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Status of the Fishery Resources Off the Northeastern United States for 1990

Conservation and Utilization Division, Northeast Fisheries 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 Fisheries Center
Woods Hole, Massachusetts

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The following personnel of the Northeast Fisheries Center, listed alphabetically, assisted in writing this report: Frank Almeida, Vaughn Anthony, Stephen Clark, Darryl Christensen, Wendy Gabriel, Josef Idoine, Phil Logan, Ralph Mayo, Margaret McBride, Steven Murawski, William Overholtz, Joan Palmer, Anne Richards, Fredric Serchuk, Gary Shepherd, Mark Terceiro, Gordon Waring, and Susan Wigley.

Joanne McDonald completed word processing. Publication editing was completed by Steve Murawski and Gene Heyerdahl; design and layout by Teri Frady; photo processing and management by Brenda Figuerido.

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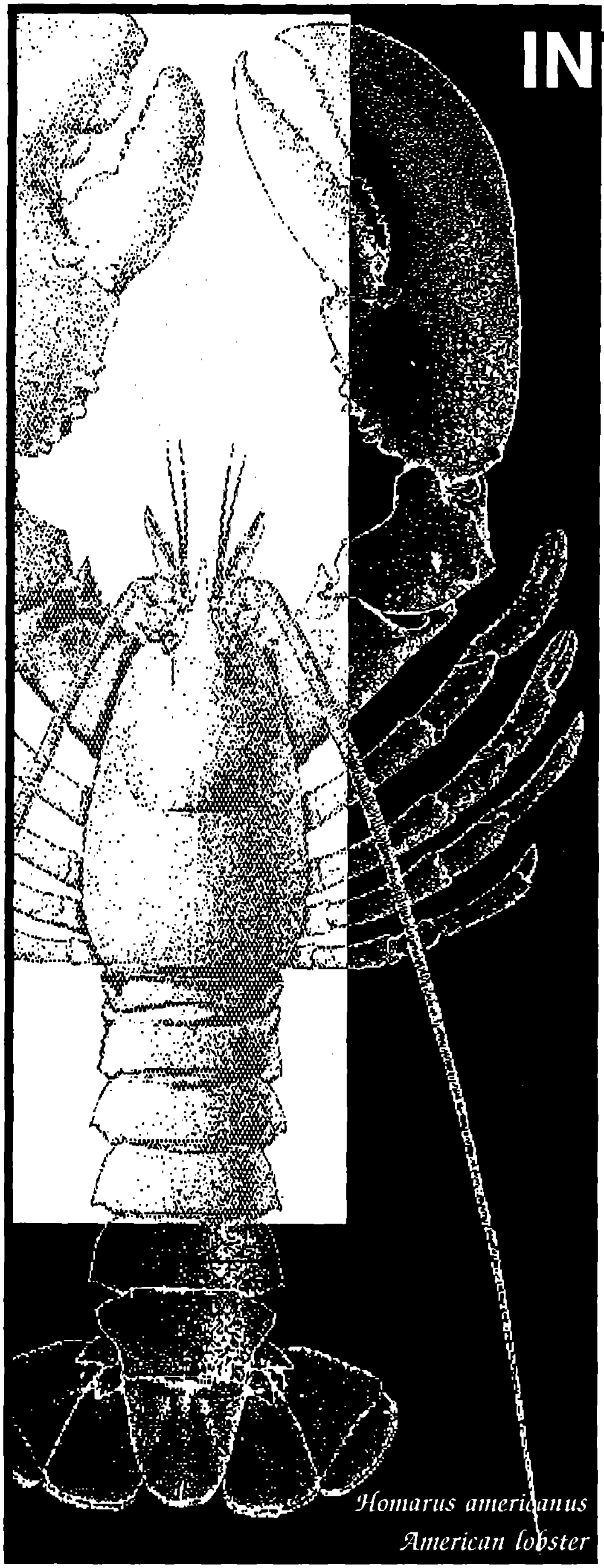
AGGREGATE SUMMARIES

INTRODUCTION



The Conservation and Utilization Division of the Northeast Fisheries Center (NEFC), with headquarters in Woods Hole, Massachusetts, annually updates its assessments of finfish and shellfish resources off the northeast coast of the United States, and presents detailed information as needed to administrators, managers, the fishing industries, and the public. This report is based on those assessments and summarizes the general status of selected finfish and shellfish resources off the northeast coast of the United States from Cape Hatteras to Nova Scotia through 1989.

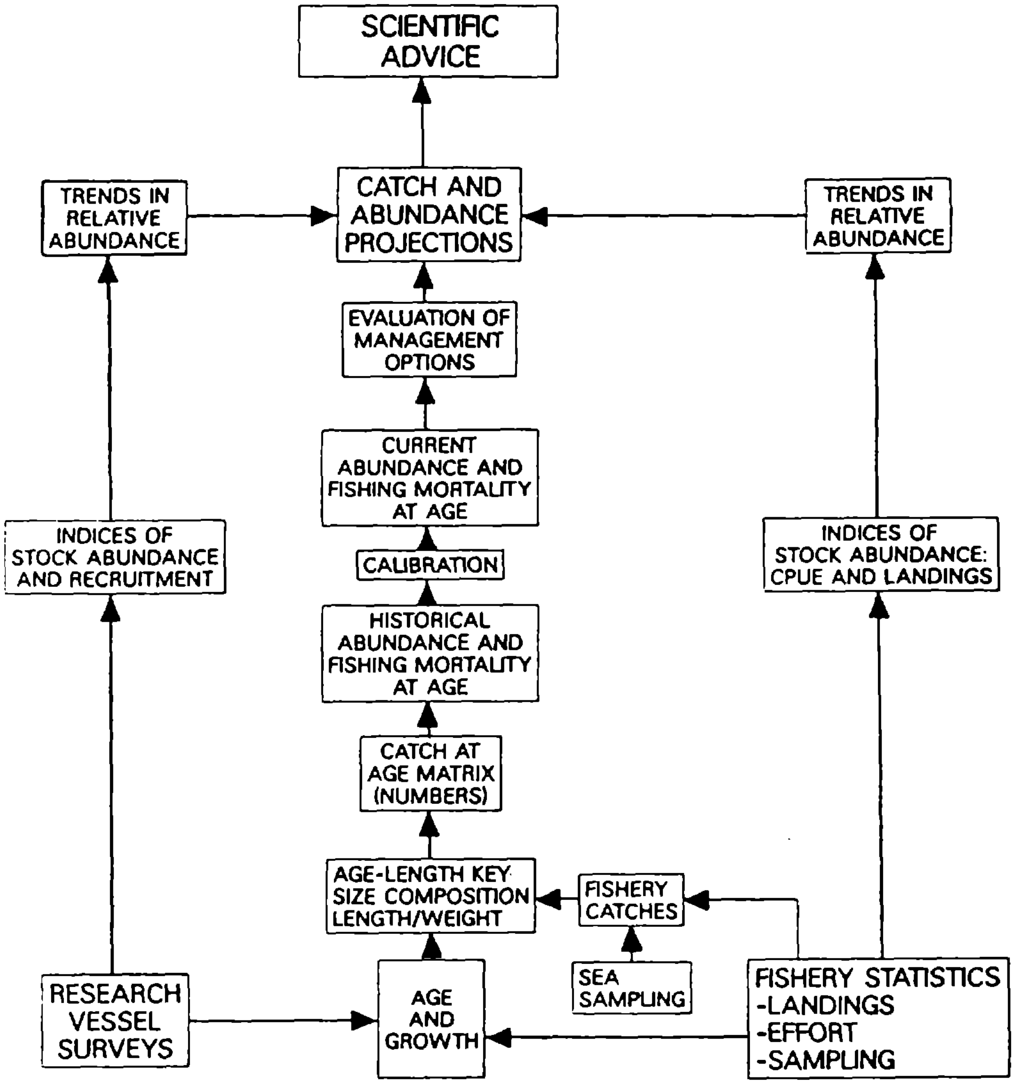
This report is divided into two sections, Aggregate Summaries and Species Synopses. The Aggregate Summaries section includes general descriptions of Fishery Landings Trends, Aggregate Resource Trends and Commercial Fishery Economic Trends. The Species Synopses section, on the other hand, includes information about the status of individual populations or stocks of some 34 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, sandlance, sea urchins, menhaden, and pelagic sharks. Some of these are migratory species which seasonally move outside the northeast FCZ, while others are fisheries that have not been routinely assessed by the Northeast Fisheries Center.

OVERVIEW OF ASSESSMENT APPROACHES

Depending on the nature of the fishery, the type and amount of fishery-generated data, and the information required for management, the assessment information reported here may be generated in several different ways. Figure 1 is a diagram of several ways in which catch and survey data, in the lower left and right boxes respectively, can be combined to provide assessment advice, illustrated at the top of the diagram. The simplest approach is when catch data are used to generate indices of abundance, as seen by moving vertically along the right side of Figure 1. A more complex approach is when the catch data from the first approach is combined with

Figure 1. Diagram of alternate ways in which fishery-generated data and research data (lower right and left boxes, respectively) are combined to provide scientific advice on the status of the stocks (top box).

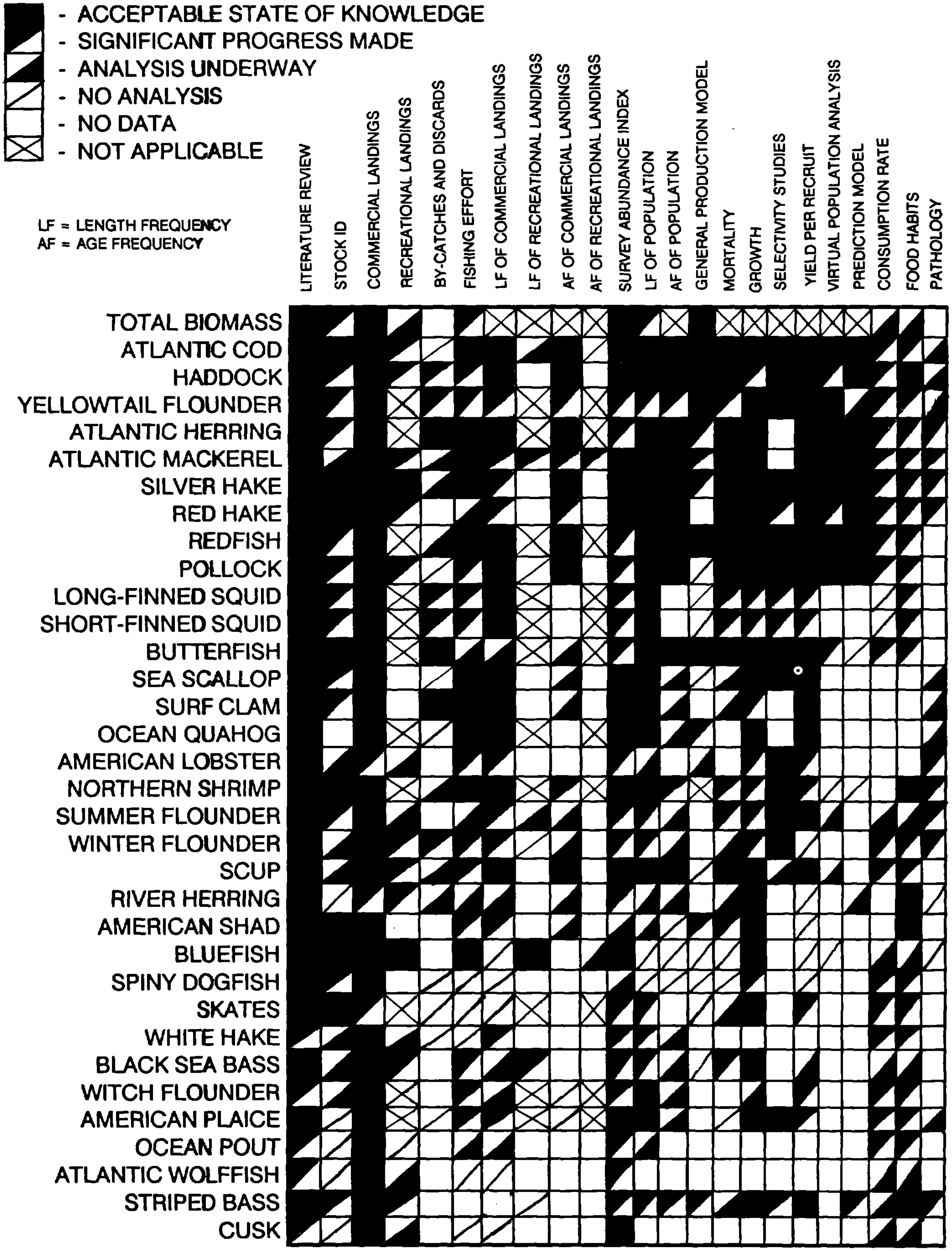


trawl survey data to generate indices of abundance, as seen by moving vertically along the left side of Figure 1. Both of these approaches are frequently supplemented with knowledge of the life history generated from biological data from sampling the commercial and survey catches. A third approach is to utilize the information about total stock size and population productivity generated under the first two approaches to determine the relationship between productivity and stock size; this is referred to as production models. Finally, for those species where the age composition of the catch or of the survey samples can be determined reliably, more complex analytic assessments can be developed that use the information in the age structure of the population and the catches to determine productivity as seen by moving vertically along the center of Figure 1.

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.

The different information paths in Figure 1 result in assessment information having different levels of sophistication and reliability. The

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



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 research done to interpret this information. Although there is some overlap, the assessments presented here can be roughly grouped in order of increasing level of complexity into the following categories, each one including features of all simpler levels.

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

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

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

SPAWNING STOCK: assessment also includes analysis of the data on spawning stock size and subsequent recruitment.

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

For example, in Figure 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 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 variability of the survival of young fish.

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

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

Both Figures 1 and 2 reflect information about each species separately, as if they had no interactions with each other. Similarly, the assessments in the Species Synopses section of this report are presented individually, with little indication of the biological interactions among species or of the technical interactions due to the mixed species nature of many of the fisheries. The significance of the mixed species nature of the trawl fisheries in the Northeastern U.S. is illustrated in the section entitled Aggregate Resources Trends. There, aggregate research trawl survey and commercial trawl data are presented illustrating major trends in abundance and catches. The information presented there, however, is rather simple, and does not address many of the complexities of these multispecies fisheries. Additional studies of the dynamics of the mixed species trawl fishery, and of the mixed species complex that it catches, are needed to adequately address pressing management needs.

FISHERY MANAGEMENT

Fisheries occurring primarily in the Fisheries Conservation Zone (FCZ) off the Northeastern U.S. are managed under Fishery Management Plans (FMPs) developed by the New England Fisheries Management Council, 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.

Assessment level: The "level" of an assessment depends on how complex it is and the type of data used to make the assessment. The different types, or levels, of assessment used in this report are: 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 allows prediction of future (one or two years ahead) stock sizes and catches (PREDICTIVE). Of these, the predictive assessment is the most complex. 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 curves for equilibrium yield per recruit and spawning stock biomass per recruit, and from 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

Table 1. Federal and interstate fishery management plans currently in place or under development for fisheries off the northeastern United States

Fish	Type	Organization Responsible	Since	Last Amendment	Amendment Number
1. Multispecies[1]	FMP	NEFMC	1986	1990[2]	4
2. Squid, mackerel and butterfish	FMP	MAFMC	1978	1990	3
3. Silver and red hake	PMP	NMFS	1977	1990[2]	-
4. Herring	FMP	NEFMC	1978	-	-
5. Lobster	FMP	NEFMC	1983	1989[2]	3
6. Scallop	FMP	NEFMC	1982	1989	4
7. Surf clam and ocean quahog	FMP	MAFMC	1977	1990	8
8. Northern shrimp	INTERSTATE	ASMFC	1976	1986[3]	-
9. Summer flounder	FMP	MAFMC	1988	1990[2]	1
10. Striped bass	INTERSTATE	MAFMC/ASMFC	1981	1989	4
11 Bluefish	FMP	MAFMC[5]	1989	-	-
12. Atlantic salmon	FMP	NEFMC	1988	-	-

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[1] **Atlantic cod, haddock, redfish, pollock, yellowtail flounder, American plaice, witch flounder, winter flounder, white hake, windowpane flounder**

[2] **In process**

[3] **Rewritten**

[4] **Silver and red hake included in Amendment 4 of the Multispecies FMP**

[5] **Implemented together with the ASMFC**

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 present at the beginning of the year, the annual exploitation rate would be 0.72.

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

For example, if fishing mortality (F) is equal to 1.5, then approximately 1.5/365 or 0.411 percent of the population dies each day from fishing. If fishing were the only cause of death, then the number of fish that survive the fishery over the year from a population of 1 million alive at the beginning of the year is 1 million multiplied by $e^{-1.5}$ or 223,130 fish. During fishing, there are other causes of death among the population of fish, and these must also 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 [that is, F/Z multiplied by $(1-e^{-z})$ multiplied by 1 million.] If the total mortality rate is 1.7 (fishing mortality [1.5] plus natural mortality of 0.2), 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 percent 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 of the curve's slope 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 exceed the gain in weight due to growth. This point is defined as F_{max}.

Long-term potential catch: The largest annual harvest in weight that 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. The easiest way is by 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 percent of the population of fish died during the year. In general, annual mortality rates can range from 0 to 1.0, that is 0 to 100 percent mortality.

Annual rates are easy to understand, but difficult to use when trying to describe the relative contribution of different causes of mortality, such as fishing and predation, to the total mortality of fish during a year. One way to describe mortality and overcome this limitation of annual rates is by using instantaneous rates, although this approach is more difficult to grasp. 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 percent. In practice, instantaneous rates range from 0 to values as high as 1.5 or 2.0, but theoretically could take on any large value. Because instantaneous rates make comparing the relative importance of different sources of mortality very easy, as discussed next, they are frequently used by fishery biologists, and are used throughout this report. To aid in interpretation, the following explanation of correspondence between the simpler annual rates and the more useful instantaneous rates may be helpful:

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

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

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

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

Following these examples, M is equal to Z-F or 1.7-1.5 = 0.2. The number of fish that die during the year from natural causes is, therefore the proportion of total mortality (Z) due to natural causes multiplied by the proportion that actually die multiplied by the population alive at the beginning of the year:

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

or

$$(0.1176)\,(0.8173)\,(1,000,000)$$

Therefore, 96,114 fish or 9.6 percent 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 percent 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.

Quota: A portion of a total allowable catch (TAC) allocated to an operating unit, such as a size class of vessels or a country.

Recruitment: The 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. This is used to describe the strength of a year class.

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 and an increasing proportion of juveniles in the catch.

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 (for example, per age 2 individual). 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 fishing patterns can be compared with it. For example, the maximum SSB/R for Georges Bank haddock is approximately 9 kg.

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

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

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

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

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:

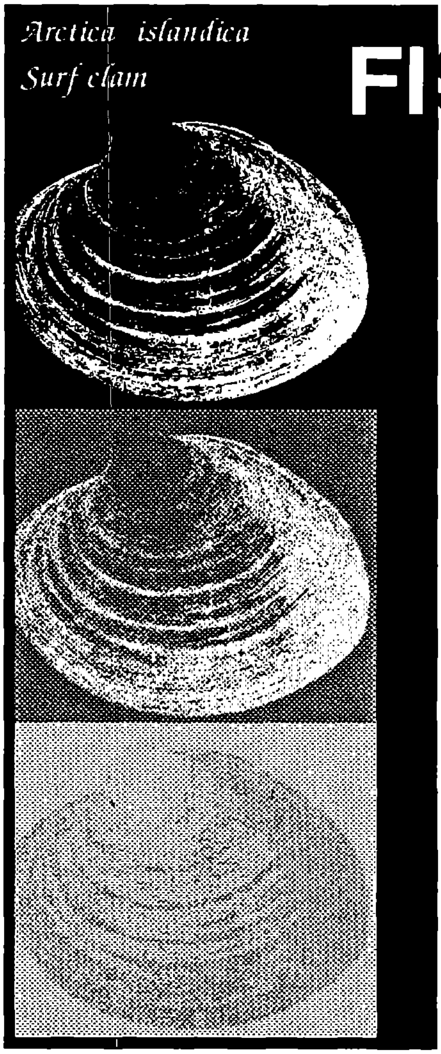
Vessel class	GRT
2	5 to 50
3	51 to 150
4	151 to 500

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. Working backward year by year, one can be virtually certain that at least 100 fish were alive at the beginning of 1970. A virtual population analysis goes a step further and calculates the number of fish that must have been alive if some fish also died from causes other than fishing. For example, if the instantaneous natural mortality rate was known in addition to the 10 fish caught per year in the fishery, then a virtual population analysis calculates the number that must have been alive each year to produce a catch of 10 fish each year in addition to those that died from natural causes.

If one knows the fishing mortality rate during the last year for which catch data are available (in this case 1979), then the exact abundance of the year class can be determined in each and every year if the catches are known with certainty. If the fishery removes a large proportion of the stock each year, so that the population declines quite rapidly over time, then an approximate fishing mortality rate can be used in the last year (1979), and by calculating backward year by year for the year class, a precise estimate of abundance can be determined for the previous three or four years (1976 or 1975). Accuracy depends on the rate of population decline and the correctness of the starting value of the fishing mortality rate (in the most recent year). This technique is used extensively in fishery assessments since the conditions for its use are so common: many fisheries are heavily exploited, the annual catches for a year class can be easily determined, and the natural mortality rate is known within a fairly small range and is low compared with the fishing mortality rate.

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

Yield per recruit analysis: The expected lifetime yield per recruit 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 1989 are estimated to be more than 3,800,000 metric tons (mt), of which approximately 18 percent were from this region. Total U.S. recreational landings are estimated to exceed 200,000 mt (excluding Alaska, Hawaii, and Pacific coast salmon). Aggregate statistics for U.S. fisheries are described in detail in Fisheries of the United States, 1989.

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, domestic commercial and recreational as well as foreign, from the several stocks of the 34 species groups described here totaled 480,300 mt in 1989, down slightly from 1988 (Table 2). Of these landings, 24 percent were from foreign and 67 percent from domestic commercial fishing, and 9 percent from recreational fishing. Landings

> **"...landings decreased slightly in all groups in 1989 except among principal pelagics (up 9 percent) and invertebrates (up 20 percent)."**

in 1989 for both foreign and recreational fishing declined slightly (12 and 37 percent respectively) while the domestic commercial landings increased (6 percent).

The landings from six groups of species reveals major differences:

The most important in terms of weight of fish landed are the principal groundfish (Atlantic cod, haddock, redfish, silver hake, red hake, and pollock), accounting for 28 percent of the landings in 1988 and 26 percent in 1989.

The principal pelagic species (Atlantic herring, Atlantic mackerel) and the invertebrates (short- and long-finned squid, American lobster, Northern shrimp, surf clams, ocean quahogs, sea scallops) accounted for 24 and 23 percent of the total landings in 1989, the same as in 1988.

The fourth highest landings were from the other pelagic species (butterfish, bluefish, river herring, American shad, and striped bass), which accounted for 9 percent of the landings in 1989, down from 11 percent in 1988. Nearly 73 percent of this was bluefish, primarily a recreational species.

Next in importance in terms of weight are the flounders, accounting for 6 percent of the total landings in 1989, and other groundfish, accounting for less than 5 percent.

Within each of these groups of species, landings decreased slightly in all groups in 1989 except among principal pelagics (up 9 percent) and invertebrates (up 20 percent). The landings of the invertebrate species increased the greatest percentage, 15 percent, while the principal pelagics increased by 5 percent.

Table 2. Total landings of selected assessment species groups off the northeastern United States, domestic and foreign commercial fishing, and for recreational fishing, 1988 and 1989 (1,000 mt)

	Commercial				Recreational			
	Foreign		USA		USA		Total	
	1988	1989	1988	1989	1988	1989	1988	1989
Principal Groundfish								
Atlantic cod	12.7	7.9	34.3	35.5	7.6	6.8	54.6	50.2
Haddock	6.0	3.0	2.9	1.7	<0.1	<0.1	8.9	4.7
Redfish	0.1	<0.1	1.1	0.6	0	0	1.2	0.6
Silver hake	0	0	16.0	17.8	0.1	0.1	16.1	17.9
Red hake	0	0	1.8	1.6	<0.1	<0.1	1.8	1.6
Pollock	41.7	41.2	14.9	10.5	0.2	0.3	58.1	52.0
Subtotal	**61.9**	**52.1**	**71.0**	**67.7**	**7.9**	**7.2**	**140.8**	**127.0**
Flounders								
Yellowtail flounder	0	0	3.9	5.0	0	0	3.9	5.0
Summer flounder	0	0	16.3	9.7	8.4	1.6	24.7	11.3
American plaice	0.1	0.1	3.3	2.3	0	0	3.4	2.4
Witch flounder	<0.1	<0.1	3.2	2.1	0	0	3.2	2.1
Winter flounder	<0.1	<0.1	8.4	6.8	4.9	2.9	13.3	9.7
Subtotal	**0.1**	**0.1**	**35.1**	**25.9**	**13.3**	**4.5**	**48.5**	**30.5**
Other Groundfish								
Scup	0	0	5.8	3.6	2.3	3.5	8.1	7.1
Black sea bass	0	0	1.7	1.2	1.6	2.1	3.3	3.3
Ocean pout	0	0	1.8	1.3	0	0	1.8	1.3
White hake	0.6	0.6	5.4	5.0	<0.1	<0.1	6.0	5.6
Cusk	0.4	0.7	1.1	0.9	<0.1	<0.1	1.5	1.6
Atlantic wolffish	0.1	0.1	0.5	0.5	<0.1	<0.1	0.6	0.6
Spiny dogfish	<0.1	<0.1	2.9	4.5	0	0	2.9	4.5
Skates	0	0	5.9	6.6	0	0	5.9	6.6
Subtotal	**1.1**	**1.4**	**16.3**	**12.5**	**3.9**	**5.6**	**21.3**	**19.5**
Principal Pelagics								
Atlantic herring	0	0	40.2	53.7	0	0	40.2	53.7
Atlantic mackerel	65.9	58.8	12.3	14.6	3.8	0.9	82.0	74.3
Subtotal	**65.9**	**58.8**	**52.5**	**68.3**	**3.8**	**0.9**	**122.2**	**128.0**
Other Pelagics								
Atlantic butterfish	0	<0.1	2.1	3.1	0	0	2.1	3.1
Bluefish	0	0	6.2	4.5	35.3	22.4	41.5	26.9
River herring	<0.1	<0.1	2.4	1.8	-	-	2.4	1.8
American shad	0	0	1.3	1.3	0	0	1.3	1.3
Striped bass	0	0	0.2	0.1	0.8	0.3	1.0	0.4
Subtotal	**<0.1**	**<0.1**	**21.0**	**21.9**	**36.1**	**22.7**	**57.1**	**44.6**
Invertebrates								
Short-finned squid	0	0	2.0	6.8	0	0	2.1	6.8
Long-finned squid	<0.1	<0.1	19.1	23.4	0	0	19.1	23.4
American lobster	<0.1	<0.1	22.2	24.0	-	-	22.2	24.0
Northern shrimp	0	0	3.1	3.6	0	0	3.1	3.6
Surf clams	0	0	28.8	30.4	0	0	28.8	30.4
Ocean quahog	0	0	21.0	23.1	0	0	21.0	23.1
Sea scallop	4.4	4.7	13.2	14.7	0	0	17.6	19.4
Subtotal	**4.4**	**4.7**	**109.5**	**126.0**	**0**	**0**	**113.9**	**130.7**
Total	**133.4**	**117.1**	**305.4**	**322.3**	**65.0**	**40.9**	**503.8**	**480.3**

The increase in the principal pelagic landings was mostly due to increases for Atlantic herring, primarily through domestic fishing. The changes in invertebrate landings involved all species increasing in catches. The decreases in the principal groundfish were seen in all species except silver hake, which increased by 11 percent.

Total 1989 foreign vessel landings of fish originating in U.S. waters was 117,100 mt, down 8 percent from 1988. This includes catches of pollock and mackerel, for example, by Canadian fishermen after these fish moved from U.S. to Canadian waters. 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 and Atlantic herring. 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.

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

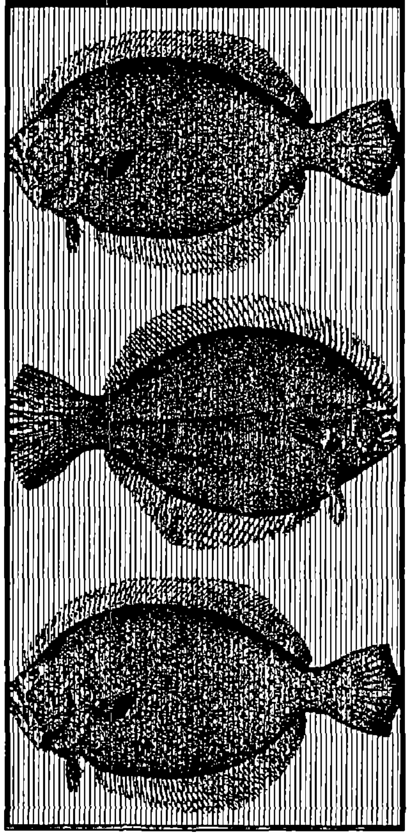
For more information

NMFS. 1990. Fisheries of the United States, 1989. Washington, D.C.: U.S. Department of Commerce. Current Fishery Statistics No. 8900. 116 pp. Available from: Superintendent of Documents, U.S. Government Printing Office, Wash. D.C. 20402

AGGREGATE RESOURCE TRENDS

Paralichthys dentatus
Summer flounder

Pseudopleuronectes americanus
Winter flounder



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

These relationships result in significant interactions among gear types, termed *technical interactions*, and among some species, termed *biological interactions*. Management of fishing activity in this region is complex because of these two types of interactions. This complexity is reflected, for example, in the structure of some of the fishery management plans (FMPs). The groundfish resources 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 needed to manage these fisheries requires knowledge of the dynamics of individual populations of each species, there is 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 United States.

Two sources of data are available for measuring the trends in aggregate resource abundance: research vessel trawl survey data, and 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 in fishing activity during recent years.

RESEARCH VESSEL TRAWL SURVEY DATA

The Northeast Fisheries Center has conducted an intensive bottom

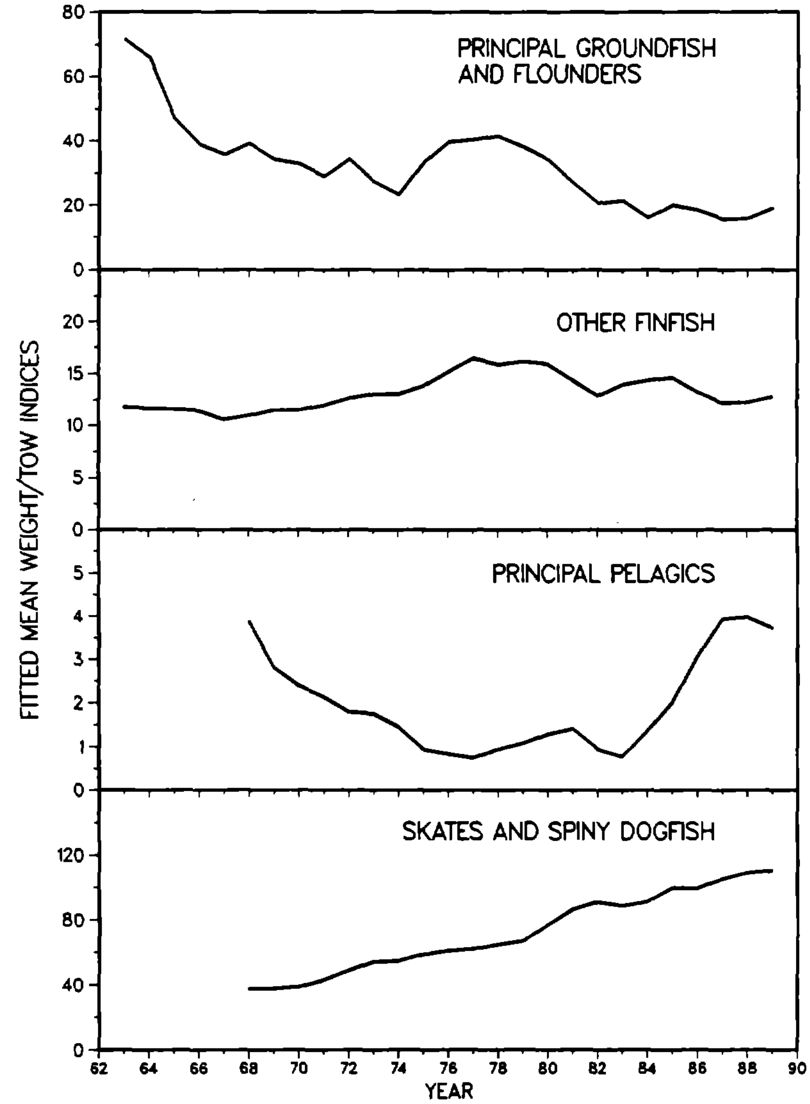


Figure 3. Trends in indexes of aggregate abundance (catch in weight per survey trawl haul) for four species groups, reflecting the major changes in fishery resources, 1962-1990.

trawl survey program off the northeast United States 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**: includes demersal species such as Atlantic cod, haddock, and yellowtail flounder, which have supported historically important trawl fisheries.
2. **Other finfish**: includes 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**: of minor commercial importance but 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 percent 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 proportion of dogfish and skates in Georges Bank survey catches has increased from roughly 25 percent by weight in 1963 to nearly 75 percent in recent years..."**

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 1989 index value was slightly higher reflecting a modest improvement in recruitment for some of these species.

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 U.S. 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 subsequently declined to minimal levels for 1987-1988 and then recovered somewhat, primarily due to high catches 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 that has accelerated in recent years; index values for 1987-89 are among the highest observed in the series, reflecting pronounced increases in abundance of both species (Figure 3). This trend is corroborated by virtual population analysis (VPA) of commercial catch at age data indicating recovery of both the Gulf of Maine herring stock and the Northwest Atlantic mackerel stock since 1980.

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 - little, winter, thorny, smooth-tailed, leopard, briar, and barndoor are included in this index. The continued increase in this index since the late 1960s reflects major changes in relative abundance within the finfish species complex, with increasing abundance of species of low commercial value. Survey catches of both dogfish and skates since 1986 have been the highest observed in the time series. The proportion of dogfish and skates in Georges Bank survey catches has increased from roughly 25 percent by weight in 1963 to nearly 75 percent in recent years, reflecting both the increases in dogfish and skate abundance and the declining abundance of groundfish and flounders.

COMMERCIAL TRAWL CATCH AND EFFORT DATA

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

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

1. Gulf of Maine (GM)
2. Georges Bank (GB)

3. Northern Mid-Atlantic Bight (N. MA; comprising the area from Cape Cod through New Jersey)

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

Total landings of all finfish and invertebrate species caught by trawlers were aggregated over all vessel size classes (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 percent. Landings in 1988 were approximately equal to the 1976 and 1977 totals. Nominal fishing effort in terms of number of days fished (Figure 4) nearly doubled from roughly 25,000 standard days in the 1976-78 period to roughly 48,000 in 1985. Subsequently, effort declined slightly, and has remained relatively constant since 1986.

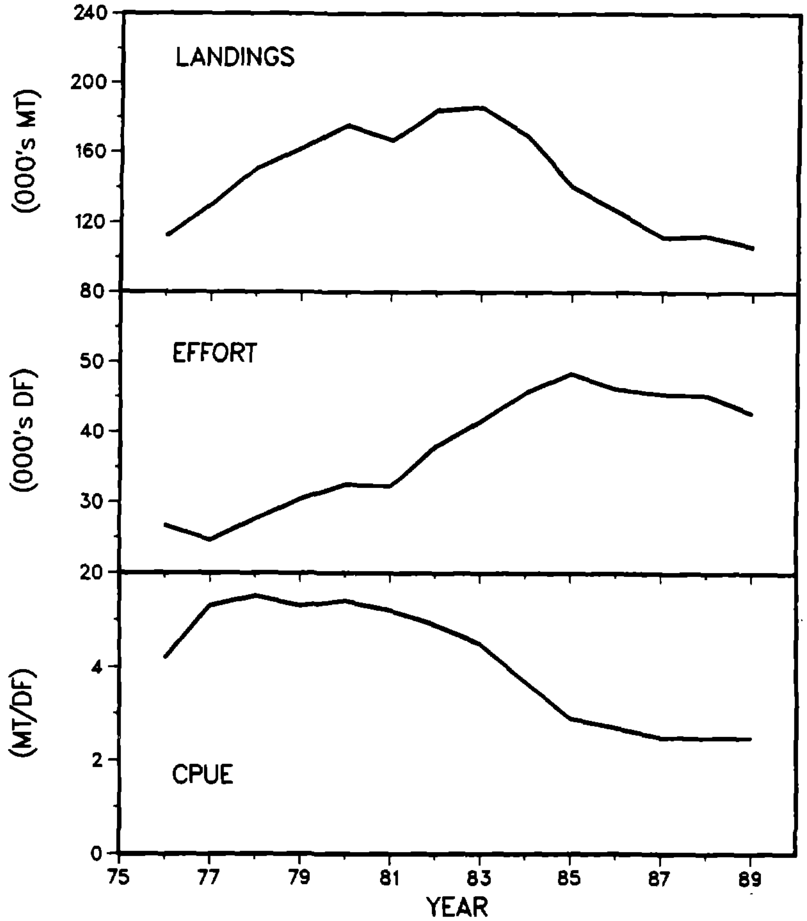


Figure 4. Total trawl catch (mt, all areas), standardized trawl fishing effort (DF, days fished), and catch divided by effort (CPUE, mt/DF) since the introduction of MFCMA in 1977, reflecting major changes in trawl fishing activity and aggregate resource abundance.

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

The total landings (mt) divided by the total standardized effort (days fished, DF) for all three regions combined is a 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 percent to 2.5 in 1987. The 1988 index was nearly identical to that for 1987. The changes in this CPUE index are similar to those observed in the research trawl data for principal groundfish and flounders, with an initial rise and subsequently a major decline. The trend in this CPUE index is markedly different from the research trawl data for pelagic species and for other finfish, as might be expected given the nature of the trawl fishery. This CPUE index may, however, underestimate the actual declines in abundance of demersal species because of increasing fleet efficiency. Also, this index includes species not included in the principal 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 1976-87 nominal effort increased 100 percent in the Gulf of Maine, 58 percent on Georges Bank, and 63 percent in the Northern Mid-Atlantic. Effort in 1988 decreased 12 percent in the Gulf of Maine and 2.5 percent in Southern New England, while it increased 7 percent on Georges Bank. Landings peaked in 1983 for the Gulf of Maine (125,000 mt), in 1982 on Georges Bank (196,000 mt), and 1984 in the Northern Mid-Atlantic, (98,000 mt). Landings by 1987 had declined 31, 55, and 28 percent in the three areas, respectively, since their peak years. In 1988 they declined further in the Gulf of Maine, by 21 percent over 1987, while they increased by 14 percent and 11 percent over 1987 on Georges Bank and in

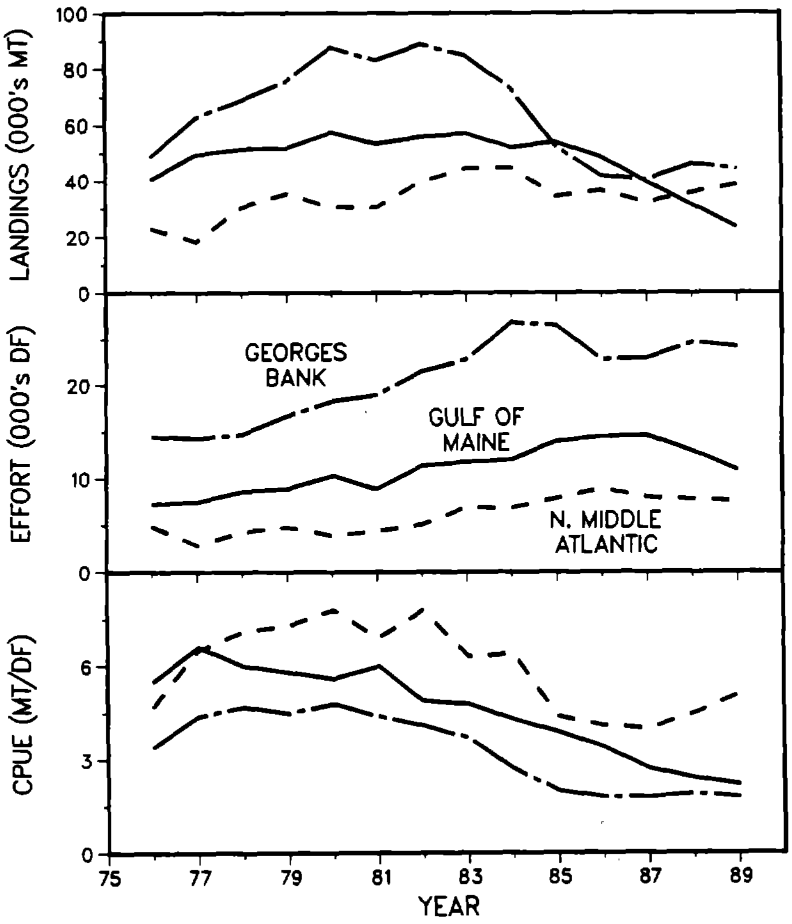


Figure 5. Total trawl catch (mt), standardized fishing effort (DF, days fished), and catch divided by effort (CPUE, mt/DF) since 1976, for three regions, reflecting changes in trawl fishing activitiy and aggregate resource abundance.

southern New England, respectively. CPUE declines were pronounced from 1977 to 1987, indicating rapid declines in stock abundance. The CPUE index for the Gulf of Maine region declined by more than 50 percent from its 1977 peak. Similarly, the index for Georges Bank region declined by more than 60 percent from its 1980 peak, while the index for the Northern Mid-Atlantic region declined by 50 percent from its 1982 peak. The CPUE index continued to decline in the Gulf of Maine, falling 8 percent over the 1987 level, but increased 5 and 14 percent on Georges Bank and in southern New England, respectively.

During the period covered in these analyses, the species composition of landings changed dramatically for most vessel size classes and areas. In the Gulf of Maine, landings of cod, redfish, and flounders have declined. Currently, pollock, silver hake, and shrimp predominate in the landings. On Georges Bank, haddock and yellowtail flounder stocks have declined and are a small fraction of overall catches, which are primarily cod, winter flounder, and windowpane flounder. In the Northern Mid-Atlantic Bight, catches are generally highly mixed, but several trends are notable. Yellowtail, winter, and summer flounder catches have declined relative to other species such as *Loligo* squid, butterfish, and silver hake.

CONCLUSIONS ABOUT RESOURCE ABUNDANCE

Both the research trawl data and the aggregate trawl fishery data suggest major changes in the abundance of resources in the Northeast Atlantic, especially since the implementation of the FCMA in 1977. Increases in abundance of groundfish and flounders associated with the reduction of foreign fishery effort during the mid-1970s were followed by increases in domestic fishing effort and landings. Abundance of groundfish and flounders started declining after 1978, and currently are at historically low levels. Abundance of other finfish has fluctuated widely, while that of the principal pelagics has increased steadily in recent years. More recently, the Georges Bank herring stock appears to be recovering. Trawl fishing effort increased steadily through 1985, and remains at near record high levels. Total trawl catches increased until 1983, and have subsequently declined to levels comparable to those seen in 1976 despite the great increase in fishing effort. These major changes in the fisheries have included extensive changes in the species composition of the catches, with shifts to previously less-desirable species. At the same time, major increases have occurred in the abundance of nontarget species such as spiny dogfish and skates.

It appears that most of these changes in resource abundance are directly related to changes in fishing 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 expands this pattern, with populations of several species being dominated by only one or two age groups.

> **"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."**

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 percent 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 the point that too few young fish result from each year's spawning.

The elevated levels of fishing mortality clearly have resulted in the first problem. Total catch has been less than what is possible because exploitation rates for many species far exceed 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 adults to produce sufficient numbers of young fish to maintain populations at even the 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 would result in an increased abundance of fishery resources.

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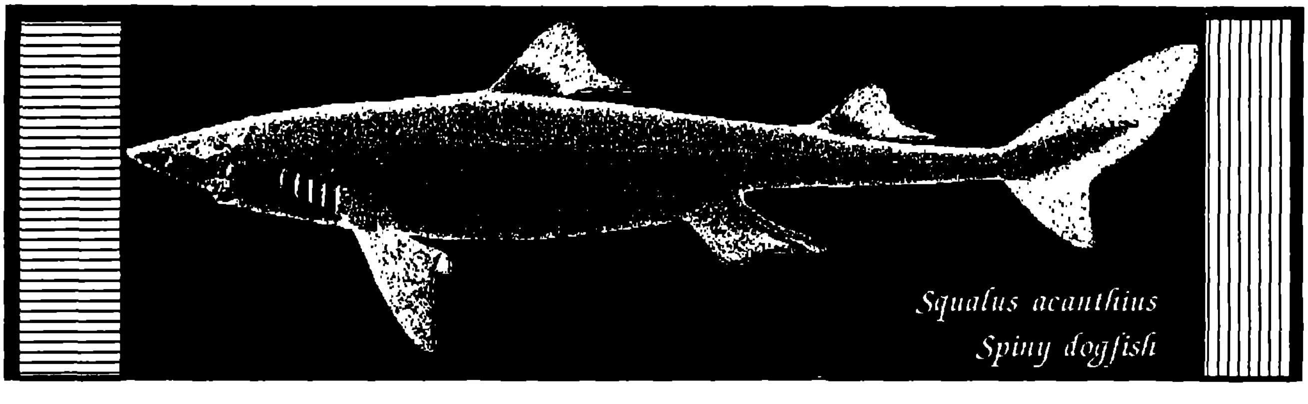
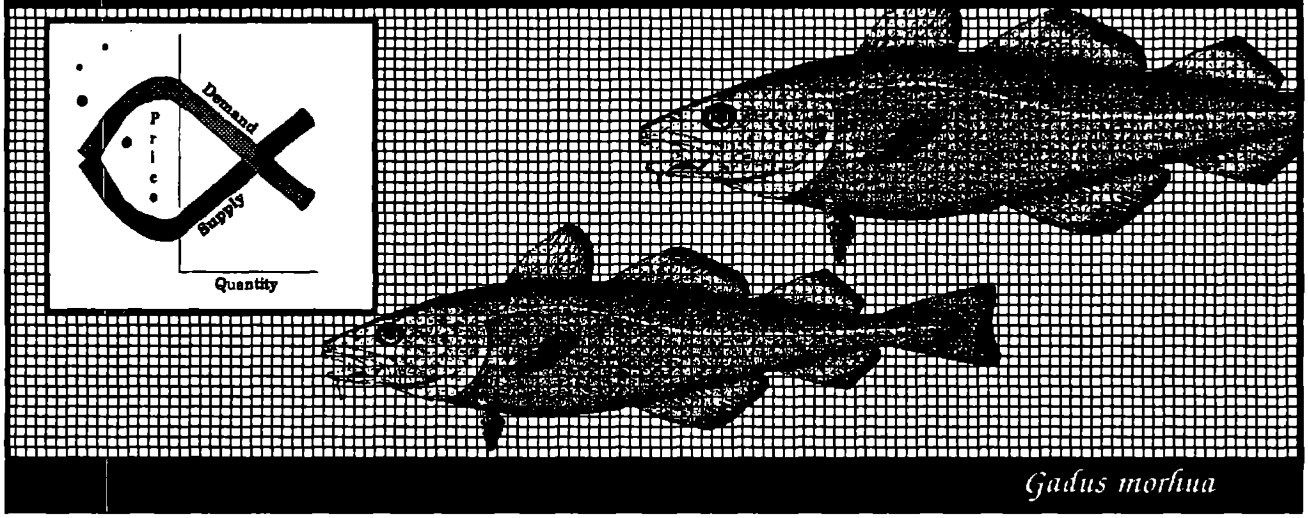


Squalus acanthias

Spiny dogfish

FISHERY ECONOMIC TRENDS



PREFACE

This section, formerly entitled "Commercial Fishery Economic Trends," has been significantly expanded in this issue. The scope is broader, going beyond an enlarged description of harvest sector activity to include, as available data permit, information on other sectors including processing and recreational fisheries. As now constituted, this document serves as the principal document in the Northeast Region's unified Stock Assessment and Fishery Evaluation Report (SAFE report). Regional SAFE reports, which include a profile of the fisheries in their wider economic context, are required under NOAA's Guidelines for Fishery Management Plans (50 CFR Part 602: July, 1989).

INTRODUCTION

In the Northeast Region, fishing that occurs in inland waters and near shore (less than three miles) is monitored and regulated by the individual states in New England (Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut), in the Mid-Atlantic (New York, New Jersey, and Delaware) and in the Chesapeake area (Maryland and Virginia). Certain near-shore and inshore fisheries come under the aegis of interstate bodies such as the Atlantic States Marine Fisheries Commission (ASMFC). This group coordinates both research and planning for important species such as striped bass, bluefish, and Northern shrimp, whose range in the territorial sea spans several states.

