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Status of the Fishery Resources Off the Northeastern United States for 1989

Conservation and Utilization Division, Northeast Fisheries Center

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Table of Contents

Aggregate Summaries

Species Synopses

Invertebrates

AGGREGATE SUMMARIES

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, and presents detailed information as needed to administrators, managers, the fishing industries, and the public. This report is based on those assessments and summarizes the general status of selected finfish and shellfish resources off the northeast coast of the United States from Cape Hatteras to Nova Scotia through 1988.

This report is divided into two sections, Aggregate Summaries and Species Synopses. The Aggregate Summaries section includes general descriptions of Fishery Landings Trends, Commercial Fishery Economic Trends, and Aggregate Resource Trends. The Species Synopses section, on the other hand, includes information about the status of individual populations or stocks of some 33 species of finfish and shellfish.

The species described in the Species Synopses section can be grouped conveniently under seven headings: principal groundfish, flounders, other groundfish, principal pelagics, other pelagics, and invertebrates. There are several other species of commercial and recreational importance which are not included here, such as bluefin and yellowfin tuna, swordfish, Atlantic salmon, red crabs, sandlance, sea urchins, menhaden, and pelagic sharks. Some of these are migratory species which seasonally move outside the northeast FCZ, while others are fisheries that have not been routinely assessed by the Northeast Fisheries Center.

OVERVIEW OF ASSESSMENT APPROACHES

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. 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. A more complex approach is when the catch data from the first approach 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 is to utilize the information about total stock size and population productivity generated under the first two approaches to determine the relationship between productivity and stock size; this is referred to as **production models**. Finally, for those species where the age composition of the catch or of the survey samples can be determined reliably, more complex **analytic assessments** can be developed that 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 diagrammed in Figure B. 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 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.

The different information paths in Figure A result in assessment information having different levels of sophistication and reliability. The actual level of complexity of an assessment is determined by the amount of information available, as indicated in Figure B, and by the amount of research done to interpret this information. Although there is some overlap, the assessments presented here can be roughly grouped in order of increasing level of complexity into the following categories, each one including features of all simpler levels.

INDEX: assessment relies on an index of stock size, from resource survey data or from catch per unit of effort data.

YIELD: assessment also includes an evaluation of yield tradeoffs for different levels of fishing mortality and ages of fish caught, (*e.g.* yield per recruit analysis).

AGE STRUCTURE: assessment also includes analysis of the observed age composition of the catch (*e.g.* virtual population analysis).

SPAWNING STOCK: assessment

[1] **All tables and figures in this section and the Aggregate Summaries are labeled with letters of the alphabet to distinguish them from the decimally labeled tables and figures in the Species Synopses section.**

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 the stocks (top box).

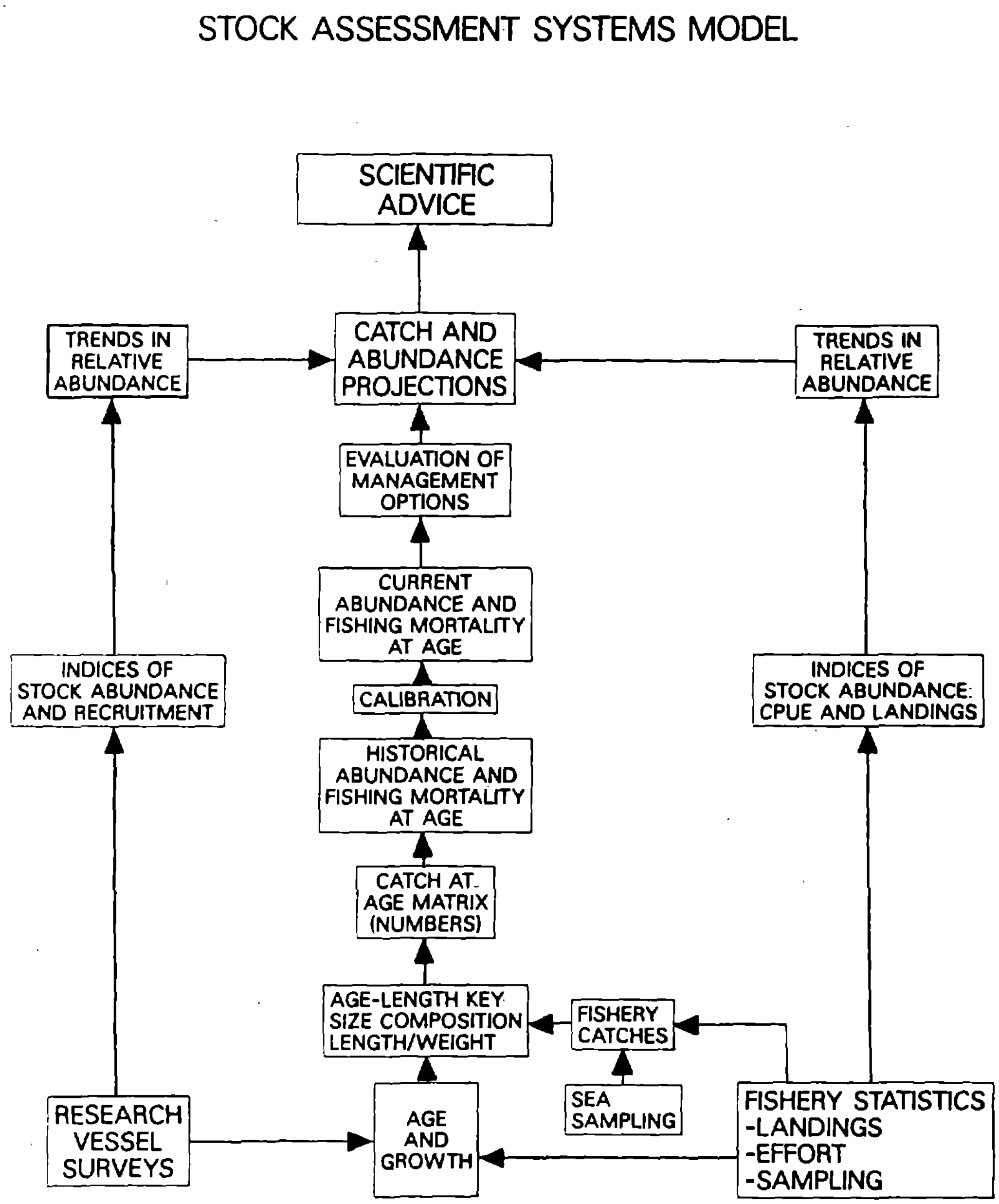
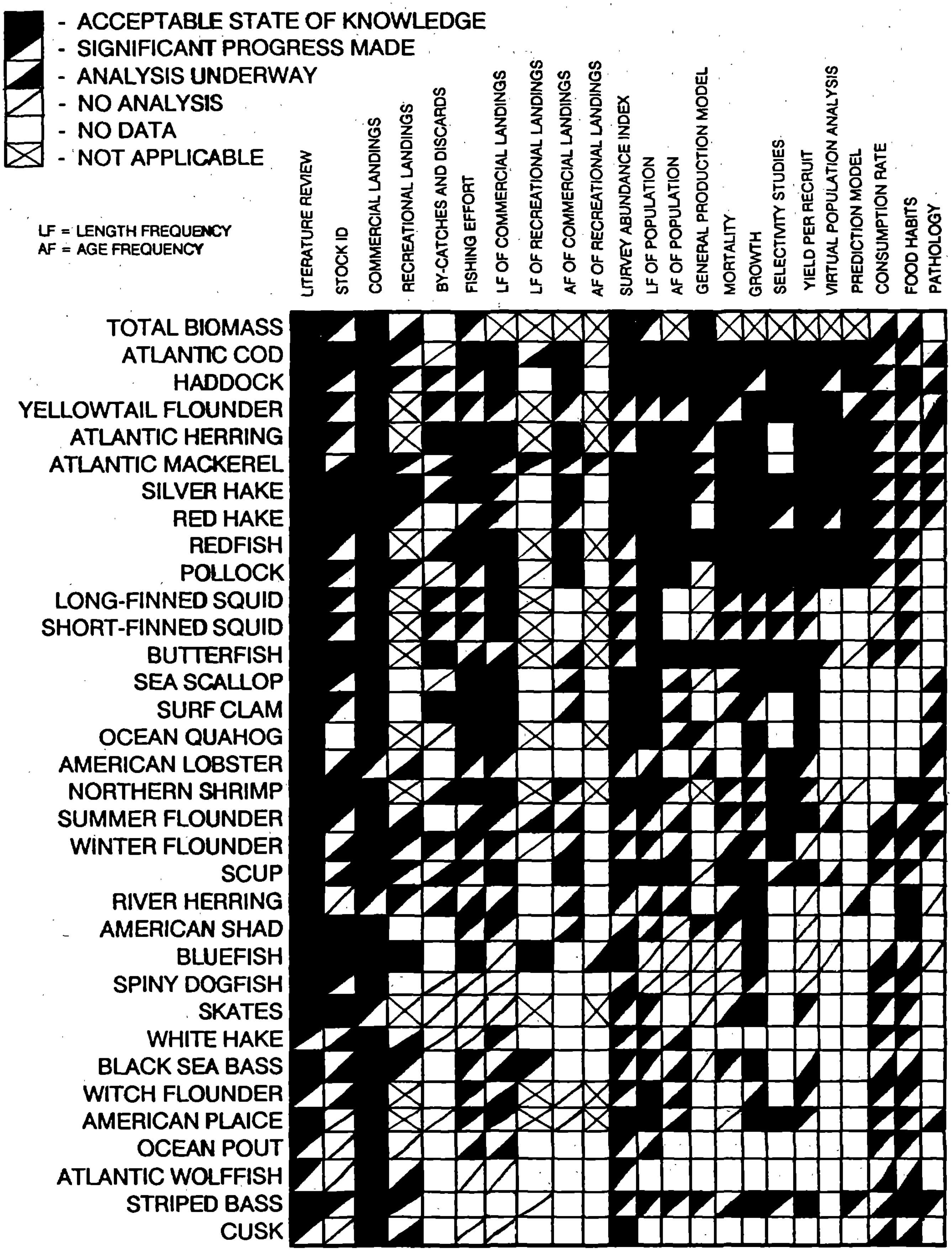


Figure B. Status of biological assessment knowledge required for fishing management.



also includes analysis of the data on spawning stock size and subsequent recruitment.

PREDICTIVE: assessment also includes a model for future stock conditions that accounts for random variations in the environment.

For example, in Figure A an **index** level assessment involves information generated by following either the rightmost or leftmost vertical arrows depending on whether commercial or survey data were available. A **yield** level assessment would also involve information from the box in the lowest rank labeled **age and growth**. Assessments at the **age structure** and **spawning stock** levels would require, in addition to the above, information represented in the middle column of boxes in Figure A. Finally, a **predictive** level assessment would require substantial additional information on the variability of the survival of young fish.

Increasing the level of complexity of an assessment requires substantial additional research; subsequently, substantially more activity each year is required to maintain it at its more complex level. Conversely, the level of an assessment can decrease relatively quickly if sufficient activity is not done to interpret each year's events and new data.

The needed level of an assessment depends on the complexity of the information needs for management. If management requires estimates of annual **quota** levels, for example, then a more complex assessment is generally needed.

Both Figures A and B reflect information about each species separately, as if they had no interactions with each other. Similarly, the assessments in the Species Synopses section of this report are presented individually, with little indication of the biological interactions among species or of the technical interactions due to the mixed species nature of many of the fisheries. The significance of the mixed species nature of the trawl fisheries in the northeastern U.S. is illustrated in the section entitled *Aggregate Resources Trends*. There, aggregate research trawl survey and commercial trawl data are presented illustrating major trends in abundance and catches. The information presented there, however, is rather simple, and does not address many of the complexities of these multispecies fisheries. Additional studies of the dynamics of the mixed species trawl fishery, and of the mixed species complex that it catches, are needed to adequately address pressing management needs.

FISHERY MANAGEMENT

Fisheries occurring primarily in the Fisheries Conservation Zone (FCZ) off the northeastern U.S. are managed under Fishery Management Plans (FMPs) developed by the New England Fisheries Management Council (NEFMC), the Mid-Atlantic Fisheries Management Council (MAFMC), and, in a few instances, under Preliminary Fishery Management Plans (PMPs) developed by the National Marine Fisheries Service (NMFS). Fisheries occurring primarily in state waters are managed by the individual states or under Interstate Agreements under the auspices of the Atlantic States Marine Fisheries Commission. The management currently in place is shown in Table A.

DEFINITION OF TECHNICAL TERMS

Certain assessment terms used throughout this document may not be familiar to all. A brief explanation of some follows, organized alphabetically. All terms defined are in boldface type when used for the first time in other definitions.

Assessment level: A rough categorization of the level of complexity of each assessment ranging from a simple index of abundance (INDEX), to a **yield per recruit** analysis (YIELD), to an analysis of the age structure of the catch (AGE STRUCTURE), to an analysis including the relationship between **recruitment** and spawning stock size (SPAWNING STOCK), to, finally, an assessment that allows prediction of future **year class** strength (PREDICTIVE). These levels are defined further in the section titled *Overview of Assessment Approaches*.

Exploitation pattern: The distribution of fishing mortality over the ages of the fish, determined by the type of fishing gear and spatial and seasonal distribution of fishing, and the growth and migration of the fish. The pattern can be changed by modifications to fishing gear; for example, increasing mesh or hook size.

Table A. Federal and interstate fishery management plans currently in place or under development for fisheries off the northeastern U.S.

Plan	Type	Organization Responsible	Since	Last Amendment
1. Multispecies[1]	FMP	NEFMC	1986	1989[2]
2. Squid, mackerel and butterfish FMP	FMP	MAFMC	1978	1986
3. Silver and red hake	PMP	NMFS	1977	1989[2]
4. Lobster	FMP	NEFMC	1983	1989[2]
5. Scallop	FMP	NEFMC	1982	1989
6. Surf clam, ocean quahog	FMP	MAFMC	1977	1987
7. Northern shrimp	Interstate	ASMFC	1976	1986[3]
8. Summer flounder	FMP	MAFMC	1988	-
9. Striped bass	Interstate	ASMFC	1981	1989

[1] Atlantic cod, haddock, redfish, pollock, yellowtail flounder, American plaice, witch flounder, winter flounder, white hake, windowpane flounder.
[2] In process.
[3] Rewritten.

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.

Fishing mortality rate: The part of the **total mortality rate** applying to a fish population that is caused by man's harvesting. Fishing mortality is usually expressed as an instantaneous rate, as discussed under **Mortality rate**, and can range from 0 for no fishing to very high values such as 1.5 or 2.0. The corresponding annual fishing mortality rate can be computed in the same manner as total mortality rates. Fishing mortality rates are estimated using a variety of techniques, depending on the available data for a species or stock.

For example, 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. During fishing, there are other causes of death that also act on the population of fish, and must be considered in calculating the number that die from fishing. The number that die from fishing is the proportion of the total mortality that is caused by fishing, 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 given 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.

F_{max}: The rate of fishing mortality for a given method of fishing that maximizes the harvest in weight taken from a single **year class** of fish over its entire lifespan.

$F_{0.1}$: A **fishing mortality rate** less than F_{max} that reflects the diminishing returns in terms of yield per recruited fish from increasing fishing mortality.

Both F_{max} and $F_{0.1}$ can be technically defined in terms of the increase in yield from a **year class** over its lifespan as fishing mortality increases. When no fish are taken, there is no yield from the year class. As fishing increases, the yield increases, but at a decreasing rate. F_{max} is the point at which the increased yield for additional effort is zero; that is, additional fishing mortality will not increase yield, but in fact, may decrease it as fish are caught before they have grown enough. $F_{0.1}$ is a point at which the increase in yield for increased effort is 10 percent of what it was when fishing mortality was very low. Both the $F_{0.1}$ and F_{max} values are indicators of how close a stock is to full exploitation.

Long-term potential catch: The largest annual harvest in weight which could be removed from a fish stock year after year, under existing environmental conditions. 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.

Maintenance Spawning Stock Biomass Per Recruit (MSSBR): An estimate of the **spawning stock biomass per recruit** required to maintain *spawning stock biomass*, based on the observed success of spawning in recent years. **Exploitation patterns** that result in a SSBR below this level will cause the spawning stock biomass to decline in the long term. Such values have been adopted in the New England Fishery Management Council's Multispecies Fishery Management Plan (FMP) as management targets. If the **Projected Spawning Stock Biomass Per Recruit** (PSSBR) is less than the maintenance spawning stock biomass per recruit, then the intensity of fishing is too high. For example, for Georges Bank haddock, MSSBR is approximately 2.7 kg per fish recruited at age 2, some 30% of the maximum SSBR. The PSSBR at about 1.6 kg is currently less than the MSSBR, implying that fishing intensity is too high as defined by the FMP.

Mortality rate: The rate at which fish die from natural causes (disease, predation, old age) or fishing. Mortality rates can be described in several ways. Conceptually the easiest way is the total annual mortality rate, the fraction of the fish alive at the beginning of a year that die during the year. For example, a total annual mortality rate of 0.50 means that 50% of the population of fish died for whatever reason during the year. In general, annual mortality rates can range from 0 to 1.0, that is 0% to 100% mortality.

Annual rates are easy to understand, but difficult to use when describing the relative contribution of different types of mortality, such as fishing and natural causes, to the total mortality of fish during a year. One way to describe mortality and overcome this limitation of annual rates is by using instantaneous rates, although this approach is conceptually more difficult. An instantaneous mortality rate is the fraction of the population of fish that dies in each very short period of time.

The derivation of instantaneous rates is mathematically complex, but there is a relatively simple connection between them and the simpler annual rates. Any particular instantaneous mortality rate, often denoted by Z, is equivalent to one specific annual rate A, according to the formula:

$$A = 1 - e^{-z}$$

That is, the annual rate is equal to e, (this is the number 2.718, the base of the natural logarithms) raised to the negative power of the instantaneous rate, subtracted from 1.0. For example, the instantaneous mortality rate of 1.1 is equivalent to an annual mortality rate of 0.67, or 67%. In practice, instantaneous rates range from 0 to values as high as 1.5 or 2.0, but theoretically could take on any large value. Because instantaneous rates make comparing the relative importance of different sources of mortality very easy, as discussed next, they are frequently used by fishery biologists, and are used throughout this report. To aid in interpretation, the following explanation of correspondence between the simpler annual rates and the more useful instantaneous rates may be helpful:

Relationship between instantaneous mortality rate, annual mortality rate, and annual percentage mortality.

Instantaneous Mortality Rate	**Annual Mortality Rate**	**Annual Percentage Mortality (%)**
0	0	0
0.10	0.10	10
0.20	0.18	18
0.30	0.26	26
0.40	0.33	33
0.50	0.39	39
0.60	0.45	45
0.70	0.50	50
0.80	0.55	55
0.90	0.59	59
1.00	0.63	63
1.50	0.78	78
2.00	0.86	86

Instantaneous rates are used in as**sessments** 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. For example, if Z = 1.7 and a day represents the time interval, then approximately 1.7/365 or 0.466% of the population is dying daily, 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.

The part of the **total mortality rate** applying to a fish population attributed to natural causes is usually assumed to mean all causes other than fishing. These many causes of death are usually lumped together for convenience since they usually account for much less than fishing mortality in adult fish, and are usually of less immediate interest. Natural mortality is usually expressed as an instantaneous rate, as discussed above, and can range from 0 to very high values 0.5 or 1.0. The corresponding annual mortality due to natural causes acting alone can be computed in the same manner shown for total mortality rates. The most important causes are predation, disease, cannibalism, and perhaps increasingly, environmental degradation such as pollution. When particular mortality factors are of interest, a separate instantaneous mortality term is often defined. Natural mortality rates have proven very difficult to estimate, and often values are assumed based on the general life history of a particular fish. For example, for many demersal round fish, natural mortality is usually assumed to be 0.2, or 18% annual mortality.

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 natural causes. 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.

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

Projected Spawning Stock Biomass Per Recruit (PSSBR): The **spawning stock biomass per recruit** that would be achieved from an individual fish from a **year class**, if current mortality and age of entry were to hold throughout the life span of the fish. For example, PSSBR for Georges Bank haddock is currently about 1.6 kg per fish recruited at age 2, only 18% of the maximum of 9 kg per fish recruited at age 2.

Quota: A portion of a **TAC** allocated to an operating unit, such as a size class of vessels or a country.

Recruitment: The amount of fish, in numbers or weight, that reach a certain size or age in a specific year. For example, the weight or number fish that grow to become vulnerable to the fishing gear in one year would be the recruitment to the fishable population in that year. This term is also used in referring to the number or weight of fish from a **year class** reaching a certain age. For example, all fish reaching their second year would be age 2 recruits. This is often used to describe the strength of a year class.

Spawning Stock Biomass (SSB): The total weight of all sexually mature fish in the population. This quantity changes naturally depending on the size of new year classes, the growth rate of the young fish, the age at onset of sexual maturity, the growth and natural mortality rate of older fish, and the magnitude of fishing mortality.

Spawning Stock Biomass Per Recruit (SSBR): The **spawning stock biomass** divided by the number of fish recruited to age 2. This number is in units of weight (kg) and measures the average or expected contribution of any one young fish to the spawning stock biomass over its lifetime. It can be calculated based on the actual growth and mortality rates experienced by a group of young fish as they age, or based on what such fish would likely experience under prevailing growth and **fishing mortality rates.**

A useful reference point is the level of SSBR that would be obtained if there were no fishing. This is a maximum value for SSBR, and levels of SSBR under different fishing patterns can be compared to it. For example, the maximum SSBR for Georges Bank haddock is approximately 9 kg.

Status of exploitation: An appraisal of the status of exploitation is given for each stock of each species in the Species Synopsis section, using the terms unknown, protected, not exploited, under exploited, moderately exploited, fully exploited, and over exploited. These terms are used to describe the effect of current fishing effort on each stock, and represent the assessment scientist's educated opinion based on current data and the knowledge of the stocks over time.

Sustainable yield: The number or weight of fish in a stock that can be taken by fishing without reducing the stock's biomass from year to year, assuming that environmental conditions remain the same.

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

Total mortality rate: The combined effect of all sources of mortality acting on a fish population. This is conveniently expressed in terms of instantaneous mortality rates because the total instantaneous mortality rate is simply the sum of the instantaneous fishing and natural mortality rates. For example, the total instantaneous mortality rate that is occurring when the instantaneous fishing mortality rate is 0.5 and the instantaneous natural mortality rate is 0.2 would be 0.7, which is equivalent to an annual rate of 50%.

Vessel class: Commercial fishing vessels are classified according to their gross registered tons (GRT) of displacement. Vessels displacing less than 5 tons are not routinely monitored, and are referred to as "undertonnage". Larger vessels are classified as follows:

Vessel class	GRT
2	5 - 50
3	51 - 150
4	151 - 500

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 backward 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 catches are known with certainty. 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 backward year by year for the year class, a very precise estimate of the abundance can be determined for the previous three or four years (1976 or 1975). 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 annual catches 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.

Year Class (or Cohort): Fish of the same stock born in the same year. For example, the 1987 year class of cod includes all cod born in 1987, and they would be age 1 in 1988. Occasionally a stock produces a very small or very large year class and this group of fish is followed closely by assessment scientists since it can be pivotal in determining the stock abundance in successive years.

Yield Per Recruit Analysis: A mathematical calculation of the theoretical yield that would be obtained from a group of fish of one age if they were harvested according to a certain **exploitation pattern** over the life span of the fish. Certain critical **fishing mortality rates** are estimated that are used as biological reference points for management, such as F_{max}.

FISHERY LANDINGS TRENDS

Recreational and commercial fishing for marine and estuarine fish stocks which occur off the northeastern USA results in landings that are a significant portion of total USA landings. Total USA commercial landings in 1988 are estimated to be more than 3,000,000 metric tons (mt), of which 8% were from this region. Total USA recreational landings are estimated to be 279,000 mt. of which 21% were from this region. Aggregate statistics for USA fisheries are described in detail in Fisheries of the United States, 1988.[2]

Fishery statistics are collected in the northeastern USA through an integrated system of reporting by commercial fishermen and sampling surveys of recreational fishermen. The reports by commercial fishermen are generally termed *weighout slips*, and these are collected by employees of state agencies as well as the National Marine Fisheries Service. Recreational fishermen are surveyed both as they complete fishing trips and through telephone calls to households. While these statistics are not without statistical errors and some biases, they reveal roughly how much is landed, and certainly reveal trends in fishing activity and catches.

The total landings, domestic commercial and recreational as well as foreign, from the several stocks of the 33 species groups described here totaled 500,900 mt in 1988, down slightly from 1987 (Table B). Of these landings, 27% were from foreign and 60% from domestic commercial fishing, and 13% from recreational fishing. Slightly more of the total landings were from recreational fishing in 1987, and slightly less from foreign fishing.

"...landings...totaled 500,900 mt in 1988, down slightly from 1987."

The landings from six groups of species reveals major differences. The most important in terms of weight of fish landed are the **Principal Groundfish**, (Atlantic cod, haddock, redfish, silver hake, red hake, and pollock) accounting for 27% of the landings in 1987 and 28% in 1988. The **Principal Pelagic** species and the **Invertebrates** accounted for 24% and 23% of the total landings in 1988, nearly the same as in 1987. The fourth highest landings were from the **Other Pelagic** species, which accounted for 11% of the landings in 1988, down from 15% in 1987; nearly 73% of this was bluefish, primarily a recreational species. Next in importance in terms of weight are the **Flounders**, accounting for 9% of the total landings in both 1987 and 1988, and **Other Groundfish**, accounting for less than 5%.

Within each of these groups of species, landings increased slightly in all groups in 1988 except the Other Groundfish (down 7%), Other Pelagics (down 23%), and Invertebrates (down 3%). Butterfish, bluefish, and river herring catches decreased markedly. The landings of the Principal Pelagic species increased the greatest percentage, 7%, and the Principal Groundfish increased by 3%.

The increases in the Principal Pelagic landings were mostly due to increases for Atlantic mackerel, primarily by foreign fishing. The changes in Invertebrate species involved in-

[2] O'Bannon, Barbara K., ed. 1989. Fisheries of the United States, 1988. U.S. Department of Commerce, National Marine Fisheries Service: Fisheries Statistics Division. Current Fisheries Statistics No. 8700. Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; (202)783-3238.

Table B. Total landings (1,000 mt) of selected species and species groups off the northeastern U.S., for domestic and foreign commercial fishing, and for recreational fishing, for 1987 and 1988

	Commercial				Recreational		Total	
	Foreign		USA		USA			
	1987	1988	1987	1988	1987	1988	1987	1988
Principal Groundfish								
Atlantic cod	12.4	12.8	26.5	34.3	3.8	7.6	42.7	54.7
Haddock	4.3	6.0	3.0	2.9	<0.1	<0.1	7.3	8.9
Redfish	0.1	0.1	1.9	1.1	0	0	2.0	1.2
Silver hake	0	0	15.5	16.0	0.1	0.1	15.6	16.1
Red hake	0	0	1.9	1.8	<0.1	<0.1	1.9	1.8
Pollock	46.2	43.0	20.4	14.9	0.1	0.2	66.7	58.1
Total	**63.0**	**61.9**	**69.2**	**71.0**	**4.0**	**7.9**	**136.2**	**140.8**
Flounders								
Yellowtail flounder	0	0	5.5	3.9	0	0	5.5	3.9
Summer flounder	0	0	9.5	13.4	6.3	8.4	15.8	21.8
American plaice	<0.1	0.1	3.8	3.3	0	0	3.8	3.4
Witch flounder	<0.1	<0.1	3.4	3.2	0	0	3.4	3.2
Winter flounder	<0.1	<0.1	9.0	8.4	5.9	4.9	14.9	13.3
Total	**<0.1**	**0.1**	**31.2**	**32.2**	**12.2**	**13.3**	**43.4**	**45.6**
Other Groundfish								
Scup	0	0	6.1	5.8	3.2	2.3	9.3	8.1
Black sea bass	0	0	1.8	1.7	1.0	1.6	2.8	3.3
Ocean pout	0	0	2.2	1.8	0	0	2.2	1.8
White hake	0.7	0.6	5.5	5.4	<0.1	<0.1	6.2	6.0
Cusk	0.3	0.4	1.4	1.1	<0.1	<0.1	1.7	1.5
Atlantic wolffish	0.1	0.1	0.7	0.5	<0.1	<0.1	0.8	0.6
Total	**1.1**	**1.1**	**17.7**	**16.3**	**4.2**	**3.9**	**23.0**	**21.3**
Principal Pelagics								
Atlantic herring	0	0	39.2	40.2	0	0	39.2	40.2
Atlantic mackerel	57.2	65.9	12.3	12.3	5.6	3.8	75.1	82.0
Total	**57.2**	**65.9**	**51.5**	**52.5**	**5.6**	**3.8**	**114.3**	**122.2**
Other Pelagics								
Atlantic butterfish	<0.1	<0.1	4.7	2.1	0	0	4.7	2.1
Bluefish	0	0	6.9	6.2	49.7	35.3	56.6	41.5
River herring	<0.1	<0.1	4.1	2.4	-	-	4.1	2.4
American shad	0	0	0.9	1.3	0	0	0.9	1.3
Striped bass	0	0	0.2	0.2	0.4	0.8	0.6	1.0
Spiny dogfish	0	<0.1	2.6	2.9	0	0	2.6	2.9
Skates	0	0	5.1	5.9	0	0	5.1	5.9
Total	**<0.1**	**<0.1**	**24.5**	**21.0**	**50.1**	**36.1**	**74.6**	**57.1**
Invertebrates								
Short-finned squid	0	0	10.3	2.1	0	0	10.3	2.1
Long-finned squid	<0.1	<0.1	11.5	19.1	0	0	11.5	19.1
American lobster	<0.1	<0.1	20.7	22.2	-	-	20.7	22.2
Northern shrimp	0	0	5.0	3.1	0	0	5.0	3.1
Surf clam	0	0	27.6	28.8	0	0	27.6	28.8
Ocean quahog	0	0	22.9	21.0	0	0	22.9	21.0
Sea scallop	6.8	4.4	13.2	13.2	0	0	20.0	17.6
Total	**6.8**	**4.4**	**111.2**	**109.5**	**0**	**0**	**118.0**	**113.9**
Grand Total	**128.1**	**133.4**	**305.3**	**302.9**	**76.1**	**65.0**	**509.5**	**500.9**

creases in catches of long-finned squid, *Loligo*, entirely in the domestic fishery, and decreases in catches of scallops, primarily in the domestic fishery. The increases in the Principal Groundfish was due to a 28% increase in Atlantic cod, which was partly offset, however, by a 13% decrease in pollock landings.

Total foreign vessel landings of fish originating in U.S. waters was 135,400 mt. This includes catches of pollock and mackerel, for example, by Canadian fishermen after these fish have moved from U.S. into Canadian waters. It also includes catches of cod, haddock, yellowtail flounder, and scallops from their Georges Bank stocks which occur on the Canadian portion of that fishing grounds. Finally, there are some landings by foreign vessels fishing in U.S. waters, such as those for Atlantic mackerel and Atlantic herring; these catches are made under joint U.S. and foreign country fishing operations under the auspices of the Fisheries Management Councils and state governments.

The total landings are important in terms of how the removals affect the several populations or stocks of these species. However, the market value of the different groups of fish varies greatly, with some invertebrates having the greatest value per ton, and certain pelagics being worth the least. The importance of the changes in the landings described here on the economics of the fisheries is discussed in

COMMERCIAL FISHERY ECONOMIC TRENDS

THE NORTHEAST REGION

The Northeast Region's commercial oceanic and estuarine fisheries produced domestic landings worth $771 million dockside in 1988, a four percent decrease in value from the 1987 level. The total yield of all these fisheries also dropped, by 3%, to 660.8 thousand mt. This reduction occurred because of a drop in finfish landings which was not offset by an increase in shellfish landings. Ex-vessel payments for the 484 thousand mt of finfish decreased 11% to $288 million. Shellfish landings increased slightly to 177 thousand mt, bringing in $483 million, a 1% increase in revenue for the year.

A total of 1,968 vessels of five or more gross registered tons (GRT) participated in one or more of the various ocean fisheries in the Northeast region, an increase of 71 vessels over the previous year. The performance of vessels, grouped by predominant gear type, is discussed for the New England and Mid-Atlantic-Chesapeake areas below.

NEW ENGLAND

In 1988, New England otter trawl vessel landings were valued at $176.3 million, a 14% decrease from the previous year (Table C). This was based on landings of 131.6 thousand mt, down 7%. Revenue per vessel also declined by 13% on average for the 918 (or 8 fewer) vessels participating in the fishery, despite the fact that landings per vessel remained fairly steady (Table C). This drop in gross revenue was uniform across the three tonnage class categories, as illustrated in Figure C.

In the scallop dredge fishery both revenues and landings increased over 1987 levels: revenues by almost five percent to $96.3 million, and landings by 13 percent to 91.9 thousand mt. The number of scallop dredge vessels participating in the New England scallop fishery increased by 25% as 38 additional vessels joined the fleet. Consequently, revenue per vessel decreased between 12 % and 28 % for all 3 vessel classes as reflected in Figure D.

The total of operating, maintenance and repair, labor, and fixed costs was relatively stable between 1987 and 1988, rising only about 1%. Nominal ex-vessel values and prices for the three most important shellfish and nine most important finfish species in New England is shown in Table D. Ex-vessel prices declined, in general, except for lobster and winter flounder, which increased, and shrimp, whose price remained unchanged (Table D). The lower ex-vessel prices coupled with the smaller landings per vessel explains the dismal picture portrayed in Figure C and D. The ex-vessel price of sea scallop meats decreased slightly, by about 2% in 1988, while landings stayed about one percent higher than their elevated levels of 1987 (Table D). For all other spe-

"...1,968 vessels...participated in one or more of the various ocean fisheries..."

Table C. New England fleet landings and revenue 1978-1988, vessels of 5 gross registered tons or more[1]

Year	Number of Vessels	Total Revenue All Trips (million $)	Total Revenue All Trips (1978 $) (million $)	Total Landings All Trips (1,000 mt)	Landings Per Vessel Primary Gear Only (mt)
		All Vessels			
1978	919	161.5	161.5	285.0	
1979	1,153	194.9	175.2	294.2	
1980	1,316	212.0	167.9	328.2	
1981	1,364	242.9	174.2	317.1	
1982	1,376	261.6	176.8	380.6	
1983	1,353	312.1	204.4	377.6	
1984	1,423	286.5	179.9	355.6	
1985	1,361	264.8	160.3	302.3	
1986	1,254	285.2	169.8	275.3	
1987	1,333	324.2	186.2	277.6	
1988	1,392	306.8	168.8	295.4	
		Otter Trawl Vessels			
1978	650	106.4	106.4	191.7	228.7
1979	779	121.5	109.3	193.5	199.4
1980	902	136.2	107.8	215.7	189.4
1981	922	156.5	112.3	209.5	181.4
1982	1,010	188.7	127.5	257.3	187.9
1983	996	200.4	131.2	230.9	186.9
1984	1,021	192.2	120.7	216.6	166.2
1985	972	180.6	109.3	177.9	147.9
1986	894	185.7	110.5	147.1	146.1
1987	926	204.8	117.6	141.4	120.9
1988	918	176.3	97.0	131.6	119.7
		Scallop Dredge Vessels			
1978	132	46.5	46.5	68.4	477.0
1979	201	61.6	55.4	71.5	322.0
1980	273	69.0	54.6	71.0	229.3
1981	292	91.1	65.3	94.7	252.2
1982	191	72.7	49.1	79.2	315.2
1983	220	99.2	65.0	76.6	260.4
1984	213	80.2	50.4	57.8	222.4
1985	170	61.1	37.0	47.7	247.8
1986	136	71.2	42.4	51.7	364.3
1987	153	92.1	52.9	81.2	488.9
1988	191	96.3	53.0	91.9	438.4

[1] Landings and revenue figures are total annual amounts, regardless of port of sale, for all vessels of 5 grt or more that sold at least one trip's catch in Maine, New Hampshire (1982 onward), Massachusetts, or Rhode Island. The deflated figures are used to compare revenue over several years and are expressed in 1978 dollars (CPI 1978=100).

cies except lobster, the landed values decreased from 1987 to 1988, as prices and landings both declined.

IMPORTS

Table E shows the volume of New England imports of selected fishery products and selected species from Canada and all other sources. The selected species, including cod, cusk, hake, haddock, pollock, ocean perch, halibut, turbot and other flatfish account for 77%(686 thousand mt) of the total imported volume of all species and all product forms in 1988. This represents a 14% reduction from the 1987 level of 798 thousand mt.

In 1988, the volume (live weight equivalent) of all product forms of finfish imports to New England from

Figure C. 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.

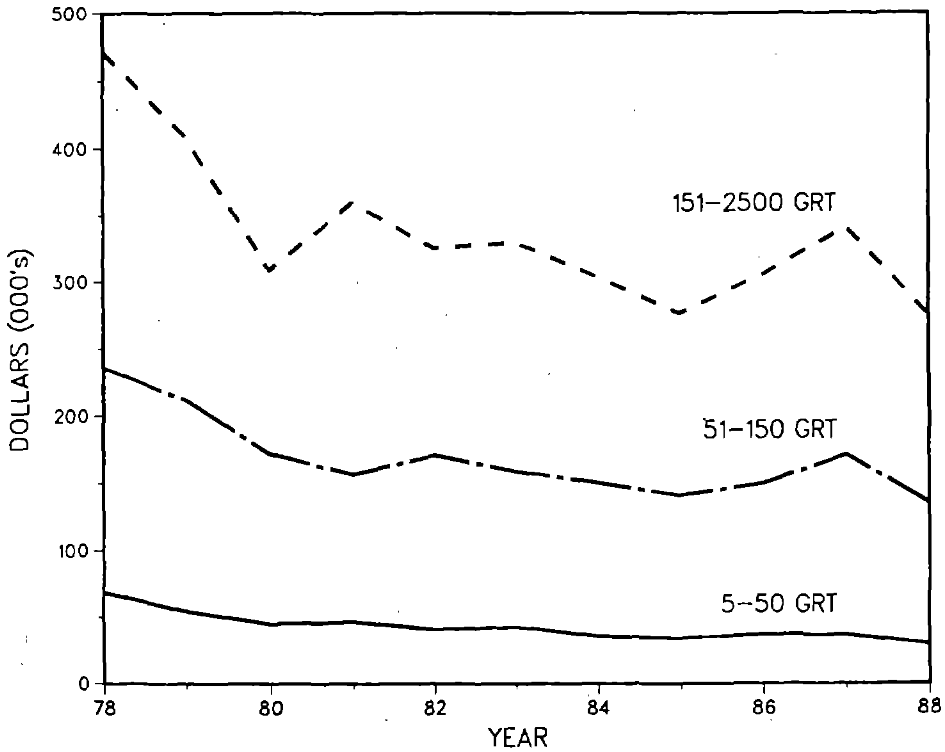


Figure D. Deflated (adjusted) gross revenue per vessel by tonnage class for those vessels using scallop dredge gear and landing the catch in a New England port at least once during the year. All revenue is included, regardless of what gear was used or where catches were sold. Revenue adjusted by the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

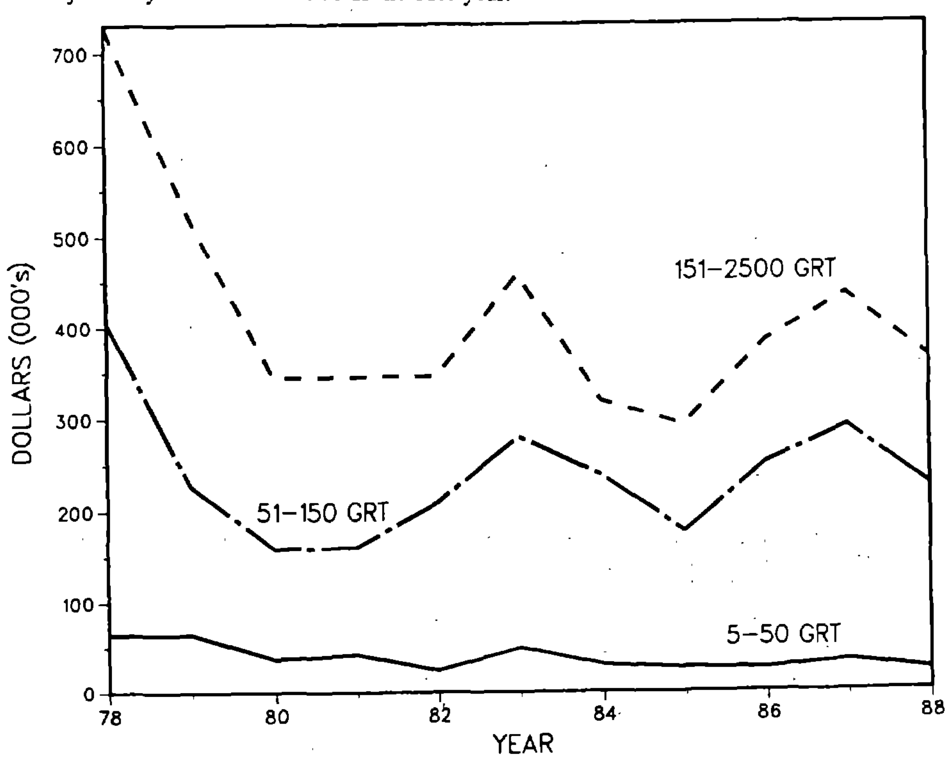


Table D. New England landings (1,000 mt), ex-vessel values (million $), and prices ($/lb) of species of major importance, 1978-1988[1]

		Ex-Vessel			Ex-Vessel			Ex-Vessel	
	Landings	Value	Price	Landings	Value	Price	Landings	Value	Price
		Lobster			**Scallop Meats**			**Cod**	
1978	14.9	61.1	1.86	7.9	44.3	2.53	39.0	21.3	0.25
1979	16.1	68.4	1.92	7.4	55.2	3.39	44.1	28.2	0.29
1980	16.1	71.8	2.02	7.7	65.5	3.85	53.6	31.9	0.30
1981	16.3	82.1	2.29	8.8	79.4	4.06	45.3	32.8	0.33
1982	16.9	85.0	2.28	7.2	57.2	3.61	47.2	37.1	0.36
1983	19.1	100.7	2.39	6.3	77.9	5.57	50.7	37.5	0.34
1984	18.8	107.0	2.58	5.0	62.5	5.63	43.5	35.6	0.37
1985	19.0	102.4	2.44	4.6	50.0	4.90	37.3	34.7	0.42
1986	19.6	112.2	2.59	5.2	60.0	5.28	27.5	35.7	0.59
1987	19.4	124.5	2.91	8.2	80.6	4.43	26.6	43.7	0.75
1988	20.5	133.6	2.96	8.3	80.0	4.35	34.2	42.3	0.56
		Yellowtail			**Winter Flounder**			**Pollock**	
1978	11.2	14.9	0.61	10.7	10.4	0.44	17.7	6.6	0.17
1979	15.5	17.3	0.51	11.4	9.3	0.40	15.5	6.6	0.19
1980	18.4	19.1	0.47	15.5	12.0	0.35	18.0	7.2	0.18
1981	14.4	15.8	0.50	17.4	16.2	0.42	16.9	8.5	$0.23
1982	20.1	24.5	0.55	13.7	14.5	0.48	14.2	7.0	0.22
1983	31.4	33.8	0.49	14.1	15.2	0.49	14.0	5.4	0.17
1984	16.4	26.4	0.73	13.5	20.2	0.68	17.9	6.4	0.16
1985	10.7	19.6	0.83	9.7	18.5	0.86	19.7	7.0	0.16
1986	10.1	20.5	0.92	7.2	16.0	1.01	24.7	14.0	0.26
1987	7.4	20.4	1.25	8.1	21.6	1.21	20.7	17.9	0.39
1988	5.0	13.0	1.19	7.4	19.9	1.22	15.0	11.1	0.33
		Fluke			**Haddock**			**Shrimp**	
1978	2.1	3.6	0.77	17.9	12.7	0.32	-.-	-.-	-.--
1979	1.9	3.1	0.73	19.0	17.7	0.42	0.5	0.3	0.32
1980	0.7	1.5	0.91	25.0	21.4	0.39	0.3	0.5	0.65
1981	1.7	3.6	0.94	25.0	22.0	0.40	1.0	1.4	0.63
1982	3.0	5.5	0.81	20.3	22.0	0.50	1.5	2.0	0.59
1983	3.2	6.1	0.86	14.8	19.0	0.58	1.6	2.3	0.67
1984	2.8	6.3	1.03	11.8	18.4	0.71	3.2	3.5	0.49
1985	4.5	10.5	1.06	6.5	13.5	0.94	4.2	4.0	0.44
1986	4.6	13.1	1.30	5.0	10.9	0.99	4.7	6.5	0.63
1987	3.9	14.3	1.64	3.0	8.5	1.28	5.0	12.2	1.10
1988	3.5	11.6	1.51	2.9	7.0	1.09	3.1	7.5	1.10
		Whiting			**White Hake**			**Redfish**	
1978	15.9	4.7	0.13	4.9	1.7	0.16	16.1	6.1	0.17
1979	7.3	2.8	0.17	4.0	1.5	0.17	15.4	7.2	0.21
1980	7.9	3.0	0.17	4.7	1.7	0.17	11.0	5.6	0.23
1981	9.2	3.9	0.19	5.5	2.3	0.19	8.4	5.3	0.28
1982	10.9	4.6	0.19	6.2	2.4	0.18	8.5	5.2	0.27
1983	11.7	3.8	0.15	6.4	2.2	0.19	6.0	3.5	0.26
1984	15.0	4.2	0.13	6.8	2.6	0.17	5.6	3.6	0.29
1985	14.1	5.4	0.17	7.4	3.3	0.21	4.4	3.2	0.33
1986	14.2	5.9	0.19	6.6	4.9	0.34	3.0	3.2	0.48
1987	11.7	7.4	0.29	6.1	5.5	0.41	1.9	2.7	0.64
1988	11.4	5.5	0.22	5.4	3.6	0.30	1.1	1.5	0.62

[1] **Note: Includes fish landed in the states of Connecticut, Massachusetts, Rhode Island, New Hampshire, and Maine for both domestic and non-domestic stocks.**

Table E. New England imports (1,000 mt) of selected fishery products from Canada and all other sources, 1978-1988[1]

Year	Cod		Other Groundfish		Flatfish		Total Finfish		Scallops	
	Canada	Other	Canada	Other	Canada	Other	Canada	Other	Canada	Other
1978	151	284	93	151	87	39	331	474	10.7	0.7
1979	204	229	92	153	88	28	384	410	8.3	0.8
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	154	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	101	115	63	20	465	325	5.8	2.1
1987	309	173	109	114	73	20	491	307	6.6	2.0
1988	289	154	86	97	54	6	429	257	7.6	2.6

[1] **Product forms include 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 weights.**

Canada and all other sources decreased 17 percent from 1,071 to 890.8 thousand mt. The value of total imports dropped from $1.2 billion to $973.9 million. Cod products dominated these finfish imports with 50% of the volume and Canadian cod accounted for 65 percent of that specie's imports. Imports of scallop meats increased significantly (19%) from both Canada and other sources to 10.2 thousand mt in 1988.

