown

[1] Commercial only.

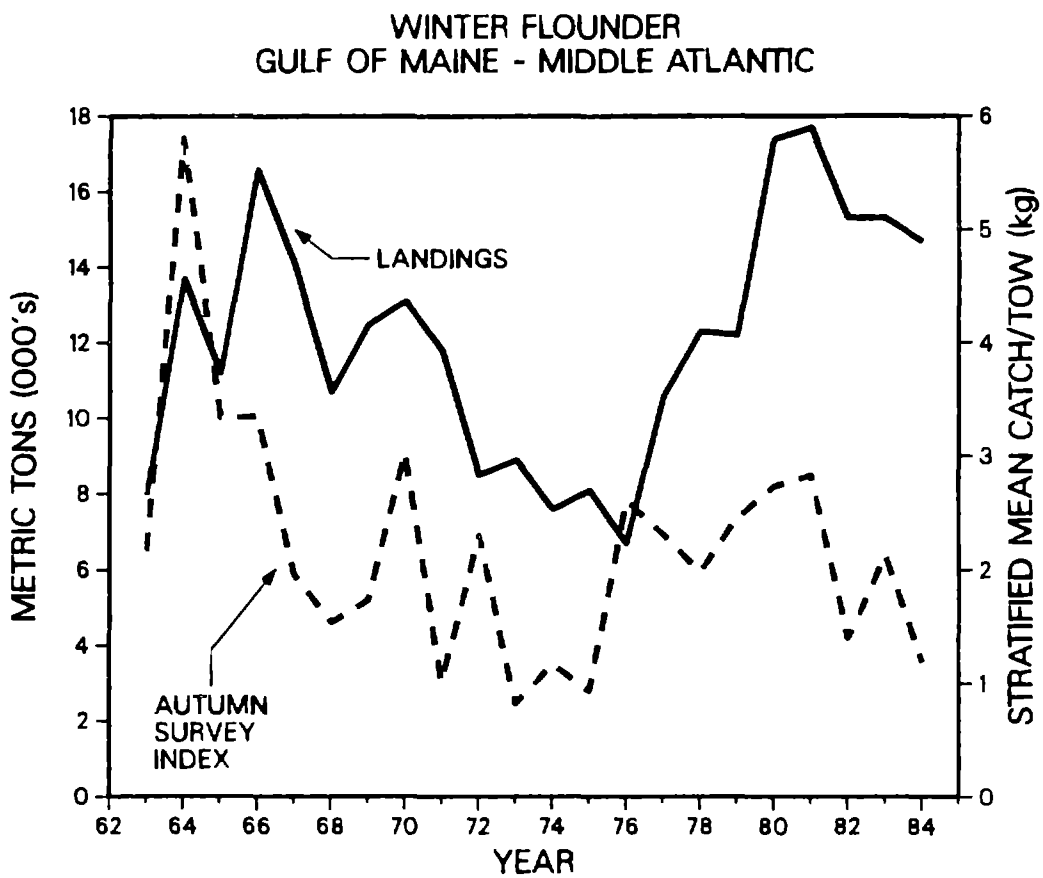


Figure 21. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of winter flounder in the Gulf of Maine - Mid-Atlantic area.

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. 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 1984 estimate was 2,800 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 1974-1984 were fairly steady at around 11,000 mt per year. After increasing to about 11,800 mt between 1980-1982, total estimated catches have declined slightly to 10,600 mt in 1983-1984 (Table 26, Figure 22).

Since the early 1970's, the USA nominal commercial catch has steadily increased and reached a recent peak of 9,800 mt in 1981. The 1983 and 1984 landings were both approximately 7,800 mt, 7% below the average for the past five years. Most of the earlier 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 750 mt per year; the 1984 nominal catch was 700 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. 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. Estimates have not been made for 1984.

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 22). In 1984, the index rose, close to the long term (1967-1984) average. 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 -1984. 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, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational[1]	2.4	2.8	2.5	2.3	3.9	2.0	3.1	2.8	2.8
Commercial									
USA	6.2	8.3	8.9	8.0	7.9	9.8	8.7	7.8	7.8
Canada	-	-	-	-	-	-	-	-	-
Other	1.0	<0.1	<0.1	-	<0.1	<0.1	-	-	-
Total nominal catch	9.6	11.2	11.4	10.3	11.8	11.8	11.8	10.6	10.6
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_{1984} = 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 1983-1984 determined by applying the 1982 ratio to commercial catches.

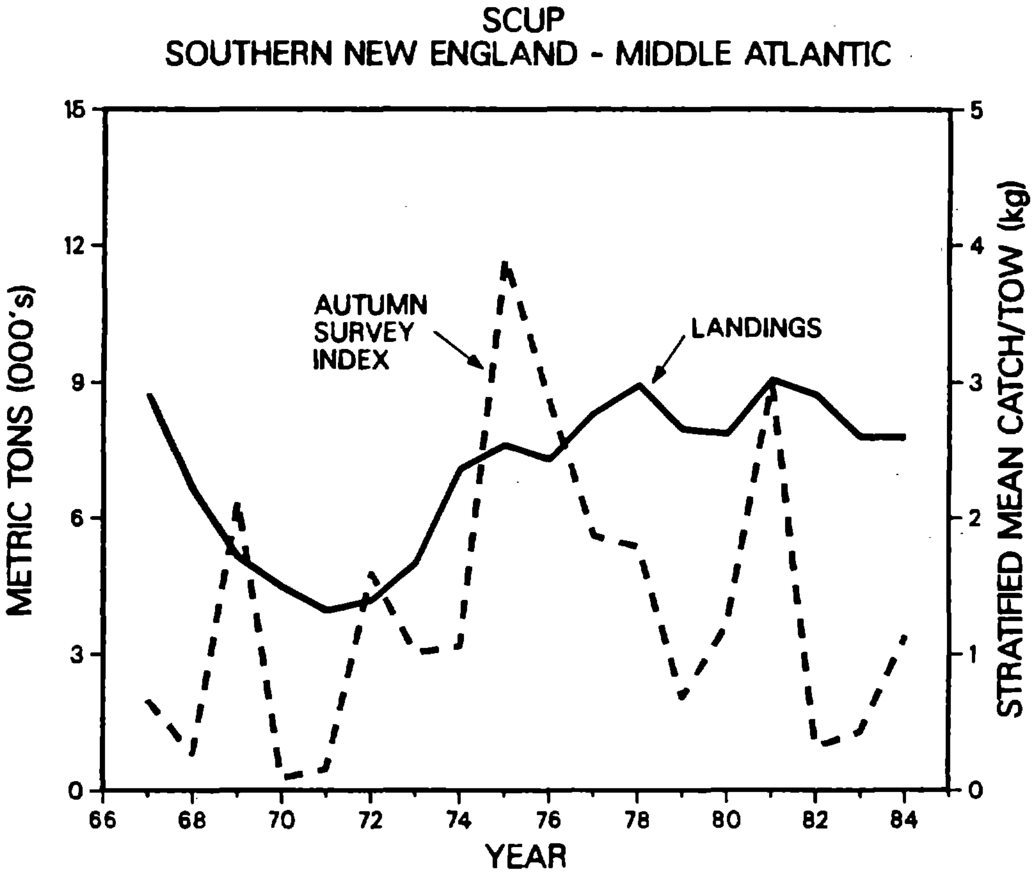


Figure 22. Total commercial and recreational landings and stock biomass indices from NEFC autumn bottom trawl surveys of scup in the southern New England - Mid-Atlantic area.

OCEAN POUT

The ocean pout (Macrozoarces americanus) is a demersal eel-like species ranging from Labrador to Delaware which attains lengths of up to 98 cm (39 in) and weights of 5.3 kg (14.2 lb). Ocean pout prefer depths of 15 to 80 meters and temperatures of 6° to 7°C. Tagging studies indicate that ocean pout do not undertake extensive migrations, but rather move seasonally to different substrates. During winter and spring, ocean pout feed over sand or sand-gravel bottom and are vulnerable to otter trawl fisheries. In summer ocean pout stop feeding and move to rocky areas, where they spawn in September and October. The demersal eggs are guarded by both parents until hatching. During this period ocean pout are not available to commercial fishing operations. Catches typically increase again when adults return to their feeding grounds in late autumn and winter. The diet consists primarily of invertebrates: brittle stars, sand dollars, sea urchins, and bivalves, with fish being only a minor component. Stock identification studies suggest the existence of two stocks: one occupying the Bay of Fundy area and the northern Gulf of Maine east of Cape Elizabeth, and a second stock ranging from Cape Cod Bay south to Delaware. This southern stock is characterized by faster growth rates, and, to date, has supported the commercial fishery.

Commercial interest in ocean pout has fluctuated widely. Ocean pout were marketed as a food fish during World War II, and landings peaked at 4,500 metric tons in 1943. However, an outbreak of a protozoan parasite which caused lesions eliminated consumer demand for ocean pout as a food item. From 1964 to 1974, an industrial fishery developed, and nominal catches for the USA averaged 4,700 mt during these years (Table 27, Figure 23). Soviet vessels began harvesting ocean pout in large quantities in 1966 with nominal catches peaking at 27,000 mt in 1969. Foreign catches subsequently declined substantially and none have been reported since 1974. USA nominal catches declined to an average of 560 mt annually from 1975 to 1983; however, catches increased to 1324 mt in 1984 largely due to the development of a small directed fishery in Cape Cod Bay supplying the fresh fillet market.

Due to the ocean pout's pattern of seasonal distribution, the NEFC spring survey index is more useful in evaluating relative abundance. From 1968 to 1975 (encompassing peak levels of foreign fishing and the domestic industrial fishery), commercial landings and NEFC spring survey indices followed similar trends; both declined from historic high values (27,000 mt and 6.15 kg/tow) in 1969 to lows of 277 mt and 1.34 kg/tow, respectively, by 1975 (Figure 23). Since 1975, relative abundance has steadily increased. Above-average recruitment appears to have occurred in 1978, 1980, and 1981, and the average weight of an ocean pout caught in NEFC spring surveys has increased from 0.29 kg in 1978 to 0.75 kg in 1985. With relative abundance near an historic high level, it would appear that catches of 3,000-4,000 mt are sustainable for the next several years.

For further information see:

Olsen, Y.H., and Merriman, D. 1946. Studies on the marine resources of southern New England, IV. The Biololgy and Economic Importance of the ocean pout, Macrozoarces americanus (Bloch and Schneider). Bull Bingham Oceanogr. Collec. 9:1-184.

Orach-Meza, F.L. 1975. Distribution and abundance of ocean pout, *Macrozoarces americanus* (Bloch and Schneider) in the western North Atlantic Ocean. MS Thesis. Kingston, RI: Unv. Rhode Island.

Table 27. Nominal catches (thousand metric tons) and management information for ocean pout from middle Atlantic - southern New England area, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	1.9	1.0	1.0	0.7	0.4	0.3	0.3	0.4	1.3
Canada	-	-	-	-	-	-	-	-	-
Other	0.9	-	-	-	-	-	-	-	-
Total nominal catch	2.8	1.0	1.0	0.7	0.4	0.3	0.3	0.4	1.3
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 = Unknown
Size at 50% maturity = Unknown

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1984} = Unknown

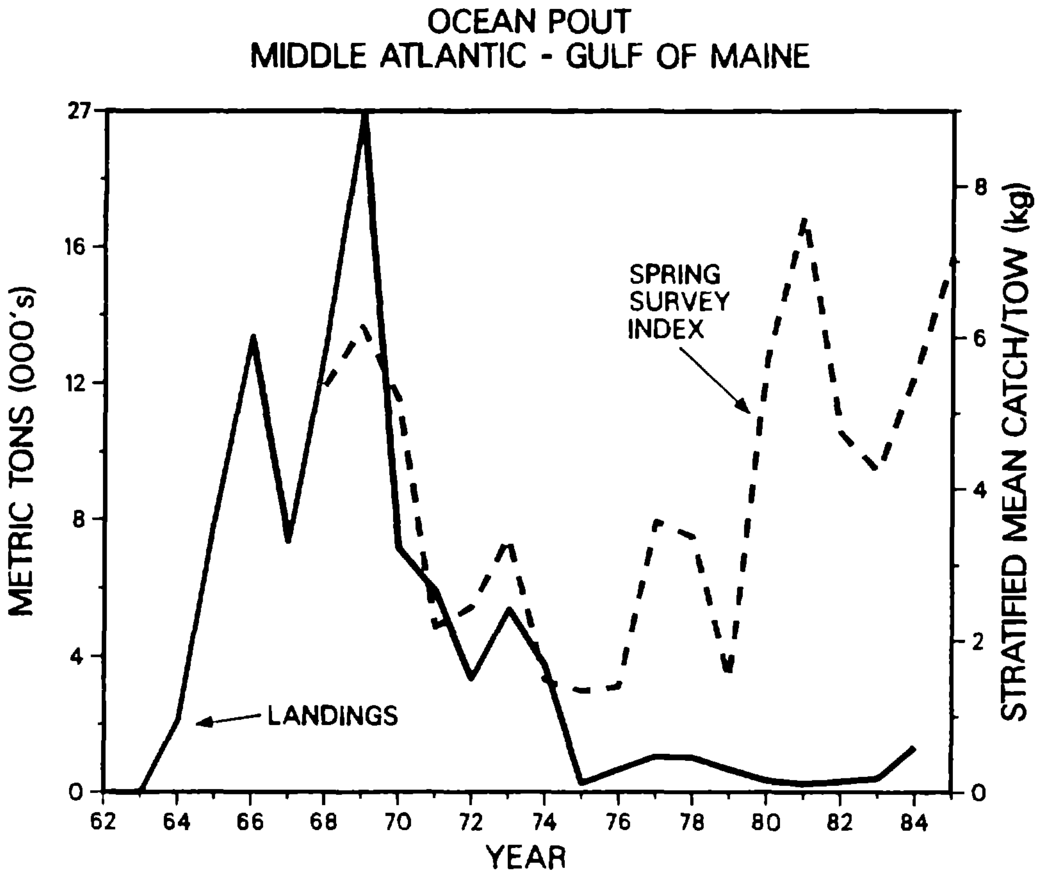


Figure 23. Total commercial landings and stock biomass indices from NEFC spring bottom trawl surveys of ocean pout in the Mid-Atlantic - Gulf of Maine area.

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. Depth distribution varies by age and season; juveniles typically occupy shallower areas than adults, but individuals of all ages tend to move inshore or shoalward in spring and summer, dispersing to deeper areas in autumn. Most trawl catches are taken at depths of 110 m (60 fathoms) or more, although they are taken as shallow as 27 m (15 fathoms) during gillnetting operations in summertime.

Much remains to be learned about the biology of this species. In the Gulf of Maine region, spawning occurs in winter and spring although the season is not clearly defined. Little is known about growth or maturation rates. White hake attain total lengths of 135 cm (53 inches) and weights of up to 21 kg (46 pounds) with females being larger. Ages of over 20 years have been documented in the Gulf of Maine. Juveniles feed primarily upon shrimp and other crustaceans, but fish become more important with approaching maturity and adults feed almost exclusively on other fish, including juveniles of their own species.

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. Since 1968, USA vessels have accounted for approximately 94% of the Gulf of Maine - Georges Bank white hake catch. Total nominal catch averaged 4,500 mt during 1971-1980, but has since increased steadily to over 7,500 mt in 1984 (Table 28, Figure 24). This increase appears to reflect both a general increase in incidental catches associated with recent increases in size and total fishing power of the New England otter trawl fleet as well as an increase in directed effort. 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.

During the 1970's, the NEFC autumn survey index fluctuated without a definite trend, although values have declined somewhat in more recent years (Figure 24). NEFC spring survey catches have also declined sharply since 1981. These results, together with recent increases in nominal catch, indicate declining abundance and increased fishing mortality in recent years. It appears unlikely that current harvest levels (of 7,000 tons or more) will be sustainable over the long term.

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.

Burnett, J., S.H. Clark and L. O'Brien. 1984. A preliminary assessment of white hake in the Gulf of Maine-Georges Bank area. NMFS, NEFC Woods Hole Lab. Ref. Doc. No. 84-31, 33 p.

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

Table 28. Nominal catches (thousand metric tons) and management information for white hake from the Gulf of Maine - Georges Bank area, 1972-1984.