Since the passage of the Magnuson Fisheries Conservation and Management Act (MFCMA) in 1976, either the New England or Mid-Atlantic Fishery Management Council has developed fishery management plans (FMPs) or preliminary management plans (PMPs) for most commercially important species caught predominantly in the region's fishery conservation zone (FCZ), the area between 3 and 200 miles offshore.

Where significant inshore and offshore fisheries target the same species, two management plans may be in effect. When this occurs, they are closely coordinated. For important species whose range spans beyond the Northeast region, several councils, with one as lead, promulgate the regulations.

Some highly migratory fish species come under international management. Most significant is the International Commission for the Conservation of Atlantic Tunas (ICCAT), which fosters cooperative management by member states and sets regulations for the high seas.

Prior to reauthorization of the Magnuson Act in 1990, the United States did not exercise management authority over tunas in the U.S. Economic Exclusionary Zone (EEZ), which is the same offshore area as the FCZ. However, the Northeast Regional Office of NMFS did administer an ICCAT quota for bluefin tuna. Portions of billfish stocks that moved through the EEZ were under multi-council management. Various ways of managing sharks and swordfish in the EEZ were under consideration in 1989.

In the Northeast, five exclusively regional FMPs are in effect covering 1) multispecies groundfish (consisting of ten demersal species), 2) sea scallops, 3) surf clams and ocean quahogs, 4) offshore lobster, and 5) squid, mackerel, and butterfish. A sixth, for summer flounder includes the South Atlantic Council as a participant.

Table 3. Northeast landings (1,000 mt), values ($ million) and prices ($/lb) of important species - 1985-1989

Year	Quantity	Value	Price	Quantity	Value	Price	Quantity	Value	Price	Quantity	Value	Price	Quantity	Value	Price
Year	**Lobster[1,2]**			**Sea Scallops[3,2]**			**Hard Clam[1]**			**Cod[2]**			**Blue Crab[1]**		
1985	21.3	117.0	2.49	6.8	72.0	4.82	5.7	45.8	3.64	37.4	35.0	0.42	48.0	36.0	0.34
1986	20.8	120.1	2.62	8.3	91.0	4.97	4.7	40.6	3.92	27.6	36.0	0.59	42.9	34.3	0.36
1987	20.8	142.1	3.10	13.2	123.4	4.23	5.0	50.3	4.59	26.8	44.2	0.75	38.9	37.6	0.44
1988	22.2	146.4	2.99	13.0	121.9	4.24	6.8	48.7	3.25	34.6	43.0	0.56	41.8	40.6	0.44
1989	24.0	148.9	2.82	14.4	126.6	3.98	4.2	50.6	5.48	35.6	47.8	0.61	45.6	42.0	0.42
Year	**Menhaden[1]**			**Surf Clam[2,3]**			**Oyster Meats[3]**			**Summer Flounder[1,2]**			***Loligo* Squid[2]**		
1985	314.6	31.0	0.04	32.1	37.8	0.53	6.7	30.0	2.04	10.8	23.4	0.99	9.0	6.2	0.31
1986	222.6	24.3	0.05	35.4	42.2	0.54	6.8	37.8	2.51	9.5	26.3	1.25	11.5	9.0	0.35
1987	300.0	32.5	0.05	27.4	27.9	0.46	4.3	29.5	3.11	9.9	32.0	1.46	10.5	9.3	0.40
1988	273.5	29.7	0.05	28.6	28.9	0.46	3.1	26.2	3.81	11.6	33.6	1.31	18.9	15.4	0.37
1989	287.8	31.3	0.05	30.4	30.7	0.46	2.4	22.3	4.16	6.2	22.2	1.63	23.0	21.8	0.43
Year	**Bluefin Tuna[4]**			**Winter Flounder[1,2]**			**Soft Clam[3]**			**Swordfish[4]**			**Ocean Quahog[2]**		
1985	1.3	9.0	3.16	11.0	20.6	0.85	3.3	20.0	2.73	2.0	11.1	2.50	22.5	15.7	0.32
1986	0.9	15.2	7.92	8.0	17.6	1.00	2.9	20.8	3.21	2.0	13.1	3.01	20.6	15.7	0.35
1987	1.0	11.9	5.54	9.0	24.1	1.21	3.4	19.2	2.58	2.1	16.0	3.39	22.8	16.6	0.33
1988	0.8	11.3	6.61	8.4	22.4	1.20	3.5	20.1	2.60	2.7	18.1	2.99	21.0	14.9	0.32
1989	1.1	19.7	8.01	6.6	19.6	1.34	2.9	19.4	2.98	2.7	17.2	2.92	23.1	16.4	0.34
Year	**Yellowtail Flounder[2]**			**Goosefish**			**Pollock[2]**			**Silver Hake[2]**			**Witch Flounder[2]**		
1985	11.2	20.3	0.82	7.2	4.5	0.28	19.8	7.0	0.16	20.2	8.3	0.19	6.4	12.9	0.91
1986	10.4	21.0	0.92	6.7	6.9	0.47	24.6	14.0	0.26	18.0	8.2	0.21	5.2	12.9	1.14
1987	7.6	20.1	1.20	6.9	9.8	0.64	20.7	17.9	0.39	15.7	11.6	0.33	3.8	12.2	1.45
1988	5.0	13.2	1.19	7.6	10.4	0.62	15.0	11.0	0.33	16.1	8.6	0.24	3.6	11.6	1.46
1989	5.6	13.9	1.13	11.3	12.6	0.51	10.5	9.9	0.43	17.8	9.4	0.24	2.4	9.0	1.73
Year	**American Plaice[2]**			**Northern Shrimp[1]**			**Scup[1,2]**			**Atlantic Herring[1]**			**Haddock[2]**		
1985	8.4	15.0	0.81	4.2	4.1	0.44	6.5	8.1	0.57	25.9	3.0	0.05	6.5	13.5	0.94
1986	6.1	12.4	0.92	4.7	6.5	0.63	6.7	8.3	0.56	32.0	3.8	0.05	5.0	10.9	0.99
1987	5.1	11.9	1.07	5.0	12.2	1.10	6.0	8.7	0.66	39.4	4.5	0.05	3.0	8.5	1.28
1988	4.7	10.5	1.01	3.1	7.5	1.10	5.6	8.1	0.66	40.9	5.2	0.06	2.9	7.0	1.09
1989	3.5	8.8	1.14	3.6	7.8	0.98	3.5	6.1	0.78	40.7	5.0	0.06	1.7	4.5	1.19
Year	**White Hake[2]**			**Butterfish[2]**			***Illex* Squid[2]**			**Atlantic Mackerel[2]**			**Windowpane Flounder[2]**		
1985	7.4	3.3	0.21	4.6	3.5	0.34	2.4	0.8	0.15	2.9	1.0	0.15	4.2	4.9	0.53
1986	6.4	4.8	0.34	4.5	6.5	0.66	4.4	1.5	0.15	4.0	1.1	0.13	3.2	3.7	0.52
1987	5.8	5.2	0.41	4.6	6.4	0.63	7.0	3.1	0.20	4.3	1.0	0.11	2.3	3.1	0.61
1988	4.8	3.2	0.31	2.1	3.2	0.68	2.0	0.6	0.13	6.4	1.9	0.13	2.6	3.0	0.53
1989	5.1	4.4	0.39	3.0	3.9	0.60	6.8	3.2	0.22	8.1	3.2	0.18	2.6	3.1	0.55
Year	**Sea Bass[1,2]**			**Bigeye Tuna[4]**			**Weakfish[1]**			**Tilefish[2]**			**Yellowfin Tuna[4]**		
1985	1.2	2.7	0.99	0.4	2.0	2.39	2.7	3.2	0.53	2.0	4.9	1.13	0.4	0.4	0.53
1986	1.6	3.5	0.99	0.6	4.4	3.43	2.7	2.7	0.45	2.0	5.0	1.17	0.7	1.8	1.16
1987	1.7	3.9	1.02	0.6	4.7	3.56	2.2	2.7	0.55	3.2	7.9	1.11	0.9	2.6	1.25
1988	1.3	3.2	1.08	0.5	4.0	3.95	2.2	2.3	0.48	1.4	5.3	1.76	0.8	2.4	1.46
1989	1.0	2.7	1.20	0.4	2.7	3.18	1.7	2.7	0.73	0.5	2.0	1.81	0.5	1.6	1.33
Year	**Bluefish[1]**			**Ocean Perch[2]**			**Red Hake[2]**			**Striped Bass[1]**			**Ocean Pout[2]**		
1985	4.2	1.6	0.17	4.4	3.2	0.33	1.8	0.5	0.13	0.4	1.5	1.53	1.5	0.3	0.09
1986	4.6	1.8	0.18	3.0	3.2	0.48	2.1	0.7	0.14	0.1	0.2	1.06	0.8	0.2	0.11
1987	3.8	2.0	0.24	1.9	2.7	0.64	2.0	0.9	0.20	0.1	0.2	1.32	2.2	0.5	0.10
1988	4.3	1.8	0.19	1.1	1.5	0.62	1.7	0.6	0.16	0.1	0.4	1.39	1.8	0.4	0.10
1989	2.7	1.3	0.22	0.6	0.9	0.66	1.6	0.6	0.17	0.1	0.4	2.12	1.3	0.3	0.11

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[1] Inshore fisheries managed by or being considered for management by the Atlantic States Marine Fisheries Commission (ASMFC)

[2] Offshore fisheries managed by or being considered for management by regional fishery management councils under a Fishery Management Plan (FMP)

[3] Inshore individual state management

[4] EEZ landings monitored by NMFS for the International Commission for the Conservation of Atlantic Tunas (ICCAT), Secretary of Commerce asserted in 1991

Table 4. Number of operating craft in the region and principal gears used

Gear Type	New England[1]		Mid-Atlantic[1]		Chesapeake[2]		Total	
	Vessels	Boats	Vessels	Boats	Vessels	Boats	Vessels	Boats
Haul seine-beach	-	13	-	26	15	99	15	138
Danish/Scottish seine	14	-	-	-	-	-	14	-
Stop seine	-	71	-	-	-	-	-	71
Purse seine	22	105	3	-	36	-	61	105
Otter trawl - fish	886	186	272	23	268	-	1,426	209
Otter traw - lobster, scallop	7	7	30	-	43	-	80	7
Otter trawl - shrimp	251	117	-	-	-	-	251	117
Trawl, mid-water	7	-	-	-	2	-	9	-
Weir	-	43	-	-	-	2	-	45
Pound net	-	5	5	57	99	121	104	183
Pound net-crab	-	-	-	-	1	200	1	200
Fyke/hoop net	-	7	1	29	23	128	24	164
Floating trap	8	29	-	-	-	-	8	29
Pot/trap - crab	3	89	3	288	697	3,018	703	3,395
Pot/trap - conch	-	150	-	50	-	-	-	200
Pot/trap - eel	-	56	-	60	6	156	6	272
Pot/trap - fish	3	68	9	2	67	197	79	267
Pot/trap - lobster	1,148	7,291	73	440	-	-	1,221	7,731
Pot/trap - shrimp	10	34	-	-	-	-	10	34
Gill net	163	154	13	246	201	1,477	377	1,877
Gill net/small drift	8	82	1	107	245	1,954	254	2,143
Hand line	34	2,184	22	1,022	3	108	59	3,314
Troll line	8	890	6	17	1	-	15	907
Trot line w/bait	-	-	-	-	445	9,091	445	9,091
Longline/line trawl	94	46	94	50	46	27	234	93
Nets - dip, push, drop	-	82	-	-	-	-	-	82
Harpoon/spear	5	90	-	20	-	-	5	110
Dredge - clam	19	188	134	15	267	75	420	278
Dredge - crab, conch	-	2	18	82	158	40	176	124
Dredge - mussel	-	155	-	-	-	-	-	155
Scrapers	-	-	-	-	30	52	30	52
Dredge - oyster	15	92	12	-	194	199	221	291
Dredge - bay scallop	-	654	1	5	-	-	1	659
Dredge - sea scallop	157	266	62	-	170	-	389	266
Tong/grab - oyster	-	85	-	1	1,239	3,793	1,239	3,897
Tong/grab - clam, other	-	74	-	1,237	97	236	97	1,547
Rake	-	3,583	-	2,291	-	19	-	5,893
Hoes, forks, picks, *etc.*	-	2,748	-	30	-	-	-	2,778
Diving outfits	-	201	-	-	-	113	-	314
Other hand methods	-	37	-	660	-	1	48	154
All other	-	26	1	127	27	8	-	705
Gears in use	2,862	19,910	780	6,855	4,380	21,114	8,022	47,879
Craft in use (no duplication)	2,434	15,334	658	5,935	2,464	16,838	5,556	38,107

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[1] **Based on 1987 surveys**

[2] **Based on projections from 1982 surveys**

REGIONAL PRODUCTION SUMMARY

The Northeast's commercial oceanic and estuarine fisheries produced domestic landings worth $794 million dock side in 1989, a slight increase of $12 million, or 1.5 percent, over the previous year. Total landings were up 3 percent to 687,000 mt. Finfish landings brought in $277 million, representing 35 percent of the revenue generated, but continuing an absolute and relative decline in overall contribution. Shellfish landings increased by more than 21,000 mt, to slightly less than 199,000 mt.

The most important species of fish and shellfish landed in the region are shown in Table 3, along with their prices, total live weight, and value for the last five years. This table includes all species currently or soon to be managed by the two councils plus other commercially important species. They are ranked by the value of 1989 landings. Six of the top eight are shellfish. Four of these are harvested predominantly in inshore fisheries. The majority of sea scallops, cod, and surf clams are caught in the EEZ.

There are a great variety of trends in the prices and landings of the species shown. Many species have experienced substantial declines in landings over the five years. In most cases, prices have rebounded from their 1988 decline. The large number of flatfish species upon which many vessels depend have had steadily reduced landings over the five years shown. Also striking is the increasing importance of and apparent resilience of the top five species over the five year period.

A large number of craft and a great variety of gears are employed in the various fisheries in the Northeast. The most complete set of figures available describes that diversity as of 1987 and is shown in Table 4. Vessels are defined as craft of five or more gross registered tons displacement (GRT), whereas boats are less than 5 GRTs. The 1987 surveying activity noted over 5,500 vessels and 38,000 active boats. Although a majority of vessels and boats used a single gear, a significant number of each employed more than one. Most fishing operations are small and do not operate in the EEZ. Various crab fisheries employ the largest number of gear/boat combinations, followed by inshore lobster operations.

The latest available indication of the relative importance of these gears, in terms of landings and revenue, is shown for 1988 landings in Table 5. Purse seines, bottom otter trawls and surf clam dredges account for 75 percent of the landings by weight, while the revenue is more widely, but not evenly, distributed. Otter trawls produce the most revenue followed by combined inshore and offshore lobster gear and then clam dredges.

"The Northeast's commercial oceanic and estuarine fisheries produced domestic landings worth $794 million dockside in 1989, a slight increase of $12 million, or 1.5 percent, over the previous year."

Table 5. Northeast region landings (1,000 mt) and ex-vessel revenue (million $) by gear used, 1988

Gear Type	Landings	Revenue
Haul seine, common seine, beach seine	1.8	1.0
Danish seine/Scottish seine	0.5	0.8
Stop seine	0.7	0.1
Purse seines		
herring/mackerel/menhaden/tuna/other	300.7	37.2
Otter trawls, bottom-fish	145.4	190.7
Otter trawl, bottom-shrimp	4.0	8.4
Otter trawl, bottom-lobster/scallop; pair	0.5	3.6
Otter trawl, mid-water, mid-water pair	1.4	0.9
Weir	1.2	0.5
Pound nets-fish/crab/horseshoe/other	13.5	5.0
Fyke net, hoop nets-fish/crab/other	0.5	0.5
Floating trap	2.3	2.1
Pot/trap-crab	35.0	34.3
Pot/trap-fish/eel/conch/octopus/other	2.3	5.1
Pot/trap-shrimp	0.1	0.2
Pot/trap, inshore-lobster	20.6	122.0
Pot/trap, offshore-lobster	3.4	19.5
Gill net/set/stake/sink-sea bass, crab	0.1	0.1
Gill net/drift-small pelagics, large pelagics	3.1	2.9
Gill net/runaround	0.9	0.6
Gill net/other	18.6	15.5
Hand lines/hand-line auto jig	2.2	8.2
Troll lines/tuna, other	0.2	1.0
Trot line with bait-crab	6.3	7.5
Longline/set line/line trawl	7.8	32.2
Harpoons/spear	0.2	2.0
Dredge/common suction-oyster	1.2	12.6
Dredge-bay scallop	0.2	3.1
Dredge-sea scallops	18.6	125.0
Dredge-clam	54.5	58.9
Dredge-crab	3.7	3.2
Dredge-mussel	3.2	2.7
Dredge-conch/other; scrapes	0.4	0.8
Tong/grab-oyster; patented oyster	1.9	12.2
Tong/grab-clam, other	1.2	13.2
Rakes-oyster, other	2.6	29.5
Hoes, forks, shovels, picks, *etc.*	1.6	11.1
Diving outfits	2.4	2.5
Other hand methods	0.6	3.2
All others including various hand-held nets	0.7	2.4
1988 Total	**666.1**	**782.3**

Table 6. Fishermen and crew in the Northeast region - based on the 1987 census of boats and vessels

	Vessels	Boats	
	Full-time Crew	Full-time Fishermen	Part-time Fishermen
New England	9,039	7,301	11,619
Mid-Atlantic	2,487	1,229	7,048
Chesapeake	6,388	7,190[1]	14,836[1]
Total	**17,914**	**15,720**	**33,503**

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[1] Projections based on 1982 census

Table 7. Permits issued in the Northeast by gear, 1989

Proposed Gear Use	Number of Vessels Using Gear	Number of Boats Using Gear
Purse seine	41	-
Beach seine	4	-
Boat seine	20	-
Bottom trawl	1,724	-
Mid-water trawl	156	-
Other trawl	107	5
Boat dredge	1,283	78
Gill/entanglement net	460	102
Potsand trap	1,253	247
Handline	691	452
Rod and reel	-	1,163
Longline/set line	612	97
Harpoon	82	21
Other gear	79	23
Diving gear	165	57
Permits by gear	**6,677**	**2,245**
Permitted craft	**4,681**	**1,702**

Over 66,000 persons were estimated to have had at least part time dependence as harvesters on the commercial fisheries of the region in 1987 (Table 6). Half of these were fully dependent as vessel and boat owners and crew. These numbers are likely to be conservative, especially for vessel crew member estimates. This is discussed next.

DATA COLLECTION CONSIDERATIONS

In the Northeast Region, NMFS collects information on landings through a network of 25 federal and state port agents located at the busiest ports. The principal activity in these ports is the collection of weighout sales receipts at the point of first sale. Weekly and monthly visits to less busy ports supplement the weighout collections. An annual census, combined with state data collections (primarily for inshore species), completes the landings enumerations. All of the landings are recorded along 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 able one is to associate landings with a particular craft and the type of fishing gear used.

All vessels 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. In addition, all boats and vessels that commercially exploit the species managed under federal FMPs in the region are required to apply annually for the appropriate fishery specific permits. Table 7 shows the vessels and boats granted permits to fish certain gears in 1989 (most boat applications were for rod and reel permits to fish bluefin tuna). Bottom trawls, scallop and clam dredges, and pot and trap gear requests predominate among vessels. In many instances the number of permits issued exceeds the numbers of vessels actually using that gear in a given year. Table 8 shows the total number of vessels, scallop dredge vessels, and otter trawl vessels represented in the weighout data base from 1980 through 1989.

The collection of weighout receipts coupled with the ability to identify the particular vessel involved allows landings to be associated with vessel and gear characteristics. Post-trip interviews augment that relationship with effort information. The new sea sampling program is contributing greatly to refining the associations among landings, effort, fishing strategies, and discards.

The vessels that hold permits for the regulated fisheries of the northeastern United States, and which are required to carry Coast Guard registration, are the primary target of and vehicle for federal and council fishery management activity in the region. This fleet's activity is the focus of the commercial data collection activity along the coast.

In theory, all landings of regulated species made by vessels should be associated with specific vessels in the weighout data base system. In reality, port coverage would have to be much more extensive to do so. Table 9 is a listing of landings made and revenue generated by gear of identified vessels that were recorded

"Bottom trawls, scallop and clam dredges, and pot and trap gear permit requests predominate among vessels."

Table 8. Number of identifiable vessels using otter trawl, scallop dredge and other gear in the Northeast region by ton class[1], 1980-1989

		Scallop Dredges				Otter Trawls				All Vessels[2]			
Year		TC2	TC3	TC4+	Total	TC2	TC3	TC4+	Total	TC2	TC3	TC4+	Total
1980	Northeast[3]	44	191	109	344	504	434	96	1,034	768	678	204	1,650
	New England[4]	39	148	86	273	457	361	82	900	616	532	168	1,316
	Mid-Atlantic & Chesapeake[5]	5	88	37	130	53	97	16	166	162	222	57	441
1981	Northeast	30	173	140	343	491	491	117	1,099	798	752	256	1,806
	New England	30	141	120	291	449	386	86	921	623	550	191	1,364
	Mid-Atlantic & Chesapeake	1	82	51	134	49	139	37	225	189	303	106	598
1982	Northeast	18	107	111	236	538	515	140	1,193	838	738	247	1,823
	New England	16	86	89	191	487	403	120	1,010	653	533	190	1,376
	Mid-Atlantic & Chesapeake	2	47	34	83	56	149	38	243	201	288	96	585
1983	Northeast	61	121	109	291	496	556	140	1,192	776	800	254	1,830
	New England	52	84	84	220	448	435	113	996	581	583	193	1,357
	Mid-Atlantic & Chesapeake	9	72	39	120	54	175	44	273	215	334	103	652
1984	Northeast	43	125	117	285	492	609	140	1,241	795	850	273	1,918
	New England	37	83	93	213	443	459	119	1,021	611	595	217	1,423
	Mid-Atlantic & Chesapeake	6	72	44	122	54	205	31	290	197	360	104	661
1985	Northeast	20	91	117	228	474	553	154	1,181	772	795	290	1,857
	New England	20	64	86	170	421	422	129	972	590	554	217	1,361
	Mid-Atlantic & Chesapeake	0	48	44	92	59	171	35	265	193	316	110	619
1986	Northeast	10	87	105	202	437	536	150	1,123	732	782	284	1,798
	New England	10	46	80	136	379	389	126	894	540	505	209	1,254
	Mid-Atlantic & Chesapeake	0	53	39	92	63	186	39	288	203	341	108	652
1987	Northeast	17	101	116	234	508	536	141	1,185	810	797	292	1,899
	New England	17	47	89	153	445	369	112	926	631	493	209	1,333
	Mid-Atlantic & Chesapeake	0	64	34	98	65	195	34	294	187	358	98	643
1988	Northeast	27	111	136	274	486	564	161	1,211	828	817	329	1,974
	New England	26	56	109	191	422	370	126	918	651	499	242	1,392
	Mid-Atlantic & Chesapeake	1	63	42	106	64	225	39	328	177	368	113	658
1989	Northeast	41	116	159	316	402	551	151	1,104	735	812	341	1,888
	New England	38	57	125	220	360	374	112	846	599	509	247	1,355
	Mid-Atlantic & Chesapeake	4	68	54	126	44	217	46	307	143	365	130	638

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[1] TC2 = 5-50 gross registered tons (grt), TC3 = 51-150 grt, TC4 = 151+ grt

[2] The "all vessels" columns provide a unique count of vessels regardless of gear used.

[3] Northeast vessels include those that landed at least once in ME, MA, NH, RI, NY, NJ, MD, VA. The "Northeast" row eliminates duplication of vessels that landed in both sub-regions.

[4] New England vessels include those that landed at least once in ME, MA, NH, RI.

[5] Mid-Atlantic & Chesapeake vessels include those that landed at least once in NY, NJ, MD, VA. Maryland and Virginia joined this reporting system in 1981, and New York in 1986.

Table 9. Identified vessels' landings (1,000 mt) and ex-vessel revenue (million $) in the Northeast by gear used, 1989

Gear Types	Landings	Revenue
Otter trawl, bottom-fish	113.02	158.6
Dredge-sea scallop	19.05	127.5
Dredge-surf clam & ocean quahog	50.03	42.6
Pots & traps-lobster, offshore,inshore	3.65	19.6
Longline/set line/line trawl	3.44	18.7
Gill net, other	15.06	13.4
Purse seine-tuna	0.45	8.4
Otter trawl, bottom-shrimp	3.40	6.6
Otter trawl, bottom-scallop	0.42	3.0
Pots & traps-crabs	2.38	3.0
Gill net, drift-small pelagics	0.38	2.8
Purse seine-herring	21.75	2.8
Floating trap	1.15	1.5
All other gears	11.65	4.3
1989 total	**245.83**	**413.0**

Table 10. Ex-vessel value of principal species caught by individually identifiable vessels in 1989 (million $), and the percentage this represents of the species' total regional landed value

Species	Value	%	Species	Value	%
Sea scallops	120.7	96.2	Butterfish	3.5	89.2
Cod	41.6	87.0	*Illex* squid	3.2	99.1
Surf clam	27.9	90.8	Atlantic herring	3.1	61.8
Lobster-offshore	19.7	13.3	Windowpane flounder	3.1	96.9
Loligo squid	18.2	83.3	Atlantic mackerel	2.9	91.6
Winter flounder	18.0	91.7	Mussels[1,2]	2.9	75.9
Summer flounder	17.8	80.4	Bigeye tuna	1.9	63.0
Swordfish	15.6	90.8	Black sea bass	1.9	68.5
Ocean quahog	14.7	89.6	Yellowfin tuna	1.2	73.5
Yellowtail flounder	12.0	86.5	Jonah crab[1]	1.0	89.0
Goosefish[1]	11.8	93.4	Menhaden	1.0	3.2
Pollock	8.7	87.8	Weakfish-Squeteague	0.9	32.7
Witch flounder	8.6	95.8	Ocean perch	0.9	97.2
Bluefin tuna	8.4	42.7	Cusk[1]	0.9	87.4
American plaice	8.3	94.9	Tilefish	0.8	42.1
Silver hake	6.5	69.0	Spiny dogfish[1]	0.7	84.1
Northern shrimp	5.9	74.9	Bluefish	0.7	48.9
Haddock	4.4	95.9	Red hake	0.5	81.9
Scup	4.3	70.5	Wolffishes[1]	0.4	93.6
White hake	3.7	83.3	Ocean pout	0.3	97.7
			Skates[1,2]	0.3	36.3

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[1] **Currently not under consideration for federal management**

[2] **The 1988 ratio is the latest available**

in 1989. The landings shown are about 35 percent of all landings for all fisheries in all waters of the region, while the revenue represented is slightly more than 53 percent. A comparison of this table with Table 5 shows that the representation across gears varies widely.

More important is whether port collection activity adequately covers, or presents the opportunity for covering, the fishing activity associated with regulated species. Table 10 gives an indication of this coverage for 1989 by ranking the most important species caught by identified vessels based on the revenue generated, and by comparing that revenue to the total revenue generated by that species in 1989 from all sources. With the exception of lobsters, the coverage is very extensive for all species except those that have a large inshore and/or recreational catch component.

Lastly, the standard weighout information contained on the slips themselves has been augmented significantly. In 1989, 15 percent of the trips by vessels that regularly take single day trips were interviewed at their conclusion. Forty-nine percent of the trips by vessels regularly taking multiple-day trips were interviewed.

FLEETS AND FISH

The tables that follow contain condensed pictures of the activity of known vessels 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 how vessels are performing. Most of the information concerns effort, landings, and revenue. No cost information is explicit.

Although all management plans affect individual vessels and fleets of vessels, our ability to see those impacts varies tremendously from fish-

Table 11. New England otter trawl vessels, ton class 2, all gears used

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Vessel count	457	449	487	448	443	421	379	445	422	360
Average age	22	22	22	22	23	23	23	22	23	24
Average grt	26	27	27	27	28	27	27	30	27	28
Average days absent	69	66	69	78	68	65	66	62	62	62
Average crew size	2.8	2.8	2.7	2.7	2.8	2.7	2.7	2.6	2.7	2.8
Revenue per day absent($)	819	988	866	827	827	857	929	1,022	866	920
Lb per day absent	2,679	2,797	2,471	2,328	2,448	2,172	2,020	1,670	1,633	1,585
Average number of trips/vessel	55	52	54	54	54	54	56	53	53	54

Table 12. New England otter trawl vessels, ton class 3, all gears used

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Vessel count	361	386	403	435	459	422	389	369	370	374
Average age	15	15	21	20	19	19	20	21	17	16
Average grt	96	97	99	98	100	101	110	100	99	101
Average days absent	116	106	116	119	121	129	129	131	130	123
Average crew size	5.5	5.5	5.6	5.4	5.5	5.4	5.4	5.3	5.3	5.3
Revenue per day absent($)	1,868	2,061	2,170	2,034	1,976	1,797	1,944	2,276	1,892	1,844
Lb per day absent	6,913	6,449	6,547	5,391	4,884	3,758	3,223	3,105	2,983	2,685
Average number of trips/vessel	38	33	36	35	35	37	38	38	38	35

Table 13. New England otter trawl vessels, ton class 4, all gears used

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Vessel count	82	86	120	113	119	129	126	112	126	112
Average age	11	11	9	9	9	8	8	8	9	8
Average grt	196	190	187	184	181	193	191	177	193	193
Average days absent	141	156	154	163	165	166	169	175	163	174
Average crew size	7.6	7.6	7.9	7.8	7.8	7.7	7.6	6.9	7.2	7.1
Revenue per day absent($)	2,767	3,221	3,134	3,086	2,931	2,746	3,042	3,395	3,075	3,305
Lb per day absent	8,735	8,638	9,600	7,369	6,760	5,931	5,256	5,892	5,107	5,955
Average number of trips/vessel	22	23	24	25	25	24	24	26	23	25

ery to fishery. The clearest relationship is to be found in the management of the mid-Atlantic surf clam fishery. For several years now, the fleet has been a fixed pool composed entirely of vessel-class craft, all of which were based within the region. Also, all of each vessel's fishing activity was known and recorded. In this regard, the data collection system was so complete as to constitute an individual vessel time-series. Furthermore, in this fishery, almost all of the fishing activity was directed at surf clams, although that which was not could also be tracked. Lastly, there was virtually no gear switching. Resource monitoring was simplified in this fishery because of the very small amount of by-catch.

Where one or more of these direct and simplifying relations is lacking, the actual impact of fishery regulations is more difficult to discern. In reality, the absence of several of these connections typifies most of the fisheries in the region.

> **"Although all management plans affect individual vessels and fleets of vessels, our ability to see those impacts varies tremendously from fishery to fishery."**

In the tables that follow, an attempt has been made to show aggregations of identified vessels that impact the regulated species and which are, in turn, impacted by fishery management plans. Again, the connections vary from very close to tenuous. This set of associations is not exhaustive: not all landings of all the species of interest can be associated with the gears shown, nor are all of the vessels of the region represented. The vast majority of each is accounted for.

Table .14 . Mid-Atlantic otter trawl vessels, ton class 2, all gears used

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Vessel count	53	49	56	54	54	59	63	65	64	44
Average age	28	24	29	27	29	27	26	23	23	21
Average grt	30	31	32	32	32	31	30	31	31	30
Average days absent	55	52	51	54	53	48	44	41	37	55
Average crew size	2.5	2.8	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.7
Revenue per day absent ($)	820	760	813	873	652	785	780	1,000	910	861
Lb per day absent	3,542	2,425	2,192	2,709	2,522	27,35	2,443	1,966	2,142	2,241
Average number of trips/vessel	49	46	42	48	43	44	38	34	33	54

Table 15. Mid-Atlantic otter trawl vessels, ton class 3, all gears used

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Vessel count	97	139	149	175	205	171	186	195	225	217
Average age	12	13	13	13	13	15	14	14	14	15
Average grt	99	99	101	101	100	100	101	134	134	103
Average days absent	58	48	59	67	68	67	64	61	65	70
Average crew size	4.7	5.0	5.0	5.0	4.8	4.7	4.9	4.5	4.5	4.8
Revenue per day absent($)	1,573	1,488	1,676	1,895	1,803	1,528	1,847	2,130	1,974	1,682
Lb per day absent	5,003	4,445	5,526	4,556	5,289	3,057	4,120	3,411	3,819	4,536
Average number of trips/vessel	30	20	21	21	23	24	23	19	17	22

Table 16. Mid-Atlantic otter trawl vessels, ton class 4, all gears used

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Vessel count	16	37	38	44	31	35	39	34	39	46
Average age	5	3	6	5	6	6	7	7	7	8
Average grt	173	172	173	174	171	173	174	176	176	175
Average days absent	78	89	122	112	131	118	118	100	102	99
Average crew size	8.0	6.5	7.2	7.6	7.1	7.6	7.6	7.6	7.6	7.4
Revenue per day absent($)	3,251	2,315	2,377	3,166	2,471	2,007	2,863	3,615	3,329	3,226
Lb per day absent	11,655	6,303	7,235	6,436	7,288	5,113	7,014	10,825	8,559	8,017
Average number of trips/vessel	33	17	23	21	27	30	25	24	22	19

Where no identified fleet catches a majority of a species, the gear that does best among the known vessels is chosen.

Several caveats are in order concerning which vessels get included in a given table. 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 gear use. For example, if a vessel uses a gill net and, in the same year, 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 gillnet use or that describing longline use. For some gears this distinction between primary and total activity is not displayed because a gear's use constitutes an overwhelming majority of the activity of the fleet in question.

To address the shortcoming in information about individual vessel performance, some of the weighout data has been aggregated from a different perspective 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, which has only been developed through 1988, is incorporated into the following text associated with the tables.

New England Otter Trawl

Roughly 90 percent of the revenue from landings of species managed under the multispecies groundfish plan is earned by identifiable vessels. The fleet most closely associated with these earnings is the New England otter trawl fleet. It brings in between 72 and 97 percent of this (identified) revenue from each of the species under this plan, with the exception of pollock. Pollock revenues result from otter trawling (55 percent) and from gill net use (45 percent).

In 1989, New England otter trawl vessels continued to exhibit decreased average landings when compared with the late 1970s and early 1980s (Tables 11, 12, and 13). Total landings have declined steadily since 1980. Average revenue per vessel recovered slightly in 1989, but is still far below its 1987 record. The total number of vessels participating in this fishery has decreased to 846, a pre-1980 level. The reductions have occurred in the smaller classes. The average number of days at sea has remained fairly constant over time for all tonnage classes in the aggregate.

Mid-Atlantic Otter Trawl

Summer flounder revenues earned by the known fleet are approximately 80 percent of the total. Of these, almost all are generated (97 percent) by otter trawls. This can also be said for 82 percent of the known value of scup and 53 percent of that of black sea bass (both approximately 70 percent of the total). A significant portion (33 percent) of the known value of black sea bass is also landed using fish pots. While these species are landed in New England and the mid-Atlantic, the latter's council has the lead in their management. Consequently, mid-Atlantic otter trawlers' activity is represented as well (Tables 14, 15 and 16).

In 1989, total revenue decreased from the peak of 1988. Total landings, however, reached a new high of 50.3 thousand mt. Receipts per vessel rose by 2 percent over 1988, but landings increased by more than 20 percent on average. The number of vessels using otter trawls and landing in the mid-Atlantic in 1989 fell by 21 vessels to 328.

For the entire region, vessels using otter trawls did not do a significant amount of fishing with other gears. For individual vessels, 1988 figures revealed that approximately 60 percent of the tonnage class two otter trawl vessels had revenues less than $50,000, 52 percent of the tonnage class three vessels earned between $100,000 and $400,000, while gross revenue for more than 47 percent of the tonnage class four vessels exceeded $500,000. There was also great variability in the number of days absent. This reflects, to some extent, the frequency of encounters with some vessels as much as it reflects actual fishing vessel behavior. Total annual days absent have ranged from less than 10 to 75 for tonnage class two,

Table 17. Northeast scallop dredge vessels, ton class 3, all gears used

	1982	1983	1984	1985	1986	1987	1988	1989
Vessel count	107	121	125	91	87	101	111	116
Average age	12	12	13	13	14	13	14	15
Average grt	117	116	119	121	121	121	119	119
Average days absent	124	133	145	144	141	147	149	149
Average crew size	7.9	7.5	7.8	8.2	8.1	7.8	7.5	7.7
Revenue per day absent ($)	2,346	2,791	2,416	2,033	2,641	3,150	2,682	2,421
Lb per day absent	5,984	5,273	4,490	3,539	4,474	6,583	5,644	5,412
Average number of trips/vessel	18	20	20	18	17	18	18	20

Table 18. Northeast scallop dredge vessels, ton class 4, all gears used

	1982	1983	1984	1985	1986	1987	1988	1989
Vessel count	111	109	117	117	105	116	136	159
Average age	11	11	13	12	12	13	12	13
Average grt	181	181	182	181	183	182	181	182
Average days absent	155	177	160	176	165	182	185	182
Average crew size	10.1	10.2	9.9	9.9	9.8	9.8	9.5	9.3
Revenue per day absent ($)	3,087	3,653	3,017	2,512	3,579	3,969	3,440	3,301
Lb per day absent	7,116	5,822	4,674	4,463	5,783	7,611	7,097	7,249
Average number of trips/vessel	18	19	17	18	16	18	19	18

Table 19. Northeast vessels that used shrimp trawls, ton class 2, all gears used and shrimp trawl gear only

	1982	1983	1984	1985	1986	1987	1988	1989
All Gears								
Vessel count	117	113	150	151	167	198	207	169
Average age	18	18	19	18	18	18	20	20
Average grt	27	28	27	26	25	24	25	26
Average days absent	88	115	82	70	68	66	63	63
Average crew size	2.4	2.6	2.5	2.4	2.5	2.4	2.5	2.4
Revenue per day absent ($)	807	655	771	880	957	1,050	831	845
Lb per day absent	2,295	1,820	2,239	2,519	2,134	1,567	1,454	1,324
Average number of trips/vessel	73	75	70	61	60	60	58	59
Shrimp Trawl Gear Trips								
Average days absent	15	18	21	26	24	28	24	28
Average crew size	2.4	2.6	2.5	2.4	2.5	2.4	2.5	2.4
Revenue per day absent ($)	961	924	666	586	991	1,126	902	902
Lb per day absent	1,866	1,824	1,446	1,366	1,718	1,155	912	1,006
Average number of trips/vessel	16	17	19	20	24	28	23	27

Table 20. Northeast vessels that used shrimp trawls, ton class 3, all gears used and shrimp trawl gear only

	1982	1983	1984	1985	1986	1987	1988	1989
All Gears								
Vessel count	24	23	38	54	61	61	55	49
Average age	22	22	20	16	18	19	22	20
Average grt	68	66	73	81	82	83	77	81
Average days absent	113	113	106	119	119	129	106	100
Average crew size	4.5	4.2	4.4	4.9	5.0	5.3	4.9	4.8
Revenue per day absent ($)	1,560	1,267	1,265	1,538	1,722	1,953	1,427	1,461
Lb per day absent	5,749	3,837	4,934	5,524	3,875	3,441	2,914	2,385
Average number of trips/vessel	83	83	78	68	70	72	75	64
Shrimp Trawl Gear Trips								
Average days absent	18	22	18	21	26	37	28	35
Average crew size	4.5	4.2	4.4	4.9	5.0	5.3	4.9	4.8
Revenue per day absent ($)	1,435	1,306	1,102	1,345	1,798	2,211	1,722	1,418
Lb per day absent	2,939	2,718	2,453	3,471	3,451	2,290	1,994	1,712
Average number of trips/vessel	17	21	17	19	23	29	25	32

from 75 to 200 for tonnage class three and from 150 to 250 for tonnage class four.

In 1989, more than 85 percent of the value of domestic landings of squid, mackerel, and butterfish was earned by vessels using fish otter trawls in both the mid-Atlantic and New England areas. Other catches of these species by foreign fleets and by U.S. vessels operating under joint venture arrangements are discussed next.

Northeast Scallop Dredge

More than 95 percent of all sea scallop landings are made by known vessels. Total landings and revenue generated by this fleet increased in 1989 with this trend driven by tonnage class four vessels (Tables 17 and 18). The number of vessels participating in the scallop dredge fleet in the region has increased steadily for the last four years. Tonnage class two participation is currently very slight and has been highly variable. It is overlooked here. Revenue per day absent has been declining slightly recently while landings per day absent (here, live weight equivalents) have declined for tonnage class three and risen for tonnage class four. For tonnage class three, the number of vessels absent for more than 200 days per year has increased from 2 percent of the total in 1982 to 44 percent in 1988. For tonnage class

Table 21. Northeast vessels that used gill nets, ton class 2, all gears used and gill net trips only

	1982	1983	1984	1985	1986	1987	1988	1989
All Gears								
Vessel count	190	153	150	151	134	185	215	224
Average age	13	13	14	12	13	14	14	14
Average grt	20	19	19	20	19	21	22	21
Average days absent	55	62	60	64	69	62	62	67
Average crew size	3.0	2.9	2.9	2.8	2.8	2.8	2.8	2.6
Revenue per day absent($)	813	728	768	794	1,044	1,193	951	1,117
Lb per day absent	3,158	2,865	3,226	2,856	3,824	2,893	2,682	3,429
Average number of trips/vessel	49	51	55	60	65	54	54	61
Gill Net Trips Only								
Average days absent	39	48	48	47	60	49	50	51
Average crew size	3.0	2.9	2.9	2.8	2.8	2.8	2.8	2.6
Revenue per day absent($)	812	677	771	787	1,016	1,209	908	1,126
Lb per day absent	3,407	2,956	3,532	3,135	3,014	2,702	2,545	3,006
Average number of trips/vessel	35	41	44	45	56	43	43	47

Table 22. Northeast vessels that used gill nets, ton class 3, all gears used and gill net trips only

	1982	1983	1984	1985	1986	1987	1988	1989
All Gears								
Vessel count	6	9	10	4	2	5	15	23
Average age	22	15	28	26	33	19	16	18
Average grt	81	89	84	77	87	89	79	81
Average days absent	89	100	71	123	184	79	93	92
Average crew size	5.0	5.0	3.7	*[1]	*	5.0	3.6	4.3
Revenue per day absent ($)	1,485	2,099	2,114	1,149	1,874	2,227	2,037	2,247
Lb per day absent	4,862	3,413	31,693	2,726	3,675	2,928	4,344	8,963
Average number of trips/vessel	58	31	42	58	114	35	46	51
Gill Net Trips Only								
Average days absent	24	18	25	49	150	27	31	45
Average crew size	5.0	5.0	3.7	*	*	5.0	3.6	4.3
Revenue per day absent($)	466	865	1,385	858	1,664	2,187	1,995	2,658
Lbs per day absent	1,795	3,044	4,820	3,040	3,508	2,230	5,041	6,185
Average number of trips/vessel	24	17	17	40	96	20	22	21

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[1] *** = no data available**

four, the percentage has increased from 31 percent in 1982 to 56 percent in 1988.

It is worth noting that crew size numbers are based upon vessel berths and do not represent actual observations of crew at the end of a trip. For the scallop fleet, the number of people represented as full-time crew is likely to be grossly underestimated. Recent regulations have resulted in incentives to carry more crew than sleeping spaces.

Northeast Shrimp Trawl

The northern shrimp fleet is a part-time fleet. Seventy-five percent of the landed value of these shrimp is collected by known vessels. Ninety-six percent of the known landings are made by vessels using the shrimp trawl, bringing in approximately $6 million in 1989.

Roughly two-thirds of the fleet is composed of small, tonnage class two vessels. The principal gears used by these vessels in the six months of the fishery's closure are otter trawls, gill nets and lobster traps. Tables 19 and 20 show the activity of this fleet in pursuing shrimp and all other fishing activity. Shrimp trawl gear is used on average 29 days out of an average of 81 days at sea. No individual vessel's data have been examined with regard to the distribution of revenues or fishing activity. It is unlikely that these vessels operate as little as is shown by these encounters. Given the revenue per day absent, it is clear that shrimping activity contributes substantially to the annual revenue of these vessels.

Northeast Gill Net

This broad category of gears excludes the large mesh drift net used for large pelagics. Small mesh drift and sink gill nets capture the majority of bluefish that are landed by known vessels, but this is less than 10 percent of the total regional bluefish landings (Tables 21 and 22). However, 45 percent of the pollock landings and smaller percentages of several groundfish species were attributable to these gears. The majority of gill net vessels are small, tonnage class two 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 has increased steadily, from 190 to 251 vessels since 1987. Average landings and average revenue increased significantly for these vessels in 1989, but this was not based on gill net activity exclusively.

The amount of striped bass caught commercially is very slight due to strict rebuilding strategies in place under the ASMFC and the individual states. Identified vessels land less than two percent of striped bass caught commercially, and this is distributed over several gears. Therefore, no vessel performance tables related to striped bass are included.

Longline and Line Trawl

These related gears land the vast majority of swordfish, bigeye tuna, and yellowfin tuna, and about half of the tilefish. These gears generate almost all of the known vessel landings of these species. They also land a surprising 6 percent by value of all cod.

The number of vessels has remained fairly constant in the aggregate, with modest growth in the tonnage class four fleet (Tables 23, 24, and 25). In general, the larger the vessel class, the more this form of fishing represents of the total fishing done by the vessel. In tonnage class four, the number of days absent using these gears has increased dramatically for the average vessel.

Surf Clam and Ocean Quahog Dredge

This intensively monitored fleet was responsible for more than 90 percent of all surf clam landings in the region and almost all of the ocean quahog landings. An inshore surf clam fishery is overseen by the state of New Jersey. Most of the vessels in that fishery are represented here as well. Ocean quahog landings were worth approximately half of the $28 million in known FCZ surf clam landings. The activity represented in Tables 26, 27, and 28 is divided between the activity of all vessels using that gear and the activity of vessels that made landings in the mid-Atlantic. Only 8 vessels of the fleet of 143 operating in 1989 did not make landings in mid-Atlantic or Chesapeake ports.

This extremely stable fishery is about to undergo substantial change because an individual vessel transferrable quota management system has been established. A significant reduction in the number of vessels in the fishery is expected as vessel quotas are consolidated within and across firms. Note the average vessel ages.

Offshore Lobster Traps/ Pots

The delineation between offshore and inshore fisheries is admittedly cloudy. The greatest amount of unidentified vessel activity takes place in this fishery. Identified lobster landings still brought in $19.7 million in revenue. Roughly $16 million was from the use of offshore gear. This represented only slightly more than 10 percent of all recorded lobster sales. Most of this fleet has been composed of tonnage class three vessels with a fairly variable tonnage class two component (Tables 29, 30, and 31. For the tonnage class three and four vessels, the use of this gear constitutes almost all of their fishing activity. Therefore, only the table describing tonnage class two vessels shows alternative activity. The constancy of the tonnage class three fleet size is matched by the striking constancy of the landings per day absent for that segment of the fleet.

TRADE

The Northeast Region runs a large trade deficit in edible fishery products partially as a result of having a busy port of entry in New York and partly because of its proximity to Canadian fishing ports. Estimates have been made that as much as 70 percent by weight of what enters the Northeast Region in imports of edible fish products finds its final destination outside the region (Emerson 1988). The regional trade deficit is symptomatic of the national trade deficit in these products. Regionally our exports (Table 32) are less than one tenth of our imports in value (Table 33).

"Estimates have been made that as much as 70 percent by weight of what enters the Northeast Region in imports of edible fish products finds its final destination outside the region."