The market share of edible fishery product imports coming into New England from Canada rose from 63% to 68% of the total between 1987 and 1988. In spite of the market share increase, the value of Canadian imports decreased by $104.5 million, to $891.7 million. Imports from the rest of the world declined in value by $155.6 million, to $421.3 million. New England imports from Canada are predominantly composed of finfish products (67%) valued at $595.2 million. Other Canadian imports include lobster products (20%) valued at $179.4 million, scallop products (8.3%) valued at $73.8 million, crab products (3.2%) valued at $28.7 million, and other fishery products (1.6%) valued at $14.5 million.

The total value of edible fish product imports to the Northeast region declined by $381.8 million to $2.4 billion, comprising 45.5% of total U.S. imports. The decline occurred across all principal sources, including Canada, at $932.1 million, the European Economic Community, at $200.2 million, Iceland, at $164 million, Norway, at $144 million, Japan, at $88.7 million, and the Korean Republic, at $100 million.

Even though, as in 1987, almost 37%of the Northeast region's expenditures on imports of edible fish was spent on shellfish products, total imports of these products declined in volume by 39.1 thousand mt and $144 million in value. Of significance to the region's fisheries were imports from all sources of 49.8 thousand mt (l.w.e.) of lobster worth $302.1 million, 13.6 thousand metric tons (l.w.e) of crab products worth $42.4 million and 3.6 thousand metric tons (l.w.e.) of clam products worth $6.6 million (Table F).

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 for finfish. Inshore and offshore finfish landings decreased nine percent between 1987 and 1988 to 294 thousand mt and their value decreased 7% to $90.5 million. Inshore and offshore shellfish landings dropped slightly to 108 thousand mt, while value decreased similarly to $187 million.

Overall, the Mid-Atlantic and Chesapeake fisheries experienced a decrease in gross revenue of 2.5%. Revenues increased in the otter trawl and surf clam and ocean quahog fleets but dropped in the scallop dredge fleet (Table G). However, the scallop dredge fleet continued to generate the highest revenue in the area, followed closely by otter trawl vessels, and then surf clam and ocean quahog vessels.

Otter trawl receipts per vessel fell an average of one percent over the past year while landings per vessel rose three percent to 132 metric tons. Landings and revenue generated by the scallop dredge fleet decreased (Table G) by 10 percent and five percent, respectively, from 1987 levels. Ex-vessel value and prices for the most important shellfish and the two most important finfish species in the Mid-Atlantic and Chesapeake are shown in Table H. The price per pound of scallop meats rose by four percent but still resulted in decreased total revenue due to the reduced landings.

The surf clam and ocean quahog fishery experienced a slight increase in nominal revenues, but landings were off by two percent (Table G). The gross revenue per vessel for all three vessel classes is illustrated in Figure

Table F. Northeast Region imports (1,000 mt) of selected fishery products from all sources, 1978-1988[1]

Year	Lobster Products				Clam Products		Crab Products	
	Quantity (1,000 mt)			Value	Quantity	Value	Quantity	Value
	Live	Other	Total	(million $)	(1,000mt)	(million $)	(1,000 mt)	(million $)
1978	5.5	43.1	48.6	175.3	1.3	1.9	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	84.4
1985	12.2	63.1	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
1987	14.0	38.8	52.8	330.1	5.8	11.2	15.5	45.4
1988	13.9	35.9	49.8	302.1	3.6	6.6	13.6	42.4

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

Table G. Mid-Atlantic and Chesapeake landings (1,000 mt) and revenue (million $), 1978-1988, vessels of 5 gross registered tons or more[1]

Year	Number of Vessels	Total Revenue All Trips	Total Revenue All Trips (1978 $)	Total Landings All Trips	Total Number of vessels	Revenue Revenue All Trips	Total All Trips (1978 dollars)	Landings All Trips
			All Vessels			Surf Clam and Quahog Vessels		
1978	392	47.5	47.5	47.5	96	12.6	12.6	42.1
1979	478	53.6	48.2	48.2	90	14.0	12.6	40.6
1980	441	49.0	38.8	38.8	64	12.1	9.6	106.7
1981	598	66.8	47.9	47.9	135	21.3	15.3	152.4
1982	585	88.2	59.6	288.3	134	37.4	25.2	232.4
1983	652	116.5	76.3	313.7	128	33.0	21.6	241.5
1984	661	124.5	78.2	368.2	138	46.3	29.1	295.8
1985	618	106.5	64.5	370.9	138	48.6	29.4	322.3
1986	652	121.1	72.1	369.9	142	48.4	28.8	311.8
1987	643	129.2	74.2	384.1	136	39.3	22.6	310.4
1988	658	125.9	69.3	375.9	133	39.7	21.9	304.8
		Otter Trawl Vessels				Scallop Dredge Vessels		
1978	146	13.2	13.2	21.6	75	16.4	16.4	25.6
1979	177	1.9	15.2	25.3	124	22.0	19.8	26.0
1980	166	15.2	12.0	23.9	130	21.5	17.0	23.2
1981	225	19.5	14.0	25.6	134	23.0	16.5	23.5
1982	243	28.0	18.9	40.0	83	22.2	15.0	22.9
1983	273	40.4	26.4	42.2	120	46.6	30.5	35.6
1984	290	36.9	23.2	50.0	122	42.3	26.6	36.0
1985	265	28.0	16.9	29.0	92	29.9	18.1	25.5
1986	288	37.5	22.3	40.2	92	35.9	21.4	28.9
1987	294	40.3	23.1	37.5	98	50.3	28.9	47.9
1988	328	44.5	24.5	43.3	106	47.9	26.4	42.9

[1] **Landings and revenue figures are total annual amounts, regardless of port of sale, for all vessels of 5 grt or more than sold at least one trip's catch in New York (1986 onward), New Jersey, Maryland (September 1981 onward). The deflated figures are used to compare revenue over several years and are expressed in 1978 dollars (CPI = 100).**

E. Surf clam and ocean quahog value, and nominal and deflated prices for the entire Northeast region are listed in Table I. Ocean quahog prices increased significantly in New England and New York, generating $1.9 million in value. The dramatic price rise in the New England area was due to the discovery of new beds off the coast of Maine consisting of higher priced cherrystones and littlenecks. In the southern part of the region, quahog prices remained constant while revenue dropped. Surf clam prices stayed fairly constant across the entire region.

Figure E. 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 what gear was used or where catches were sold, is included. revenue adjusted by the Consumer Price Index (CPI) with 1978 as the base year.

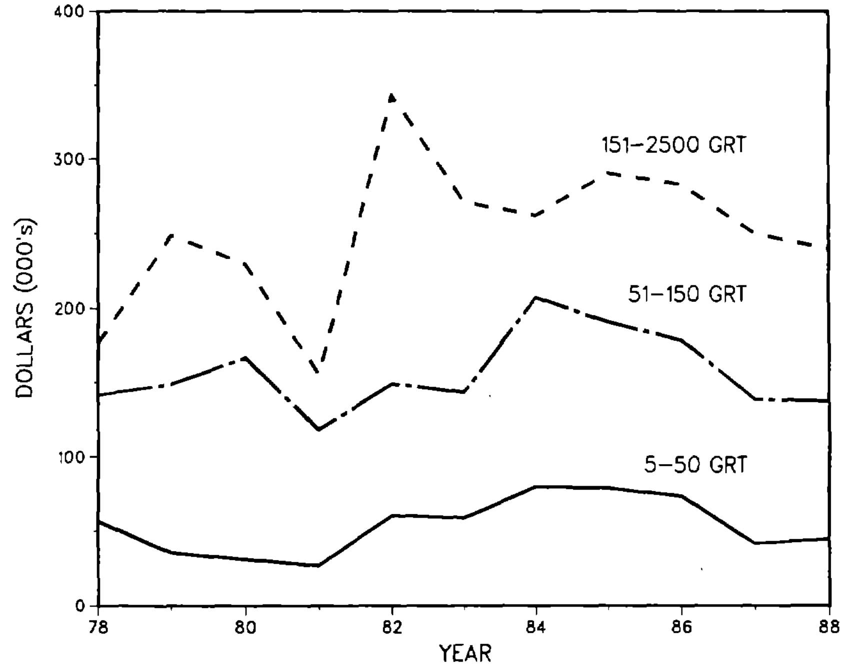


Table H. Mid-Atlantic and Chesapeake landings (1,000 mt) , ex-vessel values (million $) and prices ($/lb)of species of major importance ,1978-1988

Year	Landings	Value	Price	Landings	Value	Price	Landings	Value	Price
	Scallop Meats			Fluke			Tilefish		
1978	5.8	31.0	3.20	6.3	8.2	0.58	2.9	3.4	0.54
1979	6.1	43.7	3.20	8.8	10.2	0.53	3.2	4.3	0.60
1980	4.7	40.0	3.89	7.2	8.4	0.53	3.5	5.9	0.77
1981	2.7	24.2	4.09	4.6	6.9	0.68	3.1	6.2	0.92
1982	1.8	15.7	3.93	4.9	7.9	0.72	1.9	4.1	1.01
1983	2.6	31.7	5.63	7.0	9.8	0.64	1.8	4.4	1.12
1984	2.1	31.6	5.35	8.7	12.5	0.65	1.9	4.3	1.02
1985	2.1	21.9	4.64	6.2	12.8	0.93	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
1987	4.9	42.3	3.88	6.1	17.9	1.34	2.9	7.4	1.14
1988	4.6	40.7	4.04	8.0	21.7	1.22	1.2	4.8	1.79

[1] Mid-Atlantic landings include those landings for the states of Delaware, New Jersey, and New York. Chesapeake landings include those landings for the states of Maryland and Virginia.

Table I. Northeast region surf clam and ocean quahog ex-vessel values (million $), prices ($/lb) and deflated prices (p), 1978 $/lb), 1978-1988[1]

	New England and New York						Chesapeake and New Jersey					
	(0-3 miles from shore)			(3-200 miles from shore)			(0-3 miles from shore)			(3-200 miles from shore)		
Year	Value	Price	p	Value	Price	p	Value	Price	p	Value	Price	p
						Surf Clam Meats						
1978	1.3	0.37	0.37	-	-	-	1.7	0.35	0.35	18.1	0.58	0.57
1979	1.1	0.48	0.43	*	0.47	0.43	1.2	0.34	0.30	16.9	0.59	0.53
1980	1.0	0.42	0.33	-	-	-	0.3	0.35	0.28	17.9	0.52	0.41
1981	1.1	0.39	0.28	-	-	-	2.0	0.34	0.24	20.4	0.55	0.39
1982	2.6	0.49	0.33	-	-	-	2.4	0.32	0.22	20.9	0.57	0.38
1983	1.6	0.47	0.31	1.4	0.48	0.32	2.5	0.33	0.22	19.4	0.46	0.30
1984	1.3	0.44	0.27	3.3	0.43	0.27	5.6	0.45	0.28	24.1	0.51	0.32
1985	4.5	0.45	0.27	3.7	0.52	0.31	5.4	0.51	0.31	25.3	0.52	0.32
1986	5.4	0.41	0.24	3.1	0.52	0.31	5.5	0.54	0.32	27.2	0.58	0.35
1987	1.6	0.40	0.23	2.2	0.48	0.28	3.4	0.43	0.25	20.8	0.47	0.27
1988	1.6	0.43	0.24	2.5	0.48	0.26	3.1	0.43	0.24	22.0	0.46	0.25
						Ocean Quahog Meats						
1978	0.8	0.29	0.29	*	0.30	0.30	-	-	-	5.9	0.29	0.29
1979	1.0	0.31	0.28	*	0.29	0.26	-	-	-	9.3	0.29	0.26
1980	1.0	0.31	0.24	0.1	0.33	0.26	-	-	-	9.1	0.30	0.22
1981	0.2	0.19	0.14	1.1	0.19	0.14	-	-	-	8.9	0.30	0.22
1982	0.2	0.38	0.26	1.2	0.38	0.26	-	-	-	9.5	0.30	0.21
1983	0.6	0.36	0.23	0.7	0.35	0.23	-	-	-	9.6	0.30	0.20
1984	0.9	0.36	0.22	0.2	0.35	0.22	-	-	-	10.7	0.30	0.19
1985	-	-	-	0.1	0.35	0.21	-	-	-	12.7	0.30	0.18
1986	-	-	-	*	0.31	0.18	-	-	-	10.8	0.30	0.18
1987	-	-	-	0.1	0.35	0.20	-	-	-	10.6	0.29	0.17
1988	1.5	0.56	0.31	0.4	0.97	0.53	-	-	-	8.3	0.29	0.16

[1] Deflated price (p) is the actual price paid which has been adjusted downward for inflation using the consumer price index with 1978=100. A (*) indicates that revenue is less than $0.1 million. A (-) indicates that revenue was generated by too few vessels to be disclosed.

AGGREGATE RESOURCE TRENDS

The fishery resources off the northeastern USA are harvested by a variety of fishing gears, including trawls, gill nets, traps, long lines, and dredges. While each type of gear takes a different mixture of species, few fishermen target exclusively one species. The degree of mixture in the catches varies among the types of gear used in different areas. In addition, there are predatory and competitive relations among many of the fishery resources.

These relationships result in significant interactions among gear types, termed technical interactions, and among some species, termed biological interactions. Management of fishing activity in this region is substantially more complex because of these two types of interactions. This complexity is reflected, for example, in the structure of some of the fishery management plans (FMPs). The groundfish resources are managed in the northern portion of the northeastern U.S. under the Multispecies FMP. Several pelagic fisheries in the southern portion of the region are managed in one plan, the Squid, Mackerel, and Butterfish FMP. Further, there is interest in expanding the Summer Flounder FMP to include black sea bass and scup.

While much of the stock assessment advice required for managing these fisheries involves knowledge of the dynamics of individual populations of each species, there is an increasing recognition of the need to consider information on fishery resource abundance on a more aggregated level to fully understand the dynamics of the fisheries as a whole. In this section, resource trends are presented for several of the fishery resources in aggregate form to illustrate major changes in the fishery ecosystems off the northeastern USA.

Two sources of data are available for measuring the trends in aggregate resource abundance: (1) research vessel trawl survey data, and (2) commercial trawl catch and effort data. While neither data source completely reflects the changes in all fishery resources, both provide information that is useful in interpreting changes in fishery resources and fishing activity in recent years.

RESEARCH VESSEL TRAWL SURVEY DATA

The Northeast Fisheries Center has conducted an intensive bottom trawl survey program off the northeast USA for more than 25 years. An autumn survey has been conducted annually since 1963; a spring survey was initiated in 1968, and summer and winter surveys have been conducted intermittently. These surveys have employed standard gear and sampling procedures following a stratified-random sampling design and thus provide a valuable time series of data for monitoring resource trends. Since bottom-tending gear is used, the data are most appropriate for demersal species, although reliable indices of abundance have been developed for some pelagic species as well.
Four groups of species are considered:

1. **Principal groundfish and flounders**, including demersal species such as Atlantic cod, haddock and yellowtail flounder, that have supported important trawl fisheries.
2. **Principal pelagics** (Atlantic herring and Atlantic mackerel).
3. **Other finfish**, including a variety of demersal and pelagic species that are collectively of considerable economic importance.
4. **Skates and spiny dogfish**, which have been of minor commercial importance but are a major component of the total finfish biomass.

For each of these groups, an aggregate index of abundance has been developed to monitor resource trends. Autumn survey data (stratified mean catch per tow, kg) were used for principal groundfish and flounders and for other finfish, while spring survey data were used for principal pelagics and for skates and spiny dogfish. For each group of species an aggregate index of abundance has been computed as the sum of the individual stratified mean catch per tow values, smoothed to compensate for between-year variability using a first order autoregressive model. No adjustments have been made for differences in the vulnerability of each species to the trawl gear, so the overall index in each case tends to reflect trends in abundance of those species within each group that are most vulnerable. However, vulnerability to the gear is not thought to change markedly over time, so the aggregate indices derived from these data appear to provide a useful general index of overall resource trends, although they are weighted toward certain species.

SUMMARY OF TRENDS

Principal Groundfish and Flounders

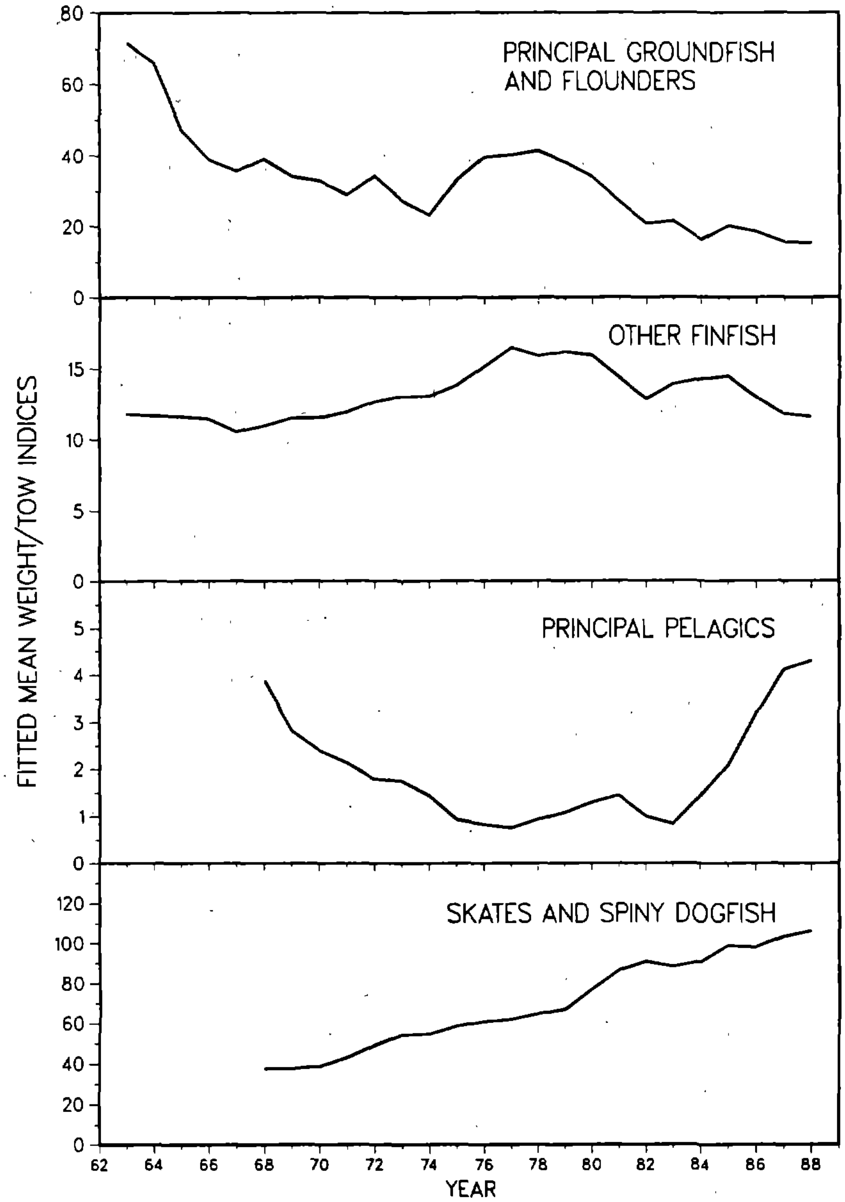
This group includes important gadoid species (Atlantic cod, haddock, redfish, silver and red hake, and pollock) and several flatfish (yellowtail flounder, summer and winter flounder, American plaice, and witch flounder). The combined index for this group declined almost continually

"Pronounced declines in abundance occurred for many species-stocks in this group, notably Georges Bank haddock, most silver and red hake stocks, and most flatfish stocks."

between 1963 and 1974, reflecting substantial increases in exploitation associated with the advent of distant-water fleets (Figure F). Pronounced declines in abundance occurred for many species-stocks in this group, notably Georges Bank haddock, most silver and red hake stocks, and most flatfish stocks. By 1974, indices of abundance for many species had dropped to the lowest level since the survey was started.

Partial resource recovery occurred during the mid-to-late 1970s. This has been attributed to reduced fishing effort associated with increasingly restrictive management under the International Commission for the Northwest Atlantic Fisheries (ICNAF) during the early 1970s and implementation of the Magnuson Fishery Conservation and Management Act (MFCMA) in 1977. Cod and haddock abundance increased markedly; stock biomass of pollock increased more or less continually, and recruitment and abundance also increased for several flatfish stocks. The aggregate index peaked in 1978. Subsequently, the combined index has decreased steadily with marked declines in catch per tow for individual species; 1987 and 1988 values were the lowest in the time series. Since 1985, survey catch per tow values for individual species within this group have either declined further or have fluctuated about a low level.

Figure F. Trends in indexes of aggregate abundance (catch in weight per survey trawl haul) for four species groups, reflecting the major changes in fishery resources in recent decades.



Other Finfish

This group includes a number of demersal and pelagic species that are taken in directed fisheries or are important in mixed fishery situations. The combined index for this group (Figure F) includes data for 10 demersal species (white hake, cusk, croaker, black sea bass, scup, weakfish, spot, wolffish, ocean pout, and goosefish) and five pelagic species (alewife, blueback, shad, butterfish and bluefish). Landings for many of these species have been small although their combined contribution to USA commercial and recreational harvests has been significant.

The aggregate index for this group was relatively stable from 1963 to 1970 and then increased to peak levels from 1977 to 1980, reflecting unusually high survey catches of Atlantic croaker and spot and strong recruitment of butterfish from the 1979 and 1980 year classes. Survey catches in 1982 were anomalously low for a number of demersal species for unknown reasons. Strong 1983 and 1984 butterfish year classes contributed to the 1985 peak. The index has since declined, reflecting declining abundances for almost all species in the group.

Principal Pelagics

Abundance of Atlantic herring and Atlantic mackerel has been monitored using spring survey data; an aggregate index is given in Figure F. In general, survey catch per tow data for these species have been more variable than those collected for principal groundfish and flounders, although the aggregate index is adequate to depict overall trends. This index declined to minimal levels in the mid-1970s, reflecting pronounced declines in abundance for both herring and mackerel (including the collapse of the Georges Bank herring stock). This has been followed by an increasing trend that has accelerated in recent years; index values for 1987-88 were among the highest observed in the series, reflecting pronounced increases in survey catches of both species. This trend is corroborated by virtual population analysis (VPA) of commercial catch at age data indicating recovery of both the Gulf of Maine herring stock and the Northwest Atlantic mackerel stock.

"...commercial catch at age data indicating recovery of both the Gulf of Maine herring stock and the Northwest Atlantic mackerel stock."

Skates and Spiny Dogfish

The remaining aggregate index includes data for two important resource components, spiny dogfish and skates, which are most effectively monitored using spring survey data (Figure F). Spiny dogfish and seven skate species - little, winter, thorny, smooth-tailed, leopard, briar and barndoor -are included in this index. The continued increase in this index since the late 1960s reflects major changes in relative abundance within the finfish species complex, with increasing abundance of species of low commercial value. Recent survey catches of both dogfish and skates have been among the highest observed. These increases in dogfish and skate abundance, in conjunction with the decreases in principal groundfish and flounder abundance, has resulted in the proportion of trawl survey catches on Georges Bank of dogfish and skates increasing from roughly 25% by weight in 1963 to nearly 75% in recent years.

"Recent survey catches of both dogfish and skates have been among the highest observed."

COMMERCIAL TRAWL CATCH AND EFFORT DATA

Commercial trawl landings and effort data collected by NEFC using dock-side interviews and weigh-out reports have been collected consistently since implementation of the MFCMA. Because of the mixed-species nature of this fishery throughout most of the region, the relationship between the amount of nominal fishing effort and the landings of individual species or stocks is complex. While simple indices based on total landings and effort will not directly reflect the abundance of any one species, such indices do provide useful measures of aggregate abundance that appear to reflect general overall trends, although increases in the efficiency of fishermen over time generally results in underestimates of the magnitude of change.

Indices of multispecies CPUE were derived by aggregating trawl landings and effort data for three major fishery assessment areas:

1. Gulf of Maine (GM)
2. Georges Bank (GB)
3. Northern Mid-Atlantic Bight (N. MA; comprising the area from Cape Cod through New Jersey)

Nominal fishing effort was standardized to account for variability in the size composition of trawl vessel fleets in the three regions, and the changes in fleet compositions over time. Data collected prior to 1976 were not included because of the problems of standardizing foreign fishing effort, and because complete trawl fishing effort data were not available for the more southern ports. Fishing effort was standardized to the performance of a class 3 trawler fishing on Georges Bank. Appropriate weighting coefficients for smaller- and larger-sized vessels were then applied to derive single estimates of total standardized fishing effort by sub-area.

Total landings of all finfish and invertebrate species caught by trawlers were aggregated over all vessel

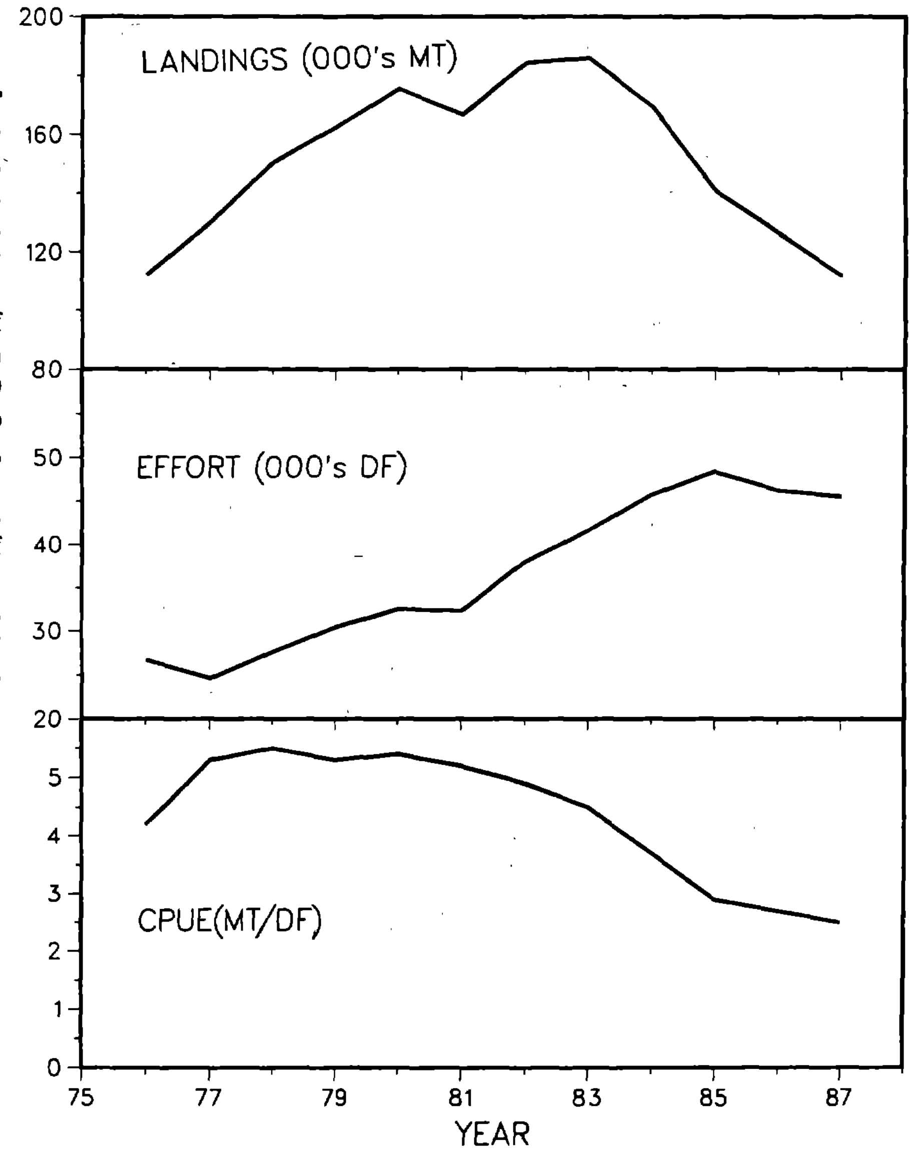
"...vessels have become larger, with more powerful engines, larger nets, and more sophisticated electronic equipment..."

size classes (Figure G). These landings peaked in 1983 at 186,000 mt, and declined steadily to 112,000 mt in 1987 and 1988, a decrease of 40%. Landings in 1988 were approximately equal to the 1976 and 1977 totals. Nominal fishing effort in terms of number of days fished (Figure G) nearly doubled from roughly 25,000 standard days in the 1976-78 period to roughly 48,000 in 1985. Subsequently, effort declined slightly, and has remained relatively constant since 1986.

The total increase in the effect of fishing has been greater than indicated by these increases in days fished, however, because the fishing power of individual vessels has increased as vessels have become larger, with more powerful engines, larger nets, and more sophisticated electronic equipment.

The total landings (mt) divided by the total standardized effort (days fished, DF) for all three regions combined is a catch per unit effort (CPUE) index reflecting the major changes in aggregate species abundance (Figure G). This index rose from 4.2 in 1976, held roughly steady from 1977 to 1980, but has since declined steadily and dramatically by about 50% to 2.5 in 1987. The 1988 index was nearly identical to that for 1987. The changes in this CPUE index are similar to those observed in the research trawl data for principal groundfish and flounders, with an initial rise and subsequently a major decline. The trend in this CPUE index is markedly different from the research trawl data for pelagic species and for other finfish, as might be expected given the nature of the trawl fishery. This CPUE index may, however, underestimate the actual declines in abundance of demersal species because of increasing fleet efficiency. Also, this index includes species not included in the principal

Figure G. Total trawl catch (mt), standardized trawl fishing effort (days fished), and catch divided by effort (CPUE, mt/DF) since the introduction of the MFCMA in 1976, reflecting major changes in trawl fishing activity and aggregate resource abundance.

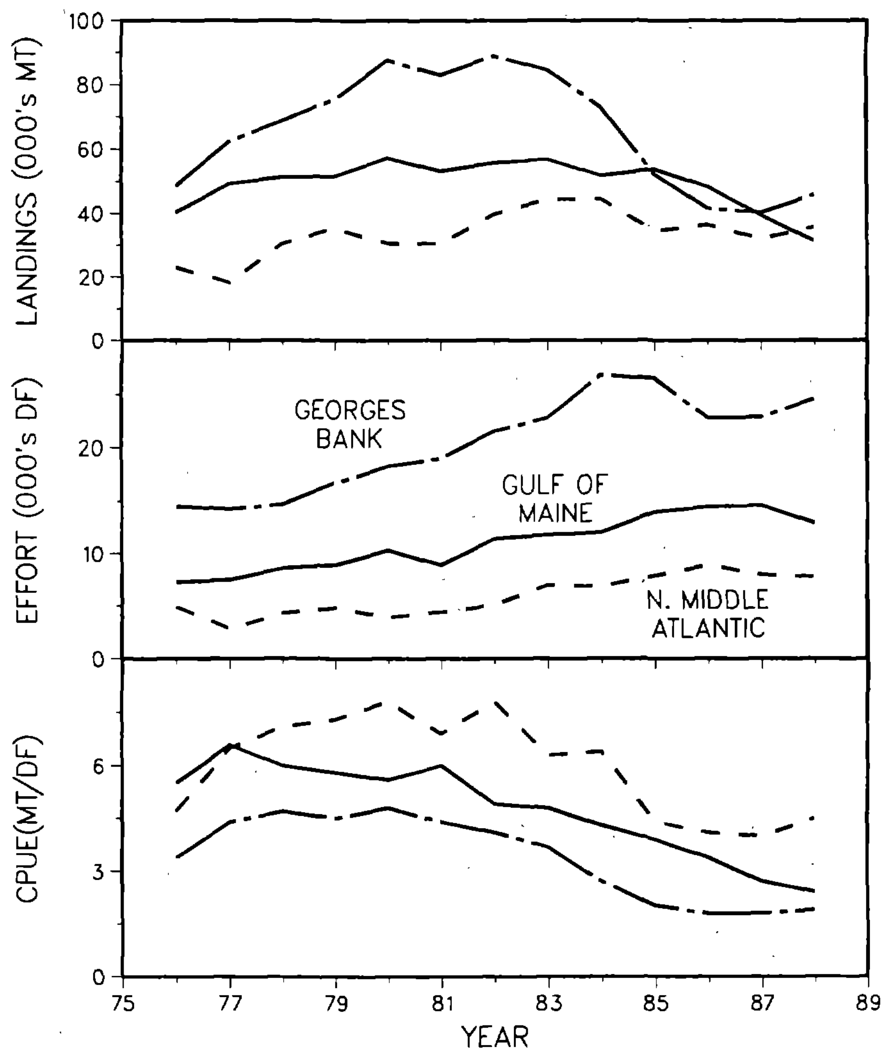


groundfish trawl index species that have remained at relatively high stock sizes, such as butterfish and mackerel.

The same general trends in catch, effort, and CPUE are apparent in the data when treated separately for the three assessment regions (Figure H). During the period 1976-87 nominal effort increased 100% in the Gulf of Maine, 58% on Georges Bank, and 63% in the Northern Mid-Atlantic. Effort in 1988 decreased 12% in the Gulf of Maine and 2.5% in Southern New England, while it increased 7% on Georges Bank. Landings peaked in 1983 for the Gulf of Maine (125,000 mt), in 1982 on Georges Bank (196,000 mt), and 1984 in the Northern Mid-Atlantic, (98,000 mt). Landings by 1987 had declined 31, 55, and 28% in the three areas, respectively, since their peak years. In 1988 they declined further in the Gulf of Maine, by 21% over 1987, while they increased by 14% and 11% over 1987 on Georges Bank and in southern New England, respectively. CPUE declines were pronounced from 1977 to 1987, indicating rapid declines in stock abundance. The CPUE index for the Gulf of Maine region declined by more than 50% from its 1977 peak. Similarly, the index for the Georges Bank region declined by more than 60% from its 1980 peak, while the index for the Northern Mid-Atlantic region declined by 50% from its 1982 peak. The CPUE index continued to decline in the Gulf of Maine, falling 8% over the 1987 level, but increased 5% and 14% on Georges Bank and in southern New England, respectively.

During the period covered in these analyses, the species composition of landings changed dramatically for most vessel size classes and areas. In the Gulf of Maine, landings of cod, redfish, and flounders have declined. Currently, pollock, silver hake, and shrimp predominate in the landings. On Georges Bank, haddock and yellowtail flounder stocks have declined and are a small fraction of overall catches, which are primarily cod, winter flounder, and windowpane flounder. In the Northern Mid-Atlantic Bight, catches are generally highly

Figure H. Total trawl catch (mt), standardized fishing effort (days fished), and catch divided by effort (CPUE, mt/DF) since 1976, for three regions, reflecting major changes in trawl fishing activity and aggregate resource abundance.



mixed, but several trends are notable. Yellowtail, winter, and summer flounder catches have declined relative to other species such as *Loligo* squid, butterfish, and silver hake.

CONCLUSIONS ABOUT RESOURCE ABUNDANCE

Both the research trawl data and the aggregate trawl fishery data suggest major changes in the abundance of resources in the Northeast Atlantic, especially since the implementation of the FCMA in 1976. Increases in abundance of groundfish and flounders associated with the reduction of foreign fishery effort during the mid-1970s were followed by increases in domestic fishing effort and landings. Abundance of groundfish and flounders started declining after 1978, and currently are at historically low levels. Abundance of other finfish has fluctuated widely, while that of the principal pelagics has increased steadily in recent years. More recently, the Georges Bank herring stock appears to be recovering. Trawl fishing effort increased steadily through 1985, and remains at near record high levels. Total trawl catches increased until 1983, and have subsequently declined to levels comparable to those seen in 1976 despite the great increase in fishing effort. These major changes in the fisheries have included extensive changes in the species composition of the catches, with shifts to previously less-desirable species. At the same time, major increases in the abundance of nontarget species such as spiny dogfish and skates, have occurred.

It appears that most of the changes in resource abundance described above are directly related to changes in fishing mortality. For example, increases in abundance occurred from 1975 to 1978 when fishing effort was being reduced by international and domestic management actions. Subsequently, decreases in abundance began in the early 1980s while fishing effort continued increasing. Fishing intensity appears to have been the principal cause of changes in resource abundance. Decreases in fishing activity allowed more fish to survive and grow in the late 1970s, indicating the intensity of and significance of fishing activity on determining resource abundance. Record increases in fishing effort continuing through the 1980s have reduced several strong year classes before they were able to achieve full growth and reproduce. Continued high fishing effort has repeated this pattern, with several species being represented by only one or two age groups at present.

"Abundance of groundfish and flounders...are at historically low levels."

Factors other than fishing effort may have played a role in these changes, as, for example, in years when exceptionally strong or weak recruitment occurred for some species. However, there is little evidence of long-term climatic changes that might have affected the recruitment of several species simultaneously as would be necessary to cause declines in abundance of the magnitude apparent in these data. Similarly, there is little suggestion that environmental contamination has played a significant role in these changes in resource abundance because comparable decreases have been seen in all three regions even though pollution levels vary greatly. The effects of pollution are limited to near shore regions, while fish abundance has declined in all areas.

Increased fishing effort in the three regions has resulted in elevated fishing mortality (exploitation) rates on the target species. Up to 70% of some harvestable stocks are removed by fishing each year. The high rates of population removal can result in two effects:

1. Catching young, fast growing fish which may result in decreased aggregate yield in weight from a particular group of recruits
2. Reducing the total level of adult biomass to the point that too few young fish result from each year's spawning

The elevated levels of fishing mortality clearly have resulted in the first problem. Total catch has been less than what is possible because exploitation rates for many species are far in excess of the levels that result in maximum yield per recruited fish. Recent analyses of the relationship between the production of young fish and adult spawning biomass suggest that the second problem is also occurring. Present fishing mortality rates do not allow sufficient young fish to be produced to maintain their populations at even their current low abundance levels.

While the causes of the changes in resource abundance shown by the indices of aggregate abundance described here are not completely understood, fishing is probably the major cause. Climatic or environmental changes of sufficient magnitude to cause simultaneous changes in all of these stocks are not apparent. The amount of fishing has increased markedly, exceeding levels producing maximum catch per recruit, and for several species exceeds those levels that allow recruitment sufficient to maintain spawning stock size. While further research is needed, especially in terms of the possible effects of environmental or climatic changes,

"..there is little evidence of long-term climatic changes that might have affected the recruitment of several species simultaneously as would be necessary to cause declines in abundance of the magnitude apparent in these data."

the changes that have occurred following a decline in fishing in the mid-1970s and a subsequent doubling in the amount of fishing, are consistent with similar changes that were clearly seen when fishing effort in the North Sea declined during and then increased after World Wars I and II. The message that was clear then is no less clear today: reduced fishing would result in an increased abundance of fishery resources.

"...reduced fishing would result in an increased abundance of fishery resources."