Category	Year 1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial									
USA	4.1	5.3	5.1	4.1	4.8	5.7	6.0	6.2	6.5
Canada	0.1	0.2	0.2	0.3	0.3	0.5	0.8	0.8	1.0
Other	<0.1	0.2	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1
Total nominal catch	4.2	5.7	5.3	4.4	5.1	6.2	6.8	7.0	7.5
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = 5.0
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_{1984} = Unknown

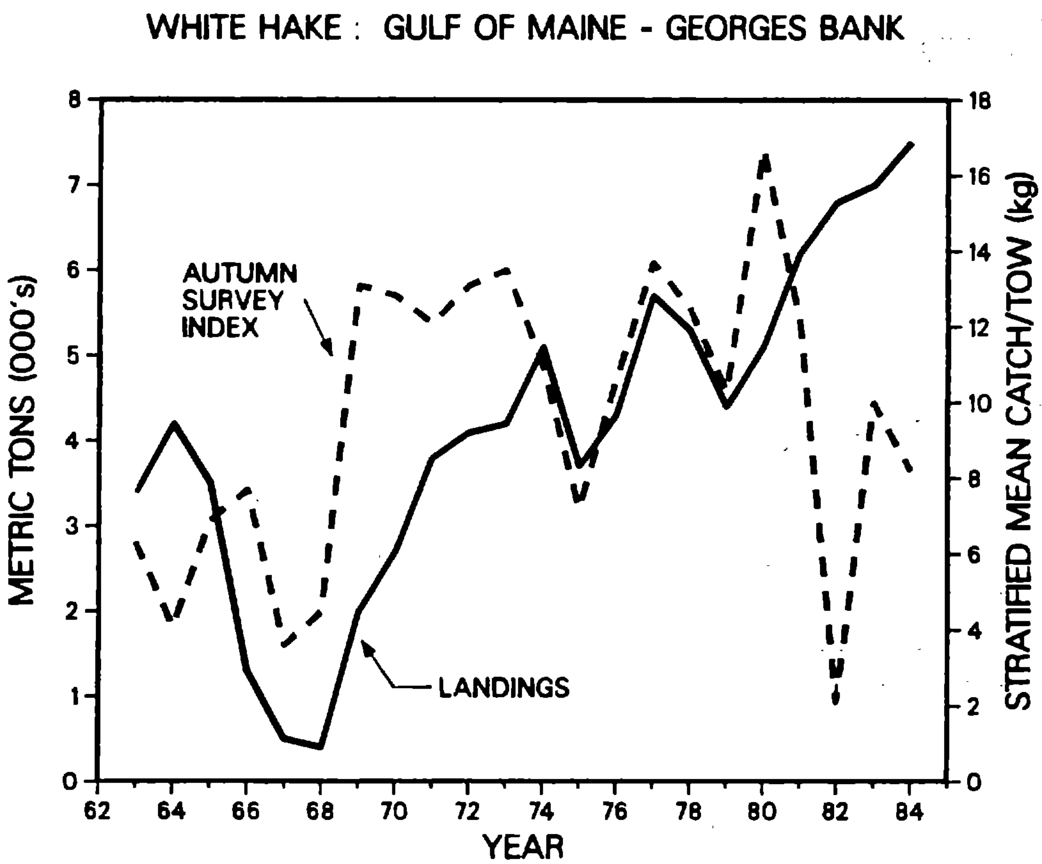


Figure 24. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of white hake in the Gulf of Maine - Georges Bank area.

CUSK

The cusk (Brosme brosme) is a deepwater species which is found in rocky, hard bottom areas throughout the Gulf of Maine. 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 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, most recent surveys indicate annual recreational catches of less than 50 mt. The total nominal catch for the Georges Bank - 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 29, Figure 25). Landings have since declined to approximately 2,200 mt.

NEFC spring and autumn survey indices have fluctuated considerably, and in recent years no consistent trends have been evident. The autumn 1984 survey index value was comparable to the long-term average (Figure 25) and the spring survey index, which had been declining since 1981, increased sharply in 1985.

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 cusk from the Gulf of Maine - Georges Bank area, 1972-1984.

Category	Year 1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1
Commercial									
USA	1.2	1.2	1.5	1.7	1.8	1.8	1.8	1.8	1.7
Canada	0.5	0.2	0.4	0.5	0.6	2.1	1.2	0.6	0.5
Other	<0.1	-	-	-	-	-	-	-	-
Total nominal catch	1.7	1.4	1.9	2.2	2.4	3.9	3.1	2.4	2.2
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = Unknown
Importance of recreational fishery = Insignificant
Status of management = None
Status of exploitation = Unknown
Age at 50% maturity = Unknown
Size at 50% maturity = Unknown

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1984} = Unknown

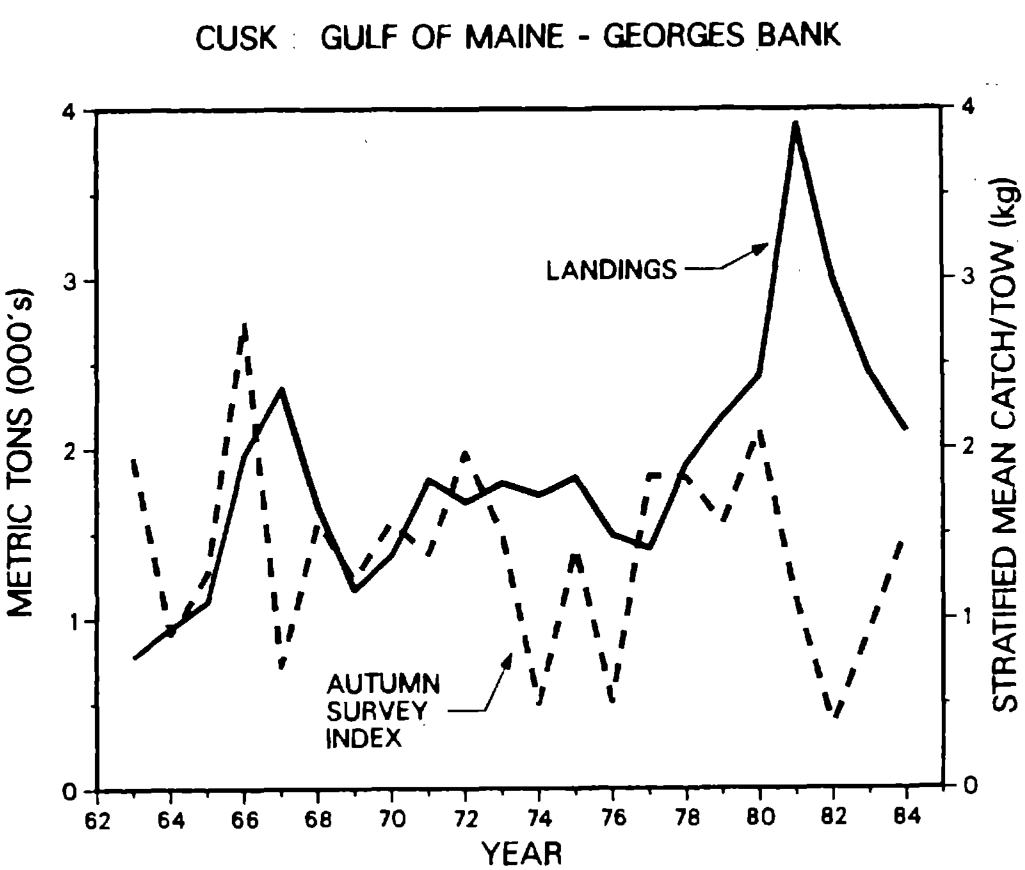


Figure 25. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of cusk in the Gulf of Maine - Georges Bank area.

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 shellfish predators.

Wolffish have been taken primarily as by-catch, although the species may also be an intended component 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 have been minor. The total Georges Bank-Gulf of Maine nominal catch increased from 170 mt in 1970 to an average of nearly 1,300 mt in 1983-1984 (Table 30, Figure 26). The NEFC spring survey index has fluctuated considerably while exhibiting a downward trend in recent years (Figure 26), 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 30. Nominal catches (thousand metric tons) and management information for Atlantic wolffish from the Gulf of Maine - Georges Bank area, 1972-1984.

Category	Year 1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
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	0.6	0.7	0.9	0.7	0.9	1.2	1.0
Canada	<0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1
Other	0.1	-	-	-	-	-	-	-	-
Total nominal catch	0.4	0.5	0.8	0.8	1.0	0.8	1.1	1.3	1.1
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_{1984} = Unknown

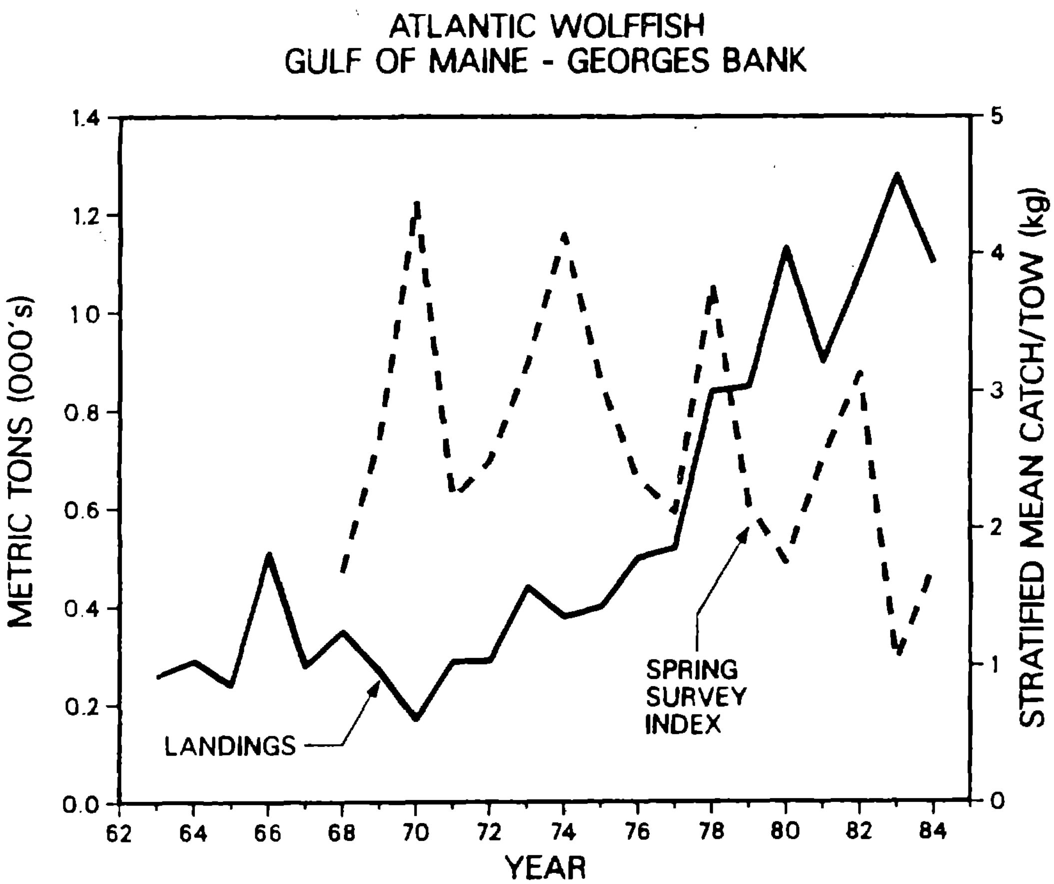


Figure 26. Total commercial landings and stock biomass indices from NEFC spring bottom trawl surveys of Atlantic wolffish in the Gulf of Maine - Georges Bank area.

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 31, Figure 27). Catches declined steadily to about 3,400 mt in 1981 and to approximately 1,800 mt in 1983, with a slight increase to about 1,900 mt in 1984.

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 1981-1984. 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 27). Estimates of fishing effort and CPUE have not been analyzed for 1984, but are thought to have not changed much from 1983. In the last several years, the fishery has only been conducted during winter-spring, with the participating vessels switching to swordfish and tuna during summer-autumn. In the last year or two, there has also been a shift to a more efficient type of longline gear, which may have resulted in a slight increase in effective fishing effort.

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. F in 1984 is unknown, but probably similar to that estimated for 1982 and 1983. 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 effort in 1982-1983.

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 and subsequent years 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 decreased substantially in response to the excessive levels of fishing mortality exerted since the late 1970's. Average size of fish caught also declined during this time and continued to remain low in 1984. This stock continues to be overexploited.

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 31. Nominal catches (thousand metric tons) and management information for tilefish from the Georges Bank - Mid-Atlantic area, 1972-1984.

Category	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial									
USA	0.6	2.1	3.4	3.8	3.7	3.4	2.0	1.8	1.9
Canada	-	-	-	-	-	-	-	-	-
Other	0.3	0.3	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total nominal catch	0.9	2.4	3.6	3.9	3.7	3.4	2.0	1.8	1.9
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_{1984} = Unknown

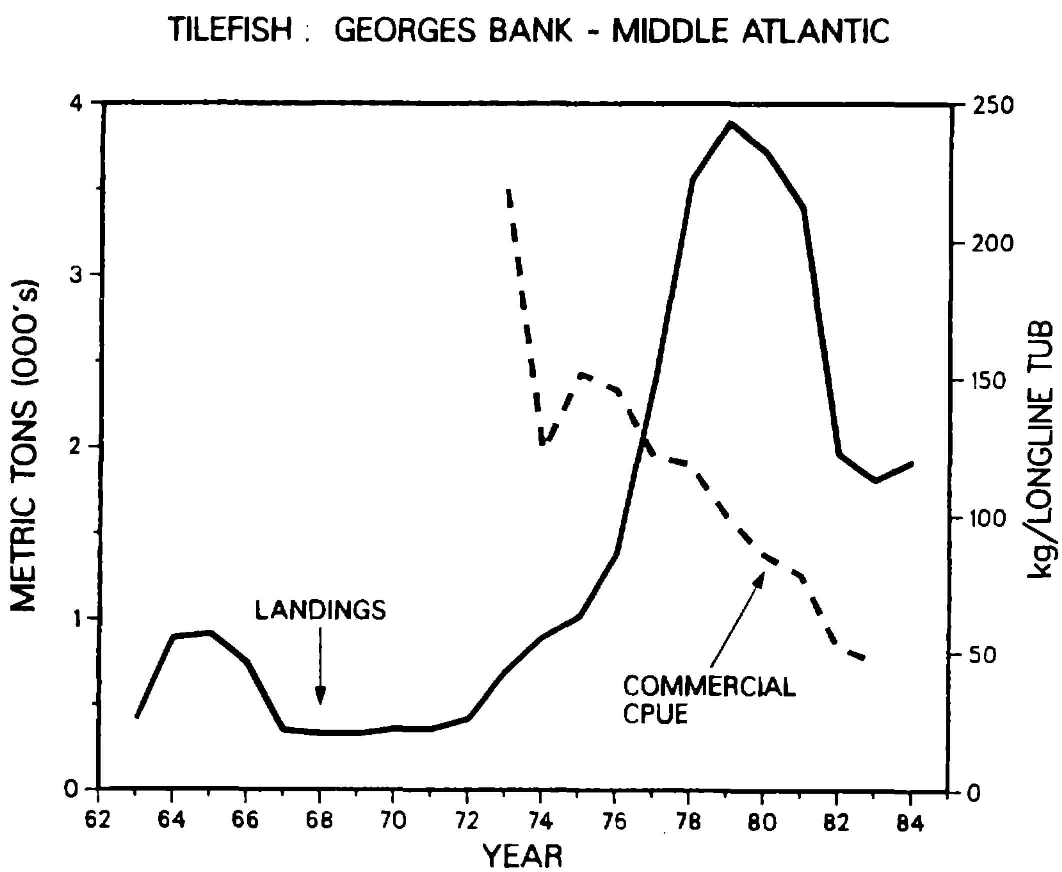


Figure 27. Total commercial landings and catch per unit effort of tilefish in the Georges Bank - Mid-Atlantic area.