Table 23. Northeast vessels that used long lines or line trawls, ton class 2, all trips regardless of gear used and longline/ line trawl trips only

	1982	1983	1984	1985	1986	1987	1988	1989
All Gears								
Vessel count	80	81	67	65	70	79	75	71
Average age	11	10	12	11	14	12	14	15
Average grt	23	27	26	27	27	27	23	23
Average days absent	50	44	56	51	46	51	51	52
Average crew size	3.6	3.0	2.7	3.1	2.7	2.6	2.6	2.4
Revenue per day absent ($)	1,234	1,099	1,315	1,660	1,722	1,688	1,414	1,217
Lb per day absent	2,550	1,389	1,909	3,078	1,708	1,325	1,654	1,878
Average number of trips/vessel	34	18	30	31	22	24	36	40
Longline/ Line Trawl Trips Only								
Average days absent	21	27	31	27	30	36	39	36
Average crew size	3.6	3.0	2.7	3.1	2.8	2.6	2.6	2.4
Revenue per day absent ($)	1,622	1,332	1,612	1,336	1,975	1,784	1,450	1,239
Lb per day absent	1,626	918	943	1,112	1,007	1,120	1,394	1,414
Average number of trips/vessel	8	7	9	10	9	14	25	25

Table 24. Northeast vessels which used longlines/line trawls, ton class 3, all trips regardless of gear used and longline/line trawl trips only

	1982	1983	1984	1985	1986	1987	1988	1989
All Gears								
Vessel count	74	80	57	59	63	64	70	62
Average age	10	8	8	9	10	10	11	11
Average grt	90	87	86	94	89	89	92	94
Average days absent	71	73	85	87	97	85	83	85
Average crew size	5.2	4.9	4.5	4.6	4.7	4.3	4.7	4.8
Revenue per day absent ($)	2,275	1,885	2,271	2,415	2,372	2,840	2,541	2,382
Lb per day absent	3,141	2,459	1,474	1,982	1,790	1,342	1,063	1,125
Average number of trips/vessel	13	9	10	13	15	11	10	10
Longline/Line Trawl Trips Only								
Average days absent	50	57	74	74	76	68	61	65
Average crew size	5.2	4.9	4.5	4.6	4.7	4.3	4.8	4.8
Revenue per day absent($)	2,387	1,845	2,328	2,529	2,505	2,882	2,538	2,456
Lb per day absent	1,265	994	1,080	1,637	1,342	1,167	1,029	949
Average number of trips/vessel	5	6	7	8	7	7	5	5

Table 25. Northeast vessels which used longlines/line trawls, ton class 4, all trips regardless of gear used and longline/line trawl trips only

	1982	1983	1984	1985	1986	1987	1988	1989
All Gears								
Vessel count	7	6	8	9	11	16	19	16
Average age	9	5	5	12	13	8	9	6
Average grt	171	174	179	187	189	175	172	173
Average days absent	98	143	152	116	61	81	93	119
Average crew size	8.8	9.0	9.2	8.3	9.6	7.4	7.2	6.9
Revenue per day absent ($)	4,074	3,022	3,982	3,154	3,012	3,186	3,503	3,395
Lb per day absent	3,447	2,102	2,539	3,130	2,336	1,173	1,244	1,832
Average number of trips/vessel	9	11	12	11	6	5	3	6
Longline/Line Trawl Trips Only								
Average days absent	73	127	94	71	42	75	92	105
Average crew size	8.8	9.0	9.2	8.3	9.6	7.4	7.2	6.9
Revenue per day absent ($)	4,193	2,923	4,233	3,637	3,064	3,282	3,507	3,375
Lb per day absent	2,082	1,280	1,616	2,650	1,332	1,088	1,243	1,287
Average number of trips/vessel	6	9	5	6	4	4	3	4

Table 26. Northeast region surf clam and ocean quahog vessels and Mid-Atlantic vessels, ton class 2, all trips

	1982	1983	1984	1985	1986	1987	1988	1989
All Regional Surf Clam/Ocean Quahog Vessels								
Vessel count	24	27	21	22	16	13	11	10
Average age	48	36	39	40	45	40	44	42
Average grt	36	35	35	35	40	40	42	42
Average days absent	65	59	67	49	43	39	48	43
Average crew size	3.3	3.2	2.8	3.0	3.0	3.0	3.1	3.0
Revenue per day absent($)	1,292	1,582	1,774	2,240	2,470	2,083	2,281	2,217
Lb per day absent (live wt)	12,656	15,160	17,237	20,651	21,037	20,852	23,934	22,995
Average number of trips/vessel	54	48	63	45	39	34	38	36
Mid-Atlantic Surf Clam/Ocean Quahog Vessels								
Vessel count	17	16	15	14	12	10	9	8
Average days absent	55	53	53	41	42	31	34	37
Average crew size	3.4	3.2	2.8	3.0	3.1	3.1	3.1	3.0
Revenue per day absent($)	1,617	1,688	2,401	3,219	2,939	2,322	2,385	2,279
Lb per day absent(live wt)	17,966	20,612	25,154	33,851	26,795	23,240	26,343	24,626
Average number of trips/vessel	54	51	48	40	37	32	34	36

Table 27. Northeast region surf clam and ocean quahog vessels and Mid-Atlantic vessels, ton class 3, all trips

	1982	1983	1984	1985	1986	1987	1988	1989
All Regional Surf Clam/Ocean Quahog Vessels								
Vessel count	91	89	87	85	91	91	89	87
Average age	24	23	23	23	23	22	22	22
Average grt	102	101	102	100	99	102	103	103
Average days absent	89	78	79	67	54	49	54	61
Average crew size	3.8	3.7	3.8	3.7	3.7	3.8	4.0	3.8
Revenue per day absent($)	2,450	2,758	4,116	4,598	5,468	4,801	4,556	4,633
Lb per day absent (live wt)	36,593	42,975	57,100	63,851	67,375	72,627	63,269	71,479
Average number of trips/vessel	84	70	74	64	48	46	46	60
Mid-Atlantic Surf Clam/Ocean Quahog Vessels								
Vessel count	82	76	80	80	85	84	81	81
Average days absent	81	75	77	67	53	47	50	60
Average crew size	3.4	3.8	3.9	3.7	3.8	3.9	3.9	3.9
Revenue per day absent ($)	2,729	2,909	4,286	4,734	5,693	5,112	5,042	4,879
Lb per day absent (live wt)	39,607	46,260	58,475	65,969	71,195	78,545	72,591	76,227
Average number of trips/vessel	83	72	73	65	49	46	46	61

Table 28. Northeast region surf clam and ocean quahog vessels and Mid-Atlantic vessels, ton class 4, all trips

	1982	1983	1984	1985	1986	1987	1988	1989
All Regional Surf Clam/Ocean Quahog Vessels								
Vessel count	37	89	87	85	91	91	89	87
Average age	24	23	21	21	22	25	26	25
Average grt	193	194	190	189	196	191	190	189
Average days absent	98	78	79	85	70	75	78	67
Average crew size	6.2	6.2	6.1	6.0	8.4	8.5	8.3	8.3
Revenue per day absent($)	5,390	5,189	5,217	5,742	6,679	5,763	5,509	5,625
Lb per day absent (live wt)	64,977	87,206	78,732	86,872	108,394	113,287	109,027	110,653
Average number of trips/vessel	85	77	59	66	61	66	66	61
Mid-Atlantic Surf Clam/Ocean Quahog Vessels								
Vessel count	35	36	43	45	45	42	81	46
Average days absent	102	80	79	80	69	74	50	67
Average crew size5.9	5.9	5.9	5.9	5.8	5.8	5.6	3.9	8.3
Revenue per day absent ($)	4,988	5,202	5,255	6,019	6,886	5,868	5,042	5,625
Lb per day absent (live wt)	65,435	87,494	79,454	94,736	114,256	117,176	110,290	110,653
Average number of trips/vessel	89	79	60	67	63	46	46	61

Table 29. Northeast vessels using offshore lobster gear, ton class 2, all trips and offshore lobster trips

	1982	1983	1984	1985	1986	1987	1988	1989
				All Gear				
Vessel count	34	33	41	38	27	23	26	41
Average age	9	9	8	12	11	11	12	15
Average grt	30	32	29	30	30	30	28	24
Average days absent	68	112	89	60	75	84	69	88
Average crew size	2.9	3.2	3.3	5.3	3.1	3.2	3.1	2.7
Revenue per day absent ($)	1,566	1,346	1,110	1,677	1,760	1,671	1,564	1,255
Lb per day absent	861	1,250	447	943	748	726	814	549
Average number of trips/vessel	33	36	25	27	30	36	34	69
				Offshore Lobster Trips Only				
Average days absent	46	83	76	48	62	62	51	40
Average crew size	2.9	3.2	3.3	5.3	3.1	3.2	3.1	2.7
Revenue per day absent ($)	1,839	1,230	1,158	1,820	1,898	1,872	1,728	1,371
Lb per day absent	734	463	407	670	707	676	742	575
Average number of trips/vessel	15	18	16	17	20	20	17	22

Table 30. Northeast vessels using offshore lobster gear, ton class 3, all trips regardless of gear

	1982	1983	1984	1985	1986	1987	1988	1989
Vessel count	28	44	48	50	49	44	40	42
Average age	9	9	10	8	9	10	10	10
Average grt	85	83	83	84	84	83	84	86
Average days absent	113	153	101	106	111	120	135	139
Average crew size	4.6	4.3	4.3	4.2	4.1	4.2	4.2	4.2
Revenue per day absent($)	2,261	1,666	2,700	2,396	2,660	2,717	2,469	2,215
Lb per day absent	1,203	2,496	1,567	1,340	1,591	1,070	1,002	948
Average number of trips/vessel	25	33	32	29	32	31	36	35

Table 31. Northeast vessels that used offshore lobster gear, ton class 4, all trips regardless of gear

	1982	1983	1984	1985	1986	1987	1988	1989
Vessel count	2	4	6	5	2	3	4	3
Average age	7	5	13	10	4	3	4	5
Average grt	160	178	183	188	178	172	168	72
Average days absent	218	151	121	82	100	119	140	169
Average crew size	6.5	6.3	6.7	5.5	5.0	5.0	5.0	5.0
Revenue per day absent ($)	2,963	3,610	3,395	2,617	2,170	3,039	3,571	3,259
Lb per day absent	7,350	6,843	2,235	862	720	1,050	2,795	1,308
Average number of trips/vessel	33	27	21	18	25	23	43	45

Table 32. Northeast region: value of exported fishery products for selected years (million $)

Product Category	1976	1986	1987	1988	1989
Live eel	N.A.[1]	1.93	4.56	5.59	6.04
Eel, other	N.A.	0.15	0.32	0.36	0.89
Herring, f&f[2]	N.A.	0.74	0.54	0.68	3.71
Salmon f&f	1.73	11.83	16.29	16.88	7.47
Butterfish	N.A.	1.51	4.29	2.59	2.43
Other fish, f&f	11.33	16.90	24.22	31.97	38.28
Fish fillets, f&f	5.48	12.76	19.13	26.48	26.57
Fish dried *etc.*	0.56	0.48	0.52	2.04	3.79
Salmon canned	0.39	0.98	3.65	1.93	0.58
Other canned fish	4.59	0.92	1.91	7.65	8.76
Fish sticks & portions	N.A.	2.29	3.47	3.30	1.00
Fish roe	N.A.	1.85	2.26	2.01	5.61
Shrimp, fresh	0.76	1.81	4.48	2.92	0.47
Shrimp, frozen	8.51	7.72	13.66	14.39	15.02
Lobster, f&f	N.A.	5.03	7.73	21.34	32.81
Crab	0.29	3.00	4.19	7.24	5.34
Squid, f&f	N.A.	6.69	4.45	10.89	23.06
Shellfish, fresh	N.A.	3.65	5.68	6.90	9.74
Clam, frozen	N.A.	1.61	1.55	1.86	1.88
Scallop, f&f	N.A.	1.76	1.74	1.29	4.18
Shrimp, canned	2.56	1.50	0.75	0.98	0.85
Squid, canned	0.47	0.56	0.13	0.20	0.15
Other shellfish	10.62	2.90	3.51	4.78	7.83
Total	**47.29**	**88.58**	**129.03**	**174.27**	**206.46**

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[1] **NA = data not available**

[2] **F&F = fresh and frozen**

Table 33. Northeast region: value of imported edible fishery products (million $) for selected years

Product Category	1976	1986	1987	1988	1989
Fresh or frozen sea herring	1.93	2.67	3.78	4.47	2.60
Fresh whole groundfish, halibut and other flatfish	6.43	58.46	61.90	48.76	58.48
Frozen whole groundfish, halibut and other flatfish	6.95	8.63	9.25	8.69	8.11
Salmon, fresh or frozen	4.39	59.20	65.18	89.14	93.30
Other fish fresh or frozen	37.43	63.15	54.77	52.45	54.62
Frozen groundfish blocks	195.73	314.47	456.89	339.37	262.80
Ocean perch fillets	43.35	61.54	70.49	55.72	56.54
Fresh groundfish and flatfish fillets	6.77	46.70	64.50	55.77	54.85
Frozen groundfish and flatfish fillets	203.78	393.60	572.05	423.38	436.14
Other fresh, frozen fillets	10.72	88.00	129.90	122.17	133.25
Salted or dried groundfish	28.96	46.95	55.62	47.60	24.00
Salted herring	9.96	6.11	5.69	5.94	3.99
Canned tuna	48.12	132.13	102.68	166.30	211.45
Canned sardines	22.10	30.63	36.89	33.03	33.03
Minced fish	3.50	21.77	18.21	22.01	23.85
Clam products	3.63	13.14	11.19	6.59	4.43
Crab products	8.21	63.62	45.44	42.43	29.00
Lobster products	164.29	252.48	330.08	302.11	270.77
Scallops	51.51	127.94	115.57	96.38	103.85
Shrimp products	158.82	442.98	448.04	371.95	440.35
Analog fish products	N.A	30.49	28.08	23.64	19.99
Squid	N.A	6.78	14.38	6.85	18.75
Other fishery products	41.47	110.12	111.14	105.19	144.70
Total	**1,058.05**	**2,381.57**	**2,811.70**	**2,429.94**	**2,488.84**

Table 34. New England imports (1,000 mt) of selected fishery products from Canada and all other sources, 1978-1989[1]

Year	Cod		Other Groundfish		Flatfish		Total Finfish		Scallops	
	Canada	Other	Canada	Other	Canada	Other	Canada	Other	Canada	Other
1978	151	284	93	151	87	39	331	474	10.7	0.7
1979	204	229	92	153	88	28	384	410	8.3	0.8
1980	199	161	72	115	71	9	342	285	6.6	1.0
1981	233	157	114	109	96	7	443	273	8.4	1.3
1982	154	157	105	138	72	14	431	309	6.6	1.1
1983	290	193	86	136	60	8	436	337	5.9	2.0
1984	279	195	93	122	68	16	440	333	3.8	3.4
1985	276	189	97	117	67	26	440	332	5.1	1.9
1986	302	190	101	115	63	20	465	325	5.8	2.1
1987	309	173	109	114	73	20	491	307	6.6	2.0
1988	289	154	101	73	54	10	444	237	7.6	2.6
1989	296	145	100	108	53	31	449	284	9.7	1.8

[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.**

Exports have grown significantly since 1986. Squid and mackerel (included in other fish f&f), fish fillets, lobsters, and shrimp are the principal commodities. Shrimp, tuna, and fish fillets dominate the imports of final products, while frozen blocks of groundfish dominate that which will be further processed.

Almost half a million metric tons of edible finfish products are imported into the region from Canada, our largest fish trading partner. This number has been surprisingly stable over the period 1981-1989, while scallop imports have climbed steadily almost reaching 1978 levels after a 1984 low for the twelve years shown (Table 34).

PROCESSING

Fish processing in the Northeast relies on the domestic fisheries and imported product for its supplies. The largest product processed by both weight and value in 1989 was frozen blocks, the vast majority of which was imported (Table 35). The second largest operation by volume was in industrial fish plants working with menhaden and herring. Edible fish processing of regionally caught species was

Table. 35 Quantity and value of final products processed in the Northeast, 1989

Species	Value ($ million)	Weight (1,000 mt)
	Industrial Fish	
Menhaden, herring, *etc.*	44.2	134.09
	Edible Fish	
Surf clam	130.1	63.82
Shrimp	123.8	14.55
Flounders	108.2	13.10
Cod	66.8	13.11
Ocean quahog	59.1	37.06
Blue crab	56.5	9.22
Salmon, unclass.	37.6	2.62
Oysters	29.4	2.98
Atlantic herring (edible)	28.1	9.64
Soft clam	26.8	3.22
Haddock	25.7	3.27
Sea weeds	23.9	3.38
Pollock	18.3	4.99
Sea scallop	16.4	1.85
Monkfish	14.8	2.53
Non-specified fish (predominantly breaded, batter-dipped, frozen)	554.6	179.34
All other species	98.5	23.90
Total	**1462.9**	**522.68**

Table 36. Marine products processing and wholesaling establishments and their employment levels for 1978, 1983, 1989

	Processing		Wholesaling		Total	
	Plants	Emp.	Plants	Emp.	Plants	Emp.
			1978			
New England	246	7,903	251	1,252	497	9,155
Mid-Atlantic & Chesapeake	312	9,635	446	3,145	758	12,780
Northeast Region	558	17,538	697	4,397	1,255	21,935
			1983			
New England	221	6,923	282	1,626	503	8,549
Mid-Atlantic and Chesapeake	290	9,973	384	3,036	674	13,009
Northeast Region	511	16,896	666	4,662	1,177	21,558
			1989			
New England	261	6,582	627	2,470	888	9,052
Mid-Atlantic & Chesapeake	210	7,739	363	2,760	573	10,499
Northeast Region	471	14,321	990	5,230	1,461	19,551

Table 37. U.S. income from directed foreign fishing for squid, mackerel and butterfish, and Northeast region vessel gross revenues from joint venture transfers to foreign vessels; < = less than, (1) = information confidential, - = no activity

	U.S. Directed Foreign Fishing Income								
	Illex squid		*Loligo* squid		Butterfish		Mackerel		Other
	(mt)	($000)	(mt)	($000)	(mt)	($000)	(mt)	($000)	(mt)
1984	638	38.3	11,029	1,477.9	430	67.1	9,478	236.9	1,433.0
1985	1,008	57.5	6,558	747.6	802	128.3	26,384	1,292.8	2,489.0
1986	249	34.6	4,862	1,098.8	125	27.5	19,144	957.2	1,406.0
1987	-	-	0.3	0.1	<136	<40.0	29,294	1,728.3	<220.7
1988	<293	<30.5	3.4	0.8	<293	<80.5	42,879	2,935.4	<371.6
1989	<180	<18.7	3.5	0.9	0.9	<0.2	36,823	2,519.8	<274.6

	EEZ Joint Venture Transfers and Gross Revenue Earned (by selected species)							
	Illex squid		*Loligo* squid		Whiting		Mackerel	
	(mt)	($000)	(mt)	($000)	(mt)	($000)	(mt)	($000)
1984	6,010	2,000.0	760	395.0	(1)	(1)	1,423	220.0
1985	2,540	595.0	1,082	599.0	-	-	3,788	584.0
1986	(1)	(1)	(1)	(1)	65	9.0	(1)	(1)
1987	3,140	628.0	993	745.0	5	0.5	8,012	1,058.0
1988	(1)	(1)	-	-	-	-	5,685	760.0
1989	-	-	-	-	-	-	(1)	(1)

> **"Recreational landings of most species now covered by Federal management plans are minor or insignificant relative to commercial landings."**

headed in both value and volume by surf clam processors. Several of the larger of these have been purchased recently by foreign interests. Shrimp, flounder, and cod processing follow in terms of the value of the final product. It is unclear, however, what percentage of the seafood used in this processing was produced domestically.

The number of plants and their average annual employment is shown in Table 36 for 1978, 1983, and 1989 for New England, and for the Mid-Atlantic and Chesapeake areas combined. The number of plants has grown in New England while traditional species stocks have declined. Plant sizes, as reflected in the employee ratio, have declined, however. In the mid-Atlantic and Chesapeake, the number of plants has declined steadily as has the number of employees.

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. They have both been directed at species considered underexploited. Since 1982, regional vessels have sold *Illex* and *Loligo* squid and mackerel to foreign vessels. Foreign vessels had been able to fish directly for all three species through 1986, but since then only for mackerel. A small whiting joint venture arrangement existed for a short time as well.

In recent years, ratios have been imposed on the foreign fleet that tie the amount of direct fishing it can do for mackerel to the amount it must buy from U.S. industry, either over the

Table 38. Recreational catch (million fish) and participation (thousand anglers) in the Northeast 1985-1989[1]

	Atlantic Cod			**Bluefish**	
Year	**Catch**	**Anglers**	**Year**	**Catch**	**Anglers**
1985	3.67	-[2]	1985	21.58	841
1986	1.55	131[3]	1986	29.03	735
1987	2.01	138	1987	24.74	742
1988	2.99	144[3]	1988	12.41	675
1989	2.46	113[3]	1989	14.60	720
	Winter Flounder			**Striped Bass**	
Year	**Catch**	**Anglers**	**Year**	**Catch**	**Anglers**
1985	31.06	371	1985	0.61	60
1986	10.43	406	1986	1.39	21[3]
1987	13.04	278	1987	0.76	47
1988	14.32	356	1988	0.84	73
1989	8.47	313	1989	1.33	95
	Atlantic Mackerel			**Weakfish**	
Year	**Catch**	**Anglers**	**Year**	**Catch**	**Anglers**
1985	8.28	-[2]	1985	3.13	153
1986	5.88	80	1986	1.12	185[4]
1987	7.73	37[3]	1987	6.47	197[4]
1988	8.86	91	1988	8.02	195[4]
1989	4.86	44[3]	1989	1.53	100
	Summer Flounder			**Tautog**	
Year	**Catch**	**Anglers**	**Year**	**Catch**	**Anglers**
1985	15.77	277	1985	4.14	84
1986	22.70	467	1986	9.18	170
1987	21.32	544	1987	4.89	133
1988	19.67	594	1988	5.18	150
1989	2.34	288	1989	3.69	166
	Scup			**All Species**	
Year	**Catch**	**Anglers**	**Year**	**Catch**	**Anglers**
1985	15.43	49	1985	159.56	3,805
1986	32.36	107	1986	220.32	3,837
1987	12.91	60[3]	1987	144.50	3,184
1988	9.34	77	1988	135.08	3,340
1989	11.51	112	1989	95.58	2,986
	Black Sea Bass			**All Species Effort**	
Year	**Catch**	**Anglers**	**Year**	**Million Trips**	
1985	8.09	-[2]	1985	26.5	
1986	31.24	58[4]	1986	28.9	
1987	5.66	24	1987	22.6	
1988	10.76	34[4]	1988	27.4	
1989	6.75	53[4]	1989	18.4	

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[1] Source: *Marine Recreational Fishery Statistics Survey, Atlantic and Gulf Coasts,* various years.

[2] Cannot be calculated from published results.

[3] Only Mid-Atlantic, total not available.

[4] Only New England, total not available.

"To date, little is known about the demand for and value of sport-caught fish in the Northeast Region."

side from U.S. vessels or in U.S. processed product. In 1989, for example, the ratio required that for 9 mt of mackerel caught directly, they must purchase 3 mt over the side and 1 mt of processed product.

Table 37 shows both sets of activity since 1984. Butterfish and other allowances in the directed fishery are for bycatch only. In 1989, more than $2.5 million in receipts were earned by the United States for the directed fishing activity in the region. Mackerel are still considered grossly underexploited. The number of vessels participating in the region's joint ventures was approximately 65 from 1984 to 1987. Since 1988, the number has been fewer than 10.

RECREATIONAL FISHING

In 1979, NMFS implemented what is now called the Marine Recreational Fishery Statistics Survey (MRFSS) to collect data on participation, catch, and effort from anglers. Estimates of catch and participation since 1985 are reported in Table 38 for the most commonly targeted species in the Northeast Region, including many covered by FMPs. Overall, total annual catch in the Northeast was reported to vary from about 100 to 200 million fish between 1985 and 1989; total participation is estimated at about 3 million anglers from the region; and total fishing trips are in the neighborhood of 25 million, including out-of-state trips to the region.

Recreational landings of most species now covered by Federal management plans are minor or insignificant relative to commercial landings. (See Species Synopses section in this document for landings of these species and comparisons with commercial landings.) Of those species routinely targeted by anglers in the Northeast, bluefish appears to be the most popular, based on the number of participants, followed by winter and summer flounders. Intercept and telephone surveys are done for many other species that are targeted by only a small percentage of all anglers, such as tunas and sharks, but the sample sizes are too small for good estimates of catch and effort.

The MRFSS is presently under review with the aim of improving the survey's reliability and utility in economic analyses as well as biological assessments. One option being considered is to expand the MRFSS to improve estimates of participation, catch, and effort on a species-area-mode basis.

To date, little is known about the demand for and value of sport-caught fish in the Northeast Region. A variety of efforts are under way to consolidate the available information. Similarly, little has been published on the size, structure, and economic performance of the sport fishing industry--charter boats, party boats, and boat rentals. Estimates are available (see Sports Fishing Institute 1987).

Every five years, as part of its National Survey of Fishing, Hunting, and Wildlife Associated Recreation, the U.S. Fish and Wildlife Service reports estimates of how much anglers spend to go fishing in estuarine and marine waters. In 1985, this estimate was $7.2 billion (USFWS 1988). In addition, SFI augments these estimates with information on anglers' expenditures from other sources and also allocates its final results to regions and species based on MRFSS catch and effort data.

Accordingly, SFI (1987) estimates that anglers spent slightly more than $1.5 billion on marine recreational fishing in the Northeast in 1985. Of this amount, approximately $345 million was spent to fish for bluefish, $110 million for summer flounder, and $86 million for winter flounder.

Expenditure data are widely regarded as an index of economic activity, but should be interpreted carefully. First, some of the estimates of regional and species-specific expenditures are tentative because they are based on the MRFSS's small samples. The estimates of expenditures also include more categories than are appropriate for demand analysis and valuation of sport-caught fish--particularly expenditures on food and other goods and services which are not essential to catch fish (see Edwards 1990).

NET NATIONAL BENEFITS

Congress emphasized in the Magnuson Fishery Conservation and Management Act that marine fishery resources could contribute significantly to the food supply, economy, and health of the nation. A fundamental purpose of the act was to achieve and maintain optimum yield (OY) from each fishery on a continuing basis. Optimum yield was defined as the amount of fish that provides the greatest overall benefit to the nation, particularly in the areas of food production and recreation. The primary mission of NOAA's NMFS is to "achieve a continued optimum utilization of living resources for the benefit of the Nation."

Given the goals and missions of Congress, the councils, and NMFS, the distance between the actual economic performance of the Northeast's fisheries and that which could be considered economically efficient is clearly germane to this report. National Standard Five of the Magnuson Act makes clear that factors other than efficiency (such as financial or employment impacts on the fishing industry in the short run) should be considered in determining OY. However, without high unemployment in labor markets, it is difficult to imagine how reductions in stock sizes below that corresponding to some measure of MSY can benefit the nation as a whole.

In what follows, the economic costs and benefits of the nation's investment in fisheries are identified and, where possible, quantified.

CATEGORIES OF COSTS AND BENEFITS

Costs

1. **Management**: administration, enforcement, and research.
2. **Efficiency-reducing regulations**: costs resulting when regulations protect stocks by making fishing enterprises less efficient, but also increase the unit costs of supplying fish.
3. **Overcapacity** (overcapitalization and "overlaborization"): a cost manifested in terms of more capital (such as vessels) and labor (such as crew members) than are needed to maximize the nation's return on its fisheries. Such "extra" inputs are not making a net contribution to gross national product (GNP) and, where they drive stocks below the equivalent of MSY, actually contribute negatively.

Benefits

1. **Resource "rent"**: the economic value of the resource itself, as opposed to the value that labor and capital contribute to landings. Resource rent is the income that the nation could receive if property rights to fishery resources were well-defined and the resource could be leased, or rented, to harvesters. Resource rents are collected from other industries that extract publicly-owned natural resources, such as offshore oil and timber in national forests.
2. **Economic profit or rent from fishery related skills**: that amount of a fisherman's, captain's, or vessel owner's income or profit that is attributable to above-normal skill or other advantages. In financial terms, these rents are part of the fishing industry's profit margin. Resource rents, to the extent they occur in the short run under open access, also become part of the fishing industry's profit because the Magnuson Act effectively precludes charging fishermen a royalty, or rent, for use of publicly-owned fishery resources.
3. **Economic profit in fishery dependent industries**: income in excess of what labor, entrepreneurs, and owners of capital (such as buildings and equipment) in the industry would earn in another line of work.
4. **Consumer value** (consumer surplus)--the economic benefit that seafood consumers and recreational fishermen enjoy once the costs of seafood and sport fishing are subtracted from total economic value. Consumer surplus changes in proportion to landings.
5. **Impacts on the economy**: income (and employment) from industries that sell goods and services to the commercial fishing industry, to the charter boat industry (including "party" boats), and to recreational fishermen ("indirect" effects); and also, the income (and employment) in industries that sell goods and services to commercial fishermen and to people working in the indirectly affected industries ("induced" effects).

> **"From an efficiency standpoint...economists maintain that all stocks that are subject to virtual open access are economically overexploited, because the same landings could be made with less financial and physical capacity."**

Available Information on Costs and Benefits

In 1989, the federal government spent about $20 million in the Northeast Region to carry out the Magnuson Act. This figure includes estimates of what NMFS identifies as regional MFCMA costs (more than $16 million), the combined budgets of the New England and Mid-Atlantic Fishery Management Councils (nearly $2 million), and the fisheries enforcement budget of NOAA/NMFS (about $1.6 million).

If one adds the entire regional portion of the Coast Guard's fishery enforcement budget to MFCMA purposes (estimated at $40 million) the result is a figure equivalent to about 12 percent of the landings revenue of species covered by FMPs in the Northeast, and 9 percent of total landings revenue for all species landed in the region. How this cost estimate would compare with the increase in net economic value attributable to management is unknown, and to determine the answer would require an extensive benefit-cost analysis.

Effort controls imposed by FMPs, such as restrictions on gear, time limits, area closures, and so on, are intended to maintain or rebuild stocks. But they also reduce the productivity of any fishing enterprise and, therefore, increase the unit cost of harvesting fish. Estimates of the costs generated by efficiency reducing (or stock rebuilding) regulations in the Northeast are not yet available.

Many, if not the majority, of groundfish stocks reviewed in this document are judged by assessment biologists to be overexploited relative to some notion of a maximum sustainable yield. From an efficiency standpoint, however, economists maintain that all stocks that are subject to virtual open access are economically overexploited, because the same landings could be made with less financial and physical capacity. Economic efficiency will always coincide with stock sizes larger than those required to maximize biological productivity. Long run target stock sizes smaller than those providing maximum yield are difficult to defend on both economic and biological grounds.

Beyond estimates of about 50 to 60 percent excess effort in Maine's lobster fishery (Bell 1972; Rothschild *et al.* 1977), there is little quantitative knowledge about overcapacity in the Northeast Region's fisheries. In other parts of the country, estimates of overcapacity in various groundfish fisheries range from 40 percent (Cook and Copes 1987; Huppert and Squires 1987) to about 55 percent (Arnason 1986). Estimates of excess effort in various commercial salmon fisheries range from 20 percent (Dupont 1990) to 80 percent (Crutchfield and Pontecorvo 1969).

Resource rents are dissipated by excess capacity because the value of potential growth and recruitment of the fish resource is short-circuited. Where increases in exvessel prices result in revenues growing faster than the costs of fishing on depleted stocks, overcapacity can be exacerbated. There are few estimates of dissipated rents because of a lack of basic, detailed economic data on costs and effort. The following estimates of foregone annual resource rents were reported in the studies cited:

(1) $1 million in Cook's (1990) bioeconomic analysis of Canada's Pacific halibut fishery ($5 million in 1989 dollars);
(2) $22 million in Huppert and Squires's (1987) simulation of the U.S. Pacific groundfish trawl fleet ($26 million in 1989 dollars);
(3) $50 million in Crutchfield and Pontecorvo's (1969) classic study of the eastern Pacific salmon fisheries ($169 million in 1989 dollars);
(4) $155 million in Arnason's (1986) bioeconomic analysis of Iceland's groundfish fishery ($185 million in 1989 dollars); and
(5) $2 to $3 billion in all North Atlantic fisheries (Crutchfield 1979), or $3.5 to $5 *billion* in 1989 dollars.

In addition, the loss of both resource rents and other economic rents as discussed earlier have been reported to be $7 million ($21 million in 1989 dollars) in Maine's lobster fishery (Rothschild *et al.* 1977) and $108 million ($140 million in 1989 dollars) in British Columbia's salmon fishery (Dupont 1990).

In New England's multispecies groundfish fishery, rent dissipation was estimated to be between $104 and $138 million a year or more, depending upon the extent of unaccounted for under-reporting and discarding. This line of research, particularly estimation of inframarginal rents and, therefore, fishing industry's profit, is hampered by a general lack of detailed vessel cost and effort data. These same data are also required to fully evaluate the implications of access limitation schemes.

"...time-series data on consumption in restaurants and at home--including information required to aggregate models of household demand to the entire population of seafood consumers--are needed for a fundamental understanding of seafood consumption and value."

Before consumers buy seafood, the Northeast's landings pass through a number of processing and marketing levels. At each step, value is added to seafood products, generating income and employment throughout the seafood sector (NMFS 1988). The cost and revenue data required to estimate economic profit in the processing, wholesale, and retail industries are lacking, although estimates of value-added have been made.

Many recreational fishermen use charter or other rental boats to gain access to fish stocks, generating income and employment in this industry. The dependence of the charter fishing industry's economic profit on stock sizes and catch rates also appears to be unknown.

The demands for products supporting the commercial fishery, such as vessels, gear, and fuel, result in so-called "indirect" income (and employment) in the economy. Similarly, recreational fishermen use supplies and services in their "production" of sport-caught fish, including tackle, boats, and sometimes the services of the charter boat industry. These demands also result in indirect income (and employment).

The income earned by labor and entrepreneurs in the sectors that serve the commercial and sport fishing industries is spent (for example, by boatbuilders) throughout the economy for food, clothing, housing, entertainment, and transportation. The income (and employment) generated by these expenditures is part of the "induced" effect. Eventually, the incremental effects of spending and re-spending on goods and services eventually vanishes. The overall result of "recycling" money within an economy is called the gross multiplier effect. It should be noted that the widespread use of multipliers greater than three (and perhaps even less) is inappropriate because the results probably do not account for adjustments in production and employment throughout the economy.

Gross multiplier effects in fisheries can be calculated from the input-output models recently developed by A.T. Kearney, Inc. (1989) and the Sport Fishing Institute (1987). For example, the gross, unadjusted income and employment effects corresponding to a recovery of the groundfish stocks has been estimated to exceed $500 million a year and 35,000 person-years annually throughout New England's economy. However, existing input-output models of economic activity associated with commercial and recreational fisheries only describe linkages that currently exist within New England's economy, not how the economy would adjust to changes in stock sizes and catches. Therefore it is not possible at this time to determine how much income or employment is actually being foregone because of the state of New England's groundfish stocks.

Consumer value, or "surplus," is an essential and, undoubtedly, substantial component of the total economic value of domestic landings. While it is sometimes mentioned in FMPs, consumer surplus tends not to be evaluated in Regulatory Impact Reviews. Part of the problem with estimating foregone consumer value (as well as other behavior, such as responses to news of seafood contamination) is the dearth of information on seafood consumers and retail sales. The 1981 Seafood Consumption Survey shed some light on aspects of household demand for fish and shellfish (see Cheng and Capps 1987), but time-series data on consumption in restaurants and at home--including information required to aggregate models of household demand to the entire population of seafood consumers--are needed for a fundamental understanding of seafood consumption and value. In addition, knowledge of consumers is important because fishing effort and the demand for landings are ultimately derived from consumer demand for seafood.

Until such data become available, consumer surplus associated with landings in the Northeast can be approximated from exvessel demand models using general equilibrium theory of demand (Just *et al.* 1987). The applicability of this theory to fisheries is currently being evaluated through a Saltonstall-Kennedy grant. Our estimates using this procedure place foregone consumer value associated with low groundfish landings in the Northeast between at least $20 and more likely $30 million annually.

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SPECIES SYNOPSES

The synopses of information on the status of the stocks of the 34 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 that are not in the tables and figures.

Catch statistics in the tables are given in thousands of metric tons, rounded to the nearest 100 mt; 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 that are not yet available are indicated by N/A.

Many of the assessments relied 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.

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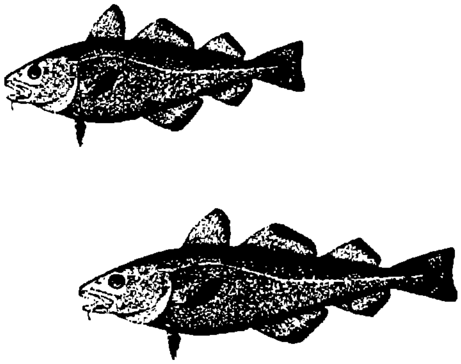
[1] **The tables and figures in this section are labled using decimal notation by species and by table or figure within species. For example, Figure 7.3 indicates the third figure for the seventh species synopsis, yellowtail flounder.**

1. ATLANTIC COD



The Atlantic cod, *Gadus morhua*, is a demersal gadoid species distributed in the Northwest Atlantic from Greenland to North Carolina. Cod are omnivorous feeders and commonly attain lengths up to 130 cm (51 in.) and weights up to 25 to 35 kg (55 to 77 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 6; spawning occurs during winter and early spring.

In U.S. 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.

United States commercial and recreational fisheries for cod are managed under the New England Fishery Management Council's (NEFMC) Multispecies Fishery Management Plan (FMP). Total cod landings declined 8 percent in 1989 (54,600 mt to 50,200 mt).

GULF OF MAINE

Total nominal commercial catch (exclusively USA) in 1989 was 10,400 mt, 30% higher than in 1988 (8,000 mt), and the highest annual catch since 1985. Purported Canadian landings from the Gulf of Maine since 1977 are believed to be misreported catches from the Scotian Shelf area and have been reassigned by Canada to the Scotian Shelf stock. Hence, all commercial landings after 1976 have been solely by the United States.

United States otter trawl fishing effort, which accounted for 59 percent of the 1989 landings, declined 14 percent from 1988 and was the lowest since 1981. United States commercial CPUE (catch per day fished) for all trips catching cod increased sharply in 1989 [to its highest level since 1984/85]. "Directed trips", which accounted for between 15 and 35 percent of the annual U.S. otter trawl catch during 1984-88, accounted for 49 percent of the 1989 total, the highest percentage ever.

Fishery age composition data indicate that commercial landings in 1989 were dominated by the 1985 and 1986 year classes; these two cohorts comprised 77 percent of the landings by number and 69 percent by weight. Otter trawl landings accounted for 59 percent of the 1989

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 = 2.7 yrs (males); 2.4 yrs (females)
Size at 50% maturity = 46 cm (18.1 in.) males; 41 cm (16.1 in.) females
Assessment level = Age structured

$M = 0.20$ $F_{0.1} = 0.15$ $F_{max} = 0.27$ $F_{1989} = 0.55$

"Rebuilding of the [Gulf of Maine] stock occurred in 1988 and 1989, primarily due to improved recruitment."

Gulf of Maine cod catch, while gill net landings accounted for 39 percent.

NMFS research vessel weight per tow indices in both the spring and autumn 1989 surveys were the highest since 1985 reflecting strong recruitment from the 1985, 1986, and 1987 year classes. The autumn 1989 number per tow index was among the highest ever recorded. Survey age composition data indicate that the 1985 and 1986 year classes comprised about 65 percent of the total population, by both number and weight, during 1989. Catch per tow indices of age 2 fish in both the spring 1989 State of Massachusetts inshore survey and the autumn 1989 NEFC survey were the highest ever observed indicating outstanding recruitment of the 1987 year class. These surveys also indicated that recruitment of the 1988 year class is above-average.

Although an updated VPA for the Gulf of Maine cod stock is not yet available (the last VPA analysis was conducted using data through 1987), the recent increases observed in survey abundance and biomass indices, coupled with increases in commercial CPUE and reduced fishing effort, suggest that fishing mortality declined in 1989 from the record-high levels noted in 1986 and 1987. Based on analysis of survey data alone, fishing mortality in 1989 was estimated to be about F = 0.55.

Rebuilding of the stock occurred in 1988 and 1989, primarily due to improved recruitment. However, fishing mortality in 1989 was still twice as large as F_{max} and well above the F range (0.29 to 0.33) needed to attain 20 percent of maximum spawning potential, the management target established for this stock. As such, despite the recent reduction in F, the stock remains overexploited.

Atlantic Cod

Gulf of Maine

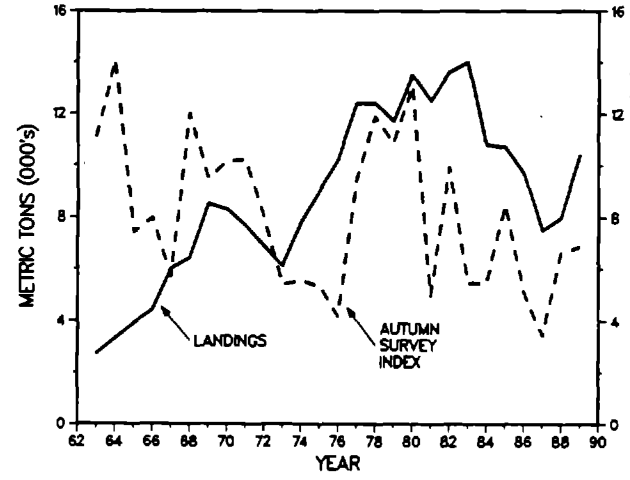


Table 1.1 Recreational catches and commercial landings (1,000 mt)

	Year									
Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational[1]										
USA	3.1	1.1	1.2	1.1	1.7	2.7	1.6	0.9	1.3	2.5
Commercial										
USA	13.5	12.5	13.6	14.0	10.8	10.7	9.7	7.5	8.0	10.4
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	16.6	13.6	14.8	15.1	12.5	13.4	11.3	8.3	9.3	12.9

[1] Estimated for Maine and New Hampshire.

GEORGES BANK AND AREAS TO THE SOUTH

Total nominal commercial catch (United States and Canada) in 1989 was 33,000 mt, 15 percent less than in 1988 (39,000 mt). The 1989 U.S. catch (25,100 mt) was 5 percent less than in 1988 (26,300 mt), the fourth lowest catch since 1977, and less than the 1977-88 annual average of 29,500 mt. Canadian 1989 landings totaled 7,900 mt, 38 percent lower than in 1988, and the lowest annual catch since 1984.

United States commercial fishing effort in 1989 declined 5 percent from the record high 1988 level, while U.S. commercial CPUE remained the same in 1989 as in 1988. Although still among the lowest values in the 1965-89 time series, CPUE in 1989 was about 18 percent higher than the record low 1986 and 1987 values.

Fishery age composition data indicate that both total and U.S. landings in 1989 were dominated by the strong 1985 year class, which comprised 39 percent of the catch by number and 47 percent by weight. Otter trawl landings accounted for 78 percent of the 1989 U.S. Georges Bank cod catch, while gill net landings accounted for 14 percent, a record high percentage.

NMFS research vessel indices in 1989 were markedly higher than in 1988 due to strong recruitment from the 1987 and 1988 year classes. The spring 1989 number and weight per tow indices were the highest since 1985, while the autumn 1989 indices were the highest since 1981. Age composition data from the 1989 surveys indicated that the 1985 year class continues to dominate the population by weight, accounting for about 34 percent of the stock biomass. In terms

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 = 2.4 yrs (males); 2.2 yrs (females)
Size at 50% maturity = 50 cm (19.7 in.) males; 47 cm (18.5 in.) females
Assessment level = Age structured

$M = 0.20$ $F_{0.1} = 0.15$ $F_{max} = 0.27$ $F_{1989} = 0.56$

Atlantic Cod
Georges Bank

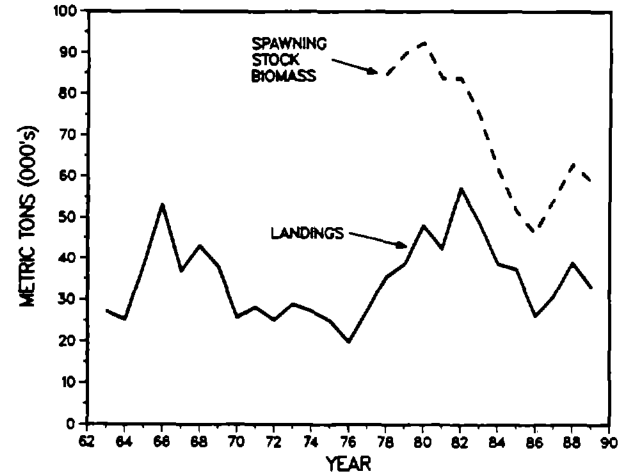


Table 1.2 Recreational catches and commercial landings (1,000 mt)

	Year									
Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
USA recreational[1]	3.3	7.5	6.8	7.2	3.7	6.3	1.8	2.9	6.3	4.3
Commercial										
USA	40.0	33.9	39.3	36.8	32.9	26.8	17.5	19.0	26.3	25.1
Canada	8.1	8.5	17.9	12.1	5.8	10.5	8.5	11.9	12.7	7.9
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	51.4	49.9	64.0	56.1	42.4	43.6	27.8	33.8	45.3	37.3

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

of numbers, the 1985 and 1987 cohorts accounted for 60 percent of the population in spring 1989 and 32 percent in autumn 1989. Catch per tow indices of age 1 fish in both the autumn 1989 State of Massachusetts inshore survey and the autumn 1989 NEFC survey were among the highest ever observed indicating excellent recruitment of the 1988 year class. In both surveys the 1989 year class appeared to be only average in strength.

An updated VPA analysis (using data through 1989) indicated that fishing mortality declined in 1989 to F=0.56 (ages 3 to 8, unweighted) from the record high level estimated in 1988 (F=0.78). Despite this decline, F in 1989 was still about twice as large as F_{max} (F=0.27), slightly above F_{med} (F=0.47), and well in excess of the F needed to attain 20 percent maximum spawning potential (F=0.30), the management target established for this stock. In this context, the stock is overfished.

> **"Spawning stock biomass at the beginning of 1990 (66,400 t) was 43 percent higher than in 1986...but less than any of the SSB levels observed during 1978-83."**

Spawning stock biomass [SSB] at the beginning of 1990 (66,400 t) was 43 percent higher than in 1986 (due to the strong 1985 and 1987 cohorts which together constitute 50 percent of the 1990 SSB), but less than any of the SSB levels observed during 1978-83. However, SSB is expected to further increase in 1991 (to slightly above the 1978-88 average of 70,000 t) due to nearly full recruitment of the excellent 1988 year class to the spawning stock. This cohort should account for about 40 percent of the catch weight and SSB in both 1991 and 1992.

At the current level of fishing, commercial landings during 1990-92 are expected to be about 40,000 t/yr. By 1993, however, the 1988 year class will no longer be a major component of the stock. If above average recruitment does not occur before then, fishing mortality will need to be reduced to maintain spawning stock biomass.

For further information

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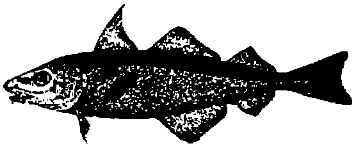
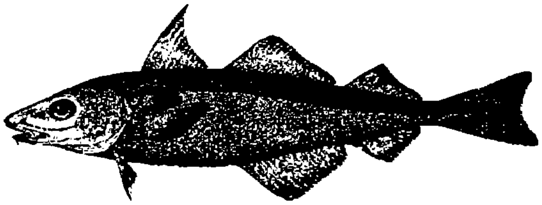
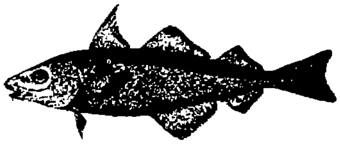


2. HADDOCK





The haddock, *Melanogrammus aeglefinus*, a demersal gadoid species, is distributed on both sides of the North Atlantic; in the Northwest Atlantic, haddock range from West Greenland to Cape Hatteras. Highest concentrations off the U.S. coast occur on northern and eastern Georges Bank and in the southwestern Gulf of Maine. Haddock are most common at depths of 45 to 135 m (25 to 75 fathoms) and temperatures of 2° to 10°C (36° to 50°F). Georges Bank haddock appear to be relatively sedentary, but seasonal coastal movements occur in the western Gulf of Maine. Small invertebrates constitute the bulk of the diet.

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 U.S. 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 two and three at approximately 38 cm (15 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. 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. Two populations or stocks have been identified, termed the Gulf of Maine and the Georges Bank stocks. The principal commercial fishing gear used to catch haddock is the otter trawl. Recreational catches are insignificant. Fishing is managed under the New England Fishery Management Council's Multispecies Fishery Management Plan (FMP). Total reported catches decreased by 47 percent in 1989 (8,900 mt to 4,700 mt), although

Gulf of Maine Haddock

Long-term potential catch = 5,000 mt
Importance of recreational fishery = Minor
Management = Multispecies FMP
Status of exploitation = Overexploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 38 cm (15 in.)
Assessment level = Yield per recruit

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

"Recruitment has been too poor to support landing levels, and further declines in landings of this overexploited stock are anticipated."

a portion of the decrease may reflect misreporting in 1988. Domestic nominal catches decreased by 41 percent (2,900 mt to 1,700 mt) in 1989.

GULF OF MAINE STOCK

Nominal catches of Gulf of Maine haddock decreased from about 5,000 mt annually in the mid-1960s to less than 1,000 mt in 1973, coincident with a decline in the NEFC autumn bottom trawl survey index. Catches and the survey index increased together until 1978; catches then continued to increase, averaging 7,000 mt annually during 1980-83, but subsequently plummeted to a historic low of 300 mt in 1989. Recreational catches have also declined, from 1,700 mt in 1979 to insignificant levels since 1981. U.S. fishermen have accounted for 80 percent of the total catch from 1981 to 1989.

