OUR LIVING OCEANS

REPORT ON THE STATUS OF U.S. LIVING MARINE RESOURCES, 1992

UNITED STATES
DEPARTMENT
OF COMMERCE

OUR LIVING OCEANS

REPORT ON THE STATUS OF U.S. LIVING MARINE RESOURCES, 1992

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U.S. DEPARTMENT OF COMMERCE

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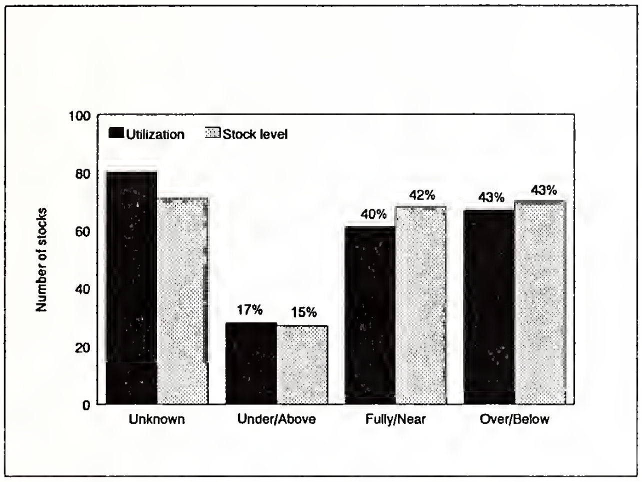
Errata
Our Living Oceans, 1992

P. 4 (column 1, line 6)
"Fishery Management **Council's**" should read "Fishery Management **Councils.**"

P. 12 (Figure 5)
should show the following percentages:



P. 17 (column 1, first paragraph under heading "Management Concerns")
"**30%** of all stocks and **45%** of the stocks where status is known" should read "**28%** of all stocks and **43%** of the stocks where status is known."

P. 20 (column 1, first sentence under heading "Scientific Information and Adequacy of Assessments")
"**33%**" should read "**34%.**"

P. 39 (column 1, first paragraph under heading "Bycatch and Multispecies Interactions")
"**range** of resources" should read "**diversity** of resources."

P. 41 (Table 2-1, footnote 4)
"**47%**" should read "**42%**" of the RAY.

P. 42 (column 1, lines 2-5)
should read **"Present commercial landings are well below CPY's. For the complex of stocks, CPY's exceed RAY's by 284% (473,500 t)."**

P. 47 (column 1, 5 lines from bottom)
"fishing rates **resulting in** maximum cohort yields" should read "fishing rates **that provide for** maximum cohort yields."

P. 49 (column 2, last four lines)
should read **"regulations control the length of the harvesting season (December to May) and harvest gear."**

P. 57 (column 2, 9 lines from the bottom)
"**53%**" should read "**58%.**"

P. 58 (column 1, line 1)
"**25%**" should read "**27%.**"

P. 64 (column 1, line 9)
"A classic example **it** the popularity of 'blackened redfish'" should read "A classic example **is** the popularity of 'blackened redfish.'"

P. 64 (column 2, second paragraph, line 5)
"adult population increases in **size**" should read "adult population increases in **population abundance**."

P. 66 (column 2, line 6)
"briefly during the spring of **1988**" should read "briefly during the spring of **1989**."

P. 85 (column 2, lines 5-8)
"Its ex-vessel value was **$95** million" should read "Its ex-vessel value was **$101** million."
"The important species harvested were Pacific whiting (**290,600** t valued at **$94.5** million)" should read "The important species harvested were Pacific whiting (**210,400** t valued at **$32.1** million)."

P. 118 (column 1, paragraph under heading "Harbor Porpoise")
should begin **"The northwestern Atlantic harbor porpoise is found from Newfoundland to Florida."**

P. 146 (column 1, lines 8-9)
"***Chionecetes** bairdi, **Chionecetes** opilio*" should read "***Chionoecetes** bairdi, **Chionoecetes** opilio.*"

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PREFACE

This second annual status review of U.S. living marine resources updates and augments the 1991 edition. It provides a scientific overview of the health of the nation's marine fisheries as well as protected marine mammals and sea turtles. These national resources are under the stewardship of the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS). This report draws together, for the public, results from the extensive scientific programs of NMFS aimed at evaluating and monitoring our living marine resources. The management of these resources is described and outstanding issues and recent progress are highlighted. Over 60 NMFS scientists and staff (Appendix 1) assisted in the preparation of this edition of "Our Living Oceans."

Part 1: OVERVIEW

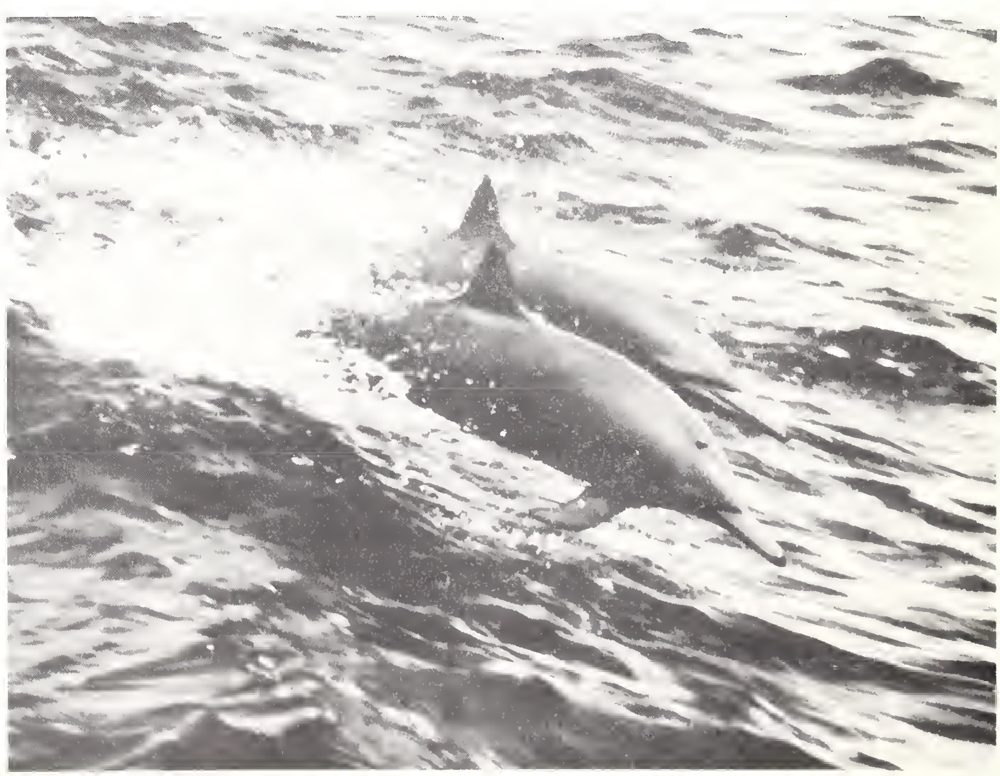
OUR LIVING MARINE RESOURCES

The living marine resources (LMR's) of the United States are an extremely valuable heritage. In 1991, U.S. commercial fisheries produced $3.9 billion in revenue to fishermen at U.S. ports, with a total (i.e., direct, indirect, and induced) impact on the GNP of more than $50 billion. In addition, 17 million American anglers enjoy saltwater fishing each year and catch more than 230 million fish. Also, there are economic benefits from subsistence fishing, aquaculture, and recreational viewing (e.g., whale watching) industries, as well as the intangible assets accruing from the protection and recovery of depleted stocks of marine mammals, sea turtles, and other threatened and endangered species.

The responsibilities of the National Marine Fisheries Service are primarily set out in three major pieces of legislation: 1) The Magnuson Fisheries Conservation and Management Act (MFCMA) for the fisheries resources in the 200-mile U.S. Exclusive Economic Zone (EEZ), 2) the Marine Mammal Protection Act (MMPA) for monitoring, protection, and management of marine mammal stocks in U.S. waters, and 3) the Endangered Species Act (ESA) for monitoring and protection of marine life considered to be at risk of extinction. Each of these laws has a primary requirement that the best scientific information be used as the basis for management actions. NMFS takes a leading role in the collection and analysis of scientific data on living marine resources. The Agency prepares hundreds of specialized scientific reports each year along with numerous presentations by scientific staff to managers, industry groups, and the public.

This report provides a broad overview of this large body of technical work. It considers most living marine resources of interest to the U.S. (either harvested partially or totally by the U.S. or present in the U.S. EEZ for a portion of their life). As in last year's edition, the status of each resource is evaluated and current and potential harvest levels are given, along with information on current management controls.

The MFCMA contains seven national standards for the development of Fishery Management Plans (FMP's). In brief, conservation and management measures shall 1) prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery, 2) be based on the best scientific information, 3) manage stocks of fish as a unit and coordinate management of interrelated stocks, 4) not discriminate between residents of different



Spinner dolphin

... OUR LIVING MARINE RESOURCES

states and allocate fishing privileges fairly, 5) promote efficiency in resource utilization, 6) allow for variations between fisheries, and 7) minimize costs and unnecessary duplication. In addition, the MFCMA established eight regional Fishery Management Council's (Councils) which are partners with NMFS in the preparation of FMP's. The Councils and their FMP's are listed in Appendix 2.

This report is organized in three major sections which contain some new features. The first section contains a national overview of the status of our living marine resources. It includes this Introduction, a brief discussion of scientific principles and terms, region by region resource summaries, an overview of issues of national concern effecting all regions, and a discussion of progress made during the last year in scientific information and resource management. Section one also includes two "spotlight articles"; essays on important topics affecting fisheries and the marine environment. This year, these spotlights examine the El Niño climatic/oceanographic phenomenon and the incidental capture of animals not specifically targeted by fishermen.

The second section reviews in greater detail the status of our living marine resources in 24 separate units. These unit synopses describe species or groups linked geographically, ecologically, and by characteristics of their harvesting operations. Appendices, the third section, list contributing authors and editors, the Councils, FMP's, recent FMP amendments, and the scientific and common names of the species covered in this report.

INTRODUCTION

A POPULATION IS a group of animals that are genetically related owing to interbreeding. Ideally, populations should be considered distinct groups for fishery management purposes. But it is difficult to determine which individuals of a species form a population, and it may not be practical to manage them as a population. Thus, this report uses the term "population" to identify interbreeding biological groups. The term "stock" is used to identify groups of animals for management purposes.

Much of the information in this report comes from the scientific analysis of fisheries data to develop **stock assessments**. In general terms, a stock assessment is an estimation of the amount or abundance of the resource, the rate at which it is being removed due to harvesting and other causes, and one or more reference levels of harvesting rate and/or abundance at which the stock can maintain itself in the long-term. Such assessments often also contain short-term (1 to 5 years, typically) projections or prognoses for the stock under a number of different management scenarios. This information on resource status is used by policy makers and managers to determine what actions are needed to promote the best use of marine resources.

Stock assessment analyses rely on various sources of information to estimate resource abundance and population trends. The principal information comes from the commercial and recreational harvests themselves. The amount of fish removed from the stock, the individual sizes of the fish caught and their biological characteristics (e.g., age, maturity, sex), and how much fish was caught per unit of time spent fishing, for example, are the basic data for stock assessments. In addition, NMFS conducts dozens of resource surveys with specialized research vessels or chartered fishing vessels every year. These surveys, which are sometimes done in cooperation with state marine resource agencies, universities, international scientific organizations or even with the fisheries agencies of other nations, produce an index of the resource abundance. Research surveys are very different from commercial fishing operations. While commercial operations seek out the greatest concentrations of fish and focus on them to obtain the largest or most valuable catch, research surveys fish in a uniform way over a wide range of stations within the waters inhabited by the stock to provide a consistent population abundance and distribution index year after year. The survey data is then used in conjunction with commercial and recreational catch data to assess the resource. The final critical type of data used in the assessments comes from studies on the basic biology of the animals of the sea. Understanding the natural history of the harvested species and other species with which they interact is crucial to understanding resource status.

Fish abundance or population size can be expressed as either the number of fish or the total fish weight (or "biomass"). Increases in the amount of fish are determined by body growth of the individual fish in the stock and the addition or **recruitment** of new generations of young fish (i.e., "recruits") to the population. Those gains must then be balanced against removals from the population by harvesting (called **fishing mortality**) and other removals due to predation, starvation, disease, habitat loss, and pollution (called **natural mortality**). In stock assessment work, fish removals are commonly expressed in terms of rates within a time period. The fishing mortality

Skipjack tuna

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rate is a function of **fishing effort** (the amount of fishing gear and the time spent fishing).

Surplus production (or just "production") is the weight (biomass) of fish that can be removed by fishing without causing a change in population size. It is calculated as the sum of the growth in weight of individuals in a population, plus the addition of biomass from new recruits, minus the biomass of animals lost to natural mortality.

The **production rate** is expressed as a proportion of the population size or biomass. The production rate is highly variable owing to environmental fluctuations, predation, and other biological interactions with other populations. On average, production decreases at low and high population sizes. Thus, surplus production tends to be low at the extremes of population size (i.e., where biomass or production rate is low). It is more likely to be high at some intermediate level of population biomass. But, on average, biomass decreases as the amount of fishing effort increases. This means there is a relationship between average production and fishing effort. The relationship is known as the **production function**. A hypothetical production function is shown in Figure 1. Production functions are the basis for two important terms used in this report: **Long-term Potential Yield** (LTPY) and **Current Potential Yield** (CPY). In addition, **Recent Average Yield** (RAY) and **Stock Level** are measures of the current status of the resource.