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 average nominal catch level declined to 21,097 mt; the 1984 nominal catch was 19,512 mt. The reduction noted during recent years 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 1984 NEFC spring survey index indicated a slight recovery in 1984 relative to 1982-83 levels. Prospects for the coastal fisheries may be improved in 1985 based on a State of Massachusetts estuarine survey which indicated that estimated abundance of brit herring (1 year old) was among the highest on record. A larval herring sampling program conducted by the State of Maine also indicated prospects for some recovery in 1985.

The 1984 nominal catch of 12,255 mt in the western Gulf of Maine (Jeffreys Ledge) mobile gear fishery represented a marked increase relative to the 1982-83 level of 5,972 mt, but remained well below the 1975-80 mean level of 22,895 mt. The fishery was primarily dependent on the 1979-81 year classes during 1984. Due to declines in export markets in recent years with recovery of the North Sea fishery, a significant proportion of the adult herring catch has not been used for human consumption.

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 28). 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 32.

Table 32. Nominal catches (thousand metric tons) and management information for Atlantic herring from the Gulf of Maine (coastal Maine and the western Gulf of Maine), 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	43.8	50.2	48.4	63.7	82.1	63.6	31.7	22.5	31.1
Canada	8.0	0.9	-	-	-	-	-	-	-
Other	5.4	-	-	-	-	-	-	-	-
Total nominal catch[1]	57.2	51.1	48.4	63.7	82.1	63.6	31.7	22.5	31.1
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 $F_{1984} = 0.40$

[1]Age groups 1 and older.

[2]Age groups 3 and older.

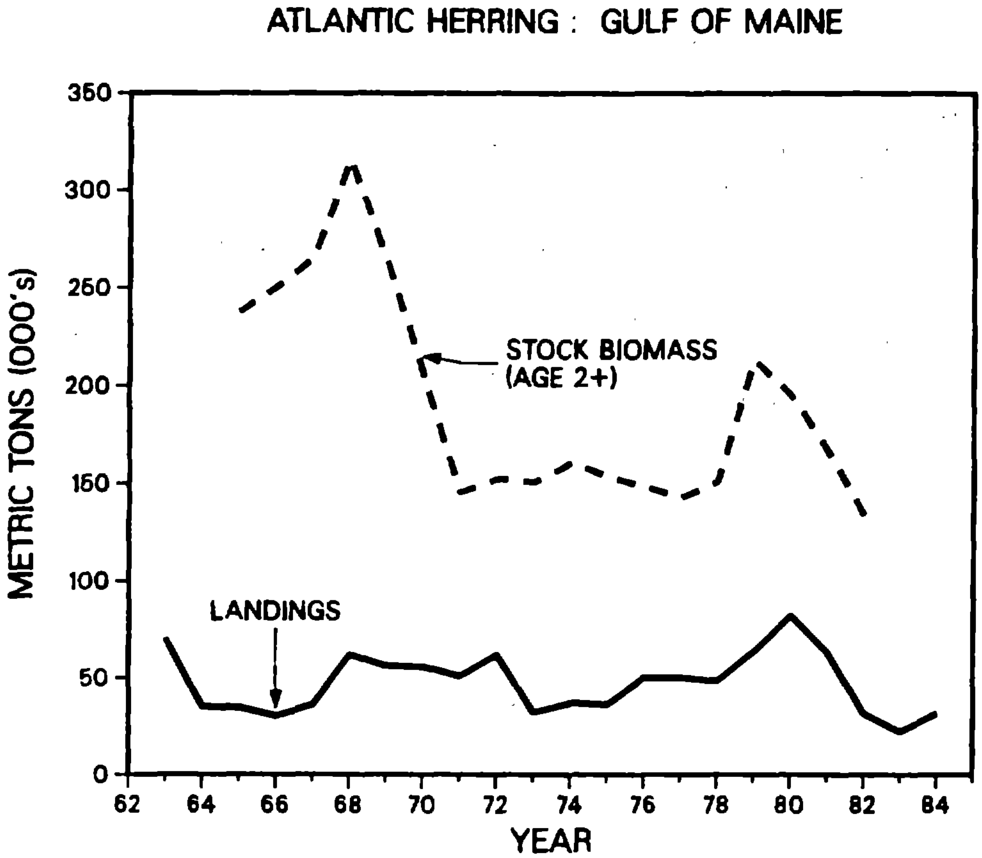


Figure 28. Total commercial landings and estimates of stock biomass of Atlantic herring in the Gulf of Maine.

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 33.

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 33. Nominal catches (thousand metric tons) and management information for Atlantic herring from the Georges Bank area[1], 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	3.8	0.7	0.4	2.1	1.1	1.7	0.7	1.0	1.6
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	1.6
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 $F_{1984} = <0.01$

[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 increased from 32,556 mt in 1983 to 37,600 mt in 1984 (Table 34). Catches remained fairly stable during 1978-1984, averaging 32,800 mt annually, and were taken largely by Canadian and USA fishermen. The increase in 1984 was due primarily to joint ventures in USA waters. 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 29).

The USA accounted for 20% of the 1984 international catch, including about 4,400 mt commercial and an estimated 3,000 mt recreational, a slight increase from 1983. The Canadian catch declined from 19,785 mt in 1983 to about 14,400 mt in 1984, 38% of the total. The distant-water-fleet catch increased from about 6,000 mt in 1983 to 15,800 mt in 1984. About 5,500 mt of the 1984 catch was taken by Poland in a research fishery with the NEFC.

Fish from the 1981 year class (age 2) comprised 26% of the international catch in numbers in 1983. The 1974 year class (age 9) with 19% and the 1978 year class (age 5) with 13%, were also important contributors to the 1983 international catch. The 1983 Canadian catch consisted of 24% age 9 and 15% age 5 fish. The USA commercial catch was 63% 1981 year-class fish (age 2) followed by 7% 1982 year-class fish and 7% 1974 year-class fish. The distant-water-fleet catch in 1983 (principally Polish) consisted primarily of the 1981 (33%) and 1974 (17%) year classes. A January-April 1984 Polish research catch of about 5,500 mt was comprised mainly of the 1982 (32%) and 1981 (28%) year classes.

The catch-per-tow indices for mackerel from the NEFC spring and autumn bottom trawl surveys increased sharply from 1983 to 1984. USA commercial catch-per-day for ages 4 and older increased slightly from 1982 to 1983 reflecting the steady increase in biomass of age 4 and older fish.

Fishing mortality (F) at ages 3 and older in 1983 was estimated to be 0.06; 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 1983. Results of this analysis indicated a dome-shaped pattern increasing from 2% at age 1 to 268% at age 9 and decreasing to 50% at age 13. 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 0.59 in 1976 and then dropped to an average of 0.08 during 1978-1982 and to 0.06 in 1983. The catch of 37,700 mt in 1984 generated an estimated F of 0.05. $F_{0.1}$ for mackerel at the current pattern of exploitation in the fishery is 0.29.

The 1975-1979 year classes were all weak. Year classes beginning with the 1980 cohort have been much stronger (except for the apparently weak 1983 year class), particularly the 1982 year class, which is the strongest to appear since 1969.

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 a stable low level during 1977-1981 which averaged 485,000 mt per year (Figure 29). The total stock increased to about 1,200,000 mt at the beginning of 1985. Spawning stock biomass (50% of age 2 fish and 100% of ages 3 and older) increased from about 400,000 mt in 1981 to an estimated 1,000,000 mt at the start of 1985.

Rebuilding of the mackerel stock has been aided by relatively low catches during 1978-1984 (average of 32,800 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 1985 can be increased substantially without adversely affecting the spawning stock biomass. Management measures recommended by the Mid-Atlantic Fishery Management Council for the 1 April 1985 - 31 March 1986 fishing year include an OY (USA waters only) of 225,300 mt, a DAH of 123,200 mt, a TALFF of 51,050 mt, and a Reserve of 51,050 mt. These recommendations are based on a projected catch of 270,300 mt for the total international mackerel fishery in the Northwest Atlantic resulting from fishing mortality at $F_{0.1} = 0.29$.

For further information see:

Anderson, E.D. 1984. Status of the Northwest Atlantic mackerel stock - 1984. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 85-03, 46 p.

Table 34. Nominal catches (thousand metric tons) and management information for Atlantic mackerel from Labrador to North Carolina, 1972-1984.

Category	Year: 1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	8.7	0.5	6.6	3.7	2.4	5.1	1.1	3.0	3.0
Commercial									
USA	1.8	1.4	1.6	2.0	2.7	2.9	3.3	3.8	4.4
Canada	16.8	20.4	25.4	30.2	22.1	19.3	16.4	19.8	14.4
Other	321.0	56.1	0.8	0.4	0.6	5.4	6.6	6.0	15.8
Total nominal catch	348.3	78.9	34.4	36.4	27.8	32.6	27.5	32.6	37.6
Total allowable catch[1,2]	-	105.0	15.5	15.5	30.0	30.0	30.0	101.7	87.0

Long-term potential catch = 134.0[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

$M = 0.20$ $F_{0.1} = 0.29$ $F_{max} = 0.62$ $F_{1984} = 0.05$

[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 1961-1984 year classes and fishing mortality at $F_{0.1}$.

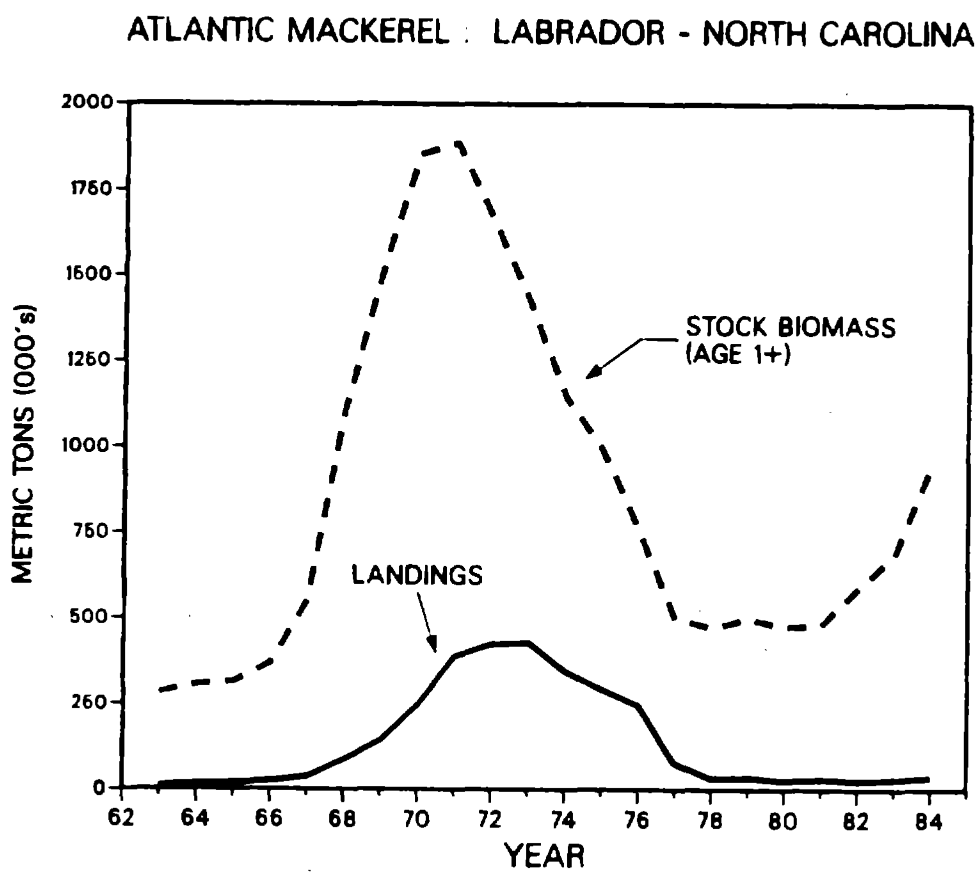


Figure 29. Total commercial and recreational landings and estimates of stock biomass of Atlantic mackerel in the Labrador - North Carolina area.

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 increased 127% from 5,466 mt in 1983 to 12,425 mt in 1984 (Table 35, Figure 30). 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 increased from 4,905 mt in 1983 to a record high of 11,993 mt in 1984. Increased USA landings in 1984 were due to a strong export market and the development of a new "supersmall" market category in response to an abundance of small butterfish. The DWF nominal catch declined from 561 mt in 1983 to 432 mt in 1984, representing the third consecutive yearly decline in DWF catches.

During 1984, discards by USA trawlers averaged 30% by weight of the landed catch. Due to the high abundance of small fish, traditional at-sea sorting practices were abandoned by many domestic vessels in favor of having the catch culled at shore-based processing plants. Therefore, in addition to undersize fish, the 1984 discards also included blemished marketable size fish. Furthermore, to reduce the operating costs for icing and transporting undersize fish, some vessels installed culling machines. These shakers allow vessels to profitably fish in areas of high abundance of small butterfish.

The catch-per-tow index (all ages) from the NEFC 1984 autumn bottom trawl survey (11.6 kg) declined 9% from 1983 (Figure 30). Likewise, the recruitment index (number per tow at age 0) from the 1984 autumn survey (269) declined 25% for the record high 1983 index (359). Although the recruitment index declined in 1984, it was slightly above the strong indices observed in 1979 (232), 1980 (233) and 1981 (235).

The 1984 autumn survey recruitment and biomass indices were greater than values observed during 1973-1976 when nominal catches from the international fishery were high (11,200-19,500 mt). This suggests that sufficient fish are available to support a catch up to the maximum (16,000 mt) currently allowed by the FMP. However, continued high rates of discard can be expected to have an adverse effect on the fishery and the stock. Since butterfish have a short life span (about 4 years) and a relatively high natural mortality rate (M = 0.8), delaying the age of first harvest from age 0 to an older age does not lead to higher yields, as would be the case for longer-lived species with lower natural mortality rates. One benefit from delaying capture would be that a larger fish would probably command a higher price per pound to the fishermen. However, if age 0 fish were not caught, stock biomass, on average, would be nearly 25% higher than with present levels of fishing mortality of age 0 fish. An increased stock will improve spawning potential, hopefully ensure a higher probability of producing good recruitment, and provide a buffer to help support the fishery in the event of poor recruitment.

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 35. Nominal catches (thousand metric tons) and management information for butterfish from the Gulf of Maine - Mid-Atlantic area, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	1.7	1.4	3.7	2.8	5.4	4.9	9.1	4.9	12.0
Canada	-	-	-	-	-	-	-	-	-
Other	9.9	3.2	1.3	0.8	0.9	0.9	0.8	0.6	0.4
Total nominal catch	11.6	4.7	5.0	3.7	6.3	5.8	9.7	5.5	12.4
Total allowable catch	-	18.0	18.0	18.0	11.0[1]	11.0[1]	11.0[1]	11.0[1]	≤16.0[2]

Long-term potential catch = 16.0
Importance of recreational fishery = Insignificant
Status of management = FMP in force since 1979
Status of exploitation = Becoming fully exploited
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_{1984} = Unknown

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

[2]Maximum sustainable yield

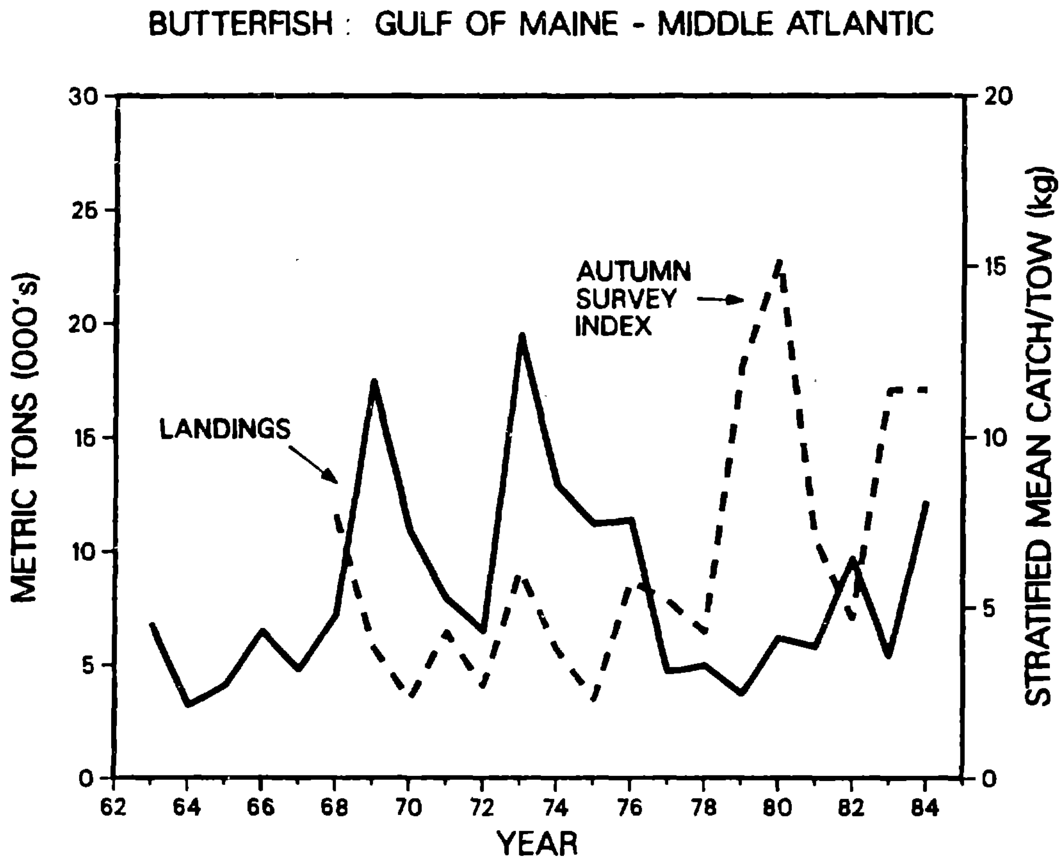


Figure 30. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of butterfish in the Gulf of Maine - Mid-Atlantic area.