The NEFC autumn survey index has declined in nearly every year since 1978, while spring index values have shown a general downward trend since 1981. The autumn survey index for 1989 is the lowest in the time series. Research vessel surveys indicated that the 1979, 1980, and 1982 year classes were relatively strong; these year classes have been greatly reduced by fishing, and stock biomass is currently low. Autumn surveys conducted by the Massachusetts Division of Marine Fisheries suggest that recruitment from the inshore portion of the Gulf of Maine has been negligible since 1982.

The 86 percent decline in landings from 1983 to 1987 (7,600 mt to 1,000 mt) accelerated in 1988 and 1989 (70 percent decline from 1,000 mt to 300 mt), and is indicative of the status of this stock. Recruitment has been too poor to support landing levels, and further declines in landings of this overexploited stock are anticipated. Spawning stock biomass is less than maintenance level, and is likely to remain so in the near future.

Haddock

Gulf of Maine

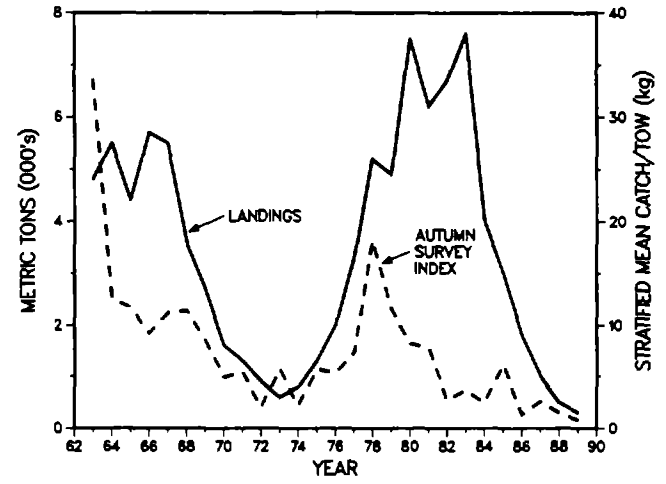


Table 2.1 Recreational catches and commercial landings (1,000 mt)

	Year									
Category	1980	1981	1982	1983	1984	1985	1986	1986	1988	1989
USA recreational	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	-	<0.1	<0.1	<0.1
Commercial										
USA	7.3	5.7	5.6	5.6	2.8	2.2	1.6	0.8	0.4	0.3
Canada	0.2	0.5	1.1	2.0	1.2	0.8	0.2	0.2	0.1	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	7.7	6.2	6.7	7.6	4.0	3.0	1.8	1.0	0.5	0.3

GEORGES BANK STOCK

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, and subsequently declined through 1976. Catches increased between 1977 and 1980, reaching about 28,000 mt, but subsequent catches declined steadily to 6,100 mt by 1987. An increase in the 1988 reported catch to 8,400 mt may reflect the possible misreporting of up to 2,000 mt of Canadian catch from Georges Bank instead of the Scotian Shelf. Regardless of the degree of possible misreporting in 1988, total 1989 landings declined sharply to 4,400 mt while U.S. landings decreased by 44 percent to 1,400 mt. United States fishermen accounted for 69 percent of the nominal commercial catch between 1977 and 1984, but the percentage has declined to less than 40 percent of the total since 1987.

The NEFC autumn bottom trawl survey results have indicated a marked decline in the overall stock biomass of haddock since 1979. The 1988 and 1989 autumn survey indices (5.6 kg per tow in each year) represent only 20 percent of the 1979 index and 9 percent of the 1964 value. The NEFC spring survey indices also show a similar decline since 1979. An increase in the 1988 and 1989 spring and autumn indices from 1987 levels was due almost entirely to growth and recruitment of the 1985 and 1987 year classes.

Research vessel survey data for 1979-89 reveal a succession of weak year classes throughout the 1980s. The 1981, 1982, 1984, 1986, 1987, and 1988 young of year indices for Georges Bank were among the lowest on record. Subsequent age 1 indices

Georges Bank Haddock

Long-term potential catch = 47,000 mt
Importance of recreational fishery = Insignificant
Management = Multispecies MP
Status of exploitation = Overexploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 38 cm (15 in.)
Assessment level = Yield per recruit

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

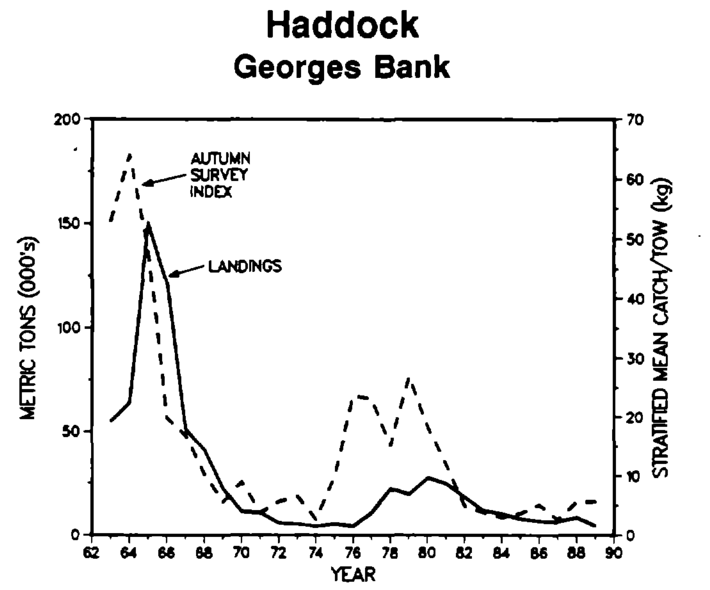


Table 2.2 Recreational catches and commercial landings (1,000 mt)

	Year									
Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
USA recreational	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-	-
Commercial										
USA	17.5	19.2	12.6	8.7	8.8	4.3	3.3	2.2	2.5	1.4
Canada	10.1	5.7	5.6	3.2	1.4	3.5	3.4	4.1	5.9[1]	3.0
Other	-	<0.1	-	-	-	-	-	-	-	-
Total nominal catch	27.6	24.9	18.2	11.9	10.2	7.8	6.7	6.3	8.4[1]	4.4

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

in the autumn and age 2 indices in the spring, however, suggest that the 1987 year class was undersampled at age 0 and may have been comparable in strength to the 1983 and 1985 year classes. Estimates of the 1983 year class, and indices for the 1985 and 1987 year classes, suggest that they were all of moderate strength, comparable to the 1972 year class. Recent surveys continue to indicate that the 1988 year class is relatively weak. The fishery in 1990 will, therefore, depend almost entirely on recruitment of age 3 fish from the 1987 year class.

Fishing effort, mortality, and discarding have been high in recent years and appear to have reduced the 1983 and 1985 year classes rapidly. The relatively steady landings from 1985 to 1988 (average 6,800 mt) have been maintained on fish recruiting from these year classes. Landings in 1990 can be expected to be maintained based on recruitment from the 1987 year class. Future catch levels will depend on the strength of future year classes. Targets for maintenance of spawning stock biomass are not being met under the Multispecies FMP, and unless fishing mortality and discarding rates decline, stock size is expected to remain low and to possibly decline further in 1990, continuing its overexploited condition.

"Fishing effort, mortality, and discarding have been high in recent years and appear to have reduced the 1983 and 1985 year classes rapidly."

For further information

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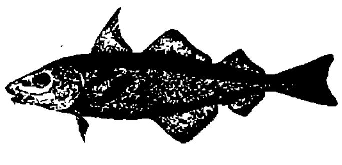
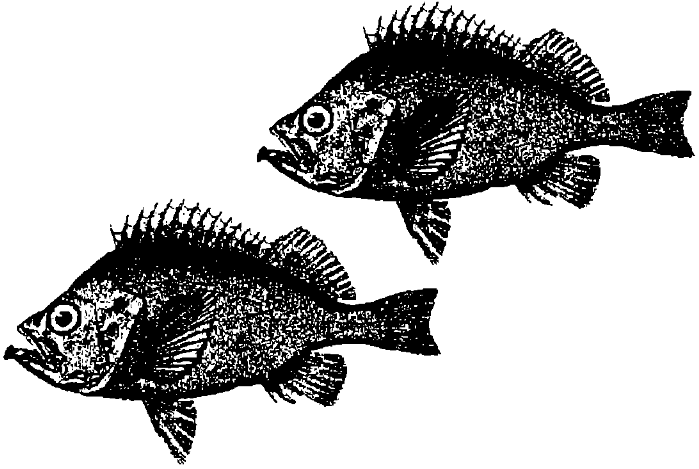


3. REDFISH



Redfish or ocean perch, *Sebastes*, spp., are distributed throughout the North Atlantic from the coast of Norway to Georges Bank. Off New England, *Sebastes fasciatus* are most common in deep waters of the Gulf of Maine to depths of 300 m (975 ft). Redfish are slow growing, long-lived animals with an extremely low natural mortality rate. Ages in excess of 50 years and maximum sizes of 45 to 50 cm (18 to 20 in.) have been noted. In the Gulf of Maine, redfish reach maturity in about 5 to 6 years at an average length of 20 to 23 cm (8 to 9 in.). Females are viviparous, retaining eggs in the ovary after fertilization until yolk sac absorption. Mating takes place in autumn, with subsequent larval extrusion occurring the following spring and summer.

The principal commercial fishing gear used to catch redfish is the otter trawl. Recreational catches are insignificant. Fishing is managed under the New England Fishery Management Council's Multispecies FMP. Total nominal catches decreased by 50 percent in 1989 (1,200 mt to 600 mt).

During the development phase of the Gulf of Maine fishery, U.S. nominal catches rapidly rose to a peak level of about 60,000 mt in 1942 followed by a gradual decline. Nominal catches in recent years increased from approximately 10,000 to 11,000 mt during 1974-76 to approximately 14,000 to 15,000 mt in 1978-79. In 1988 and 1989, however, catches declined to 1,100 and 600 mt, respectively, the lowest annual figures since the directed fishery commenced in the early 1930s. The Gulf of Maine redfish population is presently dominated by the 1971 and 1978 year classes. The 1971 year class accounted for 63 percent of the numbers landed in the commercial fishery in 1980 and 1981. In 1983, however, the 1978 year class recruited to the fishery, accounting for 15 percent of the total. By 1985, this year class represented 36 percent of the total number landed. Subsequent year classes, however, have been weak. Catch at age estimates for 1986-90 are not yet available.

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. Estimates of exploitable biomass (ages 5 and older) from virtual population analysis declined by 75 percent 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.

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 in.)
Assessment level = Yield per recruit

$M = 0.05$ $F_{0.1} = 0.07$ $F_{max} = 0.14$ $F_{1989} \leq F_{0.1}$

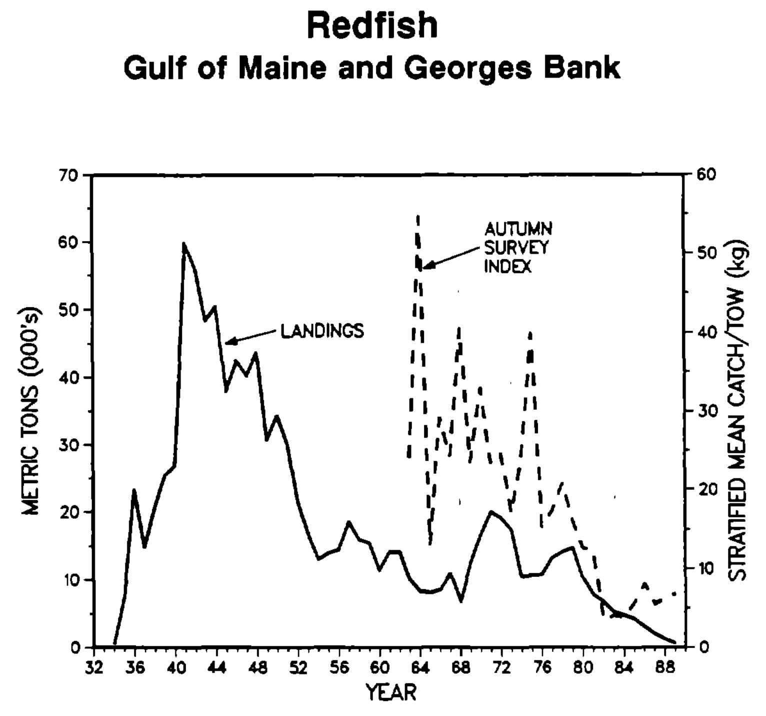


Table 3.1 Recreational catches and commercial landings (1,000 mt)

	Year									
Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
USA recreational	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	10.1	7.8	6.7	5.2	4.7	4.2	2.9	1.9	1.1	0.6
Canada	0.1	<0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	<0.1
Other	-	<0.1	-	-	-	-	-	-	-	-
Total nominal catch	10.2	7.8	6.8	5.3	4.8	4.3	3.0	2.0	1.2	0.6

Average fishing mortality during the 1970s was slightly greater than F_{max} (0.14) and about 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 percent 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, however, surplus production in the near future will be considerably less than that, as indicated by the sharp decline in nominal catches.

Unless recruitment improves substantially, however, biomass and yield are not expected to increase; the population remains overexploited.

The decline in the landings in 1989 continues a trend evident since 1980, reflecting a decreasing level of fishing mortality. Given the present exploitation pattern, the fishery is extremely dependent on recruitment. Recruitment has been poor since 1971 except for the moderate 1978 year class. Despite the low levels of catch seen in recent years, stock biomass has not increased appreciably. Unless recruitment improves substantially, however, biomass and yield are not expected to increase; the population remains overexploited.

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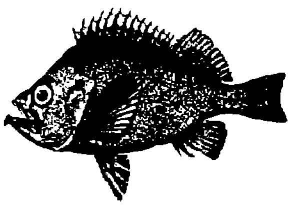
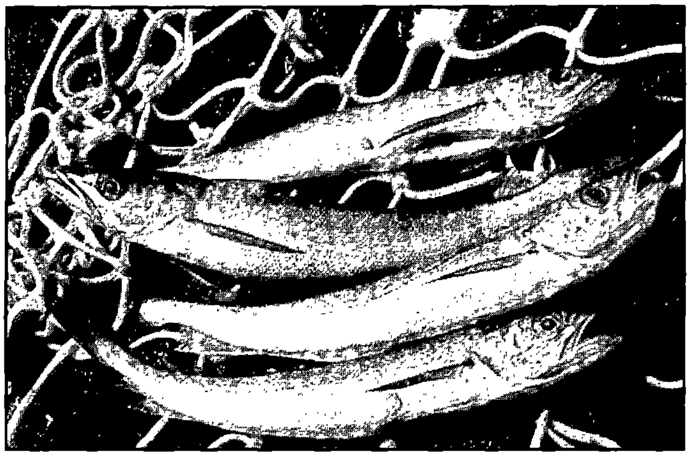
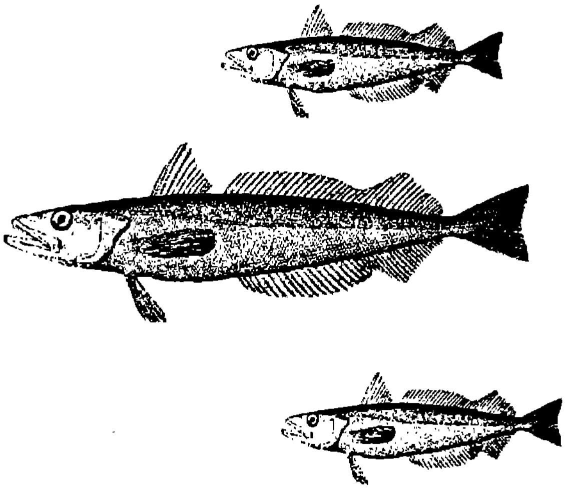


4. SILVER HAKE





The silver hake or whiting, *Merluccius bilinearis*, are widely distributed, slender, swiftly swimming fish with a range extending from Newfoundland to South Carolina, but are most abundant from Maine to New Jersey. Research vessel bottom trawl surveys indicate that silver hake have wide geographic and depth ranges throughout the year. Concentrations vary from season to season in response to 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 wintering 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 percent of age two fish (20 to 30 cm), and nearly all age 3 fish (25 to 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 percent 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 Hake Preliminary Management Plan. Total nominal catches increased by 11 percent in 1989 (16,100 mt to 17,900).

GULF OF MAINE - NORTHERN GEORGES BANK STOCK

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; although activity by distant water fleets diminished after 1977, landings subsequently increased, averaging 4,800

Gulf of Maine - Northern Georges Bank Silver Hake

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

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

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, and dropped further in 1989 to 4,600 mt.

The 4,600 mt of silver hake taken in 1989 included 3,100 mt landed exclusively by an experimental silver hake fishery conducted on the Northeastern portion of Georges Bank 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 (greater than 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 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, because of the strong 1984 and 1985 year classes. Biomass indices declined slightly in 1987 and 1988, but increased sharply in 1989. The 1986 and 1987 year classes appear to be relatively poor, but the increase in the 1989 survey index reflects the recruitment of a potentially strong 1988 year class. In general, bottom trawl survey biomass indices since 1975 have remained high compared to those for the period prior to 1975.

"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 continue to indicate extremely low stock biomass levels compared to the pre-1975 period, despite the low level of landings. Until these inconsistencies are resolved, the status of exploitation remains uncertain."

Georges Bank - Middle Atlantic Silver Hake

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

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

Mean fishing mortalities (F) for fully recruited fish ranged from 0.19 to 1.29 between 1955 and 1988. Before the introduction of the DWF, mean F remained fairly steady, ranging from 0.20 to 0.36 (average = 0.27) between 1955 and 1961. With increased fishing effort on the stock beginning in 1962, F rose rapidly and reached 0.70 in 1964. Fishing mortality declined sharply in 1965, and remained relatively stable during 1965-70 (average = 0.41). Except for a sharp increase in 1971, F fluctuated between 0.28 and 0.78 in alternate years throughout most of the 1970s before declining to 0.20 in 1979 after inception of MFCMA. Since then, F has remained fairly steady, averaging 0.42 from 1980 though 1988.

Spawning stock biomass (SSB) increased from 251,800 mt in 1958 to a high of 301,900 mt in 1962. During the following ten years, spawning stock biomass declined by 84 percent to 47,900 mt by 1972. Recruitment of several strong year classes from the early 1970s increased spawning stock biomass to 73,700 mt by 1975; SSB declined thereafter to only 12,100 mt by 1981, but has since increased to 33,500 mt in 1987.

The increase in landings in 1988 reflects recruitment from the strong 1984 and 1985 year classes, while the subsequent decline in 1989 may be related to poorer recruitment from the 1986 and 1987 year classes. This recent decline in landings, coupled with the increase in biomass noted in the autumn survey, suggests that the projected F for 1989 may have declined below the 1988 level. 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 continue to indicate extremely low stock biomass levels compared to the pre-1975 period, despite the low level of landings. Until these inconsistencies are resolved, the status of exploitation remains uncertain. 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 can not support increased fishing and must be considered fully exploited.

SOUTHERN GEORGES BANK - MID-ATLANTIC STOCK

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 to 18,400 mt in 1979. Prior to the inception of the MFCMA, DWF landings represented about 87 percent of the total; activity by distant-water fleets diminished after 1977, and landings continued to decline, averaging 13,500 and 9,700 mt during 1980-85 and 1986-88, respectively. Catches by distant-water fleets are now taken primarily as bycatch in the squid fishery. In 1989, commercial landings increased to 13,200 mt. Recreational landings are insignificant, estimated to be only 100 mt in 1989.

The autumn NEFC bottom trawl biomass index decreased sharply in 1966 and continued to decline steadily through 1974. With the appearance of the strong 1973 and 1974 year classes, biomass indices increased between 1975 and 1978 and fluctuated without any significant trends through 1984. The index increased again in 1985, but declined sharply thereafter, and has since increased steadily through 1989. The 1977, 1981, and 1982 cohorts were above average, while the 1984 and 1985 year classes appeared to be quite strong. Year class strength has been at or below average since 1986, although the 1989 cohort may be potentially strong.

Mean fishing mortalities (F) for fully recruited fish ranged from 0.09 to 0.98 between 1955 and 1988. Before the introduction of the DWF, mean F remained 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. Fishing mortality quickly declined by 1967 and averaged 0.52 during 1967-77. Following the inception of MFCMA, F declined from 0.78 in 1977 to 0.33 in 1980, increased

Silver Hake

Gulf of Maine-Northern Georges Bank

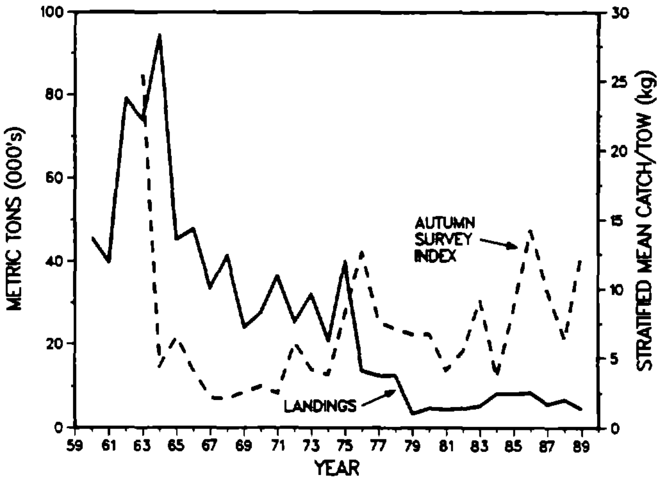


Table 4.1 Recreational catches and commercial landings (1,000 mt)

	Year									
Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
USA recreational	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	4.7	4.4	4.7	5.3	8.3	8.3	8.5	5.7	6.8	4.6
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	4.7	4.4	4.7	5.3	8.3	8.3	8.5	5.7	6.8	4.6

Southern Georges Bank-Middle Atlantic

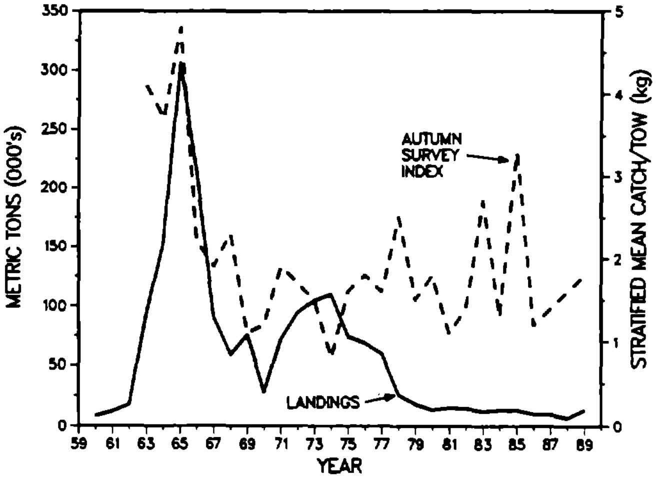


Table 4.2 Recreational catches and commercial landings (1,000 mt)

	Year									
Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
USA recreational	0.1	0.1	0.3	<0.1	<0.1	<0.1	0.1	0.1	0.1	0.1
Commercial										
USA	11.7	11.7	11.9	11.5	12.7	11.8	9.4	9.8	9.2	13.2
Canada	-	-	-	-	-	-	-	-	-	-
Other	1.7	3.0	2.4	0.6	0.4	1.3	0.5	-	-	-
Total nominal catch	13.5	14.8	14.6	12.1	13.1	13.1	10.0	9.9	9.3	13.3

during 1981-84, and averaged 0.62 during 1985-88.

Spawning stock biomass increased from 51,600 mt in 1955 to a high of 655,700 mt in 1965 before declining steadily to 143,000 mt in 1970. Spawning biomass increased to 220,000 mt in 1974, but declined rapidly thereafter, reaching a record low of 24,200 mt in 1983. By 1987, SSB had increased to only 35,300 mt.

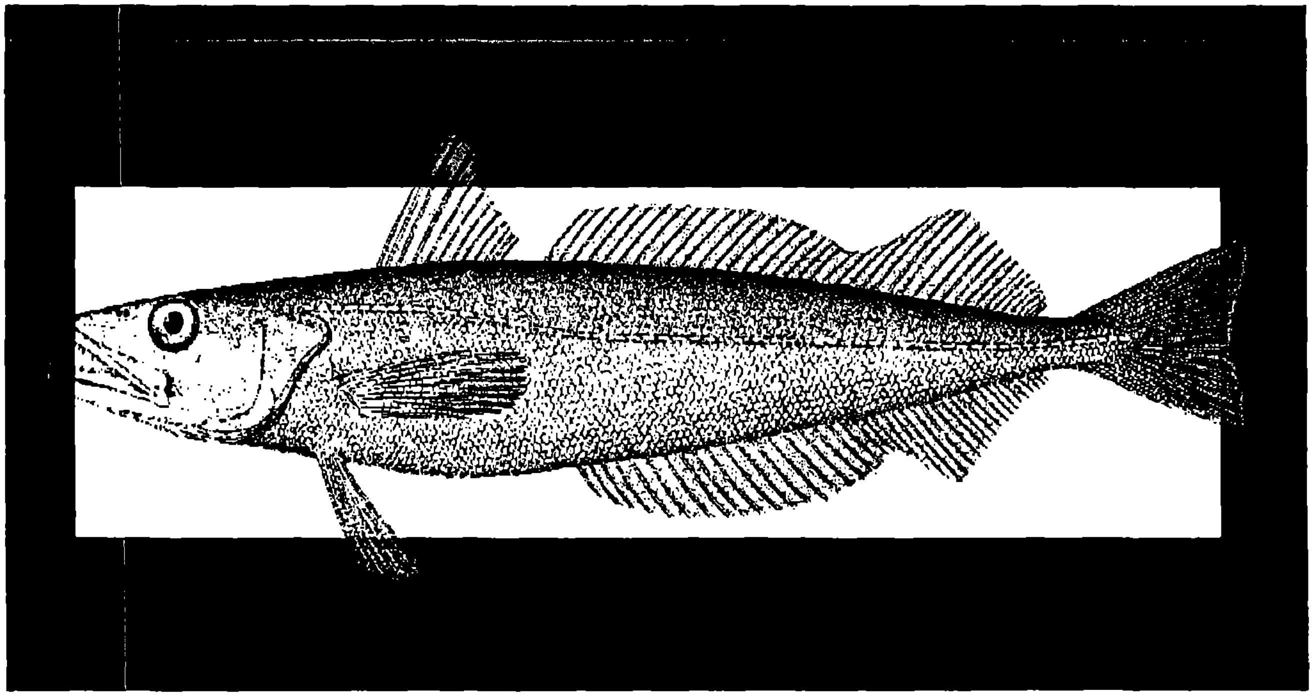
The increase in landings in 1989, coupled with relatively low survey biomass indices, suggests that F in 1989 may have increased slightly above the 1988 level. Although bottom trawl survey indices suggest that silver hake biomass over the past 15 years has remained at or above levels observed during the late 1960s and early 1970s, results from the VPA continue to indicate extremely low stock biomass levels compared to the pre-1975 period, despite the low level of landings. Until these inconsistencies are resolved, the status of exploitation remains uncertain. Since it is not likely that F will decline substantially below the 0.3 to 0.4 range in the near future, and given the rapid removal of recruits from the stock in recent years, it appears that this stock can not support increased fishing and must be considered fully exploited.

For further information

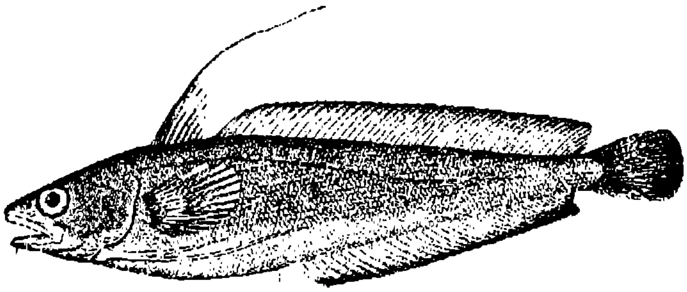
Almeida, F. P. 1987. Status of silver hake resources of the northeast coast of the United States - 1987. Woods Hole, MA: NOAA/NMFS/NEFC. Woods Hole Laboratory Reference Document 87-03. Available from: Northeast Fisheries Center, Woods Hole, MA 02543.

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

"Year class strength has been at or below average since 1986, although the 1989 cohort may be potentially strong."



5. RED HAKE



The red hake, *Urophycis chuss*, is widely distributed with a range extending from the Gulf of St. Lawrence to North Carolina, but is most abundant between Georges Bank and New Jersey. Research vessel bottom trawl surveys indicate that red hake have wide geographic and depth ranges throughout the year. The major concentration of fish varies from season to season in response to hydrographic conditions, availability of food, and spawning requirements. Their migration is extensive, wintering in the deep waters of the Gulf of Maine and along the outer continental shelf and slope south and southwest of Georges Bank. During their spawning period from May through November, red hake are found in the warmer shoal and inshore waters.

Major spawning areas include the southwest part of Georges Bank and Southern New England waters south of Montauk Point, Long Island. The maximum length reached by red hake is approximately 50 cm (19.7 in.). The maximum age is reported to be about 12 years, but few fish are seen older than 8 years of age. Two stocks have been assumed for management purposes, divided north and south in the central Georges Bank region.

The principal commercial fishing gear used to catch red hake is the otter trawl. Recreational catches are negligible. The fishery is scheduled to be managed under the proposed Amendment 4 to the New England Fishery Management Council's Multispecies FMP. Total reported catches in 1989 were very similar to 1988 (1,600 mt versus 1,900 mt), all domestic.

GULF OF MAINE - NORTHERN GEORGES BANK STOCK

Nominal 1989 landings from the northern red hake stock were 800 mt, taken exclusively by U.S. vessels. The 1989 catch was 11 percent lower than in 1988 and the lowest in the past 30 years. Trends in total landings from this stock have shown three distinct periods. The first period, from the early 1960s through 1971, was characterized by relatively low landings

Gulf of Maine - Northern Georges Bank Red Hake

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

$M = 0.40$ $F_{0.1}$ = Unknown $F_{max} > 2.00$ F_{1989} = Unknown

> **"It is unlikely that this stock will undergo any major declines in 1990 if landings remain at or somewhat above the levels reported in recent years."**

Red Hake

Gulf of Maine - Northern Georges Bank

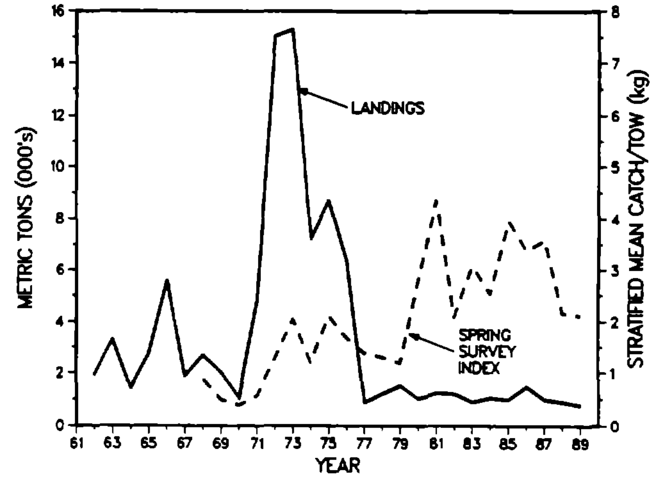


Table 5.1 Recreational catches and commercial landings (1,000 mt)

Category	Year 1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	1.0	1.2	1.2	0.9	1.1	1.0	1.5	1.0	0.9	0.8
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	1.0	1.2	1.2	0.9	1.1	1.0	1.5	1.0	0.9	0.8

Southern Georges Bank - Middle Atlantic

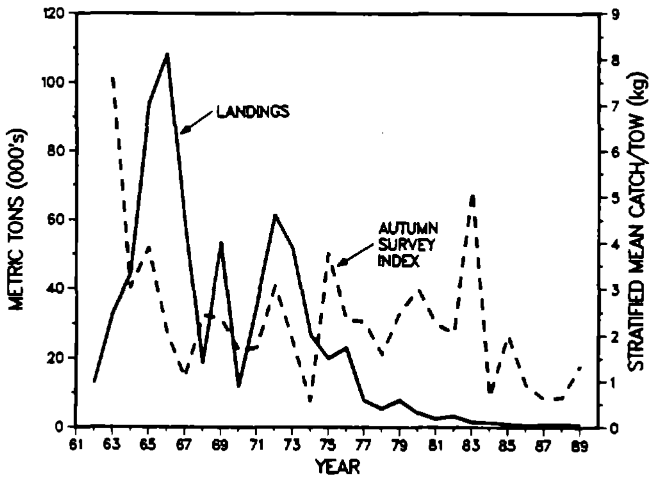


Table 5.2 Recreational catches and commercial landings (1,000 mt)

Category	Year 1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
USA recreational	0.1	0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial										
USA	3.9	2.1	3.0	1.3	1.2	0.8	0.6	0.9	0.9	0.8
Canada	-	-	-	-	-	-	-	-	-	-
Other	0.2	0.2	0.2	0.1	0.1	0.1	-	-	-	-
Total nominal catch	4.2	2.4	3.3	1.5	1.3	0.9	0.6	0.9	0.9	0.8

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 percent of the total annual landings were taken by the distant-water fleet (DWF) on northern Georges Bank. Total landings then dropped sharply and have averaged only 1,100 mt from 1980 to the present, due primarily to the displacement of DWF from the waters inhabited by this stock.

The NEFC spring bottom trawl survey index increased from low levels in the late 1960s, fluctuated at intermediate levels from 1972 to 1979, and attained high values during 1980-87. The 1989 value was the lowest since 1979, continuing a three year decline during which the index decreased by 41 percent. Survey catch per tow at age data indicate that the 1973 and 1974 year classes were the strongest since 1970. Year classes produced between 1975 and 1979 were of average strength with the exception of a weak 1977 cohort. The 1980 and 1981 year classes appeared to be above average while the 1983 year class appeared to be weak in comparison to other years. The 1985 year class appeared to be quite strong, recording the second highest age O autumn index in the 1970-85 time series. The strength of the 1988 year class appeared to be above average.

The combination of low fishing pressure, low catches and the average and above-average year classes produced since about 1980 seems at odds with the declining survey index in recent years, suggesting that significant discarding of the species may be occurring. It is unlikely that this stock will undergo any major declines in

Southern Georges Bank - Middle Atlantic Red Hake

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

$M = 0.40$ $F_{0.1}$ = Unknown $F_{max} > 2.00$ F_{1989} = Unknown

> **"If the 1988 year class is as strong as the autumn index suggests, then an increase in stock biomass might be expected in the next year or two."**

1990 if landings remain at or somewhat above the levels reported in recent years. The stock is underexploited and substantially higher catches could be supported.

SOUTHERN GEORGES BANK- MIDDLE ATLANTIC STOCK

Nominal 1989 landings of the southern red hake stock were 800 mt, about 11 percent less than in 1988, and the second lowest annual catch in the 1960-89 period. No DWF landings were reported. Recreational landings were estimated to be approximately 8 mt.

Total landings from this stock rose dramatically with the introduction of the DWF, from 4,600 mt in 1960 to a high of 108,000 mt in 1966. Landings averaged 38,000 mt during 1967 to 1972. 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 inception of 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 high of 32,600 mt in 1964 and then began a steady decline to 4,000 mt in 1966. Landings remained relatively steady between 1967 and 1979, averaging 4,100 mt annually, but have since declined steadily to current low levels.

The NEFC autumn bottom trawl survey index declined steadily from the highest levels in the mid-1960s, remained fairly constant between 1968 and 1973, and then dropped to a series low in 1974. The index increased sharply in 1975, declined slightly and remained fairly steady between 1976 and 1982 at a level similar to that between 1968 and 1973. The index reached its second highest level in 1983, dropped sharply in 1984 (almost to the lowest level), but increased in 1985. It dropped again in 1986 and dropped even further in 1987 and 1988 to the lowest levels since 1974. The 1989 index was about double those of 1987-88. Survey catch per tow at age indices indicated that the 1974 and 1979 to 1981 year classes were stronger than other years in the series, with the 1974 cohort being the strongest. Other year classes since 1970 appeared to be of only average strength with the exception of the 1983 year class, which appeared to be weak. However, the autumn 1985 prerecruitment index was the second highest in the time series, indicating the possibility of a strong 1985 year class. Weak 1986-87 year classes appeared to be followed by an above average 1988 year class.

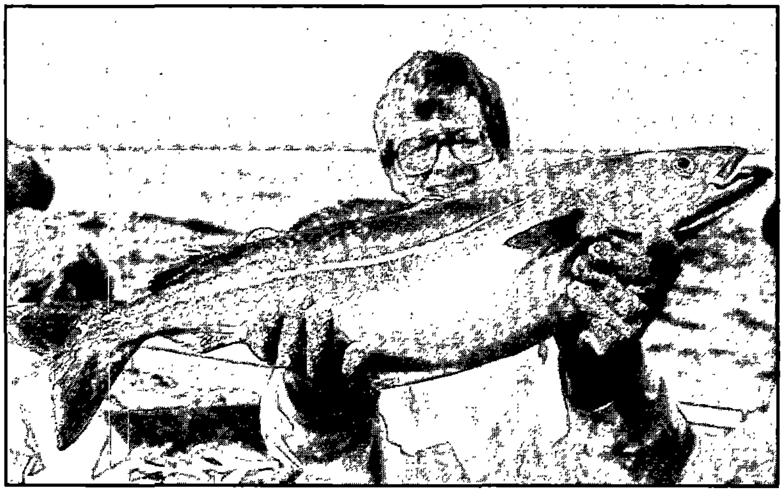
The low catches in recent years (average 1,000 mt since 1983) reflect low fishing pressure, which has allowed the age structure to remain fairly stable with three or four year classes contributing strongly to the survey indices. However, the survey indicates that the stock has declined somewhat in recent years. If the 1988 year class is as strong as the autumn index suggests, then an increase in stock biomass might be expected in the next year or two. The stock is underexploited, and increased catches could be sustained over the next few years.

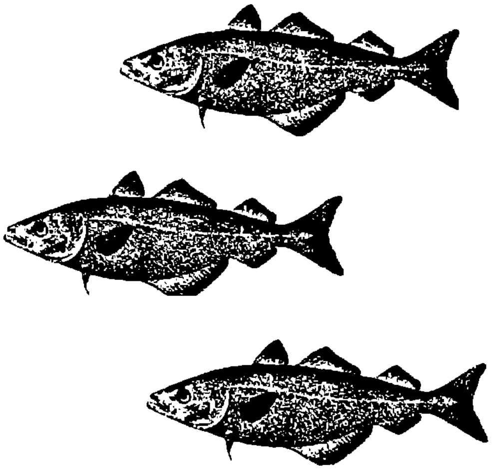
For further information

Northeast Fisheries Center. 1986. Report of the Second Stock Assessment Workshop. Woods Hole, MA: NOAA/NMFS/NEFC. Woods Hole Laboratory Reference Document 86-09. 114 p. Available from: Northeast Fisheries Center, Woods Hole, MA, 02543.

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

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 had been 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. 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 7 percent in 1989 (58,100 mt to 53,800 mt), with most of the decrease due to a 30 percent decline in U.S. commercial catches (14,900 mt to 10,500 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 1972-76 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 1985-87. United States catches have increased from an average of 9,700 mt during 1973-77 to more than 14,000 mt annually between 1978 and 1988, peaking at 24,500 mt in 1986. Nominal catches by distant water fleets have declined from an annual average of 9,800 mt during 1970-73 to less than 1,400 mt during 1981-88. The 1989 DWF catch increased to 1,800

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	=	3.7 yrs
Size at 50% maturity	=	50 cm (20 in.)
Assessment level	=	Age structured

$M = 0.20$ $F_{0.1} = 0.29$ $F_{max} = 0.57$ $F_{1989} = 0.5\text{-}0.7$

mt in 1989. Most of this catch has been taken by Soviet vessels on the Scotian Shelf. Estimated U.S. recreational catches have fluctuated between 100 and 1,300 mt since 1979. No information is available for the Canadian recreational harvest, although it appears to be of minor importance. The total nominal catch, including recreational, declined for the third consecutive year to 53,800 mt in 1989. Although landings for Canada and the United States decreased in 1989, most of the decline since 1986 was due to sharp reductions in U.S. landings in 1987, 1988, and 1989.

Total stock size, after increasing throughout the late 1970s and early 1980s, has declined substantially since the mid-1980s. Autumn biomass indices derived from NEFC autumn bottom trawl surveys increased during the mid-1970s, but have declined sharply since 1981. 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. Canadian commercial abundance indices (mt/hour fished) increased between 1974 and 1984, but declined sharply in 1985, 1987 and 1988. Indices for U.S. trawlers have also declined consistently since 1983, but CPUE indices for both countries increased slightly in 1989. Virtual population analyses have also indicated a 45 percent decrease in age 2+ stock biomass between 1984 and 1988. Recruitment conditions were favorable throughout the 1970s and early 1980s, with moderate to strong year classes appearing regularly every 3 to 4 years. The most recent strong year class was produced in 1982 and recruited to the fishery at age 2 in 1984. Except for a potentially strong 1985 year class, those recruiting after 1984 have been below the long-term average.

Under recruitment conditions which prevailed during the 1970s and early 1980s, fishing at $F_{0.1}$ could provide a long-term catch of 53,600 mt, while fishing at F_{max} could provide a catch of 58,100 mt. Although potential yield is approximately 8 percent greater at the F_{max} level, fishing at $F_{0.1}$ provides for a 55 percent increase in total stock and a 74 percent increase in spawning stock biomass over those allowed under F_{max}, thereby providing for greater stability in reproductive potential and resilience to environmental perturbations. Continued fishing at or exceeding F_{max} will likely result in a long-term decline in spawning stock, since this strategy does not account for fluctuating recruitment.

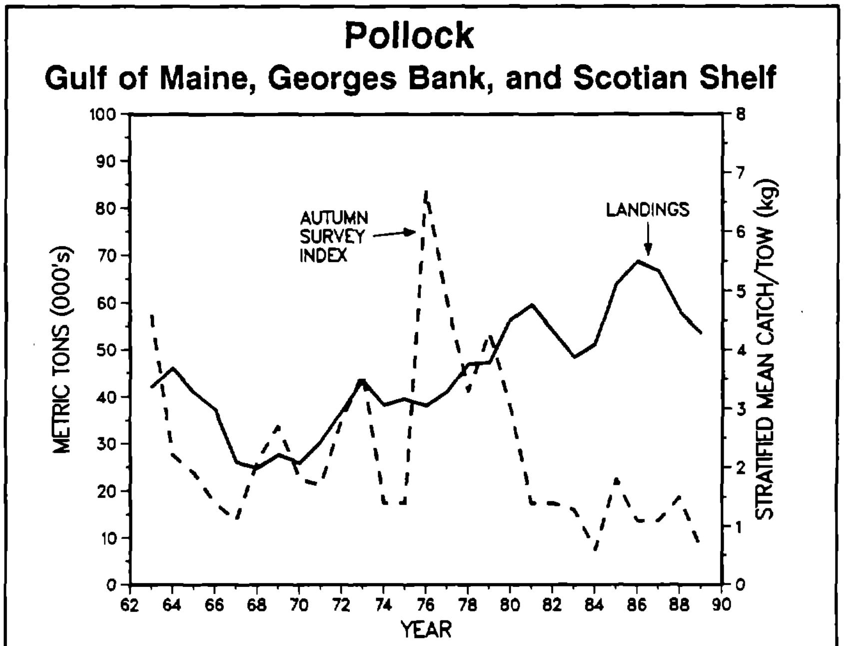


Table 6.1 Recreational catches and commercial landings (1,000 mt)

	Year									
Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
USA recreational	1.0	0.7	1.3	1.3	0.2	0.7	0.2	0.1	0.2	0.3
Commercial										
USA	18.3	18.2	14.4	14.0	17.8	19.5	24.5	20.4	14.9	10.5
Canada	36.0	40.3	38.0	32.7	33.2	43.3	43.0	45.3	41.7	41.2
Other	1.2	0.5	0.4	0.5	0.1	0.4	1.0	0.9	1.3	1.8
Total nominal catch	56.5	59.7	54.1	48.5	51.3	63.9	68.7	66.7	58.1	53.8

The relatively poor recruitment evident since 1982, coupled with the recent increase in total landings in excess of 65,000 tons, has resulted in high fishing mortality rates ranging from 0.5 to 0.7 during 1986-88. Although total landings have declined in 1988 and 1989, these reduced catch levels are still generating excessive fishing mortality rates because stock biomass has also decreased. The stock continues to be overexploited, and no increase in stock size is likely in 1990 unless recruitment improves.

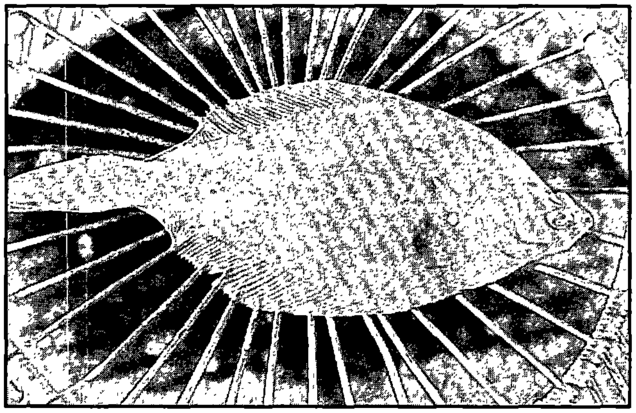
For further information

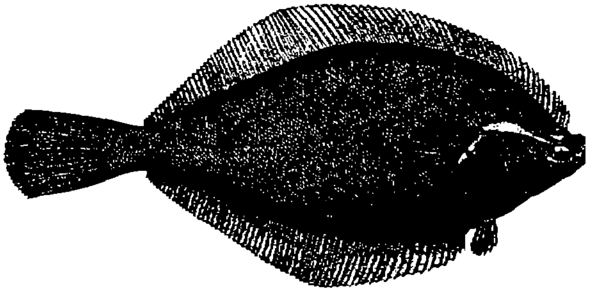
Annand, C., D. Beanlands, and J. McMillan. 1988. Assessment of Divisions 4VWX and Subarea 5 pollock, *Pollachius virens*. Canadian Atlantic Fisheries Scientific Advisory Committee. Research Document 88/71. 65p. Available from: DFO, P.O. Box 1006, Dartmouth, N.S., Canada B2Y4A2.

Mayo, R. K., J.M. McGlade, and S. H. Clark. 1989. Patterns of exploitation and biological status of pollock *Pollachius virens* L. in the Scotian Shelf, Gulf of Maine, and Georges Bank area. *J. Northw. Atl. Fish. Sci.* 9:13-36.

Mayo, R.K. S.H. Clark, and M.C. Annand. 1989. Stock assessment information for pollock, *Pollachius virens* L., in the Scotian Shelf, Georges Bank, and Gulf of Maine regions. Woods Hole, MA: NOAA/ NMFS/NEFC. NOAA Technical Memorandum NMFS-F/NEC-65.

7. YELLOWTAIL FLOUNDER





The yellowtail flounder, *Limanda ferruginea*, ranges from Labrador to Chesapeake Bay. Off the U.S. 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 U.S. 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 (*i.e.*, the "tail of the bank"). Yellowtail commonly attain lengths up to 47 cm (18.5 in.) and weights up to 1.0 kg (2.2 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 occurs among them.

The principal fishing gear used to catch yellowtail flounder is the otter trawl. Current levels of recreational and foreign fishing are insignificant. The U.S. fishery is managed under the New England Fishery Management Council's Multispecies FMP. Total landings of yellowtail flounder increased by 44 percent in 1989 to 5,600 mt.

> **"...rebuilding of the stock will require reduced fishing mortality and several years of improved recruitment."**

GEORGES BANK

Total landings of yellowtail from Georges Bank averaged 16,300 mt during 1962-76 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) but have since declined once more, reaching a record low of 1,100 mt in 1989.

NEFC autumn survey biomass indices for Georges Bank yellowtail declined between 1963 and 1976, stabilized at relatively low levels during 1977-83 [with the exception of the elevated 1980 index], and subsequently fell to record low levels during 1984 and 1988. In 1989, due to above average recruitment from the 1987 year class, the survey index increased to its highest level since 1983. United States commercial CPUE indices for Georges Bank yellowtail have been extremely low since 1984. The 1989 CPUE index was the lowest in the 1960-89 time series.

Fishing mortality rates ranged between 0.5 and 0.8 from 1969 to 1973, but increased to 1.0 during 1974-86. Although the 1986 VPA has not been updated yet, it is likely that F remained high in the 1987-89 period.

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 reduced fishing mortality and several years of improved recruitment. The population is severely overexploited, and is likely to remain depressed despite current record low catch levels.

