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Status of the Fishery Resources Off the Northeastern United States for 1991

Conservation and Utilization Division

Northeast Fisheries Science Center

U. S. DEPARTMENT OF COMMERCE

Robert A. Mosbacher, Secretary

National Oceanic and Atmospheric Administration

John A. Knauss, Administrator

National Marine Fisheries Service

William W. Fox, Jr., Assistant Administrator for Fisheries

Northeast Region

Northeast Fisheries Science Center

Woods Hole, Massachusetts

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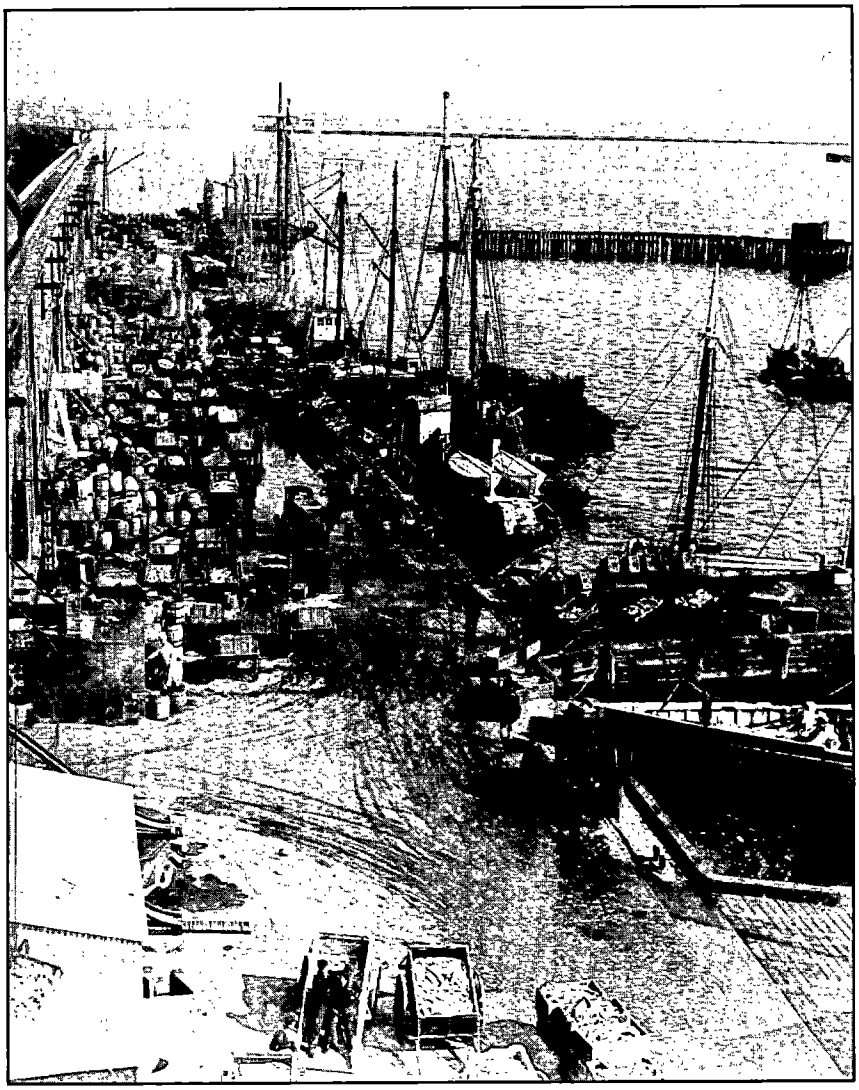
Introduction

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 by summer 1991.

This report is divided into two sections, Aggregate Summaries and Species Synopses. The Aggregate Summaries section includes general descriptions of Fishery Landings Trends, Aggregate Resource Trends and Commercial Fishery Economic Trends. A special section is added this year highlighting recreational fishing trends and data collection programs in the region. The Species Synopses section, on the other hand, includes information about the status of 50 individual populations or stocks of some 37 species of finfish and shellfish.

The species described in the Species Synopses section can be grouped conveniently under eight headings: principal groundfish, flounders, other groundfish, principal pelagics, other pelagics, invertebrates and anadromous species. There are several other species of commercial and recreational importance which are not included here, such as bluefin and yellowfin tuna, swordfish, red crabs, sand lance, sea urchins, menhaden, pelagic sharks and inshore shellfish, including softshell and hard clams, oysters and blue mussels. 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.



Boston Fish Pier circa 1931. NMFS/NEFC archive photo by O.E. Sette

OVERVIEW OF ASSESSMENT APPROACHES

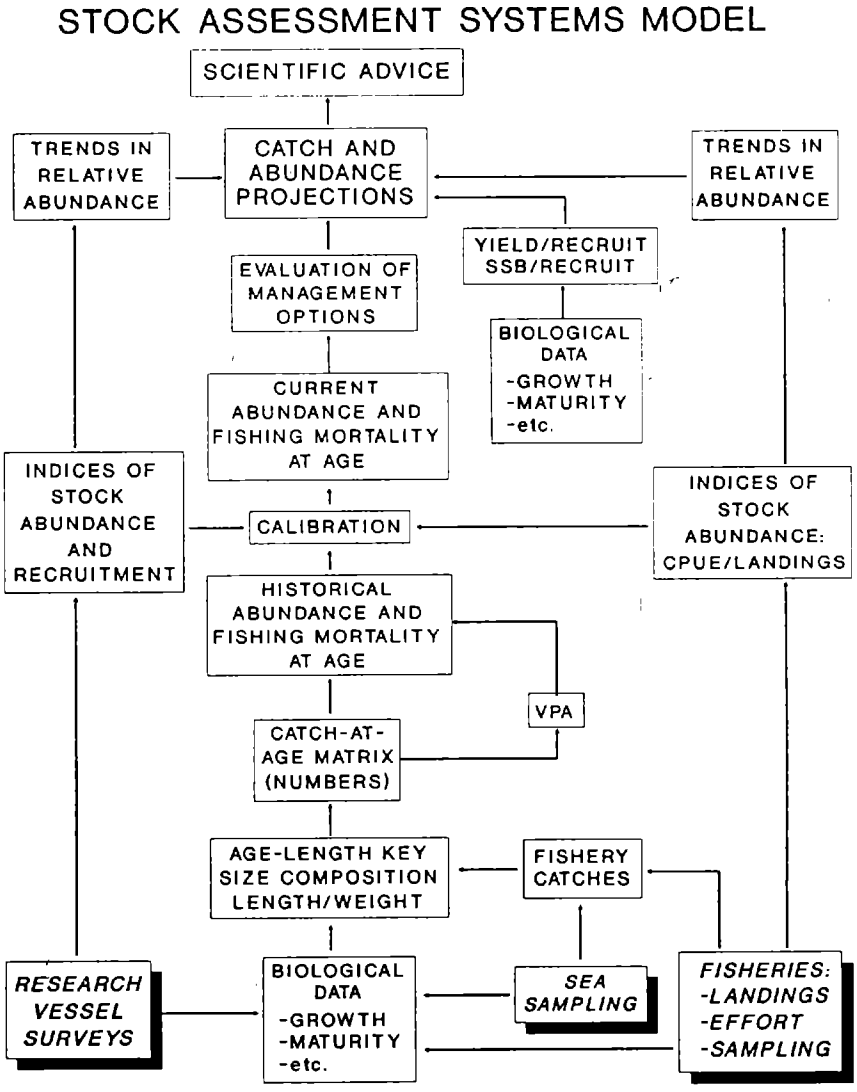
Depending on the nature of the fishery, the type and amount of data from the fishery and from research surveys, and the information required for management, the assessment information reported here may be generated in several different ways. Figure 1 is a diagram of several ways in which catch and survey 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 up the right side of Figure 1. A more complex approach is when the catch data are combined with trawl survey data to generate indices of abundance, as seen by moving vertically up the left side of Figure

1. 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 detailed analytic assessments can be developed that use the information in the age structure of the population and the catches to determine productivity.

The status of information pertaining to the various elements in Figure 1 is diagrammed in Figure 2. 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 1. 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. Much of the biological information (*e.g.* growth and maturity rate) must be continually updated since these parameters are apt to change significantly with the level of exploitation and due to environmental variation.

The different information paths in Figure 1 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 2, and by the amount of information needed by management. 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.

Figure 1. Diagram of alternative ways in which fishery-generated data and research data (lower right and left boxes, respectively) are combined to provide scientific advice no the status of the stocks.



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 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 variations in the environment.

For example, in Figure 1 an INDEX level assessment involves information generated by following either the rightmost or leftmost vertical arrows depending on whether commercial or survey data were

Figure 2. Status of biological assessment knowledge required for fishery management.

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 1. Finally, a PREDICTIVE level assessment would require substantial additional information on the survival of year classes not yet recruited to the fishery.

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 needed to interpret each year's events and new data.

The required 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 1 and 2 reflect information about each species separately, as if they had no interactions with each other. There are significant biological (predator/prey) and technological (by catch) interactions among northeast fishery resources, and a large part of the Center's research program has been dedicated to collecting information for and modeling the effects of interactions among these resources. 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 Exclusive Economic Zone (EEZ) off the Northeastern U.S. are managed under Fishery Management Plans (FMPs) developed by the New England Fisheries Management Council, the Mid-Atlantic Fisheries Management Council, and, in a few instances, under Preliminary Fishery Management Plans (PMPs) developed by the National Marine Fisheries Service. 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 1.

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 italics when used for the first time in other definitions.

Assessment level: Categories of the level of complexity and data available of each assessment included in this document: index of abundance (INDEX), yield per recruit analysis (YIELD), analysis of the age structure of the catch (AGE STRUCTURE), analysis including the relationship between recruitment and spawning stock size (SPAWNING STOCK) and assessment that allow prediction of future (one or two years ahead) stock sizes and catches (PREDICTIVE). These levels are defined further in the section title "Overview of Assessment Approaches."

Biological Reference Points: Fishing mortality rates that may provide acceptable protection against growth overfishing and/or recruitment overfishing for a particular stock. They are usually calculated from equilibrium yield per recruit curves, spawning stock biomass per recruit curves and stock-recruitment data. Examples are $F_{0.1}$, F_{max} and F_{med}.

Exploitation pattern: The distribution of fishing mortality over the age composition of the fish population, determined by the type of fishing gear, 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, or by changing the ratio of harvest by gears exploiting the fish (*e.g.*, gill net, trawl, hook and line, *etc.*).

Exploitation rate: The proportion of a population at the beginning of a given time period that is caught during that time period (usually expressed on a yearly basis). For example, if 720,000 fish were caught during the year from a population of 1 million fish alive 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 fishing. 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. 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

Table 1. Federal and interstate fishery management plans currently in place or under development for fisheries off the Northeastern USA

Plan	Type	Organization Responsible	Since	Last Amendment	Amendment Number
1. Northeast Multispecies	FMP	NEFMC	1986	1991	4
2. Atlantic sea scallop	FMP	NEFMC	1982	1989	4
3. American Lobster	FMP	NEFMC	1983	1989	3[1]
4. Surf clam-Ocean quohog	FMP	MAFMC	1977	1990	8
5. Squid-Mackerel-Butterfish	FMP	MAFMC	1978	1990[3]	
6. Summer flounder	FMP	MAFMC	1988	1991	1[1]
7. Bluefish	FMP	MAFMC	1989	-	-
8. Atlantic herring	Cooperative	ASMFC/NEFMC		Under Development	
9. Northern Shrimp	Interstate	ASMFC	1974	1986	-
10. Striped Bass	Interstate	ASMFC	1981	1989	4
11. Swordfish	FMP	NMFS		Under Development	
12. Pelagic sharks	FMP	NMFS		Under Development	
13. Atlantic billfish	FMP	NMFS		Under Development	
14. Tilefish	FMP	MAFMC		Under Development	

[1]Amendment revision in process

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 these 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 exploitation pattern rate of growth and natural mortality, that results in the maximum level of yield per recruit. This is the point that defines growth overfishing.

$F_{0.1}$: The fishing mortality rate at which the increase in yield per recruit in weight for an increase in a unit of effort is only 10% of the yield per recruit produced by the first unit of effort on the unexploited stock (*i.e.*, the slope of the yield per recruit curve for the $F_{0.1}$ rate is only 1/10 the slope of the curve at its origin).

Growth Overfishing: The rate of fishing as indicated by an equilibrium yield per recruit curve above which the losses in weight from total mortality exceeds the gain in weight due to growth. This point is defined as F_{max}.

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.

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 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. Note that the exploitation rate is the same as the annual fishing mortality rate.

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 because they cannot be added. 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 (because instantaneous rates can be added), 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 if no other mortality exists on the fish.

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 assessments because they are mathematically easy to use (*e.g.*, they can be added directly while percentages cannot be). If a year is divided into a large number (n) of equal time intervals, Z/n is the proportion of the population which dies during each time interval. 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 from causes 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 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 roundfish, 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 (M/Z) due to natural causes multiplied by the total number that actually die.

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

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. Remember these are not catches but landings.

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

Recruitment: The amount of fish added to the fishery each year due to growth and/or migration into the fishing area. For example, the number of fish that grow to become vulnerable to the fishing gear in one year would be the recruitment to the fishable population that year. This term is also used in referring to the number of fish from a year class reaching a certain age. For example, all fish reaching their second year would be age 2 recruits.

Recruitment Overfishing: The rate of fishing above which the recruitment to the exploitable stock becomes significantly reduced. This is characterized by a greatly reduced spawning stock, a decreasing proportion of older fish in the catch, and generally very low recruitment year after year.

Spawning Stock Biomass (SSB): The total weight of all sexually mature fish in the population. This quantity depends on the abundance of year classes, the exploitation pattern, the rate of growth, both fishing and natural mortality rates, the onset of sexual maturity and environmental conditions.

Spawning Stock Biomass Per Recruit (SSB/R): The expected lifetime contribution to the spawning stock biomass for a recruit of a specific age (*e.g.*, per age 2 individual) such as the spawning stock biomass divided by the number of fish recruited to age 2. For a given exploitation pattern, rate of growth and natural mortality, an equilibrium value of SSB/R is calculated for each level of F. This means that under constant conditions of growth, natural mortality and exploitation patterns over the life span of the species, an expected average SSB/R would result from each constant rate of fishing.

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

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, underexploited, moderately exploited, fully exploited, and overexploited. 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 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 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 from stock born in the same year. For example, the 1987 year class of cod includes all cod born in 1987, which 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 later years.

Yield Per Recruit Analysis: The expected lifetime yield per fish of a specific age (*e.g.*, per age 2 individual). For a given exploitation pattern, rate of growth and natural mortality, an equilibrium value of Y/R is calculated for each level of F. This means that under constant conditions of growth, natural mortality and exploitation patterns over the life span of the species an expected average Y/R would result from each constant rate of fishing.

Fishery Landings Trends

Recreational and commercial fishing for marine and estuarine fish stocks that occurs off the northeastern United States results in landings that are a significant portion of total U.S. landings. Total U.S. commercial landings in 1990 are estimated to be more than 4.4 million metric tons (mt), of which approximately 18% were from the northeast region. Total U.S. recreational landings are estimated to exceed 144,000 mt (excluding Alaska, Hawaii, and Pacific coast salmon). Aggregate statistics for U.S. fisheries are described in detail in Fisheries of the United States, 1990.

Fishery statistics are collected in the northeastern United States 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 numbers 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 of both domestic commercial and recreational as well as foreign and joint venture, from the 37 species described in this document totaled 501 thousand mt in 1990, 1% from 1989 (Table 2). Of these landings, 15% were from foreign, 79% from domestic commercial, and 6% from domestic recreational fishing. Foreign commercial landings and domestic recreational catches declined

Dogfish and skates in Georges Bank survey catches have increased from roughly 25% by weight in 1963 to nearly 75% in recent years. NMFS/NEFC archive photo.

Table 2. Total landings of selected assessment species groups off the northeastern United States, domestic and foreign commercial fishing, and for recreational fishing 1989 and 1990 (1,000 mt)

Species	Commercial				Recreational		Total	
	Foreign		USA					
	1989	1990	1989	1990	1989	1990	1989	1990
Principal Groundfish								
Atlantic cod	7.9	14.3	35.5	43.4	6.8	5.5	50.2	63.2
Haddock	3.1	3.3	1.7	2.5	<0.1	<0.1	4.8	5.8
Redfish	<0.1	<0.1	0.6	0.6	0.0	0.0	0.6	0.6
Silver hake	0.0	0.0	17.8	20.2	<0.1	<0.1	17.8	20.2
Red hake	0.0	0.0	1.6	1.6	<0.1	0.0	1.6	1.6
Pollock	43.0	37.5	10.5	9.5	0.4	0.1	53.9	47.1
Subtotal	**54.0**	**55.1**	**67.7**	**77.8**	**7.2**	**5.6**	**128.9**	**138.5**
Flounders								
Yellowtail flounder	0.0	0.0	5.0	12.0	0.0	0.0	5.0	12.0
Summer flounder	0.0	0.0	9.9	5.4	1.6	2.4	11.5	7.8
American plaice	0.1	<0.1	2.3	2.5	0.0	0.0	2.4	2.5
Witch flounder	<0.1	<0.1	2.1	1.4	0.0	0.0	2.1	1.4
Winter flounder	<0.1	<0.1	6.8	6.6	2.9	0.4	9.7	7.0
Windowpane	0.0	0.0	2.7	1.9	0.0	0.0	2.7	1.9
Subtotal	**0.1**	**<0.1**	**28.8**	**29.8**	**4.5**	**2.8**	**33.4**	**32.6**
Other Groundfish								
Goosefish	1.2	1.6	11.6	10.6	<0.1	<0.1	12.8	12.2
Scup	0.0	0.0	3.6	4.2	3.2	1.9	6.8	6.1
Black sea bass	0.0	0.0	1.2	1.5	2.1	1.3	3.3	2.8
Ocean pout	0.0	0.0	1.3	1.3	0.0	0.0	1.3	1.3
White hake	0.6	0.5	5.0	5.0	<0.1	<0.1	5.6	5.5
Cusk	0.7	0.5	0.9	1.2	<0.1	<0.1	1.6	1.7
Atlantic wolffish	0.1	0.1	0.5	0.4	<0.1	<0.1	0.6	0.5
Tilefish	<0.1	<0.1	0.5	0.9	<0.1	<0.1	0.5	0.9
Spiny dogfish	<0.1	0.0	4.4	14.3	0.0	0.0	4.4	14.3
Skates	0.0	0.0	6.6	11.3	0.0	0.0	6.6	11.3
Subtotal	**2.6**	**2.7**	**35.6**	**50.7**	**5.3**	**3.2**	**43.5**	**56.6**
Principal Pelagics								
Atlantic herring	0.0	<0.1	53.5	62.2	0.0	0.0	53.5	62.2
Atlantic mackerel	56.8	10.9	14.6	31.8	0.9	2.0	72.3	44.7
Subtotal	**56.8**	**10.9**	**68.1**	**94.0**	**0.9**	**2.0**	**125.8**	**106.9**
Other pelagics								
Atlantic butterfish	<0.1	<0.1	3.2	2.4	0.0	0.0	3.2	2.4
Bluefish	0.0	0.0	4.7	6.3	23.9	18.2	28.6	24.5
River herring	<0.1	<0.1	1.8	1.4	0.0	0.0	1.8	1.4
American shad	0.0	0.0	1.3	1.0	0.0	0.0	1.3	1.0
Striped bass	0.0	0.0	0.1	0.5	0.3	1.2	0.4	1.7
Subtotal	**<0.1**	**<0.1**	**11.1**	**11.6**	**24.2**	**19.4**	**35.3**	**31.0**
Invertebrates								
Short-finned squid	0.0	0.0	6.8	11.7	0.0	0.0	6.8	11.7
Long-finned squid	<0.1	0.0	23.0	15.5	0.0	0.0	23.0	15.5
American lobster	0.1	0.1	24.0	27.6	-	-	24.1	27.7
Northern shrimp	0.0	0.0	3.6	4.4	0.0	0.0	3.6	4.4
Surf clams	0.0	0.0	30.4	32.6	0.0	0.0	30.4	32.6
Ocean quahog	0.0	0.0	23.1	21.2	0.0	0.0	23.1	21.2
Sea scallop	4.7	5.2	14.7	17.4	0.0	0.0	19.4	22.6
Subtotal	**4.8**	**5.3**	**125.6**	**130.4**	**0.0**	**0.0**	**130.4**	**135.7**
Total	**118.3**	**74.0**	**336.9**	**394.3**	**42.1**	**33.0**	**497.3**	**501.3**

*Research cruises form the basis of biological time series information about important commercial fish. Left, Ace Nelson, R/V **Oregon** crew member, measures scallops in the bienniel scallop cruise. Below left, scientist Bill Michaels gets a first look at a trawl haul during a semi-annual groundfish cruise aboard the R/V **Delaware II**. Below, co-op student Salina Cox gets ready to age a redfish on a groundfish cruise aboard the R/V **Delaware II** in 1989. NMFS/NEFC Photos by Brenda Figueirido*

(37 and 22%, respectively) while the domestic commercial landings increased (17%).

The landings trends for six groups of species contributing to northeast fisheries are as follows:

The most important group in terms of weight of fish landed are the principal groundfish (Atlantic cod, haddock, redfish, silver hake, red hake, and pollock) accounting for 28% of the landings in 1990 and 26% in 1989.

The invertebrates (short- and long-finned squid, American lobster, Northern shrimp, surf clams, ocean quahogs, sea scallops) accounted for 27% of the landings in 1990 up from 26% in 1989. Principal pelagic species (Atlantic herring, Atlantic mackerel) also decreased in percentage from 25 to 21 between 1989 and 1990.

The fourth highest landings were from the other groundfish (goosefish, scup, black sea bass, ocean pout, white hake, cusk, Atlantic wolffish, tilefish, spiny dogfish, skates), which accounted for 11% of the landings in 1990, up from 9% in 1989.

Next in importance in terms of weight are the flounders, accounting for 6% of the total landings in 1990, and other pelagics, also accounting for 6%

The increase in other groundfish (30%) was caused primarily by the increase in the two elasmobranchs, spiny dogfish and skates. The smallest increase was in the invertebrates (up 4%).

Total 1990 foreign vessel landings of species and stocks occurring in USA waters was 74,000 mt down 37% from 1989. This includes for example, catches of transboundary migratory pollock and mackerel stocks by Canadian fishermen. It also includes catches of cod, haddock, and scallops from the Georges Bank stocks, which occur on the Canadian portion of that fishing ground. Finally, there are some landings by foreign vessels fishing in U.S. waters, such as those for Atlantic mackerel. These catches are made by U.S. and foreign vessels fishing in joint operations under the auspices of the Fishery Management Councils and state governments.

For more information

NMFS, 1991. Fisheries of the United States, 1990. Washington, D.C.: U.S. Department of Commerce. Current Fishery Statistics No.9000. 116 pp. Available from: Superintendent of Documents, U.S. Government Printing Office, Wash. D.C.

Aggregate Resource Trends

The fishery resources off the northeastern USA are harvested by a variety of fishing gears, including trawls, gillnets, 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 the northeast region is a complex problem 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 off New England are managed 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, and a new FMP is being developed to include summer flounder, black sea bass and scup.

While much of the stock assessment advice required for managing these fisheries requires 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.

Sal Chermisino circa 1964 aboard Bureau of Commercial Fisheries R/V Delaware I. NMFS/ NEFC archive photo

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 historically important trawl fisheries.

2. **Other finfish**, including a variety of demersal and pelagic species that are collectively of considerable economic importance.

3. **Principal pelagics** (Atlantic herring and Atlantic mackerel).

4. **Skates and spiny dogfish**, which have been of minor commercial importance but are now 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, witch flounder and windowpane). The combined index for this group declined by almost 70% between 1963 and 1974, reflecting substantial increases in exploitation associated with the advent of distant-water fleets (Figure 3). 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 of these species had dropped to the lowest levels observed in the history of the survey time series.

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 again declined; 1987 and 1988 values were the lowest in the time series. The index has since increased somewhat reflecting improved recruitment for some of these species, primarily cod, redfish, silver and red hake, and American plaice.

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 3) 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 declined during 1986-1987 and then recovered somewhat primarily due to increased abundance of butterfish.

Principal Pelagics

Abundance of Atlantic herring and Atlantic mackerel has been monitored using spring survey data. 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 in recent years; index values for 1987-1990 are among the highest observed in the series, reflecting high levels of abundance for both species (Figure 3). Although survey indices for principal pelagics have declined slightly since 1987, this is thought to reflect survey variability of these species rather than resource declines. Virtual population analysis (VPA) of commercial catch at age data indicate recovery of both the Gulf of Maine herring stock and the Northwest Atlantic mackerel stock since 1980. There is also evidence for some degree of recovery of the Georges Bank herring stock.

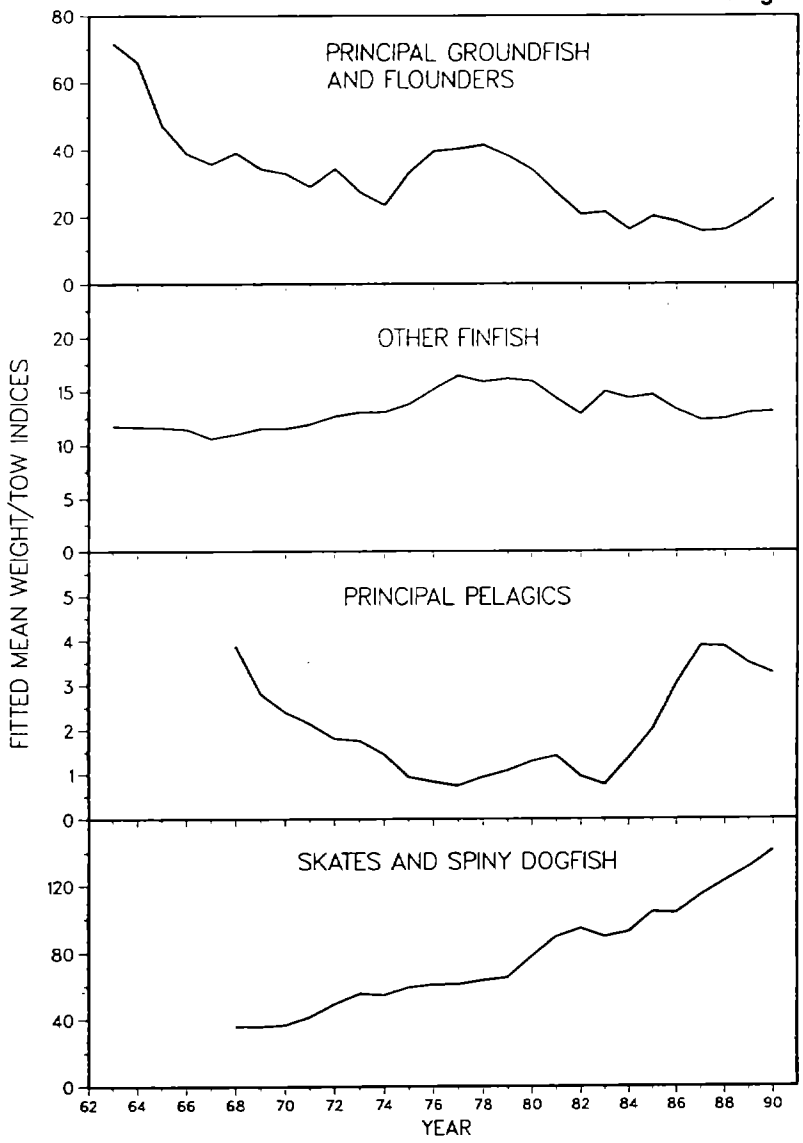


Figure 3. Trends in indexes of aggregate abundance (catch in weight per survey trawl haul) for four species groups, reflecting the major changes in fishery resources, 1962-1990.

Skates and Spiny Dogfish

The remaining aggregate index includes data for two important resource components, spiny dogfish and skates, which are effectively monitored using spring survey data (Figure 3). Spiny dogfish and seven skate species are included in this index: little, winter, thorny, smooth-tailed, leopard, briar and barndoor. 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. Survey catches of both dogfish and skates since 1986 have been the highest observed in the time series. These increases in dogfish and skate abundance, in conjunction with declining abundance of groundfish and flounders, has resulted in the proportion of dogfish and skates in Georges Bank survey catches increasing from roughly 25% by weight in 1963 to nearly 75% in recent years.

COMMERCIAL TRAWL CATCH AND EFFORT DATA

Commercial trawl landings and effort data collected by NEFC using dockside 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 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 weighing 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 size classes over all areas (Figure 4). 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 1989 were approximately equal to the 1976 and 1977 totals. Otter trawl landings in 1990 increased to 128,100 mt (21 % greater than 1989), primarily due to increased landings of yellowtail flounder, Atlantic cod, spiny dogfish and skates. Nominal fishing effort in terms of number of days fished (Figure 4) nearly doubled from roughly 25,000 standard days in the 1976-1978 period to roughly 48,000 in 1985. Subsequently, effort declined slightly, and has remained relatively constant since 1986. Total trawl effort increased 4% (to 44,300 days fished) from 1989 to 1990.

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

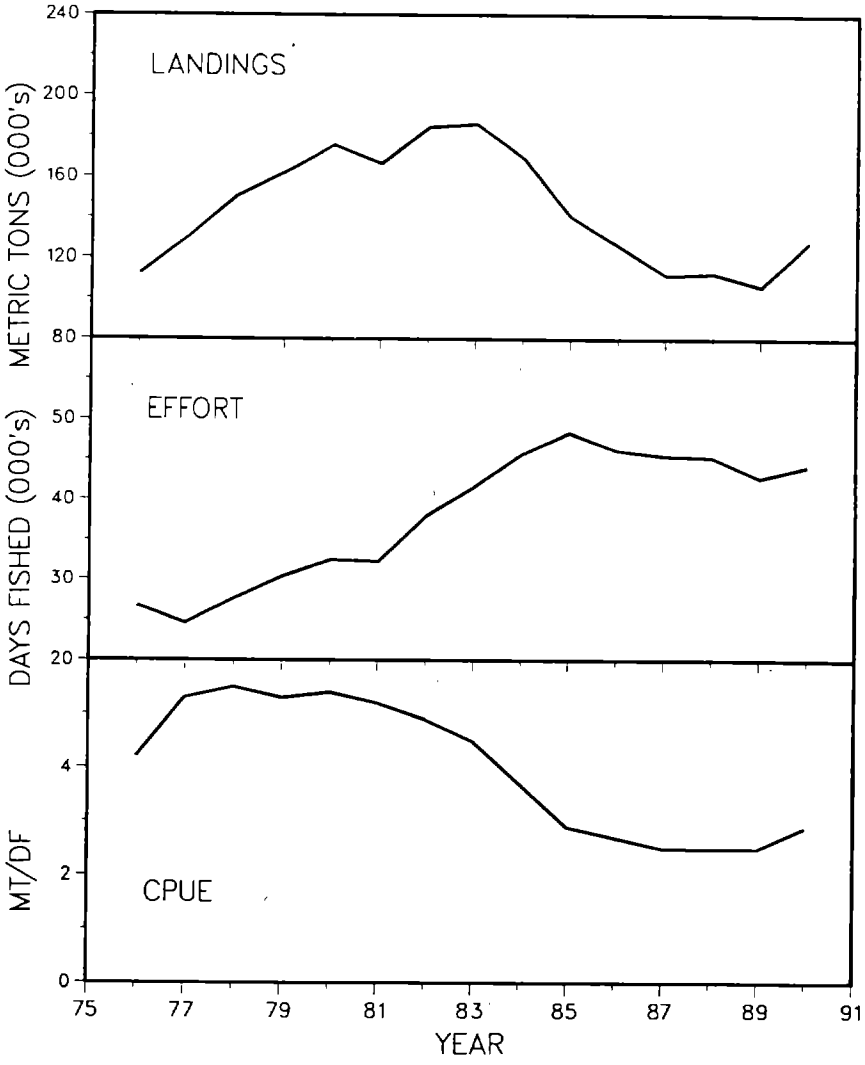


Figure 4. Total trawl catch (mt, all ages), standardized trawl fishing effort (DF, days fished), and catch divided by effort (CPUE, mt/DF) since the introduction of MFCMA in 1977, reflecting major changes in trawl fishing activity and aggregate resource abundance.

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 4). 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 1990 index increased 16% (to 2.9 mt/df, reflecting improved status of several groundfish stocks, as well as greater retention of dogfish and skates. 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 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 5). During the period 1976-1987 nominal effort increased 100% in the Gulf of Maine, 58% on Georges Bank, and 63% in the Northern Mid-Atlantic. Total effort in the Gulf of Maine area declined from a peak of 14,600 days fished in 1987 to 10,900 days fished in 1989 (-25%), reflecting declines in CPUE of 19% and landings of 41%. Landings, effort and CPUE increased in 1990, primarily due to the improved resource status of the Gulf of Maine Cod stock. Georges Bank effort remained relatively stable since 1988 (increasing 5% from 1989 to 1990). Landings and CPUE on Georges Bank increased 30 and 22%, respectively in 1990, due primarily to improved landings of cod and yellowtail flounder. Landings and effort in the northern Mid-Atlantic declined from 1989 to 1990 (4 and 9% respectively), although CPUE increased 4%.

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 pollock, redfish, and flounders have declined. Currently, cod, 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 mixed, but several trends are notable. Winter and summer flounder catches have declined relative to other species such as *Loligo* squid, butterfish, and silver hake. Yellowtail flounder catches improved in the area in 1990 due to the recruitment of a strong 1987 year class.

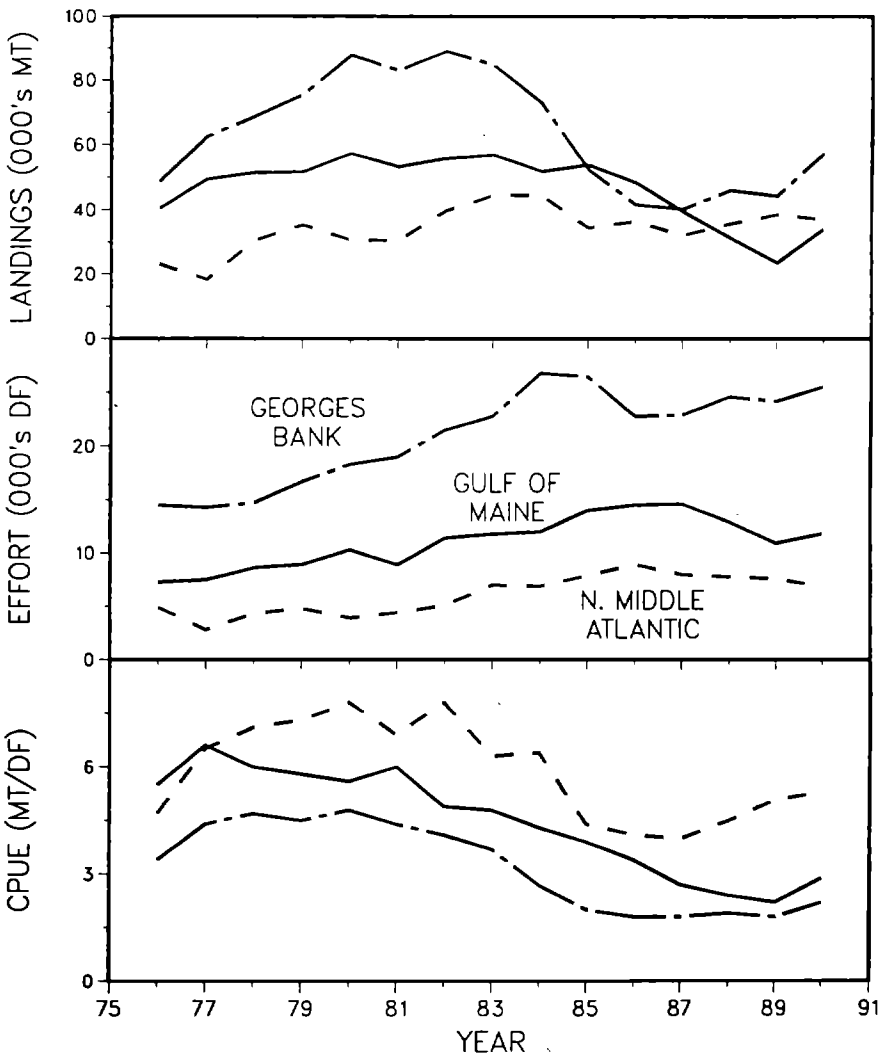


Figure 5. Total trawl catch (mt), standardized fishing effort (DF, days fished), and catch divided by effort (CPUE, mt/DF) since 1976, for three regions, reflecting changes in trawl fishing activity and aggregate resource abundance.

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. Trawl catches reached a time-series low in 1989 and improved somewhat in 1990. 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, has occurred.

It appears that most of the changes in resource abundance described above are directly related to changes in fish-

ing mortality. For example, increases in abundance of groundfish and flounder 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 for these species. Decreases in fishing activity allowed more fish to survive and grow in the late 1970s, indicating the intensity of and significance of fishing on resource abundance. Record increases in fishing effort continuing through the 1980s have reduced several new year classes before they were able to achieve full growth and reproduce. Continued high fishing effort continues this pattern, with populations of several species being dominated by only one or two age groups.

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. Moreover, 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; and

2. Reducing the total level of adult biomass to a point that too few young fish result from each year's spawning

"Record increases in fishing effort continuing through the 1980s have reduced several new year classes before they were able to achieve full growth and reproduce. Continued high fishing effort continues this pattern, with populations of several species being dominated by only one or two age groups."

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, it appears that 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, 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 will result in an increased abundance of fishery resources.

For further information

NEFC. 1987. Status of mixed demersal finfish resources in New England and scientific basis for management. Woods Hole, MA: NMFS, NEFC. Laboratory Reference Document 87-08. 105pp. Available from: Northeast Fisheries Center, Woods Hole, MA 02543.

NEFMC. 1988. An assessment of the effectiveness of the Northeast Multispecies Fishery Management Plan with recommendations for plan and management system improvements. Saugus, MA. 40 p. Available from: New England Fishery Management Council, Suntaug Office Park, 5 Broadway (Rte. 1), Saugus, MA 01906.

NEFC. 1990. Report of the Eleventh Stock Assessment Workshop. Woods Hole, MA: NMFS, NEFC. NEFC Reference Document 90-09. Available from: Northeast Fisheries Center, Woods Hole, MA 02543.

NEFC. 1991. Report of the Twelfth Stock Assessment Workshop. Woods Hole, MA: NMFS, NEFC. NEFC Reference Document 91-03. Available from: Northeast Fisheries Center, Woods Hole, MA 02543.

Fishery Economic Trends

PREFACE

The focus of this section was broadened last year. New information was added to better reflect the breadth of the region's living marine resource use and the management context in which it occurs. This year this section omits several tables that do not bear annual updating.

An expanded section on the economics of marine recreational fishing in the Northeast has been relocated within this report.

REGIONAL SUMMARY

The commercial oceanic and estuarine fisheries of the Northeast Region produced domestic landings worth $857 million dockside in 1990 (preliminary figure), an increase of $63 million, or 7% over 1989. Total landings were up 8% to 753 thousand mt (preliminary). Finfish landings brought in $319 million, representing 37 percent of the revenue generated. Shellfish landings remained about the same at 197,000 mt.

The most important species of fish and shellfish landed in the region are shown in Table 3 along with their prices, weight, and value for the last six years. Landings of finfish, lobster, shrimp, and crab are given in live weight; landings of all other shellfish are expressed in meat weight. Of the eight most important species, six are shellfish. Five of the top eight are harvested in predominantly inshore fisheries. The eight most important species include lobster, sea scallops, cod, hard clams, blue crab, oysters, menhaden, and surf clams.

Scallop fishing effort, both in terms of the number of vessels and average days at sea, has risen throughout the late 1980s to obtain its highest level in 1990. NMFS/NEFC photo by Brenda Figuerido

Table 3. Northeast landings (1,000 mt), values ($ million) and prices ($/lb) of important species - 1985-1990 (preliminary data, 1990)

Year	Quantity	Value	Price	Quantity	Value	Price	Quantity	Value	Price	Quantity	Value	Price	Quantity	Value	Price
	Lobster			**Sea Scallops**			**Cod**			**Hard Clam**			**Blue Crab**		
1985	21.3	117.0	2.49	6.8	72.0	4.82	37.4	35.0	0.42	5.7	45.8	3.64	48.0	36.0	0.34
1986	20.8	120.1	2.62	8.3	91.0	4.97	27.6	36.0	0.59	4.7	40.6	3.92	42.9	34.3	0.36
1987	20.8	142.1	3.10	13.2	123.4	4.23	26.8	44.2	0.75	5.0	50.3	4.59	38.9	37.6	0.44
1988	22.2	146.4	2.99	13.0	121.9	4.24	34.6	43.0	0.56	6.8	48.7	3.25	41.8	40.6	0.44
1989	24.0	148.9	2.82	14.4	126.6	3.98	35.6	47.8	0.61	4.2	50.6	5.48	45.6	42.0	0.42
1990	27.0	151.2	2.54	17.1	146.5	3.88	43.3	61.1	0.64	4.4	45.3	4.61	42.2	42.4	0.46
	Oyster Meats			**Menhaden**			**Surf Clam**			**Yellowtail Flounder**			**Bluefin Tuna**		
1985	6.7	30.0	2.04	314.6	31.0	0.04	32.1	37.8	0.53	11.2	20.3	0.82	1.3	9.0	3.16
1986	6.8	37.8	2.51	222.6	24.3	0.05	35.4	42.2	0.54	10.4	21.0	0.92	0.9	15.2	7.92
1987	4.3	29.5	3.11	300.0	32.5	0.05	27.4	27.9	0.46	7.6	20.1	1.20	1.0	11.9	5.54
1988	3.1	26.2	3.81	273.5	29.7	0.05	28.6	28.9	0.46	5.0	13.2	1.19	0.8	11.3	6.61
1989	2.4	22.3	4.16	287.8	31.3	0.05	30.4	30.7	0.46	5.6	13.9	1.13	1.1	19.7	8.01
1990	3.1	38.8	5.61	335.9	37.2	0.05	32.6	32.3	0.45	14.4	28.1	0.89	1.0	21.2	9.29
	Soft clam			**Winter Flounder**			**Ocean Quahog**			**Swordfish**			***Loligo* squid**		
1985	3.3	20.0	2.73	11.0	20.6	0.85	22.5	15.7	0.32	2.0	11.1	2.50	9.0	6.2	0.31
1986	2.9	20.8	3.21	8.0	17.6	1.00	20.6	15.7	0.35	2.0	13.1	3.01	11.5	9.0	0.35
1987	3.4	19.2	2.58	9.0	24.1	1.21	22.8	16.6	0.33	2.1	16.0	3.39	10.5	9.3	0.40
1988	3.5	20.1	2.60	8.4	22.4	1.20	21.0	14.9	0.32	2.7	18.1	2.99	18.9	15.4	0.37
1989	2.9	19.4	2.98	6.6	19.6	1.34	23.1	16.4	0.34	2.7	17.2	2.92	23.0	21.8	0.43
1990	2.4	20.4	3.89	6.9	17.0	1.11	21.2	16.3	0.35	2.3	14.9	2.91	15.0	14.0	0.42
	Monkfish			**Summer Flounder**			**Whiting**			**Pollock**			**Northern Shrimp**		
1985	7.2	4.5	0.28	10.8	23.4	0.99	20.2	8.3	0.19	19.8	7.0	0.16	4.2	4.1	0.44
1986	6.7	6.9	0.47	9.5	26.3	1.25	18.0	8.2	0.21	24.6	14.0	0.26	4.7	6.5	0.63
1987	6.9	9.8	0.64	9.9	32.0	1.46	15.7	11.6	0.33	20.7	17.9	0.39	5.0	12.2	1.10
1988	7.6	10.4	0.62	11.6	33.6	1.31	16.1	8.6	0.24	15.0	11.0	0.33	3.1	7.5	1.10
1989	11.3	12.6	0.51	6.2	22.2	1.63	17.8	9.4	0.24	10.5	9.9	0.43	3.6	7.8	0.98
1990	10.1	13.1	0.59	3.0	12.0	1.84	20.0	11.1	0.25	9.5	10.4	0.50	4.4	6.9	0.72
	***Illex* squid**			**Scup**			**Haddock**			**Witch Flounder**			**Atlantic Herring**		
1985	2.4	0.8	0.15	6.5	8.1	0.57	6.5	13.5	0.94	6.4	12.9	0.91	25.9	3.0	0.05
1986	4.4	1.5	0.15	6.7	8.3	0.56	5.0	10.9	0.99	5.2	12.9	1.14	32.0	3.8	0.05
1987	7.0	3.1	0.20	6.0	8.7	0.66	3.0	8.5	1.28	3.8	12.2	1.45	39.4	4.5	0.05
1988	2.0	0.6	0.13	5.6	8.1	0.66	2.9	7.0	1.09	3.6	11.6	1.46	40.9	5.2	0.06
1989	6.8	3.2	0.22	3.5	6.1	0.78	1.7	4.5	1.19	2.4	9.0	1.73	40.7	5.0	0.06
1990	11.3	6.5	0.26	4.0	6.0	0.69	2.5	6.0	1.10	1.5	5.8	1.78	51.3	5.7	0.05
	American Plaice			**White Hake**			**Bigeye Tuna**			**Tilefish**			**Atlantic Mackerel**		
1985	8.4	15.0	0.81	7.4	3.3	0.21	0.4	2.0	2.39	2.0	4.9	1.13	2.9	1.0	0.15
1986	6.1	12.4	0.92	6.4	4.8	0.34	0.6	4.4	3.43	2.0	5.0	1.17	4.0	1.1	0.13
1987	5.1	11.9	1.07	5.8	5.2	0.41	0.6	4.7	3.56	3.2	7.9	1.11	4.3	1.0	0.11
1988	4.7	10.5	1.01	4.8	3.2	0.31	0.5	4.0	3.95	1.4	5.3	1.76	6.4	1.9	0.13
1989	3.5	8.8	1.14	5.1	4.4	0.39	0.4	2.7	3.18	0.5	2.0	1.81	8.1	3.2	0.18
1990	2.5	5.6	1.03	4.9	4.3	0.39	0.4	3.9	4.03	0.9	3.9	2.01	9.9	3.6	0.16
	Sea Bass			**Butterfish**			**Yellowfin Tuna**			**Weakfish**			**Bluefish**		
1985	1.2	2.7	0.99	4.6	3.5	0.34	0.4	0.4	0.53	2.7	3.2	0.53	4.2	1.6	0.17
1986	1.6	3.5	0.99	4.5	6.5	0.66	0.7	1.8	1.16	2.7	2.7	0.45	4.6	1.8	0.18
1987	1.7	3.9	1.02	4.6	6.4	0.63	0.9	2.6	1.25	2.2	2.7	0.55	3.8	2.0	0.24
1988	1.3	3.2	1.08	2.1	3.2	0.68	0.8	2.4	1.46	2.2	2.3	0.48	4.3	1.8	0.19
1989	1.0	2.7	1.20	3.0	3.9	0.60	0.5	1.6	1.33	1.7	2.7	0.73	2.7	1.3	0.22
1990	1.3	2.9	1.03	2.3	2.8	0.56	0.6	2.4	1.71	1.4	2.1	0.69	3.4	2.0	0.26
	Windowpane Flounder			**Striped Bass**			**Ocean Perch**			**Red Hake**			**Ocean Pout**		
1985	4.2	4.9	0.53	0.4	1.5	1.53	4.4	3.2	0.33	1.8	0.5	0.13	1.5	0.3	0.09
1986	3.2	3.7	0.52	0.1	0.2	1.06	3.0	3.2	0.48	2.1	0.7	0.14	0.8	0.2	0.11
1987	2.3	3.1	0.61	0.1	0.2	1.32	1.9	2.7	0.64	2.0	0.9	0.20	2.2	0.5	0.10
1988	2.6	3.0	0.53	0.1	0.4	1.39	1.1	1.5	0.62	1.7	0.6	0.16	1.8	0.4	0.10
1989	2.6	3.1	0.55	0.1	0.4	2.12	0.6	0.9	0.66	1.6	0.6	0.17	1.3	0.3	0.10
1990	2.0	1.7	0.38	0.2	0.7	1.34	0.6	0.7	0.53	1.6	0.6	0.17	1.3	0.3	0.10

There are some noteworthy trends in the prices and landings of the species shown in Table 3 . Some species have experienced substantial declines in landings over the last six years. Scallops and cod are notable exceptions. Lobsters remain the most valuable species in the Northeast, but sea scallops have become nearly as important. Sea scallops, cod, menhaden, and yellowtail flounder landings accounted for large gains in value in 1990. Both Atlantic herring and menhaden made significantly large gains in landings in 1990. Summer flounder landings and value were strikingly low in 1990. In more cases than not, prices have declined from their 1989 level. The top seven species have remained of great importance to the Northeast over the six year period, accounting by themselves for 64 percent of the total value in 1990.

Although a majority of vessels and boats used a single gear, a significant number of them employed more than one. The most important gear types used, in terms of landings, include purse seines, bottom otter trawls, and surf clam dredges, accounting for about 75 percent of the landings by weight. Otter trawls produce the most revenue followed by sea scallop dredges, combined inshore and offshore lobster gear, clam dredges, purse seines, and crab pots and traps.

DATA COLLECTION CONSIDERATIONS

In the Northeast Region, NMFS collects information on landings through a network of 27 federal and state port agents located at the busiest ports. The principal data collection activity in these ports is the collection of weighout sales receipts at the point of first sale. A series of weekly and monthly visits to less busy ports supplements the weighout collections. An annual census completes the landings enumerations. All of the landings recorded are associated with the type of gear that produced them. However, in general, the further removed the collection of landings information is from the date and place of first sale, the less likely it is that landings can be associated with particular craft and the fishing effort that produced the landings.

All vessels (those craft greater than 5 gross registered tons) fishing in the exclusive economic zone (EEZ) are required by law to be registered with the U.S. Coast Guard. The registration number must be clearly displayed so that the vessels can be identified. Boats (those craft less than 5 gross registered tons) must have either a state registration number or a Coast Guard registration number displayed on the side of the craft. In addition, all boats and vessels that commercially exploit species managed under federal FMPs in the region are required to apply annually for the appropriate fishery specific permits. Table 4 shows numbers of vessels and boats granted permits to fish certain gears in 1989 and 1990. In 1990, once again, rod and reel predominated the boat category. Bottom trawl was the major gear type for vessels along with boat dredges and pots and traps. Although there were a large number of vessels issued rod and reel permits, these were thought to be mainly for incidental catches of bluefin tuna. In many instances the number of permits issued exceeds the numbers of vessels actually using that gear in a given year.

Table 5 shows the total number of all vessels, scallop dredge vessels, and otter trawl vessels represented in the weighout data base from 1980 through 1990. The movement out of the otter trawl fishery and into the scallop fishery is taking place across all regions in the Northeast. This trend is consistent with the fact that the value derived from sea scallops increased significantly in 1990, as compared with the mixed otter trawl fishery.

The data collection of weighout receipts coupled with the ability to identify the particular vessel involved allows the association of landings with vessel and gear characteristics. A listing of landings made and revenue generated by gear of identified vessels which were recorded in 1990 is shown in Table 6. This table points out the fact that we are able to associate only a portion of the landings with the specific vessels that made those landings in the weighout database. The landings shown are about 35% of all

Table 4. Permits issued in the Northeast by gear 1989-1990

	1989		1990	
	Number of Vessels Using Gear	Number of Boats Using Gear	Number of Vessels Using Gear	Number of Boats Using Gear
Purse seines	41	3	41	5
Beach seines	4	2	4	1
Boat seines	20	4	15	4
Bottom trawls	1,753	63	1,602	60
Mid-water trawl	162	8	171	6
Other trawl	111	5	101	3
Boat dredges	1,305	62	1,283	64
Gill/entanglement net	467	95	442	98
Pots and traps	1,272	225	1,320	257
Handlines	710	417	789	637
Rod and reel	1,658	1,090	1,519	1,085
Longlines/set lines	641	89	423	88
Harpoons	87	19	63	22
Other gear	81	23	60	18
Diving gear	166	57	179	55
Permits by gear	**8,478**	**2,162**	**8,012**	**2,403**
Permitted craft	**4,681 vessels**	**1,702 boats**	**4,427 vessels**	**1,780 boats**

Table 5. Number of identifiable vessels using otter trawl, scallop dredge and other gear in the Northeast region by ton class - 1980-1990

Year		Scallop Dredge				Otter Trawl				All Vessels			
		TC2	TC3	TC4+	Total	TC2	TC3	TC4+	Total	TC2	TC3	TC4+	Total
1980	Northeast	44	191	109	344	504	434	96	1034	768	678	204	1650
	New England	39	148	86	273	457	361	82	900	616	532	168	1316
	Mid-Atlantic & Chesapeake	5	88	37	130	53	97	16	166	162	222	57	441
1981	Northeast	30	173	140	343	491	491	117	1099	798	752	256	1806
	New England	30	141	120	291	449	386	86	921	623	550	191	1364
	Mid-Atlantic & Chesapeake	1	82	51	134	49	139	37	225	189	303	106	598
1982	Northeast	18	107	111	236	538	515	140	1193	838	738	247	1823
	New England	16	86	89	191	487	403	120	1010	653	533	190	1376
	Mid-Atlantic & Chesapeake	2	47	34	83	56	149	38	243	201	288	96	585
1983	Northeast	61	121	109	291	496	556	140	1192	776	800	254	1830
	New England	52	84	84	220	448	435	113	996	581	583	193	1357
	Mid-Atlantic & Chesapeake	9	72	39	120	54	175	44	273	215	334	103	652
1984	Northeast	43	125	117	285	492	609	140	1241	795	850	273	1918
	New England	37	83	93	213	443	459	119	1021	611	595	217	1423
	Mid-Atlantic & Chesapeake	6	72	44	122	54	205	31	290	197	360	104	661
1985	Northeast	20	91	117	228	474	553	154	1181	772	795	290	1857
	New England	20	64	86	170	421	422	129	972	590	554	217	1361
	Mid-Atlantic & Chesapeake	0	48	44	92	59	171	35	265	193	316	110	619
1986	Northeast	10	87	105	202	437	536	150	1123	732	782	284	1798
	New England	10	46	80	136	379	389	126	894	540	505	209	1254
	Mid-Atlantic & Chesapeake	0	53	39	92	63	186	39	288	203	341	108	652
1987	Northeast	17	101	116	234	508	536	141	1185	810	797	292	1899
	New England	17	47	89	153	445	369	112	926	631	493	209	1333
	Mid-Atlantic & Chesapeake	0	64	34	98	65	195	34	294	187	358	98	643
1988	Northeast	27	111	136	274	486	564	161	1211	828	817	329	1974
	New England	26	56	109	191	422	370	126	918	651	499	242	1392
	Mid-Atlantic & Chesapeake	1	63	42	106	64	225	39	328	177	368	113	658
1989	Northeast	41	116	159	316	402	551	151	1104	735	812	341	1888
	New England	38	57	125	220	360	374	112	846	599	509	247	1355
	Mid-Atlantic & Chesapeake	4	68	54	126	44	217	46	307	143	365	130	638
1990	Northeast	35	129	161	325	413	516	143	1072	767	786	338	1891
	New England	32	77	133	242	373	358	108	839	598	512	252	1362
	Mid-Atlantic & Chesapeake	3	82	55	140	42	189	43	274	180	353	129	662

Notes: TC2 = 5-50 gross registered tons (GRT), TC3 = 51-150 grt, TC4 = 151+ grt.
Northeast vessels include those that landed at least once in ME, MA, NH, RI, CT, NY, NJ, MD, VA, DE.
New England vessels include those that landed at least once in ME, MA, NH, RI, CT.
Mid Atlantic & Chesapeake vessels include those that landed at least once in NY, NJ, MD, VA, DE.
Maryland and Virginia joined this reporting system in 1981, and New York in 1986.
The "all vessels" columns provide a unique count of vessels regardless of gear used.
The "Northeast" row eliminates duplication of vessels that landed in both sub-regions.

landings for all fisheries in all waters of the region, while the revenue represented is slightly more than 53 percent. In 1990, otter trawl gear continues to bring in the most revenue. Tables representing the activity of vessels using their major gear types follow.