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 36, Figure 31). 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 5,500 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 31).

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 36. Nominal catches (thousand metric tons) and management information for bluefish from the Atlantic coast (Maine-Florida), 1972-1984.

Category	Year 1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	NA[1]	NA	NA	62.3	67.5	55.9	47.3	NA	NA
Commercial									
USA	4.2	4.9	4.9	5.6	6.5	7.2	7.4	5.5	4.2[2]
Canada	-	-	-	-	-	-	-	-	-
Other	0.1	<0.1	-	-	<0.1	-	-	-	-
Total nominal catch	-	-	-	67.9	74.0	63.1	54.7	-	-
Total allowable catch	-	-	-	-	-	-	-	-	-

Long-term potential catch = Incomplete
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_{1984} = Unknown

[1]Not available

[2]Preliminary

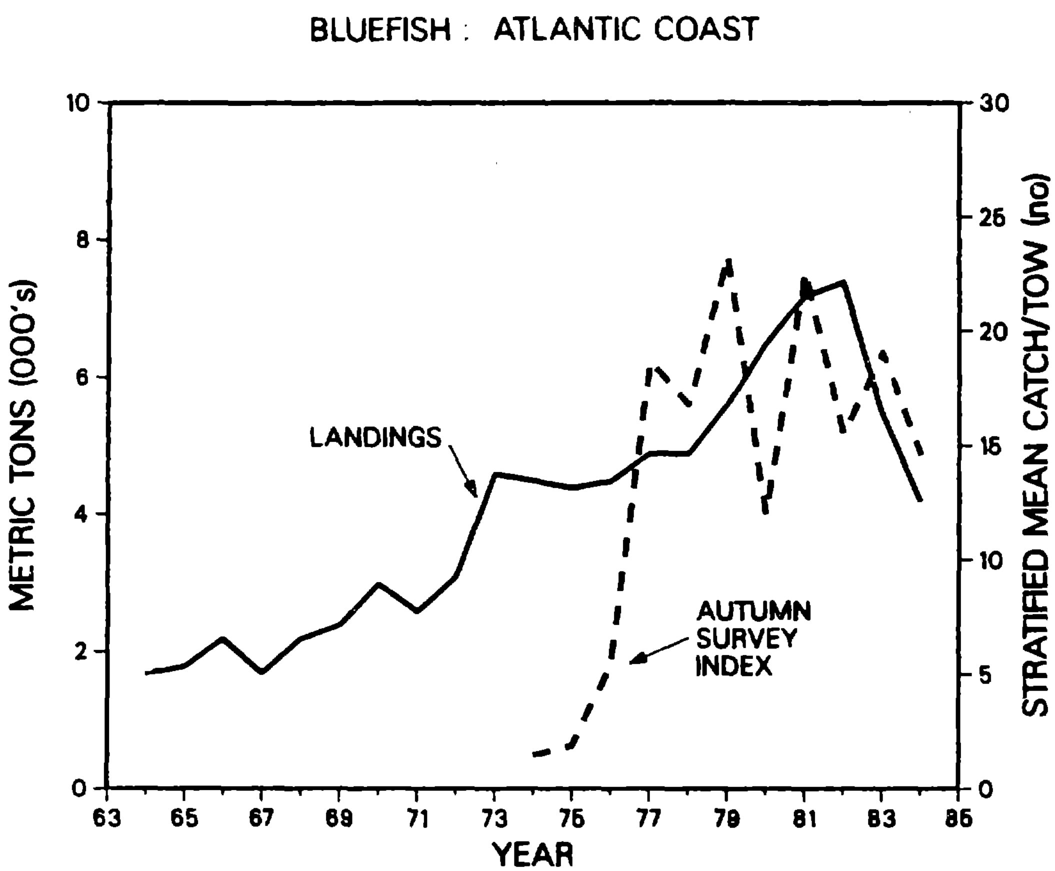


Figure 31. Total commercial landings and recruitment indices from NEFC autumn bottom trawl surveys of bluefish along the Atlantic coast.

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 32), 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 37).

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 37. Nominal catches (thousand metric tons) and management information for river herring (alewife and blueback herring) from the Gulf of Maine - Mid-Atlantic area, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	11.5	6.1	5.4	4.2	4.7	3.2	5.7	4.2	4.1
Canada	-	-	-	-	-	-	-	-	-
Other	10.2	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total nominal catch	21.7	6.3	5.4	4.2	4.7	3.2	5.7	4.2	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_{1984} = Unknown

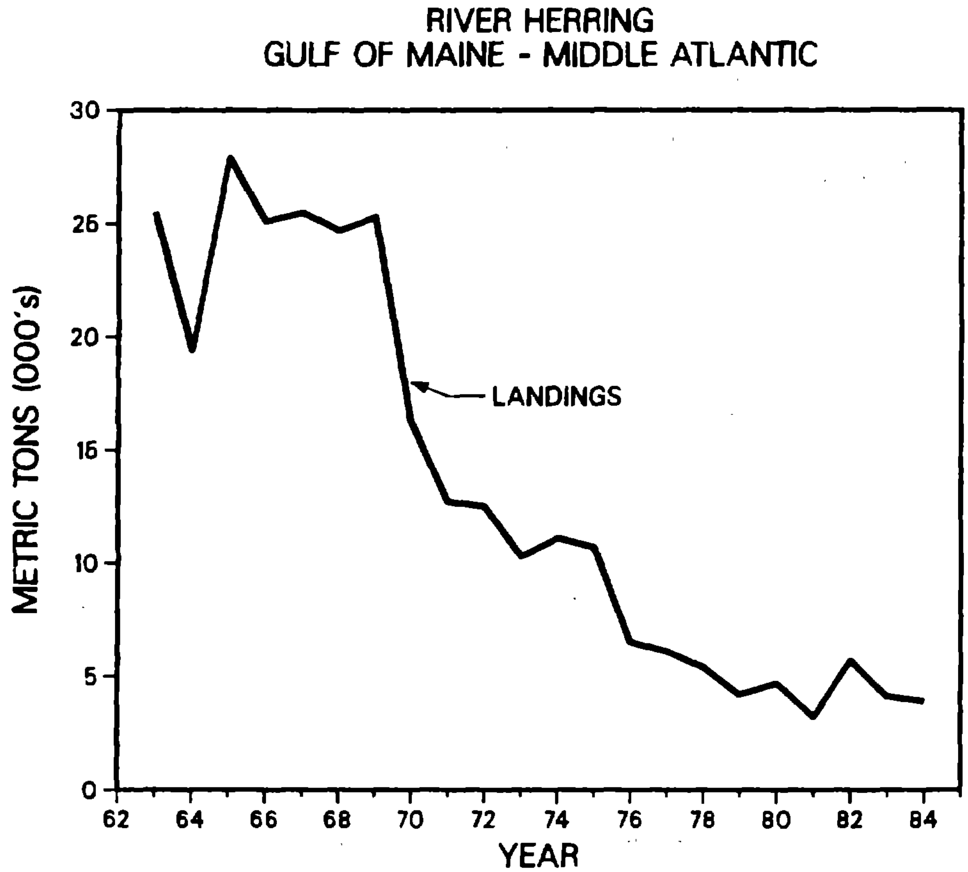


Figure 32. Total commercial landings of river herring (alewife and blueback herring) in the Gulf of Maine - Mid-Atlantic area.

AMERICAN SHAD

The American shad (Alosa sapidissima) is an anadromous member of the family Clupeidae (herrings). Along the Atlantic coast, its range extends from southern Labrador to northern Florida. Virtually every major coastal river along the Atlantic seaboard has, at one time, supported a stock.

American shad 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. Nominal commercial catch reported for states along the Atlantic coast in the 1980's has been the lowest on record (Table 38, Figure 33). Restoration efforts (particularly in the Delaware and Connecticut river systems) are apparently starting to be effective, nominal catch appears to be leveling off.

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 38. Nominal catches (thousand metric tons) and management information for American shad from the Gulf of Maine - Mid-Atlantic area, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	1.5	1.2	1.2	0.8	0.9	0.7	0.9	0.7	1.0
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	1.5	1.2	1.2	0.8	0.9	0.7	0.9	0.7	1.0
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_{1984} = Unknown

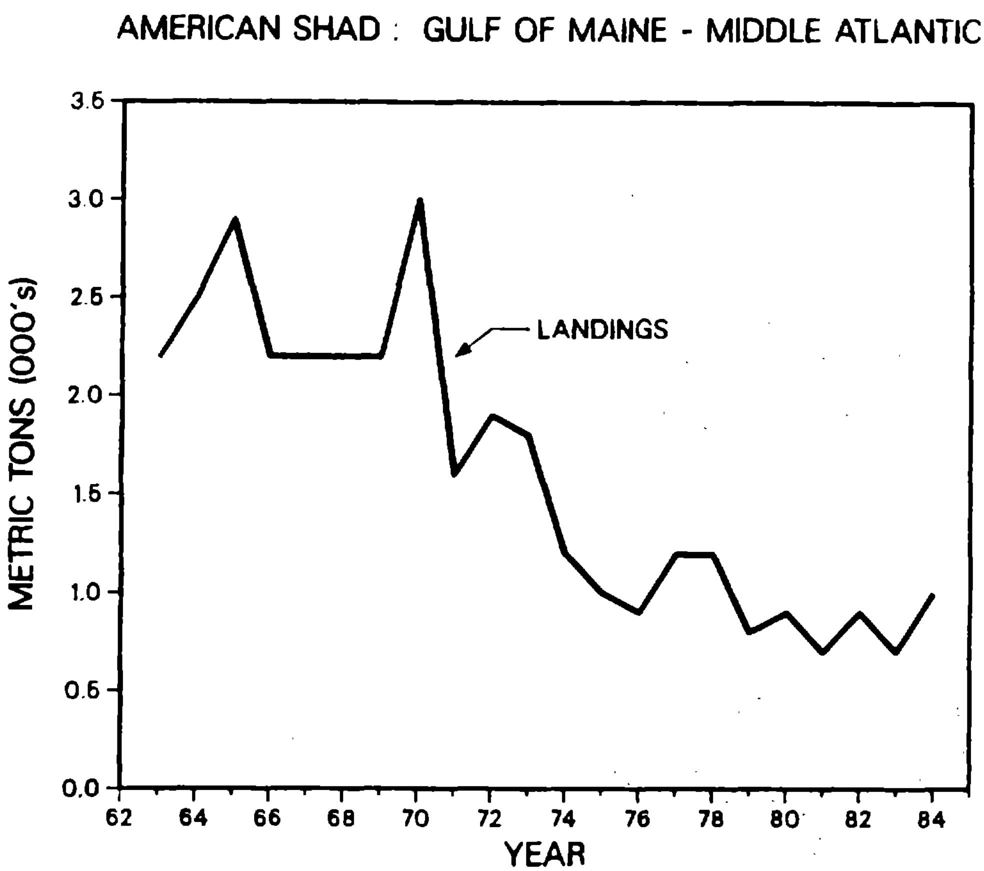


Figure 33. Total commercial landings of American shad in the Gulf of Maine - Mid-Atlantic area.

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.

Reported commercial landings 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 1,519 mt in 1984 (Table 39, Figure 34). The only reported catch by distant-water fleets was 1,494 mt in 1964. The estimated recreational catch has varied from 36% (1979) to 88% (1982) of the total nominal catch in those years for which comparisons are available. Estimated recreational catches also show a downward trend from 5,398 mt in 1960 to 1,531 mt in 1980. The 1982 recreational catch was estimated at 8,440 mt. However, this enormous increase is inconsistent with the available stock abundance indices, and is perhaps attributable to an increase in party/charter boat effort.

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. Trap CPUE rose to 46.85 in 1977 and has since fallen to the most recent (1980) CPUE value of 18.6 kg/trap. NEFC spring offshore bottom trawl survey data indicate an increase in abundance from 1970 (0.3 fish/tow) to 1977 (18.3 fish/tow) followed by a precipitous decline to 0.6 fish/tow in 1984 (Figure 34).

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 39. Nominal catches (thousand metric tons) and management information for black sea bass from the Gulf of Maine - Mid-Atlantic area, 1972-1984.

Category	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	NA[1]	NA	NA	1.0	1.5	1.0	8.4	NA	NA
Commercial									
USA	1.1	2.4	2.1	1.9	1.3	1.1	1.2	1.5	1.5
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	-	-	-	2.9	2.8	2.1	9.6	-	-
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)

$M = 0.3$ $F_{0.1} = 0.2$ $F_{max} = 0.3$ F_{1984} = Unknown

[1]Not available

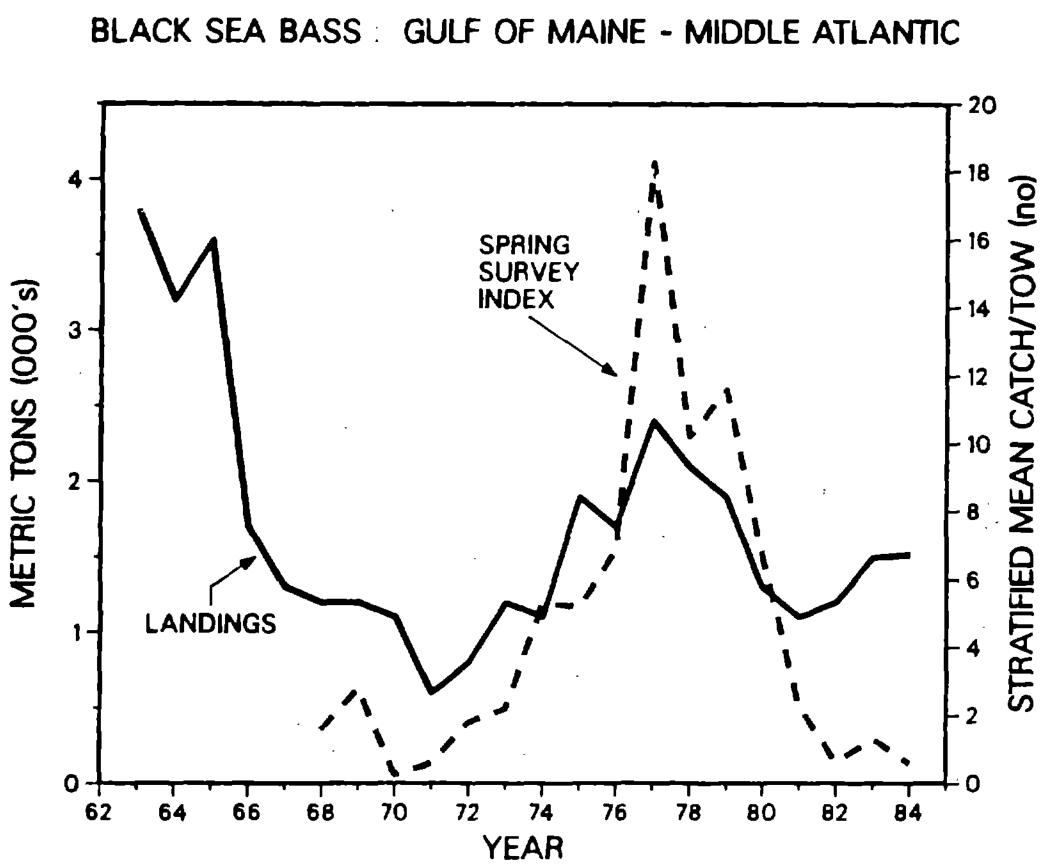


Figure 34. Total commercial landings and stock abundance indices from NEFC spring bottom trawl surveys of black sea bass in the Gulf of Maine - Mid-Atlantic area.