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

$M = 0.20$ $F_{0.1} = 0.21$ $F_{max} = 0.58$ $F_{1989} > F_{max}$

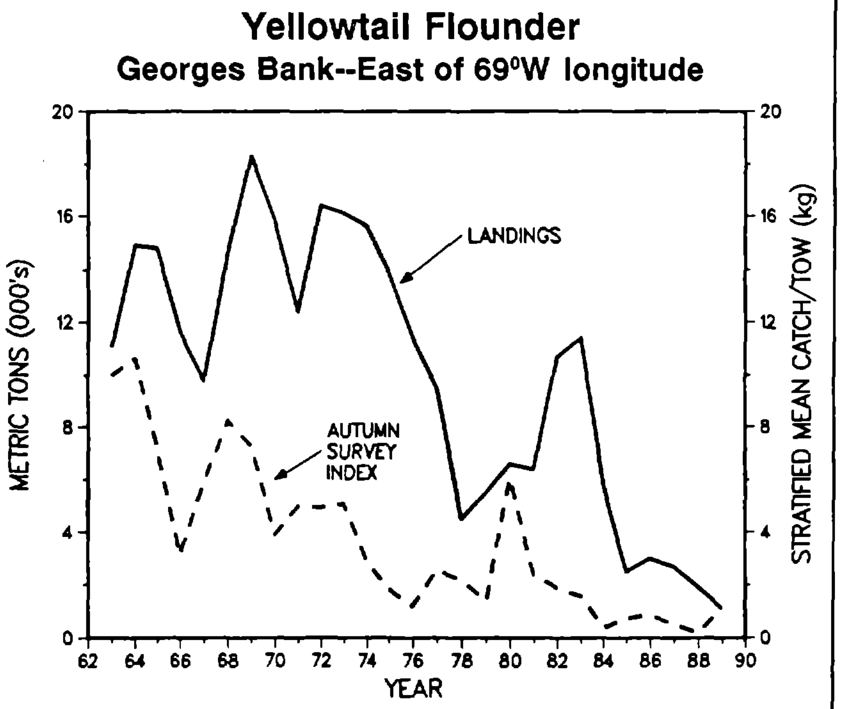


Table 7.1 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	6.4	6.4	10.7	11.4	5.8	2.5	3.0	2.7	1.9	1.1
Canada	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	6.4	6.4	10.7	11.4	5.8	2.5	3.0	2.7	1.9	1.1

SOUTHERN NEW ENGLAND

Total landings of yellowtail flounder from the Southern New England stock averaged 28,000 mt during 1963-70 but declined rapidly afterward, reaching a low of 1,700 mt in 1976. Landings increased during 1977-83, peaking at 18,500 mt in 1983, but subsequently declined to a record low of only 900 mt in 1988. In 1989, landings increased to 2,500 mt 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 1985-88 were the lowest on record. The 1989 indices increased to their highest levels since 1983 due to strong recruitment from the 1987 year class. United States commercial CPUE indices for Southern New England yellowtail declined to record low levels during 1985-88. CPUE doubled in 1989, due to recruitment in the fishery of the strong 1987 year class, but the 1989 index was still far lower than any recorded in the 1960s and early 1970s.

"CPUE doubled in 1989, due to recruitment in the fishery of the strong 1987 year class, but the 1989 index was still far lower than any recorded in the 1960s and early 1970s."

Fishing mortality rates ranged between 0.6 and 0.8 during 1970-1973, increased to about 1.0 during 1975-82, and increased to record high levels from 1983 to 1986. Although the latest VPA for this stock was conducted in 1986, it is likely that recent Fs have remained above F=1.0.

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

$M = 0.20$ $F_{0.1} = 0.21$ $F_{max} = 0.54$ $F_{1989} > F_{max}$

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

"In 1990...most individuals will have grown to legal size and thus landings in 1990 are expected to increase markedly (perhaps as high as 11,000 mt). At this level of catch, the 1987 year class will not sustain the fishery beyond 1991."

Yellowtail Flounder
Southern New England
West of 69°W

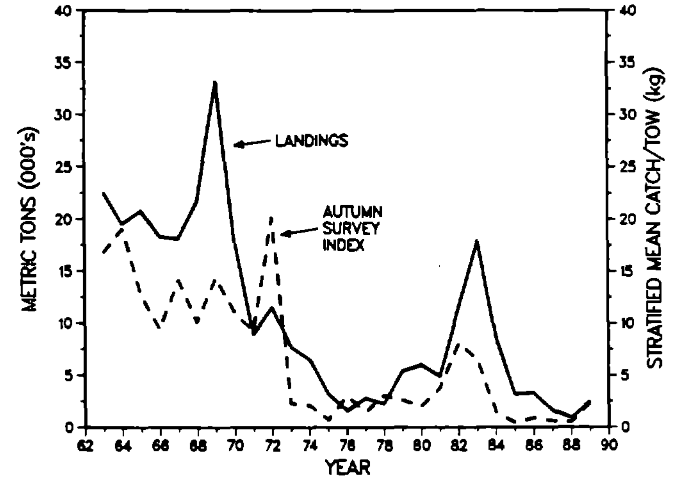


Table 7.2 Recreational catches and commercial landings (1,000 mt)

	Year									
Category	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
USA recreational	-	-	-	-	-	-	-	-	-	-
Commercial										
So. New England	6.0	4.9	11.5	17.9	8.5	3.2	3.3	1.6	0.9	2.5
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	6.0	4.9	11.5	17.9	8.5	3.2	3.3	1.6	0.9	2.5

As in the Georges Bank stock, abundance of the Southern New England stock improved in 1989 due to the strong 1987 year class. This cohort is relatively stronger in Southern New England than on Georges Bank, and essentially comprises the entire (97 percent) Southern New England stock. Significant quantities of this cohort were discarded in 1989 since, as two-year-olds, virtually all fish were less than the minimum legal landing size of 13 in.

In 1990, however, most individuals will have grown to legal size and thus landings in 1990 are expected to increase markedly (perhaps as high as 11,000 mt). At this level of catch, 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 revert to the low pre-1989 levels.

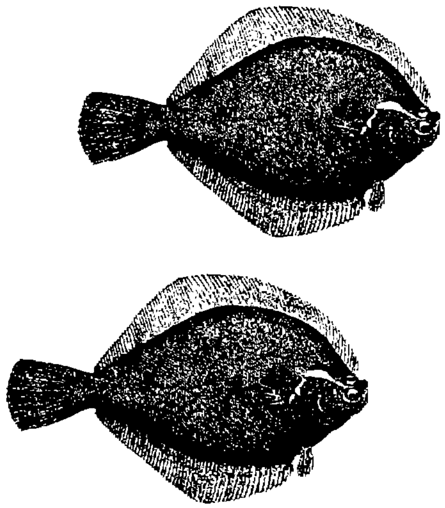
This stock is overexploited and, despite the 1987 year class, current fishing mortality is too high to achieve the target spawning potential established for this stock.

CAPE COD

Total landings of yellowtail flounder from the Cape Cod stock generally fluctuated between 1,500 mt 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 1989 were only 900 mt.

NEFC autumn survey indices have been highly variable, but have reflected the general pattern of landings. The 1989 value is the highest since 1980, due to the strong 1987 year class.

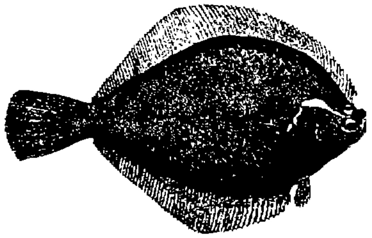
Recent declines in landings and the corresponding general downward trends in the survey indices suggest that stock biomass has been reduced by the high catches of the late 1970s and early 1980s. A short-term increase in landings associated with the 1987 year class may occur, but the stock is considered to be overexploited.



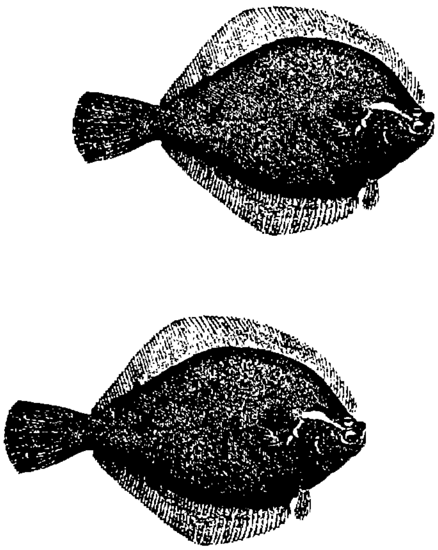
Cape Cod Yellowtail Flounder

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_{1989} = Unknown



> **"A short-term increase in landings associated with the 1987 year class may occur, but the stock is considered to be overexploited."**



Yellowtail Flounder
Cape Cod

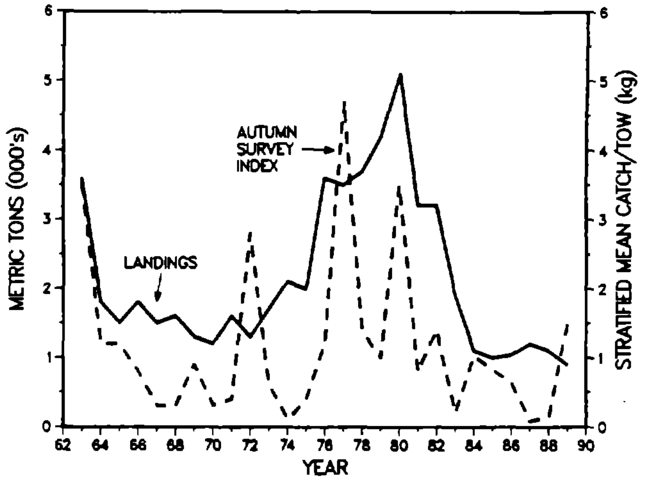


Table 7.3 Recreational catches and commercial landings (1,000 mt)

	Year									
Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
USA recreational	-	-	-	-	-	-	-	-	-	-
Commercial										
Cape Cod	5.1	3.2	3.2	1.9	1.1	1.0	1.0	1.2	1.1	0.9
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	5.1	3.2	3.2	1.9	1.1	1.0	1.0	1.2	1.1	0.9

Mid-Atlantic Yellowtail Flounder

Long-term potential catch = Unknown
Importance of recreational fishery = Insignificant
Management = Multispecies FMP
Status of exploitation = Overexploited
Projected spawning stock biomass = Unknown per recruit
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_{1989} = Unknown**

"The 1988 survey index reversed the declining trend, and the 1989 index is the highest since 1982."

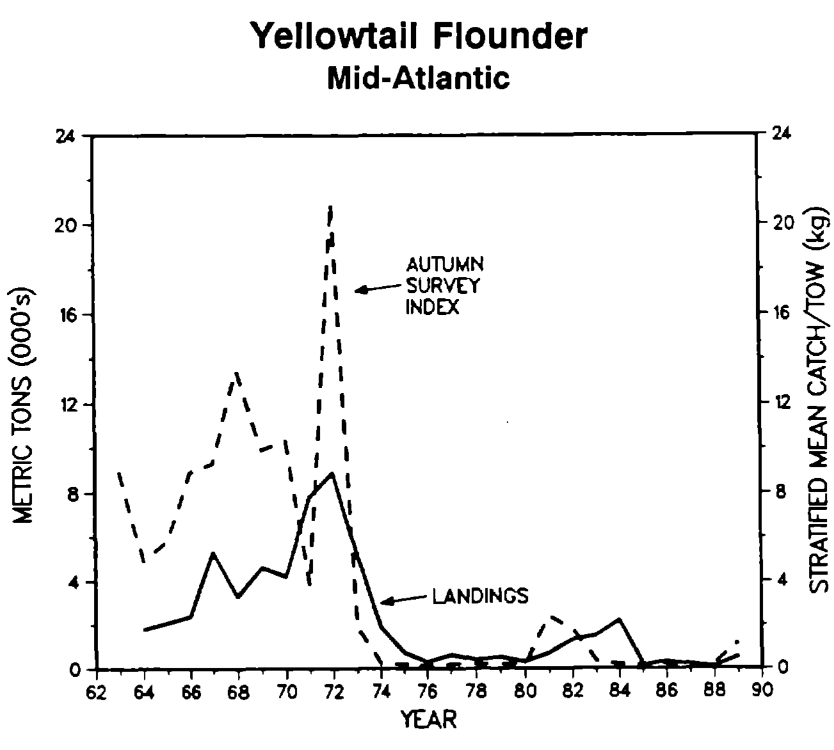


Table 7.4 Recreational catches and commercial landings (1,000 mt)

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

MID-ATLANTIC

Trends for the Mid-Atlantic have been generally similar to those observed for Southern New England. Landings declined from more than 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 1989 increased only slightly, to 500 mt.

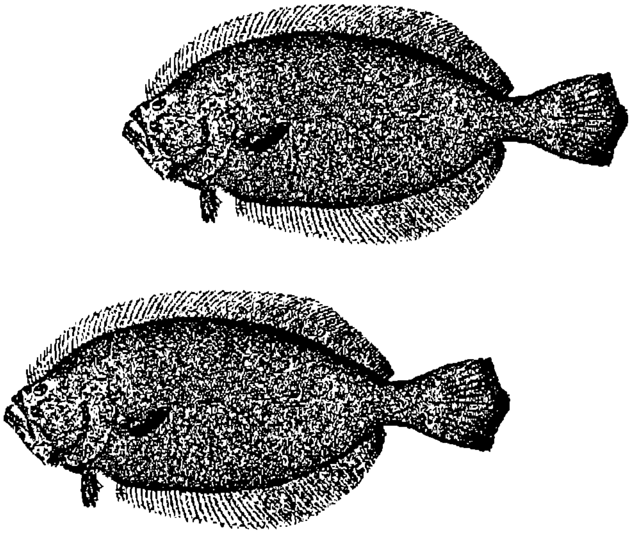
NEFC autumn survey indices declined to very low levels in the mid-1970s, followed by an increase during 1981-82 with improved year class strength. Subsequent indices have declined to levels similar to those observed during the mid-to late 1970s, with the 1987 autumn survey value representing the lowest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

For further information

Clark, S. H., M. M. McBride, and B. Wells. 1984. Yellowtail flounder assessment update - 1984. Woods Hole, MA: NOAA/NMFS/NEFC. Woods Hole Laboratory Reference Document 84-39. 30 p. Available from: Northeast Fisheries Center, Woods Hole, MA, 02543.

Northeast Fisheries Center. 1989. Report of the Seventh Stock Assessment Workshop. Woods Hole, MA: NOAA/NMFS/NEFC. NEFC Center Reference Document 89-04. 108 p. Available from: Northeast Fisheries Center, Woods Hole, MA, 02543.

8. SUMMER FLOUNDER



The summer flounder or fluke, *Paralichthys dentatus*, occurs from the southern Gulf of Maine to South Carolina. Important commercial and recreational fisheries for summer flounder exist within the Mid-Atlantic Bight (Cape Cod to Cape Hatteras).

Summer flounder are concentrated in coastal embayments and estuaries from late spring through early autumn. An offshore migration to the outer continental shelf is undertaken in autumn; larger individuals tend to move to more northerly locations. Spawning occurs during the offshore autumn migration, and the larvae are transported toward coastal areas by prevailing water currents. Development of post-larvae and juveniles occurs primarily within embayments and estuarine areas, notably Pamlico Sound and Chesapeake Bay. Growth rates differ appreciably between the sexes with females attaining weights up to 11.8 kg (26 lb). Female summer flounder may live up to 20 years, but males rarely are older than 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 percent of the total catch. The fishery is managed under the Summer Flounder FMP.

Nominal total catches averaged 23,100 mt during 1980-88, peaking at 30,100 mt in 1983 and 1984. Total catch in 1989 (11,200 mt) was 55 percent lower than in 1988 (24,700 mt). Nominal commercial catches of summer flounder averaged 13,600 mt during 1980-88, reaching a high of 17,000 mt in 1984. The commercial catch in 1989 was 9,700 mt, a 41 percent decrease relative to the 1988 level of 16,300 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 may

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

$M = 0.20$ $F_{0.1} = 0.14$ $F_{max} = 0.23$ $F_{1988} > 1.40$

exceed the commercial landings. The estimated recreational harvest of summer flounder averaged 9,400 mt during 1980-88, peaking in 1983 at 16,200 mt. The recreational catch decreased dramatically (by 82 percent) between 1988 and 1989 to 1,500 mt, the lowest level since the current system to monitor the recreational fishery was implemented in 1979. In addition to the summer flounder harvested by recreational fishermen, between 0.9 and 17.1 million fish were caught and released alive annually between 1980 and 1989. 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 1.21 kg/tow in 1976. The survey index has declined since 1985 from 1.94 kg/tow to 0.24 kg/tow in 1989 and 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 (1984-90) and fishery age composition data (1982-89) suggest that current fishing 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 also suggest that stock abundance, and hence the fishery, is currently being sustained primarily by fish aged 2 and younger. The marked decrease in combined commercial and recreational landings of more than 50 percent in 1989 likely reflects decreased adult (age 2 and older) stock size and very poor recruitment in 1988. In summary, current data and analyses indicate that the stock continues to be overexploited.

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

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 81-25. 57 p.

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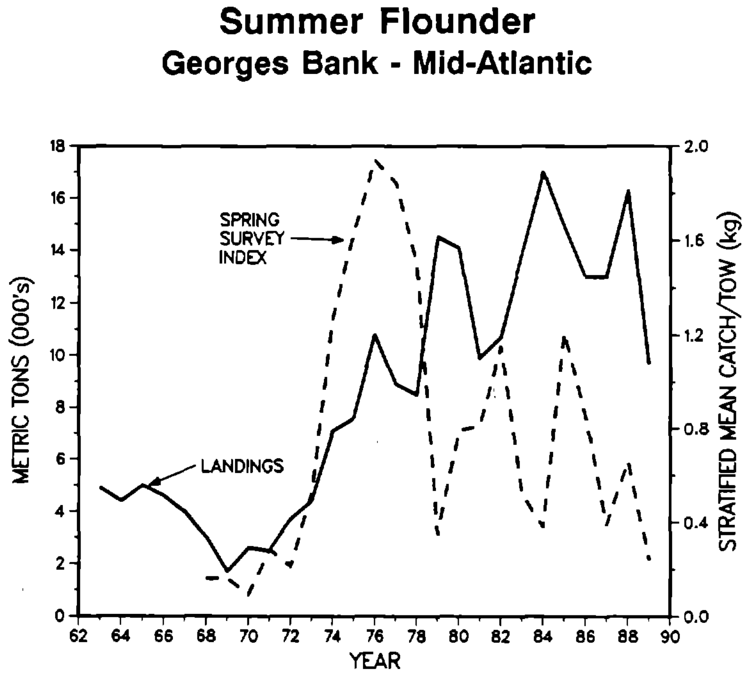
Northeast Fisheries Center. 1986. Report of the Third NEFC Stock Assessment Workshop. Woods Hole, MA: NOAA/NMFS/NEFC. Woods Hole Laboratory Reference Document 86-14. 98 p.

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.



Summer Flounder
Georges Bank - Mid-Atlantic

Table 8.1 Recreational harvest and commercial landings (1,000 mt)[1]

					Year					
Category	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
Recreational										
USA	11.7	5.1	8.6	16.2	13.1	7.8	8.0	6.0	8.4	1.5
Commercial										
USA	14.1	9.9	10.7	13.9	17.0	14.9	13.0	13.0	16.3	9.7
Canada	-	-	-	-	-	-	-	-	-	-
Other	<0.1	<0.1	<0.1	<0.1	-	-	-	-	-	-
Total nominal catch	25.8	15.0	19.3	30.1	30.1	22.7	21.0	19.0	24.7	11.2

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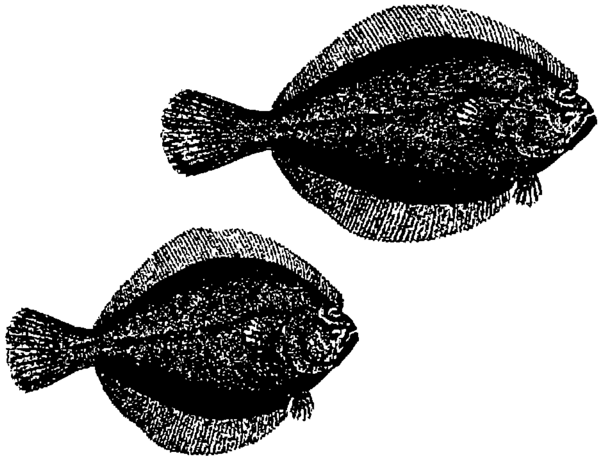
[1] **Recreational harvest and commercial landings revised per NEFC 1990.**

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 U.S. 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 U.S. fishery is managed under the New England Fishery Management Council's Multispecies FMP. Total catches declined 29 percent in 1989 (from 3,400 mt to 2,400 mt) and were the lowest since 1974.

Landings of American plaice increased steadily from a low of 2,100 mt in 1973-74 to 15,000 mt in 1982. Subsequently, annual landings have sequentially declined and are at now at the same level as in the early 1970s.

United States commercial CPUE indices were relatively stable between 1964 and 1969, declined in the early 1970s, and sharply increased in 1977 when total landings doubled. CPUE indices in the Gulf of Maine peaked in 1981, while Georges Bank CPUE values peaked in 1983; in these years, record CPUE values were attained. Subsequently, annual CPUE indices have declined steadily. The 1989 indices in both areas were the lowest in the 1964-89 time series.

Between 1960 and 1974, 67 percent of U.S. landings were from deep water areas on Georges Bank. Since then, Gulf of Maine landings have greatly exceeded those from Georges Bank. The 1989 Gulf of Maine catch (1,650 mt) was more than twice as large as that from Georges Bank (700 mt). In both areas, however, shifts in landings by vessel class have occurred. In 1989, for the sixth consecutive year, small

Gulf of Maine- Georges Bank American Plaice

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

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

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

American Plaice
Gulf of Maine-Georges Bank

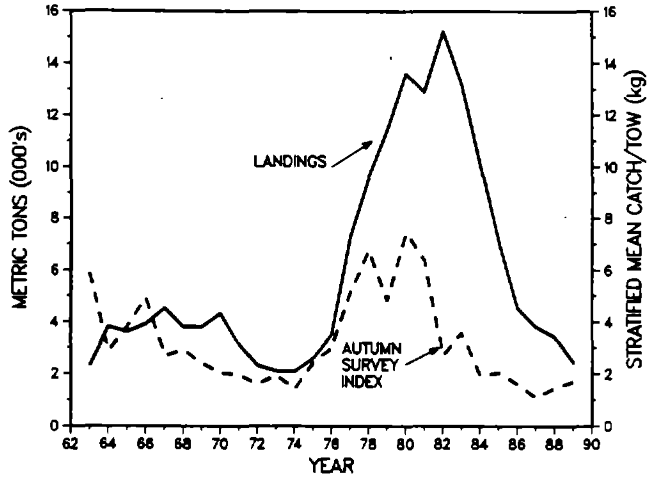


Table 9.1 Recreational catches and commercial landings (1,000 mt)

	Year									
Category	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	13.5	12.9	15.1	13.2	10.1	7.0	4.1	3.8	3.3	2.3
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	13.6	12.9	15.2	13.2	10.1	7.0	4.1	3.8	3.4	2.4

vessels (Class 2), accounted for less than half (38 percent) of the Gulf of Maine plaice catch. Medium sized (Class 3) and large (Class 4) vessels accounted for 47 percent and 15 percent, respectively, of the total 1989 Gulf of Maine catch. On Georges Bank, Class 3 vessels accounted for 67 percent of the 1989 catch while Class 4 vessels accounted for 31 percent.

In both the Gulf of Maine and Georges Bank regions, fishing for American plaice became highly directed during 1981 and 1982. Subsequently, directed trips have become much less important in accounting for yield; in 1989, directed trips accounted for just 6 percent of the Gulf of Maine catch (the lowest percentage since 1973) and only 3 percent of the Georges Bank catch (the lowest percentage on record).

Abundance and biomass indices from autumn NEFC research vessel surveys reached record low values in 1987 but have since increased. The 1989 number per tow index was the highest since 1981 while the 1989 weight per tow index was the highest since 1985. Survey size frequency data indicate relatively strong 1986 and 1987 year classes. The average size of individuals in these cohorts (10 and 8 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 1990 and early 1991. 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, 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 overexploited.

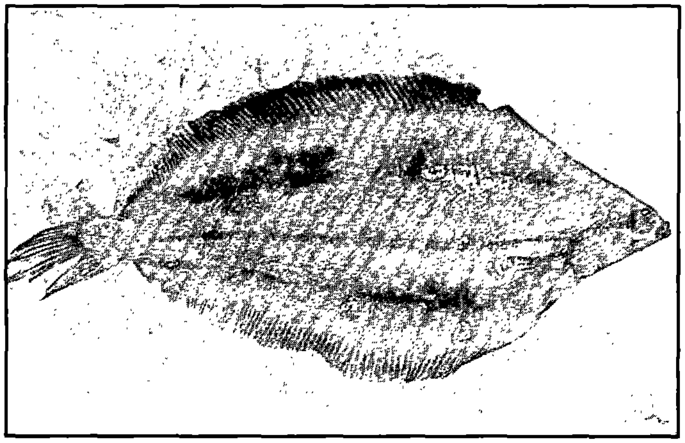
For further information

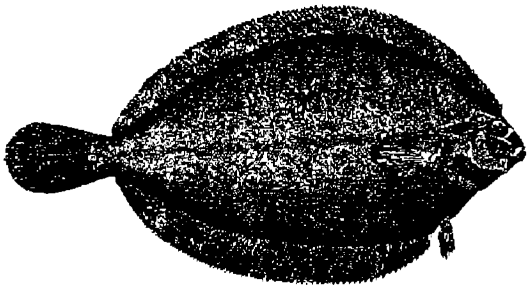
Northeast Fisheries Center. 1987. Report of the Third Stock Assessment Workshop. Woods Hole, MA: NOAA/NMFS/NEFC. Woods Hole Laboratory Reference Document 86-14. 98 p. Available from: Northeast Fisheries Center, Woods Hole, MA, 02543.

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

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

10. WITCH FLOUNDER





The witch flounder or gray sole, *Glyptocephalus cynoglossus*, is common throughout the Gulf of Maine and also occurs in deeper areas on and adjacent to Georges Bank and along the shelf edge as far south as Cape Hatteras. Research vessel survey data suggest that the Gulf of Maine population may be relatively discrete from populations in other areas. Witch flounder appear to be sedentary, preferring moderately deep areas; few fish are taken shallower than 27 m (15 fathoms) and most are caught between 110 and 275 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 Fishery Management Council's Multispecies FMP. Total landings decreased 34 percent in 1989 (from 3,200 mt to 2,100 mt).

Since 1960, the U.S. nominal catch has been distributed almost evenly between Georges Bank and the Gulf of Maine, although in recent years most of the U.S. catch has come from the latter area. Canadian nominal catches from both areas have been minor (less than 50 mt annually since 1970). Distant-water fleet catches on Georges Bank averaged 2,600 mt in 1971-72, but subsequently declined sharply and have been negligible since 1977. After averaging 2,800 mt during 1973-81, nominal catches increased sharply to an average of 5,500 mt during 1982-86. Total landings have decreased steadily since 1986 to 2,100 mt in 1989. A Grand Banks fishery for witch flounder developed in 1985 and has accounted for an annual U.S. harvest of 400 mt through 1989.

NEFC autumn survey catches seem to accurately reflect trends in biomass. Heavy exploitation by distant-water fleets in 1971-72 was followed by a decline in the autumn index from an average of 3.6 kg/tow in 1966-70 to 1.0 kg/tow in 1976. Abundance increased sharply in 1977-78; subsequent indices, however, have steadily decreased, with the 1989 value

Gulf of Maine - Georges Bank Witch Flounder

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

$M = 0.15$ $F_{0.1}$ = Unknown F_{max} = Unknown F_{1989} = Unknown

> **"...harvests of 3,000 mt or more cannot be sustained over the long term, given recent and historical trends, although a short term increase in landings may occur in 1990-91 as the 1985 year class recruits to the large mesh fishery."**

of 0.4 kg/tow being the lowest in the time series. There is evidence in recent NEFC surveys of a relatively strong 1985 year class (largest age 4 index since 1983 in spring 1989 survey).

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, given recent and historical trends, although a short term increase in landings may occur in 1990-91 as the 1985 year class recruits to the large mesh fishery. The population is overexploited.

For further information

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

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Witch Flounder
Gulf of Maine - Georges Bank

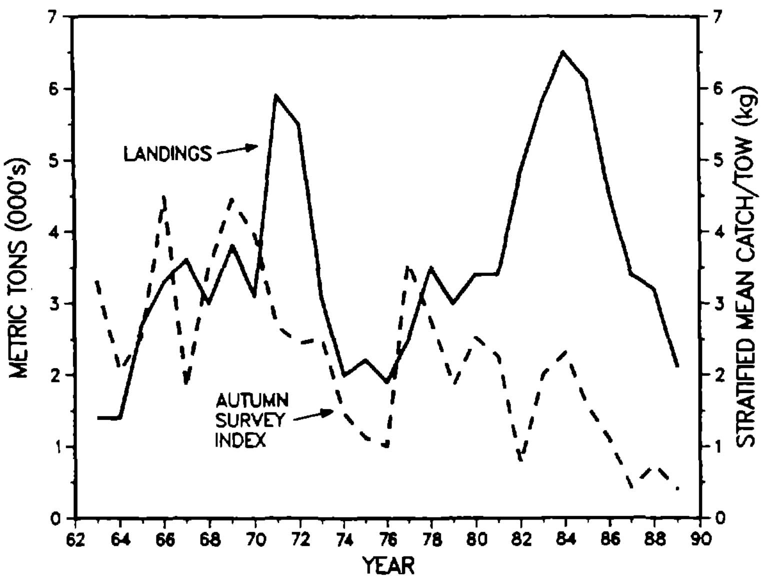
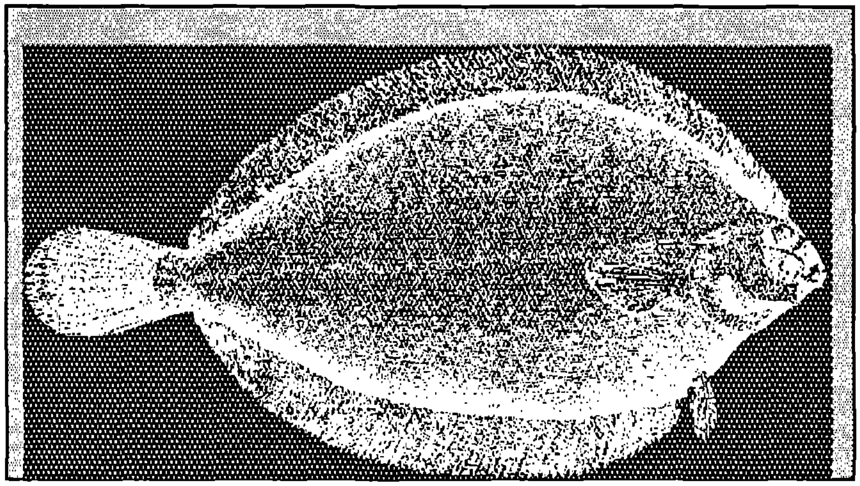
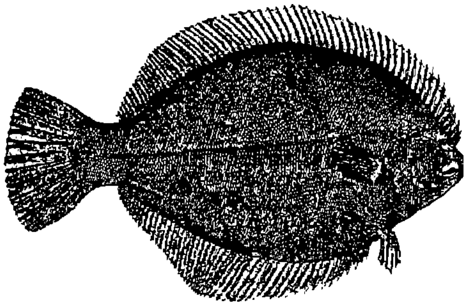


Table 10.1 Recreational catches and commercial landings (1,000 mt)

Category	Year 1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
USA recreational	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	3.4	3.4	4.8	5.8	6.5	6.0	4.5	3.4	3.2	2.1
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	3.4	3.4	4.8	5.8	6.5	6.1	4.5	3.4	3.2	2.1



11. WINTER FLOUNDER



The winter flounder, blackback, or lemon sole, *Pseudopleuronectes americanus*, is distributed in the Northwest Atlantic from Labrador to Georgia. Abundance is highest from the Gulf of St. Lawrence to Chesapeake Bay. Winter flounder may attain sizes up to 58 cm (23 in.) total length. The diet consists primarily of benthic invertebrates. Movement patterns are generally localized. Small-scale seasonal migrations occur during winter to estuaries, embayments, and salt-water 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 shoals, particularly Georges Bank and Nantucket Shoals, support important winter flounder fisheries.

The principal commercial fishing gear used to catch winter flounder is the otter trawl. Recreational catches are significant in the southern parts of the range. The fishery is managed under the New England Fisheries Management Council's Multispecies FMP. Total commercial landings declined 19 percent in 1989 (6,800 mt vs 8,400 mt in 1988), and were near the lowest on record.

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 = 2 yrs
Size at 50% maturity = 25 cm (9.8 in.) males
26 cm (10.2 in.) females
Assessment level = Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1989} = Unknown

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

"Because recreational catches are equal to or greater than commercial landings, future improvements in the condition of the stock will depend on decreases in exploitation in both sectors, and on improved recruitment."

due to much lower recreational landing estimates, and have continued at lower levels, fluctuating with changes in the recreational landings. Combined landings in 1989 were only 2,100 mt.

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 1988-89. Commercial catch per unit effort indices (tonnage class 3 otter trawlers) peaked in the late 1960s-early 1970s, averaging 3 mt/df between 1968 and 1971. The index has declined steadily since then, to a new record low of 0.9 mt/df in 1989.

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

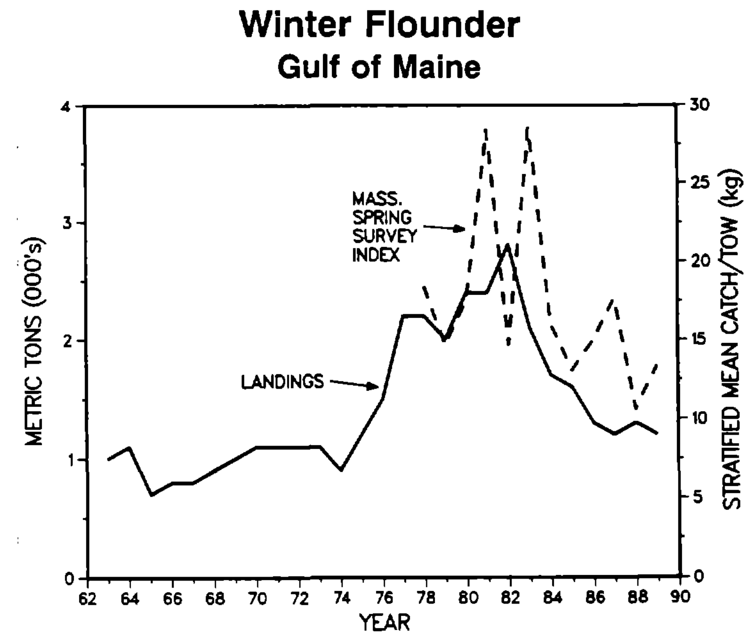
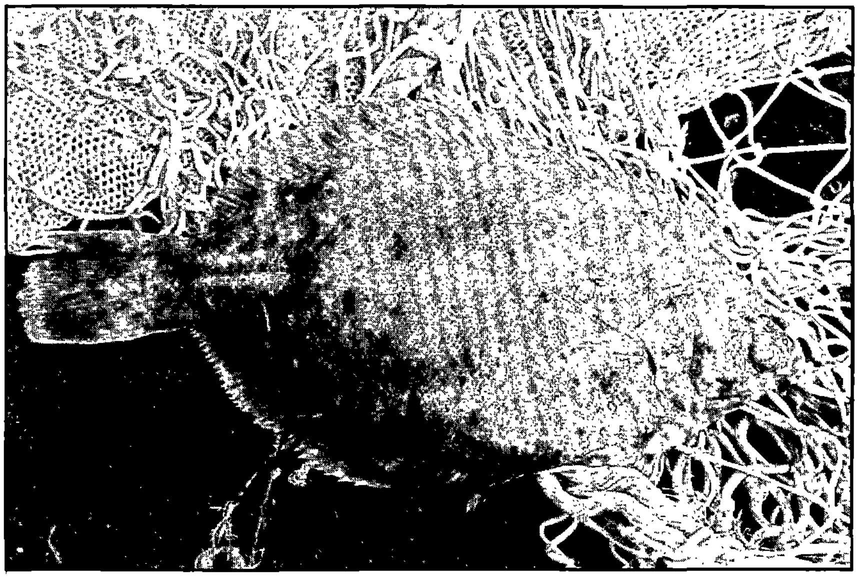


Table 11.1 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	3.5	3.7	4.3	1.3	1.2	2.0	0.3	1.9	1.0	0.9
Commercial										
USA	2.4	2.4	2.8	2.1	1.7	1.6	1.3	1.2	1.3	1.2
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	5.9	6.1	7.1	3.4	2.9	3.6	1.6	3.1	2.3	2.1

"The stock at present appears to be overexploited, although the status cannot be determined with certainty without increasing the level of the assessment."



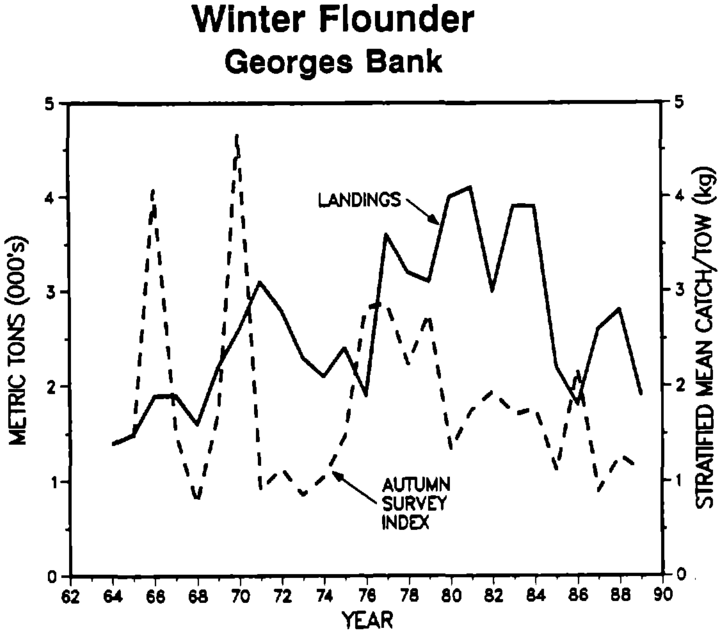


Table 11.2 Recreational catches and commercial landings (1,000 mt)

Category	Year 1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	4.0	4.1	3.0	3.9	3.9	2.2	1.8	2.6	2.8	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	4.0	4.1	3.0	3.9	3.9	2.2	1.8	2.6	2.8	1.9

"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."

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 = 2 yrs
Size at 50% maturity = 25 cm (9.8 in.) males; 26 cm (10.2 in.) females
Assessment level = Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1989} = Unknown

GEORGES BANK

Commercial landings from the Georges Bank region increased from 1,900 mt in 1976 to near record-high levels during 1980-84 (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 1989 (1,900 mt) declined 32 percent from 1988 levels and were near the lowest on record. CPUE indices in 1989 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 1989 and was the second lowest in the 27-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 - MID-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 most of that period. Commercial catches declined from their early 1980s level, while recreational catches increased from 1980 to 1985. More recently, recreational catches have also declined. The combined recreational and commercial landings declined by 30 percent between 1988 and 1989 to a low of about 5,700 mt. Commercial landings declined from 4,300 mt in 1988 to a near record low of 3,700 mt in 1989 while recreational landings declined from 3,900 to 2,000 mt.

NEFC spring survey indices have shown trends similar to commercial catches since about 1975, increasing through 1981 (1 kg/tow) and generally declining, with the exception of

"The continued decline in landings since 1981 and the commercial and survey indices in the more recent years, suggests that landings will not increase in the near future."

1985, to near record low levels in 1989 (0.2 kg/tow). Commercial catch per unit effort indices (tonnage class 3 otter trawlers) show a continuous decline from the 1964-1983 average of 2.7 mt/df to a record low of 0.8 mt/df in 1989.

The continued decline in landings since 1981 and the 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

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Foster, K. L. 1987. Status of winter flounder *Pseudopleuronectes americanus* stocks in the Gulf of Maine, Southern New England and Middle Atlantic areas. Woods Hole, MA: NMFS, NEFC. Woods Hole Laboratory Reference Document 87-06. 70p. Available from: Northeast Fisheries Center, Woods Hole, MA, 02543.

Southern New England - Mid-Atlantic Winter Flounder

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

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

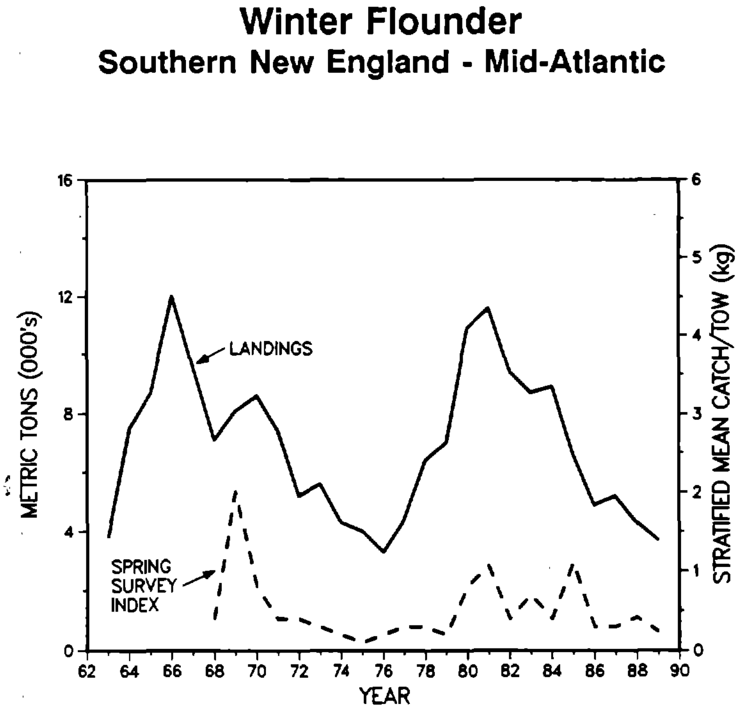
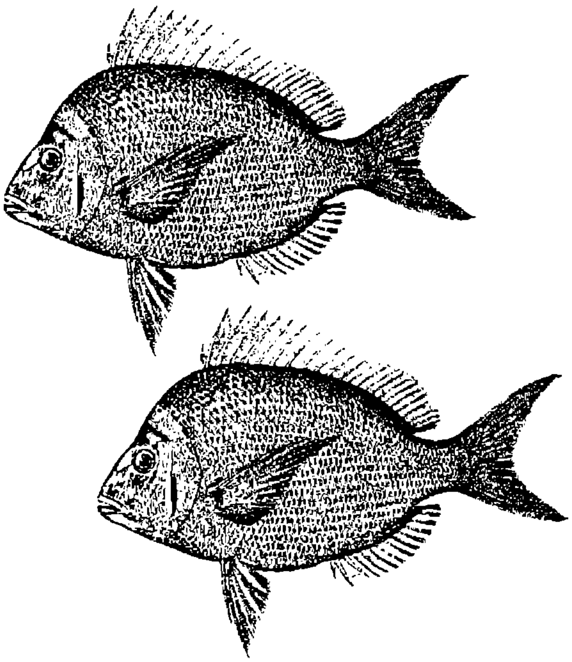


Table 11.3 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	2.7	3.3	3.2	5.0	6.4	7.9	3.3	4.0	3.9	2.0
Commercial										
USA	10.9	11.6	9.4	8.7	8.9	6.6	4.9	5.2	4.3	3.7
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	13.6	14.9	12.6	13.7	15.3	14.5	8.2	9.2	8.2	5.7

12. SCUP



Scup or porgy, *Stenotomus chrysops*, occurs primarily in the Mid-Atlantic Bight from Cape Cod to Cape Hatteras. Seasonal migrations occur during spring and autumn. In summer, scup are common in inshore waters from Massachusetts to Virginia, while in winter scup are found in offshore waters between Hudson Canyon and Cape Hatteras at depths ranging from 70 to 180 m. Sexual maturity is essentially complete by age 2 at a total length of 21 cm (8.3 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 (15.7 in.). Tagging studies have indicated the possibility of a Southern New England stock and another stock extending south from New Jersey. However, because the separation of stocks is not documented, it is not used here.

The principal commercial fishing gear is the otter trawl. Recreational catches are significant. The fishery is not subject to management except locally within individual state waters. Total reported landings decreased 12 percent in 1989 (from 8,100 mt to 7,100 mt), due to lower commercial landings.

Nominal commercial catches by U.S. 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 U.S. nominal commercial catch steadily increased and reached a peak of 9,800 mt in 1981. Landings have declined significantly since then. The 1989 catch dropped to 3,600 mt, the lowest level on record (since 1960).

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

Southern New England - Mid-Atlantic Scup

Long-term potential catch = 10,000 to 15,000 mt
Importance of recreational fishery = Major
Management = Individual states
Status of exploitation = Overexploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 17 cm (7.7 in.)
Assessment level = Yield per recruit

$M = 0.20$ $F_{0.1} = 0.20$ $F_{max} = 0.35$ $F_{1989} > F_{max}$

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

Scup
Southern New England - Mid-Atlantic

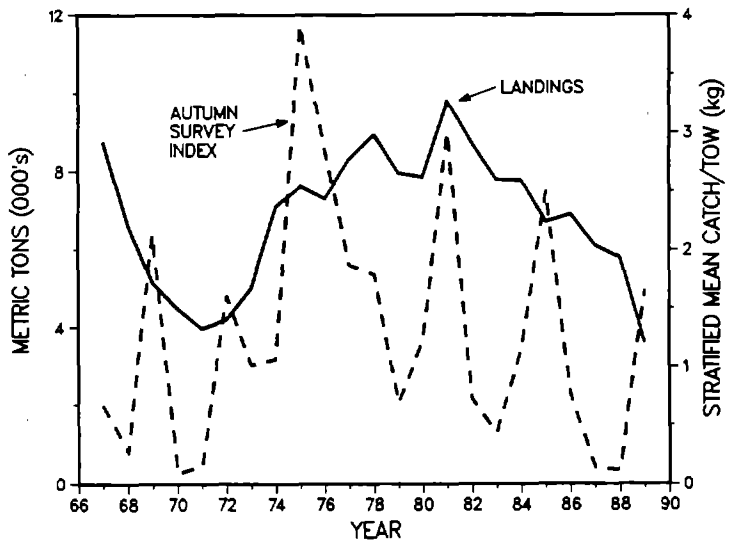


Table 12.1 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	3.9	2.0	3.1	3.4	1.4	3.3	5.9	3.2	2.3	3.5[1]
Commercial										
USA	7.9	9.8	8.7	7.8	7.8	6.7	6.9	6.1	5.8	3.6
Canada	-	-	-	-	-	-	-	-	-	-
Other	<0.1	<0.1	-	-	<0.1	<0.1	<0.1	-	-	-
Total nominal catch	11.8	11.8	11.8	11.2	9.2	10.0	12.8	9.3	8.1	7.1[1]

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[1] **Preliminary**

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 percent of the total prior to 1967, to 2 to 16 percent since 1973. Estimated recreational catches represent 20 to 50 percent of total nominal catches in the past ten years. The 1989 preliminary recreational catch estimate (3,500 mt) is 52 percent above the 1988 level, but only slightly above the 1980-88 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 1982-84 to 2.8 mt/day fished in 1989, approaching record low levels of 1971-72. 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, and 1986-88 values were below the long-term mean. The 1989 index, although above 1986-88 levels, is still lower than peaks observed in 1981 and 1985.

A comparison of scup length frequencies from the commercial and recreational fisheries during 1983-88 reveal that commercial length frequency distributions have shifted to smaller fish (including young of year) while recreational length frequency distributions have remained relatively stable. There are generally few larger, older scup (larger than 35 cm, older than 7 years) in both commercial and recreational fisheries. The maximum length observed in NEFC autumn surveys has declined from a mean of 30 cm between 1982 and 1986, to 23 cm between 1987 and 1989. 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: NOAA/NMFS/NEFC. Woods Hole Laboratory Reference Document 82-46, 59 p. Available from: Northeast Fisheries Center, Woods Hole, MA.

