NOAA Technical Memorandum NMFS-F/NEC-50

# Status of the Fishery Resources Off the Northeastern United States for 1987

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Center
Woods Hole, Massachusetts
October 1987

## 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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**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.

*(continued on inside back cover)*

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# Status of the Fishery Resources Off the Northeastern United States for 1987

Conservation & Utilization Division, Northeast Fisheries Center

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October 1987

## ACKNOWLEDGEMENTS

The following personnel of the Northeast Fisheries Center, listed alphabetically, assisted in writing this report: Frank Almeida, Vaughn Anthony, Sukwoo Chang, Stephen Clark, Darryl Christensen, Michael Fogarty, Karen Foster, Wendy Gabriel, Josef Idoine, John Joyce, Anne Lange, Phil Logan, Carol MacMurray, Bridget Mansfield, Ralph Mayo, Margaret McBride, Tom Morrissey, Steven Murawski, William Overholtz, Joan Palmer, Tom Polacheck, Anne Richards, Fredric Serchuk, Gary Shepherd, Mark Terceiro, Gordon Waring and Susan Wigley.

Computer plotting of the figures was by Gretchen Tripp. Janeen Cox completed the word processing, and, with Tim Smith, completed the editing and coordination.

## TABLE OF CONTENTS

# INTRODUCTION

The Conservation and Utilization Division of the Northeast Fisheries Center (NEFC), with headquarters in Woods Hole, Massachusetts, annually updates its assessments of finfish and shellfish resources off the northeast coast of the United States from Cape Hatteras to Nova Scotia, and presents detailed information as needed to administrators, managers, the fishing industries, and the public. This report describes trends in recreational and commercial fisheries in this overview section and 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 1986 in the species synopses section.

Many of the assessments are described in Laboratory Reference Documents at the Woods Hole Laboratory, which may be obtained upon request. The most recent complete assessments for each stock are cited in the appropriate species synopsis. Additionally, in recent years NEFC has initiated a new procedure of reviewing assessments of selected species-stocks in workshops. For species-stocks where the conclusions of the most recent complete assessment still hold, detailed updates to that information are reviewed, as described in the workshop reports. Those reports are cited in the species synopses for those species which were reviewed.

The assessment information contained in the present report varies among the species-stocks because of differences in available data and in the need for assessment information. Some species, such as mackerel, Georges Bank herring, silver hake, red hake, butterfish, and squid, were fished most heavily in the past decade by foreign 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. Assessments of the status of these stocks then had to rely increasingly on research vessel survey information rather than fishery-generated information. This is because fishing effort by the United States was initially lower than that of the distant-water fleets that they were replacing and fishery-generated data provides less information on status at lower fishing intensities. While this has weakened the analysis, assessment information may not be as critical now for these stocks since and the demand for achieving maximum harvest from these stocks has been greatly reduced.

For some fisheries (e.g., yellowtail flounder, butterfish), the mortality of discarded small fish is a very significant proportion of the total mortality of the stock. The ability to estimate quantities discarded for these fisheries is crucial for the production of accurate assessments. Recently there has been an acceptance in the market of smaller fish of some species. The definitions of market categories have changed in many ports in response. Since 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 substantial but lesser proportions of fishing pressure from such fishermen. Catch and effort information has been especially poor for the recreational fisherman, although significant progress in collecting this information is now being made.

Many of the species assessments herein are fairly new, developed in response to management initiatives of the Fishery Management Councils established under the FCMA. These assessments may involve an examination of harvest levels, biology, and survey abundance indices only for recent years; in contrast, assessments of some other species (e.g., haddock, cod, mackerel, and herring) are based on longer time series of catch and survey information, and on detailed analyses of the age composition of the catch.

Depending on the nature of the fishery, the type and amount of fishery-generated data, and the information required for management, the assessment information reported here may be generated in several different ways. Figure A[1] is a diagram of several ways in which catch and survey data in the lower left and right boxes respectively, can be combined to provide assessment advice, illustrated at the top of the diagram. (1) The simplest approach is when catch data are used to generate indices of abundance, as seen by moving vertically along the right side of Figure A[1]. A more complex approach (2) is when the catch data from approach (1) is combined with trawl survey data to generate indices of abundance, as seen by moving vertically along the left side of Figure A. Both of these approaches are frequently supplemented with knowledge of the life history generated from biological data from sampling the commercial and survey catches. A third approach (3) is to utilize the information abaout total stock size and population productivity generated under approaches (1) and (2) to determine the relationship between productivity and stock size, termed production models. Finally, for those species where the age composition of the catch or of the survey samples can be determined reliably, (4) more complex analytic assessments can be developed which use the information in the age structure of the population and the catches to determine productivity as seen by moving vertically along the center of Figure A.

The status of information pertaining to the various elements in Figure A is shown diagramatically in Table A. The great differences in availability of different types of information, columns, for the several species of interest in this region, rows, suggests why assessments of different species involve different paths in Figure A. Although research on some of the species has

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[1] All Tables and Figures in this Overview section are labeled with letters of the alphabet, to distinguish them from the decimally labeled tables and figures in the Species Synopses section.

STOCK ASSESSMENT SYSTEMS MODEL

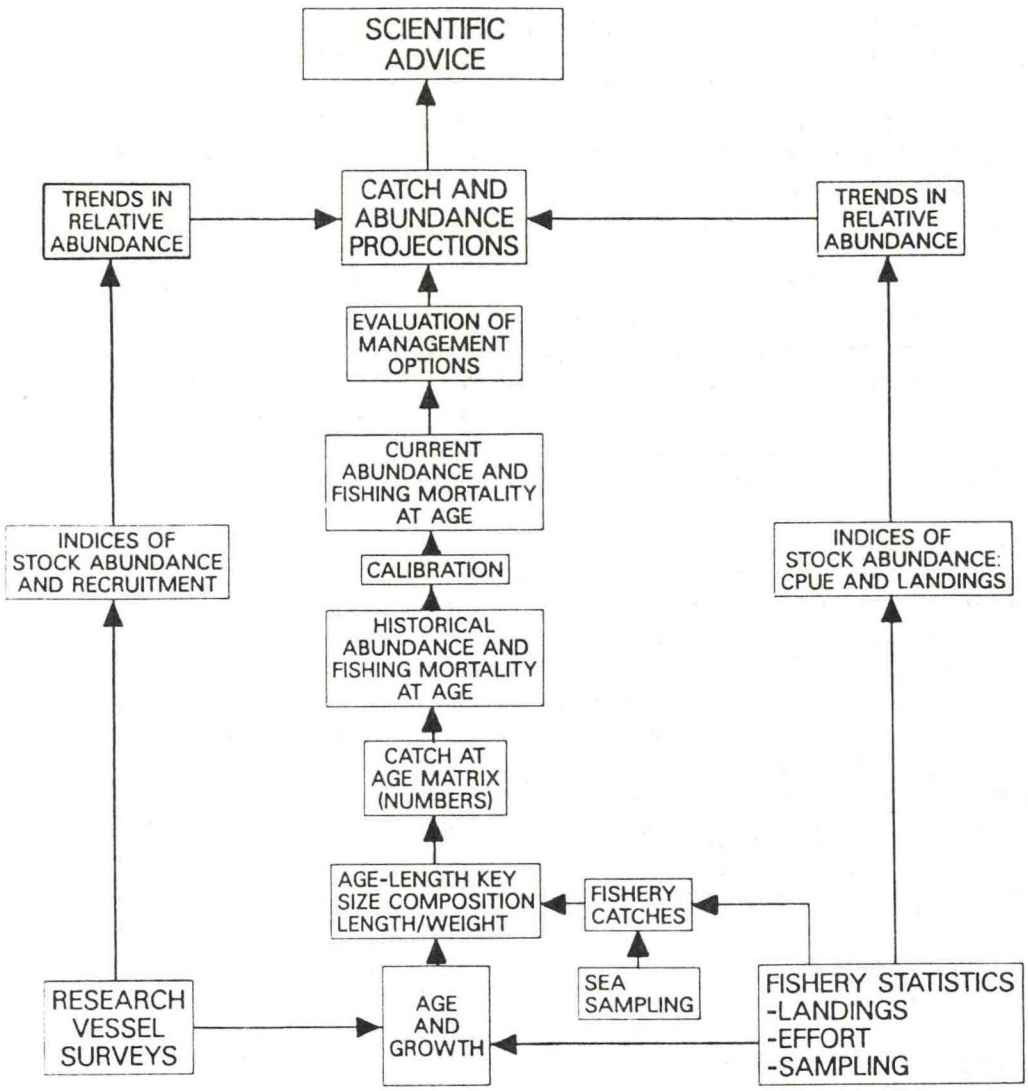



Figure A. Diagram of alternate ways in which fishery-generated data and research data (lower right and left boxes, respectively) are combined to provide scientific advice on the status of stocks (top box).

been underway for many years, some of the items are still not known. As fisheries become more intense, more of the categories will need to be filled to evaluate the effects of fishing on the resource.

Both Figure A and Table A reflect information about each species separately, as if they had no interactions with each other. Similarly, the assessments in this report are presented individually, with little indication of the biological interactions among species or of the mixed species nature of many of the fisheries. These interactions have implications for how assessment information is generated, and for the impact of management of fisheries on one species-stock on other species and other fisheries. [Research and management initiatives are being taken to address this limited perspective, but the needed information is difficult to obtain.]
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 or equivalent of the landings as indicated in the units applied. Nominal catches do not include unreported discards or unidentified young fish put into fish meal.

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 from an allowance or estimated estimated catch.

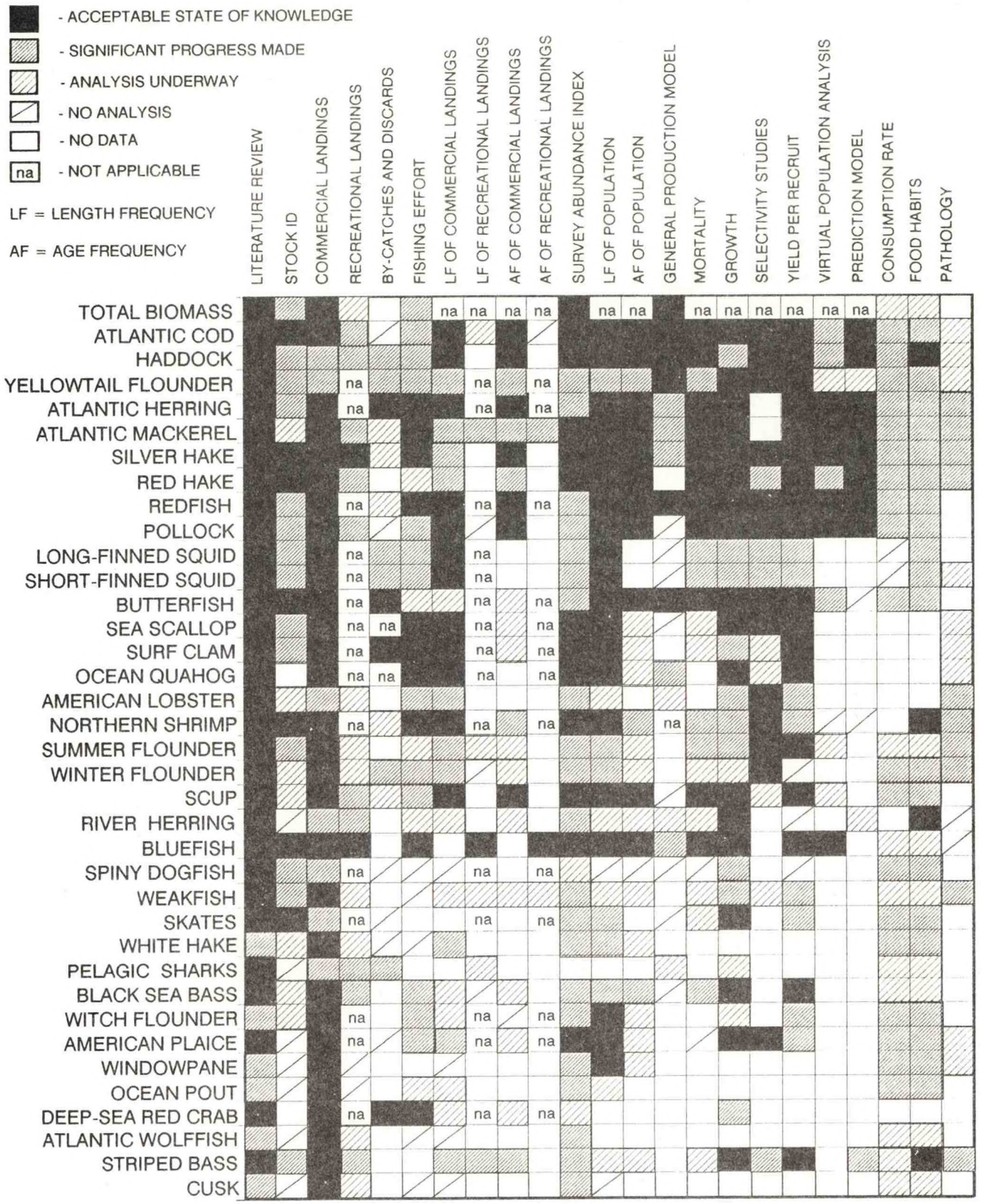
Year Class (or Cohort) This term refers to a group of fish which were born in a particular year and are referred to throughout their life by their year of birth. It is a very useful term because occasionally fish born in a particular year are extremely abundant or extremely scarce, and there is a need 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 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

Table A

# STATUS OF BIOLOGICAL ASSESSMENT KNOWLEDGE REQUIRED FOR FISHERY MANAGEMENT



represents the time interval, then approximately 1.7/365 or 0.466% of the population is declining, but the instantaneous rate is constant. Actually 0.465% of the population dies each day instead of 0.466% because a day only approximates an instantaneous time period. If hours were used, the approximation would be even closer. During the first day of the year, about 4,660 fish will die and 995,340 will survive out of a population of 1 million. The survival rate over the year is $e^{-1.7}$ (where e = 2.71828) or 0.1827. Multiplying 0.1827 by the number of fish alive at the beginning of the year (1 million) gives 182,684 fish that survive to the beginning of the next year. The proportion that actually dies during the year is, therefore, $1-e^{-1.7}$ or 0.8173. This is called the annual mortality rate (A) which, of course, can never exceed 1.0.

Instantaneous Fishing Mortality Rate (F) This is the instantaneous rate of death due to fishing, usually expressed over the entire year. If F = 1.5, then approximately 1.5/365 or 0.411% of the population dies each day from fishing. If fishing were the only cause of death, then the number of fish that survive the fishery over the year from a population of 1 million alive at the beginning of the year is 1 million multiplied by $e^{-1.5}$ or 223,130 fish. There are other causes of death, however, that are also acting on the population of fish at the same time as the fishery that must be considered in calculating the number that die from fishing. The number that die from fishing is the proportion that fishing is of the total mortality, multiplied by the number that die from all causes [i.e., F/Z multiplied by $(1-e^{-Z})$ multiplied by 1 million.] If the total mortality rate is 1.7, as explained above, then this calculation is:

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

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

or 721,186 fish that die from fishing.

Instantaneous Natural Mortality Rate (M) This is also an instantan- eous 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:

$$\frac{M}{Z} (1-e^{-Z}) (1,000,000)$$

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.

Long-term potential catch The largest average annual harvest in weight which could be removed from a fish stock year after year, under existing environmental conditions, while maintaining the stock size. This can be estimated in a variety of ways, ranging from maximum values from production models to average observed catches over a suitable period of years.

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 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 9% from 1985 to 1986. The total catch decreased from 1.31 million metric tons (mt) in 1985 to 1.19 million mt in 1986. The catch of finfish decreased 17% while the catch for invertebrates increased by 2%.

### Groundfish

Total groundfish commercial catches decreased 14% from 1985 to 1986. Catches of the principal groundfish (cod, haddock, redfish, red hake, silver hake, and pollock) decreased 12% from 108,712 mt in 1985 to 95,175 mt in 1986. Cod, haddock, and redfish catches decreased 26%, 21%, and 29% respectively. Silver hake and red hake catches also declined, the first by 12% and the latter by 26%.

Flounder catches decreased 7,112 mt from 1985 to 1986 (15%). Atlantic halibut catch decreased from 114 mt in 1985 to 65 mt in 1986, a 43% decline. American plaice, witch and winter flounder catches decreased 36%, 25%, and 21% respectively. The yellowtail flounder catch increased from 7,340 mt in 1985 to 7,843 mt in 1986 (7%). The summer flounder catch increased by 3% from 1985 to 1986.

Other groundfish catches decreased by 16% from 1985 to 1986. Scup catches increased by 3%, while other species catches decreased.

### Pelagics

Total catches of the principal pelagic species, herring and mackerel, increased only 3% from 1985 (65,279 mt) to 1986 (67,287 mt). The USA herring catch increased 24%, 6,090 mt, and the USA mackerel catch increased by 43%. However, the foreign catch for mackerel catches decreased 21% from 1985 (32,604 mt) to 1986 (25,651 mt).

The catches of other pelagic species decreased 25%, largely due to the 26% drop in menhaden catches between 1985 (312,626 mt) and 1986 (231,681 mt). There was a 23% increase in catches for bluefish from 1985 to 1986.

### Other Finfish

The catch of other finfish decreased 4% from 1985 (31,686 mt) to 1986 (30,448 mt). There was a 28% increase in river herring between 1985 (1,218 mt) and 1986 (3,996 mt), and a decrease of 35% in the catches of spiny dogfish from 1985 to 1986.

Invertebrates

The total USA and foreign catch of invertebrates increased 2% from 706,421 mt in 1985 to 695,116 mt in 1986. Foreign catches increased 10%, and the USA increased 2% from 1985 to 1986.

Total squid catches increased 3%. Foreign catches of *Loligo* decreased 34% from 1985 (6,495 mt) to 1986 (4,317 mt), and the catches of *Illex* decreased by 80% between 1985 (1,082 mt) and 1986 (213 mt). The USA catches of *Loligo* increased 32% and the *Illex* catches increased 10% between 1985 and 1986.

Table B. USA commercial and foreign nominal catches* (mt) from the marine finfish and invertebrate resources off the northeastern United States (Gulf of Maine to Cape Hatteras, North Carolina Mid-Atlantic) in 1985 and 1986. All catches are expressed in live weight, 1986 catches are provisional, and recreational catches are not included.

| Species | Foreign | | USA Commercial | | Total | |
|---|---|---|---|---|---|---|
| | 1985 | 1986 | 1985 | 1986 | 1985 | 1986 |
| Principal Groundfish | 19,444 | 15,646 | 86,268 | 79,529 | 108,712 | 95,175 |
| Cod | 11,885 | 9,308 | 37,341 | 27,265 | 49,226 | 36,573 |
| Haddock | 4,275 | 3,640 | 6,505 | 4,929 | 10,780 | 8,569 |
| Redfish | 118 | 139 | 4,162 | 2,913 | 4,280 | 3,052 |
| Silver hake | 1,322 | 362 | 20,139 | 17,981 | 21,461 | 18,343 |
| Red hake | 80 | 6 | 1,820 | 2,125 | 1,900 | 2,131 |
| Pollock | 1,764 | 2,191 | 19,301 | 24,316 | 21,065 | 26,507 |
| Flounders | 520 | 499 | 46,558 | 39,467 | 47,078 | 39,966 |
| American plaice | 41 | 34 | 7,027 | 4,476 | 7,068 | 4,510 |
| Witch flounder | 48 | 67 | 6,069 | 4,534 | 6,117 | 4,601 |
| Yellowtail flounder | 3 | 27 | 7,337 | 7,816 | 7,340 | 7,843 |
| Greenland halibut | 0 | 0 | 0 | 0 | 0 | 0 |
| Atlantic halibut | 57 | 32 | 57 | 33 | 114 | 65 |
| Winter flounder | 12 | 25 | 10,865 | 8,003 | 10,877 | 8,028 |
| Summer flounder | 0 | 0 | 10,727 | 11,046 | 10,727 | 11,046 |
| Windowpane flounder | 0 | 0 | 4,205 | 3,223 | 4,205 | 3,223 |
| Flatfishes (not specified)** | 359 | 314 | 271 | 336 | 630 | 650 |
| Other Groundfish | 3,330 | 1,551 | 23,285 | 20,841 | 26,615 | 22,392 |
| Cusk | 298 | 126 | 2,341 | 1,843 | 2,639 | 1,969 |
| Scup | 18 | 16 | 6,709 | 6,884 | 6,727 | 6,900 |
| White hake | 953 | 956 | 6,360 | 5,302 | 7,313 | 6,258 |
| Atlantic wolffish | 81 | 0 | 940 | 858 | 1,021 | 858 |
| Groundfish (not specified) | 1,980 | 453 | 6,935 | 5,954 | 8,915 | 6,407 |
| Principal Pelagics | 32,612 | 25,652 | 32,667 | 41,635 | 65,279 | 67,287 |
| Atlantic herring | 8 | 1 | 25,908 | 31,998 | 25,916 | 31,999 |
| Atlantic mackerel | 32,604 | 25,651 | 6,759 | 9,637 | 39,363 | 35,288 |
| Other Pelagics | 439 | 361 | 324,305 | 244,223 | 324,744 | 244,584 |
| Bluefish | 0 | 0 | 4,207 | 5,192 | 4,207 | 5,192 |
| Atlantic butterfish | 207 | 127 | 4,739 | 4,418 | 4,946 | 4,545 |
| Atlantic menhaden | 81 | 18 | 312,545 | 231,663 | 312,626 | 231,681 |
| Pelagic (not specified) | 151 | 216 | 2,814 | 2,950 | 2,965 | 3,166 |
| Other Finfish | 1,472 | 940 | 30,214 | 29,508 | 31,686 | 30,448 |
| River herring | 217 | 62 | 1,001 | 3,934 | 1,218 | 3,996 |
| Spiny dogfish | 94 | 13 | 3,944 | 2,629 | 4,038 | 2,642 |
| Skates | 0 | 106 | 3,972 | 4,222 | 3,972 | 4,328 |
| Finfish (not specified) | 1,161 | 759 | 21,297 | 18,723 | 22,458 | 19,482 |
| Invertebrates | 39,849 | 43,860 | 666,572 | 651,256 | 706,421 | 695,116 |
| Illex | 1,082 | 213 | 4,987 | 5,492 | 6,069 | 5,705 |
| Loligo | 6,495 | 4,317 | 10,123 | 13,397 | 16,618 | 17,714 |
| American lobster | 309 | 275 | 21,219 | 20,862 | 21,528 | 21,137 |
| Shrimp (Pandalid) | 0 | 0 | 4,198 | 4,685 | 4,198 | 4,685 |
| Crab (not specified) | 0 | 2 | 58,918 | 51,210 | 58,918 | 51,212 |
| Surf clams | 0 | 0 | 166,154 | 184,327 | 166,154 | 184,327 |
| Ocean quahog | 0 | 0 | 183,072 | 169,830 | 183,072 | 169,830 |
| Sea scallop | 31,963 | 39,050 | 55,956 | 68,379 | 87,919 | 107,429 |
| Invertebrates | 0 | 3 | 161,945 | 133,074 | 161,945 | 133,077 |
| Grand Total | 97,666 | 88,509 | 1,212,869 | 1,106,459 | 1,310,535 | 1,194,968 |

* Catches for specific stocks given in the species synopses later in this report may differ because they are for the species in selected geographic areas.

** Not specified indicates that there are other species in this category which are not listed in the table.

## Commercial Trends

## RECREATIONAL FISHING TRENDS

Recreational landings of many species of fish and shellfish harvested in marine waters of the northeastern United States equal or exceed the commercial landings. Notable examples are mackerel, striped bass, bluefish, weakfish, white marlin, and pelagic sharks. In addition, recreational landings are a significant part of the total catch of numerous other species.

Between 1960 and the mid-1970's, NMFS and the NEC conducted a variety of surveys to obtain catch and other information about the recreational fishery. Because of considerable uncertainty about the data from these surveys, NMFS implemented in 1979 the Marine Recreational Fishery Statistics Survey (MRFSS), which consists of two complimentary surveys: a telephone survey of households and a direct-intercept creel census. Since 1979 the recreational fisheries of the Atlantic and Gulf coasts have been surveyed annually as part of the MRFSS. Since the MRFSS methodology represents a radical change from previous methodologies, data from the MRFSS is not directly comparable to the results of the earlier surveys. Data from the MRFSS are reported in the Species Synopsis sections; data from earlier surveys are not used here.

Recreational fishery data are an important factor in determining the status of many stocks, and results from the MRFSS have been incorporated into some of the species-stocks assessments summarized in this report. However, obtaining detailed records on the recreational catch is a formidable task. In 1986, for example, recreational fishermen made an estimated 29 million fishing trips in marine waters of the northeastern U.S. The trips were made at all hours of the day and night and to virtually every coastal river, bay, and sound of the region, as well as in the open ocean. The anglers fished from private boats, rental boats, party and charter boats, the shore, and from man-made structures such as piers, bridges and jetties.

Although significant progress in collecting reliable recreational catch and effort information is being made, the use of recreational survey data to monitor the status of fish stocks should be done with caution and with other indices of stock abundance, such as pre-recruit survey data or total adult biomass indices.

### Total Recreational Catch

The estimated total number of fish caught by recreational fishermen in marine waters of the northeastern United States (Maine through Virginia) increased more than 38% from 1985 to 1986. The total recreational catch increased from an estimated 160 million fish in 1985 to an estimated 220 million fish in 1986. The estimate of the proportion of the total catch released alive by anglers increased slightly, from 29% in 1985 to 33% of the catch in 1986.

### Principal Recreational Species

The estimated recreational catch of winter flounder, which was the leading species in numbers caught in the northeast in 1985, decreased 20.6

million fish, or 66%, from 1985 to 1986. Scup, which ranked fourth in numbers caught in 1985 with a catch of 15.4 million fish, was the leading species in 1986 with a catch of 32.4 million fish (110% increase). Black sea bass catches increased from 8.1 million fish in 1985 to 31.2 million fish in 1986 (286% increase), to make this species the second most important in numbers caught in 1986.

Bluefish catches increased 7.5 million fish (34% increase) and summer flounder catches increased 6.9 million fish (44% increase) from 1985 to 1986. Other leading recreational species showing increased catches from 1985 to 1986 are spot (3.6 million fish or 30%), Atlantic croaker (7.4 million fish or 134%), searobins (7.6 million fish or 183%), weakfish (8.0 million fish or 256%), and tautog (5.0 million fish or 128%).

Catches of other principal recreational species decreased 35% from 1985 to 1986. Among these, the catch of Atlantic mackerel declined from 8.3 million fish in 1985 to 5.9 million fish in 1986 (29% decrease). The catch of Atlantic cod decreased 2.1 million fish (58% decrease) and the catch of pollock decreased 1.7 million fish (80% decrease) from 1985 to 1986.

For futher information see:

U.S. Department of Commerce. 1987. Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts, 1986. Current Fishery Statistics No. 8392.

Table C. Principal species and total numbers caught (millions of fish) by recreational fishermen in marine waters of the northeastern United States in 1985 and 1986.

| SPECIES | 1985 New England | 1985 Mid Atlantic | 1986 New England | 1986 Mid Atlantic | TOTAL 1985 | TOTAL 1986 |
|---|---|---|---|---|---|---|
| Winter Flounder | 8.4 | 22.6 | 5.4 | 5.0 | 31.1 | 10.4 |
| Bluefish | 7.9 | 13.7 | 10.7 | 18.4 | 21.6 | 29.0 |
| Summer Flounder | 0.5 | 15.2 | 4.3 | 18.4 | 15.8 | 22.7 |
| Scup | 8.4 | 7.0 | 21.6 | 10.8 | 15.4 | 32.4 |
| Spot | 0 | 12.1 | 0 | 15.7 | 12.1 | 15.7 |
| Atlantic Mackerel | 5.0 | 3.3 | 1.2 | 4.6 | 8.3 | 5.9 |
| Black Sea Bass | 0.2 | 7.9 | 1.0 | 30.3 | 8.1 | 31.2 |
| Atlantic Croaker | 0 | 5.6 | 0 | 13.0 | 5.6 | 13.0 |
| Searobins | 0.6 | 3.6 | 0.8 | 10.9 | 4.1 | 11.7 |
| Tautog | 0.6 | 3.6 | 4.2 | 5.0 | 4.1 | 9.2 |
| Atlantic Cod | 3.6 | 0.1 | 1.5 | 0.1 | 3.7 | 1.6 |
| Cunner | 1.7 | 1.5 | 1.3 | 1.4 | 3.2 | 2.7 |
| Weakfish | - | 3.1 | - | 11.1 | 3.1 | 11.1 |
| Toadfishes | 0.1 | 3.1 | - | 2.8 | 3.1 | 2.7 |
| Pollock | 2.2 | - | 0.4 | - | 2.2 | 0.5 |

- Denotes less than thirty thousand reported

## COMMERCIAL FISHERY ECONOMIC TRENDS

### The Northeast Region

The Northeast region's commercial oceanic and estuarine fisheries produced domestic landings worth $694 million in 1986, an increase in value of almost $50 million over that of 1985 landings. The total yield of all of these fisheries, however, was down 100,000 metric tons or 14 percent. Most of this reduction occurred in finfish landings. Despite this, ex-vessel payments for finfish remained unchanged at $266 million. Reflecting the same trend in price increases, shellfish landings held constant at 168,000 metric tons, but brought in $45.6 million of additional revenue.

A total of 1793 vessels of five gross registered tons (GRT) or more participated in one or several of the various ocean fisheries in the region, a decline of fifty-five vessels from the previous year. Thirty-nine of these fifty-five were from the the smallest vessel class, i.e., in the 5-50 GRT range. The performance of vessels, grouped by predominant gear type, is discussed for the New England and Mid-Atlantic-Chesapeake areas below.

### New England

In 1986, Otter Trawl vessel landings were valued at $185.7 million, a 2.5% increase over the previous year. This was based on landings of 147,900 metric tons or 83% of the 1985 catch. Income per vessel rose by 11% for the 895 (or 77 fewer) vessels involved (Table D.). Each New England otter trawl vessel class continued to experience lower catches per day at sea, but the trend in revenue per day improved as higher fish prices more than compensated. Figure B, which shows the ten year trend in per vessel revenue using deflated (adjusted) dollars, reflects this mild turnaround in real terms for each of the three tonnage classes.

The number of Scallop Dredge vessels participating in the New England scallop fishery declined by thirty six. The majority of those leaving were in the intermediate (51-150GRT) range. In spite of this, total landings rose by 12% to 53,000 metric tons and total revenues increased by almost 17% to $71.2 million as prices and landings per vessel increased. With the exception of the smallest vessel class, numbering only ten vessels, both the landings and revenue per day at sea rose for the 46 intermediate and 174 large vessels. As a result, revenue per vessel climbed by almost 30% over the previous year. Figure C reflects this trend for the two larger classes of vessels.

On balance, the total of operating, maintenance and repair, labor and other fixed costs was relatively stable between 1985 and 1986, rising two to three percent. Ex-vessel price increases (Table E.) resulted in increased revenues per day at sea, even for vessels whose catches declined. As a result, the financial picture was slightly brighter for the average otter trawl vessel fishing in 1986, and considerably brighter for the average scallop dredge vessel than it had been a year ago.