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 35), 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. The 1984 index for the Roanoke River was approximately 50% of the 1983 index, and the 1984 Cheasapeake Bay index was slightly higher than the 1983 index. The Hudson River index was slightly above the long-term average in 1984.

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 40) was the lowest since 1931. The large increase in recreational catch in 1982 was due to an increase in the number of large fish landed in Southern New England waters.

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 recently amended the plan to include an additional 55% reduction in fishing mortality. The ASMFC is also considering raising the minimum size limit to 28 inches (71.1 cm) along the coast.

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. Low pH has recently been implicated as a possible reason for poor production of striped bass in the Maryland eastern shore rivers of the Chesapeake Bay.

Table 40. Nominal catches (thousand metric tons) and management information for striped bass from the Gulf of Maine - Mid-Atlantic area, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	NA	NA	NA	3.8	0.9	0.6	5.9	NA	NA
Commercial									
USA	4.7	2.5	2.1	1.7	2.0	1.8	1.0	0.8	1.2
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	-	-	-	5.5	2.9	2.4	6.9	-	-
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_{1984} = Unknown

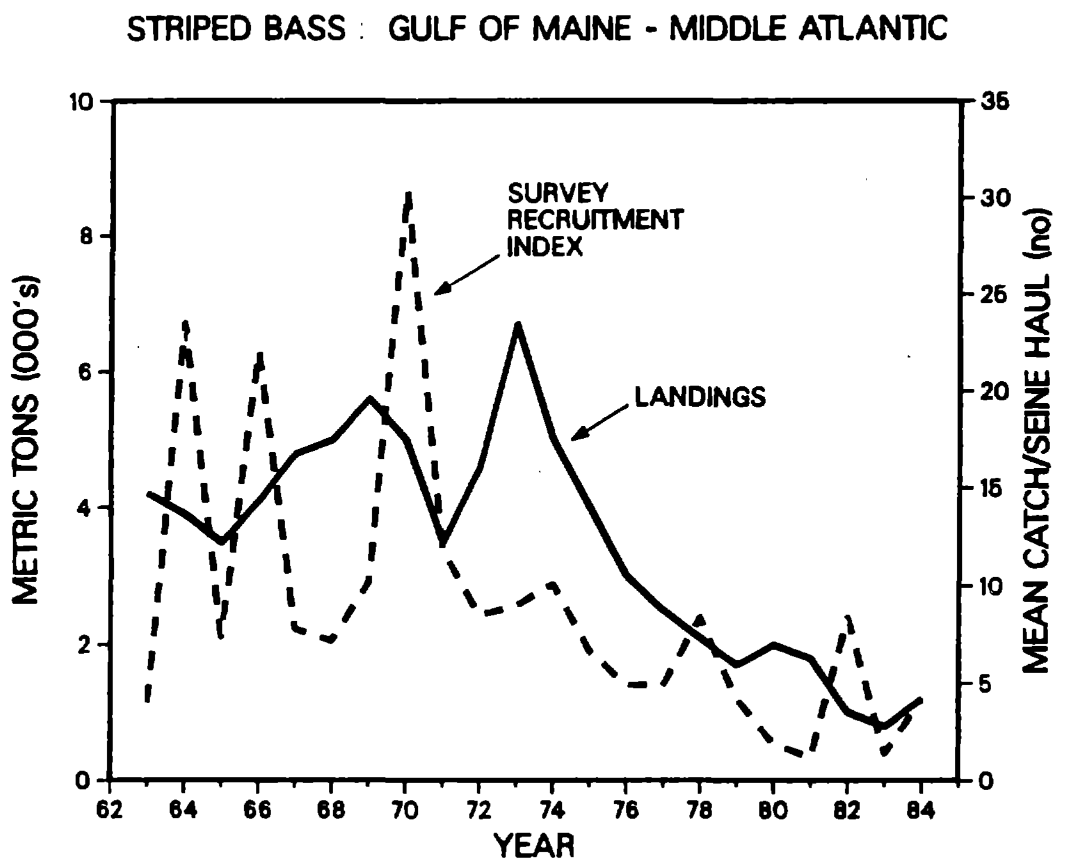


Figure 35. Total commercial landings and recruitment indices (from Maryland seine surveys in Chesapeake Bay) for striped bass in the Gulf of Maine - Mid-Atlantic area.

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 41, Figure 36). Distant-water fleets consistently accounted for virtually all of the reported catches. The reported USA nominal catch declined from 4,900 mt in 1983 to 4,400 mt in 1984, which represents the third consecutive year of declining catches. 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 increased from 229,000 mt in 1983 to 275,000 mt in 1984, slightly above the 1968-1983 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 41. Nominal catches (thousand metric tons) and management information for spiny dogfish from the Gulf of Maine - Mid-Atlantic area, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	0.2	0.5	0.9	4.8	4.2	6.9	6.6	4.9	4.4
Canada	-	-	-	-	-	-	-	-	-
Other	16.9	6.5	0.6	-	0.2	0.3	0.4	-	-
Total nominal catch	17.1	7.0	1.5	4.8	4.4	7.2	7.0	4.9	4.4
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_{1984} = Unknown

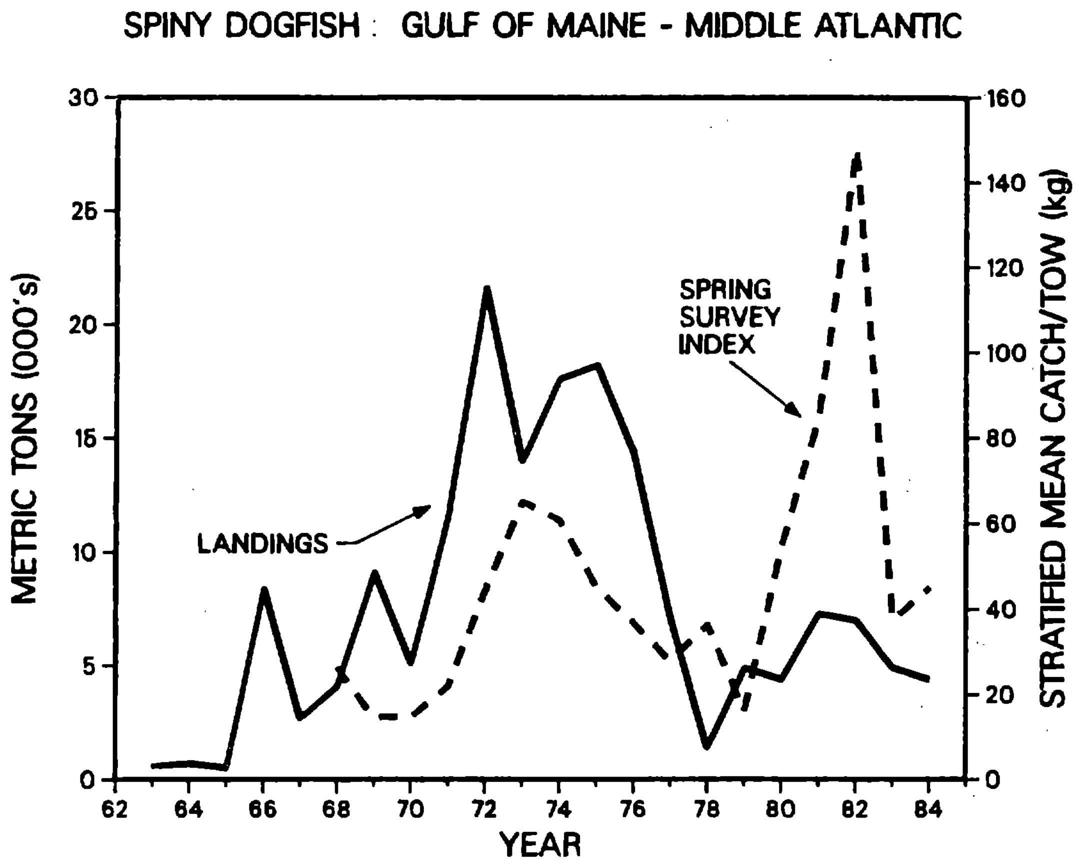


Figure 36. Total commercial landings and stock biomass indices from NEFC spring bottom trawl surveys of spiny dogfish in the Gulf of Maine - Mid-Atlantic area.

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 42). Most of the domestic catch has traditionally been discarded at sea. The reported USA nominal catch increased 14% from 3600 mt in 1983 to 4100 mt in 1984. Beginning in 1983 domestic catches began increasing in response to an expansion of both the European export and domestic markets.

The species composition of the 1984 catch of skates 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 export or domestic market expands.

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 107,000 mt in 1983 to 81,000 mt in 1984 (Figure 37). The 1984 estimate was about 35% less than the 1968-1983 average of 124,000 mt. Since 1974, the total skate biomass estimate has remained at about or below 100,000 mt, excepting 1983 (117,000 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.

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 42. Nominal catches (thousand metric tons) and management information for skates (all species) from the Gulf of Maine - Mid-Atlantic area, 1972-1984.

Category	Year 1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	1.1	1.3	1.5	1.6	2.0	0.8	1.0	3.6	4.1
Canada	<0.1	-	-	-	-	-	-	-	-
Other	5.0	0.2	-	-	-	-	-	-	-
Total nominal catch	6.1	1.5	1.5	1.6	2.0	0.8	1.0	3.6	4.1
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_{1984} = Unknown

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

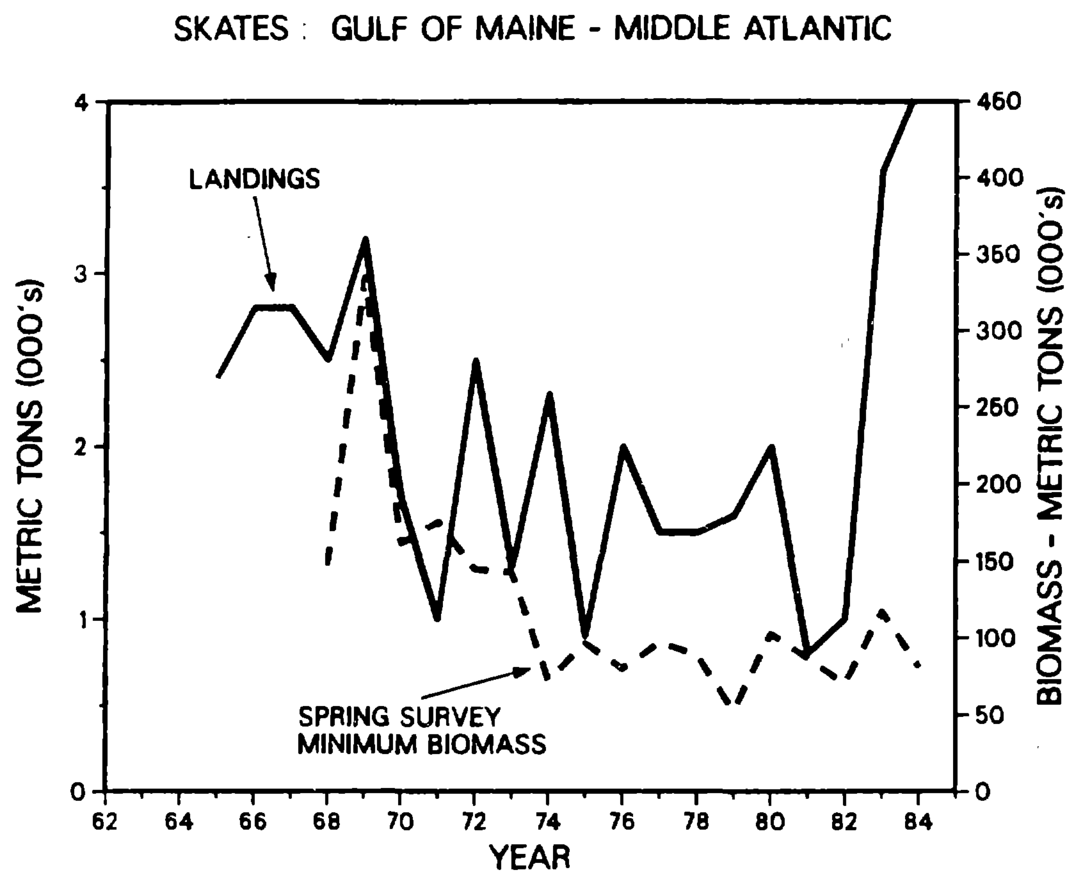


Figure 37. Total commercial landings and estimates of minimum stock biomass from NEFC spring bottom trawl surveys of skates in the Gulf of Maine - Mid-Atlantic area.

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 inches) individuals which are probably 8-24 months of age.

Total catches decreased from 11,720 mt in 1983 to 9,983 mt in 1984, compared to the 1972-1982 mean of 19,250 mt. The USA nominal catch decreased from 9,944 mt in 1983 to 9,307 mt in 1984 (Table 43). (USA catches include prorated amounts of non-specified squids which are not included in Table 2. The 1983 and 1984 USA catches represented almost six-fold increases over the 1977-1982 average. The 1984 catch included about 6,010 mt taken in joint ventures. Distant-water-fleet catches during 1984 were 676 mt, a 62% decrease from 1983 (1,776 mt), and 96% below the 1972-1982 mean catch of 18,202 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 162,000 mt in 1979. The 1982 catch was about 9,000 mt.

The NEFC autumn survey index for *Illex* increased three-fold from 1983 to 1984 but was 33% below the 1968-1982 mean (Figure 38). Minimum abundance off the USA coast was estimated to be 32 million individuals in 1984 compared to 10 million in 1983. This was 46% below the 1968-1983 mean. Pre-recruit (≤10 cm) abundance in 1984 was double the low 1983 level but was 76% below the 1968-1983 average. The pre-recruits sampled in the 1984 autumn survey will comprise the bulk of the catch in the 1985-1986 fishery.

For further information see:

Lange, Anne M.T. 1984. Status of the short-finned squid (*Illex illecebrosus*) off the Northeastern USA, November 1984. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 84-38, 20 p.

Table 43. Nominal catches (thousand metric tons) and management information for the short-finned squid (Illex) from the Gulf of Maine - Mid-Atlantic area, 1972-1984.

Category	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	0.3	1.0	0.4	1.6	0.3	0.6	5.4	9.9	9.3
Canada	-	-	-	-	-	-	-	-	-
Other	19.8	23.8	17.3	16.3	19.6	14.9	12.4	1.8	0.7
Total nominal catch	20.1	24.8	17.7	17.9	17.9	15.4	17.8	11.7	10.0
Total allowable catch	-	30.0	35.0	30.0[1]	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_{1984} = Unknown

[1] 1 April - 31 March fishing year.