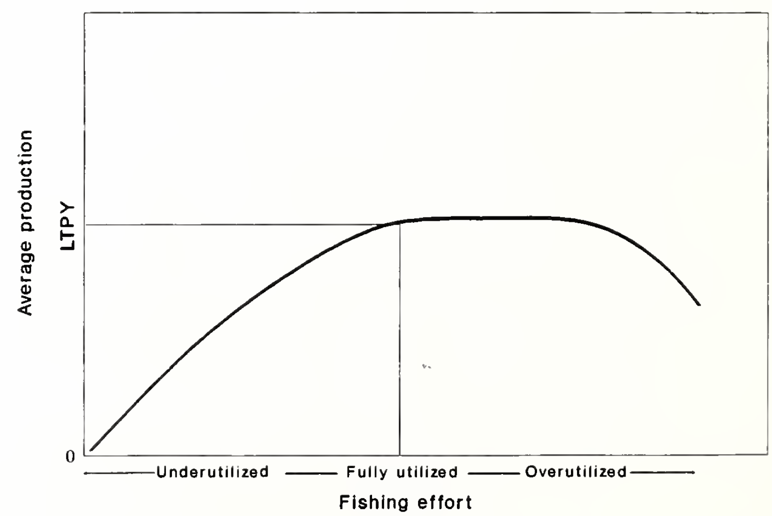


Figure 1.–Hypothetical production function. In this case, the function has a flat region where average production is insensitive to the amount of fishing effort. This occurs for many populations when the effect of growth and natural mortality on production are almost in balance. But eventually excess fishing effort reduces the size of the population to the point where production and recruitment declines precipitously.

LONG-TERM POTENTIAL YIELD (LTPY)

LTPY is the maximum long-term average yield (catch) that can be achieved through conscientious stewardship, by controlling the fishing mortality rate to maintain the population at a size that would produce a high average yield or harvest over the long-term. LTPY is difficult to estimate. Nevertheless, NMFS scientists have used their best professional judgment to provide estimates whenever possible.

CURRENT POTENTIAL YIELD (CPY)

The yield or catch that can be taken at present depends on the current abundance of fish and the current production rate. This yield may be either greater than or less than LTPY, and this report uses the term "current potential yield." CPY is the yield that will maintain the current population level (biomass) or, for overutilized stocks, stimulate a trend toward the recovery of a population that will produce the LTPY. For underutilized stocks at high biomass levels, the CPY may be larger than the LTPY.

. . . CURRENT POTENTIAL YIELD (CPY)

This large catch would not be sustainable in the long run, but would bring the stock down to the level supporting LTPY. CPY is usually estimated by applying the fishing mortality rate associated with LTPY to the current population size. CPY is also difficult to estimate, but NMFS scientists have used their best professional judgment here as well.

RECENT AVERAGE YIELD (RAY)

To document the actual fish catches, this report employs the term "recent average yield." This is the reported fishery landings averaged for the 3-year period, 1989-91.

STOCK LEVEL

Production can be expressed in terms of fishing effort or biomass as noted above. To further clarify resource status, the stock level (i.e., abundance) in 1991 is compared with the long-term average level (the level of abundance which would support the LTPY). This is expressed as near, below, or above average. In some cases, heavy fishing in the past reduced a stock to a low level, and even if it is currently only lightly harvested, it may take many years for the stock to rebuild.

EVALUATING FISHERY RESOURCE LEVELS

To evaluate the level of use of a fishery resource (i.e., underutilized, overutilized, or fully utilized) we must see how the existing fishing effort compares with the effort necessary to achieve LTPY. To do this, it is useful to compare CPY with LTPY and to compare RAY and stock level with both.

In this report, a fishery resource is defined as **fully utilized** when the amount of fishing effort used is about equal to the effort needed to achieve LTPY. For fully utilized fisheries, the RAY and CPY are usually about equal. In most cases, LTPY and CPY are also about equal, but they may differ as a result of production variability. Stock level should be near the long-term average level for the CPY to approach the LPTY (e.g., most Bering Sea groundfish stocks, in Unit 19).

RAY = CPY = LTPY

A fishery resource is considered **overutilized** when more fishing effort is used than is necessary to achieve LTPY. When RAY is greater than CPY, and CPY is less than LTPY, overutilization is indicated. If stock level is near the long-term average, RAY may be greater than LTPY for an overutilized stock, implying that recent landings levels can not be sustained (e.g., Atlantic cod in Unit 1). If stock level is below average, RAY will likely be less than LTPY (e.g., Gulf red snapper in Unit 8). Additionally, it is possible for RAY, CPY, and LTPY to be about equal while the fishery resource is overutilized (e.g., Gulf shrimp in Unit 11). This occurs when reducing fishing effort would have little effect on the catch. In such cases, overutilization may not have an apparent adverse effect on production, but it further reduces the size of the population, and it wastes effort and economic resources.

A fishery resource is termed **underutilized** when more effort is required to achieve LTPY. This situation is generally indicated when RAY is less than CPY and CPY is greater than LTPY while stock level is high (e.g., Atlantic mackerel in Unit 2). But there may be exceptions. For example, RAY may be held below CPY and LTPY by management to compensate for uncertainty in population estimates.

These are the major factors NMFS considers in determining the degree of utilization of a resource, but they do not give a complete picture. In cases where knowledge about the stock is incomplete or when comparing LTPY, CPY, RAY, and stock level gives ambiguous results, the classification of a fishery's status is based on the best scientific judgment of NMFS staff who conduct research on the stock in question.

This report serves as only one information source on the status of LMR's. Another source is the assessments made with respect to the guidelines set under the Magnuson Act that require FMP's to define "overfishing" in a measurable way. MFCMA guidelines allow considerable flexibility in the formulation of FMP overfishing definitions. Annual evaluations will determine if fishery resources are overfished according to these definitions. Determinations of the degree of utilization reported in

. . . EVALUATING FISHERY RESOURCE LEVELS

this document are an attempt to standardize the classification across regions and fisheries. The terms "overutilization" as used in this document and "overfishing" as used to fulfill Magnuson Act requirements are not interchangeable.

This document also reports on marine mammals and sea turtles that are protected under the Marine Mammal Protection Act (MMPA) and/or the Endangered Species Act (ESA). The same scientific principles apply to the population dynamics of these protected species, but the terminology of underutilized, fully utilized, and overutilized does not apply. Instead, marine mammals are referred to as **depleted** when their population size is below the level of **maximum net production** (i.e., analogous to LTPY for a fishery resource). This is often referred to as their "**optimum sustainable population level**" (in the MMPA this is defined as a population size between the largest supportable within the ecosystem and the level where productivity is at a maximum, i.e., to the right of the maximum on Fig. 1). Protected marine mammals and turtles may also be classified as "threatened" or "endangered" under the ESA. A species is considered threatened if it is likely to become an endangered species in the foreseeable future throughout a significant portion of its range. A species is considered endangered if it is in danger of extinction throughout a significant portion of its range. In addition to marine mammals and turtles, several Pacific salmon stocks are now listed as threatened or endangered under the ESA (e.g., Sacramento River winter run chinook are threatened and Snake River sockeye are endangered: Unit 12).

NATIONAL OVERVIEW: STATUS AND POTENTIAL OF U.S. LIVING MARINE RESOURCES

INTRODUCTION

The LTPY of all fishery resources fished by the U.S. (Table 1) is estimated at 9.5 million metric tons (t). This is a slight increase over the 1991 estimated LTPY due to revised 1992 estimates and corrections from the previous report. The Food and Agriculture Organization of the United Nations (FAO) estimates the limit of the world's annually sustainable yield of marine and freshwater fish is about 100 million t. Therefore, the long-term potential marine fish harvest from fisheries involving the U.S. is about 9.5% of the total world potential. Note, however, that some of this potential yield is shared with neighboring countries and high-seas fishing nations, and would not accrue solely to the U.S.

LTPY cannot simply be divided between U.S. and foreign fisheries because as abundance changes, the U.S. share may change disproportionately. However, if the LTPY was prorated between the U.S. and foreign countries based on recent shares of the yield, the "prorated U.S. LTPY" would be about 7.7 million t, or 81% of the total LTPY. Most of the difference is in Pacific and Atlantic highly migratory pelagics (Units 5 and 18).

The geographical distribution of the potential yield (Appendix 4) shows that the Alaska region dominates in terms of the tonnage that could be obtained in the long term (Fig. 2). The picture is somewhat different in terms of the total potential value of the fisheries (both foreign and domestic) due to the difference in prices among different species. Figure 2 indicates the long-term potential value, assuming that the current commercial price at first sale would be maintained if yields were adjusted to their LTPY's. The total value across all regions is $6.5 billion. Note again, however, that several important stocks are transboundary and this value is shared with other fishing nations. The Northeast region has the highest valued resources in

Table 1.—Recent average, current potential, and long-term potential yields of U.S. LMR's in metric tons (t). LTPY and CPY are reported for the entire stock inside and outside U.S. waters. RAY is given for the entire stock. For several units that have a particularly significant non-U.S. harvest, the U.S. share of the RAY is given in parentheses.

Unit and fishery	LTPY	CPY	RAY	(U.S. share)
1. Northeast demersal[1]	533,500	408,000	225,421	(170,221)
2. Northeast pelagic[1]	470,000	640,000	166,600	(130,500)
3. Atlantic anadromous	3,773	3,773	3,773	
4. Northeast invertebrate[1]	100,200	104,700	105,300	(100,000)
5. Atlantic highly migratory pelagic[1]	271,939	252,625	226,980	(16,512)
6. Atlantic sharks	9,730	7,630	9,530	
7. Atlantic coastal migratory pelagic	27,374	18,837	15,838	
8. Atlantic/Gulf of Mexico/Caribbean reef fish	41,404[2]	28,065[3]	35,186	
9. Southeast drum and croaker	75,934[2]	25,808[3]	25,808	
10. Southeast menhaden and butterfish	1,166,500	946,500	939,586	
11. Southeast/Caribbean invertebrate	126,632	120,025	126,960	
12. Pacific coast salmon	51,493[4]	51,493[4]	43,360[4]	
13. Alaska salmon	278,226	278,226	318,104	
14. Pacific coast and Alaska pelagic	543,100	231,100	120,400	
15. Pacific coast groundfish[1]	361,638	386,938	381,538	(288,538)
16. Western Pacific invertebrate	560	407	395	
17. Western Pacific bottomfish and armorhead	2,812	819	558	
18. Pacific highly migratory pelagic[1]	1,649,928	1,569,261	1,601,261	(430,061)
19. Alaska groundfish (total)	3,432,098	3,463,459	1,903,324	
Eastern Bering Sea	2,998,685	2,773,355	1,661,766	
Gulf of Alaska	413,413	656,604	202,308	
Pacific halibut (less Canada)	20,000	33,500	39,250	
20. Alaska shellfish	111,638	123,821	123,821	
21. Nearshore	225,185	225,185	225,185	
Total	9,483,664	8,886,672	6,598,928	(5,027,660)
Percent of LTPY		93.7%	69.6%	

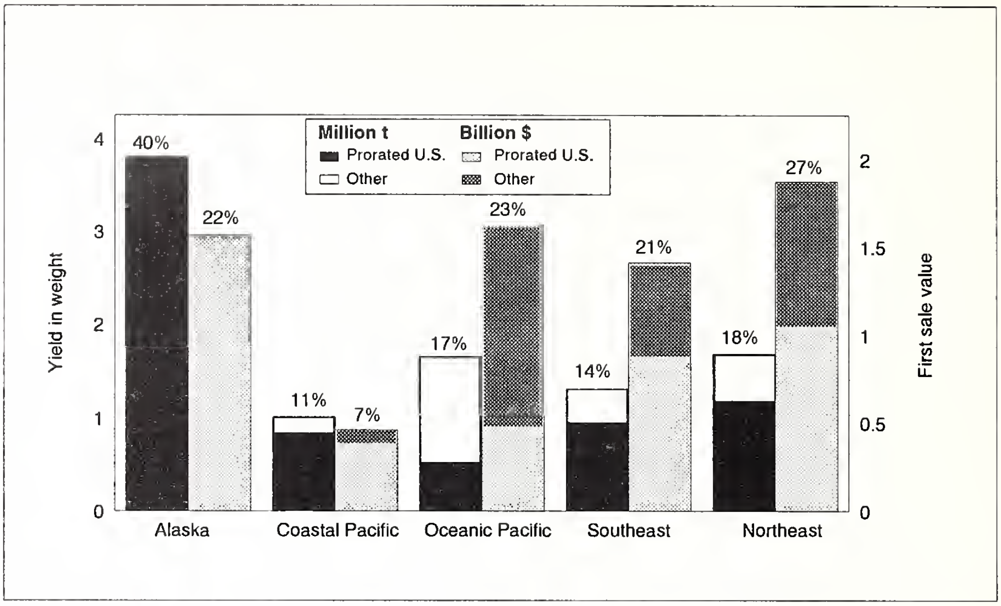
[1]Includes some transboundary stocks so LTPY may not accrue solely to the U.S. RAY reported for U.S. landings only in parentheses.

[2]Underestimate.

[3]Overestimate.

[4]Approximate yield in weight, using average fish weight in commerical catch. Catch reported in numbers. See Unit report.

Figure 2.—Long-term potential yield and value by region. Figures at the top of each bar are the percent of the total yield or value. Information is provided for entire fishery units, along with the prorated U.S. shares.



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terms of average price times the LTPY, but the Alaska region has the highest prorated U.S. value (Fig. 2). Note that this analysis of the value of fisheries does not include the value of recreational uses of marine resources or their importance in the local economy. The prorated U.S. LTPY and prorated long-term potential value are also shown in Figure 2. The transboundary nature of the valuable highly migratory pelagic species in the Atlantic and Pacific are indicated by the large shares taken outside U.S. waters by other nations.

Bottom dwelling "groundfish" make up 48% of the total LTPY, while highly migratory and coastal pelagic species constitute 43%. The remaining 9% is almost equally divided between anadromous and nearshore finfishes and the invertebrate fishery resources. Three fishery units—Alaska groundfish (Unit 19), Pacific tunas and billfish (Unit 18), and Southeast menhaden and butterfish (Unit 10)—account for 66%, or 6.2 million t of the LTPY.

The estimate of the total current potential yield for the fishery resources from fisheries involving the U.S. is 94% of the LTPY. There are, however, important differences among regions, units, and individual stocks. For example, LTPY exceeds CPY by 30% or more for New England groundfish (Unit 1), Atlantic coastal pelagics (Unit 7), southeast drums and reef fish (Units 8 and 9), and Pacific coast pelagics (Unit 14). This indicates that some of the stocks in these units are at low levels and will need to be rebuilt before their potential can be realized. CPY exceeds LTPY by substantial amounts for northeast pelagics (Unit 2) and some Gulf of Alaska groundfish (Unit 19), indicating that those stocks are currently above the level which would result in LTPY. For the other units, CPY and LTPY are similar.