For further information

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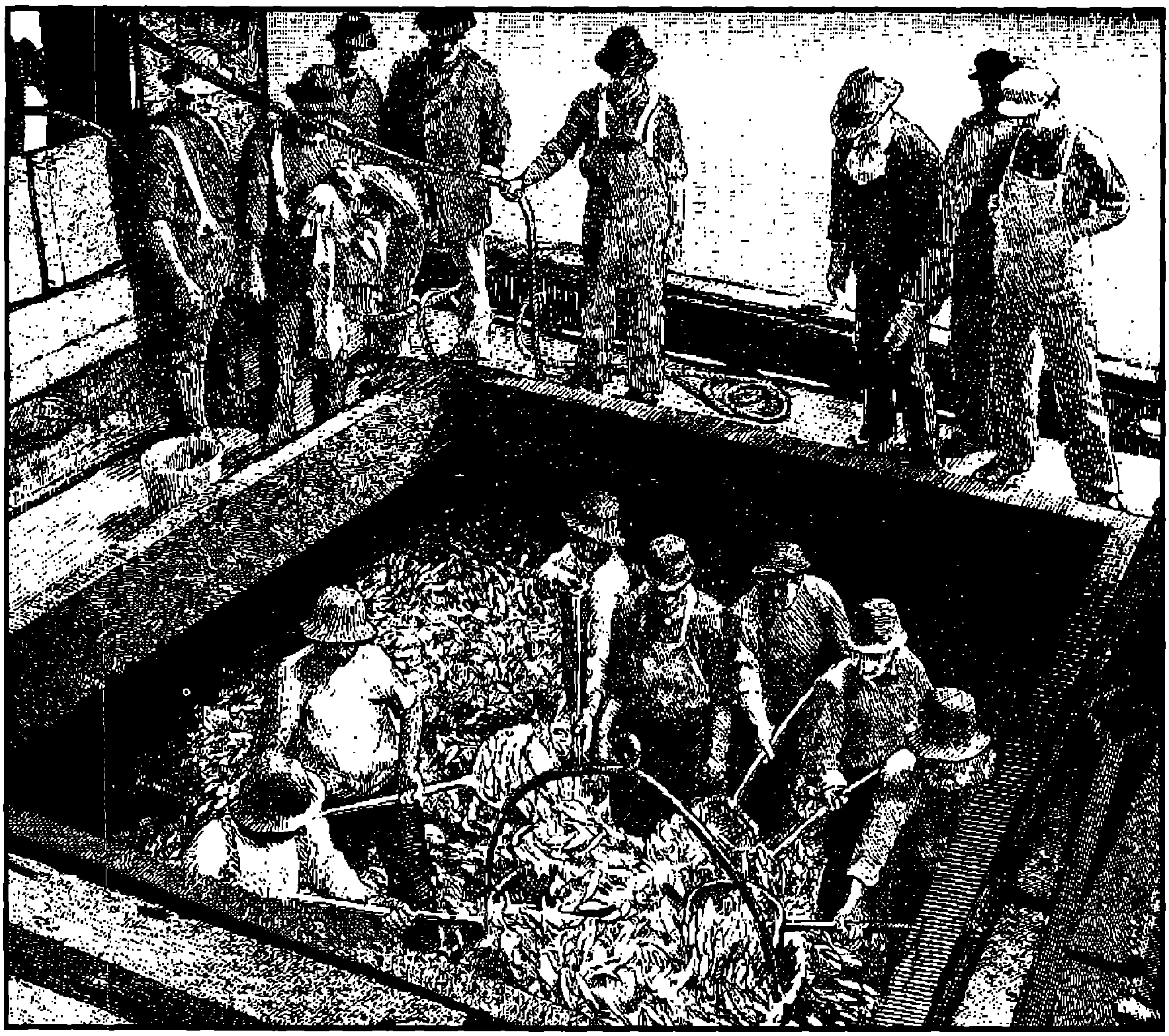


SPECIES SYNOPSES

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 Introduction to this report. The synopses are arranged by the major groups described in the introduction (principal groundfish, flounders, other groundfish, principal pelagics, invertebrates.) Each synopsis briefly reviews the biology of the animals and the general nature of the fishery, summarizes recent catch statistics and research survey results, indicates the general status of the target stocks, and where possible, predicts future stock status for possible developments within the fishery.

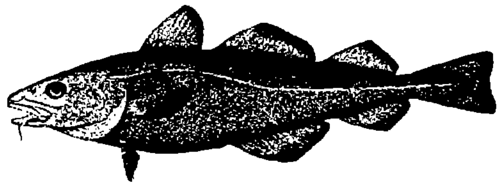
For each stock or species a summary table[1] of catch statistics is included, along with one or more graphs showing how landings and, stock abundance have varied over time. The measures of stock abundance used include trawl survey catch per tow, estimated stock biomass from virtual population analyses, and catch per unit of fishing effort. References in the text to catches or indices of abundance are usually to values given in these tables and figures, although some summary statistics are given in the text for different areas, fishing gears, or data sources which are not in the tables and figures.

Catch statistics in the tables are given in thousands of metric tons, rounded to the nearest one hundred metric tons; values less than 100 mt are indicated as <0.1. Values quoted in the text are also usually rounded to the nearest 100 mt when greater than that value, and are rounded to the nearest 10 mt when less. Values smaller than 10 mt are indicated by a dash. Values which are not yet available are indicated by N/A.

Many of the assessments relied on here are described in Northeast Fisheries CenterReference Documents listed at the end of each species summary, which may be obtained upon request. The most recent complete assessment for each stock is cited. Additionally, in recent years the NEFC has reviewed assessments of selected species-stocks in semi-annual workshops. The reports of those workshops are cited in the species synopses sections for those species that have been reviewed.

[1] **The tables and figures in this section are labled 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.**

1. ATLANTIC COD



The Atlantic cod, *Gadus morhua*, is a demersal gadoid species distributed in the Northwest Atlantic from Greenland to North Carolina. Cod are omnivorous feeders and commonly attain lengths up to 130 cm (51 in.) and weights up to 25 to 35 kg (55 to 77 pounds). Maximum age is in excess of 20 years, although young fish (ages 2 to 5) generally comprise the bulk of the catch. Sexual maturity is attained between ages 2 to 6; spawning occurs during winter and early spring.

In US waters, cod are assessed as two stocks: Gulf of Maine, and Georges Bank and southward. Important commercial and recreational fisheries occur in both. The commercial fisheries are conducted year-round with otter-trawls and gill nets as primary gear. Recreational fishing also occurs year-round; peak activity occurs during the late summer in the lower Gulf of Maine, and during late-autumn to early spring from Massachusetts southward.

USA commercial and recreational fisheries for cod are managed under the New England Fishery Management Council's Multispecies Fishery Management Plan. Total cod landings increased 28% in 1988 (42,700 mt to 54,700 mt). Ex-vessel value of USA commercial cod landings decreased 3% in 1988 (26,500 mt worth $43.7 million to 34,200 mt worth $42.3 million).

GULF OF MAINE

Total nominal commercial catch (USA and Canada) in 1988 was 8,100 mt, about the same as in 1987 (8,000 mt), and the second lowest annual catch since 1974. The 1988 USA catch (8,000 mt) was 6% higher than in 1987 (7,500 mt) but still the second lowest in the past 14 years and less than 60% of the peak 1983 catch (14,000 mt). Reported 1988 Canadian landings were 130 mt, 73% lower than in 1987 (490 mt). Canadian landings during 1982 to 1988, however, should be considered tentative since substantial misreporting of Canadian Scotian Shelf landings as Gulf of Maine catch is believed to have occurred.

United States otter trawl fishing effort in 1988 was the second-highest ever and only 9% below the peak 1987 level. USA CPUE indices (catch

Gulf of Maine Atlantic Cod

Long-term potential catch	=	10,000 mt
Importance of recreational fishery	=	Major
Management	=	Multispecies FMP
Status of exploitation	=	Over exploited
Proj. spawning stock per recruit	=	Below maintenance level
Age at 50% maturity	=	4.2 yrs (males) 3.8 yrs (females)
Size at 50% maturity	=	54 cm (21.3 in.) males 50 cm (19.7 in.) females
Assessment level	=	Age structured

$M = 0.20$ $F_{0.1} = 0.15$ $F_{max} = 0.27$ $F_{1988} \cong 0.90$

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per day fished) in 1988 were marginally higher than the record-low 1987 levels. "Directed trips" (trips where cod comprised 50% of more of the trip catch, by weight), which accounted for between 15 and 25% of the USA catch in 1984-1987, accounted for 35% of the 1988 USA total, the highest percentage since 1983.

"...the overall stock is in poor condition."

Fishery age composition data indicate that USA landings in 1988 were dominated by the 1984 and 1985 year classes. Otter trawl landings accounted for 57% of the 1988 USA Gulf of Maine cod catch (the lowest percentage by otter trawls in the 1965-1988 time series), while gill net landings accounted for 42% (the highest percentage by gill nets in the time series).

NMFS research vessel indices in both the spring and autumn 1988 surveys were much higher than in 1987 (the 1987 survey values were record-lows) due to strong recruitment of the 1986 and 1987 year classes. The number-per-tow indices in the spring and autumn 1988 surveys were the highest since 1981 and 1980, respectively. Survey age composition data for 1988 indicate that the 1986 year class comprised about 35% of the total population, by number. In terms of weight, however, the 1984 and 1986 cohorts were co-dominant, each accounting for about 20% of the total stock biomass. Results from the 1987 and 1988 State of Massachusetts inshore autumn surveys indicate that recruitment of 1987 year class may be outstanding. Catch-per-tow indices of this cohort at age 0 and at age 1 were the highest in the 11-year Massachusetts inshore survey time series.

Fishing mortality for all ages has increased, with that for fully recruited age groups (age 4+) increasing from 0.62 in 1982 to 1.00 in 1985, and remained at this record-high level during 1986 and 1987. At the beginning of 1988, spawning stock biomass was only 40% of that in 1982 and at a record-low level.

Although there are indications of strong 1986 and 1987 year classes in the population, the overall stock is in poor condition. Fishing mortality in 1988 was three times larger than F_{max}, suggesting that the yield-per-recruit could be increased markedly. Continuation of the present high fishing mortality rate will preclude attainment of the target percent spawning stock potential (% MSP) management targets established for this stock, hence increasing the possibility of poor recruitment in the future. The stock is over exploited.

Georges Bank Atlantic Cod

Long-term potential catch	=	35,000 mt
Importance of recreational fishery	=	Major
Management	=	Multispecies FMP
Status of exploitation	=	Over exploited
Projected spawning stockt per recruit	=	Below maintenance level
Age at 50% maturity	=	2.6 yrs (males) 2.9 yrs (females)
Size at 50% maturity	=	44 cm (17.3 in.) males; 51.5 cm (20.3 in.) females
Assessment level	=	Age structured

$M = 0.20$ $F_{0.1} = 0.15$ $F_{max} = 0.27$ $F_{1988} \cong 0.90$

GEORGES BANK AND AREAS TO THE SOUTH

Total nominal commercial catch (USA and Canada) in 1988 was 39,000 mt, 26% higher than in 1987 (30,900 mt), and the highest annual total since 1983. The 1988 USA catch (26,300 mt) was 38% greater than in 1987 (19,000 mt), but was still the third lowest since 1977 and below the 1977-1985 annual average of 32,200 mt. Canadian 1988 landings totaled 12,700 mt, 7% more than in 1986, and the highest annual catch since 1982.

USA commercial fishing effort in 1988 attained a record-high level. For the first time since 1982, USA commercial CPUE indices increased. Although still among the lowest values in the 1965-1988 time series, the 1988 CPUE indices for all trips catching cod were higher than the record-low 1986 and 1987 values, while the 1988 CPUE indices for "directed trips" (which accounted for a record-high 77% of the 1988 USA catch) were slightly above the record-low 1987 indices.

"...some rebuilding in stock abundance and spawning stock biomass occurred in 1988."

Fishery age composition data indicate that USA landings in 1988 were dominated by the strong 1985 year class. Otter trawl landings accounted for 83% of the 1988 USA Georges Bank cod catch, while gill net and line trawl landings each accounted for 8%.

NMFS research vessel indices in 1988 increased from the low 1987 values due to strong recruitment of the 1985 and 1987 year classes. The spring 1988 weight-per-tow index was the highest since 1986, while the autumn 1988 weight-per-tow value was

Atlantic Cod

Gulf of Maine

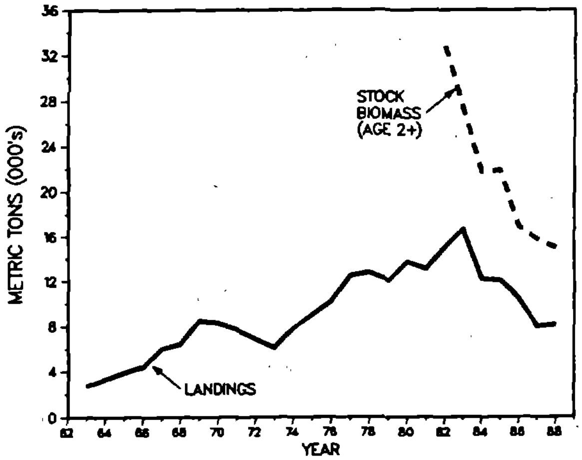

Table 1.1 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational[1]	3.1	1.1	1.2	1.1	1.7	2.7	1.6	0.9	1.3
Commercial									
USA	13.5	12.5	13.6	14.0	10.8	10.7	9.7	7.5	8.0
Canada	0.2	0.6	1.4	2.7	1.4	1.4	0.8	0.5	0.1
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	16.8	14.2	16.2	17.8	13.9	14.8	12.1	8.9	9.4

[1] **Estimated for Maine and New Hampshire.**

Georges Bank and South

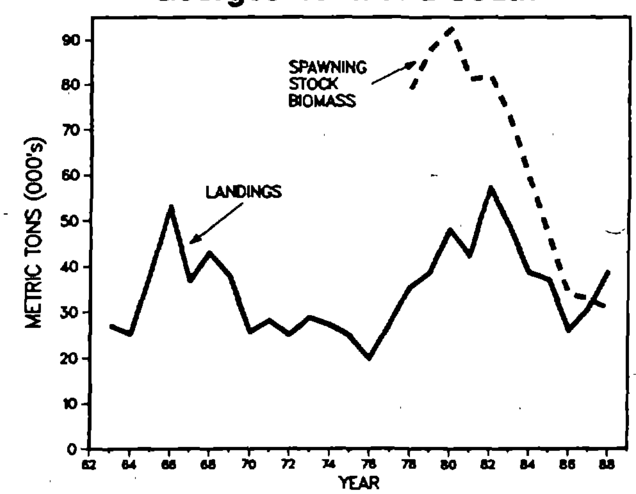

Table 1.2 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational[1]	3.3	7.5	6.8	7.2	3.7	6.3	1.8	2.9	6.3
Commercial									
USA	40.0	33.9	39.3	36.8	32.9	26.8	17.5	19.0	26.3
Canada	8.1	8.5	17.9	12.1	5.8	10.5	8.5	11.9	12.7
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	51.4	49.9	64.0	56.1	42.4	43.6	27.8	33.8	45.3

[1] **Estimated for Massachusetts and southward.**

the highest since 1985. Age composition data from the 1988 surveys indicated that the 1985 year class continues to dominate the population, accounting for about 40% of the total stock by number and for about 45% by weight. The surveys also indicate that recruitment of the 1988 year class may be above-average.

Fishing mortality in 1987 was a record-high (F=0.95 for ages 3+), more than three times F_{max}, and spawning stock biomass at the beginning of 1988 was at a record-low. The observed increases in the 1988 CPUE and research vessel survey indices suggest that some rebuilding in stock abundance and spawning stock biomass occurred during 1988 due to the strong 1985 and 1987 year classes. However, at the present level of fishing effort, any gains in stock size will be short-lived even with good recruitment. Because the fishery continues to be highly dependent on mostly young fish (ages 2 and 3), significant rebuilding of the spawning stock is being forgone in favor of short-term catch. At the current level of fishing, the percent spawning stock potential (% MSP) management target established for this stock in the Northeast Multispecies Fishery Management Plan will not be achieved, and the stock is over exploited.

For further information

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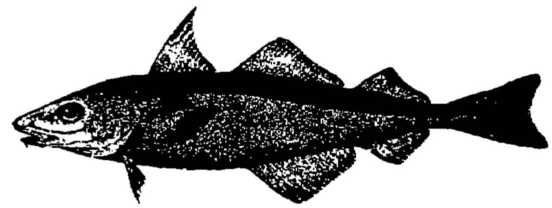
2. HADDOCK



The haddock, *Melanogrammus aeglefinus*, is a demersal gadoid species commonly attaining lengths of 75 to 80 cm (30 to 32 in.) and weights up to 5 kg (11 lbs). In recent USA landings, average lengths have ranged from 50 to 60 cm (20 to 24 in.), while average weights have ranged between 1.5 and 2.5 kg (3 to 5 lbs). Haddock mature sexually at ages 2 to 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 to 135 m (25 to 75 fathoms) and temperatures of 2° to 10°C (36° to 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. Two populations or stocks have been identified, termed the Gulf of Maine and the Georges Bank stocks.

The principal commercial fishing gear used to catch haddock is the otter trawl. Recreational catches are insignificant. Fishing is managed under the New England Fishery Management Council's Multispecies Fishery Management Plan (FMP). Total reported catches increased 22% in 1988 (7,300 mt to 8,900 mt); the apparent increase may be due to misreporting, however. Domestic nominal catches decreased slightly in 1988 (3,000 mt to 2,900 mt). Domestic ex-vessel value decreased in 1988 by 18% ($8.5 million to $7.0 million).

Gulf of Maine Haddock

Long-term potential catch	=	5,000 mt
Importance of recreational fishery	=	Minor
Management	=	Multispecies FMP
Status of exploitation	=	Over exploited
Projected spawning stock biomass per recruit	=	Below maintenance level
Age at 50% maturity	=	2 years
Size at 50% maturity	=	38 cm (15 in.)
Assessment level	=	Yield per recruit

$M = 0.20$ $F_{0.1} = 0.26$ $F_{max} = 0.55$ $F_{1988} > F_{max}$

Gulf of Maine Stock

Nominal catches of Gulf of Maine haddock declined from roughly 5,000 mt in the mid-1960s to less than 1,000 mt in 1973, parallel to the autumn trawl survey index. Catches and the survey index increased together until 1978; catches continued to increase reaching roughly 7,000 mt in the 1980-83 period, and subsequently plummeted to a historic low of 500 mt in 1988. Recreational catches declined from 1,700 mt in 1979 to insignificant levels since 1981. USA fishermen accounted for 84% of the catches from 1980 to 1988.

"...further declines in landings of this over-exploited stock are anticipated."

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 1988 were among the lowest in the time series. Research vessel surveys indicated that the 1979, 1980 and 1982 year classes were relatively strong; these year classes have been greatly reduced by fishing, and stock biomass is currently low. 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.

The 86% decline in landings from 1983 to 1987 (7,600 mt to 1,000 mt) was continued in 1988 (50% decline from 1,000 mt to 500 mt), and is indicative of the status of this stock. Recruitment has been too poor to support landing levels, and further declines in landings of this over-exploited stock are anticipated. Spawning stock biomass is below maintenance level, and likely to remain so in the near future.

Haddock

Gulf of Maine

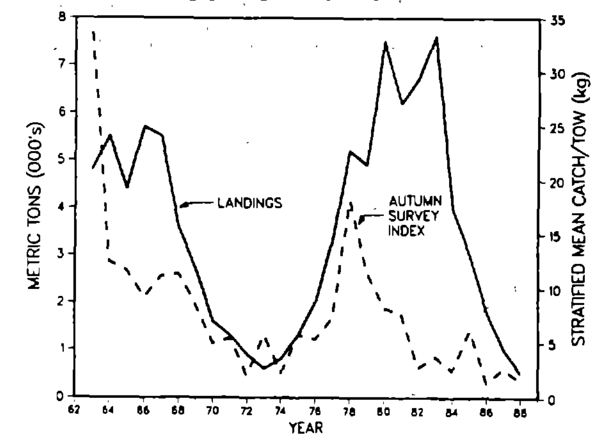


Table 2.1 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1986	1988
USA recreational	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1
Commercial									
USA	7.3	5.7	5.6	5.6	2.8	2.2	1.6	0.8	0.4
Canada	0.2	0.5	1.1	2.0	1.2	0.8	0.2	0.2	0.1
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	7.7	6.2	6.7	7.6	4.0	3.0	1.8	1.0	0.5

Georges Bank

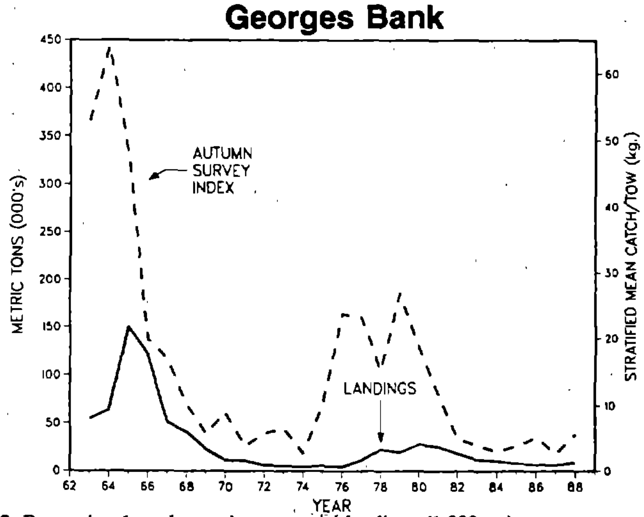


Table 2.2 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-
Commercial									
USA	17.5	19.2	12.6	8.7	8.8	4.3	3.3	2.2	2.5
Canada	10.1	5.7	5.6	3.2	1.4	3.5	3.4	4.1	5.9
Other	-	<0.1	-	-	-	-	-	-	-
Total nominal catch	27.6	24.9	18.2	11.9	10.2	7.8	6.7	6.3	8.4[1]

[1] **Suspected of being roughly 2,000 mt too high due to misreporting.**

Georges Bank Haddock

Long-term potential catch	=	47,000 mt
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Over exploited
Projected spawning biomass per recruit	=	Below maintenance level
Age at 50% maturity	=	2 years
Size at 50% maturity	=	38 cm (15 in.)
Assessment level	=	Yield per recruit

$M = 0.20$ $F_{0.1} = 0.26$ $F_{max} = 0.55$ $F_{1988} > F_{max}$

"Landings in 1989 ...expected to be maintained based on recruitment from the 1987 year class."

Georges Bank Stock

Nominal catches of Georges Bank haddock increased from roughly 50,000 mt prior to 1965 to nearly triple that amount in that year and in 1966, and subsequently declined until 1976. Catches increased from 1977 to 1980, reaching roughly 28,000 mt, but declined subsequently to 6,100 mt in 1987. Reported catches increased in 1988 to 8,400 mt, but uncertainties exist about that number because of possible misreporting of catch by Canadian fishermen. Up to 2,000 mt of haddock officially reported as coming from Georges Bank is thought to have been caught on the Scotian Shelf.

USA fishermen accounted for 69% of the nominal commercial catch between 1977 and 1984, but the percentage declined to 34% in 1987. In 1988, this percentage dropped to 27% based on official statistics, but may actually have been similar to the percentage observed in 1987 because of the possible misreporting noted above. The NEFC autumn survey indices have been a reliable indication of stock size. Overall stock size has declined markedly since 1979. The 1988 autumn survey index of 5.57 is only 20% of the 1979 value and 9% of the 1964 value. The NEFC spring survey indices also show a similar decline since 1979. The 1988 spring and autumn indices increased from their 1987 level due to growth and recruitment of the 1985 and 1987 year classes.

Research vessel survey data for 1979-87 indicates a succession of weak year classes. The fishery in 1989 will be dependent upon the 1985 year class and on recruitment of age 2 fish from the 1987 year class. The 1981, 1982, 1984, and 1986, through 1988 young-of-year indices for Georges Bank were among the lowest on record. Subsequent age 1 indices in the autumn and age 2 indices in the spring, suggest that the 1987 year class was undersampled at age 0 and may be comparable to the 1983 and 1985 year classes. Estimates of the 1983 year class and indices for the 1985 and 1987 year classes suggest that they are of moderate strength, comparable to the 1972 year class.

Fishing effort, mortality, and discarding have been high in recent years and appear to have reduced the 1983 and 1985 year classes rapidly. The relatively steady landings from 1985 to 1988 (average 6,800 mt) have been maintained on fish recruiting from these year classes. Landings in 1989 can be expected to be maintained based on recruitment from the 1987 year class. Future catch levels will depend on the strength of future year classes. Targets for maintenance of spawning stock biomass are not being met under the Multispecies FMP, and unless fishing mortality and discarding rates decline, stock size is expected to remain low and to possibly decline further in 1989, continuing its over exploited condition.

For further information

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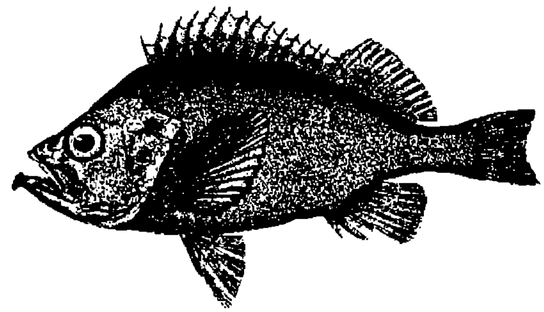
3. REDFISH



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 ft.). 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 to 50 cm (18 to 20 in.) have been noted. In the Gulf of Maine, redfish reach maturity in about 5 to 6 years at an average length of 20 to 23 cm (8 to 9 in.). Females are viviparous, retaining eggs in the ovary after fertilization until yolk sac absorption. Mating takes place in autumn, with subsequent larval extrusion occurring the following spring and summer.

The principal commercial fishing gear used to catch redfish is the otter trawl. Recreational catches are insignificant. Fishing is managed under the New England Fisheries Management Council's Multispecies FMP. Total nominal catches decreased 40% in 1988 (2,000 mt to 1,200 mt). Domestic ex-vessel value decreased in 1988 by 44% ($2.7 million to $1.5 million).

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 to 11,000 mt during 1974-1976 to approximately 14,000 to 15,000 mt in 1978-79. In 1987 and 1988, however, catches declined to 1,900 and 1,100 mt, respectively, the lowest annual figures since the directed fishery commenced in the early 1930s. The Gulf of Maine redfish population is presently 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 1988, this year class represented 64% 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 0.7 and 0.5 mt/day in 1987 and 1988, respectively. The NEFC autumn survey index declined from an average of 122 fish/tow in 1967-68 to an average of 9 fish/tow in 1982-84. Although the 1986 autumn index increased to 26 fish/tow, estimates for 1987 and 1988 declined to 14 and 12 fish per tow, respectively. 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 1989 indicate a 5+ stock biomass of 23,000 mt.

Gulf of Maine and Georges Bank Redfish

Long-term potential catch	=	14,000 mt
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Over exploited
Projected spawning stock biomass per recruit	=	Increasing toward maintenance level
Age at 50% maturity	=	5-6 years
Size at 50% maturity	=	20-23 cm (7.9 - 9.0 in.)
Assessment level	=	Yield per recruit

$M = 0.05$ $F_{0.1} = 0.07$ $F_{max} = 0.14$ $F_{1988} = F_{0.1}$

Average fishing mortality during the 1970s 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 1970s. Fishing mortality has declined in recent years to a point about equal to $F_{0.1}$ and well below F_{max}. Equilibrium surplus production models have indicated that the long-term potential catch is about 14,000 mt. Given the current low population abundance and poor recruitment, however, surplus production in the near future will be considerably less than that, as indicated by the sharp decline in nominal catches.

"...the fishery is extremely dependent on recruitment."

The decline in the landings in 1988 continues a trend since 1980, reflecting a decreasing level of fishing mortality. The population age structure remains in a severe state of disequilibrium, and with the present exploitation pattern, the fishery is extremely dependent on recruitment. Recruitment has been poor since 1971 except for the moderate 1978 year class. With the low levels of F seen in the past two years, stock biomass appears to have stabilized at the 20,000-25,000 mt level. Unless recruitment improves substantially, however, biomass and yield are not expected to increase; the population is over exploited.

Redfish
Gulf of Maine and Georges Bank

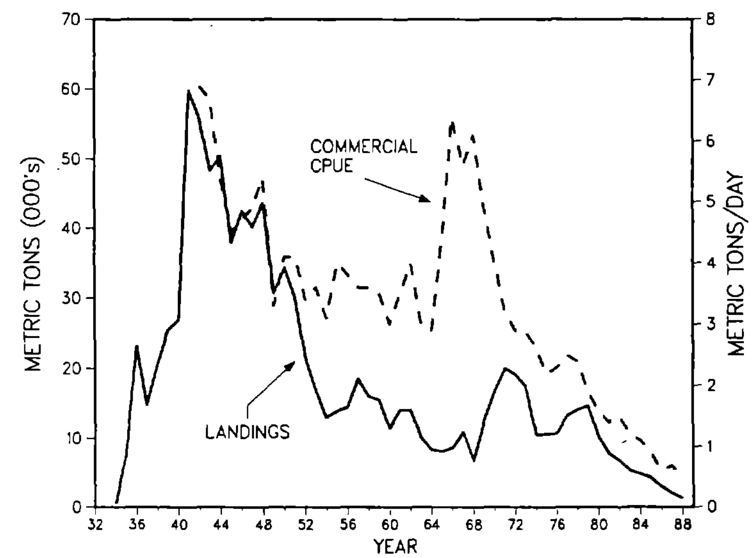


Table 3.1 Commercial landings (1,000 mt)

Category	Year 1980	1981	1982	1983	1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	10.1	7.8	6.7	5.2	4.7	4.2	2.9	1.9	1.1
Canada	0.1	<0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Other	-	-	<0.1	-	-	-	-	-	-
Total nominal	10.2	7.8	6.8	5.3	4.8	4.3	3.0	2.0	1.2

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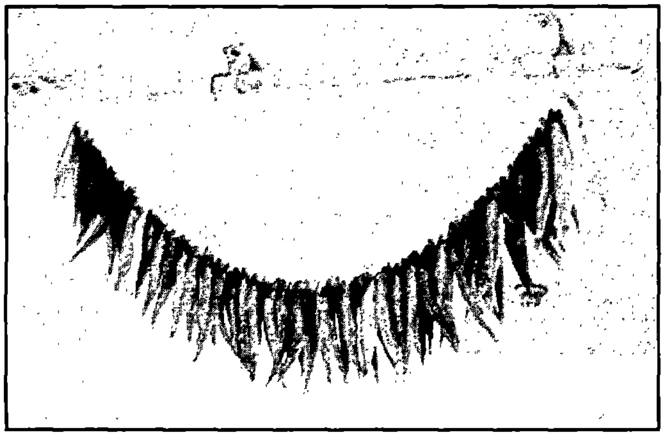
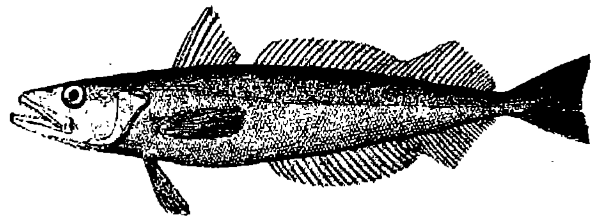
4. SILVER HAKE





The silver hake or whiting, *Merluccius bilinearis*, are widely distributed, slender, swiftly swimming fish with a range extending from Newfoundland to South Carolina, but are most abundant from Maine to New Jersey. Research vessel bottom trawl surveys indicated that silver hake have a wide geographic and depth ranges throughout the year. The major concentrations of fish vary from season to season in response to seasonal hydrographic conditions, availability of food and spawning requirements. Two stocks have been identified based on morphological differences, north and south of Georges Bank. Migration is extensive, with overwintering in the deeper waters of the Gulf of Maine for northern stock and along the outer continental shelf and slope for southern stock, and with movements to shallow waters from March to November to feeding and spawn.

Major spawning areas 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. More than a half of two year old fish (20-30 cm) spawn, and nearly all three year old (25-35 cm) spawn. Silver hake grow to a maximum length of around 65 cm. Ages of 15 years have been reported, but few fish are seen beyond age six. Natural instantaneous mortality is estimated to be 0.4 (annual rate of 33 percent). This is twice average natural death rate for most groundfish.

The principal commercial fishing gear used to catch silver hake is the otter trawl. Recreational catches are insignificant. The fishery is managed under the Hake Preliminary Management Plan. Total nominal catches increased by 3% in 1988 (15,600 mt to 16,100 mt). Domestic ex-vessel value of the whiting landed in New England decreased in 1988 by 26% ($7.4 million to $5.5 million).

Gulf of Maine - Northern Georges Bank Stock

With introduction of the distance water fleet (DWF) in 1962, landings reached a peak of 94,500 mt in 1964, then dropped sharply in 1965, declined for 13 years, and reached the lowest in time series of 3,400 mt in 1979. During 1980-86 landings gradually increased to average about 6,400

Gulf of Maine - Northern Georges Bank Silver Hake

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Insignificant
Management	=	Hake PMP
Status of exploitation	=	Under exploited
Age at 50% maturity	=	2 years
Size at 50% maturity	=	23.8 cm (9.4 in.) males; 25.0 cm (9.4 in.) females
Assessment level	=	Yield per recruit

M = 0.40 **$F_{0.1}$ = 0.44** **F_{max} > 2.00** **F_{1988} = .46**

mt and reached 8,500 mt in 1986, then dropped again in 1987 to 5,700 mt. Prior to the inception of the MFCMA, the DWF landings averaged about 49% of the total; the DWF was excluded from these waters in 1978.

The nominal catches of silver hake in 1988 were 6,800 mt, including 2,200 mt landed exclusively by an experimental silver hake fishery from July to October. The purpose of the 1988 experimental silver hake fishery was to determine the feasibility of conducting a small mesh fishery for silver hake in the offshore waters of Georges Bank where large mesh (>5.5 in.) trawl gear for groundfish is currently required of all commercial fishing activities.

The autumn NEFC bottom trawl survey catch-per-tow index reached a high in 1975 and 1976 and declined through 1984. In 1985 and 1986 autumn index increased sharply due primarily to strong 1984 and 1985 year classes. The autumn index in 1987 and 1988 indicated that the 1983 year class was quite weak and the 1984, 1985, and 1986 year classes relatively strong especially 1985. Subsequent yearclasses appear to be only average.

Fishing mortalities (F) for fully recruited fish ranged from 0.19 to 1.29 during 1955-87, and averaged 0.43. Before the introduction of the DWF, F was fairly steady, averaging 0.27 during 1955-61. F rose rapidly however, with the increased fishing effort placed on the stock beginning in 1962 and reached 0.70 in 1964. In 1965 both landings and F declined sharply, and then F stabilized during 1965-70

"...stock...could support increased fishing."

at an average 0.41. In 1971 F increased dramatically, reaching 1.29, but dropped to 0.42 in 1972 and fluctuated in alternate years during 1972-78 between 0.28 and 0.78 before dropping 0.19 in 1979 after inception of MFCMA. Since then, F remained fairly steady, averaging 0.41 though 1987.

Georges Bank - Middle Atlantic Silver Hake

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Minor
Management	=	Hake PMP
Status of exploitation	=	Under exploited
Age at 50% maturity	=	2 years
Size at 50% maturity	=	24.7 cm (9.7 in.) males 25.7 cm (10.1 in.) females
Assessment level	=	Yield per recruit

$M = 0.40$ $F_{0.1} = 0.35$ $F_{max} > 2.00$ $F_{1988} = 0.33$

Spawning stock biomass increased from 251,800 mt in 1958 to a high of 301,900 mt in 1962, then began a steady ten year to decline to 47,900 mt in 1972. As a result of strong year classes in 1971, 1972 and 1973, spawning biomass increased to 73,700 mt in 1975, but declined to only 12,000 mt by 1982. Biomass has increased since 1981 to 33,500 mt for 1987. Estimates of F and biomass are not available for 1988 because the level of assessment has been reduced.

The increase in landings in 1988 may reflect recruitment from the strong 1984-86 year classes. Estimates of F and biomass are not available for 1988 because the level of assessment has been reduced. Although there is greater uncertainty in the status of exploitation because of the lower level of the assessment, it still appears that even though the stock size is much lower than in the 1960s, it could support increased fishing and is thus under exploited.

Southern Georges Bank - Mid-Atlantic Stock

With introduction of DWF in 1962 landings reached a peak of 307,100 mt in 1965, and declined sharply up to 1970, then increased to form a secondary peak of 109,900 mt

"...catches are a small proportion of the spawning stock biomass."

in 1975. Since then, the landings were downward to the present level. The DWF landings from 1963 to the inception of MFCMA in 1977 dominated the total landings from this stock, averaging 87% annually. With restrictions on DWF in 1978 total landings declined to an average of 12,300 mt since 1980. The DWF landings is now taken primarily as by catch in the squid fishery. Recreational landings for silver hake in 1988 were estimated to be about 100 mt. The nominal 1988 landings were 9,200 mt, included 6,400 mt of landings from joint venture, which is the lowest level since 1960.

The autumn NEFC bottom trawl catch-per-tow index decreased from its highest during 1963-65 to the lowest in 1974, increased slightly between 1975 and 1978, and then decreased through 1982. The indices fluctuated between 1983 and 1988, and the 1985 year class appeared quite strong. The strength of 1986 year class appeared to be below the average level, and weakest since 1973, while 1987-88 year classes appeared to be better than that of 1986.

The F ranged from 0.09 to 0.98 between 1955 and 1986 and averaged 0.45. During 1955-59, F averaged

0.32, but dropped to 0.11 during 1960-62 before increasing dramatically with the DWF to 0.98 in 1965. F then dropped during 1968-77 and averaged 0.52. With the inception of MFCMA and the restrictions placed on the DWF, F declined from 0.76 in 1977 to 0.31 in 1980, increased during 1981-84 and averaged 0.33 in 1985-87.

Spawning stock biomass increased from 51,600 mt in 1955 to a series high of 655,700 mt 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. It has been increasing since to an estimated 35,200 mt in 1987.

Estimates of F and biomass are not available for 1988 because the level of the assessment has been reduced and the virtual population analysis discontinued. Although this change has increased the uncertainty about the status of exploitation, it still appears that the catches are a small proportion of the spawning stock biomass, even though the stock biomass is much lower than in the 1960s and 1970s. Thus the stock could support increased fishing and is under exploited.

For further information

Almeida, F. P. 1987. Status of silver hake resources of the northeast coast of the United States - 1987. Woods Hole, MA, NMFS,NEFC. Woods Hole Laboratory Reference Document 87-03. 60 p. Available from: Northeast Fisheries Center, Woods Hole, MA 02543.

Almeida, F. P. 1987. Stock definition of silver hake in New England Middle Atlantic area. *North Am. J. Fish. Mgmt.* 7(2):169-186.

Silver Hake

Gulf of Maine-Northern Georges Bank

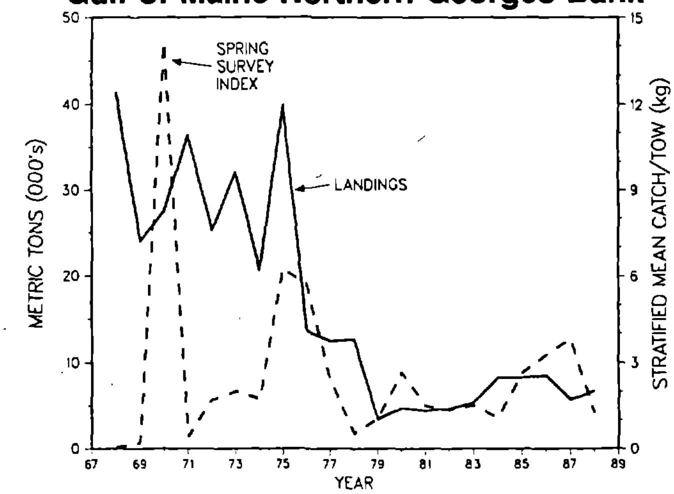


Table 4.1 Commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	4.7	4.4	4.7	5.3	8.3	8.3	8.5	5.7	6.8
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	4.7	4.4	4.7	5.3	8.3	8.3	8.5	5.7	6.8

Southern Georges Bank-Middle Atlantic

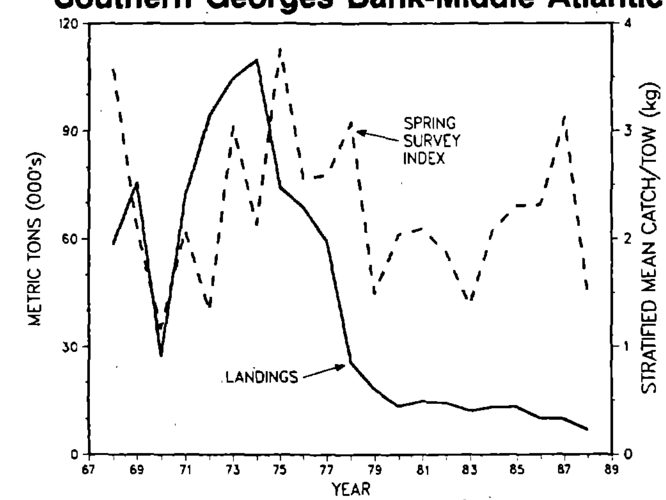
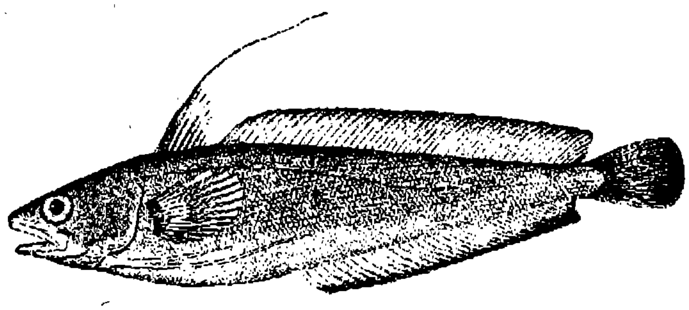


Table 4.2 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational	0.1	0.1	0.3	<0.1	<0.1	<0.1	0.1	0.1	0.1
Commercial									
USA	11.7	11.7	11.9	11.5	12.7	11.8	9.4	9.8	9.2
Canada	-	-	-	-	-	-	-	-	-
Other	1.7	3.0	2.4	0.6	0.4	1.3	0.5	-	-
Total nominal catch	13.5	14.8	14.6	12.1	13.1	13.1	10.0	9.9	9.3

5. RED HAKE



The red hake, *Urophycis chuss*, is widely distributed with a range extending from the Gulf of St. Lawrence to North Carolina, but is most abundant between Georges Bank and New Jersey. Research vessel bottom trawl surveys indicated that red hake have wide geographic and depth ranges throughout the year. The major concentration of fish varies from season to season in response to seasonal hydrographic conditions, availability of food and spawning requirements. Their migration is extensive, overwintering 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 reached by red hake is approximately 50 cm (19.7 in.). The maximum age is reported to be about 12 years, but few fish are seen beyond 8 years of age. Two stocks have been identified, divided north and south in the central Georges Bank region.

The principal commercial fishing gear used to catch red hake is the otter trawl. Recreational catches are negligible. The fishery is managed under the Hake Preliminary Management Plan. Total reported catches in 1988 were very similar to 1977 (1,900 mt versus 1,800 mt), all domestic.

Gulf of Maine - Northern Georges Bank Stock

The nominal landings of this stock of red hake in 1988 were 900 mt, taken exclusively by the US vessels. These landings are about 14% less than those of 1987 and continue the low levels reported since 1977. Trends in total landings from this stock have shown three distinct periods. The first period, from the early 1960s through

Gulf of Maine - Northern Georges Bank Red Hake

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Insignificant
Management	=	Hake PMP
Status of exploitation	=	Under exploited
Age at 50% maturity	=	2 years
Size at 50% maturity	=	28.1 cm (11.1 in.)
Assessment level	=	Yield per recruit

$M = 0.40$ $F_{0.1}$ = Unknown $F_{max} > 2.00$ F_{1988} = Unknown

1971, was characterized by relatively low landings ranging from about 1,000 to 5,000 mt. The second period, from 1972 to 1976, showed a sharp increase, with landings ranging from 6,300 to 15,300 mt. During this period approximately 93% of the total annual landings were taken by the distant-water-fleet (DWF) on northern Georges Bank. Total landings then dropped sharply and have averaged only 1,100 mt from 1977 to the present, due primarily to the displacement of DWF from the waters inhabited by this stock.

"...low fishing pressure ...has resulted in an increase in stock size."

The NEFC spring bottom trawl survey index increased from low levels in the late 1960s, and has fluctuated at roughly the same level since. The 1985 value was the third highest recorded in the series, but the 1988 index has declined by a third compared to the 1987 index. Survey catch-per-tow-at-age data indicate that the 1973 and 1974 year classes were the strongest since 1970. Year classes produced between 1975 and 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. The 1985 year class appeared to be quite strong, recording the second highest age 0 autumn index in the 1970-85 time series. The strength of the 1987 year class appeared to be above average, while the 1988 year class appeared to be average.