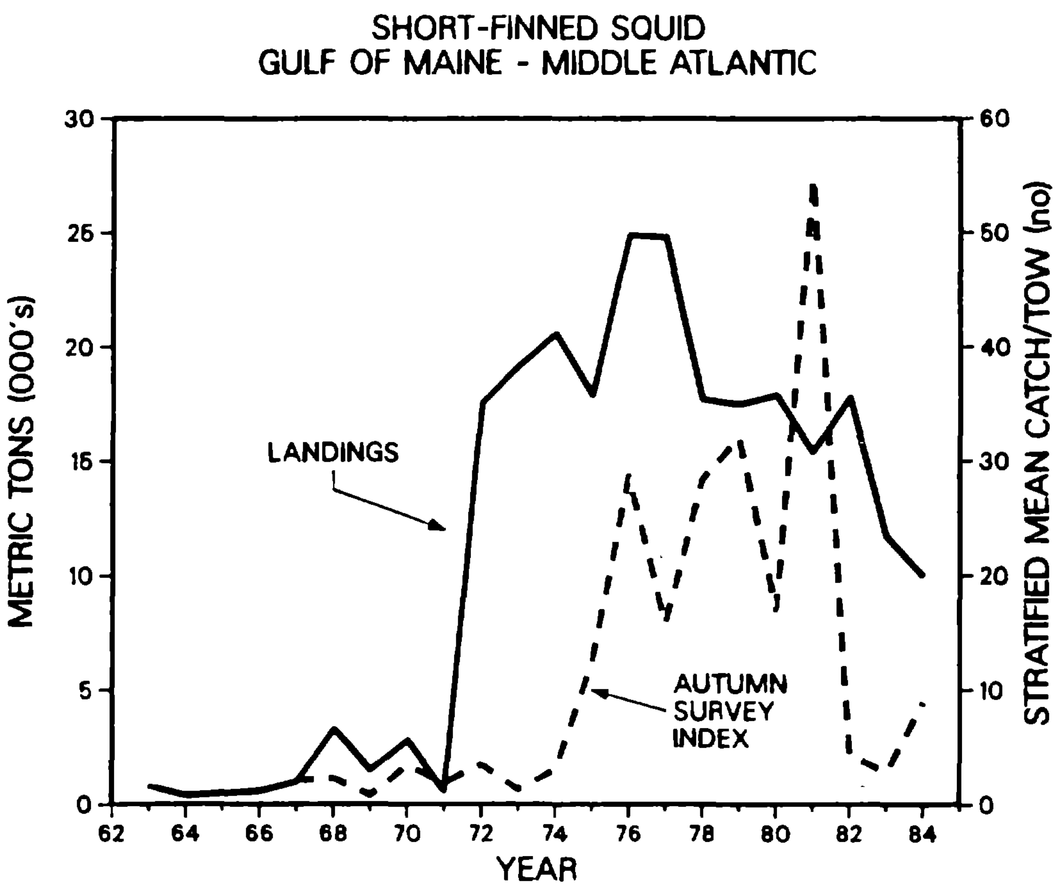


Table 38. Total commercial landings and stock abundance indices from NEFC autumn bottom trawl surveys of short-finned squid in the Gulf of Maine - Mid-Atlantic area.

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 decreased from 27,663 mt in 1983 to 22,382 mt in 1984 (Table 44) and were 4% below the 1970-1982 average (23,300 mt). The USA nominal catch decreased from 15,943 mt in 1983 to 11,351 mt in 1984, the highest level yet recorded. (USA catches include prorated amounts of non-specified squid which are not included in Table 2.) Joint venture catches accounted for 760 mt. Distant-water-fleet catches during 1984 were 11,031 mt compared with 11,720 mt in 1983. The 1984 catches were 49% below the 1970-1982 mean (21,480 mt).

The NEFC autumn survey index for 1984 decreased 52% from 1983 and was 34% below the 1968-1983 average (Figure 39). The 1984 pre-recruit index was 46% less than in 1983 and 43% below the 1968-1982 mean. Minimum abundance was estimated to be 2.5 billion individuals during the time of the 1984 autumn survey, with 76% (1.9 billion) being of pre-recruit size ($\leq$8 cm or $\leq$3 inches). Recruitment from the 1984 year class should be 1.9-4.2 billion individuals assuming 100%-45% catchability of *Loligo* to the survey net. Yield-per-recruit and stock recruitment relationship analyses indicate that yields from this level of recruitment would be between 24,000 and 29,000 mt with the present fishery, if fishing mortality were increased to the level corresponding to the maximum equilibrium yield.

For further information see:

Lange, Anne M.T. 1984. An assessment of the long-finned squid resource off the Northeastern United States, Autumn 1984. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 84-37, 24 p.

Table 44. Nominal catches (thousand metric tons) and management information for long-finned squid (Loligo) from the Gulf of Maine - Mid-Atlantic area, 1972-1984.

Category	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	1.9	1.1	1.3	4.3	4.0	2.3	5.4	15.9	11.4
Canada	-	-	-	-	-	-	-	-	-
Other	30.4	15.6	9.4	13.1	19.8	20.2	15.9	11.7	11.0
Total nominal catch	32.3	16.7	10.6	17.3	23.7	22.5	21.3	27.6	22.4
Total allowable catch	-	44.0	44.0	44.0[1]	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_{1984} = Unknown

[1] 1 April - 31 March fishing year.

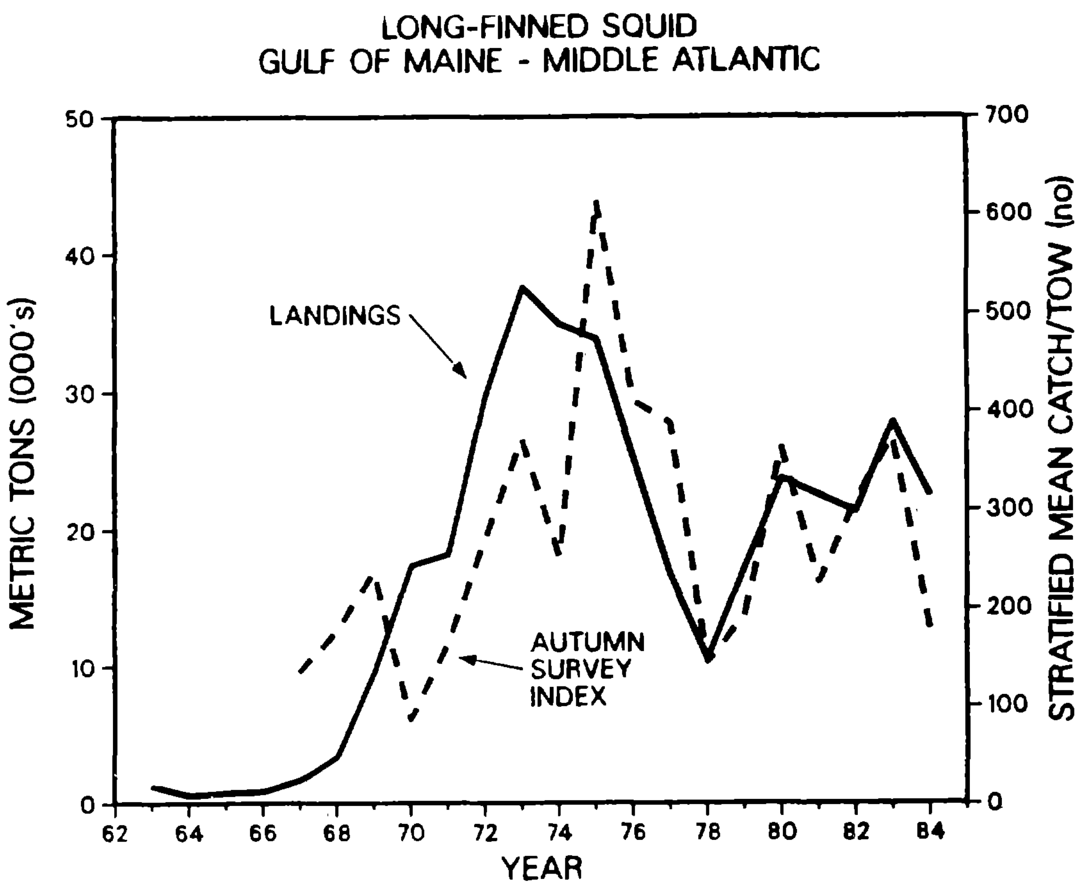


Table 39. Total commercial landings and stock abundance indices from NEFC autumn bottom trawl surveys of long-finned squid in the Gulf of Maine - Mid-Atlantic area.

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. A significant proportion of lobsters caught in inshore waters are not sexually mature.

Nominal catches in the USA inshore 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 1979-1982, averaging 15,400 mt and peaking in 1983 at 17,600 mt (Table 45). The 1984 nominal catch declined slightly to 16,400 mt. Nominal catches for the offshore lobster trap fishery increased rapidly following its inception in 1969 from 50 mt in 1969 to 2,900 mt in 1972. Yield remained relatively stable at approximately 2,000 mt during 1975-1978; landings during 1982-1983 averaged 2,200 mt, but increased to 3000 mt in 1984. The offshore trawl fishery averaged 1,900 mt per year during 1965-1974 and then decreased steadily to only 230 mt in 1981; landings during 1982-1983 averaged 230 mt, declining slightly to 200 mt in 1984. Total offshore landings have declined in recent years relative to levels of the mid-1970's (Figure 40), 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 40). The autumn index increased slightly to 1.06 kg/tow in 1984, The commercial CPUE index (kg-per-trap-haul-set-over-day or kg/THSOD) for the Southern New England region also indicated sharp declines in stock biomass during the 1970's, dropping from 1.5 kg/THSOD in 1969 to only 0.4 kg/THSOD in 1972. This index subsequently increased to 0.5 kg/THSOD in 1974 before dropping to 0.20 kg/THSOD in 1983. 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 45. Commercial and recreational landings (thousand metric tons, live weight) of American lobster from the Gulf of Maine - Mid-Atlantic area, 1972-1984. Landings statistics have been revised to reflect unreported catches and therefore may not agree with Table 2.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational									
State waters[1]	-	-	-	-	-	-	-	-	-
Commercial									
USA: Offshore[2]	2.9	2.5	2.7	2.2	1.9	1.8	2.5	2.4	3.2
Inshore[3]	10.8	11.9	12.9	14.7	14.9	15.9	16.1	17.6	16.4
Canada: Georges Bank	0.2	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.2
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	13.9	14.6	15.9	17.2	17.0	17.9	18.8	20.2	19.8
Total allowable catch	-	-	-	-	-	-	-	-	-

*Long-term potential catch = 3.4
Importance of recreational fishery = Insignificant
Status of management = FMP in place
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) $F_{1983} = >F_{max}$

*Offshore fishery only

[1]Unknown.

[2]Outside 12 miles.

[3]Within 12 miles.

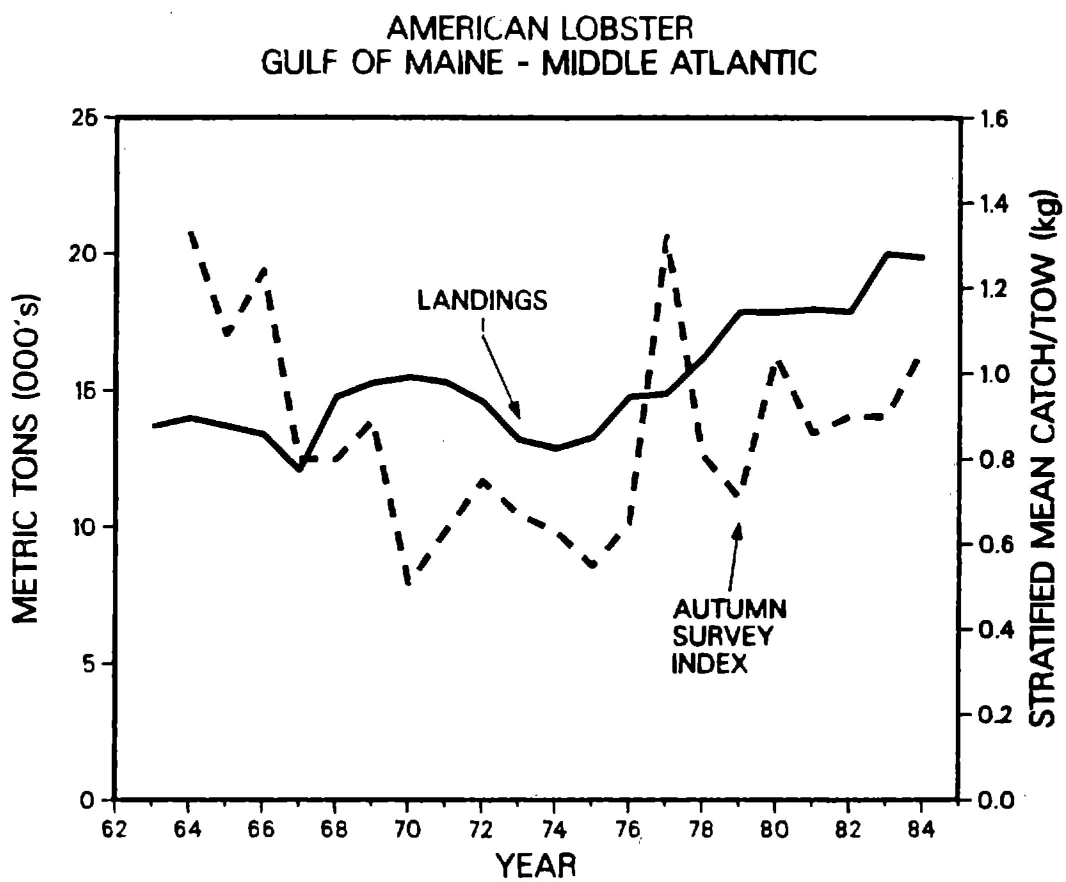


Figure 40. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of American lobster in the Gulf of Maine - Mid-Atlantic area.

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. The fishery has been managed primarily by mesh size regulations and seasonal closures. The 1983-1984 fishing season extended from 15 December to 30 April; and during 1984-1985 the season extended from 1 December-15 May.

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. Shrimp have been taken primarily by otter trawling, although pots have also been used successfully along the central Maine coast.

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 46, Figure 41). 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 further to 3,000 mt, and a harvest of 4,000 mt is projected for 1984-85. This increase reflects both increased abundance and a substantial increase in fishing effort (during 1983-1984, the number of trips directed towards shrimp almost doubled compared to the preceding season).

NEFC spring and autumn (Figure 41) survey indices have increased substantially in recent years, although values remain considerably below average levels of the late 1960's and early 1970's. Also, results of cooperative surveys by state and federal personnel during 1983 and 1984 indicate a sharp increase in harvestable biomass due to recruitment of the 1982 year class, apparently the strongest to appear in a decade. Harvestable biomass and mortality estimates calculated from these data indicate a relatively low exploitation rate during the 1983-1984 season in spite of the above-mentioned effort increase.

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. 1984. Gulf of Maine northern shrimp stock status - 1984. Report to Northern Shrimp Section of Atlantic States Marine Fisheries Commission, November 1984, 21 p.

_____________________________. 1984. Cruise results - Gulf of Maine Northern Shrimp Survey, August 1984. Unpublished Rept., Woods Hole, MA, 16 p.

Table 46. Nominal catches (thousand metric tons) and management information for Gulf of Maine northern shrimp, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978[1]	1979	1980	1981	1982	1983[2]	1984[3]
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	6.9	0.4	<0.1	0.5	0.3	1.0	1.5	1.4	3.0
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	6.9	0.4	<0.1	0.5	0.3	1.0	1.5	1.4	3.0
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_{1984} = Unknown

[1]Fishery closed during 1978.

[2]15 December 1982 - 15 May 1983.

[3]15 December 1983 - 30 April 1984.