FLEETS AND FISH

The tables that follow contain condensed pictures of the known vessel activity captured by the port data collection system. All of the information available on an individual vessel's activity has been aggregated into an annual picture. This information is then aggregated across vessels into groups or fleets on the basis of gear use, area fished, and tonnage class. The purpose is to give some continuing set of indicators of vessel performance. Most of the information concerns effort, landings, and revenue. Data associated with the costs of fishing are not available and therefore will not be discussed.

Several caveats are in order concerning categorizing vessels in a given fleet. In general, if a vessel has landings recorded at least once in a port in the region, or in an area such as New England, its total activity (all of the trips it takes regardless of gear used) will be ascribed to that region. Hence, several vessels and their activity may be represented more than once. The same multiple representation exists for use of a gear. If a vessel uses a gill net, for example, and in the same year uses a longline, its total activity will be represented in the total activity section of two tables, but its "primary gear" activity in only one--that describing gill net use or that describing longline use. For some gears this distinction between primary gear activity and total activity is not displayed because a gear's use constitutes an overwhelming majority of the activity of the fleet in question.

Some of the weighout data have been combined to reveal the distribution of individual vessel-based statistics such as annual revenue. These statistics help answer questions such as "what is the distribution of annual gross revenue across vessels in a particular gear-defined fleet?" Some of this information is incorporated into the text associated with the tables that follow.

In 1990, average landings per day absent have increased for the New England otter trawl fleet. An increase in revenue per day absent can be seen in Table 7 for all tonnage classes. The total number of vessels participating in this fishery declined from 846 in 1989 to 839 in 1990. The reductions have occurred primarily in the larger size vessels.

Total landings recovered slightly in 1990 from their steady decline through the 1980s. Average revenue per vessel increased in 1990 but remains below its 1987 record. The average number of days at sea has remained fairly constant over time for all tonnage classes in the aggregate.

Mid-Atlantic otter trawlers primarily land summer flounder, scup, and black sea bass, as well as many other species (Table 8). The number of vessels engaged in this fishery dropped in 1990 to 274 vessels, 33 less than the previous year. The average number of days absent increased by 26%, however, from 1989 to 1990. Despite this increase in the average number of days absent from port among all tonnage classes, only tonnage class 2 showed an improvement in the revenue per day absent and amount of landings.

Total revenue increased in 1990, and total landings reached another

Table 6. Identified vessels' landings (1,000 mt) and ex-vessel revenue ($ million) in the Northeast by gear used, 1990

Gear Types	Landings	Revenue
Otter trawl, bottom-fish	132.84	166.2
Dredge-sea scallop	19.64	146.1
Dredge-surf clam & ocean quahog	47.91	42.8
Pots& taps-lobster	4.39	22.8
Long line, set line, line trawl	3.59	19.4
Gill net, other	13.70	13.6
Purse seine-tuna	0.42	8.7
Otter trawl, bottom-shrimp	4.24	6.4
Otter trawl, Bottom-scallop	0.50	3.5
Gill net, drift-large pelagics	0.44	3.5
Purse seine-herring	28.28	2.8
Dredge-oyster	0.22	2.3
Pots & traps-crabs	1.51	1.9
All other gears	16.66	8.6
Total for 1990	**274.36**	**448.5**

Table 7. New England otter trawl vessels, all gears used

	Ton Class 2			Ton Class 3			Ton Class 4		
	1988	1989	1990	1988	1989	1990	1988	1989	1990
Vessel count	422	360	373	370	374	358	126	112	108
Average age	23	24	24	17	16	17	9	8	10
Average grt	27	28	27	99	101	102	193	193	178
Average days absent	62	62	62	130	123	133	163	174	173
Average crew size	2.7	2.8	2.8	5.3	5.3	5.3	7.2	7.1	7.0
Revenue per day absent ($)	866	920	944	1892	1844	1960	3075	3305	3321
Lb per day absent	1633	1585	2020	2983	2685	3454	5107	5955	6302
Average number of trips/vessel	53	54	51	38	35	37	23	25	28

Table 8. Mid-Atlantic otter trawl vessels, all gears used

	Ton Class 2			Ton Class 3			Ton Class 4		
	1988	1989	1990	1988	1989	1990	1988	1989	1990
Vessel count	64	44	42	225	217	189	39	46	43
Average age	23	21	26	14	15	16	7	8	11
Average grt	31	30	30	134	103	105	176	175	175
Average days absent	37	55	63	65	70	84	102	99	135
Average crew size	2.5	2.7	2.7	4.5	4.8	4.8	7.6	7.4	7.3
Revenue per day absent ($)	910	861	731	1974	1682	1750	3329	3226	3020
Lb per day absent	2142	2241	2057	3819	4536	4561	8559	8017	7727
Average number of trips/vessel	33	54	61	17	22	25	22	19	28

Table 9. Northeast scallop dredge vessels, all gears used

	Ton Class 3				Ton Class 4			
	1987	1988	1989	1990	1987	1988	1989	1990
Vessel count	101	111	116	129	116	136	159	161
Average age	13	14	15	16	13	12	13	13
Average grt	121	119	119	118	182	181	182	181
Average days absent	147	149	149	152	182	185	182	191
Average crew size	7.8	7.5	7.7	7.3	9.8	9.5	9.3	9.2
Revenue per day absent ($)	3150	2682	2421	2542	3969	3440	3301	3399
Lb per day absent	6583	5644	5412	5887	7611	7097	7249	7129
Average number of trips/vessel	18	18	20	19	18	19	18	19

Table 10. Northeast vessels that used shrimp trawls, all gears used and shrimp gear only

	Ton Class 2				Ton Class 3			
	1987	1988	1989	1990	1987	1988	1989	1990
All Gears								
Vessel count	198	207	169	178	61	55	49	46
Average age	18	20	20	18	19	22	20	20
Average grt	24	25	26	26	83	77	81	78
Average days absent	66	63	63	67	129	106	100	115
Average crew size	2.4	2.5	2.4	2.4	5.3	4.9	4.8	4.8
Revenue per day absent ($)	1050	831	845	873	1953	1427	1461	1619
Lb per day absent	1567	1454	1324	1673	3441	2914	2385	3022
Average number of trips/vessel	60	58	59	60	72	75	64	67
Shrimp trawl gear trips								
Average days absent	28	24	28	27	37	28	35	36
Average crew size	2.4	2.5	2.4	2.4	5.3	4.9	4.8	4.8
Revenue per day absent ($)	1126	902	902	808	2211	1722	1418	1448
Lb per day absent	1155	912	1006	1164	2290	1994	1712	2271
Average number of trips/vessel	28	23	27	26	29	25	32	30

new high of 56 thousand mt. Receipts per vessel rose by approximately 25 percent over 1989 as landings increased by the same figure, on average.

For the entire region, vessels using otter trawls did not generally use that gear alone. On an individual vessel basis, 1990 data revealed that approximately 65 percent of the tonnage class two otter trawl vessels had revenues less than $50,000; 26 percent of the tonnage class three vessels earned less than $50,000; but 58 percent had revenues evenly distributed between $50,000 and $400,000. More than 58 percent of the tonnage class 4 vessels grossed more than $500,000. There was also great variability in the number of days absent. This reflects, to some extent, lack of 100% sampling of weigh-outs, particularly in smaller tonnage classes, as much as it reflects actual fishing vessel behavior. Total annual days absent most frequently ranges from less than 10 to 75 for tonnage class 2, from 75 to 200 for tonnage class 3 and from 150 to 250 for tonnage class 4.

Table 9 shows the activity of the Northeast scallop fleet for tonnage classes 3 and 4. Tonnage class 2 vessels accounted for very low levels of effort and landings and are therefore not considered here.

Fishing effort, both in terms of the number of vessels and average days at sea, has risen throughout the late 1980s to obtain its highest level in 1990. Annual landings and revenue have followed suit since 1985. Revenue per day absent has risen in the past year while landings per day absent have risen for tonnage class 3 and declined for tonnage class 4.

Information analyzed by the Fleet Modeling Group activity of the NEFC reveals that for tonnage class 3, the number of vessels absent for more than 200 days per year has increased from two percent of the total in 1982 to 44 percent in 1990. For tonnage class 4 the percentage has increased from 31 percent in 1982, to 56 percent in 1988, to 60 percent in 1990.

It is worth noting that crew size numbers that are based on vessel berths do not represent actual observations

of crew at the end of a trip. For the scallop fleet, the number of people represented as fulltime crew is likely to be grossly underestimated. Regulations in force in recent years have resulted in incentives for a vessel to carry more crew members than it has sleeping spaces.

Northern shrimp trawl activity is generated by a part-time fleet. Ninety-six percent of the shrimp landings are made by vessels using the shrimp trawl, bringing in more than $6 million in 1990. Annual revenue and total landings both rose in 1990, as did total effort.

Roughly two-thirds of the fleet is tonnage class 2 vessels. If alternative fisheries and gears used by vessels landing shrimp are considered, the principal gears used by these vessels in the six months when shrimping is not allowed are otter trawls, gill nets and lobster traps. Table 10 shows the activity of this fleet in pursuing shrimp in addition to all its other fishing activity. Shrimp trawl gear is used an average of 31 days out of an average of 91 days at sea. Given the revenue per day absent, it is clear that the shrimping activity contributes substantially to the annual revenue of these vessels.

Gillnets comprise a broad category of gear but excludes the large mesh drift net used for large pelagics. Small-mesh drift and sink gill nets capture a substantial amount of pollock, a small amount of bluefish, and several other groundfish species, including Atlantic cod and spiny dogfish (Table 11).

The majority of gill net vessels are tonnage class 2 vessels that employ some other gear for approximately 20 percent of the year, usually otter trawls and shrimp trawls.

The total number of vessels in this fishery increased steadily from 1986 to 1989, but 1990 was the first year with a 25 vessel decline, from 251 to 226. Average landings declined in 1990 to their 1988 level, but average revenue remained high. This was not based on gill net activity exclusively, but on revenue from all gears fished by these vessels.

Longline and line trawl gears land the vast majority of swordfish, bigeye tuna, and yellowfin tuna, about half of the tilefish, and a small amount of cod.

The number of vessels in the tonnage class 2 fleet has grown in the past year by 19 vessels (Table 12). Average revenue for all vessels increased in 1990, but average landings increased for only the tonnage class 3 vessels. In general, the larger the vessel class, the more these two gear types contribute to their total fishing activity.

Table 11. Northeast vessels that used gill nets, all gears used and gill net trips only

	Ton Class 2				Ton Class 3			
	1987	1988	1989	1990	1987	1988	1989	1990
All Gears								
Vessel count	185	215	224	226	5	15	23	16
Average age	14	14	14	15	19	16	18	14
Average grt	21	22	21	22	89	79	81	80
Average days absent	62	62	67	67	79	93	92	110
Average crew size	2.8	2.8	2.6	2.7	5.0	3.6	4.3	4.3
Revenue per day absent ($)	1193	951	1117	1031	2227	2037	2247	1959
Lbs per day absent	2893	2682	3429	2407	2928	4344	8963	3875
Average number of trips/vessel	54	54	61	60	35	46	51	58
Gill Net Trips Only								
Average days absent	49	50	51	53	27	31	45	54
Average crew size	2.8	2.8	2.6	2.7	5.0	3.6	4.3	4.3
Revenue per day absent ($)	1209	908	1126	1042	2187	1995	2658	1949
Lb per day absent	2702	2545	3006	2555	2230	5041	6185	5323
Average number of trips/vessel	43	43	47	48	20	22	21	35

Table 12. Northeast vessels that used long lines or line trawls: all trips regardless of gear used and longline/line trawl trips

	Ton Class 2			Ton Class 3			Ton Class 4		
	1988	1989	1990	1988	1989	1990	1988	1989	1990
All Gears									
Vessel count	75	71	90	70	62	60	19	16	11
Average age	14	15	14	11	11	12	9	6	6
Average grt	23	23	27	92	94	91	172	173	174
Average days absent	51	52	55	83	85	88	93	119	111
Average crew size	2.6	2.4	2.7	4.7	4.8	4.4	7.2	6.9	6.0
Revenue per day absent ($)	1414	1217	1334	2541	2382	2516	3503	3395	3709
Lb per day absent	1654	1878	1732	1063	1125	1307	1244	1832	1911
Average number of trips/vessel	36	40	36	10	10	12	3	6	6
Longline/Line Trawl Trips Only									
Average days absent	39	36	32	61	65	71	92	105	103
Average crew size	2.6	2.4	2.7	4.8	4.8	4.4	7.2	6.9	6.0
Revenue per day absent ($)	1450	1239	1428	2538	2456	2626	3507	3375	3641
Lb per day absent	1394	1414	1259	1029	949	1068	1243	1287	1519
Average number of trips/vessel	25	25	15	5	5	7	3	4	5

The surf clam and ocean quahog fishery experienced a substantial change during 1990 as a result of the establishment of an individual vessel transferrable quota management system. However, the full effect of this change will not be seen with the 1990 data. We are beginning to see a reduction in the number of vessels in the fishery as vessel quotas are consolidated within and across firms.

The surf clam and ocean quahog activity represented in Table 13 is divided among the activity of all vessels using that gear, and the activity of vessels that made landings in the mid-Atlantic. In general, total revenue and revenue per day absent increased. Average days at sea dropped significantly. Only 7 of the 133 vessels in the fleet operating in the region in 1990 did not make landings in mid-Atlantic or Chesapeake ports.

Information from the Fleet Modeling Group reveals that almost all of the vessels in this fleet met their 1990 quota in less than 25 days at sea, a substantial change in their fishing operations.

The delineation between offshore and inshore lobstering is not precise. Roughly 23 percent of the revenue generated from lobstering was from offshore fishing, while 75 percent was due to the use of inshore lobster gear.

The offshore lobster fleet is mostly composed of tonnage class 2 and 3 vessels with a substantial increase having occurred in the tonnage class 2 component during 1989-1990 (Table 14). Annual landings of lobster increased among this fleet due to more entrants into this fishery, and average landings and average revenue were up as well. Revenue per day absent increased only for the tonnage class 3 vessels. If only offshore lobstering trips are considered, revenue per day absent increased in 1990 for class 2 and 3 vessels, but declined slightly for class 4 (Table 14).

Table 13. Northeast region surf clam and ocean quahog vessels and Mid-Atlantic vessels: all trips

	Ton Class 2			Ton Class 3			Ton Class 3		
	1988	1989	1990	1988	1989	1990	1988	1989	1990
All Regional Scallop/Ocean Quahog Vessels									
Vessel count	11	10	9	89	87	81	44	46	43
Average age	44	42	41	22	22	23	26	25	27
Average grt	42	42	42	103	103	104	190	189	189
Average days absent	48	43	46	54	61	45	78	67	58
Average crew size	3.1	3.0	3.0	4.0	3.8	4.0	8.3	8.3	8.6
Revenue per day absent ($)	2281	2217	2254	4556	4633	6621	5509	5625	7198
Lb per day absent (live wt.)	23934	22995	19854	63269	71479	98106	109027	110653	121480
Average number of trips/vessel	38	36	50	46	60	55	66	61	58
Mid-Atlantic Scallop/Ocean Quahog Vessels									
Vessel count	9	8	6	81	81	78	43	46	42
Average days absent	34	37	36	50	60	45	79	67	57
Average crew size	3.1	3.0	3.0	3.9	3.9	4.0	5.6	8.3	8.7
Revenue per day absent ($)	2385	2279	2183	5042	4879	6699	5556	5625	7354
Lb per day absent (live wt.)	26343	24626	21169	72591	76227	99907	110290	110653	122893
Average number of trips/vessel	34	36	44	46	61	56	67	61	59

Table 14. Northeast vessels using offshore lobster gear, all trips and offshore lobster trips

	Ton Class 2			Ton Class 3			Ton Class 4		
	1988	1989	1990	1988	1989	1990	1988	1989	1990
All gears									
Vessel count	26	41	61	40	42	44	4	3	4
Average age	12	15	15	10	10	10	4	5	10
Average grt	28	24	23	84	86	87	168	172	178
Average days absent	69	88	104	135	139	120	140	169	188
Average crew size	3.1	2.7	2.6	4.2	4.2	4.3	5.0	5.0	5.0
Revenue per day absent ($)	1564	1255	1246	2469	2215	2753	3571	3259	2997
Lb per day absent	814	549	683	1002	948	1352	2795	1308	3626
Average number of trips/vessel	34	69	86	36	35	34	43	45	74
Offshore Lobster Trips Only									
Average days absent	51	40	57	123	132	112	102	169	103
Average crew size	3.1	2.7	2.6	4.2	4.2	4.3	5.0	5.0	5.0
Revenue per day absent ($)	1728	1371	1509	2582	2268	2848	3977	3253	3228
Lb per day absent	742	575	653	1000	944	1199	1572	1306	1616
Average number of trips/vessel	17	22	40	30	31	28	27	45	41

TRADE

Historically, the Northeast region has run a trade deficit in edible fishery products, due to a large port of entry in New York and the region's proximity to Canadian fishing ports. In 1990, this trade imbalance decreased $347 million from the 1989 level. The value of imports declined $239 million (roughly 10%, Table 15) while exports increased by $108 million (approximately 53%, Table 16).

Increases in product-specific exports were led by frozen shrimp ($10.3 million), fresh lobster ($14.6 million), and fresh and frozen scallops ($8.6 million). Combined, these three products accounted for slightly more than 30% of the increased value of exports from the Northeast region.

Table 15. Northeast region: value of imported edible products ($ millions) for selected years

Product Category	1989	1990
Fresh or frozen sea herring	2.60	3.12
Fresh whole groundfish, halibut and other flatfish	58.48	45.82
Frozen whole groundfish, halibut and other flatfish	8.11	9.24
Salmon, fresh or frozen	93.22	93.06
Other fish fresh or frozen	48.98	58.81
Frozen groundfish blocks	262.80	313.42
Ocean perch fillets	56.54	56.35
Fresh groundfish and flatfish fillets	54.85	48.63
Frozen groundfish and flatfish fillets	436.14	343.54
Other fresh, frozen fillets	133.25	124.97
Salted or dried groundfish	21.86	30.19
Salted herring	2.44	3.74
Canned tuna	213.29	161.78
Canned sardines	33.03	30.38
Minced fish	23.85	18.61
Clam Products	4.43	8.83
Crab products	29.00	36.26
Lobster, fresh	106.62	111.80
Lobster, frozen	162.74	139.95
Other Lobster products	1.42	5.80
Scallops	103.85	82.20
Shrimp products	440.35	366.08
Analog fish products	14.66	10.53
Squid	12.37	9.58
Other fishery products	163.95	136.68
Total	**2,488.8**	**2,249.4**

Table 16. Value of exported fishery products in the Northeast Region for selected years ($ million)

Product Category	1989	1990
Live eels	ND[1]	ND
Eels, other	0.89	0.70
Herring, fresh and frozen	3.71	0.67
Salmon, fresh and frozen	7.47	17.29
Butterfish	2.43	2.16
Other fish, fresh and frozen	44.31	100.85
Fish fillets, fresh and frozen	21.31	22.30
Fish, dried, etc.	3.78	5.76
Salmon, canned	0.58	2.01
Other canned fish	8.41	11.06
Fish sticks & portions	1.35	3.86
Fish roe	5.28	6.86
Shrimp, fresh	0.47	2.39
Shrimp, frozen	15.51	25.77
Lobster, fresh	29.76	44.33
Lobster, frozen	2.09	2.47
Other lobster products	1.25	1.29
Crab products	6.31	6.79
Squid, fresh and frozen	13.23	15.74
Shellfish, fresh	5.08	5.50
Clam products	2.68	3.43
Scallop, fresh and frozen	4.18	12.76
Shrimp, canned	0.33	0.62
Squid, canned	0.15	0.01
Other shellfish	2.75	3.38
Other edible fishery products	19.94	13.68
Total	**203.25**	**311.68**

[1] **Data not available.**

The largest reductions in product-specific imports were frozen groundfish and flatfish fillets ($92.6 million), canned tuna ($51.5 million), frozen lobster ($22.8 million), scallops ($21.7 million), and shrimp products ($74.3 million). However, these decreases were offset partially by increases in imports of frozen groundfish blocks ($50.6 million), salted or dried groundfish ($8.3 million), crab products ($7.3 million), and fresh lobster ($5.28 million).

Canada has traditionally been the most important trading partner for the New England states. In 1990, imports of finfish, as measured by live-weight equivalent, and scallops declined from their 1989 levels (Table 17). Finfish imports decreased by roughly 84 thousand mt (16%) while scallops decreased by 2.5 thousand mt (25.8%). Although the total quantity of these imports from Canada declined, in three out of the five categories, Canadian market share increased slightly, thus reinforcing the Canadians importance as a trading partner.

PROCESSING

Fish processing in the Northeast relies on domestic landings and increasingly on imported product for its supplies. The most important materials processed continue to be imported frozen blocks of fish followed by industrial grade menhaden and herring. Edible fish product processing of regionally caught species was again headed by surf clam processors.

The number of plants and their average annual employment levels, as identified in the annual survey, are shown in Table 18 for 1989 and 1990. The total number of plants has increased slightly with the additions coming in wholesaling activity and declines in processing. Consequently, the average number of employees per plant has declined.

Total regional employment in this sector has declined since the early days of the Magnuson Act. In 1978 almost 22,000 persons worked in these activities, with four persons in pro-

cessing for every one person in wholesaling. Today, 19,250 persons are employed with the processing/wholesaling ratio reduced to 2.4.

FOREIGN FISHING AND JOINT VENTURES

There have been directed foreign fishing operations in the region since the Magnuson Act's passage in 1976 and joint venture arrangements since 1982. Since 1986, foreign vessels have been allowed to take only mackerel in a directed fishery. Table 19 shows that tonnage and revenue from the mackerel joint ventures was reduced substantially in 1990: the resource rent received from this use fell by a factor of more than four.

In recent years, ratios have been imposed on the foreign fleet linking the amount of foreign catches to the amount that must be bought "over the side" from U.S. vessels in joint ventures, and to amounts that must be bought of processed product from U.S. mackerel processors. In 1989 and again in 1990, the ratio required that for 9 mt of mackerel caught directly, the foreign fleet had to purchase 3 mt over the side and 1 mt of processed product.

The number of vessels participating in regional mackerel joint venture activities roughly doubled in 1990 from the year before, to just under twenty. The number of firms coordinating the activity was fewer than three, hence the information is confidential. Gross revenues to participating vessels tripled from the 1989 level, however.

NET NATIONAL BENEFITS

Last year, the status of fishery resources document introduced a section on net national benefits. Several categories of economic benefits and costs that relate to net national benefits were discussed, including resource rents (*i.e.*, the economic value

Table 17. New England imports (1,000 mt) of selected fishery products from Canada and all other sources, 1989-1990[1]

	1989		1990	
	Canada	Other	Canada	Other
Cod	316.74	144.24	286.54	99.89
Groundfish	95.86	108.28	95.72	97.81
Flatfish	57.42	31.28	48.48	27.98
Other Finfish	70.68	53.76	26.05	34.98
Scallops	9.68	1.84	7.16	1.04

[1] Product forms include whole fresh and frozen, frozen blocks, 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.

Table 18. Marine products processing and wholesaling establishments and employment levels for 1989 and 1990

	Processing		Wholesaling		Total	
	Plants	Emp	Plants	Emp	Plants	Emp
1989						
New England	261	6582	627	2470	888	9052
Mid-Atlantic and Chesapeake	210	7739	363	2760	573	10499
Northeast Region	471	14321	990	5230	1461	19551
1990						
New England	252	6182	682	2745	934	8927
Mid-Atlantic and Chesapeake	191	7472	371	2860	562	10332
Northeast Region	443	13654	1053	5605	1496	19259

Table 19. U.S. income from Northeast region directed foreign fishing for squid, mackerel and butterfish; Northeast vessel gross revenues from joint venture transfers to foreign vessels

U.S. Income From Directed Foreign Fishing

	Illex squid		*Loligo* squid		Butterfish		Mackerel		Other & Confidential
	mt	$000	mt	$000	mt	$000	mt	$000	mt
1984	638	38.3	11029	1477.9	430	67.1	9478	236.9	1433.0
1985	1008	57.5	6558	747.6	802	128.3	26384	1292.8	2489.0
1986	249	34.6	4862	1098.8	125	27.5	19144	957.2	1406.0
1987	-	-	0.3	0.1	<136	<40.0	29294	1728.3	<220.7
1988	<293	<30.5	3.4	0.8	<293	<80.5	42879	2935.4	<371.6
1989	<180	<18.7	3.5	0.9	0.9	<0.2	36823	2519.8	<274.6
1990	(1)	-	(1)	-	(1)	-	8670	593.3	<537.7

Gross Revenues to Regional Vessels from Joint Venture Transfers (by selected species)

	Illex squid		*Loligo* squid		Whiting		Mackerel	
	mt	$000	mt	$000	mt	$000	mt	$000
1984	6010	2000.0	760	395	(2)	(2)	1423	220
1985	2540	595.0	1082	599	-	-	3788	584
1986	(2)	(2)	(2)	(2)	65	9	(2)	(2)
1987	3140	628.0	993	745	5	0.5	8012	1058
1988	(2)	(2)	-	-	-	-	5685	760
1989	-	-	-	-	-	-	(2)	(2)
1990	-	-	-	-	-	-	(2)	(2)

(1) = not broken out, included in "Other" total, (2) = information confidential

of a fish resource vis-a-vis labor or capital) and consumer surplus (*i.e.*, an economic "profit" enjoyed by consumers that exceeds their expenditures on seafood).

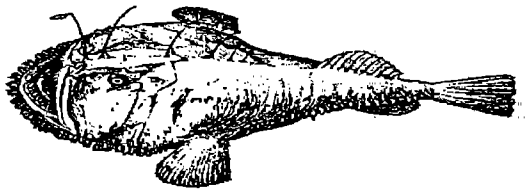
The preliminary results from an analysis of foregone resource rent and consumer surpluses in the overfished New England otter trawl fishery were revised in 1990. Optimum yield from the offshore multispecies groundfish resource would require a 70 percent reduction in fishing effort, leading to a sevenfold increase in the size of the harvestable resource and a threefold increase in sustainable yield. Under these conditions, per capita consumption of fresh fish by New Englanders could increase by about 6 lb. Furthermore, net national benefits are estimated to increase by about $150 million. (These benefits would most likely be concentrated in New England.) Nearly 90 percent of these benefits would be resource rents. In the absence of payments that are charged for use of all other publicly-owned natural resources (including seabed energy resource and hard minerals), the resource rents would profit the fishing industry directly. The remaining benefit would be enjoyed by consumers, who would pay lower prices for seafood.

Other sectors of the New England economy would gain both income and employment from a recovery of the groundfish resource as a result of "multiplier effects," particularly during a recession and in the long run as a growing population looks for work. It is emphasized that the net impacts of such a large increase in fishery output on regional income and employment were impossible to determine without a model of the New England economy that predicts to what extent production would decline in sectors that lose labor and capital to the seafood sector. In addition, it was not possible to predict to what extent consumers would substitute greater domestic landings of groundfish for other foods, including imported fish.

NMFS/NEFC archive photo

Haddock (top) landings in the Gulf of Maine have decined by 95% since 1983, and are only about 6% of the late 1970s harvest level on Georges Bank. Goosefish, (left) a non-traditional species, is supporting a growing market for tails and livers and is providing some market diversity for Northeastern U.S. commercial fishermen

*Chuck Byrne, NEFC scientist with a goosefish from the NMFS Groundfish Survey aboard the **R/V Delaware II**. NMFS/NEFC photo by Brenda Figuerido.*

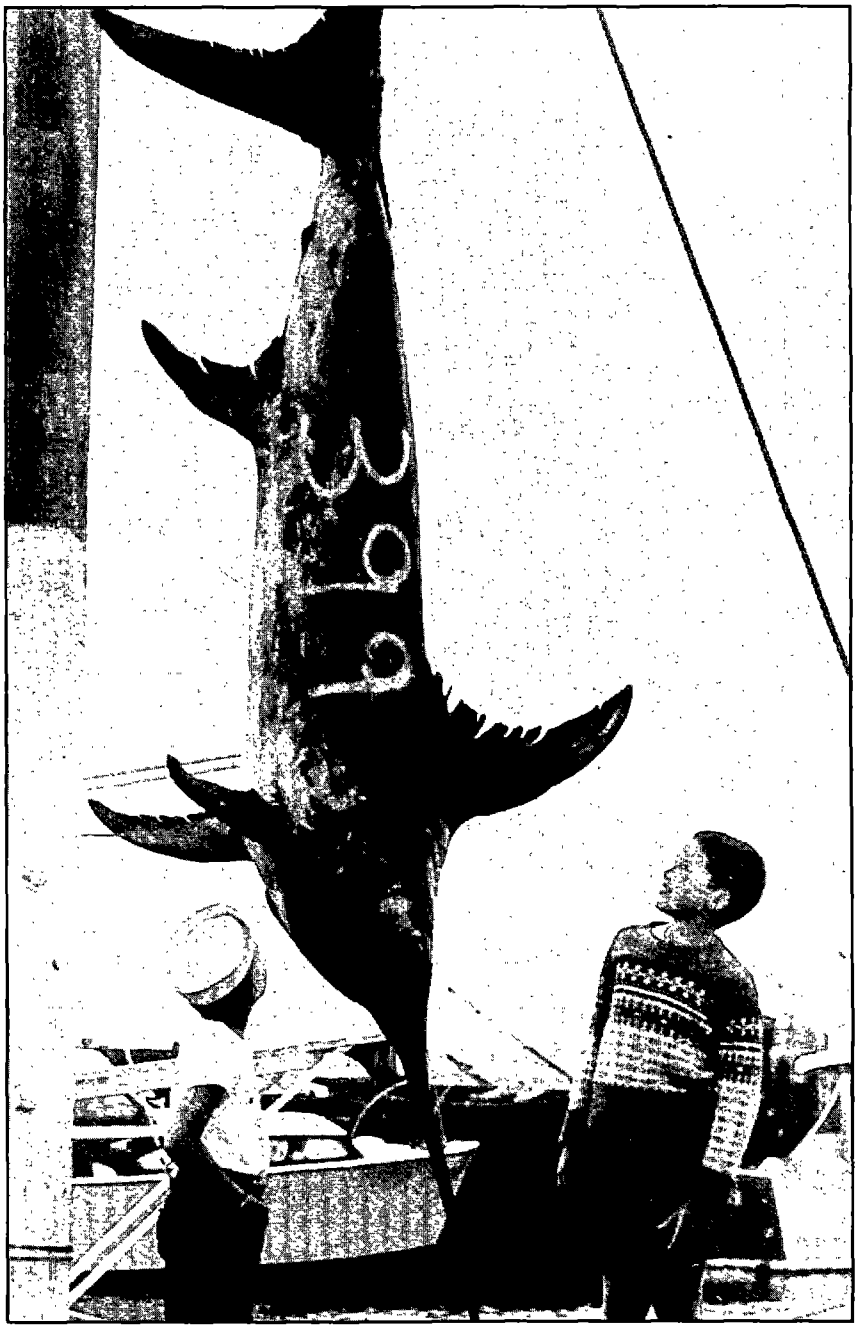


Recreational Fishery Trends

INTRODUCTION

The estimated recreational catches of many fish species harvested off the northeastern United States, including black sea bass, bluefish, striped bass, summer flounder, weakfish, and pelagic sharks, may approach or exceed their respective U.S. commercial landings in weight. For Atlantic cod, Atlantic mackerel, scup, and winter flounder, recreational catch is greater than 10% of their total U.S. commercial catch. Recreational fishery data are therefore an important factor in determining the status of many stocks, and have been incorporated into some of the stock assessments summarized in this report.

Recreational anglers made between 18 and 33 million fishing trips annually in the marine waters off the northeastern U.S. during 1980 to 1990. Recreational fishing trips are made at all hours of the day in the coastal rivers, bays, and sounds of the northeast region, as well as in the open ocean. Anglers fish from private boats, rental boats, party and charter boats, the shore, and man-made structures such as piers, bridges and jetties. A complete, annual census of this large and diverse fishing effort is not possible. Between 1960 and the mid-1970s, NMFS and NEFC conducted a variety of surveys to obtain estimates of catch and other information about the recreational fishery. Because of considerable uncertainty about the accuracy of the catch estimates derived from these early surveys, a new series of studies, the Marine Recreational Fishery Statistics Survey (MRFSS), was implemented by NMFS in 1979 to obtain reliable estimates of catch and effort by recreational fishermen in the marine waters of the United States.



In previous years, swordfish were an important recreational species, but recreational catch has declined significantly in recent years. This photo was taken around 1960. NMFS/NEFC archive photo

This section describes methodology and results of the MRFSS, which documents fishing activity directed to commonly-caught marine species. The MRFSS does not precisely estimate the catches of 'rare event fisher-

ies', such as those directed to large pelagic species (billfishes, tunas, sharks and others). Accordingly, a separate survey directed to likely participants in these fisheries is carried out by NEFC, in cooperation with various other organizations in the northeast. Some of the results of these 'Large Pelagics Recreational Fishery Surveys' are reported here. Finally, the status of knowledge of the economics associated with marine recreational fishing in the northeast region is evaluated.

MRFSS SURVEY METHODOLOGY

MRFSS data are collected by two complementary surveys: a telephone survey of households and an intercept survey of fishermen at fishing sites. The telephone survey is used to estimate the number of fishing trips made by fishermen, the time and location of these trips, and the number of fishermen in each household. Various catch data, including number, length, and weight of fish caught, and trip information, such as fishing mode (shore or boat) and distance from shore (area) of fishing activity, are recorded in the intercept survey. Data from these two independent surveys are then combined to estimate total catch and effort by recreational fishermen.

The total number of fishing households is estimated every two months from the telephone survey by deriving the proportion of households with fishing activity in the sample, and multiplying this factor by census data on the total number of households. The proportion of trips by fishing mode and distance from shore (area) in the household sample is then applied to the estimated total number of fishing households to estimate total fishing trips by mode and area. The total number of fish caught by recreational fishermen is calculated by multiplying the estimated total number of fishing trips times the average catch per trip from the intercept survey.

The estimated total catch is reported in three categories, depending on the nature of the sample catch from which it was derived. Catch type A is estimated from catch available for identification and measurement of length and weight. Catch type B1 is estimated from catch not available for identification, because the fish were either used for bait, cleaned, or discarded dead. Catch type B2 is estimated from the released catch. Estimated standard errors of the catch estimates are also made for use in the calculation of confidence intervals. Coefficients of variation (CV), which express the standard error as a percentage of the estimate, are employed as a measure of precision, and are useful for comparing the relative precision of estimates for different species. For U.S. Northwest Atlantic stocks with major recreational fisheries, the estimates of total catch in numbers for bluefish and summer flounder are the most precise (CV of 10-20%), and are among the most precise of all the species included in the MRFSS. Such low values of CV reflect the cosmopolitan distribution of these species along the coast and resulting wide availability to anglers, and hence large intercept sample sizes. By contrast, the CV values for species such as Atlantic cod and Atlantic mackerel are generally higher (25-50%), reflecting limited availability and/or exploitation coastwide, and thus a smaller available sample size from which to estimate catch.

More detailed information on the procedures used to estimate total catch and effort from telephone and intercept survey samples is available from MRFSS publications (USDOC 1984, 1985a, 1985b, 1986, 1987, and 1991).

MRFSS RECREATIONAL CATCH AND EFFORT TRENDS

The estimated total number of fish caught by recreational fishermen in marine waters off the northeastern United States (Maine through Virginia) increased about 17% from 1989 to 1990, from 96 million fish in 1989 to 112 million fish in 1990 (Table 20). Since 1986, however, the estimated total number of fish caught has declined by 49%, from 220 million fish. For the period 1980 to 1990, total fishing effort ranged from 18 to 33 million recreational fishing trips. During the past three years (1988-1990) recreational fishing trips declined 31 percent (Table 20). The decline in participation may be partially related to decreases in catch rates of various target species groups (see next section).

The number of fishery management regulations imposed on recreational fishermen, such as increased minimum sizes and bag limits, has increased significantly since 1986 as the result of actions by state fishery agencies, ASMFC and the federal Management Councils. The influence of these regulations on angling practices may be reflected in the increasing proportion of the total catch released: from 33% in 1986 to 37% in 1989 and 46% in 1990.

MRFSS PRINCIPAL RECREATIONAL SPECIES

The catches of nearly all the principal recreational species have declined since 1986 (Table 21). Most dramatic have been the 1986 to 1990 declines in catches of weakfish (85%), summer flounder (68%), scup (68%), and black sea bass (70%). Total catches of winter flounder and tautog declined 61% over this period, while the total catch of bluefish declined by 60%, from 29 million fish in 1986 to less than 12 million fish in 1990. Only the total catches of Atlantic cod (69%) and striped bass (34%) increased during the last five years (Table 21).

One way to interpret trends in total catches of the principal recreational species in terms of the health of the resource is to look at corresponding trends in effort (fishing trips) targeted at different species groups, or "multispecies aggregations" (Table 22). These categories are based on the manner in which the fish co-occur in

Table 20. Trends in marine recreational fishery catch (thousands of fish) and effort (thousands of angling trips) as estimated from the Marine Recreational Fishery Statistical Survey (MRFSS) off the northeast USA, 1980-1990. Data are presented separately for the North Atlantic region (NOR=states of Maine to Connecticut) and the Mid-Atlantic region (MID=New York to Virginia). Total catch included types A+B1+B2 (see text).

Area	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
						Total Catch (thousands of fish)					
NOR	46,637	40,256	48,699	43,833	31,090	45,662	56,654	36,218	31,605	26,051	21,015
MID	157,776	104,160	90,626	149,347	137,388	113,898	163,670	108,281	103,473	69,527	90,506
TOT	204,413	144,416	139,325	193,180	168,478	159,560	220,324	144,499	135,078	95,578	111,521
						Total Trips (thousands)					
NOR	7,768	6,556	7,672	9,385	6,639	8,701	8,333	6,293	7,696	5,433	5,801
MID	24,913	14,771	17,029	23,012	21,090	17,816	20,561	16,332	19,744	12,989	13,033
TOT	32,681	21,327	24,701	32,397	27,729	26,517	28,894	22,894	27,440	18,422	18,834

anglers catches, and from information on primary species sought gathered during MRFSS interviews. We can define the following four categories which accounted for about 75% of the marine recreational total catch and 95% of the marine recreational fishing trips in the northeastern U.S. in 1990: 1) summer flounder/scup/black sea bass/spot/Atlantic croaker, 2) bluefish/striped bass/weakfish, 3) winter flounder and tautog, and 4) Atlantic cod and pollock. Total catch in these categories has decreased by about 60% during 1986 to 1990, except for cod and pollock, which increased by 50% (1986 vs. 1990). In contrast, effort has declined by only 23% in the summer flounder group, by 13% for winter flounder and tautog, and by 4% in the bluefish group. Effort targeted at cod and pollock increased by 22% (Table 23). Indices of abundance based on this multispecies scheme exhibit the same trends indicated by single-species indices developed from fishery independent resource surveys and from commercial fisheries information (*e.g.*, see individual species synopses for recreationally-caught species). As in those data, the recreational multispecies indices suggest that decreasing trends in catches of the principal recreational species are not only the result of diminished recreational fishing effort, but also are due to declining abundances of the targeted stocks (Figure 6).

Table 21. Principal species, total numbers caught (millions of fish) by recreational fishermen off the northeastern United States, 1986-1990

Species	1986	1987	1988	1989	1990	Mean Values 1986-1990
Scup	32.4	12.9	9.3	11.5	10.5	15.3
Black sea bass	31.3	5.7	10.8	6.7	9.3	12.8
Bluefish	29.4	24.7	12.4	14.6	11.9	18.6
Summer flounder	22.7	21.3	19.7	2.3	7.3	14.7
Spot	15.7	11.3	6.2	10.0	14.8	11.6
Atlantic croaker	13.0	7.2	9.7	4.5	6.1	8.1
Weakfish	11.1	6.5	8.2	1.5	1.7	5.8
Winter flounder	10.4	13.0	14.	8.5	4.1	10.1
Tautog	9.2	4.9	5.2	3.7	3.6	5.3
Atlantic mackerel	5.9	7.7	6.9	4.9	4.1	5.9
Atlantic cod	1.6	2.0	3.0	2.5	2.7	2.4
Striped bass	1.4	0.8	0.8	1.3	2.0	1.3
Pollock	0.5	0.7	1.4	0.7	0.4	0.7

Table 22. Multispecies aggregations of principal species caught by recreational fishermen in marine waters off the northeastern United States, 1986 to 1990: total numbers caught (millions), total numbers of fishing trips (millions), and catch in number per trip (CPUE)

Category	1986	1987	1988	1989	1990	Mean Values 1986-1990
			Bluefish, Striped bass, Weakfish			
Total Catch	41.9	32.0	21.4	17.4	15.6	25.7
Total trips	7.6	7.2	7.7	5.8	7.3	7.1
CPUE	5.5	4.4	2.8	3.0	2.1	3.6
			Summer flounder, Scup, Black sea bass, Spot, Atlantic croaker			
Total catch	115.1	58.4	55.7	35.0	48.0	62.4
Total trips	6.5	5.5	6.5	3.5	5.0	5.4
CPUE	17.7	10.6	8.6	10.0	9.6	11.3
			Winter flounder, Tautog			
Total catch	19.6	17.9	19.5	12.2	7.7	15.4
Total trips	4.7	3.0	4.0	3.0	4.1	3.8
CPUE	4.2	6.0	4.9	4.1	1.9	4.2
			Atlantic cod, Pollock			
Total catch	2.1	2.7	4.4	3.2	3.1	3.1
Total trips	0.9	1.1	1.3	0.6	1.1	1.0
CPUE	2.3	2.5	3.4	5.3	2.8	3.3

RECREATIONAL FISHING FOR LARGE PELAGICS

Since 1984, the Northeast Fisheries Center has conducted a special survey in cooperation with several states and the Virginia Institute of Marine Science, to document the catch, catch per unit of effort and biological characteristics of large pelagic species (tunas, billfishes and sharks) taken by rod and reel fishermen off the northeast. Over the period 1984-1986, the survey was conducted in the area from New York through Virginia. In 1987, the survey was expanded to include Massachusetts, Rhode Island and Connecticut.

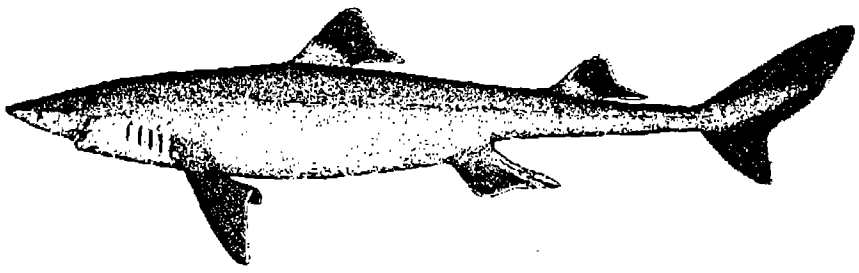
LARGE PELAGICS SURVEY METHODOLOGY

The large pelagic survey consists of a random telephone survey of captains of charter and private boats known to target large pelagic species, and random dockside interviews of the operators of boats as they return to marinas. Telephone listings are maintained for each person contacted in the survey, and the resulting list of boats/captains is considered to be a representative sample of the captains and boats engaged in the fishery. A random sample of the captains is contacted by phone or mail throughout the year and asked to name other captains/boats in the fishery. The ratio of names already on the list to all names mentioned by the captains sampled is used to calculate the total number of boats in the fleet.

The dockside interviews provide catch, effort, and biological data on a per-trip basis. Additional information collected includes fishing location, hours fished, number of lines, number of anglers, and gear and boat type. Phone surveys are conducted on a weekly basis throughout the fishing season (generally May-October) to obtain additional interviews and the number of trips per vessel. Total trips and total catch are estimated on the basis of the estimated number of vessels in the fleet, the average trips per

Table 23. Number of large pelagic fish, by species, caught in interviewed fishing trips by recreational anglers off the northeast USA, 1988-1990. Data are based on the cooperative NEFC-Virginia Institute of Marine Science-State large pelagic survey. These data represent the numbers of fish counted in the survey and **not** expanded estimates of the entire recreational catch of these species.

Species	Kept			Released		
	1988	1989	1990	1988	1989	1990
Marlins						
White	48	70	89	87	631	525
Blue	8	23	9	27	81	45
Tunas						
Yellowfin	1,424	2,457	1,902	169	331	227
Bluefin	782	3,162	3,984	100	118	386
Skipjack	580	607	793	129	68	324
Little	607	478	651	104	115	1,005
Albacore	264	539	1,281	333	54	65
Bigeye	28	168	101	11	19	4
Unclassified	-	-	23	-	-	-
Sharks						
Shortfin mako	79	163	234	13	66	98
Blue	120	131	131	797	827	768
Sandbar	23	75	25	87	221	121
Dusky	18	46	52	40	105	137
Tiger	4	34	11	4	23	22
Unclassified	-	-	-	2	-	-
Hammerhead	3	16	22	3	19	15
Thresher	9	9	17	5	2	8
Sand tiger	14	-	-	5	1	6
Atl. sharpnose	11	16	-	1	18	
Great white	1	1	2	-	-	2
Dogfish	-	-	-	10	-	-
Blacktip	-	8	-	2	-	-
Others						
Dolphin	924	8,642	5,304	22	149	270
Bluefish	516	819	2,832	60	429	1,098
Bonito	719	236	1,070	125	48	268
King mackerel	92	450	299	-	2	1
Wahoo	24	53	27	-	2	-
Amberjack	50	154	55	62	142	190
Span. mackerel	4	9	53	-	-	2
Cobia	1	6	2	-	-	-
Swordfish	2	6	11	2	-	-
Others	-	54	71	-	88	72
Total	**6,373**	**18,432**	**19,051**	**2,200**	**3,559**	**5,659**



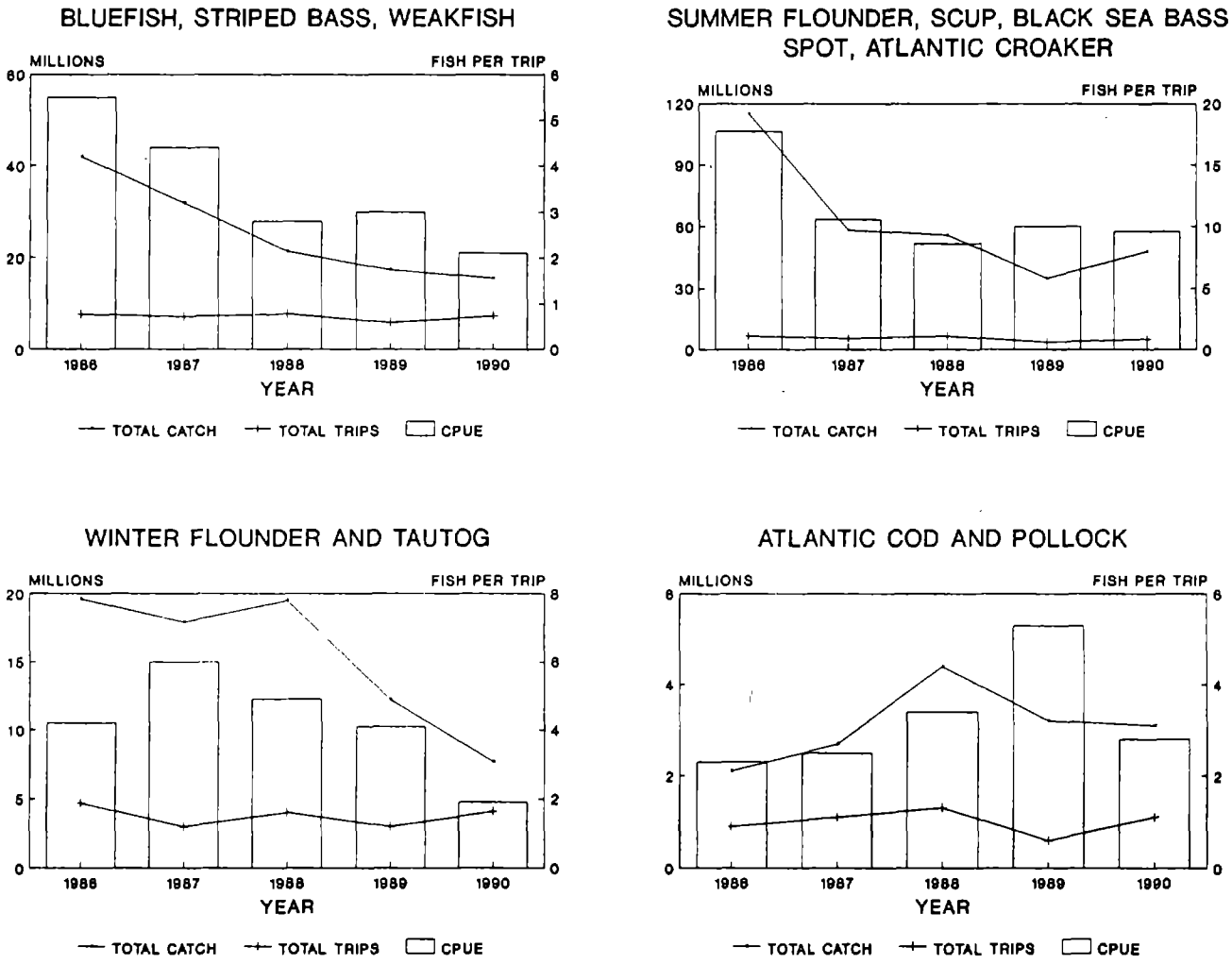


Figure 6. Recreational catch, effort, and catch per effort for four species groups off the northeast USA, 1986-1990. Effort is expressed in numbers of angler trips, CPUE is numbers of fish per trip. Data are from the Marine Recreational Fishery Statistical Survey (MRFSS).

vessel and the average catch per trip, stratified by target species, time period and area.

LARGE PELAGICS RECREATIONAL FISHERIES--CATCH AND SPECIES COMPOSITION

The species composition of the recreational catch of large pelagics off the northeast varies considerably from year-to-year due to annual variability in sea surface temperatures and associated fish migration patterns (Table 23). Table 23 presents the numbers of fish reported from interviews and not the expanded estimates of total catch by species. Given the differences in sampling coverage between years, data in Table 23 are indicative of catch patterns within years, but not necessarily among years. About 29 species comprise the rod and reel catch of large pelagics in most years. The catch generally includes substantial numbers of blue and white marlins, six species of tunas, 12 species of sharks, swordfish, dolphin, bonito, bluefish, amberjack, king and spanish mackerels, cobia, and wahoo. The principal target species are blue marlin, white marlin, albacore, bigeye, bluefin, and yellowfin tuna, and dusky and mako sharks. Overall, about 25 percent of the catch is released alive (ranging from more than 75 percent of blue marlin to about 15 percent of food fishes such as dolphin, tunas and mako shark).

Expanded estimates of total recreational catches of some of the large pelagics are given in Table 24 for 1985-1988. These data indicate an increase in harvests of white marlin and bluefin tuna, and reductions in the catches of bigeye and yellowfin tuna and dusky and mako sharks over that period. More recent estimates for all these species are not yet available, although expanded estimates for some species (*i.e.*, bluefin tuna) have been made and incorporated into stock assessments.