The combination of low fishing pressure, low catches (average 1,100 mt since 1983) and the average and above average year classes produced since about 1980 has resulted in an increase in stock size as indicated from the NEFC bottom trawl survey. It is unlikely that this stock will undergo any major declines in 1989 if landings remain at or somewhat above

Red Hake

Gulf of Maine - Northern Georges Bank

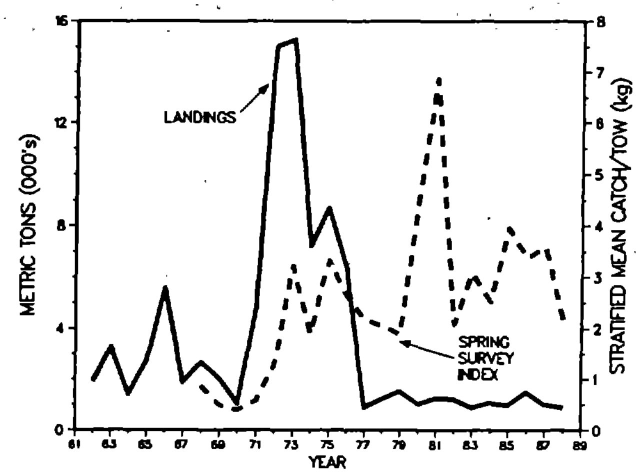


Table 5.1 Commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	1.0	1.2	1.2	0.9	1.1	1.0	1.5	1.0	0.9
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	1.0	1.2	1.2	0.9	1.1	1.0	1.5	1.0	0.9

Southern Georges Bank - Middle Atlantic

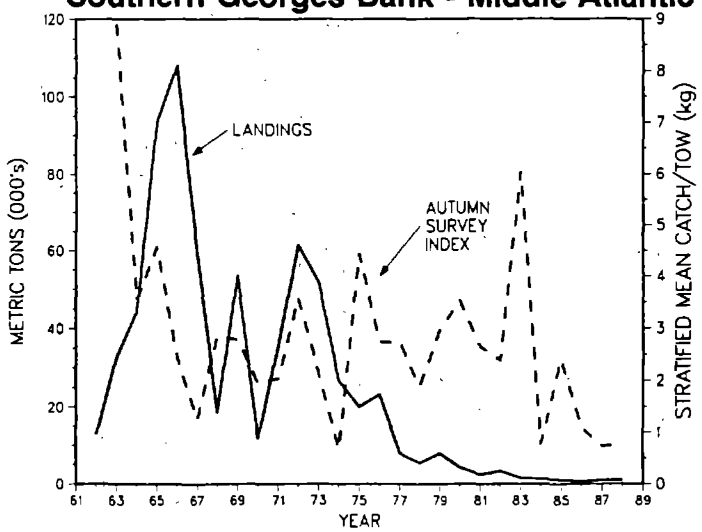


Table 5.2 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational	0.1	0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial									
USA	3.9	2.1	3.0	1.3	1.2	0.8	0.6	0.9	0.9
Canada	-	-	-	-	-	-	-	-	-
Other	0.2	0.2	0.2	0.1	0.1	0.1	-	-	-
Total nominal catch	4.2	2.4	3.3	1.5	1.3	0.9	0.6	0.9	0.9

Southern Georges Bank - Middle Atlantic Red Hake

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Minor
Management	=	Hake PMP
Status of exploitation	=	Under exploited
Age at 50% maturity	=	2 years
Size at 50% maturity	=	27.6 cm (10.9 in.)
Assessment level	=	Yield per recruit

$M = 0.40$ $F_{0.1}$ = Unknown $F_{max} > 2.00$ F_{1988} = Unknown

" If the 1985 year class is as strong as the autumn survey index has indicated, then an increase in stock biomass will be expected in the next one or two years."

the levels reported in recent years. The stock is under exploited and substantially higher catches could be supported.

Southern Georges Bank-Middle Atlantic Stock

The nominal landings of this stock of red hake in 1988 were 900 mt, the same as 7% less than in 1987. Landings in 1986 were the lowest reported in the 1960-86 time series and continued a trend of decreasing landings that began in 1977. The DWF landings were reported to be none. Recreational landings were estimated to be approximately 30 mt.

Total landings 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. Landings 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 landings, initially because of a modest decline in DWF landings and later because of a sharp decline in DWF landings after of the USSR was excluded from the fishery. From 1965 to 1976 the fishery was dominated by the DWF, which averaged 83% of the total annual landings. Since 1978, the DWF landings have averaged only 10% of the total annual landings due to restrictions placed on the fleet after the inception of MFCMA. The DWF landings of red hake in recent years have been taken as by-catch in the squid fishery.

USA commercial landings 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 landings have remained relatively steady between 1967 and 1979, when landings averaged 4,100 mt annually, and have since declined steadily.

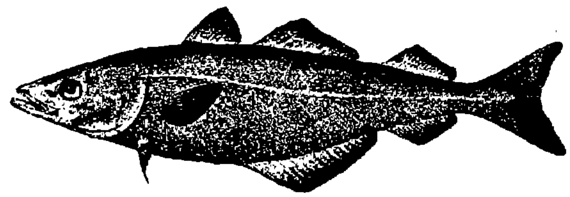
The NEFC autumn bottom trawl survey index declined steadily from the highest levels in the mid-1960s, remained fairly constant between 1968 and 1973, and then dropped to a series low in 1974. The index increased sharply in 1975, declined slightly and remained fairly steady between 1976 and 1982 at a level similar to that between 1968 and 1973. The index reached the second highest in 1983, dropped sharply in 1984 (almost to the lowest level), but increased in 1985. It dropped again in 1986 and dropped even further in 1987 to the second lowest level since 1963. The 1988 index was the same level as that of 1987. Survey catch-per-tow-at-age indices indicated that the 1974 and 1979 to 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 pre-recruitment index was the second highest in the time series, indicating the possibility of a strong 1985 year class. The strength of the 1986-88 year classes appeared to be much weaker than the average.

The low catches in recent years (average 1,000 mt since 1983) reflects low fishing pressure, which has allowed the age structure to remain fairly stable with three or four year classes contributing strongly to the survey indices. However, the survey indicates 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 one or two years. The stock is under exploited, and increased catches could be supported over the next few years.

For further information

Northeast Fisheries Center. 1986. Report of the Second Stock Assessment Workshop. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 86-09. 114 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

6. POLLOCK



Pollock, *Pollachius virens*, occur on both sides of the North Atlantic; in the Northwest Atlantic, they are most abundant on the Scotian Shelf and in the Gulf of Maine. One major spawning area exists in the western Gulf of Maine, and several areas have been identified on the Scotian Shelf. Tagging studies suggest considerable movement of pollock between the Scotian Shelf and Georges Bank and, to a lesser extent, between the Scotian Shelf and the Gulf of Maine. Electrophoretic analyses of pollock tissue samples from the Scotian shelf and western Gulf of Maine showed no significant differences between areas, although differences in some morphometric and meristic characteristics were significant. Accordingly, pollock from Cape Breton and south continue to be assessed as a unit stock. Spawning occurs in winter and sexual maturation is essentially complete by age 6 although most fish are mature by age 4. Juvenile "harbor" pollock are common in inshore areas, but move offshore as the grow older. Pollock attain lengths up to 110 cm (43 in.) and weights of 16 kg (35 lbs).

Traditionally, pollock had been taken as by-catch in the demersal otter trawl fishery, but, in recent years, directed effort has increased substantially. Much of this increase in effort has occurred in the winter gillnet fishery. The domestic portion of the fishery is managed under the Multispecies FMP. The Canadian fishery is managed under quotas; the two management regimes do not interact. Total nominal catches declined 12% in 1988 (66,700 mt to 58,100 mt), with most of the decrease due to declines in U.S. commercial catches (27%; 20,400 mt to 14,900 mt). The ex-vessel value of the domestic landings declined by 38% ($17.9 million to $11.1 million).

Nominal commercial catches from the entire Scotian Shelf, Gulf of Maine, and Georges Bank region increased from 38,200 mt during 1972-76 to 68,500 mt in 1986. Nominal catches for Canada increased steadily from 24,700 mt in 1977 to an average of 43,900 mt during 1985-87. USA catches have increased from an average of 9,700 mt during 1973-77 to more than 14,000 mt annually since 1978, peaking at 24,500 mt in 1986.

Gulf of Maine, Georges Bank, Scotian Shelf Pollock

Long-term potential catch	=	54,000 mt
Importance of recreational fishery	=	Minor
Management	=	Multispecies FMP
Status of exploitation	=	Over exploited
Projected spawning stock biomass per recruit	=	Below maintenance level
Age at 50% maturity	=	3.7 years
Size at 50% maturity	=	50 cm (20 in.)
Assessment level	=	Age structured

$M = 0.20$ $F_{0.1} = 0.29$ $F_{max} = 0.57$ $F_{1988} = 0.66$

Pollock
Gulf of Maine, Georges Bank, and Scotian Shelf

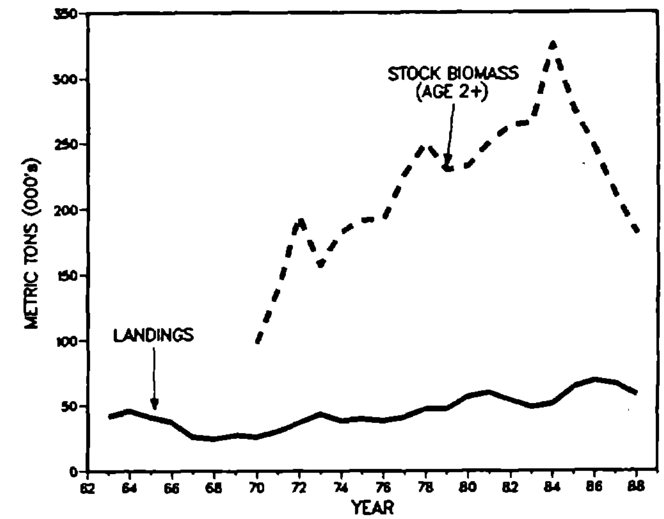


Table 6.1 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational	1.0	0.7	1.3	1.3	0.2	0.7	0.2	0.1	0.2
Commercial									
USA	18.3	18.2	14.4	14.0	17.8	19.5	24.5	20.4	14.9
Canada	36.0	40.3	38.0	32.7	33.2	43.3	43.0	45.3	41.7
Other	1.2	0.5	0.4	0.5	0.1	0.4	1.0	0.9	1.3
Total nominal catch	56.5	59.7	54.1	48.5	51.3	63.9	68.7	66.7	58.1

Nominal catches by distant water fleets have declined from an annual average of 4,200 mt during 1973-77 to less than 1,400 mt since 1981. Most of this catch has been taken by USSR vessels on the Scotian Shelf. Estimated USA recreational catches have fluctuated between 100 and 1,300 mt since 1979. No information is available for the Canadian recreational harvest, although it appears to be of minor importance. The total nominal catch, including recreational, declined for the second consecutive year to 58,100 mt in 1988. Although landings for Canada and the USA decreased in 1988, most of the decline since 1986 was due to sharp reductions in USA landings in 1987 and 1988.

Total stock size, after increasing throughout the late 1970s and early 1980s, has declined substantially since the mid-1980s. Canadian commercial abundance indices (mt/hour fished) were relatively high between 1978 and 1984 but declined sharply in 1985, 1987 and 1988. Indices for USA trawlers have also declined consistently since 1983. Abundance indices derived from NEFC spring bottom trawl surveys increased during the 1970s, but have also declined sharply since 1981. Virtual population analysis indicates a decrease in age 2+ stock biomass from 326,000 mt in 1984 to 181,200 mt in 1988. Recruitment conditions were favorable throughout the 1970s and early 1980s, with moderate to strong year classes appearing regularly every 3-4 years. The most recent strong year class was produced in 1982 and recruited to the fishery at age 2 in 1984. Year classes recruiting after 1984, however, have been below the long-term average.

"...declines have been caused by high fishing pressure coupled with below average recruitment..."

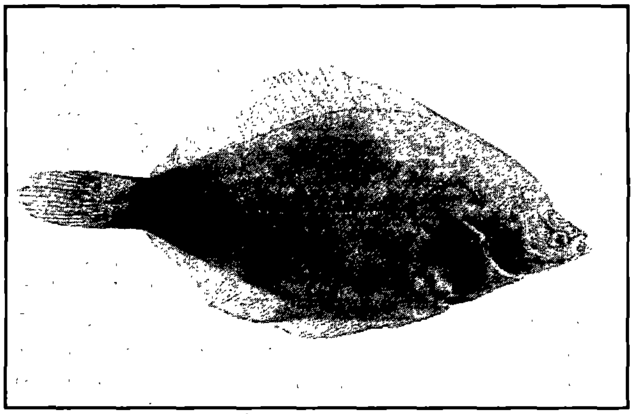
Under recruitment conditions observed during the 1970s and early 1980s, fishing at $F_{0.1}$ would provide a long-term catch of 53,600 mt from a stock biomass of 317,700 mt, while fishing at F_{max} would provide a catch of 58,100 mt from a stock biomass of 204,600 mt. Although potential yield is approximately 8% greater at the F_{max} level, fishing at $F_{0.1}$ provides for a 55% increase in total stock and a 74% increase in spawning stock biomass over those allowed under F_{max}, thereby providing for greater stability in reproductive potential and resilience to environmental perturbations. Continued fishing at F_{max} will likely result in a long-term decline in spawning stock, since this strategy does not account for fluctuating recruitment and environmental conditions. The decline in landings started in 1987, continued in 1988, and reflects a declining stock biomass. Even these catch levels, however, reflect increasing fishing mortality rates, because the stock biomass has been declining. These declines have been caused by high fishing pressure coupled with below average recruitment in recent years, resulting in the stock being over exploited. Further declines in stock size are likely in 1989.

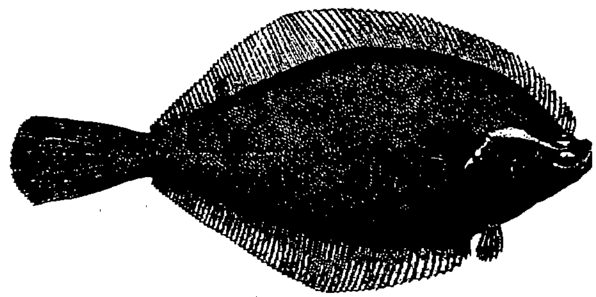
For further information

Annand, C., D. Beanlands, and J. McMillan. 1988. Assessment of Divisions 4VWX and Subarea 5 pollock, Pollachius virens. Dartmouth, Nova Scotia: Department of Fisheries and Oceans, Canadian Atlantic Fisheries Scientific Advisory Committee. Research Document 88/71. 65p. Available from: DFO, P.O. Box 1006, Dartmouth, N.S., Canada B2Y4A2.

Mayo, R. K., J.M. McGlade, and S. H. Clark. 1989. Patterns of exploitation and biological status of pollock *Pollachius virens* L. in the Scotian Shelf, Gulf of Maine, and Georges Bank area. *J. Northw. Atl. Fish. Sci.*, Vol. 9 (In Press).

7. 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, in the Mid-Atlantic, and off Southern New England, generally at depths of 37 to 73 m (20 to 40 fathoms). Also, yellowtail are landed by US fishermen on the Grand Banks of Newfoundland outside the Canadian 200-mile limit (*i.e.*, the "Tail of the Bank"). Yellowtail commonly attain lengths up to 47 cm (18.5 in.) and weights up to 1.0 kg (2.2 lbs); commercial catches tend to be dominated by smaller fish. Yellowtail appear to be relatively sedentary, although seasonal movements have been documented. Spawning occurs during spring and summer peaking in May; larvae drift for a month or more, then assume adult characteristics and become demersal.

Tagging studies and other information indicate that Southern New England, Georges Bank, and Cape Cod yellowtail flounder form relatively discrete groups, although some intermingling does occur. Two principal groups are those east of 69° west longitude, the Georges Bank group, and those west of 69° west longitude but south of Cape Cod, the southern New England group. A third historically less important group, occurs around Cape Cod itself. Yellowtail are also fished commercially in the Mid-Atlantic and in the northern Gulf of Maine.

The principal fishing gear used to catch yellowtail flounder is the otter trawl. Current levels of recreational and foreign fishing are insignificant.

> **"...excessively high fishing mortality has caused a long-term decline of the population, and virtual collapse of the fishery..."**

Fishing is managed under the NEFMC's Multispecies FMP. Total landings of yellowtail flounder decreased 29% in 1988 to 3,900 mt and the ex-vessel value of New England landings decreased 35% ($20.4 million to $13.0 million).

Georges Bank Yellowtail Flounder

Long-term potential catch	=	16,000 mt
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Over exploited
Projected spawning stock biomass per recruit	=	Below maintenance level
Age at 50% maturity	=	2 years
Size at 50% maturity	=	26 cm (10 in.)
Assessment level	=	Age structured

$M = 0.20$ $F_{0.1} = 0.21$ $F_{max} = 0.58$ $F_{1988} > F_{max}$

Georges Bank

USA landings of yellowtail from

Southern New England Yellowtail Flounder

Long-term potential catch	=	23,000 mt[1]
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Over exploited
Projected spawning stock biomass per recruit	=	Below maintenance level
Age at 50% maturity	=	2 years
Size at 50% maturity	=	26 cm (10 in.)
Assessment level	=	Age structured

M = 0.20 **$F_{0.1}$ = 0.21** **F_{max} = 0.54** **$F_{1988} > F_{max}$**

[1] Includes potential from Cape Cod and Mid-Atlantic groups

"Rebuilding this population will require several years of improved recruitment and dramatically reduced fishing mortality."

Georges Bank fluctuated between roughly 4,000 mt and 6,000 mt in the 1960s and early 1970s, beginning a decline in the mid-1970s to a low of roughly 4,500 mt in 1978. Landings subsequently increased to over 11,000 mt in 1983 before beginning a steady decline to the 1988 low of 1,900 mt.

Trawl survey indices of abundance for yellowtail flounder on Georges Bank generally declined from 1963 to 1979, reaching a record low that year. The index increased markedly in 1980, an event reflected by the increased landings in 1982 and 1983, before beginning a decline to new record low levels in each year since 1984. Commercial catch per unit of fishing effort patterns have been similar to the trawl survey indices, reaching record low levels in recent years.

Fishing mortality rates appear to have fluctuated between roughly 0.5 and 0.8 from 1969 to 1973. They then increased and fluctuated between 1.0 and 2.0 from 1974 through 1986.

Fishing mortality rates as high as yellowtail has experienced imply that roughly 63% of the population by weight has been removed annually for more than a decade. This excessively high fishing mortality has caused a long term decline of the population, and virtual collapse of the fishery. Catches approaching the long term potential catch (16,000 mt) will not be possible until some strong year classes occur that are not subject to such high fishing rates. The population has been reduced from having five or six age classes in significant abundance to having one or two age classes; rebuilding of the population age structure will require several years of improved recruitment and reduced fishing mortality. The population is severely over exploited, and at present, is far from meeting the management targets for maintenance spawning stock biomass.

Southern New England

USA landings of yellowtail flounder from Southern New England ranged from 10,000 - 20,000 mt during the 1960s. Landings had decreased to a record low of 1,600 mt by 1976. Landings subsequently increased to nearly 18,000 mt in 1983, before beginning a decline to new record low levels in recent years. Landings in 1988 have continued this decline, dropping 44% to a new record low of 900 mt.

Trawl survey indices of abundance fluctuated with little trend from 1963 to 1972, reaching a record high that year. In 1973, the indices decreased to a record low level, and continued at roughly that level until 1983. The 1983 index was moderately high, marking the beginning of a decline that has reached near zero levels. To illustrate, where the research survey trawl caught as high as 50 to 60 yellowtail flounder per tow in the 1960s, catches now average two or three fish per tow, with many tows catching none. Commercial catch per unit effort indices follow similar trends to the trawl survey indices, with high levels in the 1960s, low levels in the mid-1970s, an increase in the early 1980s, followed by recent historic low levels.

Fishing mortality rates appear to have fluctuated between 0.6 and 0.8 from 1970 to 1973, and then increased to and fluctuated about 1.0 from 1975 through 1982. Mortality rates were substantially higher from 1983 to 1986, reaching 1.5 and nearly 2.0 in some years.

Fishing mortality rates as high as seen in recent years suggest that as much as 80 - 90% of the population by weight may have been removed in some years, and as much as 60% in many years over the past decade or more. This excessively high fishing pressure has caused the long term decline in the abundance, despite the occurrence of several strong year classes. This fishing pressure has also reduced the population from having several age classes in significant abundance to one having only one or two year classes.

This population is severely over exploited and is far from achieving the management targets for maintenance spawning stock biomass. Rebuilding this population will require several years of improved recruitment and dramatically reduced fishing mortality.

Yellowtail Flounder

Georges Bank--East of 69°W longitude

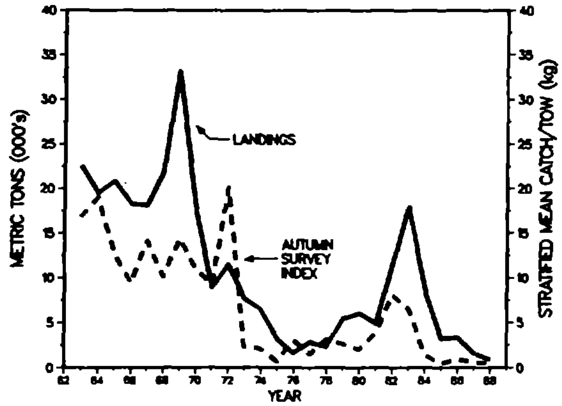


Table 7.1 Commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	6.4	6.4	10.7	11.4	5.8	2.5	3.0	2.7	1.9
Canada	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	6.6	6.4	10.7	11.4	5.8	2.5	3.0	2.7	1.9

Southern New England

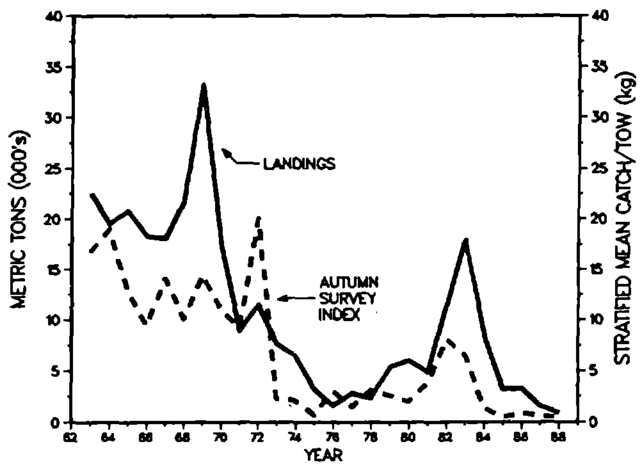


Table 7.2 Commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
So. New England	6.0	4.9	11.5	17.9	8.5	3.2	3.3	1.6	0.9
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	6.0	4.9	11.5	17.9	8.5	3.2	3.3	1.6	0.9

"...landings...reaching record low levels during the mid-1980s."

Cape Cod

USA landings of yellowtail flounder from the Cape Cod stock generally fluctuated between 1,500 mt and 2,000 mt in the 1960s, increased during the late 1970s to approximately 5,000 mt in 1980, and then began to decline reaching record low levels during the mid 1980s. Landings in 1987 increased slightly (1,200 mt), only to decrease slightly in 1988 (1,100 mt).

Trawl survey indices have been highly variable, but have reflected the general pattern of landings, especially at the higher levels and recently at the very low levels.

Recent declines in landings and the corresponding general downward trends in the survey indices suggest that stock biomass has been reduced by the high catches of the late 1970s and early 1980s. The stock is over exploited.

For further information

Clark, S. H., M. M. McBride, and B. Wells. 1984. Yellowtail flounder assessment update - 1984. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 84-39. 30 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

Northeast Fisheries Center. 1986. Report of the Seventh Stock Assessment Workshop. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 89-04. 108 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

Cape Cod Yellowtail Flounder

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Over exploited
Projected spawning stock biomass per recruit	=	Unknown
Age at 50% maturity	=	2 years
Size at 50% maturity	=	26 cm (10 in.)
Assessment level	=	Yield per recruit

M = 0.20 **$F_{0.1}$ = 0.21** **F_{max} = 0.55** **F_{1988} = Unknown**

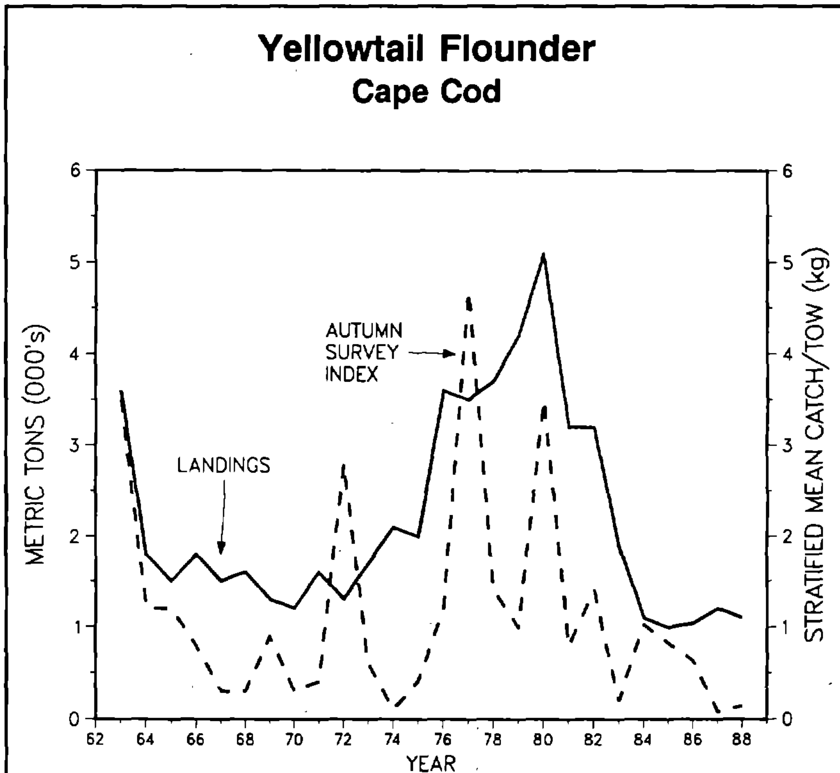
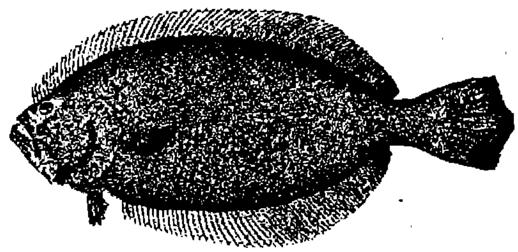


Table 7.3 Commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
Cape Cod	5.1	3.2	3.2	1.9	1.1	1.0	1.0	1.2	1.1
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	5.1	3.2	3.2	1.9	1.1	1.0	1.0	1.2	1.1

8. 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 lbs). Female summer flounder may live up to 20 years, but males rarely exceed 7 years. No separate stocks have been identified in this region.

The principal gear used in commercial fishing for summer flounder is the otter trawl. Nominal total catches increased 38% in 1988 (15,800 mt to 21,800 mt), while nominal commercial landings increased 41% (9,500 mt to 13,400 mt). Recreational catches constitute roughly 40% of the total catch. The fishery is managed under the Summer Flounder FMP.

Nominal commercial catches of summer flounder averaged 8,300 mt during 1950-60 and declined sharply to 1,700 mt in 1969. Yield began to recover in the early 1970s, reached a high of 14,500 mt in 1979, and averaged 11,000 mt from 1980-87. The USA nominal catch in 1988 was 13,400 mt, a 41% increase relative to the 1987 level of 9,500 mt, and the highest catch since 1984. The recreational fishery for summer flounder harvests a significant proportion of the total nominal catch of this species, and in some

Georges Bank-Mid-Atlantic Summer Flounder

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Major
Management	=	Summer Flounder FMP
Status of exploitation	=	Over exploited
Age at 50% maturity	=	2 years (females)
Size at 50% maturity	=	32 cm (12.6 in.)
Assessment level	=	Yield per recruit

$M = 0.20$ $F_{0.1} = 0.16$ (females) $F_{max} = 0.26$ (females) $F_{1988} > F_{max}$

years, recreational harvest may exceed the commercial landings. The estimated recreational harvest of summer flounder ranged from 5,000 to 15,900 mt (8.6 to 25.4 million fish) between 1979 and 1988. The recreational catch increased in 1988, and was the highest since 1984. In addition to the summer flounder harvested by recreational fishermen, 2.5 to 16.7 million fish were caught and released alive between 1979 and 1988. Since the inception of the MFCMA, nominal catches by foreign vessels have been very low.

Stock biomass is currently at a higher average level than during the late 1960s and early 1970s, based on

"An increase in...landings of 41% in 1988 likely reflects increases in fishing activity rather than increased stock size."

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. Since the late 1970s, the survey index has fluctuated widely, from a low of 0.22 kg/tow in 1979 to a high of 0.82 kg/tow in 1985. The 1988 index value was 0.44 kg/tow.

Catch curve analysis of survey and commercial age composition data collected from 1976 through 1983 indicated fishing mortality rates of about 0.8 to 0.9, well in excess of F_{max}. Although mortality estimates are not available for the last several year classes, they have probably remained high.

An increase in combined commercial and recreational landings of 41% in 1988 likely reflects increases in fishing activity rather than increased stock size. Current fishing mortality rates greatly exceed those resulting in maximum yield per recruit, and are likely reducing stock size and hence long term yield. Preliminary analysis suggests that the stock is over exploited; the level of the assessment is being increased to age structured in order to check this.

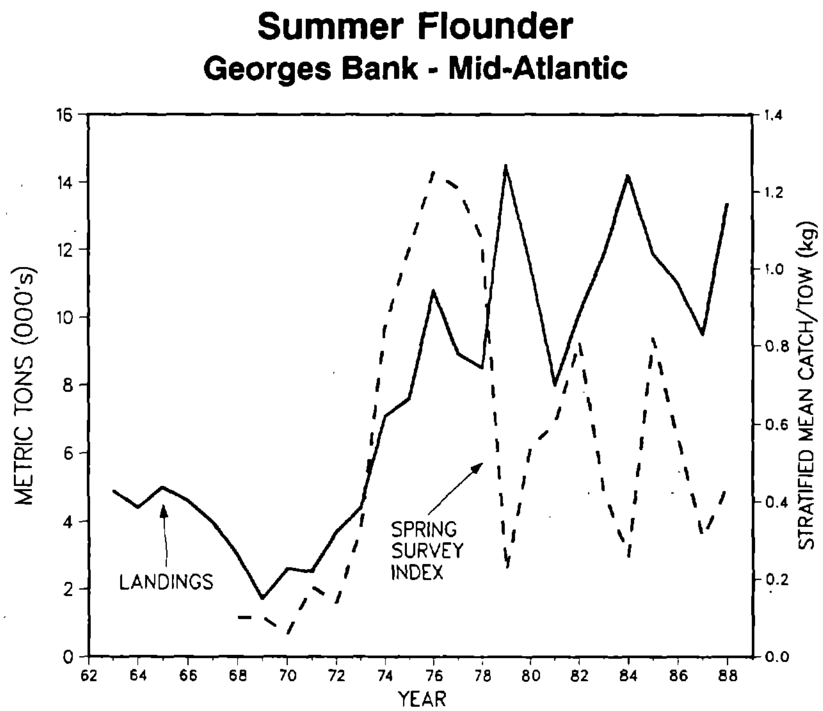


Table 8.1 Recreational catches and commercial landings (1,000 mt)

Category	Year 1980	1981	1982	1983	1984	1985	1986	1987	1988
USA recreational	12.2	5.0	8.0	15.9	12.5	7.1	7.8	6.3	8.4[1]
Commercial									
USA	11.5	8.0	10.1	11.8	14.2	11.9	11.1	9.5	13.4
Canada	-	-	-	-	-	-	-	-	-
Other	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-
Total nominal catch	23.7	13.0	18.1	27.7	26.7	19.0	18.9	15.8	21.8

[1] **Preliminary NMFS data.**

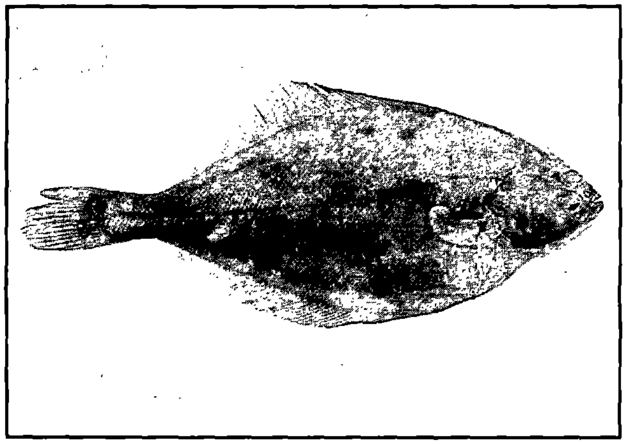
For further information

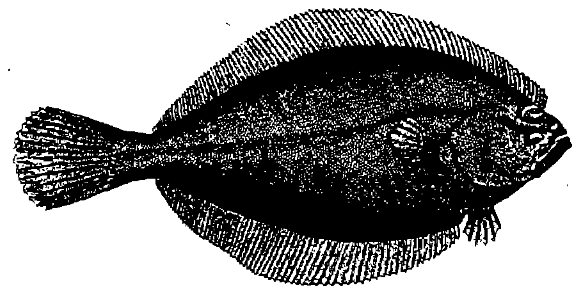
Northeast Fisheries Center. 1986. Report of the Third NEFC Stock Assessment Workshop. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 86-14. 98 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

Fogarty, M. J. 1981. Review and assessment of the summer flounder *Paralichthys dentatus* in the Northwest Atlantic. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 80-22. 57 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

Lange, A. M. T. 1984. Long-term effects of change in mesh size on yield of summer flounder. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 84-04. 14 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

9. 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 and 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 to 11 in.) in length and weigh between 90 and 190 g (0.2 and 0.4 lbs). After age 4, females grow faster than males.

The principal commercial fishing gear used to catch American plaice is the otter trawl. Recreational catches and foreign catches are insignificant., Fishing is managed under the New England Fisheries Management Council's Multispecies FMP. Total catches declined 13% in 1988 (from 3,800 mt to 3,400 mt).

Landings of American plaice increased steadily from a low in the mid-1970s until 1982, from roughly 3,000 mt to more than 15,000 mt. Subsequently, landings have declined steadily to levels approaching those of the mid-1970s.

USA commercial CPUE indices were relatively stable between 1964 and 1969, declined in the early 1970s, 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 declined steadily. The 1988 indices in both areas declined from 1987 levels and are among the lowest observed. Effort in 1988, however, was near record high.

Between 1960 and 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 1987 Gulf of Maine catch (2,200 mt) was nearly twice as large as that from Georges Bank (1,100 mt). In both areas, however, shifts in landings by vessel class have occurred. In 1988, for the fifth year in succession in the Gulf of Maine, plaice landings by small vessels (Class

Gulf of Maine- Georges Bank American Plaice

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Over exploited
Projected spawning stock per recruit	=	Unknown
Age at 50% maturity	=	3.2 yrs (males) 3.8 yrs (females)
Size at 50% maturity	=	25.6 cm (10.1 in.) males 29.7 cm (11.7 in.) females
Assessment level	=	Yield per recruit

M = 0.20 $F_{0.1}$ = 0.17 F_{max} = 0.34 F_{1988} = Unknown

2), accounted for less than half of the Gulf of Maine catch. Medium size (Class 3) and large, (Class 4) vessels accounted for 42% and 15% respectively of the 1988 total Gulf of Maine landings. On Georges Bank, Class 3 vessels accounted for 66% of the 1988 catch and Class 4 vessels for 32%.

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 1988, directed trips accounted for only 11% of the Gulf of Maine catch and 14% of the Georges Bank catch. Landings trends have generally paralleled trends in NEFC autumn indices.

The 1988 autumn off-shore survey weight per tow index increased from the record low value of 1.1 observed in 1987 to 1.5. This increase

"...abundance and landings are expected to remain low."

was due to an increase in the number of small plaice caught in the survey. Thus, 91% (by number) of the survey catch in 1988 was composed of individuals below the legal minimum size of 14 inches compared to 78% in 1987. These small fish tend to be concentrated in the Gulf of Maine in near-shore waters. The large number of small plaice in the 13 to 25 cm size range suggests 1986 and 1987 year classes have been relatively strong compared to recent years, although they are smaller than those observed during the late 1970s. The NEFC inshore and the Massachusetts State bottom trawl surveys also suggest relatively strong 1986 and 1987 year classes.

The continuing decline in landings that started in 1983 reflects a declining biomass, as indicated in both catch per unit effort indices (near record low) and survey indices. The apparently strong 1986 and 1987 year classes offer the opportunity to reverse the biomass trend if fishing mortality and discarding are reduced. However, fishing effort has been increasing in recent years, especially in the small mesh fisheries in the Gulf of Maine, and both fishing and discard mortality are likely to remain high. Given these conditions, abundance and landings are expected to remain low. The population is over exploited.

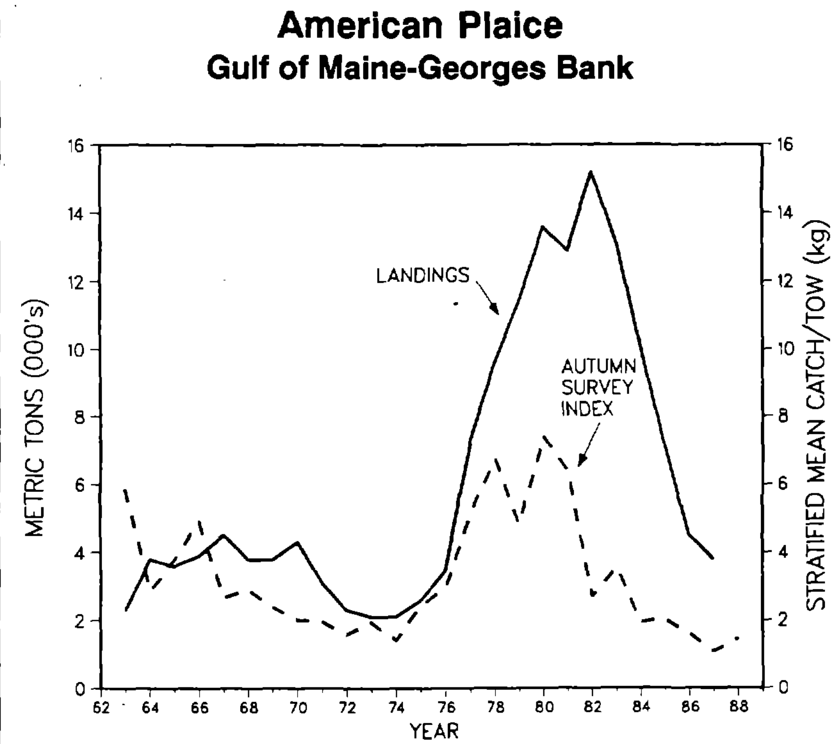


Table 9.1 Recreational catches and commercial landings (1,000 mt)

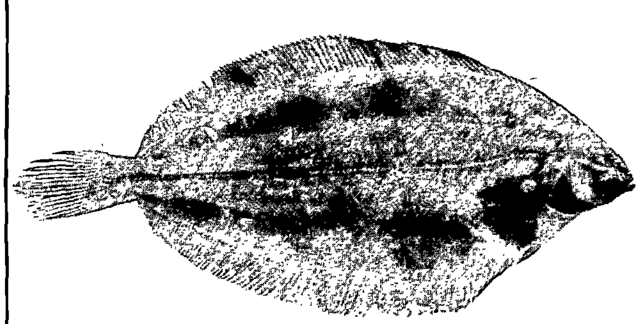
Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-
Commercial									
USA	13.5	12.9	15.1	13.2	10.1	7.0	4.5	3.8	3.3
Canada	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Other	-	<0.1	-	-	-	-	-	-	-
Total nominal catch	13.6	12.9	15.2	13.2	10.1	7.0	4.5	3.8	3.4

For further information

Northeast Fisheries Center. 1987. Report of the Third Stock Assessment Workshop. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 86-14. 98 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

Sullivan, L.F. 1982. American plaice, *Hippoglossoides platessoides*, in the Gulf of Maine. Kingston, RI: University of Rhode Island. 96 p. Masters thesis.

10. 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, preferring moderately deep areas; few fish are taken shallower than 27 m (15 fathoms) and most are caught between 110 and 275 mt (60 and 150 fathoms). Spawning occurs in late spring and summer. Witch flounder attain lengths up to 60 cm (24 in.) and weights of approximately 2 kg (4.5 lbs).

The principal fishing gear used to catch witch flounder is the otter trawl. Recreational catches and foreign catches are insignificant. Fishing is managed under the New England Fisheries Management Council's Multispecies FMP. Total landings decreased slightly in 1988 (from 3,400 mt to 3,200 mt).

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. Canadian nominal catches from both areas have been minor (less than 50 mt annually since 1970). Distant water fleet catches on Georges Bank averaged 2,600 mt in 1971-72, but subsequently declined sharply and have been negligible since 1977. The total Georges Bank - Gulf of Maine nominal catch increased from 1,000 mt in 1961 to an annual average of 5,700 mt in 1971-1972 and subsequently declined to 1,800 mt in 1976. Nominal catches, subsequently, increased steadily from 1976 to 6,500 mt in 1984 and then began to decline to the present level some 50% lower than the maximum.

NEFC autumn survey catches seem to accurately reflect trends in biomass. Heavy exploitation by distant water

" The decline in landings since 1984 reflects a declining biomass."

Gulf of Maine - Georges Bank Witch Flounder

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Over exploited
Projected spawning stock biomass	=	Unknown
Age at 50% maturity	=	4 years (males) 5 years (females)
Size at 50% maturity	=	29 cm (11.4 in.) males; 32 cm (12.6 in.) females
Assessment level	=	Index

$M = 0.15$ $F_{0.1}$ = Unknown F_{max} = Unknown F_{1988} = Unknown

fleets in 1971-72 was followed by a decline in the autumn index from an average of 3.6 kg/tow in 1966-70 to 1.0 kg/tow in 1976. Abundance increased sharply in 1977-78; subsequent indices have been lower, with the 1988 value 1.7 kg/tow below the long-term average.

The decline in landings since 1984 reflects a declining biomass, as indicated in the survey indices and in some preliminary catch per unit effort indices. These declines suggest that this resource is being adversely affected by current levels of exploitation. It appears that harvests of 4,000 mt or more cannot be sustained over the long term, given recent and historical trends. The population is over exploited.