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

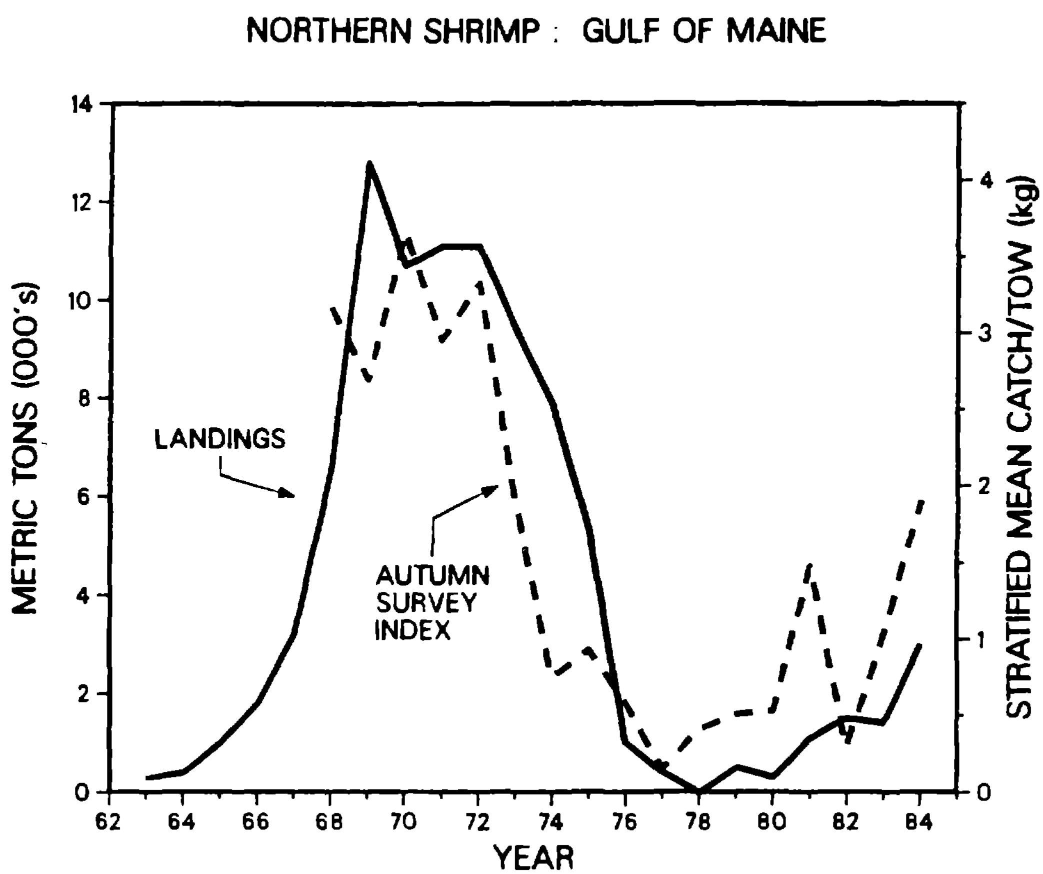


Figure 41. Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of northern shrimp in the Gulf of Maine.

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 [>4 1/2 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 1984 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, on Georges Bank, 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 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 management areas (New England and Mid-Atlantic) are identified in the management plan reflecting the different status of resources and fisheries within these regions. Separate quotas have been established for the Middle Atlantic region (Cape Hatteras to Montauk) Southern New England, and Georges Bank. Quota levels for the three areas in 1985 were 2.65 million, 200 thousand and 300 thousand bushels, respectively.

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 47 and Figure 42). 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 1984, 60% of Middle Atlantic FCZ surf clam landings were taken off New Jersey, 34% off the Delmarva Peninsula, and 6% from the southern Virginia - North Carolina region. Total Middle Atlantic FCZ landings in 1984 were 20,500 mt, slightly greater than the annual quota.

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 42). 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 (1978-1984) 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 13-cm (5-1/4") 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 1985 and 1986.

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 1982 and 1983. The slight increase in activity in the two areas was primarily due to the predominance of small clams in catches off northern New Jersey and Delmarva necessitated laborious culling of the catch to land legal-sized clams. The increases in surf clam landings from southern New England and Georges Bank during 1983 and 1984 were also a result of the restrictions on fishing effort and clam size for the Middle Atlantic FCZ fishery.

Research vessel survey data indicate adequate surf clam resources currently exist to support the Middle Atlantic FCZ fishery at near current levels (18-23 thousand mt of meats) until the Mid-1990's. Likewise, landings of 3-4 thousand mt of meats can be sustained from the New England management area (Southern New England and Georges Bank) for the next decade as well. The 1983 year class off New Jersey appears to be the strongest observed in the Mid-Atlantic since 1977, however, a definitive evaluation of cohort strength and its potential impacts on the fishery must await future surveys.

For further information see:

Murawski, S.A. and F.M. Serchuk. 1984. Assessment update for Middle Atlantic offshore surf calm, Spisula solidissima, populations - autumn 1984. U.S. Nat. Mar. Fish. Serv. Woods Hole Lab. Ref. 84-32. 40 pp.

Murawski, S.A., and F.M. Serchuk. 1984. An assessment of the Georges Bank surf clam resource - summer 1984. U.S. Nat. Mar. Fish. Serv. Woods Hole Lab. Ref. 84-28. 23 pp.

Murawski, S.A., and F.M. Serchuk. 1984. An assessment of the surf clam resource in FCZ waters off Southern New England - spring 1983. U.S. Nat. Mar. Fish. Serv. Woods Hole Lab. Ref. 83-20. 19 pp.

Table 47. Nominal catches (thousand metric tons) and management information for surf clams from the New England - Mid-Atlantic area, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA:									
FCZ waters	26.2	19.5	14.2	13.2	15.7	16.9	16.7	20.5	23.5
State waters	8.1	3.7	3.6	2.6	1.4	4.0	5.9	4.9	8.7
Total	34.3	23.2	17.8	15.8	17.1	20.9	22.5	25.4	32.2
Total allowable FCZ catch	-	-	-	13.6	13.6	18.1	18.1	18.9	24.3

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_{1984} = Unknown, probably 0.1

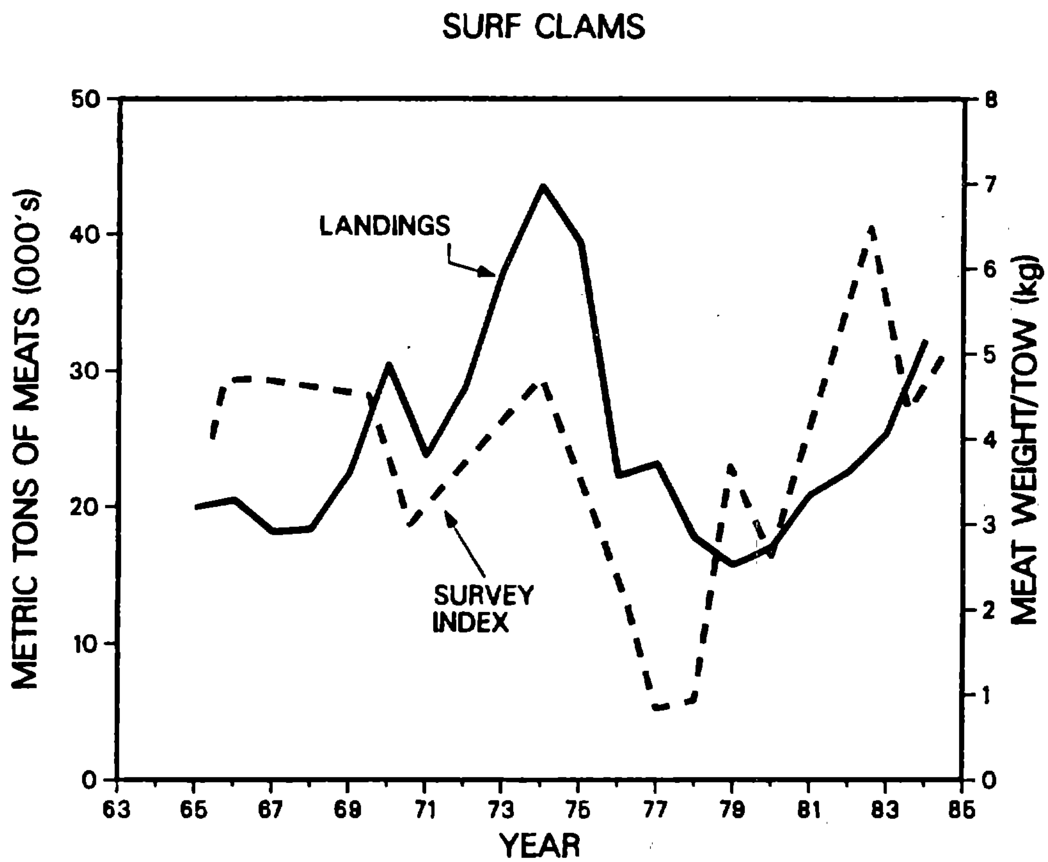


Figure 42. Total commercial landings and stock biomass indices from NEFC dredge surveys of surf clams in the Mid-Atlantic area.

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 surf 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 48, Figure 43). Landings in 1984 were 19,200 mt, of which more than 90% was from FCZ waters. Most of the FCZ landings were from off New Jersey and the remainder Delmarva Peninsula. 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, 18,100 mt in 1981-1984, and 20,000 mt in 1985.

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 1979-1984 were evaluated using mandatory logbook data submitted by each permitted vessel (Figure 43). The offshore ocean quahog fishery is conducted primarily with dredging vessels greater than 100 GRT. Average catch per hour for the large vessels varied somewhat during the period, exhibiting a declining trend during 1979 - early

1980, and again in 1983-1984. CPUE is likely to continue to exhibit such variability as new beds are located and brought into production. 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 1.6% of the total estimated stock, landings considerably in excess of this level 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 48. Nominal catches (thousand metric tons, meats and management information for ocean quahogs from the New England - Mid- Atlantic area, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA:									
FCZ waters	0.4	7.3	9.2	14.3	13.9	16.0	15.6	15.3	17.7
State waters	0.6	1.1	1.2	1.4	1.5	0.4	0.2	0.7	1.5
Total	1.0	8.4	10.4	15.8	15.3	16.4	15.8	16.0	19.2
Total allowable FCZ catch	-	-	13.6	13.6	15.9	18.1	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, probably <0.1

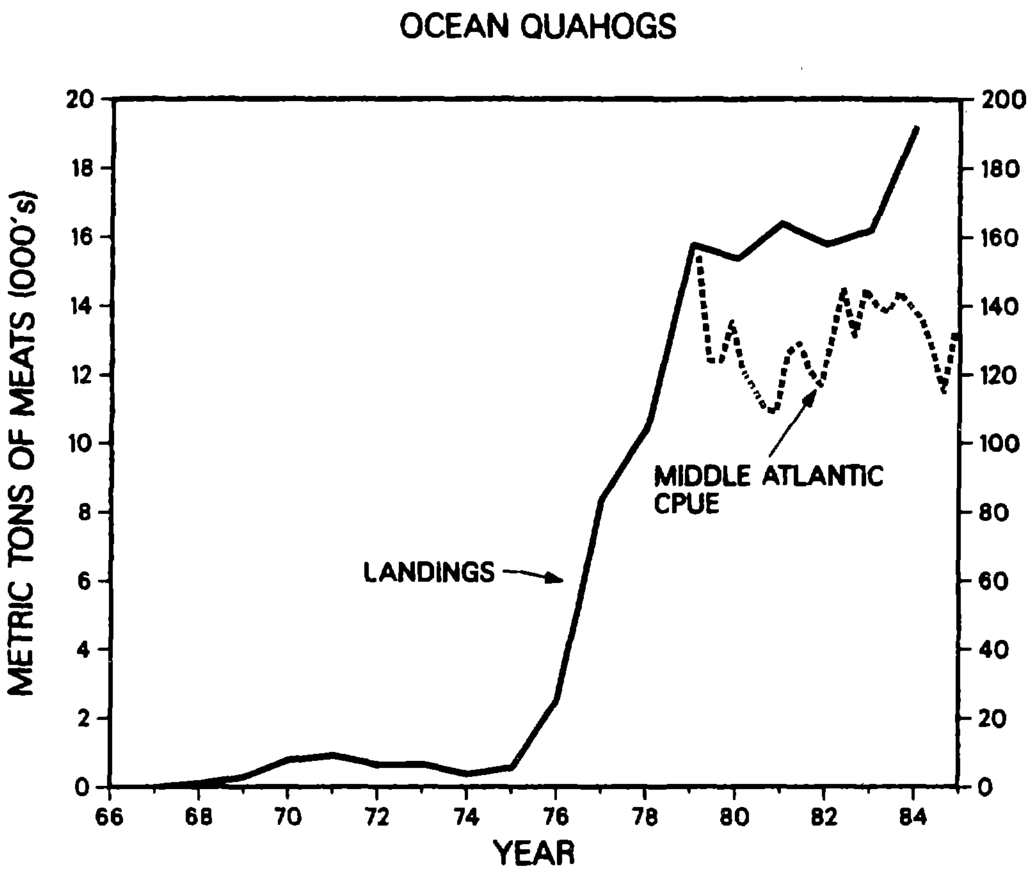


Figure 43. Total commercial landings of ocean quahogs in the New England - Mid-Atlantic area and commercial catch per unit effort in the New Jersey and Delmarva ocean quahog dredge fisheries.

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 1984 landings were 775 mt (meat weight), 267 mt less than in 1983 (Table 49, Figure 44). Both USA and Canadian landings (678 and 97 mt, respectively) were sharply lower than in 1983 (895 and 147 mt, respectively). As in 1983, most (77%) of the 1984 USA catch was from inshore territorial waters along the coast of Maine. Offshore landings in 1984 were 57% less than in 1983 (159 vs 372 mt) indicating greater dependence by the fishery on the inshore beds and a return to historical patterns of fishing. 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 declined in 1984 by 31% from the record 1983 value. USA 1984 commercial CPUE remained at the relatively low 1983 level.

NEFC 1984 sea scallop survey results in the Gulf of Maine were similar to those observed from the 1983 survey; significant quantities of scallops were observed on Fippennies and Jeffreys Ledges. On Fippennies Ledge, above average recruitment of scallops from the 1979 and 1980 year classes was evident. On Jeffreys Ledge, the 1978 year class of scallops was the dominant cohort. In both areas, however, most scallops were small, above 35 count in meat size.

Both the survey results and performance patterns in the commercial fishery indicate that the Gulf of Maine fishery will continue to depend on inshore rather than offshore sea scallop beds in the next few years. Increased exploitation of offshore beds is only likely if fishing effort is transferred from the Georges Bank fishery.

Table 49. 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, 1972-1984.

Category	Year								
	1972-1976 average	1977	1978	1979	1980	1981	1982	1983	1984
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
Gulf of Maine									
USA	0.5	0.3	0.2	0.4	1.6	1.3	0.7	0.9	0.7
Canada	-	-	-	-	<0.1	<0.1	<0.1	0.1	0.1
Total	0.5	0.3	0.2	0.4	1.6	1.3	0.7	1.0	0.8
Georges Bank									
USA[1]	1.1	4.8	5.6	6.7	5.8	8.5	6.7	4.6	3.2
Canada	6.3	13.1	12.2	9.2	5.2	8.0	4.3	2.8	2.0
Total	7.4	17.9	17.8	15.9	11.0	16.5	11.0	7.4	5.2
Mid-Atlantic									
USA	2.6	5.9	8.6	7.2	5.1	1.9	1.7	3.2	3.8
Total nominal catch	10.5	24.1	26.6	23.5	17.7	19.7	13.4	11.6	9.8
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) $F_{1984} = >F_{max}$ in all areas

[1]For USA, Georges Bank landings include Southern New England catches (0.2 t in 1984).

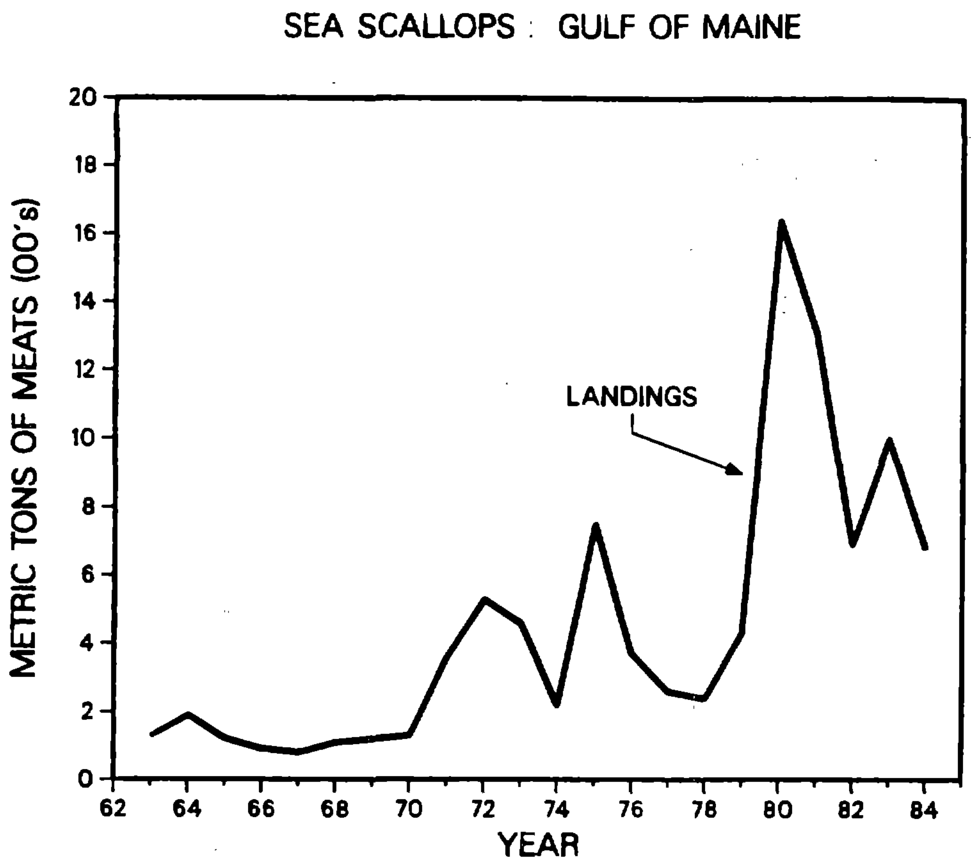


Figure 44. Total commercial landings of sea scallops in the Gulf of Maine.