ECONOMICS OF MARINE RECREATIONAL FISHING IN THE NORTHEAST REGION

Table 24. Estimated recreational catch (number of fish) of selected large pelagic species off the northeastern USA, 1985-1988. Estimates were made by Southeast Fisheries Center staff, and are based on phone and dockside interview data and tournament sampling. Estimates for all of these species for 1989 and 1990 are not yet available.

Species	Year			
	1985	1986	1987	1988
Marlins				
Blue	189	212	288	188
White	1,075	797	2,029	2,422
Tunas				
Albacore	610	6,135	10,482	4,069
Bigeye	1,151	2,475	2,285	692
Bluefin	8,793	12,729	25,442	24,995
Yellowfin	16,323	47,902	63,401	25,819
Sharks				
Dusky	740	923	1,198	227
Mako	2,380	4,171	3,375	2,405

The 1980s marked an ongoing period of profound interest in the economics of marine recreational fishing in the Northeast Region. Much is made of the contribution of recreational fishing to the regional and coastal economies. How anglers' expenditures compare to revenues in commercial landings markets is also emphasized in debates over the allocation of shared fish resources. Notable was the use of financial arguments to persuade the Fishery Management Councils in New England, the mid-Atlantic, and areas south to reserve billfishes for use by sport fishermen. The Sport Fishing Institute has estimated that saltwater anglers fishing in the Northeast Region spent over $1 billion to catch fish in 1985 (about $360 million in New England and $720 million the mid-Atlantic), the most recent year for which an expenditures survey was conducted. During that year, most money was spent on travel to fishing sites, followed closely by the costs of new boats and marina services, and then by expenditures for bait and fishing tackle. In addition, over $400 million was spent on food and lodging during fishing trips (about $140 million in New England and $290 million in the mid-Atlantic). Although the current recession and the estimates of fewer anglers taking fewer trips suggest that expenditures were less in 1990 than in 1985, the amount is expected to be hundreds of millions of dollars.

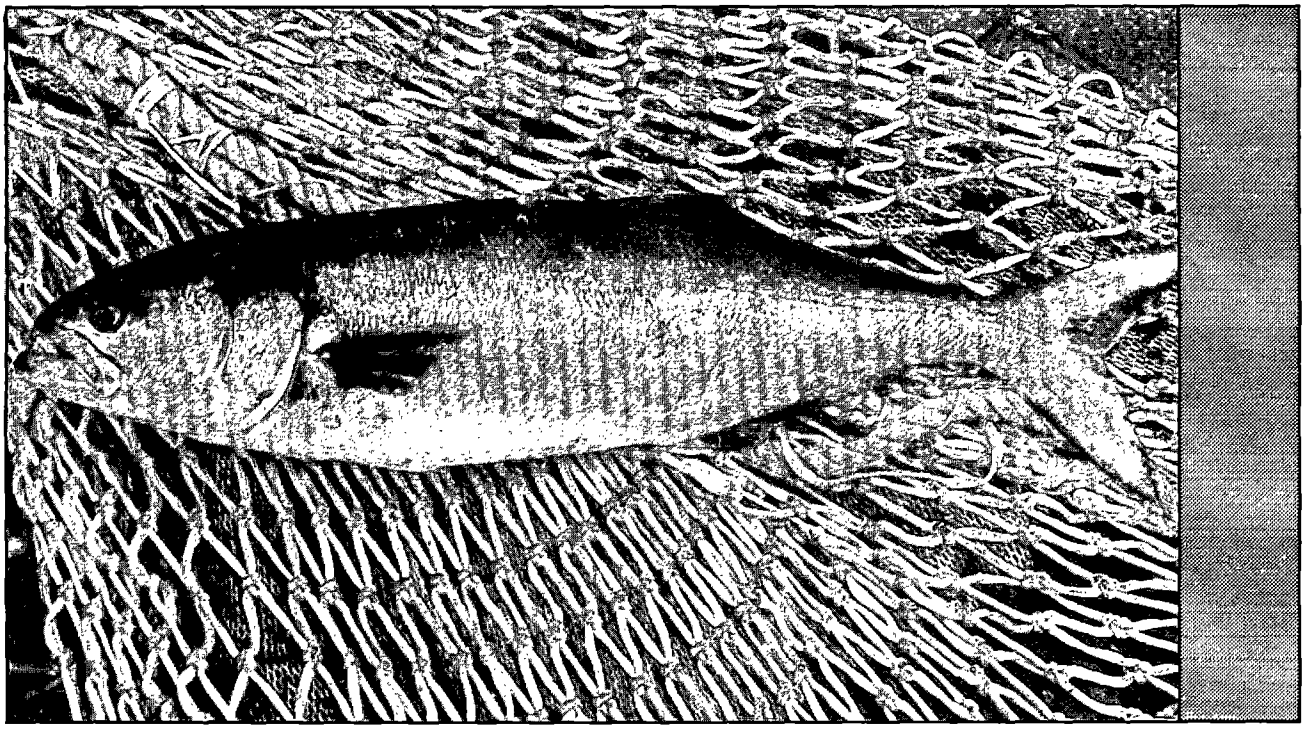
Although indicative of the importance of marine recreational fishing to anglers and the recreational fishing industry, expenditures do not measure the economic value of marine recreational fishing. To see this, consider the fact that recreational fishermen would most likely spend the same amount of their income on other goods, services, and activities if the opportunity to go fishing was not available. This should not indicate, however, that the other products are equally valued. Similarly, the money spent to clean up and monitor the oil spill in Rhode Island waters in 1990 was a financial boon to certain businesses, but to say that it measures the value of the oil spill underscores the illogic of the expenditures argument.

The economic value of marine recreational fishing can and should be understood in the same terms used to characterize the value of commercial fishing and seafood consumption. Accordingly, the value of the fish resources in the Northeast Region (*i.e.*, the resource rental value mentioned in the commercial overview) is determined in part by their contribution to the enjoyment of anglers and to the economic profits of the recreational fishing industry. Because we are only beginning to learn about the economic performance of the charter and party boat fishing industry in the Northeast, nothing further will be said on this topic here. Relatively more is known about how recreational fishing profits anglers, however.

Catching fish is economically valuable regardless of whether the services of a charter or party boat business are hired. The gross economic value of marine recreational fishing (or any good, service, or activity) is defined and measured by the maximum amount of one's income that an angler is willing to spend to catch bluefish, summer flounder, sharks, or some other species. Notice that an important distinction is being made between what an angler actually spends when going fishing and the most that he/she would be willing to spend. The key here is to find the point where the angler is indifferent to going fishing or doing something else. Also note that it is one's expenditure of income that confers monetary units to economic value, not prices.

The difference between maximum willingness to pay and actual expenditures measures what economists call consumer surplus, or the net economic value that recreational fishermen derive from going fishing. Consumer surplus is similar to profit in that it is a return to anglers in the form of satisfaction which exceeds costs. Consumer surplus is the appropriate measure of the economic value of marine recreational fishing to anglers, not expenditures.

If available, market prices would help to reveal consumer surplus from marine recreational fishing. The "law of demand" predicts that when price increases (decreases), the number of fishing trips during a season decreases (increases). The resulting relationship between price and fishing trips would trace demand and, therefore, the gross value of successive fishing



Bluefish is one of the most popular angler catchs in the Northeast USA. NMFS/NEFC photo by Brenda Figuerido

trips. Subtracting actual expenditures from the sum of successive values would yield consumer surplus.

Inadequate market price data undermine this market-based approach to measuring the value of recreational fishing, however. When fishing from shore or a private boat (the principal modes of fishing in the Northeast Region) there is no market for fishing trips. In other cases when boats are rented or the services of a party or charter boat are hired, there generally is not enough variation in prices to identify demand.

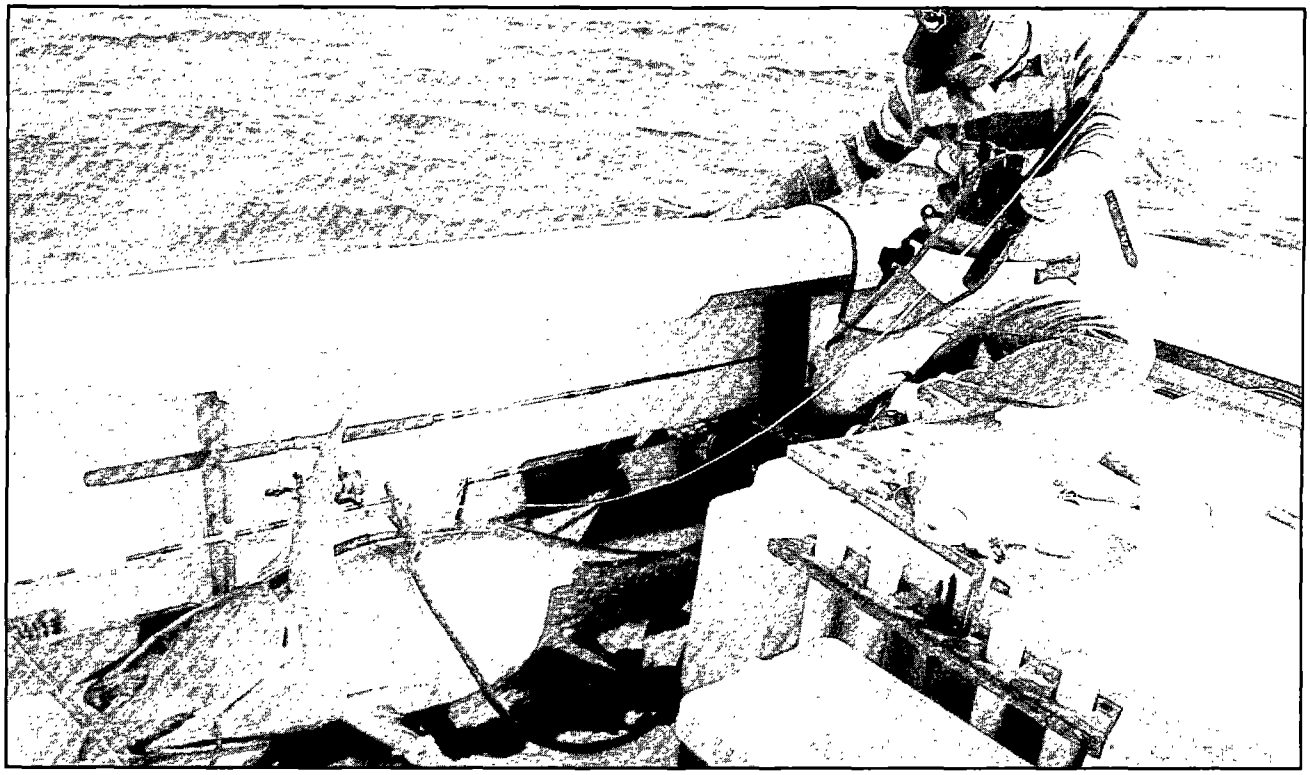
In the absence of adequate market price data, economists have turned to two alternatives for revealing the demand for and value of marine recreational fishing. The travel cost technique uses the costs of traveling to a fishing site as well as other fishing expenses to estimate demand for fishing trips. Travel costs vary in direct proportion to distance from the site, thereby providing the necessary variation. Alternatively, the contingent valuation technique can be used to estimate consumer surplus directly rather than after estimating demand. In this case, anglers are asked for their valuation of fishing trips using techniques that minimize response bias. In addition, the contingent valuation method can be used to learn the value of catch rates or other factors that characterize a fishing trip, including how fish size or catch limits affect consumer surplus.

When compared to other forms of outdoor recreation, there have been relatively few applications of the travel cost and contingent valuation techniques to marine recreational fishing. In 1988, the Sport Fishing Institute summarized the findings of existing studies, including only four studies in the Northeast Region. Estimates of consumer surplus varied widely depending on what technique was applied, what quantity was being valued (*e.g.*, trips or catch), and other characteristics of the studies or anglers. For example, estimates of consumer surplus associated with a day of fishing for striped bass ranged from about $40 in the Chesapeake Bay, to $90 in New England, and to $170 in the mid-Atlantic in one study. In another study in Delaware, a day of charter boat fishing was estimated to be roughly two times more valuable on average than fishing from a party boat or the shore.

Since the Sport Fishing Institute's report, there have been a few additional studies undertaken by economists at state universities to measure the demand for commonly sought species. These studies have not yet been published. In contrast, there is scant research into the value of recreational fishing for large pelagics, such as sharks and school bluefin tuna.

The Marine Recreational Fishery Statistics Survey and the large pelagics survey have been reviewed by economists at NMFS and in academia. There is general agreement that, with increased funding, these surveys could be better used to measure participation and fishing trips by mode, geographic area, and species or species group. More detailed information required for analyses of the economic value of marine recreational fishing will require specialized add-on surveys.

Harder quantitative information on the economic value of marine recreational fishing in the Northeast Region is needed to determine the impacts of depleted stocks and of re-



Because they are popular food fish, tuna are not released as often by anglers as other large pelagics. NMFS/NEFC photo by Tom Azarovitz

source allocations on anglers, on the recreational fishing industry, and on income and employment in coastal economies. For example, it is conceivable (although only a hypothesis at this time) that the apparent declines in the number of marine recreational fishermen and in fishing trips since the early 1980s is attributable, in part, to known declines in the fish stocks. That is, fewer would-be anglers would be expected to go fishing when stocks decline, and those who do participate would be expected to go less often because catch rate is lower. These events would result in a decline in the aggregate demand for fishing trips, a decline in fishing trips, and, therefore, a loss of consumer surplus. In turn, expenditures by anglers would be expected to decline, having negative impacts on incomes and employment in the party and charter fishing industry and in coastal economies. It is not possible at this time, however, to test this hypothesis and, where appropriate, quantify the impacts.

The estimation of economic impacts from allocation of a fish stock between recreational and commercial fisheries is also constrained by a lack of data and analyses. Nevertheless, the allocation debate is characterized, in part, by a misuse of "multiplier effects." By multiplier effect is meant how expenditures by anglers (or seafood consumers) stimulate the economy. For example, expenditures by recreational fishermen on charter fishing trips is considered a direct impact on the economy. Also, in order to provide the service, the charter boat fleet must buy goods and services, such as fuel, bait, and the labor of mates, from its suppliers and the suppliers from their suppliers. These are called indirect impacts of the anglers' expenditures. Finally, the incomes earned by the captains, mates, and employees along the chain of markets that are connected to charter boat fishing are spent on food, clothing, shelter, and entertainment. These latter impacts are called induced impacts. If one adds together the direct, indirect, and, possibly, induced impacts and then divides by the direct impact, a multiplier results. For example, a type-II (includes induced impacts) Keynesian multiplier for income of 3.0 would mean that each dollar of expenditures by anglers has resulted in $3 of income in the economy. Employment multipliers are also potentially important; however, output, or revenue, multipliers are irrelevant.

A common abuse of usual multipliers occurs when a multiplier is applied to a change in expenditures expected from an increase or decrease in recreational fishing, and it is concluded that income or employment in the economy will change by the result. This procedure fails to account for adjustments in other industries which will dampen the net impact on the overall economy, depending on unemployment. Thus, an increase in the demand for, say, striped bass fishing will result in growth of the recreational fishing sector. However, the new labor, capital, and materials used to support this growth will be taken away from another sector of the economy resulting in less production there. The overall net result on a

coastal economy could be a good deal less than expected from the way multiplier effects are often calculated.

Much of what is important to anglers, the recreational fishing industries, coastal economies, and fishery managers depends on a quantitative understanding of factors that affect participation in and demand for marine recreational fishing. At this time, though, very little of a quantitative nature can be said of these matters.

References cited

U.S. Dept. Commerce. 1984. Marine recreational statistics survey, Atlantic and Gulf coasts, 1979(revised) - 1980. Current Fish. Stat. No. 8322.

U.S. Dept. Commerce. 1985a. Marine recreational statistics survey, Atlantic and Gulf coasts, 1981 - 1982. Current Fish. Stat. No. 8324.

U.S. Dept. Commerce. 1985b. Marine recreational statistics survey, Atlantic and Gulf coasts, 1983 - 1984. Current Fish. Stat. No. 8326.

U.S. Dept. Commerce. 1986. Marine recreational statistics survey, Atlantic and Gulf coasts, 1985. Current Fish. Stat. No. 8327.

U.S. Dept. Commerce. 1987. Marine recreational statistics survey, Atlantic and Gulf coasts, 1986. Current Fish. Stat. No. 8392.

U.S. Dept. Commerce. 1991. Marine recreational statistics survey, Atlantic and Gulf coasts, 1987 - 1989. Current Fish. Stat. No. 8904.

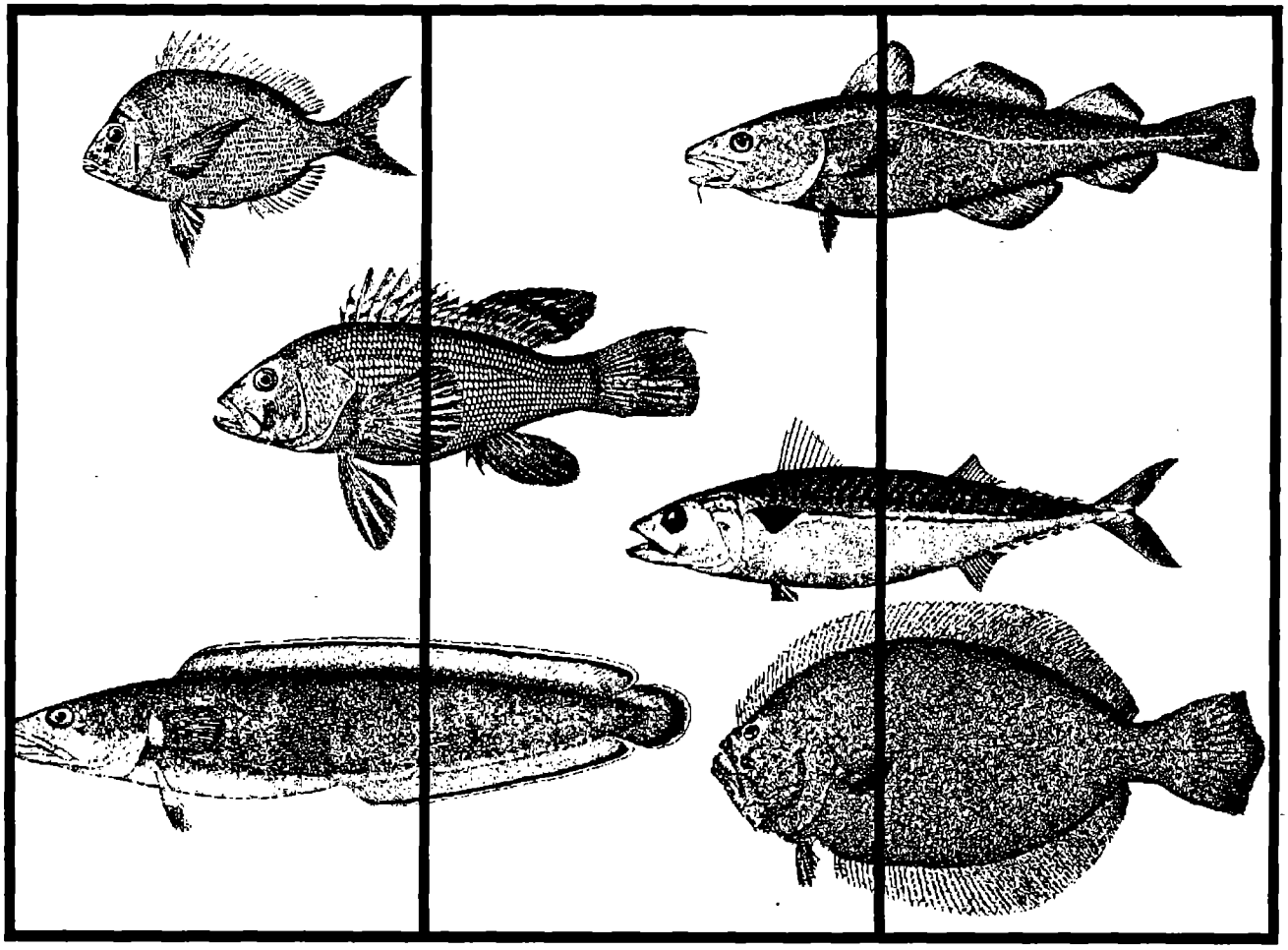
Species Synopses

The synopses of information on the status of the stocks of the 37 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 major groups of groundfish, flounders, pelagics, elasmobranchs, invertebrates and anadromous species. 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 reported on here are described in NEFC Reference Documents at the Northeast Fisheries Center, 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 which 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

Photo by Brenda Figueridо, NMFS

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 lb). 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 4; 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 (NEFMC) Multispecies Fishery Management Plan (FMP). Total commercial cod landings from the Georges Bank and Gulf of Maine stocks in 1990 were 57,700 mt, up 33% from the 43,400 mt in 1989. USA commercial catches increased by 22%, from 35,500 mt in 1989 to 43,350 mt in 1990.

Gulf of Maine Atlantic Cod

Long-term potential catch	=	10,000 mt
Importance of recreational fishery	=	Major
Management	=	Multispecies FMP
Status of exploitation	=	Overexploited
Age at 50% maturity	=	2.3 yrs, males 2.1 yrs, females
Size at 50% maturity	=	36 cm (14.2 in.) males 32 cm (12.6 in.) females
Assessment level	=	Age structured

$M = 0.20$ $F_{0.1} = 0.16$ $F_{max} = 0.27$ $F_{1990} = 0.94$

Gulf of Maine

Total nominal commercial catch in 1990 was 15,150 mt, 46% higher than in 1989 (10,400 mt), and the highest annual catch since 1906. Since 1977, commercial landings of Gulf of Maine cod have been taken exclusively by the USA. Canadian landings reported as Gulf of Maine catch during 1977-1989 are believed to be misreported catches from the Scotian Shelf area and have been reassigned by Canada to the Scotian Shelf stock.

Atlantic Cod
Gulf of Maine

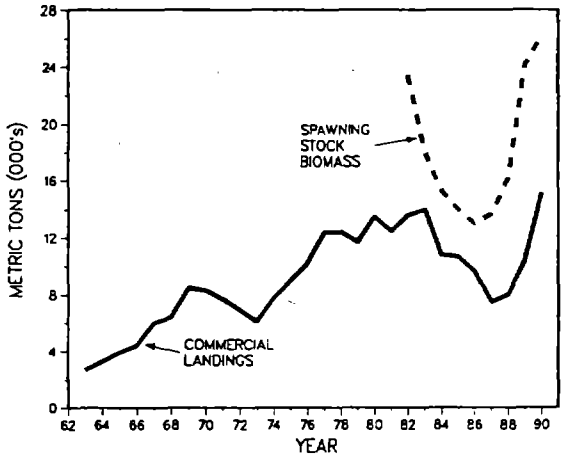


Table 1.1 Recreational catches and commercial landings (thousand metric tons)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
USA Recreational[1]	1.1	1.2	1.1	1.7	2.7	1.6	0.9	1.3	2.5	1.7
Commercial										
USA	12.5	13.6	14.0	10.8	10.7	9.7	7.5	8.0	10.4	15.2
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	13.6	14.8	15.1	12.5	13.4	11.3	8.4	9.3	12.9	16.9

[1] Estimated for Maine and New Hampshire

Georges Bank and South

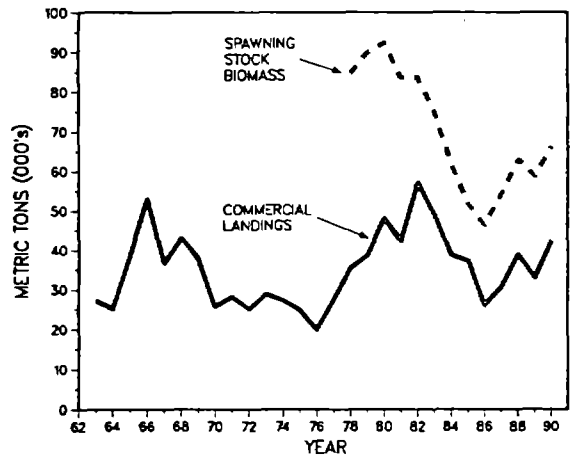


Table 1.2 Recreational catches and commercial landings (thousand metric tons)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
USA Recreational[1]	7.5	6.8	7.2	3.7	6.3	1.8	2.9	6.3	4.3	3.8
Commercial										
USA	33.9	39.3	36.8	32.9	26.8	17.5	19.0	26.3	25.1	28.2
Canada	8.5	17.9	12.1	5.8	10.5	8.5	11.9	12.7	7.9	14.3
Other	-	-	-	-	-	-	-	-		
Total nominal catch	49.9	64.0	56.1	42.4	43.6	27.8	33.8	45.3	37.3	46.3

[1] Estimated for Massachusetts and southward.

"To halt the declining trend in SSB, fishing mortality needs to be markedly reduced."

USA otter trawl fishing effort (nominal days fished), which accounted for 69% of the 1990 landings, was 7% higher in 1990 than in 1989. USA commercial CPUE (catch per day fished for all trips catching cod) increased sharply in 1990 to its highest level since the early 1980s. "Directed trips", which accounted for between 15 and 49% of the annual USA otter trawl catch during 1984-1989, accounted for a record high 67% of the 1990 total.

Fishery age composition data indicate that commercial landings in 1990 were dominated by the 1986 and 1987 year classes; these two cohorts comprised 86% of the landings by number and 69% by weight.

NMFS research vessel weight per tow indices in both the spring and autumn 1990 surveys were the highest since 1985 reflecting strong recruitment from the 1986 and 1987 year classes. Together, the 1986 and 1987 year classes comprised about 80% of the 1990 population by number and 70% by weight. Survey data also indicated that recruitment of the 1988 year classes is average, while the 1989 year class is poor.

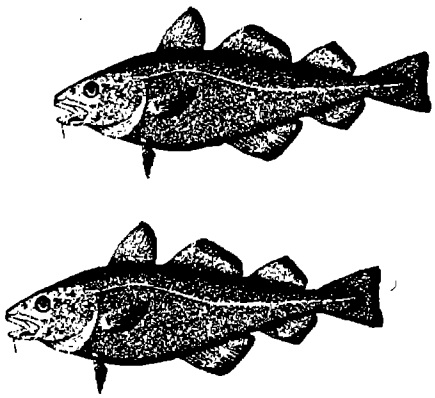
An updated VPA analysis (using data through 1990) indicated that fishing mortality in 1990 was F=0.94 [ages 4-8], essentially unchanged from the high level of F=1.00 during 1983-1989. Fishing mortality in 1990 was far beyond F_{max} (F=0.27) and well in excess of the F needed to attain 20% maximum spawning potential ($F_{20\%}$ = 0.40), the management target established for this stock. As such, the stock is overexploited.

Spawning stock biomass [SSB] at the beginning of 1991 was estimated to be a record high 30,000 mt due to nearly full recruitment of the strong 1987 year class to the spawning stock. However, SSB is expected to decline during 1991 and 1992 as the 1987 cohort is fished down and the much

Georges Bank Atlantic Cod

Long-term potential catch	=	35,000 mt
Importance of recreational fishery	=	Major
Management	=	Multispecies FMP
Status of exploitation	=	Overexploited
Age at 50% maturity	=	1.9 yrs, males 1.7 yrs, females
Size at 50% maturity	=	41 cm (16.1 in.) males 39 cm (15.4 in.) females
Assessment level	=	Age structured

$M = 0.20$ $F_{0.1} = 0.15$ $F_{max} = 0.27$ $F_{1990} = 0.56$



weaker 1988 and 1989 year classes recruit to the spawning stock.

At the current level of fishing mortality, commercial landings are expected to increase further in 1991, but decline to below 14,000 mt in 1992. By 1993, the 1987 year class will no longer be a major component of the stock. To halt the declining trend in SSB, fishing mortality needs to be markedly reduced.

Georges Bank and Areas to the South

Total nominal commercial catch (USA and Canada) in 1990 was 42,500 mt, 29% greater than in 1989 (33,000 mt). The 1990 USA catch (28,200 mt) was the highest since 1984, and just below the 1977-1989 annual average of 29,100 mt. Canadian 1990 landings totaled 14,300 mt, 81% higher than in 1989, and the third highest on record.

Nominal USA commercial fishing effort increased by 3% in 1990 and was slightly below the record-high 1988 level. USA commercial CPUE increased by 20% in 1990 to its highest level since 1984.

USA landings in 1990 were dominated by the strong 1985, 1987 and 1988 year classes. Together, these three cohorts accounted for 85% of the catch by number (13, 30, 42%, respectively) and 76% by weight (25, 26, 25%, respectively).

NMFS research vessel survey indices in 1990 were among the highest in the past five years, reflecting strong recruitment from the 1987 and 1988 year classes. The survey data indicate that the 1989 and 1990 year classes are about average in strength.

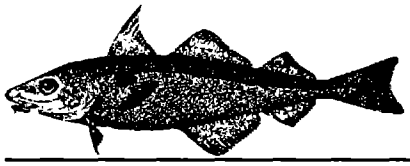
Fishing mortality in 1989 was estimated from VPA analysis to be F=0.56. Although an updated VPA for 1990 is not yet available, the high 1990 survey and commercial CPUE indices suggest that fishing mortality did not increase during the past year. However, F in 1989 was still about twice as large as F_{max} (F=0.27) and well in excess of the F needed to attain 20% maximum spawning potential ($F_{20\%}$ = 0.30), the management target established for this stock. In this context, the stock remains overfished.

For further information

Northeast Fisheries Center. 1990. Report of the Eleventh NEFC Stock Assessment Workshop, Fall 1990. Woods Hole, MA: NMFS, NEFC. Northeast Fisheries Center Reference Document 90-09. Available from: Northeast Fisheries Center, Woods Hole, MA.

Northeast Fisheries Center. 1991. Report of the Twelfth NEFC Stock Assessment Workshop, Spring 1991. Woods Hole, MA: NMFS, NEFC. Northeast Fisheries Center Reference Document. Available from: Northeast Fisheries Center, Woods Hole, MA.

Photo by Brenda Figueridо, NMFS



2. Haddock

The haddock, *Melanogrammus aeglefinus*, a demersal gadoid species, is distributed on both sides of the North Atlantic. In the western Atlantic, haddock range from West Greenland to Cape Hatteras; in the eastern Atlantic they range from France to Norway. Highest concentrations off the USA coast occur on the northern and eastern section of 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). Adult haddock on Georges Bank appear to be relatively sedentary, but seasonal coastal movements occur in the western Gulf of Maine. Haddock prey primarily on small invertebrates, but fish (particularly sand lance) are also consumed by adult haddock.

Haddock attain maximum lengths of 75 to 80 cm (30 to 32 in.) and weights up to 5 kg (11 lb); ages up to 18 years have been documented on Georges Bank, although ages in excess of 9 years are uncommon. 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 lb). Haddock become sexually mature between ages one and three at approximately 30 cm (12 in.). Spawning occurs between January and June, with peak activity during late March and early April. Individual females may produce up to 3 million eggs, but a 55 cm (22 in.) individual produces approximately 850 thousand eggs. Major spawning concentrations occur on eastern Georges Bank, although some spawning also occurs to the east of Nantucket Shoals and along the Maine coast. Juvenile haddock remain pelagic for several months before settling to the bottom. In US waters, two stocks occur 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 were 5,000 mt in 1990, up 6% from the 4,700 mt reported in 1989. Domestic nominal catches increased by 47%, from 1,700 mt in 1989 to 2,500 mt in 1990.

Photo by Brenda Figueridо, NMFS

"Recruitment has been insufficient to support the level of landings, resulting in stock depletion."

Gulf of Maine

Nominal catches of Gulf of Maine haddock declined from about 5,000 mt annually in the mid-1960s to less than 1,000 mt in 1973. Total landings increased dramatically from 1974 to 1980, averaging 7,000 mt annually from 1980-83. Subsequently, catches have markedly declined to record low

Gulf of Maine Haddock

Long-term potential catch	=	5,000 mt
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Overexploited
Age at 50% maturity	=	1.8 yrs, females
		2.1 yrs, males
Size at 50% maturity	=	35 cm (14 in.)
Assessment level	=	Yield per recruit

M = 0.20 **$F_{0.1}$ = 0.26** **F_{max} = 0.55** **F_{1990} = Unknown**

Haddock
Gulf of Maine

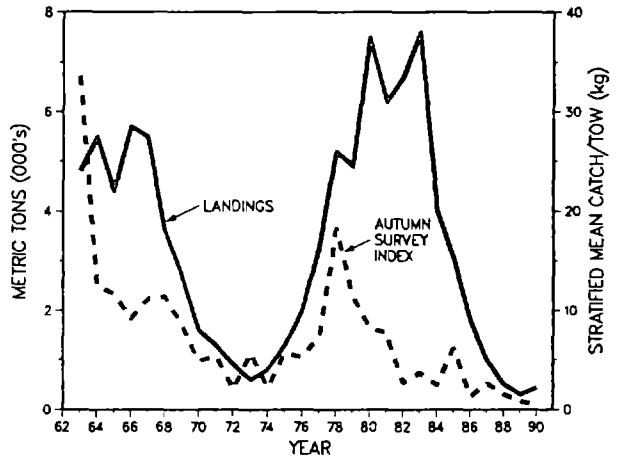


Table 2.1 Recreational catches and commercial landings (thousand metric tons)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
USA recreational	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1	<0.1
Commercial										
USA	5.7	5.6	5.6	2.8	2.2	1.6	0.8	0.4	0.3	0.4
Canada	0.5	1.1	2.0	1.2	0.8	0.2	0.2	0.1	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	6.2	6.7	7.6	4.0	3.0	1.8	1.0	0.5	0.3	0.4

Georges Bank

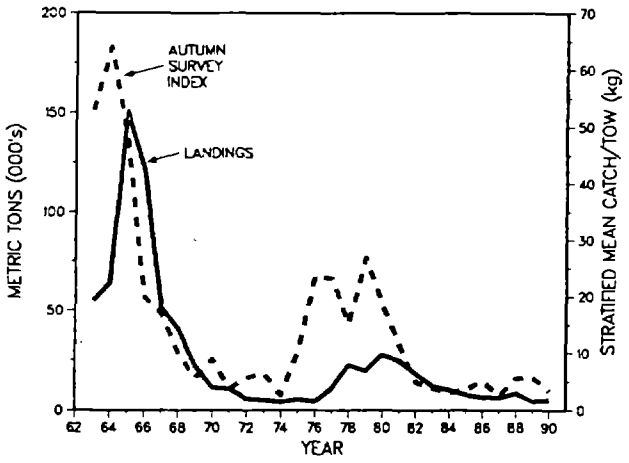


Table 2.2 Recreational catches and commercial landings (thousand metric tons).

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
USA recreational	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-
Commerscial										
USA	19.2	12.6	8.7	8.8	4.3	3.3	2.2	2.5	1.4	2.0
Canada	5.7	5.6	3.2	1.4	3.5	3.4	4.1	5.9[1]	3.0	3.3
Other	<0.1	-	-	-	-	-	-	-	-	-
Total nominal catch	24.9	18.2	11.9	10.2	7.8	6.7	6.3	8.4	4.4	5.4

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

levels (300 mt in 1989; 400 mt in 1990). Recreational catches have also declined, from 1,700 mt in 1979 to insignificant levels since 1981. Virtually all of the catch from this stock currently is taken in the USA fishery. From 1981 through 1989, Canadian landings accounted for 20% of the total landings.

The spring and autumn NEFC survey indices have declined sharply since 1978. In 1990, catch per tow indices in both surveys were the lowest in their respective time series. Survey catch at age data indicate that since 1982 recruitment has been poor. Autumn surveys conducted by the Massachusetts Division of Marine Fisheries further support this conclusion.

The 95% decline in landings from 1983 to 1990 (7,600 mt to 400 mt) and 84% decline in fall research surveys (3.46 kg/tow to 0.55 kg/tow) are indicative of the status of this stock. Recruitment has been insufficient to support the level of landings, resulting in stock depletion. Spawning stock biomass is below maintenance level and is likely to remain so in the near future.

Georges Bank

Nominal catches of Georges Bank haddock increased from about 50,000 mt annually prior to 1965 to nearly triple that amount in 1965 and 1966 due to intense fishing by the distant water fleets. Following the high levels of landings during the mid-1960s, landings declined through 1976. Catches increased between 1977 and 1980, reaching about 28,000 mt, but catches declined after 1980, dropping to 6,100 mt in 1987. In 1988, the reported catch was 8,400 mt, however this may be high due to suspected misreporting of up to 2,000 mt of Canadian catch from the Scotian Shelf as coming from Georges Bank. Regardless of the accuracy of landings reported in 1988, total 1989 landings declined sharply to 4,400 mt. In 1990, total landings (5,300 mt) were about 20% higher

"The low abundance of incoming year classes suggests that the survey index will remain at record or near record low levels for at least two to three years."

Georges Bank Haddock

Long-term potential catch	=	47,000 mt
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Overexploited
Age at 50% maturity	=	1.5 yrs (females) 1.3 yrs (males)
Size at 50% maturity	=	30 cm (12 in.) females 27 cm (11 in.) males
Assessment level	=	Yield per recruit

M = 0.20 **$F_{0.1}$ = 0.26** **F_{max} = 0.55** **$F_{1989} > F_{max}$**

than in 1989. Much of this increase occurred in USA landings which increased from 1400 mt in 1989 to 2000 mt in 1990. Canadian landings increased by about 10%, from 3000 mt to 3300 mt.

The NEFC spring and autumn bottom trawl survey results have indicated a marked decline in the stock biomass of haddock since 1979. The 1990 autumn survey index (3.30 kg per tow) is the fourth lowest in the time series. Survey data indicate a succession of weak year classes throughout the 1980s, with the 1989 and 1990 year classes continuing this trend. The low abundance of incoming year classes suggests that the survey index will remain at record or near record low levels for at least two to three years. Currently, the stock is dominated by one age group (the 1987 year class). Thus, landings in 1991 will continue to depend largely on the survivors of this year class and the strength of incoming year classes. Because of the low levels of spawning stock biomass, relatively poor recruitment is expected for at least the short-term, perpetuating the over exploited condition of this stock.

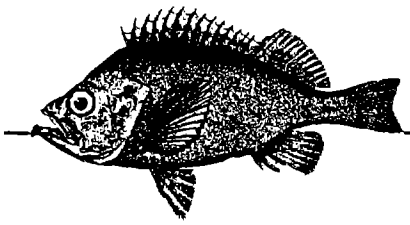
For further information

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

Overholtz, W.J., S.H. Clark, and D.Y. White. 1983. A review of the status of the Georges Bank and Gulf of Maine haddock stocks for 1983. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 83-23. 31 p. 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.

Photo by Bob Brigham, NMFS/NEFC



3. Redfish

Photo by Brenda Figueridо, NMFS

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.

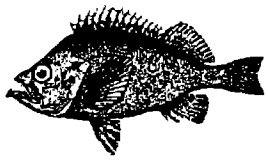
The principal commercial fishing gear used to catch redfish is the otter trawl. Recreational catches are insignificant. Fishing is managed under the New England Fishery Management Council's Multispecies FMP. The total nominal catch was unchanged between 1989 and 1990 at 600 mt.

During the development phase of the Gulf of Maine fishery, USA nominal catches rapidly rose to a peak level of about 60,000 mt in 1942 followed by a gradual decline. Nominal catches in recent years increased from approximately 10,000-11,000 mt during 1974-1976 to approximately 14,000-15,000 mt in 1978-79. In 1989 and 1990, however, catches declined to 600 mt, the lowest annual figures since the directed fishery commenced in the early 1930s. The Gulf of Maine redfish population has been dominated by the 1971 and 1978 year classes. In the past 20 years, only two strong year classes, those produced in 1971 and 1978, have recruited to this fishery. However, length composition data from bottom trawl surveys suggest

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	=	Overexploited
Age at 50% maturity	=	5 to 6 yrs
Size at 50% maturity	=	20 to 23 cm (7.9 to 9.0 in.)
Assessment level	=	Yield per recruit

$M = 0.05$ $F_{0.1} = 0.07$ $F_{max} = 0.14$ $F_{1990} \leq F_{0.1}$



that one or more moderately strong year classes produced in the mid-1980s will recruit to the fishery during the early 1990s.

The standardized catch per unit effort (CPUE) index declined from 6.1 mt/day in 1968 to approximately 2.4 mt/day between 1975 and 1978, and to less than 1.0 mt/day since 1987. The NEFC autumn survey biomass index declined from 40.4 kg/tow in 1968 to an average of 3.8 kg/tow during 1982-84. Although the 1986 autumn index increased to 8.0 kg/tow, estimates for 1987-89 have averaged only 6.2 kg/tow. The 1990 autumn biomass index of 12.2 kg/tow was the highest since the early 1980s, but is still well below the average of the 1960s and early 1970s. However, the increase in biomass in 1990 is consistent with incremental increases in survey abundance indices (mean number per tow) noted during the past two to three years, and reflects accumulated recruitment and growth of one or more recent year classes whose strength is likely to be above the 1980s average.

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 are not available for 1990 because the virtual population analysis was discontinued in 1986. 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 likely declined in recent years to a point less than or 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 during most of the 1980s, surplus production in the near future will remain considerably less than that, as indicated by the continued decline in nominal catches.

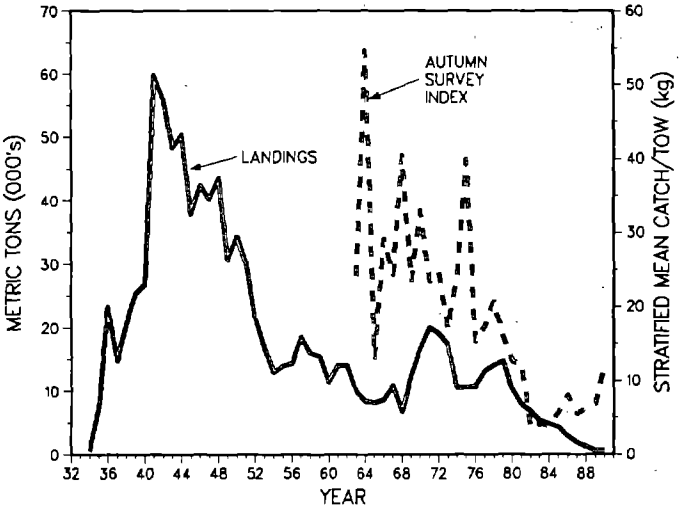


Table 3.1 Recreational catches and commercial landings (thousand metric tons)

	Year									
Category	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
USA recreational	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	7.8	6.6	5.2	4.7	4.2	2.9	1.9	1.1	0.6	0.6
Canada	<0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	<0.1	<0.1
Other	<0.1	-	-	-	-	-	-	-	-	-
Total nominal catch	7.8	6.8	5.3	4.8	4.3	3.0	2.0	1.2	0.6	0.6

The extremely low 1990 landings level continues a trend evident since 1980, reflecting a decreasing level of fishing mortality. Given the present exploitation pattern, the fishery remains extremely dependent on recruitment. Recruitment has been poor since 1971, except for the moderate 1978 year class and recent indications of some modest recruitment from the mid-1980s. Despite the low levels of catch seen in recent years, stock biomass remains low. Unless recruitment improves, biomass and yield are not expected to increase substantially; the population remains over exploited.

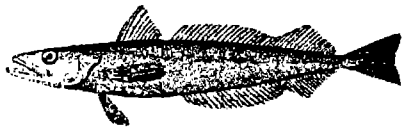
For further information

Mayo, R. K. 1980. Exploitation of redfish, *Sebastes marinus* (L.), in the Gulf of Maine-Georges Bank region, with particular reference to the 1971 year class. *J. North. Atl. Fish. Sci.* 1:21-38.

Mayo, R. K., U. B. Dozier, and S. H. Clark. 1983. An assessment of the redfish, *Sebastes fasciatus*, stock in the Gulf of Maine - Georges Bank region. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 83-22. 55 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

Mayo, R.K. 1987. Recent exploitation patterns and future stock rebuilding strategies for Acadian redfish, *Sebastes fasciatus* Storer, in the Gulf of Maine-Georges Bank region of the Northwest Atlantic. Proc. Int. Rockfish Symp., Oct., 1986, Anchorage, AK. Alaska Sea Grant Report 87-2, p 335-353.

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.



4. Silver Hake

NMFS/NEFC archive photo

The silver hake or whiting, *Merluccius bilinearis*, is a widely distributed, slender, swiftly swimming fish with a range extending from Newfoundland to South Carolina. The center of abundance is from Maine to New Jersey. Silver hake are important predators and concentrate in response to seasonal variations in hydrographic conditions, food availability, and spawning requirements. Two stocks have been identified based on morphological differences; one extends from the Gulf of Maine to northern Georges Bank, and the second occurs from southern Georges Bank to the mid-Atlantic area. Migration is extensive, with overwintering in the deeper waters of the Gulf of Maine for the northern stock and along the outer continental shelf and slope for the southern stock. Movement towards shallow water occurs from March to November for spawning.

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 50% of age 2 fish (20-30 cm), and nearly all age 3 fish (25-35 cm) are sexually mature. Silver hake grow to a maximum length of around 65 cm. Ages up to 15 years have been reported, but few fish beyond age 6 have been observed in recent years. Instantaneous natural mortality is assumed to be 0.4 (33% annual rate).

The otter trawl is the principal gear used in the commercial fishery and the recreational fishery is insignificant. The commercial fishery is currently managed under the New England Fishery Management Council's Multispecies FMP. Total nominal catches increased by 14% in 1990 (17,900 to 20,400 mt).

Gulf of Maine-Northern Georges Bank Silver Hake

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Fully exploited
Age at 50% maturity	=	2 yrs
Size at 50% maturity	=	22.3 cm (8.8 in.) males 23.1 cm (9.1 in.) females
Assessment level	=	Age structured

$M = 0.40$ $F_{0.1} = 0.44$ $F_{max} = N/A$ $F_{1988} = .70$

"The 1986 and 1987 year classes appear to be relatively poor, but the increases in the 1989 and 1990 survey index reflect the recruitment of a potentially strong 1988 year class."

Silver Hake
Gulf of Maine-Northern Georges Bank

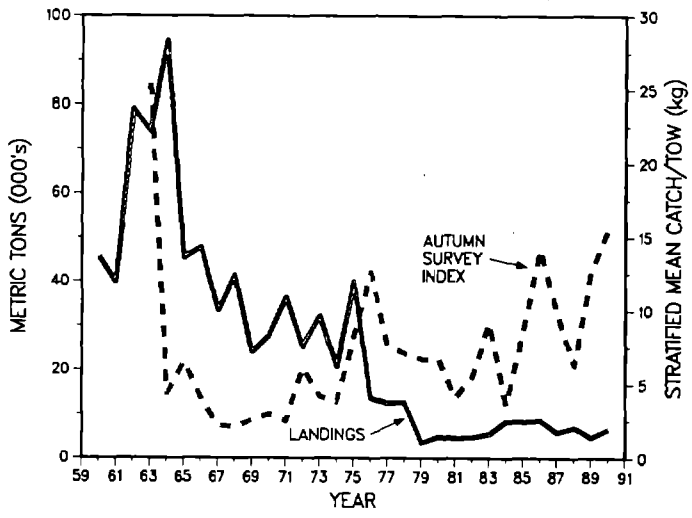


Table 4.1 Recreational catches and commercial landings (thousand metric tons)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
USA recreational	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	4.4	4.7	5.3	8.3	8.3	8.5	5.7	6.8	4.6	6.4
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	4.4	4.7	5.3	8.3	8.3	8.5	5.7	6.8	4.6	6.4

Gulf of Maine-Northern Georges Bank

Following the introduction of distant water fleets (DWF) in 1962, total landings increased rapidly to a peak of 94,500 mt in 1964, dropped sharply in 1965, and declined for 13 years, reaching the lowest level in the series (3,400 mt) in 1979. Prior to the inception of the MFCMA, DWF landings averaged about 49% of the total. Activity by distant water fleets diminished after 1977. Landings increased during the early 1980s, averaging 4,800 mt annually during 1980-1983, and 8,400 mt during 1984-1986. Landings declined to 5,700 and 6,800 mt in 1987 and 1988, respectively, dropped further in 1989 to 4,600 mt and then increased in 1990 to 6,400 mt.

The 4,600 mt of silver hake taken in 1989 included 3,100 mt landed exclusively by an experimental silver hake fishery conducted from July to October. The experimental silver hake fishery, in effect since 1988, is designed to determine the feasibility of allowing 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 NEFC autumn bottom trawl survey biomass index declined sharply in 1964 and remained relatively low through the mid-1970s. With the appearance of the strong 1973 and 1974 year classes, biomass indices increased sharply in 1975 and 1976, remained relatively high until 1980, but declined thereafter through 1984. The autumn indices increased again in 1985 and 1986, due primarily to the strong 1984 and 1985 year classes. Biomass indices declined slightly in 1987 and 1988, but increased sharply in 1989; and increased further in 1990. The 1986 and 1987 year classes appear to be relatively poor, but the increases in the 1989 and 1990 survey index reflect the recruitment of a potentially strong 1988 year class. In general, bottom trawl survey biomass indices since 1975 have remained high com-

Fishing mortality rates (F) for fully recruited fish fluctuated in the range 0.38 to 1.1 during the period 1973 to1982; and generally increased from 1982 (0.45) through 1988 (0.70). Recruitment of several strong year classes in the early 1970s increased spawning stock biomass (SSB) to a recent peak of 48,000 mt in 1974; SSB declined thereafter to only 8,000 mt by 1981, but has since increased to 23,000 mt in 1988. Landings in recent years (1988-1990) are being supported by the strong 1984 and 1985 year classes. These year classes will not contribute significantly to the landings in 1991. With the possible exception of the 1988 year class, subsequent year classes do not appear to be strong.

Although bottom trawl survey indices suggest silver hake biomass over the past 15 years has remained at or above levels observed prior to 1975, results from the VPA show a significant decline (through 1986) in stock biomass levels compared to the pre-1975 period, despite the rather low level of landings. Until these inconsistencies are resolved, the precise level of exploitation remains uncertain. However, since it is not likely that F will decline substantially below the 0.4 to 0.5 range in the near future, and given the rapid removal of recruits from the stock in recent years, it appears that this stock cannot support increased fishing and must be considered fully exploited.

Southern Georges Bank - Middle Atlantic

Following the introduction of distant-water fleets in 1962, total landings increased rapidly to a peak of 307,100 mt in 1965, declined sharply through 1970, and increased to a secondary peak of 109,900 mt in 1974. Landings declined sharply thereafter and have remained below 15,000 mt since 1980. Prior to inception of the MFCMA, DWF landings comprised about 87% of total commercial landings. Catches by distant-water fleets are now taken primarily as bycatch in

Georges Bank - Middle Atlantic Silver Hake

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Minor
Management	=	Multispecies FMP
Status of exploitation	=	Fully exploited
Age at 50% maturity	=	2 yrs
Size at 50% maturity	=	22.7 cm (8.9 in.) males 23.2 cm (9.1 in.) females
Assessment level	=	Age structured

$M = 0.40$ $F_{0.1} = 0.35$ $F_{max} = N/A$ $F_{1988} = 0.42$

"It seems unlikely that F will decline below 0.3 to 0.4 in the near future, and given the rapid removal of recruits from the stock in recent years, it appears this stock cannot support increased fishing and must be considered fully exploited."

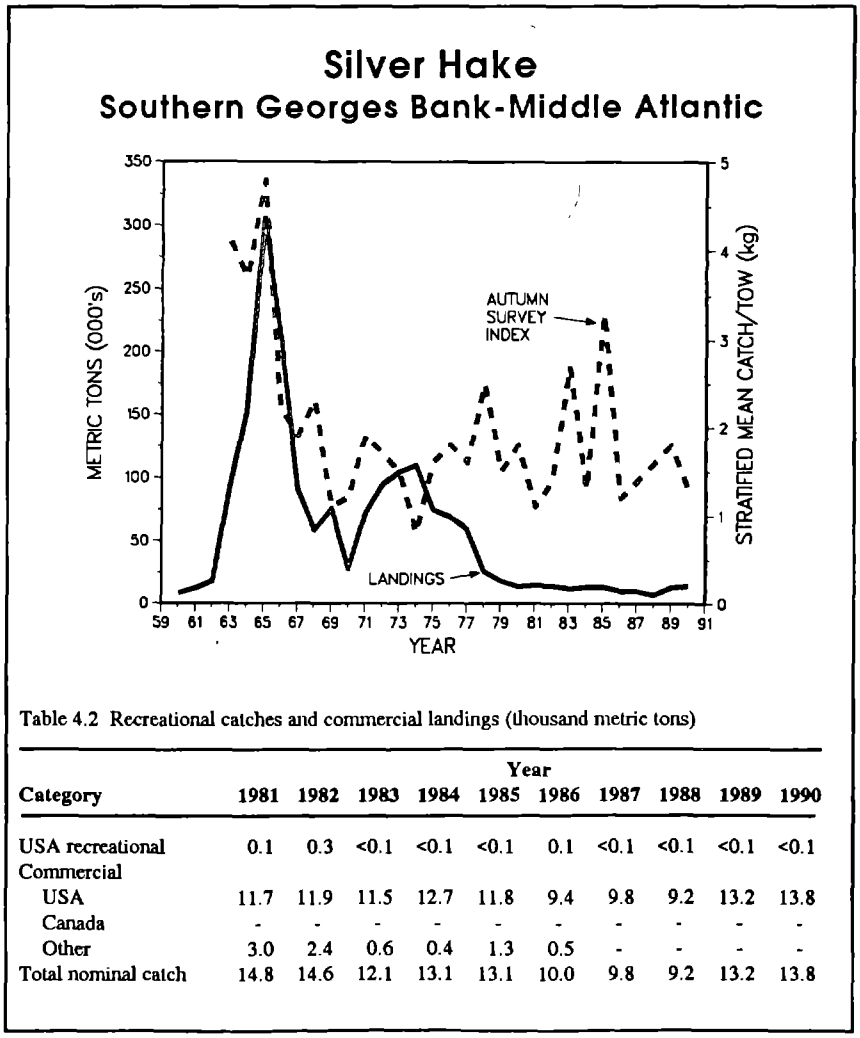


Table 4.2 Recreational catches and commercial landings (thousand metric tons)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
USA recreational	0.1	0.3	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
Commercial										
USA	11.7	11.9	11.5	12.7	11.8	9.4	9.8	9.2	13.2	13.8
Canada	-	-	-	-	-	-	-	-	-	-
Other	3.0	2.4	0.6	0.4	1.3	0.5	-	-	-	-
Total nominal catch	14.8	14.6	12.1	13.1	13.1	10.0	9.8	9.2	13.2	13.8

the squid fishery. In 1990, commercial landings were 13,800 mt. Recreational landings are insignificant and have not been estimated individually for silver hake since 1986.