The total RAY, including recreationally caught fish and those from transboundary stocks landed by other nations, is 6.6 million t. The U.S. RAY is about 5.0 million t. This is higher than the catch reported in the NMFS publication "Fisheries of the United States." Some landings information collected by scientists and included here may be unreported in "Fisheries of the United States." RAY (combined commercial and recreational fisheries) for the fisheries involving the U.S. is a little more than 6% of the recent world catch. In recent years, the United States has ranked about fifth or sixth among major fishing nations, following the former USSR, China, Japan, and Peru and/or Chile.

The recreational finfish catch on the Atlantic and Gulf coasts was estimated at 234 million fish, or 65,000 t, in 1990; for the west coast it was estimated at 41 million fish, or 13,000 t, for 1989 (the last year for which data are available). This catch total is exclusive of Pacific salmon,

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which historically has composed about 2% of the entire west coast recreational catch. Total RAY for all units is 70% of the total LTPY (Table 1). The total U.S. share of the RAY (5 million t) is about 65% of the "prorated U.S. LTPY." The primary requirement for increasing the yield to the LTPY is to rebuild stocks that have been overutilized. Figure 3 summarizes the status of utilization and stock level for all stocks by region. Figure 4 shows, by region, the stock levels relative to the level needed to support LTPY. Across all regions combined, for those stocks where the status is known, 45% are overutilized and 43% are below the stock level necessary to support LTPY (Fig. 5). Rebuilding these stocks would bring the RAY substantially closer to the LTPY.

There are also many cases of fully utilized stocks (37% where status is known) where stock abundance is near the level that produces LTPY (41% where the level is known; Fig. 5). These stocks need to be maintained in healthy condition. The underutilized stocks currently at a high stock level (18% underutilized, 16% above level needed for LTPY where known; Fig. 5), need to be fished harder to produce their long term potential. But, several factors should be considered when increasing fishing pressure on these underutilized stocks:

1) Estimates of LTPY and CPY are sometimes imprecise; therefore, harvest levels may be set conservatively to reduce the risk of depleting fishery resources (e.g., Alaska's walleye pollock, Unit 19).

2) Increasing the yield will result in a reduction in abundance, catch rates, and size of fish, which may adversely affect some users of the resource (e.g., anglers who desire a high catch rate and/or large fish).

3) There are limited markets for increased landings of several species for which RAY is less than CPY and LTPY (e.g., dogfish off New England and arrowtooth flounder off Alaska).

Brief regional summaries of potential yields and the status of fisheries resources, as well as marine mammals and sea turtles, are given below.

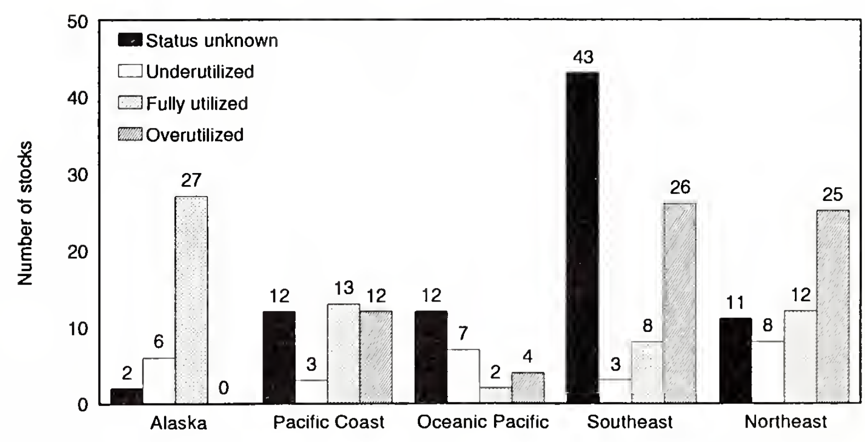


Figure 3.—Utilization of U.S. living marine resources by region. Numbers at the top of each bar indicate the number of stocks in that category.

NORTHEAST U.S. LMR'S

The fisheries of the northeast region annually contribute about 25% of the value and 13% of the volume of the Nation's commercial fisheries. In 1991, the total northeast landings were 753,000 t, valued at $857 million. The "mixed groundfish" category is the most valuable component of the commercial fishery ($178 million), followed by American lobster ($151 million) and Atlantic sea scallop ($147 million). Marine sport angling is extremely important and contributes an estimated

Figure 4.—Stock levels relative to the level needed to support LTPY. The numbers at the top of each bar are the number of stocks in that category.

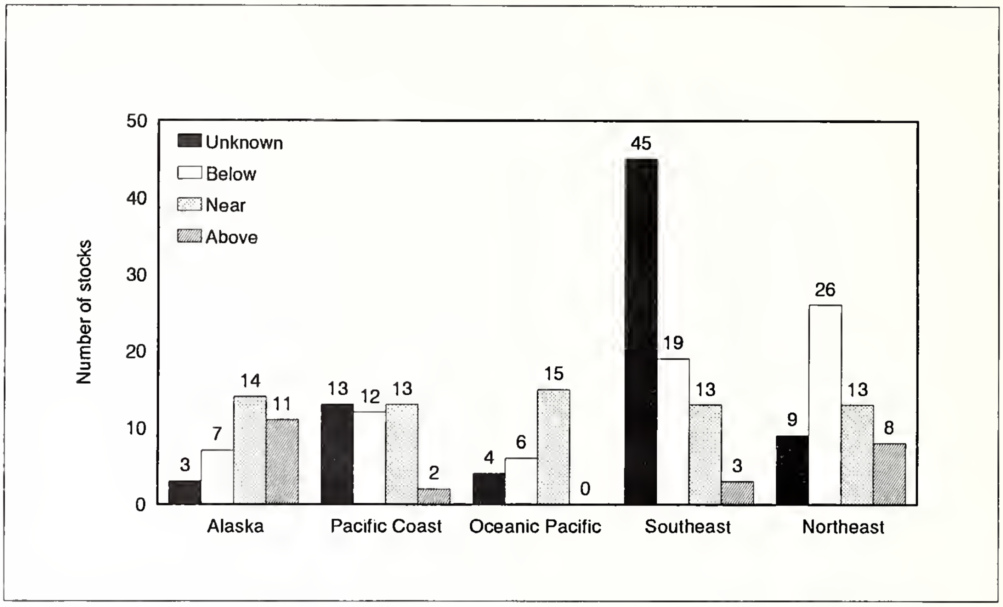
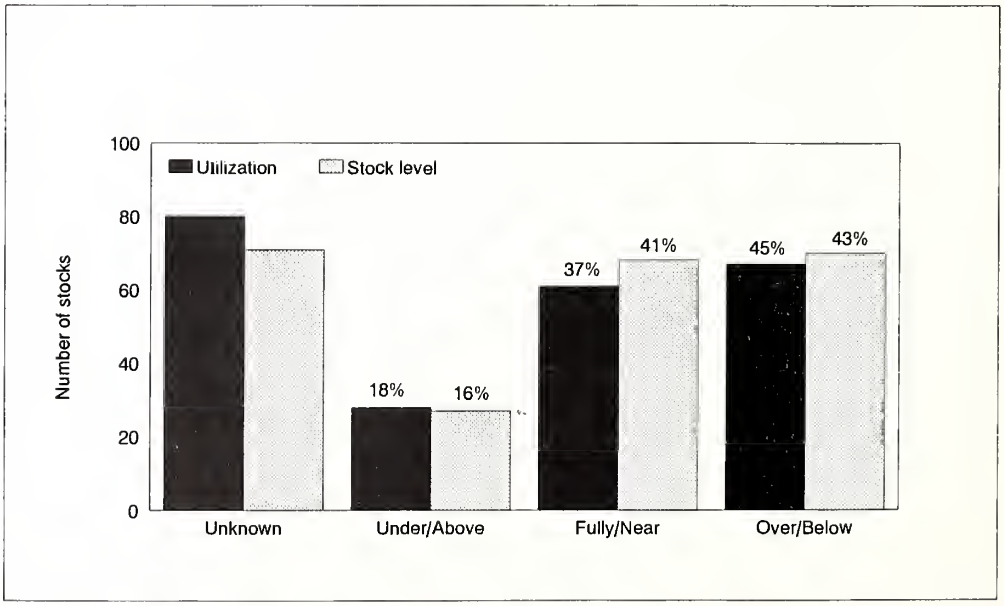


Figure 5.—Status of U.S. living marine resources for all regions combined. Utilization and stock level relative to the level needed to support LTPY are given for all stocks including nearshore resources. The bars represent the number of stocks, and the figures given at the top of each bar are the percent of the stocks for which the status is known in that category of utilization or stock level.



. . . NORTHEAST U.S. LMR'S

$1.5 billion per year to the region's economy.

Northeast finfish and invertebrate fisheries have an estimated LTPY of over 1.68 million t or 18% of the total LTPY. Recent annual landings in this region have totaled only 500,000 t—about 30% of their long-term potential yield. The large discrepancy between recent landings and potential yield results from overutilization of 25 regional stocks (including most groundfish and flounders) and 8 underutilized stocks (including Atlantic mackerel, squids, and butterfish) (Fig. 3). Several important New England stocks are shared with Canada and therefore some of the benefits of rebuilding can be expected to be shared.

SOUTHEAST U.S. LMR'S

The combined LTPY for southeast Atlantic, Gulf of Mexico and Caribbean LMR's is estimated at about 1.3 million t (14% of the total LTPY); recent catches have run about 80% of CPY and 77% of LTPY. Atlantic swordfish and bluefin tuna, many south-

Shortbelly rockfish

. . . SOUTHEAST U.S. LMR'S

east Atlantic snappers and groupers, and Caribbean reef fish have been overutilized, and some stocks are at historically low levels. The status of many other reef fish stocks is unknown, but they are likely to be overutilized as well. Individually, these stocks are minor portions of the catch, but, in aggregate, they have supported important recreational and commercial fisheries. The recreationally and commercially important coastal pelagic species (e.g., mackerels, dolphin fish, and cobia) yield only about 58% of their estimated aggregate LTPY as a result of overutilization. Certain individual stocks are severely depressed (e.g., Gulf of Mexico king mackerel). The impact of Mexican fisheries on these stocks is not well known, but may affect stock rebuilding efforts.

Currently, all commercially important shrimp species are being harvested at the LTPY level, but because these fisheries are overcapitalized, they could produce similar yields with considerably less effort if fishing mortality were reduced. The dominant catches are Gulf of Mexico brown, white, and pink shrimp, which represent 89% of the total national shrimp catch. In 1991, those three species produced a total catch of 104,361 t, valued in excess of $400 million.

WEST COAST AND WESTERN PACIFIC LMR'S

West coast, Pacific-wide, and Pacific island fisheries (Units 12 and 14-18) account for more than 2.6 million t and 28% of the total LTPY. These include salmon, groundfish, and northern anchovy (west coast), tuna and billfish (Pacific-wide), and reef and seamount finfish and lobster (Pacific islands).

On the Pacific coast most of the stocks are fully utilized or overutilized, with only 3 of 40 stocks classified as underutilized (Fig. 3). In the oceanic Pacific, 7 of the 25 stocks are underutilized. Insufficient data exist to assess 24 stocks (37% of the total) in these regions, and as a result they are assigned an "unknown" status. The large biomasses that once existed for most of the long-lived species (sablefish, Dover sole, rockfish) have been fished down to the point where these species are fully utilized and the CPY is very close to the LTPY. Several rockfish stocks need to be rebuilt following overutilization and a period of poor recruitment. Other species, like jack mackerel and shortbelly rockfish, are presently underutilized for lack of markets. The status 12 of the other 18 highly migratory stocks (Unit 18) is unknown.

The total economic value of these resources is conservatively set at $2.0 billion. Of this, Pacific salmon produce commercial landings worth about $140 million to west coast fishermen. Conservatively valuing each recreationally caught salmon at $20.00 gives an

. . . WEST COAST AND WESTERN PACIFIC LMR'S

estimated recreational catch value of over $24 million. The Pacific tuna fisheries are valued at more than $1.3 billion (a large share is non-U.S.), and although no estimate is available for billfishes (owing to the variety of species in this category and a large recreational fishery component), the three principal species (swordfish and blue and striped marlins) are all valued in excess of $2,000/t for both recreational and commercial fisheries. Pacific groundfish commercial landings are valued at about $100 million.

ALASKA LMR'S

The Alaska fisheries have historically focused on salmon, halibut, and crab (Units 13, 19, and 20). With the displacement of foreign distant-water fleets by U.S. vessels, groundfish stocks of the eastern Bering Sea and Gulf of Alaska have become the basis for the largest domestic fish catch by volume and one of the world's largest single-species fisheries (walleye pollock). Conservatively estimated, Alaska's combined LTPY represents more than 40% of the total LTPY. Twenty-seven fisheries (77% of the regional total) are fully utilized; none are considered overutilized (Fig. 3). The 1989-91 RAY is steady at about 2.4 million t, or 61% of the long-term regional potential yield, and is valued at more than $1.1 billion.

The CPY of 3.9 million t is very near the LTPY estimate of 3.8 million t, owing in large measure to the current high abundance and above-average recruitment that have occurred in individual fisheries (principally certain Alaska salmon stocks, Pacific halibut, Pacific cod, and most Bering Sea and Gulf of Alaska flatfish). Owing to the favorable biological health of the resources, the current yield from 6 of the stocks could be increased. This reflects, in part, the North Pacific Fishery Management Council's annual cap on groundfish harvests at 2 million t and bycatch restrictions for nontarget species. The cap provides a margin of safety for eastern Bering Sea groundfish to allow for uncertainty in biological fluctuations.