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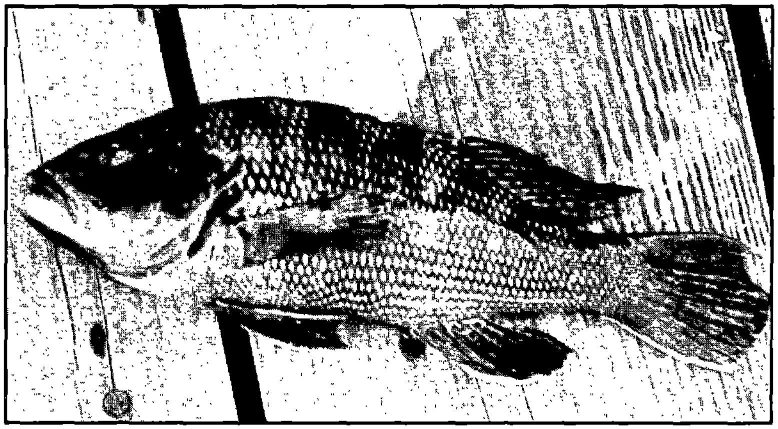
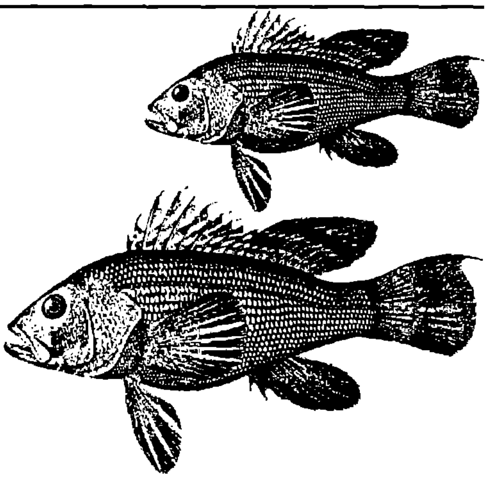
13. BLACK SEA BASS





Black sea bass, *Centropristis striata*, occur off the northeast United States along the entire Atlantic coast, with the greatest concentrations found within the middle Atlantic Bight. Black sea bass winter along the 100 m depth contour off Virginia and Maryland, then migrate north and west into the major coastal bays and become associated with structured bottom habitat (reefs, oyster beds, wrecks). Spawning begins in March off North Carolina and occurs progressively later (until October) further north. Most black sea bass are protogynous hermaphrodites, beginning life as females and later transforming into males. As a result, females generally mature at a smaller size (age 2, 18 cm or 7 in., standard length) than males (age 2, 21 cm or 8 in.). Females are rarely found older than 8 years (greater than 35 cm or 14 in.), while males may live up to 15 years (greater than 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 fish traps and otter trawls. Recreational fishing is as significant as commercial fishing. Currently there is no management outside state waters. Total catches remained constant in 1989 at 3,300 mt.

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 1987, commercial landings averaged 1,400 mt. Commercial landings declined from 1,700 mt in 1988 to 1,200 mt in 1989. The only reported catch by distant-water fleets was 1,500 mt in 1964. Estimated recreational landings 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 percent (1981) to 87 percent (1982) of the total nominal catch in the past ten years. Estimated recreational landings for 1989 from the middle Atlantic and New England regions were 2,100 mt.

"The biologically optimum age at first harvest for black sea bass, based on yield per recruit analysis, is 6 years at F=0.3."

Standardized catch per unit effort (CPUE, mt/days fished in trips of 25 percent 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 1989 decreased to 1.60 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 0.8 and 1.0 fish/tow in 1989 and 1990, respectively. Prerecruit indices (fish smaller than 20 cm) from the autumn inshore bottom trawl survey indicate above average year classes occurred in 1977, 1982, and 1986.

Size composition data from commercial landings indicate that black sea bass recruit fully to the trap

> **"The assessment information is insufficient to allow a definitive understanding of the status of this stock, but the stock appears to be fully exploited."**

and trawl fisheries by ages 2 and 3, respectively. The biologically optimum age at first ahrvest for black sea bass, based on yield per recruit analysis, is 6 years at F=0.3. Total landings have fluctuated without trend in the 1980s, punctuated by years with much higher recreational catches. High prerecruit 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 appears 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.

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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 = 10-13 cm (4-5 in.)
Assessment level = Yield per recruit

$M = 0.3$ $F_{0.1} = 0.2$ $F_{max} = 0.3$ F_{1989} = Unknown

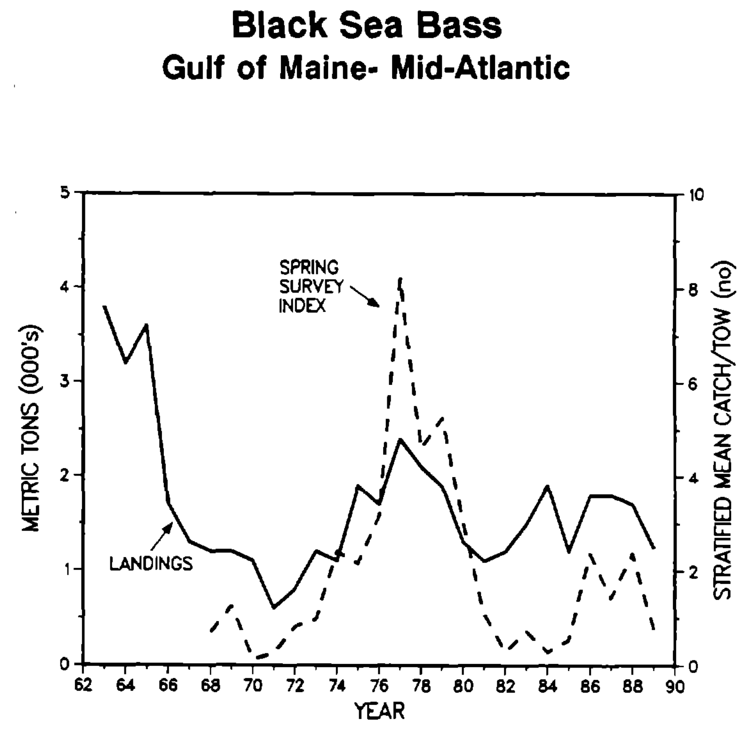
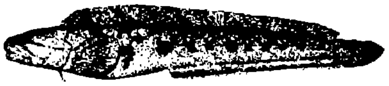
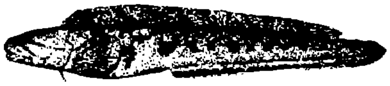


Table 13.1 Recreational and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	0.7	0.5	8.1	2.3	0.7	1.5	6.3	1.0	1.6	2.1
Commercial										
USA	1.3	1.1	1.2	1.5	1.9	1.2	1.8	1.8	1.7	1.2
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	2.0	1.6	9.3	3.8	2.6	2.7	8.1	2.8	3.3	3.3

14. OCEAN POUT





The ocean pout, *Macrozoarces americanus*, is a demersal eel-like species ranging from Labrador to Delaware that attains lengths of up to 98 cm (39 in.) and weights of 5.3 kg (14.2 lb). Ocean pout prefer depths of 15 to 80 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 stop feeding and move to rocky areas, where they spawn in September and October. The demersal eggs are guarded by both parents until they hatch. During this period, ocean pout are not available to commercial fishing operations. Catches typically increase when adults return to their feeding grounds in late autumn and winter. The diet consists primarily of invertebrates: brittle stars, sand dollars, sea urchins, and bivalves, with fish being only a minor component.

Stock identification studies suggest the existence of two stocks: one occupying the Bay of Fundy area and the northern Gulf of Maine east of Cape Elizabeth, and a second stock ranging from Cape Cod Bay south to Delaware. This southern stock is characterized by faster growth rates, and to date has supported the commercial fishery.

The principal fishing gear used to catch ocean pout is the otter trawl, and the fishery occurs primarily between December and May each year. The fishery in federal waters is scheduled to be managed under the proposed Amendment 4 to 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 declined 28 percent in 1989 (1,800 mt to 1,300 mt); projected 1990 landings should approximate 1989 figures.

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 United States 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.

Mid-Atlantic - Gulf of Maine
Ocean Pout

Long-term potential catch = 10,000 to 15,000 mt
Importance of recreational fishery = Major
Management = None
Status of exploitation = Fully Exploited
Age at 50% maturity = 2 yrs
Size at 50% maturity = 17 cm (7 in.)
Assessment level = Yield per recruit

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

> **"Declining relative abundance since 1985 coupled with increasing nominal catches suggests that fishing mortality has rapidly increased."**

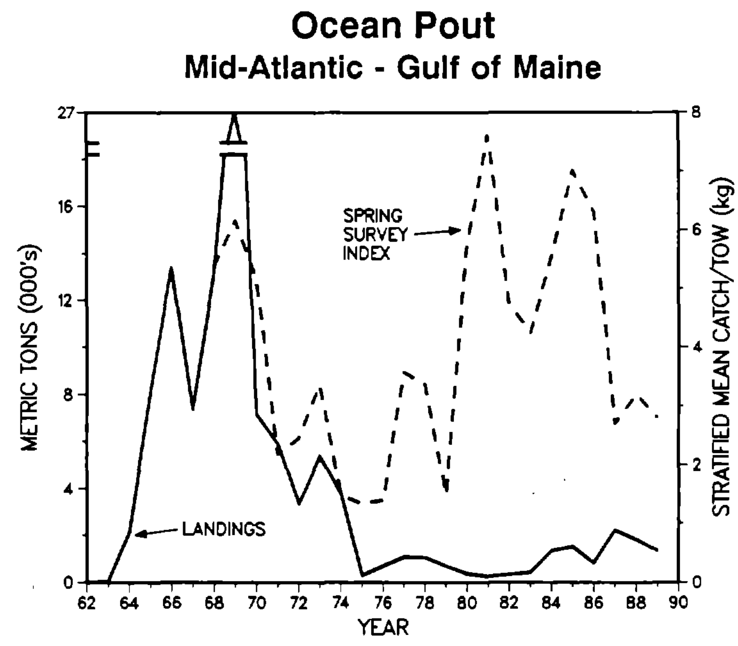


Table 14.1 Recreational catches and commercial landings (1,000mt)

Category	Year 1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	0.4	0.3	0.3	0.4	1.3	1.5	0.8	2.2	1.8	1.3
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	0.4	0.3	0.3	0.4	1.3	1.5	0.8	2.2	1.8	1.3

Foreign catches subsequently declined substantially and none have been reported since 1974. U.S. 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 for 1989 decreased to 1,300 mt and, although landings in 1990 are expected to remain unchanged from 1989, a relatively strong 1985 year class will began to recruit to the commercial fishery during 1990. Landings from southern New England dominated the catch for the second year in a row, accounting for 74 percent of the total 1989 U.S. harvest, reversing landings patterns observed in 1986-87 when the Cape Cod Bay fishery comprised the majority.

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 identifying 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 (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 1988 and 1989 (3.2 kg and 2.8 kg per tow, respectively). However, the spring 1990 index of 5.1 kg per tow is the highest since 1986, and there is evidence of a strong 1987 year class in both the 1989 and 1990 surveys.

Declining relative abundance since 1985 coupled with increasing nominal catches suggests that fishing mortality has rapidly increased. The prospect for increased landings during 1991-93 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, but catches at the present level may be sustainable over the short term.

For further information

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Olsen, Y. H., and D. Merriman. 1946. The biology and economic importance of the ocean pout, *Macrozoarces americanus* (Bloch and Schneider). In *Studies on the marine resources of southern New England,* Vol. 4. *Bull. Bingham Oceanogr. Collec.* 9:1-184.

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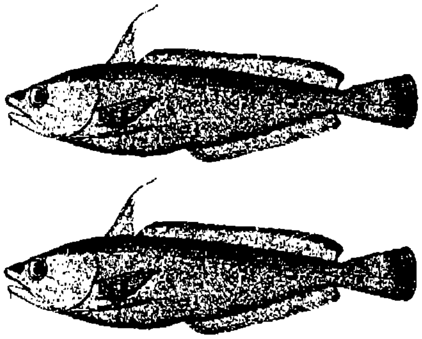
15. WHITE HAKE



The white hake, *Urophycis tenuis*, is a boreal species that is common on muddy bottom throughout the Gulf of Maine. Stock boundaries are uncertain, although research vessel survey data indicate that the Gulf of Maine population is more or less discrete from populations further east. Depth distribution varies by age and season; juveniles typically occupy shallower areas than adults, but individuals of all ages tend to move inshore or shoalward in spring and summer, dispersing to deeper areas in autumn. Most trawl catches are taken at depths of 110 m (60 fathoms) or more, although they are taken as shallow as 27 m (15 fathoms) during gillnetting operations in summertime.

In the Gulf of Maine, spawning is thought to occur 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. Fish more than 20 years old have been documented in the Gulf of Maine. Juveniles feed primarily upon shrimp and other crustaceans, but fish become more important in the diet with approaching maturity. Adults feed almost exclusively on other fish, including juveniles of their own species.

The principal fishing gear used to catch white hake are otter trawls and gill nets. Recreational catches are insignificant, and foreign catches of minor importance. Fishing is managed under the New England Fishery Management Council's Multispecies FMP. Total landings decreased slightly in 1989 (6,000 mt to 5,600 mt).

The U.S. nominal catch has been taken primarily in the western Gulf of Maine, both incidentally in directed operations for other demersal species and as an intended component in mixed species fisheries. Since 1968, U.S. vessels have accounted for approximately 94 percent 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 5,600 mt in 1989. The increase evident

Gulf of Maine - Georges Bank
White Hake

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

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1989} = Unknown

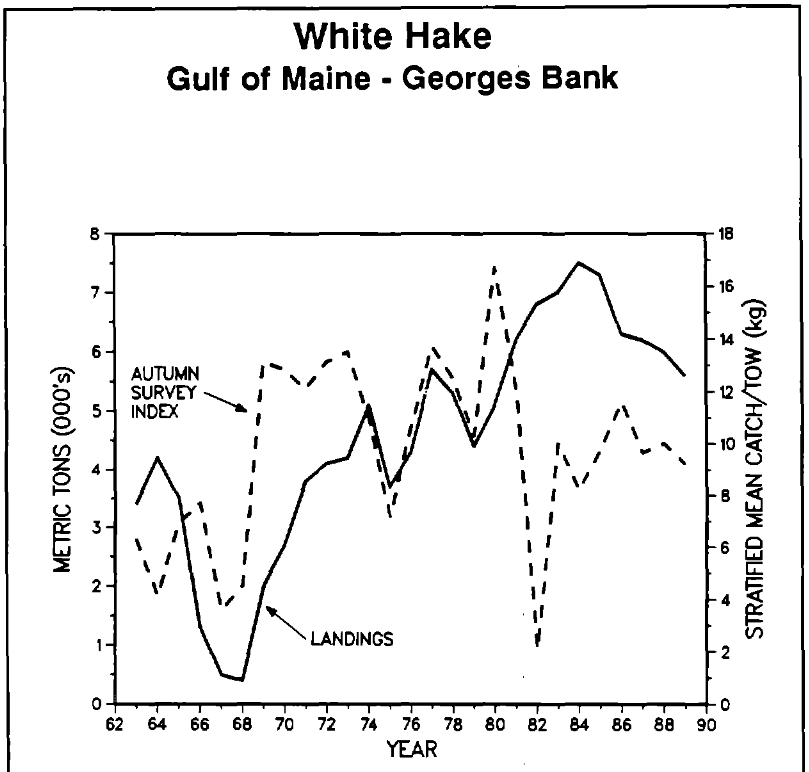


Table 15.1 Recreational catches and commercial landings (1,000 mt)

	Year									
Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial										
USA	4.8	5.7	6.0	6.2	6.5	6.4	5.3	5.5	5.4	5.0
Canada	0.3	0.5	0.8	0.8	1.0	0.9	1.0	0.7	0.6	0.6
Other	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Total nominal catch	5.1	6.2	6.8	7.0	7.5	7.3	6.3	6.2	6.0	5.6

> **"...declines in 1986-89 catches suggest that harvest levels in excess of 7,000 mt, evident in 1984 and 1985, cannot be sustained at current biomass levels."**

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 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 1989 have been quite stable, while catches have continued to remain high relative to pre-1981 levels. However, declines in 1986-89 catches suggest that harvest levels in excess of 7,000 mt, evident in 1984 and 1985, cannot be sustained at current biomass levels. The population is fully exploited.

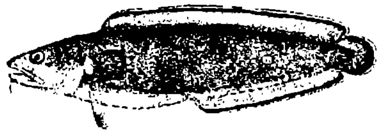
For further information

Burnett, J., S. H. Clark, and L. O'Brien. 1984. A preliminary assessment of white hake in the Gulf of Maine - Georges Bank area. Woods Hole, MA: NOAA/NMFS/NEFC. Woods Hole Laboratory Reference Document 84-31. 33 p. Available from: Northeast Fisheries Center, Woods Hole, MA, 02543.

Northeast Fisheries Center. 1986. Report of the Second Stock Assessment Workshop. Woods Hole, MA: NOAA/NMFS/NEFC. Woods Hole Laboratory Reference Document 86-09. 114 p. Available from: Northeast Fisheries Center, Woods Hole, MA, 02543.

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

16. CUSK



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

The principal fishing gears used to catch cusk are the otter trawl and gill nets. Recreational fishery is insignificant and foreign catches are minor. The fishery is not under management. Total catches in 1989 increased 7 percent (from 1,500 mt to 1,600 mt).

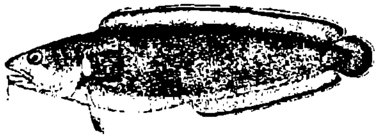
Between 1977 and 1987, annual landings of cusk from the Gulf of Maine-Georges Bank region ranged between 1,400 mt (1977) and 4,000 mt (1981) and averaged 2,300 mt per year. In this period, 75 percent of the catch was taken by the United States with almost all the remainder taken by Canada. The bulk of the U.S. catch has been taken from the Gulf of Maine while nearly all of the Canadian catch has been from Georges Bank. The 1989 U.S. catch was 900 mt and accounted for 56 percent of the total yield. Canadian landings in 1989 were 700 mt. Historically, otter trawls have accounted for between 50 and 87 percent of the annual U.S. landings. Before 1985, longline landings never exceeded 2 percent of the total. In 1985-86, longline landings of cusk increased dramatically to 23 percent of the total landings as a result of a new auto-longline fishery. However, this new auto-longline fishery collapsed during 1987 and longline landings accounted for only 7 percent of the total since then. Otter trawls accounted for the majority of landings in 1989, while gill nets and line trawls accounted for most of the remainder.

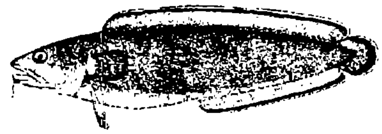
The NEFC autumn survey index has fluctuated considerably. The 1989 autumn index of 0.5 kg/tow represents a 63 percent decrease from the 1988 value.

While annual landings have generally declined since 1983, survey indices of abundance have fluctuated without a consistent trend, although the 1989 autumn index was the second lowest in the 27 year time series. The current level of assessment is too low for the status of the stock to be predicted with confidence.

For further information

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





Cusk
Gulf of Maine - Georges Bank

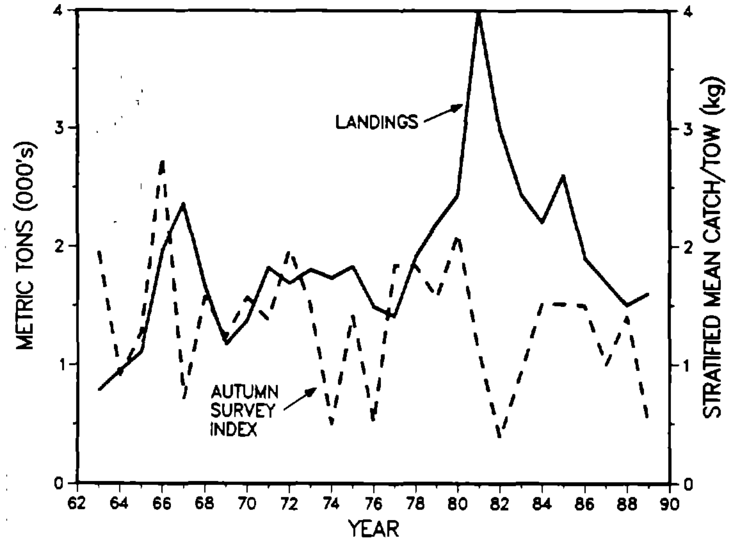


Table 16.1 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial										
USA	1.8	1.9	1.8	1.8	1.7	2.3	1.8	1.4	1.1	0.9
Canada	0.6	2.1	1.2	0.6	0.5	0.3	0.1	0.3	0.4	0.7
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	2.4	4.0	3.0	2.4	2.2	2.6	1.9	1.7	1.5	1.6

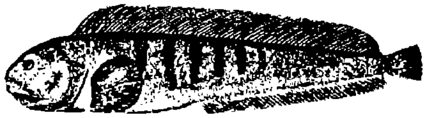
"The current level of assessment is too low for the status of the stock to be predicted with confidence."

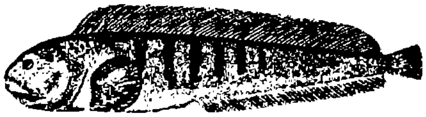
Gulf of Maine-Georges Bank Cusk

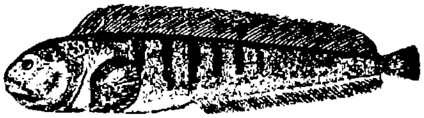
Long-term potential catch = Unknown
Importance of recreational fishery = Insignificant
Management = None
Status of exploitation = Unknown
Age at 50% maturity = Unknown
Size at 50% maturity = Unknown
Assessment level = Index

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1989} = Unknown

17. ATLANTIC WOLFFISH







The wolffish or catfish, *Anarhichas lupus*, is a cold water species of relatively minor importance in Gulf of Maine fisheries. Northeast Fisheries Center research vessel surveys indicate that populations on Georges Bank and in the western Gulf of Maine are discrete from groups in the Browns Bank - Scotian Shelf area. West of the Scotian Shelf, abundance appears to be highest in the southwestern portion of the Gulf of Maine from Jeffreys Ledge to the Great South Channel at depths of 80 to 120 m (45 to 65 fathoms). Wolffish are sedentary and rather solitary in habit, and populations tend to be localized. Little is known about the biology of this species. Individuals may attain lengths

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_{1989} = Unknown

"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."

Atlantic Wolffish

Gulf of Maine - Georges Bank

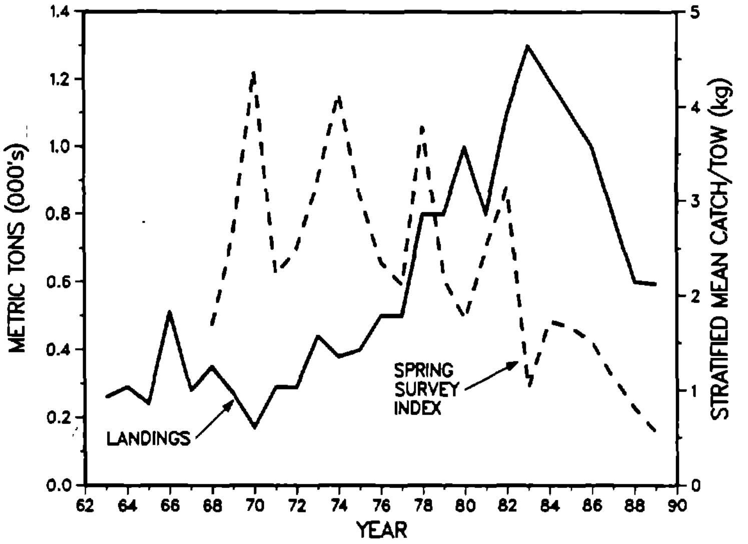


Table 17.1 Recreational catches and commercial landings (1,000 mt)

Category	Year 1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Commercial										
USA	0.9	0.7	0.9	1.2	1.1	1.0	0.9	0.7	0.5	0.5
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	0.6

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 1989 were 600 mt, about the same as in 1988.

Since 1970, the U.S. nominal commercial catch has been about evenly divided between Georges Bank and the Gulf of Maine. In the last two decades, U.S. vessels have taken more than 75 percent 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. U.S. landings in 1989 were just over 500 mt, similar to those in 1988, stopping the trend of a 100 to 200 mt decline per year since 1983.

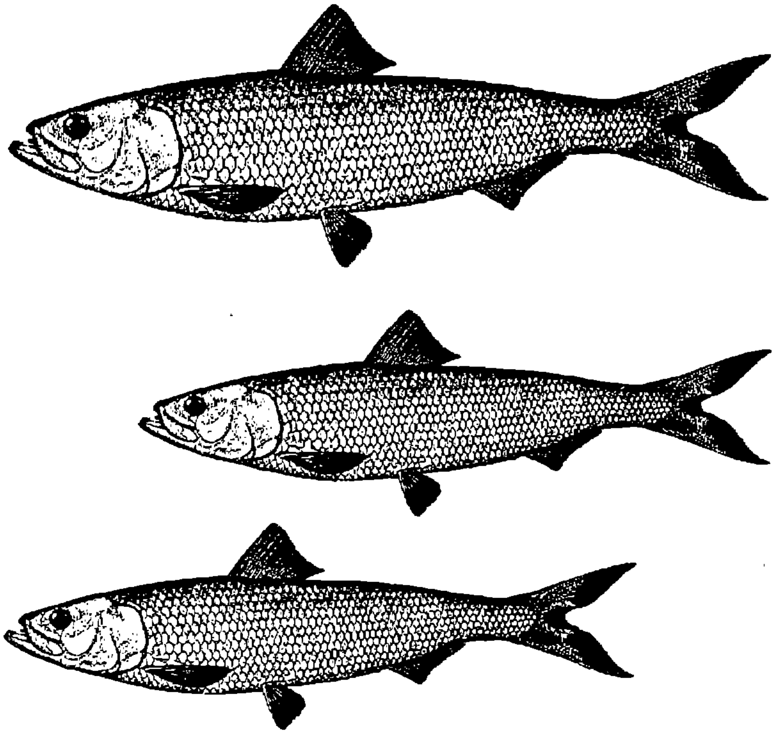
The NEFC spring survey index, after fluctuating considerably from 1968 to 1982, has exhibited a downward trend since then. The 1989 spring value of 0.56 is the lowest that has been observed.

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.

18. ATLANTIC HERRING



The Atlantic herring, *Clupea harengus*, is widely distributed in continental shelf waters from Labrador to Cape Hatteras. Important commercial fisheries for juvenile herring (ages 1 to 3) have existed 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 farther 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 to 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

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

$M = 0.20$ $F_{0.1} = 0.24$ $F_{max} = \text{None}$ $F_{1989} = 0.28$

---

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

> **"The general reduction [in nominal catches] 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."**

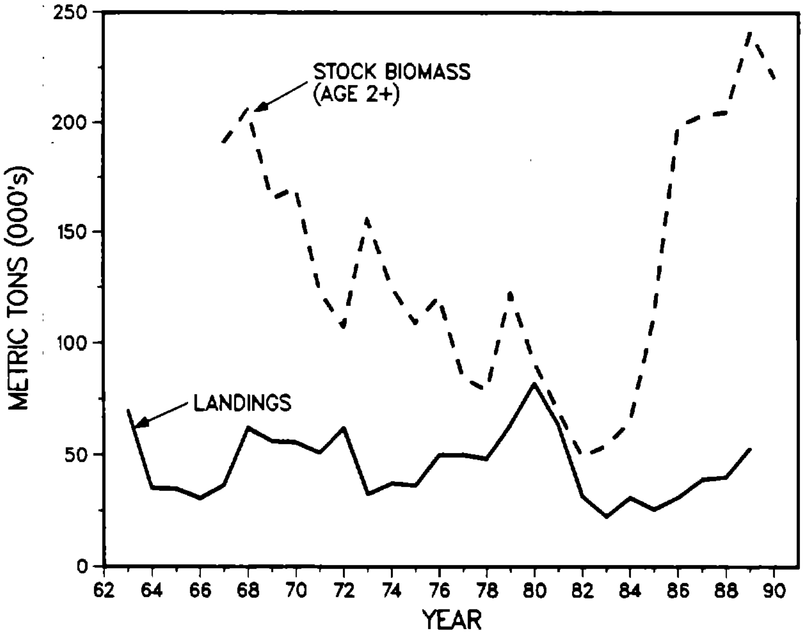
are typically deposited on rock or gravel substrates. Primary spawning locations off the northeastern United States occur on Jeffreys Ledge and Nantucket Shoals; Georges Bank formerly supported an extensive spawning ground. Incubation is temperature dependent, but usually requires 7 to 10 days. Larvae 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.

GULF OF MAINE

Total catches in the Gulf of Maine declined from an average of 61,800 mt from 1977-81 to 22,500 mt in 1983. Landings have increased subsequently, reaching 53,500 mt in 1989. The relative importance of two principal fisheries, by coastal fixed gear and mobile gear, has changed over time.

Coastal Maine nominal catches averaged 57,000 mt during 1950-65, subsequently declining to an average of 23,000 mt during 1966-79. Catches from this fishery are taken primarily from July to November. With the exception of the strong 1970 year class, recruitment up until 1978 remained below average. Nominal catches increased to an average of 45,000 mt during 1979-81, with recruitment of a succession of relatively strong year classes in 1976, 1977, and 1979. The general reduction noted since the early

Atlantic Herring



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

Table 18.1 Recreational catches and commercial landings (1,000 mt)

	Year									
Category	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	82.1	63.6	31.7	22.5	31.1	25.8	31.2	39.2	40.2	53.5
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch[1]	82.1	63.6	31.7	22.5	31.1	25.8	31.2	39.2	40.2	53.5

---

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

Georges Bank

Table 18.2 Recreational catches and commercial landings (1,000 mt)[1]

	Year									
Category	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	1.1	1.7	0.7	1.0	1.6	0.2	0.2	-	-	0.2
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	1.1	1.7	0.7	1.0	1.6	0.2	0.2	-	-	0.2

---

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

1980s appears to be related to reduced availability to the fixed gear fisheries and reduced abundance as measured by NEFC survey indices. The 1984-89 NEFC spring survey indices indicate a recovery relative to 1982-83 levels. The fixed gear fishery on the Maine coast continued to represent a small proportion of the total catch in 1989, accounting for only 1,400 mt, or 3 percent of the total. Meanwhile, the 1989 nominal catch of 35,500 mt in the mobile gear fishery[1] represented 66 percent 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.

Georges Bank
Atlantic Herring

Long-term potential catch = 100,000 mt
Importance of recreational fishery = Insignificant
Management = None
Status of exploitation = Not significantly 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** **$F_{1989} < 0.01$**

"...high survey catches have occurred in the Nantucket Shoals area, which may in part explain high incidental catches of herring south of Cape Cod. Prospects for redevelopment of the fishery are being studied."

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 from U.S. and Canadian bottom trawl surveys during 1984-89 and reports of incidental catches by commercial vessels. In particular, high survey catches have occurred in the Nantucket Shoals area, which may in part explain high incidental catches of herring south of Cape Cod. Prospects for redevelopment of the fishery are 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: NOAA/NMFS/NEFC. Woods Hole Laboratory Reference Document 83-46. 33 p. Available from: Northeast Fisheries Center, Woods Hole, MA, 02543.

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

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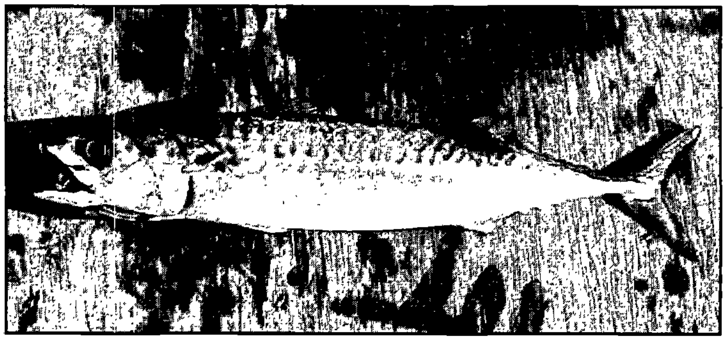
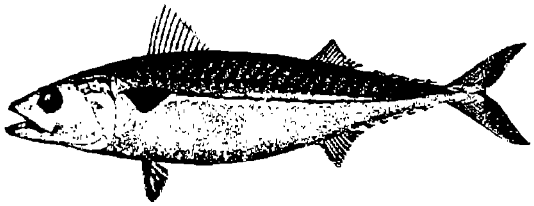
[1] **Includes offshore Maine and southern New England landings and catches processed at sea.**

19. ATLANTIC MACKEREL





Atlantic mackerel, *Scomber scombrus*, is a fast swimming, pelagic, schooling species distributed in the Northwest Atlantic between Labrador and North Carolina. There are two major spawning components of this population, a southern group, 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 winter between Sable Island (off Nova Scotia) and Cape Hatteras in waters generally warmer than 7°C, with extensive northerly (spring) and southerly (autumn) migrations to and from spawning and summering grounds. Maximum observed size in recent years is about 47 cm or 18.5 in. (fork length) and 1.3 kg (3 lbs) in weight. Sexual maturity begins at age 2 and is usually complete by age 3. Maximum age is about 20 years.

Mackerel are subjected to seasonal fisheries, both commercial and recreational, throughout most of their distributional range. U.S. 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. U.S. 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 March 1, 1977, mackerel in U.S. 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 to 1988, and declined in 1989. Total landings from this stock declined 13 percent in 1989 (82,659 mt to 72,289 mt). Increases in landings in the 1980s are due to larger USA and

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 = Yield per recruit

$M = 0.20$ $F_{0.1} = 0.29$ $F_{max} = 0.62$ F_{1989} = Unknown

---

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

foreign joint venture fishing operations.

The United States accounted for 21 percent of the 1989 international catch, including about 14,556 mt of commercial and an estimated 2,251 mt of recreational catch. The Canadian catch declined from 23,288 mt in 1988 to 18,659 mt in 1989. The distant-water fleet catch dropped from 42,858 mt in 1988 to 36,823 mt in 1989.

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 the series began in 1962. The 1984 to 1986 cohorts also appear to be relatively strong.

Total stock biomass (ages 1 and older) increased from around 300,000 mt in 1962-65 to 1.9 million mt in 1970-71 before dropping to a stable low level during 1977-81 averaging 485,000 mt per year. The total stock increased since 1981, reaching roughly 2 million mt in 1988, and may decline somewhat in 1990. Spawning stock biomass (50 percent of age 2 fish and 100 percent of ages 3 and older) increased from about 600,000 mt in 1981 to an estimated 1.8 million mt at the start of 1988, and will be slightly smaller in 1990. This increase in biomass is similar to that observed in the late 1960s, which supported the large catches in the 1970s.

Mackerel stock rebuilding has been aided by relatively low catches during 1980-89 (average of 53,990 mt) as well as improved recruitment from the 1981-82 and 1984 to 1986 year classes. Projections indicate that the catch in 1990 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 underexploited.

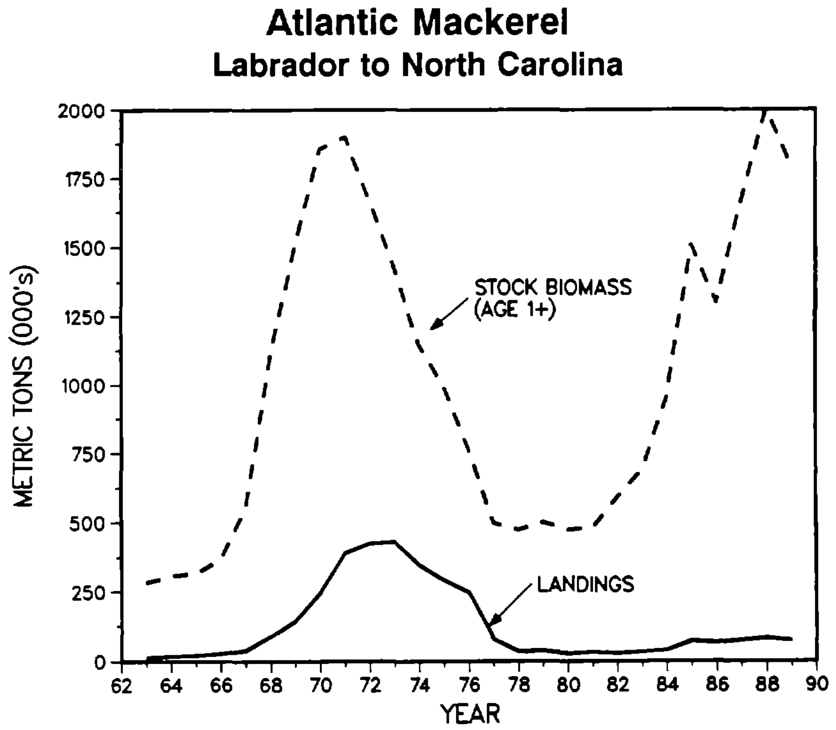


Table 19.1 Recreational catches and commercial landings (1,000 mt)

	Year									
Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	2.4	8.5	1.2	3.3	2.6	3.3	3.9	5.6	4.2	2.3
Commercial										
USA	2.7	2.9	3.3	3.8	6.0	6.6	9.6	12.3	12.3	14.6
Canada	22.3	19.4	16.4	19.8	18.2	30.9	31.1	22.2	23.3	18.7
Other	0.6	5.4	6.6	6.0	15.0	32.4	25.4	35.1	42.9	36.8
Total nominal catch	28.0	36.2	27.5	32.9	41.8	73.2	70.0	75.2	82.7	72.4

"Projections indicate that the catch in 1990 can be increased without adversely affecting the productivity of the spawning stock biomass."

For further information

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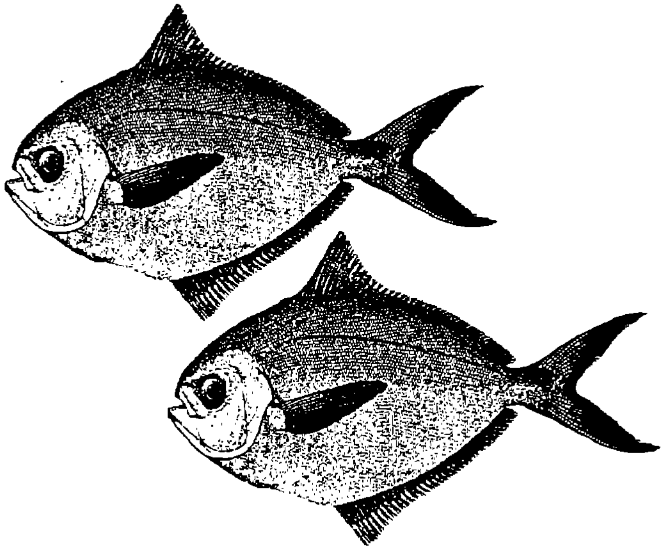
Overholtz, W.J., and B.L. Parry. 1985. Update of the status of the Northwest Atlantic mackerel stock for 1985. Woods Hole, MA: NOAA/NMFS/NEFC. Woods Hole Laboratory Reference Document 85-13. 16 p. Available from: Northeast Fisheries Center, Woods Hole, MA, 02543.

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: NOAA/NMFS/NEFC. NOAA Technical Memorandum NMFS-F/NEC-62. 49p. Available from: Northeast Fisheries Center, Woods Hole, MA, 02543.

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

20. BUTTERFISH



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

Spawning takes place chiefly during the summer months, with the peak in July. Butterfish begin recruiting to the spawning stock at the end of their first year. The maximum recorded age for this species is 6 years, but few fish are seen beyond age 3. Butterfish are important prey for a number of fishes including bluefish, silver hake, swordfish, tuna, and pelagic sharks.

The principal fishing gear used for catching butterfish is the otter trawl. The recreational fishery is negligible, and foreign catches have declined in recent years to insignificant levels. Fishing is managed under the Mid-Atlantic Fishery Management Council's Squid, Mackerel, and Butterfish FMP. The management is based on a total allowable catch (TAC) limit which was increased in 1986 from 11,000 mt to 16,000 mt. Total landings have been far less than the TAC, but increased 52 percent in 1989 (2,100 mt to 3,200 mt).

Butterfish landings fluctuated widely over the 1960s and 1970s, being roughly steady at around 5,000 mt from 1977 to 1981. Landings were somewhat higher in 1982 and 1984, and have subsequently decreased. The 1989 domestic catch is the third lowest observed since 1977. Furthermore, the 1989 catch is 40 percent below the 1978-88 average (5,300 mt), a period when domestic butterfish catches were relatively high. The decline in domestic catches since 1984 is attributed in part to decreased availability of marketable size butterfish on the traditional southern New England fishing grounds.

Reported discard rates of small butterfish in the domestic fishery during 1989 were low compared to rates reported in the early 1980s (less than 10 percent, compared with 40 to 70 percent by weight of the landed catch). This is attributable to declines in the Japanese market for small butterfish, and low availability of butterfish on traditional grounds.

The catch per tow index (all ages) from the NEFC 1989 autumn bottom trawl survey (12.2 kg/tow) increased

Gulf of Maine - Mid-Atlantic Butterfish

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

M = 0.80 **$F_{0.1}$ = 1.60** **F_{max} > 2.50** **F_{1989} = Unknown**

67 percent from 1988. Likewise, the recruitment index (332 age 0 fish/tow) increased 18 percent. Additionally, the 1989 age 1^+ index increased 88 percent (66 age one and older fish/tow), following three consecutive declines. Also, the 1989 recruitment (332), age 1^+ (66), and biomass (12.2) indices are 125, 49, and 77 percent, respectively, greater than the 21 year (1968-1988) averages (148, 44, and 7).

The 1989 Massachusetts inshore autumn bottom trawl survey (1.5 kg/tow) and (104 number/tow) abundance indices declined nearly 80 percent from the record high 1988 values. Furthermore, the 1989 indices are nearly 50 percent less than the 11-year (1978-1988) averages. Overall, however, Massachusetts 1978-1989 indices do not exhibit the same yearly trends seen in NEFC data.

The general inverse relationship between the Massachusetts and NEFC butterfish abundance indices may be attributed to differences in environmental conditions between the two survey regions. Since Massachusetts coastal waters are within the northernmost range of this species, it seems likely that butterfish would be more sensitive to water temperatures within this region. However, a strong relationship between autumn temperature data and survey abundance indices has not been documented.

Total instantaneous mortality (Z) rates between ages 0 and 1 averaged 1.36 from 1978 to 1989 and are nearly identical to the 1968-77 average (1.39). This implies that current domestic fishing mortality rates are equivalent to historical levels, assuming natural mortality, M=0.8, has remained constant over time. The component of natural mortality that is caused by pelagic fish and large whale predation has not been estimated, but it is probably the most important segment. The average Z between ages 1 and 2 declined between the 1968-77 (2.38) and 1978-89 (1.39) time periods. However, the average Z between ages 2 and 3 (2.70) during 1978-89 was 33 percent greater than the earlier time period.

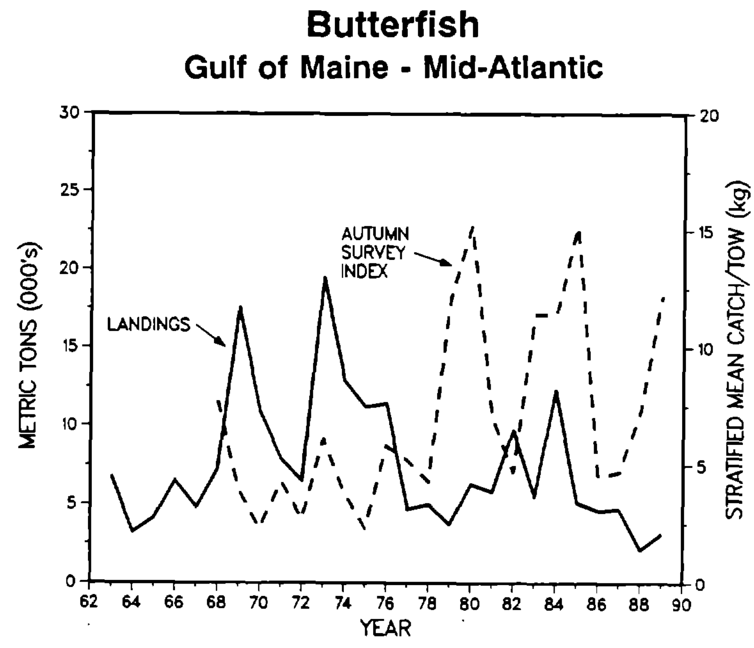


Table 20.1 Recreational catches and commercial landings (1,000 mt)

	Year									
Category	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	5.4	4.9	9.1	4.9	11.8	4.7	4.6	4.7	2.1	3.2
Canada	-	-	-	-	-	-	-	-	-	-
Other	0.9	0.9	0.8	0.6	0.4	0.4	0.1	<0.1	<0.1	<0.1
Total nominal catch	6.3	5.8	9.7	5.5	12.3	5.1	4.7	4.7	2.1	2.1
Total allowable catch[1]	11.0	11.0	11.0	11.0	<16.0	<16.0	<16.0	<16.0	<16.0	,16.0

---

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

The 1989 autumn abundance indices are greater than the 1968-76 levels when total international nominal catches were high (6,500 to 19,500 mt). This suggests that sufficient fish are available to support catches at the current TAC. However, the spatial and seasonal nature of the U.S. fishery may prevent achievement of catches approaching MSY. This fishery is prosecuted principally in autumn in southern New England waters, whereas prior to 1977 distant-water fleets harvested butterfish throughout its range.

The recent declines in landings have not been associated with declines in abundance. The strong 1989 year class suggests that abundance will continue at relative high levels over the next few years. Much larger catches could be supported by the population, and it is underexploited.

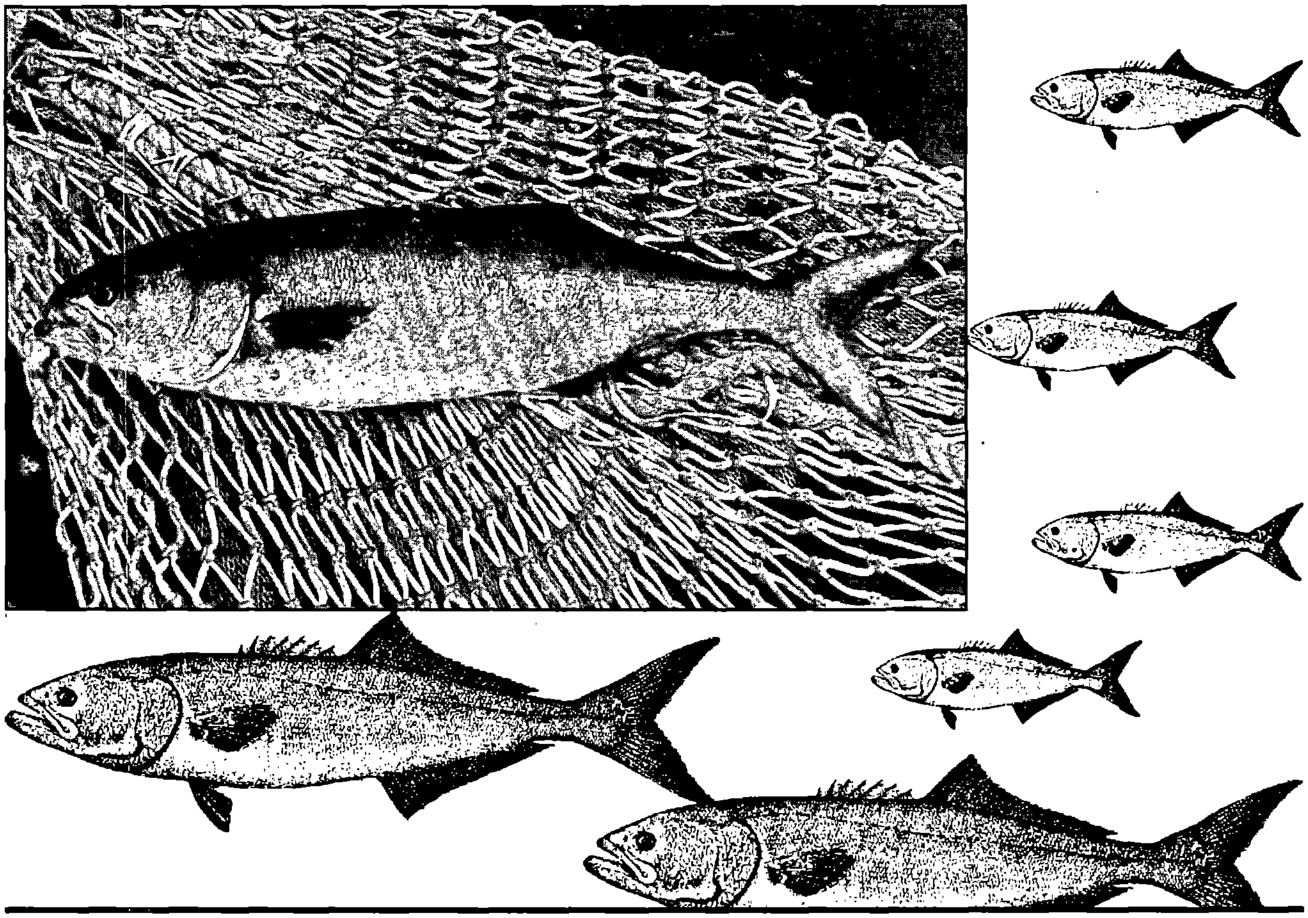
For further information

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

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

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

21. BLUEFISH



The bluefish, *Pomatomus saltatrix*, is a migratory, pelagic species found throughout the world in most temperate coastal regions, except the eastern Pacific. Along the U.S. 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.) in length and 14 kg (31 lb) in weight.