After dropping sharply in 1966, the NEFC autumn trawl survey index has fluctuated without major trend. The index was high in 1983 and 1985, but has remained at average levels since then. The 1982 and 1985 cohorts were above average, and the 1986 year class appears to be quite strong.

Before introduction of the DWF, fishing mortality (F) was relatively low, ranging from 0.09 to 0.41 (average = 0.24) between 1955 and 1962. With increased fishing effort on the stock beginning in 1963, F rose rapidly and reached 0.98 by 1965. Since passage of the MFCMA in 1977, F has averaged 0.82. Increased landings in 1989 and 1990 coupled with relatively low survey biomass indices suggest that F in 1989 and 1990 may have increased somewhat above the 1988 level.

VPA estimates of spawning stock biomass have decreased steadily since 1973, and in the late 1980s were only about 10% of the biomass estimates for the mid-1970s. In contrast, bottom trawl survey results indicate that silver hake biomass has remained at or above levels observed during the late 1960s and early 1970s. Until these inconsistencies are resolved, the status of exploitation remains uncertain. It seems unlikely that F will decline below 0.3 to 0.4 in the near future, and given the rapid removal of recruits from the stock in recent years, it appears this stock can not support increased fishing and must be considered fully 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.

Northeast Fisheries Center. 1990. Report of the Eleventh NEFC Stock Assessment Workshop, Fall 1990. Woods Hole, MA: NMFS, NEFC. Northeast Fisheries Center Reference Document 90-09. Available from: Northeast Fisheries Center, Woods Hole, MA.

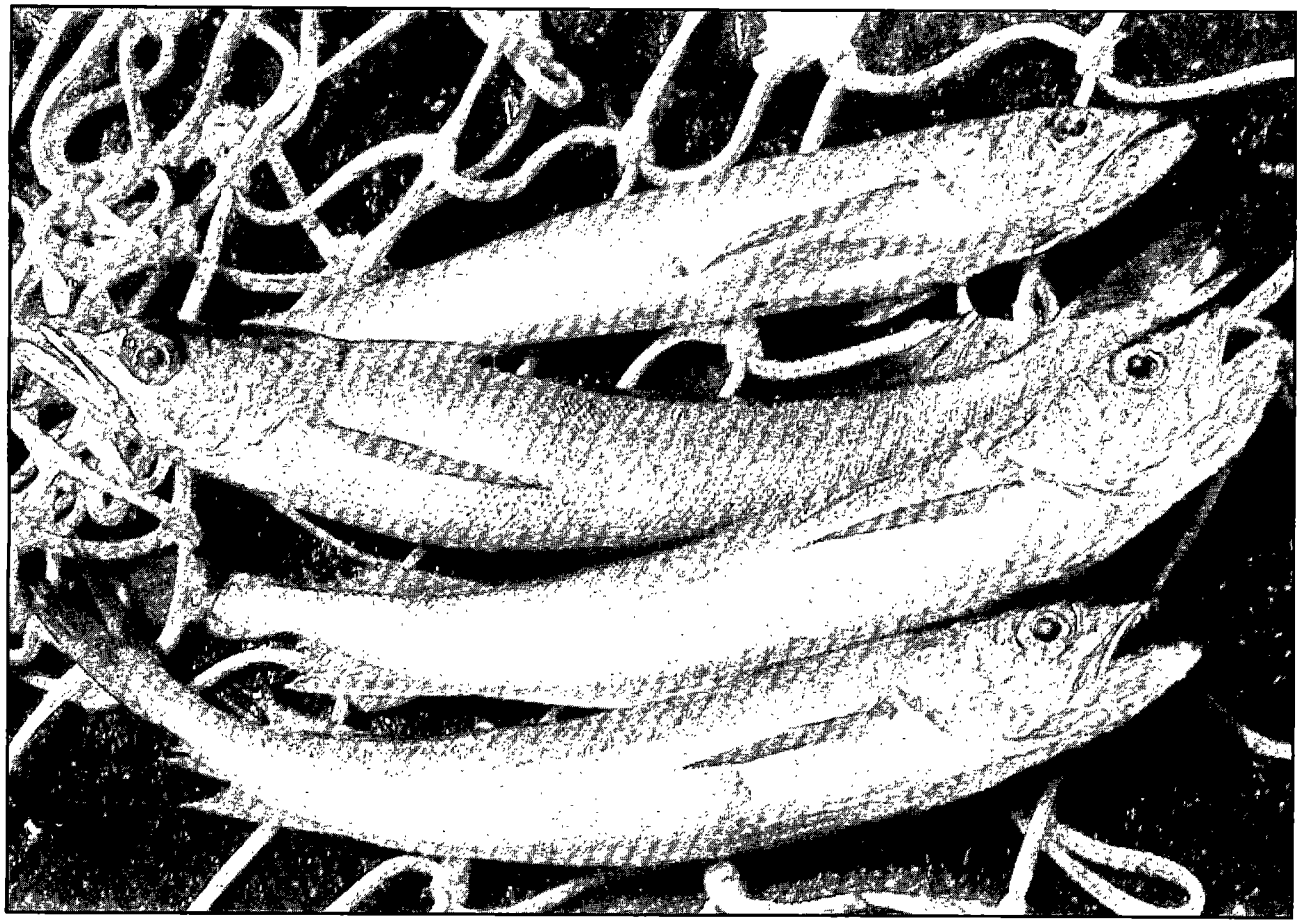
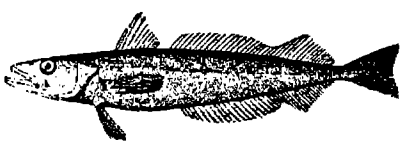
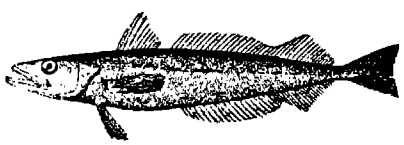
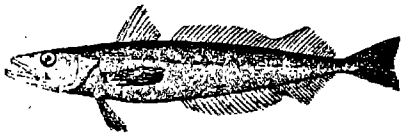
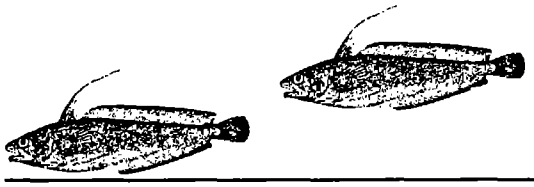


Photo by Brenda Figuerido, NMFS









5. Red Hake

The red hake, *Urophycis chuss*, is widely distributed ranging from the Gulf of St. Lawrence to North Carolina, but is most abundant between Georges Bank and New Jersey. Research vessel bottom trawl surveys indicate that red hake have a broad geographic and depth distribution throughout the year, undergoing extensive seasonal migrations. Red hake over-winter in the deep waters of the Gulf of Maine and along the outer continental shelf and slope south and southwest of Georges Bank. Spawning occurs from May through November, with major spawning areas located on the southwest part of Georges Bank and in the southern New England area south of Montauk Point, Long Island. Red hake feed primarily on crustaceans, but adult red hake also feed extensively on other fish. The maximum length reached by red hake is approximately 50 cm (19.7 in.). Maximum age of red hake is reported to be about 12 years, but few fish survive beyond 8 years of age. Two stocks have been assumed for management purposes, divided north and south in the central Georges Bank region.

Otter trawls are the principal commercial fishing gear used to catch red hake. Recreational catches are negligible. The fishery is scheduled to be managed under the proposed Amendment 4 to the New England Fishery Management Council's Multispecies FMP. Total commercial catches in 1990, taken exclusively by the USA, were essentially unchanged from 1989 (1,600 mt each year).

Photo by Brenda Figueirido, NMFS

Gulf of Maine - Northern Georges Bank

Nominal 1990 landings from the Northern red hake stock were 800 mt, virtually the same as in 1989. Trends in landings from this stock have shown three distinct periods. The first period, from the early 1960s through 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 fleets (DWF) on northern Georges Bank. Following implementation of the Magnuson Fisheries Conservation and Management Act (MFCMA) in 1977, total landings and the proportion of landings by the DWF dropped sharply. From 1977 to the present, annual landings from this stock have averaged 1,100 mt.

The NEFC autumn bottom trawl survey index has shown a steady increase from 1968 (0.2 kg/tow) to the present (7.9 kg/tow in 1989; 4.2 kg/tow in 1990). Survey data indicate that year class strength of red hake has been average or above for most of the 1980s except for the 1987 year class, which was conspicuously weak. Based on catch at age 0, the 1990 year class also appears weak.

Gulf of Maine-Northern Georges Bank Red Hake

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Underexploited
Age at 50% maturity	=	1.8 yrs, females 1.4 yrs, males
Size at 50% maturity	=	27 cm (11 in.) females 22 cm (9 in.) males
Assessment level	=	Yield per recruit

M = 0.40 $F_{0.1}$ = Unknown F_{max} > 2.00 F_{1990} = Unknown

"Survey data indicate that year class strength of red hake has been average or above for most of the 1980s except for the 1987 year class, which was conspicuously weak. Based on catch at age 0, the 1990 year class also appears weak."

Red Hake
Gulf of Maine-Northern Georges Bank

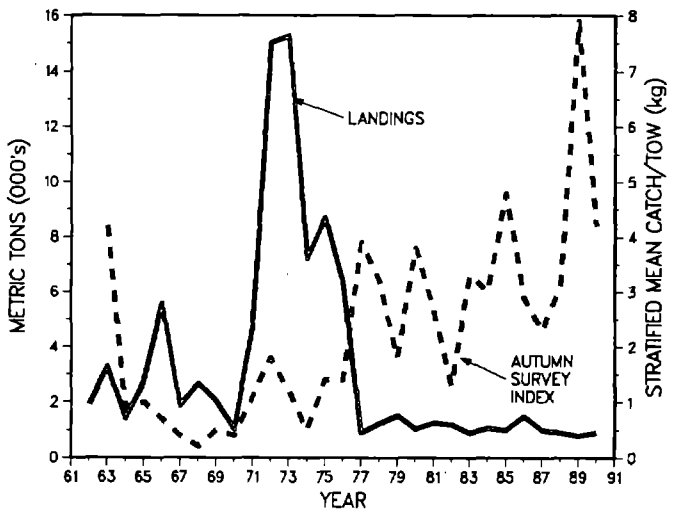


Table 5.1 Recreational catches and commercial landings (thousand metric tons)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
USA recreational	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	1.2	1.2	0.9	1.1	1.0	1.5	1.0	0.9	0.8	0.8
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	1.2	1.2	0.9	1.1	1.0	1.5	1.0	0.9	0.8	0.8

It appears that the combination of low landings and the relatively good year classes produced during the past decade has allowed the biomass of this stock to increase. This stock is underexploited and substantially higher catches could be supported.

Southern Georges Bank-Middle Atlantic

Nominal 1990 landings from the Southern red hake stock were at the same level as in 1989 (800 mt). Historically, 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. From 1967 to 1972, annual landings averaged 38,000 mt. Since 1972, there has been a steady decline in total landings due to the decline in DWF landings. From 1965 to 1976 the fishery was dominated by the DWF, which averaged 83 percent of the total annual landings. Since 1978, the DWF landings have averaged only 10 percent of the total annual landings due to restrictions placed on the fleet after the implementation of the MFCMA. The DWF landings of red hake in recent years have been taken as bycatch in the squid fishery.

United States 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 remained relatively steady between 1967 and 1979, when landings averaged 4,100 mt annually. Following 1979, domestic landings have declined to the current level of less than 1,000 mt / year.

The NEFC autumn bottom trawl survey index declined from its highest levels in the early 1960s to a relatively constant level between 1968 and 1982, except for 1974 where the survey index was relatively low. During this time period, the survey index averaged 2.2 kg/tow. During 1983, the survey index increased greatly, reaching its second highest value in the time series. Following this point, the index de-

Southern Georges Bank - Middle Atlantic Red Hake

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Minor
Management	=	Multispecies FMP
Status of exploitation	=	Underexploited
Age at 50% maturity	=	1.7 yrs, females; 1.8 yrs, males
Size at 50% maturity	=	25 cm (10 in.) females 24 cm (9 in.) males
Assessment level	=	Yield per recruit

M = 0.40 **$F_{0.1}$ = Unknown** **F_{max} > 2.00** **F_{1990} = Unknown**

"This stock is underexploited and substantially higher catches could be supported."

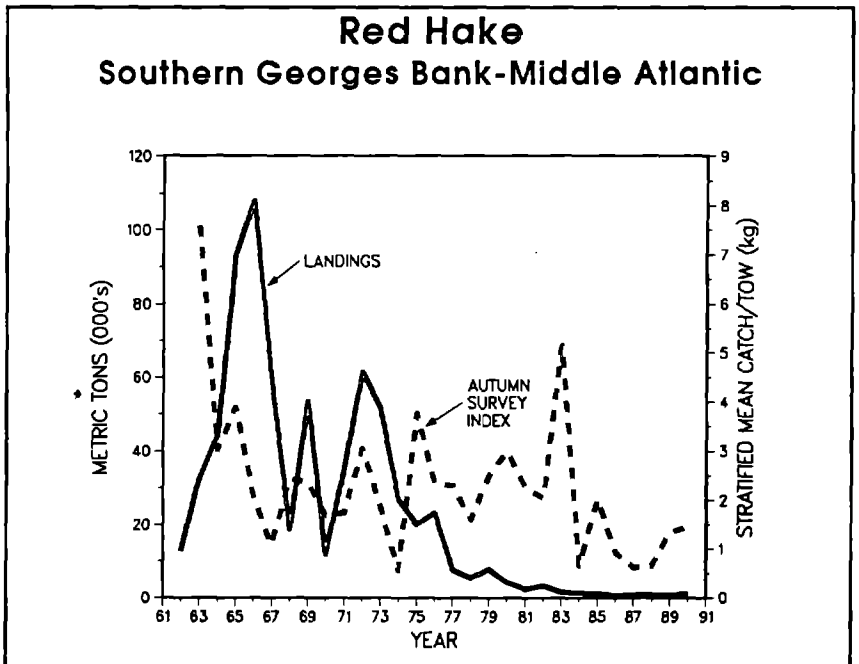


Table 5.2 Recreational catches and commercial landings (thousand metric tons)

	Year									
Category	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
USA recreational	0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial										
USA	2.1	3.0	1.3	1.2	0.8	0.6	0.9	0.9	0.8	0.8
Canada	-	-	-	-	-	-	-	-	-	-
Other	0.2	0.2	0.1	0.1	0.1	-	-	-	-	-
Total nominal catch	2.4	3.3	1.5	1.3	0.9	0.6	0.9	0.9	0.8	0.8

clined, reaching the minimum in the time series during 1987 and 1988. The 1990 index value of 1.3 kg/tow during the autumn survey is the same as 1989, and although it is about twice that during 1987 and 1988, it is still low compared to the 1968-1982 average.

Survey data indicate that except for the 1983 year class which was very weak, the other year classes produced during the 1980s were low to moderate in strength. Catch rates of age 0 fish were very low during 1990, indicating that this year class is also likely to be relatively weak. Current indices of the 1988 year class, which appeared relatively strong at age 0, indicate that this year class is only average in strength.

The decline of the autumn index since 1982 does not appear to be due to landings from this stock; landings during the entire decade were relatively low (less than 5,000 mt/year) compared to the landings during the late 1960s and early 1970s (over 20,000 mt most years) when the survey index showed no trend. The recent decline is likely due in part to the relatively weak year classes that have been produced during the past four to five years. Other sources of mortality, however, cannot be discounted as having an effect on the status of this stock. This stock is underexploited and substantially higher catches could be supported.

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.

Northeast Fisheries Center. 1990. Report of the Eleventh NEFC Stock Assessment Workshop, Fall 1990. Woods Hole, MA: NMFS, NEFC. Northeast Fisheries Center Reference Document 90-09. Available from: Northeast Fisheries Center, Woods Hole, MA.

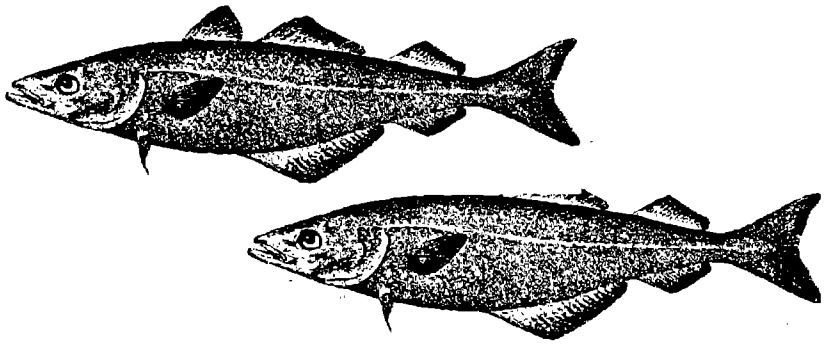
6. Pollock

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 they grow older. Pollock attain lengths up to 110 cm (43 in.) and weights of 16 kg (35 lb).

Traditionally, pollock were taken as bycatch 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 gill net fishery. Since 1984, the USA fishery has been restricted only to that fraction of the stock that occurs in areas of the Gulf of Maine and Georges Bank west of the line delimiting the USA and Canadian fishery zones. The domestic portion of the fishery is managed under the New England Fishery Management Council's Multispecies FMP. The Canadian fishery is managed under quotas; the two management regimes do not interact. Total nominal catches declined by 13% in 1990 (from 53,900 to 47,100 mt), with most of the decrease due to a 12% decline in Canadian catches (41,200 mt to 36,200 mt).

Photo by Brenda Figueridо, NMFS

"Total stock size, after increasing throughout the late 1970s and early 1980s, has declined substantially since the mid-1980s."



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	=	Overexploited
Age at 50% maturity	=	2.2 yrs
Size at 50% maturity	=	40 cm (16 in.)
Assessment level	=	Age structured

M = 0.20 **$F_{0.1}$ = 0.29** **F_{max} = 0.57** **F_{1990} = Unknown**

USA commercial landings declined by 10% in 1990 (10,500 mt to 9,500 mt).

Nominal commercial catches from the entire Scotian Shelf, Gulf of Maine, and Georges Bank region increased from an annual average of 38,200 mt during 1972-1976 to 68,500 mt by 1986. Nominal catches for Canada increased steadily from 24,700 mt in 1977 to an average of 43,900 mt during 1985-1987. USA catches increased from an average of 9,700 mt during 1973-1977 to more than 14,000 mt annually between 1978 and 1988, peaking at 24,500 mt in 1986. Nominal catches by distant water fleets, however, have declined from an annual average of 9,800 mt during 1970-1973, to less than 1,400 mt per year during 1981-1988. The DWF catch increased to 1,800 mt in 1989, but declined to 1,300 mt in 1990. Most of this catch has been taken by USSR vessels on the Scotian Shelf. Estimated USA annual 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 from the stock, including recreational, declined for the fourth consecutive year to 47,100 mt in 1990. Most of the decline since 1986 was due to sharp reductions in USA landings in 1987, 1988, and 1989 followed by a substantial decline in Canadian landings in 1990.

Pollock
Gulf of Maine, Georges Bank, and Scotian Shelf

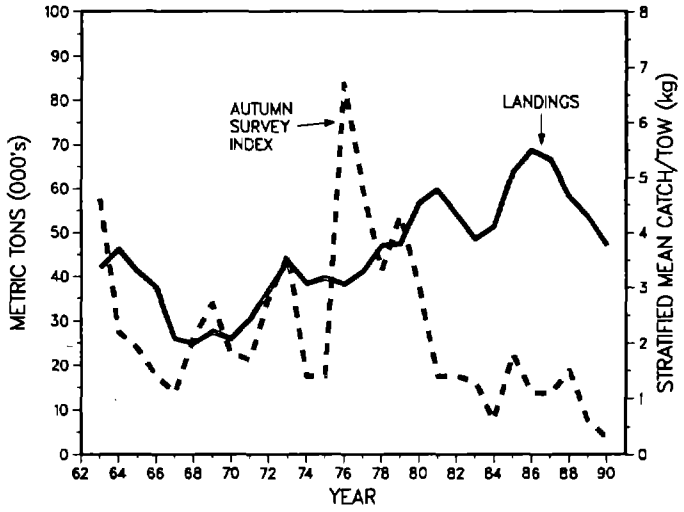
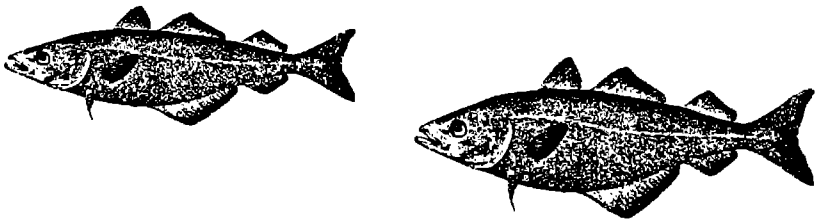


Table 6.1 Recreational catches and commercial landings (thousand metric tons)

	Year									
Category	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
USA recreational	0.7	1.3	1.3	0.2	0.7	0.2	0.1	0.2	0.4	0.1
Commercial										
USA	18.2	14.4	14.0	17.8	19.5	24.5	20.4	14.9	10.5	9.5
Canada	40.3	38.0	32.7	33.2	43.3	43.0	45.3	41.7	41.2	36.2
Other	0.5	0.4	0.5	0.1	0.4	1.0	0.9	1.3	1.8	1.3
Total nominal catch	59.7	54.1	48.5	51.3	63.9	68.7	66.7	58.1	53.9	47.1



Total stock size, after increasing throughout the late 1970s and early 1980s, has declined substantially since the mid-1980s. Biomass indices for the Gulf of Maine-Georges Bank portion of the stock, derived from NEFC autumn bottom trawl surveys, increased during the mid-1970s, but have declined sharply since 1981. However, indices derived from Canadian bottom trawl surveys conducted on the Scotian Shelf have increased since the early 1980s and suggest a relatively high level of pollock abundance in this region. Commercial CPUE indices for USA trawlers fishing predominantly in the Gulf of Maine increased during the late 1970s, but have declined consistently since 1983. Canadian commercial CPUE indices from the Scotian Shelf also increased between 1974 and 1984, but declined in 1985, 1987 and 1988; CPUE indices for both countries increased slightly in 1989 and 1990.

Virtual population analyses have indicated a gradual increase in age 2+ stock biomass during the 1970s followed by a 45% decrease between 1984 and 1988. The increases in stock biomass during the 1970s resulted from recruitment and growth of several relatively strong year classes, notably those of 1971, 1975 and 1979. Recruitment conditions were favorable throughout the 1970s and early 1980s, with moderate to strong year classes appearing regularly every three to four years. The most recent strong year class which contributed to this earlier increase in stock biomass was produced in 1982 and recruited to the fishery at age 2 in 1984. By 1989 and 1990, however, the catch composition of the USA fishery was dominated by the 1985 and 1986 year classes, which are considered to be only moderate in size.

Under the favorable recruitment conditions which prevailed during the

Photo by Bob Brigham, NMFS/NEFC

1970s and early 1980s, fishing at $F_{0.1}$ would provide a long-term catch of 53,600 mt, while fishing at F_{max} would provide a catch of 58,100 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 achieved under F_{max}, thereby providing for greater stability in reproductive potential and resilience to environmental perturbations. Continued fishing at or above F_{max} will likely result in a long-term decline in spawning stock, since this strategy does not account for fluctuating recruitment.

Increases in total landings during the mid-1980s (in excess of 63,000 tons per year between 1985 and 1987) resulted in relatively high fishing mortality rates ranging from 0.5 to 0.7 during the latter part of the decade. Although total landings have declined by about 30% since the 1986 peak, these reduced catch levels may still generate high fishing mortality rates because stock biomass has also decreased. Overall, the stock continues to be over exploited, and no increase in stock size is likely in 1992 unless recruitment improves.

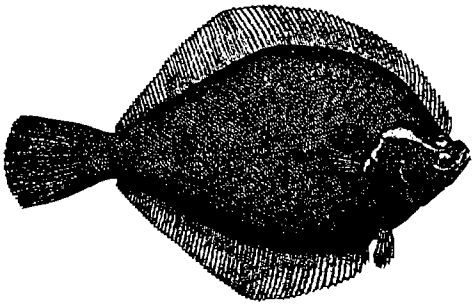
For further information

Amand, 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.

Amand, C., D. Beanlands, and J. McMillan. 1990. Assessment of pollock (*Pollachius virens*) in Divisions 4VWX and Subdivision 5Zc for 1989. Dartmouth, Nova Scotia: Department of Fisheries and Oceans, Canadian Atlantic Fisheries Scientific Advisory Committee. Research Document 90/42. 63p. 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.* 9: 13-36.

Mayo, R.K. S.H. Clark, and M.C. Amand. 1989. Stock assessment information for pollock *Pollachius virens* L. in the Scotian Shelf, Georges Bank, and Gulf of Maine regions. NOAA Tech. Mem. NMFS-F/NEC-65, 30p.



7. Yellowtail Flounder

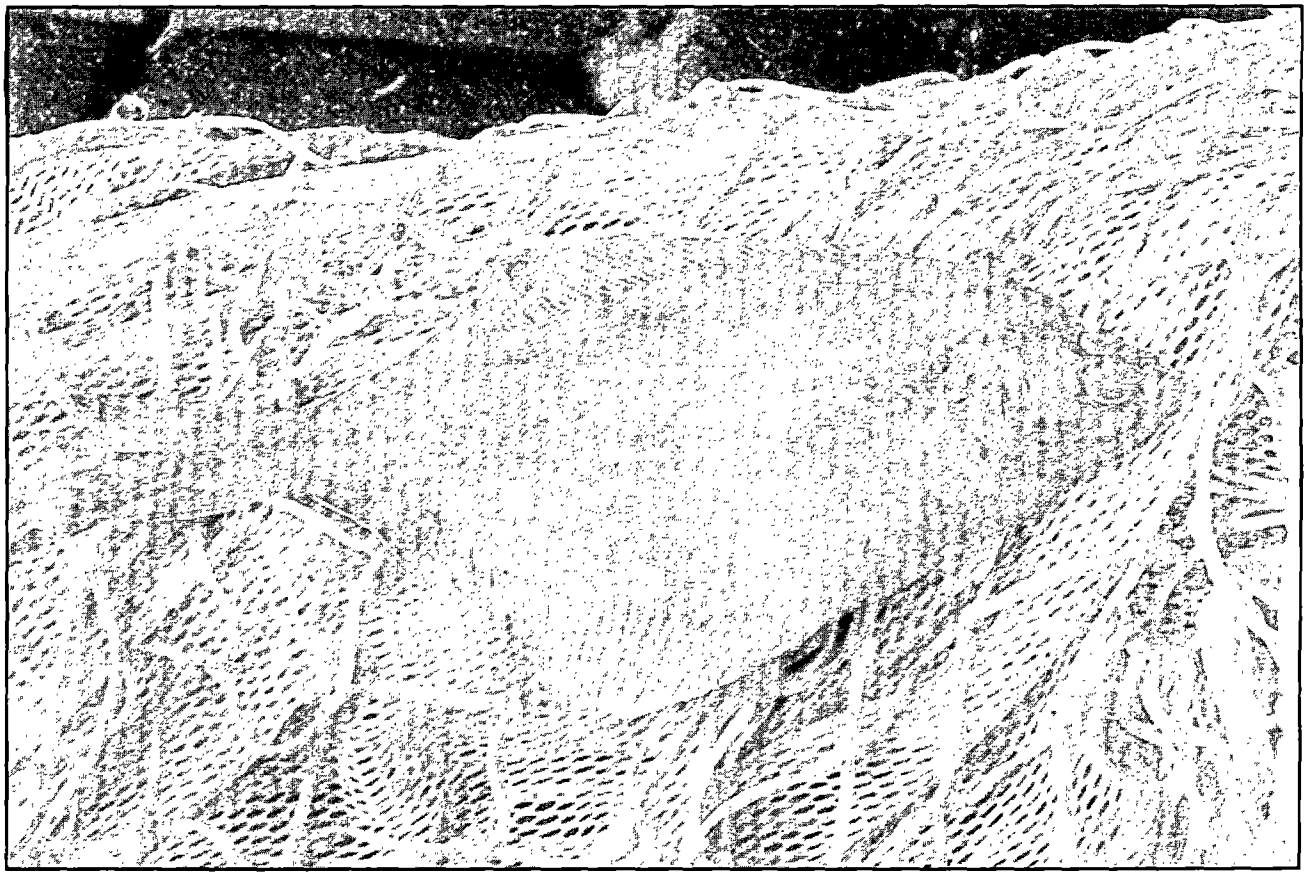


Photo by Brenda Figueridо, NMFS

The yellowtail flounder, *Pleuronectes ferrugineus*, ranges from Labrador to Chesapeake Bay. Off the USA coast, commercially important concentrations are found on Georges Bank, off Cape Cod, and in Southern New England, generally at depths between 37 and 73 m (20 to 40 fathoms). Fishing for yellowtail by the USA fleet also occurs in the northern Gulf of Maine, in the Mid-Atlantic Bight, and on the Grand Banks of Newfoundland outside the Canadian 200-mile limit (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 lb); 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 of fish among these groups occurs.

The principal fishing gear used to catch yellowtail flounder is the otter trawl. Current levels of recreational and foreign fishing are insignificant. The USA fishery is managed under the New England Fishery Management Council's Multispecies FMP. Total landings of yellowtail flounder increased by 256% in 1990 to 14,333 mt.

Georges Bank

Total landings of yellowtail from Georges Bank averaged 16,300 mt during 1962-1976 but declined to an average of 5,800 mt between 1978 and 1981. Landings increased to over 11,000 mt in 1982 and 1983 due to strong recruitment from the 1979 and 1980 year classes. Since then landings have generally declined, reaching a

"...rebuilding of the stock will require a major reduction in fishing mortality and several years of improved recruitment. The population is severely overexploited, and the stock is at a record low level."

record low of 1,100 mt in 1989 and increasing slightly to 2,740 mt in 1990.

NEFC autumn survey biomass indices for Georges Bank yellowtail declined between 1963 and 1976, stabilized at relatively low levels during 1977-1983 (with the exception of the elevated 1980 index), and subsequently fell to record low levels during 1984 and 1988. After increasing slightly in 1989, due to above average recruitment from the 1987 year class, the survey index declined again in 1990.

Fishing mortality rates ranged between 0.5 and 0.8 between 1969 and 1973, but increased to well over 1.0 during 1974-1988. An apparent drop in F in 1989 was followed by an increase to 0.82 in 1990.

Although abundance of the Georges Bank stock increased modestly in 1989 due to the above average 1987 year class, the stock is still at a very low level and is comprised of few age groups. Recent recruitment following the 1987 cohort appears to be poor. Hence, rebuilding of the stock will require a major reduction in fishing mortality and several years of improved recruitment. The population is severely overexploited, and the stock is at a record low level.

Southern New England

Total landings of yellowtail flounder from the Southern New England stock averaged 28,000 mt during 1963-1970 but declined rapidly afterward, reaching a low of 1,700 mt in 1976. Landings increased during 1977-1983, peaking at 18,500 mt in 1983, but

Yellowtail Flounder
Georges Bank--East of 69°W Longitude

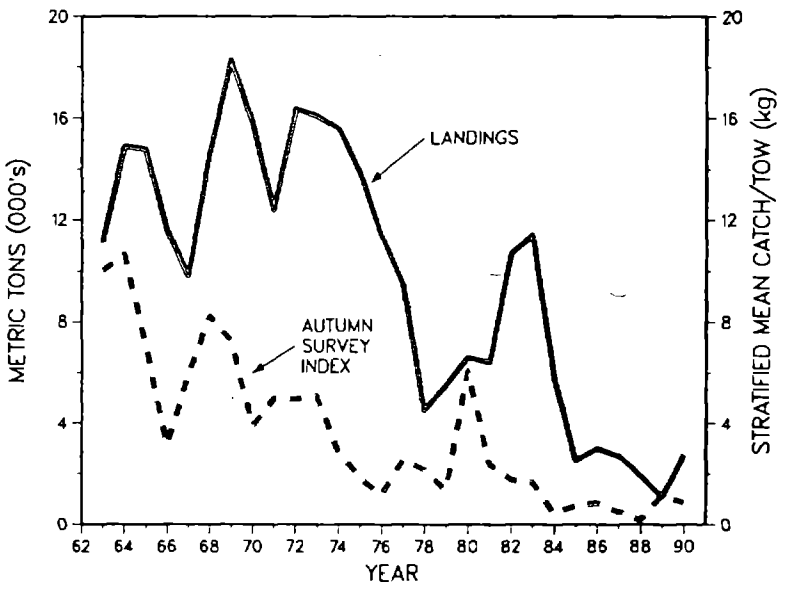


Table 7.1 Recreational catches and commercial landings (thousand metric tons)

	Year									
Category	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	6.4	10.7	11.4	5.8	2.5	3.0	2.7	1.9	1.1	2.7
Canada	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	6.4	10.7	11.4	5.8	2.5	3.0	2.7	1.9	1.1	2.7

Georges Bank Yellowtail Flounder

Long-term potential catch	=	16,000 mt
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Overexploited
Age at 50% maturity	=	2 yrs
Size at 50% maturity	=	26 cm (10 in.)
Assessment level	=	Age structured

M = 0.20 **$F_{0.1}$ = 0.25** **F_{max} = 0.63** **F_{1990} = 0.82**

Yellowtail Flounder
Southern New England--West of 69°W Longitude

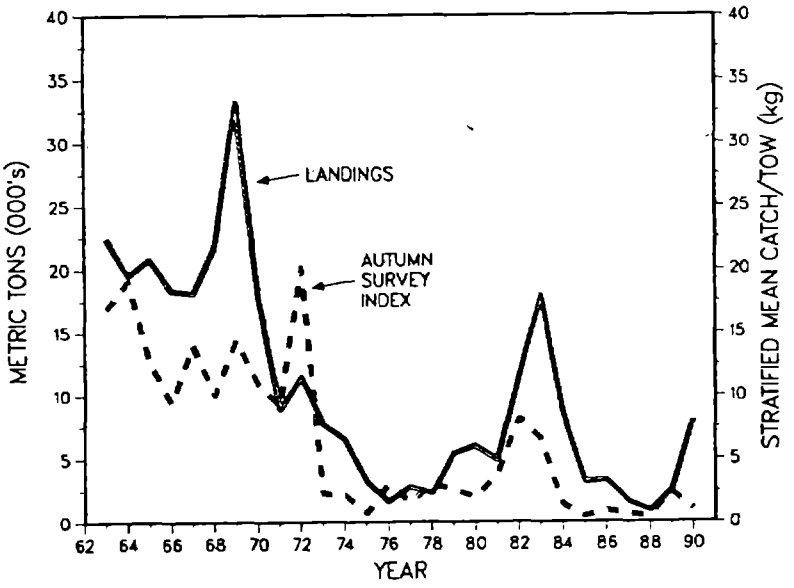


Table 7.2 Recreational catches and commercial landings (thousand metric tons)

	Year									
Category	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
USA recreational	-	-	-	-	-	-	-	-	-	-
Commercial										
Southern New England	4.9	11.5	17.9	8.5	3.2	3.3	1.6	0.9	2.5	8.0
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	4.9	11.5	17.9	8.5	3.2	3.3	1.6	0.9	2.5	8.0

Southern New England Yellowtail Flounder

Long-term potential catch	=	23,000 mt[1]
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Overexploited
Age at 50% maturity	=	2 yrs
Size at 50% maturity	=	26 cm (10 in.)
Assessment level	=	Age structured

$M = 0.20$ $F_{0.1} = 0.22$ $F_{max} = 0.48$ $F_{1990} = 1.62$

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

"Significant quantities of this [strong 1987] cohort were discarded in 1989 since, as two-year-olds, virtually all fish were less than minimum legal landing size of 13 in. Significant discarding continued on this year class in 1990, especially early in the year."

subsequently declined to a record low of only 900 mt in 1988. In 1989 and 1990, landings increased to 2,500 mt and 8,008 mt respectively, due to recruitment from the strong 1987 year class.

NEFC autumn survey abundance and biomass indices were at historically high levels between 1963 and 1972, but declined markedly in 1973 and remained very low until 1982 when both abundance and biomass values increased due to strong recruitment from the 1980 and 1981 cohorts. These increases, however, were short-lived; survey indices during 1985-1988 were the lowest on record. The 1989 indices increased to their highest levels since 1983 due to strong recruitment from the 1987 year class. However, this increase was again short-lived, as the 1990 index dropped precipitously.

Fishing mortality rates (on the fully recruited ages) fluctuated between 0.6 and 1.0. during 1973 to 1979. After 1979 fishing mortality rates were generally well in excess of 1.0, with a peak of 1.9 in 1984 and a recent high of 1.6 in 1990.

As for the Georges Bank stock, abundance of the Southern New England stock improved in 1989 and 1990 due to the strong 1987 year class. This cohort was relatively stronger in Southern New England than on Georges Bank, and essentially comprises the entirety (97%) of the Southern New England stock. Significant quantities of this cohort were discarded in 1989 since, as two-year-olds, virtually all fish were less than minimum

"Recent declines in [Cape Cod] 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."

legal landing size of 13 in. Significant discarding continued on this year class in 1990, especially early in the year.

At this level of catch (*i.e.*, landings plus discards), the 1987 year class will not sustain the fishery beyond 1991. Since recruitment of the 1988 and 1989 year classes appears to be poor, landings and stock size will then likely revert to the low pre-1989 levels.

This stock is overexploited and, despite the 1987 year class, current fishing mortality is too high to achieve the target spawning potential established for this stock.

Cape Cod

Total landings of yellowtail flounder from the Cape Cod stock generally fluctuated between 1,500 and 2,000 mt in the 1960s, increased during the 1970s to approximately 5,000 mt in 1980, and then declined reaching record low levels during the 1980s. Landings in 1990 were 2,979 mt.

NEFC autumn survey indices have been highly variable, but have reflected the general pattern of landings. The 1989 value was the highest since 1980, due to the strong 1987 year class, but the index declined sharply again in 1990.

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. A short term increase in landings associated with the 1987 year class occured in 1990, but the stock is considered to be overexploited.

Yellowtail Flounder
Cape Cod-West of 69°W Longitude

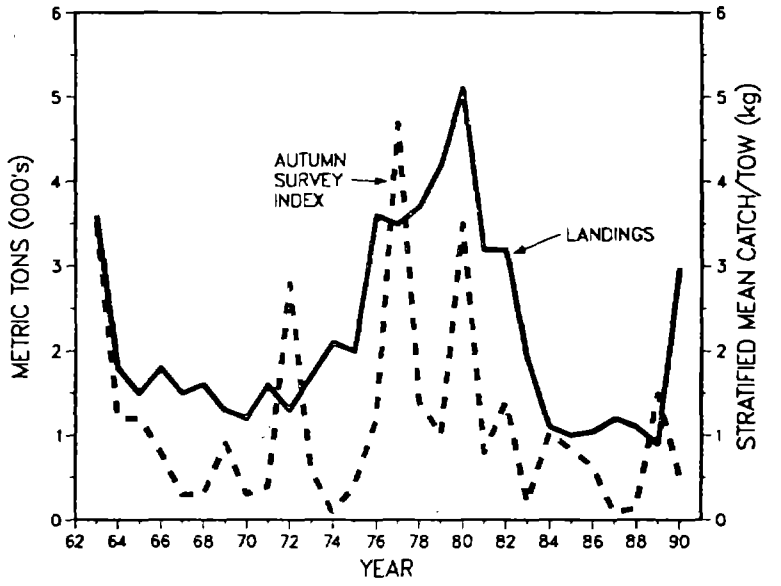


Table 7.3 Recreational catches and commercial landings (thousand metric tons)

	Year									
Category	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
USA recreational	-	-	-	-	-	-	-	-	-	-
Commercial										
Cape Cod	3.2	3.2	1.9	1.1	1.0	1.0	1.2	1.1	0.9	3.0
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	3.2	3.2	1.9	1.1	1.0	1.0	1.2	1.1	0.9	3.0

Cape Cod Yellowtail Flounder

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Overexploited
Age at 50% maturity	=	2 yrs
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_{1990} = Unknown**

Yellowtail Flounder
Middle Atlantic

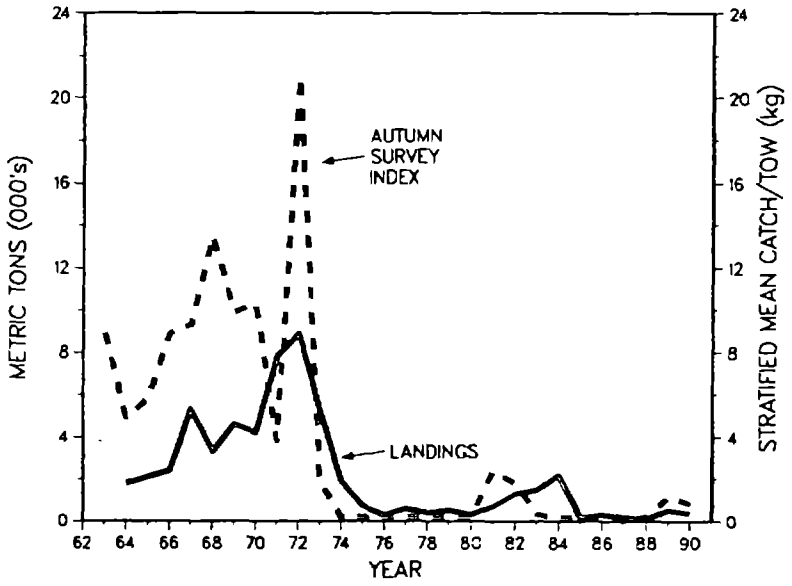


Table 7.4 Recreational catches and commercial landings (thousand metric tons)

	Year									
Category	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
USA recreational	-	-	-	-	-	-	-	-	-	-
Commercial										
Mid-Atlantic	0.7	1.3	1.5	2.2	0.2	0.3	0.2	<0.1	0.5	0.4
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	0.7	1.3	1.5	2.2	0.2	0.3	0.2	<0.1	0.5	0.4

" The assessment level for yellowtail in this region is too low to evaluate the current status of exploitation."

Middle Atlantic

Trends for the Mid-Atlantic have been generally similar to those observed for Southern New England. Landings declined from over 8,000 mt in 1972 to less than 1,000 mt between 1976 and 1980. Landings increased gradually during the early 1980s, from 300 mt in 1980 to 1,500 mt and 2,200 mt in 1983 and 1984, respectively, reflecting improved recruitment. Landings have since declined to the low levels of the late 1970s. Landings in 1990 declined to 400 mt.

NEFC autumn survey indices declined to very low levels in the mid-1970s, followed by an increase during 1981-82 with improved year class strength. Subsequent indices have declined to levels similar to those observed during the mid- to late 1970s, with the 1987 autumn survey value representing the lowest on record. The 1988 survey index reversed the declining trend, and the 1989 and 1990 indices are the highest since 1982, but very much lower than those observed in the 1960s and early 1970s. The assessment level for yellowtail in this region is too low to evaluate the current status of exploitation.

Middle Atlantic Yellowtail Flounder

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Overexploited
Age at 50% maturity	=	2 yrs
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_{1990} = Unknown**

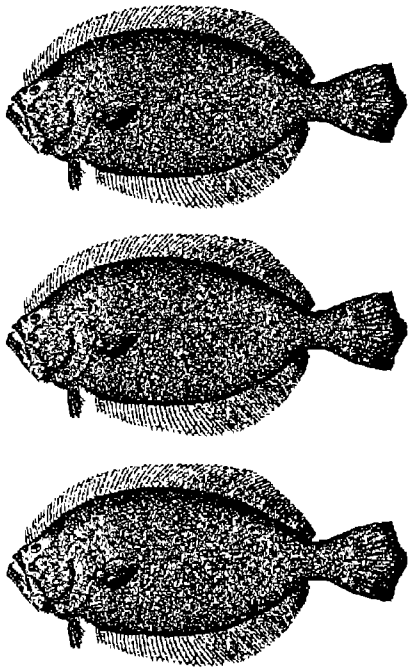
For further information

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.

Northeast Fisheries Center. 1991. Report of the Twelfth Northeast Regional Stock Assessment Workshop. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 90-03.

8. Summer Flounder

Photo by Brenda Figuerido, NMFS



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 lb).

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. Recreational catches historically constitute about 40% of the total catch. The fishery is managed under the Summer Flounder FMP.

Nominal total catches averaged 21,700 mt during 1981-1989, peaking at 30,300 mt in 1983. Total catch in 1990 (7,800 mt) was 32% lower than in 1989 (11,500 mt). Nominal commercial catches of summer flounder averaged 13,200 mt during 1981-1989, reaching a high of 17,100 mt in 1984. The commercial catch in 1990 was only 5,400 mt, a 46% decrease relative to the 1989 level of 9,900 mt. The recreational fishery for summer flounder harvests a significant proportion of the total nominal catch of this species, and in some years, recreational harvest has exceeded the commercial landings. The estimated recreational harvest of summer flounder averaged 8,500 mt during 1981-1989, peaking in 1983 at 16,400 mt. The recreational harvest decreased dramatically (by 81%) between 1988 and 1989 to 1,600 mt, the lowest level since the current system to monitor the recreational fishery was implemented in 1979. Recreational harvest rebounded slightly to 2,400 mt in 1990. In addition to the summer flounder harvested by recreational fishermen, 0.9 to 17.1 million fish were caught and released alive between 1980 and 1990. Since the inception of the MFCMA, nominal catches by foreign vessels have been very low.

Based on NEFC survey indices, stock biomass is currently at the lowest average level since the late 1960s and early 1970s. The spring survey index (mean weight per tow) rose from 0.09 kg/tow in 1970 to a peak of 1.94 kg/tow in 1976. The survey index has declined since 1985 from 1.21 kg/tow to 0.27 kg/tow in 1990. Catch curve analysis of survey and commercial age composition data collected from 1976 through 1983 indicated fishing mortality rates of about 0.6 to 0.7, well in excess of F_{max} (NEFC 1986). Analyses of more recent NEFC spring survey age composition data (1984-1990) and fishery age composition data (1982-1989) suggest that current fish-

Summer Flounder
Georges Bank-Middle Atlantic

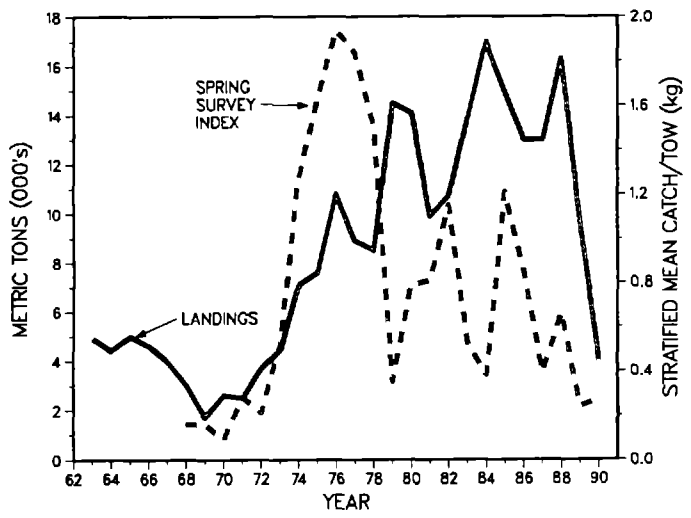


Table 8.1 Recreational harvest and commercial landings (thousand metric tons)

	Year									
Category	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
USA recreational	4.9	9.6	16.4	13.1	7.6	8.5	6.4	8.4	1.6	2.4[1]
Commercial										
USA	9.9	10.7	13.9	17.1	14.9	13.0	13.0	16.3	9.9	5.4
Canada	-	-	-	-	-	-	-	-	-	-
Other	<0.1	<0.1	<0.1	-	-	-	-	-	-	-
Total nominal catch	14.8	20.3	30.3	30.2	22.5	21.5	19.4	24.7	11.5	7.8[1]

[1] Preliminary estimate

Georges Bank-Mid-Atlantic Summer Flounder

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Major
Management	=	Summer Flounder FMP
Status of exploitation	=	Overexploited
Age at 50% maturity	=	1 yr (females)
Size at 50% maturity	=	27 cm (10.6 in.)
Assessment level	=	VPA

$M = 0.20$ $F_{0.1} = 0.14$ $F_{max} = 0.23$ $F_{1990} > 1.4$

"... fishing mortality rates continue to greatly exceed those resulting in maximum yield per recruit, and are reducing long-term potential yields."

ing mortality rates are greater than 1.4. Thus, fishing mortality rates continue to greatly exceed those resulting in maximum yield per recruit, and are reducing long-term potential yields. NEFC survey indices and VPA results indicate that stock abundance, and hence the catches, are currently being sustained primarily by fish aged 2 and younger. The marked decrease in combined commercial and recreational catch by nearly 70% since 1988 likely reflects decreased adult (age 2 and older) stock size and very poor recruitment in 1988. Current data and analyses indicate that the stock continues to be significantly overexploited.

For further information

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

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

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

Northeast Fisheries Center. 1990. Report of the Eleventh NEFC Stock Assessment Workshop, Fall 1990. Woods Hole, MA: NOAA/NMFS/NEFC. Northeast Fisheries Center Reference Document 90-09. 121 p.

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 lb). 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. The USA fishery is managed under the New England Fisheries Management Council's Multispecies FMP. Total catches increased 4% in 1990 (from 2,400 to 2,500 mt).

Landings of American plaice increased steadily from a low of 2,100 mt in 1973-1974 to 15,000 mt in 1982. Subsequently, annual landings have declined and are at now at the same level as in the early 1970s.

Between 1960 and 1974, 67% of USA landings were from deepwater areas on Georges Bank. Since then, Gulf of Maine landings have greatly exceeded those from Georges Bank. The USA 1990 Gulf of Maine catch (1,800 mt) was more than twice as large as that from Georges Bank (600 mt).

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. Subsequently, annual CPUE indices have declined steadily.

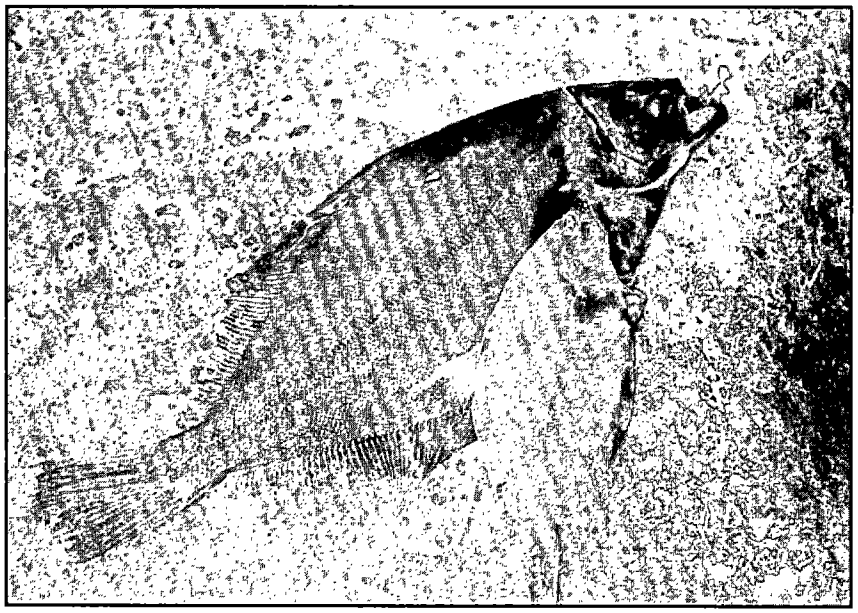
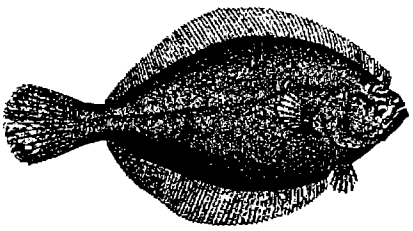
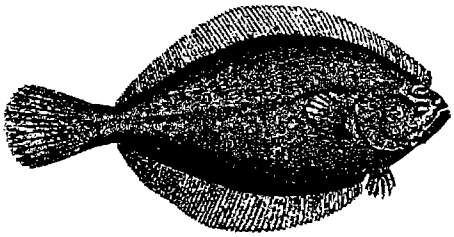


Photo by Brenda Figueredo, NMFS





The Gulf of Maine 1990 index is the second lowest, while the Georges Bank index is the lowest, in the 1964-1990 time series.