Table D. New England Fleet Landings and Revenue 1978 - 1986: Vessels of Five Gross Registered Tons or More (see note).

| Year | Number of Vessels | Total Revenue All Trips $ 000,000 Nominal | Total Revenue All Trips $ 000,000 Deflated | Total Landings All Trips 000's (m.t.) | Landings per Vessel Primary Gear Only (m.t.) |
|---|---|---|---|---|---|
| | | | All Gears | | |
| 1978 | 907 | 161.3 | 161.3 | 278.8 | |
| 1979 | 1145 | 194.7 | 175.1 | 293.9 | |
| 1980 | 1306 | 211.7 | 167.6 | 327.7 | |
| 1981 | 1356 | 242.3 | 173.8 | 316.3 | |
| 1982 | 1366 | 261.7 | 176.8 | 380.6 | |
| 1983 | 1620 | 298.6 | 195.5 | 368.1 | |
| 1984 | 1420 | 286.4 | 179.9 | 355.7 | |
| 1985 | 1368 | 303.2 | 183.6 | 373.0 | |
| 1986 | 1255 | 285.0 | 169.8 | 269.3 | |
| | | | Otter Trawl Vessels | | |
| 1978 | 643 | 106.2 | 106.2 | 186.8 | 230.0 |
| 1979 | 768 | 121.4 | 109.2 | 192.9 | 201.8 |
| 1980 | 894 | 136.0 | 107.7 | 215.5 | 190.5 |
| 1981 | 918 | 156.4 | 112.2 | 209.2 | 180.6 |
| 1982 | 1005 | 189.2 | 127.8 | 257.9 | 192.1 |
| 1983 | 994 | 191.5 | 125.4 | 225.5 | 190.0 |
| 1984 | 1018 | 192.2 | 120.7 | 216.6 | 170.8 |
| 1985 | 972 | 181.1 | 109.6 | 178.5 | 152.3 |
| 1986 | 895 | 185.7 | 110.6 | 147.9 | 146.8 |
| | | | Scallop Dredge Vessels | | |
| 1978 | 129 | 46.4 | 46.4 | 67.5 | 480.0 |
| 1979 | 200 | 61.6 | 55.4 | 71.4 | 322.0 |
| 1980 | 272 | 68.9 | 54.6 | 71.0 | 229.6 |
| 1981 | 292 | 91.3 | 65.5 | 99.5 | 251.1 |
| 1982 | 191 | 72.7 | 49.1 | 79.2 | 314.7 |
| 1983 | 221 | 98.9 | 64.7 | 84.9 | 262.3 |
| 1984 | 213 | 80.2 | 50.4 | 57.8 | 222.4 |
| 1985 | 168 | 61.1 | 37.0 | 47.7 | 250.8 |
| 1986 | 136 | 71.2 | 42.4 | 53.3 | 369.4 |

Note. Landings and revenue figures are total annual amounts, regardless of port of sale, for all vessels of 5 GRT or more which sold at least one trip's catch in Maine, New Hampshire (1982 onward), Massachusetts or Rhode Island. Previous editions of this table excluded vessels landing in New Hampshire. The deflated figures are used to compare revenue over several years and are expressed in 1978 dollars (CPI 1978 = 100).

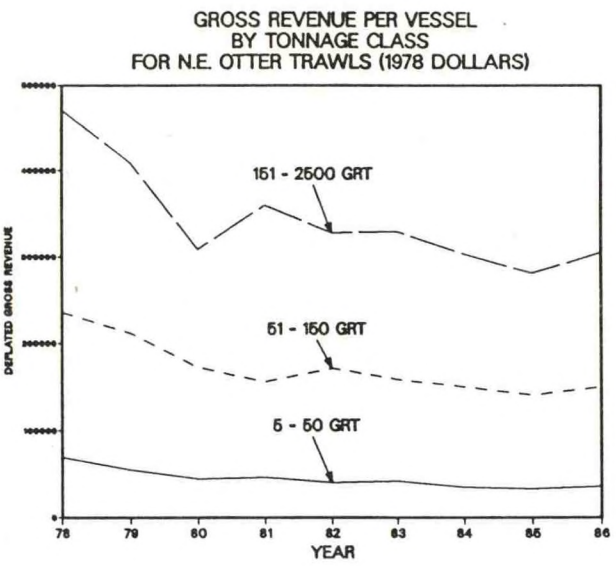



Figure B. Deflated (adjusted) gross revenue per vessel by tonnage class for those vessels using otter trawl gear and landing the catch in a New England port at least once during the year. All revenue, regardless of whatever gear was used or wherever catches were sold, is included. Revenue adjusted by the Consumer Price Index (CPI) with 1978 as the base year.

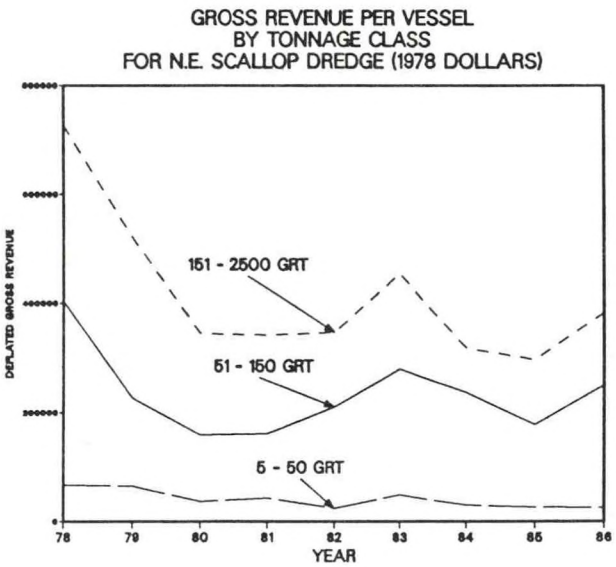



Figure C. Deflated (adjusted) gross revenue per vessel by tonnage class for those vessels using scallop dredge gear and landing the catch in a New England port at least once during the year. All revenue, regardless of whatever gear was used or wherever catches were sold, is included. Revenue adjusted by the CPI with 1978 as the base year.

Ex-vessel prices and, consequently, consumer prices for the three most important shellfish and nine most important finfish species in New England increased in 1986. For lobsters and scallops, the first and second most valuable species, and for northern shrimp, both prices and landings increased over 1985 levels (Table E).

Pollock, fluke and whiting catches brought in more revenue in 1986 also as a result of increased landings coupled with larger ex-vessel prices. The value of cod, yellowtail and white hake landings rose as well, even though catches were smaller than in the previous year.

Higher prices for redfish just offset the decline in landings to yield the same $3.2 million. The drop in winter flounder landings, off 26% from 1985's 9,700 metric tons, was too large to sustain last year's $18.5 million in revenue. Instead, as its average ex-vessel price rose by 17% per pound, the revenue it produced fell by 14 percent.

## Imports

Supplies of finfish (all forms expressed in live weight equivalent, l.w.e.) to New England from Canada and all other sources increased slightly from 772 to 790 thousand metric tons in 1986 (Table F). Cod products (62%) dominated these finfish imports and Canadian cod accounted for 61% of that species' imports. The live weight equivalent of Canadian cod products sent to New England was roughly eleven times the live weight equivalent of New England cod landings. Imports of scallop meats increased slightly from both Canada and other sources to 7.9 thousand metric tons in 1986.

Total edible fishery products coming into New England from Canada were worth $792 million in 1986, an increase of $136 million over the 1985 figure. This accounted for 66% of the $1.2 billion of total New England imports in this category. The value of these Canadian imports was composed of finfish products worth $394 million (50%), lobster products worth $153 million (19%), scallop products valued at $65 million (8%), crab products at $40 million (5%) and other fish products (18%) worth $140 million.

The Northeast region imported a record $2.3 billion worth of edible fish products in 1986. The principal sources of these imports included Canada, $848 million (37%), Iceland, $203 million (9%), the European Economic Community, $167 million (7%), Norway, $137 million (6%), and Japan and South Korea at slightly less than $60 million each.

Forty percent of the region's expenditures on edible fish imports was spent on shellfish products. Of significance to the region's fisheries were imports of 49,000 mt (l.w.e.) of lobster worth $252 million, 6.6 thousand tons (l.w.e.) of clam products worth $13.1 million and slightly less than 25,000 mt (l.w.e.) of crab products worth $63.7 million (Table G.).

Table E. New England Landings, Ex-vessel Value and Price of Species of Major Importance 1978 - 1986.

| Year | 000 m.t. | $ Million | $/lb. | 000 m.t. | $ Million | $/lb. | 000 m.t. | $ Million | $/lb. |
|---|---|---|---|---|---|---|---|---|---|
| | Lobster | | | Scallop Meats | | | Cod | | |
| 1978 | 14.9 | 61.1 | 1.86 | 7.9 | 44.3 | 2.53 | 39.0 | 21.3 | .25 |
| 1979 | 16.1 | 68.4 | 1.92 | 7.4 | 55.2 | 3.39 | 44.1 | 28.2 | .29 |
| 1980 | 16.1 | 71.8 | 2.02 | 7.7 | 65.5 | 3.85 | 53.6 | 31.9 | .30 |
| 1981 | 16.3 | 82.1 | 2.29 | 8.8 | 79.4 | 4.06 | 45.3 | 32.8 | .33 |
| 1982 | 16.9 | 85.0 | 2.28 | 7.2 | 57.2 | 3.61 | 47.2 | 37.1 | .36 |
| 1983 | 19.1 | 100.7 | 2.39 | 6.3 | 77.9 | 5.57 | 50.7 | 37.5 | .34 |
| 1984 | 18.8 | 107.0 | 2.58 | 5.0 | 62.5 | 5.63 | 43.5 | 35.6 | .37 |
| 1985 | 19.0 | 102.4 | 2.44 | 4.6 | 50.0 | 4.90 | 37.3 | 34.7 | .42 |
| 1986 | 19.6 | 112.2 | 2.59 | 5.2 | 60.0 | 5.28 | 27.5 | 35.7 | .59 |
| | Yellowtail | | | Winter Flounder | | | Pollock | | |
| 1978 | 11.2 | 14.9 | .61 | 10.7 | 10.4 | .44 | 17.7 | 6.6 | .17 |
| 1979 | 15.5 | 17.3 | .51 | 11.4 | 9.3 | .40 | 15.5 | 6.6 | .19 |
| 1980 | 18.4 | 19.1 | .47 | 15.5 | 12.0 | .35 | 18.0 | 7.2 | .18 |
| 1981 | 14.4 | 15.8 | .50 | 17.4 | 16.2 | .42 | 16.9 | 8.5 | .23 |
| 1982 | 20.1 | 24.5 | .55 | 13.7 | 14.5 | .48 | 14.2 | 7.0 | .22 |
| 1983 | 31.4 | 33.8 | .49 | 14.1 | 15.2 | .49 | 14.0 | 5.4 | .17 |
| 1984 | 16.4 | 26.4 | .73 | 13.5 | 20.2 | .68 | 17.9 | 6.4 | .16 |
| 1985 | 10.7 | 19.6 | .83 | 9.7 | 18.5 | .86 | 19.7 | 7.0 | .16 |
| 1986 | 10.1 | 20.5 | .92 | 7.2 | 16.0 | 1.01 | 24.7 | 14.0 | .26 |
| | Fluke | | | Haddock | | | Shrimp | | |
| 1978 | 2.1 | 3.6 | .77 | 17.9 | 12.7 | .32 | -.- | -.- | -- |
| 1979 | 1.9 | 3.1 | .73 | 19.0 | 17.7 | .42 | 0.5 | 0.3 | .32 |
| 1980 | 0.7 | 1.5 | .91 | 25.0 | 21.4 | .39 | 0.3 | 0.5 | .65 |
| 1981 | 1.7 | 3.6 | .94 | 25.0 | 22.0 | .40 | 1.0 | 1.4 | .63 |
| 1982 | 3.0 | 5.5 | .81 | 20.3 | 22.0 | .50 | 1.5 | 2.0 | .59 |
| 1983 | 3.2 | 6.1 | .86 | 14.8 | 19.0 | .58 | 1.6 | 2.3 | .67 |
| 1984 | 2.8 | 6.3 | 1.03 | 11.8 | 18.4 | .71 | 3.2 | 3.5 | .49 |
| 1985 | 4.5 | 10.5 | 1.06 | 6.5 | 13.5 | .94 | 4.2 | 4.0 | .44 |
| 1986 | 4.6 | 13.1 | 1.30 | 5.0 | 10.9 | .99 | 4.7 | 6.5 | .63 |
| | Whiting | | | White Hake | | | Redfish | | |
| 1978 | 15.9 | 4.7 | .13 | 4.9 | 1.7 | .16 | 16.1 | 6.1 | .17 |
| 1979 | 7.3 | 2.8 | .17 | 4.0 | 1.5 | .17 | 15.4 | 7.2 | .21 |
| 1980 | 7.9 | 3.0 | .17 | 4.7 | 1.7 | .17 | 11.0 | 5.6 | .23 |
| 1981 | 9.2 | 3.9 | .19 | 5.5 | 2.3 | .19 | 8.4 | 5.3 | .28 |
| 1982 | 10.9 | 4.6 | .19 | 6.2 | 2.4 | .18 | 8.5 | 5.2 | .27 |
| 1983 | 11.7 | 3.8 | .15 | 6.4 | 2.2 | .19 | 6.0 | 3.5 | .26 |
| 1984 | 15.0 | 4.2 | .13 | 6.8 | 2.6 | .17 | 5.6 | 3.6 | .29 |
| 1985 | 14.1 | 5.4 | .17 | 7.4 | 3.3 | .21 | 4.4 | 3.2 | .33 |
| 1986 | 14.2 | 5.9 | .19 | 6.6 | 4.9 | .34 | 3.0 | 3.2 | .48 |

Table F. New England Imports of Selected Fishery Products from Canada and from All Other Sources 1978-1986 (see note).

| | Cod | | Other Groundfish | | Flatfish | | Total Finfish | | Scallops | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Canada | Other | Canada | Other | Canada | Other | Canada | Other | Canada | Other |
| Year | Thousand Metric Tons | | | | | | | | | |
| 1978 | 151 | 284 | 93 | 151 | 87 | 39 | 331 | 474 | 10.7 | .7 |
| 1979 | 204 | 229 | 92 | 153 | 88 | 28 | 384 | 410 | 8.3 | .8 |
| 1980 | 199 | 161 | 72 | 115 | 71 | 9 | 342 | 285 | 6.6 | 1.0 |
| 1981 | 233 | 157 | 114 | 109 | 96 | 7 | 443 | 273 | 8.4 | 1.3 |
| 1982 | 254 | 157 | 105 | 138 | 72 | 14 | 431 | 309 | 6.6 | 1.1 |
| 1983 | 290 | 193 | 86 | 136 | 60 | 8 | 436 | 337 | 5.9 | 2.0 |
| 1984 | 279 | 195 | 93 | 122 | 68 | 16 | 440 | 333 | 3.8 | 3.4 |
| 1985 | 276 | 189 | 97 | 117 | 67 | 26 | 440 | 332 | 5.1 | 1.9 |
| 1986 | 302 | 190 | 100 | 115 | 63 | 20 | 465 | 325 | 5.8 | 2.1 |

Note. Product forms include whole fresh, whole frozen, frozen blocks and fresh and frozen fillets. Groundfish are Cusk, Hake, Haddock, Pollock and Ocean Perch. Flatfish include Halibut. Finfish weights are expressed in live weight equivalents and scallops in meat weight.

Table G. Northeast Region Imports of Selected Fishery Products from All Sources 1978-1986 (see note).

| | Lobster Products | | | | Clam Products | | Crab Products | |
|---|---|---|---|---|---|---|---|---|
| | Live | Other | Total | Value | Quantity | Value | Quantity | Value |
| Year | Quantity | | 000 mt. | $Mil. | 000 m.t. | $Mil. | 000 m.t. | $Mil |
| 1978 | 5.5 | 43.1 | 48.6 | 175.3 | 1.3 | 1.8 | 12.6 | 20.6 |
| 1979 | 6.5 | 41.6 | 48.1 | 182.4 | 1.1 | 1.8 | 10.7 | 16.7 |
| 1980 | 5.4 | 32.3 | 37.7 | 156.5 | 2.3 | 3.7 | 9.8 | 16.9 |
| 1981 | 7.1 | 34.6 | 41.7 | 197.8 | 5.0 | 6.1 | 20.2 | 34.2 |
| 1982 | 7.7 | 32.5 | 40.2 | 204.8 | 7.3 | 8.9 | 26.4 | 57.4 |
| 1983 | 9.2 | 33.3 | 42.5 | 202.9 | 6.7 | 8.7 | 28.2 | 71.8 |
| 1984 | 10.6 | 39.7 | 50.3 | 250.4 | 5.7 | 9.6 | 24.3 | 48.4 |
| 1985 | 12.2 | 36.1 | 48.3 | 246.7 | 6.2 | 11.4 | 27.8 | 53.2 |
| 1986 | 13.1 | 35.8 | 48.9 | 252.5 | 6.6 | 13.1 | 24.7 | 63.7 |

Note. Lobster quantities are live weight equivalent and include lobsters in airtight containers, rock lobster tails and other products. Clam and crab products expressed in live weight equivalents.

Mid-Atlantic and Chesapeake

As in New England, the Mid-Atlantic and Chesapeake shellfish fisheries were responsible for a greater percentage of industry revenue than were those pursuing finfish. Finfish landings fell by almost 27% between 1985 and 1986 to 239,400 tons. Their value remained constant at $73 million. In contrast, shellfish catches remained relatively constant at 111,000 tons, but generated an additional $20 million above 1985's $151.6 million.

The most important ocean fisheries are carried out by vessels using surf clam and ocean quahog dredges, otter trawl nets and scallop dredges. There is also a small but, by volume of landings, significant menhaden fishery. Seasonal gear switching between otter trawl nets, scallop dredge gear and other gears is common on vessels in this area.

The financial trends are less clear here than in New England fisheries. All vessels taken together experienced an increase in gross income of almost seven percent on landings very close to those of 1985. One significant fleet experienced declining revenues. For those for which receipts rose, the reasons differed. To generalize, ex-vessel price increases were not found to apply to all species caught by the various fleets.

Otter trawl vessel receipts rose an average of 20% per vessel over the past year (Table H.). Landings per vessel, however, declined. The smallest and largest classes of vessels experienced decreased landings per day at sea and, in spite of some rising prices, their revenue per day at sea also declined as well. The 51-150 GRT class, comprising 65% of this fleet, however, had increases in both landings and revenues per day at sea.

Average annual landings and gross income rebounded over 1985 levels for the scallop dredge fleet, but not back as high they had been in 1983 and 1984. Significant increases for the two larger classes of vessels were noted in both landings and revenue per day at sea. This resulted from increased landings alone, however, as the price per pound of scallop meats declined slightly in this area (Table I.). There have been no 5-50 GRT class scallop dredge vessels operating in the area since 1984.

The single most important fishery in this area, the surf clam and ocean quahog fishery, experienced a very slight decline in total revenues on landings which were off by 3%. All vessels fishing this class of gears and landing in the states noted are represented in Table H. The trend in their adjusted gross income per vessel distinguished by vessel class is shown in Figure D.

Surf clam and ocean quahog landings, value, and nominal and deflated prices for the entire Northeast region are shown in Table J. Ocean Quahog prices fell in the northern part of the region, and remained constant in the southern. Landings in both areas decreased. Surf clam prices, on averaged, declined in New England and New York ports on unchanged landings. In New Jersey, Maryland and Virginia, the inshore and offshore surf clam fisheries experienced price rises of six and ten percent respectively on reduced landings of four percent for both fisheries.

Table H. Mid-Atlantic and Chesapeake Fleet Landings and Revenue 1978 - 1986: Vessels of Five Gross Registered Tons or More (see note).

| Year | No. of Vessels | Revenue $Millions | Landings 000 m.t. | No. of Vessels | Revenue $Millions | Landings 000 m.t. |
|---|---|---|---|---|---|---|
| | All Vessels All Gears | | | Surf Clam and Quahog Vessels | | |
| 1978 | 391 | 47.4 | 133.3 | 96 | 12.6 | 42.1 |
| 1979 | 476 | 53.6 | 98.7 | 90 | 14.0 | 40.6 |
| 1980 | 440 | 49.0 | 151.6 | 64 | 12.1 | 106.7 |
| 1981 | 597 | 66.8 | 244.9 | 135 | 21.3 | 152.4 |
| 1982 | 578 | 88.1 | 287.8 | 131 | 37.3 | 231.9 |
| 1983 | 652 | 117.1 | 314.1 | 128 | 32.9 | 241.5 |
| 1984 | 661 | 124.5 | 368.2 | 138 | 46.3 | 295.8 |
| 1985 | 616 | 106.4 | 370.9 | 138 | 48.7 | 322.3 |
| 1986 | 651 | 120.6 | 368.5 | 142 | 48.4 | 311.8 |
| | Otter Trawl Vessels | | | Scallop Dredge Vessels | | |
| 1978 | 146 | 13.2 | 21.5 | 75 | 16.4 | 25.6 |
| 1979 | 176 | 16.9 | 25.3 | 123 | 22.0 | 26.0 |
| 1980 | 166 | 15.2 | 23.9 | 130 | 21.5 | 23.2 |
| 1981 | 225 | 19.5 | 25.6 | 135 | 23.0 | 23.5 |
| 1982 | 241 | 28.0 | 40.0 | 83 | 22.2 | 22.9 |
| 1983 | 273 | 40.9 | 42.6 | 120 | 46.6 | 35.6 |
| 1984 | 291 | 36.9 | 50.0 | 122 | 42.3 | 36.0 |
| 1985 | 263 | 27.9 | 28.9 | 92 | 29.9 | 25.5 |
| 1986 | 287 | 37.0 | 30.5 | 92 | 35.9 | 29.0 |

Note. Landings and revenue figures are total annual amounts, regardless of port of sale, for all vessels of 5 GRT or more which sold at least one trip's catch in New York (1986 only), New Jersey, Maryland (9/81-onward) or Virginia (9/81 onward). With the exception of New Jersey fisheries, landings from inshore vs ocean fisheries are excluded.

Figure D. Deflated (adjusted) gross revenue per vessel by tonnage class for those vessels using surf clam and ocean quahog gear and landing the catch in a Mid-Atlantic or Chesapeake port at least once during the year. All revenue, regardless of whatever gear was used or wherever catches were sold, is included. Revenue adjusted by the Consumer Price Index (CPI) with 1978 as the base year.

Table I. Mid-Atlantic and Chesapeake Landings, Ex-Vessel Value and Price of Species of Major Importance 1978 - 1986.

| | Scallop Meats | | | Fluke | | | Tilefish | | |
|---|---|---|---|---|---|---|---|---|---|
| | 000 mt. | $Mil | $/lb | 000 mt. | $Mil | $/lb | 000 mt. | $Mil | $/lb |
| 1978 | 5.8 | 31.0 | 3.20 | 6.3 | 8.2 | .58 | 2.9 | 3.4 | .54 |
| 1979 | 6.1 | 43.7 | 3.20 | 8.8 | 10.2 | .53 | 3.2 | 4.3 | .60 |
| 1980 | 4.7 | 40.0 | 3.89 | 7.2 | 8.4 | .53 | 3.5 | 5.9 | .77 |
| 1981 | 2.7 | 24.2 | 4.08 | 4.6 | 6.9 | .68 | 3.1 | 6.2 | .92 |
| 1982 | 1.8 | 15.7 | 3.93 | 4.9 | 7.9 | .72 | 1.9 | 4.1 | 1.01 |
| 1983 | 2.6 | 31.7 | 5.63 | 7.0 | 9.8 | .64 | 1.8 | 4.4 | 1.12 |
| 1984 | 2.1 | 31.6 | 5.35 | 8.7 | 12.5 | .65 | 1.9 | 4.3 | 1.02 |
| 1985 | 2.1 | 21.9 | 4.64 | 6.2 | 12.8 | .93 | 1.7 | 4.4 | 1.21 |
| 1986 | 3.0 | 29.3 | 4.46 | 4.9 | 13.1 | 1.19 | 1.8 | 4.7 | 1.10 |

Table J. Northeast Region Surf Clam and Ocean Quahog Meats: Value, Price (P) and Deflated Price (p) 1978-1985 (see notes).

| | ---New England and New York------ | | | | | | ---Chesapeake and New Jersey----- | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (0 - 3 miles) | | | (3 - 200 miles) | | | (0 - 3 miles) | | | (3 - 200 miles) | | |
| | $Mil | P | p | $Mil | P | p | $Mil | P | p | $Mil | P | p |
| | Surf Clam Meats | | | | | | | | | | | |
| 1978 | 1.3 | .37 | .37 | - | - | - | 1.7 | .35 | .35 | 18.1 | .58 | .57 |
| 1979 | 1.1 | .48 | .43 | * | .47 | .43 | 1.2 | .34 | .30 | 16.9 | .59 | .53 |
| 1980 | 1.0 | .42 | .33 | - | - | - | .3 | .35 | .28 | 17.9 | .52 | .41 |
| 1981 | 1.1 | .39 | .28 | - | - | - | 2.0 | .34 | .24 | 20.4 | .55 | .39 |
| 1982 | 2.6 | .49 | .33 | - | - | - | 2.4 | .32 | .22 | 20.9 | .57 | .38 |
| 1983 | 1.6 | .47 | .31 | 1.4 | .48 | .32 | 2.5 | .33 | .22 | 19.4 | .46 | .30 |
| 1984 | 1.3 | .44 | .27 | 3.3 | .43 | .27 | 5.6 | .45 | .28 | 24.1 | .51 | .32 |
| 1985 | 4.5 | .45 | .27 | 3.7 | .52 | .31 | 5.4 | .51 | .31 | 25.3 | .52 | .32 |
| 1986 | 5.4 | .41 | .24 | 3.1 | .52 | .31 | 5.5 | .54 | .32 | 27.2 | .58 | .35 |
| | Ocean Quahog Meats | | | | | | | | | | | |
| 1978 | .8 | .29 | .29 | * | .30 | .30 | - | - | - | 5.9 | .29 | .29 |
| 1979 | 1.0 | .31 | .28 | * | .29 | .26 | - | - | - | 9.3 | .29 | .26 |
| 1980 | 1.0 | .31 | .24 | .1 | .33 | .26 | - | - | - | 9.1 | .30 | .22 |
| 1981 | .2 | .19 | .14 | 1.1 | .19 | .14 | - | - | - | 8.9 | .30 | .22 |
| 1982 | .2 | .38 | .26 | 1.2 | .38 | .26 | - | - | - | 9.5 | .30 | .21 |
| 1983 | .6 | .36 | .23 | .7 | .35 | .23 | - | - | - | 9.6 | .30 | .20 |
| 1984 | .9 | .36 | .22 | .2 | .35 | .22 | - | - | - | 10.7 | .30 | .19 |
| 1985 | - | - | - | .1 | .35 | .21 | - | - | - | 12.7 | .30 | .18 |
| 1986 | - | - | - | * | .31 | .18 | - | - | - | 10.8 | .30 | .18 |

Note. Deflated price (p) is the actual price paid (P) which has been adjusted downward for inflation using the Consumer Price Index with 1978=100. A (*) indicates that revenue is less than .1 million dollars. Landings of all vessels, all gears Maine through Virginia inclusive.

## SUMMARY STATUS OF THE FISHERY RESOURCES

### Groundfish

Atlantic cod. The nominal 1986 commercial catch from the Gulf of Maine cod stock was 10,500 mt, the lowest since 1976. The USA catch in 1986 (9,700 mt) was 1,000 mt less than in 1985 and the lowest since 1975. USA commercial fishing effort was a record-high in 1986 while CPUE declined to a record-low. The 1986 catch was dominated by the 1983 and 1982 year classes; together these cohorts accounted for 83% of the commercial catch by number and 66% by weight. Research vessel survey indices in 1986 were among the lowest ever recorded. The spring 1987 survey biomass index was the lowest in the 20-year spring survey time series. Recruitment of the 1985 year class presently appears to be above-average while the 1986 year class appears below-average. Record-high fishing effort and record-low CPUE and survey values imply that fishing mortality in 1986 remained at a record-high level. Continued fishing at this F level will result in further declines in stock biomass and landings.

Total nominal 1986 commercial catches from the Georges Bank and South cod stock were 26,100 mt, the lowest since 1976. The USA catch in 1986 (17,600 mt) was the lowest since 1976 and fell below 20,000 mt for the first time in 10 years. USA commercial fishing effort in 1986 declined by 23% from the record-high 1984/1985 level. CPUE values in 1986 for all trips catching cod and for "directed trips" declined to new record-low levels. As in 1985, USA commercial catches in 1986 were dominated by the strong 1983 year class (which accounted for 56% of the catch by number and 43% by weight). Spring and autumn 1986 research vessel survey indices showed disparate patterns; the spring indices declined from 1985 while the autumn indices slightly increased. Spring 1987 survey indices, however, were among the lowest ever indicating that, despite strong recruitment from the 1983 and 1985 year classes, stock size has continued to decline. Recruitment of the 1986 year class presently appears to be poor. Fishing mortality in 1986 is estimated to be about $F = 0.50$. Although this F value is lower than in 1985, continued fishing at this level will not result in significant rebuilding of the spawning stock from its presently low level. The 1987 fishery is expected to focus on incoming recruitment from the strong 1985 year class which, in 1987, which still be comprised of mostly immature fish. Unless F is reduced further, both yield and stock biomass will continue to decline.

Haddock. The nominal commercial and recreational catch in the Gulf of Maine averaged 6,800 mt from 1981-1983, but dropped to only 1,800 mt in 1986. Research vessel surveys indicated that the 1979, 1980 and 1982 year class were relatively strong, but information from 1986 suggests that these cohorts have been much reduced by fishing and stock biomass is low. The Georges Bank catch was 6,700 mt in 1986. The 1983 year class is currently supporting the fishery since all year classes between 1979-1982 were very poor. The 1985 year class is probably stronger than any since 1983, but the stock will probably decline further in 1987-1988.

Redfish. The nominal catch of 2,900 mt in 1986 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 $F_{0.1}$ and slightly below $F_{max}$.

Silver hake. Nominal catches in the Gulf of Maine - Middle Atlantic area totaled about 23,400 mt in 1985: 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 continued to be 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 revision in stock boundary definition; new 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 totaled only 1,900 in 1985, continuing a series of very low catches reported since about 1978. Catches were 1,000 mt in the Gulf of Maine - northern Georges Bank and 900 mt in southern Georges Bank - Middle Atlantic areas. 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 totaled 69,600 mt in 1986, the highest level ever observed. Stock biomass increased from 107,000 mt in 1970 to 258,000 mt in 1984 but has since declined to 179,000 mt in 1986. The 1979 year class is strong and there are also indications that the 1982 year class is also strong. Fishing mortality exceeded $F_{max}$ in recent years.

Yellowtail flounder. Nominal landings for 1986 (preliminary) totaled 7,600 mt for the Georges Bank and Cape Cod, Southern New England, Mid-Atlantic management units (5Z E & W of 69 W, respectively), a 13% increase over the 1985 value. This increase was due to a dramatic recruitment of the 1984 year class in the final quarter of 1986. Research survey age data, however, do not indicate that this year class is a strong one. It is not expected to contribute significantly to the fishery beyond 1987. The fishery remains heavily dependent upon incoming recruitment. In keeping with the historical pattern, fishing mortality remains substantially above $F_{max}$.

Summer flounder. Nominal catches were 11,000 mt in 1986, roughly equal to the 1980-1985 average, but 25% below the 1979 peak of 14,500 mt. Estimated recreational catches have comprised from 26-77% of the total catch from 1979-1985. Stock biomass has been at a higher level in the last 8-10 years than during the late 1960's - early 1970's, but has fluctuated considerably in the last 5 years. Current estimates of fishing mortality exceed $F_{max}$.

American plaice. Nominal catches in 1986 were 4,500 mt, 35% less than in 1985, and the lowest since 1976. 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 1,900 mt in 1976 to 6,500 mt in 1984, the highest ever, but declined to 4,500 in 1986. Stock biomass, after declining steadily since 1977, increased in 1983 and 1984 but was below the long-term average in 1986. There is some evidence that current levels of exploitation are adversely affecting the resource, and historical trends seem to preclude sustainable harvests above 6,000 mt.

Winter flounder. The nominal commercial catches in 1986 declined to 8,000 mt, 27% below 1985 and 55% below the peak in 1981. Recreational catches are in 1986 were less than one-half the level of commercial catches. Overall stock biomass increased from 1978-1986, and appears to have declined substantially from 1982-1986, relative to the 1980-1981 level.