For further information

Burnett, J., and S. H. Clark. 1983. Status of witch flounder in the Gulf of Maine - 1983. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 83-36. 31 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

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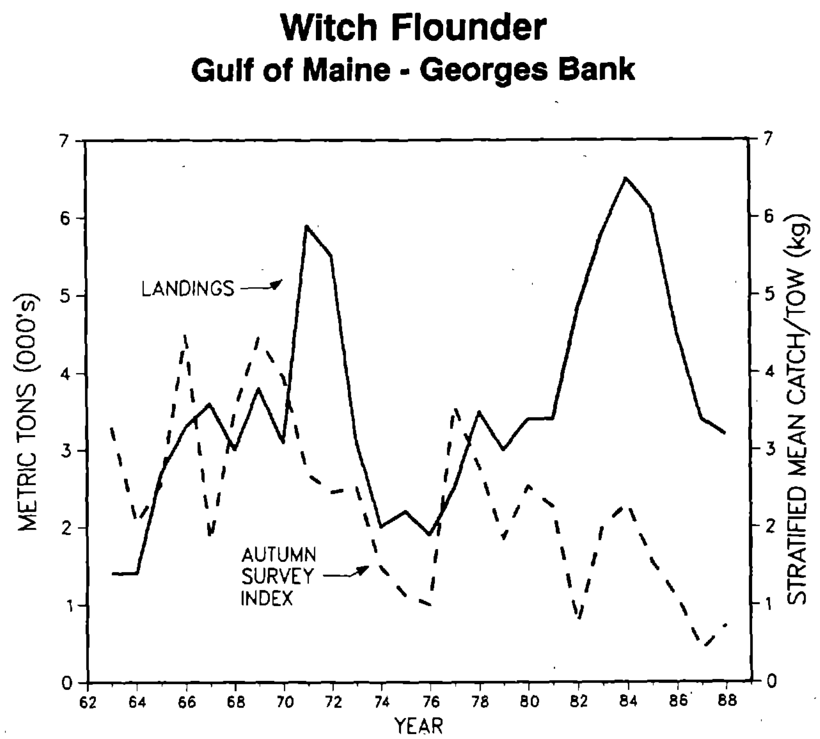
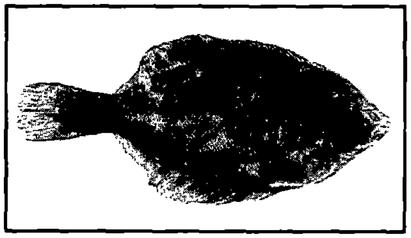
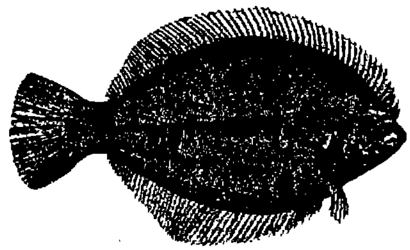


Table 10.1 Commercial landings (1,000 mt)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	3.4	3.4	4.8	5.8	6.5	6.0	4.5	3.4	3.2
Canada	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	3.4	3.4	4.8	5.8	6.5	6.1	4.5	3.4	3.2

11. 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 in.) total length. The diet consists primarily of benthic invertebrates. Movement patterns are generally localized. Small-scale seasonal migrations occur during winter to estuaries, embayments, and saltwater ponds to spawn, and 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 growth, meristic, and morphometric characteristics suggest that relatively discrete local groups exist.

Tagging and meristic studies indicate discrete groups of winter flounder north of Cape Cod, east and south of Cape Cod, and on Georges Bank. For descriptive purposes, groups will be described separately for the Gulf of Maine, Southern New England - Middle Atlantic, and Georges Bank; additional studies of stock structure are needed. Winter flounder are typically exploited in coastal locations, although offshore shoal areas, particularly Georges Bank and Nantucket Shoals, support important winter flounder fisheries.

The principal commercial fishing gear used to catch winter flounder is the otter trawl. Recreational catches are significant in the southern parts of the range. The fishery is managed under the New England Fisheries Management Council's Multispecies FMP. Total reported landings in 1988 declined slightly (14,900 mt to 13,300 mt). The

Georges Bank
Winter Flounder

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Fully exploited
Projected spawning stock biomass per recruit	=	Unknown
Age at 50% maturity	=	2 years
Size at 50% maturity	=	25 cm (9.8 in.) males 26 cm (10.2 in.) females
Assessment level	=	Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1988} = Unknown

"...the steady decline in the survey indices over the past decade and the low CPUE indices suggest that this stock may be approaching over exploitation. However, the level of assessment is too low to allow a definitive statement."

ex-vessel value of the commercial landings in New England ports decreased 8% (from 8,100 mt worth $21.6 million to 7,400 mt worth $19.9 million).

GEORGES BANK

Commercial landings from the Georges Bank region increased from roughly 2,000 mt in the mid 1970s to record high levels of roughly 4,000 mt over the period 1977 to 1984. There are no recreational catches in this area. Subsequently, landings decreased in 1985 and 1986 to roughly 2,000 mt.

Landings in 1988 increased to 2,800 mt, 8% more than 1987 landings. However, 1987 landings were still 32% below the catches taken during the early 1980s. CPUE indices in 1988 were among the lowest that have been observed. The NEFC autumn survey index fluctuates widely but has had a downward trend since 1976. The 1988 index of 1.3 kg/tow represents a slight increase over 1987, but is still among the lowest values observed in the 26 year time series.

Although the increase in landings in 1987 and 1988 is encouraging, the steady decline in the survey indices over the past decade and the low CPUE indices suggest that this stock may be approaching over exploitation. However, the level of the assessment is too low to allow a definitive statement.

SOUTHERN NEW ENGLAND AND MID-ATLANTIC

Southern New England - Mid-Atlantic Winter Flounder

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Significant
Management	=	Multispecies FMP
Status of exploitation	=	Fully exploited
Age at 50% maturity	=	2 years
Size at 50% maturity	=	25 cm (9.8 in.) males; 26 cm (10.2 in.) females
Assessment level	=	Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1988} = Unknown

Commercial landings from the southern New England - Mid-Atlantic area increased from roughly 4,000 mt in the mid-1970s to nearly 12,000 mt in 1981. Recreational catches are not known for that period. Commercial catches declined from their early 1980s level, while recreational catches increased from 1980 to 1985. More recently, recreational catches have also declined. The combined recreational and commercial landings declined by 11% in 1988 to about 8,200 mt. Most of this decline was due decreases in commercial landings (5,200 mt to 4,300 mt).

NEFC spring survey indices have shown similar trends as commercial catches since about 1975, increasing through 1981 (1.0 kg/tow) and generally declining, with the exception of 1985, until 1987. In 1988, the index increased to 0.6 kg/tow, a value double that of 1987 but still low in comparison to earlier years in the time series.

The continued decline in landings since 1981 and in the survey indices in the most recent years, suggests that landings will not increase in the near future. There are uncertainties, however, in the stock structure in this region with suggestions of many localized groups. Thus, local fluctuations in catches might be expected since fishing pressure is not applied uniformly throughout the region. The status of the stocks can not be determined with certainty without increasing the level of the assessment.

GULF OF MAINE

Commercial landings from the Gulf of Maine increased from a steady 1,000 mt for the period 1961 to 1977 to nearly 3,000 mt in 1982. Recreational landing estimates, which became available starting in 1980, also increased from 1980 through 1982, giving a total catch of 7,100 mt in that year. Total landings dropped precipitously in 1983 to 3,400 mt primarily due to much lower recreational landing estimates, and have continued at lower levels, fluctuating with changes in the recreational landings. Combined landings in 1988 were only 2,300 mt.

Bottom trawl survey abundance indices from the Massachusetts Division of Marine Fisheries spring survey for the Massachusetts Bay sampling area (where the majority of the Gulf of Maine nominal catch is taken) decreased sharply from 1981 to 1983, remained relatively constant during 1984-1986, averaging 12.3 kg/tow, but increased to 20.7 kg/tow in 1987. In 1988, the index dropped again to 10.6 kg/tow, indicating that the sharp increase in 1987 may have been anomalous.

" ...local fluctuations in catches might be expected since fishing pressure is not applied uniformly throughout the region."

The continuing low level of landings and the lower trawl survey index in 1988 suggest that winter flounder abundance in the Gulf of Maine has been reduced substantially by recent exploitation. Because recreational catches are equal to or greater than commercial landings, future improvements in the condition of the stock will depend on decreases in exploitation in both sectors, and on improved recruitment. The stock at present appears to be over exploited, although the status can not be determined with certainty without increasing the level of the assessment.

For further information

Almeida, F.P. 1989. In press. Allocation of recreational catch statistics using MRFSS intercept data - and application to winter flounder. Washington, DC: U.S. Dept. of Commerce, NOAA, NMFS, NEFC. NOAA Technical Memorandum NMFS-F/NEC-71. Available from: Northeast Fisheries Center, Woods Hole, MA.

Foster, K. L. 1987. Status of winter flounder *Pseudopleuronectes americanus* stocks in the Gulf of Maine, Southern New England and Middle Atlantic areas. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 87-06. 70p. Available from: Northeast Fisheries Center, Woods Hole, MA.

Winter Flounder
Georges Bank

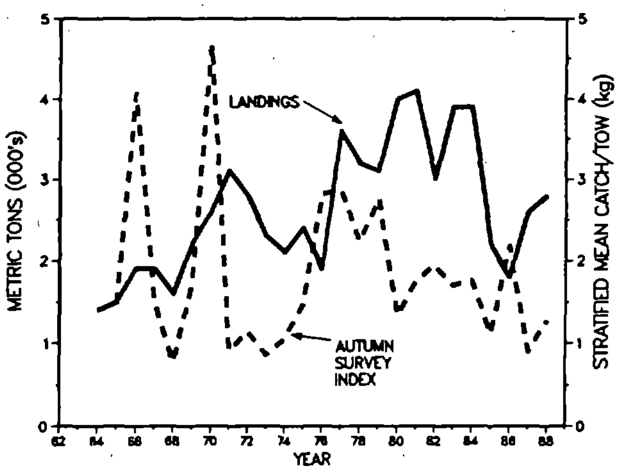


Table 11.1 Commercial landings (1,000 mt)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	4.0	4.1	3.0	3.9	3.9	2.2	1.8	2.6	2.8
Canada	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	4.0	4.1	3.0	3.9	3.9	2.2	1.8	2.6	2.8

Southern New England - Mid-Atlantic

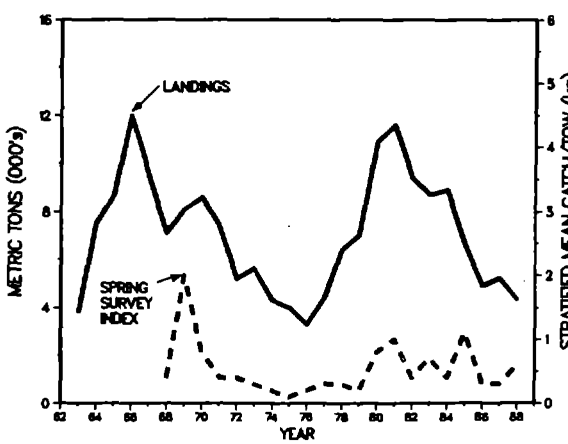


Table 11.2 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988
USA recreational	2.7	3.3	3.2	5.0	6.4	7.9	3.3	4.0	3.9
Commercial									
USA	10.9	11.6	9.4	8.7	8.9	6.6	4.9	5.2	4.3
Canada	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other	-	-	-	-	-	-	-	-	-
Total nominal	13.6	14.9	12.6	13.7	15.3	14.5	8.2	9.2	8.2

"... winter flounder abundance in the Gulf of Maine has been reduced substantially by recent exploitation."

Gulf of Maine Winter Flounder

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Major
Management	=	Multispecies FMP
Status of exploitation	=	Over exploited
Projected spawining stock biomass per recruit	=	Unknown
Age at 50% maturity	=	2 years
Size at 50% maturity	=	25 cm (9.8 in.) males 26 cm (10.2 in.) females
Assessment level	=	Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1988} = Unknown

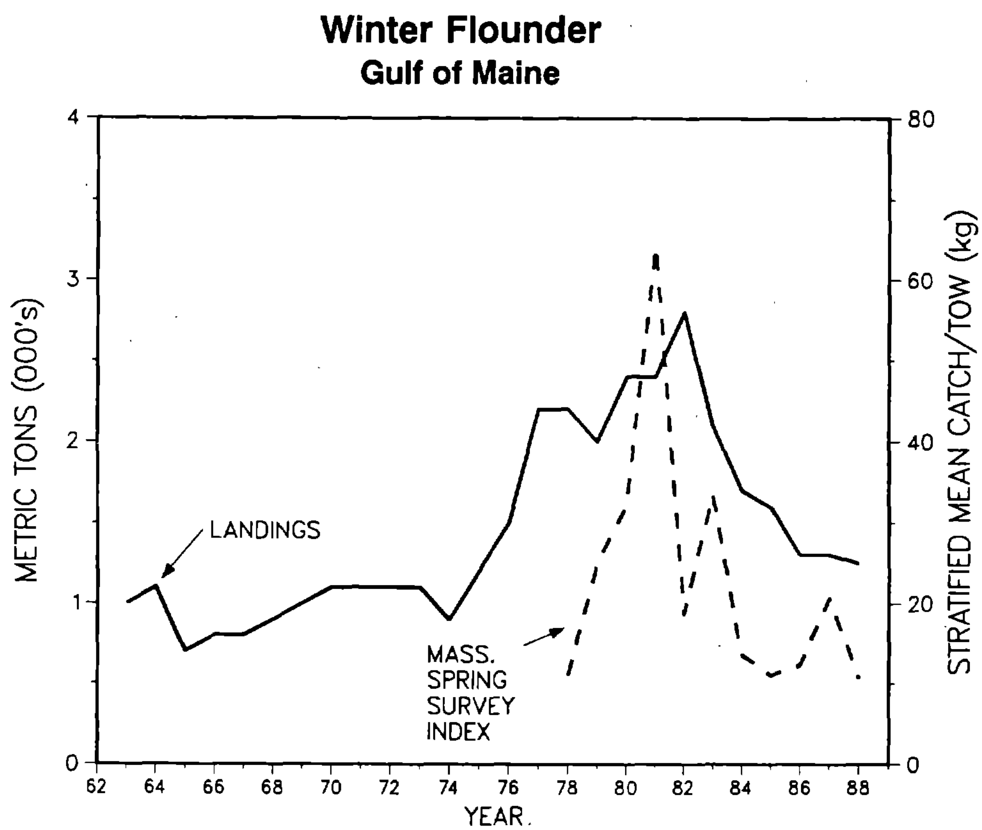
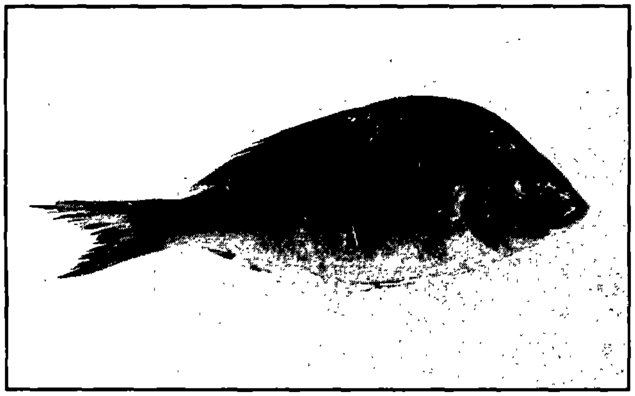
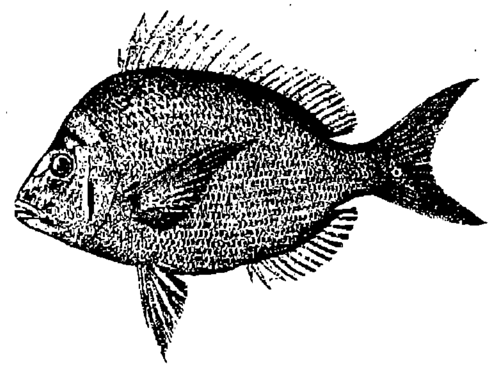


Table 11.3 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational	3.5	3.7	4.3	1.3	1.2	2.0	0.3	1.9	1.0
Commercial									
USA	2.4	2.4	2.8	2.1	1.7	1.6	1.3	1.2	1.3
Canada	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	5.9	6.1	7.1	3.4	2.9	3.6	1.6	3.1	2.3

12. SCUP





Scup or porgy, *Stenotomus chrysops*, occurs primarily in the Mid-Atlantic Bight from Cape Cod to Cape Hatteras. Seasonal migrations occur during spring and autumn. In summer, scup are common in inshore waters from Massachusetts to Virginia, while in winter scup are found in offshore waters between Hudson Canyon and Cape Hatteras at depths ranging from 70 to 180 m. Sexual maturity is essentially complete by age 2 at a total length of 21 cm (9 in.); spawning occurs during summer months. Although ages up to 20 years have been reported, recent catches have been dominated by age 2 to 3 fish. Scup attain a maximum length of about 40 cm (16 in.). Tagging studies have indicated the possibility of a Southern New England stock and another stock extending south from New Jersey. However, because there is considerable uncertainty about exactly where the separation may occur, this separation is not used here.

The principal commercial fishing gear is the otter trawl. Recreational catches are significant. The fishery is not subject to management except locally within individual state's waters. Total reported landings decreased 13% in 1988 (from 9,300 mt to 8,100 mt), mostly due to lower estimated recreational landings.

Nominal commercial catches by USA vessels fluctuated between 18,000 and 22,000 mt annually between 1953 and 1963, but declined to between 4,000 and 5,000 mt during the early 1970s. 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 1970s, the USA nominal commercial catch steadily increased and reached a peak of 9,800 mt in 1981. Landings continue to decrease considerably. The 1988 catch decreased to 5,800 mt, 25% below the average for the past eight years, making it the 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 produced nominal catches in excess of 5,000 mt in the early 1960s, has averaged less than 350 mt in the past 10 years. The proportion taken by the Virginia fishery has declined from 40 to 60% of the total prior to 1967, to 2 to 16% since 1973.

Estimated recreational catches represent 20 to 50% of total nominal catches from 1979 to 1987 except in 1986, when it represented 86%. The 1988 preliminary recreational catch estimate is 28% below the 1987 level, continuing a decline which began last year.

Catch per unit effort of Southern New England otter trawlers increased from 2.2 mt/day fished in 1971 to 6.2

Southern New England - Mid-Atlantic Scup

Long-term potential catch	=	10,000 to 15,000 mt
Importance of recreational fishery	=	Major
Management	=	Some state regulations
Status of exploitation	=	Over exploited
Age at 50% maturity	=	2 years
Size at 50% maturity	=	21 cm (9 in.)
Assessment level	=	Yield per recruit

$M = 0.20$ $F_{0.1} = 0.20$ $F_{max} = 0.35$ $F_{1988} > F_{max}$

"...truncated age distributions suggest that exploitation has reduced the population level, and is increasingly focusing on young fish,"

mt/day in 1977 and 1979. Recent values have decreased markedly from 5.9 mt/day fished in 1984 to 3.8 mt/day fished in 1988. The NEFC autumn offshore survey index (age 1 and older) is quite variable. The index increased sharply from 1979 to the second highest value in the time series in 1981. Since 1981, the index has fluctuated greatly. Recently the 1986-88 indices were below the long term mean, with the current indices being nearly as low as the series minimum back in 1970.

In recent years, stock abundance appeared to be considerably lower in the Mid-Atlantic (MA) area than in the Southern New England (SNE) area. In 1988, although the young-of-the-year (YOY) index increased 85% over 1987 in SNE and decreased 61% from the 1987 anomaly in MA, indices for all fish were approximately equal in both areas. Commercial length frequency samples also indicate an increase in the number of YOY scup in 1988. Previously, YOY scup were abundant in the 1985 and 1986 autumn inshore NEFC indices and commercial length frequencies.

A comparison of scup length frequencies from the commercial and recreational fisheries during 1983-88 reveal that commercial length frequency distributions have shifted to smaller fish (including YOY) while recreational length frequency distributions have remained relatively stable. Mean lengths for both commercial fishery and NEFC autumn offshore survey exhibit decreases since 1983, in fact, NEFC mean lengths have decreased 44% from 1983 to 1988. There is a general lack of larger, older scup (>35cm, >7 yrs.) in both commercial and recreational fisheries. Instantaneous fishing mortality in the Southern New England area was estimated to be about 0.3 in 1981 but has probably exceeded F_{max} in recent years.

The steady decrease in landings, the decreased CPUE levels, and the near record low survey indices suggest that recent exploitation has reduced stock abundance substantially. The truncated age distributions suggest that exploitation has reduced the population level, and is increasingly focusing on young fish. These considerations suggest that the population is over exploited.

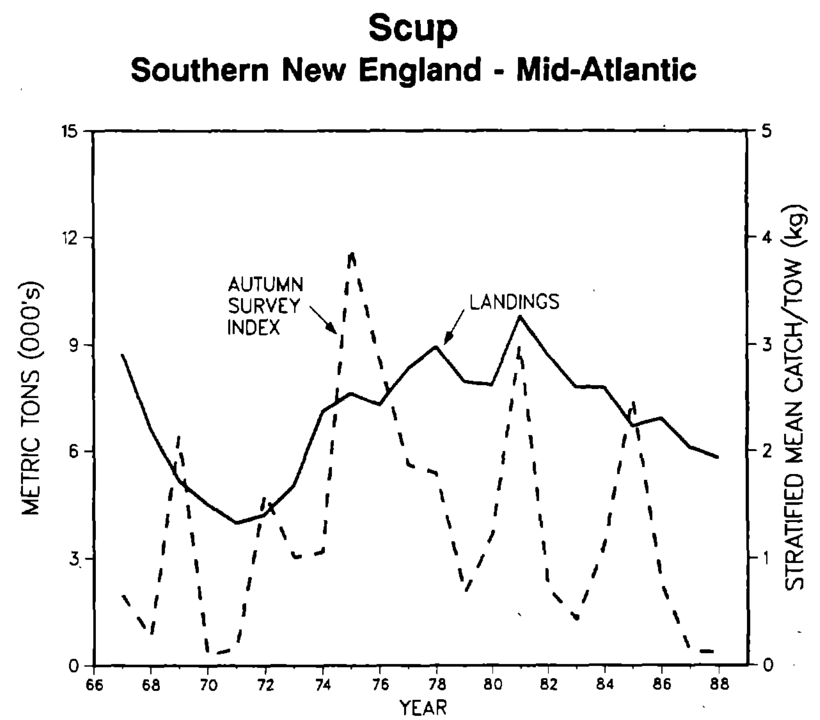


Table 12.1 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988
USA recreational	3.9	2.0	3.1	3.4	1.4	3.3	5.9	3.2	2.3[1]
Commercial									
USA	7.9	9.8	8.7	7.8	7.8	6.7	6.9	6.1	5.8
Canada	-	-	-	-	-	-	-	-	-
Other	<0.1	<0.1	-	-	<0.1	<0.1	<0.1	-	-
Total nominal catch	11.8	11.8	11.8	11.2	9.2	10.0	12.8	9.3	8.1[1]

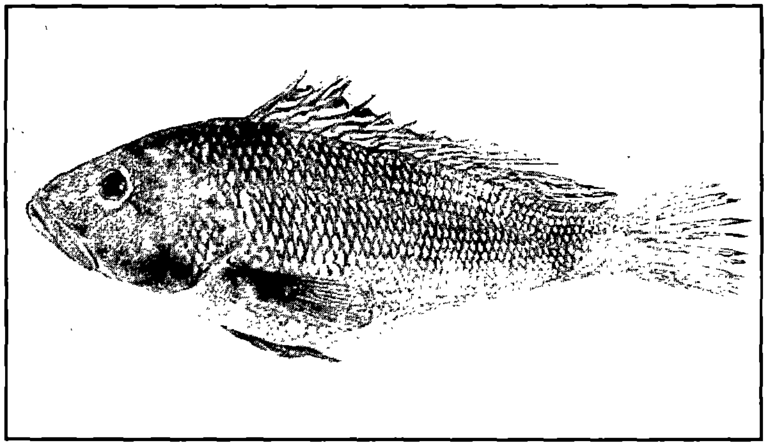
[1] Preliminary

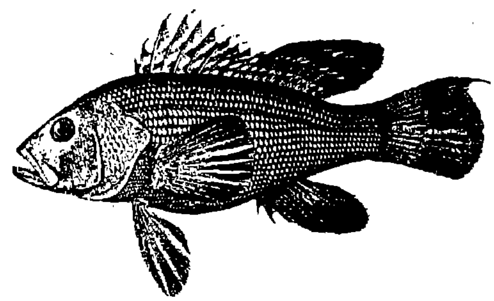
For further information

Mayo, R. K., 1982. An assessment of the scup, *Stenotomus chrysops* L., population in the Southern New England and Mid-Atlantic regions. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 82-46, 59 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

Northeast Fisheries Center. 1989. Report of the Seventh Stock Assessment Workshop. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 89-04. 108 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

13. BLACK SEA BASS





Black sea bass, *Centropristis striata*, occur off the northeast United States along the entire Atlantic coast of the United States, with the greatest concentrations found within the middle Atlantic Bight. Black sea bass overwinter along the 100 m depth contour 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 March off North Carolina 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 at a smaller size (age 2, 18.3 cm or 7.2 in., standard length) than males (age 2, 21.1 cm or 8.3 in.). Females are rarely found older than 8 years (>35 cm or 13.8 in.), while males may live up to 15 years (>60 cm or 23.6 in.). Black sea bass are omnivores, feeding on crustaceans, molluscs, echinoderms, fish, and plants.

The commercial fisheries principall use traps and otter trawls to catch black sea bass. Recreational fishing is as significant as commercial fishing. There is no management outside state waters. Total catches increased 18% in 1988 (2,800 mt to 3,300 mt).

Reported commercial landings north of Cape Hatteras fluctuated around 2,600 mt from 1887 to 1948, when it increased to 6,900 mt. Catches peaked at 9,900 mt in 1952, declined steadily to 600 mt in 1971, and then increased to 2,400 mt in 1977. Nominal catches averaged 1,400 mt from 1980 to 1987 and were 1,700 mt in 1988. The only reported catch by distant water fleets was 1,500 mt in 1964. The estimated recreational catch has ranged from 500 mt to 8,100 mt in the 1980s, with no apparent trend. 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 1988 recreational catches from the middle Atlantic and New England regions was 1600 mt, but has ranged between 300 and 8,100 mt since 1980. The high values for 1982 and 1986, 8,100 mt and 6,300 mt respectively, are consistent with stock abundance indices, for black sea bass under 20 cm.

Gulf of Maine - Mid-Atlantic Black Sea Bass

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Major
Management	=	Some state regulations
Status of exploitation	=	Fully exploited
Age at 50% maturity	=	2 years
Size at 50% maturity	=	19.7 cm (7.8 in.)
Assessment level	=	Yield per recruit

$M = 0.3$ $F_{0.1} = 0.2$ $F_{max} = 0.3$ F_{1988} = Unknown

"...the fishery tends to reduce incoming year classes rapidly."

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 (0.1 fish/tow) to 1977 (8.2 fish/tow) followed by a decline to 0.3 fish/tow in 1985. Indices increased to 2.4 fish/tow in 1986, but has dropped to 1.0 fish/tow in 1988. Pre-recruit indices (fish <20 cm) from the autumn inshore bottom trawl survey indicate above average year classes occurred in 1976, 1981, and 1985.

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. Total landings have fluctuated without trend in the 1980s, punctuated by years with much higher recreational catches. The correspondence of these high catches with high pre-recruit indices the year previously, suggests that the fishery tends to reduce incoming year classes rapidly. The assessment information is insufficient to allow a definitive understanding of the status of this species, but it would appear to be fully exploited.

Black Sea Bass
Gulf of Maine- Mid-Atlantic

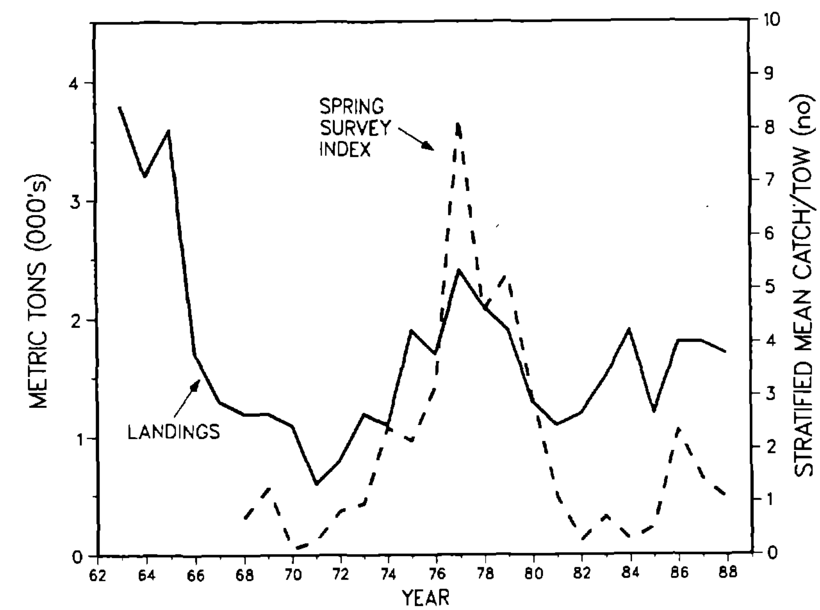


Table 13.1 Recreational catches and commercial landings (1,000 mt)

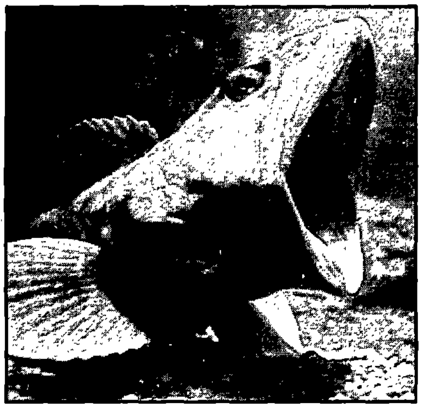
Category	1980	1981	1982	1983	1984	1985	1986	1987	1988
USA recreational	0.7	0.5	8.1	2.3	0.7	1.5	6.3	1.0	1.6
Commercial									
USA	1.3	1.1	1.2	1.5	1.9	1.2	1.8	1.8	1.7
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	2.0	1.6	9.3	3.8	2.6	2.7	8.1	2.8	3.3

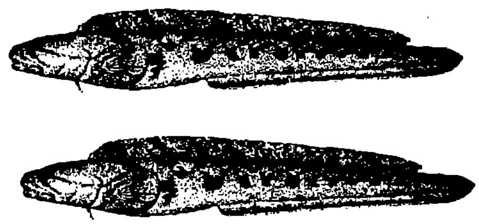
For further information

Low, B.A., Jr. 1981. Mortality rates and management strategies for black sea bass off the southeast coast of the United States. *North Amer. J. of Fisheries Mgmt.* 1(2):93-103.

Musick, J.A. and L.P. Mercer. 1977. Seasonal distribution of black sea bass, *Centropristis striata,* in the Mid-Atlantic Bight with comments on the ecology of fisheries of the species. *Trans. Am. Fish. Soc.* 106(1):12-25.

14. OCEAN POUT





The ocean pout *Macrozoarces americanus*, is a demersal eel-like species ranging from Labrador to Delaware that 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.

The principal fishing gear used to catch ocean pout is the otter trawl, and the fishery occurs primarily between December and May each year. There is no fishery management plan in place for federal waters; the state of Massachusetts regulates the fishery which primarily occurs near shore. Total nominal landings declined 18% in 1988 (2,200 mt to 1,800 mt).

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 mt in 1943. However, an outbreak of a protozoan parasite that 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 in 1984 and 1985 to 1,300 mt and 1,500 mt respectively, due to the development of a small di-

Mid-Atlantic - Gulf of Maine
Ocean Pout

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Insignificant
Management	=	Some state regulations
Status of exploitation	=	Fully exploited
Age at 50% maturity	=	Unknown
Size at 50% maturity	=	Unknown
Assessment level	=	Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1988} = Unknown

rected fishery in Cape Cod Bay supplying the fresh fillet market. Although landings fell to 800 mt in 1986, catches increased markedly in 1987 to 2,200 mt, the highest annual total since 1974, and remained high at 1,800 mt in 1988. Landings from southern New England and Cape Cod Bay dominated the catch, accounting for 58% and 34% respectively, of the total 1988 USA harvest, reversing landings patterns observed in 1986-87.

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, respectively, in 1975. Between 1975 and 1985, survey indices increased to record high levels, peaking in 1981 and 1985 to more than 7.0 kg/tow. Subsequently, survey catch per tow indices declined; the spring 1987 index (2.7 kg/tow) was the lowest since 1979, and the index remained low (3.2 kg/tow) in 1988. More importantly, the values for average weight and mean length of individual fish has decreased recently to 1976-82 values, when the stock was dominated by small fish and landings were at historic low levels.

" ...fishing mortality has rapidly increased."

Declining relative abundance since 1985 coupled with increasing nominal catches and decreasing fish size suggests that fishing mortality has rapidly increased. The population appears to be fully exploited, but catches at the present level may not be sustainable.

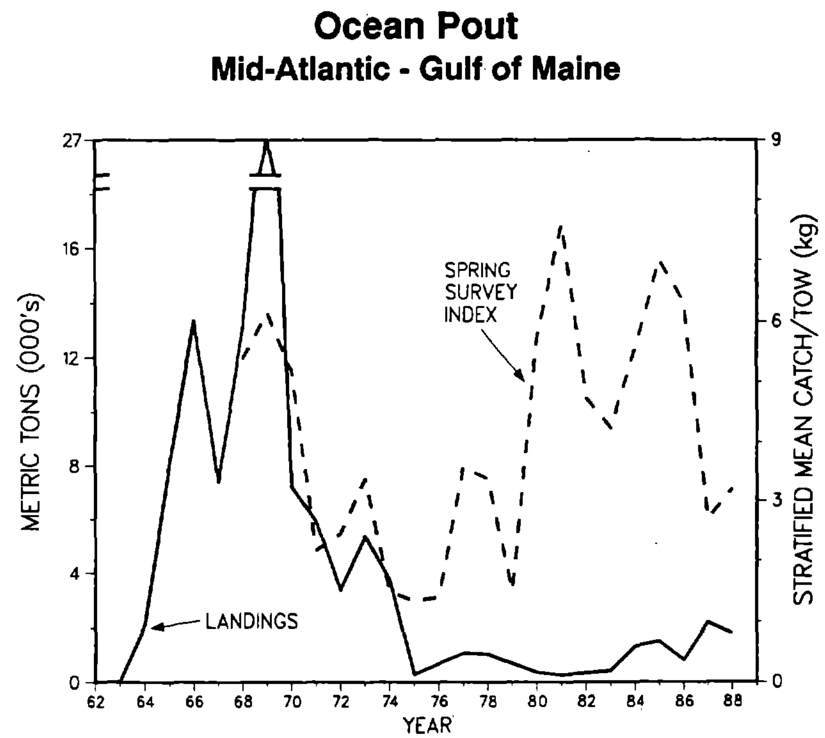


Table 14.1 Commercial landings (1,000 mt)

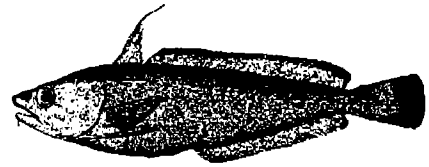
Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	0.4	0.3	0.3	0.4	1.3	1.5	0.8	2.2	1.8
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	0.4	0.3	0.3	0.4	1.3	1.5	0.8	2.2	1.8

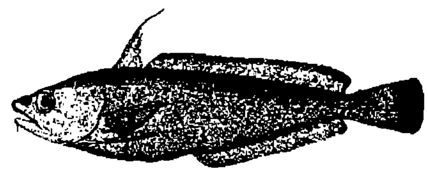
For further information

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. Kingston, RI: University of Rhode Island. Master's thesis.

15. WHITE HAKE





The white hake, *Urophycis tenuis*, is a boreal species that is common on muddy bottom throughout the Gulf of Maine. Stock boundaries are uncertain, although research vessel survey data indicate that the Gulf of Maine population is 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 in.) and weights of up to 21 kg (46 lb) 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 principal fishing gear used to catch white hake are otter trawls and gill nets. Recreational catches are insignificant, and foreign catches of minor importance. Fishing is managed under the New England Fisheries Management Council's Multispecies FMP. Total landings decreased slightly in 1988 (6,200 mt to 6,000 mt). The ex-vessel value of the domestic landings decreased by 28% ($5.5 million to $3.6 million).

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 increased steadily from less than 1,000 mt during the late 1960s to a peak level of 7,500 mt in 1984, and has since declined to 6,000 mt in 1988. The increase evident throughout the 1970s and early 1980s likely reflects both a general increase in incidental catches associated with

Gulf of Maine - Georges Bank White Hake

Long-term potential catch	=	5,000 mt
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Fully exploited
Projected spawning stock biomass per recruit	=	Unknown
Age at 50% maturity	=	Unknown
Size at 50% maturity	=	42 cm (16.5 in.)
Assessment level	=	Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1988} = Unknown

"...harvest levels in excess of 7,000 mt...cannot be sustained at current biomass levels."

the greater fishing power of the expanded New England otter trawl fleet and an increase in directed fishing effort toward white hake. Small individuals are difficult to distinguish from red hake, *Urophycis chuss*, resulting in an unknown degree of bias in reported nominal catches.

The NEFC autumn survey biomass index has fluctuated without any consistent long-term trends since the early 1970s, although total landings tended to follow inter-annual fluctuations until the early 1980s. Except for an anomalously low index in 1982, indices for 1981 to 1988 have been quite stable, while catches have continued to remain high relative to pre-1981 levels. However, declines in 1986-88 catches suggest that harvest levels in excess of 7,000 mt, evident in 1984 and 1985, cannot be sustained at current biomass levels. The population is fully exploited.

For further information

Burnett, J., S. H. Clark, and L. O'Brien. 1984. A preliminary assessment of white hake in the Gulf of Maine - Georges Bank area. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 84-31. 33 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

Northeast Fisheries Center. 1986. Report of the Second Stock Assessment Workshop. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 86-09. 114 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

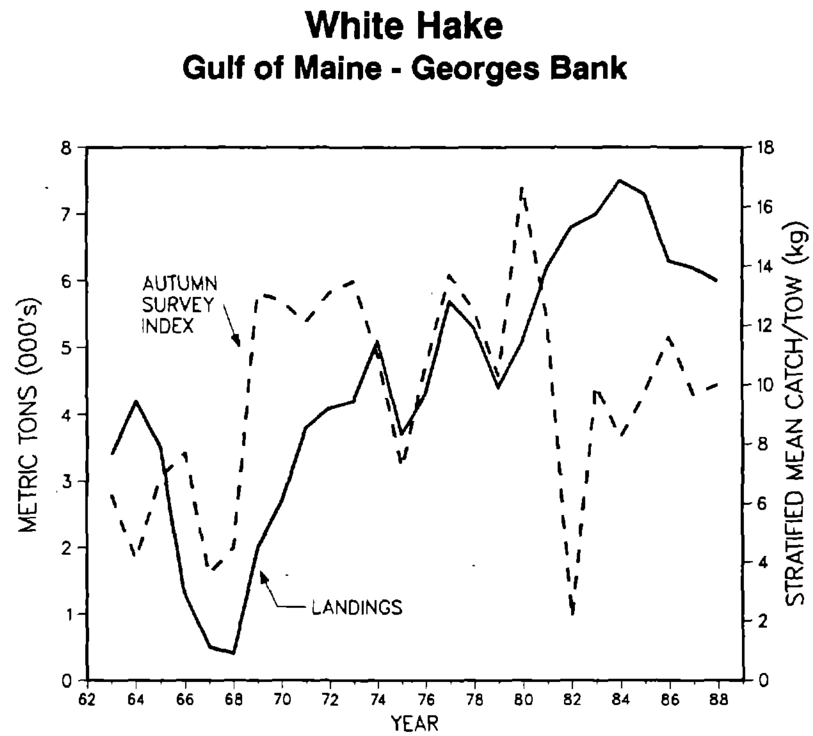
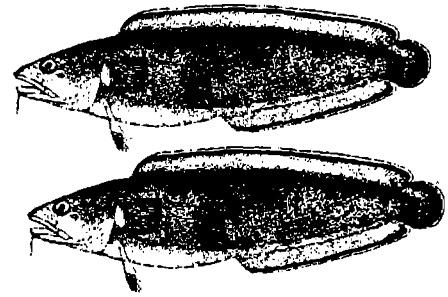


Table 15.1 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988
USA recreational	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial									
USA	4.8	5.7	6.0	6.2	6.5	6.4	5.3	5.5	5.4
Canada	0.3	0.5	0.8	0.8	1.0	0.9	1.0	0.7	0.6
Other	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total nominal catch	5.1	6.2	6.8	7.0	7.5	7.3	6.3	6.2	6.0

16. CUSK



The cusk, *Brosme brosme*, is a deepwater species that is found in rocky, hard bottom areas throughout the Gulf of Maine. Spawning occurs in spring and early summer; eggs rise to the surface where hatching and larval development occur. Juveniles move to the bottom at about 5 cm (2 in.) in length where they become sedentary and rather solitary in habit. Individuals commonly attain lengths up to 80 cm (32 in.) and weights up to 4.5 kg (20 lbs). Little is known about stock structure.

The principal fishing gears used to catch cusk are the otter trawl, and recently, long lines. Recreational fishery is insignificant and foreign catches are minor. The fishery is not under management. Total catches in 1988 decreased 12% (1,700 mt to 1,500 mt).

Between 1977 and 1987, 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 2,300 mt per year. In this period, 75% 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 1988, cusk landings totaled 1,500 mt, 12% less than in 1987. The 1988 USA catch was 1,100 mt and accounted for 73% of the total yield. Canadian landings in 1988 were 400 mt. Historically, otter trawls have accounted for between 50 and 87% of the annual USA landings. Before 1985, longline landings never exceeded 2% of the total. In 1985 and 1986, longline landings of cusk increased dramatically to 23% of the total landings as a result of a new auto-longline fishery. However, this new auto-longline fishery collapsed during 1987 and longline landings fell to 90 mt, 6% of the total. Otter trawls accounted for the majority of landings in 1988 while gill nets and line trawls accounted for most of the remainder.

NEFC spring and autumn survey indices have fluctuated considerably. The spring survey index declined by 22% in 1988 while the autumn index increased by 37%. The autumn index was about equal to the overall average mean in the 26 year time series.

Although the declining trend in landings which started after the 1982 high catch is continuing, the indices of abundance have not shown a consistent trend. The current level of assessment is too low to allow the status of the stock to be predicted with confidence.

For further information

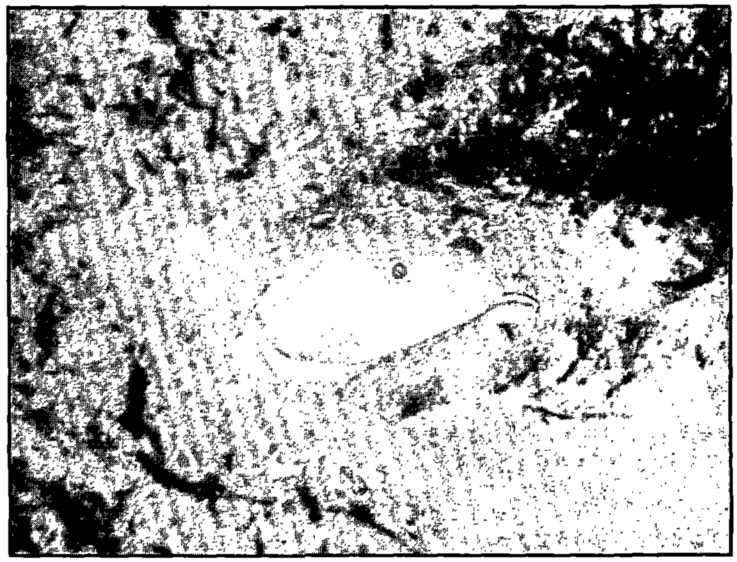
Bigelow, H.B., and W.C. Schroeder, 1953. Fishes of the Gulf of Maine. Cambridge, MA: Harvard University. Museum of Comparative Zoology.

Gulf of Maine - Georges Bank
Cusk

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

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1988} = Unknown

" ...level of assessment is too low to allow the status of the stock to be predicted with confidence."