Abundance and biomass indices from autumn NEFC research vessel surveys reached record low values in 1987 but have since increased. The 1990 number per tow index was the highest in the 1963-1990 time series while the 1990 weight per tow index was the highest since 1981. Survey number per tow indices indicate relatively strong 1986 and 1987 year classes. The average size of individuals in these cohorts (11 and 9 in., respectively) is well below the minimum legal landing size of 14 in., and these year classes will not begin to contribute to fishery yields until mid-1991 (for the 1986 cohort) and mid-1992 (for the 1987 cohort). However, large numbers of fish from these year classes are likely to be taken as bycatch and discarded in small-mesh fisheries (particularly the northern shrimp fishery) during 1991 and early 1992. To the extent that such discarding occurs, future yield and spawning potential of American plaice will be sacrificed.

The continuing decline in landings that began in 1983 reflects a declining trend in harvestable biomass, as indicated in both catch per unit effort and survey indices. The apparently strong 1986 and 1987 year classes offer the opportunity to halt and reverse this trend if fishing mortality and discarding are reduced. However, fishing effort has been high in recent years, especially in the small mesh fisheries in the Gulf of Maine,

"The apparently strong 1986 and 1987 year classes offer the opportunity to halt and reverse this trend [decline in harvestable biomass] if fishing mortality and discarding are reduced."

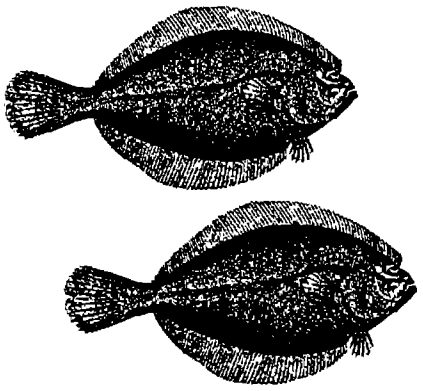
and at current levels both fishing and discard mortality are likely to remain high. Given these conditions, abundance and landings of American plaice are expected to remain low and the stock will continue to be over exploited.

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.

Northeast Fisheries Center. 1990. Report of the Eleventh Stock Assessment Workshop. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document. 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. Master's thesis.



American Plaice
Gulf of Maine-Georges Bank

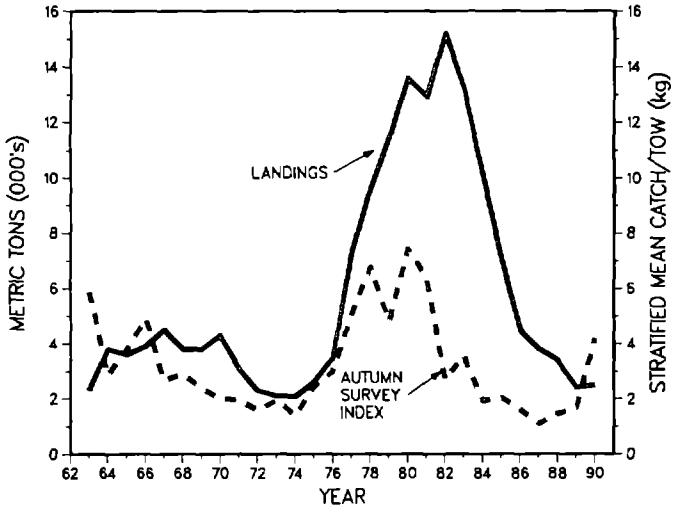
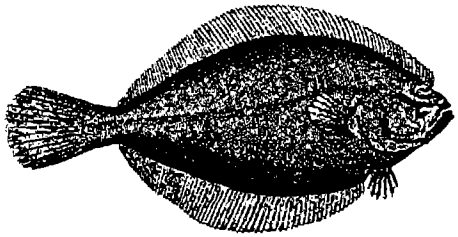


Table 9.1 Recreational catches and commercial landings (thousand metric tons)

	Year									
Category	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	12.9	15.1	13.2	10.1	7.0	4.1	3.8	3.3	2.3	2.5
Canada	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1	<0.1
Other	<0.1	-	-	-	-	-	-	-	-	-
Total nominal catch	12.9	15.2	13.2	10.1	7.0	4.1	3.8	3.4	2.4	2.5



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
Age at 50% maturity	=	3.0 yrs (males) 3.6 yrs (females)
Size at 50% maturity	=	22.1 cm (8.7 in.) males 26.8 cm (10.6 in.) females
Assessment level	=	Yield per recruit

M = 0.20 **$F_{0.1}$ = 0.17** **F_{max} = 0.34** **F_{1989} = Unknown**

10. Witch Flounder

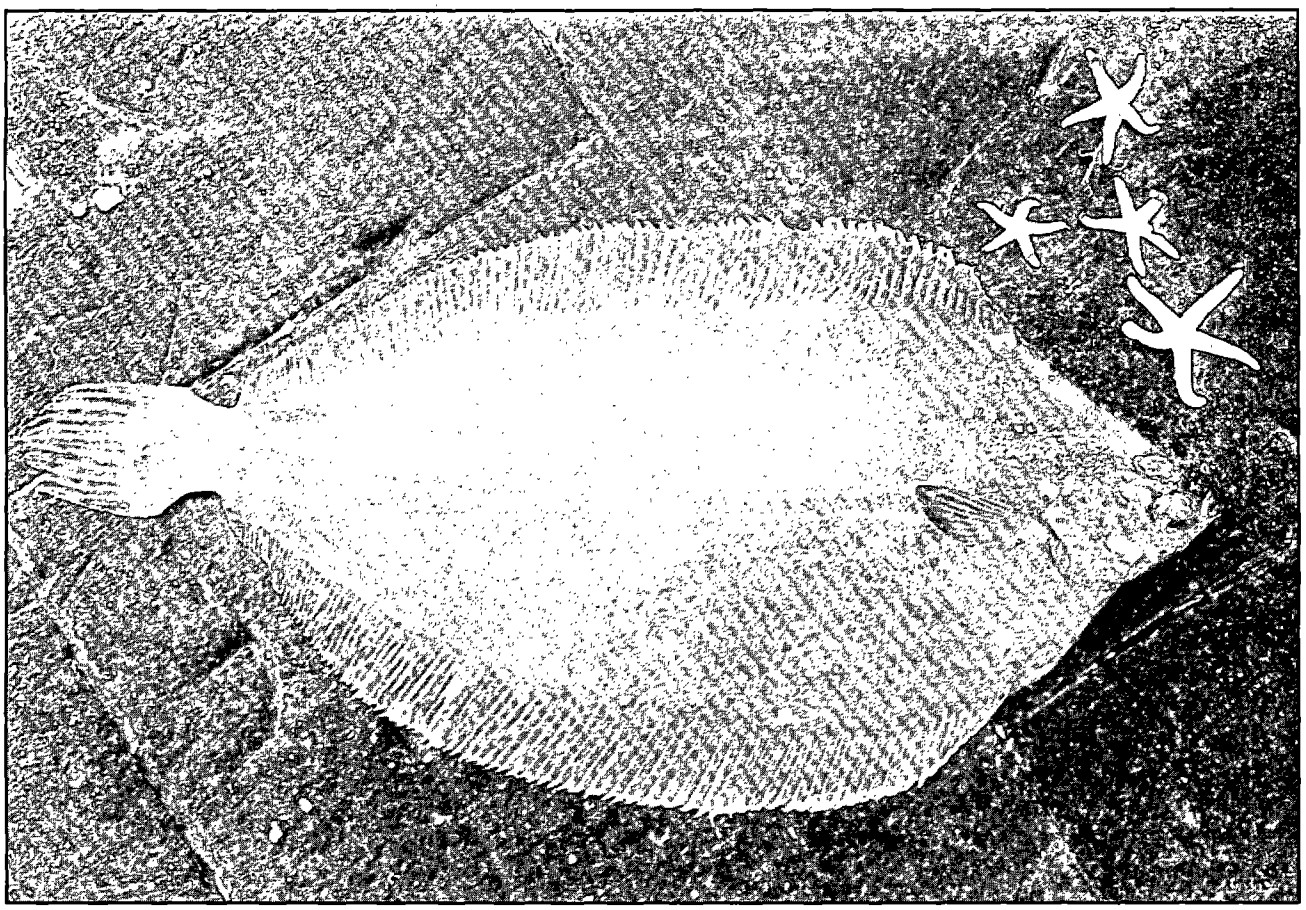


Photo by Brenda Figueridо, NMFS

Gulf of Maine - Georges Bank Witch Flounder

Long-term potential catch	=	<3000 mt
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Overexploited
Age at 50% maturity	=	3.6 yrs, males 4.4 yrs, females
Size at 50% maturity	=	25.3 cm (10.0 in.) males 30.4 cm (12.0 in.) females
Assessment level	=	Index

M = 0.15 **$F_{0.1}$ = Unknown** **F_{max} = Unknown** **F_{1990} = Unknown**

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 m (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 lb).

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 33% in 1990 (from 2,100 to 1,400 mt).

Since 1960, the USA nominal catch has been distributed almost

Witch Flounder
Gulf of Maine-Georges Bank

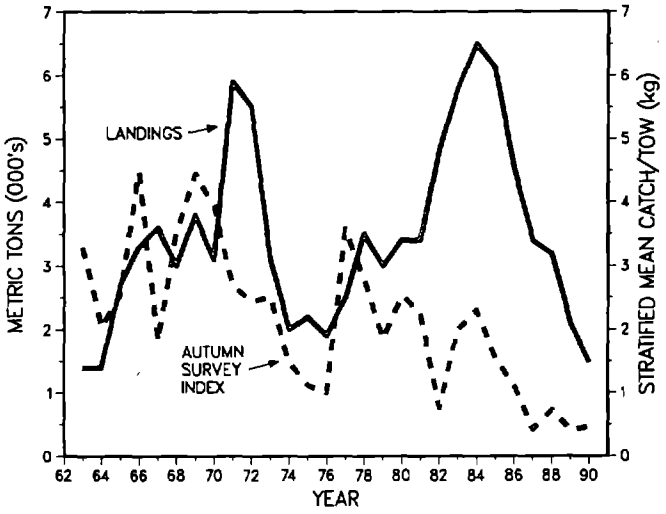


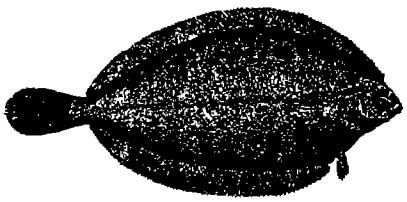
Table 10.1 Recreational catches and commercial landings (thousand metric tons)

	Year									
Category	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
USA recreational	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	3.4	4.8	5.8	6.5	6.0	4.5	3.4	3.2	2.1	1.4
Canada	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	3.4	4.8	5.8	6.5	6.1	4.5	3.4	3.2	2.1	1.4

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 1971-1972, but subsequently declined sharply and have been negligible since 1977. After averaging 2,800 mt during 1973-1981, nominal catches increased sharply to an average of 5,500 mt during 1982-1986. Total landings have decreased steadily since 1986 to 1,400 mt in 1990. A Grand Banks fishery for witch flounder, which developed in 1985 and accounted for an annual USA harvest of 400 mt through 1989, is now insignificant, accounting for only 2 mt in 1990. Also, 35 mt was harvested in 1990 in the Mid-Atlantic region.

NEFC autumn survey catches seem to accurately reflect trends in biomass. Heavy exploitation by distant water fleets in 1971-1972 was followed by a decline in the autumn index from an average of 3.6 kg/tow in 1966-1970 to 1.0 kg/tow in 1976. Abundance increased sharply in 1977-1978 due to reduced effort in the northern shrimp fishery. Subsequent indices, however, have steadily decreased, with the 1989 value of 0.4 kg/tow being the lowest in the time series. The 1990 value of 0.5 kg/tow represents no change in the resource condition. There is evidence in recent NEFC surveys of a relatively strong 1985 year class (largest age 4 index since 1983 in spring 1989 survey) and a possibly strong 1989 year class.

The decline in landings since 1984 reflects a declining biomass, as reflected in the survey indices and in catch per unit effort indices. These declines suggest that this resource is being adversely affected by current levels of exploitation. Additionally, high discard rates of juvenile witch flounder are associated with the small mesh Northern shrimp fishery in the Gulf of Maine. It appears that harvests of 3,000 mt or more cannot be sustained over the long term. Landings may occur in 1991 as the 1985 year class recruits to the large mesh fishery. The population is overexploited.



"There is evidence in recent NEFC surveys of a relatively strong 1985 year class (largest age 4 index since 1983 in spring 1989 survey) and a possibly strong 1989 year class."

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.

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.

11. Winter Flounder

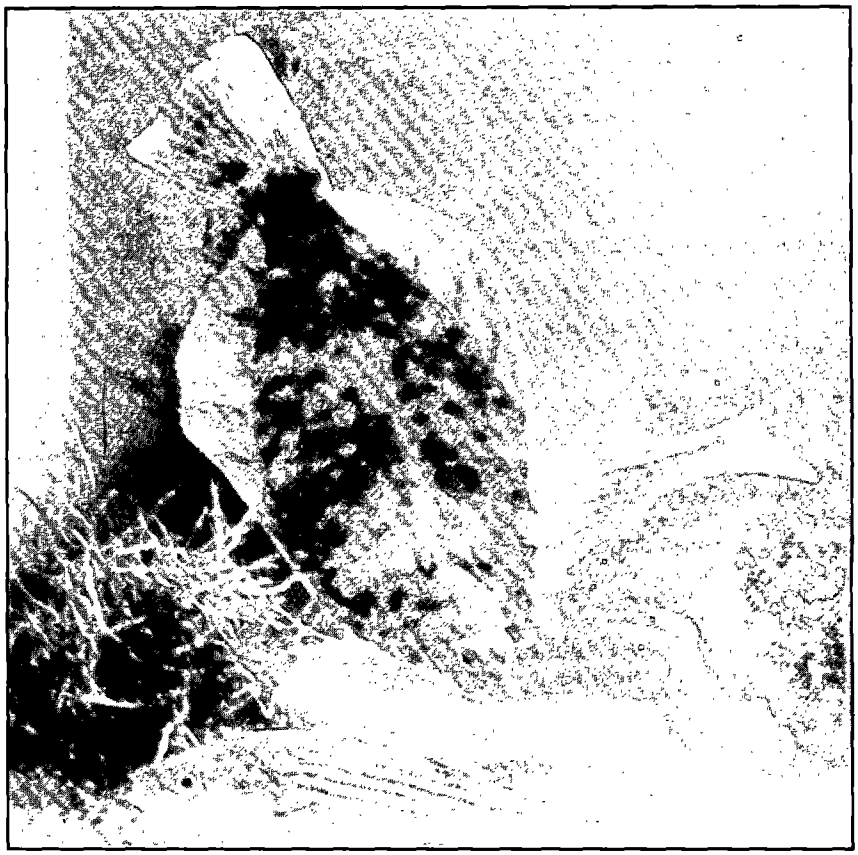
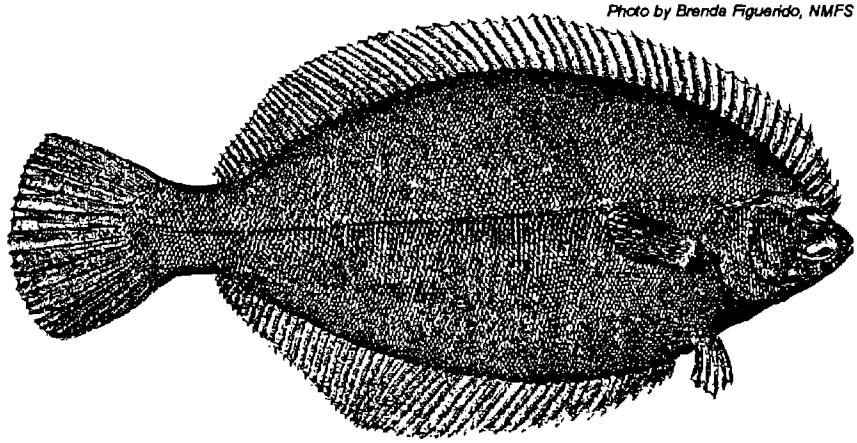


Photo by Brenda Figueredo, NMFS



The winter flounder, blackback, or lemon sole, *Pleuronectes 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, especially in the southern parts of the range. The fishery is managed under the New England Fisheries Management Council's Multispecies FMP. Total commercial landings in 1990 (6,600 mt) were similar to levels in 1989 (6,800 mt), remaining near the lowest on record.

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 a 70% reduction in recreational landing estimates and a 25% reduction in commercial landings. Since then landings in the recreational fisheries have fluctuated, but landings in both fisheries have continued to trend downwards. Combined landings in 1990 were only 1,500 mt, a record low

Winter Flounder
Gulf of Maine

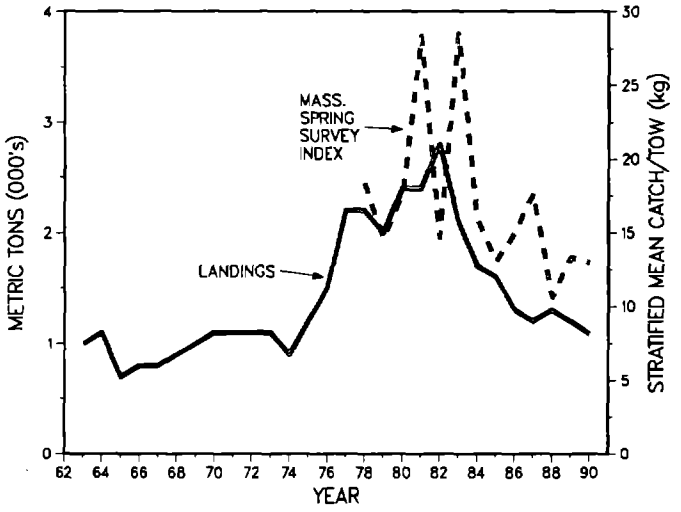
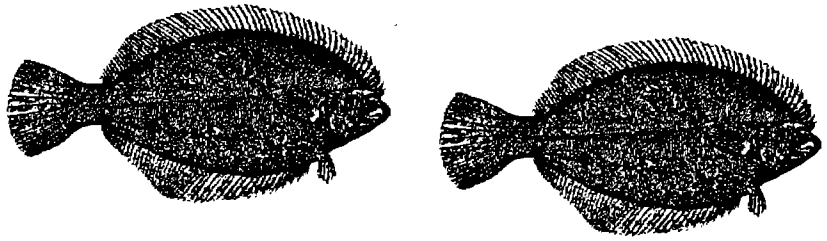


Table 11.1 Recreational catches and commercial landings (thousand metric tons)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	3.7	4.3	1.3	1.2	2.0	0.3	1.9	1.0	0.9	0.4[1]
Commercial										
USA	2.4	2.8	2.1	1.7	1.6	1.3	1.2	1.3	1.2	1.1
Canada	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	6.1	7.1	3.4	2.9	3.6	1.6	3.1	2.3	2.1	1.5[1]

[1] Preliminary estimate



Gulf of Maine Winter Flounder

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Major
Management	=	Multispecies FMP
Status of exploitation	=	Overexploited
Age at 50% maturity	=	3.4 yrs
Size at 50% maturity	=	27.6 cm (10.9 in.) males 29.7 cm (11.7 in.)females
Assessment level	=	Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1990} = Unknown

"...winter flounder abundance in the Gulf of Maine has been reduced substantially by recent exploitation. Because recreational catches have been equal to or greater than commercial landings, future improvements in the condition of the stock will depend on decreases in exploitation in both sectors..."

for the ten-year time series. Estimated recreational catches in 1990 (400 mt) were near the lowest levels observed. Commercial landings of 1,100 mt were the lowest since 1974.

Bottom trawl survey abundance indices from the Massachusetts Division of Marine Fisheries spring survey for the Massachusetts Bay-Cape Cod Bay areas decreased after 1983, and have trended downward to the lowest values in the series in 1988-1990. Commercial catch per unit effort indices (tonnage class 2 otter trawlers) peaked in the late 1960s to early 1970s, averaging 3.0 mt/days fished between 1968 and 1971. The index has declined steadily since then, to new record lows of 0.9 mt/df in 1989 and 1990.

The continuing low level of landings, continuing declines in commercial catch per unit effort indices, and the lowest trawl survey indices in recent years indicate that winter flounder abundance in the Gulf of Maine has been reduced substantially by recent exploitation. Because recreational catches have been 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 is considered to be overexploited.

Winter Flounder
Georges Bank

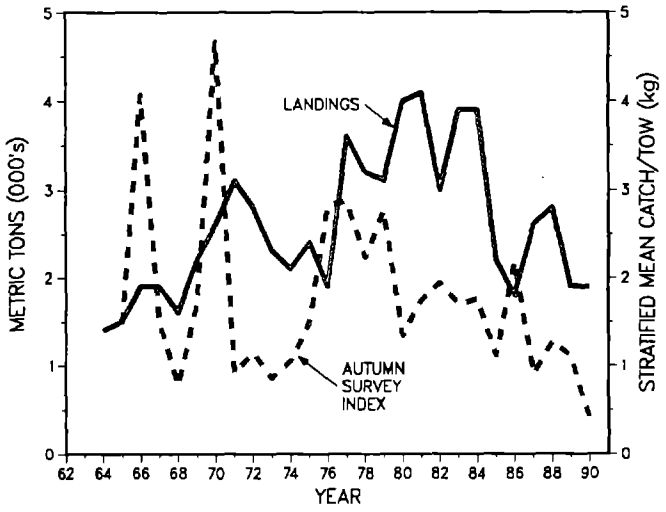
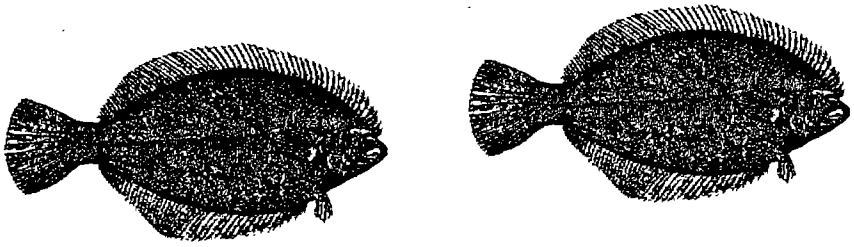


Table 11.2 Recreational catches and commercial landings (thousand metric tons)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	4.1	3.0	3.9	3.9	2.2	1.8	2.6	2.8	1.9	1.9
Canada	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	4.1	3.0	3.9	3.9	2.2	1.8	2.6	2.8	1.9	1.9



Georges Bank Winter Flounder

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Overexploited
Age at 50% maturity	=	1.9 yrs
Size at 50% maturity	=	25.6 cm (10.1 in.) male 24.9 cm (9.8 in.) females
Assessment level	=	Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1990} = Unknown

"Landings in 1990 (1,900 mt) remained unchanged from 1989, near the lowest on record. CPUE indices in 1990 were also among the lowest ever observed."

Georges Bank

Commercial landings from the Georges Bank region increased from 1,900 mt in 1976 to near record high levels during 1980-1984 (average of 3,800 mt/yr). Between 1985 and 1988, landings averaged 2,400 mt per year. No recreational catches have been reported from this stock.

Landings in 1990 (1,900 mt) remained unchanged from 1989, near the lowest on record. CPUE indices in 1990 were also among the lowest ever observed. The NEFC autumn survey stock biomass index has generally trended downward since 1976. The survey index declined again in 1990 to the lowest value in the 28-year survey time series.

Although a formal assessment of the Georges Bank stock has yet to be conducted, commercial and survey data both indicate that the stock has declined to record low levels, and is overexploited.

Southern New England-Middle Atlantic

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 have declined steadily from their early 1980s level, while recreational catches increased from 1980 to 1985, and then declined. The combined recreational and commercial landings dropped by 21% between 1989 and 1990 to a record low of about 4,500 mt. Commercial landings in

Winter Flounder
Southern New England-Middle Atlantic

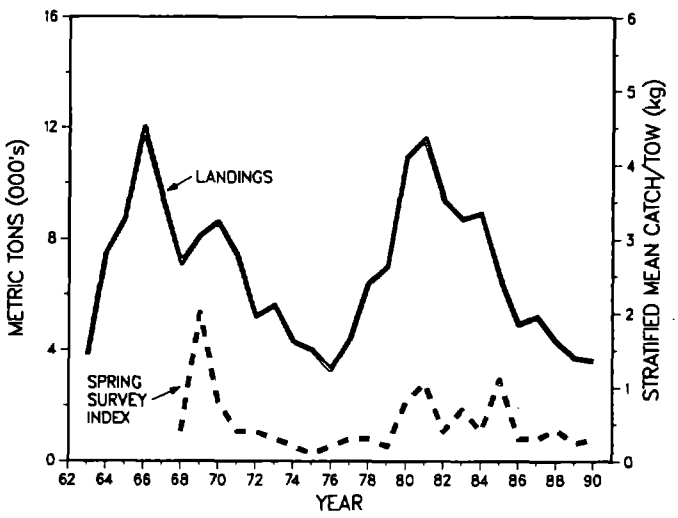


Table 11.3 Recreational catches and commercial landings (thousand metric tons)

	Year									
Category	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Recreational										
USA	3.3	3.2	5.0	6.4	7.9	3.3	4.0	3.9	2.0	0.9[1]
Commercial										
USA	11.6	9.4	8.7	8.9	6.6	4.9	5.2	4.3	3.7	3.6
Canada	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	14.9	12.6	13.7	15.3	14.5	8.2	9.2	8.2	5.7	4.5[1]

[1] **Preliminary estimate**

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

Southern New England - Middle Atlantic Winter Flounder

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Significant
Management	=	Multispecies FMP
Status of exploitation	=	Overexploited
Age at 50% maturity	=	3.1 yrs
Size at 50% maturity	=	29.0 cm (11.4 in.) males 27.6 cm (10.9 in.) females
Assessment level	=	Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1990} = Unknown

1990 (3,600 mt) remained near record low levels. Recreational landings declined from 2,000 mt to approximately 900 mt, a record low level.

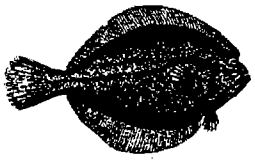
NEFC spring survey indices have shown similar trends as commercial catches since about 1975, increasing through 1981 and generally declining, with the exception of 1985, to near record low levels in 1989 and 1990. Commercial catch per unit effort indices (tonnage class 3 otter trawlers) showed a continuous decline from the 1964-1983 average of 2.7 mt/df to a record low of 0.8 mt/df in 1989, and remained low in 1990 (0.9 mt/df).

The continued decline in landings since 1981 and the low commercial and survey indices in the more 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, although it appears likely that on average the stocks are overexploited.

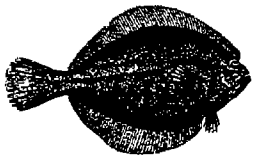
For further information

Almeida, F.P. 1989. 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-73.

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.



12. Windowpane Flounder



Windowpane or sand flounder, *Scophthalmus aquosus*, is a thin-bodied, "left-handed" flounder distributed along the Northwest Atlantic continental shelf from the Gulf of St. Lawrence to Florida. The greatest commercial concentrations exist in waters less than 46 m (25 fathoms) from Georges Bank and Southern New England. Sexual maturity occurs between ages 3 and 4. Spawning occurs from late spring to autumn, peaking in July-August on Georges Bank and September in Southern New England. Windowpane commonly attain lengths up to 41 cm (16.1 in.).

No stock structure information is presently available; a provisional summary of information is given for two areas, based on suggested differences in growth, maturity and abundance trends between fish from Georges Bank and Southern New England. Because the proportion of landings contributed by the Gulf of Maine and Mid-Atlantic areas is low (less than 7%), information from these two areas is combined with that from Georges Bank and Southern New England areas, respectively.

The principle commercial fishing gear for windowpane flounder is otter trawl. Recreational and foreign catches are insignificant although historic foreign catches in the industrial fishery category may have been substantial. The windowpane fishery is managed under the NEFMC's Multispecies FMP. Total USA landings in 1990 (1,900 mt) approximate the average landings for this fishery over the past five years, but declining 6% from 1989.

Windowpane were first exploited as a commercial species in 1943-1945 during the end of World War II. Between then and 1975, these fish were

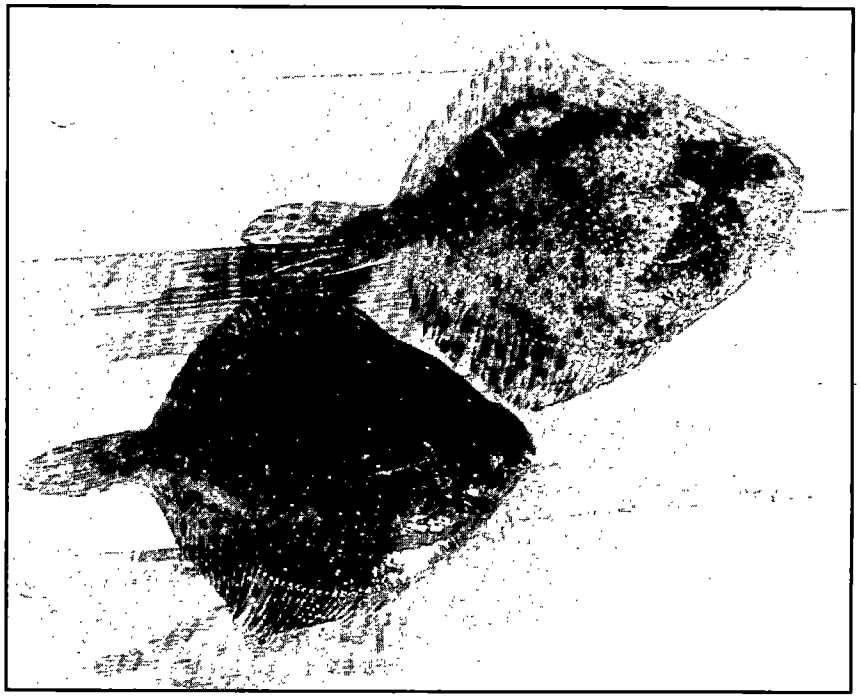


Photo by Brenda Figueirido, NMFS

"Recreational and foreign catches are insignificant although historic foreign catches in the industrial fishery category may have been substantial."

Gulf of Maine - Georges Bank Windowpane Flounder

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Fully exploited
Age at 50% maturity	=	Unknown
Size at 50% maturity	=	22 cm (8.7 in.)
Assessment level	=	Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1990} = Unknown

Photo by Brenda Figueredo, NMFS

"Increased landings since 1987 probably reflect targeting of this species as an alternative to other depleted flatfish stocks."

Windowpane Flounder
Gulf of Maine-Georges Bank

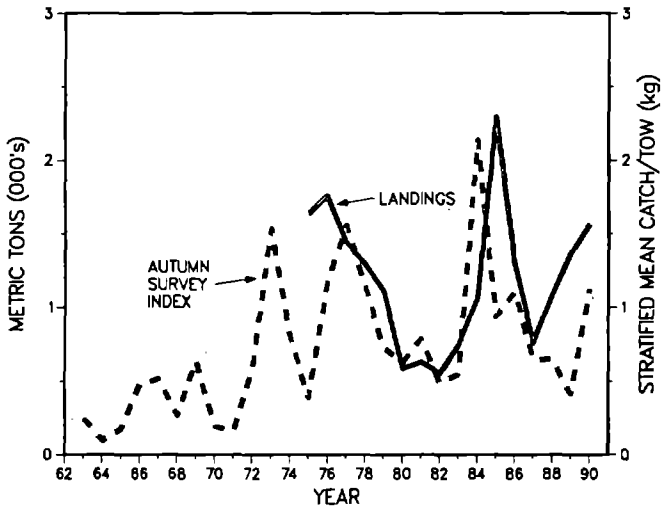


Table 12.1 Recreational catches and commercial landings (thousand metric tons)

	Year									
Category	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	0.6	0.5	0.8	1.1	2.3	1.3	0.8	1.1	1.4	1.6
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	0.6	0.5	0.8	1.1	2.3	1.3	0.8	1.1	1.4	1.6

exploited (and reported) only as an industrial species. Separate commercial landings data for this species were first available in 1975. Commercial landings declined from 1975-1976 to a low of 900 mt in 1980. Subsequently, annual landings increased to a peak of 3,400 mt in 1985 and are now at 56% of this record level, at 1,900 mt.

Gulf of Maine-Georges Bank

Commercial landings from the Gulf of Maine-Georges Bank area have fluctuated between 550 and 2,300 mt since 1975, and have averaged 1,200 mt. Landings for 1990 (1,600 mt) show a 13% increase from 1989. No recreational catches have been reported from this area.

NEFC autumn offshore indices have been highly variable, but have reflected the general pattern of landings. Increased landings since 1987 probably reflect targeting of this species as an alternative to other depleted flatfish stocks.

The limited assessment information presently available (commercial and survey indices) suggest that the stock is fully exploited in this region.

"The steady decline from 1985 to this level and a similar decline in landings suggest that the stock is overfished."

Southern New England-Middle Atlantic

Commercial landings from the Southern New England-Mid-Atlantic area increased from 300 mt in 1977 to 1,200 mt in 1985. Between 1986 and 1989, landings averaged 800 mt per year. No recreational catches have been reported from this area.

Landings in 1990 (400 mt) declined 47% from 1989 and approach the low levels of the late 1970s. NEFC autumn offshore indices show a general decline in biomass since 1985.

The indices for 1989 and 1991 were about the lowest in the time series since 1964. The steady decline from 1985 to this level and a similar decline in landings suggest that the stock is overfished. Since a detailed assessment is not available, the status is somewhat uncertain.

Windowpane Flounder
Southern New England-Mid-Atlantic

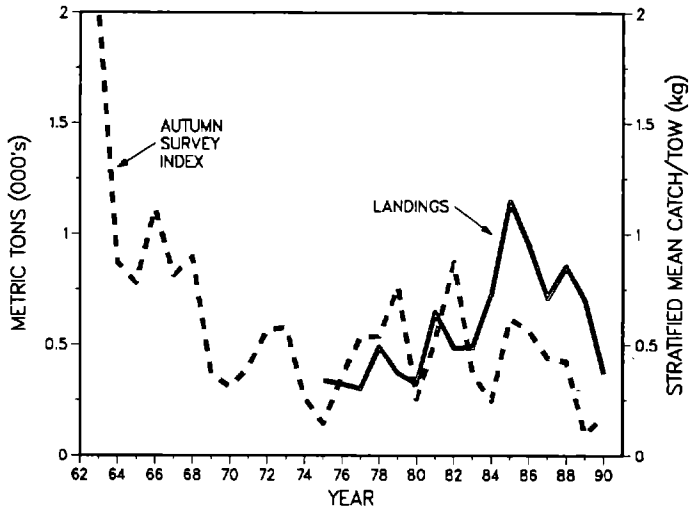


Table 12.2 Recreational catches and commercial landings (thousand metric tons)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	0.6	0.5	0.5	0.7	1.2	1.0	0.7	0.9	0.7	0.4
Other										
Total nominal catch	0.6	0.5	0.5	0.7	1.2	1.0	0.7	0.9	0.7	0.4

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.

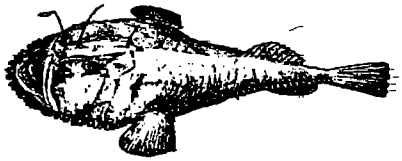
Moore, E.L. 1947. Studies on the marine resources of Southern New England. VI. The sand flounder, *Lophopsetta aquosa* (Mitchill); a general study of the species with special emphasis on age determination by means of scales and otoliths. *Bull. Bingham Oceanogr. Collect. Yale Univ.* 11(3):1-79.

O'Brien, L., Burnett, J. and R.K. Mayo. 1991. Maturation of nineteen species of finfish off the northeast coast of the United States, 1985-1990. Woods Hole, MA: NOAA/NMFS/NEFC. NOAA Tech. Report - In Press.

Southern New England-Middle Atlantic Windowpane Flounder

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Overexploited
Age at 50% maturity	=	Unknown
Size at 50% maturity	=	21 cm (8.3 in.)
Assessment level	=	Index

M = Unknown $F_{0.1}$ **= Unknown** F_{max} **= Unknown** F_{1990} **= Unknown**



13. Goosefish

Goosefish, also called monkfish or angler, *Lophius americanus*, range from the Grand Banks and northern Gulf of St. Lawrence south to Cape Hatteras, North Carolina. These fish exhibit a eurybathic depth distribution from the tideline to as deep as 840 m, although few larger individuals are found deeper than 400 m. Goosefish have been found in waters ranging from 0°-24°C, but are most abundant in the range of 3°-11°C (depending on the region). Seasonal migrations appear to be related to a attempt to avoid water warmer than 15°C or availability of preferred foods such as squids, butterfish, hakes, and sand lance.

The goosefish has been described as mostly mouth, with a tail attached, and reports are common of goosefish eating prey items almost as big as themselves. Growth is fairly rapid and similar for both sexes up to age 4, 47-48 cm (19 in.). After this, females grow a bit more rapidly than the males and seem to live longer, about 12 years, reaching a size of slightly more than 100 cm (39.4 in.). Males have not been found older than age 9, approximately 90 cm (35.4 in.) with few above age 6.

Female goosefish mature at about 4 years, 49 cm (19.3 in.), compared to males at 3 years, 37 cm (14.5 in.). Goosefish spawn in spring, summer and early autumn (depending on latitude). This a protracted period during which the females lay a non-adhesive, mucoid egg raft or veil that is buoyant and contains a complex structure of individual chambers, each containing one to three eggs and an opening for water circulation. This veil is unique to goosefishes, and can be as large as 12 m (39 ft) in length by 1.5 m (5 ft) in width. Incubation ranges from 7 to 22 days, after which the larvae spend several months in a pelagic phase before settling to a benthic existence at a size of about 8 cm (3.1 in).

NMFS/NEFC archive photo

Goosefish are almost exclusively a bycatch of groundfishing and scalloping ventures. Until recent times, this species has not been a common market product in the U.S., and as a consequence, most of the U.S. caught fish went to 'shack'. Recently, however, "monkfish" or "poor man's lobster", has been sold in response to the dwindling supply (and rising prices) of traditional species of groundfish. Additionally, the livers of goosefish have found a growing market in the last ten years (mostly as exports to Japan), and as a result landings have shown a steady increase from 1970 to 1990. Landed weight of tails rose from 19.3 mt in 1964 to 643 mt in 1975, and from 1975 to 1980 increased to 2,305 mt. By 1989, 4,323 mt were

landed (representing about 11,000 mt of live weight) before dropping to 3,844 in 1990.

Of interest has been the steady growth of the liver market. From 1982, when 10 mt where landed, this product jumped to 28 mt in 1985 and to 180 mt in 1990. Along with this increase in landings has been a significant increase in ex-vessel price. With prices rising from $0.92/lb in 1982, to $4.02/lb in 1990, the proportion of total goosefish revenues represented by livers has grown from <1% to slightly over 12% in that time.

Since this fish is a bycatch from other fisheries, catch per unit effort (CPUE) indices are difficult to obtain. However, the NEFC autumn survey biomass index shows a reasonably sharp decline over the last 10 years. The average standardized catch-per-tow over the last ten years is 1.14 kg/tow, as compared to the average of the preceding years (2.57 kg/tow). In the last four years this value has been below 1.0kg/tow and in 1990, the value of 0.7kg/tow was the third lowest on record.

Given the fact that landings do not give us a good historic pattern of the exploitation of this species, there is some cause for concern based on the declining survey index as the landings increased. The increase in landings of tails and livers may indicate a true increase in fishing mortality that is being expressed in the survey index. Further work is needed to resolve this and we cannot be certain as to the status of the resource at this time.

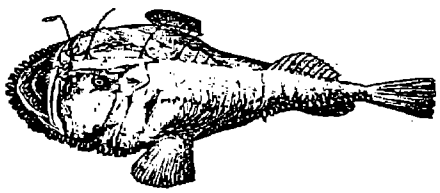
For further information

Armstrong, M.P. 1987. Life history of the goosefish, *Lophius americanus*. MS thesis. College of William and Mary in Virginia.

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

Grosslein, M.D. and T.R. Azarovitz. 1982. Goosefish, *Lophius americanus*. In: Fish distribution. Mesa N.Y. Bight Atlas Monograph 15.

"Of interest has been the steady growth of the liver market. From 1982, when 10 mt where landed, this product jumped to 28 mt in 1985 and to 180 mt in 1990."



Goosefish
Gulf of Maine - Mid-Atlantic

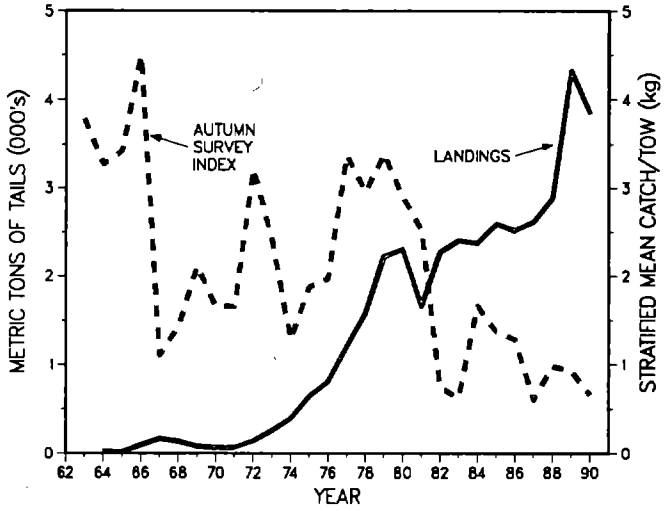


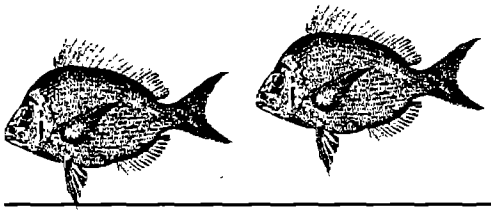
Table 13.1 Recreational catches and commercial landings (thousand metric tons)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial										
USA	2.2	2.6	2.6	2.6	3.0	2.4	6.9	8.1	11.6	10.6
Canada	<0.1	<0.1	<0.1	0.3	1.3	0.3	0.7	0.9	1.2	1.6
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	2.2	2.6	2.6	2.9	4.3	2.8	7.7	9.0	12.8	12.2

Gulf of Maine - Middle Atlantic Goosefish

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Insignificant
Management	=	None
Status of exploitation	=	Unknown
Age at 50% maturity	=	4 yrs, females 3 yrs, males
Size at 50% maturity	=	49 cm (19.3 in.) females 37 cm (14.6 in.) males)
Assessment level	=	Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1990} = Unknown



14. Scup

Photo by Brenda Figuerido, NMFS

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 19 cm (7.5 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. Because the separation of stocks is not well-defined spatially, this separation is not used here.

The principal commercial fishing gear is the otter trawl. Recreational catches are significant. The fishery is not yet subject to management except locally within individual states' waters although an FMP is planned. Total reported landings decreased 10% in 1990 (from 6,800 mt to 6,100 mt), due to lower recreational catches.

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 have declined significantly since then. The 1990 catch of 4,200 mt followed a record low catch in 1989 (3,600 mt). The catch in 1990 was the fourth lowest level on record (since 1930).

Most of the increase in landings during the 1970s 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 in the past ten years. The 1990 preliminary recreational catch estimate (1,900 mt) is 40% below the 1989 level, and 40% below the 1980-1989 mean (3,200 mt).

Catch per unit effort of Southern New England otter trawlers increased from 2.2 mt/day fished in 1971 to 6.2 mt/day in 1977 and 1979. Recent values have decreased markedly from an average of 5.8 mt/day fished between 1982-1984 to 2.8 mt/day fished in 1989, approaching record low levels of 1971-1972. In 1990, values remained low, at 3.4 mt/day fished. 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 widely, but appears to be trending downward. 1987-1988 values were the lowest observed in the time series. The 1990 index, although above 1987-1988 levels, is still the seventh lowest value observed in the time series.

A comparison of scup length frequencies from the commercial fisheries during 1983-1990 reveal that commercial length frequency distributions have shifted to smaller fish (including young of year). There are generally few larger, older scup (more than 35 cm, more than 7 years) in both com-

Scup
Southern New England-Middle Atlantic

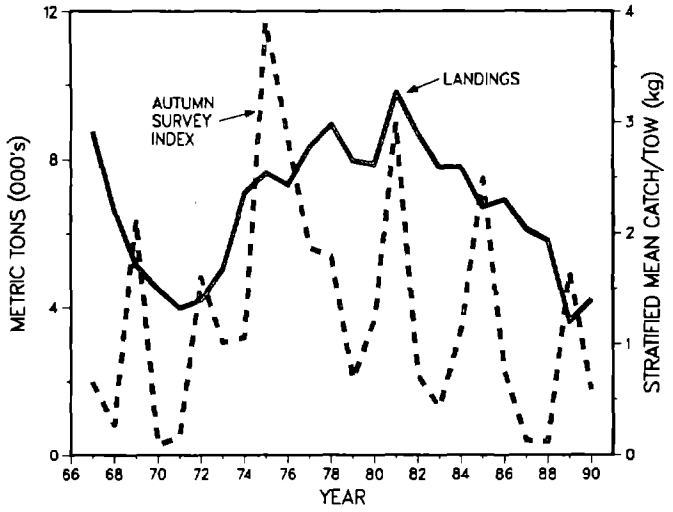
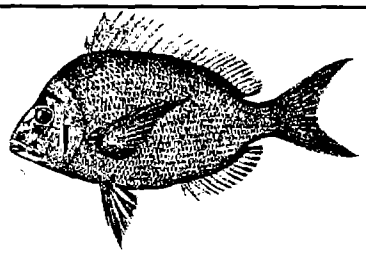


Table 14.1 Recreational catches and commercial landings (thousand metric tons)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	2.0	3.1	3.4	1.4	3.3	5.9	3.2	2.3	3.2	1.9[1]
Commercial										
USA	9.8	8.7	7.8	7.8	6.7	6.9	6.1	5.8	3.6	4.2
Canada	-	-	-	-	-	-	-	-	-	-
Other	<0.1	-	-	<0.1	<0.1	<0.1	-	-	-	-
Total nominal catch	11.8	11.8	11.2	9.2	10.0	12.8	9.3	8.1	6.8	6.1[1]

[1] **Preliminary estimate**



Southern New England - Mid-Atlantic Scup

Long-term potential catch	=	10,000 to 15,000 mt
Importance of recreational fishery	=	Major
Management	=	None
Status of exploitation	=	Overexploited
Age at 50% maturity	=	2 yrs
Size at 50% maturity	=	15.5 cm (6.1 in.)
Assessment level	=	Yield per recruit

M = 0.20 **$F_{0.1}$ = 0.20** **F_{max} = 0.35** **$F_{1990} > F_{max}$**

"There are generally few larger, older scup (more than 35 cm, more than 7 years) in both commercial and recreational fisheries."

mercial and recreational fisheries. The maximum length observed in NEFC autumn surveys has declined from a mean of 30 cm between 1982-1986 to 24 cm between 1987-1990. Instantaneous fishing mortality (F) 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, record low CPUE level, and overall declining trend in survey indices suggest that recent exploitation has reduced stock abundance substantially. The truncated age distributions suggest that exploitation is increasingly focusing on young fish. These considerations suggest that the population is overexploited.

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.

Northeast Fisheries Center. 1990. Report of the Eleventh Stock Assessment Workshop. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document. Available from: Northeast Fisheries Center, Woods Hole, MA.

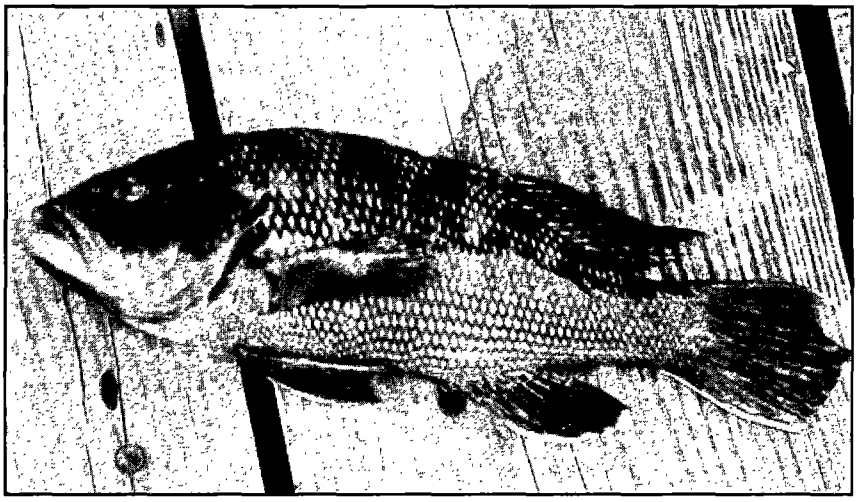
15. Black Sea Bass

Black sea bass, *Centropristis striata*, occur off the northeast United States along the entire Atlantic coast of the United States, and consist of two stocks north and south of Cape Hatteras, North Carolina. The northern group of 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. Both sexes reach 50% maturity by age 2 with the median size at maturity for males and females at 19.0 and 19.1 cm (7.5 in.), respectively. Transformation from female to male generally occurs between ages 2 and 5. Females are rarely found older than 8 years (>35 cm or 14 in.), while males may live up to 15 years (>60 cm or 24 in.). Black sea bass are omnivores, feeding on crustaceans, molluscs, echinoderms, fish, and plants.

The principal commercial fishing gears used to catch black sea bass are otter trawls and fish traps. Recreational fishing is as significant as commercial fishing. Currently there is no management outside state waters. Total catch declined in 1990 to 2800 mt, down from 3300 mt in 1988 and 1989.

Reported commercial landings north of Cape Hatteras fluctuated around 2,600 mt from 1887 until 1948, when landings increased to 6,900 mt. Landings peaked at 9,900 mt in 1952, declined steadily to 600 mt in 1971, and then increased to 2,400 mt in 1977. Between 1980 and 1989, com-

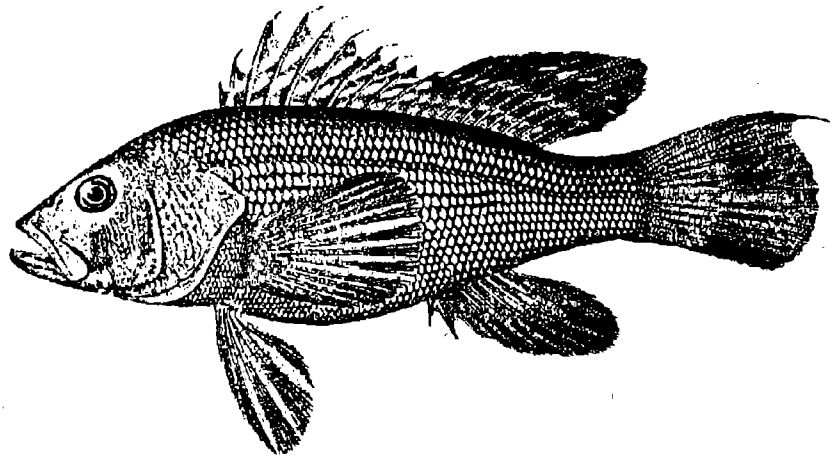


NMFS/NEFC archive photo

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 yrs
Size at 50% maturity	=	19 cm. (7.5 in.)
Assessment level	=	Yield per recruit

M = 0.3 **$F_{0.1}$ = 0.2** **F_{max} = 0.3** **F_{1990} = Unknown**



" High pre-recruit indices from the NEFC survey correspond to increased commercial landings two years later, but periods of higher landings (and CPUE) are brief. This suggests that the fishery tends to reduce incoming year classes rapidly."

Black Sea Bass
Gulf of Maine-Mid-Atlantic

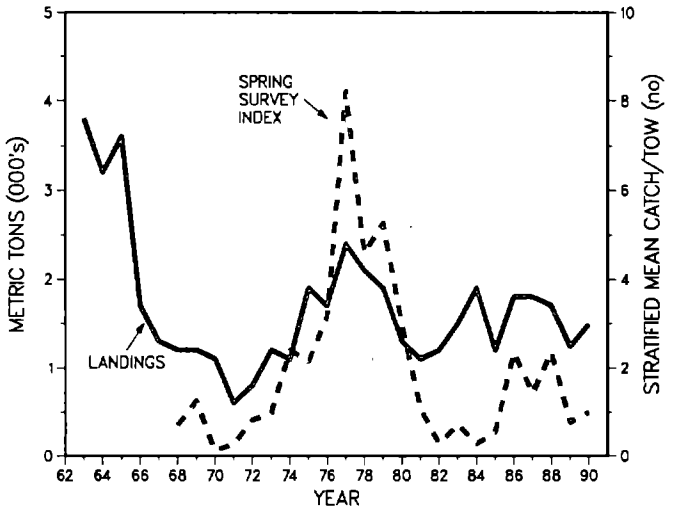


Table 15.1 Recreational and commercial landings (thousand metric tons)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	0.5	8.1	2.3	0.7	1.5	6.3	1.0	1.6	2.1	1.3[1]
Commercial										
USA	1.1	1.2	1.5	1.9	1.2	1.8	1.8	1.7	1.2	1.5
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	1.6	9.3	3.8	2.6	2.7	8.1	2.8	3.3	3.3	2.8[1]

[1] **Preliminary estimate**

mercial landings have ranged from 1,100 to 1,900 mt, with average landings of 1,470 mt. Total landings have fluctuated without trend in the 1980s, punctuated by years with much higher recreational catches. Commercial landings in 1990 were 1,500 mt. The only reported catch by distant-water fleets was 1,500 mt in 1964. Estimated recreational landings, occurring primarily in the middle Atlantic states, have ranged from 500 mt to 8,100 mt in the 1980s, with no apparent trend. (The high values for 1982 and 1986, 8,100 mt and 6,300 mt respectively, are due in part to sampling effects.)