Alaska salmon stocks have rebounded to record high levels. Catches since 1980 have steadily increased to an all-time record of 189 million salmon landed in 1991. Pacific halibut stocks are in good condition, with CPY and RAY at 168% and 196%, respectively, of the species' long-term yield. Both king and tanner crab have experienced wide recruitment swings and are slowly recovering following population declines during the early 1980's.

U.S. NEARSHORE LMR'S

It is difficult to assess the status of all nearshore species (Unit 21) around the entire U.S. coast because they come under varied management and data collection regimes. No realistic estimates exist for LTPY or CPY because of the diverse nature of these coastal and estuarine species and their fisheries. Management authority is usually a regional, state, and/or local responsibility because most fisheries occur within the 3-mile interior boundary to the Federally controlled EEZ. But, generally, Atlantic oysters, hard and softshell clams, bay scallops, and abalones are overutilized, at least in part of their ranges. Fully utilized resources include Pacific shrimp and clams, Dungeness crab, blue crab, and calico scallop. The status of 20 of the 36 stocks included in this unit cannot be determined from the existing data. The latest RAY is conservatively set at 225,181 t. The commercial value of all nearshore resources is about $376 million, which does not include the substantial recreational component.

MARINE MAMMALS AND SEA TURTLES

The MMPA and ESA require regular status updates for marine mammal and sea turtle populations. The current state of our knowledge allows only 21 of some 82 populations or stocks to be assigned abundance trend estimates (Table 2). The rest are of unknown status (particularly the Atlantic and Pacific dolphin and porpoise stocks).

Marine Mammals

At least thirty-six species of marine mammals (Unit 22) range the western North Atlantic Ocean and the Gulf of Mexico, including 33 species of whales, dolphins, and porpoises, two seal species (harbor and gray seals; a third, the Caribbean monk seal is believed to be extinct), and the West Indian manatee. This report considers 29 stocks, but even simple abundance estimates are known for 18 stocks. Of these, 7 species found off the east coast and Gulf of Mexico are listed as endangered under ESA (i.e., West Indian manatee and sperm, blue, fin, humpback, sei and North Atlantic right whales). Also, following a 1987-1988 mass die-off, there is serious concern about the status of Mid-Atlantic coastal and offshore bottlenose dolphins.

There are far too few data on other stocks to evaluate their status. Abundance trends are known for only 3 Atlantic stocks (Table 2).

At least forty-two marine mammal species (Unit 23) occur in U.S. waters of the eastern North Pacific Ocean and eastern tropical Pacific, including 28 species of whales, dolphins, and porpoises, 11 species of seals and sea lions, walrus, polar bear, and sea otter. Simple abundance estimates are known for 31 species. Of these, 13 species are listed as endangered or threatened under ESA guidelines. Although the data are incomplete, right whales in the eastern North Pacific are at critically low levels; only 5-7 sightings have been made in the past 25 years. The eastern North Pacific or "California" stock of gray whales is believed to have recovered to 21,000 animals, near to or surpassing its historical abundance level. Moreover, south of Alaska some marine mammals have also recovered or are recovering to near historical abundance levels (i.e., California sea lion and the northern elephant seal). As with the Atlantic species, data are insufficient to assess the status of most Pacific whales, dolphins, and porpoises, and abundance trends are known for only 13 stocks (Table 2).

Table 2.—Status and trends of marine mammals and sea turtles.

Unit and stocks	Unknown	Increasing	Decreasing	Stable	ESA/MMPA status[1]
22. Atlantic marine mammals	26	2	0	1	7E
23. Pacific marine mammals	29	8	2	3	10E/2T/1D
24. Sea turtles	6	2	2	1	8E/3T
Total	61	12	4	5	25E/5T/1D
Percent of total	74%	15%	5%	6%	

[1]E = Endangered, T = Threatened, D = Depleted.

Sea Turtles

Six species of sea turtles (Unit 24) regularly spend all or part of their lives off the U.S. Atlantic and Pacific coasts, and in U.S. territorial waters of the Caribbean and western Pacific Ocean: The Kemp's ridley, olive ridley (Pacific only), loggerhead, green, hawksbill, and leatherback. Limited stock assessment data exist for about half of the turtle species in U.S. waters.

Studies of nesting densities, however, provide a partial picture of population trends. The Kemp's ridley population has experienced a major decline since 1947 from an estimated 40,000 nesting females to less than 800 nests per year between 1978 and 1988. Loggerhead nesting populations have declined over the last 20-30 years in the northern portion of their range (e.g., Georgia and South Carolina). On the Atlantic beaches of south Florida, however, loggerheads have not shown a decline, and might even be increasing. Green turtle nestings on Florida beaches are low, but they increased between 1971 and 1989. Leatherbacks nest on beaches of the Virgin Islands and Puerto Rico. Although

. . . Sea Turtles

nesting records are too few to detect trends, their numbers do not appear to be declining.

Kemp's ridleys, leatherbacks, and hawksbills are listed as endangered throughout their ranges; green turtles are endangered in Florida and threatened in all other locations; and loggerheads are listed as threatened throughout their range. Currently all five species are protected under the Endangered Species Act (Table 2).

Hawksbill Turtle

INTRODUCTION

The management of living marine resources is a complex problem involving many biological, economic, social, and political factors. Each region and each fishery discussed in this report, even those that are currently well managed and yielding near their long-term potential for the benefit of the nation, must continually adjust and adapt to a number of factors which can undermine management. Increasing the long term benefits of overutilized and depleted resources requires confronting the issues and management practices which have resulted in overutilization and resource depletion.

In each of the fishery unit reports, major issues affecting the resource and its management are discussed. Although each fishery unit has unique features, there are common issues that are important to many, if not all, units. These issues can be summarized under seven headings: Management Concerns, Bycatch and Multispecies Interactions, Resource Allocation, Jurisdiction and Transboundary Issues, Habitat Concerns, Underutilized Species, Recovery of Protected Species, and Scientific Information and the Adequacy of Assessments. These headings are briefly described below, along with recent progress in addressing these issues.

MANAGEMENT CONCERNS

Ultimately, management must be a concern when a large number of stocks are overutilized or at a level of abundance too low to produce the LTPY. Management is also a concern when the economic performance of fisheries is poor because there are more vessels than required to harvest the available amount of fishery resources (i.e., overcapitalization). Table 3 summarizes the status of utilization for each fishery unit. Some stocks are overutilized in most units (30% of all stocks and 45% of the stocks where status is known; Figure 5). The situation is about the same for stock levels. The list of overutilized and/or stocks below the level required to produce LTPY includes some of the Nations's most valuable fishery resources, such as New England groundfish, Atlantic sea scallops, Gulf shrimp, several pelagic highly migratory stocks (including Atlantic bluefin tuna and swordfish), some Pacific salmon stocks, many nearshore stocks (including some oyster populations, bay scallops, abalones, Pacific striped bass), some rockfish stocks off Alaska, and Alaska king crab.

Many of our fisheries, including both overutilized and fully utilized stocks, are overcapitalized. As generally understood, this means that there are more fishing vessels and gear trying to catch fish than are necessary to harvest the resource efficiently. In effect, this means that the nation may be losing more production of other valuable goods and services than it gains from the fish being harvested by excess capital. Such overcapitalization is a major factor contributing to overutilization of a resource. Where fisheries are overcapitalized and performing poorly economically, short-term economic concerns tend to be given undue weight relative to the steps necessary to achieve the long-term biological and economic potential. The excess capital may maintain pressure to increase catch limits beyond potential yield levels, depleting the resource, and once depleted, preventing its recovery. Many of the other issues discussed in this report are aggravated by overcapitalization. For example, when there is an excess number of boats, fish allocation problems are exacerbated.

Economic theory and experience in most U.S. fisheries and worldwide, indicates that overcapitalization is an inevitable consequence of fisheries management that allows anyone that wants to participate in the fishery to do so. Only recently has U.S. fisheries management begun to control access to fisheries.

Although only discussed as a major problem in a few of the units, economic issues are important in all the fisheries described in this report. Data for evaluating the economic performance of most of our fisheries are scarce. More economic information will be needed to improve management of LMR's. As noted above, the economic performance of fisheries is also a management concern, in addition to concerns about stock level and yield.

Table 3.—Utilization of assessed stocks of U.S. living marine resources.

Unit and fishery	Unknown	Over	Full	Under	Total
1. Northeast demersal	2	15	5	3	25
2. Northeast pelagic			1	5	6
3. Atlantic anadromous	3	1	1		5
4. Northeast invertebrate		2	3		5
5. Atlantic highly migratory pelagic	4	2	3	1	10
6. Atlantic shark	1	1		1	3
7. Atlantic coastal migratory pelagic	3	3		1	7
8. Atlantic/Gulf of Mexico/Caribbean reef fish	17	10	1		28
9. Southeast drum and croaker	4	3			7
10. Southeast menhaden and butterfish		1	2		3
11. Southeast/Caribbean invertebrate	5	8	1		14
12. Pacific coast salmon		5			5
13. Alaska salmon			5		5
14. Pacific coast and Alaska pelagic			4	2	6
15. Pacific coast groundfish	7	2	7	2	18
16. Western Pacific invertebrate			2		2
17. Western Pacific bottomfish and armorhead		2		4	6
18. Pacific highly migratory pelagic	12	2	1	3	18
19. Alaska groundfish	1		17	5	23
20. Alaska shellfish	1		2	1	4
21. Nearshore resources	20	10	6		36
Total	80	67	61	28	236
Percent of total	34%	28%	26%	12%	100%

BYCATCH AND MULTISPECIES INTERACTIONS

The issue of incidental capture of nontarget species and the interactions between species affects most of the units in this report (Table 3). Spotlight article two in this report discusses the general nature of the bycatch problem. The management of many stocks, including the recovery of protected species of marine mammals and sea turtles, can potentially be undermined by bycatch in other fisheries. For example, the recovery of depleted reef fishes in the Gulf of Mexico (Unit 8) may be slowed or prevented by bycatch of young fish by shrimpers. Bycatch issues affect management decisions on the allocation of resources to user groups as well. Groundfish fisheries in Alaska (Unit 19) are now restricted to reduce the bycatch harvest of halibut and crabs incidentally captured in their trawls. Bycatch of marine mammals and sea turtles by commercial fisheries may need to be reduced to promote recovery of these stocks.

Many fisheries, such as the Pacific groundfishery (Unit 15), catch a large number of species on a single fishing trip. Management is complicated because different species are able to withstand different fishing mortality rates. Finding a management scheme which allows full utilization of highly productive species, while protecting low productivity species when they are harvested together, is a major challenge in all parts of the country.

Ecological interactions may also impact management of LMR's. Harvesting one component of an ecosystem may shift the balance towards other, less valuable, species. In the northeast, commercially important groundfish used to dominate the fish biomass but now skates and dogfish make up a much larger share than previously (Unit 1).

RESOURCE ALLOCATION

Allocation of fish between user groups is a difficult socio-economic problem for many fisheries. Conflicts often arise between different sectors of the commercial industry (e.g., inshore and offshore fishermen in the Bering Sea and Gulf of Alaska, Unit 19; longliners and trawlers on the Pacific coast, Unit 15), between commercial fishermen and recreational fishermen (e.g., fisheries for coastal migratory pelagics, Unit 7) and between conservation groups and "ecotourists" and fishermen (e.g., reef fish

. . . RESOURCE ALLOCATION

resources in the southeast). In many cases, economic analysis is needed to guide and justify allocation decisions; in others, social factors may predominate.

At present, it is up to Fishery Management Councils and the Federal government to resolve allocation problems. Often, this amounts to deciding who are the "winners and losers" without objective criteria and/or adequate information. It may be possible to reduce the role of government in allocation decisions by allowing shares in a fishery to be traded (i.e., bought and sold) between participants. This way, participants can assess the value they place on participation (based on monetary and/or non-monetary factors). Market forces will tend to allocate shares in the fishery to those who place the greatest value on participation.

This approach requires that access to the fishery be controlled (see section on management concerns); otherwise the value of everyone's shares will be dissipated by overcapitalization. Individual Transferable Quota (ITQ) management combines controlled access (i.e., must own quota to participate) and trading of shares (i.e., transferability). This method is gaining popularity worldwide, in part, because it reduces overcapitalization and reduces or eliminates the need for the government to make allocation decisions, once initial shares are determined.

JURISDICTION AND TRANSBOUNDARY ISSUES

Many living marine resources are shared with other nations, including our immediate neighbors Canada and Mexico. Other stocks of concern to the United States, like Atlantic salmon, migrate through the waters of other nations such as Greenland (Unit 3). In addition, many stocks straddle the boundaries between state and Federal waters and between state jurisdictions. This means that several management authorities may have responsibilities for management of the same resource including data collection, scientific analysis, and management controls. State, Federal, and international agencies may be involved in management of some resources such as Pacific halibut (Unit 19) or Atlantic highly migratory pelagics (Unit 5). The search for agreement among competing interests and various agencies can slow the management process or undermine it altogether and requires careful coordination and agreement on actions to promote responsible resource use.

HABITAT CONCERNS

The productivity of a living marine resource is a function of the environmental conditions in which the animals live as well as their biological characteristics. If, for example, the quality and/or amount of habitat available to support young fish is reduced, the overall productivity of the stock will decrease and fewer will be available for harvesting. These concerns are particularly important for anadromous species such as salmon (Units 3, 12, 13) and for many of the nearshore species, since our rivers and coastal areas tend to be more affected by pollution and habitat alteration than areas further offshore. For example, shrimp resources (Unit 11) in the southeast are also critically dependent on nearshore habitat during their life cycle. Loss of estuaries and marshes could have major consequences for shrimp fisheries, one of our most valuable marine resources.

UNDERUTILIZED SPECIES

A few large resources, such as pelagic stocks in the Northeast (Unit 2) are currently underutilized. A much larger yield could potentially be obtained from these stocks, but market conditions or the availability of more valuable or accessible alternatives has kept the harvest low. However, underutilized fish stocks may live in the same areas as overutilized stocks. Shifting fishing pressure from one to the other could relieve some pressure from stressed stocks and aid in rebuilding of depleted resources while reducing the adverse impact of a rebuilding period on the industry.