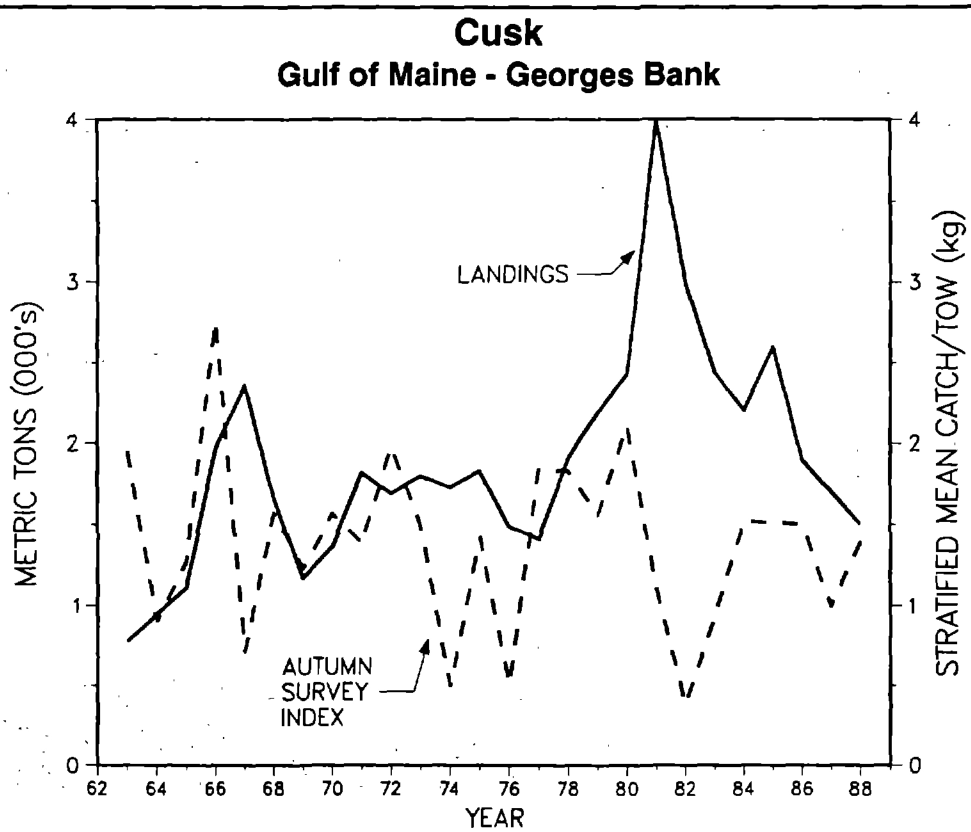
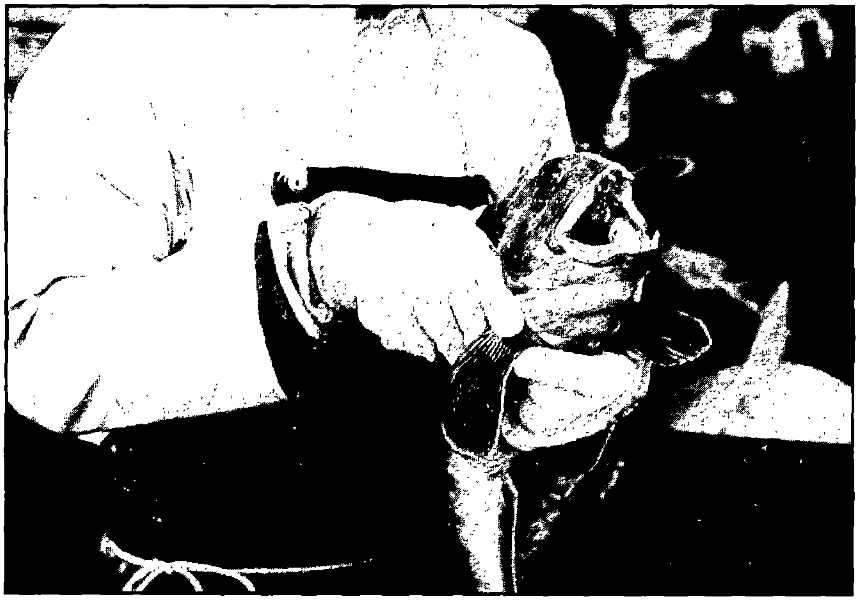
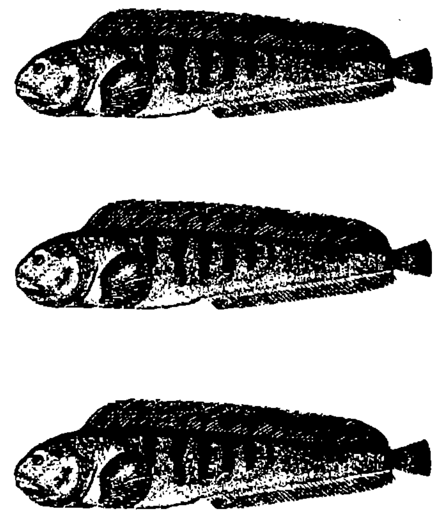


Table 16.1 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial									
USA	1.8	1.9	1.8	1.8	1.7	2.3	1.8	1.4	1.1
Canada	0.6	2.1	1.2	0.6	0.5	0.3	0.1	0.3	0.4
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	2.4	4.0	3.0	2.4	2.2	2.6	1.9	1.7	1.5

17. ATLANTIC WOLFFISH





The wolffish or catfish, *Anarhichas lupus*, is a cold water species of relatively minor importance in Gulf of Maine fisheries. Northeast Fisheries Center 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 to 120 m (45 to 65 fathoms). Wolffish are sedentary and rather solitary in habit, and populations tend to be localized. Little is known about the biology of this species. Individuals may attain lengths of 150 cm (59 in.) and weights of perhaps 18 kg (40 lbs). They are significant shellfish predators.

Wolffish have been taken primarily as by-catch in the otter trawl fishery, although the species may also be an intended component in some mixed fishery situations. Recreational catches are insignificant, and foreign catches of minor importance. There is no management. The total landings declined 25% in 1988 (800 mt to 600 mt).

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. 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 1988 were just over 500 mt, a decline of around 30% from 1987 and have been declining at a rate of 100 to 200 mt a year since 1983.

The NEFC spring and fall survey index has fluctuated considerably while exhibiting a downward trend in recent years. Both the spring and fall index declined in 1988 and the spring value of 0.82 is the lowest that has been observed.

The continuing decline in landings since 1982 and the longer term decline in the trawl survey indices suggest that recent levels of exploitation have reduced biomass substantially. Although the assessment level is too low to allow a definitive appraisal, the stock appears to be over exploited.

For further information

Bigelow, H.B., and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. Cambridge, MA: Harvard Museum of Comparative Zoology.

"The continuing decline in landings since 1982 and the longer term decline in the trawl survey indices suggest that recent levels of exploitation have reduced biomass substantially."

Gulf of Maine - Georges Bank Atlantic Wolffish

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Insignificant
Management	=	None
Status of exploitation	=	Over exploited
Age at 50% maturity	=	Unknown
Size at 50% maturity	=	Unknown
Assessment level	=	Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1988} = Unknown

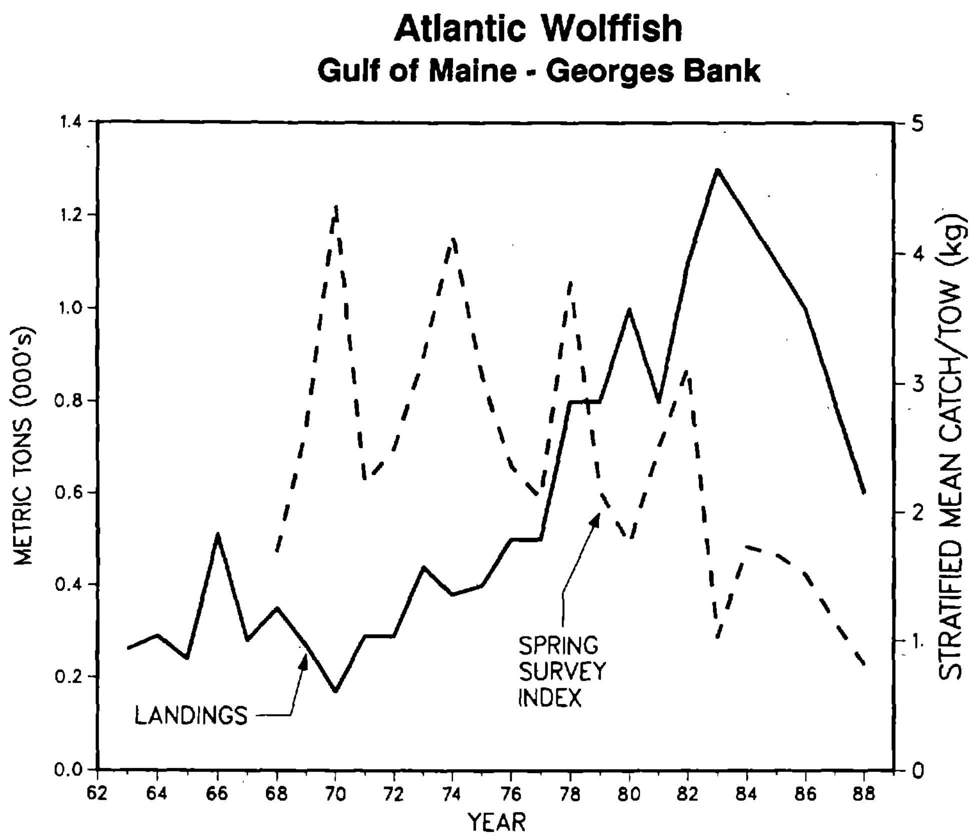
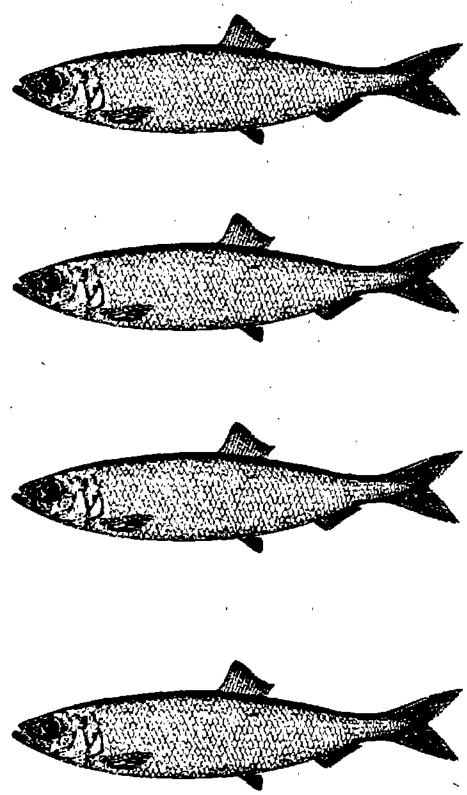


Table 17.1 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial									
USA	0.9	0.7	0.9	1.2	1.1	1.0	0.9	0.7	0.5
Canada	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1
Other	-	-	-	-	-	-	-	-	-
Total nominal	1.0	0.8	1.1	1.3	1.2	1.0	1.0	0.8	0.6

18. 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. 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

**Gulf of Maine
Atlantic Herring**

Long-term potential catch[1]	=	20,000 mt
Importance of recreational fishery	=	Insignificant
Management	=	None
Status of exploitation	=	Fully exploited
Age at 50% maturity	=	3 years
Size at 50% maturity	=	26 cm (10.2 in.)
Assessment level	=	Age structured

$M = 0.20$ $F_{0.1} = 0.24$ F_{max} = None F_{1988} = Unknown

[1] **Age groups 3 and older, Jeffreys Ledge component only.**

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.

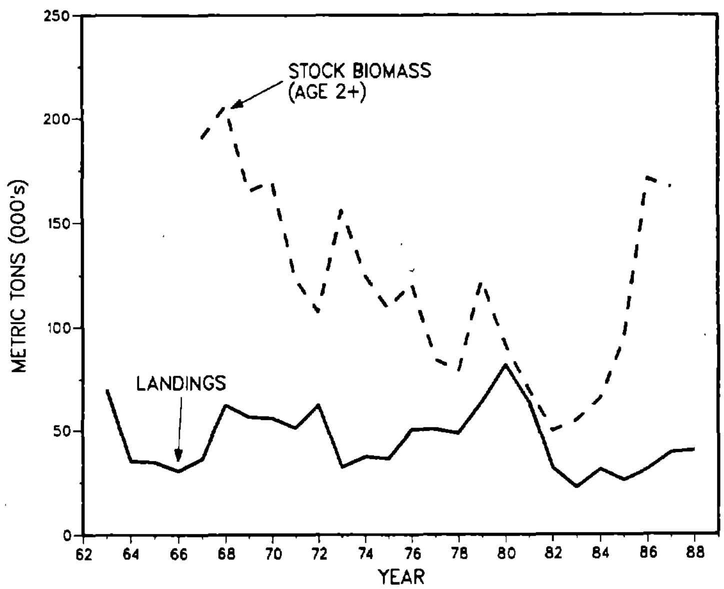
GULF OF MAINE

Total catches in the Gulf of Maine declined from an average of 61,800 mt from 1977-1981 to 22,500 mt in 1983. Landings have increased subsequently reaching 40,200 in 1988. These changes are best understood by examining the changes in the two principal fisheries, the coastal fixed gear and the western Gulf mobile gear.

"Due to declines in export markets in recent years with recovery of the North Sea fishery, a signifiant portion of the adult herring catch has not been used for human consumption."

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

Atlantic Herring



Gulf of Maine
(coastal Maine and western Gulf of Maine)

Table 18.1 Commercial landings (1,000 mt)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	82.1	63.6	31.7	22.5	31.1	25.8	31.2	39.2	40.2
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch[1]	82.1	63.6	31.7	22.5	31.1	25.8	31.2	39.2	40.2

(Year spans columns 1980–1988.)

[1] **Age groups 1 and older.**

Georges Bank

Table 18.2 Commercial landings (1,000 mt)[1]

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	1.1	1.7	0.7	1.0	1.6	0.2	0.2	-	-
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	1.1	1.7	0.7	1.0	1.6	0.2	0.2	-	-

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

from July to November. With the exception of the strong 1970 year class, recruitment up until 1978 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 1988 yield was 15,500 mt, a 21% decline from 1987. The general reduction noted since the early 1980s appears to be related to reduced availability to the fixed gear fisheries and reduced abundance as measured by NEFC survey indices. The 1984-88 NEFC spring survey indices indicate a recovery relative to 1982-83 levels.

The 1988 nominal catch of 24,700 mt in the western Gulf of Maine mobile gear fishery represented a 27% increase over 1987 levels and exceeded the 1975-80 mean level of 22,900 mt. Due to declines in export markets in recent years with recovery of the North Sea fishery, a significant proportion of the adult herring catch has not been used for human consumption.

Stock biomass (ages 2 and older) for the total Gulf of Maine region (coastal Maine and western Gulf of Maine) averaged 183,000 mt between 1965 and 1970 before declining to an estimated 124,000 mt in 1971. After increasing to 122,000 mt in 1979, stock biomass declined steadily to an estimated 50,000 mt in 1982, the lowest level yet observed. Recent estimates indicate an increase to 170,000 mt in 1986 and 1987. The spawning stock biomass estimates are not available for 1988, so this apparent increasing trend can not be confirmed.

Georges Bank
Atlantic Herring

Long-term potential catch	=	100,000 mt
Importance of recreational fishery	=	Insignificant
Management	=	None
Status of exploitation	=	Not exploited
Age at 50% maturity	=	3 years
Size at 50% maturity	=	26.4 cm (10.4 in.)
Assessment level	=	None

$M = 0.20$ $F_{0.1} = 0.36$ $F_{max} = \text{None}$ $F_{1988} < 0.01$

"...Indication...of recovery has been obtained based on US and Canadian bottom trawl surveys during 1984-1988 and reports of incidental catches by commercial vessels."

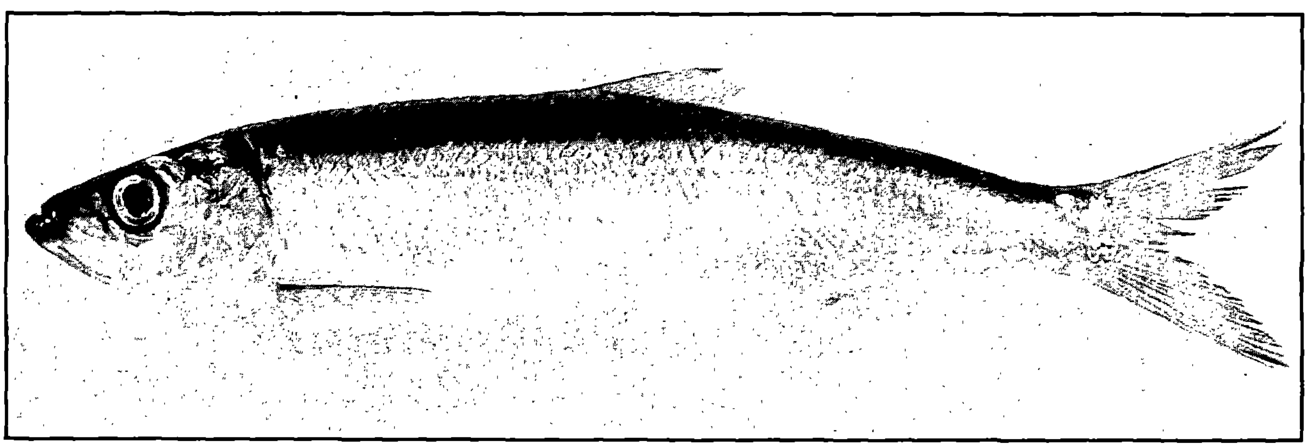
GEORGES BANK

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 as the stock collapsed. The 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 since that time.

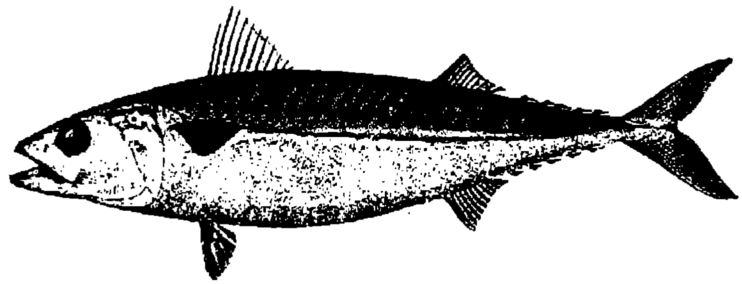
Indication of some level of recovery has been obtained based on US and Canadian bottom trawl surveys during 1984 - 1988 and reports of incidental catches by commercial vessels. Prospects for redevelopment of the fishery are currently being studied.

For further information

Fogarty, M.J., and S.H. Clark. 1983. Status of herring stocks in the Gulf of aine region for 1983. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 83-46. 33 p. Available from: Northeast Fisheries Center, Woods Hole, MA.



19. 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 and May, and a northern group which spawns in the Gulf of St. Lawrence in June and 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 in. (fork length) and 1.3 kg (3 lbs) in weight. Sexual maturity begins at age 2 and is usually complete by age 3. Maximum age is about 20 years.

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

Mackerel in the northwest Atlantic were managed by nationally-allocated catch quotas between 1973 and 1977 by ICNAF. Since implementation of the MFCMA on 1 March 1977, mackerel in USA waters have been managed by the NMFS, initially under a PMP and since February 1980 under the Mid-Atlantic Fishery Management Council's Squid, Mackerel, Butterfish FMP. Management is based on total allowable catch (TAC) limits, which have been increased over the 1980s. Landings from this stock increased 9% in 1988 (75,100 mt to 82,000 mt), still far less than the TAC limit of 196,500 mt.

Mackerel landings increased dramatically beginning in the late 1960s,

"...the population can sustain substantially more fishing."

Labrador to North Carolina
Atlantic Mackerel

Long-term potential catch	=	134,000[1] mt
Importance of recreational fishery	=	Moderate
Management	=	Squid, Mackerel, Butterfish FMP
Status of exploitation	=	Under exploited
Age at 50% maturity	=	2 years
Size at 50% maturity	=	32.7 cm (12.9 in.) fork length
Assessment level	=	Yield per recruit

$M = 0.20$ $F_{0.1} = 0.29$ $F_{max} = 0.62$ $F_{1988} = 0.05$

[1] **Assuming constant recruitment at level of geometric mean of 1961-1984 year classes**

reaching a peak of roughly 400,000 mt in 1973. Landings subsequently declined to roughly 30,000 mt in the late 1970s, and have increased steadily since 1980. This latter increase has been due primarily to increasing USA and foreign joint venture fishing operations.

The USA accounted for 20% of the 1988 international catch, including about 12,300 mt of commercial and an estimated 3,900 mt of recreational catch. The Canadian catch increased from 22,100 mt in 1987 to 23,000 mt in 1988. The distant-water fleet catch increased from 35,100 mt in 1987 to 42,900 mt in 1988.

Year classes from 1975 to 1980 were all relatively weak. Cohorts since 1981 have been much stronger (except for 1983), particularly the 1982 year class which is the strongest since 1969. The 1984 to 1986 cohorts also appear to be relatively strong.

Total stock biomass (ages 1 and older) increased from around 300,000 mt in 1962-65 to 1.9 million mt in 1970-71 before dropping to a stable low level during 1977-81 averaging 485,000 mt per year. The total stock increased since 1981, reaching roughly 2.0 million mt at the beginning of 1988. 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 1.8 million mt at the start of 1988. This increase in biomass is similar to that observed in the late 1960s, which supported the large catches in the 1970s.

Relatively low catches during 1980-88 (average of 50,400 mt) and improved recruitment from the 1981-82 and 1984 to 1986 year classes have helped to rebuild the mackerel stock. Projections indicate that the 1989 catch can be increased without adversely affecting the productivity of the spawning stock biomass. These recommendations are based on a projected $F_{0.1}$ catch of roughly 399,000 mt for the total international mackerel fishery in the Northwest Atlantic.

Given the large biomass and recent decreases in the growth rate of individual fish, the population can sustain substantially more fishing, and is under exploited.

Atlantic Mackerel
Labrador to North Carolina

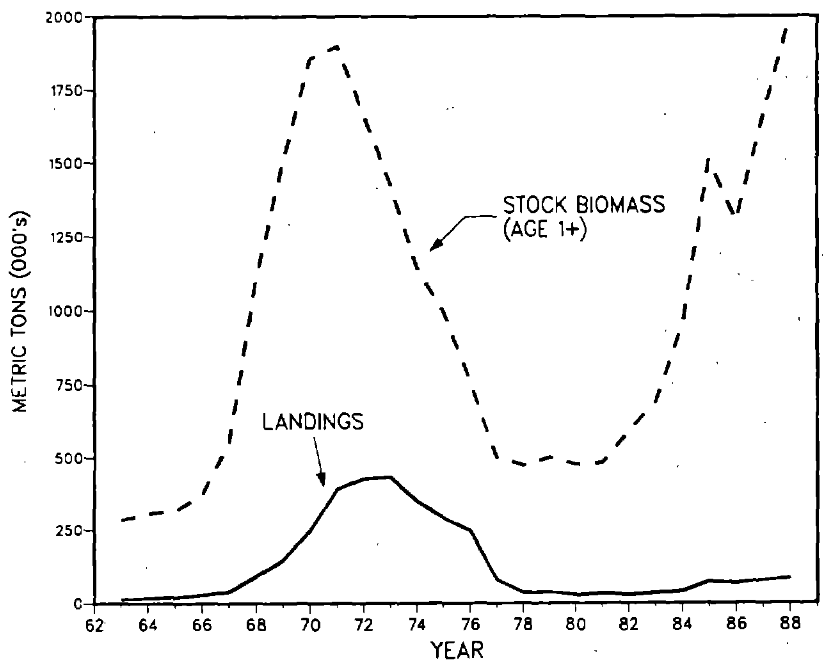


Table 19.1 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational	2.4	5.1	1.1	3.0	3.0	1.5	4.0	5.6	3.8
Commercial									
USA	2.7	2.9	3.3	3.7	4.4	6.6	9.6	12.3	12.3
Canada	22.1	19.3	16.4	19.8	17.0	29.8	25.4	22.1	23.0
Other	1.6	5.4	6.6	6.0	15.0	33.2	26.4	35.1	42.9
Total nominal catch	27.8	32.6	27.5	32.6	39.4	71.1	65.4	75.1	82.0

For further information

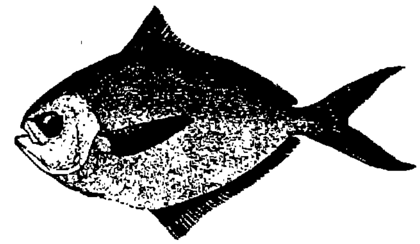
Anderson, E.D. 1984. Status of the Northwest Atlantic mackerel stock - 1984. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 85-03. 46 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

Overholtz, W.J., and B.L. Parry. 1985. Update of the status of the Northwest Atlantic mackerel stock for 1985. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 85-13. 16 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

Overholtz, W.J., S.A. Murawski, W.L. Michaels, and L.M. Dery. 1988. The effects of density dependent population mechanisms on assessment advice for the northwest Atlantic mackerel stock. Woods Hole, MA: NMFS, NEFC. NOAA Technical Memorandum NMFS-F/NEC-62. 49p. Available from: Northeast Fisheries Center, Woods Hole, MA.

Northeast Fisheries Center. 1986. Report of the Second NEFC Stock Assessment Workshop. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 86-09. 114 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

20. 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. Butterfish are an important prey item for a number of fishes including bluefish, silver hake, swordfish, tuna, and pelagic sharks.

The principal fishing gear used for catching butterfish is the otter trawl. The recreational fishery is insignificant, and foreign catches have declined in recent years to nearly insignificant levels. Fishing is managed under the Mid-Atlantic Fishery Management Council's Squid, Mackerel, and Butterfish FMP. The management is based on a total allowable catch (TAC) limit which was increased in 1986 from 11,000 mt to 16,000 mt. Total landings have been far less than the TAC and declined 55% in 1988 (4,700 mt to 2,100 mt).

Butterfish landings fluctuated widely over the 1960s and 1970s, being roughly steady at around 5,000 mt from 1977 to 1981. Landings were somewhat higher in 1982 and 1984, and have subsequently decreased. The 1988 catch is the lowest observed since 1977. The decline in domestic catches since 1984 is attributed to decreased availability of marketable size butterfish on the traditional southern New England fishing grounds.

Discard rates of small butterfish in the domestic fishery during 1988 were low compared to rates reported in the early 1980s (<10% compared to 40-70% by weight of the landed catch). This is attributable to declines in the Japanese market for small butterfish, and low availability of butterfish.

Gulf of Maine - Mid-Atlantic Butterfish

Long-term potential catch	=	16,000 mt
Importance of recreational fishery	=	Insignificant
Management	=	Squid, Mackerel, and Butterfish FMP
Status of exploitation	=	Under exploited
Age at 50% maturity	=	1.5 years
Size at 50% maturity	=	14.0 cm (5.5 in.) fork length
Assessment level	=	Yield per recruit

$M = 0.80$ $F_{0.1} = 1.60$ $F_{max} > 2.50$ F_{1988} = Unknown

"...declines in landings have not been associated with declines in abundance."

The catch-per-tow index (all ages) from the NEFC 1988 autumn bottom trawl survey (7.3 kg/tow) increased 55% from 1987. Likewise, the recruitment index (282.3 age 0 fish/tow) increased 260%. The age 1^+ index, however, (35.1 age one and older fish/tow) from the 1988 autumn survey declined 10%, and is the lowest index observed since 1982. Also, whereas the 1988 recruitment index is double the 20-year (1968-1987) average, the age 1^+ and biomass indices are 22.3% and 5.8% below the 20-year averages.

The 1988 autumn abundance indices are generally above 1968-1976 levels when total international nominal catches were high (6,500 - 19,500 mt). In addition, results of the Massachusetts 1988 inshore autumn bottom trawl survey indicate that the 1988 year class is strong. This suggests that sufficient fish are available to support a catch up to the current TAC. However, a limitation to achieving catches approaching the fishery potential 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.

The recent declines in landings have not been associated with declines in abundance. The strong 1988 year class suggests that abundance will continue at relative high levels over the next few years. Much larger catches could be supported by the population, and it is under exploited.

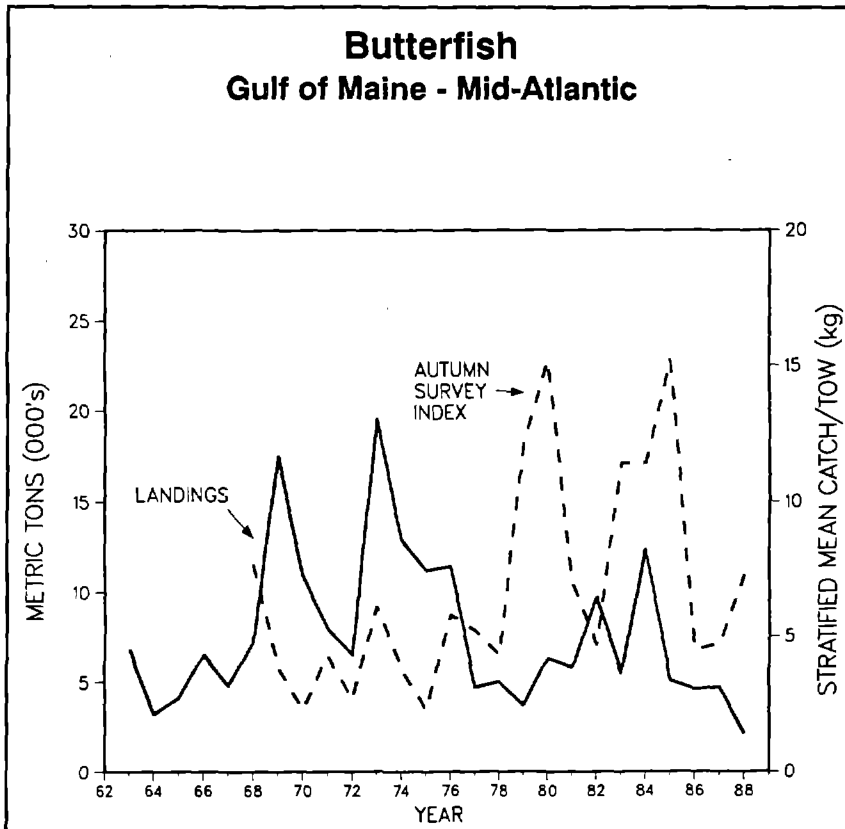


Table 20.1 Commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	5.4	4.9	9.1	4.9	11.8	4.7	4.6	4.7	2.1
Canada	-	-	-	-	-	-	-	-	-
Other	0.9	0.9	0.8	0.6	0.4	0.4	0.1	<0.1	<0.1
Total nominal catch	6.3	5.8	9.7	5.5	12.3	5.1	4.7	4.7	2.1
Total allowable catch	11.0[1]	11.0[1]	11.0[1]	11.01	≤16.0[1]	≤16.0[1]	≤16.0[1]	≤16.0[1]	≤16.0[1]

[1] 1 April - 31 March fishing year.

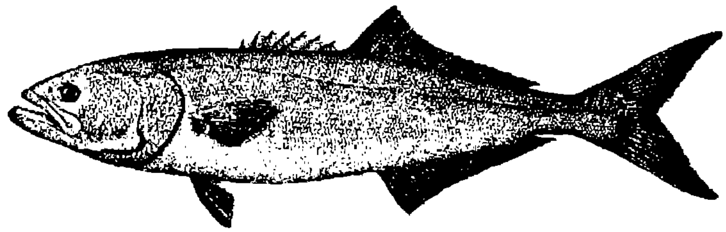
For further information

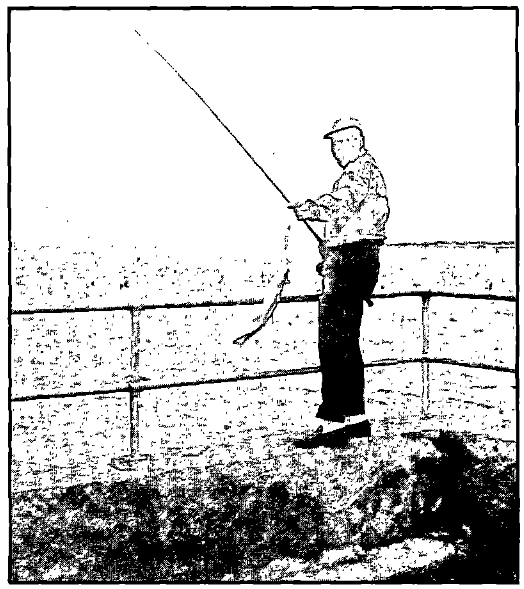
Murawski, S.A. and G.T. Waring. 1979. A population assessment of butterfish, *Peprilus triacanthus*, in the northwestern Atlantic Ocean. *Trans. Am. Fish. Soc.* 108:427-439.

Waring, G.T. 1986. An analysis of spatial difference in size composition and abundance of butterfish, *Peprilus triacanthus*, off the Northeast United States. Woods Hole, MA. NMFS, NEFC. Woods Hole Laboratory Reference Document 86-04. 23 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

Waring, G.T. and E.D. Anderson. 1983. Status of the Northwestern Atlantic butterfish stock - 1983. Woods Hole, MA. NMFS, NEFC. Woods Hole Laboratory Reference Document 83-41. 39 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

21. BLUEFISH





The bluefish, *Pomatomus saltatrix*, is a migratory, pelagic species found throughout the world in most temperate coastal regions, except the eastern Pacific. Along the US Atlantic coast, bluefish are found from Maine to Florida, migrating northward in the spring and southward in the fall. Bluefish are voracious 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 (39 in.) in length and 14 kg (31 lbs.) in weight. Currently, a unit stock along the Atlantic coast is assumed for management purposes.

The principal commercial fishing gear used to catch bluefish is the otter trawl. Recreational fishing is very important with catches far exceeding commercial catches. A fishery management plan for bluefish is currently being developed by the Atlantic States Marine Fisheries Commission (ASMFC) in cooperation with the New England, Mid-Atlantic, and South Atlantic Fishery Management Councils and the coastal states. Total landings declined 27% in 1988 (56,600 mt to 41,500 mt), mostly due to lower recreational catches.

Atlantic Coast Bluefish

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Major
Management	=	None
Status of exploitation	=	Unknown
Age at 50% maturity	=	1 year
Size at 50% maturity	=	35 cm (13.8 in.)
Assessment level	=	Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1988} = Unknown

"...recent exploitation has reduced abundance. Stock assessment information...is insufficient."

Total catches of bluefish (commercial and recreational) from Maine to Florida peaked in 1980 at an estimated 76,200 mt. Total catches have declined generally from 1980 to the present, but with some fluctuations. The commercial component of these totals have fluctuated between 5,800 mt and 7,600 mt, with no apparent trend. The larger recreational component has followed roughly the pattern of the total, declining from a peak of nearly 70,000 mt in 1980 to 35,000 mt in 1988.

Most of the recreational catch of bluefish is taken in the Middle Atlantic states (NY to VA) by boat-based fishermen. The largest fish are usually caught in the North Atlantic states (ME to CT), and the smallest in the South Atlantic states (NC to FL). Coastwide, bluefish recreational catch per angler trip by weight and numbers rose from 2.11 kg/trip (1.18 fish/trip) in 1979 to a peak of 2.72 kg/trip (1.49 fish/trip) in 1981, and has since trended downward, declining to 1.35 kg/trip (0.89 fish/trip) in 1987 and 0.95 kg/trip (0.42 fish/trip) in 1988 (preliminary estimate). The mean recreational CPUE during 1979-87 was 1.76 kg/trip (1.06 fish/trip).

The downward trend in recreational catches has been matched by a downward trend in the catch per angler fishing trip, suggesting that recent exploitation has reduced abundance. Stock assessment information, however, is insufficient to allow a determination of the status of exploitation.

Bluefish
Atlantic Coast, Maine to Florida

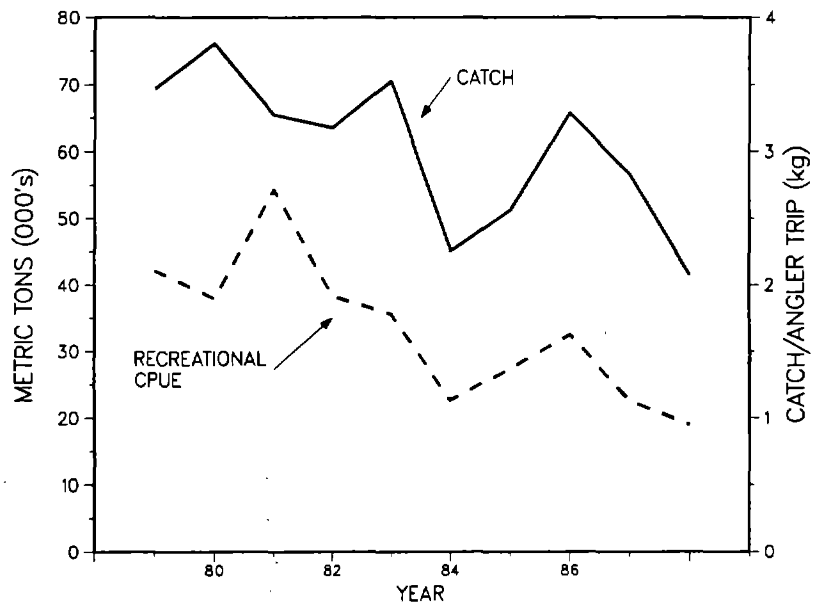


Table 21.1 Recreational catches and commercial landings (1,000 mt)

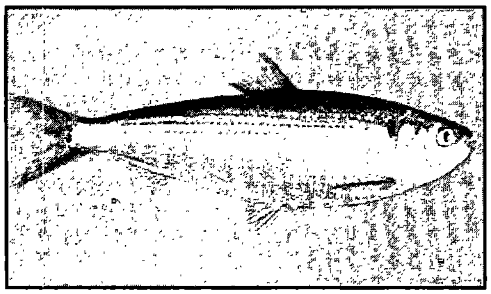
Category	1980	1981	1982	1983	1984	1985	1986	1987	1988
USA recreational	69.6	58.2	56.6	62.8	39.3	45.0	59.4	49.7	35.3
Commercial									
USA	6.5	7.2	6.9	7.6	5.8	6.2	6.3	6.9	6.2
Canada	-	-	-	-	-	-	-	-	-
Other	<0.1	-	-	-	-	-	-	-	-
Total nominal catch	76.2	65.4	63.5	70.4	45.1	51.2	65.7	56.6	41.5

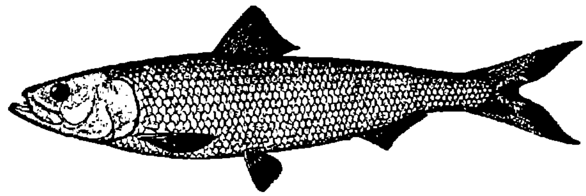
For further information

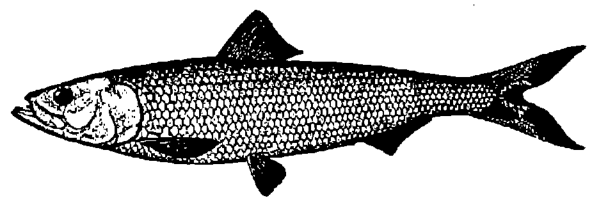
Northeast Fisheries Center. 1988. Report of the Fifth NEFC Stock Assessment Workshop (Fifth SAW). Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 87-12. 66 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

Northeast Fisheries Center. 1988. Report of the Sixth NEFC Stock Assessment Workshop (Sixth SAW). Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 88-02. 78p. Available from: Northeast Fisheries Center, Woods Hole, MA.

22. 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 length of 36 cm (14 in.). Blueback herring live for about seven or eight years and reach a maximum length of about 32 cm (13 in.).

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 to 5, with age 4 being dominant.

The river herring fishery is one of the oldest in North America and was exclusively a USA inshore fishery until the late 1960s, 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 began a downward trend until the mid-to-late 1970s, and has since averaged 4,000 to 5,000 mt. Total landings north of Cape Hatteras, NC declined 41% in 1988 (4,100 mt to 2,400 mt). North Carolina remains the only state with a substantial commercial fishery, accounting for approximately 80% of total landings.

The principal fishing gear used to catch river herring is otter trawls. Recreational fishing is significant, but no estimates of landings are available. In response to the observed decline in nominal catch and the lack of a coastwide increase in stock biomass, the Atlantic States Marine Fisheries Commission has prepared a comprehensive coastwide management plan for shad and river herring with the participation of all coastal states between Maine and Florida. The by-catch of river herring in the joint venture and foreign directed fisheries is managed under the Mid-Atlantic Fishery Management Council's Squid, Mackerel, and Butterfish FMP.

An MSY estimate of 23,000 to 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 in any river systems. 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.

For further information

Boreman, J. 1981. River herring stocks along the Atlantic coast. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 81-35. 23 p. Available from: Northeast Fisheries Center, Woods Hole MA.

Hoagman, W. J., J. V. Merriner, R. St. Pierre, and W. L. Wilson. 1973. Biology and management of river herring and shad in Virginia. Gloucester Pt., VA: Virginia AFC 7-1 to 7-3, Completion Report. Available from: VIMS, Gloucester Pt., VA.

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. Columbia, MD: Martin Marietta Environmental Center. Available from: Atlantic States Marine Fisheries Commission, Washington, DC.

"...stock levels have been relatively stable since 1968."

Maine - Mid-Atlantic River Herring

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Minor
Management	=	Shad and River Herring Interstate Plan Squid, Mackerel, and Butterfish FMP
Status of exploitation	=	Unknown
Age at 50% maturity	=	2-4 (varies by latitude)
Size at 50% maturity	=	28 cm (11.0 in.)
Assessment level	=	Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1988} = Unknown

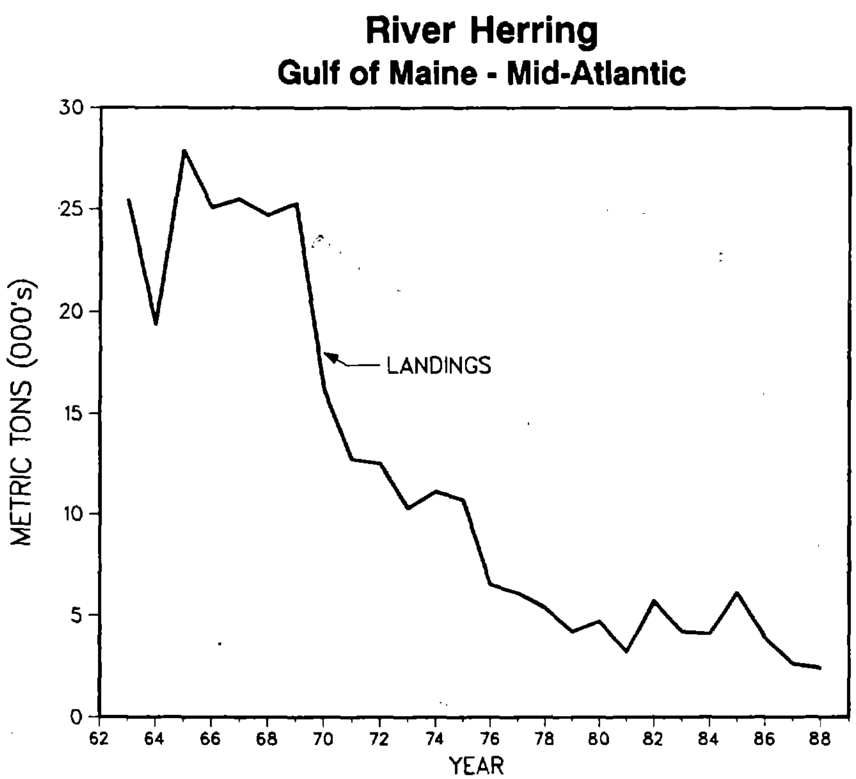
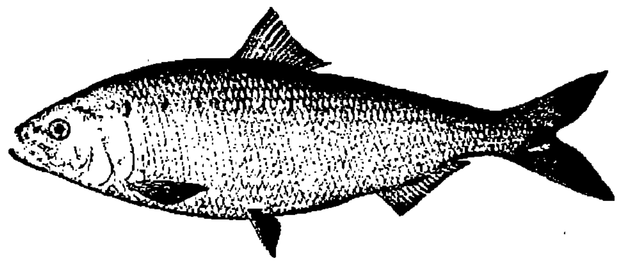


Table 22.1 Commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	4.7	3.2	5.7	4.2	4.1	6.1	3. 9	4.1	2.4
Canada	-	-	-	-	-	-	-	-	-
Other	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total nominal catch	4.7	3.2	5.7	4.2	4.1	6.1	3.9	4.1	2.4

23. 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. American shad undergo extensive seasonal migrations along the Atlantic coast. Shad migrate into rivers for spawning beginning in April in southern rivers, and continuing until July in the northernmost rivers. Following their downstream migration, shad migrate north along the coast to Canada where they feed during the summer. A southward migration occurs along the continental shelf where the fish overwinter prior to spring spawning migrations to their natal rivers.