Scup. Nominal commercial and recreational catches increased to 14,300 mt in 1986, significantly above the 1978-1985 mean. The stock biomass index in the Southern New England - Mid-Atlantic area has decreased from a high level in 1981. Following a decrease in 1982, the index fluctuated during 1981-1986 reaching some of the lowest levels observed. The stock, particularly in the Mid-Atlantic area, appears to be fully exploited.

Ocean Pout. Nominal catches decreased to 800 mt, 53% lower than in 1985. 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. The 1986 catch declined to 6,300 mt. Except for 1982, stock biomass has remained relatively constant since 1969.

Cusk. Nominal catches in 1986 were 1,900 mt, 23% less than in 1985. Stock biomass indices, while fluctuating considerably, declined sharply in 1986 to a near historic low.

Atlantic wolffish. Nominal catches increased steadily from 200 mt in 1970 to a peak of 1,300 mt in 1983, and decreased slightly to 1,000 mt in 1986, representing a 10% decline from 1985. Stock biomass indices, while fluctuating considerably, have generally exhibited a declining trend throughout this period.

Pelagics

Atlantic herring. Coastal Maine nominal catches dropped from about 48,200 mt in 1981 (the highest since 1963) to 15,500 mt in 1986. Western Gulf of Maine (Jeffreys Ledge) catches (adults) were about 15,700 mt in 1986. 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 commercial and recreational catches for this stock were 65,400 mt in 1986. The USA commercial catch has increased slowly in every year since 1970, reaching 9,600 mt in 1986. Fishing mortality remained stable from 1977-1985 at a level much lower than $F_{0.1}$. The stock underwent rapid increases in numbers and biomass with recruitment of the strong 1981, and 1982 year classes. Total stock biomass increased from about 480,000 in 1980 to 1,500,000 mt in 1986. The 1984 year class also appears to be strong.

Butterfish. Nominal catches declined 17% from 5,400 mt in 1985 to 4,500 mt in 1986. The USA catch declined slightly from 4,600 mt in 1985 to 4,500 mt in 1986. Stock abundance is currently about equal to the long-term average. The high discard rates observed during the past several years eased considerably in the latter half of 1986, which is attributed to a decline in Age 0 abundance.

Bluefish. Nominal total catch increased from an estimated 51,000 mt in 1985 to an estimated 65,700 mt in 1986. Commercial catch rose from 6,000 mt in 1985 to 6,300 mt in 1986. Recreational catch, which continues to account for about 90% of the total catch, rose from an estimated 45,000 mt in 1985 to an estimated 59,400 mt in 1986. Recruitment indices based on recreational CPUE and NEFC trawl survey CPUE indicate that strong year classes recruited to the stock in 1977, 1981 and 1984. A Fishery Management Plan for Atlantic coast bluefish is currently being developed by the ASMFC in cooperation with the Atlantic coast Fishery Management Councils, NMFS, and the Atlantic coastal states.

Other Finfish

River herring. Nominal catches in 1986 were about 3,900 mt, down from 6,100 mt in 1985. 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 from around 2,500 mt in the 1960's to a low of about 700 mt in 1985. 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 currently underway in several areas are beginning to experience modest success.

Black sea bass. Nominal commercial catches in 1986 were 8,100 mt, well above the 1981-1985 average of 1,400 mt. Recreational catches have comprised 21-86% of the combined catch in years for which estimates are available. Stock abundance has declined since 1977. It appears that the stock is fully exploited at the present time.

Striped bass. Nominal commercial catches in 1986 were only 200 mt, reflecting both decreased abundance of harvestable striped bass and major

regulatory changes. Estimated recreational catches have accounted for 24-64% of the total catch during 1979-1985. Recruitment has generally been poor since 1970, although the 1982 year class was above average. Efforts are currently underway to rebuild the striped bass resource by protecting the spawning stocks and by improving water quality.

Spiny dogfish. Nominal catches in 1986 were 2,900 mt, down from 4,000 mt in 1985. Minimum biomass estimated from NEFC spring survey catches decreased 370% from 990,500 mt in 1985 to 269,000 mt in 1986, 18% below the long-term average (327,000 mt). Since dogfish school and are highly migratory, there tends to be rather high variability among the random survey catches which results in large fluctuations in the annual biomass estimates.

Skates. Nominal catches were 4,200 mt in 1986. Skates are taken principally as by-catch in groundfish fisheries, and both the domestic and export markets are limited. Minimum biomass estimates from survey data of all skates combined was 507,500 mt in 1986, which was 306% greater than the 1968-1985 average of 125,000 mt. The increase is attributable to large catches of winter skate on Georges Bank.

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 20 mt in 1985. The USA catch increased markedly from about 300 mt in 1980 to a record 9,900 mt in 1983 and 9,500 mt in 1984. However, the 1985 USA catch decreased significantly to 5,000 mt. increasing to 5,600 mt in 1986. Due to the low USA catch in 1986 and the minimal foreign catch, the total international catch decreased to a low of 5,800 mt in 1986. Stock abundance in USA waters is currently at the third lowest annual level since 1974. However, pre-recruit abundance in autumn 1986 was the highest since 1982.

Long-finned squid. Nominal catches of *Loligo pealei* were about 17,700 mt in 1986, 36% below the 1983 catch. The USA catch in 1986 was 13,400 mt, the second highest ever, about 16% below the catch in 1983. Stock abundance is currently above the long-term average. The 1985 year class, if fished at the average 1978-1981 level of fishing mortality, should support catches during the 1986-1987 fishing year at well below the 1985 level.

American lobster. Nominal catches in 1986 were 20,900 mt, a slight increase relative to 1984 levels. Inshore catches in 1986 were 17,750 mt, while offshore catches (including Canadian catches on Georges Bank) were about 3,100 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 1985 totaled 4,200 mt, and a catch of 4,700 mt was taken in 1986. Abundance has increased substantially in recent years with recruitment of the 1982 new class. Subsequent year classes appear weaker, suggesting that abundance will decline in the near future as the 1982

year class passes through the fishery. Research vessel survey data suggest relatively low levels of exploitation at present.

Surf clams. Nominal landings (FCZ and state waters) in 1986 totaled 35,700 mt (meat weight), representing a 9% increase over 1985 landings, and the highest total since 1975. FCZ landings in 1986 were 24,900 mt, an increase of 5% over the previous year. Inshore landings (from state waters) increased 17% from 9,200 mt in 1985 to 10,800 mt in 1986, primarily due to increased production from inshore waters in New Jersey, New York, and Massachusetts. Sufficient stock biomass exists in the Middle-Atlantic and Georges Bank regions to sustain the FCZ fishery at current landings levels into the early 1990's. There do not appear to be, however, additional strong year classes offshore following the strong 1976 and 1977 year classes off New Jersey and the Delmarva Peninsula. The FCZ fishery in the Middle Atlantic 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 1986 were 20,600 mt (meat weight), representing a 13% decrease over the 1985 record production of 23,600 mt. Although landings declined slightly during 1986, adequate resources exist to supply the annual FCZ catch quota of 27,200 mt. Virtually all (96%) of the 1986 landings were 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 2% of the standing stock, but significant increases in the exploitation rate are not warranted 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 several years, after which the fishery may shift northeasterly to more dense concentrations of ocean quahogs.

Sea scallops. Nominal commercial catches in 1986 from the Gulf of Maine, Georges Bank, and Mid-Atlantic areas totaled 12,900 mt (meats), 22% higher than in 1985, and the highest annual catch since 1982. Compared to 1985, catches in 1986 declined in the Gulf of Maine (350 mt; -24%), remained unchanged in the Mid-Atlantic (3,400 mt; +2%), but markedly increased on Georges Bank (9,200 mt: +35%) due to a 50% increase in USA landings (3,000 mt to 4,500 mt) and a 23% increase in Canadian landings (3,800 mt to 4,700 mt). Total USA landings in 1986 were 8,200 mt, the highest since 1983. USA fishing effort in 1986 declined in the Gulf of Maine and Mid-Atlantic fisheries but increased on Georges Bank. Since overall USA effort in 1986 was about the same as in 1985, the changes in effort patterns in 1986 reflect displacement of effort from one fishery region to another. USA CPUE values increased in 1986 in both the Georges Bank and Mid-Atlantic fisheries (to their highest levels since 1983) due to partial recruitment of the strong 1982 year class in both regions. Abundance indices from the 1986 sea scallop indicated that the marked improvement in abundance that began in 1985 has continued. In both the USA sector of Georges Bank and in the Mid-Atlantic region, the 1986 survey indices were the highest or near the highest recorded in the 12-year survey time series. The survey results also indicated that the strong 1982 year class has been followed by an even stronger 1983 year class in both regions. Due to the excellent 1982 and 1983 year classes, catches and CPUE in 1987 and 1988 are expected to be very much higher than in 1986.

## SPECIES SYNOPSES

The synopses of information on the status of the stocks of the 33 species or groups of species presented in this section are based on commercial and recreational fishery data and on research survey data, as described in the overview to this report. Each synopsis briefly reviews the biology of the animals and the general nature of the fishery, summarizes recent catch statistics and research survey results, describes the current management of the fishery, and suggests the likely general status of the target stocks for different possible developments within the fishery.

For each stock or species a summary table[2] of catch statistics is included, along with one or more graphs showing how landings and, where possible, stock abundance, have varied over time. The measures of stock abundance used include trawl survey catch per tow, estimated stock biomass from virtual population analyses, and catch per unit of fishing effort. Specific references in the text to catches or indices of abundance are usually to values given in these tables and figures, although some summary statistics for different areas, fishing gears, or data sources which are not in the tables and figures are given in the text.

Catch statistics in the tables are given in thousands of metric tons, rounded to the nearest one hundred metric tons; values less than 110 mt are indicated as <0.1. Values quoted in the text are also usually rounded to the nearest 100 mt when less. Values too small to be of any importance, or which are zero, or which are not defined in certain situations, or for which suitable data to base estimates on do not exist, are indicated by a dash. Values which are not yet available are indicated by N/A.

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[2] The tables and figures in this section are labeled using decimal notation by species and by table or figure within species. For example, Figure 7.3 indicates the third figure for the seventh species synopsis, yellowtail flounder.

## 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 assessed as two stock 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

Total nominal catch (USA and Canada) in 1986 was 10,500 mt, 14% less than in 1985 (10,150 mt), and the lowest annual catch since 1976. The 1986 USA catch (9,700 mt) was the lowest since 1975 and was 1,000 mt less than in 1985. Reported 1986 Canadian landings were 800 mt, 45% lower than in 1985. However, reported Canadian landings since 1982 should be considered tentative, because substantial misreporting of Canadian Scotian Shelf landings as Gulf of Maine catch is believed to have occurred.

USA commercial fishing effort in 1986 attained a record-high level. USA CPUE indices, however, declined to record-low levels. "Directed trips" (trips in which cod comprised 50% or more of the trip catch, by weight), which accounted for 44% of the USA catch in 1983 and 23-25% in 1984-1985, only accounted for 18% of the 1986 USA total, the second lowest percentage in the past 21 years.

The 1986 USA catch was dominated by the 1982 and 1983 year classes. Together these cohorts accounted for 83% of the catch by number and 66% of the catch by weight. The 1983 year class was the most dominant, in terms of both numbers (60% of total) and weight (41%) landed. Otter trawl landings accounted for 69% of the 1986 USA Gulf of Maine cod catch, while gill-net landings accounted for 28%.

NMFS research vessel survey indices in 1986 were among the lowest ever.

The spring 1987 weight per tow index was the lowest in the 20-year spring survey time series. Survey age composition data indicate the 1983 year class dominated the Gulf of Maine cod population in 1986, accounting for about 34% of the population size by number and about 30% by weight. The surveys also indicate that the 1985 year class is above-average in strength while the 1986 year class is below average.

Record-high fishing effort and record-low CPUE and survey abundance values imply that fishing mortality in 1986 remained at a record-high level. Given the depressed condition of the Gulf of Maine cod stock, continued declines in stock biomass and landings are expected if fishing mortality is not reduced.

Georges Bank and South

Total nominal catch (USA and Canada) in 1986 was 26,100 mt, 30% less than in 1985. The 1986 catch was the lowest since 1976 and marked the fourth consecutive year in which annual yield has declined. The 1986 USA catch (17,600 mt), the lowest since 1976, declined 34% from 1985 and was below 20,000 mt for the first time in ten years. Canadian 1986 landings totaled 8,500 mt, 19% lower than in 1985.

USA nominal commercial fishing effort in 1986 declined (-23%) from the record-high levels attained in 1984-1985 to its lowest level since 1979. USA commercial CPUE indices in 1986 also declined; CPUE values for all trips catching cod and for "directed trips" (which accounted for 67% of the 1986 USA Georges Bank cod catch) were the lowest on record.

As in 1985, the USA catch in 1986 was dominated by the 1983 year class. This cohort accounted for 56% of the 1986 catch in numbers and 43% of the catch in weight. The next most important year classes were the 1984 year class which accounted for 19% of the number of cod landed (but only 9% by weight), and the 1980 year class which accounted for 17% of the catch weight (but only 7% by number).

NMFS research vessel survey indices in 1986 showed disparate patterns. The spring 1986 indices (number and weight per tow) declined from 1985 while the autumn indices slightly increased. The 1980 year class was dominant in the spring survey (36% of the total number of cod) while the 1985 year class was dominant in the autumn survey (73% of the total number of cod). In both surveys, however, the 1983 cohort accounted for a major proportion of the biomass (23% in both spring and autumn).

The spring 1987 survey results reveal that the 1985 and 1983 year classes are currently the most important in the stock, comprising 50% and 27%, respectively, of the population by number. However, both total number and weight per tow indices from the spring 1987 survey were among the lowest recorded indicating that overall stock size has declined despite strong recruitment from the 1983 and 1985 cohorts. Recruitment from the 1986 year class appears poor based on the two 1986 surveys and the spring 1987 survey.

Fishing mortality in 1986 is estimated to be about F=0.50. Although $F_{1986}$ is less than in $F_{1985}$, continuation of this fishing mortality rate in the

future will not result in significant rebuilding of spawning stock biomass from its presently low level. The fishery in 1987 will likely focus on the strong 1985 year class which, at age 2 (in 1987), will be comprised mostly of immature fish. Unless F is reduced, both yield and spawning potential will be sacrificed for short-term catch. Since the Georges Bank stock has declined to a level well below its normal historical range and because cod is a major component in the USA northeast multispecies fishery, the present state of the stock gives cause for concern.

For further information see:

Serchuk, F.M., and S.E. Wigley. 1986. Assessment and status of the Georges Bank and Gulf of Maine Atlantic cod stocks - 1986. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 86-12, 84 p.

Northeast Fisheries Center. 1986. Report of the Third NEFC Stock Assessment Workshop. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 86-14, 98 p.

Table 1.1 Nominal catches (thousand metric tons) and management information for Atlantic cod from the Gulf of Maine.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational[1] | - | 1.0 | 3.1 | 1.2 | 1.7 | 1.1 | 1.8 | 2.8 | N/A |
| Commercial | | | | | | | | | |
| USA | 12.4 | 11.7 | 13.5 | 12.5 | 13.6 | 14.0 | 10.8 | 10.7 | 9.7 |
| Canada | 0.4 | 0.4 | 0.2 | 0.6 | 1.4 | 2.7 | 1.4 | 1.4 | 0.8 |
| Other | - | - | - | - | - | - | - | - | - |
| Total nominal catch | 12.8[2] | 13.1 | 16.8 | 14.3 | 16.7 | 17.8 | 14.0 | 14.9 | N/A |

Long-term potential catch = 10,000 mt
Importance of recreational fishery = Major
Status of management = FMP in force since October 1986
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 $F_{1986}$ > 0.62

1 Estimated for Maine and New Hampshire.
2 Recreational catches unknown.

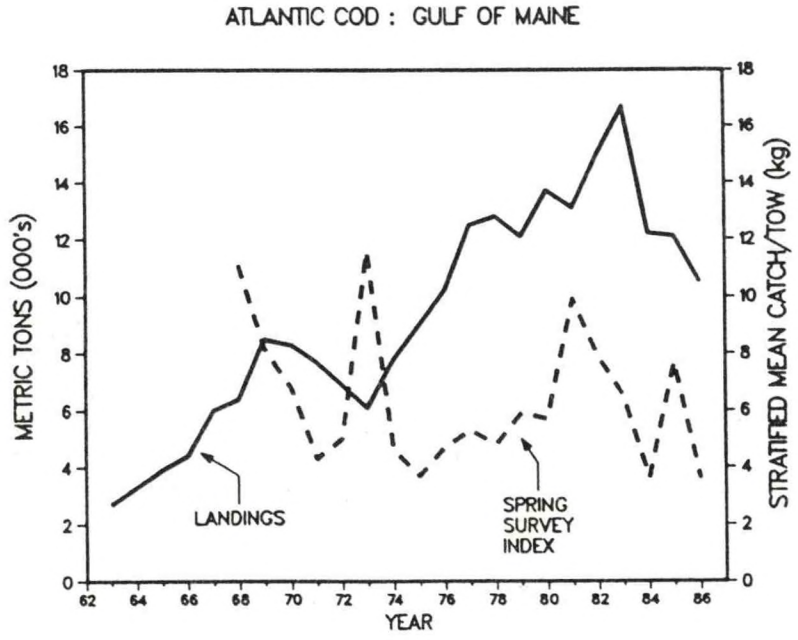


Figure 1.1 Total commercial landings and stock biomass indices from NEFC spring bottom trawl surveys of Atlantic cod in the Gulf of Maine.

Table 1.2 Nominal catches (thousand metric tons) and management information for Atlantic cod from Georges Bank and South.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational[1] | - | 2.8 | 3.3 | 7.4 | 6.3 | 7.2 | 3.6 | 6.2 | N/A |
| Commercial | | | | | | | | | |
| USA | 26.6 | 32.7 | 40.0 | 33.9 | 39.3 | 36.8 | 32.9 | 26.8 | 17.6 |
| Canada | 8.9 | 6.0 | 8.1 | 8.5 | 17.9 | 12.1 | 5.8 | 10.5 | 8.5 |
| Other | - | - | - | - | - | - | - | - | - |
| Total nominal catch | 35.5[2] | 41.5 | 51.4 | 49.8 | 63.5 | 56.1 | 42.3 | 43.5 | N/A |

| | |
|---|---|
| Long-term potential catch | = 35,000 mt |
| Importance of recreational fishery | = Major |
| Status of management | = FMP in force since October 1986 |
| 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 $F_{0.1}$ = 0.16 $F_{max}$ = 0.28 $F_{1986}$ = 0.50

1 Estimated for Massachusetts and southward.
2 Recreational catches unknown.

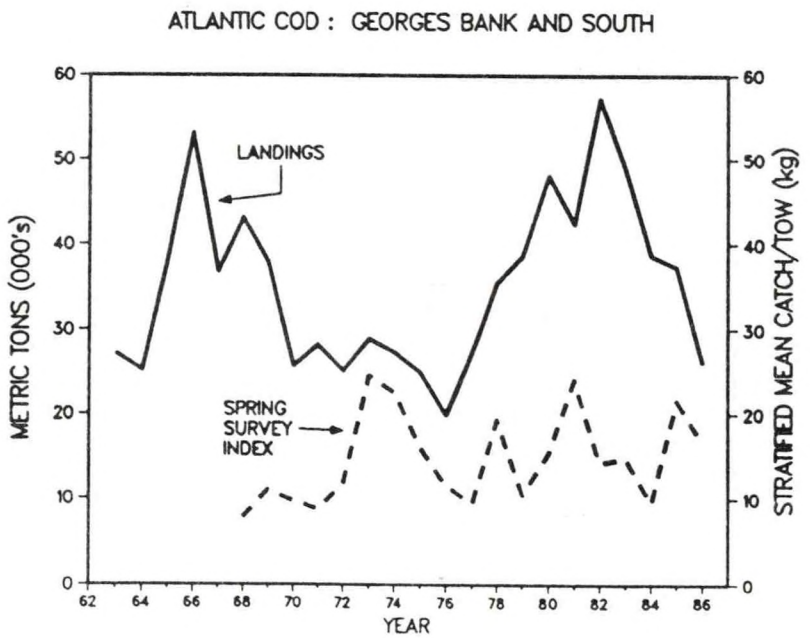


Figure 1.2 Total commercial landings and stock biomass indices from NEFC spring bottom trawl surveys of Atlantic cod in the Georges Bank and South area.

## 2. Cod

## 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 50-60 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 early 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.

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 catch quotas, seasonal spawning area closures, codend mesh size regulations and mandatory data reporting requirements. The 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. The Northeast Multispecies Fishery Management Plan was implemented in October 1986. It provides the basis for managing the ten important demersal species in the New England area.

### Gulf of Maine

During 1978-1984, USA fishermen accounted for 86% 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 7,700 mt in 1980, averaged 6,800 mt from 1981-1983, and declined steadily to 1,800 mt in 1986. Since 1980, the fishery has been supported primarily by the 1978, 1979, 1980 and 1982 year classes. Estimated recreational catches have declined from 1,700 mt in 1979 to less than 50 mt in 1981-1986.

The NEFC autumn survey index has declined in nearly every year since 1978 while spring index values have shown a general downward trend since 1981. Spring and autumn index values for 1986 were among the lowest on record and autumn indices were the lowest in the time series. Although recent surveys indicated that the 1979, 1980 and 1982 year classes were relatively strong;

data for 1986 suggest that these year classes have been much reduced by fishing and that the stock is now in extremely poor condition. Autumn surveys by the Massachusetts Division of Marine Fisheries suggest that recruitment from the inshore portion of the Gulf of Maine has been negligible since 1982.

Georges Bank

USA fishermen accounted for 69% of the nominal commercial catch during 1977-1984, but the percentage declined to 55% in 1985 and 49% in 1986. 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 ending 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 22,400 mt in 1978 to 27,600 mt in 1980 and declined in every year since that time to 6,700 mt in 1986. Since 1981, the Georges Bank fishery has been supported primarily by the 1978 and 1983 year classes. Research vessel survey data for 1979-1985 indicate a succession of weak year classes. The fishery is highly dependent on the 1983 and 1985 year classes at the present time.

The NEFC spring survey index for Georges Bank rose to 35.7 kg/tow in 1980, declined from 1981 - 1984 to 4.9 kg/tow, increased to 11.1 kg/tow in 1985 and declined again in 1986 to 5.9 kg/tow. The autumn survey index rose to 26.9 kg/tow in 1979,declined to 3.0 kg/tow in 1984, and increased to 5.1 kg/tow in 1986. These recent increases resulted primarily from recruitment and growth of the 1983 and 1985 year classes. The 1981, 1982, 1984 and 1986 young-of-year indices for Georges Bank were among the lowest on record. Estimates for the 1983 year class and indices for the 1985 year class suggest that they may be comparable to the 1972 year class in size, however, high fishing mortality and discarding reduced these cohorts quickly.

Stock size estimates (age 2 and older) calculated from virtual population analysis or VPA have declined from 95 million fish or 116,000 mt in 1980 to 9 million fish and 13,000 mt in 1986. 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 remain stable in 1987 and decline further in 1988.

For further information see:

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.

Northeast Fisheries Center. 1986. Report of the Second NEFC Stock Assessment Workshop. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 86-09, 114 p.

Table 2.1 Nominal catches (thousand metric tons) and management information for Gulf of Maine haddock.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | 1.7 | 0.2 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Commercial | | | | | | | | | |
| USA | 4.5 | 4.6 | 7.3 | 5.7 | 5.6 | 5.6 | 2.8 | 2.2 | 1.6 |
| Canada | 0.6 | 0.3 | 0.2 | 0.5 | 1.1 | 2.0 | 1.2 | 0.8 | 0.2 |
| Other | - | - | - | - | - | - | - | - | - |
| Total nominal catch | 6.1[1] | 6.6 | 7.7 | 6.2 | 6.7 | 7.6 | 4.0 | 3.0 | 1.8 |

| | | | |
|---|---|---|---|
| Long-term potential catch | = 5,000 mt | | |
| Importance of recreational fishery | = Minor | | |
| Status of management | = FMP in force since October 1986 | | |
| Status of exploitation | = Fully exploited | | |
| Age at 50% maturity | = 2 years | | |
| Size at 50 maturity | = 38 cm (15 inches) | | |
| M = 0.20 | $F_{0.1}$ = 0.26 | $F_{max}$ = 0.55 | $F_{1986} > F_{max}$ |

1 Recreational catches unknown.

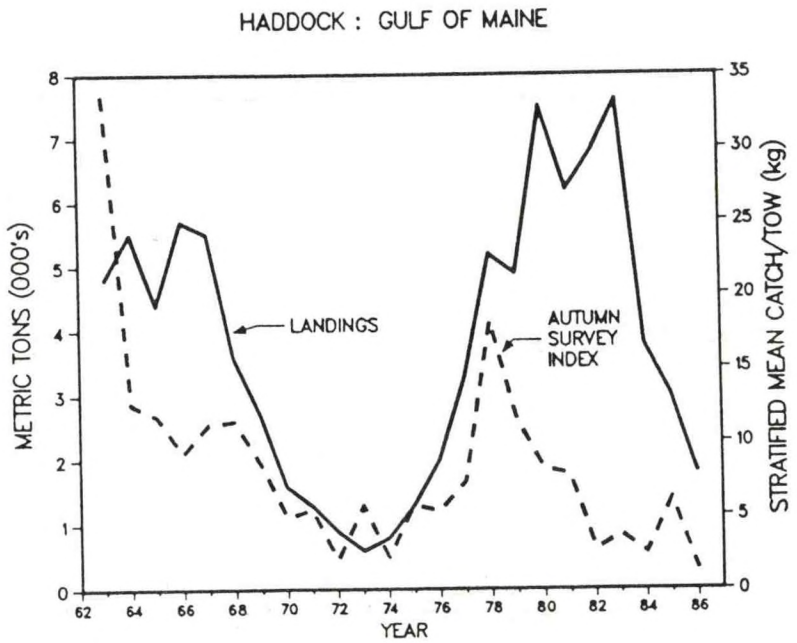


Figure 2.1 Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of haddock in the Gulf of Maine.

Table 2.2 Nominal catches (thousand metric tons) and management information for Georges Bank haddock.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | - |
| Commercial | | | | | | | | | |
| USA | 12.2 | 14.3 | 17.5 | 19.2 | 12.6 | 8.7 | 8.8 | 4.3 | 3.3 |
| Canada | 10.2 | 5.2 | 10.1 | 5.7 | 5.6 | 3.2 | 1.4 | 3.5 | 3.4 |
| Other | - | - | - | <0.1 | - | - | - | - | - |
| Total nominal catch | 22.4 | 19.5 | 27.6 | 24.9 | 18.2 | 11.9 | 10.2 | 7.8 | 6.7 |

| | |
|---|---|
| Long-term potential catch | = 47,000 mt |
| Importance of recreational fishery | = Insignificant |
| Status of management | = FMP in force since October 1986 |
| Status of exploitation | = Fully exploited |
| Age at 50% maturity | = 2 years |
| Size at 50% maturity | = 38 cm (15 inches) |
| M = 0.20 $F_{0.1}$ = 0.26 | $F_{max}$ = 0.55 $F_{1986} > F_{max}$ |

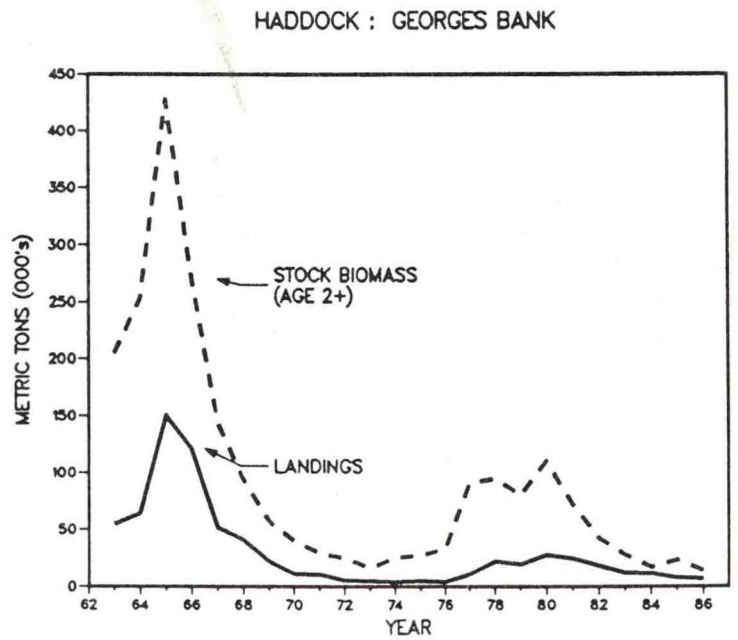


Figure 2.2 Total commercial landings and estimates of stock biomass of haddock on Georges Bank.

# 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. In 1985 and 1986, however, catches declined to 4,200 and 2,900 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 and 1978 year classes. The 1971 year class accounted for 63% of the numbers landed in the commercial fishery in 1980 and 1981. In 1983, however, the 1978 year class recruited to the fishery, accounting for 15% of the total. In 1986, this year class represented 63% of the total number landed.

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 0.9 and 0.6 mt/day in 1985 and 1986, respectively. The NEFC autumn survey index declined from an average of 122 fish/tow in 1967-1968 to an average of 10 fish/tow in 1983-1985 although the 1986 autumn index increased slightly to 18 fish/tow. Estimates of exploitable biomass (ages 5 and older) from virtual population analysis declined by 75% from 136,000 mt in 1969 to 32,000 mt in 1985. Projections for 1987 indicate a 5+ stock biomass of 26,000 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 above the calculated $F_{0.1}$ value and slightly below $F_{max}$. Equilibrium surplus production models have indicated that the long-term potential catch is about 14,000 mt. However, given the current low population abundance and poor recruitment, surplus production in the near future will be considerably less than that, as indicated by the sharp decline in 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 year class, recruitment has been poor; thus, biomass is not expected to increase substantially in the near future.

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. North. 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.

Northeast Fisheries Center. 1986. Report of the Second Stock Assessment Workshop. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 86-09, 114 p.

Table 3.1 Nominal catches (thousand metric tons) and management information for redfish from the Gulf of Maine and Georges Bank area.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| USA | 14.0 | 14.7 | 10.1 | 7.8 | 6.7 | 5.2 | 4.7 | 4.2 | 2.9 |
| Canada | 0.1 | <0.1 | 0.1 | <0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| Other | - | <0.1 | - | - | <0.1 | - | - | - | - |
| Total nominal catch | 14.1 | 14.7 | 10.2 | 7.8 | 6.8 | 5.3 | 4.8 | 4.3 | 3.0 |

Long-term potential catch = 14,000 mt
Importance of recreational fishery = Insignificant
Status of management = FMP in effect since October 1986
Status of exploitation = Fully exploited
Age at 50% maturity = 8-9 years
Size at 50% maturity = 22-23 cm (8.5 - 9.0 inches)
M = 0.05 $F_{0.1}$ = 0.07 $F_{max}$ = 0.14 $F_{1986}$ = 0.12

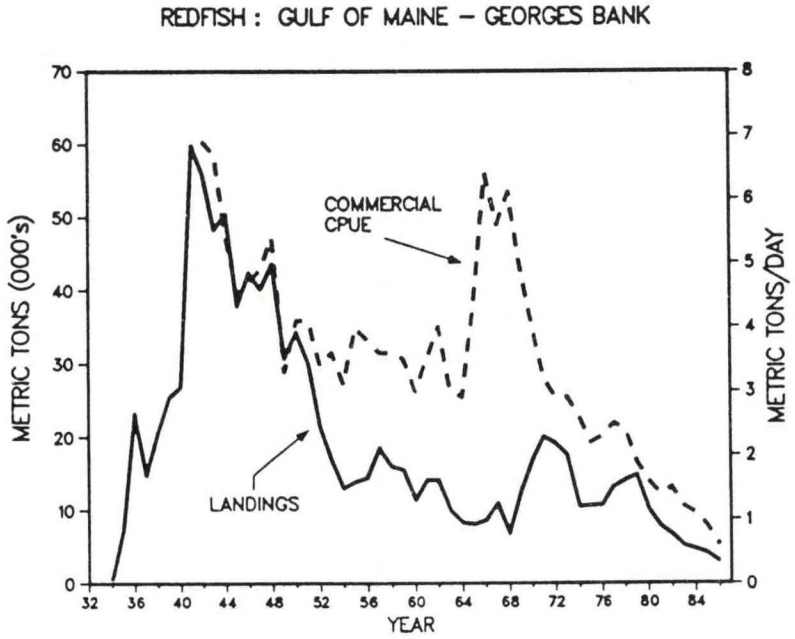


Figure 3.1 Total commercial landings and catch per unit effort of redfish in the Gulf of Maine - Georges Bank area.