The estimated recreational landings have contributed 31% (1981) to 87% (1982) of the total nominal catch in the past ten years. Estimated recreational landings for 1990 from the middle Atlantic and New England regions were 1300 mt.

Standardized catch per unit effort (CPUE, mt/days fished in trips of 25% or greater black sea bass) in the Mid-Atlantic trawl fishery peaked at 3.39 in 1984, declined to 1.18 in 1986 and increased to 2.49 in 1988. CPUE for 1990 decreased to 0.87 mt/days fished. 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 have dropped to 1.1 fish/tow in 1991. Pre-recruit indices (fish <20 cm) from the autumn inshore bottom trawl survey indicate above average year classes occurred in 1977, 1982, and 1986. Recruitment in 1990 appears average.

Size composition data from commercial landings indicate that black sea bass recruit fully to the trap and trawl fisheries by ages 2 and 3, respectively. The biologically optimum age at first harvest for black sea bass, based on yield per recruit analysis, is 6 years at F=0.3. High pre-recruit indices from the NEFC survey correspond to increased commercial landings two years later, but periods of higher landings (and CPUE) are brief. This 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 stock, but the stock would appear to be fully exploited.

For further information

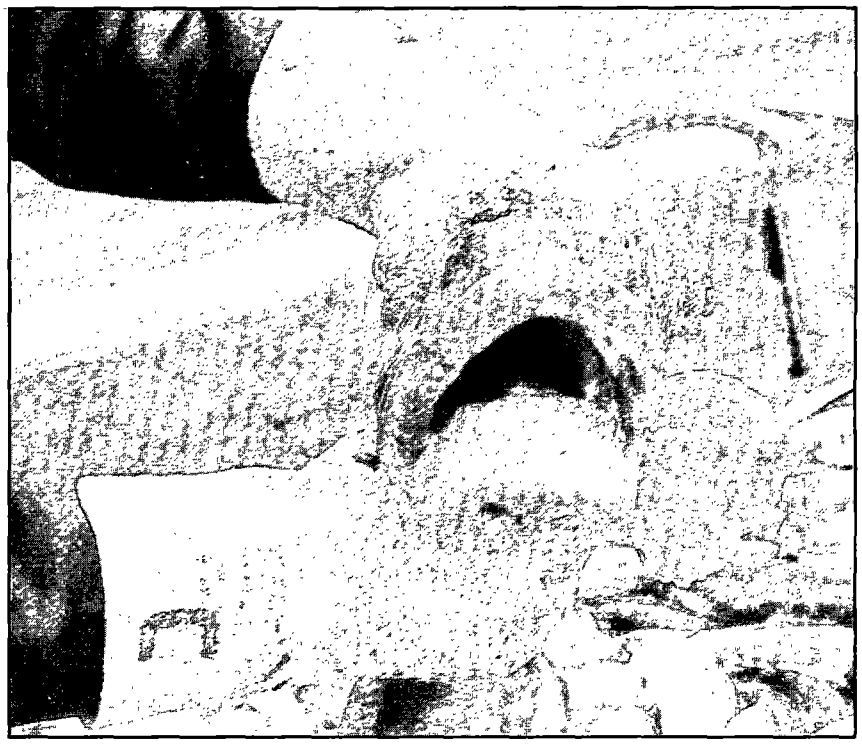
Low, B.A., Jr. 1981. Mortality rates and management strategies for black sea bass off the southeast coast of the United States. *North Amer. J. of Fisheries Mgmt.* 1(2):93-103.

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.

Northeast Fisheries Center. 1990. Report of the Eleventh Stock Assessment Workshop. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document. Available from: Northeast Fisheries Center, Woods Hole, MA.

16. Ocean Pout

Photo by Brenda Figueridо, NMFS



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 m 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 cease 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, 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. Fishing in federal waters is managed under the New England Fishery Management Council's Multispecies FMP; the state of Massachusetts regulates the inshore fishery which occurs in Cape Cod Bay. Total nominal landings for 1990 (1,300 mt) remained unchanged from 1989.

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 directed 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 declined slightly in 1989-1990 to 1,300 mt. Although a relatively strong 1985 year class recruited to the commercial fishery in 1990, landings for 1991 are expected to approximate those in the past two years due to a limited market for the species. Landings from southern New England dominated the catch for the third year in a row, accounting for 76% of the total 1990 USA harvest, reversing landings patterns observed in 1986-1987 when the Cape Cod Bay fishery was dominant.

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. The Massachusetts spring inshore survey appears to be useful in the identification of strong year classes. 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

"The population appears to be fully exploited, and catches at the present level appear sustainable."

(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 per tow. Subsequently, survey catch per tow indices declined; the spring 1987 index (2.7 kg per tow) was the lowest since 1979, and the index remained low in both the 1988 and 1989 surveys. The spring 1990 index of 5.1 kg per tow was the highest since 1986, due to strong recruitment from the 1987 year class.

The prospect for increased landings during 1991-1993 appears possible as the 1985 and 1987 year classes recruit to the fishery, although landings for this species are somewhat constrained by market conditions. The population appears to be fully exploited, and catches at the present level appear sustainable.

Ocean Pout
Mid-Atlantic-Gulf of Maine

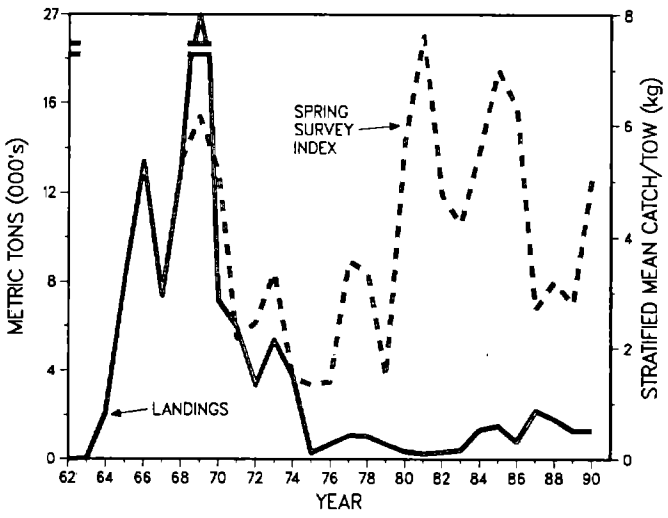
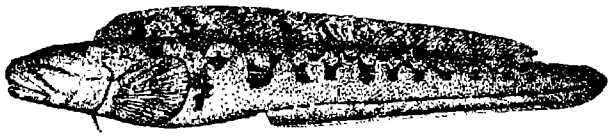


Table 16.1 Recreational catches and commercial landings (thousand metric tons)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	0.3	0.3	0.4	1.3	1.5	0.8	2.2	1.8	1.3	1.3
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	0.3	0.3	0.4	1.3	1.5	0.8	2.2	1.8	1.3	1.3



For further information

Northeast Fisheries Center. 1990. Report of the Eleventh Stock Assessment Workshop. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document. Available from: Northeast Fisheries Center, Woods Hole, MA.

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.

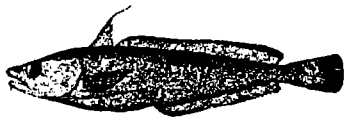
Orach-Meza, F. L.. 1975. Distribution and abundance of ocean pout, *Macrozoarces americanus* (Bloch and Schneider) in western North Atlantic Ocean. Kingston, RI: University of Rhode Island. Master's thesis.

Mid-Atlantic - Gulf of Maine Ocean Pout

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP and state regulations
Status of exploitation	=	Fully exploited
Age at 50% maturity	=	Unknown
Size at 50% maturity[1]		
Gulf of Maine	=	26.2 cm, females 30.3, males
Southern New England	=	31.3 cm, females 31.9, males
Assessment level	=	Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1990} = Unknown

[1] Ocean pout appear to have a three-year egg development period.



17. White Hake

Photo by Brenda Figueridо, NMFS

The white hake, *Urophycis tenuis*, a boreal species that occurs from Newfoundland to Southern New England, is found 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 north and 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 hake are taken as shallow as 27 m (15 fathoms) during gillnetting operations in summer.

In the Gulf of Maine region, spawning occurs in winter and spring although the season and the extent of spawning is not clearly defined. White hake attain maximum 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. Juveniles feed primarily upon shrimp and other crustaceans, but adults feed almost exclusively on 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 Fishery Management Council's Multispecies FMP. Total landings were essentially unchanged in 1990 (5,500 mt) compared to 1989 (5,600 mt).

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 5,500 mt in 1990. The increase evident throughout the 1970s and early 1980s likely reflects both a general increase in incidental catches associated with 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

"Given the stability in stock biomass since 1981, the mean 1981-1990 catch of 6,500 mt may be an appropriate estimate of the long-term potential catch."

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 1990 have been quite stable at a level 30-40% below the 1970-1980 average. Catches have been declining since 1986 but still remain high relative to pre-1981 levels. Given the stability in stock biomass since 1981, the mean 1981-1990 catch of 6,500 mt may be an appropriate estimate of the long-term potential catch. Since recent catches have been close to this level, the population is considered to be 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.

Northeast Fisheries Center. 1990. Report of the Eleventh Stock Assessment Workshop. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document. Available from: Northeast Fisheries Center, Woods Hole, MA.

White Hake
Gulf of Maine-Georges Bank

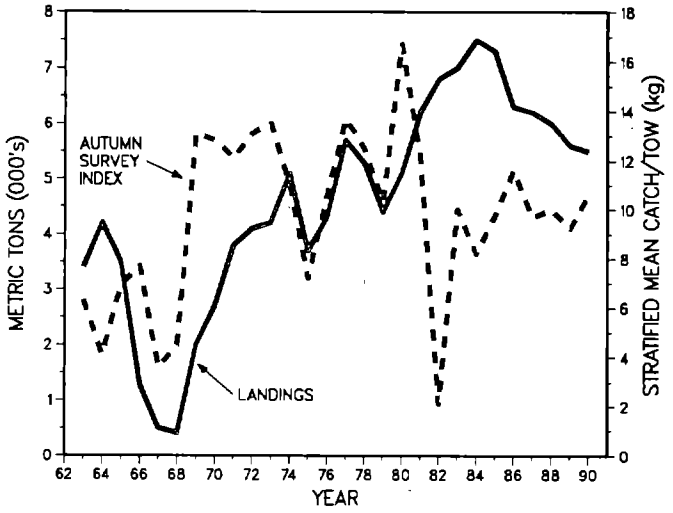
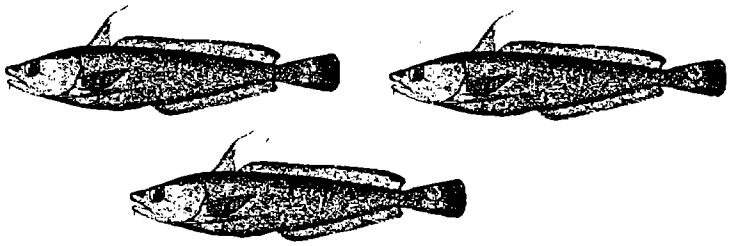


Table 15.1 Recreational catches and commercial landings (thousand metric tons)

	Year									
Category	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Recreational										
USA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial										
USA	5.7	6.0	6.2	6.5	6.4	5.3	5.5	5.4	5.0	5.0
Canada	0.5	0.8	0.8	1.0	0.9	1.0	0.7	0.6	0.6	0.5
Other	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-
Total nominal catch	6.2	6.8	7.0	7.5	7.3	6.3	6.2	6.0	5.6	5.5



Gulf of Maine - Georges Bank White Hake

Long-term potential catch	=	6,500 mt
Importance of recreational fishery	=	Insignificant
Management	=	Multispecies FMP
Status of exploitation	=	Fully exploited
Age at 50% maturity	=	1.4 yr
Size at 50% maturity	=	34 cm (13.4 in.)
Assessment level	=	Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1990} = Unknown

18. Cusk

Photo by Brenda Figueridо, NMFS

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 lb). Little is known about stock structure.

The principal fishing gear used to catch cusk are otter trawls and gill nets. Recreational fishery is insignificant and foreign catches are minor. The fishery is not under management. Total catches in 1990 increased 6% (from 1,600 mt to 1,700 mt).

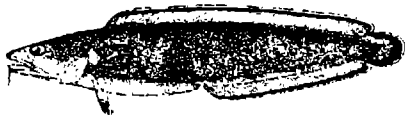
Between 1980 and 1990, annual landings of cusk from the Gulf of Maine-Georges Bank region ranged between 1,500 mt (1988) and 4,000 mt (1981) and averaged 2,500 mt per year. In this period, 72% of the catch was taken by the USA with almost all the remainder taken by Canada. The bulk of the USA catch has been taken from the Gulf of Maine while nearly all of the Canadian catch has been from Georges Bank. The 1990 USA catch was 1,200 mt and accounted for 72% of the total yield. Canadian landings in 1990 were 500 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 1985-1986, longline landings of cusk increased dramatically to 23% of the total landings as a result of a new auto-longline fishery. However, this fishery ceased operations in 1987 and longline landings have since accounted for only 7% of the total catch. Otter trawls accounted for the majority of landings in 1990 while gill nets and line trawls accounted for most of the remainder.

The NEFC autumn survey index has fluctuated considerably. The 1990 autumn index of 0.44 kg/tow represents a 14% decrease from the 1989 value.

While annual landings have generally declined since 1983, survey indices of abundance have fluctuated without a consistent trend, although the 1990 autumn index was the second lowest in the 28 year time series. The current level of assessment is too low to allow the status of the stock to be predicted with confidence.

"Otter trawls accounted for the majority of landings in 1990 while gill nets and line trawls accounted for most of the remainder."



Cusk
Gulf of Maine-Georges Bank

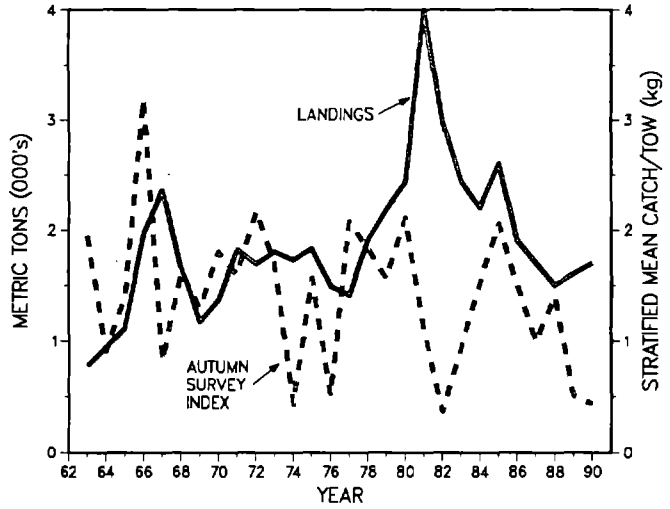


Table 18.1 Recreational catches and commercial landings (thousand metric tons)

	Year									
Category	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Recreational										
USA	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial										
USA	1.9	1.8	1.8	1.7	2.3	1.8	1.4	1.1	0.9	1.2
Canada	2.1	1.2	0.6	0.5	0.3	0.1	0.3	0.4	0.7	0.5
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	4.0	3.0	2.4	2.2	2.6	1.9	1.7	1.5	1.6	1.7

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_{1990} **= Unknown**

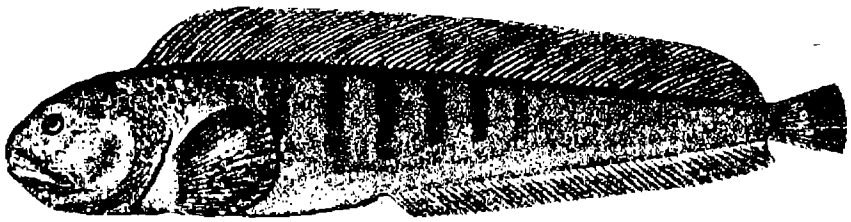
19. Atlantic Wolffish

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 lb). They are significant shellfish predators.

Wolffish have been taken primarily as bycatch 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 for 1990 were 500 mt, the lowest since the mid-1970s.

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. USA landings in 1990 were just under 400 mt, continuing the trend of a 100 to 200 mt decline per year since 1983.

The NEFC spring survey index, after fluctuating considerably from 1968 to 1982, has exhibited a downward trend since then. The 1990 spring

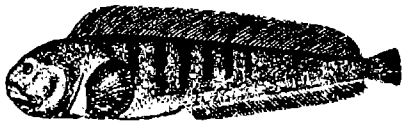


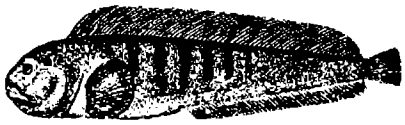
value of 0.451 is the lowest that has been observed.

The decline in landings since 1983 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 overexploited.

For further information

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





Atlantic Wolffish
Gulf of Maine - Georges Bank

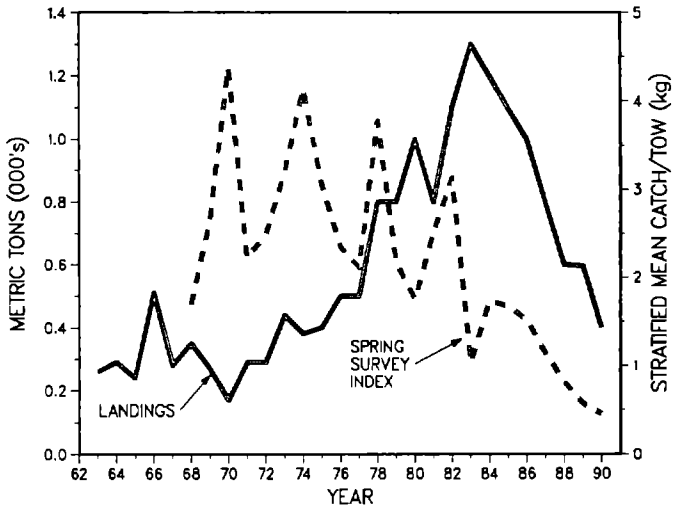


Table 19.1 Recreational catches and commercial landings (thousand metric tons)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial										
USA	0.7	0.9	1.2	1.1	1.0	0.9	0.7	0.5	0.5	0.4
Canada	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	1.0	0.8	1.1	1.3	1.2	1.1	1.0	0.8	0.6	0.5

Photo by Brenda Figueridо, NMFS

Gulf of Maine - Georges Bank Atlantic Wolffish

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

M = Unknown $F_{0.1}$ **= Unknown** F_{max} **= Unknown** F_{1990} **= Unknown**

20. Tilefish

NMFS/NEFC archive photo

Tilefish, *Lopholatilus chamaeleonticeps*, inhabit the outer continental shelf from Nova Scotia to South America and are relatively abundant in the Southern New England-Mid-Atlantic area at depths of 80-440 m (44-240 fathoms). They are generally found in and around submarine canyons where they occupy burrows in the sedimentary substrate. Tilefish are relatively slow growing and long-lived, with a maximum age and length of 35 years and 110 cm (43.3 in.) fork length in females and 26 years and 112 cm (44.1 in.) fork length in males. At lengths in excess of 70 cm (27.6 in.), the predorsal adipose flap, characteristic of this species, is larger in males and can be used to distinguish the sexes. Tilefish of both sexes become functionally mature by age 5 (50 cm or 19.7 in.).

Nominal catches were first recorded in 1915 (148 mt); 4,500 mt were taken in 1916, which is the largest annual catch to date, but only 5 mt were reported by 1920. Landings experienced a brief increase to 1,000-1,500 mt during the early 1950s followed by a decline to 30 mt in 1968-1969. Most recently, catches increased to 3,800 mt in 1979 but have steadily declined to 1990 landings of 900 mt. Since the 1970s, the predominant gear type used in this fishery is longlines. A small recreational fishery developed during the late 1960s in New York and New Jersey with landings never exceeding 100 mt. Recent recreational catches are virtually non-existent.

Beginning in the early 1970s, a directed commercial tilefish fishery by longliners expanded rapidly from New Jersey and New York. Fishing effort in standardized tubs of longline (1 tub=225 hooks and 0.5 mile of line) increased from 2,300 tubs in 1973 to about 44,600 tubs in 1979. Subsequently, catch per tub fished declined from 219 kg/tub in 1973 to 47 kg/tub in 1983. Catch/effort data have not been

Georges Bank - Middle Atlantic Tilefish

Long-term potential catch	=	2,400 mt
Importance of recreational fishery	=	Insignificant
Management	=	None
Status of exploitation	=	Overexploited
Age at 50% maturity	=	5-7 yrs
Size at 50% maturity	=	50 cm (19.7 in.) females 60 cm (23.6 in.) males
Assessment level	=	Yield per recruit

M = 0.15 **$F_{0.1}$ = 0.17** **F_{max} = 0.27** **F_{1990} = Unknown**

"Available data indicate that tilefish were heavily overexploited during the height of the longline fishery between 1977 and 1982. Fishing mortality exceeded the estimates of F_{max} by three times."

available since 1983 but indications are that the fishery has become more seasonal, with landings occurring primarily during winter and spring.

A yield per recruit analysis calculated in the early 1980s estimated $F_{0.1}$ = 0.17 and F_{max} = 0.27, based on age at entry of 4. Estimates of F from a VPA during the late 1970s and early 1980s increased from 0.20 (1977) to 0.74 (1981). Estimates of F have not been available since 1984, when a voluntary log book system was abolished. Long term potential catch for tilefish estimated from a surplus production model was about 2,400 mt.

Available data indicate that tilefish were heavily overexploited during the height of the longline fishery between 1977 and 1982. Fishing mortality exceeded the estimates of F_{max} by three times. Catches during this period were well above the long term potential yield of the stock. This period was followed by steadily declining values in CPUE, total landings, and average size as well as changes in the breeding structure of the population with decreases in the size/age of maturity in males. Current levels of exploitation or abundance are unknown, although significant declines in total landings since the early 1980s probably reflect overexpoitation.

Tilefish
Georges Bank-Middle Atlantic

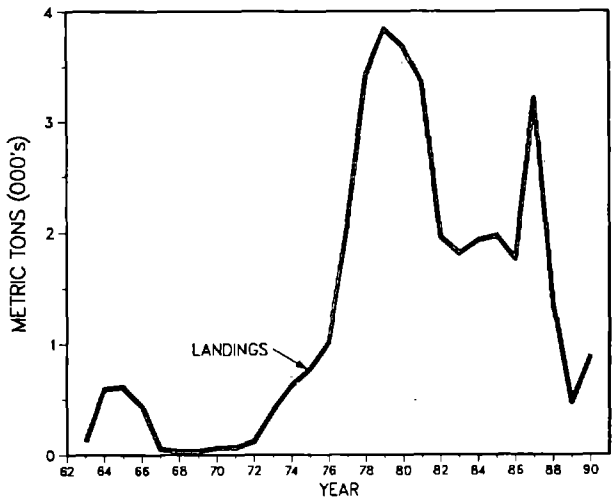
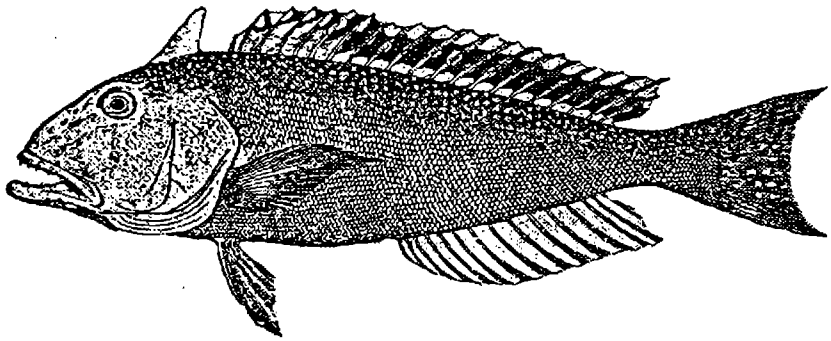


Table 20.1 Recreational catches and commercial landings (1,000 mt)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial										
USA	3.4	2.0	1.8	1.9	2.0	1.8	3.2	1.4	0.5	0.9
Canada	-	-	-	-	-	-	-	-	-	-
Other										
Total nominal catch	3.4	2.0	1.8	1.9	2.0	1.8	3.2	1.4	0.5	0.9



For further information

Turner,S.C., C.B. Grimes, and K.W. Able. 1983. Growth, mortality, and age/size structure of the fisheries for tilefish, *Lopholatilus chamaelonticeps*, in the Middle Atlantic-Southern New England region. *Fish. Bull.* 81(4):751-763.

Turner,S.C. 1986. Population dynamics of and, impact of fishing on tilefish, *Lopholatilus chamaelonticeps*, in the Middle Atlantic-Southern New England region during the 1970s and early 1980s. Ph.D. dissertation. Rutgers Univ., New Brunswick, N.J.

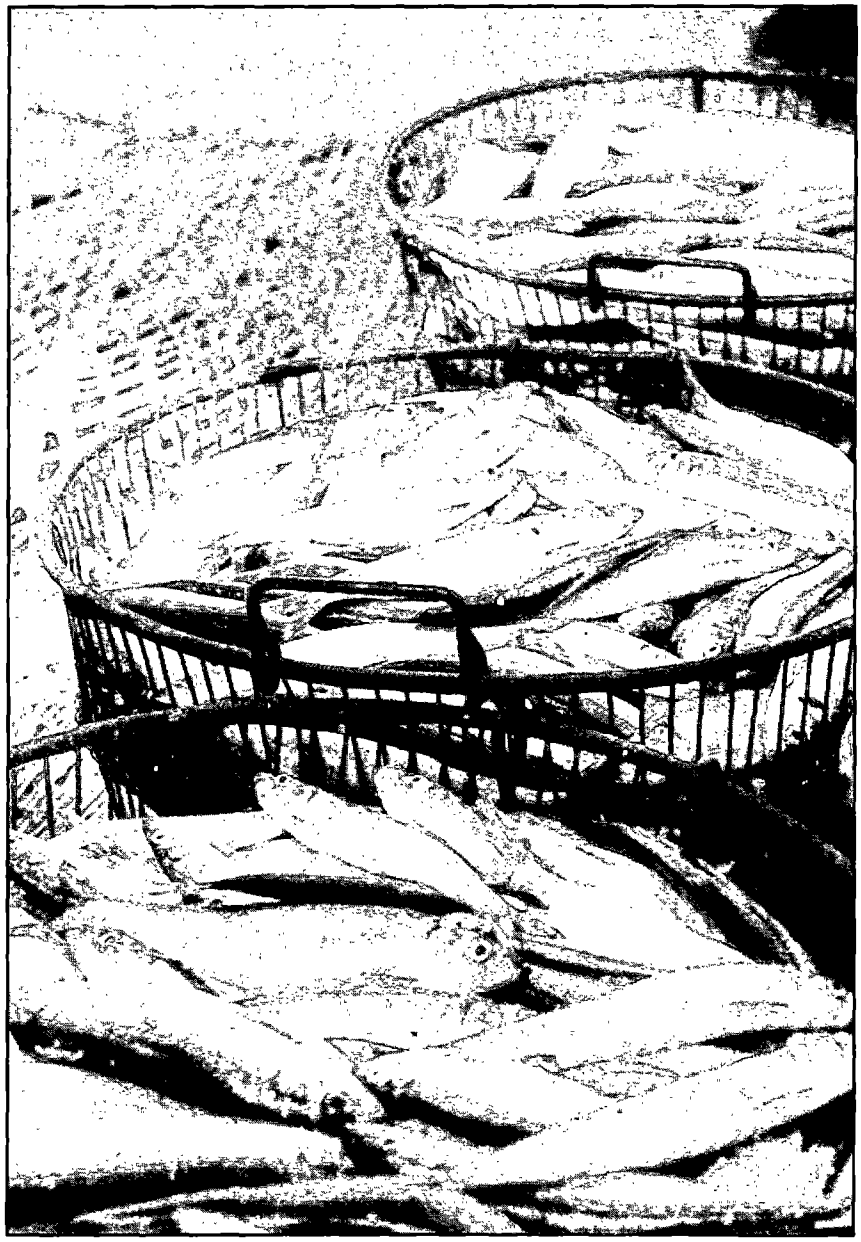
Grimes, C.B., C.F. Idelberger, K.W. Able, and S.C. Turner. 1988. The reproductive biology of tilefish, *Lopholatilus chamaelonticeps* Goode and Bean, from the United States Mid-Atlantic Bight, and the effects of fishing on the breeding system. *Fish. Bull.* 86(4):745-76.

21. 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 to 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 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 to 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 to 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 which have greatly declined in recent years.

Photo by Brenda Figueirido, NMFS

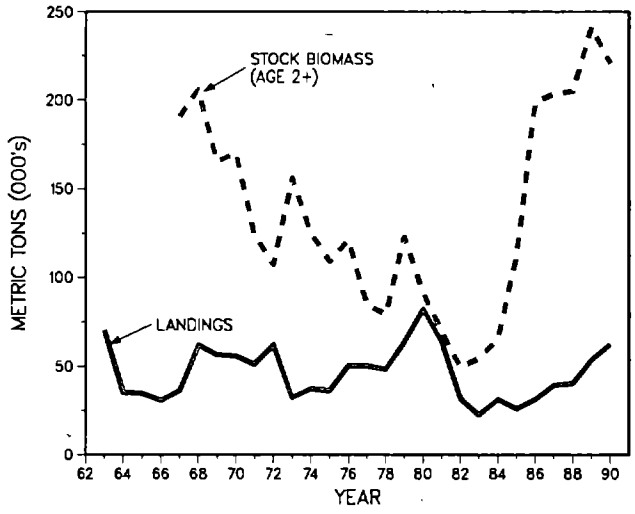


Gulf of Maine

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 62,200 in 1990. These changes are best understood by examining the changes in the two principal fisheries, the coastal fixed gear and the western Gulf mobile gear.

Coastal Maine nominal catches averaged 57,000 mt during 1950-1965, subsequently declining to an average of 23,000 mt during 1966-1979. Catches from this fishery are taken primarily from July to November. With the exception of the strong 1970

Atlantic Herring



Gulf of Maine

Table 21.1 Recreational catches and commercial landings (thousand metric tons)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	63.6	31.7	22.5	31.1	25.8	31.2	39.2	40.2	53.5	62.2
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch[1]	63.6	31.7	22.5	31.1	25.8	31.2	39.2	40.2	53.5	62.2

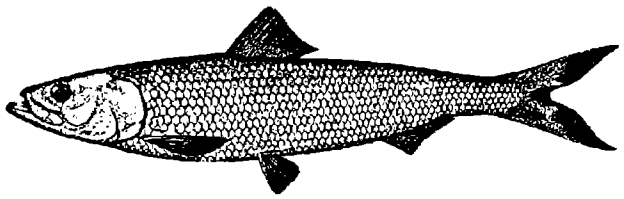
[1] **Age groups 1 and older.**

Georges Bank

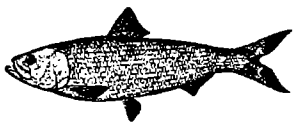
Table 21.2 Recreational catches and commercial landings (thousand metric tons)[1]

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	1.7	0.7	1.0	1.6	0.2	0.2	-	-	-	-
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	1.7	0.7	1.0	1.6	0.2	0.2	-	-	-	-

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



"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 1984-1990 NEFC spring survey indices indicate a recovery relative to 1982-1983 levels."

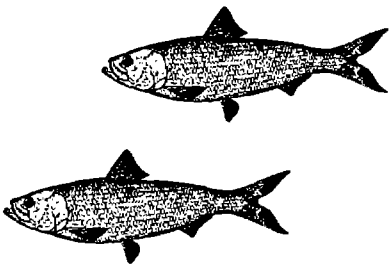


year class, recruitment up until 1978 remained below average. Nominal catches increased to an average of 45,000 mt during 1979-1981 with recruitment of a succession of relatively strong year classes in 1976, 1977, 1979. The general reduction noted since the early 1980s appears to be related to reduced availability to the fixed gear fisheries and reduced abundance as measured by NEFC survey indices. The 1984-1990 NEFC spring survey indices indicate a recovery relative to 1982-1983 levels. The fixed gear fishery on the Maine coast continued to represent a small proportion of the total catch in 1990, accounting for only 630 mt, or 1% of the total. Meanwhile, the 1990 nominal catch of 41,900 mt in the mobile gear fishery[1] represented 67% of the total catch. Due to declines in export markets in recent years with recovery the North Sea fishery, a significant proportion of the adult herring catch has not been used for human consumption.

Stock biomass (ages 2 and older) for the total Gulf of Maine region (coastal Maine and western Gulf of Maine) averaged 162,000 mt between 1967 and 1971 before declining to an estimated 79,800 mt in 1977. After increasing to 118,900 mt in 1979, stock biomass declined steadily to an estimated 49,300 mt in 1982, the lowest level yet observed. Recent estimates indicate an increase to over 200,000 mt since 1987.

[1] Includes offshore Maine and southern New England landings.

"Indication of some level of recovery has been obtained based on US and Canadian bottom trawl surveys during 1984-1990 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 1984-1990 and reports of incidental catches by commercial vessels. Prospects for re-development 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 Maine 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.

Gulf of Maine Atlantic Herring

Long-term potential catch[1]	=	20,000 mt
Importance of recreational fishery	=	Insignificant
Management	=	Spawning Area Closure
Status of exploitation	=	Fully exploited
Age at 50% maturity	=	3 yrs
Size at 50% maturity	=	26.0 cm (10.2 in.)
Assessment level	=	Age structured

M = 0.20 **$F_{0.1}$ = 0.24** **F_{max} = None** **F_{1989} = 0.275**

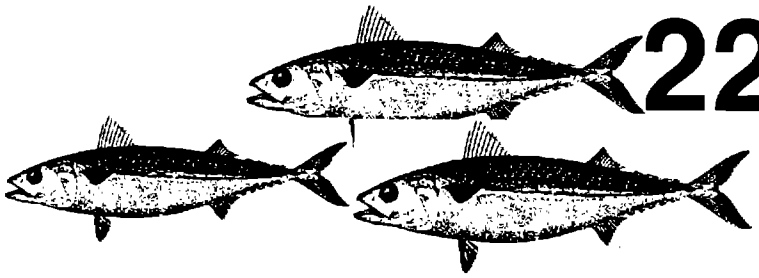
[1] Age groups 3 and older, Jeffreys Ledge component only Georges Bank

Photo by Brenda Figueirido, NMFS

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 yrs
Size at 50% maturity	=	26.4 cm (10.4 in.)
Assessment level	=	Index

M = 0.20 **$F_{0.1}$ = 0.36** **F_{max} = None** **$_{1989}$< 0.01**



22. 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 that spawns primarily in the Mid-Atlantic Bight during April and May, and a northern group that 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 lb) in weight. Sexual maturity begins at age 2 and is usually complete by age 3. Maximum age is about 20 years.

Photo by Brenda Figuerido, NMFS

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.

Mackerel landings increased dramatically beginning in the late 1960s, reaching a peak of roughly 400,000 mt in 1973. Landings subsequently declined to roughly 30,000 mt in the late 1970s, increased steadily from 1980-1988, and declined in 1989 and 1990. Total landings from this stock declined 16% in 1990 (72,290 mt to 60,590 mt). Increases in landings in the 1980s were due to larger USA and foreign joint venture fishing operations.

The USA accounted for 55% of the 1990 international catch on the Northwest Atlantic stock, including about 31,260 mt of commercial and an estimated 2,000 mt of recreational catch. The Canadian catch declined slightly from 18,200 mt in 1989 to 18,000 mt in 1990. The distant-water fleet catch dropped from 36,820 mt in 1989 to 9,130 mt in 1990.

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 largest since 1967. The 1984 to 1988 cohorts also appear to be relatively strong.

Total stock biomass (ages 1 and older) increased from around 300,000 mt in 1962-1965 to 1.6 million mt in 1969 before dropping to a stable low level during 1977-1981 averaging 776,000 mt per year. The total stock increased since 1981, reaching over 2.0 million mt in 1990. Spawning stock biomass (50% of age 2 fish and 100% of ages 3 and older) increased from about 600,000 mt in 1982 to over 2.0 million mt in 1990. This increase

"Rebuilding of the mackerel stock has been aided by relatively low catches during 1980-1990... as well as improved recruitment..."

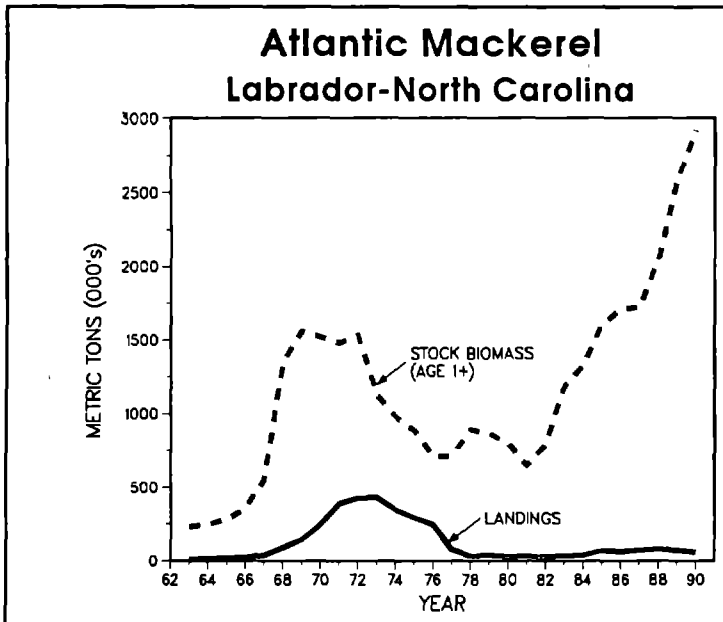


Table 22.1 Recreational catches and commercial landings (thousand metric tons)

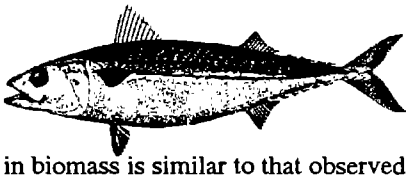
	Year									
Category	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Recreational										
USA	8.5	1.2	3.3	2.6	3.3	3.9	5.6	4.2	2.3	2.0
Commercial										
USA	2.9	3.3	3.8	6.0	6.6	9.6	12.3	12.3	14.6	31.3
Canada	19.4	16.4	19.8	18.2	30.1	31.1	22.2	23.3	18.7	18.2
Other	5.4	6.6	6.0	15.0	32.4	25.4	35.1	42.9	36.8	9.1
Total nominal catch	36.1	27.5	32.9	41.8	73.2	70.0	75.2	82.7	72.4	60.6

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	=	Underexploited
Age at 50% maturity	=	2 yrs
Size at 50% maturity	=	32.7 cm (12.9 in.) fork length
Assessment level	=	Age structured

M = 0.20 **$F_{0.1}$ = 0.27** **F_{max} = 0.96** **F_{1990} = 0.02**

[1] Assuming constant recruitment at level of geometric mean of 1961-1984 year classes and fishing mortality at $F_{0.1}$



in biomass is similar to that observed in the late 1960s, which supported the large catches in the 1970s.

Rebuilding of the mackerel stock has been aided by relatively low catches during 1980-1990 (average of 55,000 mt) as well as improved recruitment from the 1981-1982 and 1984 to 1988 year classes. Projections indicate that the catch in 1991 can be increased without adversely affecting the productivity of the spawning stock biomass. Given the large biomass, and the recent decreases in the growth rate of individual fish, the population can sustain substantially more fishing, and is under exploited.

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. 1991. Report of the Twelfth Northeast Regional Stock Assessment Workshop. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 90-03.

23. Butterfish

Photo by Brenda Figueredo, NMFS

Atlantic butterfish (*Peprilus triacanthus*) are present in commercially significant amounts between Cape Hatteras and Southern New England. The butterfish population is assumed to constitute a unit stock in waters north of Cape Hatteras where the stock migrates inshore and northward during the summer and returns to offshore waters in the winter due to temperature preferences. Spawning takes place chiefly during the summer months and peaks in July. Juvenile butterfish begin recruiting to the spawning stock at the end of their first year, but, although the maximum recorded age for this species is 6 years, few fish are observed beyond age 3.

Butterfish have been landed by domestic fishermen since the 1800s, and, from 1920 to 1962, the annual domestic harvest averaged 3,500 mt. Foreign catches began in the 1960s and the average annual landings increased to more than 11,000 mt in the late 1960's and early 1970s (Murawski and Waring 1979). Overall, landings have dropped to an average of 3,000 mt per year since foreign allocations have been curtailed. In 1990, domestic butterfish landings totaled 2,395 mt. This represents a decrease of 25% from the 3,200 mt landed in 1989.

Butterfish are managed by the Mid-Atlantic Fishery Management Council under provisions of the Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan. For 1990, the maximum optimum yield and the allowable biological catch for butterfish were 16,000 mt while the domestic allowable harvest was 10,000 mt (MAFMC 1989). Similar regulations are in effect for 1991 (MAFMC 1990).

The catch per tow index (total weight for all ages) from the NEFC 1990 autumn bottom trawl survey (8.9 kg/tow) decreased by 27% from 1989. In addition, the 1990 age 1+ index (38 age one and older fish/tow) decreased by 42% from 1989. Above average pre-recruit indices over the past three years, however, suggest that butterfish reproduction remains strong in

'Above average pre-recruit indices over the past three years, however, suggest that butterfish reproduction remains strong in the Northwest Atlantic."

the Northwest Atlantic. In addition, relatively large butterfish catches were observed in the 1991 NEFC Spring bottom trawl survey in comparison to 1990 and 1989 surveys suggesting that levels of abundance may be even higher in 1991.

Overall, it appears that the butterfish population is at a relatively high level of abundance in comparison to the period of heavy exploitation in the 1970s. Stock abundance is probably sufficient to support catches at the OY level (16,000 mt), and presently, butterfish are an underexploited resource in the Northwest Atlantic.

For further information

Mid-Atlantic Fishery Management Council. 1989. 1990 Allowable biological catch, optimum yield, domestic annual harvest, domestic annual processing, joint venture processing, and total allowable level of foreign fishing recommendations for *Loligo*, *Illex*, and Butterfish. MAFMC. Dover, DE.

Mid-Atlantic Fishery Management Council. 1990. 1991 Allowable biological catch, optimum yield, domestic annual harvest, domestic annual processing, joint venture processing, and total allowable level of foreign fishing recommendations for Atlantic Mackerel, *Loligo*, *Illex*, and Butterfish. MAFMC. Dover, DE.

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

NEFC. 1990. Report of the Spring 1990 NEFC Stock Assessment Workshop (10th SAW). NEFC Reference Document 90-07.

Butterfish
Gulf of Maine to Middle Atlantic Bight

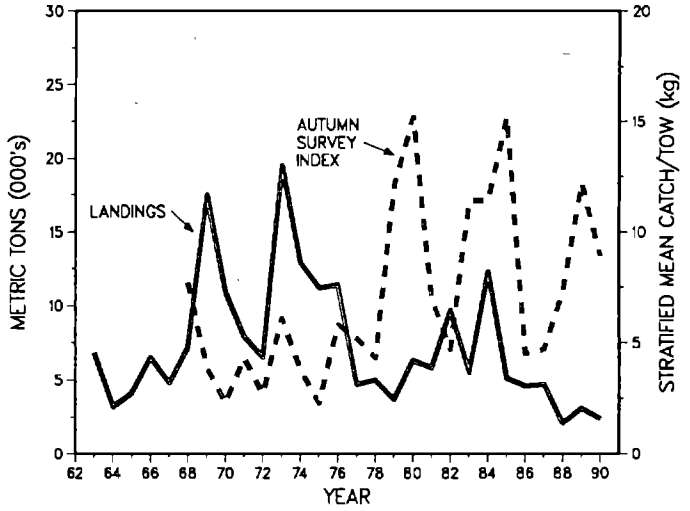
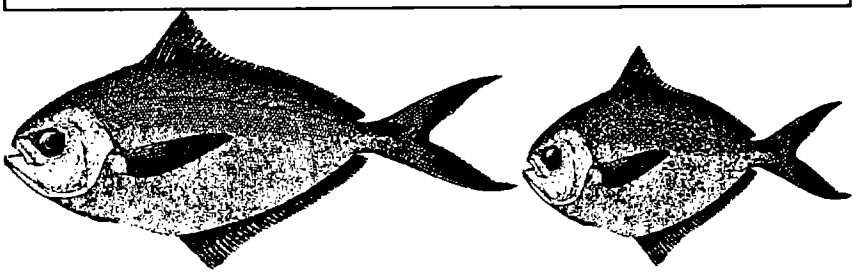


Table 23.1 Recreational and commercial catches (thousand metric tons)

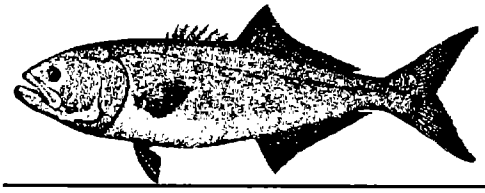
Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	4.9	9.1	4.9	12.0	4.7	4.4	4.5	2.1	3.2	2.4
Canada	-	-	-	-	-	-	-	-	-	-
Other	0.9	0.6	0.6	0.4	0.8	0.2	0.0	0.0	<0.1	<0.1
Total nominal catch	5.8	9.7	5.5	12.4	5.5	4.6	4.5	2.1	3.2	2.4
Total allowable catch	11.0	11.0	11.0	11.0	<16.0	<16.0	<16.0	10.0	10.0	10.0



Gulf of Maine - Middle Atlantic Butterfish

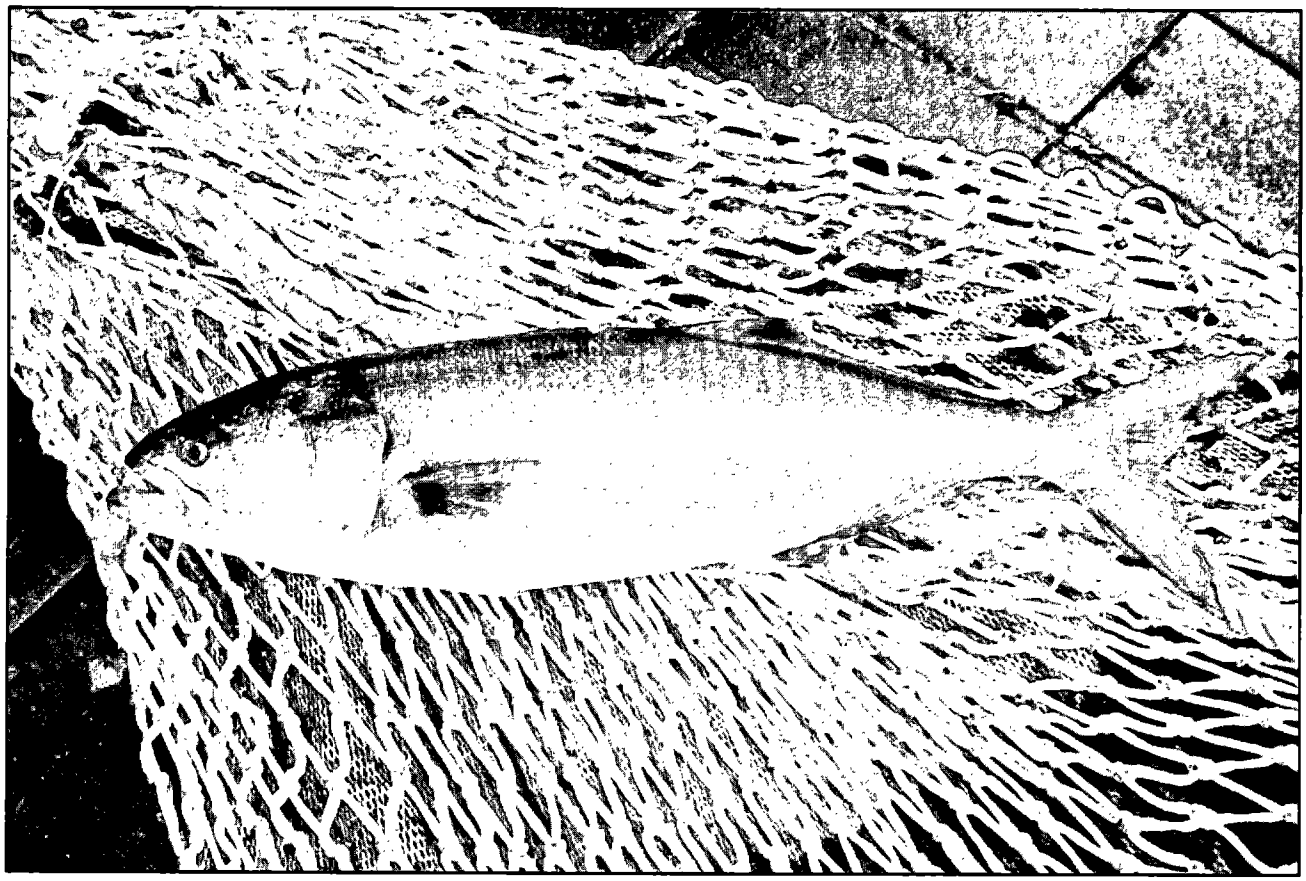
Long-term potential catch	=	16,000 mt
Importance of recreational fishery	=	Insignificant
Management	=	Squid, Mackerel, and Butterfish FMP
Status of exploitation	=	Underexploited
Age at 50% maturity	=	0.9 yrs
Size at 50% maturity	=	12.0 cm. fork length
Assessment level	=	Yield per recruit

M = 0.80 **$F_{0.1}$ = 1.60** **F_{max} > 2.50** **F_{1990} = Unknown**



24. Bluefish

Photo by Brenda Figueredo, NMFS



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. A unit stock of bluefish along the Atlantic coast is assumed for management purposes. 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.) and 14 kg (31 lb).

The principal commercial fishing gear used to catch bluefish is the otter trawl. Recreational fishing is very important with catches far exceeding commercial catches. Most of the recreational catch of bluefish is taken in the Middle Atlantic states (NY to VA) by boat-based fishermen. A fishery management plan for bluefish developed by the Mid-Atlantic Fishery Management Council (MAFMC) and the Atlantic States Marine Fisheries Commission (ASMFC) was approved by the Secretary of Commerce in early 1990. The principal management measures enacted include:

1) implementation of a commercial fishing permit in order to sell bluefish,
2) imposition of a commercial catch quota if commercial landings are projected to exceed 20% of the total catch, and
3) restriction of recreational fishermen to a possession limit of no more than ten bluefish.

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. Total landings declined 14% from 1989 to 1990 (28,600 mt to 24,500 mt), due to lower recreational catches. Commercial catch peaked in 1983 at 7,600 mt. Commercial catch increased 34% in 1990, from 4,700 mt to 6,300 mt. The commercial landings accounted for about 26% of the total catch in 1990.

The recreational component of the fishery, which has historically constituted 80 to 90% of the total catch, decreased from a peak of nearly 70,000 mt in 1980 to 18,200 mt in 1990. The 1990 recreational catch level was a decline of 24% from the previous year (23,900 mt). The recreational catch was about 74% of the total catch in

1990. An index of recreational fishing effort for bluefish trended upward from 1981 (21.4 million bluefish trips) to a peak in 1988 at an estimated 37.2 million bluefish trips, but has since declined to about 29 million trips in 1990. Coastwide, recreational catch per bluefish trip by weight and numbers peaked in 1981 at 2.72 kg/trip (1.49 fish/trip), and has since trended downward, declining to 0.63 kg/trip (0.52 fish/trip) in 1990.

Current stock assessment information is insufficient to allow a quantitative determination of the status of exploitation for bluefish. Indices of juvenile bluefish abundance suggest that a moderately strong year class recruited to the stock in 1989. However, continuing downward trends in recreational catches and the index of abundance based on recreational catch and effort data suggest that bluefish abundance has decreased substantially during the past decade, and that the stock is fully exploited.