RECOVERY OF PROTECTED SPECIES

A substantial number of our protected marine mammal and turtle stocks are listed as endangered or threatened under the ESA and/or depleted under the MMPA. Developing and implementing management strategies to minimize the adverse impact of human activities on these animals and to encourage their recovery, while not unnecessarily restricting commercial and recreational fisheries, is a major challenge.

SCIENTIFIC INFORMATION AND ADEQUACY OF ASSESSMENTS

The status of utilization is unknown for 33% (Fig. 5, Table 3) of the fish species or species groups considered in this report. The stock level relative to the stock level that would produce LTPY is unknown for 30% (Fig. 5). The trend in abundance is unknown for 74% (Table 2) of the marine mammal and sea turtle stocks. The percentage is higher than was reported last year because this year's report considers more stocks. Even for the stocks included in the table where status or the trend in abundance is known, the information is often imprecise. There are also large gaps in fundamental understanding of the structure and dynamics of LMR populations and the ecosystems of which they are a part.

Many potential benefits from LMR's may not be achievable because of insufficient information. When the status of LMR's is unknown or imprecisely known, it is necessary to harvest them conservatively to guard against accidental depletion. The Gulf of Alaska pollock fishery (Unit 19) is an example of such a cautious strategy. On the other hand, lack of precision in assessments of fishery resources has unfortunately been used in other cases to argue that the evidence of overutilization was not strong enough to justify restricting a fishery. This argument has led to the depletion of many stocks (e.g., most traditional New England groundfish and flounders in Unit 1).

Uncertainty about the relationship between marine mammals and fisheries now threatens both. For example, because they compete for the same resources, it is possible that interactions with Bering Sea fisheries are adversely affecting Steller sea lion populations (Unit 23), but the scientific basis to test this question is inadequate to determine if a cause and effect relationship exists. The outcome of making management decisions without sufficient information could be that, in the case of Steller sea lions, a valuable fishery is unnecessarily restricted to protect the population or, alternatively, that the fishery unknowingly contributes to the depletion of the population.

This is the second annual report on the status of U.S. living marine resources. One purpose of issuing annual reports is to allow comparisons so that progress toward achieving long-term potential benefits can be evaluated. However, since this is a long-term goal, it is not realistic to expect this second annual report to indicate significant quantitative progress relative to last year's report. In fact, most quantitative differences are a result of refinement of estimates and inclusion of additional information. Nevertheless, there were new research and management initiatives during the time period covered by this report that should help improve conservation and wise use of living marine resources. Some of these are discussed below.

Over the last year, some progress has been made with regard to each of the issues described above. A number of changes in management have been enacted, including some 20 amendments to existing fishery management plans (see Appendix 2 for details). New management controls have been developed or are in an advanced stage of discussion for reef fishes in the Southeast (Unit 8), Pacific coastal pelagic stocks (Unit 14), Pacific and Alaska groundfish (Units 15 and 19), western Pacific groundfish and invertebrates (Units 16 and 17) and Northeast ground-fish (Unit 1). Many of these changes are moving towards controlled access systems of management: Restricting the number of participants in the fishery to control fishing mortality and improve economic efficiency. In many cases, moratoria on new entrants into a given fishery are being discussed or have been implemented as a first step in controlling access. In two cases (Units 4 and 8), a system of property rights, through the development of individual transferable quotas (ITQ's) have been implemented and are being monitored for their effectiveness. Under these systems, historical participants in the fishery are granted rights to fish for a portion of each year's set catch limit. They may use this right to harvest, or they may lease or sell it to another fisherman. The fishermen then have a vested interest in conserving the resource for long-term benefit. NMFS commissioned feasibility studies for ITQ systems for Atlantic sea scallops, South Atlantic king and Spanish mackerel, Gulf of Mexico shrimp, and North Pacific groundfish fisheries. These studies were completed in the autumn and are intended to provide NMFS and the Councils with detailed information on one possible management option for our marine resources.

New efforts to address the problem of bycatch have been underway in several regions. Programs of observers on fishing vessels who can collect data on bycatch species have been expanded in the Northeast and Alaska. Regulations to control bycatch of halibut (Unit 19) have been implemented in Alaska and international agreements have been made to reduce the bycatch of Pacific salmon on the high seas. In the Gulf of Mexico, NMFS and the fishing industry have been working together to develop a research plan for addressing the problem of finfish bycatch by shrimpers. The fishing industry, in cooperation with NMFS, has held a bycatch workshop and established a National Bycatch Committee to address the bycatch problem.

In Alaska and in Hawaii, the difficult problem of allocation between sectors of the commercial industry has been addressed in new FMP amendments (see Appendix 2). In both areas, new regulations for the recovery of protected species have been implemented as well.

The protection of endangered Pacific salmon stocks has come to the fore through the invocation of the ESA. NMFS evaluated several petitions to list populations as either threatened or endangered. Recovery plans are being prepared for implementation. Real progress will have been made when these populations have recovered to the point where they are "delisted," but protection under the ESA is a necessary step.

Gray whale stocks in the Pacific, which have been protected under the ESA and MMPA, have substantially recovered to the population level estimated for the mid-1800's. NMFS has proposed their removal from the list of endangered and threatened species. Recovery plans for endangered northern right and humpback whales and for threatened Steller sea lions are being drafted.

Progress has also been made on maintaining productive Alaska fisheries through two new international agreements. These agreements, enacting a two-year moratorium of fishing for pollock in international waters of the Bering Sea and banning high seas driftnet fishing in the North Pacific for vessels which catch salmon, should bolster management for these valuable fisheries.

There have been no major changes in the status of any of the resources described in this report since it was first published in 1991. While progress has been made, the fisheries resources themselves respond slowly. Over the next several years, improved management controls based on improved scientific information should allow the nation to obtain even greater benefits from our living marine resources.

NMFS has developed a "Strategic Plan for the Conservation and Wise Use of America's Living Marine Resources." It addresses the concerns discussed above. The plan is a fundamental departure from the approaches of the past. In particular, it calls for:

1) Risk-averse decisions in the face of uncertainty (i.e., decisions erring on the side of conservation, not resource depletion);

2) Reduction of uncertainty by greatly expanding the scientific information base upon which decisions are based;

3) Controlled access to fisheries to reduce the tendency toward excess fishing capacity, economic waste, conflicts between user groups, and industry pressure to make "risk-prone" decisions;

4) Development of more selective fishing practices to reduce bycatch; and

5) Implementation of a cohesive strategy, built on all applicable legislative authorities, to protect and restore the quality of the environments supporting LMR's.

For the plan to be successful, NMFS will need the cooperation of all those who use and benefit from the ocean's living marine resources. It will also need the support of all Americans concerned about the conservation and wise use of our common ocean heritage.

INTRODUCTION

In 1992, effects of the ocean warming phenomenon known as El Niño, which had been developing in the equatorial Pacific during the previous year, strengthened and spread to U.S. waters. The phenomenon produces major changes in the ocean environment every 2-10 years and affects fish and fishing, as well as producing abnormally high water temperatures in the central and eastern tropical Pacific Ocean.

The name El Niño (Spanish for "the child") is thought to refer to the Christ child, since the phenomenon usually develops off the South American coast around Christmas time. El Niño episodes off South America have been documented as far back as the 16th century, and there is evidence that climatic effects linked with them stem back to the time before Christ. Although the effects are most pronounced along the coasts of Ecuador and Peru, during strong El Niño years, fisheries are also affected in the Northern Hemisphere, and weather patterns are affected over much of the globe. Although every El Niño is different, each also has certain similarities.

ENSO

Climatologists and oceanographers refer to the phenomenon as the El Niño Southern Oscillation (ENSO). It begins in the Pacific along the equator when atmospheric pressures at the opposite sides of the Pacific Ocean change to create a shift in wind patterns. This shift allows a large pool of warm water that usually remains in the western Pacific to extend eastward as far as the South American coast. During most "normal" years, a large low-pressure system of warm, wet air dominates over Australia and Indonesia, while a high-pressure system of relatively cool, dry air rests on the eastern side of the equatorial Pacific off South America. These air pressure systems cause strong trade winds to blow westward, sweeping warm surface waters toward the western Pacific and causing the sea level there to rise about 0.5 m higher than that in the eastern Pacific.

To initiate an El Niño event, the east-west air pressure gradient relaxes and often reverses, causing the trade winds to slacken and sometimes even blow in the opposite direction. With no constant winds to retain and accumulate ocean water in the western Pacific, water begins flowing in the other direction. This slumping effect creates a wave of warm water within the ocean that travels eastward along the equator toward Central and South America at the rate of about 200 miles a day. As the wave reaches the South American continent, sea level rises, the thermocline (depth of water where temperature changes rapidly forming a barrier between the warm surface water and cold, nutrient rich, deep water) deepens, and surface water temperatures may rise by as much as 6°C (10°F). The continental shelf deflects the wave north and south, bringing warmer water to coastal North and South America.

SOUTH AMERICAN EFFECTS

A strong El Niño has a profound effect on the Peruvian and Ecuadorian coasts, bringing torrential rains to normally dry, arid areas and causing a decline in fish populations and sea bird breeding activity. In general, the intrusion and buildup of warm water interrupts nutrient-enrichment processes that normally replenish the marine food chain. Also, some of the warm water flows south along the South American coast, rising over and blocking cool, rich Humboldt Current waters that normally flow north along the coast. This process has the overall effect of replacing nutrient-rich water with warm, nutrient-poor water. Primary production of marine plants, at the base of the oceanic food chain, is impeded by the lack of nutrients in the waters near the surface, and in turn, secondary production further up the chain, of zooplankton, invertebrates, and fish, is inhibited. Marine species most often affected by El Niño are the Peruvian anchovy and fish-eating seabirds that produce valuable guano used for fertilizer. El Niño conditions may also cause extensive red tides, blooms of micro-

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scopic algae which can make shellfish toxic to humans.

This year, the National Marine Fisheries Service's Southwest Fisheries Science Center (SWFSC) in La Jolla, Calif., was designated the headquarters for the National Oceanic and Atmospheric Administration's (NOAA's) El Niño Watch project. The project is under NOAA's Coastal Ocean Program and interlinked with its nationwide Coastwatch network for monitoring anomalous environmental events in U.S. coastal waters. Since January 1992, the El Niño Watch staff has issued monthly El Niño Watch Advisories—charts that document abnormal sea surface temperature patterns off the west coast and provide the latest information on the 1991-92 phenomenon. The information, gathered in cooperation with NOAA's National Weather Service and National Environmental Satellite, Data, and Information Service, is based on satellite weather information plus shipboard and buoy data collected from the equatorial Pacific to Alaska.

EL NIÑO NORTH

The El Niño phenomenon can set in motion complex climate and oceanographic changes far from the equator. The heat accumulated by the warm water promotes increased moisture and latent heat within the atmosphere, which in turn fuel and alter large-scale air circulation patterns, including surface winds. Although it can also happen in other years, a large atmospheric low-pressure cell over the Bering Sea (the Aleutian Low) intensifies during El Niño years, causing strong winds that pile up warm surface water along the mainland coast while creating an unusually large cold water mass across the central North Pacific. Changes in the jet stream also occur that tend to intensify storms and rainfall along the west coast and in states bordering the Gulf of Mexico. In general, oceanographic patterns that develop off the U.S. west coast in late January and February in a given El Niño year usually provide the key as to whether the early warm-water conditions will develop into an "El Niño North" that particular year.

Strong El Niño years have affected the large-scale distribution of marine life along the U.S. west coast. Tropical and temperate species shift northward beyond their normal ranges and, in some cases, changes occur in their growth, survival, and production. During the 1982-83 El Niño, considered the strongest of this century, there was a drastic drop in numbers of salmon caught in all three lower Pacific coast states, and fish returning to spawning rivers were lank and emaciated. Seabirds disappeared from their breeding sites on the Farallon Islands off San Francisco, and warmwater species such as striped marlin, bonito, barracuda, dolphin fish, and pelagic red crab occurred much farther north of their usual ranges. In contrast, the ocean warming may be favorable for some subtropical stocks that spawn at the northern end of their range, such as chub (Pacific) mackerel and sardine off California, which may have high production rates. Tropical gamefishes such as dolphin fish and the bigeye, yellowfin, and skipjack tunas have also extended their ranges northward into southern California waters during strong El Niño years, much to the delight of southern California anglers.

The range of several southern California pelagic fish stocks was altered in response to the 1983 El Niño. For example, chub mackerel became abundant in regions north of their usual range, some schools were even reported along the west coast of Vancouver Island and around the Queen Charlotte Islands. Likewise, California landings of jack mackerel declined during the 1983 and 1984 El Niño years, probably owing to the species' northward shift. Spawning concentrations of northern anchovy and Pacific sardine also expanded northward during the 1983 El Niño.

The impact of El Niño events on commercially important temperate or subarctic groundfish stocks that range along the west coast of North America has been mixed. For example, a strong El Niño began in 1957 and continued through 1958. Most of the groundfish stocks had poor reproduction in 1958. In contrast, the majority of groundfish stocks had good reproduction in the year following the 1969 (weak), 1976 (moderate), and 1983 (strong) El Niño events. There was little evidence of surface ocean warming in the northeast Pacific during the moderate

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1965 and strong 1972 El Niño episodes, and a consistent pattern of strong or weak reproduction of groundfish stocks was not observed.

The mixed response of northeast Pacific groundfish stocks to El Niño events results from differences in how the events influence sea surface temperature, the depth of the mixed layer, geostrophic current patterns (currents driven by the force of gravity and the spin of the earth), and atmospheric pressure patterns. Reproduction of northeast Pacific groundfish stocks appears to be associated with winters having warm ocean surface temperatures, low upwelling, high sea level, and an intense Aleutian low-pressure cell located farther east than usual. These physical conditions are often associated with El Niño conditions in the northeastern Pacific.

El Niño episodes may also influence long-term environmental conditions in the North Pacific. Fishery biologists at the NMFS Alaska Fisheries Science Center in Seattle have discovered that every 6-12 years, winter conditions tend to switch from a succession of warm winters to a series of cold winters, and vice versa. Evidence is accumulating that suggests production of several marine fish stocks is influenced by longer term decadal-scale changes in ocean conditions. The impact of these decadal-scale changes in ocean conditions on northeast Pacific groundfish stocks is currently under investigation.