# SILVER HAKE

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

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

Silver hake grow to a maximum length of approximately 65 cm (25.6 inches). Ages of 15 years have been reported, although fish older than about 8-10 years are rarely encountered.

## Gulf of Maine - Northern Georges Bank Stock

The nominal catch of silver hake in 1986 was 8,500 mt, taken exclusively by the USA. While this catch was slightly higher than 1985 and was the highest level reported since 1978, it is still well below catches 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 (DWF) 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 39,900 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 but have increased since 1981. Prior to the inception of the MFCMA, the DWF 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.

The spring and autumn NEFC bottom trawl survey catch-per-tow indices reached high levels in 1976 and 1975 respectively, and both declined through 1984. In 1985 and 1986 both indices increased sharply due primarily to strong 1984 and 1985 year classes. The autumn index reached its highest in the time series since 1963. Survey catch-per-tow-at-age data indicate that 1974-1975 year classes were quite strong. These year classes supported the increase in commercial catch in 1975. The 1978 and 1982 year classes were also relatively strong in comparison to other years in the 1973-1983 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 strong, however, the 1985 year class may be the strongest with the autumn 1985 index of age 0 and 1 fish the highest in the time series since 1973.

Fishing mortalities for fully recruited ages determined from VPA ranged between 0.19 and 1.29 during 1955-1986 and averaged 0.43. Before the introduction of the DWF, F was fairly steady, averaging 0.27 during 1955-1961, however, F rose rapidly with the increased effort placed on the stock beginning in 1962 and reached 0.70 in 1964. In 1965, both landings and F dropped sharply and F stabilized at an average of 0.41 during 1965-1970. F increased dramatically in 1971, reaching 1.29, but dropped to 0.42 in 1972 and fluctuated in alternate years during 1972-1978 between 0.28 and 0.78 before dropping to 0.19 in 1979 after the inception of MFCMA. Since 1979, F has remained fairly steady averaging 0.41 through 1986 (0.46).

Spawning stock biomass increased from 251,800 mt in 1958 to a high of 301,900 mt in 1962 than began a steady ten year decline to 47,900 mt in 1972. As a result of strong 1971-1973 cohorts, spawning biomass increased to 73,700 mt in 1975, but declined to only 12,000 mt by 1982. Spawning biomass has increased since 1981 to an estimated 33,500 mt at the beginning of 1987.

Projection of catch in 1987 and stock sizes in 1988 were calculated under two options of recruitment in 1987. If recruitment into the fishery in 1987 is about 90 million fish, fishing at $F_{0.1}$ would result in a catch of about 14,400 mt, and would leave an age 2+ biomass of 39,200 mt in 1988, approximately a 17% decrease from 1987. A catch of 6,500 mt in 1987, requiring an F of 0.18, would leave age 2+ biomass unchanged from 1987 to 1988. If recruitment in 1987 is 120 million, fishing at $F_{0.1}$ would result in a catch of about 14,300 mt, but the resulting biomass in 1988 would be 43,500 mt, and 8% decrease from 1987. A catch of 10,700 mt in 1987, requiring an F of 0.31, would leave age 2+ biomass unchanged from 1987 to 1988.

Southern Georges Bank - Middle Atlantic Stock

The international nominal catch of silver hake in 1986 was 10,100 mt. The USA commercial catch in 1985 was 9,500 mt, the lowest level since 1976, but maintaining the fairly constant level of catches which have averaged about 12,000 mt during 1978-1983. DWF catch in 1986 was only 500 mt. The DWF catch, from 1963 to the inception of MFCMA in 1977, dominated the total catch from this stock averaging 87% annually. Recreational catch in 1986 was estimated to be about 100 mt.

Total catches from this stock averaged about 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 15,500 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 autumn catch-per-tow index decreased from its highest levels during 1963-1965 to a low in 1974, and increased slightly during 1975-1978 then decreased through 1982. The indices fluctuated during 1983-1986. 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, 1981, and 1982 cohorts, were of only average strength, however, the 1985 year class showed quite strong in comparison to other years. The strength of 1986 year class appeared to be below the average level, and the weakest since 1973.

Fishing mortality for fully recruited ages from VPA ranged from 0.09 to 0.98 during 1955-1986 and averaged 0.45. During 1955-1959 F averaged 0.32 but dropped to 0.11 during 1960-1962 before rising dramatically with the introduction of the DWF to 0.98 in 1965. F then dropped and averaged 0.52 during 1968-1977. With the inception of MFCMA and the restrictions placed on the foreign fishery, F dropped from 0.76 in 1977 to 0.31 in 1980, increased during 1981-1984, and averaged 0.36 in 1985-1986.

Spawning stock biomass increased from 51,600 mt in 1955 to a series high of 655,700 mt in 1965 before dropping steadily to 143,000 mt in 1970. Biomass then increased to 219,500 mt in 1974 but subsequently declined to only 24,200 mt in 1983, but has increased since then to an estimated 35,200 mt in 1987.

Assuming recruitment into the fishery in 1987 is about 200 million fish, fishing at $F_{0.1}$ would result in a projection of catch of about 11,500 mt, and would leave an age 2+ biomass of 43,700 mt in 1988, approximately a 2% increase from 1987. A catch of 12,600 mt in 1987, requiring an F of 0.39, would leave age 2+ biomass unchanged from 1987 to 1988.

For further information see:

Almeida, F. P. 1987. Status of the silver hake resources off the northeast coast of the United States - 1987. Woods Hole Lab. Ref. Doc. No. 87-03. 60 p.

Table 4.1 Nominal catches (thousand metric tons) and management information for silver hake from the Gulf of Maine - Northern Georges Bank stock.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| USA | 12.6 | 3.4 | 4.7 | 4.4 | 4.7 | 5.3 | 8.3 | 8.3 | 8.5 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | - | - | - | - | - | - | - | - | - |
| Total nominal catch | 12.6 | 3.4 | 4.7 | 4.4 | 4.7 | 5.3 | 8.3 | 8.3 | 8.5 |

Long-term potential catch = unknown
Importance of recreational fishery = Insignificant
Status of management = Preliminary FMP in force since 1977
Status of exploitation = Underexploited
Age at 50% maturity = 2 years
Size at 50% maturity = 23.8 cm (9.4 inches) males; 25.0 cm (9.8 inches) females

M = 0.40 $F_{0.1}$ = 0.44 $F_{max}$ > 2.00 $F_{1986}$ = .46

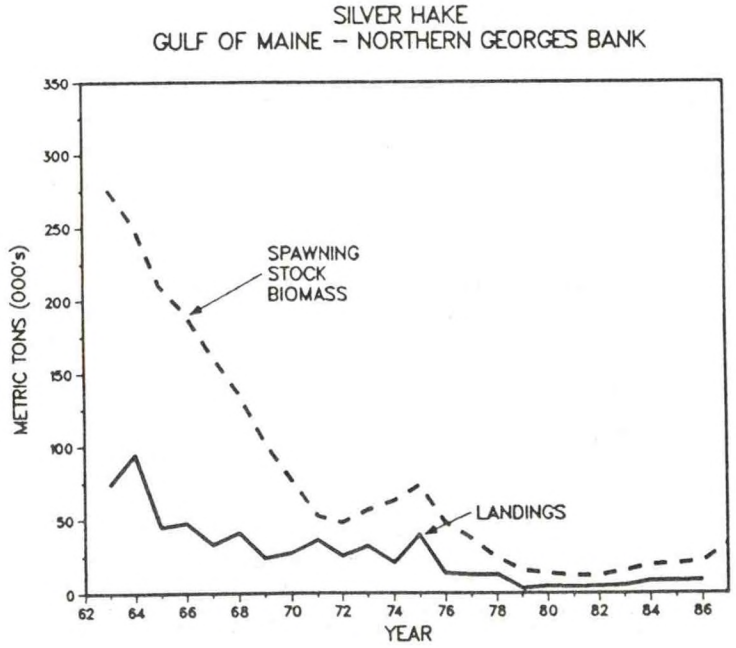


Figure 4.1 Total commercial landings and stock biomass indices for the Gulf of Maine - northern Georges Bank stock if silver hake.

Table 4.2 Nominal catches (thousand metric tons) and management information for silver hake from the Southern Georges Bank - Middle Atlantic stock.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | 0.4 | 0.1 | 0.1 | 0.3 | <0.1 | <0.1 | <0.1 | 0.1 |
| Commercial | | | | | | | | | |
| USA | 11.4 | 13.1 | 11.7 | 11.7 | 11.9 | 11.5 | 12.7 | 11.8 | 9.4 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | 14.4 | 4.9 | 1.7 | 3.0 | 2.4 | 0.6 | 0.4 | 1.3 | 0.5 |
| Total nominal catch | 25.8[1] | 18.4 | 13.5 | 14.8 | 14.6 | 12.1 | 13.1 | 13.1 | 10.0 |

| | |
|---|---|
| Long-term potential catch | = Unknown |
| Importance of recreational fishery | = Minor |
| Status of management | = Preliminary FMP in force since 1977 |
| Status of exploitation | = Underexploited |
| Age at 50% maturity | = 2 years |
| Size at 50% maturity | = 24.7 cm (9.7 inches) males<br>25.7 cm (10.1 inches) females |

M = 0.40 $F_{0.1}$ = 0.35 $F_{max}$ > 2.00 $F_{1986}$ = 0.33

1 Recreational catches unknown

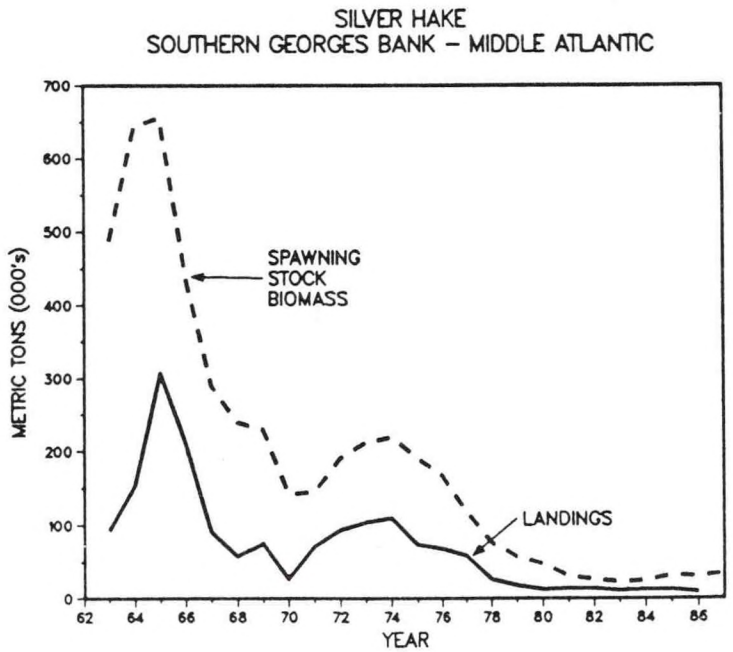


Figure 4.2 Total commercial landings and stock biomass indices for the southern Georges Bank - Middle Atlantic stock of silver hake.

## 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.

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.

### Gulf of Maine - Northern Georges Bank Stock

The nominal catch of this stock of red hake in 1986 was 1,500 mt, taken exclusively by the USA vessels. This catch represented about 50% increase from 1985 and 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, 1972-1976, showed a sharp increase, with catches ranging from 6,300 to 15,300 mt. During this period approximately 93% of the total annual catch was taken by the distant-water-fleet (DWF) 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 DWF 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 1973 then declined through 1979. The index then increased dramatically in 1980, recorded a series high in 1981, and has fluctuated at high levels since. The 1985 value was the third 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. This index also increased from low levels in the 1960's and early 1970's and has maintained a relatively high average during the 1980's. Survey catch-per-tow-at-age data indicate that the 1973 and 1974 year classes were the strongest since 1970. Year classes produced during 1975-1979 were of average strength with the exception of a weak 1977 cohort. The 1980 and 1981 year classes appeared to be above average while the 1983 year class appeared to be weak in comparison to other years. Preliminary estimates of the 1985 cohort indicate that it may be quite strong, recording the second highest age 0 autumn index in the 1970-1985 time series. The strength of 1986 year class appeared to be above average.

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 1987 if catches remain at or somewhat above the levels reported in recent years.

Southern Georges Bank-Middle Atlantic Stock

The nominal catch of this stock of red hake in 1986 was 600 mt, the lowest catch reported in the 1960-1986 time series and continuing a trend of decreasing catches which began in 1977. The USA catch in 1986 was 600 mt, and the DWF catch was reported to be none. Recreational catch was estimated to be approximately 30 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 18,700 mt in 1968, increased to 53,400 mt in 1969 then dropped 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 because of a modest decline in DWF catch and later because of a sharp decline in DWF catch after the exclusion of the USSR from the fishery. 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 squid fishery.

USA 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 4,000 mt in 1966. USA catch has remained relatively steady during 1967-1979 when catches averaged 4,100 mt annually, and has since declined steadily.

The NEFC autumn bottom trawl survey index declined steadily from the highest levels in the mid-1960's, remained fairly constant during 1968-1973, and then dropped to a series low in 1974. The index increased sharply in 1975, declined slightly and remained fairly steady during 1976-1982 at a level similar to that during 1968-1973. The index reached the second highest in 1983 and dropped sharply to the second lowest level in 1984 since 1963, but increased in 1985 and dropped again in 1986. Survey catch-per-tow-at-age indices indicate 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 weak. However, the autumn 1985 prerecruited index was the second highest in the time series, indicating the possibility of a strong 1985 year class.

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 strongly to the survey indices. However, the survey does indicate that the stock has declined somewhat in recent years. If the 1985 year class is as strong as the autumn index has indicated, then an increase in stock biomass will be expected in the next 1-2 years.

For further information see:

Northeast Fisheries Center. 1986. Report of the Second Stock Assessment Workshop. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 86-09, 114 p.

Table 5.1 Nominal catches (thousand metric tons) and management information for red hake from the Gulf of Maine - Northern Georges Bank stock.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| USA | 1.2 | 1.5 | 1.0 | 1.2 | 1.2 | 0.9 | 1.1 | 1.0 | 1.5 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | - | - | - | - | - | - | - | - | - |
| Total nominal catch | 1.2 | 1.5 | 1.0 | 1.2 | 1.2 | 0.9 | 1.1 | 1.0 | 1.5 |

Long-term potential catch = Unknown
Importance of recreational fishery = Insignificant
Status of management = Preliminary FMP in force since 1977
Status of exploitation = Underexploited
Age at 50% maturity = 2 years
Size at 50% maturity = 28.1 cm (11.1 inches)
M = 0.40 $F_{0.1}$ = Unknown $F_{max}$ > 2.00 $F_{1986}$ = Unknown

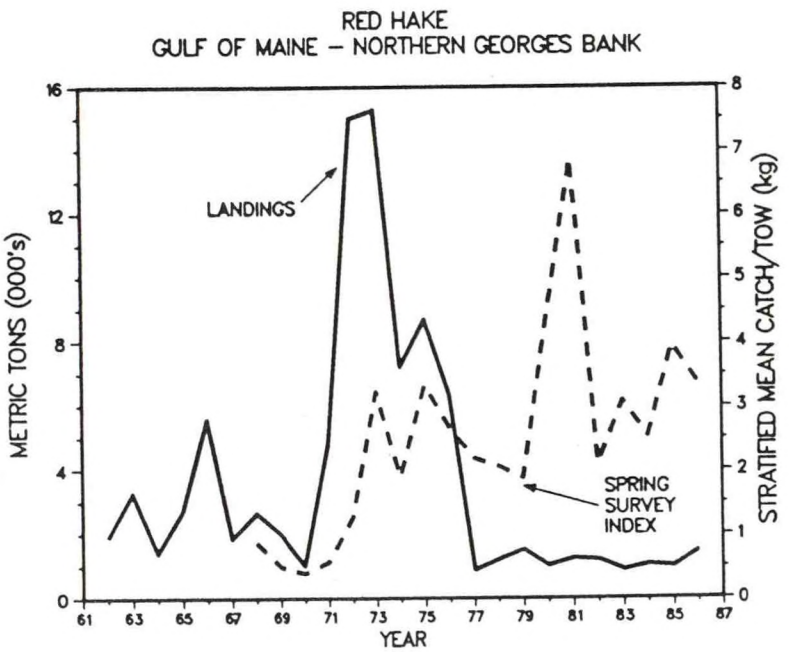


Figure 5.1 Total commercial landings and stock biomass indices for the Gulf of Maine - northern Georges Bank stock of red hake.

Table 5.2 Nominal catches (thousand metric tons) and management information for red hake from the Southern Georges Bank - Middle Atlantic stock.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | <0.1 | <0.1 | <0.1 |
| Commercial | | | | | | | | | |
| USA | 3.3 | 6.6 | 3.9 | 2.1 | 3.0 | 1.3 | 1.2 | 0.8 | 0.6 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | 2.1 | 1.0 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | - |
| Total nominal catch | 5.4[1] | 7.8 | 4.2 | 2.4 | 3.3 | 1.5 | 1.3 | 0.9 | 0.6 |

Long-term potential catch = Unknown
Importance of recreational fishery = Minor
Status of management = Preliminary FMP in force since 1977
Status of exploitation = Underexploited
Age at 50% maturity = 2 years
Size at 50% maturity = 27.6 cm (10.9 inches)
M = 0.40 $F_{0.1}$ = Unknown $F_{max}$ > 2.00 $F_{1986}$ = Unknown

1 Recreational catch unknown

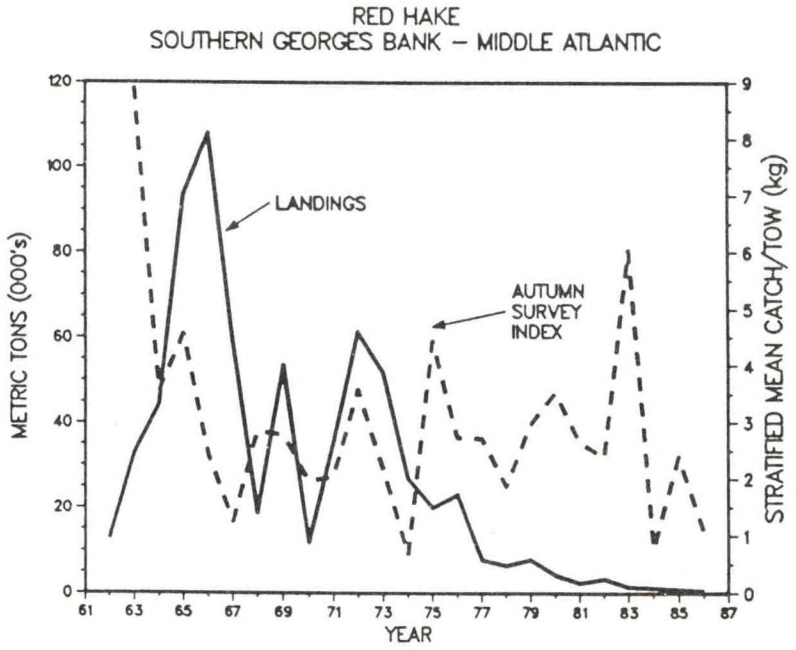


Figure 5.2 Total commercial and recreational landings and stock biomass indices for the southern Georges Bank - Middle Atlantic stock of red hake.

# 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 has 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 69,600 mt in 1986. Nominal catches for Canada increased steadily from 24,700 mt in 1977 to 43,300 mt in 1985 and 1986; USA catches have increased from an average of 9,700 mt during 1973-1977 to over 14,000 mt annually since 1978, peaking at 24,500 mt in 1986. Nominal catches by distant-water fleets have declined from an average of 4,200 mt during 1973-1977 to approximately 500 mt since 1981. Most of this catch has been taken by USSR vessels on the Scotian Shelf. Estimated USA recreational catches have fluctuated between 200 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 69,000 mt in 1986.

Total stock size, after increasing throughout the late 1970's and early 1980's, appears to have declined in 1985 and 1986. Canadian commercial abundance indices (mt/hour fished) were also relatively high during 1978-1984 but declined sharply in 1985. Indices for USA trawlers also indicate similar trends. 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 a decrease in age 2+ stock biomass from 258,000 mt in 1984 to 179,000 mt in 1986.

Equilibrium yield calculations indicate that fishing at $F_{0.1}$ would provide a long-term catch of 47,700 mt from a stock biomass of 300,600 mt, while fishing at $F_{max}$ would provide a catch of 55,000 mt from a stock biomass of 175,200 mt. In 1985, fishing mortality was above $F_{max}$.

For further information see:

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.

McGlade, J., M. C. Annand, and D. Beanlands. 1985. The exploitation and biological status of pollock in Divisions 4VWX and Subarea 5. CAFSAC Res. Doc. 85/99, 90 p.

Table 6.1 Nominal catches (thousand metric tons) and management information for pollock from the Gulf of Maine, Georges Bank, and Scotian Shelf area.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | 0.7 | 1.0 | 0.7 | 1.3 | 1.3 | 0.2 | 0.7 | 0.2 |
| Commercial | | | | | | | | | |
| USA | 17.7 | 15.5 | 18.3 | 18.2 | 14.4 | 14.0 | 17.8 | 19.3 | 24.5 |
| Canada | 26.8 | 30.0 | 36.0 | 40.3 | 38.0 | 32.7 | 33.2 | 43.3 | 44.1 |
| Other | 0.8 | 1.1 | 1.2 | 0.5 | 0.4 | 0.5 | 0.1 | 0.4 | 1.0 |
| Total nominal catch | 45.3[1] | 47.3 | 56.5 | 59.7 | 54.1 | 48.5 | 51.3 | 63.7 | 69.8 |

Long-term potential catch = 55,000 mt
Importance of recreational fishery = Minor
Status of management = FMP in effect since October 1986
Status of exploitation = Fully exploited
Age at 50% maturity = 3.7 years
Size at 50% maturity = 50 cm (20 inches)
M = 0.20 $F_{0.1}$ = 0.19 $F_{max}$ = 0.45 $F_{1986}$ = 0.52

1 Recreational catches unknown.

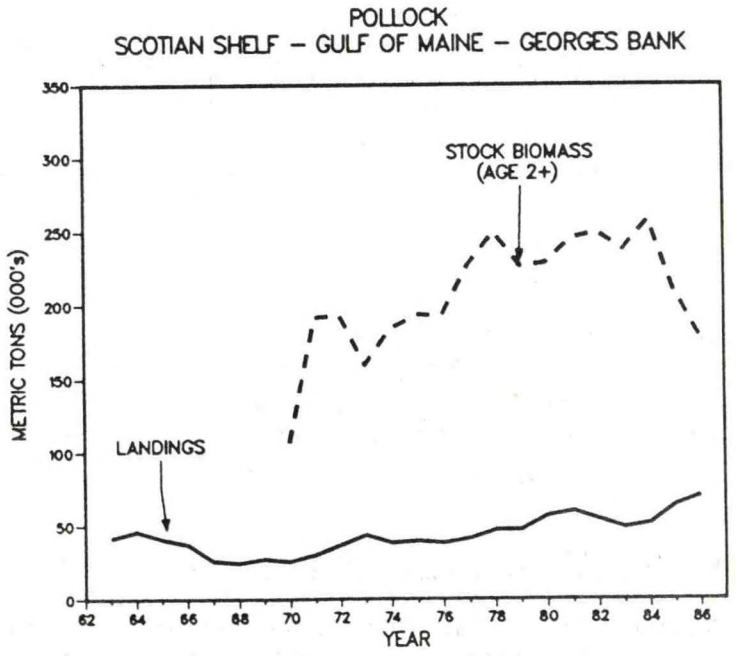


Figure 6.1 Total commercial and recreational landings and estimates of stock biomass of pollock in the Gulf of Maine, Georges Bank, and Scotian Shelf area.

# YELLOWTAIL FLOUNDER

The yellowtail flounder *Limanda ferruginea* ranges from Labrador to Chesapeake Bay. Off the USA coast, it occurs in commercially important concentrations on Georges Bank, off Cape Cod and 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); 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 of 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).

## Georges Bank (East of 69°W)

Reported landings declined from an average of 14,700 mt during 1972-1976 to only 4,600 mt in 1978. Landings increased gradually through 1980 and then rose sharply to 10,700 mt and 11,400 mt in 1982 and 1983, respectively, the highest catches since 1976. Subsequent landings declined to only 2,500 mt in 1985. Preliminary landings for 1986 were 3,100 mt; CPUE (discarded not included) was slightly higher than in 1985. This slight increase was likely due to catches of the recruiting 1984 year-class during the fourth calendar quarter. Landings during the first three quarters of 1986 were 9% lower than in 1985, respectively; in the fourth quarter of 1986 they increased 134% over 1985. The 1984 year-class made a more noticeable impact on the fishery than those of 1982 and 1983. The number of age two yellowtail reflected in the autumn 1986 survey was larger than that of 1984 and 1985, but far below the (1963-1986) time series average. Spring 1987 survey abundance indices (stratified mean number and weight per tow) decreased to levels lower than those in 1985, again indicating that the 1984 year-class cannot be considered a strong one.

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

Southern New England commercial and survey indices declined to very low levels in the mid-1970's; they then increased gradually until 1982 - 1983 with recruitment of the 1980-1981 year classes (the strongest in recent years). Indices have since declined markedly, now representing, or approaching, historic low points. Total 1986 landings did increase 3% over the 1985 value, however. Here also, landings during the first three quarters were behind 1985. The 1984 yearclass recruited noticeably during the final quarter of 1986. It, however, along with those of 1982 and 1983, cannot be considered a strong one, and is not expected to contribute appreciably to the fishery

beyond 1987. Preliminary CPUE estimates for 1985 - 1986 (discard not included) are the lowest in the time series. Survey indices for spring and autumn of 1986 did increase over those of 1985. However, spring 1987 survey indices (number and weight) were again the lowest in the time series.

Trends for the Mid-Atlantic have been generally similar to those observed for Southern New England. Landings during the early 1980's also increased gradually with improved recruitment; 1984 was the highest in recent years. Landings have since declined, with preliminary 1986 landings showing slight improvement over 1985, but remaining 86% below the 1984 value. Autumn survey indices declined to very low levels in the mid-1970's, followed by a sharp increase in numbers and weight during 1981 - 1982 with improved year-class strength. An equally sharp drop in numbers and weight ensued in 1983. The following years declined to levels similar to those observed during the late 1970's.

The Cape Cod yellowtail fishery, prior to 1980, generally appeared 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, there has been a declining trend. Preliminary 1986 landings totaled 1,000 mt. Estimates of CPUE have declined since 1981, and values for 1984 - 1986 (discard not included) are the lowest in the time series. Recent survey results have been less consistent, but generally low, and decreasing. The exceptions are that, autumn indices (numbers) have increased gradually since 1983, and 1987 spring indices (numbers and weight) have increased to the highest levels since 1982.

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.

Northeast Fisheries Center. 1986. Report of the Second Stock Assessment Workshop. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 86-09, 114 p.

Table 7.1 Nominal catches (thousand metric tons) and management information for yellowtail flounder from the Georges Bank area (east of 69°W).

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| USA | 4.5 | 5.5 | 6.5 | 6.4 | 10.7 | 11.4 | 5.8 | 2.5 | 3.0 |
| Canada | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Other | - | - | - | - | - | - | - | - | - |
| Total nominal catch | 4.5 | 5.5 | 6.6 | 6.4 | 10.7 | 11.4 | 5.8 | 2.5 | 3.0 |

Long-term potential catch = 16,000 mt
Importance of recreational fishery = Insignificant
Status of management = FMP in effect since October 1986
Status of exploitation = Fully exploited
Age at 50% maturity = 2 years
Size at 50% maturity = 26 cm (10 inches)
M = 0.20 $F_{0.1} = 0.30$ $F_{max} = 0.50$ $F_{1986} > F_{max}$

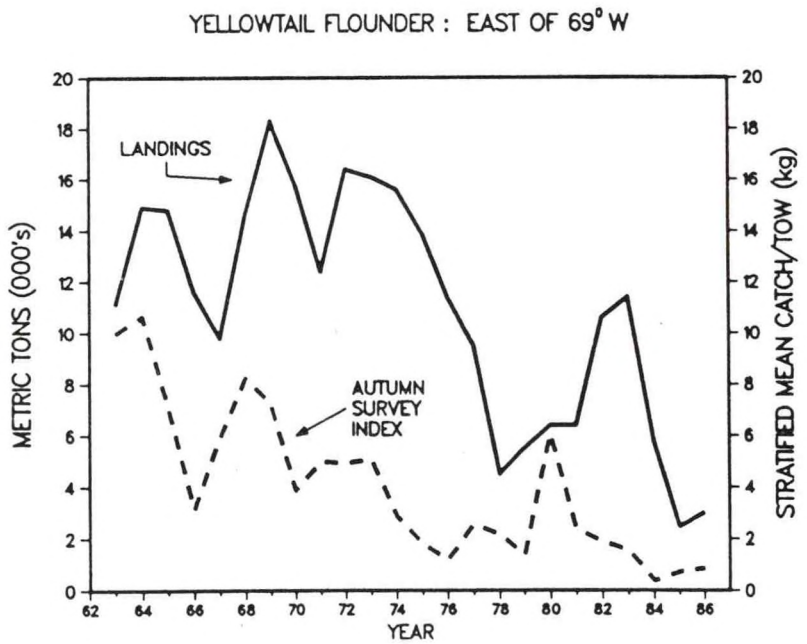


Figure 7.1 Total commercial landings and stock biomass indices from NEFC autumn trawl surveys of yellowtail flounder on Georges Bank east of 69°W longitude.

Table 7.2 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).