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

"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..."

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 yr
Size at 50% maturity = 35 cm (13.8 in.)
Assessment level = Index

M = 0.35 $F_{0.1}$ = Unknown F_{max} = Unknown F_{1989} = Unknown

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 percent 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 31 percent from 1988 to 1989 (41,500 mt to 28,600 mt), mostly due to lower recreational catches. Commercial catch peaked in 1983 at 7,600 mt, and has shown a declining trend since 1987. Commercial catch declined 24 percent in 1989, from 6,200 mt to 4,700 mt.

The recreational component of the fishery, which on average constitutes 80 to 90 percent of the total catch, has decreased from a peak of nearly 70,000 mt in 1980 to 23,900 mt in 1989. The 1989 recreational catch level was a decline of 32 percent from the previous year (35,300 mt). An index of recreational fishing effort for bluefish has trended upward since 1981 (21.4 million bluefish trips), peaking in 1988 at an estimated 37.2 million bluefish trips, then declining to 30.5 million trips in 1989. 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 1.35 kg/trip (0.89 fish/trip) in 1987, 0.96 kg/trip (0.42 fish/trip) in 1988, and 0.79 kg/trip (0.56 fish/trip) in 1989.

Bluefish

Atlantic Coast, Maine to Florida

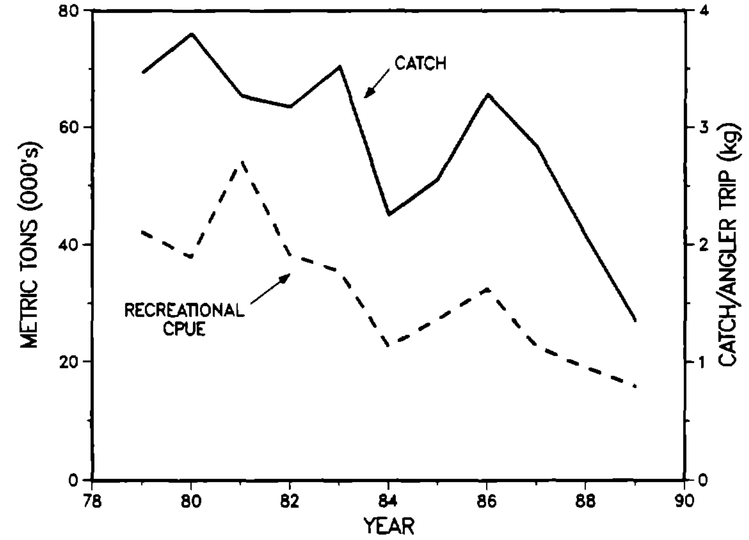


Table 21.1 Recreational catches and commercial landings (1,000 mt)

	Year									
Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	69.6	58.2	56.6	62.8	39.3	45.0	59.4	49.7	35.3	23.9
Commercial										
USA	6.5	7.2	6.9	7.6	5.8	6.2	6.3	6.9	6.2	4.7
Canada	-	-	-	-	-	-	-	-	-	-
Other	<0.1	-	-	-	-	-	-	-	-	-
Total nominal catch	76.2	65.4	63.5	70.4	45.1	51.2	65.7	56.6	41.5	28.6

Current stock assessment information is insufficient to allow a quantitative determination of the status of exploitation for bluefish. However, the recent downward trends in recreational and commercial catches, and the continuing decline in the index of abundance based on recreational catch per bluefish trip, suggests that bluefish abundance decreased during the 1980s, and that the stock is fully exploited.

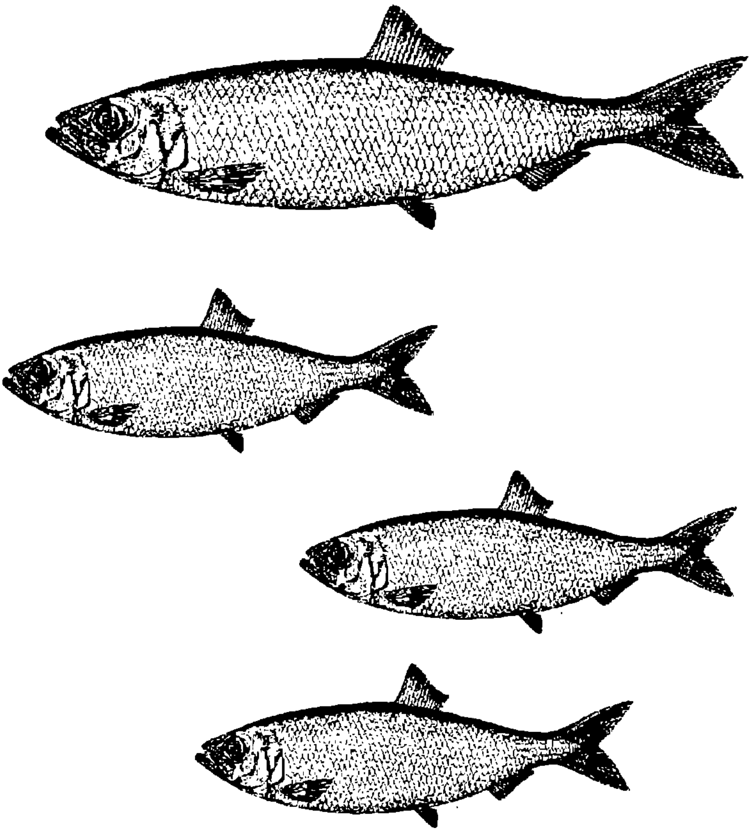
For further information

Northeast Fisheries Center. 1988. Report of the Fifth NEFC Stock Assessment Workshop (Fifth SAW). Woods Hole, MA: NOAA/NMFS/NEFC. Woods Hole Laboratory Reference Document 87-12. 66 p. Available from: Northeast Fisheries Center, Woods Hole, MA, 02543.

Northeast Fisheries Center. 1988. Report of the Sixth NEFC Stock Assessment Workshop (Sixth SAW). Woods Hole, MA: NOAA/NMFS/NEFC. Woods Hole Laboratory Reference Document 88-02. 78 p. Available from: Northeast Fisheries Center, Woods Hole, MA, 02543.

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

22. RIVER HERRING



River herring is a term applied collectively to alewife, *Alosa pseudoharengus*, and blueback herring, *Alosa aestivalis.* The coastal range of the blueback herring is from Nova Scotia to Florida; the coastal range of 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 U.S. 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

Maine - Mid-Atlantic River Herring

Long-term potential catch = Unknown
Importance of recreational fishery = Minor
Management = Shad and River Herring Interstate Plan; Squid, Mackerel, and Butterfish FMP
Status of exploitation = Unknown
Age at 50% maturity = 2 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_{1989} = Unknown

> **"Although fishing pressure on the resource has eased considerably, especially since the foreign catch was restricted in 1976, recovery to historic levels is not evident in any river system."**

gill nets. Recreational fishing does not contribute significantly to total landings. The U.S. 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 1,750 mt in 1989. 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 has 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 fisheries is managed under the Mid-Atlantic Fishery Management Council's Squid, Mackerel, and Butterfish FMP. Although fishing pressure on the resource has eased considerably, especially since the foreign catch was restricted in 1976, recovery to historic levels is not evident in any river system. River herring stocks in several rivers along the east coast are still being exploited above optimal levels. Data from the NEFC spring and autumn bottom trawl surveys indicate that stock levels have been relatively stable since 1968, although data from spring bottom trawl surveys between northern New Jersey and Cape Hatteras indicate a slight increase in biomass since 1975.

River Herring
Gulf of Maine - Mid-Atlantic

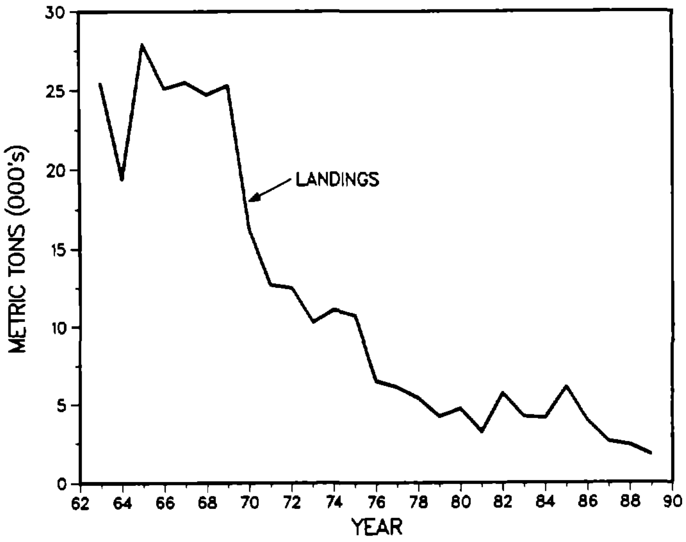


Table 22.1 Recreational catches and commercial landings (1,000 mt)

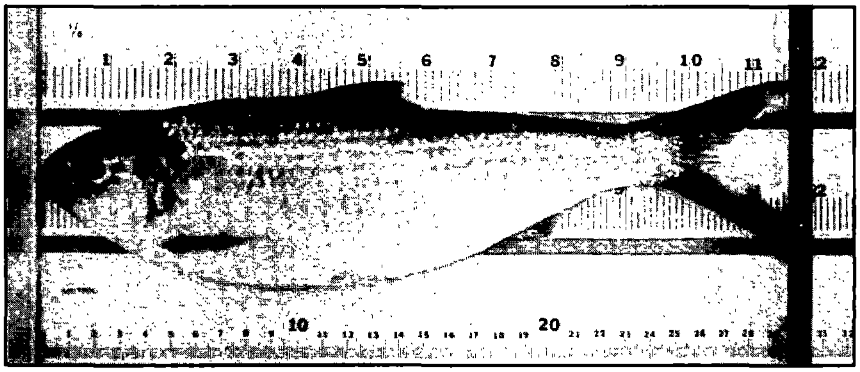
Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	-	-	-	-	-	-	-	-	-	
Commercial										
USA	4.7	3.2	5.7	4.2	4.1	6.1	3.9	4.1	2.4	1.8
Canada	-	-	-	-	-	-	-	-	-	-
Other	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total nominal catch	4.7	3.2	5.7	4.2	4.1	6.1	3.9	4.1	2.4	1.8

For further information

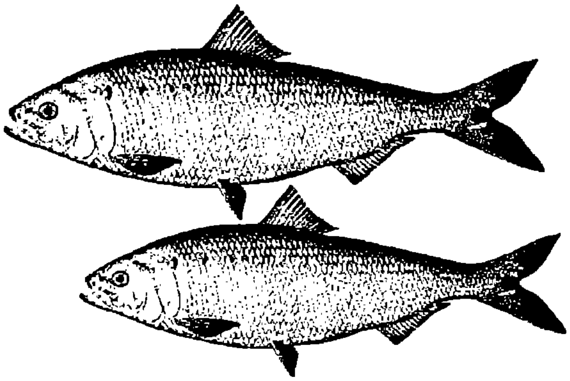
Boreman, J. 1981. River herring stocks along the Atlantic coast. Woods Hole, MA: NOAA/NMFS/NEFC. Woods Hole Laboratory Reference Document 81-35. 23 p.

Harris, P.J. and R.A. Rulifson. 1989. Investigations of ocean landings for American shad and river herring from United States east coast waters. Atlantic States Marine Fisheries Commission: Washington, D.C. Special report #19. 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, Washington, D.C.



23. AMERICAN SHAD



The American shad, *Alosa sapidissima*, is an anadromous member of the family Clupeidae (herrings). Along the Atlantic coast, its range extends from southern Labrador to northern Florida. American shad undergo extensive seasonal migrations along the Atlantic coast. Shad migrate into rivers for spawning beginning in April in southern rivers, and continuing until July in the northernmost rivers. Following their downstream migration, shad migrate north along the coast to Canada where they feed during the summer. A southward migration occurs along the continental shelf where the fish overwinter prior to spring spawning migrations to their natal rivers.

> **"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."**

Gulf of Maine - Mid-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 to 1.25**
F_{1989} = Unknown

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

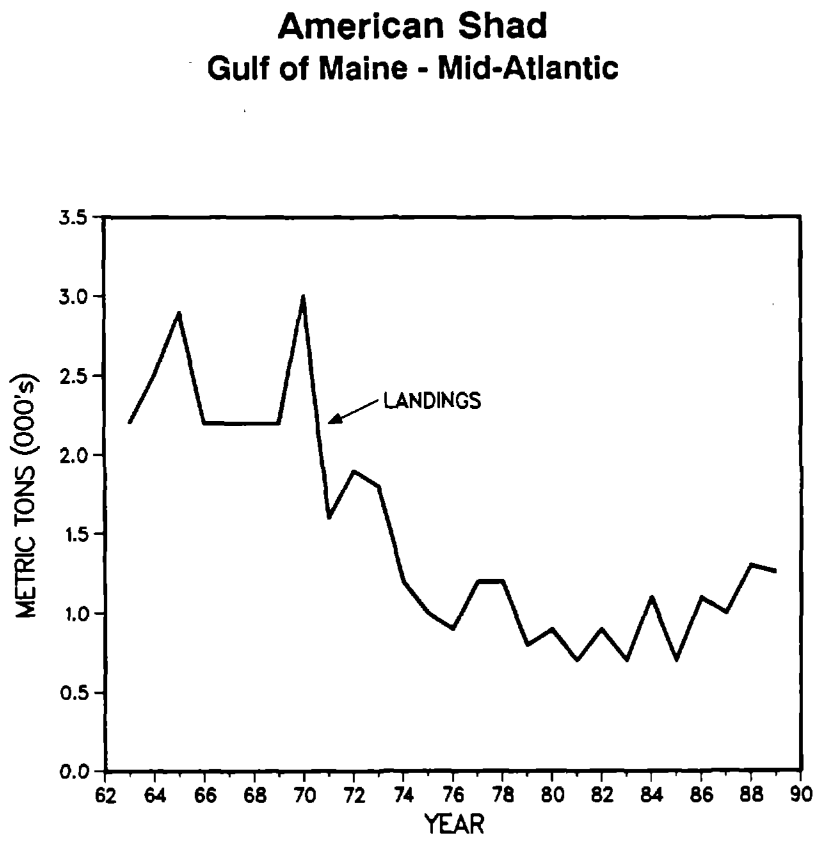


Table 23.1 Recreational catches and commercial landings (1,000 mt)

	Year									
Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	0.9	0.7	0.9	0.7	1.1	0.7	1.1	0.9	1.3	1.3
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	0.9	0.7	0.9	0.7	1.1	0.7	1.1	0.9	1.3	1.3

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 lifetime, however, increases.

Virtually every major coastal river along the Atlantic seaboard has, at one time, supported a stock. American shad have been the subject of intensive exploitation for their flesh and roe. The principal fishing gear for American shad is the gill net. Nominal commercial catch along the Atlantic coast exceeded 22,000 mt in 1896, but currently averages less than 1,000 mt per year. Commercial catch reported by states during the 1980s has been the lowest on record, although landings north of Cape Hatteras, NC increased to 1,300 mt in 1988 and 1989. 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 facilitate cooperative management and restoration plans among 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.

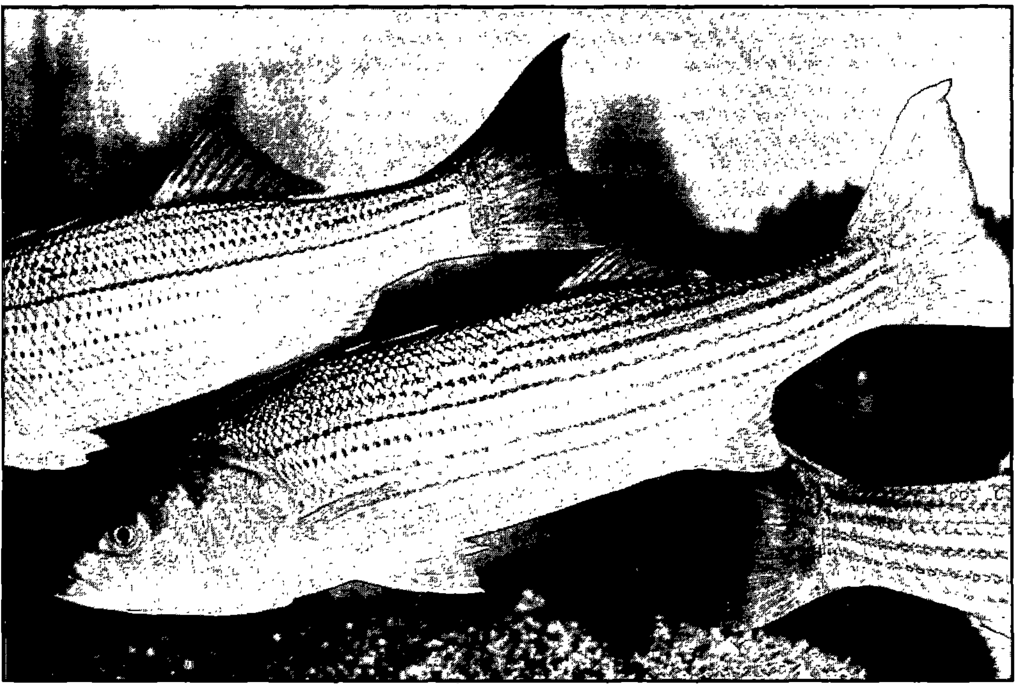
An assessment of shad from twelve rivers along the Atlantic coast with established populations indicates that MSY ranges from 6 to 1,236 mt depending on the drainage area of the river. Present catch is generally far less than these levels, although recent increases in ocean intercept fisheries for American shad contribute an unknown degree of exploitation to certain river systems. The assessment information is insufficient to confidently determine the status of individual stocks, or of aggregated stocks.

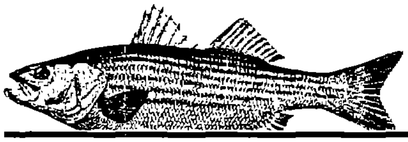
For further information

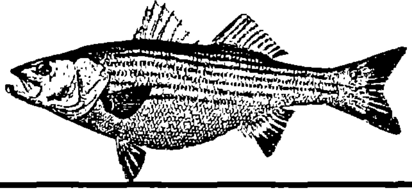
Gibson, M.R., V.A. Crecco, and D.L. Stang. 1988. Stock assessment of American shad from selected Atlantic coast rivers. Washington, D. C.: Atlantic States Marine Fisheries Commission. Special Report No. 15. 65p. Available from: Atlantic States Marine Fisheries Commission, Washington, DC.

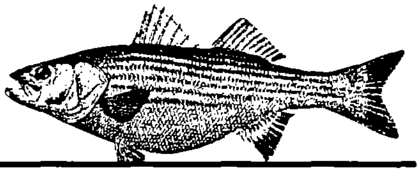
Richkus, W. A., and G. DiNardo. 1984. Current status and biological characteristics of the anadromous alosid stocks of eastern United States: American shad, hickory shad, alewife, and blueback herring. Columbia, MD: Martin Marietta Environmental Center. Available from: Atlantic States Marine Fisheries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

24. STRIPED BASS









The striped bass, *Morone saxatilis*, is an anadromous species distributed along the Atlantic coast from northern Florida to the St. Lawrence estuary, along the Pacific coast from Ensenada, Mexico to British Columbia, and in numerous inland lakes and reservoirs. Striped bass spawn in mid-February in Florida and late June or July in Canada, and from mid-March to late July in California. Spawning occurs at or near the surface in fresh or slightly brackish waters at temperatures ranging from 10° to 23°C; peak spawning activity is observed between 15° and 20°C. Larvae range from 2.0 to 3.7 mm in total length at hatching and initiate feeding after 4 to 10 days. When they are about 13 mm long, larval striped bass form small schools and move inshore; juvenile striped bass move downriver into higher salinity waters during their first summer or autumn.

Most striped bass along the Atlantic coast are involved in two types of migration: an upriver spawning migration from late winter to early spring, and a coastal migration that is apparently not associated with spawning activity. Coastal migrations may be quite extensive; striped bass tagged in Chesapeake Bay have been captured in the Bay of Fundy. Coastal migratory behavior appears to be limited to stocks north of Cape Hatteras and appears to be related to sex and age of the fish.

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 has historically produced most of the striped bass found along the coast. However since 1970, juvenile production in Chesapeake Bay has been extremely poor. Consequently, commercial landings began a severe decline in the mid-1970s. Findings of the Emergency Striped Bass Study (ongoing since 1980) suggest that the decline in abundance of the Chesapeake Bay stock is probably due to a combination of factors, including overfishing and poor water quality in spawning and nursery habitats. Water quality monitoring and field and laboratory bioassays on the spawning grounds in Maryland have shown that river water can be toxic to larvae at some times and in some areas. The study findings also indicate that the decline in commercial and recreational catch between 1974 and 1980 may have cost the Northeast approximately 7,000 jobs and more than $220 million in economic activity in 1980.

During the mid-1980s, stringent management measures were adopted by the states from Virginia to Maine to attempt to rebuild the Chesapeake stocks. These measures, aimed at protecting the 1982 and subsequent year classes until the females could spawn at least once, have increased the abundance of striped bass. Females of the protected year classes began to appear on the spawning grounds in 1987. During 1987 through 1989, indices of juvenile production in Virginia's tributaries to the Chesapeake Bay were at record high levels. Maryland's index of juvenile abundance however remained far below average until 1989. In 1989, very high juvenile abundance in the Choptank River brought the index to the second highest level on record, and exceeded management criteria for reopening the fishery in 1990. The Hudson River stock, which has not experienced a population decline, had exceptionally high juvenile indices during 1987-1989. The juvenile index for the Roanoke River stock increased slightly in 1988 and 1989, but remains low. The Roanoke stock has not been subject to interstate agreements protecting the Chesapeake stock, because it is considered predominantly nonmigratory.

Nominal catches of striped bass in the commercial fisheries from Maine to North Carolina have fluctuated widely, but averaged 2,700 mt per year between 1929 and 1983. Gill nets, haul seines, pound nets, and handlines accounted for more than 80 percent of the commercial catch. Since 1985, management restrictions have significantly curtailed landings. The nominal commercial catch from Maine to North Carolina in 1989 (129 mt) was one of the lowest on record. The recreational harvest of striped bass has remained low throughout the 1980s. During 1989, an estimated 1.4 million fish were caught by anglers; 92 percent of these were released alive.

Gulf of Maine - Mid-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 = 0.20 $F_{0.1}$ = unknown F_{max} = unknown F_{1989} = unknown

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[1] Moderate exploitation began in 1990

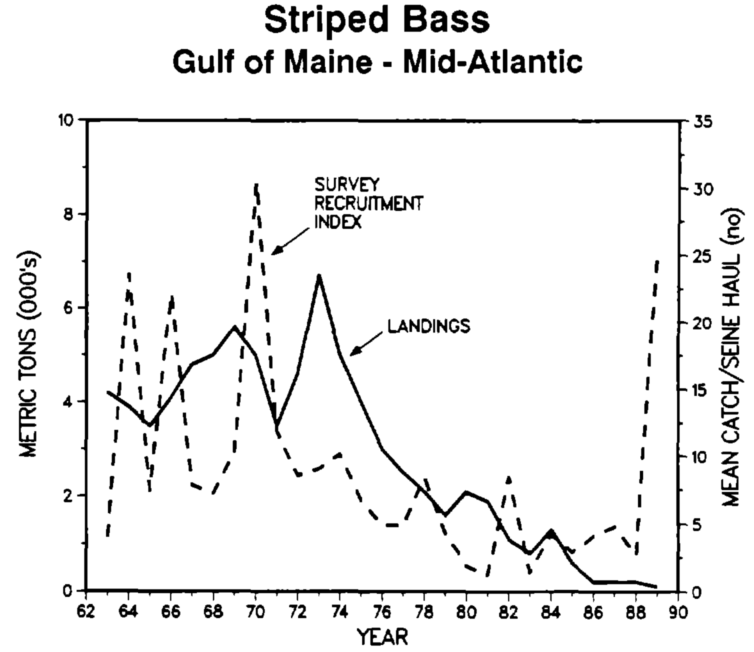


Table 24.1 Recreational catches and commercial landings (1,000 mt)

Category	Year									
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	0.8	0.6	1.6	1.2	0.5	0.8	0.4	0.4	0.6[1]	0.3[1]
Commercial										
USA	2.1	1.9	1.1	0.8	1.3	0.6	0.2	0.2	0.2	0.1
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	2.9	2.5	2.7	2.0	1.8	1.4	0.6	0.6	0.8[1]	0.4[1]

---

[1] Preliminary NMFS data

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. 1989. Emergency striped bass research study. Report for 1988. 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.

25. SPINY DOGFISH

Spiny dogfish, *Squalus acanthias*, are distributed in the western North Atlantic from Georgia to Newfoundland. During spring and autumn, they are found along the coastal waters between North Carolina and Southern New England. Dogfish are chiefly summer visitors to the Gulf of Maine (including Georges Bank) and more northern waters, and in winter are distributed primarily in deeper waters along the edge of the continental shelf. They tend to school by size and, for large mature individuals, by sex. Dogfish are voracious feeders and are known to feed on 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 six.

The principal commercial fishing gears used for catching dogfish are otter trawls and sink gill nets. 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 for dogfish. Landings increased 55 percent in 1989 (2,900 mt to 4500 mt).

Reported international nominal catches peaked at about 21,000 mt in 1972 and declined sharply from 1975 to 1978. Distant-water fleets consistently accounted for virtually all of the reported catches. Domestic catches since 1979 have fluctuated between 2,600 mt and 6,900 mt, with no trend. Landings in 1990 are expected to increase dramatically 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 increased 92 percent from 558,000 mt in 1989 to a record high 1,074,000 mt in 1990, 268 percent more than the 1968-89 geometric average of 291,000 mt. Minimum biomass estimates during the decade (1980-1989) have generally been higher than values observed

Gulf of Maine - Mid-Atlantic Spiny Dogfish

Long-term potential catch = 40,000 to 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

$M = 0.05$ $F_{0.1} = 0.10$ $F_{max} = 0.39$ $F_{1989} < F_{0.1}$

> **"The low levels of landings are not reflected in the generally increasing indices of abundance over the past decade or longer."**

Spiny Dogfish
Gulf of Maine - Mid-Atlantic

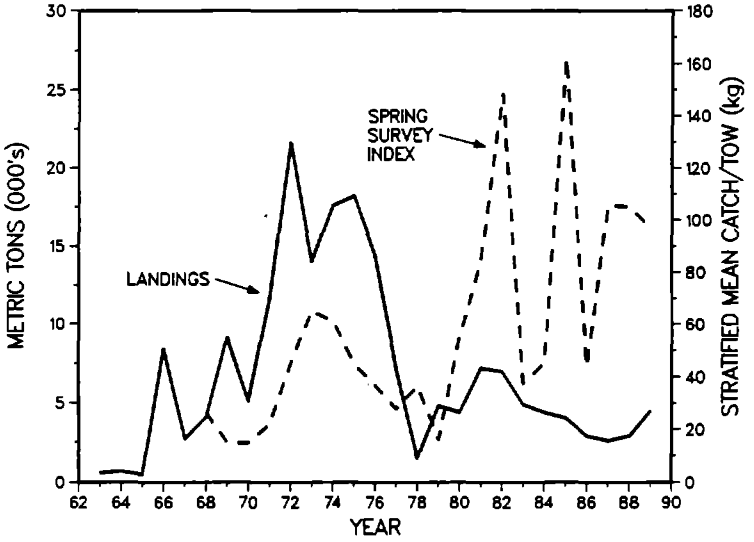


Table 25.1 Recreational catches and commercial landings (1,000 mt)

	Year									
Category	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	4.2	6.9	6.6	4.9	4.4	4.0	2.6	2.6	2.9	4.5
Canada	-	-	-	-	-	-	-	-	-	-
Other	0.2	0.3	0.4	-	-	-	0.1	-	<0.1	<0.1
Total nominal catch	4.4	7.3	7.0	5.0	4.5	4.3	2.8	2.8	3.2	4.5

between 1968-1979. The 1990 estimate is 126 percent more than the 1980-89 geometric average of 474,000 mt, or about 50 percent less than the 268 percent obtained using the 1968-89 average. Since dogfish occur in schools, there tends to be rather high variety among the survey catches, resulting in large fluctuations in the annual biomass estimates.

The U.S. 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 west coast American 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) that suggest that no more than 20 percent of the minimum biomass can be harvested annually. Under this harvest scenario, about 90,000 mt (20 percent of the 1980-90 average) could be taken annually from the present population.

Assuming that the 1990 minimum biomass estimate is correct (1.08 million mt), then about 200,000 mt could be caught from the sttock. 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, have resulted in the NEFC trawl survey catches by weight on Georges Bank, for example, changing from roughly 25 percent dogfish and skates in 1963 to nearly 75 percent 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.

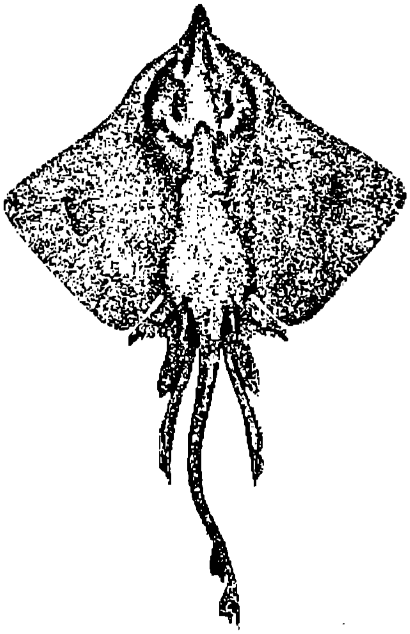
Holden, M.J. 1968. The rational exploitation of the Scottish-Norwegian stocks of spurdogs (*Squalus acanthias* L.). Ministry of Agriculture, Fisheries and Food, Fishery Investment Series II 25(8):1-27.

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: NOAA/NMFS/NEFC. NEFC Center Reference Document 90-09.

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

26. SKATES



Skates, family Rajidae, are distributed throughout the Northwest Atlantic from near the tide line to depths exceeding 700 m. Members of this family lay eggs that are enclosed in a hard, leathery case commonly called a 'mermaids purse'. Incubation time is 6 to 12 months, with the young having the adult form when they hatch. 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 in 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.

Skate landings (species combined) off the northeastern United states were 6,600 mt in 1989, representing a 12 percent increase over the 1988 total of 5,900 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 metric tons 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 need for lobster bait, and, more importantly, to the increased export market for skate wings. Importantly, the species composition of skate wing landings is unknown because of the difficulty of identifying wings dockside by species. Bait landings are primarily comprised of 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 have increased significantly but the declined again slightly (6 percent) from 167,400 mt in 1988 to 157,000 mt in 1989. The 1989 autumn survey biomass estimate was 21 percent greater than the long term (1968-1987) average of 127,600 mt.

Recent increases in skate landings and the potential for rapidly expanding export markets bring into

"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 de-stabilize the populations. "

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 de-stabilize the populations. In other areas of the world where skates are more fully utilized, their numbers have been reduced to extremely low levels (for example, in the Irish Sea). Similarly, although the aggregate population abundance indices may be increasing, particularly vulnerable species (as in the case of 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: NOAA/NMFS/NEFC. NEFC Center Reference Document 90-09. Available from: Northeast Fisheries Center, Woods Hole, MA, 02543.

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.

Gulf of Maine - Mid-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 = Yield per recuit

M=0.40[1] $F_{0.1}=0.49$[1] $F_{max}=1.00$[1] F_{1989}=Unknown

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[1] Pertains to little skate

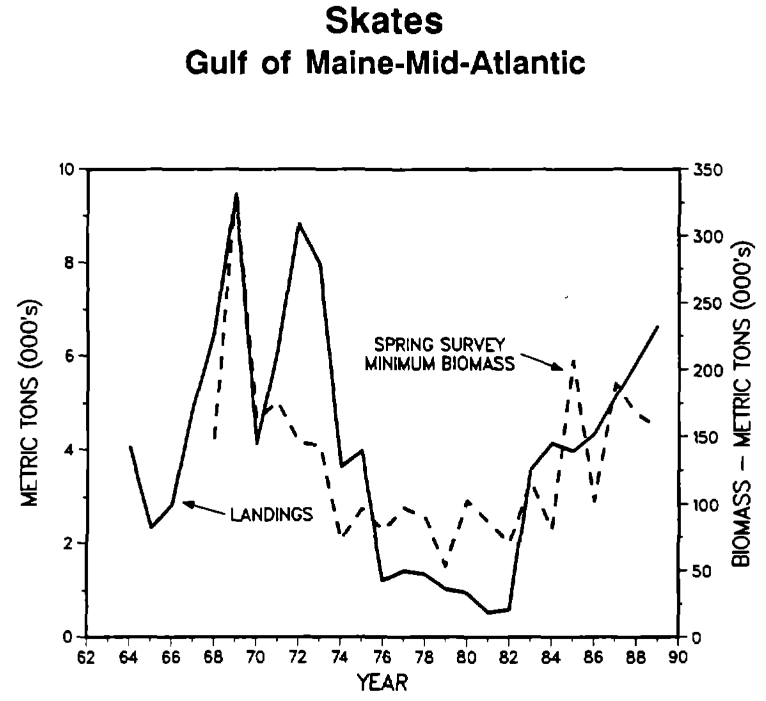
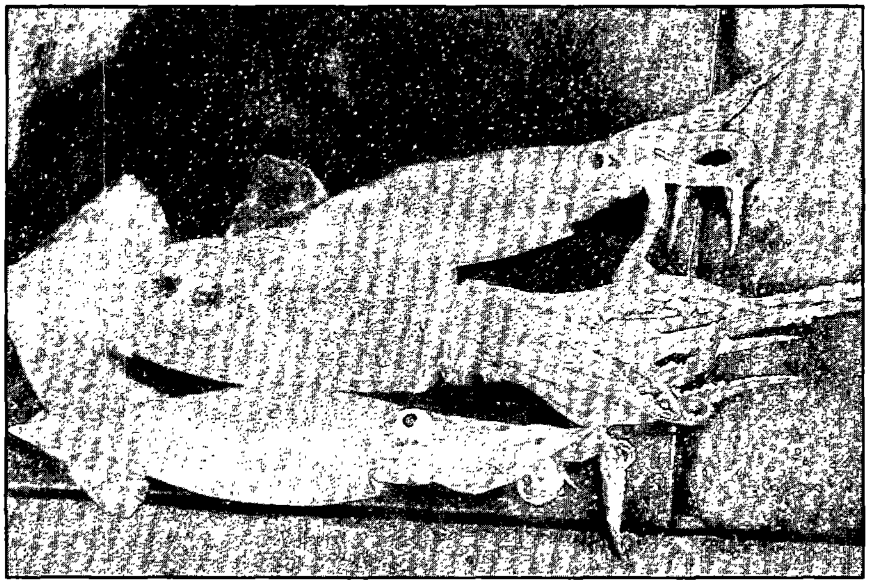
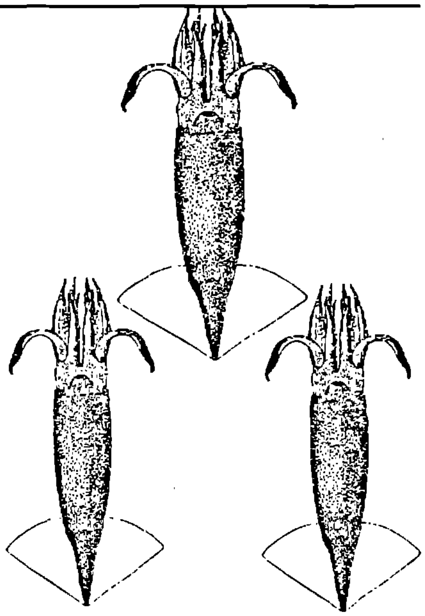


Table 26.1 Recreational catches and commercial landings (1,000 mt)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	0.9	0.5	0.6	3.6	4.1	4.0	4.2	5.1	5.9	6.6
Canada	0.1	-	-	-	<0.1	-	<0.1	<0.1	-	-
Other	<0.1	<0.1	-	-	-	-	0.1	-	-	-
Total nominal catch	1.0	0.5	0.6	3.6	4.1	4.0	4.3	5.1	5.9	6.6

27. SHORT-FINNED SQUID





The short-finned squid, *Illex illecebrosus*, is found in commercial quantities between Cape Hatteras and Newfoundland. Present scientific information indicates that this range represents the major distribution of a single stock. *Illex* migrate onto the continental shelf during summer, and move off the edge of the shelf in winter to spawn. Results of recent larval and juvenile surveys indicate that spawning probably occurs somewhere south of Cape Hatteras near the Gulf Stream. Larvae and juveniles are assumed to be transported north and east in the fringes of the Gulf Stream. In some years, the spawning season is prolonged, and two cohorts (winter and late spring) are produced. These cohorts tend to vary in relative importance from year to year. *Illex* grow to a maximum length of about 35 cm (14 in., dorsal mantle length) and live for 12 to 24 months. Commercial catches off the United States are composed mainly of 10 to 28 cm (4 to 11 in.) individuals that are probably 8 to 24 months of age.

The principal fishing gear used to catch short-finned squid is the otter trawl. Recreational catches are insignificant, and foreign catches decreased to insignificant levels during the 1980s. The fishery is managed under the Mid-Atlantic Fishery Management Council's Squid, Mackerel, and Butterfish FMP. Management is through total allowable catch (TAC), which has been reduced in recent years. Landings increased in 1989 (from 2,000 mt to 6,800 mt).

Prior to 1972, annual *Illex* landings averaged 1,300 mt. Landings then increased rapidly to an average of around 19,500 mt between 1972 and 1982, declined between 1983 and 1986, and have fluctuated about relatively low levels since 1986.

Catch per unit effort in the 1989 U.S. directed fishery was about 50 percent above the 1982-88 mean, indicating that below average landings in 1989 were caused by lower availability. In fact, effort directed at *Illex* was greatly reduced in 1988 and 1989 probably due to market conditions. The 1989 NEFC autumn survey index for *Illex* was about 70 percent greater than the 1968-89 mean, while prerecruit (less than 11 cm long) abundance in 1989 was about 30 percent above the 1968-89 average.

No significant relationship has been found between research vessel catch per tow data for *Illex* and availability to the subsequent *Illex* fishery when data for all years are examined. However, highly significant relationships ($p<0.01$) were found between Southern New England-Mid-Atlantic mean numbers per tow for years with greater than average indices, and U.S. catches in the following year. Also, *Illex* abundance indices have generally held at either high or low levels for several years before exhibiting dramatic changes. Low abundance indices were seen during 1968-74, followed by high indices for 1975-81, and low indices from 1982 to 1986. It may be expected that above average indices, as seen in 1987 through 1989 will continue for the next few years.

Research survey and commercial

> **"It may be expected that above average indices... will continue for the next few years."**

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

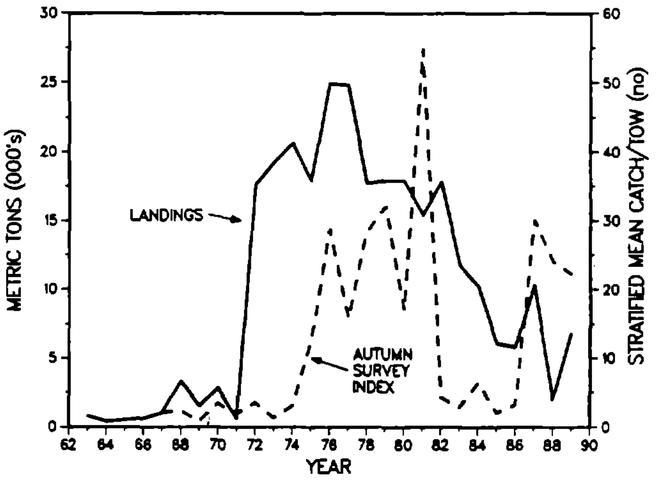
Above average apparent abundance of adult *Illex* during the autumn 1989 NEFC research vessel survey suggest that current abundance would be adequate to provide catches during 1990 at levels comparable to the average total landings from the fishery since the directed fishery began (1972-89). It is likely that the current stock size can support catches at a level similar to that seen during the previous period of high abundance (19,500 mt average during 1976-82). However, whether the domestic fishery can realize this level of catch depends on the availability of squid within the area of the fishery. This availability is associated with environmental and behavioral factors that are not yet fully understood. Also, recent low levels of catch reflect market conditions that may persist during 1990.

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

Gulf of Maine- Mid-Atlantic Short-Finned Squid

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

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1989} =Unknown



Short-Finned Squid
Gulf of Maine - Mid-Atlantic

Table 27.1 Recreational catches and commercial landings (1,000 mt)

	Year									
Category	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA[1]	0.3	0.6	5.9	9.9	9.5	5.0	5.6	10.3	2.0	6.8
Canada	-	-	-	-	-	-	-	-	-	-
Other	17.5	14.8	12.4	1.8	0.7	1.1	0.2	-	-	-
Total nominal catch	17.8	15.4	18.3	11.7	10.2	6.1	5.8	10.3	2.0	6.8
Total allowable catch	30.0[2]	30.0[2]	30.0[2]	30.0[2]	30.0[2]	25.0[2]	22.5	22.5[3]	17.0	15.0

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

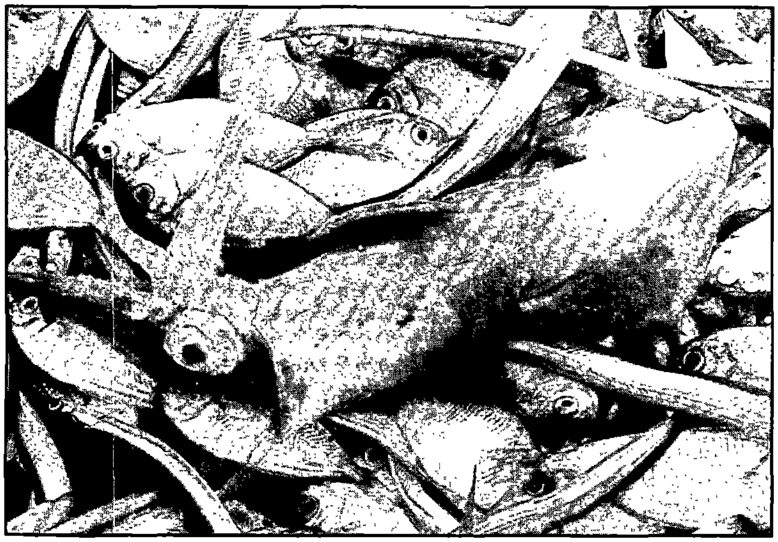
For further information

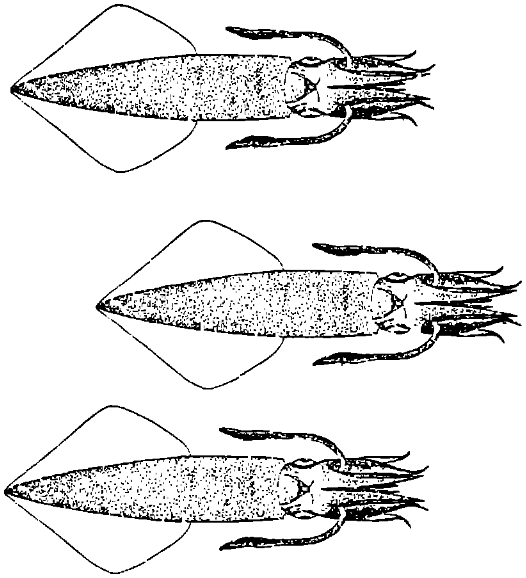
Lange, Anne M. T. 1984. Status of the short-finned squid, *Illex illecebrosus*, off the Northeastern USA, November 1984. Woods Hole, MA: NOAA/NMFS/NEFC. Woods Hole Laboratory Reference Document 84-38. 20 p.

Northeast Fisheries Center. 1990. Report of the Spring 1990 NEFC Stock Assessment Workshop (Tenth SAW). Woods Hole, MA: NOAA/NMFS/NEFC. NEFC Center Reference Document 90-07. 89 pp.

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

28. LONG-FINNED SQUID





The long-finned squid, *Loligo pealei*, is found in commercial quantities from Cape Hatteras to southern Georges Bank. *Loligo* undergo seasonal migrations, moving inshore from southern Cape Cod to the Chesapeake Bay in spring and summer to spawn. In late autumn, they begin to move offshore to the edge of the continental shelf where the distant-water fishery traditionally occurred in winter. An extended spawning season results in two cohorts, with the early (spring) cohort generally more important than the late summer cohort, although this importance may vary from year to year. *Loligo* may reach lengths of more than 40 cm (16 in., dorsal mantle length) and ages of about 3 years, but most individuals taken in commercial catches are 8 to 20 cm (3 to 8 in.) and 8 to 14 months. The timing and extent of seasonal migrations are assumed to be related, at least in part, to temperature preferences of this species. Regression analysis indicates that about 77 percent of the variation in *Loligo* mean catch per tow in the autumn NEFC bottom trawl surveys may be accounted for by changes in bottom temperature.

The principal fishing gear used to catch long-finned squid is the otter trawl. Recreational fishing is insignificant and foreign fishing activity has decreased to insignificant levels over the last decade. Fishing is managed under the Mid-Atlantic Fishery Management Council's Squid, Mackerel, and Butterfish FMP. Management is based on a total allowable catch (TAC) limit. Landings increased 23 percent in 1989 (from 19,100 mt to 23,400).

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

The 1989 NEFC autumn bottom trawl survey abundance indices (stratified mean number per tow) for the Mid-Atlantic through Georges Bank strata were the fourth highest of the series (1967-89). Total abundance was 45 percent greater than the 1967-88 mean, while the prerecruit (8 cm or less in dorsal mantle length) index was 15 percent greater than the 1967-88 mean.

Total recruitment from the 1989 year class is estimated to be 3.3 billion individuals. Yield per recruit and stock recruitment analyses based on this level of recruitment and estimates of current fishing mortality (F=0.4) indicate that potential yield of *Loligo* from the 1989 year class is between 38,000 mt and 44,000 mt. If fishing mortality were increased to the level corresponding to the maximum equilibrium yield (F=0.7), potential yields of 46,000 mt to 54,000 mt would be expected.

The 1987 autumn survey indices were the lowest of the time series and it was theorized that a massive cold pool, present in the southern New England-Mid Atlantic area during the time of that survey may have reduced availability of *Loligo* to the survey trawl. Whatever the cause of the low 1987 indices, availability to the 1988 and 1989 fisheries apparently was not affected.

Above average apparent abundance of both adults and prerecruits during the autumn 1989 NEFC research vessel survey suggest that current abundance of *Loligo* is adequate to provide 1990 catches of between 38,000 and 44,000 mt, even at F levels less than those expected to produce the highest equilibrium yield. The fluctuating catch levels over this decade have not been associated with any trends in population abundance, but the fluctuations probably reflect varying year class strengths in this short-lived species, and changing market conditions. Recent survey indices suggest that year class strengths have been good, and suggest that the stock is underexploited relative to the estimated long term potential catch of 44,000 mt.

For further information

Lange, Anne M. T. 1984. An assessment of the long-finned squid resource off the northeastern United States, Autumn 1984. Woods Hole, MA: NOAA/NMFS/NEFC. Woods Hole Laboratory Reference Documents 84-37: 24 p. Available from: Northeast Fisheries Center, Woods Hole, MA, 02543.

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

Gulf of Maine - Mid-Atlantic Long-Finned Squid

Long-term potential catch = 44,000 mt
Importance of recreational fishery = Insignificant
Management = Squid, Mackerel and Butterfish FMP
Status of exploitation = Underexploited
Age at 50% maturity = 1 yr
Size at 50% maturity = 16 cm (6.3 in.) dorsal mantle length
Assessment level = Yield per recruit

M = Unknown $F_{0.1}$ = Unknown F_{max} = Unknown F_{1989} = Unknown

"Total recruitment from the 1988 year class is estimated to be 3.3 billion individuals."