Marine mammals in certain areas may benefit from El Niño conditions while others may suffer, and there is concern about increased interactions with fisheries due to lowered food supplies. In past El Niño years, northern fur seals born in the Gulf of Alaska had a higher survival rate, while those in southern California had a 60% decrease in pup production, almost no pup survival, and a drop in numbers of adults.

In the strong El Niño of 1982-83, forage fishes for California sea lions became scarce, and there was a dramatic increase in the number of encounters between fishermen and sea lions in southern California. As the sea lion population is now 30% larger than it was in 1982, this is a serious problem if a strong El Niño develops off California in 1992.

In the central and western Pacific, the cooling associated with El Niño can bring increased catches of yellowfin tuna but also lower survival of young spiny lobsters in Hawaii. El Niño conditions have been associated with below-average production of larval spiny lobster at certain banks in the northwestern Hawaiian Islands. Yellowfin tuna, on the other hand, may be more available to surface fishing gears in the western Pacific if the thermocline, which influences its swimming depth, rises near the surface as in past El Niños. The effects of El Niño on yellowfin tuna around the main Hawaiian Islands are less predictable because the central location of the islands in the Pacific Ocean makes them susceptible to either eastern (warming) or western (cooling) Pacific effects, depending on the peculiarities of each El Niño episode.

THE 1991-92 EL NIÑO

The current El Niño evolved in the tropics early in 1991, but its progression was somewhat checked in midyear. By December 1991, however, it was evident that an equatorial El Niño was in progress—sea surface temperatures had risen 1°-2°C above normal throughout the equatorial eastern Pacific, sea level had risen several centimeters off the coast of Peru, and the thermocline had descended 40 m deeper than normal along the equator east to long. 115°W. By the last week of February 1992, severe rains and flooding had begun in northern Peru, sea surface temperatures had risen as much as 4°C above normal off Callao, guano birds had begun migrating in great numbers from their usual nesting areas in search of food, and sea lions had also begun moving south in search of forage. By April, a severe red tide had developed off Chile.

While El Niño was developing along the equator, sea surface temperatures along much of the U.S. west coast remained below normal for most of 1991. This situation changed in January 1992 when ocean

... THE 1991-92 EL NIÑO

and weather patterns shifted, sea surface temperatures rose 1.0°C above normal, and storms strengthened by tropical warming brought heavy rainfall to drought-parched California. In January, sea level at the Scripps Institution of Oceanography (SIO) pier near San Diego, Calif., was the highest seen in that month since the El Niño year of 1983; and February 1992 saw the highest sea height on record for that month. In February, a mussel sample taken from the SIO pier had unusually high concentrations of red-tide associated toxins, rare for that time of year and for the San Diego area.

From February through April 1992, El Niño conditions intensified, and reports were received of unusual catches of southern species in more northerly waters. Tropical pelagic red crab appeared off southern California in March and off northern California in April. Anglers fishing off San Francisco and Santa Cruz, Calif., began catching barracuda and bonito—fish usually found south of Point Conception. During April, SWFSC divers monitoring conditions in southern California also noted that giant kelp plants at Catalina Island had begun to decompose in the upper 2-3 m of water where water temperatures from the surface to depths below 17 m were above 18°C—the warmest for that time since the El Niño of 1982-83. Early reports from the fishery for Pacific whiting, which in 1992 began on 15 April, indicated that it had moved from the normal, early season fishing grounds off northern California and Oregon northward to northern Oregon and Washington.

While conducting research cruises off California during March and April 1992, SWFSC scientists also noted the following El Niño features—above normal water temperatures, a depressed nearshore thermocline, and very low concentrations of zooplankton and chlorophyll (an indicator of phytoplankton production). They also found a strong northerly flowing California Countercurrent with little or no active coastal upwelling, and a lack of mesoscale (1-100 k) features such as eddies and jets. Aboard one of these cruises, a joint effort with Scripps Institution of Oceanography and the Center for Ocean Analysis and Prediction, the scientists completed a comprehensive survey of circulation patterns in the California Countercurrent between Point Conception and Point Arena, which will provide an excellent and much-needed direct measure of ocean properties associated with El Niño.

By May 1992, although unusually high sea surface temperatures still remained throughout the entire eastern and central Pacific, it appeared that the equatorial El Niño had peaked and the warming episode was showing definite signs of abating. Though El Niño had weakened at its source along the equator, as evidenced by changes in the configuration of sea level pressure patterns, subsurface ocean temperatures, and wind patterns, NMFS scientists still expected residual effects of El Niño to continue off the U.S. West Coast into the second half of 1992. Reports continued of unusual fish distributions off the U.S. West Coast, such as four white seabass taken in Monterey Bay.

By spring and early summer 1992 it became apparent that California sea lions in central and southern California were feeling the effects of El Niño. Reports of both dead and live strandings of California sea lions increased dramatically from San Diego to at least San Francisco. Most of the pinniped rehabilitation facilities in California were filled to capacity. Also, a striking increase was noted in the number of yearlings and females using haul-outs in central California, indicating a net movement northward from their usual feeding grounds in southern California. Many of the animals that hauled out at the Monterey breakwater in central California were described as emaciated. Commercial sport fishing boats reported an increase in the incidence of sea lions stealing fish from lines. When NMFS biologists from the Southwest Fisheries Science Center surveyed southern California island rookeries in September and October 1992, many young sea lions seen were thin and emaciated. Data on pup weights had not yet been analyzed as of press time but were being processed to determine whether pup growth had been retarded this year, as was observed in the 1982-83 El Niño.

On the positive side, as predicted, fishing for tunas and other tropical game fishes provided a boon to San Diego and other

. . . THE 1991-92 EL NIÑO

southern California sport fishermen during the summer, who experienced the best tuna fishing in years. Also, anglers to the north continued to catch expatriate species from the south, including señorita, blacksmith, opaleye and halfmoon. Catches of yellowfin tuna and dolphin fish exceeded all-time annual sport catch records in California for these species; catches of bluefin tuna and yellowtail were also very high. In addition, for the first time on record, catches of tropical tunas and dolphin fish were higher in waters north of the Mexican border than in waters to the south. Angling success was unusually high in waters inshore of the Channel Islands off southern California, with catches of yellowfin tuna reported as close as 5 miles off the coast at several locations in the Los Angeles area. Sea lions continued to be a significant problem for sportfishing boat operators. Above normal ocean temperature conditions prevailed along the entire West Coast, even as the equatorial El Niño was abating in the tropics. In July, anomalous warm water intensified to more than 5°F above normal in coastal waters extending about 300 miles off southern California. This increase was likely the result of residual warm waters from El Niño being enhanced by air-sea interaction processes, in part related to a series of tropical storms that moved northward from lower Baja California during July. Sea surface temperatures were 3°-4°F above normal off central and northern California and 1°-2°F above normal in coastal waters off Oregon and Washington.

By August and September, temperatures appeared to return to near normal conditions off the western coast of the U.S. except for some warm water off southern California. Where sea surface temperature (SST) anomalies as great as 5°F above normal had existed off southern California in July, temperatures had dropped to 2° and 3°F above normal in September, and the plus 5°F water had receded to the south off Baja California. This cooling trend off North America seemed to reflect the decay of the tropical El Niño in equatorial regions, where SST's had returned to normal or below normal conditions.

During October, however, scientists with NOAA's El Niño Watch project noted a slight resurgence in warm water conditions with SST's returning to 2° and 3°F above normal off central California, and from 3 and 4° above normal off southern California. At the time of this writing the reason for this renewed warming was unclear, and residual effects from El Niño in temperate waters off the U.S. West Coast were still expected to diminish during the remainder of 1992.

Large-scale oceanographic events such as El Niño can have profound effects on the marine environment and on U.S. living marine resources. They are one important source of the interannual variability that characterizes fish stocks and fisheries. Increased understanding of events such as El Niño can give early warning of short-term changes in distribution and abundance of fish and allow industry and management to adjust to this natural variability.

INTRODUCTION

When fishermen go fishing, they usually target a particular species or group: Salmon fishermen go after salmon, halibut fishermen halibut, shrimp fishermen target shrimp, etc. Unfortunately, they often catch other fish that are either unwanted or unusable owing to poor market value or regulatory restrictions, such as seasonal closures or size limits. These unwanted, untargeted, accidentally caught fish are called the "bycatch" or the "incidental" catch.

Depending on the number of incidentally caught fish, this bycatch may not be a big problem. But, sometimes the number taken is so great, or the species is so rare, that the productivity of that species may be undermined. In other cases, it is simply a matter of wasting valuable resources to harvest fish when they are too small or otherwise unusable, rather than to let them grow, mature, and so gain value.

To prevent bycatch of certain species, management may impose gear, season, area, or other restrictions on fishermen. For example, in the tuna fishery of the eastern Tropical Pacific (Unit 18), American tuna fishermen dramatically changed fishing methods and reduced their bycatch of marine mammals to comply with the requirements of the Marine Mammal Protection Act (MMPA).

Concern about the bycatch in many other domestic and foreign fisheries has grown dramatically in recent years. Resolving these problems in a number of fisheries will require general agreement on definitions of the different types of bycatch and their impacts. Furthermore, the potential solutions to bycatch problems depend on current national policy as embodied in such key legislation, as the Magnuson Fishery Conservation and Management Act (MFCMA), the Endangered Species Act (ESA), and the MMPA. As policy evolves, research must continue in such areas as the magnitude and impact of bycatch in individual fisheries, and gear and management measures that may reduce or end the problems.

Defining bycatch problems is crucial to identifying information needs and possible solutions, and to constructive discussion about this complex and volatile issue. In this article two basic bycatch problems are discussed: Allocation and conservation.

TYPES OF BYCATCH PROBLEMS

Allocation Problems

Capture of nontarget (unwanted) species in one fishery may have economic effects on other fisheries result in fishing restrictions. For instance, Bering Sea trawlers targeting walleye pollock and yellowfin sole (Unit 19) capture other species such as Pacific halibut, sablefish, salmon, and king and tanner crabs that are sought by other fishermen. Regulations aimed at reducing those bycatch effects on the other fisheries require the pollock/sole trawlers to discard large quantities of the other valuable finfish and shellfish. Limits on the catch of nontarget species by Bering Sea trawlers also reduce harvest levels of the targeted pollock and sole below their potential yield. Similar new allocation problems can arise as new markets and fisheries develop for previously undesired fish that are incidentally captured in nontarget fisheries.

Conservation Problems

Bycatch may cause excessive fishing mortality on nontarget species. This occurs in two different circumstances: When target species are overexploited or when different species have a life history mismatch.

Target Species Overexploited: When there is a high level of fishing activity in an area, even species that are not directly targeted may suffer a high mortality. Fishing effort for shrimp in the Gulf of Mexico (Unit 11) is much higher than necessary to harvest the resource. As a consequence, shrimp trawl bycatch has had very dramatic effects on some finfish stocks. In the northern Gulf of Mexico, for instance, croaker were once very abundant, but they have declined since the 1950's (Unit 9); in 1991, the average croaker catch consisted of a single year class of very small fish, whereas croaker catches in the 1950's contained several year classes of much larger fish. If shrimp fishing effort were reduced, the finfish bycatch could be substantially reduced with no reduction in overall shrimp yield.

Life History Mismatch: Some fisheries

. . . Conservation Problems

generate excessive fishing mortality on nontarget species even though the target species is not overutilized. This occurs when the bycatch species is slower growing and longer lived than the target species and is therefore less tolerant of a high rate of fishing. For example, the optimal level of shrimp fishing in the Gulf of Mexico might still be excessive for the incidentally captured finfishes that mature more slowly. Reducing the take of a bycatch species through gear restrictions or modifications or area and season closures, for instance, can help solve this type of bycatch problem.

LEGISLATIVE BACKGROUND

Congress has addressed bycatch problems in commercial fisheries by amending several laws, most recently through the 1990 amendments to the MFCMA. The MFCMA encourages measures to avoid unnecessary waste of fish, the development of research programs that address bycatch and methods for its reduction, and the establishment of an observer program in the North Pacific to monitor existing bycatch measures. The 1990 amendments to the Act also mandated a research program on the impact of incidental harvest in the southeastern U.S. shrimp trawl fishery and prohibited any measures to mitigate this bycatch until 1 January 1994.

The Marine Mammal Protection Act of 1972 imposed a moratorium on the kill of marine mammals, including their incidental capture in fisheries. The 1988 amendments to the MMPA provided most commercial fisheries with a 5-year exemption from the prohibition on capture of mammals, while information on the levels and impacts of these kills is collected and analyzed. A permanent legislative approach to the capture of marine mammals in commercial fisheries is being developed for congressional consideration in the reauthorization of the MMPA in 1993.

Finally, the ESA prohibits the incidental killing of species listed as endangered and allows such prohibitions or other conditions to be placed on the kill of threatened species. The ESA does allow the incidental capture of endangered species under limited circumstances, provided that the bycatch neither violates the incidental take provisions of the Act nor jeopardizes the continued existence of the species. The 1988 amendments to the ESA also required some South Atlantic and Gulf of Mexico shrimp fishermen to use Turtle Excluder Devices (TED's) during certain times of the year to avoid incidental capture of endangered and threatened sea turtles.

INFORMATION NEEDS

Effective bycatch management requires data on the magnitude, distribution, and species composition of the bycatch in a fishery. Such information generally requires observers on fishing vessels. Multiyear observer programs are needed to reflect interannual variation in the abundance of target and nontarget species to determine the magnitude of bycatch and its effects.

However, observer programs have several drawbacks. Placing observers on fishing vessels can be expensive for both vessel owners (because valuable bunk and working space is lost) and for fishery management agencies. The number of observations made may be small because of budget constraints and may not give an accurate picture of the incidental catch. The presence of an observer can also influence the fishing methods employed by a fisherman, either to avoid or to seek bycatch species. In addition, it may take several years before data from observer programs become useful in assessing the status of fish resources and the magnitude of bycatch effects, while pressure to address the problems increases and calls for more immediate action.