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| So. New England | 2.3 | 5.3 | 6.0 | 4.9 | 11.5 | 17.9 | 8.5 | 3.2 | 3.3 |
| Cape Cod | 3.7 | 4.2 | 5.1 | 3.2 | 3.2 | 1.9 | 1.1 | 1.0 | 1.0 |
| Mid-Atlantic | 0.1 | 0.2 | 0.2 | 0.7 | 1.3 | 1.5 | 2.2 | 0.2 | 0.3 |
| Canada | <0.1 | - | - | - | - | - | - | - | - |
| Other | - | - | - | - | - | - | - | - | - |
| Total nominal catch | 6.1 | 9.7 | 11.3 | 8.8 | 16.0 | 21.3 | 11.8 | 4.4 | 4.6 |

Long-term potential catch = 23,000 mt
Importance of recreational fishery = Insignificant
Status of management = FMP in effect since October 1986
Status of exploitation = Fully exploited
Age at 50% maturity = 2 years
Size at 50% maturity = 26 cm (10 inches)
M = 0.20 $F_{0.1}$ = 0.30 $F_{max}$ = 0.50 $F_{1986} > F_{max}$

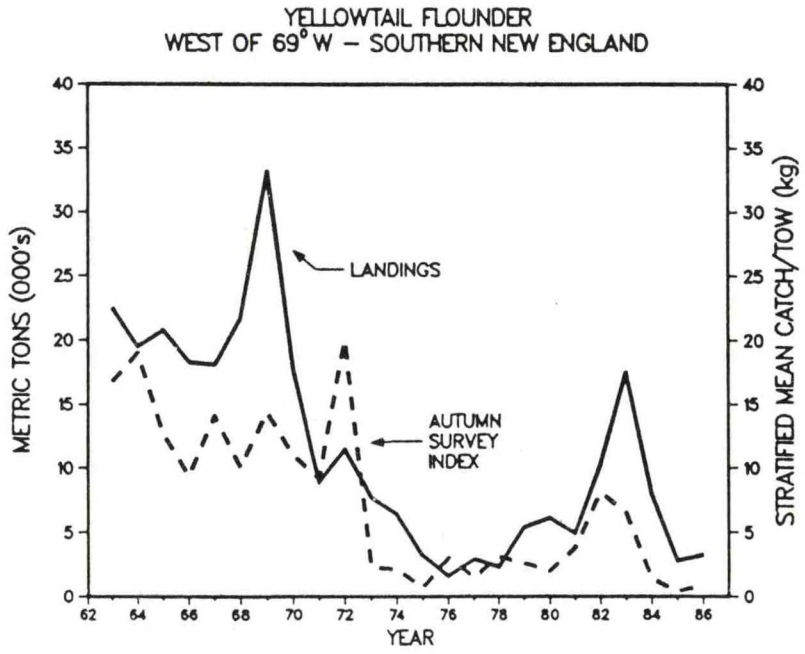


Figure 7.2 Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of yellowtail flounder west of 69°W longitude (southern New England).

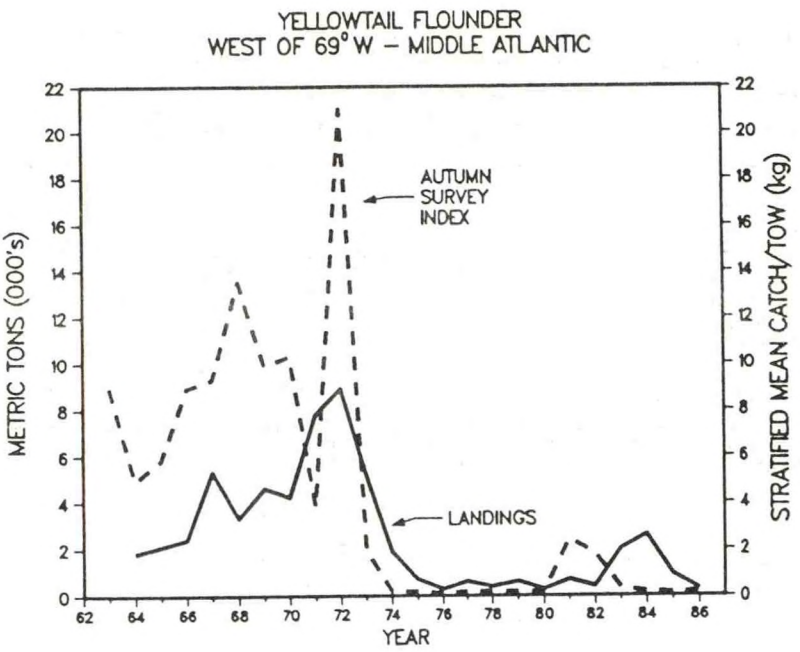


Figure 7.3 Total commercial landings and stock biomass indices from NEFC autumn bottom trawl survey of yellowtail flounder west of 69°W longitude (Mid-Atlantic).

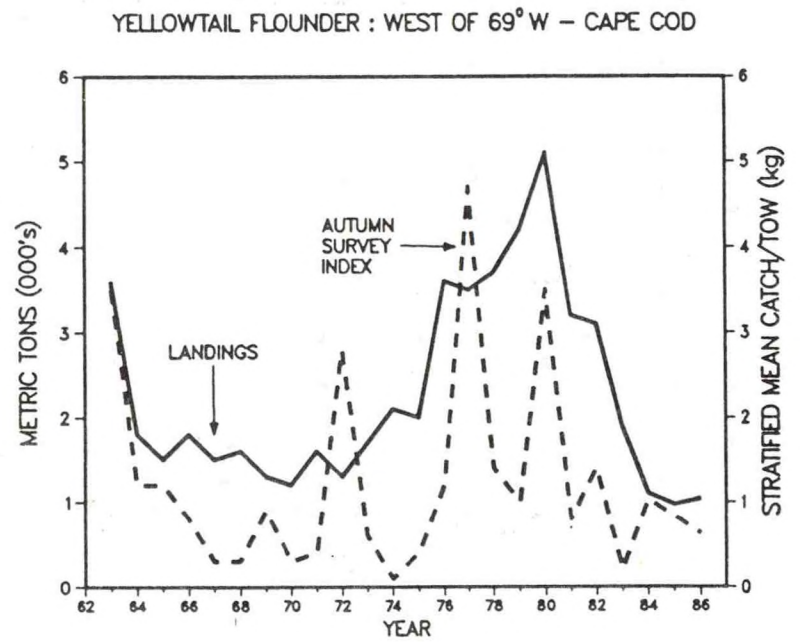


Figure 7.4 Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of yellowtail flounder west of 69°W longitude (Cape Cod).

# SUMMER FLOUNDER

The summer flounder or fluke *Paralichthys dentatus* occurs from the southern Gulf of Maine to South Carolina. Important commercial and recreational fisheries for summer flounder exist within the Mid-Atlantic Bight (Cape Cod to Cape Hatteras). Summer flounder are concentrated in coastal embayments and estuaries from late spring through early autumn. An offshore migration to the outer continental shelf is undertaken in autumn; larger individuals tend to move to more northerly locations. Spawning occurs during the offshore autumn migration, and the larvae are transported toward coastal areas by prevailing water currents. Development of post-larvae and juveniles occurs primarily within embayments and estuarine areas, notably Pamlico Sound and Chesapeake Bay. Growth rates differ appreciably between the sexes with females attaining weights up to 11.8 kg (26 pounds). 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 1986 was 11,000 mt, a slight decrease relative to the 1985 level of 11,900 mt but roughly equal to the 1980-1984 average of 11,100 mt. The estimated recreational harvest of summer flounder ranged from 5,000 to 15,900 mt (8.6 to 25.4 million fish) during 1979-1986. An additional 2.5 to 16.7 million fish were caught and released alive. Since the inception of the MFCMA, nominal catches by foreign vessels have been very small.

Stock biomass is currently at a higher level than during the late 1960's and early 1970's, based on NEFC survey indices. The spring survey index rose from 0.06 kg/tow in 1970 to a peak of 1.25 kg/tow in 1976. Following a sharp drop to 0.22 kg/tow in 1979, the index increased to 0.81 kg/tow in 1982, and has fluctuated between 0.26 and 0.82 since then. Catch curve analysis of survey and commercial age composition data collected during 1976-1983 indicated fishing mortality rates of about 0.8-0.9, well in excess of $F_{max}$. Although mortality estimates are not available for the last several year-classes, they are assumed to still be above $F_{max}$. Yield per recruit and long-term yield can be increased significantly by increasing the minimum size of fish caught and by reducing fishing mortality.

For further information see:

Northeast Fisheries Center. 1986. Report of the Third NEFC Stock Assessment Workshop. Woods Hole Lab. Ref. Doc. 86-14, 98 p.

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 8.1 Nominal catches (thousand metric tons) and management information for summer flounder from the Georges Bank - Mid-Atlantic area.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | 9.2 | 12.2 | 5.0 | 8.0 | 15.9 | 12.5 | 7.1 | 7.8 |
| Commercial | | | | | | | | | |
| USA | 8.5 | 14.5 | 11.5 | 8.0 | 10.1 | 11.8 | 14.2 | 11.9 | 11.0 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | - | - | - |
| Total nominal catch | 8.5[1] | 23.7 | 23.7 | 13.0 | 18.1 | 27.7 | 26.7 | 19.0 | 18.8 |

Long-term potential catch = 15,000 to 20,000 mt
Importance of recreational fishery = Major
Status of management = FMP in preparation
Status of exploitation = Fully exploited
Age at 50% maturity = 2 years (females)
Size at 50% maturity = 32 cm (12.6")
M = 0.20 $F_{0.1}$ = 0.16 (females) $F_{max}$ = 0.26 (females) $F_{1986}$ = Unknown

1 Recreational catches unknown.

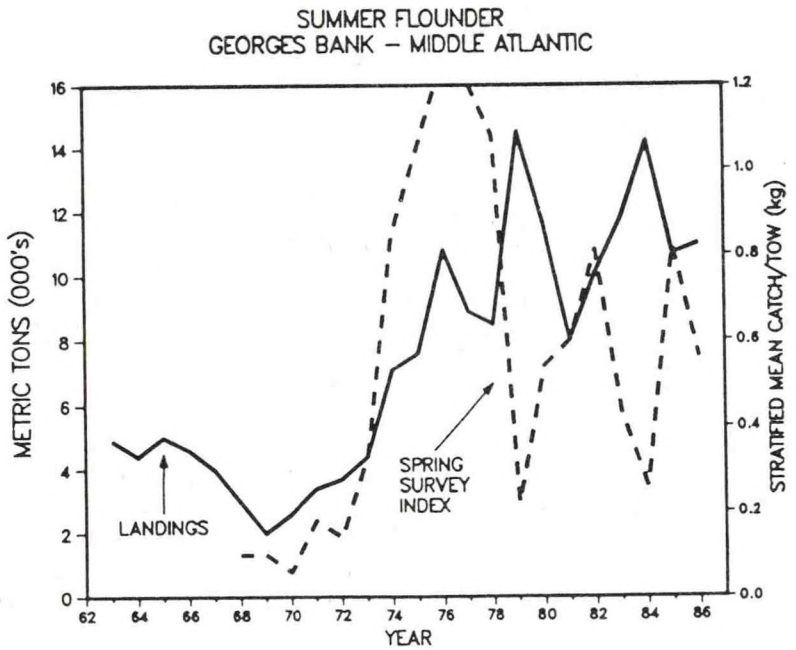


Figure 8.1 Total commercial landings and stock biomass indices from NEFC spring bottom trawl surveys of summer flounder in the Georges Bank - Mid-Atlantic area.

# 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 1986 landings of American plaice from the Gulf of Maine - Georges Bank region were 4,500 mt, 35% less than in 1985, and the lowest annual catch since 1976. Although average landings of 5,700 mt during 1985-1986 are 1.5 fold higher than the 1960-1978 mean (3,600 mt), they are less than half the 1979-1984 average (12,700 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 1986 indices in both areas were the lowest since the mid-1970's. Effort in 1986, however, was near 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 1986 Gulf of Maine catch (3,300 mt) was three times as large as that from Georges Bank (1,100 mt). In both areas, however, shifts in landings by vessel class have recently occurred. In 1986, for the third year in succession in the Gulf of Maine, plaice landings by small vessels (Class 2: 5-50 gross registered tons (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 43% and 19% respectively of the 1986 total Gulf of Maine landings, record percentages for these tonnage categories. On Georges Bank, Class 3 vessels accounted for 62% of the 1986 catch, the lowest percentage ever, while landings by Class 4 vessels comprised 35% of the Georges Bank total, above the previous 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 1986, "directed trips" accounted for only 8% of the Gulf of Maine catch and only 9% of the Georges Bank catch. Landings trends have generally paralleled trends in NEFC autumn indices. The 1986 autumn survey weight per tow index continued to decline to the lowest since the mid-1970's. 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 1987 accompanied by a continued decline in landings.

9. American Plaice

For further information see:

Northeast Fisheries Center. 1987. Report of the Third Stock Assessment Workshop. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 86-14, 98 p.

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

Table 9.1 Nominal catches (thousand metric tons) and management information for American plaice from the Gulf of Maine - Georges Bank area.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Commercial | | | | | | | | | |
| USA | 9.5 | 11.4 | 13.5 | 12.9 | 15.1 | 13.2 | 10.1 | 7.0 | 4.5 |
| Canada | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Other | <0.1 | 0.1 | - | <0.1 | - | - | - | - | - |
| Total nominal catch | 9.6 | 11.5 | 13.6 | 12.9 | 15.2 | 13.2 | 10.1 | 7.0 | 4.5 |

| | |
|---|---|
| Long-term potential catch | = Unknown |
| Importance of recreational fishery | = Insignificant |
| Status of management | = FMP in force since October 1986 |
| 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 $F_{1986}$ = Unknown

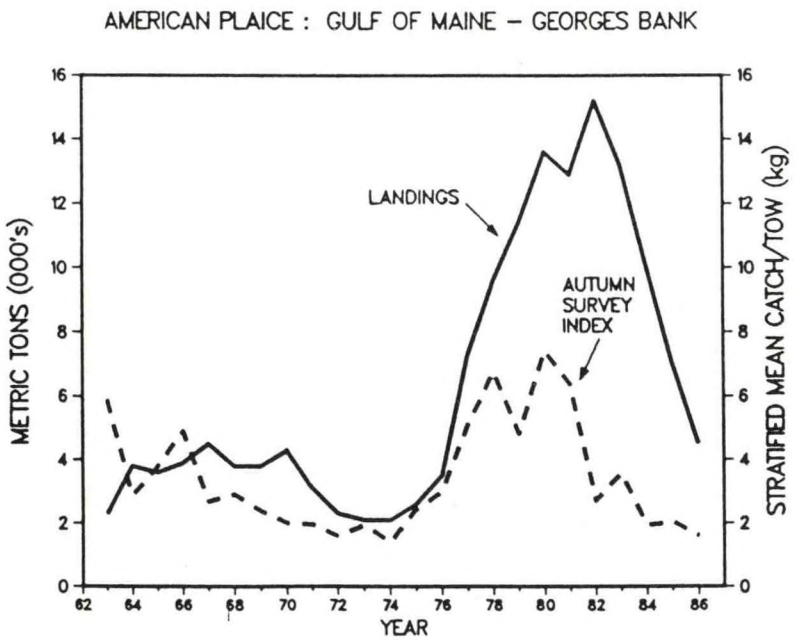


Figure 9.1 Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of American plaice in the Gulf of Maine - Georges Bank area.

# 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 shallower 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. Nominal catches have since increased more or less continually to 6,500 mt in 1984, but declined to 4,500 mt in 1986, 26% below 1985 levels.

NEFC autumn survey catches seem to accurately reflect trends in biomass 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, with the 1986 value 1.1 kg/tow below the long-term average, Spring 1986 catch levels were the lowest observed since that survey began in 1968. There is evidence, based on preliminary catch per unit effort indices and the declining trends in the autumn survey index and total catch to indicate that this resource is being adversely affected by current levels of exploitation. It appears that harvests of 6,000 mt or more cannot be sustained over the long term given recent and 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.

Northeast Fisheries Center. 1986. Report of the Second Stock Assessment Workshop. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 86-09, 114 p.

Table 10.1 Nominal catches (thousand metric tons) and management information for witch flounder from the Gulf of Maine - Georges Bank area.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| USA | 3.5 | 3.0 | 3.4 | 3.4 | 4.8 | 5.8 | 6.5 | 6.0 | 4.5 |
| Canada | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Other | <0.1 | - | - | - | - | - | - | - | - |
| Total nominal catch | 3.5 | 3.0 | 3.4 | 3.4 | 4.8 | 5.8 | 6.5 | 6.1 | 4.5 |

| | |
|---|---|
| Long-term potential catch | = Unknown |
| Importance of recreational fishery | = Insignificant |
| Status of management | = FMP in force since October 1986 |
| Status of exploitation | = Fully exploited |
| Age at 50% maturity | = 5 years (males); 6-7 years (females) |
| Size at 50% maturity | = 29 cm (11.4 inches) males<br>36 cm (14.2 inches) females |

M = 0.20 $F_{0.1}$ = Unknown $F_{max}$ = Unknown $F_{1986}$ = Unknown

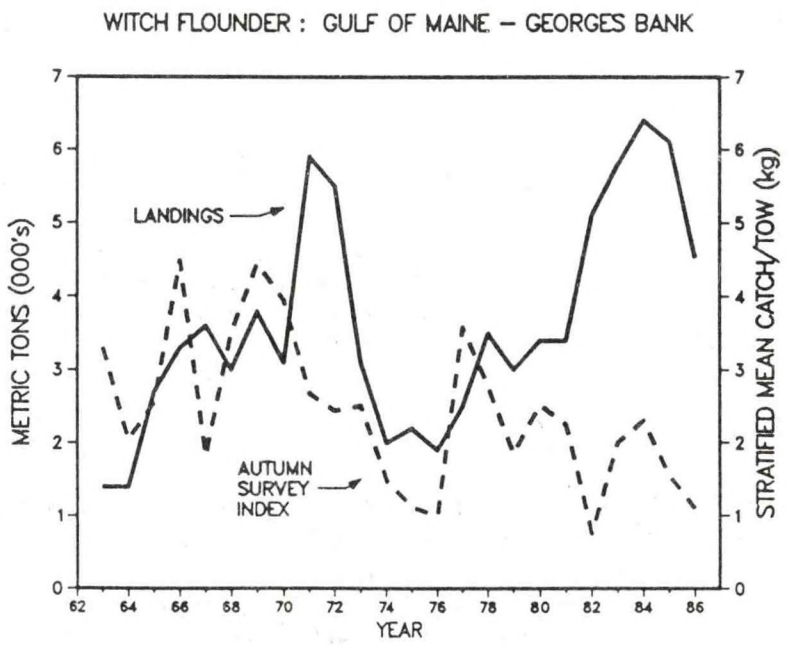


Figure 10.1 Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of witch flounder in the Gulf of Maine - Georges Bank area.

# 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.

Tagging and fin ray counts studies indicate discrete groups of winter flounder north of Cape Cod, east and south of Cape Cod, and Georges Bank. For descriptive purposes these groups are located within the approximate boundaries of: Gulf of Maine, Southern New England - Middle Atlantic and Georges Bank respectively. Winter flounder are typically exploited in coastal locations, although offshore shoal areas, particularly Georges Bank and Nantucket Shoals, support important winter flounder fisheries.

The estimated recreational catch of winter flounder in 1985 was 13,100 mt, exceeding any catch since 1979. Due to improved recreational survey methodology, the 1985 estimate is not directly comparable to previous estimates.

In the Gulf of Maine, nominal catches continued to decline from a peak of 2,800 mt in 1982 to 1,200 mt in 1986. The 1986 nominal catch was equal to the 1975 catch and was 57% less than 1985. Nominal catches were relatively low and stable from 1963 - 1974, averaging 967 mt. There was a 77% increase in catch from 1975 to 1982. The Massachusetts Division of Marine Fisheries, inshore survey abundance indices for the Massachusetts Bay sampling area (where the majority of the nominal catch originates for the Gulf of Maine area) have decreased considerably since 1981. The 1983 - 1985 indices have remained low, averaging 12.3 kg/tow. The 1986 abundance index was 81% less than 1982. CPUE declined from peaks in 1980 - 1981 to historical low levels in 1986.

For the Georges Bank area, 1986 commercial landings dropped to 1,800 mt, less than half those of 1983-1984 (3,900 mt), and the lowest landings level observed since 1976. CPUE indices in 1986 were the lowest observed. The NEFC autumn survey index fluctuates widely, but has trended downward from 1976-1985, from 7.1 to 1.1 kg/tow, the lowest index observed, increasing somewhat in 1986 to 2.2 kg/tow.

In Southern New England - Middle Atlantic area, nominal commercial catches continued to decline from the most recent peak in 1981. The 1986 catch declined 30% from 1985 and was the lowest catch since 1977. CPUE indices have declined rapidly from a peak in 1981 to historical low levels in

1986. NEFC spring offshore survey indices have remained low since 1980 and 1981, fluctuating about a mean of .60 kg/tow. The 1986 index was 70% less than 1985 and 66% less than 1981. The large decrease in catch (80%) from 1981 to 1982 exceeds the previous decrease in catch (60%) observed from 1969 to 1970.

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. 1987. Status of winter flounder *Pseudopleuronectes americanus* stocks in the Gulf of Maine, Southern New England and Middle Atlantic areas. NMFS, NEFC, Woods Hole Lab. Ref. Doc. IN REVIEW.

Gabriel, W. L. and K. L. Foster. 1986. Preliminary assessment of winter flounder Pseudopleuronectes americanus on Georges Bank. NMFS, NEFC Woods Hole Lab. Ref. Doc. 86 - IN REVIEW.

U.S. Department of Commerce. 1986. Status of the Fishery Resources off the Northeastern United States for 1986. U.S. Dept. Comm., NOAA, NMFS, NEFC, NOAA Technical Memorandum NMFS-F/NEC-43, 130 p.

Table 11.1 Nominal catches (thousand metric tons) and management information for winter flounder from the Georges Bank area.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| USA | 3.2 | 3.1 | 4.0 | 4.1 | 3.0 | 3.9 | 3.9 | 2.2 | 1.8 |
| Canada | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Other | - | - | - | - | - | - | - | - | - |
| Total nominal catch | 3.2 | 3.1 | 4.0 | 4.1 | 3.0 | 3.9 | 3.9 | 2.2 | 1.8 |

Long-term potential catch = Unknown
Importance of recreational fishery = Minor
Status of management = FMP in force since October 1986
Status of exploitation = Unknown
Age at 50% maturity = 2 years
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 $F_{1986}$ = Unknown

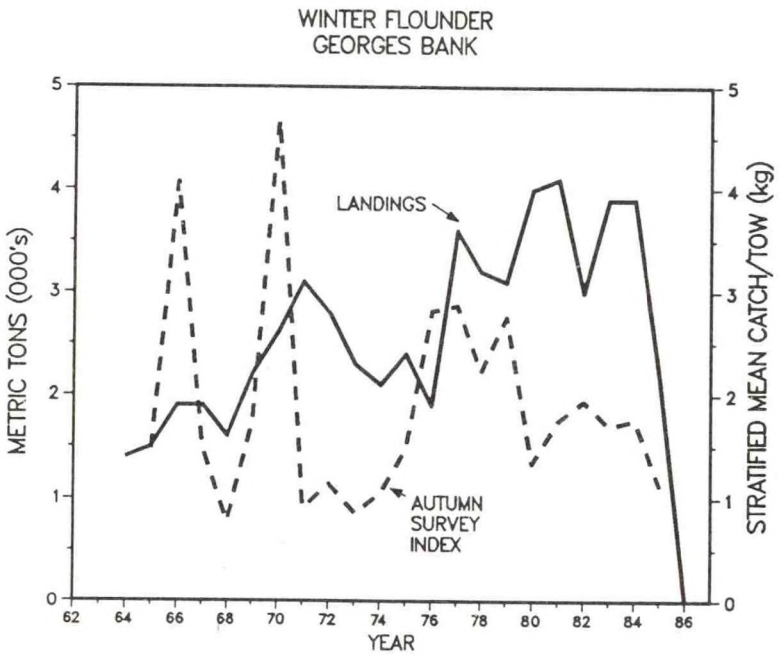


Figure 11.1 Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of winter flounder from the Georges Bank area.

Table 11.2 Nominal catches (thousand metric tons) and management information for winter flounder from the southern New England - Mid Atlantic area.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | 11.3 | 6.2 | 7.0 | 7.5 | 6.4 | 7.5 | 9.7 | 3.6 |
| Commercial | | | | | | | | | |
| USA | 6.3 | 6.5 | 10.6 | 11.2 | 9.4 | 8.7 | 8.9 | 6.6 | 4.7 |
| Canada | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Other | - | - | - | - | - | - | - | - | - |
| Total nominal catch | 6.3[1] | 17.8 | 16.8 | 18.2 | 16.9 | 15.1 | 16.4 | 16.3 | 8.3 |

| | |
|---|---|
| Long-term potential catch | = Unknown |
| Importance of recreational fishery | = Minor |
| Status of management | = FMP in force since October 1986 |
| Status of exploitation | = Fully |
| Age at 50% maturity | = 2 years |
| Size at 50% maturity | = 25 cm (9.8 inches) males<br>26 cm (10.2 inches) females |

M = Unknown $F_{0.1}$ = Unknown $F_{max}$ = Unknown $F_{1986}$ = Unknown

1 Recreational catches known but cannot be separated between the Gulf of Maine and the southern New England - Mid-Atlantic stocks, and are all included here.

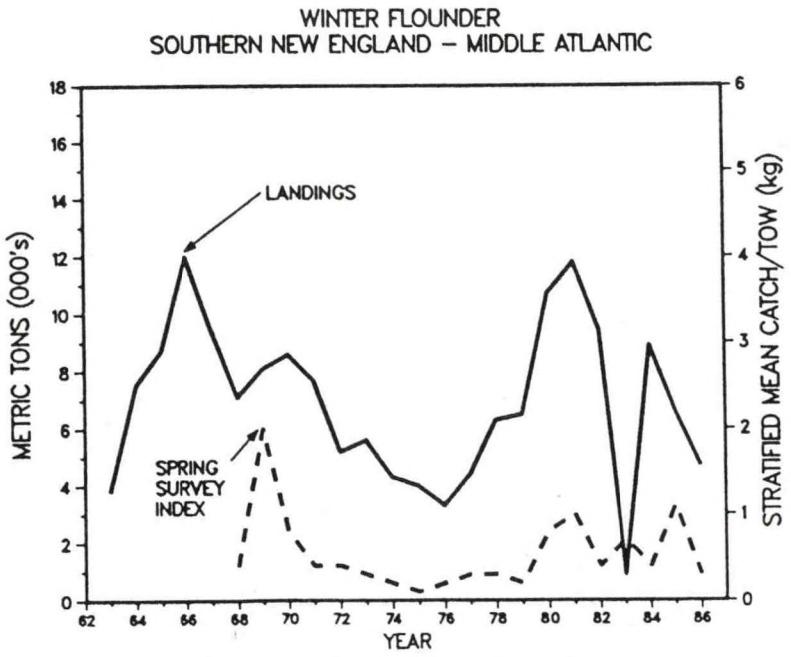


Figure 11.2 Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of winter flounder in the Southern New England - Mid-Atlantic area.

Table 11.3 Nominal catches (thousand metric tons) and management information for winter flounder from the Gulf of Maine area.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational[1] | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| USA | 2.2 | 2.0 | 2.4 | 2.4 | 2.8 | 2.1 | 1.7 | 1.6 | 1.2 |
| Canada | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Other | - | - | - | - | - | - | - | - | - |
| Total nominal catch | 2.2 | 2.0 | 2.4 | 2.4 | 2.8 | 2.1 | 1.7 | 1.6 | 1.2 |

Long-term potential catch = Unknown
Importance of recreational fishery = Minor
Status of management = FMP in force since October 1986
Status of exploitation = Fully
Age at 50% maturity = 2 years
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 $F_{1986}$ = Unknown

1 Recreational catches known but cannot be separated between the Gulf of Maine and the southern New England - Mid-Atlantic stocks, and are all included in Table 11.2.

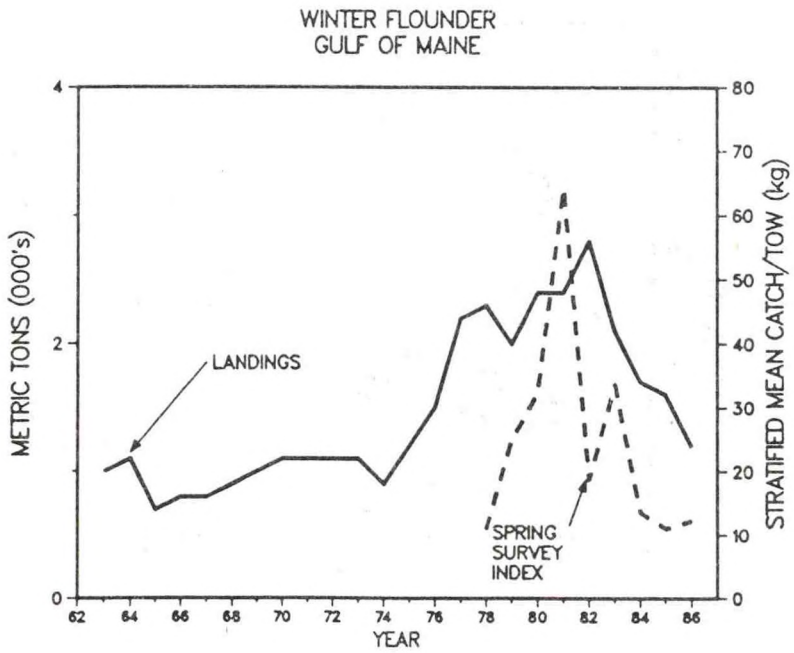


Figure 11.3 Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of winter flounder in the Gulf of Maine area.

# 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 (9 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.

Beginning in the early 1970's, the USA nominal commercial catch steadily increased and reached a recent peak of 9,800 mt in 1981. Since 1981, landings have decreased considerably. The 1986 catch increased slightly over 1985 but was 15% below the average for the past eight years and making it the second lowest catch during that time period. 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 than 75 mt in 1985, a 90% decrease from 1974, and 300 mt in 1986. The proportion taken by the Virginia fishery has declined from 40-60% of the total prior to 1967 to less than 10% since 1973. In New Jersey, catches in both the purse seine fishery, which annually accounted for up to 2,500 mt prior to 1964, and the pound net fishery, which formerly produced about 1,000 mt per year, are now negligible.

Estimated recreational catches declined from 7,500 mt in 1960 to 2,800 mt in 1974. There were further declines in the estimated recreational catch in 1984 (1,800 mt) and 1985 (1,500 mt), the lowest levels since 1972. 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 1980-1983, total estimated catches have declined to 9,600 mt and 7,900 mt in 1984 and 1985, respectively.

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 were 5.9 mt/day in 1984 and 5.5 mt/day in 1985 and 4.9 mt/day in 1986. 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. In 1985, the index increased above the long term (1967-1985) average but the 1986 index decreased 46% below that 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 1982-1986. 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.

Northeast Fisheries Center. 1986. Report of the Third Stock Assessment Workshop. NMFS, NEFC, Woods Hole Lab Ref. Doc. No. 86-14, 98 p.

Table 12.1 Nominal catches (thousand metric tons) and management information for scup from the southern New England - Mid-Atlantic area.

| | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Category | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
| USA recreational | - | 2.3 | 3.9 | 2.0 | 3.1 | 3.4 | 1.4 | 3.3 | 7.4 |
| Commercial | | | | | | | | | |
| USA | 8.9 | 8.0 | 7.9 | 9.8 | 8.7 | 7.8 | 7.8 | 6.7 | 6.9 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | <0.1 | - | <0.1 | <0.1 | - | - | <0.1 | <0.1 | <0.1 |
| Total nominal catch | 8.9[1] | 10.3 | 11.8 | 11.8 | 11.8 | 11.2 | 9.2 | 10.0 | 14.3 |

| | | | |
|---|---|---|---|
| Long-term potential catch | = 10,000 to 15,000 mt | | |
| Importance of recreational fishery | = Major | | |
| Status of management | = None | | |
| Status of exploitation | = Fully exploited | | |
| Age at 50% maturity | = 2 years | | |
| Size at 50% maturity | = 21 cm (9 inches) | | |
| M = 0.20 | $F_{0.1}$ = 0.20 | $F_{max}$ = 0.35 | $F_{1986}$ = Unknown |

1 Recreational catches unknown.

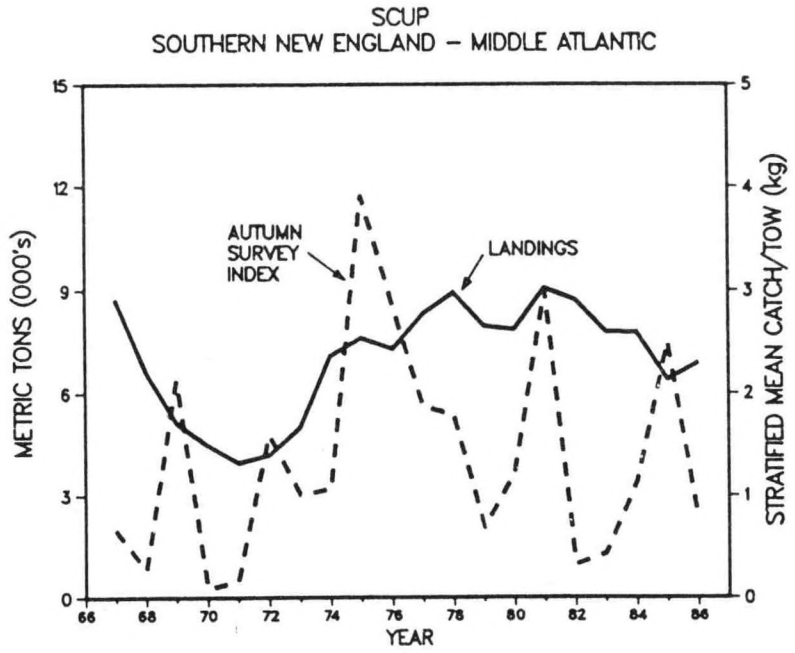


Figure 12.1 Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys in the southern New England - Mid-Atlantic area.