American shad have a range of life history patterns depending on their river of origin. In southern rivers, shad return to spawn by age 4, and spawn 300,000 to 400,000 eggs; they usually spawn only once, however. With increasing latitude, the mean age at first spanning increases to age 5 and the number of eggs per spawning decreases to 125,000 to 250,000 eggs; the number of spawnings per life time, however, increases.

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. The principal fishing gear for American shad is the gill net. Nominal commercial catch along the Atlantic coast exceeded 22,000 mt in 1896, but currently averages less than 1,000 mt per year. Commercial catch reported by states during the 1980's has been the lowest on record, although landings north of Cape Hatteras, NC increased by 44% between 1987 and 1988 (900 mt to 1,300 mt). Recreational fishing is significant, but no estimates of landings are available.

Excessive fishing has been blamed for stock declines in the Hudson and Connecticut Rivers, as well as rivers in Maryland, North Carolina, and Flor-

Gulf of Maine - Mid-Atlantic American Shad

Long-term potential catch	=	6-1,236 mt,varying among river systems.
Importance of recreational fishery	=	Major
Management	=	Individual states
Status of exploitation	=	Unknown
Age at 50% maturity	=	2-4 years (varies by latitude)
Size at 50% maturity	=	40 cm (15.8 in.)
Assessment level	=	Index

M = varies by latitude **$F_{0.1}$ = Unknown** **F_{msy} = 0.35-1.25**
F_{1988} = Unknown

"...MSY ranges from 6 to 1,236 mt depending on the drainage area of the river."

ida. 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 primary cause for the decline in the fishery in that system. The Atlantic States Marine Fisheries Commission has prepared a coastwide management plan for American shad and river herring to facilitate cooperative management and restoration plans between states. Restoration efforts involving habitat improvement, fish passageways, and stocking programs are resulting in improved returns to some river systems, particularly the Delaware and Connecticut Rivers.

An assessment of shad from twelve rivers along the Atlantic coast with established populations indicates that MSY ranges from 6 to 1,236 mt depending on the drainage area of the river. Present catch levels are generally far below these levels for most rivers. The assessment information is insufficient to confidently determine the status of individual stocks, or of aggregated stocks.

For further information

Gibson, M.R., V.A. Crecco, and D.L. Stang. 1988. Stock assessment of American shad from selected Atlantic coast rivers. ASMFC Spec. Rpt. No. 15. 65p. Available from: Atlantic States Marine Fisheries Commission, Washington, DC.

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. Columbia, MD: Martin Marietta Environmental Center. Available from: Atlantic States Marine Fisheries Commission, Washington, D.C.

American Shad
Gulf of Maine - Mid-Atlantic

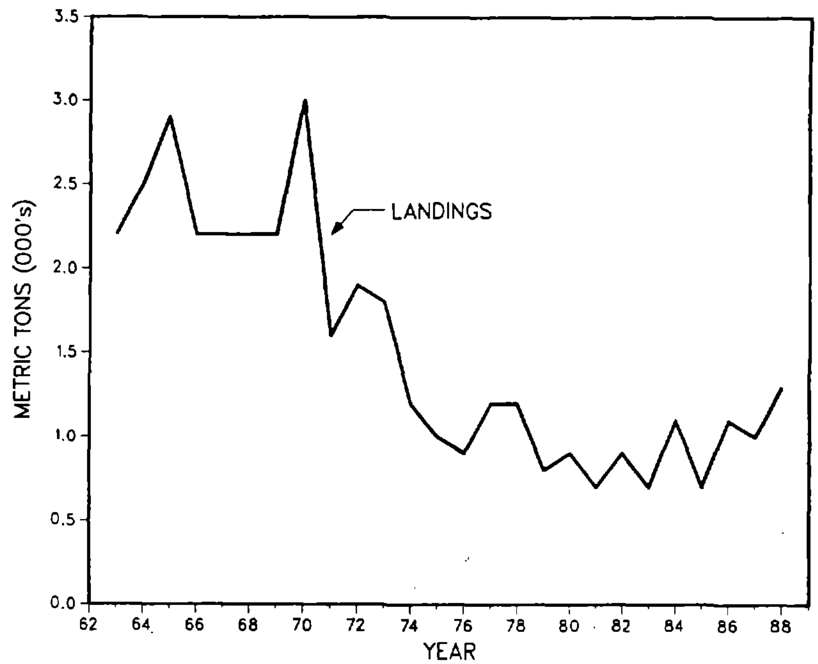
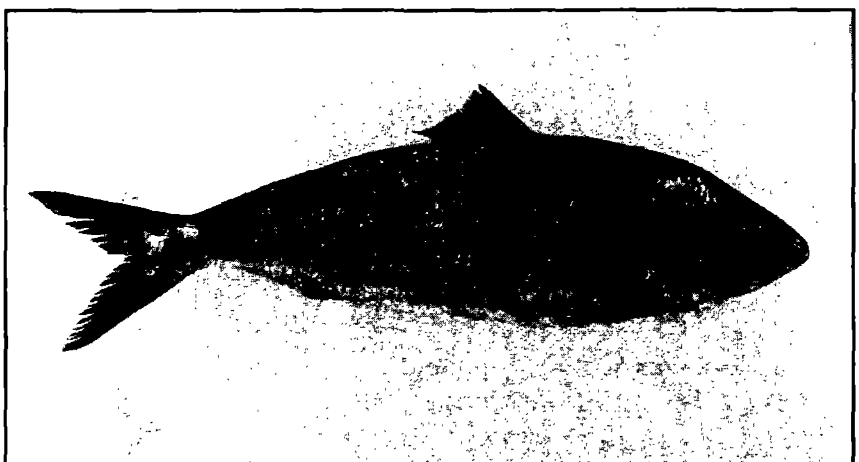
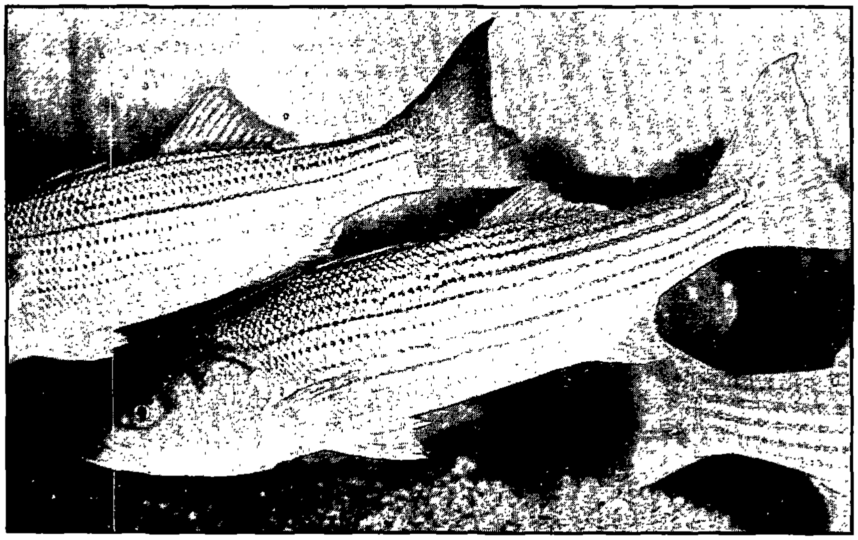


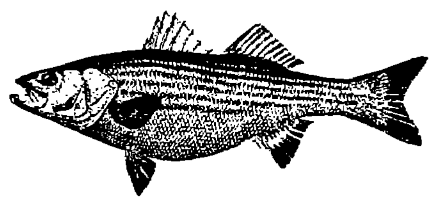
Table 23.1 Commercial landings catches (1,000 mt)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988
					Year				
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	0.9	0.7	0.9	0.7	1.1	0.7	1.1	0.9	1.3
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	0.9	0.7	0.9	0.7	1.1	0.7	1.1	0.9	1.3



24. 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° to 23°C; peak spawning activity is observed between 15° and 20°C. Larvae range from 2.0 to 3.7 mm in total length at hatching and initiate feeding after 4 to 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 from late winter to early spring, and a coastal migration that is apparently not associated with spawning activity. Coastal 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.

In the past, Atlantic coastal fisheries for striped bass relied on production from stocks spawning in the Hudson River, tributaries to the Chesapeake Bay, and possibly also the Roanoke River, North Carolina. The Chesapeake stock has historically produced most of the striped bass found along the coast. However since 1970, juvenile production in the Chesapeake Bay has been extremely poor. Consequently, commercial landings began a severe decline in the mid-1970s. Findings of the Emergency Striped Bass Study (ongoing since 1980) suggest that the decline in abundance of the Chesapeake Bay stock is probably due to a combination of factors, including overfishing and poor water quality in spawning and nursery habitats. Water quality monitoring in conjunction with field and laboratory bioassays on the spawning grounds in Maryland have shown that river water can be toxic to larvae at some times and in some areas. 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 more than $220 million in economic activity in 1980.

During the mid-1980s, stringent management measures were adopted by the states from Virginia to Maine to attempt to rebuild the Chesapeake stocks. These measures, aimed at protecting the 1982 and subsequent year-classes until the females could spawn at least once, have been effective in increasing the abundance of striped bass. Females of the protected year-classes began to appear on the spawning grounds in 1987. In 1987 and 1988, juvenile production in Virginia's tributaries to the Chesapeake Bay was at or near record highs. Maryland's index of juvenile abundance remained far below average in 1987 and 1988. Preliminary results from the 1989 Maryland survey, however, suggest very high juvenile production this year, exceeding management criteria for reopening the fishery. The juvenile index for the Roanoke River stock increased slightly in 1988, but remains at very low levels. The Hudson stock, which has not experi-

"...preliminary results from the 1989 Maryland survey...suggest very high juvenile production this year."

enced the same decline as the Chesapeake stock, had exceptionally high juvenile indices in 1987 and 1988.

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 more than 80% of the commercial catch. The nominal commercial catch from Maine to North Carolina in 1988 (185 mt) was one of the lowest on record. The recreational harvest of striped bass has remained low throughout the 1980s. Since 1986, more than 90% of the striped bass caught by recreational fisherman have been released alive. Landings during the 1980s have been affected not only by decreased abundance of striped bass but also by major changes in management regulations since 1982.

For further information

Richards, R.A. and D.G. Deuel. 1987. Atlantic striped bass: Stock status and the recreational fishery. *Marine Fisheries Review* 49(2):58-66.

USDOI and USDOC. 1987. Emergency striped bass research study. Report for 1987. Washington, DC: U.S. Department of the Interior, U.S. Department of Commerce. Available from: NMFS F/CM3, 1335 East-West Highway, Silver Springs, MD 20910.

Gulf of Maine - Mid-Atlantic Striped Bass

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Major
Management	=	Interstate Plan
Status of exploitation	=	under protection
Age at 50% maturity	=	6 years (females) 2 years (males)
Size at 50% maturity	=	29.7 cm (11.7 in.) males 71.1 cm (28.0 in.) females
Assessment level	=	Index

$M = 0.10 - 0.20$ $F_{0.1}$ = Unknown F_{max} = Unknown F_{1988} = Unknown

Striped Bass
Gulf of Maine - Mid-Atlantic

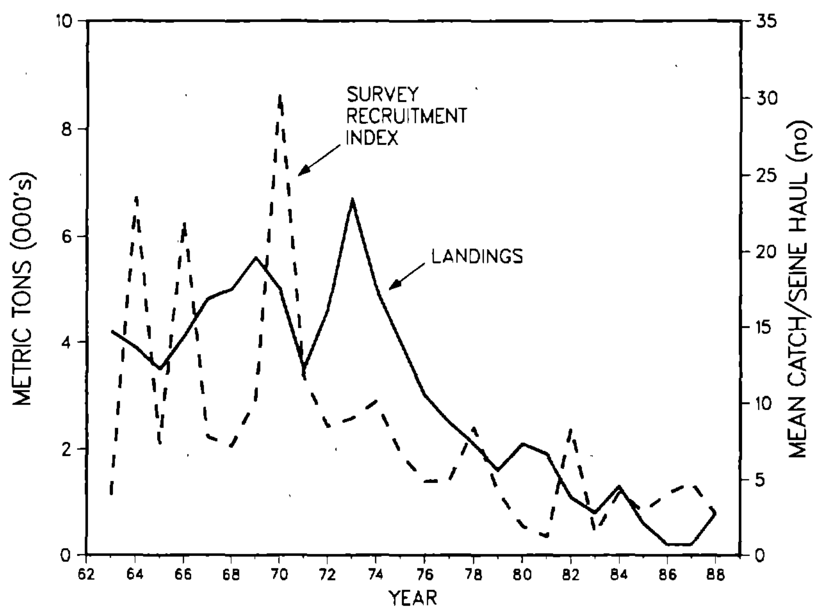
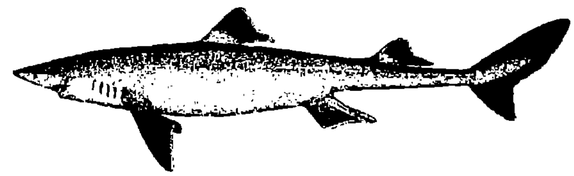


Table 24.1 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988
USA recreational	0.8	0.6	1.6	1.2	0.5	0.8	0.4	0.4	0.8[1]
Commercial									
USA	2.1	1.9	1.1	0.8	1.3	0.6	0.2	0.2	0.2
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	2.9	2.5	2.7	2.0	1.8	1.4	0.6	0.6	1.0

[1] **Preliminary NMFS data**

25. 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 summer visitors 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. 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 to 22 months producing 2 to 15 pups or an average of six.

The principal commercial fishing gear used for catching dogfish is otter trawls. Dogfish are frequently caught as by-catch during groundfish operations and discarded. Recreational fishing and foreign fishing are insignificant. There is no fishery management. Landings increased 12% in 1988 (2,600 mt to 2,900 mt).

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. Domestic catches since 1979 have fluctuated between 2,600 mt and 6,900 mt, with no trend. Low catches are attributable to a limited European market. This situation is expected to continue in 1989.

"Increases in dogfish and skate abundance, coupled with decreases in abundance of many demersal species, has resulted in ...survey catches by weight on Georges Bank...changing from roughly 25% dogfish and skates in 1963 to nearly 75%...in recent years."

Minimum biomass estimates of spiny dogfish based on NEFC spring bottom trawl survey catches declined 6% from 647,000 mt in 1987 to 606,000 mt in 1988, 131% above the 1968-87 geometric average of 262,000 mt. Since dogfish occur in schools, there tends to be rather high variability among the survey catches, resulting 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 lbs.), 83 cm (33 in.)], which are mainly mature females, to meet processing and marketing requirements. However, during certain times of the year, smaller individuals, consisting of both mature and immature males as well as immature females, are taken as 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 over exploitation 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.

A conservative estimate of the maximum sustainable yield (MSY) for the species is between 40,000 mt and 60,000 mt which is based on European studies (Holden 1968) which suggest that no more than 20% of the minimum biomass can be harvested annually. Under this harvest scenario, 120,000 tons could be taken annually from the present population.

The low levels of landings are not reflected in the generally increasing indices of abundance over the past decade or longer. Increases in dogfish and skate abundance, coupled with decreases in abundance of many demersal species, has resulted in the NEFC trawl survey catches by weight on Georges Bank, for example, changing from roughly 25% dogfish and skates in 1963 to nearly 75% these species in recent years. Such large increases in relative biomass of very low valued species has raised concerns about possible negative effects of these predators on overall fishery yields.

For further information

Grosslein, M.D. 1974. A first approximation of MSY for spiny dogfish in subareas 5 and 6 and Division 4. ICNAF Res. Doc. 74/30.

Holden, M.J. 1968. The rational exploitation of the Scottish-Norwegian stocks of spurdogs (*Squalus acanthias* L.). Ministry of Agriculture, Fisheries and Food, Fishery Investment Series II 25(8):1-27.

Nammack, M. F. 1982. Life history and management of spiny dogfish, *Squalas acanthias*, off the northeastern United States. Williamsburg, VA. College of William and Mary. 63 p. MS thesis.

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

Gulf of Maine - Mid-Atlantic Spiny Dogfish

Long-term potential catch	=	40,000 - 60,000 mt
Importance of recreational fishery	=	Insignificant
Management	=	None
Status of exploitation	=	Under exploited
Age at 50% maturity	=	6 yrs (males) 12 yrs (females)
Size at 50% maturity	=	60.1 cm (23.4 in.) males 80.7 cm (31.8 in.) females
Assessment level	=	Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1988} = Unknown

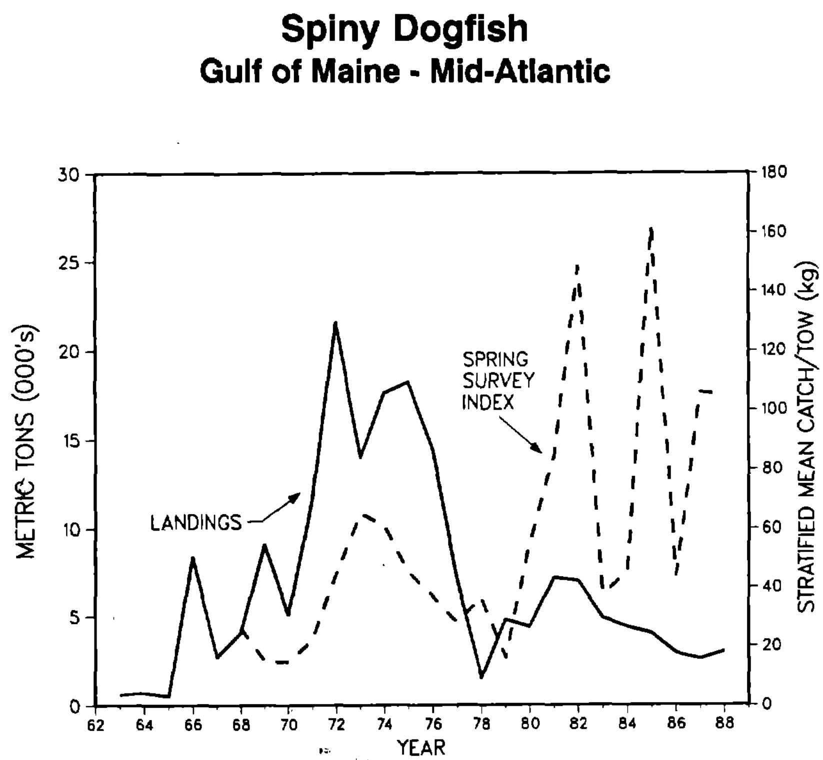
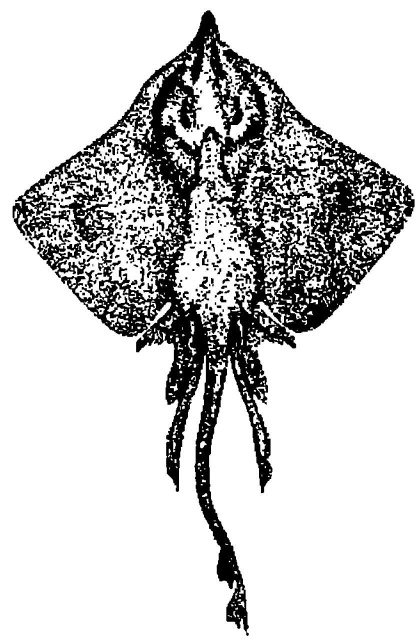


Table 25.1 Commercial landings (1,000 mt)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	4.2	6.9	6.6	4.9	4.4	4.0	2.6	2.6	2.9
Canada	-	-	-	-	-	-	-	-	-
Other	0.2	0.3	0.4	-	-	-	0.1	-	<0.1
Total nominal catch	4.4	7.2	7.0	4.9	4.4	4.0	2.7	2.6	2.9

26. 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 that are enclosed in a hard, leathery case commonly called a "mermaid's purse." Incubation time is 6 to 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.

The principal commercial fishing gear used to catch skates is the otter trawl. Skates are frequently caught as by-catch during groundfish operations and discarded. Recreational and commercial fishing is insignificant. There is no management. Catches increased 16% in 1988 (5,100 mt to 5,900 mt).

Historically, there was no directed domestic fishery for skates, and total nominal catches prior to 1983 were mostly less than 3,000 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.

The species composition of the 1988 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 markets expand.

Minimum biomass estimates for all skates in the Gulf of Maine - Mid-Atlantic area, determined from NEFC bottom trawl survey data, declined 11% from 188,400 mt in 1987 to 167,400 mt in 1988. The 1988 estimate was 11% greater than the long-term (1968-87) average of 127,600 mt. The 1988 biomass estimate increase is largely attrib-

"...substantially larger catches are possible."

utable to large catches of winter skate on Georges Bank.

A first approximation of the maximum sustainable yield (MSY) for skates is about 25,000 mt, which is based on an annual sustainable yield of 20% of the long term average minimum biomass estimate. This implies a present sustainable catch of about 33,000 tons.

Recent increases in catches have not been as large as the increases in apparent abundance, suggesting that substantially larger catches are possible. Increases in dogfish and skate abundance, coupled with decreases in abundance of many demersal species, has resulted in the NEFC trawl survey catches on Georges Bank, for example, changing from roughly 25% by weight of these species in 1963 to nearly 75% in recent years. Such large increases in relative biomass of very low valued species has raised concerns about possible negative effects of these predators on overall fishery yields.

For further information

Bigelow, H. B., and W. C. Schroeder. 1953. Fishes of the Gulf of Maine. Cambridge, MA: Harvard University Museum of Comparative Zoology.

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. Bridgewater, MA: Bridgewater State College. 122 p. MA Thesis.

Gulf of Maine - Mid-Atlantic Skates

Long term potential catch	=	25,000 mt
Importance of recreational fishery	=	Insignificant
Management	=	None
Status of exploitation	=	Under exploited
Age at 50% maturity	=	4 years[1]
Size at 50% maturity	=	40 cm (15.8 in.)[1]
Assessment level	=	Yield per recruit

$M = 0.40$[1] **$F_{0.1} = 0.49$[1]** **$F_{max} = 1.00$[1]** **F_{1988} = Unknown**

[1] **Pertains to the little skate.**

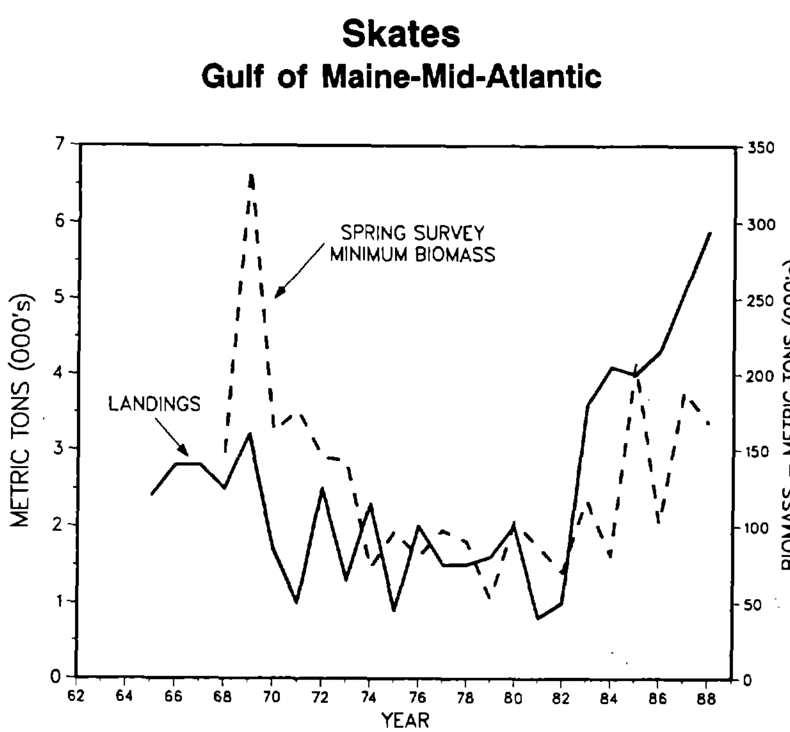
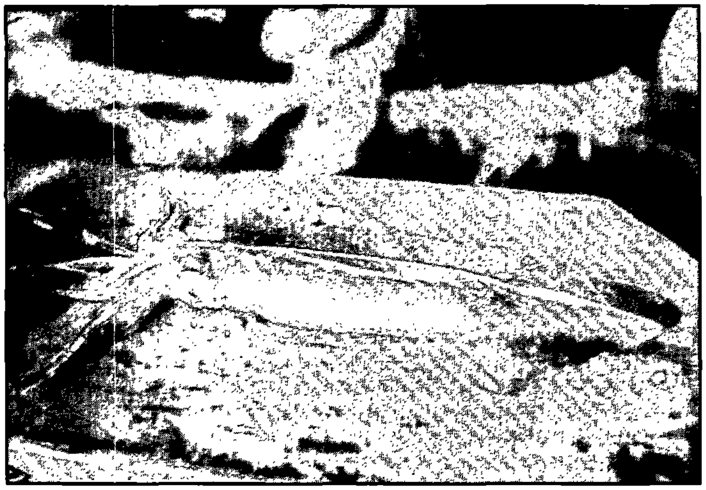
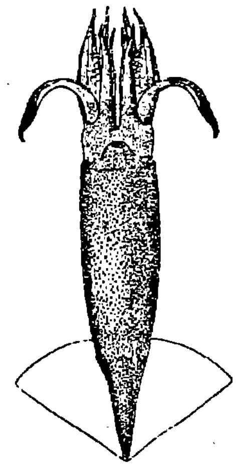


Table 26.1 Commercial landings (1,000 mt)

Category	Year 1980	1981	1982	1983	1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	2.0	0.8	1.0	3.6	4.1	4.0	4.2	5.1	5.9
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	0.1	-	-
Total nominal catch	2.0	0.8	1.0	3.6	4.1	4.0	4.3	5.1	5.9

27. 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 near the Gulf Stream. Larvae and juveniles are assumed to be transported north and east in the fringes of 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 in., dorsal mantle length) and live about 12 to 24 months. Commercial catches off the USA are comprised mainly of 10 to 28 cm (4 to 11 inches) individuals which are probably 8 to 24 months of age.

The principal fishing gear used to catch short-finned squid is otter trawls. Recreational catches are insignificant, and foreign catches have decreased to insignificant in the 1980s. The fishery is managed under the Mid-Atlantic Fishery Management Council's Squid, Mackerel, and Butterfish FMP. Management is through total allowable catch (TAC) levels, which have been reduced in recent years. Landings decreased 80% in 1988 (from 10,300 mt to 2,100 mt).

"...catch is dependent on the availability of squid within the area of the fishery."

Landings increased rapidly from near zero prior to 1972 to an average of roughly 19,500 mt between 1972 and 1982. Landings declined steadily starting in 1983 to the present 2,100 mt, with the exception of high catches in 1987. Roughly one third of the catches in that year were taken in joint venture operations.

Catch-per-unit-effort in the 1988 USA directed fishery was about 50% above the 1982-87 mean, indicating that the decrease in landings in 1988 was not due to lower availability. In fact, effort directed at *Illex* was greatly reduced in 1988, probably due to market conditions. The 1988 NEFC autumn survey index for *Illex* was about twice the 1968-87 mean, while pre-recruit (<10 cm) abundance in 1988 was about 60% below the 1968-87 average.

No significant relationship has been found between research vessel catch-per-tow data for *Illex* and availability to the subsequent *Illex* fishery when data for all years are examined. However, highly significant relationships ($p<0.01$) were found between SNE-MA mean numbers per tow for years with above average indices, and USA catches in the following year. Also, *Illex* abundance indices have generally held at either high or low levels for several years before exhibiting dramatic changes. Low abundance indices were seen during 1968-74, followed by high indices for 1975-81, and low indices from 1982 to 1986. It may be expected that above average indices, as seen in 1987 and 1988 will continue for the next few years.

Research survey and commercial

fishery data have been used to evaluate the effects of environmental variability on the *Illex* population. However, results have been inconclusive.

Above average apparent abundance of adult *Illex* during the autumn 1988 NEFC research vessel survey suggest that current abundance would be adequate to provide catches during 1989 at levels comparable to the average total landings from the fishery since the directed fishery began (1972-88). In fact, the current stock size should support catches at a level similar to that seen during the previous period of high abundance (19,500 mt average during 1976-82). However, the ability of the domestic fishery to take this level of catch is dependent on the availability of squid within the area of the fishery. This availability is associated with environmental and behavioral factors which are not yet fully understood. Also, the low level of catch during 1988 is attributed to market conditions which may persist during 1989.

The long term potential catch for *Illex* (30,000 mt) is based on an assumption of a moderate to strong relationship between stock size and recruitment, adjusted downward to account for uncertainties as to the stock structure within its range in the Northwest Atlantic and for incomplete information on its biology. At the current level of fishing, this stock in under exploited relative to the long term potential catch, and to recent above average abundance.

For further information

Lange, Anne M. T. 1984. Status of the short-finned squid, *Illex illecebrosus*, off the Northeastern USA, November 1984. Woods Hole, MA. NMFS, NEFC. Woods Hole Laboratory Reference Document 84-38. 20 p.

Northeast Fisheries Center. 1988. Report of Sixth Stock Assessment Workshop. Woods Hole, MA. NMFS, NEFC. Woods Hole Laboratory Reference Document 88-02. 78 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

Gulf of Maine- Mid-Atlantic Short-Finned Squid

Long-term potential catch	=	30,000 mt
Importance of recreational fishery	=	Insignificant
Management	=	Squid, Mackerel and Butterfish FMP
Status of exploitation	=	Under exploited
Age at 50% maturity	=	18 months
Size at 50% maturity	=	20 cm (7.9 in.) dorsal mantle length
Assessment level	=	Index

M = Unknown **$F_{0.1}$ = Unknown** **F_{max} = Unknown**
F_{1988} = Unknown

Short-Finned Squid
Gulf of Maine - Mid-Atlantic

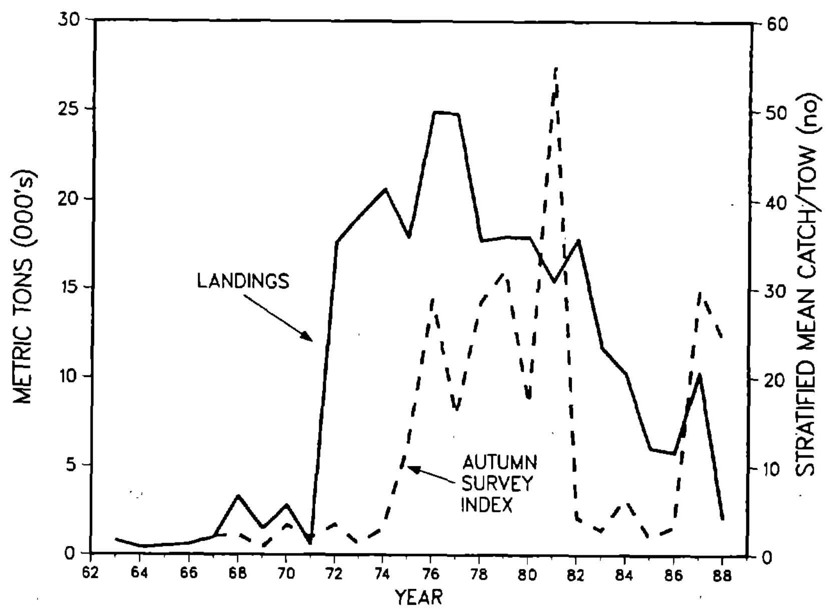
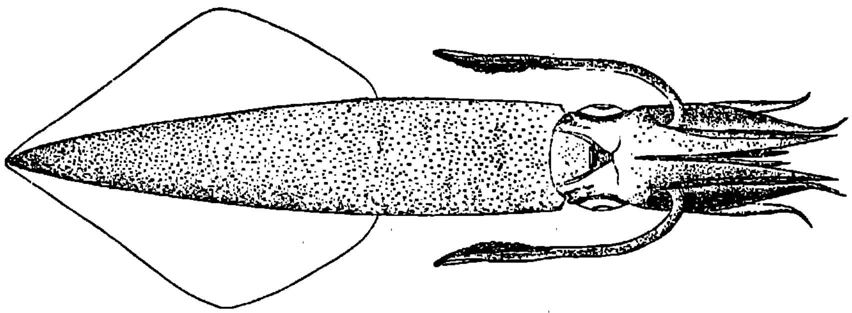


Table 27.1 Commercial landings (1,000 mt)

Category	Year 1980	1981	1982	1983	1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA[1]	0.3	0.6	5.9	9.9	9.5	5.0	5.6	10.3	2.1
Canada	-	-	-	-	-	-	-	-	-
Other	17.5	14.8	12.4	1.8	0.7	1.1	0.2	-	-
Total nominal catch	17.8	15.4	18.3	11.7	10.2	6.1	5.8	10.3	2.1
Total allowable catch	30.0[2]	30.0[2]	30.0[2]	30.0[2]	30.0[2]	25.0[2]	22.5	22.5[3]	17.0

[1] **Includes prorated amounts of squid catches not identified to species.**
[2] **1 April - 31 March fishing year.**
[3] **MSY value; actual allocated level (Final Optimum Yield (OY)) was 17.0.**

28. 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 inshore 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 traditionally occurred 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* may reach lengths of more than 40 cm (16 in., dorsal mantle length) and ages of about 3 years, but most individuals taken in commercial catches are 8 to 20 cm (3 to 8 inches) and 8 to 14 months. The timing and extent of seasonal migrations are assumed to be related, at least in part, to temperature preferences of this species. Regression analysis indicates that about 77% of the variation in *Loligo* mean catch-per-tow in the autumn NEFC bottom trawl surveys may be accounted for by changes in bottom temperature.

The principal fishing gear used to catch long-finned squid is the otter trawl. Recreational fishing is insignificant and foreign fishing activity has decreased to insignificance over the last decade. Fishing is managed under the Mid-Atlantic Fishery Management Council's Squid, Mackerel, and Butterfish FMP. Management is based on a total allowable catch (TAC) limit. Landings increased 67% in 1988 (from 11,500 mt to 19,200).

Landings of long-finned squid increased from very low levels prior to 1967 to record high levels of nearly 38,000 mt in 1973 under heavy foreign fishing. Landings dropped from 1974 through 1978 to roughly 10,000 mt, and have subsequently fluctuated between 10,000 mt and 28,000 mt. During this period there has been a change from 75% to 90% foreign catches to virtually 100% domestic catches.

The 1988 NEFC autumn bottom trawl survey abundance indices (stratified mean number per tow) for the Mid-Atlantic through Georges Bank strata were the fourth highest of the series (1967-88). Total abundance was 46% above the 1968-87 mean, while the pre-recruit ($\leq$ 8 cm dorsal mantle length individuals) index was 39% above the 1968-87 mean.

Total recruitment from the 1988 year class is estimated to be 2.6 billion individuals. Yield-per-recruit and stock recruitment analyses based on this level of recruitment and estimates of current fishing mortality (F=0.4) indicate that potential yield of *Loligo* from the 1988 year class is between 29,000 mt and 33,000 mt. If fishing mortality were increased to the level corresponding to the maximum equilibrium yield (F=0.7), potential yields of 35,000 mt to 41,000 mt would be expected.

The 1987 autumn survey indices were the lowest of the time series and it was theorized that a massive cold pool, present in the southern New England-Mid-Atlantic area during the time of that survey may have reduced availability of *Loligo* to the survey trawl. Whatever the cause of the low 1987 indices, availability to the 1988 fishery apparently was not affected.

Above average apparent abundance of both adults and pre-recruits during the autumn 1988 NEFC research vessel survey suggest that current abundance

"...year class strengths have been good..."

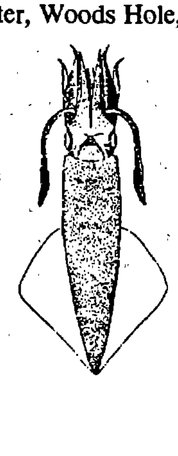
of *Loligo* is adequate to provide catches during 1989, of between 29,000 and 33,000 mt, even at F levels below those expected to produce the highest equilibrium yield. In fact, catches of *Loligo* in the 1989 domestic winter offshore fishery (9,300 mt) were over 3 times the 1988 catches for the corresponding period, indicating reasonable availability of the stock, though the effort associated with these catches is not known.

The fluctuating catch levels over this decade have not been associated with any trends in population abundance, but the fluctuations likely reflect varying year class strengths in this short lived species, and changing market conditions. Recent survey indices suggest that year class strengths have been good, and suggest that the stock is under exploited relative to the estimated long term potential catch of 44,000 mt.

For further information

Lange, Anne M. T. 1984. An assessment of the long-finned squid resource off the northeastern United States, Autumn 1984. Woods Hole, MA. NMFS, NEFC. Woods Hole Laboratory Reference Document 84-37. 24 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

Northeast Fisheries Center. 1988. Report of Sixth Stock Assessment Workshop. Woods Hole, MA. NMFS, NEFC. Woods Hole Laboratory Reference Document 88-02. 78 p. Available from: Northeast Fisheries Center, Woods Hole, MA.



Gulf of Maine - Mid-Atlantic Long-Finned Squid

Long-term potential catch	=	44,000 mt
Importance of recreational fishery	=	Insignificant
Management	=	Squid, Mackerel and Butterfish FMP
Status of exploitation	=	Under exploited
Age at 50% maturity	=	12 months
Size at 50% maturity	=	16 cm (6.3 in.) dorsal mantle length
Assessment level	=	Yield per recruit

M = Unknown **$F_{0.1}$ = Unknown** **F_{max} = Unknown**
F_{1988} = Unknown

Long-Finned Squid
Gulf of Maine - Mid-Atlantic

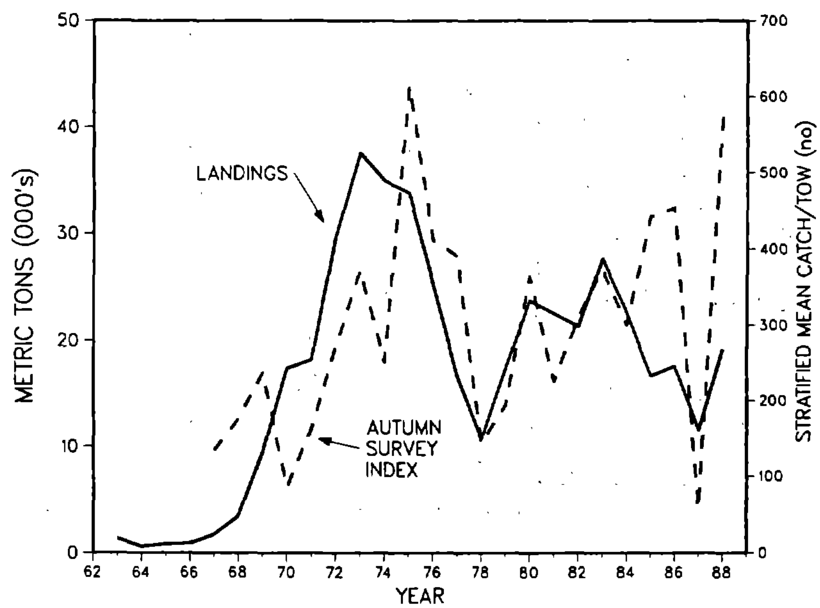
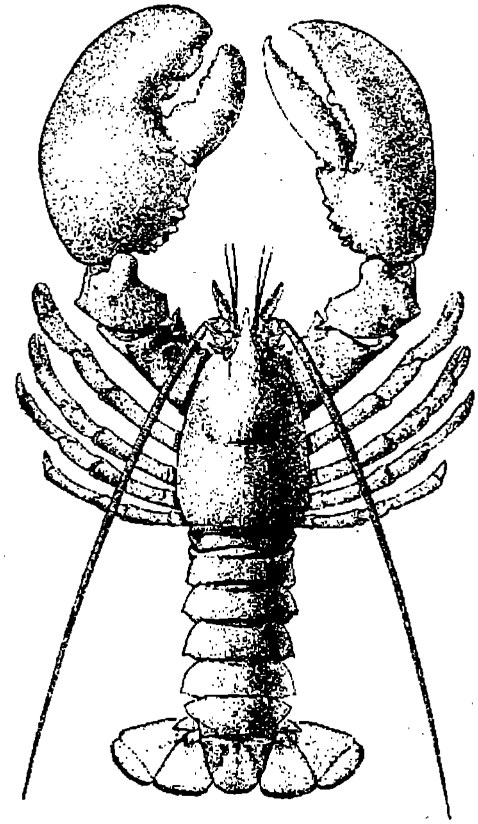


Table 28.1 Commercial catches (1,000 mt)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA[1]	4.0	2.3	5.5	15.9	11.6	10.2	13.3	11.5	19.1
Canada	-	-	-	-	-	-	-	-	-
Other	19.8	20.2	15.9	11.7	11.0	6.5	4.3	<0.1	<0.1
Total nominal catch	23.8	22.5	21.4	27.6	22.6	16.7	17.7	11.5	19.1
Total allowable catch	44.0[2]	44.0[2]	44.0[2]	44.0[2]	44.0[2]	33.0[2]	37.0[2]	37.0[3]	37.0[4]

[1] Includes prorated amounts of squid catches not identified to species.
[2] 1 April - 31 March fishing season.
[3] MSY value; actual allocated level (Final Optimum Yield) was 10.1.
[4] MSY value; actual allocated level was 17.0

29. AMERICAN LOBSTER



The American lobster, *Homarus americanus*, is distributed in the Northwest Atlantic from Labrador to Cape Hatteras from coastal regions out to depths of 700 m. Lobsters are locally abundant in coastal regions within the Gulf of Maine and off southern New England and less abundant in more southerly areas. Coastal lobsters are concentrated in rocky areas where shelter is readily available, although occasional high densities occur in mud substrates suitable for burrowing. Offshore populations are most abundant around submarine canyons along the continental shelf edge. Tagging experiments in coastal waters suggest that small lobsters undertake rather limited movement with some evidence that larger individuals may travel extensively. In contrast, offshore lobsters show well-defined shoalward migrations during the spring, traveling as much as 300 km (186 mi), regularly 80 km (50 mi). Lateral movements along the shelf edge have also been demonstrated.