Where one fishery incidentally captures fish that are of economic value to other fisheries, calculating the foregone present

... INFORMATION NEEDS

and future value of discarded catch is an important element in assessing the importance of the bycatch problem. These calculations require both biological and economic data.

Information on the geographical and temporal distribution of bycatch species is a key to evaluating whether area-time restrictions offer a means of reducing bycatch and its impacts. Understanding the behavior of nontarget species can also assist in the development of alternative fishing gear, as has been demonstrated in recent research on methods of excluding some finfish species from shrimp trawls.

Determining the impact of bycatch also requires better estimates of the abundance of nontarget species. This would help in fashioning measures that minimize the impact of restrictions on fishing operations. For example, with improved precision in estimates of abundance for protected species, fewer restrictions and prohibitions on fishing operations might be required to protect and restore endangered and threatened species. The lack of such information on protected species abundance and the impact of bycatch compels a more conservative approach and greater restriction of fishing activities.

MITIGATING BYCATCH

There are three principal approaches to reducing bycatch: 1) reducing the coincidence of target species, nontarget species, and gear through such techniques as time-area closures or alternative fishing practices; 2) reducing the capture and retention of bycatch species through gear modifications; and 3) reducing excess fishing pressure on target species.

In many instances, target and nontarget species inhabit the same general area only during limited times of the year. Directing fishing effort for the target species to times and areas where nontarget species of concern are few or absent can significantly reduce bycatch. Closing areas during times when fish of certain ages are present, as during spawning seasons, can also reduce the impact of bycatch on nontarget species. Similarly, deploying fishing gear, such as longlines, at greater or lesser depths may reduce bycatch of nontarget species. On experimental longline cruises, the NMFS Southwest Fisheries Science Center has found that hooking rates vary for tunas and billfish by depth and oceanographic factors, pointing to a possible means of reducing billfish bycatch.

Innovations in fishing gear can also reduce the capture and retention of bycatch species. The Medina panel (a gear modification to prevent the retention of dolphins) in the tuna fishery of the eastern Tropical Pacific and the Turtle Excluder Device in the shrimp fishery of the South Atlantic and Gulf of Mexico have significantly reduced the capture and retention of porpoises and sea turtles, respectively. Preliminary trials indicate that a finfish excluder device may reduce the bycatch of cod, haddock, and flounder in the New England shrimp fishery.

Nonregulatory, market-oriented measures may help address the economically wasteful discard of commercially valuable species resulting from regulations directed at resolving conflict between users in multispecies fisheries. For instance, if the quotas for those species taken directly and indirectly in different fisheries were divided into tradable shares, fishermen who chose to fish in a manner that would lead to bycatch of a species could acquire quota shares from other fishermen through purchase or lease. Such a program would reduce economic waste by allowing the landing and sale of bycatch of species under a quota share. Economic waste may also be reduced through increased utilization of bycatch. As an example, yellowtail flounder was discarded by New England groundfish fishermen for many years until new methods of filleting made them marketable in the 1930's.

Finally, reduction of fishing effort on overutilized target species will also reduce effort and capture of bycatch species, without reducing the catch of the target species. For example, bycatch in the southeast shrimp fishery could be reduced by reducing fishing pressure, without reducing total shrimp catch. The average size and value of shrimp would also be increased.

. . . MITIGATING BYCATCH

As consumer demand for fish grows, so will the pressure to reduce the wasteful discard of bycatch. Research on the magnitude, species composition, and distribution of bycatch and on methods for avoiding it can contribute to solving this problem.

Table 4.–Summary of bycatch documented in volume 2 (1992) of "Our Living Oceans."

Unit and fishery		Principal gear	Principal species affected	Affected species' status
1.	Northeast demersal	Trawl Gillnets	Goosefish Cusk Wolffish Atlantic halibut Ocean pout Weakfish Scup Black sea bass Spot Tilefish Searobin Kemp's ridley sea turtle Harbor porpoise	 Overutilized Overutilized Overutilized Overutilized Overutilized Overutilized Overutilized Endangered Unknown
2.	Northeast pelagic	Trawl	Pilot whales Common dolphins	
4.	Northeast invertebrate	Shrimp trawls	Atlantic cod Haddock	Overutilized Overutilized
5.	Atlantic highly migratory pelagic	Longlines Gillnets	Blue marlin White marlin Sailfish Pelagic sharks	Fully utilized Unknown Fully utilized Unknown
7.	Atlantic coastal migratory pelagic	Gillnets	Cobia	Unknown
11.	Southeast/Caribbean invertebrate	Shrimp trawl	Red snapper Atlantic croaker Spot Seatrouts Sea turtles Small coastal sharks	Overutilized Overutilized Unknown Unknown Endangered/ threatened Underutilized
15.	Pacific coast groundfish	Trawl	Pacific salmon, principally chinook Jack mackerel	 Overutilized Underutilized
19.	Alaska groundfish	Trawl Gillnets	Alaska salmon, principally chinook Pacific halibut King crabs Tanner crab Pacific herring Pacific herring Pacific halibut (less Canada) Marine mammals	 Fully utilized Fully utilized Fully utilized Fully utilized Fully utilized Fully utilized

Part 2: UNIT SYNOPSES

INTRODUCTION

Northeastern U.S. demersal (groundfish) fisheries include about 35 species or stocks, primarily in New England waters, but also off the Mid-Atlantic states. In New England, the groundfish group is dominated by members of the cod family (cod, haddock, hakes, pollock), flounders, dogfish sharks, and skates. Mid-Atlantic groundfish fisheries land primarily summer flounder, scup, goosefish, and black sea bass.

Northeast groundfish fishermen use such fishing gears as otter trawls, gill nets, traps, and set lines. Otter trawling is the predominant fishing method for groundfish throughout the region (there were 1,072 otter trawl vessels in the fleet in 1990); gill nets contribute a substantial proportion of the landings in the Gulf of Maine (242 vessels fished with gill nets in 1990). Many of the groundfish fishing vessels switch gears seasonally. Total U.S. landings of mixed groundfish in the northeast region were 157,000 t in 1991. If Canadian and recreational landings of these stocks are included, 1991 groundfish landings were still less than half of their estimated long-term potential yield (LPTY: Table 1-1).

Groundfishes off the northeast coast occur in mixed species aggregations, resulting in significant bycatch interactions

Table 1-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of northeast groundfish. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituted.

Long-term potential yield (LTPY) =	533,500 t	
Current potential yield (CPY) =	408,000 t	
Recent average yield (RAY)[1] =	225,421 t	(170,221 t, U.S. only)

Species	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Groundfish/flounders					
Atlantic cod[2, 3]	58,600	60,000	45,000	Over	Near
Pollock[2, 3, 4, 5]	48,200	40,000	54,000	Over	Below
Silver hake	18,200	20,000	100,000[7]	Full	Below
Summer flounder[3]	7,500	6,000	20,000[7]	Over	Below
Winter flounder[3]	9,100	9,000	16,000[7]	Over	Below
Yellowtail flounder	9,200	6,000	39,000	Over	Below
Haddock[2, 6]	5,900	6,000	52,000	Over	Below
American plaice	3,400	2,400	10,000[7]	Over	Below
Witch flounder	1,900	1,500	3,500[7]	Over	Below
Windowpane flounder	2,700	2,000	5,000[7]	Full	Near
Red hake	1,600	Unknown	40,000[7]	Under	Near
Redfish	600	600	14,000	Over	Below
Skates/dogfish					
Skates	9,700	25,000	25,000	Under	Above
Spiny dogfish	10,600	200,000	50,000	Under	Above
Other finfish					
Goosefish	11,700	10,000	10,000[7]	Over	Below
Scup[3]	7,400	6,700	12,500[7]	Over	Below
White hake[2]	5,800	5,000	5,000[7]	Full	Near
Weakfish[3]	5,000	Unknown	Unknown	Unknown	Unknown
Black sea bass[3]	3,000	Unknown	Unknown	Full	Below
Cusk[2]	1,200	1,200	1,500[7]	Over	Below
Ocean pout	1,300	1,300	12,500[7]	Full	Near
Spot[3]	1,500	Unknown	Unknown	Unknown	Unknown
Tilefish	800	900	Unknown	Over	Below
Wolffish	500	400	700[7]	Over	Below
Atlantic halibut	21	Unknown	Unknown	Over	Below

[1]1989-91 average.
[2]Includes more than 100 t of foreign landings (primarily Canadian).
[3]Includes more than 100 t of recreational landings.
[4]For pollock, U.S. landings are only 9,300 t (19%) of the RAY.
[5]Overutilized for U.S. portion of the stock, but not the Canadian portion.
[6]For haddock, U.S. landings are only 2,000 (34%) of the RAY.
[7]Provisional LTPY's, based on historical landings patterns.

. . . INTRODUCTION

among fisheries directed to particular target species or species groups. Management is very complex because of these interactions. This complexity is reflected, for example, in the use of differing mesh sizes, gears, minimum fish size rules, and seasonal closure regulations, set by such groups as the New England and Mid-Atlantic Fishery Management Councils (NEFMC and MAFMC, respectively), state fishery agencies, the Atlantic States Marine Fisheries Commission (ASMFC), and by the Canadian government, because some fish stocks often cross state and national boundaries. New England groundfish (13 species) are managed primarily under the northeast multispecies Fishery Management Plan (FMP) , as well as peripherally under provisions of the ASMFC northern shrimp FMP. Mid-Atlantic groundfish are managed under the summer flounder FMP. Management of the demersal fisheries of the region is by such indirect methods as mesh sizes, minimum fish length regulations, and some area closures. There are currently no direct controls on the New England groundfish harvest through catch quota or fishing effort regulations. The summer flounder FMP includes provisions for catch quota targets aimed at restoring this depleted stock.

Extensive historical data for the northeast demersal fisheries have been derived from both fishery-dependent (i.e. catch and effort monitoring), and fishery-independent (NOAA research vessel) sampling programs. Since 1989, a sea sampling program conducted aboard commercial vessels has been conducted in the region, to document discard rates and to collect sound data on catch by area and effort by gear type. Some of the northeast demersal stocks (cod, yellowtail flounder, haddock, and American plaice) are among the best understood and assessed fishery resources in the country.

SPECIES AND STATUS

Principal Groundfish and Flounders

The principal groundfish and flounders group includes important cod-family species (Atlantic cod, haddock, silver and red hake, and pollock), flounders (yellowtail, summer, winter, witch, windowpane, and American plaice) and redfish (Fig. 1-1). Recent annual landings of these 12 species (19 stocks) by commercial fishermen have averaged 167,000 t, as compared with their combined LTPY of nearly 400,000 t (Table 1-1).

Total value of principal groundfish and flounder commercial landings in 1991 was $165 million. The northeast groundfish group supports important recreational fisheries for species including summer flounder, winter flounder, and Atlantic cod. In 1991, recreational landings of principal groundfish and flounder species were 7,200 t. The estimated recreational fishing

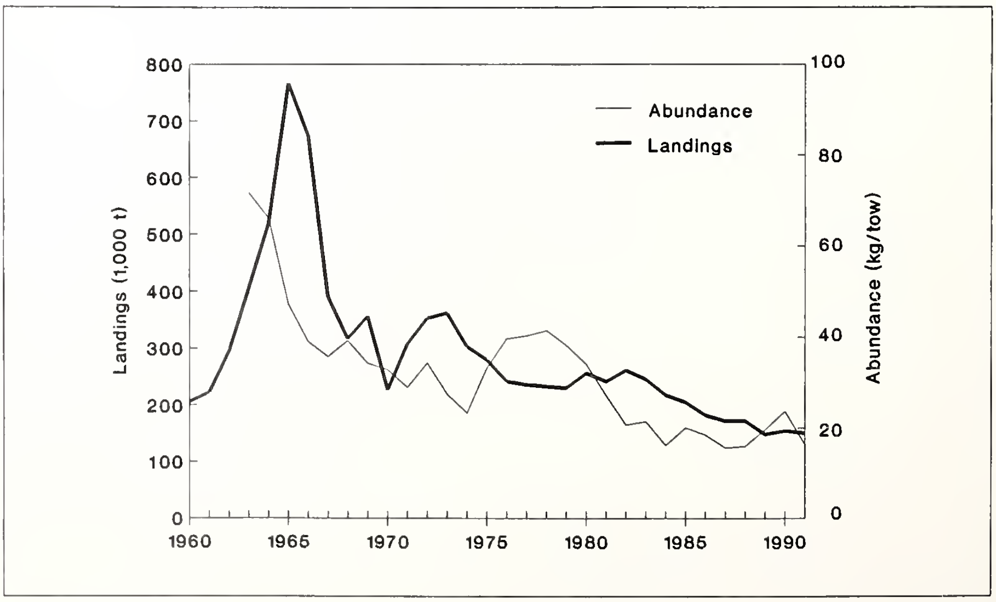


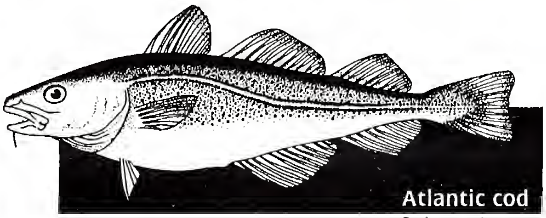
Figure 1-1.—Total commercial landings and abundance indices for principal groundfish and flounders off the New England coast, 1960-91. Abundance indices are mean weight (kg) per tow taken in Northeast Fisheries Science Center (NEFSC) autumn bottom trawl surveys. Species include: Atlantic cod, haddock, pollock, redfish, the silver, red, and white hakes, American plaice, and the yellowtail, winter, windowpane, witch, and summer flounders.

... Principal Groundfish and Flounders

value of summer and winter flounder fisheries (the two most important of the principal groundfish and flounders) was $196 million.

The abundance index for this group declined by almost 70% between 1963 and 1974, reflecting substantial increases in exploitation associated with the advent of distant-water fleets (Fig. 1-1). Many stocks declined sharply, notably Georges Bank haddock, most silver and red hake stocks, and most flatfish stocks. By 1974, abundance levels of many of these species had dropped to the lowest ever recorded.