# 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 and NEFC bottom trawl survey data 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. 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 600 mt annually from 1975 to 1983. Catches increased to 1300 mt in 1984 largely due to the development of a small directed fishery in Cape Cod Bay supplying the fresh fillet market, and increased again in 1985 to 1500 mt, the highest domestic catch since 1974. However, 1986 landings decreased by 53% to a low of 800 mt. The 1986 areal landings patterns showed similarities to the 1984 patterns, and differed markedly from 1985, probably in response to shifting market demands. In 1986 Cape Cod landings dominated the USA catch accounting for 72% of the total while southern New England landings comprised 19% (similarly, 72% and 21% respectively in 1984), whereas 1985 landings from Cape Cod Bay and southern New England each contributed 46% of the USA total. Catches of ocean pout are taken primarily during the winter and spring (December-May) with virtually no catches reported during the remainder of the year.

Due to the ocean pout's pattern of seasonal distribution, the NEFC spring survey index is more useful than the autumn survey for 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 300 mt and 1.34 kg/tow, respec-

ively, by 1975. 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 0.91 kg in 1986. 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 Biology 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 western North Atlantic Ocean. MS. Thesis. Kingston, RI: Univ. Rhode Island.

Table 13.1 Nominal catches (thousand metric tons) and management information for ocean pout from middle Atlantic - Gulf of Maine area.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| USA | 1.0 | 0.7 | 0.4 | 0.3 | 0.3 | 0.4 | 1.3 | 1.5 | 0.8 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | - | - | - | - | - | - | - | - | - |
| Total nominal catch | 1.0 | 0.7 | 0.4 | 0.3 | 0.3 | 0.4 | 1.3 | 1.5 | 0.8 |

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 $F_{1986}$ = Unknown

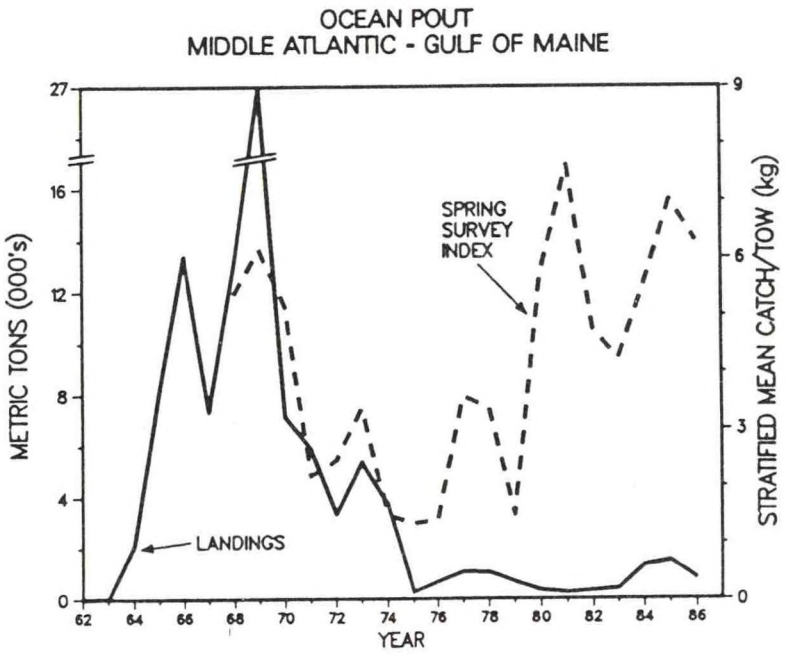


Figure 13.1 Total commercial landings and stock biomass indices from NEFC spring bottom trawl surveys of ocean pout in the Mid-Atlantic.

# WHITE HAKE

The white hake *Urophycis tenuis* is a boreal species which is common on muddy bottom 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.

In the Gulf of Maine region, spawning occurs in winter and spring although the season is not clearly defined. White hake attain total lengths of 135 cm (53 inches) and weights of up to 1 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 species fisheries. 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 7,300 mt in 1984 and 1985, but declined to 6,300 mt in 1986. 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. 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 declined sharply in 1982, recent indices for 1983 - 1986 have increased to average levels. It appears, in retrospect, that the 1982 point was anomalous. These results indicate that biomass has remained relatively stable, despite recent increases in landings. However, it appears unlikely that the 1984 - 1985 harvest levels (of 7,000 tons or more) will be sustained over the long term.

For further information see:

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.

Northeast Fisheries Center. 1986. Report of the Second Stock Assessment Workshop. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 86-09, 114 p.

Table 14.1 Nominal catches (thousand metric tons) and management information for white hake from the Gulf of Maine - Georges Bank area.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Commercial | | | | | | | | | |
| USA | 5.1 | 4.1 | 4.8 | 5.7 | 6.0 | 6.2 | 6.5 | 6.4 | 5.3 |
| Canada | 0.2 | 0.3 | 0.3 | 0.5 | 0.8 | 0.8 | 1.0 | 0.9 | 1.0 |
| Other | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | - |
| Total nominal catch | 5.3[1] | 4.4 | 5.1 | 6.2 | 6.8 | 7.0 | 7.5 | 7.3 | 6.3 |

Long-term potential catch = 5,000 mt
Importance of recreational fishery = Insignificant
Status of management = FMP in effect since October 1986
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 $F_{1986}$ = Unknown

1 recreational catch unknown

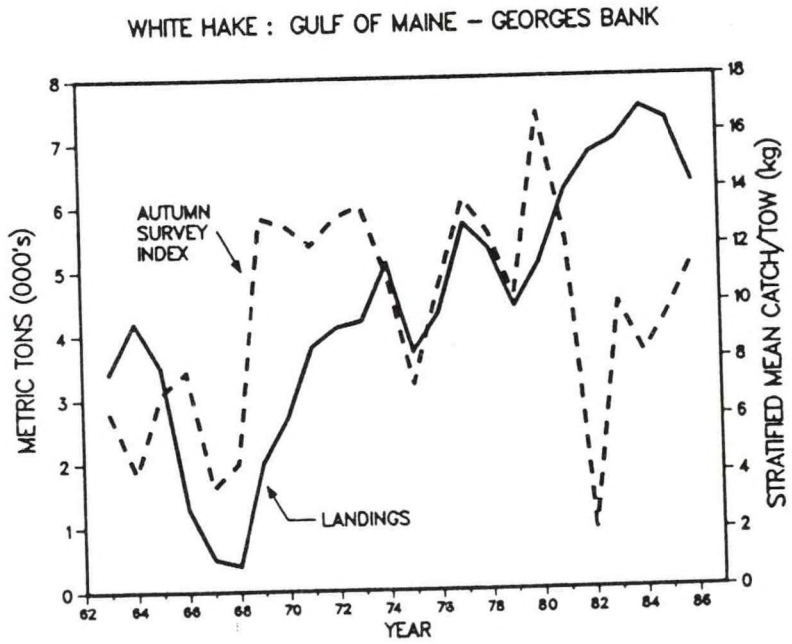


Figure 14.1 Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of white hake in the Gulf of Maine - Georges Bank area.

# CUSK

The cusk *Brosme brosme* is a deepwater species which is found in rocky, had 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 (20 pounds). Little is known about stock structure.

During 1977-1986, annual landings of cusk from the Gulf of Maine - Georges Bank region ranged between 1,400 mt (1977) and 4,000 mt (1981) and averaged 2,400 mt per year. In this period, 73% of the catch was taken by the USA with almost all the remainder taken by Canada. The bulk of the USA catch has been taken from the Gulf of Maine while nearly all of the Canadian catch has been from Georges Bank.

In 1986, cusk landings totaled 2,000 mt, 23% less than in 1985. The 1986 USA catch was 1900 mt and accounted for 94% of the total yield. Canadian landings in 1986 were 100 mt, the lowest since 1977. During the last two years, the U.S. longline fishery has taken a greater proportion of the total cusk landings. Longline landings of cusk increased from 13 mt in 1984 to 600 mt in 1985 and 336 mt in 1986. Historically, otter trawls have accounted for between 50-87% of annual USA catches; in 1986, otter trawls accounted for 69% of the USA total while longline catches accounted for 17%.

NEFC spring and autumn survey indices have fluctuated considerably. From 1982 to 1985, the autumn indices had been increasing, but in 1986 the index decreased sharply to near the 1982 historical low. The spring index, which had increased markedly in 1985, also decreased sharply in 1986 to the lowest value observed in either the spring or autumn time series.

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

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | <0.1 | <0.1 | <0.1 | 0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Commercial | | | | | | | | | |
| USA | 1.5 | 1.7 | 1.8 | 1.9 | 1.8 | 1.8 | 1.7 | 2.3 | 1.8 |
| Canada | 0.4 | 0.5 | 0.6 | 2.1 | 1.2 | 0.6 | 0.5 | 0.3 | 0.1 |
| Other | - | - | - | - | - | - | - | - | - |
| Total nominal catch | 1.9[1] | 2.2 | 2.4 | 4.0 | 3.0 | 2.4 | 2.2 | 2.6 | 1.9 |

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 $F_{1986}$ = Unknown

1 Recreational catches unknown.

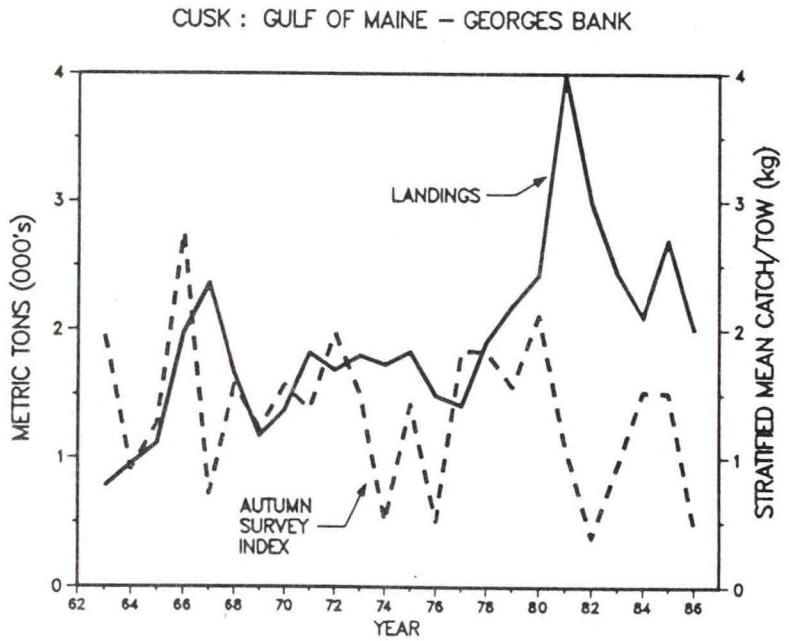


Figure 15.1 Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of cusk in the Gulf of Maine - Georges Bank area.

# 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 200 mt in 1970 to an average of around 1,000 mt since 1980. US landings in 1986 were nearly 900 mt, a decline of around 10% from 1985 and have been declining at a rate of about 100 mt a year since 1983. The NEFC spring survey index has fluctuated considerably while exhibiting a downward trend in recent years, 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 16.1 Nominal catches (thousand metric tons) and management information for Atlantic wolffish from the Gulf of Maine - Georges Bank area.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Commercial | | | | | | | | | |
| USA | 0.6 | 0.7 | 0.9 | 0.7 | 0.9 | 1.2 | 1.1 | 1.0 | 0.9 |
| Canada | 0.2 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 |
| Other | - | - | - | - | - | - | - | - | - |
| Total nominal catch | 0.8[1] | 1.0 | 0.8 | 1.1 | 1.3 | 1.1 | 1.1 | 1.0 | 1.0 |

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 $F_{1986}$ = Unknown

1 Recreational catches unknown.

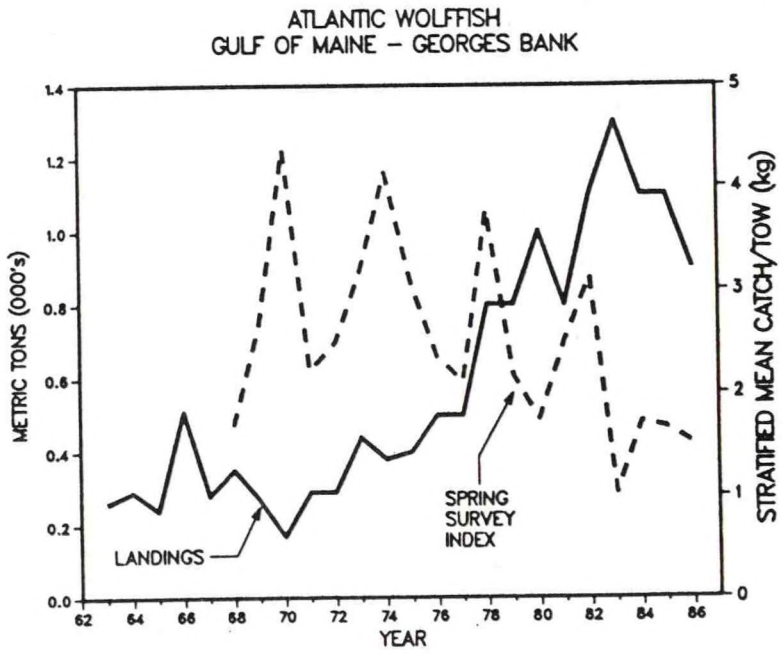


Figure 16.1 Total commercial landings and stock biomass indices from NEFC spring bottom trawl surveys of Atlantic wolffish in the Gulf of Maine - Georges Bank area.

# 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. 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

Total catches in the Gulf of Maine declined from an average of 61,800 mt from 1977-1981 to 31,200 mt in 1986. These changes are best understood by examining the changes in the two principal fisheries, the coastal fixed gear and the western Gulf mobile gear.

Coastal Maine nominal catches averaged 57,000 mt during 1950-1965, subsequently declining to an average of 23,000 mt during 1966-1979. Catches from this fishery are taken primarily during the summer-autumn from July to November. With the exception of the strong 1970 year class, recruitment during the latter period remained below average. Nominal catches increased to an average of 45,000 mt during 1979-1981 with recruitment of a succession of relatively strong year classes (1976, 1977, 1979). The 1981 yield of 48,200 mt was the highest since 1963. The 1986 nominal catch was 15,500 mt, a slight increase relative to the 1985 level of 13,900 mt. The general reduction noted since the early 1980's appears to be related to reduced availability to the fixed gear fisheries and reduced abundance as measured by NEFC survey indices. Steady declines in survey indices have been noted in recent years. The 1984 - 1986 NEFC autumn survey indices, however, indicated a slight recovery relative to 1982-83 levels.

The 1986 nominal catch of 15,700 mt in the western Gulf of Maine mobile

gear fishery[1] represented a slight increase relative to the 1985 level but remained below the 1975-80 mean level of 22,900 mt. The fishery was primarily dependent on the 1979-82 year classes during 1985. Due to declines in export markets in recent years with recovery 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. 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.

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 subsequently declined steadily to extremely low levels. There has been no directed fishery for Atlantic herring on Georges Bank in recent years. Indication of some level of recovery has been obtained based on US and Canadian bottom trawl surveys during 1984 - 1986 and reports of incidental catches by commercial vessels. Prospects for redevelopment of the fishery are currently unknown.

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.

1 Includes offshore Maine and southern New England landings.

Table 17.1 Nominal catches (thousand metric tons) and management information for Atlantic herring from the Gulf of Maine (coastal Maine the western Gulf of Maine).

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| USA | 48.4 | 63.7 | 82.1 | 63.6 | 31.7 | 22.5 | 31.1 | 25.8 | 31.2 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | - | - | - | - | - | - | - | - | - |
| Total nominal catch[1] | 48.4 | 63.7 | 82.1 | 63.6 | 31.7 | 22.5 | 31.1 | 25.8 | 31.2 |

Long-term potential catch[2] = 20,000 mt
Importance of recreational fishery = Insignificant
Status of management = None
Status of exploitation = Fully exploited
Age at 50% maturity = 3 years
Size at 50% maturity = 26 cm (10.2 inches)
M = 0.20 $F_{0.1}$ = 0.24 $F_{max}$ = None

1 Age groups 1 and older.
2 Age groups 3 and older.

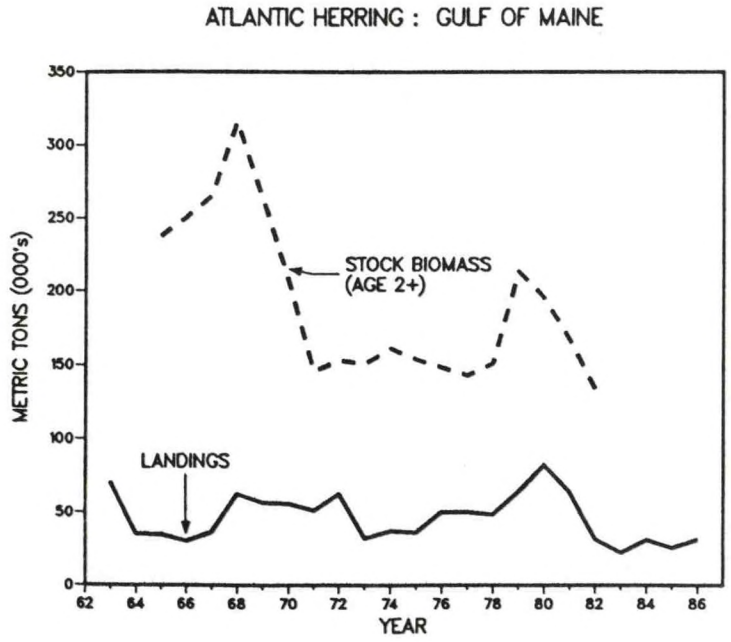


Figure 17.1 Total commercial landings and estimates of stock biomass of Atlantic herring in the Gulf of Maine.

Table 17.2 Nominal catches (thousand metric tons) and management information for Atlantic herring from the Georges Bank area[1].

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| USA | 0.4 | 2.1 | 1.1 | 1.7 | 0.7 | 1.0 | 1.6 | 0.2 | 0.2 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | 1.8 | - | - | - | - | - | - | - | - |
| Total nominal catch | 2.2 | 2.1 | 1.1 | 1.7 | 0.7 | 1.0 | 1.6 | 0.2 | 0.2 |
| Total allowable catch | 33.0 | 8.0 | 15.0 | 15.0 | 15.0 | - | - | - | - |

Long-term potential catch = 100,000 mt
Importance of recreational fishery = Insignificant
Status of management = None
Status of exploitation = Not exploited
Age at 50% maturity = 3 years
Size at 50% maturity = 26.4 cm (10.4 inches)
M = 0.20 $F_{0.1}$ = 0.36 $F_{max}$ = None $F_{1986} < 0.01$

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°C, 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 (3 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 and 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 and amendments developed by the Mid-Atlantic Fishery Management Council.

The international nominal catch of mackerel in the Northwest Atlantic increased from 39,400 mt in 1984 to 71,100 mt in 1985 and declined slightly to 65,400 mt in 1986. Catches remained fairly stable during 1978-1984, averaging 33,000 mt annually, and were taken largely by Canadian and USA fishermen. The increase in recent years (1984-1986) 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.

The USA accounted for 21% of the 1986 international catch, including about 9,600 mt of commercial and an estimated 4,000 mt of recreational catch. The Canadian catch increased from 17,000 mt in 1984 to 29,800 mt in 1985, and declined to 25,400 mt in 1986. The distant-water-fleet catch increased from about 6,000 mt in 1983 to 33,200 mt in 1985 and decreased to 26,400 mt in 1986. Approximately 6,400 mt of the 1986 catch was taken by Poland in a research fishery with the NEFC.

Fish from the 1982 (age 3) and 1981 (age 4) year classes comprised 71% and 17% respectively of the distant-water catch in numbers in 1985. The 1974, 1978 and 1984 year classes were also important. A January-April 1985 Polish research catch of about 6,400 mt was comprised mainly of the 1982 (73%) and

1981 (12%) year classes.

Fishing mortality (F) at ages 3 and older in 1985 was estimated to be 0.07; 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 0.62 in 1976 and then dropped to an average of 0.08 during 1978-1982 and has averaged 0.11 since that time. $F_{0.1}$ for mackerel under the current pattern of exploitation in the fishery is 0.29.

The 1975-1980 year classes were all weak. Year classes beginning with the 1981 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. The 1984 cohort also appears to be relatively strong.

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. The total stock increased to about 1,500,000 mt at the beginning of 1986. Spawning stock biomass (50% of age 2 fish and 100% of ages 3 and older) increased from about 600,000 mt in 1981 to an estimated 1.1 million mt at the start of 1985.

Rebuilding of the mackerel stock has been aided by relatively low catches during 1977-1986 (average of 40,800 mt) as well as markedly improved recruitment from the 1980-1982 and 1984 year classes. Projections indicate that the catch in 1987 can be increased substantially without adversely affecting the spawning stock biomass. Management measures recommended by the Mid-Atlantic Fishery Management Council for the 1 January 1986 - 31 December 1986 fishing year include an OY (USA waters only) of 74,576 mt, a DAH of 44,575 mt, and a TALFF of 30,001 mt. These recommendations are based on a projected catch of roughly 325,000 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.

Overholtz, W.J., and B.L. Parry. 1985. Update of the status of the Northwest Atlantic Mackerel Stock for 1985. NMFS, NEFC, Woods Hole Lab. Ref. Doc. 85-13, 16 p.

Northeast Fisheries Center. 1986. Report of the Second NEFC Stock Assessment Workshop. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 86-09, 114 p.

Table 18.1 Nominal catches (thousand metric tons) and management information for Atlantic mackerel from Labrador to North Carolina.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | 3.7 | 2.4 | 5.1 | 1.1 | 3.0 | 3.0 | 1.5 | 4.0 |
| Commercial | | | | | | | | | |
| USA | 1.6 | 2.0 | 2.7 | 2.9 | 3.3 | 3.8 | 4.4 | 6.6 | 9.6 |
| Canada | 25.4 | 30.2 | 22.1 | 19.3 | 16.4 | 19.8 | 17.0 | 29.8 | 25.4 |
| Other | 0.8 | 0.4 | 0.6 | 5.4 | 6.6 | 6.0 | 15.0 | 33.2 | 26.4 |
| Total nominal catch | 27.8[1] | 36.3 | 27.8 | 32.6 | 27.5 | 32.6 | 39.4 | 71.1 | 65.4 |
| Total allowable catch | 15.5 | 15.5 | 30.0[2] | 30.0[2] | 30.0[2] | 101.7[2] | 87.0[2] | 196.5[2] | 196.5 |

Long-term potential catch = 134,000[3] mt
Importance of recreational fishery = Moderate
Status of management = FMP in force since 1979
Status of exploitation = Underexploited
Age at 50% maturity = 2 years
Size at 50% maturity = 32.7 cm (12.9 inches) fork length
M = 0.20 $F_{0.1}$ = 0.29 $F_{max}$ = 0.62 $F_{1986}$ = 0.05

1 Recreational catches unknown
2 1 April - 31 March fishing year
3 Assuming constant recruitment at level of geometric mean of 1961-1984 year classes and fishing mortality at $F_{0.1}$

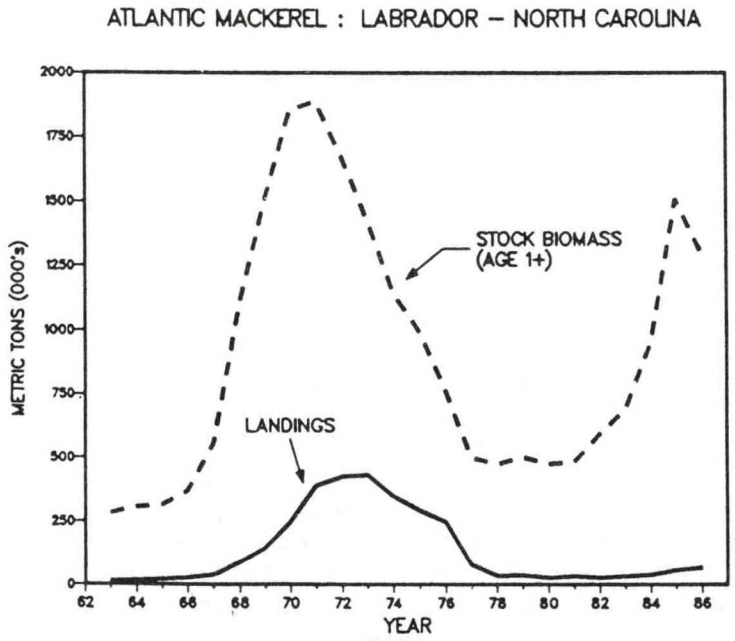


Figure 18.1 Total commercial and recreational landings and estimates of stock biomass of Atlantic mackerel in the Labrador-North Carolina area.

# BUTTERFISH

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

Spawning takes place chiefly during the summer months, with the peak in July. Butterfish begin recruiting to the spawning stock at the end of their first year. The maximum recorded age for this species is 6 years, but few fish are seen beyond age 3.

The international nominal catch declined 7% from 5,100 mt in 1985 to 4,500 mt in 1986. The international catch peaked in 1973 at 19,500 mt, most of which was taken by distant-water fleets (DWF) in conjunction with their squid fisheries. The USA nominal catch declined slightly from 4,700 mt in 1985 to 4,400 mt in 1986. The decline in domestic catches since 1984 is attributed to decreased availability of marketable size butterfish on the traditional southern New England fishing grounds. The DWF nominal catch declined 68% to 100 mt in 1986, representing the lowest butterfish catches by DWF's on record.

The high discard rates (30-70% by weight of the landed catch) of small butterfish that beset the domestic fishery during the past several years declined considerably in the latter half of 1986. Thus, discard rates in 1987 may return to historical levels of about 10%.

The catch-per-tow index (all ages) from the NEFC 1986 autumn bottom trawl survey (6.8 kg/tow) declined 55% from 1985. Likewise, the recruitment index (140.2 age 0 fish/tow) and the age $1^+$ index (44.3 age one and older fish/tow) from the 1986 autumn survey declined 51% and 56%, respectively, below the 1985 values. Also, the 1986 recruitment, age $1^+$, and biomass indices are nearly equal to the 18-year (1968-1985) averages (144.6, 45.3, and 7.0). The decline in age $1^+$ abundance is largely attributed to declines in age 1 fish.

Although the 1986 abundance indices are the lowest observed since 1983, they are generally above 1968-1976 levels when total international nominal catches were high (6,500-19,500 mt). This suggests that sufficient fish are available to support a catch up to the maximum (16,000 mt) currently allowed by the Fishery Management Plan, developed by the Mid-Atlantic Fishery Management Council for the Atlantic mackerel, squid, and butterfish fisheries. However, a limitation to achieving catch rates approaching MSY may be the spatial and seasonal nature of the USA fishery. This fishery is prosecuted principally in autumn in southern New England waters, whereas, the pre-1977 DWF fleets harvested butterfish throughout its range.

High discard rates that have beset the fishery over the past several years have eased as evidenced by an increase in the cull size in late 1986. Presently, the butterfish market remains strong which, combined with increased availability of marketable fish should maintain effort and catches at or above 1986 levels.

For further information see:

Waring, G.T. 1986. An analysis of spatial difference in size composition and abundance of butterfish, *Peprilus triacanthus*, off the Northeast United States. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 86-04, 23 p.

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

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| USA | 3.7 | 2.8 | 5.4 | 4.9 | 9.1 | 4.9 | 11.8 | 4.7 | 4.4 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | 1.3 | 0.8 | 0.9 | 0.9 | 0.8 | 0.6 | 0.4 | 0.4 | 0.1 |
| Total nominal catch | 5.0 | 3.7 | 6.3 | 5.8 | 9.7 | 5.5 | 12.3 | 5.1 | 4.5 |
| Total allowable catch | 18.0 | 18.0 | 11.0[1] | 11.0[1] | 11.0[1] | 11.0[1] | ≤16.0[1] | ≤16.0[1] | ≤16.0 |

Long-term potential catch = 16,000 mt
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 years
Size at 50% maturity = 14.0 cm (5.5 inches) fork length
M = 0.80 $F_{0.1}$ = 1.60 $F_{max}$ > 2.50 $F_{1986}$ = Unknown

1 1 April - 31 March fishing year.

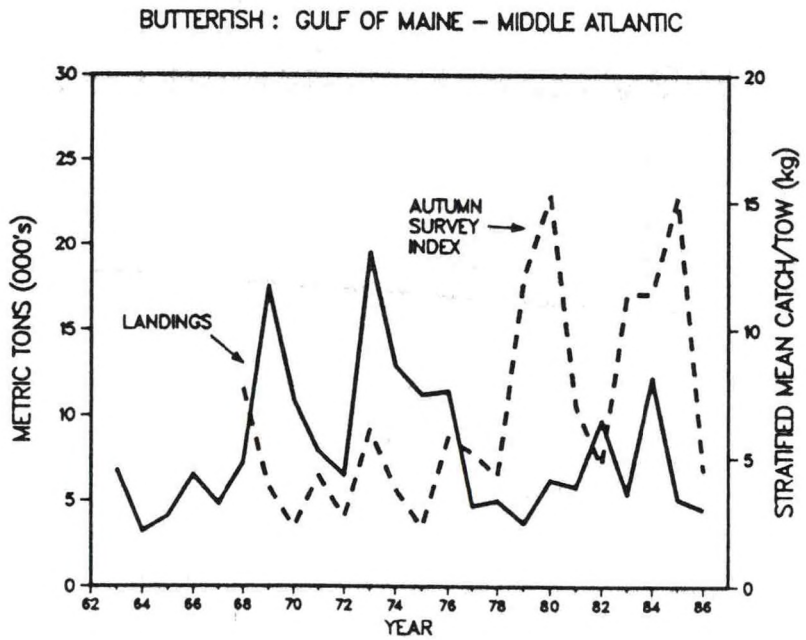


Figure 19.1 Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of butterfish in the Gulf of Maine - Mid-Atlantic area.

# 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 US Atlantic coast, bluefish are found from Maine to Florida, moving northward in the spring and southward in the autumn and winter. Currently, a unit stock along the Atlantic coast is assumed for management purposes. Bluefish are ferocious predators that feed on a wide variety of fish and invertebrates. They may reach ages of about 12 years and sizes in excess of 100 cm (30 inches) in length and 14 kg (31 pounds) in weight.

Total catches of bluefish (commercial and recreational) from Maine to Florida increased from about 24,200 mt in 1960 to about 76,200 mt in 1980. The 1986 total catch was about 67,400 mt. Since 1960, recreational catch has averaged about 90% of the total catch, peaking in 1980 at 69,600 mt. The 1986 recreational catch was about 61,100 mt. USA commercial catches steadily increased from 1,300 mt in 1960 to 7,300 mt in 1983. The 1986 commercial catch was about 6,300 mt.