Bluefish
Atlantic Coast

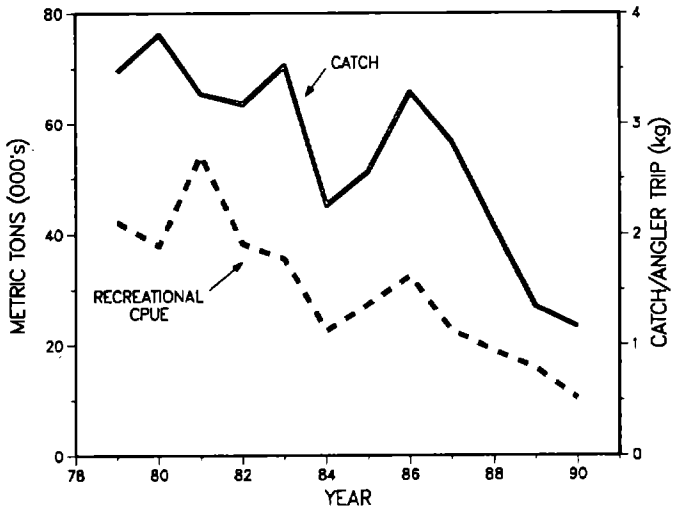


Table 24.1 Recreational catches and commercial landings (thousand metric tons)

	Year									
Category	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
USA recreational	58.2	56.6	62.8	39.3	45.0	59.4	49.7	35.3	23.9	18.2[1]
Commercial										
USA	7.2	6.9	7.6	5.8	6.2	6.3	6.9	6.2	4.7	6.3
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	65.4	63.5	70.4	45.1	51.2	65.7	56.6	41.5	28.6	24.5[1]

[1] **Preliminary estimate**

Atlantic Coast Bluefish

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Major
Management	=	Bluefish FMP
Status of exploitation	=	Fully exploited
Age at 50% maturity	=	1 year
Size at 50% maturity	=	35 cm (13.8 in.)
Assessment level	=	Index

M = 0.35 **$F_{0.1}$ = 0.18** **F_{max} = 0.27** **F_{1990} = Unknown**

For further information

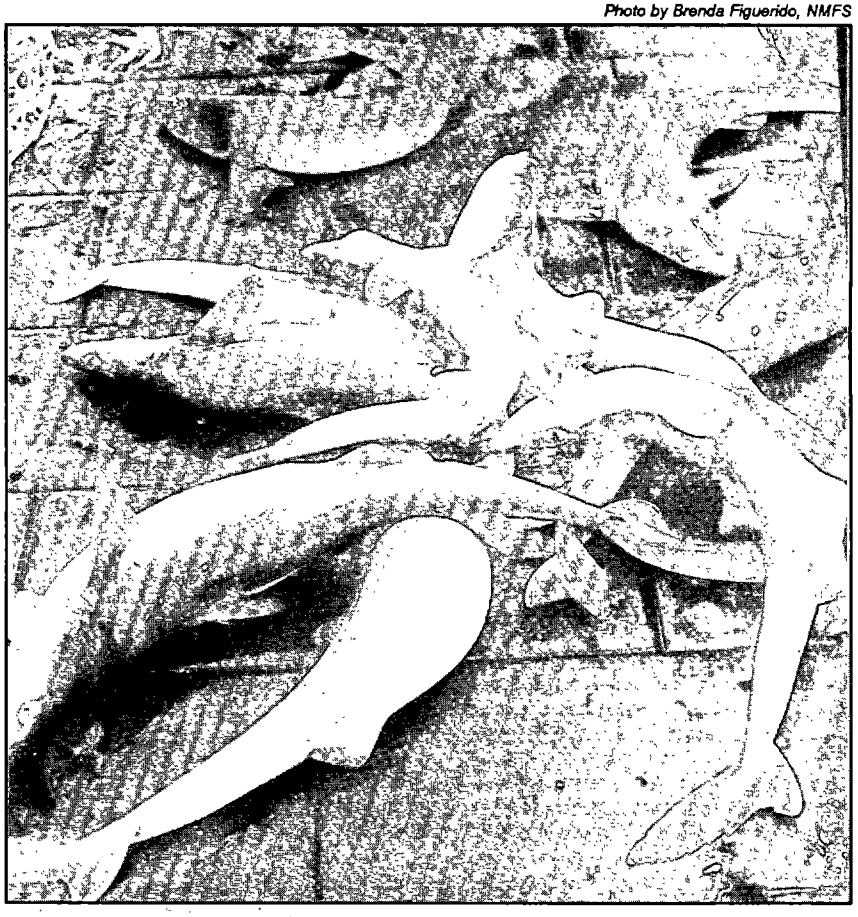
Northeast Fisheries Center. 1988. Report of the Fifth NEFC Stock Assessment Workshop (Fifth SAW). Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 87-12. 66 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

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. 78 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

Northeast Fisheries Center. 1990. Report of the Eleventh NEFC Stock Assessment Workshop Fall 1990. Woods Hole, MA: NMFS, NEFC. Northeast Fisheries Center Reference Document 90-09. 121 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

25. Spiny Dogfish

Photo by Brenda Figueirido, NMFS



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, sand lance, and other species. 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 with an average of 6.

The principal commercial fishing gears used for catching dogfish are otter trawls and sink gillnets. Dogfish are frequently caught as bycatch during groundfish operations and discarded. Recreational fishing and foreign fishing are insignificant. At present, there is no fishery management plan, but one will be implemented within two years. Landings increased 218% in 1990 (4400 mt to 14,300).

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. Landings in 1990 increased dramatically as expected and landings in 1991 are expected to remain at high levels due to the strong demand in the European market, attributable to declines in European dogfish stocks.

Minimum biomass estimates of spiny dogfish based on NEFC spring bottom trawl survey catches decreased 40% from a record high 1,074,000 mt in 1990 to 642,000 mt in 1991, still 121% above the 1968-89 geometric average of 291,000 mt. Minimum biomass estimates during the decade (1980-1989) have generally been higher than values observed between 1968-1979, The 1991 estimate is still 35% above the 1980-89 geometric average. Declines in the 1991 survey index are not indicative of abundance changes 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 US fishery for dogfish is similar in nature to the European fisheries in being selective for large individuals [larger than 2.3 kg (5.1 lb), 83 cm (33 in.)], which are mainly mature females, to meet processing and marketing requirements. However, during certain times of the year, smaller individuals, consisting of both mature and immature males as well as immature females, are taken as bycatch and discarded. Additionally, since this species bears live young, a directed fishery on mature females may significantly impact spawning potential. The potential for rapid overexploitation of sharks has been observed in U.S. West Coast and 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, 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,

about 90,000 mt (20% of the 1980-1990 average) could be taken annually from the present population.

Assuming that the 1991 minimum biomass estimate is correct (0.6 million mt), then about 128,000 mt could be landed from the stock. 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 biological interactions of elasmobranch species with more highly valued gadoid and flounder stocks.

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, *Squalus acanthias*, off the northeastern United States. Williamsburg, VA. College of William and Mary. 63 p. Master's thesis.

Northeast Fisheries Center. 1990. Report of the Eleventh Stock Assessment Workshop. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document. Available from: Northeast Fisheries Center, Woods Hole, MA.

Slauson, T. P. 1982. Growth, maturation, and fecundity of the spiny dogfish, *Squalus acanthias*, in the northwestern Atlantic. Stony Brook, NY. State University of New York at Stony Brook, 97 p. Master's Thesis.

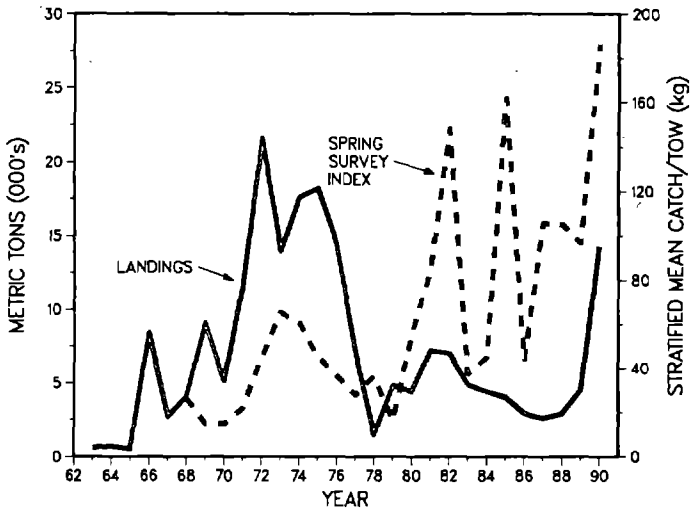


Table 25.1 Recreational catches and commercial landings (thousand metric tons)

	Year									
Category	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	6.9	6.6	4.9	4.4	4.0	2.6	2.6	2.9	4.4	14.3
Canada	-	-	-	-	-	-	-	-	-	-
Other	0.3	0.4	-	-	-	0.1	-	<0.1	<0.1	-
Total nominal catch	7.2	7.0	4.9	4.4	4.0	2.7	2.6	2.9	4.4	14.3

"...about 90,000 mt (20% of the 1980-1990 average) could be taken annually from the present population."

Gulf of Maine-Middle Atlantic Spiny Dogfish

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

M = 0.05 **$F_{0.1}$ = 0.10** **F_{max} = 0.39** **F_{1990} < F0.1**

26. Skates

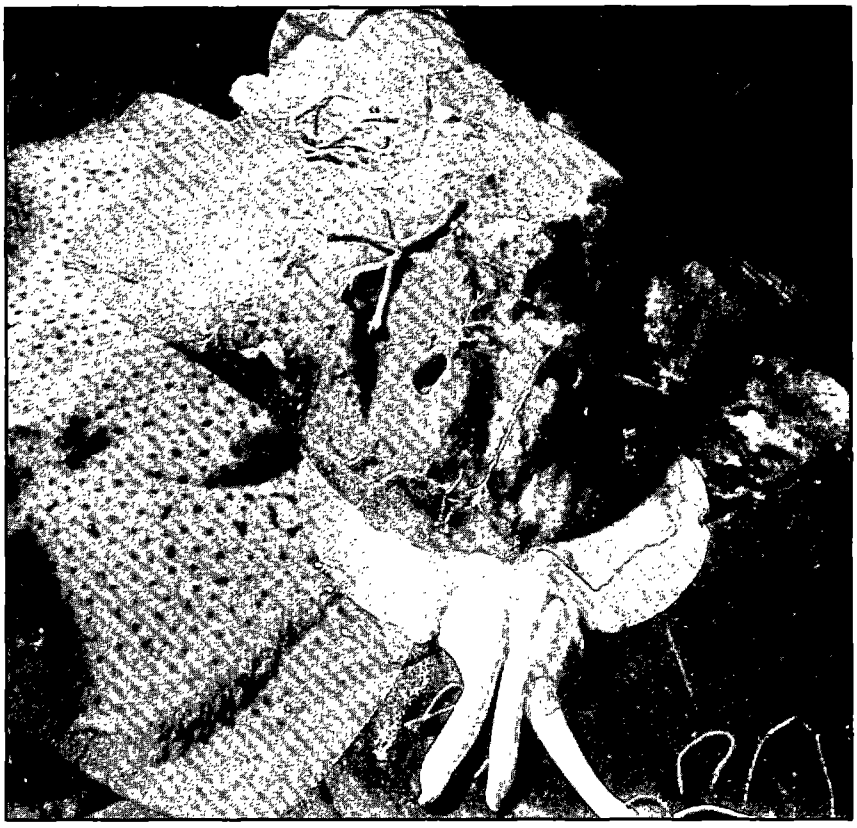


Photo by Brenda Figueredo, NMFS

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 'mermaids 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 summer and early autumn and vice-versa during the winter-spring period.

The principal commercial fishing method used to catch skates is otter trawling. Skates are frequently caught as bycatch during groundfishing operations and discarded. Recreational landings are insignificant. There are currently no regulations governing the harvesting of skates in U.S. waters.

Landings of skates (all species combined) off the northeast USA were 11,300 mt in 1990, representing a 71% increase over the 1989 total of 6,600 mt. Skates have been reported in New England fishery landings since such data have been recorded (the late 1800s). However, landings (primarily from off Rhode Island), never exceeded several hundred mt until the advent of distant water fleet fishing during the 1960s. Skate landings peaked in 1969 at 9,500 mt, and declined quickly during the 1970s. In 1981 reported skate landings bottomed out at 538 mt, and have since increased steadily. The increase in domestic landings are partially in response to the increased demand for lobster bait, and, more significantly, to the increased export market for skate wings. The species which comprise the wing landings are winter and thorny skates, which are the two species usable for human consumption. Bait landings are primarily little skate, based on the areas fished and the known species distribution patterns.

Survey abundance indices for skates (again all species combined) are expressed as the minimum population estimate from area-swept calculations. Minimum biomass declined substantially during the late 1960s and 1970s, in response to significant exploitation by the distant-water fleets. From 1979 through 1988 minimum biomass estimates for skates increased significantly, but have begun to decline again, from 167,400 mt in 1988 to 125,200 mt in 1990. The 1990 spring survey biomass estimate was 4 percent less than the long-term (1968-1989) average of 130,700 mt.

Recent increases in skate landings and the potential for rapidly expanding export markets bring into question the level at which sustainable fisheries for these species can be maintained. Given their limited net population fecundity, harvest rates that result in the average embryo production per female falling below two (replacement levels for both parents) will destabilize the populations. In other areas of the world where skates are more fully utilized, their numbers have been reduced to extremely low levels (*e.g.*, Irish Sea). Similarly, although the aggregate population abundance

Skates
Gulf of Maine-Middle Atlantic

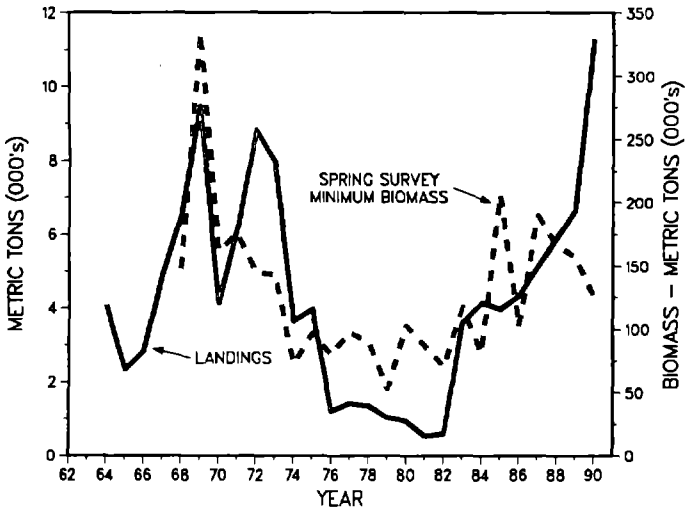


Table 26.1 Recreational catches and commercial landings (thousand metric tons)

	Year									
Category	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	0.5	0.6	3.6	4.1	4.0	4.2	5.1	5.9	6.6	11.3
Canada	-	-	-	-	<0.1	-	<0.1	<0.1	-	-
Other	<0.1	-	-	-	-	0.1	-	-	-	
Total nominal catch	0.5	0.6	3.6	4.1	4.0	4.3	5.1	5.9	6.6	11.3

Gulf of Maine-Middle Atlantic Skates

Long-term potential catch	=	25,000 mt
Importance of recreational catch	=	Insignificant
Management	=	None
Status of exploitation	=	Underexploited
Age at 50% maturity	=	4 yrs[1]
Size at 50% maturity	=	40 cm (15.8 in.)[1]
Assessment level	=	Index

M = 0.401 **$F_{0.1}$ = 0.491** **F_{max} = 1.001** **F_{1990}=Unknown**

[1] Pertains to little skate

"The increase in domestic landings is partially in response to the increased demand for lobster bait, and, more significantly, to the increased export market for skate wings."

indices may be increasing, particularly vulnerable species (*e.g.*, barndoor skate) may show signs of population overharvesting.

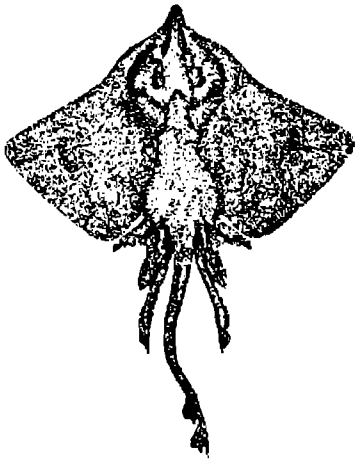
For further information

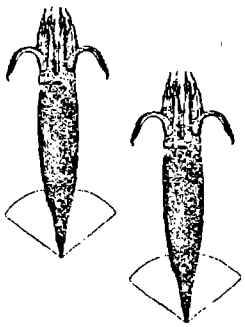
Bigelow, H.B., and W.C. Schroeder. 1953. Fishes of the Gulf of Maine. *Fishery Bulletin* 74:577 pp.

Holden, M.J. 1973. Are long-term sustainable fisheries for elasmobranchs possible? *Rapports et Proces-Verbaux Reunion Counceil International pour L'Exploration de la Mer* 164:360-367.

Northeast Fisheries Center. 1990. Report of the Eleventh Stock Assessment Workshop. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document. Available from: Northeast Fisheries Center, Woods Hole, MA.

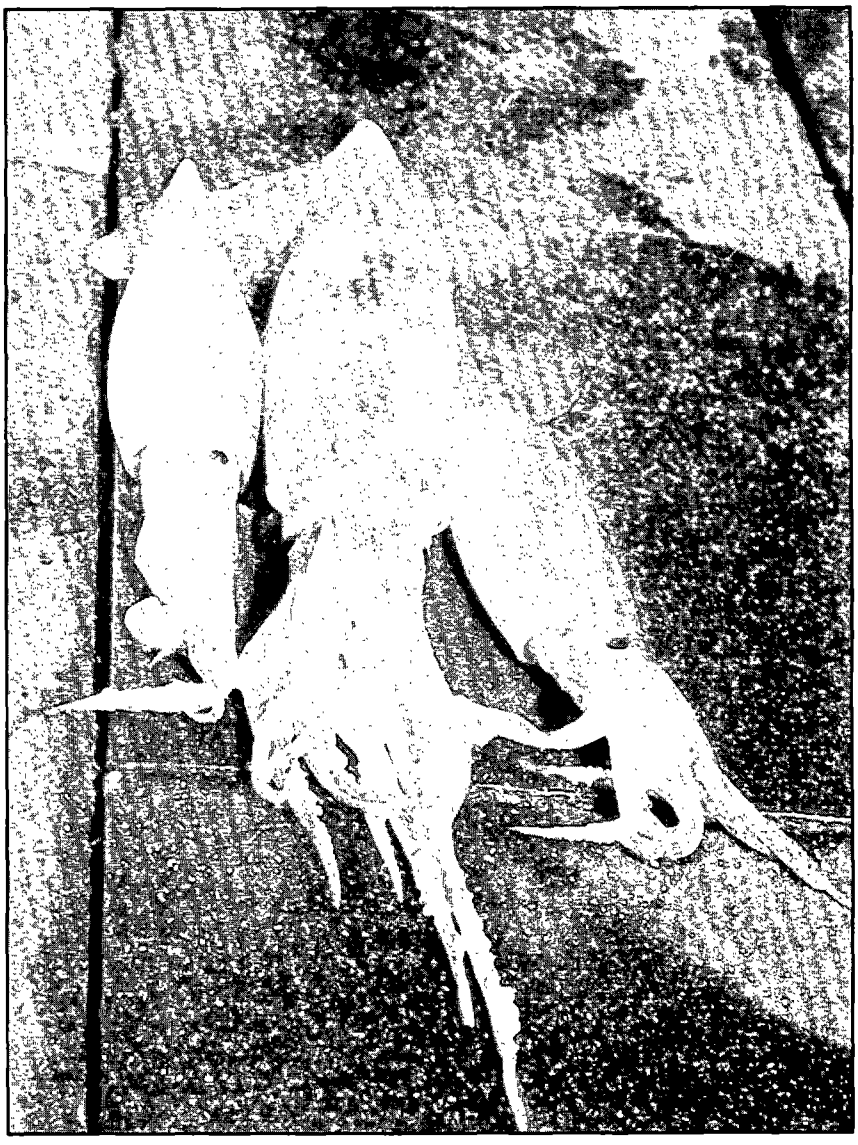
Waring, G.T. 1984. Age, growth and mortality of the little skate off the northeast coast of the United States. *Transactions of the American Fisheries Society* 113:314-321.





27. Short-finned Squid

Photo by Brenda Figueirido, NMFS



The short-finned squid (*Illex illecebrosus*) population is assumed to constitute a unit stock throughout its range of commercial exploitation from Cape Hatteras to Newfoundland. *Illex* grow to lengths of up to 35 cm (dorsal-mantle length) and live for up to 24 months. Domestic landings in the Northwest Atlantic are composed mainly of individuals between 10 and 28 cm. *Illex* migrate offshore in late autumn and return to nearshore waters in the summer to feed. *Illex* appear to have a crossover life cycle, where squid hatched in the winter spawn in the summer of the following year, and squid hatched in the summer spawn in the winter of the following year (Mesnil 1977).

Domestic landings of *Illex* began in the 1800s, and from 1928 to 1967, annual squid landings from Maine to North Carolina (including *Loligo pealei*) averaged roughly 2,000 mt. Directed foreign fishing for *Illex* began in 1972, and from 1972 to 1982 total *Illex* landings averaged 19,300 mt. From 1983 to 1990, foreign allocations have been curtailed and *Illex* landings have averaged 8,000 mt.

Domestic landings were a record 11,700 mt in 1990. This is an increase of 72% over 1989 landings and is more than 50% above the average level of domestic landings from 1982-1990. In comparison to 1989, directed effort increased in 1990, while directed catch per unit effort indices decreased. The increase in fishing effort for *Illex* is likely the result of enhanced export opportunities for U.S. *Illex* in the world squid market (MAFMC 1990).

Illex are managed by the Mid-Atlantic Fishery Management Council under provisions of the Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan. For 1990, the maximum optimum yield and the allowable biological catch for *Illex* were 30,000 and 22,500 mt, respectively. The domestic allowable harvest was 15,000 mt (MAFMC 1989). For 1991, the domestic allowable harvest was increased to 18,000 mt. (MAFMC 1990).

Indices of relative abundance for *Illex* are the stratified mean number per tow of all sizes and pre-recruits (≤ 10 cm dorsal-mantle length) obtained in the NEFC autumn bottom trawl survey. The 1990 all sizes index was 74% above the 1967-1990 mean, while the prerecruit index was equal to the 1967-1990 mean. In comparison to 1989, the 1990 all sizes increased by 10%, while the prerecruit index dropped by 37%. Over the 24-year

span of fall survey data, the *Illex* all sizes index has remained at either relatively high (1975 to 1981 and 1987 to present) or relatively low (1967 to 1974 and 1982 to 1986) levels. The all sizes index is positively correlated with catch per unit effort indices and provides a rough measure of population abundance and subsequent availability to domestic commercial effort.

It is likely that *Illex* abundance will remain high in 1991 given that the 1990 all sizes and prerecruit indices are at above average and average levels, respectively, and that the all sizes abundance index appears to remain at either high or low levels for several consecutive years. Domestic *Illex* landings in 1990 were less than those of the foreign distant-water fleets during 1972-1982, when *Illex* abundance shifted from low to high levels and then returned to low levels. Overall, the *Illex* resource is presently underexploited relative to its historic and long-term potential yields.

For further information

Mesnil, B. 1977. Growth and life cycle of squid, *Loligo pealei* and *Illex illecebrosus*, from the Northwest Atlantic. NAFO Research Document 76/VI/65.

Mid-Atlantic Fishery Management Council. 1989. 1990 Allowable biological catch, optimum yield, domestic annual harvest, domestic annual processing, joint venture processing, and total allowable level of foreign fishing recommendations for *Loligo*, *Illex*, and Butterfish. MAFMC. Dover, DE.

Mid-Atlantic Fishery Management Council. 1990. 1991 Allowable biological catch, optimum yield, domestic annual harvest, domestic annual processing, joint venture processing, and total allowable level of foreign fishing recommendations for Atlantic Mackerel, *Loligo*, *Illex*, and Butterfish. MAFMC. Dover, DE.

NEFC. 1990. Report of the Spring 1990 NEFC Stock Assessment Workshop (10th SAW). NEFC Reference Document 90-07. Woods Hole, MA.

Short-finned Squid
Gulf of Maine-Middle Atlantic

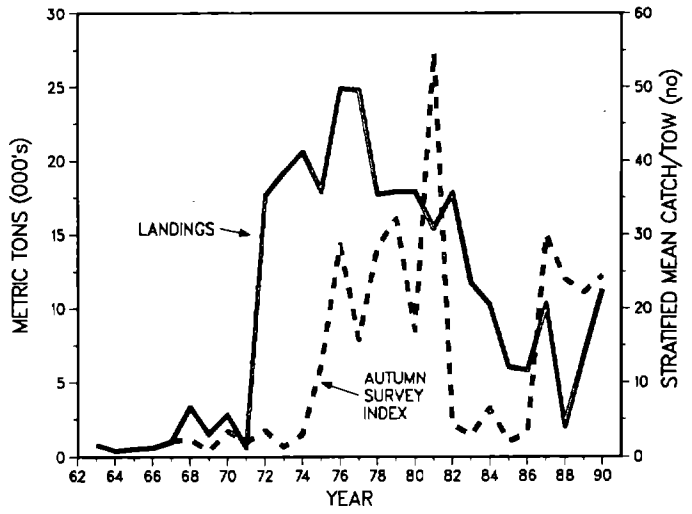
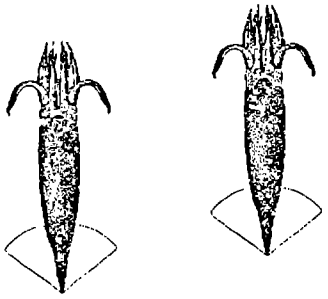


Table 27.1 Recreational and commercial catches (thousand metric tons)

	Year									
Category	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	0.6	5.9	9.9	9.5	5.0	5.2	10.3	2.0	6.8	11.7
Canada	-	-	-	-	-	-	-	-	-	-
Other	14.7	12.4	1.8	0.7	1.1	0.2	-	<0.1	-	-
Total catch	15.3	18.3	11.7	10.2	6.1	5.4	10.3	2.0	6.8	11.7
Total allowable catch	30.0	30.0	30.0	30.0	30.0	25.0	22.5	22.5	17.0	15.0

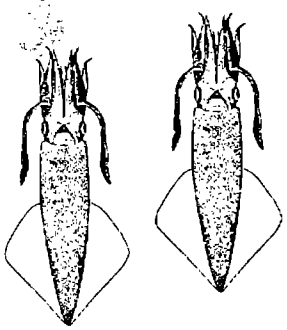
"It is likely that *Illex* abundance will remain high in 1991 given that the 1990 all sizes and prerecruit indices are at above average and average levels, respectively..."



Gulf of Maine-Middle-Atlantic Short-Finned Squid

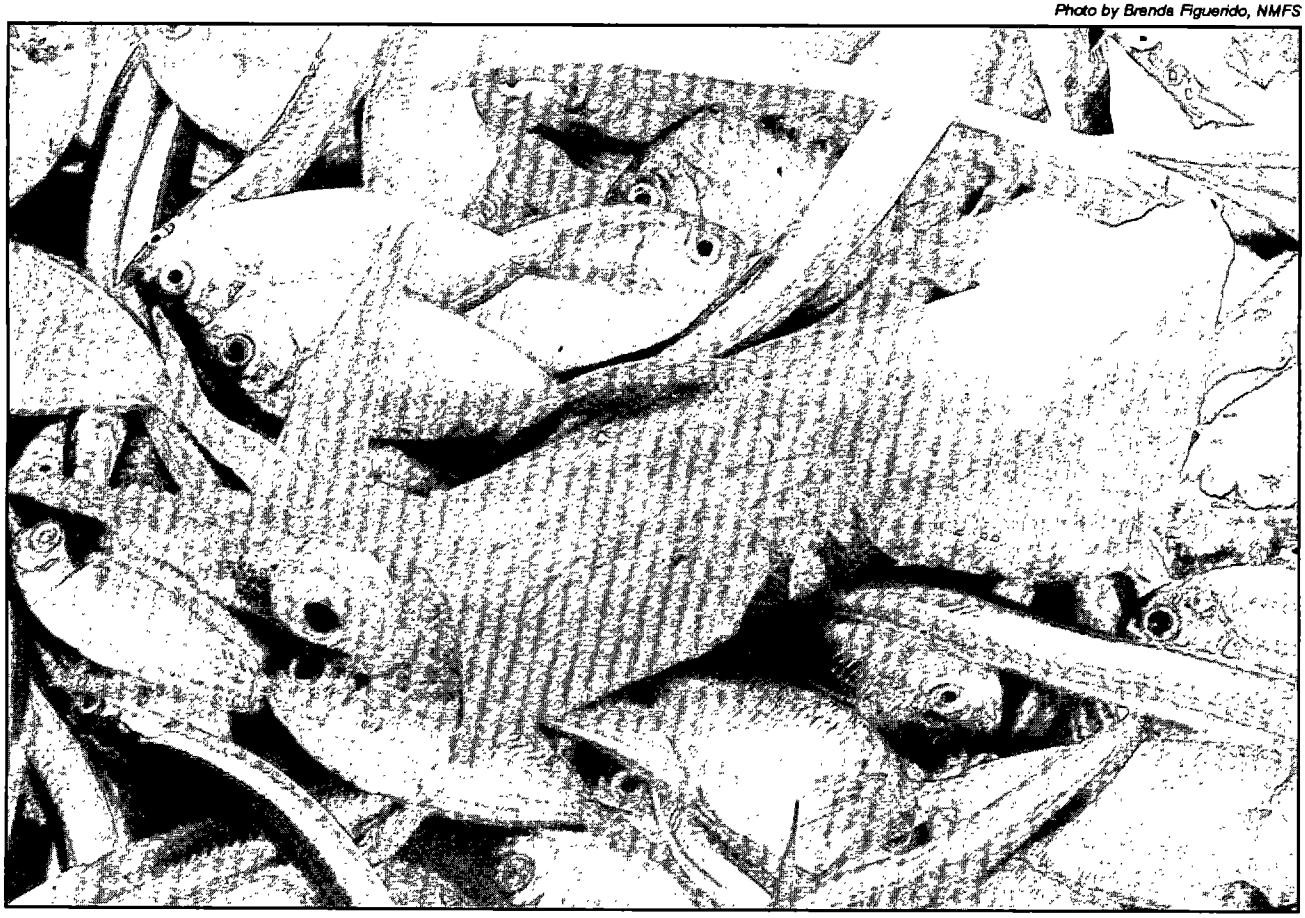
Long-term potential catch	=	30,000 mt
Importance of recreational fishery	=	Insignificant
Management	=	Squid, Mackerel and Butterfish FMP
Status of exploitation	=	Underexploited
Age at 50% maturity	=	1.5 yrs
Size at 50% maturity	=	20 cm dorsal-mantle length
Assessment level	=	Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1990} = Unknown



28. Long-finned Squid

Photo by Brenda Figueridо, NMFS



The long-finned squid *Loligo pealei* is assumed to constitute a unit stock throughout its range of commercial exploitation from Nova Scotia to Cape Hatteras. *Loligo* can attain lengths of more than 40 cm (dorsal-mantle length) and ages of up to 3 years, although most individuals captured in commercial fisheries are between 9 and 30 cm long. North of Cape Hatteras, Loligo migrate offshore during late autumn to overwinter in deeper waters and migrate inshore during the spring and summer. *Loligo* exhibit a crossover life cycle involving a return of spring-spawned hatchlings to spawn in the summer of the following year and a return of hatchlings spawned in late-summer to spawn in the spring two years later (Mesnil 1977).

The domestic fishery for *Loligo* in the Northwest Atlantic began in the late 1800s, and from 1928 to 1967, annual squid landings from Maine to North Carolina (including *Illex illecebrosus* landings) averaged roughly 2,000 mt. A directed foreign fishery for *Loligo* developed in 1967, and total annual landings averaged 19,900 mt from 1967 to 1986. Since 1986, foreign allocations have been curtailed, and domestic landings have averaged 17,300 mt.

Domestic landings in 1990 totaled 15,469 mt. This is a decrease of 33% from the record level of domestic landings in 1989. Catch per unit effort indices also decreased in 1990.

Loligo are managed by the Mid-Atlantic Fishery Management Council under provisions of the Atlantic Mackerel, Squid, and Butterfish Fishery Management Plan. For 1990, the maximum optimum yield and the allowable biological catch for *Loligo* were 44,000 and 37,000 mt, respectively. The domestic allowable harvest was 26,000 mt (MAFMC 1989). For 1991, the domestic allowable harvest has been increased to 31,000 mt (MAFMC 1990).

Indices of relative abundance for *Loligo* are the stratified mean number

per tow of all sizes, prerecruits (<9 cm), and recruits (>8cm) obtained in the NEFC autumn bottom trawl survey. The 1990 all sizes, prerecruit, and recruit indices were 24%, 55%, and 16% above the 1967-1990 means, respectively. However, in comparison to 1989, the 1990 all sizes and recruit indices dropped by 11% and 35%, respectively, while the 1990 prerecruit index was unchanged.

Above average values of the autumn survey indices indicate that the *Loligo* population is at relatively high levels of abundance in comparison to the period of heaviest exploitation in the 1970s. However, high population abundance does not necessarily imply that commercial availability of *Loligo* will be correspondingly high. Annual fluctuations in temperature distribution and other oceanographic variables can decrease *Loligo* availability to commercial fishing by increasing the spatial dispersion of the population and by altering the spatio-temporal pattern of the annual inshore/offshore migration. Preliminary landings figures for *Loligo* in the first quarter of 1991 are below those in 1990, and several predictive analyses suggest that commercial availability will decline in 1991. In summary, even though the stock is underexploited relative to its long-term potential catch, it is likely that 1991 *Loligo* landings will be at or below levels seen in recent years.

For further information

Gulf of Maine-Middle 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	=	Underexploited
Age at 50% maturity	=	1 yr
Size at 50% maturity	=	16 cm dorsal-mantle length
Assessment level	=	Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1990} =Unknown

Long-finned Squid
Gulf of Maine-Middle Atlantic

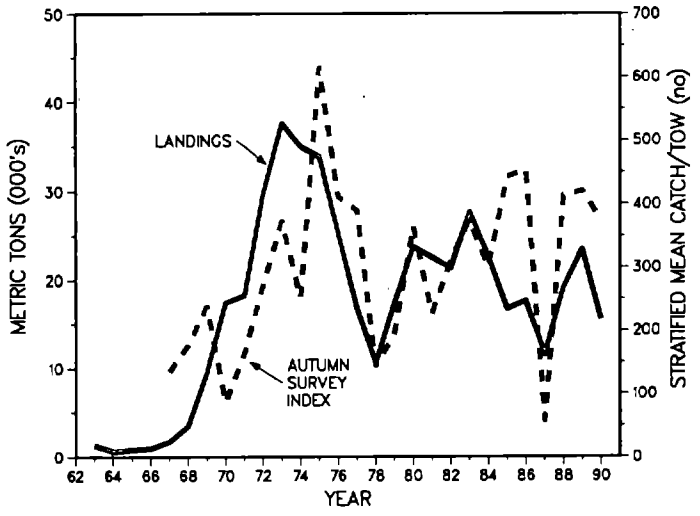


Table 28.1 Recreational and commercial catches (thousand metric tons)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	2.3	5.5	15.9	11.6	10.2	13.3	11.5	19.1	23.0	15.5
Canada	-	-	-	-	-	-	-	-	-	-
Other	20.2	15.8	11.7	11.0	6.5	4.6	<0.1	<0.1	<0.1	0.0
Total catch	22.5	21.3	27.6	22.6	16.7	17.9	11.5	19.1	23.0	15.5
Allowable biological catch	44.0	44.0	44.0	44.0	33.0	37.0	37.0	37.0	37.0	37.0

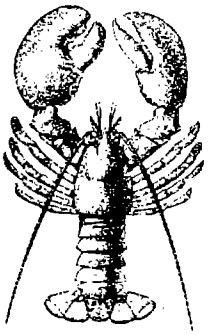
Mesnil, B. 1977. Growth and life cycle of squid, *Loligo pealei* and *Illex illecebrosus*, from the Northwest Atlantic. NAFO Research Document 76/VI/65.

Mid-Atlantic Fishery Management Council. 1989. 1990 Allowable biological catch, optimum yield, domestic annual harvest, domestic annual processing, joint venture processing, and total allowable level of foreign fishing recommendations for *Loligo*, *Illex*, and Butterfish. MAFMC. Dover, DE.

Mid-Atlantic Fishery Management Council. 1990. 1991 Allowable biological catch, optimum yield, domestic annual harvest, domestic annual processing, joint venture processing, and total allowable level of foreign fishing recommendations for Atlantic Mackerel, *Loligo*, *Illex*, and Butterfish. MAFMC.

NEFC. 1990. Report of the Spring 1990 NEFC Stock Assessment Workshop (10th SAW). NEFC Reference Document 90-07. Woods Hole, MA.

NEFC. 1990. Report of the Fall 1990 NEFC Stock Assessment Workshop (11th SAW). NEFC Reference Document 90-09. Woods Hole, MA.



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 in the vicinity of 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 been demonstrated as well.

Lobsters exhibit a complex life cycle in which mating occurs following molting of the female 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 esti-

NMFS/NEFC archive photo

mates 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 carapace length. Total landings increased 15% in 1990 (from 24,000 mt to 27,600 mt).

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 1990 the catch has risen steadily from 12,900 mt to a record 22,600 mt in 1990, an increase of about 75%. The landings for 1990 were some 9% higher than the previous year, which was a record year as well. This increase can be attributed in part to an increase in abundance of lobsters, but also in large part to a continuing trend in increase in 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.

The mean size of lobsters landed is still within one or two molts of the minimum size, representative of a continuing dependency on newly recruited animals (i.e., those lobsters that have just grown into legal size).

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 1950s to an average of over 2,000 mt in the 1960s. In 1969 technological advances permitted the introduction of trap fishing to the deeper offshore areas. Landings from

American Lobster
Gulf of Maine-Middle Atlantic

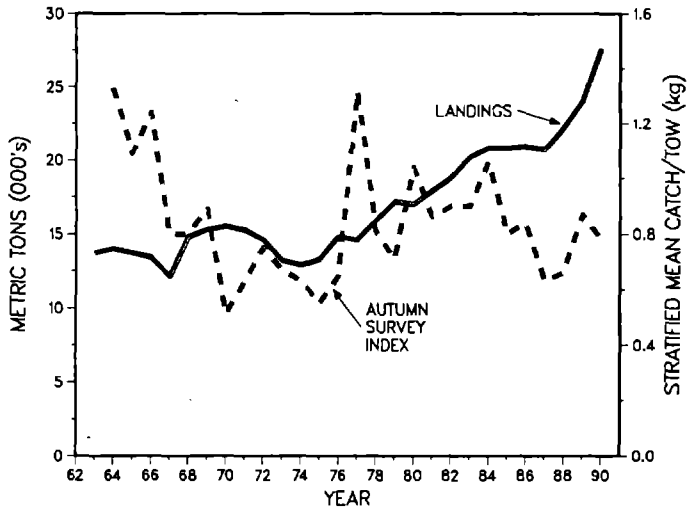


Table 29.1 Commercial and recreational landings (thousand metric tons), live weight). Landings statistics have been revised to reflect unreported catches.

	Year									
Category	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Recreational[1]										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA										
Offshore[2]	1.8	2.5	2.4	4.2	2.6	3.4	3.3	3.0	3.3	5.0*
Inshore[3]	15.9	16.1	17.6	16.4	18.0	17.8	17.3	19.2	20.7	22.6
Canada										
Georges Bank	0.2	0.2	0.2	0.2	0.2	<0.1	<0.1	<0.1	<0.1	0.1
Total nominal catch	17.9	18.8	20.2	20.8	20.8	20.9	20.7	22.2	24.0	27.7

[1] Recreational catches unknown
[2] Includes trawl and offshore trap catches
[3] Inshore trap catches
* These are provisional values awaiting final cavass runs

Gulf of Maine-Middle Atlantic American Lobster

Long-term potential catch	=	3,400 mt[1]
Importance of recreational fishery	=	Insignificant[1]
Management	=	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)** **$F_{1990} > F_{max}$**

[1]Offshore fishery only

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 1985 through 1989 trap landings averaged around 2,800 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 1970s and early 1980s to an average of around 3,000 mt, but have never comprised more than 20% of the total US landings. In 1990, the offshore landings rose to a little under 5,000 mt, the highest on record, representing an increase of about 50% over the previous year. The contribution of the offshore fishery to overall landings in 1990 was about 19% of the total.

The NEFC autumn survey biomass index declined steadily from 1.3 kg/tow in 1964 to 0.5 kg/tow in 1970. From 1971-1976 this index averaged 0.7 kg/tow, and increased to an average of 1.0 kg/tow from 1977-1980. In 1985, the autumn index dropped to 0.8 kg/tow and further to an average of about 0.65 kg/tow in 1987 and 1988. After a slight rise in 1989, the 1990 index was 0.78, about the average over the previous 20 year period. 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.

NMFS/NEFC archive photo

"...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."

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. It would be prudent to view lobsters from both areas as a whole resource, however the assessment information is insufficient to resolve such questions and the status of the stock is uncertain.

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.

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, but abundance has since increased considerably.

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. There is no recreational or foreign fishery. Management is by the participating states (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.

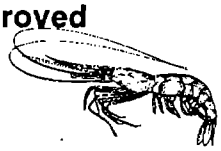
Photo by Brenda Figueridо, NMFS

Current management allows for fishing seasons of varying length within a "window" of 183 days (December 1-May 31) dependent upon resource conditions. Fishing has been allowed during the full 183 day time frame beginning with the 1986 fishing season (December 1985 through May 1986).

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 from 1,100 trips in 1980 to 12,300 trips during the 1987 fishing season; effort during the 1988-1990 fishing seasons was relatively constant about an average of 9,400 trips.

Nominal catches peaked at 12,800 mt in 1969, averaged approximately 11,000 mt during 1970-1972, 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 to an average of 3,300 mt for 1988 and 1989. Landings for 1990 totaled approximately 4,400 mt, reflecting recruitment of the strong 1987 year class. A further increase was expected for the 1991 fishing season (December 1990-May 1991) with full recruitment of this year class to the fishery at age 4, but preliminary landings data for 1991 suggest a total of about 3,500 mt. Reasons for this

"The NEFC autumn survey index has increased more or less continually since the late 1970s, again reflecting improved recruitment. "



Northern Shrimp
Gulf of Maine

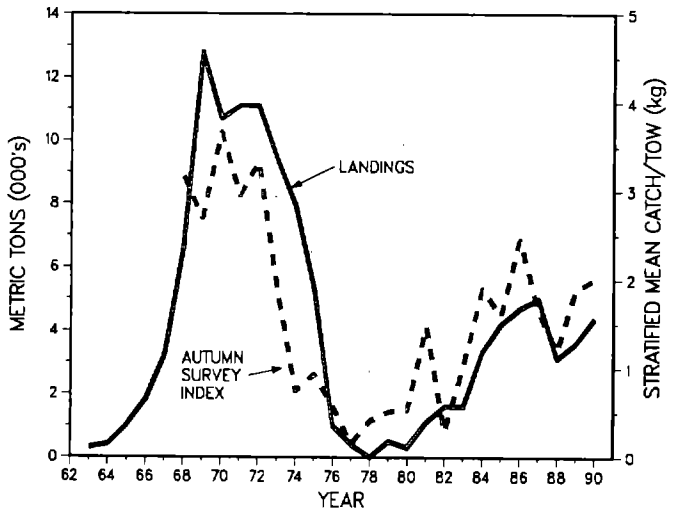


Table 30.1 Recreational catches and commercial landings (thousand metric tons)

Category	Year									
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	1.1	1.6	1.6	3.3	4.2	4.7	5.0	3.1	3.6	4.4
Canada	-	-	-	-	-	-	-	-	-	-
Other										
Total nominal catch	1.1	1.6	1.6	3.3	4.2	4.7	5.0	3.1	3.6	4.4

Gulf of Maine Northern Shrimp

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

M = 0.5 **$F_{0.1}$ = 0.5** **F_{max} = Undefined** **F_{1990} = 0.1**

decline are uncertain although changes in availability associated with above normal temperatures in early winter may be involved.

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 Center'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 1985-1986 and then declined in 1987, reflecting increased natural and fishing mortality on the 1982 year class. Catch per tow in numbers and weight have since increased sharply with recruitment of the 1987 year class; weight per tow indices for 1990 were among the highest in the time series. The NEFC autumn survey index has increased more or less continually since the late 1970s, again reflecting improved recruitment.

There is no evidence that this stock is being adversely affected by current harvest levels. Exploitation rates have been relatively low in recent years and well within limits shown to be sustainable for other pandalid shrimp stocks.

For further information

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

Northern Shrimp Technical Committee. 1990. Assessment report for Gulf of Maine northern shrimp 1990. Report to the Northern Shrimp Section of the Atlantic States Marine Fisheries Commission, October, 1990. 22p.

Northern Shrimp Technical Committee. 1990. Cruise results: Gulf of Maine northern shrimp survey, July 30-August 10, 1990. Unpublished report, Woods Hole, MA, 7p.

31. Surf Clams

Photo by Brenda Figueredo, NMFS

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 clam is the hydraulic clam dredge. Recreational and foreign fishing is insignificant. The EEZ fishery is managed under the Surf Clam-Ocean Quahog FMP of the Mid-Atlantic Fishery Management Council. The primary management measure is a total allowable catch (TAC) limit, as well as minimum size and area closures to limit the taking of small clams. Landings from EEZ and state waters increased 7% in 1990 (30,400 mt to 32,600 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, especially in EEZ waters.

Regulation of the fishery has proceeded with a principal objective being to rebuild depleted stocks. This was accomplished under Amendments #1-7 of the Surf Clam-Ocean Quahog FMP. Under Amendment #8, an ITQ (Individual Transferable Quota) system was established in 1990, whereby the annual landings quota was allocated disproportionally to the vessels participating in the fishery, based on a combination of performance history and vessel size. The intent of this system is to address economic inefficiencies that resulted from the intensive regulatory scheme used to rebuild the depleted stocks. Attendant with the adoption of the ITQ scheme, the restrictions on hours fished, days of the week, and moratorium on vessel construction have been dropped. In there place, trading of vessel allocations is intended to reduce vessel overcapitalization, and result in a more efficient use of harvest sector capital. In the first six months following the

New England-Middle 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 yrs
Size at 50% maturity	=	5 cm (2.0 in.) shell length
Assessment level	=	Index

$M = 0.5$ $F_{0.1} = 0.11$ $F_{max} = 0.46$ $F_{1990} = 0.1$

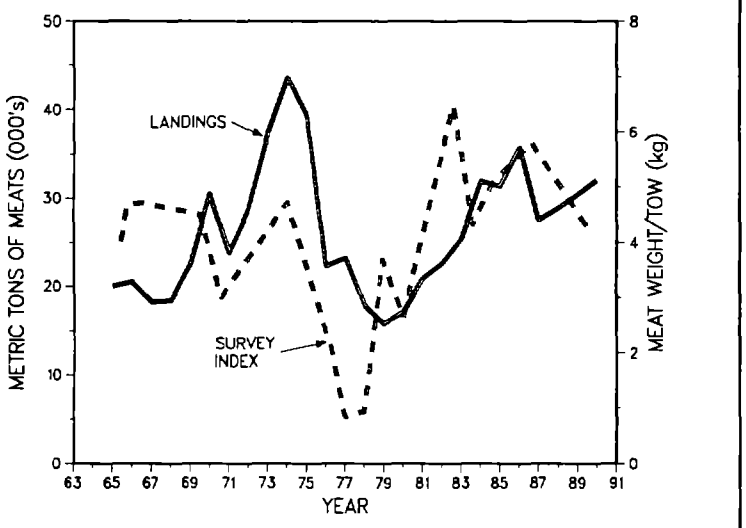


Table 31.1 Recreational catches and commercial landings (thousand metric tons, meats)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
EEZ	16.9	16.7	20.5	24.7	23.7	24.9	22.1	23.9	22.3	24.0
State waters	4.0	5.9	4.9	7.2	9.2	10.8	5.4	4.9	8.1	8.5
Canada	-	-	-	-	-	-	-	-	-	-
Total nominal catch	20.9	22.6	25.4	31.9	32.9	35.7	27.5	28.8	30.4	32.6
Total allowable EEZ catch	18.1	18.1	18.9	24.3	24.3	24.3	24.3	24.3	24.3	24.3

adoption of the ITQ system, the number of vessels participating in the fishery decreased by one third, as allocations were transferred among vessels. Two management areas (New England and Mid-Atlantic) were formerly identified in the FMP, but have been combined in Amendment #8 of the FMP. A single annual quota (24.3 thousand mt of meats in 1991) applies to all management areas. Currently, the Georges Bank region remains closed to the harvesting of surf clams, due to the presence of paralytic shellfish poisoning toxins.

Intensive fishing for surf clams was initiated during the post-World War II era in response to increasing demands and dwindling supplies of traditional clam species. Almost all of these early landings were derived off Long Island and northern New Jersey. Extensive offshore beds were discovered and developed off Pt. Pleasant, NJ during the 1950s; combined with inshore beds near Cape May-Wildwood, the New Jersey resources supported the fishery until the early 1970s. Declining productivity off New Jersey 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 1973-1975. 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 1989, most of the Middle-Atlantic landings were taken off New Jersey, with the remainder taken off the Delmarva Peninsula and south. Total EEZ landings in 1990 were 24,000 mt, representing an 8% increase from the previous year's total of 22,300 mt.

"Research vessel survey data collected through 1989 indicated adequate surf clam resource to support the Middle Atlantic EEZ fishery at or near the current levels (18 to 23 thousand mt of meats) through most of the 1990s. Likewise, landings of 3 to 4 thousand mt of meats can be sustained from New England waters (southern New England and Georges Bank) for the next decade."

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 surf 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 catches from that area. Almost all of the 1976 year class is larger than the minimum size (12 cm), which for the 1991 fishing season, was suspended due to the relatively low abundance of prerecruit-sized clams and the likely incentive under Amendment #8 to target beds of larger surf clams.

Biomass off the Delmarva Peninsula continued at relatively high levels 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 commercial sizes. Recent surveys indicate that the abundance of the 1977 year class has remained high and stable. These clams, however, have grown at substantially slower rates that the 1976 year class off New Jersey, perhaps in response to the very high density of surf clams off Delmarva.

Research vessel survey data collected through 1989 indicated adequate surf clam resource to support the Middle Atlantic EEZ fishery at or near the current levels (18 to 23 thousand mt of meats) through most of the 1990s. Likewise, landings of 3 to 4 thousand mt of meats can be sustained from New England waters (southern New England and Georges Bank) for the next decade. With the closure of the Georges Bank fishery, biomass will likely accumulate due to the low natural mortality rate of surf clams.

Landings from inshore (state) waters increased between 1987 and 1990 (5,400 mt to 8,500 mt). This increase in nearshore landings is due primarily to greater landings from inshore New York waters, and to a lesser extent, from off New Jersey.

EEZ 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 until the end of the decade. CPUE (bushels/hour fished) has peaked for the Mid-Atlantic fishery and will continue to decline gradually in the absence of strong year classes spawned since 1977.

For further information

Murawski, S.A. 1989. Assessment updates for middle Atlantic, southern New England, and Georges Bank surf clam populations. National Marine Fisheries Service, Northeast Fisheries Center. Working Paper #4, 9th Stock Assessment Workshop. 32 pp.

Murawski, S.A., and J.S. Idoine. 1990. Yield sustainability under constant catch policy and stochastic recruitment. *Transactions of the American Fisheries Society* 118(4):349-367.

Northeast Fisheries Center. 1989. Report of the fall 1989 NEFC stock assessment workshop (ninth SAW). National Marine Fisheries Service, Northeast Fisheries Center Reference Document 89-08. 71 pp.