Lobsters exhibit a complex life cycle in which mating occurs after the female molts, and the eggs (7,000 to 80,000) are carried under the female's abdomen during a 9 to 11 month incubation period. The eggs hatch during late spring or early summer and the pelagic larvae undergo four molts before attaining adult characteristics and settling to the bottom. Lobsters molt approximately 20 times (in 5 to 8 years) before reaching minimum size. A significant proportion of the lobsters caught in inshore are not sexually mature.

The principal fishing gear used to catch lobsters is the trap. Lobsters are also taken as a bycatch with otter trawls. Recreational fishing occurs, especially in coastal waters, but estimates of the catch are not available. Foreign fishing is insignificant. The fishery is managed under the New England Fishery Management Council's Lobster FMP, and within 3 miles under various state regulations. The primary regulatory measure is shell length. Total landings increased 7% in 1988 (from 20,700 mt to 22,200 mt).

Gulf of Maine - Mid-Atlantic American Lobster

Long-term potential catch	=	3,400 mt[1]
Importance of recreational fishery	=	Insignificant[1]
Management	=	Lobster FMP
Status of exploitation	=	Fully exploited[1]
Size at 50% maturity	=	10 cm (3.9 in.) carapace length
Assessment level	=	Index

$M = 0.10$ $F_{0.1}$ = Unknown F_{max} = 0.18 (males) 0.23 (females) $F_{1987} > F_{max}$

[1] Offshore fishery only.

INSHORE FISHERY

Nominal landings in the USA inshore fishery remained relatively stable from 1965 to 1975, ranging from 10,300 mt to 12,200 mt, averaging 11,100 mt. From 1978 to 1988 the catch has risen steadily from 12,900 mt to a record 19,200 mt in 1988, some 11% higher than 1987. This increase can be attributed in large part to a continuing trend of increasing effort, especially in the number of pots fished. Some of this effort increase may be in response to recent increases in minimum size limits. Fishermen, trying to cover short term losses due to the new size limits, appear to be fishing more pots in the inshore areas.

"...fishermen...appear to be fishing more pots in the inshore areas."

The increases in the inshore landings have resulted in an increasing fishing mortality rate, and an increased dependence on lobsters which have just grown larger than the minimum size limit.

OFFSHORE FISHERY

Prior to 1950, lobsters were primarily taken offshore as incidental trawl catches in the demersal fisheries. Reported offshore lobster landings increased dramatically from about 400 mt during the 1950's to an average of over 2,000 mt in the 1960's. In 1969 technological advances permitted the introduction of trap fishing to the deeper offshore areas. Landings from offshore traps rose from 50 mt in 1969 to 2,900 mt in 1972 and remained relatively stable at around 2,000 mt from 1975 to 1983.

From 1984 through 1988 trap landings averaged around 2,900 mt. This increase in offshore trap landings has been accompanied by a decrease in trawl landings from a peak of 3,200 mt in 1971 to 500 mt in 1984. In subsequent years the trawl component of the fishery has averaged a little over 300 mt. Total offshore landings have risen from a decline in the late 1970's and early 1980's to an average of around 3,000 mt, but have never comprised more than 20% of the total US landings. The contribution of the offshore fishery to overall landings in 1988 was about 13.5% of the total.

The increases in the offshore landings in the past decade and the continued intense inshore fishery has raised the question of the relationship between animals in these two areas. If consistent recruitment in the coastal areas depends on high abundance of spawning lobsters offshore, then recent decreases in the abundance caused by the development of the offshore trap fishery may result in reduced inshore catches in future years. The assessment information is insufficient, however, to resolve such questions and the status of the stock is uncertain.

"...a reduction in stock biomass following the development of the offshore fishery with stabilization of the stock at reduced levels in recent years."

The NEFC autumn survey biomass index declined steadily from 1.3 kg/tow in 1964 to 0.5 kg/tow in 1970. From 1971-76 this index averaged 0.7 kg/tow, and increased to an average of 1.0 kg/tow from 1977-80. In 1985 the autumn index dropped to 0.8 kg/tow and further to and average of about 0.65 kg/tow in 1987 and 1988. Trends in the commercial CPUE index (catch-per-trap-haul-set-over-day or kg/THSOD) follow that of the NEFC autumn survey. Thus these trends in biomass indices and offshore landings are consistent in indicating a reduction in stock biomass following the development of the offshore fishery with stabilization of the stock at reduced levels in recent years.

For further information

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.

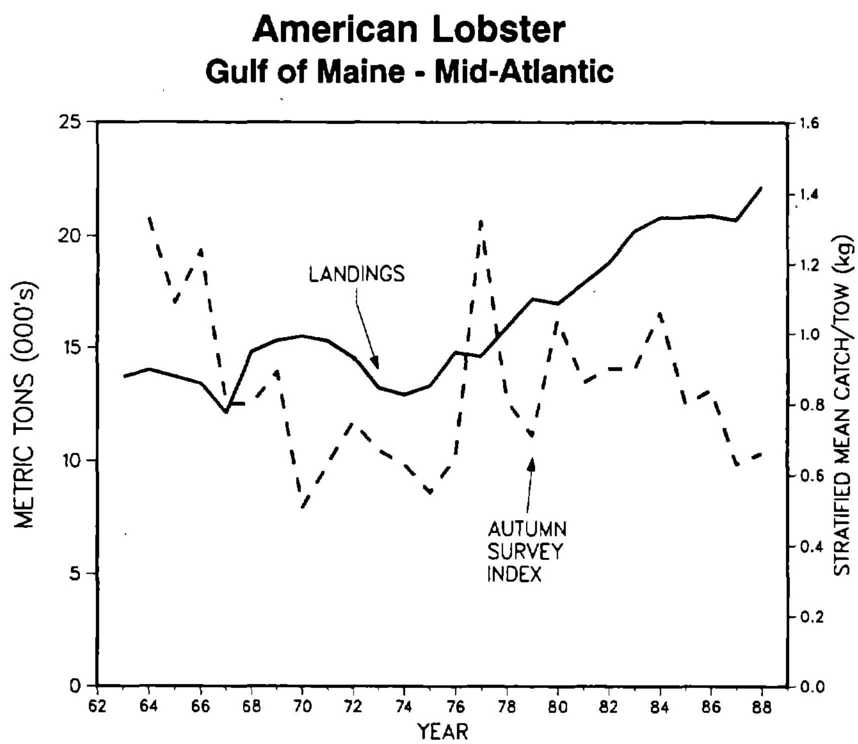
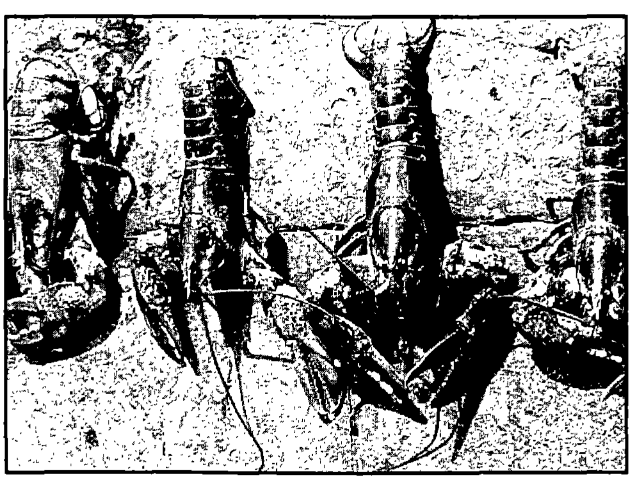


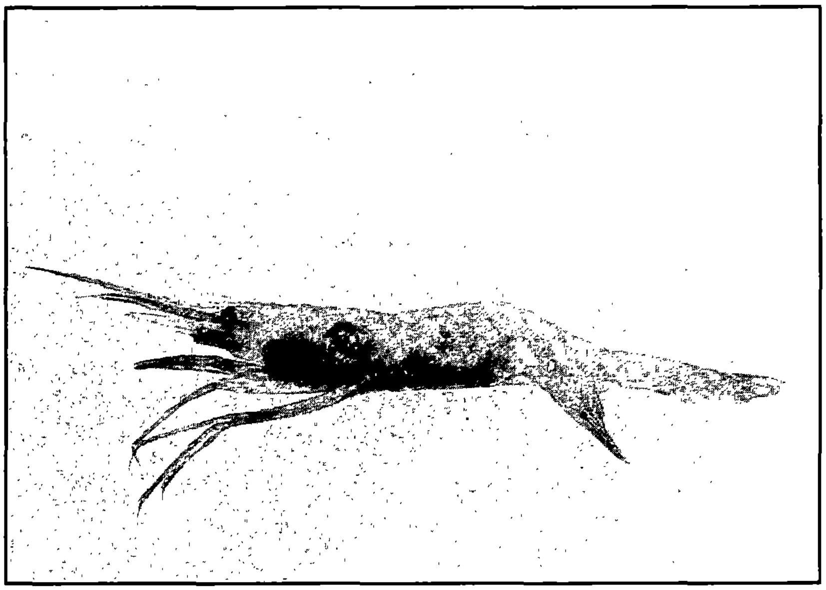
Table 29.1 Commercial (1,000 mt, live weight). Landings statistics have been revised to reflect unreported catches.

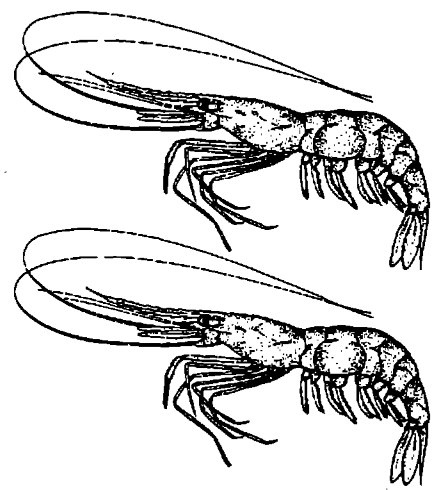
Category	1980	1981	1982	1983	1984	1985	1986	1987	1988
USA recreational[1]	-	-	-	-	-	-	-	-	-
Commercial									
USA: Offshore[2]	1.9	1.8	2.5	2.4	4.2	2.6	3.4	3.3	3.0
Inshore[3]	14.9	15.9	16.1	17.6	16.4	18.0	17.8	17.3	19.2
Canada: Georges Bank	0.2	0.2	0.2	0.2	0.2	0.2	<0.1	<0.1	<0.1
Total nominal catch	17.0	17.9	18.8	20.2	20.8	20.8	20.9	20.7	22.2

[1] Recreational catches unknown.
[2] Includes trawl and offshore trap catches.
[3] Inshore trap catches.



30. 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 to have been strongly influenced by temperature, with above-normal temperatures being associated with poor recruitment. This stock collapsed during the mid-1970s; some recovery has been evident in recent years, but abundance remains considerably below peak levels observed during the late 1960s.

Northern shrimp are protandric hermaphrodites, maturing first as males. After spawning as males in late summer at about 2.5 years of age, individual shrimp pass through a series of transitional stages the following winter and spring, and then spawn as females (age 3.5 years) the following summer. Eggs are extruded onto the abdomen and fertilized within a month of spawning. During autumn and winter, egg-bearing or "ovigerous" females migrate into inshore areas where the eggs hatch (late winter at age 4). Females may survive to spawn in subsequent years although natural mortality appears to increase sharply following first hatching.

Shrimp are taken primarily by otter trawling, although pots have also been used successfully along the central Maine coast. Recreational and foreign fishing are insignificant. The Gulf of Maine northern shrimp fishery is managed jointly by the states of Maine, New Hampshire and Massachusetts under the auspices of the Atlantic States Marine Fisheries Commission (ASMFC). The fishery has been managed primarily by mesh size regulations and seasonal closures. Landings decreased 38% in 1988 (i.e. from 5,000 mt to 3,100 mt).

Fishing effort has been directed primarily toward mature females in inshore areas during winter; effort tends to shift further offshore in spring reflecting both post-hatch movement and improving weather conditions. Total effort on this stock (number of trips) has risen steadily since the late 1970s; the 1987 season total (11,000 trips) was more than triple the 1981-82 average. A total of 8,300 trips were made during 1988. A further decline is expected for 1989 although a significant increase in effort by larger vessels has been documented in offshore areas, apparently in response to low groundfish abundance.

Nominal catches peaked at 12,800 mt in 1969, averaged approximately 11,000 mt during 1971-72, and then declined precipitously during the mid to late 1970s. Landings subsequently increased steadily from 300 mt in 1980 to 5,000 mt in 1987, and then decreased in 1988 to 3,100 mt. Landings for the 1988-89 season (December-May) are expected to be comparable to the 1987-88 season total of 3,000 mt. The upward trend during the mid-1980s reflects improved recruitment, particularly from the strong 1982 year class. The NEFC autumn survey index increased more or less continually from 1977 to 1986 but has since declined.

Since 1983, the primary source of assessment information for this stock has been the cooperative survey conducted each August by the Northern Shrimp Technical Committee aboard the NEFC's R/V *Gloria Michelle*. This survey has detected two strong year classes, one produced in 1982 and a second produced in 1987; other year classes in the time series have been considerably weaker. Summer survey index values peaked in 1985-86 and then dropped sharply in 1987. Catch per tow of age 3 and older shrimp has declined continually since 1985, reflecting increased natural and fishing mortality on the 1982 year class. Catch per tow in numbers and weight increased sharply in 1988 with recruitment of the 1987 year class, but as northern shrimp do not recruit to the fishery until age 3, this year class is not expected to have a significant impact upon commercial landings before 1990.

The increase in landings from 1985 to 1987, and the decrease in landings in 1988 were the result of the strong 1982 year class entering and then passing through the fishery. Catches are expected to increase in 1990 as the 1987 year class recruits to the fishery. Fishing mortality rates have been relatively low in recent years and well within limits shown to be acceptable for other pandalid shrimp stocks.

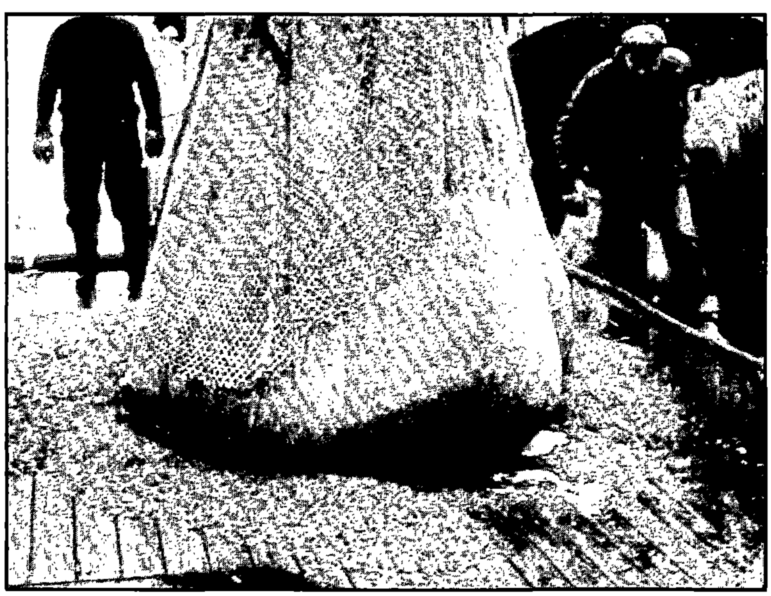
For further information

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.

McInnes, D. 1986. Interstate fishery management plan for the northern shrimp (*Pandalus borealis* Kroyer) fishery in the western Gulf of Maine. Atl. States Mar. Fish. Comm. Fish. Mgt. Rept. No. 9. 79p.

Northern Shrimp Technical Committee. 1988. Assessment report for Gulf of Maine northern shrimp stock status - 1988. Report to the Northern Shrimp Section of the Atlantic States Marine Fisheries Commission, October, 1988. 14p.

Northern Shrimp Technical Committee. 1988. Cruise results: Gulf of Maine northern shrimp survey, August 1-6 and 17-20, 1988. Unpublished report, Woods Hole, MA. 15p.



"Catches are expected to increase in 1990 as the 1987 year class recruits to the fishery."

Gulf of Maine
Northern Shrimp

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Insignificant
Management	=	Interstate Plan
Status of exploitation	=	Fully exploited
Age at 50% maturity	=	2 years
Size at 50% maturity	=	9 cm (3.5 in.)
Assessment level	=	Index

M = 0.5 **$F_{0.1}$ = Unknown** **F_{max} = Unknown** **F_{1988} = 0.3**

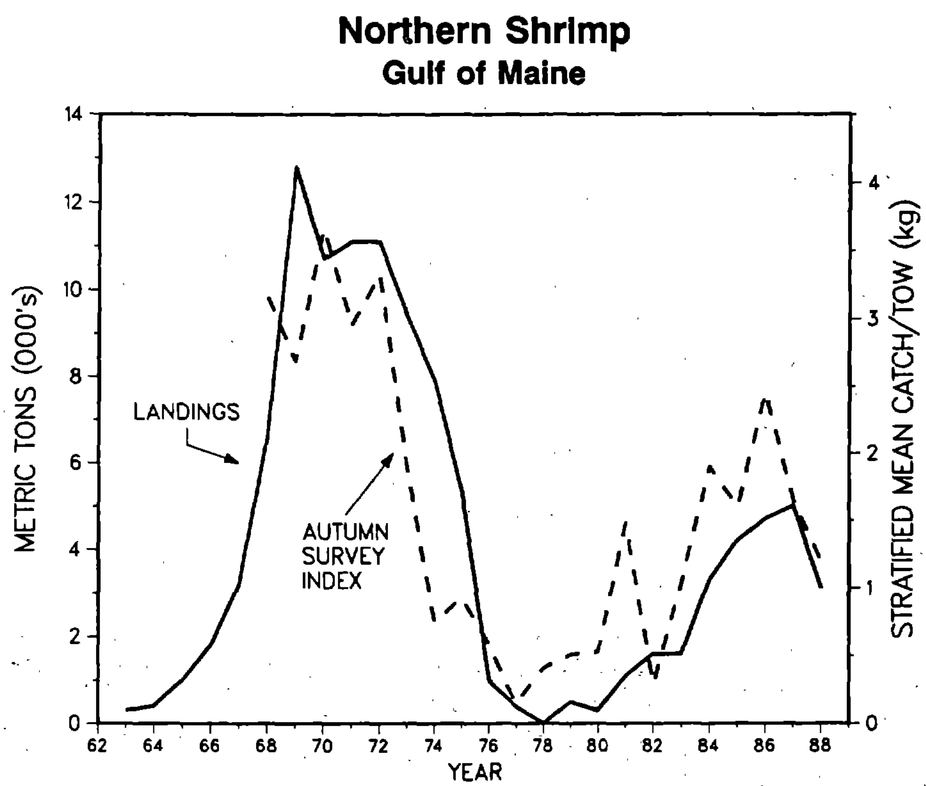
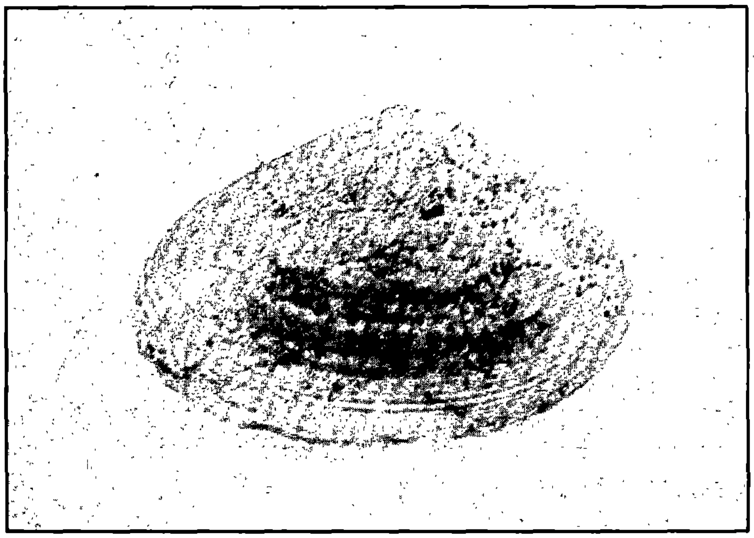
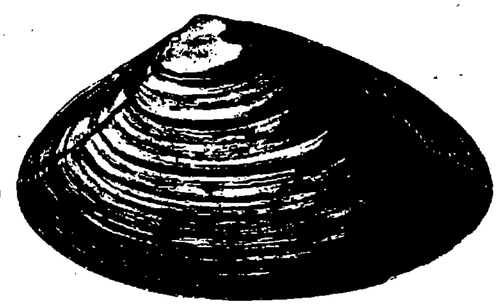


Table 30.1 Commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
USA	0.3	1.1	1.6	1.6	3.3	4.2	4.7	5.0	3.1
Canada	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-
Total nominal catch	0.3	1.1	1.6	1.6	3.3	4.2	4.7	5.0	3.1

31. SURF CLAM





Surf clams, *Spisula solidissima*, are distributed in western North Atlantic waters from the southern Gulf of St. Lawrence to Cape Hatteras. Commercial concentrations are found primarily off New Jersey and the Delmarva Peninsula, although some fishable quantities exist in Southern New England waters, 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 six to seven years. Maximum size is about 22.5 cm (8 7/8 in.), but clams larger than 20 cm (7 7/8 in.) 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 three weeks (at 22° C).

The principal fishing gear for surf clams is the hydraulic clam dredge. Recreational and foreign fishing is insignificant. Fishing is managed under the Mid-Atlantic Fishery Management Council's Surf Clam and Ocean Quahog FMP. Management is based on a total allowable catch (TAC) limit, as well as minimum landing size, closed areas to protect undersized clams, and restricted numbers of fishing trips per vessel. Landings increased 4% in 1988 (27,600 to 28,800 mt).

Total landings of surf clams averaged roughly 20,000 mt in the early 1960s, increased to over 46,000 mt by 1974, and then decreased by 1979 to well below the earlier average of 20,000 mt. Landings have subsequently increased under management restrictions, declining somewhat in the most recent years.

Regulation of the fishery has proceeded with a principal objective being to rebuild 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 identi-

New England - Mid-Atlantic Surf Clams

Long-term potential catch	=	24,300 mt
Importance of recreational fishery	=	Insignificant
Management	=	Surf Clam and Ocean Quahog FMP
Status of exploitation	=	Fully exploited
Age at 50% maturity	=	2 years
Size at 50% maturity	=	5 cm (2.0 in.)
Assessment level	=	Index

$M = 0.05$ $F_{0.1} = 0.11$ $F_{max} = 0.4$ $F_{1988} \sim 0.1$

"...resources...are sufficient to sustain the fishery for the next several years."

fied 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.

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 1950s; combined with inshore beds near Cape May - Wildwood, the New Jersey resources supported the fishery until the early 1970s. Declining productivity of New Jersey fishing areas prompted a shift of effort to the south during the early 1970s. New beds off southern Virginia and North Carolina contributed to a tremendous increase in total landings during 1973-75. Average catches in these three years of 40,100 mt (meats) were 50% greater than the 1965-77 average of 27,000 mt. The southern Virginia - North Carolina fishery collapsed during 1976; most vessels returned to more northern ports. During 1988, most of the Middle Atlantic FCZ surf clam landings were taken off New Jersey, with the remainder taken off the Delmarva Peninsula, from the southern Virginia - North Carolina region. Total FCZ landings in 1988 were 23,900 mt, representing an 8% increase from the previous year's total of 22,100 mt. The increase in total in offshore catch is primarily related to market demands for the product, rather than to any significant change in surf clam abundance.

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-1960s 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. Surveys from 1978 to 1984 indicated 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 continued high until the return of the fleet from southern Virginia - North Carolina during 1976. Concentration of the offshore fishery in Delmarva waters between 1976 and 1980 resulted in declining stocks of commer-

Surf Clams
New England-Mid-Atlantic

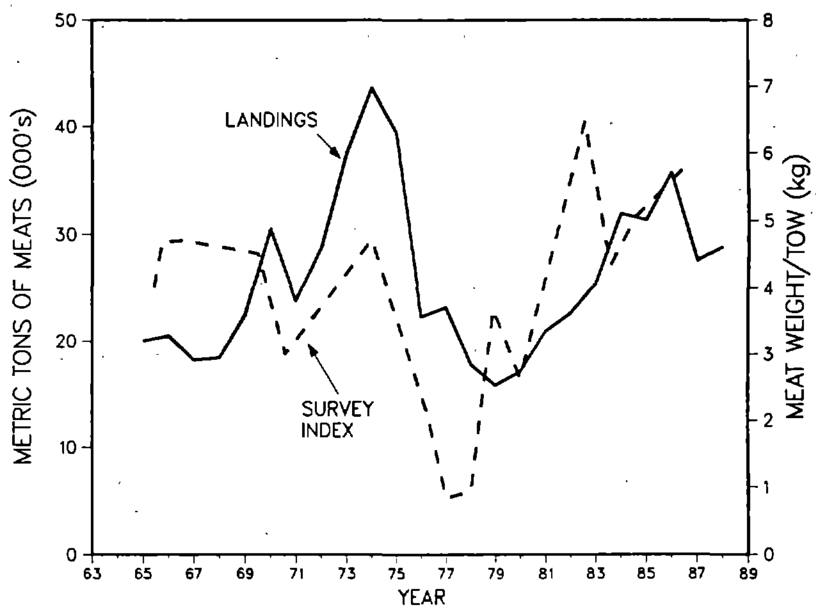


Table 31.1 Commercial landings (1,000 mt)

Category	1980	1981	1982	1983	Year 1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	--	
USA commercial									
FCZ waters	15.7	16.9	16.7	20.5	24.7	23.7	24.9	22.1	23.9
State waters	1.4	4.0	5.9	4.9	7.2	9.2	10.8	5.4	4.9
Total	17.1	20.9	22.6	25.4	31.9	32.9	35.7	27.5	28.8
Total allowable									
FCZ catch	13.6	18.1	18.1	18.9	24.3	24.3	24.3	24.3	24.3

cial sizes. Recent surveys indicate that the biomass of commercial sizes has remained relatively low, although a strong 1977 year class exists off Delmarva. Based on growth rate projections, increasing proportions of the 1977 year class will reach harvestable size during 1989 and 1990. During early 1989 there were several reports of 3-4 cm shell length clams in the Ocean City, MD area. These locations will be investigated in the NEFC ocean clam survey during the summer of 1989.

Research vessel survey data through 1986, the last year of synoptic surveying, indicated adequate surf clam resources currently exist to support the Middle Atlantic FCZ fishery at or near current levels (18,000 to 23,000 mt of meats) until the mid-1990s. Likewise, landings of 3,000 to 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. Although no resource surveys for surf clam were conducted in 1987 or 1988, it is unlikely that significant new recruits that had not been previously documented will enter the fishery, since it takes at least five years for surf clams to reach harvestable size.

Landings from inshore (state) waters decreased dramatically between 1986 and 1988 (from 10,800 to 4,900 mt). This decline in nearshore landings is due primarily to sharp reductions in landings from inshore New York waters, and to a lesser extent, from off New Jersey.

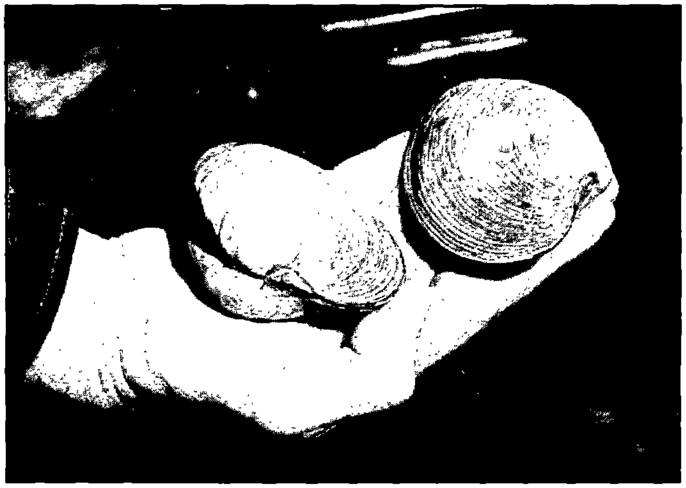
FCZ landings continue to be relatively stable due to the large standing stock, relative to the annual quota. In the last several years, concentrated fishing in the New Jersey area off Atlantic City has reduced biomass in that area. Nevertheless, substantial resources there, and especially off the Delmarva Peninsula, are sufficient to sustain the fishery for the next several years.

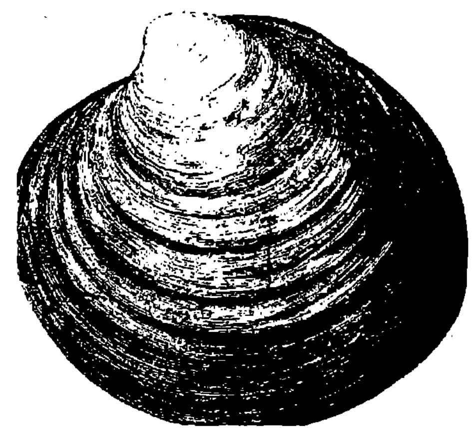
For further information

Murawski, S.A., and F.M. Serchuk. 1989. Mechanized shellfish harvesting and its management: the offshore clam fishery of the eastern United States. In: Caddy, J. ed., *Marine invertebrate fisheries: their assessment and management.* pp. 479-506. New York: John Wiley and Sons.

Murawski, S. A. 1986. Assessment updates for Middle Atlantic, New England, and Georges Bank offshore surf clam, *Spisula solidissima* , populations, - summer 1986. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 86-11. 34 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

32. OCEAN QUAHOG





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 deeper than 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 in.) 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.

The principal fishing gear used for ocean quahogs is the clam dredge. Recreational and foreign fishing is insignificant. Fishing is managed under the Mid-Atlantic Fishery Management Council's Surf Clam and Ocean Quahog FMP. The primary management measure has been a total allowable catch (TAC) limit, which has been increased in the 1980s.

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 clam stocks combined with the massive kill of surf clams off New Jersey in 1976 stimulated fishing for the deeper-dwelling ocean quahog. Total ocean quahog landings increased dramatically between 1976 and 1979 from 2,500 to 15,800 mt of meats per year. Increased landings in 1987 (22,900 mt of meat) were near

New England - Mid-Atlantic Ocean Quahogs

Long-term potential catch	=	27,200 mt
Importance of recreational fishery	=	Insignificant
Management	=	Surf Clam and Ocean Quahog FMP
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 in.) shell length
Assessment level	=	Index

M = 0.01 - 0.10 **$F_{0.1}$ = Unknown** **F_{max} = 0.03 - 0.05**
F_{1988} = Unknown, probably < 0.1

"... resource and fishery... should remain stable for the next few years."

the record high level observed in 1985. Landings decreased in 1988 to 21,000 mt. 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.

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 from 1965 to 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 from 1979 to 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 some decline as vessels sought fishable concentrations. CPUE is likely to continue to exhibit such variability as new beds are located. The catch is primarily composed of quahogs 65 to 105 mm shell length. Little size selectivity is apparent in the fishery, 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 greater than this 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.

Ocean Quahogs
New England - Mid-Atlantic

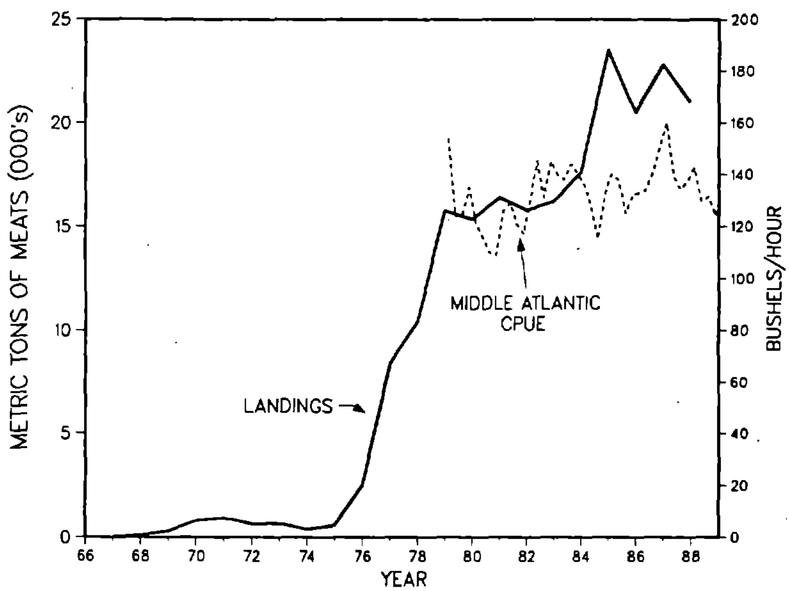


Table 32.1 Commercial landings (1,000 mt, meats)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988[1]
USA recreational	-	-	-	-	-	-	-	-	-
USA commercial									
FCZ waters	13.9	16.0	15.6	15.3	16.4	23.6	19.8	22.3	20.6
State waters	1.5	0.4	0.2	0.7	1.2	<0.1	0.8	0.6	0.4
Total nominal catch	15.3	16.4	15.8	16.0	17.6	23.6	20.5	22.9	21.0
Total allowable FCZ catch	15.9	18.1	18.1	18.1	18.1	20.4	27.2	27.2	27.2

[1] Estimated

For further information

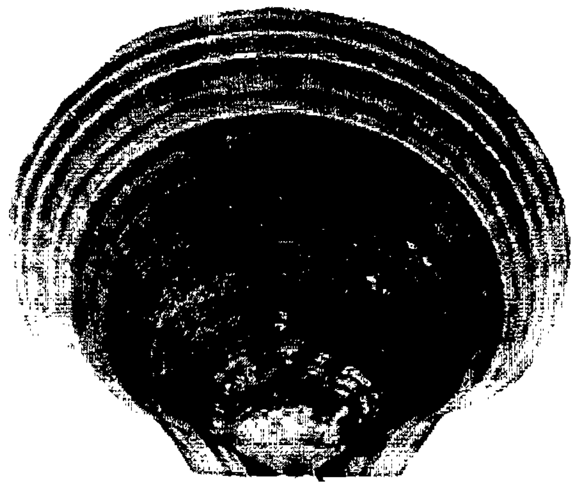
Murawski, S.A. and F.M. Serchuk. 1983. An assessment of the ocean quahog, *Arctica islandica*, resource and fishery in FCZ waters off the Northeastern USA - Autumn 1983. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 83-25. 31 p.

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. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 86-14. 98p. Available from: Northeast Fisheries Center, Woods Hole, MA.

33. SEA SCALLOP



Sea scallops, *Placopecten magellanicus*, are found 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 to 110 fathoms). Commercial concentrations generally exist between 40 and 100 m (22 to 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 to 80 percent in shell height and quadruple in meat weight. During this time span, the number of meats per pound in reduced from greater than 100 to about 23. Maximum size is about 23 cm (9.0 in.), but scallops larger than 17 cm (6.7 in.) are rare. Sexual maturity commences at age 2, 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 to 6 weeks before settling to the bottom.

The commercial fishery for scallops is conducted year-round with dredges and otter trawls as primary gear. The USA fishery is managed under the New England Fishery Management Council's FMP for the Atlantic Sea Scallop Fishery. Total (USA and Canada) landings declined 12% in 1988 (20,000 mt to 17,600 mt).

GULF OF MAINE

Nominal catch in 1988 from the Gulf of Maine was 600 mt (meat weight),49% more than in 1987. USA landings (500 mt) accounted for 89% of the 1988 total, with Canada accounting for the remaining 11%. Most of the USA catch (81%, 400 mt) was from inshore, territorial waters along the coast of Maine. USA landings (100 mt) from the EEZ (> 3 n mi from shore) remain low indicating continued dependence by the fishery on inshore beds.

"...fishing effort in 1988 increased 9%..."

Commercial fishing effort in 1988 increased 9% from 1987 but was still the second lowest since 1977. USA commercial CPUE in 1988 increased for the second consecutive year to its highest level since 1982.

GEORGES BANK

Total (USA and Canada) nominal catch from Georges Bank (Area 5Ze) in 1988 was 10,400 mt, 11% lower than in 1987, but the second highest

"...current fishing effort is far beyond what the resource can sustain."

annual catch since 1982. Of the 1988 total, USA landings accounted for 58% (6,100 mt) while Canadian landings (4,300 mt) accounted for 42%. The 1988 USA catch was 25% higher than 1987 and was the highest since 1982, while Canadian landings declined by 36% between 1987 and 1988.

USA fishing effort increased to a record-high level in 1988 (37% from 1987). USA CPUE in 1988 was slightly lower (9%) than in 1987, but was still the second highest since 1982. Most of the increase in USA effort was due to increased fishing activity by Class 4 vessels (151 - 500 GRT). Canadian fishing effort increased by 4% in 1988 while Canadian CPUE declined by 39%.

Abundance indices from the 1988 USA sea scallop research vessel survey indicate that the marked improvement in abundance that began in 1985 has continued. In the USA sector of Georges Bank, the 1988 survey abundance values were only slightly lower than high values obtained in 1987. The survey results also indicate that the 1985 year class appears to be of only average strength on Georges Bank after very strong 1982, 1983, and 1984 year classes.

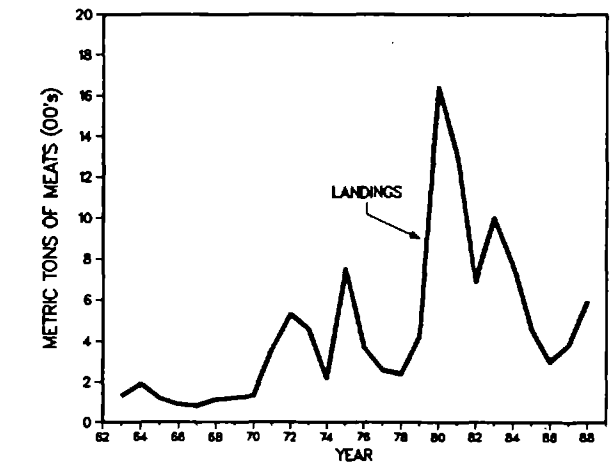
The Georges Bank scallop resource has rapidly recovered from the record-low 1983-1984 levels. Stock abundance is presently at a relatively high level. Although current fishing effort is far beyond what the resource can sustain, and landings are in excess of the long-term potential catch, USA catches and CPUE are expected to remain near their present high levels during 1989 and possibly in 1990, as recent strong year classes pass through the fishery.

MID-ATLANTIC

Total nominal catch in 1988 was 6,500 mt, 17% lower than in 1987, but still the second highest annual total

Sea Scallops

Gulf of Maine



Georges Bank

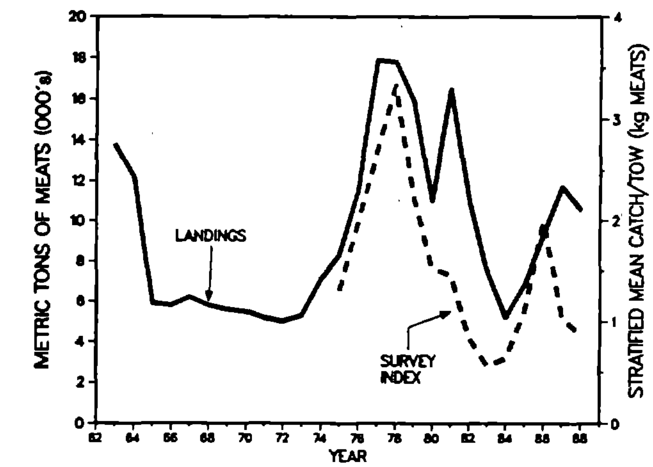


Table 33.1 Commercial landings (1,000 mt, meat weight)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988
USA recreational	-	-	-	-	-	-	-	-	-
Commercial									
Gulf of Maine									
USA	1.6	1.3	0.7	0.9	0.7	0.4	0.3	0.4	0.5
Canada	<0.1	<0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1	0.1
Total	1.6	1.3	0.7	1.0	0.8	0.5	0.3	0.4	0.6
Georges Bank									
USA[1]	5.8	8.5	6.7	4.6	3.2	3.0	4.6	4.9	6.1
Canada	5.2	8.0	4.3	2.8	2.0	3.8	4.7	6.8	4.4
Total	11.0	16.5	11.0	7.4	5.2	6.1	9.3	11.7	10.5
Mid-Atlantic									
USA	5.1	1.9	1.7	3.2	3.8	3.3	3.8	7.9	6.5
Total nominal catch	17.7	19.7	13.4	11.6	9.8	10.6	13.4	20.0	17.6

[1] **For USA, Georges Bank landings include Southern New England**

since 1979. Nearly half (49%) of the 1988 total USA sea scallop catch was taken from the Mid-Atlantic area. Although catches from the New York Bight region declined 30% between 1987 and 1988, New York Bight landings still accounted for more than half (3,500 mt, 54%) of the 1988 Mid-Atlantic catch. In the more southerly scallop regions (Delmarva and Virginia-North Carolina), landings in 1988 remained high (2,700 mt in Delmarva; 300 mt in Virginia-North Carolina).

Fishing effort in the Mid-Atlantic area decreased slightly (6%) in 1988 from the record-high 1987 level. USA CPUE in 1988 was 17% lower than in 1987 but was still the second highest since 1979.

Abundance and biomass indices from the 1988 USA sea scallop survey in the Mid-Atlantic area were among the highest in the 14-year survey time series. Outstanding recruitment of the 1982, 1983, 1984 and 1985 year classes has resulted in a three-fold increase in stock biomass from the record-low 1983 level.

Given the present high abundance of the Mid-Atlantic resource, catches from this stock are expected to remain near the 1988 level through 1990, above the estimate of long-term potential catch.

For further information

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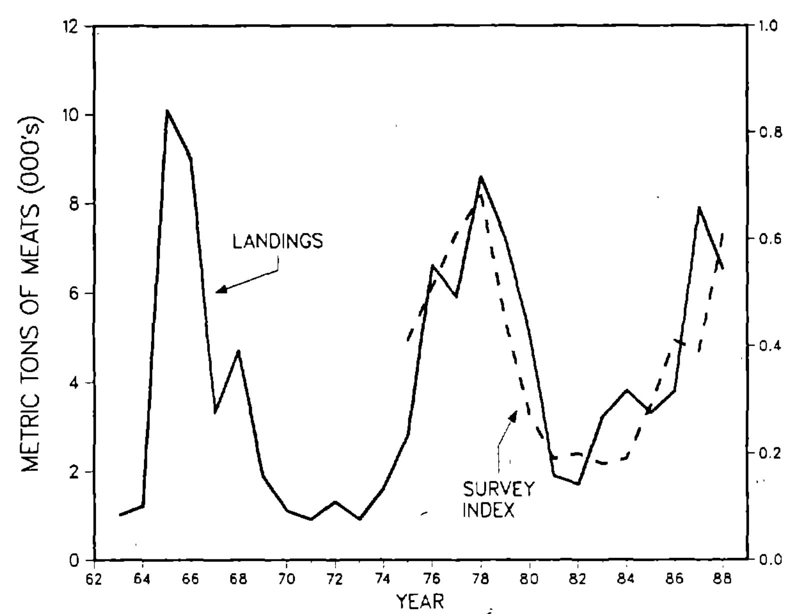
Gulf of Maine, Georges Bank, and Mid-Atlantic Sea Scallops

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
Management	=	Sea Scallop FMP
Status of exploitation	=	Fully exploited
Age at 50% maturity	=	2-4 years (GB and MA)
Size at 50% maturity	=	60-90 mm shell height (GB and MA)
Assessment level	=	Yield per recruit

M=0.10 **$F_{0.1}$=0.14(GM)** **F_{max}=0.22**
0.15(GB) **0.26(GB)**
0.14(MA) **0.25(MA)**

F_{1987}= ≥ F_{max} in all areas

Mid-Atlantic



Common Name Index

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Scientific Name Index

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