The stratified geometric mean number of bluefish per tow in the NEFC autumn inshore survey from Cape May to Cape Hatteras is used as an index of recruitment, since this measure correlates well ($r = 0.91$) with the mid-Atlantic recreational CPUE of snapper (YOY) bluefish. Strong year classes appeared to recruit to the stock in 1977, 1981, and 1984. The median value of the index was 11.6 fish/tow during 1974-1985. The 1986 estimate was slightly above the median, at 12.9 fish/tow.

A coastwide fishery management plan is currently being developed by the Atlantic States Marine Fisheries Commission (ASMFC) in cooperation with NMFS, the Fishery Management Councils, and the coastal states in response to the importance of Atlantic coast bluefish to recreational anglers.

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

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | 63.8 | 69.6 | 58.2 | 56.6 | 62.8 | 39.3 | 45.0 | 61.1 |
| Commercial | | | | | | | | | |
| USA | 4.9 | 5.6 | 6.5 | 7.2 | 6.9 | 7.3 | 5.5 | 6.0 | 6.3 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | - | - | <0.1 | - | - | - | - | - | - |
| Total Nominal catch | 4.9[1] | 69.4 | 76.2 | 65.4 | 63.5 | 70.1 | 44.8 | 51.0 | 67.4 |

Long-term potential catch = Unknown
Importance of recreational fishery = Major
Status of management = FMP in preparation
Status of exploitation = Possibly fully exploited
Age at 50% maturity = 1 year
Size at 50% maturity = 35 cm (13.8 inches)
M = Unknown $F_{0.1}$ = Unknown $F_{max}$ = Unknown $F_{1986}$ = Unknown

1 Recreational catches unknown.

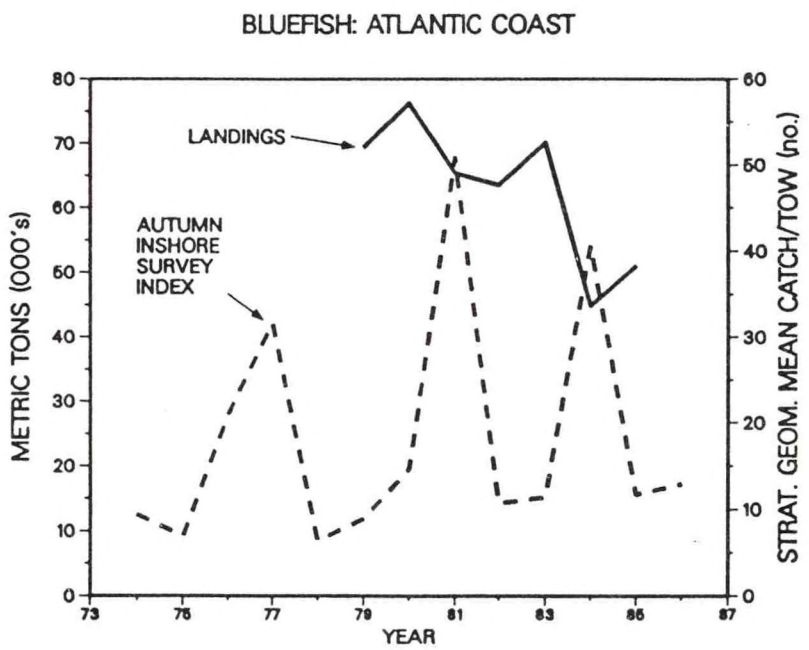


Figure 20.1 Total commercial landings and recruitment indices from NEFC autumn bottom trawl surveys of bluefish along the Atlantic coast.

# 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, 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. In 1969 the nominal catch exhibited a downward trend until the mid-to-late 1970's and has since been around 5 mt. North Carolina remains the only state with a substantial commercial fishery, accounting for approximately 80% of total landings.

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 this level is no longer a useful indication of long-term potential yield. Although fishing pressure on the resource has eased considerably, especially since the foreign catch was restricted in 1976, recovery to historic levels is not evident. Data from the NEFC spring and autumn bottom trawl surveys indicate that stock levels have been relatively stable since 1968, although data from spring bottom trawl surveys between northern New Jersey and Cape Hatteras indicate a slight 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 recommended that a comprehensive, coastwide management plan be prepared for shad and river herring. The plan has been 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 Report.

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

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| USA | 5.4 | 4.2 | 4.7 | 3.2 | 5.7 | 4.2 | 4.1 | 6.1 | 3.9 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Total nominal catch | 5.4 | 4.2 | 4.7 | 3.2 | 5.7 | 4.2 | 4.1 | 6.1 | 3.9 |

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 $F_{1986}$ = Unknown

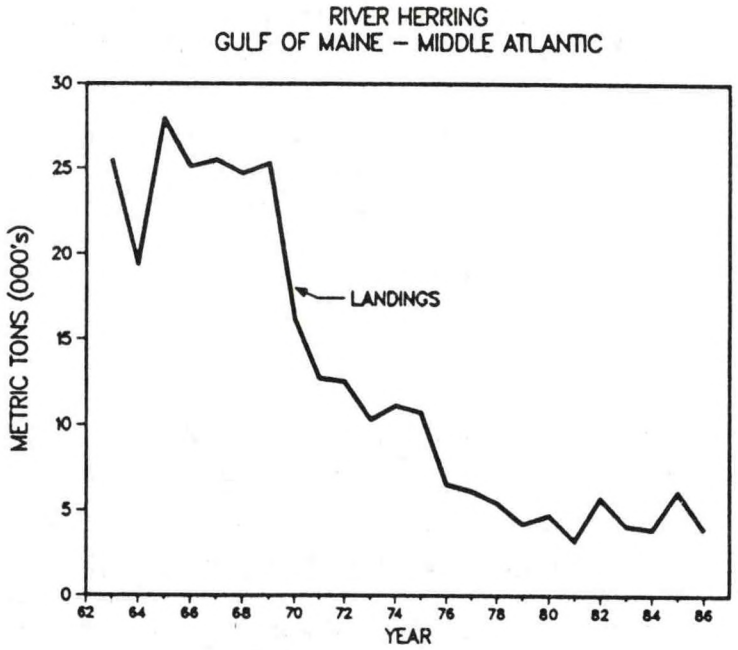


Figure 21.1 Total commercial landings of river herring (alewife and blueback herring) in the Gulf of Maine - Mid-Atlantic area.

## 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. Restoration efforts (particularly in the Delaware and Connecticut river systems) are apparently starting to be effective, as 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. 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 has prepared 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, D.C.

Table 22.1 Nominal catches (thousand metric tons) and management information for American shad from the Gulf of Maine - Mid-Atlantic area.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| USA | 1.2 | 0.8 | 0.9 | 0.7 | 0.9 | 0.7 | 1.1 | 0.7 | 1.1 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | - | - | - | - | - | - | - | - | - |
| Total nominal catch | 1.2 | 0.8 | 0.9 | 0.7 | 0.9 | 0.7 | 1.1 | 0.7 | 1.1 |

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 years (varies by latitude)
Size at 50% maturity = 40 cm (15.8 inches)
M = Unknown $F_{0.1}$ = Unknown $F_{max}$ = Unknown $F_{1986}$ = Unknown

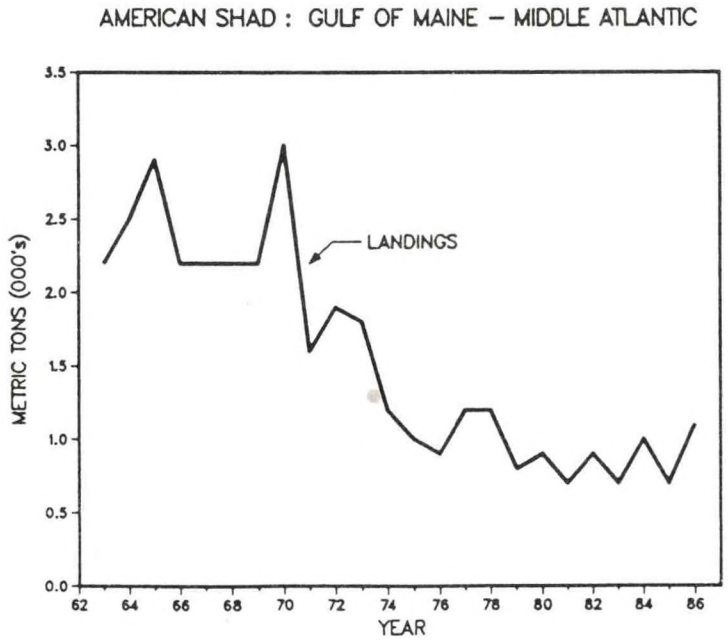


Figure 22.1 Total commercial landings of American shad in the Gulf of Maine - Mid-Atlantic area.

# 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, New Jersey. 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 structured bottom habitat (reefs, oyster beds, wrecks). Spawning begins in June off Virginia and occurs progressively later (until October) further north. Most black sea bass are protogynous hermaphrodites, beginning life as females and later transforming 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 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 9,900 mt in 1952, catch declined steadily to 600 mt in 1971 then increased to 2,400 mt in 1977. Nominal catches averaged 1,400 mt from 1981 - 1985 and were 1,800 mt in 1986. The only reported catch by distant-water fleets was 1,500 mt in 1964. The estimated recreational catch has comprised from 21% (1981) to 86% (1982) of the total nominal catch in those years for which comparisons are possible. Estimated recreational catches have ranged between 300 and 8,100 mt since 1980. The high values for 1982 and 1986, 7,300 mt and 8,100 mt respectively, are inconsistent with available stock abundance indices, and are perhaps attributable to an increase in directed 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 46.9 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 0.3 fish/tow in 1985. A slight increase to 2.4 fish/tow was experienced in 1986.

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

Connecticut, New York, and New Jersey have imposed restrictions on buying or selling 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 regulations pertaining to black sea bass. The Mid-Atlantic Fishery Management Council is considering management of black sea bass either on a single species basis or in conjunction with other associated species.

Table 23.1 Nominal catches (thousand metric tons) and management information for black sea bass from the Gulf of Maine - Mid-Atlantic area.

| Category | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
| USA recreational | - | 0.3 | 0.7 | 0.5 | 8.1 | 2.3 | 0.7 | 1.5 | 6.3 |
| Commercial | | | | | | | | | |
| USA | 2.1 | 1.9 | 1.3 | 1.1 | 1.2 | 1.5 | 1.9 | 1.2 | 1.8 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | - | - | - | - | - | - | - | - | - |
| Total nominal catch | 2.1[1] | 2.2 | 2.0 | 1.6 | 9.3 | 3.8 | 2.6 | 2.7 | 8.1 |

| | |
|---|---|
| Long-term potential catch | = Unknown |
| Importance of recreational fishery | = Major |
| Status of management | = Some state regulations |
| Status of exploitation | = Fully exploited |
| Age at 50% maturity | = 3 years |
| Size at 50% maturity | = 27.2 cm (10.7 inches) |
| M = 0.3 $F_{0.1}$ = 0.2 | $F_{max}$ = 0.3 $F_{1986}$ = Unknown |

1 Recreational catches unknown.

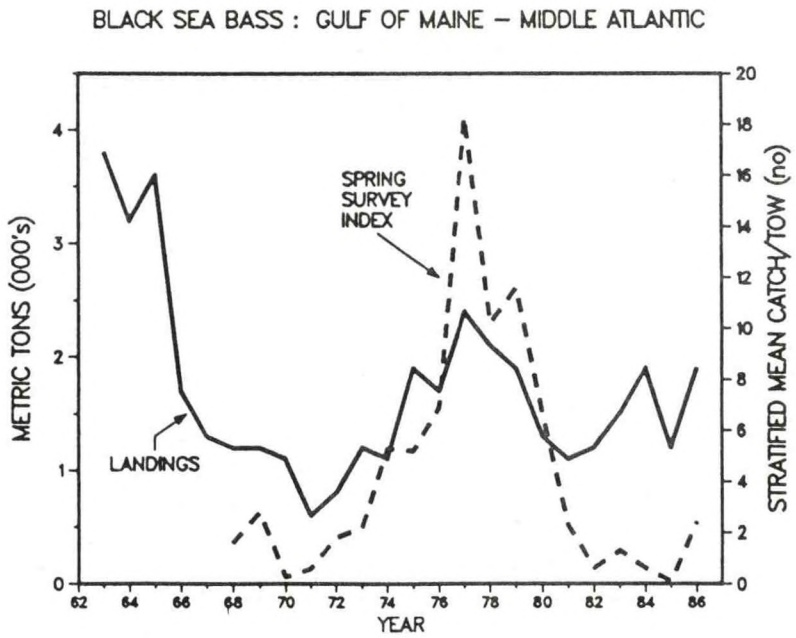


Figure 23.1 Total commercial landings and stock abundance indices from NEFC spring bottom trawl surveys of black sea bass in the Gulf of Maine - Mid-Atlantic area.

# 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 32 years, occurred in 1970 and resulted in peak commercial landings in the coastal states in 1973. The decline in landings since 1973 is primarily the result of low levels of recruitment, as evidenced by annual young-of-the-year surveys conducted in the Maryland portion of Chesapeake Bay, coupled with intensive exploitation of the adult stock. Young-of-the-year indices for the populations that contribute to the coastal migratory stock (Chesapeake Bay and Hudson River) were average or better than average in 1982, but were below the level produced in the late 1960's and early 1970's. In 1986, the Maryland juvenile index was slightly higher than the 1985 index, but was only about half the 1982 index. The Hudson River index dropped sharply in 1985 to only 14% of the long-term average and remained low in 1986. The 1986 index for the Roanoke River was one of the lowest on record.

Nominal catches of striped bass in the commercial fisheries from Maine to North Carolina averaged 2,700 mt per year between 1929 and 1983. Gill nets, haul seines, pound nets, and handlines accounted for over 80% of the commercial catch. The nominal commercial catch from Maine to North Carolina in 1986 (152 mt) was the lowest on record. The recreational harvest of striped bass has remained low throughout the 1980's. Recent landings have been affected not only by decreased abundance of striped bass but also by significant changes in management regulations which have occurred since 1982.

A coastwide management plan for striped bass was adopted by the Atlantic States Marine Fisheries Commission (ASMFC) in 1981. The plan recommended a 14-inch total length (35.6 cm) minimum size limit in nursery rivers and bays, a 24-inch total length (61.0 cm) minimum size limit on the coastal fisheries,

and that fishing be banned in spawning rivers during the spawning season. Due to the continued decline in juvenile abundance since 1981, the Plan was amended in 1984 to include an additional 55% reduction in fishing mortality. In 1985, an additional amendment was adopted which provides for protection of 1982 and subsequent year-class females until 95% have spawned at least once. This measure will result in a 33" minimum size limit in all areas by summer of 1987 and will be in effect until the Maryland recruitment index reaches a three-year average of 8.0.

Findings of the Emergency Striped Bass Study (ongoing since 1980) suggest that the decline in abundance of the Chesapeake Bay stock is due to a combination of factors, with overexploitation and contaminant toxicity being the most important. Low pH in combination with aluminum toxicity has been implicated as a possible reason for poor production of striped bass in Maryland's eastern shore rivers of the Chesapeake Bay. The Study findings also indicate that the decline in commercial and recreational catch between 1974 and 1980 may have cost the northeast approximately 7,000 jobs and over $220 million in economic activity in 1980.

For further information see:

Boreman, J. and C. P. Goodyear. 1984. Effects of fishing on the reproductive capacity of striped bass in Chesapeake Bay, Maryland. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 84-29, 20 p.

Richards, R.A. and D.G. Deuel. 1987. Atlantic striped bass: Stock status and the recreational fishery. Marine Fisheries Review, in press.

Table 24.1 Nominal catches (thousand metric tons) and management information for striped bass from the Gulf of Maine - Mid-Atlantic area.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | 2.9 | 0.8 | 0.6 | 1.6 | 1.2 | 0.5 | 0.8 | 0.9 |
| Commercial | | | | | | | | | |
| USA | 2.1 | 1.6 | 2.1 | 1.9 | 1.1 | 0.8 | 1.3 | 0.6 | 0.2 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | - | - | - | - | - | - | - | - | - |
| Total nominal catch | 2.1[1] | 4.5 | 2.9 | 2.5 | 2.7 | 2.0 | 1.8 | 1.4 | 1.1 |

Long-term potential catch = Unknown
Importance of recreational fishery = Major
Status of management = FMP in effect since October 1981
Status of exploitation = under protection
Age at 50% maturity = 2 years (males; 4 years (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 $F_{1986}$ = Unknown

1 Recreational catches unknown.

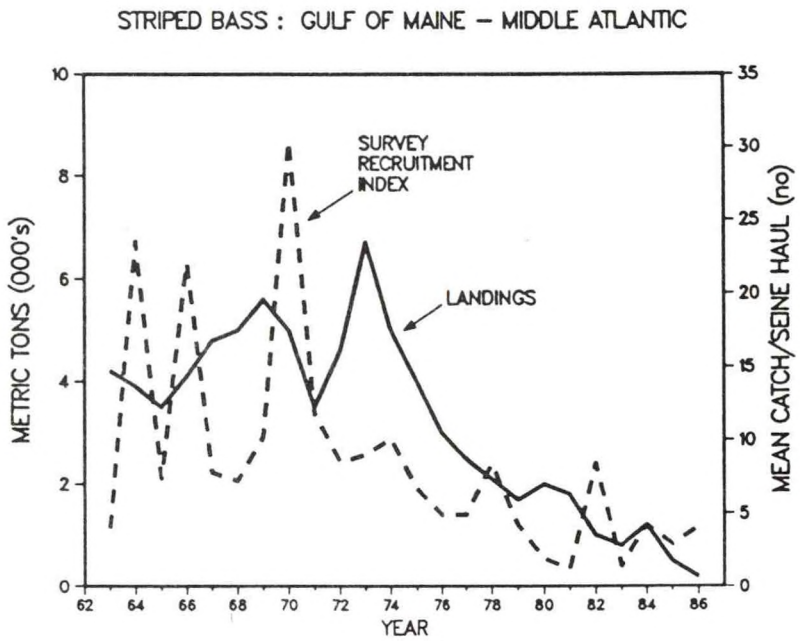


Figure 24.1 Total commercial landings and recruitment indices (from Maryland seine surveys in Chesapeake Bay) for striped bass in the Gulf of Maine - Mid-Atlantic area.

# 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 six.

Reported international nominal catches peaked at about 21,000 mt in 1972 and declined sharply from 1975 to 1978. Distant-water fleets consistently accounted for virtually all of the reported catches. The reported USA nominal catch declined from 4,000 mt in 1985 to 2,900 mt in 1986, which represents the fifth consecutive year of declining catches, and is attributable to decreased availablility of marketable size dogfish on the traditional summer fishing grounds. During summer, large concentrations of marketable-sized dogfish were usually found in the vicinity of and on Stellwagen Bank. However, in 1986 dogfish abundance within this region was low, coinciding with drastic declines in sandlance, a principal prey item. This situation is expected to continue in 1987.

Minimum biomass estimates of spiny dogfish based on NEFC spring bottom trawl survey catches decreased 370% from 990,500 mt in 1985 269,000 mt in 1986, 18% below the 1968-1985 geometric average of 327,000 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:

Colvocoresses, J. A., and J. A. Musick. 1980. A preliminary evaluation

of the potential for a shark fishery in Virginia. Virginia Inst. Mar. Sci. Spec. Rept. Appl. Mar. Sci. Ocean. Engineering No. 234, 37 p.
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.

Slauson, T. P. 1982. Growth, maturation, and fecundity of the spiny dogfish, *Squalus acanthias*, in the northwestern Atlantic. MS Thesis, State University of New York at Stony Brook, 97 p.

Table 25.1 Nominal catches (thousand metric tons) and management information for spiny dogfish from the Gulf of Maine - Mid-Atlantic area.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| USA | 0.9 | 4.8 | 4.2 | 6.9 | 6.6 | 4.9 | 4.4 | 4.0 | 2.8 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | 0.6 | - | 0.2 | 0.3 | 0.4 | - | - | - | 0.1 |
| Total Nominal catch | 1.5 | 4.8 | 4.4 | 7.2 | 7.0 | 4.9 | 4.4 | 4.0 | 2.9 |

Long-term potential catch = Unknown
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 $F_{1986}$ = Unknown

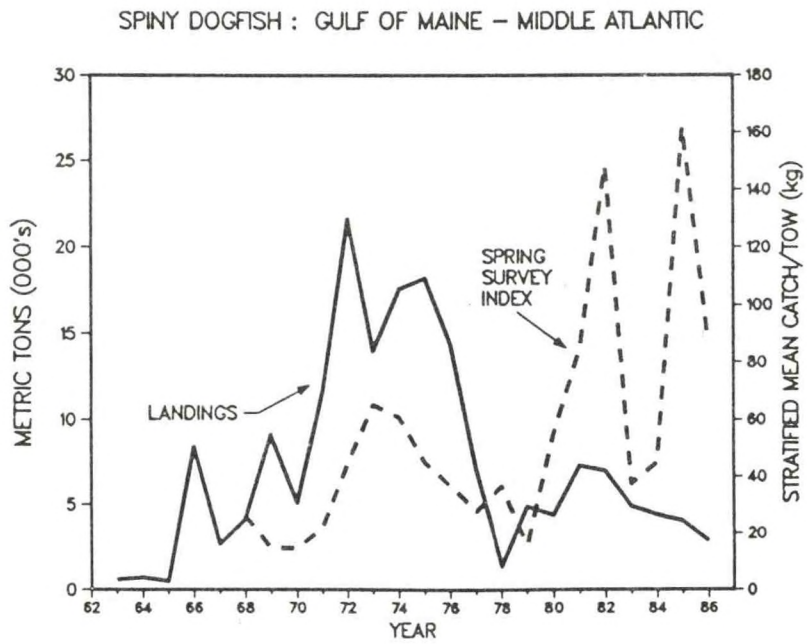


Figure 25.1 Total commercial landings and stock biomass indices from NEFC spring bottom trawl surveys of spiny dogfish in the Gulf of Maine - Mid-Atlantic area.

# 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. Most of the domestic catch has traditionally been discarded at sea. Beginning in 1983, domestic catches began increasing in response to an expansion of the domestic food fish market, and the development of a bait market in southern New England. Nominal catches in 1986 were 4,300 mt, up slightly from 1985 levels (4,000 mt).

The species composition of the 1986 catch of skates for human consumption was unknown since only the pectoral fins or wings are landed for most species. The little skate is the principal species sold as bait. Nominal catches are not expected to markedly increase in the near future unless the limited export or domestic market expands.

Minimal biomass estimates for all skates combined in the Gulf of Maine - Mid-Atlantic area determined from NEFC bottom trawl survey data increased nearly 150% from 206,600 mt in 1985 to an historical high of 507,500 mt in 1986. The 1986 estimate was 306% greater than the 1968-1985 average of 125,000 mt. The 1986 increase is largely attributable to large catches of winter skate on Georges Bank.

For further information see:

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

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

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

Table 26.1 Nominal catches (thousand metric tons) and management information for skates (all species) from the Gulf of Maine - Mid-Atlantic area.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| USA | 1.5 | 1.6 | 2.0 | 0.8 | 1.0 | 3.6 | 4.1 | 4.0 | 4.2 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | - | - | - | - | - | - | - | - | 0.1 |
| Total nominal catch | 1.5 | 1.6 | 2.0 | 0.8 | 1.0 | 3.6 | 4.1 | 4.0 | 4.3 |

Long term potential catch = Unknown
Importance of recreational fishery = Insignificant
Status of management = None
Status of exploitation = Underexploited
Age at 50% maturity = 4 years[1]
Size at 50% maturity = 40 cm (15.8 inches)[1]
$M = 0.40^1$ $F_{0.1} = 0.49^1$ $F_{max} = 1.00^1$ $F_{1986}$ = Unknown

1 Pertains to the little skate.

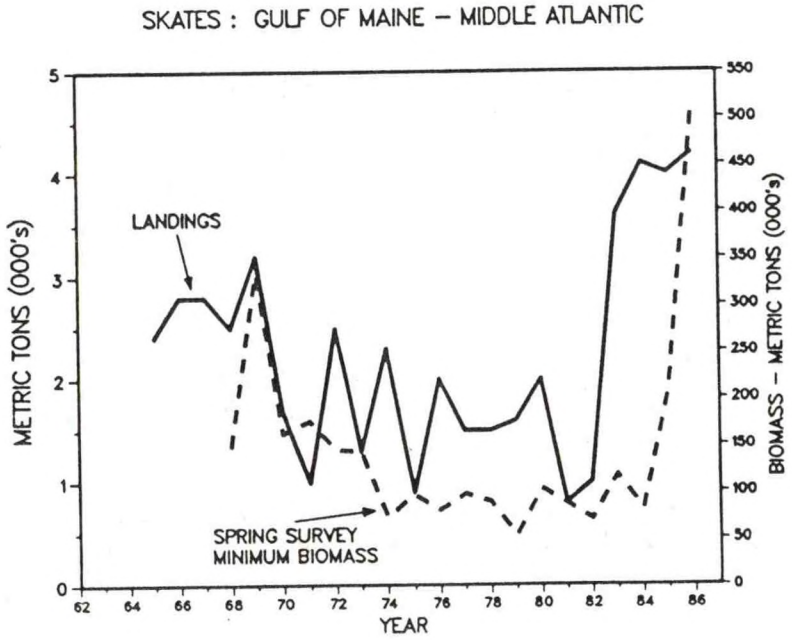


Figure 26.1 Total commercial landings and estimates of minimum stock biomass from NEFC spring bottom trawl surveys of skates in the Gulf of Maine - Mid-Atlantic area.

# 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 6,100 mt in 1985 to 5,800 mt in 1986, compared to the 1968-1982 mean of 14,700 mt. The USA nominal catch increased from 5,000 mt in 1985 to 5,600 mt in 1986. The 1986 USA catch, though about half that seen in 1983 and 1984, still represented over a fivefold increase from the 1968-1982 average. About one third of the 1986 USA catch was taken in joint ventures. Distant-water-fleet catches during 1986 were 200 mt, an 81% decrease from 1985 (1,100 mt), and 99% below the 1968-1982 mean catch of 13,800 mt.

The 1986 NEFC autumn survey index for *Illex* was about 60% greater than that for 1985 but 18% below that seen during the previous period of low abundance (1968-1974). Pre-recruit $\leq$10 cm) abundance in 1986 was also well below the 1968-1974 average. The pre-recruits sampled in the 1986 autumn survey will comprise the bulk of the catch in the 1987 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.

Northeast Fisheries Center. 1986. Report of Fourth Stock Assessment Workshop. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 86-14. 98 p.

Table 27.1 Nominal catches (thousand metric tons) and management information for the short-finned squid Illex from the Gulf of Maine - Mid-Atlantic area.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| USA[1] | 0.4 | 1.6 | 0.3 | 0.6 | 5.4 | 9.9 | 9.5 | 5.0 | 5.6 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | 17.3 | 16.3 | 19.6 | 14.9 | 12.4 | 1.8 | 0.7 | 1.1 | 0.2 |
| Total nominal catch | 17.7 | 17.9 | 17.9 | 15.4 | 17.8 | 11.7 | 10.2 | 6.1 | 5.8 |
| Total allowable catch | 35.0 | 30.0 | 30.0[2] | 30.0[2] | 30.0[2] | 30.0[2] | 30.0[2] | 25.0[2] | 22.5 |

Long-term potential catch = 30,000 mt
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 $F_{1986}$ = Unknown

1 Includes prorated amounts of squid catches not identified to species.
2 1 April - 31 March fishing year.

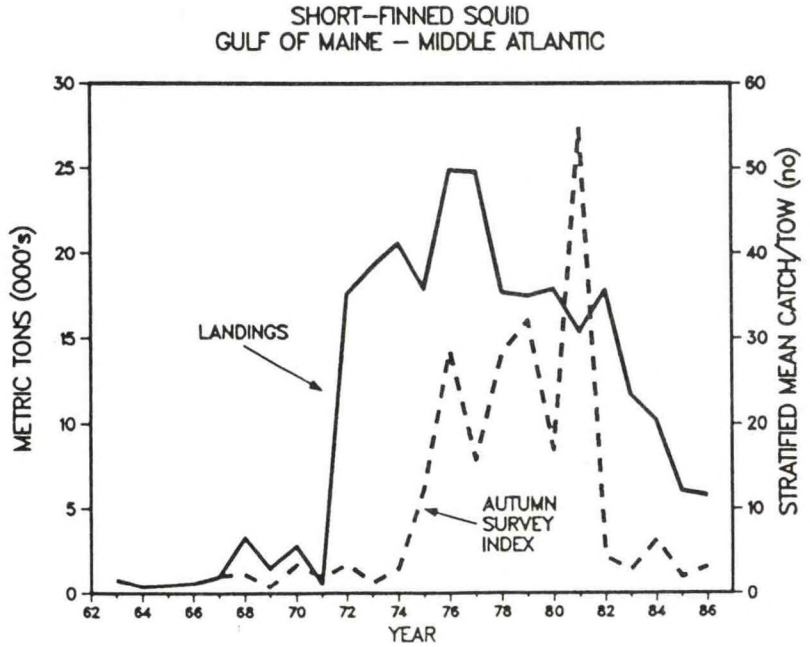


Figure 27.1 Total commercial landings and stock abundance indices from NEFC autumn bottom trawl surveys of short-finned squid in the Gulf of Maine - Mid-Atlantic area.

# LONG-FINNED SQUID

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

Total catches increased from 16,700 mt in 1985 to 17,700 mt in 1986 and were 24% below the 1970-1982 average (23,300 mt). The USA nominal catch increased from 10,200 mt in 1985 to 13,400 mt in 1986, the second highest level recorded. Joint venture catches accounted for about 15% of that total. Distant-water-fleet (DWF) catches during 1986 were 4,300 mt compared with 6,500 mt in 1985. The 1986 DWF catches were 80% below the 1970-1982 mean (21,500 mt).

The NEFC autumn survey index for 1986 increased 2% from 1985 and was 58% above the 1968-1985 average. The 1985 pre-recruit index was 16% greater than that of 1985 and 50% above the 1968-1985 mean. Minimum abundance was estimated to be 3.1 billion individuals during the time of the 1986 autumn survey, with 80% (2.5 billion) being of pre-recruit size $\leq$8 cm or $\leq$3 inches). Recruitment from the 1986 year class should be 1.7 - 3.6 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 51,000 and 60,000 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.

Northeast Fisheries Center. 1986. Report of Fourth Stock Assessment Workshop. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 86-14. 98 p.