Georges Bank

Total international (USA and Canada) 1984 commercial landings from Georges Bank were 5,016 mt, 29% less than 1983, and the lowest annual catch since 1972 (Table 49, Figure 45). The 1984 catch (3,071 mt) was the lowest since 1976, while the 1984 Canadian catch (1,945 mt) was the lowest since 1958. About 54% of the total 1984 Georges Bank catch was from the Northern Edge and Peak region of the Bank, although most of the USA catch (53%) was taken in the South Channel fishery. Declines in 1984 landings occurred in two of the three principal fishery regions on the Bank: the South Channel (-33%) and the Northern Edge and Peak (-49%). Landings in 1984 from the Southeast Peak increased 60% from 1983 (691 vs 432 mt), although this region accounted for only 14% of the total 1984 Georges Bank catch. As in 1978-1983, all of the 1984 Canadian landings on Georges Bank were taken from the Northern Edge and Peak.

Total USA effort in the 1984 Georges Bank fishery decreased 9% from 1983, and was lower than in any year since 1979. USA commercial CPUE declined by 22% between 1983 and 1984 with the 1984 CPUE value the lowest in the 1965-1984 time series. Canadian CPUE in 1984 was also the lowest recorded in 20 years. Due to declining abundance, the USA fleet continued to redirect effort during 1984 to the Mid-Atlantic region. Canadian effort in 1984 also shifted from Georges Bank to the Scotian Shelf, Bay of Fundy, and Grand Banks scallop resources.

Catch-per-tow indices from the NEFC 1984 sea scallop survey in the South Channel and Southeast Part regions of the Bank were the lowest in the 10-year survey time series. Survey indices from the Northern Edge and Peak region markedly increased in 1984 due to exceptional recruitment of scallops from the 1981 year class. Most of this recruitment, however, is localized in Canadian waters east of the World Court boundary line established in October 1984. Apart from the Northern Edge and Peak region, recruitment in other areas of the Bank remained low.

Depressed resource conditions are likely to continue in the USA portion of Georges Bank through 1985 and 1986 with population recovery expected only when recruitment improves. A marked increase in Canadian sea scallop landings from the Northern Edge and Peak region is anticipated beginning in late 1985 as scallops from the exceptionally abundant 1981 year class become fully exploited.

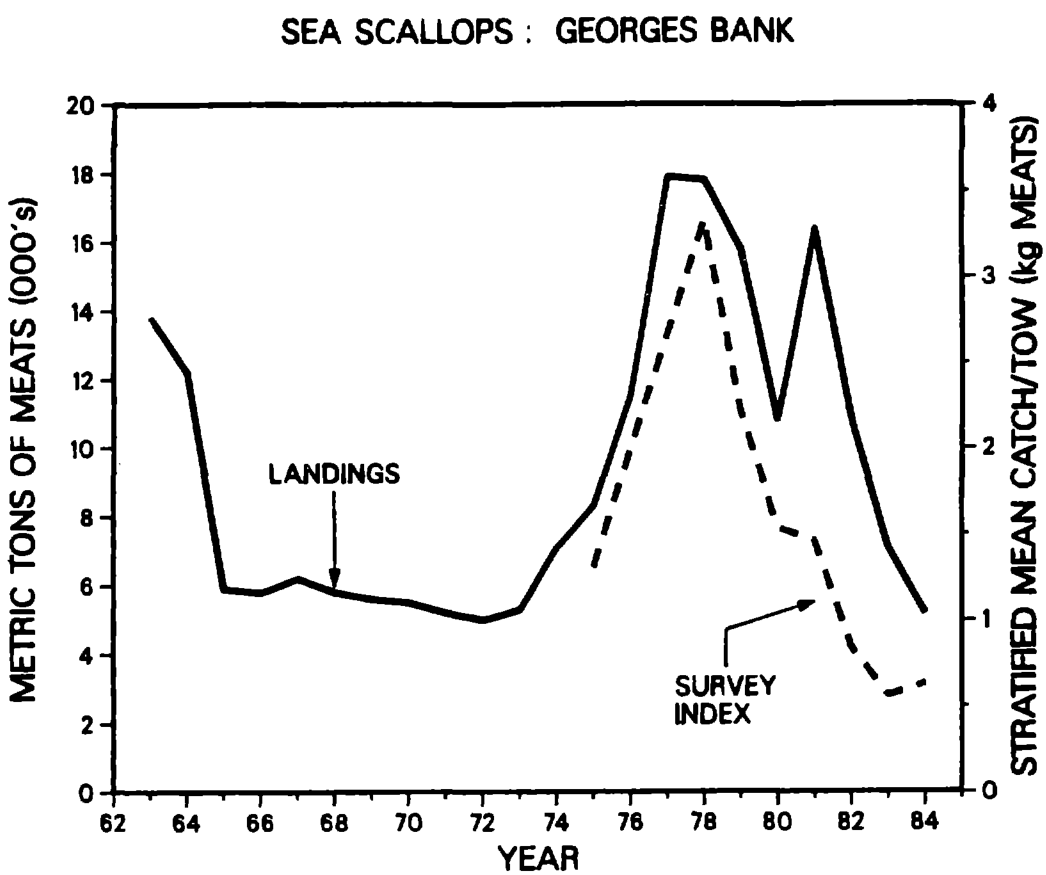


Figure 45. Total commercial landings and stock biomass indices from NEFC dredge surveys of sea scallops on Georges Bank.

Mid-Atlantic

Commercial 1984 landings (exclusively USA) from the Mid-Atlantic area were 3,825 mt, 19% higher than in 1983 (3,227 mt), and the highest annual catch since 1980 (Table 49, Figure 46). For the first time in five years, more catch was taken by the USA fleet from the Mid-Atlantic region than from Georges Bank (3,825 vs 3,071 mt). Mid-Atlantic landings comprised 49% of the total 1984 USA sea scallop harvest, compared with 37% of the total catch in 1983. Most (73%) of the 1984 Mid-Atlantic catch was taken from the New York Bight region (off Long Island and New Jersey) where landings declined slightly (-4%) from 1983. Catches in the more southerly scallop regions (Delmarva and Virginia-North Carolina) increased threefold between 1983 and 1984 (Delmarva: 298 vs 945 mt; Virginia-North Carolina: 16 vs 88 mt).

USA Mid-Atlantic scallop effort in 1984 was 50% greater than in 1983 and nearly triple that in 1982. Effort was greatest in the New York Bight region where effort attained a record high in 1984. The largest percentage increases in effort, however, occurred in the more southerly areas. Between 1983 and 1984, effort tripled off Delmarva and quadrupled off Virginia-North Carolina. In all regions, the number of trips and days fished per trip were higher in 1984 than in 1983. During both 1983 and 1984, the USA fleet redirected effort away from Georges Bank to the Mid-Atlantic grounds.

Despite increased Mid-Atlantic catch and effort in 1984, commercial CPUE declined in 1984 to its lowest level ever (0.36 mt/day fished). The decrease in CPUE between 1983 and 1984 implies that the increased 1984 catch resulted from an increase in fishing mortality rather than from improved scallop abundance.

Abundance and biomass indices from the 1984 NEFC Mid-Atlantic sea scallop survey were generally unchanged from the low values observed in 1983. A modest improvement in scallop abundance was observed in the New York Bight region, primarily due to moderate recruitment of the 1981 year class. In the two other Mid-Atlantic regions, the 1984 survey data indicated that population levels remain depressed at historically low levels.

The USA scallop fleet is expected to continue concentrating much of its activity in the Mid-Atlantic region during 1985 and 1986 due to exclusion of USA fishermen from the Northeast Peak of Georges Bank and low abundance of scallops in most other offshore grounds. However, the absence of significant recruitment throughout the Mid-Atlantic, coupled with high fishing mortality levels, will impede resource recovery. Unless reductions in fishing effort occur, sea scallop abundance and landings are expected to decline in the near future.

For further information see:

Serchuk, F. M., and S. E. Wigley. 1984. Results of the 1984 USA sea scallop research vessel survey: Status of sea scallop resources in the Georges Bank, Mid-Atlantic, and Gulf of Maine regions and abundance and distribution of Iceland scallops off the southeastern coast of Cape Cod. Woods Hole Lab. Ref. Doc. No. 84-34, 74 p.

Serchuk, F. M. 1985. The New Bedford sea scallop fishery: Historical landings and value statistics, 1939-1983. Woods Hole Lab. Ref. Doc. No. 85-02, 10 p.

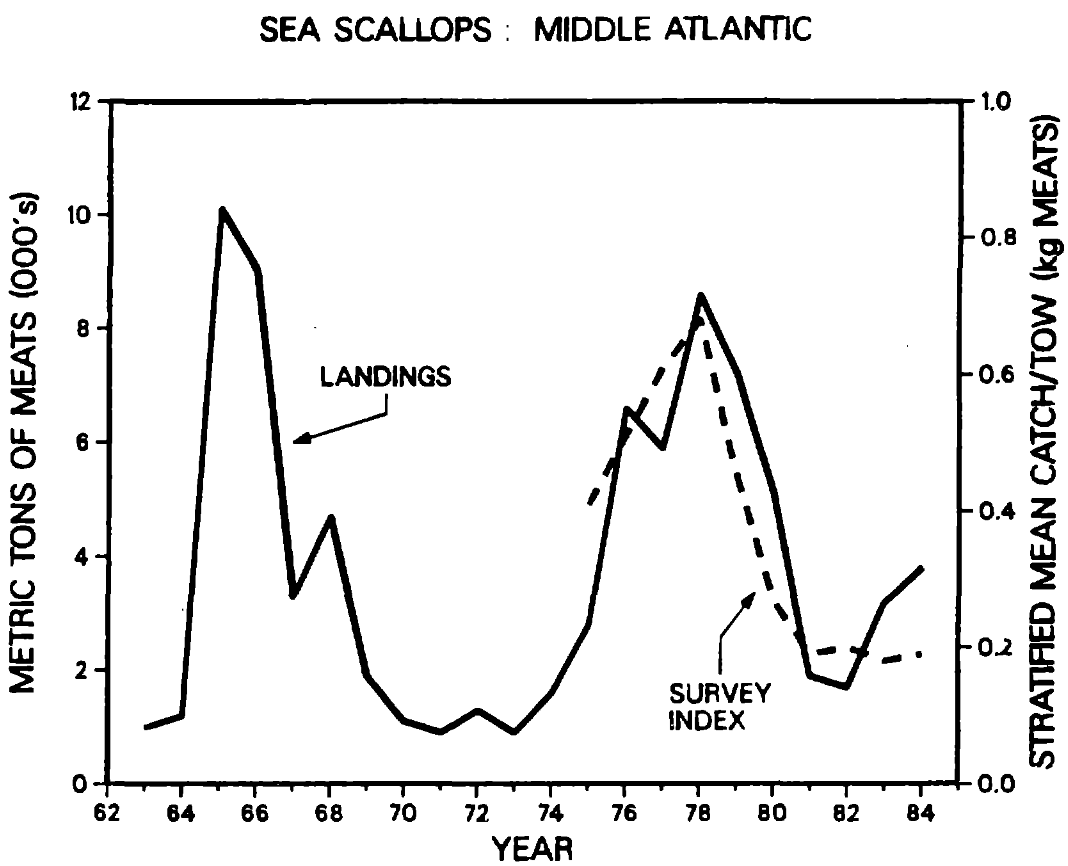


Figure 46. Total commercial landings and stock biomass indices from NEFC dredge surveys of sea scallops in the Mid-Atlantic area.

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(continued from inside front cover)

32. ***Secondary Production of Benthic Macrofauna at Three Stations of Delaware Bay and Coastal Delaware.*** By Stavros Howe and Wayne Leathem. November 1984. ix + 62 p., 6 figs., 19 tables. NTIS Access. No. PB85-145753/AS.

33. ***MARMAP Surveys of the Continental Shelf from Cape Hatteras, North Carolina, to Cape Sable, Nova Scotia (1977-1983). Atlas No. 1. Summary of Operations.*** By John D. Sibunka and Myron J. Silverman. November 1984. vii + 306 p., 52 figs., 2 tables. NTIS Access. No. PB85-150985/AS.

34. ***Oceanology: Biology of the Ocean. Volume 2. Biological Productivity of the Ocean.*** By M.E. Vinogradov, editor in chief. First printed by Nauka Press, Moscow, 1977. Translated from the Russian by Albert L. Peabody. January 1985. x + 518 p., 81 figs., 59 tables. NTIS Access. No. PB85-204683/AS.

35. ***Annual NEMP Report on the Health of the Northeast Coastal Waters, 1982.*** By John B. Pearce, Carl R. Berman, and Marlene R. Rosen, eds., and Robert N. Reid (benthos), Catherine E. Warsh (water quality), and Edith Gould (biological effects), topic coords. January 1985. xi + 68 p., 29 figs., 5 tables. NTIS Access. No. PB85-219129/AS.

36. ***Growth and Survival of Larval Fishes in Relation to the Trophodynamics of Georges Bank Cod and Haddock.*** By Geoffrey C. Laurence and R. Gregory Lough. January 1985. xvi + 150 p., 67 figs., 15 tables, 1 app. NTIS Access. No. PB85-220093/AS.

37. ***Regional Action Plan: Northeast Regional Office and Northeast Fisheries Center.*** By Bruce E. Higgins, Ruth Rehfus, John B. Pearce, Robert J. Pawlowski, Robert L. Lippson, Timothy Goodger, Susan Mello Roe, and Douglas W. Beach. April 1985. ix + 84 p., 4 figs., 6 tables, 9 app. NTIS Access. No. PB85-219962/AS.

38. ***The Shelf/Slope Front South of Nantucket Shoals and Georges Bank as Delineated by Satellite Infrared Imagery and Shipboard Hydrographic and Plankton Observations.*** By J. B. Colton, Jr., J. L. Anderson, J. E. O'Reilly, C. A. Evans-Zetlin, and H. G. Marshall. May 1985. vi + 22 p., 14 figs. NTIS Access. No. PB85-221083/AS.

39. ***USA Historical Catch Data, 1904-82, for Major Georges Bank Fisheries.*** By Anne M. T. Lange and Joan E. Palmer. May 1985. iii + 21 p., 12 figs., 2 tables. NTIS Access. No. PB85-233948/AS.

40. ***Indexing the Economic Health of the U.S. Fishing Industry's Harvesting Sector.*** By Virgil J. Norton, Morton M. Miller, and Elizabeth Kenney. May 1985. v + 42 p., 44 figs., 25 tables, 1 app. NTIS Access. No. PB85-217958/AS.

41. ***Calculation of Standing Stocks and Energetic Requirements of the Cetaceans of the Northeast United States Outer Continental Shelf.*** By Robert D. Kenney, Martin A. M. Hyman, and Howard E. Winn. May 1985. iv + 99 p., 1 fig., 5 tables, 1 app. NTIS Access. No. PB85-239937/AS.

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