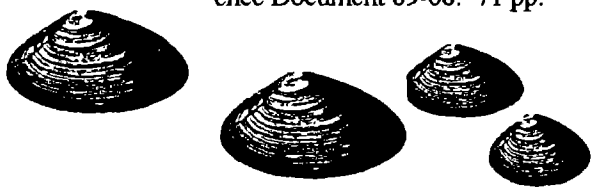
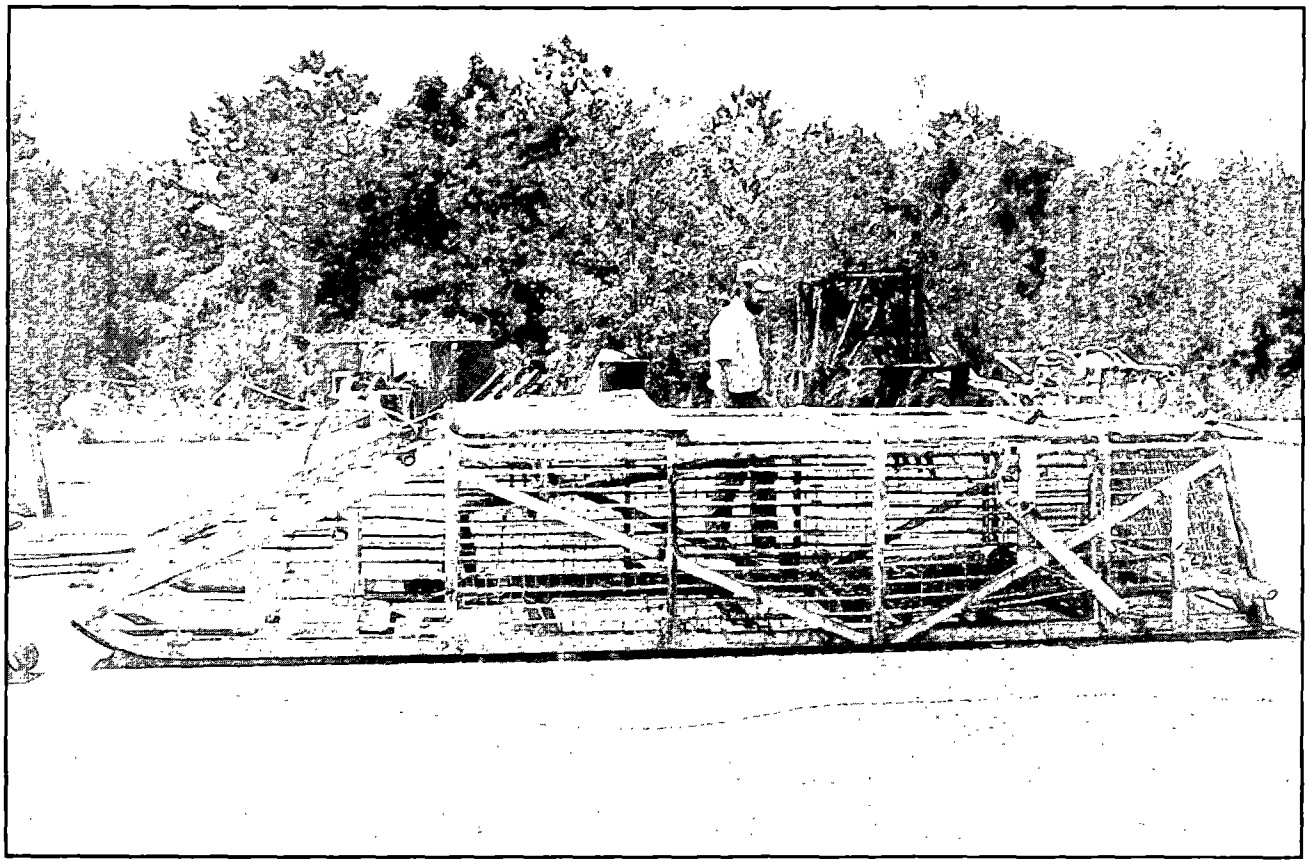
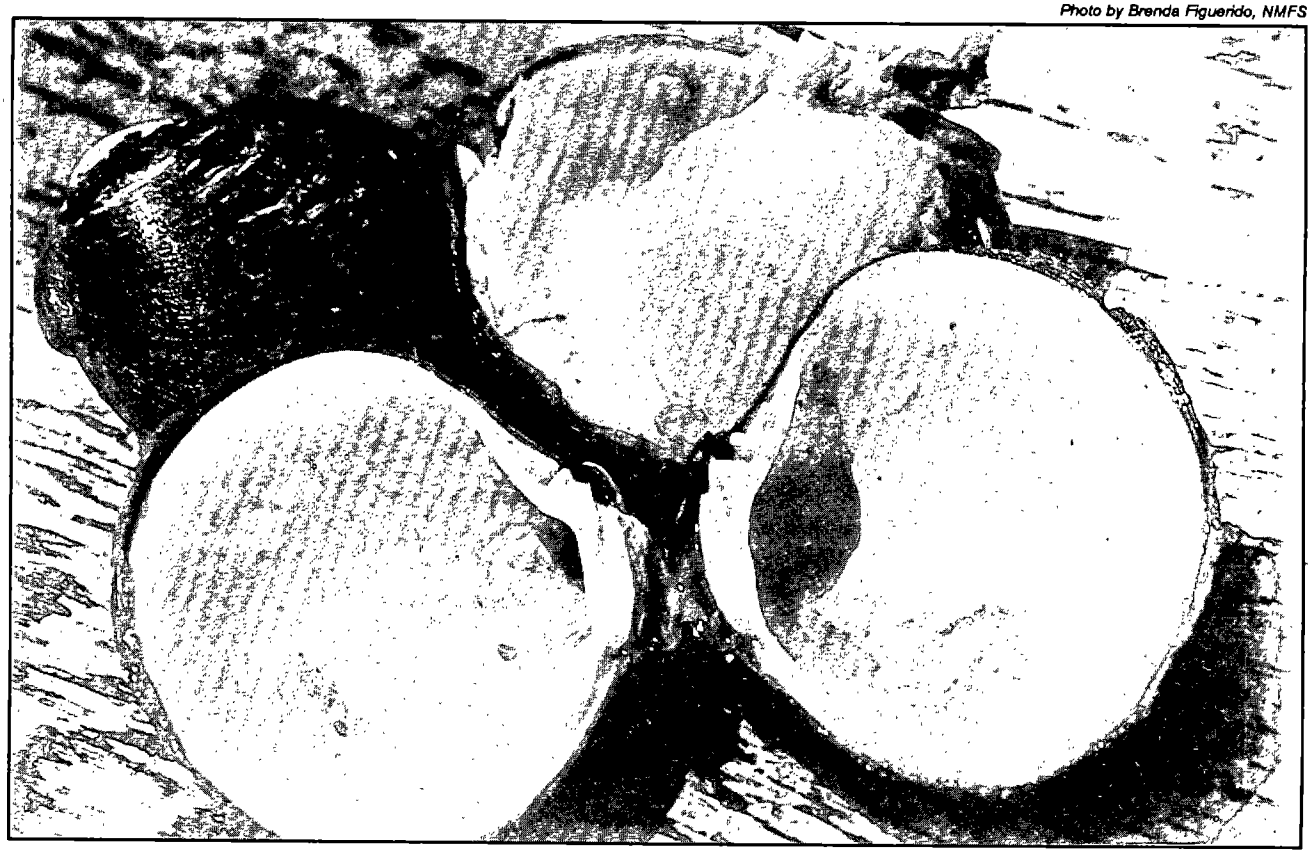


Photo by Brenda Figueirido, NMFS



32. Ocean Quahogs

Photo by Brenda Figueredo, NMFS



The ocean quahog, *Arctica islandica*, is a bivalve mollusk 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. In the Gulf of Maine region, ocean quahogs are distributed in relatively nearshore waters, with fishable concentrations 3 to 7 miles from shore.

In the Middle Atlantic region, ocean quahog populations are composed primarily of relatively large (>70 mm shell length), old individuals, and there is little evidence of recent recruitment to these populations. In contrast, Gulf of Maine populations (primarily off eastern Maine) are comprised of smaller (c.a. 50 mm shell length) individuals, with more dynamic recruitment in recent years. Growth rates of ocean quahog are similar in Gulf of Maine and Middle Atlantic areas. Results of mark-recapture, shell banding, and length frequency studies indicate that the ocean quahog has a longevity of over 100 years, and that after age 20 the growth rate is exceedingly slow. Spawning apparently occurs over a protracted interval from summer through autumn, free-floating larvae develop slowly (>90 days until setting), and thus may drift far from their parents.

The principal gear used is the hydraulic clam dredge, and most ocean quahogs are caught off southern New Jersey and the Delmarva peninsula. Recreational and foreign fishing in the EEZ are insignificant. The EEZ fishery is managed under the Surf Clam-Ocean Quahog FMP of the Mid-Atlantic Fishery Management Council. Provisions of Amendment #8 of the Surf Clam-Ocean Quahog FMP institute for the first time an ITQ (individual transferable quota) system for both surf clams and ocean quahogs, allocating percentages of the annual quota, based on vessel performance history and vessel size. For ocean quahog, management measures in effect include an annual quota (22.7 thousand mt of shucked meats), vessel allocations, and reporting requirements Both by processors and fishing vessels.

Harvesting of ocean quahog 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 Mid-Atlantic surf clam stocks combined with the massive kill of surf clams off New Jersey in 1976 stimu-

Ocean Quahogs
New England-Middle Atlantic

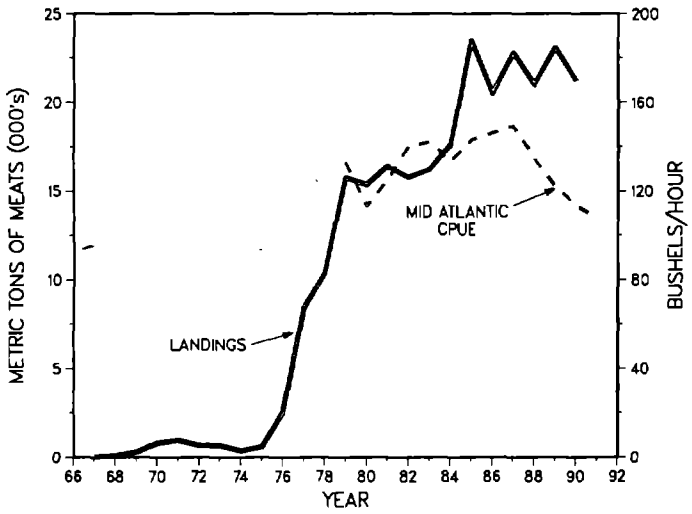


Table 32.1 Recreational catches and commercial landings (thousand metric tons, meats).

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
FCZ	16.0	15.6	15.3	16.4	23.6	19.8	22.3	20.6	22.9	21.1
State	0.4	0.2	0.7	1.2	<0.1	0.8	0.0	0.4	0.2	0.1
Canada	-	-	-	-	-	-	-	-	-	-
Total nominal catch	16.4	15.8	16.0	17.6	23.6	20.5	22.9	21.0	23.1	21.2
Total allowable FCZ	18.1	18.1	18.1	18.1	20.4	27.2	27.2	22.7	22.7	22.7

New England-Middle Atlantic Ocean Quahogs

Long-term potential catch	=	22,700 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 yrs, males 11 yrs, 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_{1990} = Unknown, probably <0.1

"The fishery has continued to expand spatially as catch rates have declined in heavily fished areas off Delmarva and southern New Jersey. Continued northward expansion of the Mid-Atlantic fishery is anticipated."

lated 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. Landings in 1990 (21,200) were near the record high level observed in 1985. Most of the landings are currently derived from the EEZ waters of the Mid-Atlantic Bight, with some EEZ landings from off Maine, and an inshore fishery (state waters) off Rhode Island. Landings from the Gulf of Maine fishery are primarily for small (c.a., 50 mm shell length) quahogs, which are sold as a fresh, in-shell product. Landings of larger quahogs in Middle Atlantic waters are used in processed clam products (*e.g.*, chowders, minced clams, juices, etc.)

Resource surveys for ocean quahog in the Georges Bank-Cape Hatteras region have been conducted by the NEFC since 1965. Biomass indices from swept-area calculations indicate a biomass (meat weight) of about 1.1 million mt. These calculations are considered a minimum estimate of standing stock to the extent that the survey dredge is not 100% efficient in catching animals encountered in the dredge path. Of this total biomass, 6% in the Southern Virginia-North Carolina region, 8% off Delmarva, 21% off New Jersey, 21%-Long Island, 28%-Southern New England, and 22% on Georges Bank.

Trends in fishery performance from 1979-1990 have been documented using catch and effort data from mandatory logbook submissions. These data indicate a significant down-

NMFS/NEFC archive photo

ward trend since 1987 (after an initial fishery-development period). In the absence of new recruitment (as indicated from NEFC surveys), CPUE in all Middle-Atlantic assessment regions will continue to decline. The fishery has continued to expand spatially as catch rates have declined in heavily fished areas off Delmarva and southern New Jersey. Continued northward expansion of the Mid-Atlantic fishery is anticipated.

Although annual landings are less that 2% of the total estimated stock in the Middle Atlantic, Southern New Jersey, and on Georges Bank, landings considerably greater than the current levels are not warranted due to the extremely slow growth rate and poor annual recruitment observed in these areas. If current harvest rates and patterns are maintained, the ocean quahog fishery off New Jersey and Delmarva should remain stable during the next half-decade. Large ocean quahog resources are currently extant on Georges Bank, but the resource has been subject to fishery closure due to the presence of paralytic shellfish poisoning toxins in that region. The Gulf of Maine fishery for ocean quahog is not currently subjected to ITQ restrictions in force in the Middle Atlantic Bight. Rather, an experimental fishery has been designated for the purpose of gathering information on the abundance, distribution and biological characteristics of the resource in EEZ waters along the Maine coast.

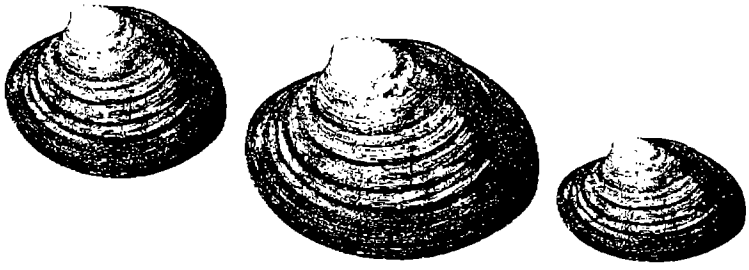
For further information

Murawski, S.A., F.M. Serchuk, J.S. Idoine, and J.W. Ropes. 1990. Population and fishery dynamics of ocean quahog, *Arctica islandica*, in the Middle Atlantic Bight. Working Paper #10, Tenth NEFC Stock Assessment Workshop. 27 pp.

Murawski, S.A., J.W. Ropes, and F.M. Serchuk. 1982. Growth of the ocean quahog, *Arctica islandica*, in the Middle Atlantic Bight. *Fishery Bulletin* 80(1):21-34.

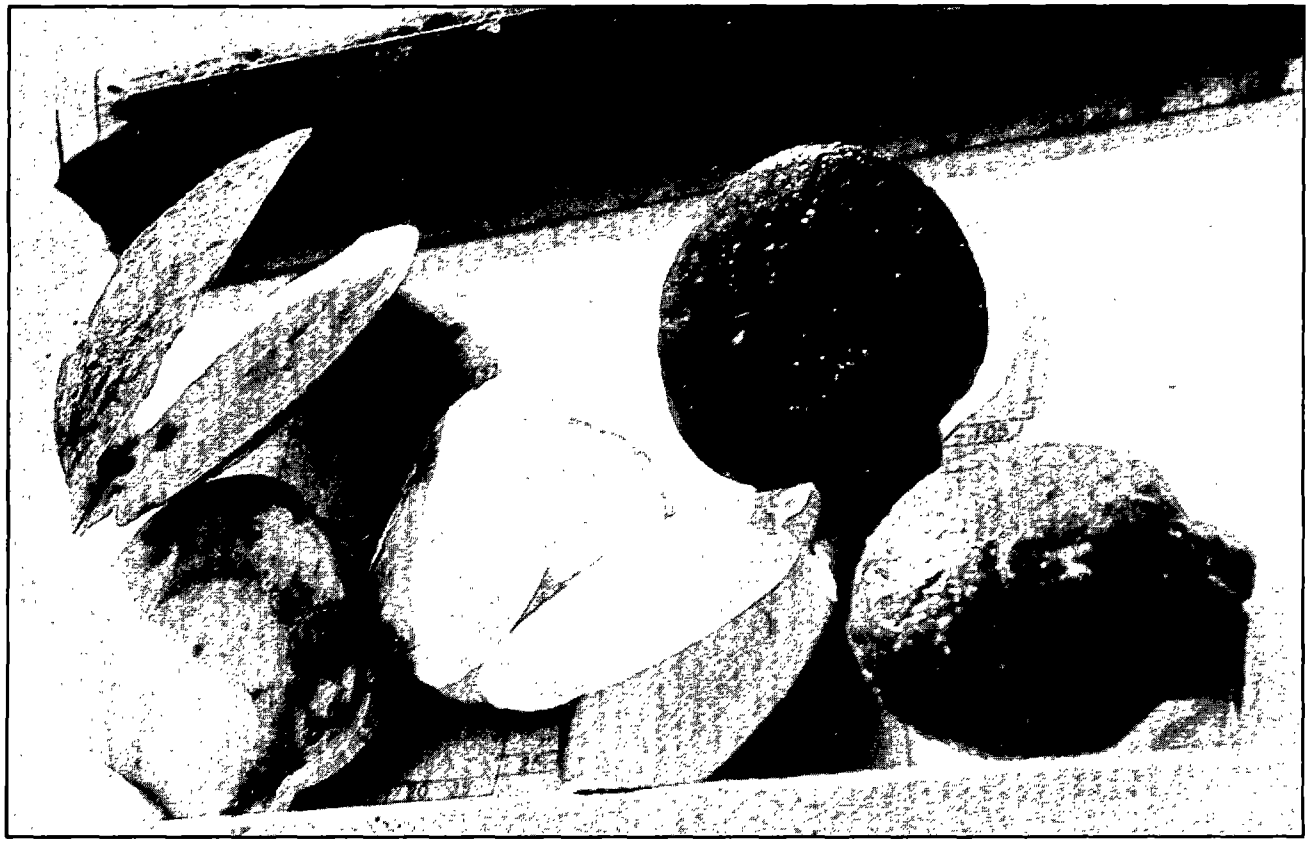
Ropes, J.W., D.S. Jones, S.A. Murawski, F.M. Serchuk, and A. Jearld, Jr. 1984. Documentation of annual growth lines in ocean quahogs, *Arctica islandica* Linne. *Fishery Bulletin* 82(1):1-19.

Northeast Fisheries Center. 1990. Report of the spring 1990 NEFC stock assessment workshop (Tenth SAW). National Marine Fisheries Service, Northeast Fisheries Center Reference Document 90-07. 89 pp.



33. Sea Scallops

Photo by Brenda Figueirido, NMFS



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

Gulf of Maine, Georges Bank, and Mid-Atlantic

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	=	Overexploited
Age at 50% maturity	=	2 to 4 yrs (GB and MA)
Size at 50% maturity	=	60 to 90 mm shell height (GB and MA)
Assessment level	=	Age Structured (DeLury)

M = 0.10 **$F_{0.1}$ =0.14 (GM) =0.15 GB, South Channel =0.14 MA, Delmarva** **F_{max} =0.22 (GM) =0.23 GB, South Channel =0.22 MA, Delmarva** **F_{1990} = >2.0 (all areas)**

"[Gulf of Maine] Commercial fishing effort in 1990 increased 16% from 1989 and was the second-highest on record. USA commercial CPUE was the second lowest on record."

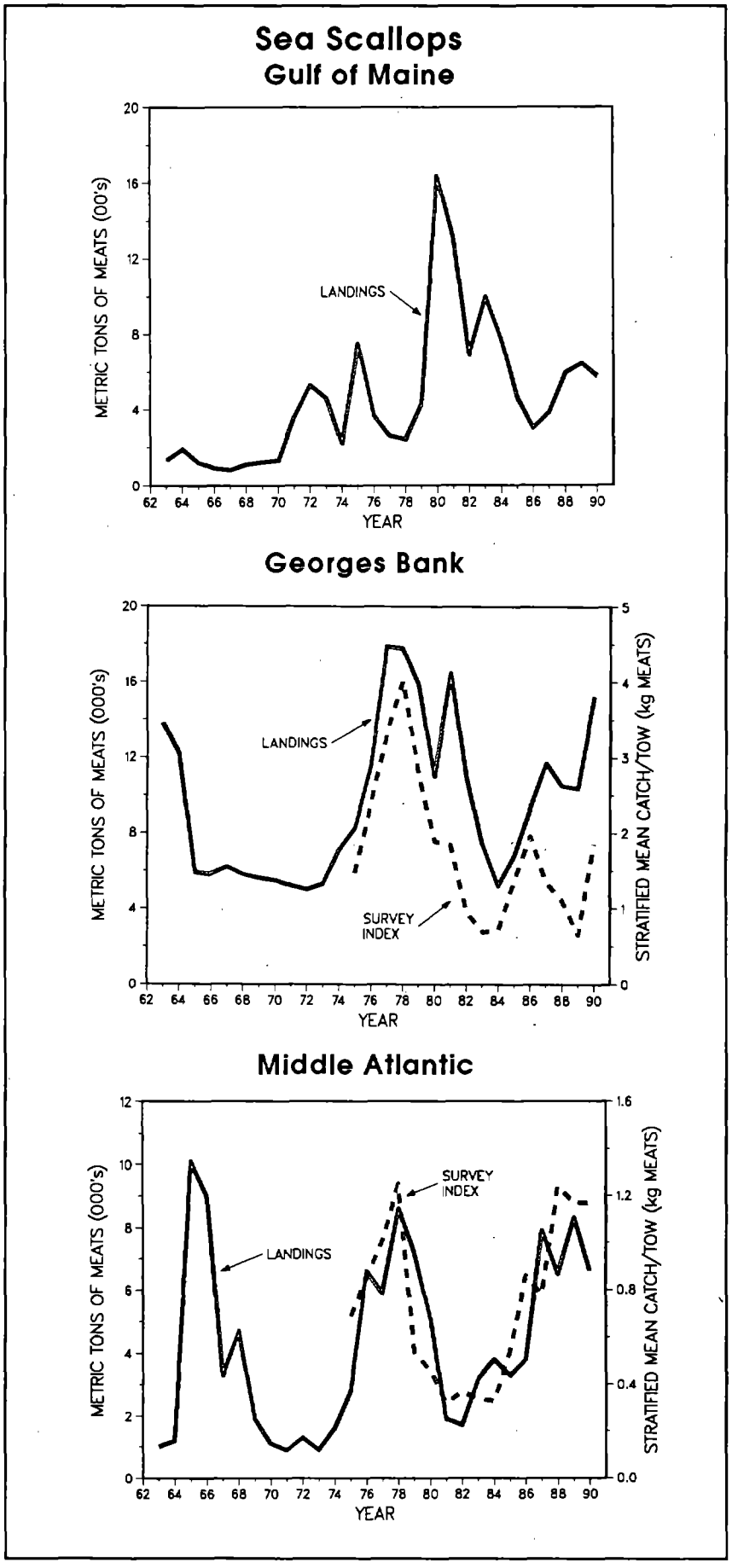
ages 3 and 5, scallops commonly increase 50 to 80% in shell height and quadruple in meat weight. During this time span, the number of meats per pound in reduced from greater than 100 to about 23. Maximum size is about 23 cm (9.0 in.), but scallops larger than 17 cm (6.7 in.) are rare. Sexual maturity 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 increased 16% in 1990 (19,400 mt to 22,600 mt).

Gulf of Maine

Nominal catch in 1990 from the Gulf of Maine was 574 mt (meat weight), 11% lower than in 1989. Most of the USA catch (89%, 511 mt) was from inshore, territorial waters along the coast of Maine. USA landings (63 mt) from the EEZ (> 3 nmi from shore) remain low indicating continued dependence by the fishery on inshore beds.

Commercial fishing effort in 1990 increased 16% from 1989 and was the second-highest on record. USA commercial CPUE was the second lowest on record.



Sea Scallops
Gulf of Maine, Georges Bank, Middle Atlantic

Table 33.1 Recreational catches and commercial landings (thousand metric tons, meat weight)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
Gulf of Maine										
USA	1.3	0.7	0.9	0.7	0.4	0.3	0.4	0.5	0.6	0.6
Canada	<0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1	0.1	0.0	0.0
Total	1.3	0.7	1.0	0.8	0.5	0.3	0.4	0.6	0.6	0.6
Georges Bank										
USA[1]	8.5	6.7	4.6	3.2	3.0	4.6	4.9	6.1	5.8	10.1
Canada	8.0	4.3	2.8	2.0	3.8	4.7	6.8	4.4	4.7	5.2
Total	16.5	11.0	7.4	5.2	6.1	9.3	11.7	10.5	10.5	15.3
Mid-Atlantic										
USA	1.9	1.7	3.2	3.8	3.3	3.8	7.9	6.5	8.3	6.6
Total nominal catch	19.7	13.4	11.6	9.8	10.6	13.4	20.0	17.6	19.4	22.6

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

"Fishing effort on Georges Bank is at record levels and far beyond what the resource can sustain in the long run...increases in stock abundance due to good recruitment will be short-lived and annual yield will fluctuate widely."

Photo by Brenda Figueridо, NMFS

Georges Bank

Total (USA and Canada) nominal catch from Georges Bank (Area 5Ze) in 1990 was 15,300 mt, 47% greater than in 1989, and the highest annual catch since 1981. Of the 1990 total, USA landings accounted for 66% (10,100 mt) while Canadian landings (5,200 mt) accounted for 33%. The 1990 USA catch was 78% greater than in 1989 and the second highest ever, while Canadian landings increased by 10% between 1989 and 1990.

USA fishing effort increased to a record high level in 1990 (33% higher than in 1989) due to a large increase in effort by both Class 3 (51-150 GRT) and Class 4 (151-500 GRT) vessels (+70% and +25% respectively). USA commercial CPUE indices for all vessel classes increased by 32%, and was the highest since 1982.

Abundance and biomass indices from the 1990 USA sea scallop research vessel survey indicate that the scallop resource in the USA sector of Georges Bank has increased over the 1989 record low levels. In the South Channel region of the Bank, 1990 survey indices of abundance and biomass were dramatically higher than in 1989 (increasing 739% and 245% by numbers and weight, respectively, from 1989). In the Southeast part of the Bank, decreases of 72% and 50% by numbers and weight, respectively, were observed from 1989 values. The USA Northern Edge and Peak region indices were the highest since the partitioning of the Bank in 1984. The survey data indicate that recruitment of the 1987 year class is above average in the South Channel and the USA Northern Edge and Peak regions, but extremely poor in the Southeast part of Georges Bank. The USA Georges Bank scallop resource is still dominated by small scallops (61% of the scallops caught in the 1990 survey were greater than 80 meat count).

Fishing effort on Georges Bank is at record levels and far beyond what the resource can sustain in the long run. Current fishing mortality in the South Channel region is estimated to be F=2.45, ten times higher than F_{max} (F=.23) (NEFC 1991). At this high fishing mortality rate the fishery is

"Given the present high abundance of the Mid-Atlantic resource, landings from this stock are expected to remain near the 1990 level (*i.e.*, 6,000 mt) through 1991, well above the estimate of long-term potential catch."

NMFS/NEFC archive photo

almost entirely dependent on incoming recruitment and the scallop resource composed of only a few age groups. As such, any increases in stock abundance due to good recruitment will be short-lived and annual yield will fluctuate widely.

If the fishery continues to focus heavily on incoming recruitment, as it has in the past, resource conditions will deteriorate.

Middle Atlantic

Total nominal catch in 1990 was 6,600 mt, 20% lower than in 1989, but still the third highest annual total since 1979. For the first time since 1986, the Mid-Atlantic region did not dominate the USA sea scallop catch as only 37% of the total was taken from the Mid-Atlantic. Most of the Mid-Atlantic catch (52%) was from the New York Bight region (3,400 mt), however, landings in this region declined by 42% between 1989 and 1990. In the more southerly scallop regions (Delmarva and Virginia/North Carolina), landings remained high, increasing by 37% for Delmarva and 2% for Virginia/North Carolina over 1989 values.

Although fishing effort in the Mid-Atlantic area decreased by 9% in 1990, it remained at a near record high level. Fishing activity declined for Class 3 and Class 4 vessels (6% and 12% respectively), but increased 38% effort for Class 2 vessels (5 to 50 GRT). Overall CPUE in the Mid-Atlantic fishery declined by 12% in 1990.

Abundance and biomass indices from the 1990 USA sea scallop survey in the Mid-Atlantic area remained high. In the Virginia-North Carolina and New York Bight regions, scallop abundance was at or near record high levels, although declines in abundance and biomass occurred in the Delmarva region. The recruitment pattern of above-average year classes throughout the area during 1982-1985, culminating in the exceptional 1986 year class, is followed by a 1987 year class of regionally variable strength. This cohort appears to be exceptionally strong in the Virginia-North Carolina region, moderately strong in the New York Bight region, and weak in the Delmarva region. The Mid-Atlantic area is still dominated by small scallops (53% of the scallops caught in this area were greater than 80 meat count).

Given the present high abundance of the Mid-Atlantic resource, landings from this stock are expected to remain near the 1990 level (*i.e.*, 6,000 mt) through 1991, well above the estimate of long-term potential catch. In this region, fishing mortality appears to have increased over time. Current fishing mortality in the Delmarva region was 2.31, far beyond biological reference points ($F_{0.1}$=.11 and F_{max} = .22) (NEFC 1991).

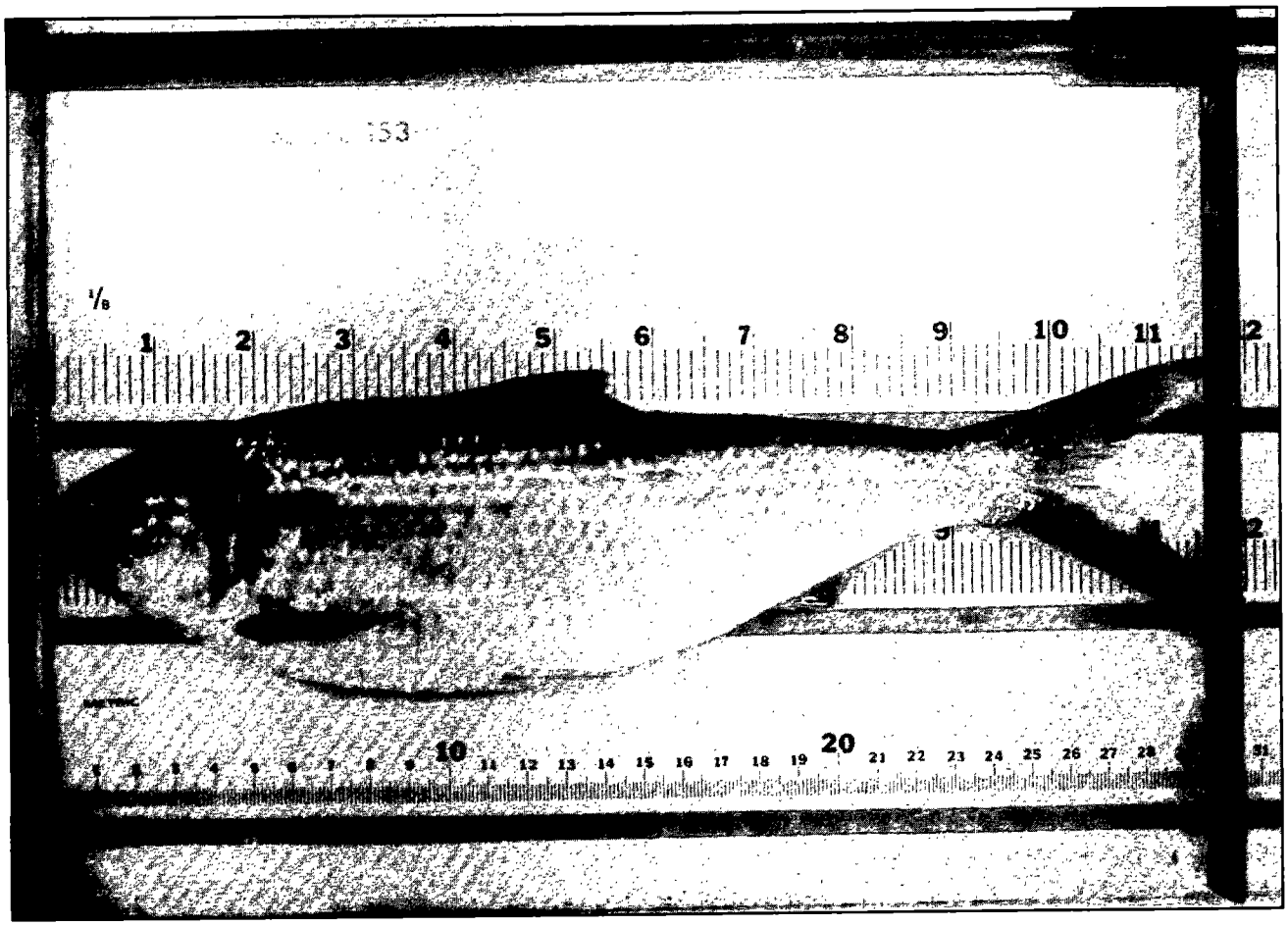
For further information

Northeast Fisheries Center. 1991. Report of the Spring 1990 NEFC Stock Assessment Workshop (Twelfth SAW). NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 91-03:

Wigley, S.E. and F.M. Serchuk. 1991. Current resource conditions in USA Georges Bank and Mid-Atlantic sea scallop populations: Results of the 1990 NMFS sea scallop research vessel survey. Working Paper No. 13, 12th NEFC Stock Assessment Workshop: 52 p.

Serchuk, F.M., and S.E. Wigley. 1991. Status of the sea scallop fisheries off the Northeastern United States, 1990. Working Paper No. 10, 12th NEFC Stock Assessment Workshop.

34. River Herring



NMFS/NEFC archive photo

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 the alewife is farther north, from Labrador to South Carolina. In coastal rivers where the ranges overlap the fisheries for the two species are mixed. Both species are anadromous and undertake 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 7 or 8 years and reach a maximum length of about 32 cm (13 in.).

Alewives spawn in the spring when water temperatures are between 16°C and 19°C; blueback herring spawn later in the spring, when water temperatures are about 5°C warmer. Fecundity and age at maturity for both species are similar. Between 60,000 and 300,000 eggs are produced per female; and maturity is reached at ages 3 to 5, primarily at age 4.

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 principal fishing gears used to catch river herring are fish weirs, pound nets, and gill nets. Recreational fishing does not contribute significantly to total landings. 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 to 1,400 mt in 1990. North Carolina, Virginia, and Maine are the only states with substantial commercial fisheries, accounting for approximately 90 percent of total landings.

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 prepared a comprehensive coastwide management plan for shad and river herring with the participation of all coastal states between Maine and Florida. Bycatch of river herring in the foreign directed fisher-

River Herring
Maine-Middle Atlantic

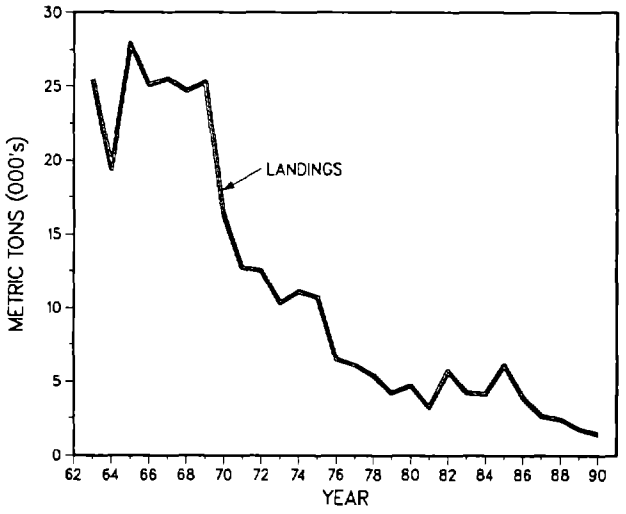
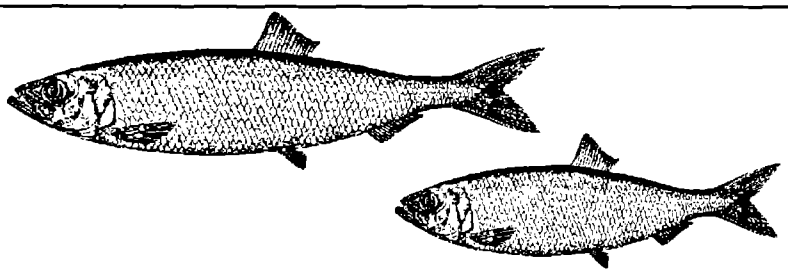


Table 34.1 Recreational catches and commercial landings (thousand metric tons)

	Year									
Category	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	3.2	5.7	4.2	4.1	6.1	3.9	4.1	2.4	1.8	1.4
Canada	-	-	-	-	-	-	-	-	-	-
Other	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total nominal catch	3.2	5.7	4.2	4.1	6.1	3.9	4.1	2.4	1.8	1.4



Maine-Middle 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 to 4 yrs (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

" Although fishing pressure on the resource has eased considerably in recent years and the condition of spawning habitats has improved, a coastwide recovery to historic levels of biomass has not occurred."

ies is managed under the Mid-Atlantic Fishery Management Council's Squid, Mackerel, and Butterfish FMP. Although fishing pressure on the resource has eased considerably in recent years and the condition of spawning habitats has improved, a coastwide recovery to historic levels of biomass has not occurred. River herring stocks in several rivers along the east coast are still being exploited above optimal levels and some potential spawning habitats remain unavailable. Data from the NEFC spring and autumn bottom trawl surveys indicate that stock levels have been relatively stable since 1968.

For further information

Crecco, V.A. and M. Gibson. 1990. Stock assessment of river herring from selected Atlantic coast rivers. Atlantic States Marine Fisheries Commission: Washington, D.C. Special Report #19. 99 pp.

Harris, P.J. and R.A. Rulifson. 1989. Investigations of ocean landings for American shad and river herring from United States east coast waters. ASMFC special report #18. 99 pp.

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, Washinton, D.C.

35. American Shad

NMFS/NEFC archive photo

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 spawning 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. Nominal commercial catch along the Atlantic coast exceeded 22,000 mt in 1896, but currently averages less than 1,000 mt per year. The principal fishing gear for American shad is the gill net. Commercial catch reported north of Cape Hatteras, NC during the 1980s has been the lowest on record, averaging 1,000 mt annually since 1980. Landings during 1990 were at the average level of 1,000 mt. Recreational fishing may be 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 Florida. Dams along the Susquehanna River have led to an almost complete disappearance of what was once a major fishery. Pollution in the lower Delaware has been cited as the 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

" Restoration efforts involving habitat improvement, fish passageways, and stocking programs are resulting in improved returns to some river systems... "

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, Connecticut, and Susquehanna 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, although recent increases in ocean intercept fisheries for American shad contribute an unknown degree of exploitation to certain river systems. The assessment information is insufficient to confidently determine the status of individual or 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-Middle Atlantic

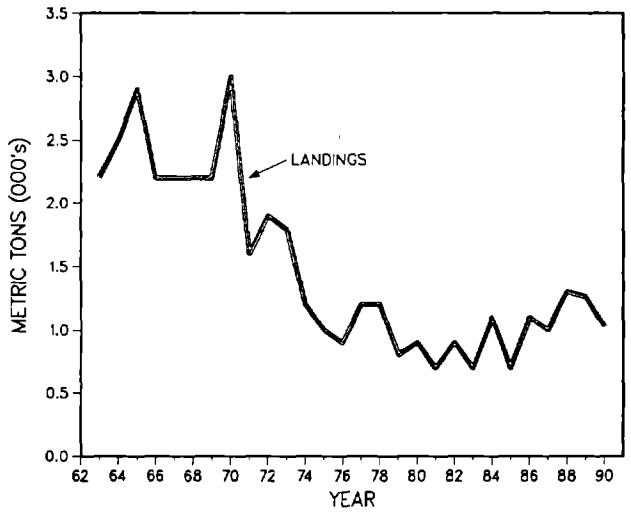
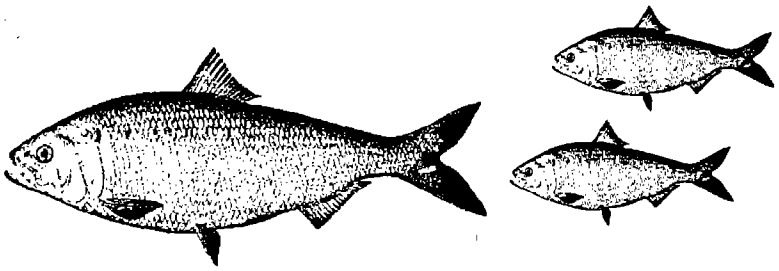


Table 35.1 Recreational catches and commercial landings (thousand metric tons)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	0.7	0.9	0.7	1.1	0.7	1.1	0.9	1.3	1.3	1.0
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	0.7	0.9	0.7	1.1	0.7	1.1	0.9	1.3	1.3	1.0

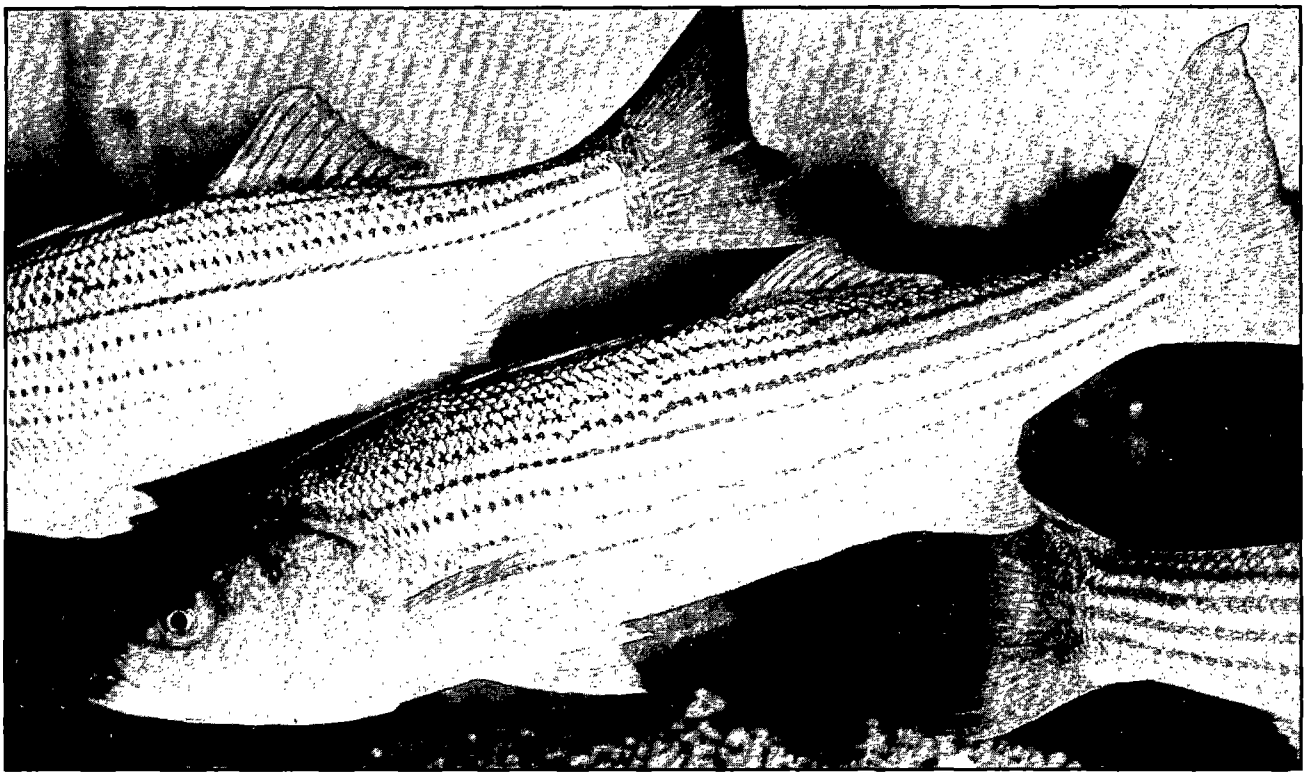


Gulf of Maine-Middle Atlantic American Shad

Long-term potential catch	=	6 to 1,236 mt, varying among river systems
Importance of recreational fishery	=	Major
Management	=	Individual states
Status of exploitation	=	Unknown
Age at 50% maturity	=	2 to 4 yrs (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_{1990} **= Unknown**

36. 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 is related to sex and age of the fish.

Atlantic coastal fisheries for striped bass rely primarily on production from stocks spawning in the Hudson River and in tributaries to the Chesapeake Bay. The Chesapeake stock historically has 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 was probably due primarily to overfishing, however poor water quality in spawning and nursery habitats likely also contributed.

During the mid-1980s, stringent

"Recreational landings of striped bass often equal or exceed commercial landings."

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 females could spawn at least once, have been effective in increasing spawning stock abundance, but not necessarily recruitment. Since 1987, indices of juvenile production in Virginia's tributaries to the Chesapeake Bay have remained at or near record high levels. However, Maryland's index of juvenile abundance has remained far below average except in 1989. Maryland's 1989 index was the second highest on record, and exceeded management criteria for relaxing fishery regulations in 1990.

Recreational landings of striped bass often equal or exceed commercial landings. In 1990, recreational landings were 1,200 mt, while commercial landings were only 400 mt. During 1990, an estimated 2 million striped bass were caught by recreational anglers; 88% of these were released alive as a result of relatively high minimum size limits still in place. Commercial harvest is made using a variety of gears, including gill nets, haul seines, pound nets, and handlines, and is closely monitored by each state that allows commercial fishing.

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. 1990. Emergency striped bass research study. Report for 1989. 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.

Striped Bass
Gulf of Maine-Middle Atlantic

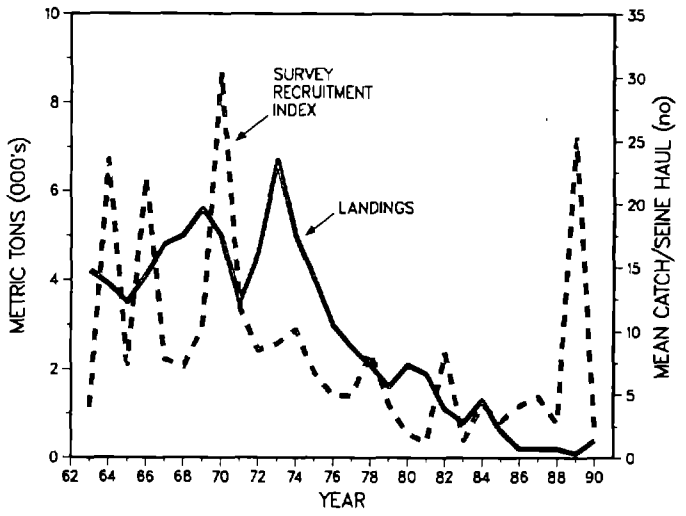


Table 36.1 Recreational harvest and commercial landings (thousand metric tons)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	0.6	1.6	1.2	0.5	0.8	0.4	0.4	0.6	0.3	1.2
Commercial										
USA	1.9	1.1	0.8	1.3	0.6	0.2	0.2	0.2	0.1	0.4
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	2.5	2.7	2.0	1.8	1.4	0.6	0.6	0.8	0.4	1.6

[1]Preliminary NMFS data

Gulf of Maine - Middle Atlantic Striped Bass

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Major
Management	=	Striped Bass ISFMP
Status of exploitation	=	Under protection[1]
Age at 50% maturity	=	2 yrs, males 6 yrs, females
Size at 50% maturity	=	29.7 cm (11.7 in.) males 71.1 cm (28.0 in.) females
Assessment level	=	Population projection

M = 0.15 **$F_{0.1}$ = unknown** **F_{max} = unknown** **F_{1990} = unknown**

[1]Moderate exploitation began in 1990

37. Atlantic Salmon

The Atlantic Salmon, *Salmo salar*, is a highly desirable food fish and prized sport catch native to New England rivers. The historic North American range of Atlantic salmon extended from the rivers of Ungava Bay, Canada to Long Island Sound, USA. As a consequence of industrial and agricultural development, most of the runs native to New England have been extirpated. Self-supporting runs of Atlantic salmon in the United States can only be found in the state of Maine. Restoration efforts, in the form of stocking and fish passage construction, are underway in the Connecticut, Pawcatuck, Merrimack and Penobscot Rivers of New England.

Atlantic salmon life history is extremely complex owing to its use of both freshwater and marine habitats and long ocean migrations. Atlantic salmon spawn in fresh water during fall. Eggs remain in gravel substrate over winter until they hatch and emerge as fry during spring. Juvenile salmon, commonly called parr, remain in freshwater 2 to 3 years in New England Rivers depending on growth. When parr grow to sufficient size (>16 cm (6.4 in.) they mature into smolts and migrate to the sea. As evidenced from tagging data for New England stocks, young salmon migrate as far north as the Labrador Sea during their first summer in the ocean.

After their first winter at sea (the fish are now referred to as "1 sea-winter salmon") a small portion of the cohort becomes sexually mature and returns to their natal rivers. Those remaining at sea forage in the coastal waters of Canada and Greenland where they are the subject of gill net fisheries primarily along the coasts of Northeastern Newfoundland, Labrador, and West Greenland. After their second winter at sea, most US salmon return to spawn. Three sea-winter and repeat spawning salmon life history patterns do occur in New England stocks.

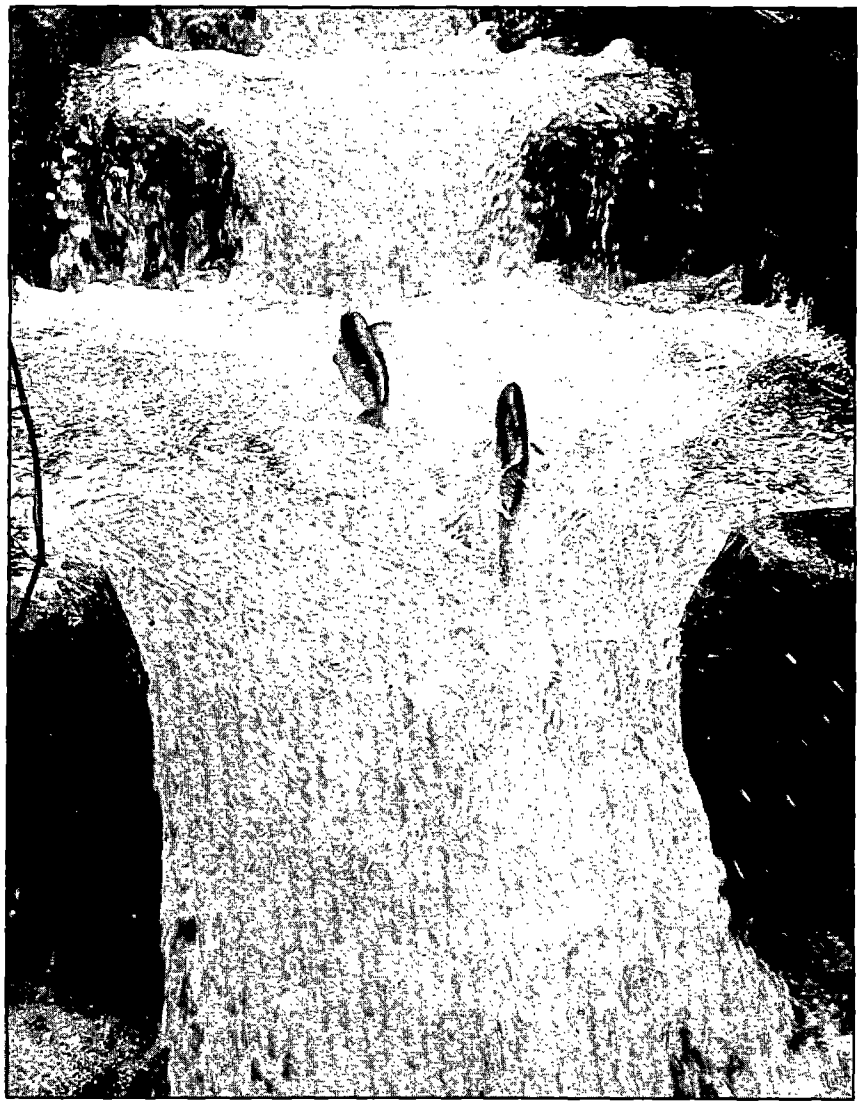


Photo by Richard Hiscock

Atlantic Salmon

Long-term potential catch	=	Unknown
Importance of recreational fishery	=	Major
Management	=	State regulation, FMP, NASCO Treaty
Status of exploitation	=	Over exploited
Age at 50% maturity	=	2 sea yrs
Size at 50% maturity	=	71.0 cm (28.0 in.)
Assessment level	=	Modified VPA

M = 0.12 **$F_{0.1}$ = Unknown** **F_{max} = Unknown** **F_{1989} = 0.9**

"As evidenced from tagging data for New England stocks, young salmon migrate as far north as the Labrador Sea during their first summer in the ocean."

Homewater fisheries are limited to an angling fishery in the state of Maine only. Angler landings averaged 444 salmon in recent years which resulted in an exploitation rate of approximately 10% of the run to Maine Rivers. Management authority for Atlantic salmon in US waters resides with the states and the New England Fishery Management Council.

Distant-water fisheries (the commercial gill net fisheries in Canada and Greenland) have been evaluated by extensive tagging experiments with US stocks. Harvest estimates based on Carlin tag returns put exploitation of the US 1 sea-winter stock component at approximately 60% in recent years and at approximately 80% for the 2 sea-winter component. These levels of exploitation indicate that the stocks are overexploited. The commercial ocean fisheries in Canada and Greenland are managed under the auspices of North Atlantic Salmon Conservation Organization (NASCO) of which the United States is a member. The Greenland fishery is managed with a quota system that has been in place since 1976. The Canadian fishery had been managed with a series of time-area closures, but beginning in 1990 the largest component of the fishery, the Newfoundland-Labrador fishery, was placed under a quota system.

For further information

Mills, D. 1989. Ecology and Management of Atlantic Salmon. Chapman and Hall. New York.

Anonymous. 1991. Report of the North Atlantic Salmon Working Group. International Council for the Exploration of the Sea. C.M.1991/Assess:11. Copenhagen. Denmark.

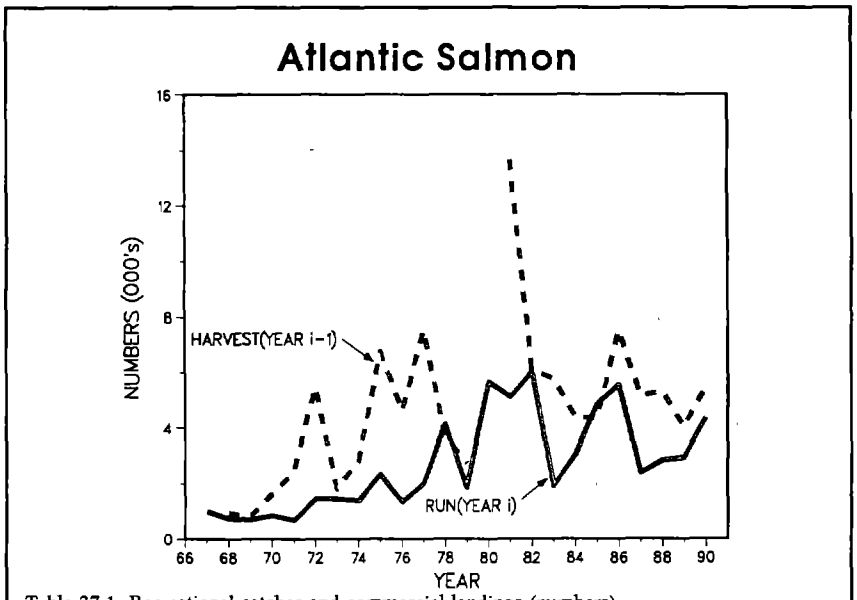


Table 37.1 Recreational catches and commercial landings (numbers)

Category	Year 1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Recreational										
USA	1141	1214	342	600	566	563	282	259	487	627
Commercial[1]										
USA	-	-	-	-	-	-	-	-	-	-
Canada	2295	3206	3401	2657	4575	1104	1161	590	1717	N/A
Greenland	3815	2567	976	1697	2939	4070	4149	3430	3784	N/A
Total	7251	6987	4719	4954	8080	5737	5592	4279	5988	627

[1]Carlin tag harvest estimates

Common Name Index

Scientific Name Index

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