Table 28.1 Nominal catches (thousand metric tons) and management information for long-finned squid Loligo from the Gulf of Maine - Mid-Atlantic area.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| USA[1] | 1.3 | 4.3 | 4.0 | 2.3 | 5.4 | 15.9 | 11.6 | 10.2 | 13.4 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | 9.4 | 13.1 | 19.8 | 20.2 | 15.9 | 11.7 | 11.0 | 6.5 | 4.3 |
| Total nominal catch | 10.6 | 17.3 | 23.7 | 22.5 | 21.3 | 27.6 | 22.6 | 16.7 | 17.7 |
| Total allowable catch | 44.0 | 44.0 | 44.0[2] | 44.0[2] | 44.0[2] | 44.0[2] | 44.0[2] | 33.0[2] | 37.02 |

Long-term potential catch = 44,000 mt
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") dorsal mantle length
M = Unknown $F_{0.1}$ = Unknown $F_{max}$ = Unknown $F_{1986}$ = Unknown

1 Includes prorated amounts of squid catches not identified to species.
2 1 April - 31 March fishing season.

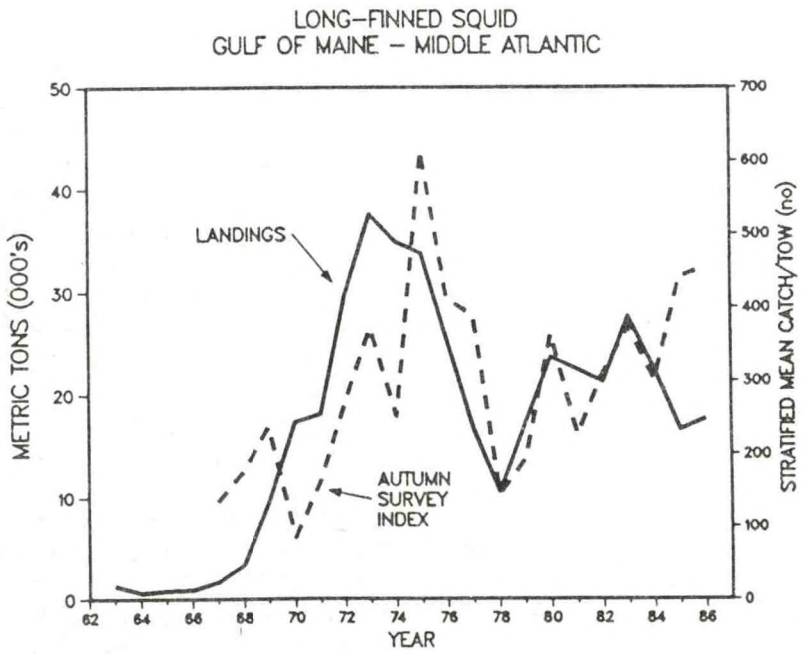


Figure 28.1 Total commercial landings and stock abundance indices from NEFC autumn bottom trawl surveys of long-finned squid in the Gulf of Maine - Mid-Atlantic area.

## 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 approximatley 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. The 1985 and 1986 nominal catches increased to around 18,000 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 2,500 mt. The 1985 nominal catch of 2,600 mt represented a decrease from the 1984 level and rose again in 1986 to 3,000 mt. The offshore trawl fishery averaged 1,900 mt per year during 1965-1974 and then decreased steadily and fluctuated from 1977 to 1985 at between 200 and 300 mt. Total offshore landings have declined from 1978 to 1981, but returned to levels of the mid-1970's more recently.

The NEFC autumn survey biomass index declined steadily from 1.3 kg/tow in 1964 to 0.5 kg/tow in 1970, averaged 0.7 kg/tow during 1971-1976, and then increased to an average of 1.0 kg/tow during 1977-1980. The autumn index decreased to 0.8 kg/tow in 1985 and stayed around 0.84 in 1986. 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 0.2 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:13, 21 p.

Table 29.1 Commercial and recreational landings (thousand metric tons, live weight) of American lobster from the Gulf of Maine - Mid-Atlantic area. Landings statistics have been revised to reflect unreported catches.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational[1] | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| USA: Offshore[2] | 2.7 | 2.2 | 1.9 | 1.8 | 2.5 | 2.4 | 4.2 | 2.6 | 3.0 |
| Inshore[3] | 12.9 | 14.7 | 14.9 | 15.9 | 16.1 | 17.6 | 16.4 | 18.0 | 17.8 |
| Canada: Georges Bank | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 |
| Other | - | - | - | - | - | - | - | - | - |
| Total nominal catch | 15.9 | 17.2 | 17.0 | 17.9 | 18.8 | 20.2 | 20.8 | 20.8 | 20.9 |

Long-term potential catch = 3,400 mt[4]
Importance of recreational fishery = Insignificant[4]
Status of management = FMP in place since 1985
Status of exploitation = Fully exploited
Size at 50% maturity = 10 cm (3.9") carapace length
M = 0.10 $F_{0.1}$ = Unknown $F_{max}$ = 0.18 (males), 0.23 (females) $F_{1986} > F_{max}$

1 Recreational catches unknown.
2 Includes trawl and offshore trap catches.
3. Inshore trap catches.
4. Offshore fishery only.

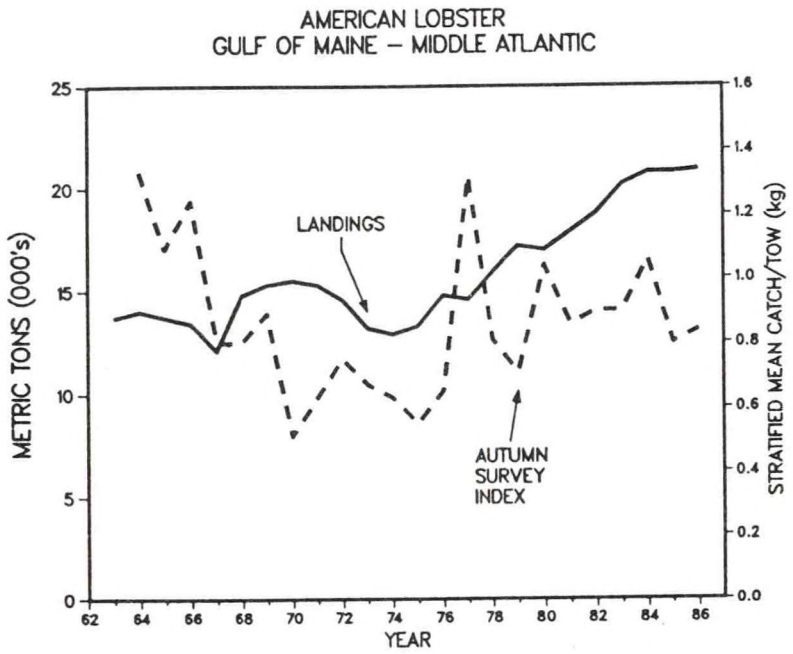


Figure 29.1 Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of American lobster in the Gulf of Maine - Mid-Atlantic area.

# 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 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 2½ years of age); they then pass through a series of transitional stages and mate again as females the following summer at age 3½. During autumn and winter, egg-bearing (ovigerous) females migrate into inshore areas where the eggs hatch. These 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. Beginning in 1985, the season has extended from 1 December - 31 May, the maximum allowable under current ASMFC policy.

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 11,000 mt during 1971-1972, and then declined precipitously to only 400 mt in 1977. Nominal catches have since increased from an average of 400 mt in 1979-1980 to 4,200 mt in 1985; the 1986 total was 4,700 mt. A total harvest of about 4,000 mt is projected for the December 1986 - May 1987 fishing season. The upward trend in recent years reflects both increased abundance and increased fishing effort. During the 1985 - 1986 season the number of trips directed towards northern shrimp was more than double the 1982-1983 average. NEFC spring and autumn survey indices have increased in recent years; the 1986 autumn survey index value was the highest observed since 1977. Results of cooperative surveys by state and federal personnel since 1983 indicate a sharp increase in abundance due to recruitment of the 1982 year class, apparently the strongest to appear in a decade. Subsequent year classes appear weaker. This suggests that a decline in abundance is imminent

as the 1982 year class has largely passed through the fishery. Harvestable biomass and mortality estimates calculated for 1985-1986 indicate relatively low exploitation rates during these years 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. 1986. Gulf of Maine northern shrimp stock status - 1986. Report to Northern Shrimp Section of Atlantic States Marine Fisheries Commission, October 1986, 20 p.

Northern Shrimp Technical Committee. 1986. Cruise results - Gulf of Maine Northern Shrimp Survey, July 29 - August 9, 1986. Unpublished Report, Woods Hole, MA, 26 p.

Table 30.1 Nominal catches (thousand metric tons) and management information for Gulf of Maine northern shrimp.

| Category | Year 1978[1] | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| USA | <0.1 | 0.5 | 0.3 | 1.1 | 1.6 | 1.6 | 3.3 | 4.2 | 4.7 |
| Canada | - | - | - | - | - | - | - | - | - |
| Other | - | - | - | - | - | - | - | - | - |
| Total nominal catch | <0.1 | 0.5 | 0.3 | 1.1 | 1.6 | 1.6 | 3.3 | 4.2 | 4.7 |

| | |
|---|---|
| Long-term potential catch | = Unknown |
| Importance of recreational fishery | = Insignificant |
| Status of management | = Jointly by participating states[2] |
| Status of exploitation | = Fully exploited |
| Age at 50% maturity | = 2 years |
| Size at 50% maturity | = 9 cm (3.5 inches) |

M = Unknown $F_{0.1}$ = Unknown $F_{max}$ = Unknown $F_{1986}$ = Unknown

1 Fishery closed during 1978
2 Under Amendment No. 1 to the Atlantic States Marine Fisheries Compact.

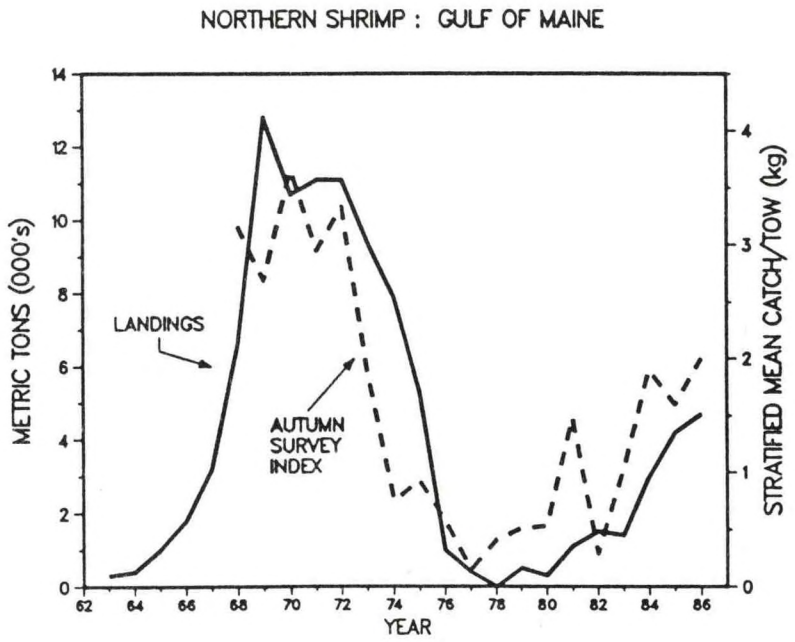


Figure 30.1 Total commercial landings and stock biomass indices from NEFC autumn bottom trawl surveys of northern shrimp in the Gulf of Maine.

# 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, although 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; total (inshore and offshore) 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, a minimum clam size, and target discarding rates to be achieved by changes in minimum shell 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 1986 and 1987 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. 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 1985, 80% of Middle Atlantic FCZ surf clam landings was taken off New Jersey, 18% off the Delmarva Peninsula, and 2% from the southern Virginia - North Carolina region. Total FCZ landings in 1986 were 24,900 mt, slightly greater than the combined annual quotas for the

Mid-Atlantic and New England areas.

Biomass indices from research vessel surveys generally parallel trends in landing statistics from various portions of the management area. 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 existence 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 has recruited to the exploitable stock, particularly since the minimum legal size has been reduced in the past two years from 14 to 12.7 cm shell length.

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 1986 and 1987.

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, 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 (18,000-23,000 mt of meats) until the mid-1990's. Likewise, landings of 3,000-4,000 mt of meats can be sustained from the New England management area (Southern New England and Georges Bank) for the next decade as well.

Landings from inshore (state) waters increased 17% between 1985-1986 (from 9,200 to 10,800 mt), reflecting the intensive harvest of clams from inshore New Jersey and Long Island Sound, New York waters. Recent data indicate decreased productivity and resource abundance in the Long Island Sound area, thus the prospects for stable inshore surf clam landings during 1987-1988 are problematic.

For further information see:

Murawski, S. A. 1986. Assessment updates for Middle Atlantic, New England, and Georges Bank offshore surf clam, *Spisula solidissima* populations, - summer 1986, NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 86-11. 34 p.

Murawski, S.A., and F.M. Serchuk. 1984. An assessment of the Georges Bank surf clam resource - summer 1984. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 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. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 83-20, 19 pp.

Murawski, S.A. 1986. Assessment updates for Middle Atlantic, New England, and Georges Bank offshore surf clam, *Spisula solidissima* populations, Summer 1986. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 86-11, 34 p.

Table 31.1 Nominal catches (thousand metric tons) and management information for surf clams from the New England - Mid-Atlantic area.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| FCZ waters | 13.2 | 13.2 | 15.7 | 16.9 | 16.7 | 20.5 | 24.7 | 23.7 | 24.9 |
| State waters | 3.6 | 2.6 | 1.4 | 4.0 | 5.9 | 4.9 | 7.2 | 9.2 | 10.8 |
| Total | 17.8 | 15.8 | 17.1 | 20.9 | 22.5 | 25.4 | 31.9 | 32.9 | 35.7 |
| Total allowable FCZ catch | 13.6 | 13.6 | 13.6 | 18.1 | 18.1 | 18.9 | 24.3 | 24.3 | 24.3 |

Long-term potential catch = 24,300 mt
Importance of recreational fishery = Insignificant
Status of management = FMP in force since November 1977
Status of exploitation = Fully exploited
Age at 50% maturity = 2 years
Size at 50% maturity = 5 cm (2.0 inches)
M = 0.20 $F_{0.1}$ = Unknown $F_{max}$ = Unknown $F_{1986}$ = Unknown, probably = 0.1

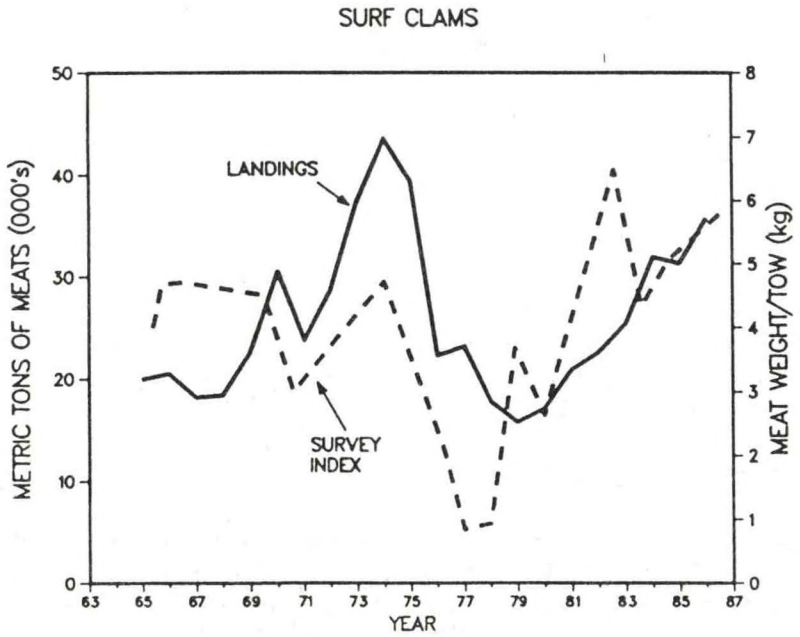


Figure 31.1 Total commercial landings and stock biomass indices from NEFC dredge surveys of surf clams in the Mid-Atlantic area.

## 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 shell length (3 inches) 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 implied 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 2,000 mt of shucked meats until 1976 when offshore exploitation began off New Jersey and Maryland. Steady declines in offshore surf slam 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 stabilized at about 16,000 mt per year between 1978-1980 and have since increased to a record 23,600 mt in 1985. Virtually all landings are derived from FCZ waters. Most of the FCZ landings are from off New Jersey, and the remainder from the 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, which has increased from 13,600 mt of meats in 1978 to 27,200 mt in 1986-1987.

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 1979-1986 were evaluated using mandatory logbook data submitted by each permitted vessel. 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

1983-1985. CPUE is likely to continue to exhibit such variability as new beds are located. 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 2% 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 few 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.

Ropes, J.W., D.S. Jones, S.A. Murawski, F.M. Serchuk, and A. Jearld, Jr. 1984 Documentation of annual growth lines in ocean quahogs, *Arctica islandica* Linne. Fish. Bull., U.S. 82(1): 1-19.

Northeast Fisheries Center. 1986. Report of the Third NEFC Stock Assessment Workshop. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 86-14, 98p.

Table 32.1 Nominal catches (thousand metric tons, meats and management information for ocean quahogs from the New England - Mid-Atlantic area.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| USA commercial | | | | | | | | | |
| FCZ waters | 9.2 | 14.3 | 13.9 | 16.0 | 15.6 | 15.3 | 16.4 | 23.6 | 19.8 |
| State waters | 1.2 | 1.4 | 1.5 | 0.4 | 0.2 | 0.7 | 1.2 | <0.1 | 0.8 |
| Total nominal catch | 10.4 | 15.8 | 15.3 | 16.4 | 15.8 | 16.0 | 17.6 | 23.6 | 20.5 |
| Total allowable FCZ catch | 13.6 | 13.6 | 15.9 | 18.1 | 18.1 | 18.1 | 18.1 | 20.4 | 27.2 |

Long-term potential catch = 27,200 mt
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 years (males); 11 years (females)
Size at 50% maturity = 50 mm (2.0 inches) shell length

M = 0.01 - 0.10 $F_{0.1}$ = Unknown $F_{max}$ = 0.03 - 0.05 $F_{1985}$ = Unknown, probably < 0.1

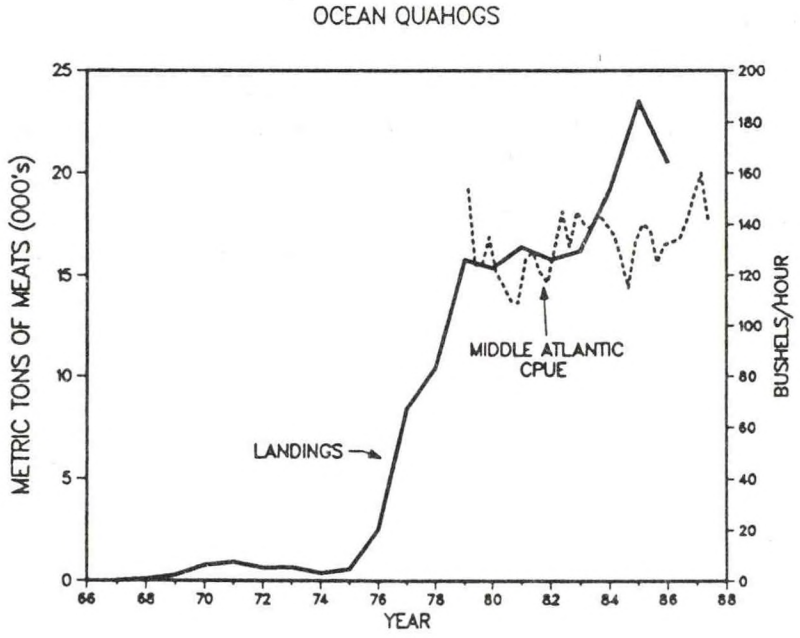


Figure 32.1 Total commercial landings of ocean quahogs in the New England - Mid-Atlantic area and commercial catch per unit effort in the New Jersey and Delmarva ocean quahog dredge fisheries.

# 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

Nominal catch in 1986 from the Gulf of Maine was 351 mt (meat weight), 24% less than in 1985. USA landings, which accounted for 90% of the 1986 total (Canada accounted for the remaining 10%), were the lowest since 1978. Most of the USA catch (78%) was from inshore, territorial waters along the coast of Maine. USA landings from the EEZ (> 3 n mi from shore) were the lowest since 1979 indicating continued dependence by the fishery on inshore beds.

Commercial fishing effort declined in 1986 (-18% from 1985 and -59% from the record-high 1983 level), largely due to sharp reductions in both Class 3 [51 - 150 gross registered tons (GRT)] and Class 4 [>151 GRT] fishing activity. USA commercial CPUE in 1986 declined, for the sixth consecutive year, to a record low.

## Georges Bank

Total (USA and Canada) nominal catch in 1986 was 9,100 mt, 35% higher than in 1985, and the highest annual catch since 1982. Of the 1986 total, USA landings accounted for 48% (4,400 mt) while Canadian landings (4,700 mt) accounted for 52%.

USA effort in the 1986 Georges Bank fishery increased 24% from 1985 and was higher than in any year except 1981. Nearly all of the increased effort was due to expanded fishing activity by large vessels (Class 4). Canadian fishing effort decreased by 50% in 1986 due to Canadian management regulations

(catch quotas and enterprise allocations) and a 100% increase in Canadian CPUE resulting from localized strong recruitment of the 1981 year class in the Canadian sector of Georges Bank. USA CPUE in 1986 also increased (+26% from 1985) due to partial recruitment of a strong 1982 year class in the USA portion of the Bank.

Abundance indices from the 1986 USA sea scallop research vessel survey indicated that the marked improvement in abundance that began in 1985 has continued. In the USA sector of Georges Bank, the 1986 survey abundance values were among the highest in the 12-year survey time series. The survey results also indicate that the strong 1982 year class has been followed by an even stronger 1983 cohort.

Due to the excellent 1982 and 1983 year classes, the Georges Bank scallop resource has rapidly recovered from the record-low 1983-1984 levels. As a result, catches and CPUE in 1987 and 1988 are expected to be very much higher than in 1986.

Mid-Atlantic

Total nominal catch (exclusively USA) in 1986 was 3,400 mt, a slight increase (+2%) from 1985. For the first time since 1983, less catch was taken by the USA fleet from the Mid-Atlantic region than from Georges Bank (3,400 mt vs. 4,400 mt). Most of the 1986 Mid-Atlantic catch (76%) was from the New York Bight region (off Long Island and New Jersey).

Fishing effort in the Mid-Atlantic area declined in 1986 (-28%). This decline was virtually identical to the increase in USA effort observed in the 1986 Georges Bank fishery (+24%) implying that the USA fleet shifted effort from one region to the other in 1986. Commercial CPUE, however, increased in the Mid-Atlantic in 1986 from the record-low 1985 level. As on Georges Bank, this increase was due to partial recruitment of the 1982 year class which is also strong in the Mid-Atlantic area.

Abundance indices from the 1986 USA Mid-Atlantic sea scallop survey were the highest ever observed. Good recruitment from the 1981 year class followed by outstanding recruitment of the 1982 and 1983 year classes has resulted in a four-fold increase in Mid-Atlantic population size from the record-low 1983 level and a doubling of stock biomass.

Given the present resource status, significant increases in catches are expected for at least 2-3 years (i.e., through 1989).

For further information see:

Serchuk, F. M., and S. E. Wigley. 1986. Status of the sea scallop resources off the Northeastern United States, 1986. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 86-08, 36 p.

Serchuk, F. M., and S. E. Wigley. 1986. Abundance, size composition, and recruitment of sea scallops in the USA Georges Bank and Mid-Atlantic regions: Results of the 1986 USA sea scallop research vessel survey. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 86-15, 55p.

Serchuk, F. M., and S.E. Wigley. 1986. Evaluation of USA and Canadian research vessel surveys for sea scallops *Placopecten magellanicus* on Georges Bank. J. Northw. Atl. Fish. Sci. 7: 1-13.

Table 33.1 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.

| Category | Year 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|---|---|---|---|
| USA recreational | - | - | - | - | - | - | - | - | - |
| Commercial | | | | | | | | | |
| Gulf of Maine | | | | | | | | | |
| USA | 0.2 | 0.4 | 1.6 | 1.3 | 0.7 | 0.9 | 0.7 | 0.4 | 0.4 |
| Canada | - | - | <0.1 | <0.1 | <0.1 | 0.1 | 0.1 | <0.1 | <0.1 |
| Total | 0.2 | 0.4 | 1.6 | 1.3 | 0.7 | 1.0 | 0.8 | 0.5 | 0.4 |
| Georges Bank | | | | | | | | | |
| USA[1] | 5.6 | 6.7 | 5.8 | 8.5 | 6.7 | 4.6 | 3.2 | 3.0 | 4.5 |
| Canada | 12.2 | 9.2 | 5.2 | 8.0 | 4.3 | 2.8 | 2.0 | 3.8 | 4.7 |
| Total | 17.8 | 15.9 | 11.0 | 16.5 | 11.0 | 7.4 | 5.2 | 6.8 | 9.2 |
| Mid-Atlantic | | | | | | | | | |
| USA | 8.6 | 7.2 | 5.1 | 1.9 | 1.7 | 3.2 | 3.8 | 3.3 | 3.4 |
| Total nominal catch | 26.6 | 23.5 | 17.7 | 19.7 | 13.4 | 11.6 | 9.8 | 10.6 | 13.0 |

Long-term potential catch
- Gulf of Maine = 300 mt (territorial waters)
- Georges Bank = 10,000 mt
- Mid-Atlantic = 3,000 mt

Importance of recreational fishery = Insignificant
Status of management = FMP in force since May 1982
Status of exploitation in 1981 = Fully exploited
Age at 50% maturity = 3-4 years (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) $F_{1986} = >F_{max}$ in all areas

1 For USA, Georges Bank landings include Southern New England catches.

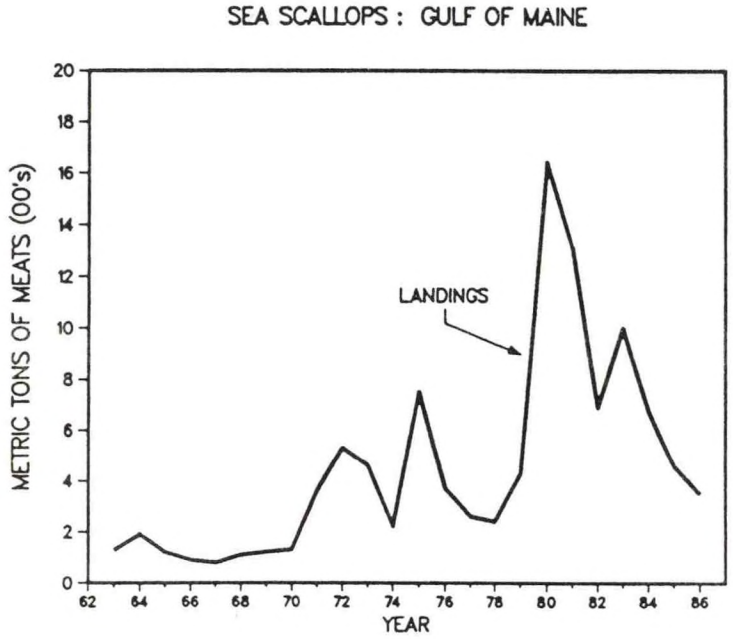


Figure 33.1 Total commercial landings of sea scallops in the Gulf of Maine.

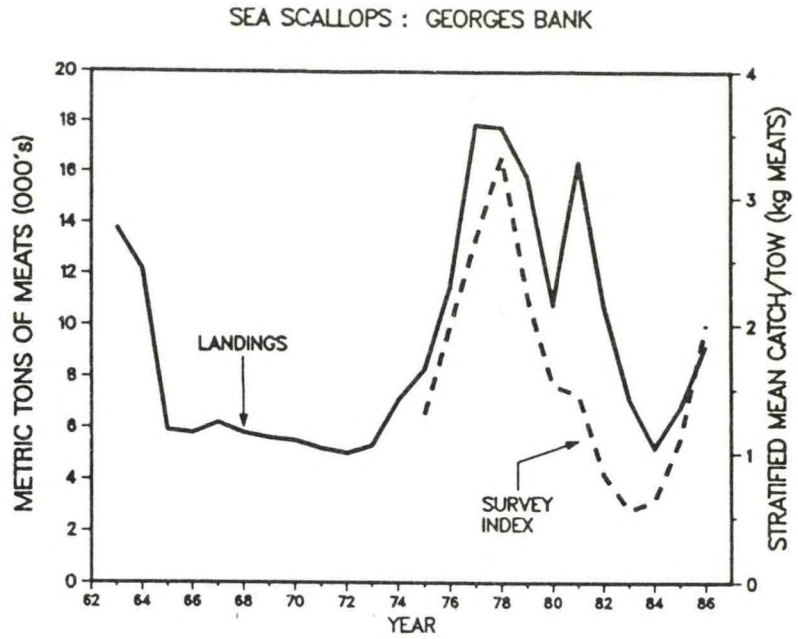


Figure 33.2 Total commercial landings and stock biomass indices from NEFC dredge surveys of sea scallops on Georges Bank.

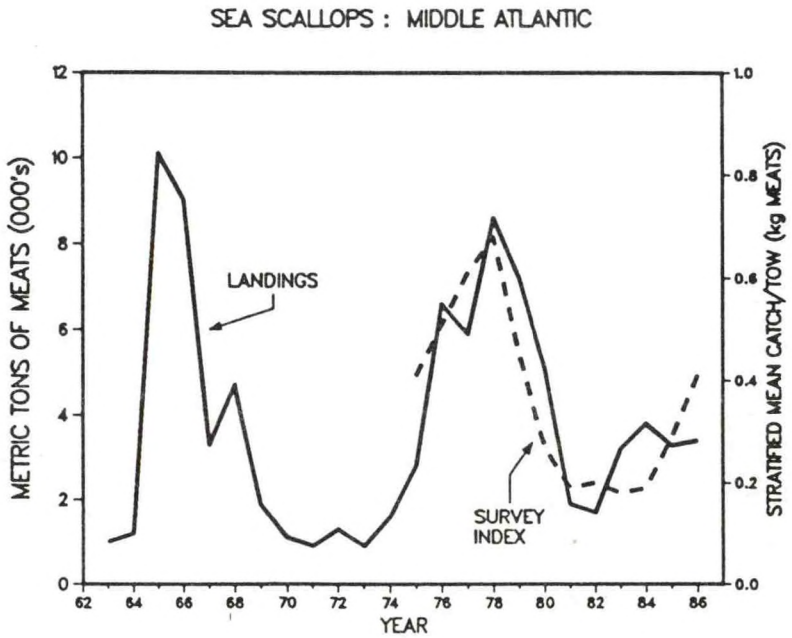


Figure 33.3 Total commercial landings and stock biomass indices from NEFC dredge surveys of sea scallops in the Mid-Atlantic area.



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*(continued from inside front cover)*

**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.

**42.** ***Status of the Fishery Resources Off the Northeastern United States for 1985.*** By Conservation & Utilization Division, Northeast Fisheries Center. August 1985. iii + 137 p., 46 figs., 49 tables. NTIS Access. No. PB86-125473/AS.

**43.** ***Status of the Fishery Resources Off the Northeastern United States for 1986.*** By Conservation & Utilization Division, Northeast Fisheries Center. September 1986. iii + 130 p., 45 figs., 48 tables. NTIS Acces. No. PB87-122115/AS.

**44.** ***NOAA's Northeast Monitoring Program (NEMP): A Report on Progress of the First Five Years (1979-84) and a Plan for the Future.*** By Robert N. Reid, Merton C. Ingham, and John B. Pearce, eds., and Catherine E. Warsh (water quality), Robert N. Reid (sediments & bottom organisms), Adriana Y. Cantillo (trace contaminants in tissues), and Edith Gould (biological effects), topic coords. May 1987. xi + 138 p., 13 figs., 1 table, 9 app. NTIS Access. No. PB87-210100.

**45.** ***Food and Distribution of Juveniles of Seventeen Northwest Atlantic Fish Species, 1973-1976.*** By Ray E. Bowman, Thomas R. Azarovitz, Esther S. Howard, and Brian P. Hayden. May 1987. xi + 57 p., 10 figs., 19 tables. NTIS Access. No. PB87-215851/AS.

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**47.** ***MARMAP Surveys of the Continental Shelf from Cape Hatteras, North Carolina, to Cape Sable, Nova Scotia (1977-1984). Atlas No. 2. Annual Distribution Patterns of Fish Larvae.*** By Wallace W. Morse, Michael P. Fahay, and Wallace G. Smith. May 1987. viii + 215 p., 27 figs., 2 tables. NTIS Access. No. PB87-232831/AS.

**48.** ***Indexed Bibliography of the Bay Scallop* (Argopecten irradians).** By Barbara D. Sabo and Edwin W. Rhodes. May 1987. iii + 85 p. NTIS Access. No. PB87-231411/AS.

**49.** ***Northeast Fisheries Center Framework for Inshore Research.*** By Research Planning & Coordination Staff, Northeast Fisheries Center. July 1987. vi + 44 p., 2 figs., 2 tables. NTIS Access No. PB87-232286/AS.

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