Long-Finned Squid

Gulf of Maine - Mid-Atlantic

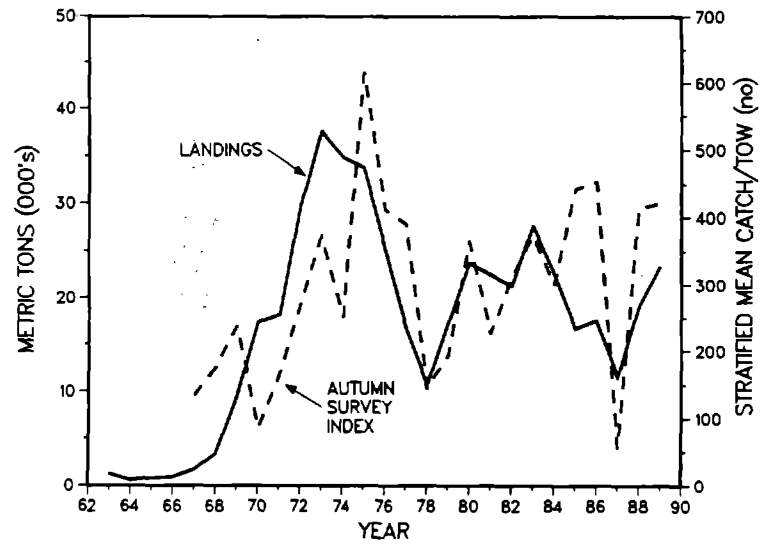

Table 28.1 Recreational catehes and commercial catches (1,000 mt)

Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA[1]	4.0	2.3	5.5	15.9	11.6	10.2	13.3	11.5	19.1	23.4
Canada	-	-	-	-	-	-	-	-	-	-
Other	19.8	20.2	15.9	11.7	11.0	6.5	4.3	<0.1	<0.1	<0.1
Total nominal catch	23.8	22.5	21.4	27.6	22.6	16.7	17.7	11.5	19.1	23.4
Total allowable catch	44.0[2]	44.0[2]	44.0	44.0[2]	44.0[2]	33.0[2]	37.0[2]	10.1[3]	17.0[3]	22.0[3]

(The header "Year" spans the year columns.)

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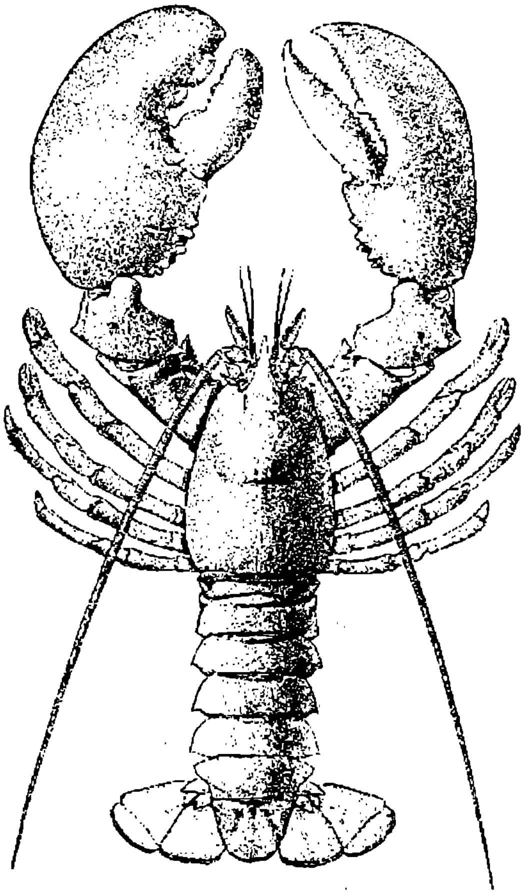
[1] **Includes prorated amounts of squid catches not identified to species.**

[2] **1 April - 31 March fishing year.**

[3] **Actual allocated level; MSY value is 37.0**

29. AMERICAN LOBSTER



The American lobster, *Homarus americanus*, is distributed in the Northwest Atlantic from Labrador to Cape Hatteras from coastal regions out to depths of 700 m. Lobsters are locally abundant in coastal regions within the Gulf of Maine and off southern New England and less abundant in more southerly areas. Coastal lobsters are concentrated in rocky areas where shelter is readily available, although occasional high densities occur in mud substrates suitable for burrowing. Offshore populations are most abundant in the vicinity of submarine canyons along the continental shelf edge. Tagging experiments in coastal wa-

Gulf of Maine - Mid-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[1]
Assessment level = Index[1]

$M = 0.10$[1] $F_{0.1}$ = Unknown[1] $F_{max} = 0.18$ (males)[1] 0.23 (females)[1] F_{1989}[1] $> F_{max}$

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[1] **Offshore fishery only**

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

The principal fishing gear used to catch lobsters is the trap. Lobsters are also taken as a bycatch with otter trawls. Recreational fishing occurs, especially in coastal waters, but estimates of the catch are not available. Foreign fishing is insignificant. The fishery is managed under the New England Fishery Management Council's Lobster FMP, and within 3 miles under various state regulations. The primary regulatory measure is carapace length. Total landings increased 8 percent in 1989, from 22,200 mt to 24,000 mt.

INSHORE FISHERY

Nominal landings in the U.S. inshore fishery remained relatively stable from 1965 to 1975, ranging from 10,300 mt to 12,200 mt, averaging 11,100 mt. From 1978 to 1988 the catch has risen steadily from 12,900 mt to a record 20,700 mt in 1989, an increase of about 60 percent. The landings for 1989 were some 8 percent higher than the previous year. This increase can be attributed in part to an increase in abundance of lobsters, and in part to a continuing in-

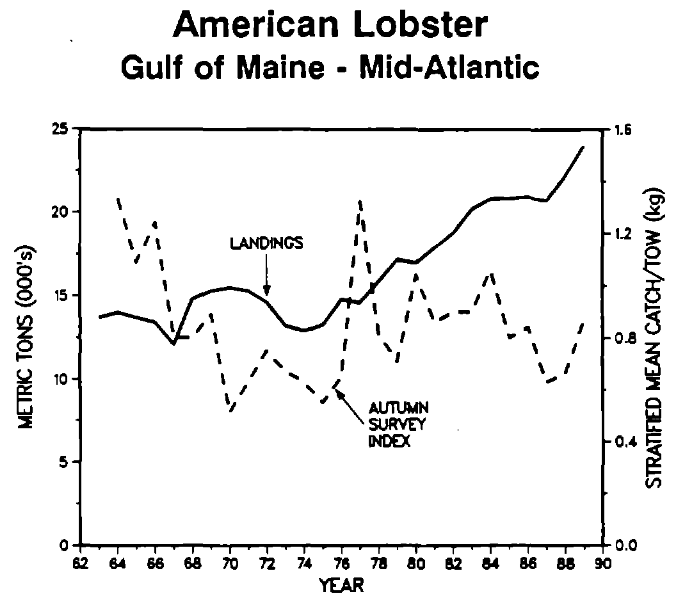

Table 29.1 Commercial landings (1,000 mt live weight).and NEFC autumn survey index (kg/tow). Landings statistics have been revised to reflect unreported catches.

	Year									
Category	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
Recreational[1]										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA										
Offshore[2]	1.9	1.8	2.5	2.4	4.2	2.6	3.4	3.3	3.0	3.3
Inshore[3]	14.9	15.9	16.1	17.6	16.4	18.0	17.8	17.3	19.2	20.7
Canada										
Georges Bank	0.2	0.2	0.2	0.2	0.2	0.2	<0.1	<0.1	<0.1	<0.1
Total nominal catch	17.0	17.9	18.8	20.2	20.8	20.8	20.9	20.7	22.2	24.0

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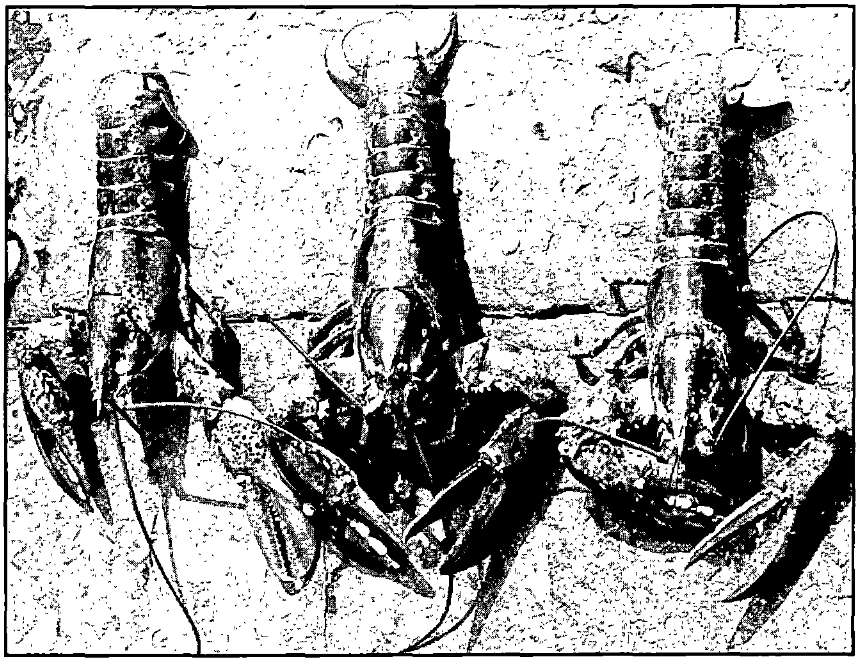
[1] **Recreational catches unknown**

[2] **Includes trawl and offshore trap catches**

[3] **Inshore trap catches**



crease 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 (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 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 percent of the total U.S. landings. The contribution of the offshore fishery to overall landings in 1989 was about 13.8 percent 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 1971-76 this index averaged 0.7 kg/tow, and increased to an average of 1.0 kg/tow from 1977-80. In 1985 the autumn index dropped to 0.8 kg/tow and further to and average of about 0.65 kg/tow in 1987 and 1988. In 1989 this index rose to 0.87 kg/tow, which is about the average over the last ten 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 consistently indicate a reduction in stock biomass after development of the offshore fishery, with stabilization of the stock at reduced levels in recent years.

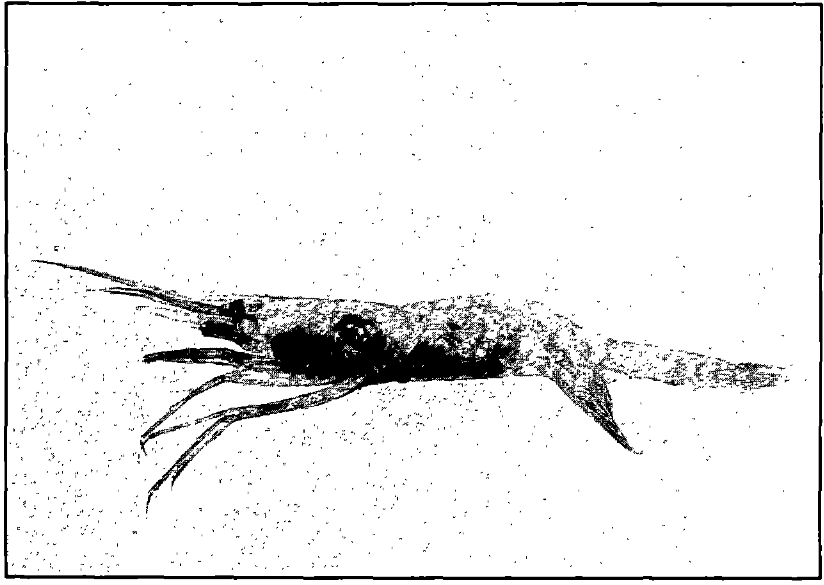
"If consistent recruitment in coastal areas depends on spawning lobsters offshore, then decreases in abundance caused by development of the offshore trap fishery may result in reduced inshore catches in future years."

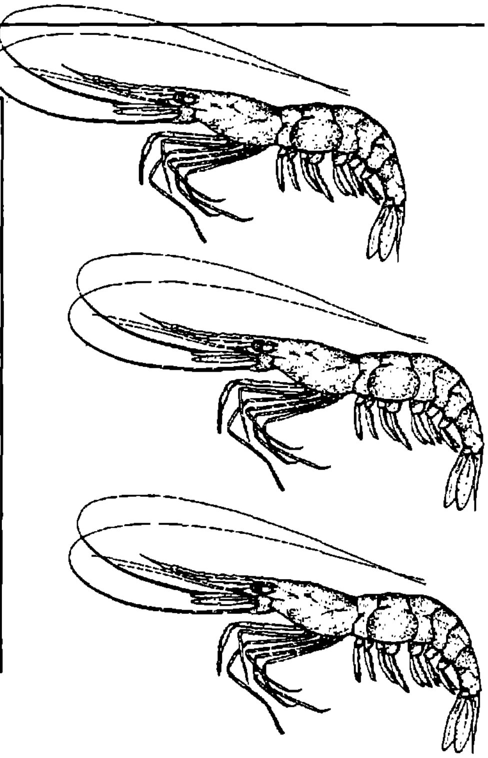
Increases in offshore landings in the past decade and continued intense inshore fishery has raised the question of the relationship between animals in these two areas. If consistent recruitment in the coastal areas depends on spawning lobsters offshore, then decreases in the abundance caused by the development 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.

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

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

$M = 0.5$ $F_{0.1} = 0.2$ F_{max} = Undefined $F_{1989} = 0.1$

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. Current management allows for 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 less than 500 trips in 1980 to 11,100 trips during the 1987 fishing season; effort subsequently declined to 8,900 trips in 1988. The total in both the 1989 and 1990 fishing seasons was 9,200 trips.

Nominal catches peaked at 12,800 mt in 1969, averaged approximately 11,000 mt during 1971-72, and then declined precipitously during the mid- to late 1970s. Landings subsequently increased steadily from 300 mt in 1980 to 5,000 mt in 1987, and then decreased in 1988 to 3,100 mt. Approximately 3,600 mt was landed in 1989. Preliminary data for the 1990 fishing season (December 1989-May 1990) indicate a total of 4,600 mt, a 39 percent increase from the corresponding 1989 season total. This increase reflects recruitment of the strong 1987 year class. A further increase is expected in the 1991 fishing season with full recruitment of this year class to the fishery at age 4.

Since 1983, the primary source of

"Given the presence of the strong 1987 year class, the outlook for the 1991 fishing season is quite favorable."

Northern Shrimp

Gulf of Maine

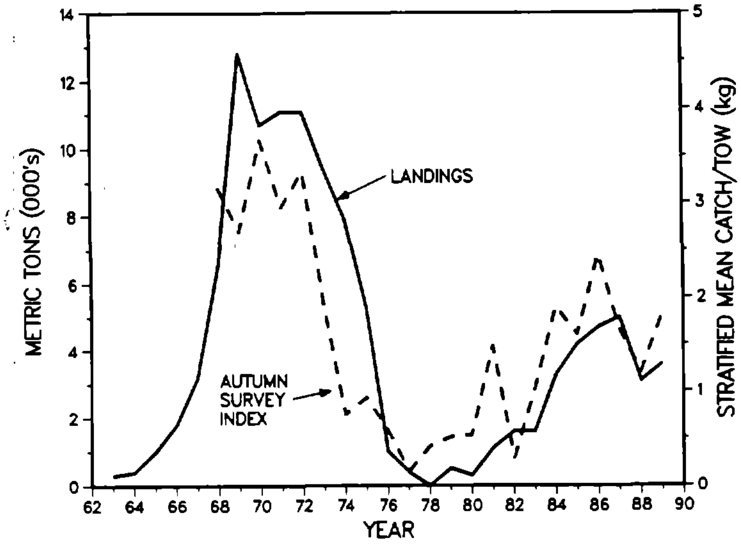


Table 30.1 Recreational catches and commercial landings (1,000 mt)

Category	Year									
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
USA	0.3	1.1	1.6	1.6	3.3	4.2	4.7	5.0	3.1	3.6
Canada	-	-	-	-	-	-	-	-	-	-
Other	-	-	-	-	-	-	-	-	-	-
Total nominal catch	0.3	1.1	1.6	1.6	3.3	4.2	4.7	5.0	3.1	3.6

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 1985-86 and then dropped sharply in 1987, reflecting increased natural and fishing mortality on the 1982 year class. Catch per tow in numbers and weight increased sharply in 1988 with recruitment of the 1987 year class, and a further increase occurred in 1989. The NEFC autumn survey index has increased more or less continually since the late 1970s, again reflecting improved recruitment from the 1982 and 1987 year classes.

Given the presence of the strong 1987 year class, the outlook for the 1991 fishing season is quite favorable. There is no evidence that this stock is being adversely affected by fishing or environmental conditions. 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

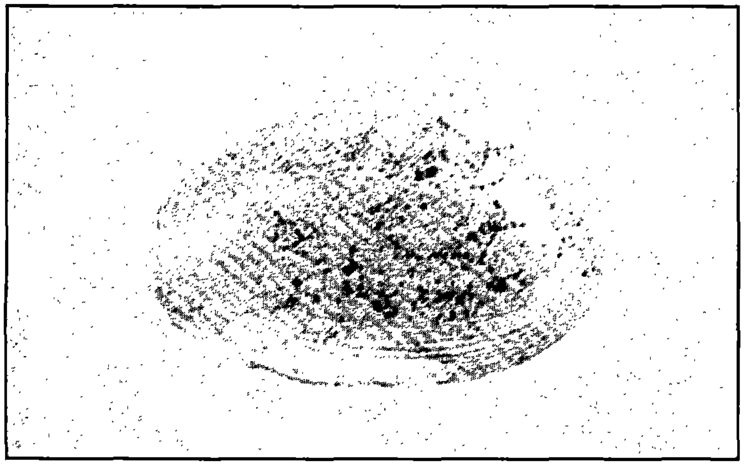
McInnes, D. 1986. Interstate fishery management plan for the northern shrimp (*Pandalus borealis* Kroyer) fishery in the western Gulf of Maine. Washington, D.C.: Atlantic States Marine Fisheries Commmittee. Management Report No. 9. 79p.

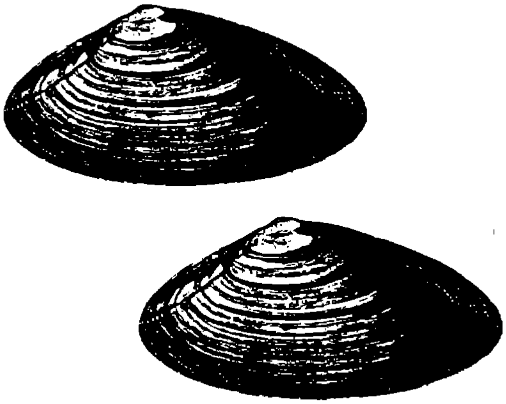
Northern Shrimp Technical Committee. 1990. Assessment report for Gulf of Maine northern shrimp - 1990. Report to the Northern Shrimp Section of the Atlantic States Marine Fisheries Commission, October, 1990. 22p.

Northern Shrimp Technical Committee. 1989. Cruise results: Gulf of Maine northern shrimp survey, August 1-11, 1989. Unpublished report, Woods Hole, MA. 23p.

"There is no evidence that this stock is being adversely affected by fishing or environmental conditions."

31. SURF CLAM





Surf clams, *Spisula solidissima*, are distributed in western North Atlantic waters from the southern Gulf of St. Lawrence to Cape Hatteras. Commercial concentrations are found primarily off New Jersey and the Delmarva Peninsula, although some fishable quantities exist in Southern New England waters, on Georges Bank, and off the Virginia Capes. In the Mid-Atlantic region, surf clams are found from the beach zone to a depth of about 60 m; beyond 40 m, however, abundance is low. Growth rates are relatively rapid, with clams reaching harvestable size in about six to seven years. Maximum size is about 22.5 cm (8 7/8 in.), but clams larger than 20 cm (7 7/8 in.) are rare. Surf clams can reproduce 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 6 percent in 1989 (28,800 mt to 30,400 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, 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

New England - Mid-Atlantic Surf Clams

Long-term potential catch = 24,300 mt
Importance of the 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 in., shell length)
Assessment level = Index

$M = 0.05$ $F_{0.1} = 0.11$ $F_{max} = 0.4$ $F_{1989} = 0.1$

"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."

of the week, and moratorium on vessel construction will not continue. In their place, trading of vessel allocations is intended to reduce vessel overcapitalization, and will probably result in a more efficient use of harvest sector capital. 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 (24,300 mt of meats in 1991) will apply 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.

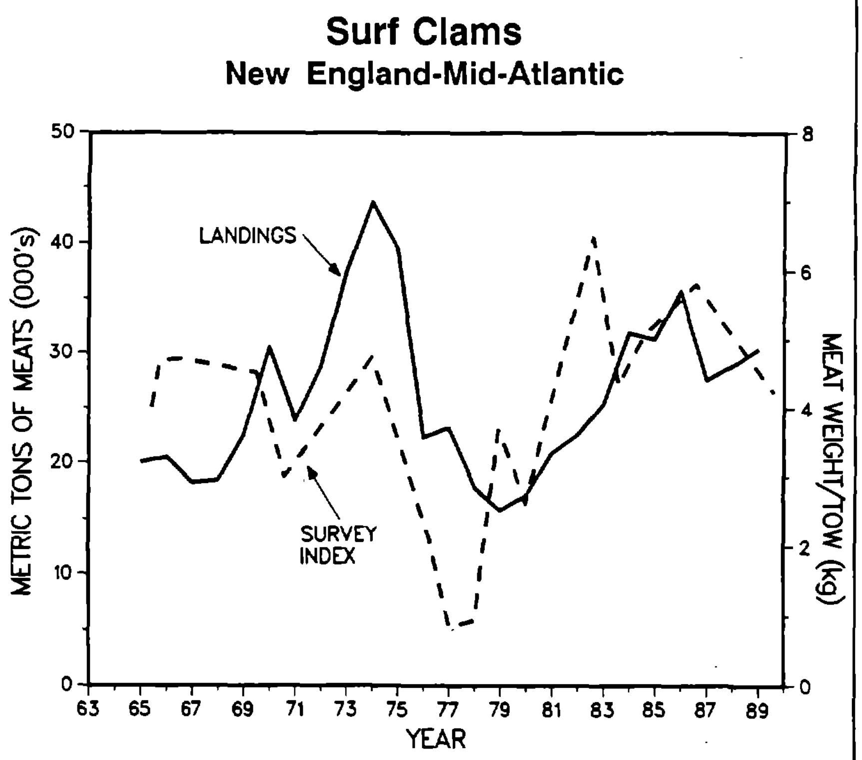


Table 31.1 Recreational catches and commercial landings (1,000 mt, meats)

Category	Year 1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
EEZ	15.7	16.9	16.7	20.5	24.7	23.7	24.9	22.1	23.9	22.3
State waters	1.4	4.0	5.9	4.9	7.2	9.2	10.8	5.4	4.9	8.1
Canada	-	-	-	-	-	-	-	-	-	-
Total nominal catch	17.1	20.9	22.6	25.4	31.9	32.9	35.7	27.5	28.8	30.4
Total allowable EEZ catch	13.6	18.1	18.1	18.9	24.3	24.3	24.3	24.3	24.3	24.3

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 percent 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 1989 were 22,300 mt, representing a 7 percent decrease from the previous year's total of 23,900 mt. The decrease in offshore landings is partly attributable to the closure of the Georges Bank fishery (due to the presence of PSP toxins), rather than an appreciable decline in the stocks.

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, will be suspended due to the relatively low abundance of pre-recruit 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 (18,000 to 23,000 mt of meats) through most of the 1990s. Likewise, landings of 3,000 to 4,000 mt of meats can be sustained in New England waters, (southern New England and Georges Bank) for the next decade as well. 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 1989 (5,400 mt to 8,100 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.

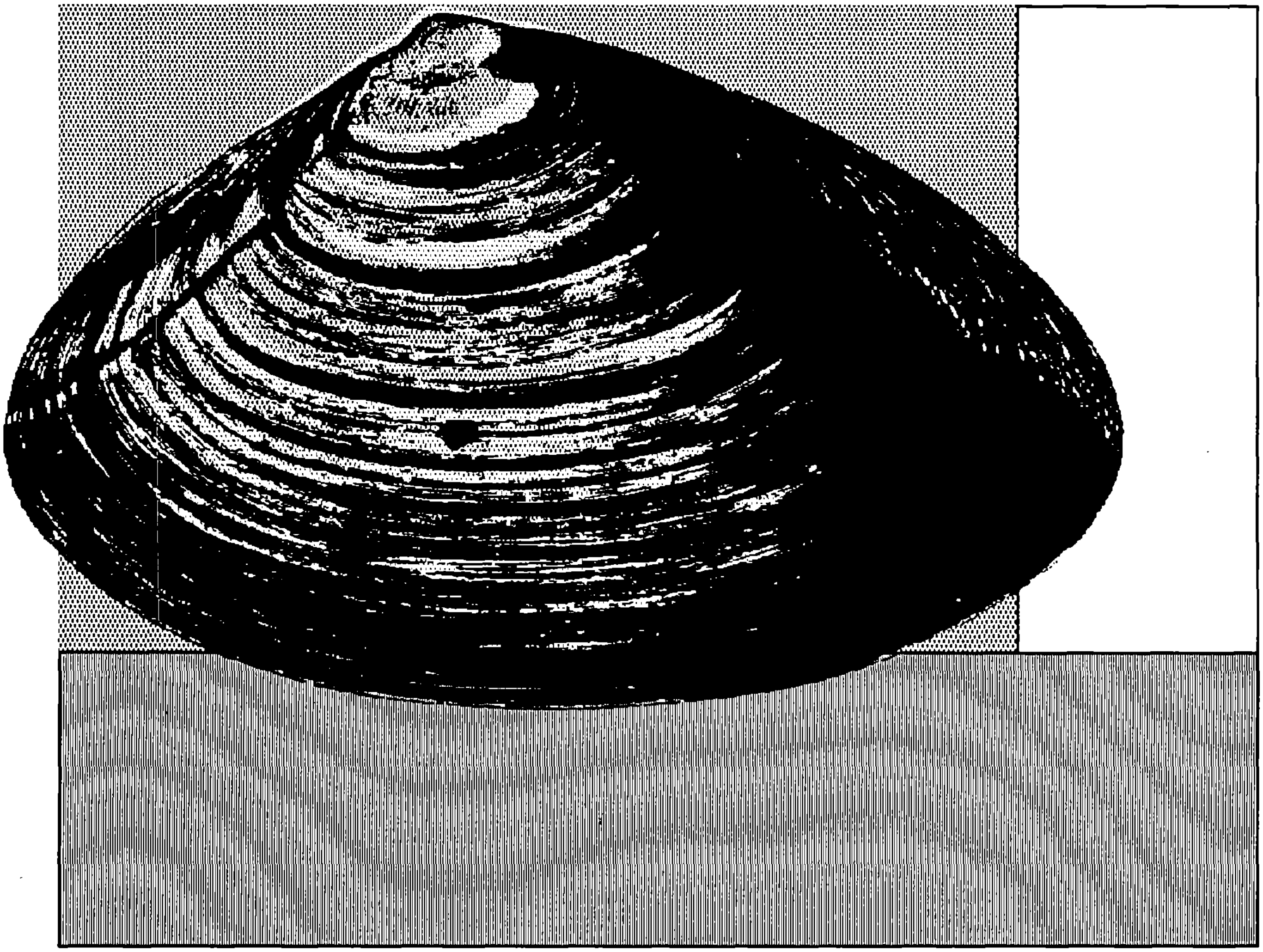
EEZ landings continue to be relatively stable due to the large standing stock, relative to the annual quota. In the last several years, concentrated fishing in the New Jersey area off Atlantic City has reduced biomass in that area. Nevertheless, substantial resources there, and especially off the Delmarva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

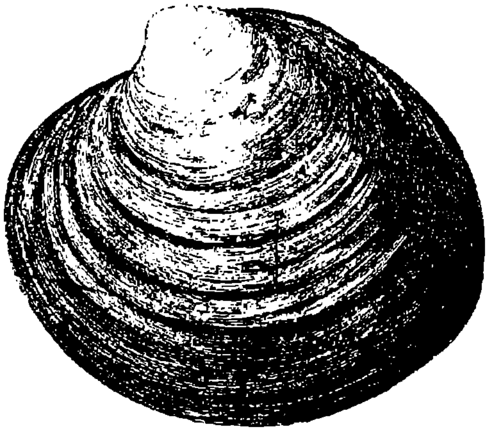
Murawski, S.A. 1989. Assessment updates for middle Atlantic, southern New England, and Georges Bank surf clam populations. Woods Hole, MA: NOAA/NMFS/NEFC. Working Paper #4, 9th Stock Assessment Workshop. 32 pp.

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). Woods Hole, MA: NOAA/NMFS/NEFC. NEFC Center Reference Document 89-08. 71 pp.



32. OCEAN QUAHOG



The ocean quahog, *Arctica islandica,* is found in temperate and boreal waters on both sides of the North Atlantic. Distribution in the western Atlantic ranges from Newfoundland to Cape Hatteras in depths from 8 to 256 m. Quahogs are rarely found where bottom water temperatures exceed 16°C and occur progressively farther offshore between Cape Cod and Cape Hatteras. In the Gulf of Maine , ocean quahogs are distributed in relatively nearshore waters, with fishable concentrations 3 to 7 miles from shore.

In the Middle Atlantic, ocean quahog populations are composed primarily of relatively large (greater than 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 composed of smaller (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 more than 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 (more than 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 (22,700 mt of shucked meats), vessel allocations, and reporting requirements for processors and vessels.

Ocean quahog harvesting was ini-

New England - Mid-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

$M = 0.01\text{-}0.10$ $F_{0.1}$ = Unknown $F_{max} = 0.03\text{-}0.05$ F_{1989} = Unknown, probably <0.1

tiated during World War II off Rhode Island. Total landings 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 stimulated fishing for the deeper-dwelling ocean quahog. Total ocean quahog landings increased dramatically between 1976 and 1979 from 2,500 to 15,800 mt of meats per year. Increased landings in 1989 (23,100) were near the record high level observed in 1985. Most of the landings are derived from the EEZ waters of the Mid-Atlantic Bight, with some EEZ landings off Maine, and an inshore fishery (state waters) off Rhode Island. Landings from the Gulf of Maine fishery are primarily for small (50 mm shell length) quahogs, which are sold as a fresh, in-shell product. Larger quahogs landed in Middle Atlantic waters are used in processed clam products (such as chowders, minced clams, juices, and so on).

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 percent efficient in catching animals encountered in the dredge path. Of this total biomass, 6 percent in the Southern Virginia - North Carolina region, 8 percent off Delmarva, 21 percent off New Jersey, 21 percent off Long Island, 28 percent for Southern New England, and 22 percent on Georges Bank.

Trends in fishery performance from 1979 to 1990 have been documented using catch and effort data from mandatory logbook submissions. These data indicate a significant downward trend since 1982 (after an initial fishery development period). Total CPUE (bushels per hour fishing) declined 27 percent off Delmarva, with a cumulative catch (1982-1989) of about 90,000 mt of meats. 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.

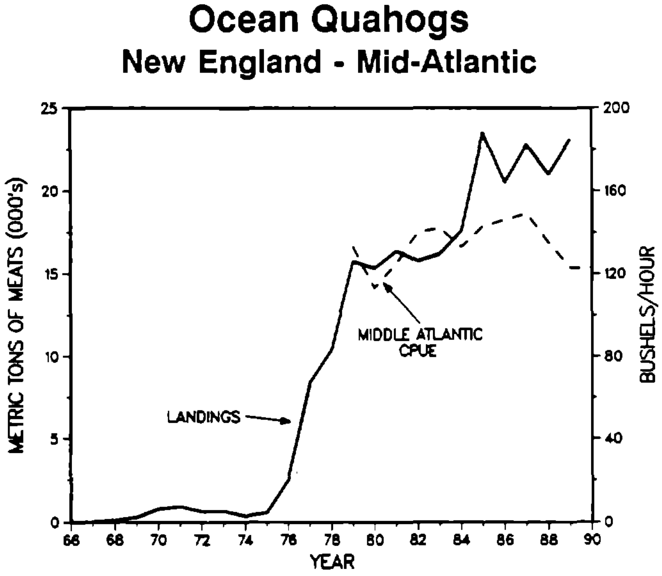


Table 32.1 Recreational catches and commercial landings (1,000 mt, meats)

	Year									
Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
FCZ	13.9	16.0	15.6	15.3	16.4	23.6	19.8	22.3	20.6	22.9
State	1.5	0.4	0.2	0.7	1.2	<0.1	0.8	0.0	0.4	0.2
Canada	-	-	-	-	-	-	-	-	-	-
Total nominal catch	15.3	16.4	15.8	16.0	17.6	23.6	20.5	22.9	21.0	23.1
Total allowable FCZ	15.9	18.1	18.1	18.1	18.1	20.4	27.2	27.2	22.7	22.7

Although annual landings are less that 2 percent of the total estimated stock, landings considerably greater than the current levels are not warranted due to the extremely slow growth rate and poor annual recruitment observed in the mid-Atlantic area. 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 currently exist on Georges Bank, but the fisheryhas been subject to closure due to the presence of paralytic shellfish poisoning toxins in that region.

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. Woods Hole, MA: NOAA/NMFS/NEFC. Working Paper #10, Tenth NEFC Stock Assessment Workshop.

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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.

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33. SEA SCALLOP

Sea scallops, *Placopecten magellanicus*, are found in western North Atlantic continental shelf waters from Newfoundland to North Carolina. North of Cape Cod, scattered concentrations may occur in shallow water less than 20 m (11 fathoms) deep, 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 U.S. commercial fisheries are conducted in the Gulf of Maine, on Georges Bank, and in the Mid-Atlantic offshore region. Recreational fishing is insignificant, occurring primarily in Maine where shallow water scallop beds frequently exist.

Scallops grow rapidly during the first several years of life. Between ages 3 and 5, scallops commonly increase 50 to 80 percent in shell height and quadruple in meat weight. During this time span, the number of meats per pound is 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 U.S. fishery is managed under the New England Fishery Management Council's FMP for the Atlantic Sea Scallop Fishery. Total (United States and Canada) landings increased 10 percent in 1989 (17,600 mt to 19,400 mt).

GULF OF MAINE

Nominal catch (exclusively United States) in 1989 from the Gulf of Maine was 644 mt (meat weight), 22 percent higher than in 1988. Most of the 1989 catch (86 percent, 555 mt) was from inshore, territorial waters along the coast of Maine. United States landings (89 mt) from the EEZ (more than 3 nautical miles from shore) remain low, indicating that the fishery continues to depend on inshore beds.

Commercial fishing effort in 1989 increased 9 percent from 1988, but was still the third lowest since 1980. U.S. commercial CPUE increased slightly in 1989 to its highest level since 1982.

GEORGES BANK

Total (United States and Canada) nominal catch from Georges Bank (Area 5Ze) in 1989 was 10,400 mt, 1 percent lower than in 1988, but the third highest annual catch since 1982. Of the 1989 total, U.S. landings accounted for 55 percent (5,700 mt) while Canadian landings (4,700 mt) accounted for 45 percent. The 1989 U.S. catch was 7 percent lower than in 1988, while Canadian landings increased by 8 percent between 1988 and 1989.

U.S. fishing effort increased to a

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

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

Importance of recreational fishery = Insignificant
Management = Sea Scallop FMP
Status of exploitation = 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 = Yield per recruit

M = 0.10	**$F_{0.1}$ = 0.14 (GM)**	**F_{max} = 0.22 (GM)**	**F_{1989} = >F_{max} (all areas)**
	0.15 (GB)	**0.26(GB)**	
	0.14 (MA)	**0.25 (MA)**	

record high level in 1989 (6 percent higher than in 1988). United States CPUE in 1989 was 12 percent lower than in 1988, and was the third lowest in the 1965-1989 time series. Declines in CPUE occurred in all vessel classes. Canadian fishing effort decreased by 5 percent in 1989 while Canadian CPUE increased by 13 percent.

Abundance and biomass indices from the 1990 U.S. sea scallop research vessel survey indicate that the scallop resource in the U.S. sector of Georges Bank has increased over the 1989 record low levels. In the South Channel of the bank, 1990 survey indices of abundance and biomass were dramatically higher than in 1989 (increasing 739 percent and 245 percent by numbers and weight, respectively, from 1989). In the South East Part of the Bank, decreases of 72 percent and 50 percent by numbers and weight, respectively, were observed from 1989 values. The U.S. Northern Edge and Peak region indicies 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 U.S. Northern Edge and Peak regions, but extremely poor in the southeastern part of Georges Bank. The U.S.A Georges Bank scallop resource is still dominated by small scallops (61 percent of the scallops caught in this area were greater than 80 meat count).

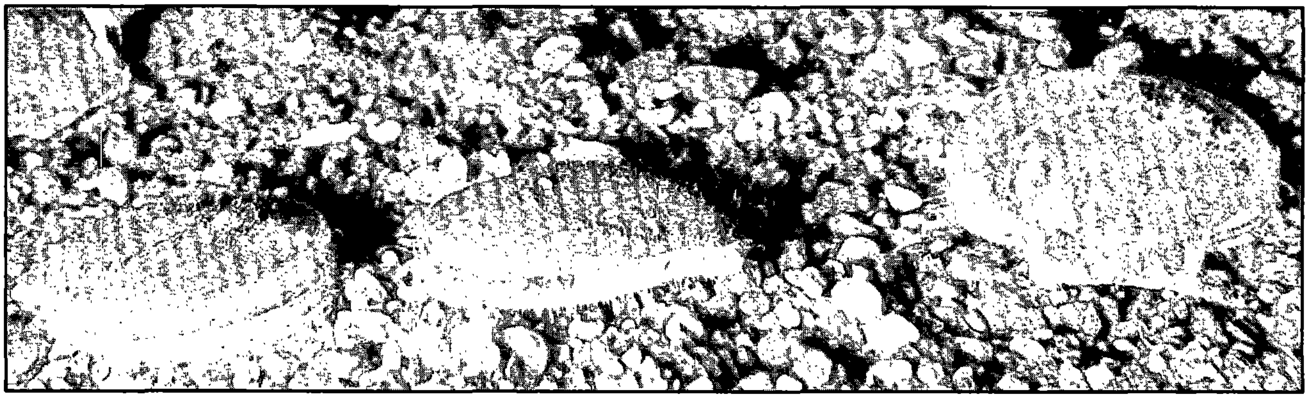
Current fishing effort on Georges Bank is at record levels and far beyond what the resource can sustain in both the long and short run. If the fishery continues to focus heavily on incoming recruitment, as it has in the past, resource conditions will deteriorate even further.

MID-ATLANTIC

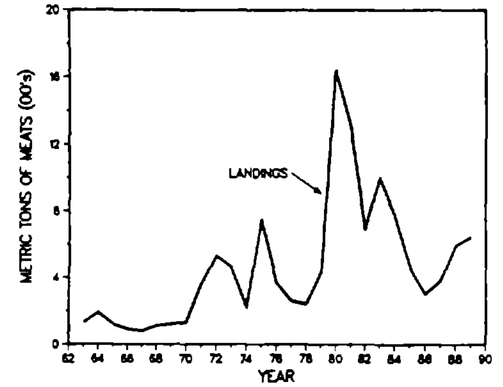
Total nominal catch in 1989 was 8,300 mt, 27 percent higher than in 1988, and the second highest annual total ever. More than half (56 percent) of the 1989 total USA sea scallop catch was taken from the Mid-Atlantic area. Most of the Mid-Atlantic catch (71 percent) was from the New York Bight region where landings reached a record-high level in 1989 (5,900 mt). In the more southerly scallop regions (Delmarva and Virginia/North Carolina), landings declined by 20 percent from 1988; the 1989 catch levels, however, were still relatively high (2,100 mt in Delmarva; 300 mt in Virginia/North Carolina).

Fishing effort in the Mid-Atlantic area increased 25 percent in 1989 and attained a new record high. Increased fishing activity occurred in all tonnage class categories, particularly in the large vessel fleet (Class 4: 150 to 500 grt) where effort expanded by 35 percent to an all time high. Despite the record high effort, CPUE in the Mid-Atlantic fishery increased in 1989 (+4 percent) and was the second highest observed since 1979.

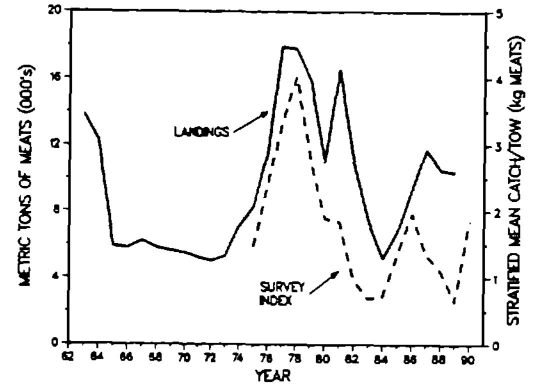
Abundance and biomass indices for the 1990 U.S. sea scallop survey in the Mid-Atlantic area remain at high levels. In the Virginia-North Carolina and New York Bight regions, scallop abundance is at or near record high



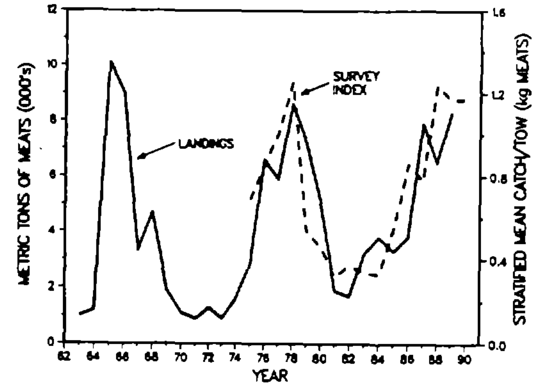
Sea Scallops



Gulf of Maine



Georges Bank



Mid-Atlantic

Table 33.1 Recreational catches and commercial landings (1,000 mt, meat weight)

	Year									
Category	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Recreational										
USA	-	-	-	-	-	-	-	-	-	-
Commercial										
Gulf of Maine										
USA	1.6	1.3	0.7	0.9	0.7	0.4	0.3	0.4	0.5	0.6
Canada	<0.1	<0.1	<0.1	0.1	0.1	<0.1	<0.1	<0.1	0.1	0.0
Total	1.6	1.3	0.7	1.0	0.8	0.5	0.3	0.4	0.6	0.6
Georges Bank										
USA[1]	5.8	8.5	6.7	4.6	3.2	3.0	4.6	4.9	6.1	5.8
Canada	5.2	8.0	4.3	2.8	2.0	3.8	4.7	6.8	4.4	4.7
Total	11.0	16.5	11.0	7.4	5.2	6.1	9.3	11.7	10.5	10.5
Mid-Atlantic										
USA	5.1	1.9	1.7	3.2	3.8	3.3	3.8	7.9	6.5	8.3
Total nominal catch	17.7	19.7	13.4	11.6	9.8	10.6	13.4	20.0	17.6	19.4

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

levels, however, declines in abundance and biomass were observed in the Delmarva region. The recruitment pattern of above average year classes throughout the area during 1982-85, culminating in the exceptional 1986 year class, is followed by a regionally variable 1987 year class. 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 percent 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 1989 level (8,000 mt) through 1991, well above the estimate of long-term potential catch.

For further information

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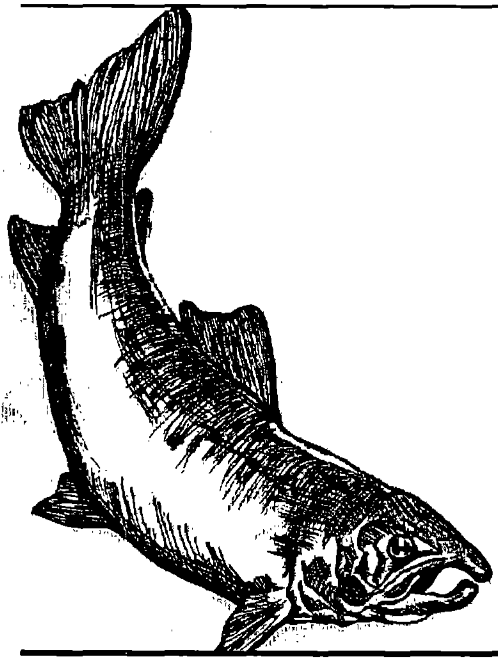
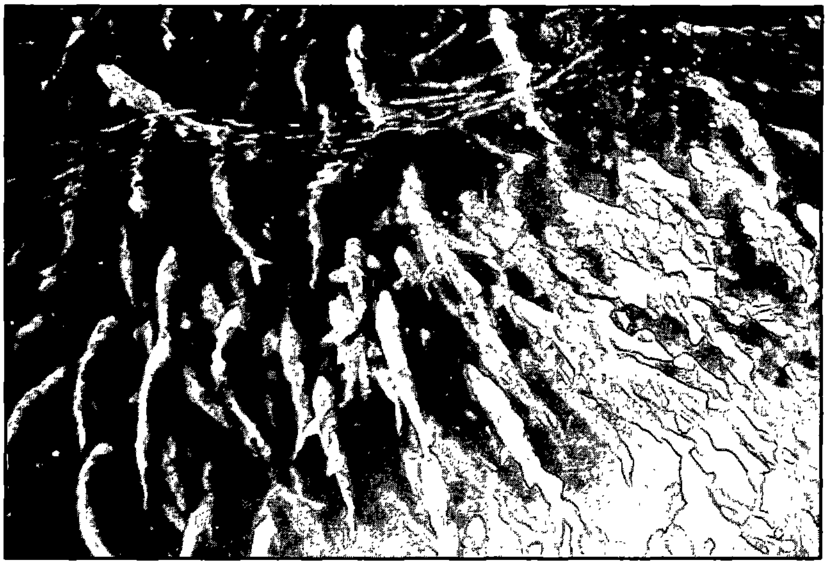
34. ATLANTIC SALMON





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, in the United States. As a consequence of industrial and agricultural development, most of the runs native to New England have been expatriated. Today, the only self-supporting runs in the United States are those in 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 reach sufficient size (greater than 16 cm or 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 U.S. salmon return

Atlantic Salmon

Long-term potential catch = Unknown
Importance of recreational fishery = Major
Management = State regulation, FMP, NASCO Treaty
Status of exploitation = Overexploited
Age at 50% maturity = 2 sea yrs
Size at 50% maturity = 71.0 cm (28.0 in.)
Assessment level = Modified VPA

M = .12 $F_{0.1}$ = Unknown F_{max} = Unknown F_{1988} = 0.9

to spawn. Three sea-winter and repeat spawning salmon life history patterns do occur in New England stocks.

Home water fisheries are limited to an angling fishery in Maine only. Angler kills averaged 430 in recent years, which represents approximately 10 percent exploitation of the run to Maine rivers. Management authority for Atlantic salmon in U.S. 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 U.S. stocks. Harvest estimates based on Carlin tag returns put exploitation of the U.S. 1 sea-winter stock component at approximately 60 percent in recent years and at approximately 80 percent 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 has been managed with a series of time-area closures, but during the 1990 fishing season the largest component of the fishery, the Newfoundland-Labrador fishery, was placed under a quota system.

For further information

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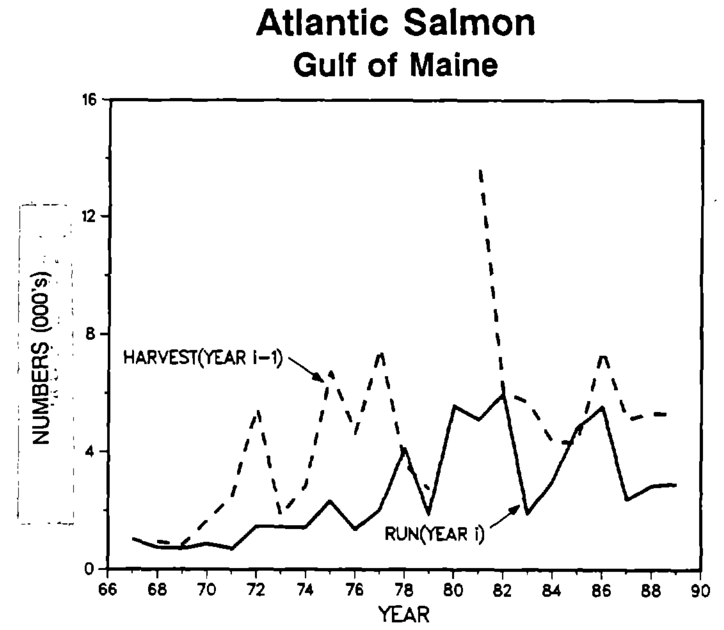

Table 34.1 Recreational catches and commercial landings (numbers)

	Year									
Category	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
Recreational										
USA	1,323	1,141	1,214	342	600	566	563	282	259	482
Commercial[1]										
USA	-	-	-	-	-	-	-	-	-	-
Canada	92,14	2,274	3,172	3,378	2,644	4,548	1,066	1,167	785	N/A
Greenland	4,401	3,803	2,547	970	1,689	2,936	4,070	4,171	4,522	N/A

---

[1] **Carlin tag harvest estimates.**

Common Name Index

A

- Alewife 98
- American lobster 112
- American plaice 69
- American shad 108
- Atlantic cod 45
- Atlantic herring 89
- Atlantic mackerel 92
- Atlantic salmon 126
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- Black sea bass 79
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- Blueback herring 98
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- Butterfish 94

C

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D

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F

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G

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H

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