Groundfish stocks partially recovered during the mid-to-late 1970's because of reduced fishing effort associated with increasingly restrictive management under the International Commission for the Northwest Atlantic Fisheries (ICNAF) during the early 1970's, and implementation of the Magnuson Fishery Conservation and Management Act (MFCMA) in 1977. Cod and haddock increased markedly; pollock stock levels 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 again low. The 1989 and 1990 abundance values were slightly higher than the previous two years, primarily due to recruitment of moderate 1987 year classes of Atlantic cod and yellowtail flounder. However, the abundance index in 1991 again declined owing largely to the rapid depletion of the 1987 yellowtail flounder year class, and declining cod numbers.



Gadus morhua

U.S. fishing for northeast demersal species increased rapidly after the implementation of the MFCMA and more than doubled in the first 10 years. Fishing effort has remained at near-peak levels, despite large declines in total catch and catch rate per unit of effort.

Skates and Dogfish Sharks

Dogfish and skates are a significant and growing part of overall northeast groundfish stocks (Fig. 1-2). Of the two dogfishes (spiny and smooth), the spiny dogfish is dominant by far. Seven species of skates, including little, winter, thorny, barndoor, brier, leopard, and smooth-tailed, occur on the northeast shelf, but the first three produce most of the landings.

Skate and spiny dogfish landings have generally increased in recent years, although spiny dogfish landings in 1991

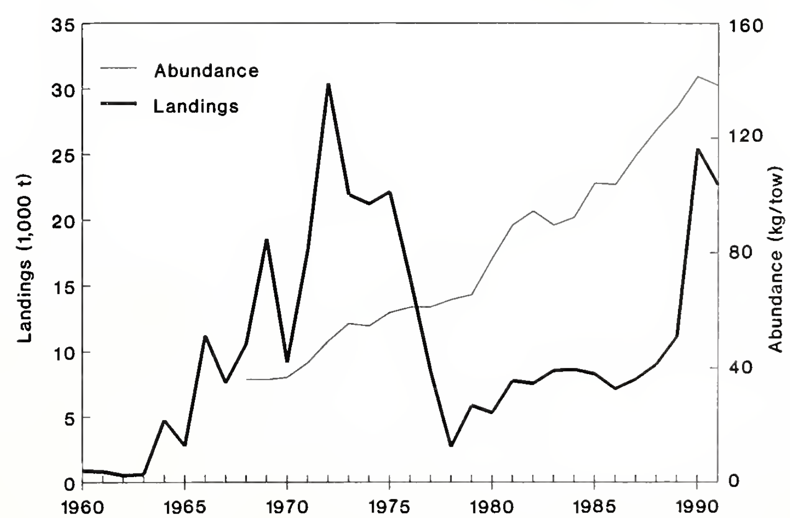


Figure 1-2.—U.S. commercial landings and abundance indices for skates and dogfish off the northeastern U.S. coast, 1960-91. Abundance indices are mean weight (kg) per tow taken in NEFSC spring bottom trawl surveys. Species include little, winter, barndoor, brier, thorny, leopard, and smooth-tailed skates, and spiny dogfish.

... Skates and Dogfish Sharks

were 12,500 t, down from 14,300 t in 1990. Skate landings (all species) were 11,200 t in 1991, and 11,300 t in 1990. These are well below the long-term potential landings for these stocks and their current potential yields. The stocks of skates and dogfish increased throughout the 1970's and 1980's (Fig. 1-2). Survey catches of both dogfish and skates since 1986 have been the highest observed in the time series. Increases in dogfish and skate abundance, in conjunction with declining abundance of groundfish and flounders, have resulted in the proportion of dogfish and skates in Georges Bank survey catches increasing from roughly 25% by weight in 1963 to nearly 75% in recent years.

Other Finfish

Other groundfish species taken primarily as bycatch in the Gulf of Maine include goosefish, white hake, cusk, wolffish, and Atlantic halibut. In southern New England, goosefish and ocean pout are important groundfish stocks, and in the Middle Atlantic, scup, weakfish, black sea bass, spot, tilefish, sea robins, and several others are landed either in directed fisheries or as bycatch. As a group, they are generally characterized as overutilized, with current landings generally well below long-term maxima (Table 1-1). Most of these stocks are managed implicitly with other species included in various FMP's. For example, white hake, goosefish, cusk, wolffish, and halibut are taken in various groundfish fisheries regulated under the northeast multispecies FMP. Similarly, scup and black sea bass represent major components of the summer flounder directed fishery, and these stocks are likely to be included in future amendments to the summer flounder FMP. The ASMFC has developed a weakfish FMP, and several of the other stocks are slated for inclusion in future FMP's. The advent of directed fishing for goosefish at the edge of the continental shelf in the Middle Atlantic and in southern New England has prompted interest in developing regulations for the fishery, primarily because very small animals are currently landed from that fishery and are also taken as bycatch from sea scallop dredging.

ISSUES

Management Concerns

New England groundfish resources are currently regulated by indirect controls on fishing mortality, including mesh and minimum fish size restrictions, and some area closures. In the face of persistent overfishing of the resource, the Conservation Law Foundation (CLF) filed litigation to reduce fishing pressure to allow the stocks to rebuild. A consent decree was entered into between NMFS and CLF, stipulating that a northeast multispecies FMP amendment (#5) would be developed before the end of 1992 that will reduce the rate of fishing to rebuild the resource base over a 5-year period. Currently there is considerable discussion on the form of regulations to achieve this goal. Likely mechanisms to be included in amendment #5 of the FMP are effort control regulations combined with increased mesh sizes.

Meeting the catch goals to prevent overfishing, as defined under the multispecies and summer flounder FMP's, will require significant effort reductions. These fisheries are now severely over- capitalized, resulting in continued pressures on already overutilized stocks and the loss of economic benefit to the nation. Rebuilt stocks will eventually provide increased net benefits to pro ducers and consumers, but, in the short-term, effort reductions will decrease revenues to fishermen. Decreased reve nues, even for a few years, may result in some business failures since many vessel operations are marginal producers under current conditions of depressed stocks. However, continued declines in the resource base will result in even grimmer prospects. To improve the picture for these fisheries will require stock rebuilding and addressing the problem of overcapitalization.

Transboundary Stocks and Jurisdiction

Significant quantities of Atlantic cod, haddock, and pollock are landed in Canadian waters from stocks that move between U.S. and Canadian waters. In 1991, 25% of Atlantic cod, 75% of haddock, and 83% of pollock landings of these transboundary stocks were taken by Canada. Management regulations used by the two countries are fundamentally different: Canada seeks to achieve target harvest rates through catch quota regulation. Although there is assessment coordination between the countries, there is no formal mechanism for joint management. The lack of coordinated management efforts has contributed to overutilization of these shared resources.

Bycatch and Multispecies Interactions

Groundfish fisheries in the northeast impact a number of species with different life histories and, therefore, differing capacities to withstand exploitation. Developing a management system which can rebuild and then maintain this range of resources is a major challenge. In addition, some groundfishing gear, particularly gillnets, incidentally kills marine mammals such as harbor porpoise. This bycatch needs to be mitigated to meet the requirements of the Marine Mammal Protection Act.

The current high abundances of skates and dogfish has the potential of impeding the complete recovery of other stocks of groundfish. These elasmobranch species may compete for similar food resources or prey upon young groundfish. Increased utilization of dogfish and skates may benefit the fisheries for cods and other important species. Nevertheless, reduced fishing mortality on groundfish stocks should translate into improved groundfish catches.

Progress

Considerable progress in the assessment and management of the northeast demersal resources was made during 1991 and 1992. The incorporation of data on fish discarded at sea into stock assessments for yellowtail flounder and American plaice lends an important new dimension to the interpretation of stock status and the effectiveness of mesh regulations. A winter trawl survey instituted during 1992 specifically to index summer and yellowtail flounder stocks along the shelf proved successful and will be continued. A monthly sampling program was begun in the Gulf of Maine to collect biological data on the onset of sexual maturity for several demersal stocks. The development of amendment #5 to the northeast multispecies FMP has been expedited by the formation of a Plan Development Team to coordinate the evaluation of alternative proposed management measures. The FMP for summer flounder includes state-by-state catch quota regulations intended to reduce fishing mortality on the stock.

INTRODUCTION

Northeast U.S. pelagic or midwater fisheries are highly seasonal, reflecting the migratory patterns of such schooling fishes as Atlantic herring, Atlantic mackerel, butterfish, bluefish, and two species of squids. All of these species winter on the Middle Atlantic shelf and undergo northward and inshore migrations in the spring and summer. These resources are harvested with a variety of gears including off-bottom and bottom trawls, gill nets, and seines. Commercial landings of pelagic fishes off the U.S. northeast coast have averaged 144,000 t since 1989, while recreational landings (primarily bluefish and mackerel) have been about 23,000 t. In 1991, the commercial landings produced about $49 million in dockside revenue, of which the squids accounted for the greatest proportion ($30 million). Bluefish and mackerel are important recreational fisheries for the region; approximately $345 million is spent annually to angle for bluefish.

All of the northeast pelagic resources were heavily exploited by foreign fleets during the 1970's, in most cases resulting in rapid declines in stock sizes and yields. Subsequently, however, there has been little U.S. interest in stocks such as mackerel, resulting in increased abundance. The pelagic stocks are managed under two Federal FMP's, one for bluefish and the other for squid, mackerel, and butterfish, developed by the Mid-Atlantic Fishery Management Council (MAFMC). Atlantic herring are managed under the auspices of the Atlantic States Marine Fisheries Commission (ASMFC).

SPECIES AND STATUS

The U.S. northeast midwater fisheries are dominated by six species: Atlantic mackerel, Atlantic herring, butterfish, bluefish, and two squids: long-finned (*Loligo*) and short-finned (*Illex*). Five of the stocks are considered underutilized (mackerel, the two squids, butterfish, and herring).

The long-term population trends for herring and mackerel, the principal pelagic species, have fluctuated considerably during the last 25 years (Fig. 2-1). The abundance index reached minimal levels in the mid-1970's, reflecting pronounced declines for both species (as well as the collapse of the Georges Bank herring resource). Both species have been increasing in recent years. Atlantic mackerel recovered during the 1980's, and stock assessments indicate a total stock in excess of 2.5 million t. Mackerel landings in 1991 were very low—only 62,700 t. Clearly, large quantities of mackerel are unused (Table 2-1), though some uncertainty in assessments remain. Growth, maturity rates, and productivity declined as the stock has grown.

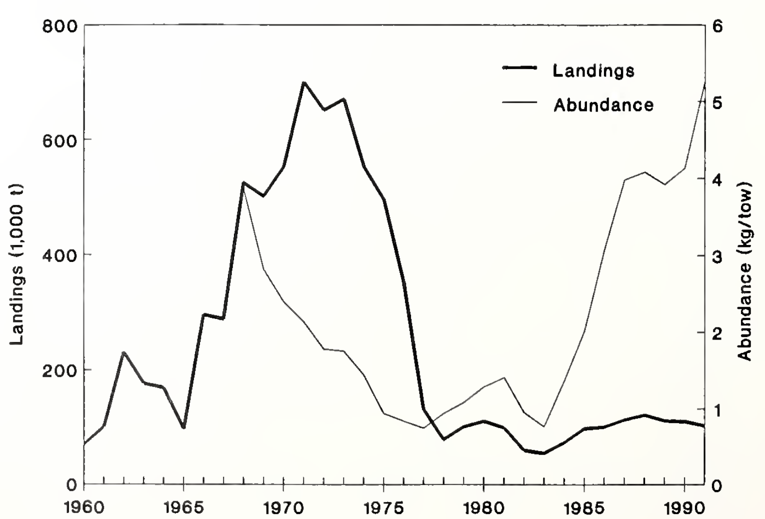


Figure 2-1.—U.S. commercial landings and abundance indices for Atlantic herring and Atlantic mackerel off the northeastern U.S. coast, 1960-91. Abundance indices are mean weight (kg) per tow taken in Northeast Fisheries Science Center (NEFSC) spring bottom trawl surveys. Landings data are for the Georges Bank and Gulf of Maine herring stocks and for the coastwide Atlantic mackerel stock throughout its range.

... SPECIES AND STATUS

The total Atlantic herring resource of the northeast U.S. is considered underutilized. Total landings from the Gulf of Maine stock in 1991 were 46,800 t, representing a substantial increase from the 1983 level. The Georges Bank herring stock was virtually extirpated, following landings in excess of 370,000 t in 1967 and later nonsustainable landings levels. This herring stock has now recovered, based on U.S. and Canadian bottom trawl surveys and larval fish studies in the region, and the most recent assessment. Herring is now reclassified as underutilized in this report.

Of the two squids, the long-finned squid is the most important, due to the significant international export market (primarily to Italy and Spain). Nevertheless, both squid stocks are considered underutilized. Surveys of both species indicate that their numbers are above average levels, while landings are below historical levels. Seasonal changes affect the availability of both species to fishermen, especially the short-finned squid.

Butterfish are likewise considered underutilized, based on current research survey results and historic landings patterns. Landings of butterfish have declined significantly in recent years, primarily due to reduced export demand. The stock is currently being fished well below its LTPY (Table 2-1).

Bluefish landings peaked in 1980 at 72,600 t, and have declined to an average of 25,100 t in recent years (Table 2-1). Most landings (over 80%) are by recreational fishermen. 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 1980's, and that the stock is fully utilized.

Table 2-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of northeast U.S. pelagic fisheries. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY) = 470,000 t
Current potential yield (CPY) = 640,000 t
Recent average yield (RAY)[1] = 166,600 t (130,500 t, U.S. only)

Species	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Atlantic mackerel[2, 3, 4]	62,700	400,000	200,000	Under	Above
Atlantic herring	46,800	120,000	120,000	Under	Above
Bluefish[3]	25,100	30,000	60,000[5]	Full	Near
Squids					
Long-finned	19,300	44,000	44,000	Under	Near
Short-finned	10,100	30,000	30,000	Under	Above
Butterfish	2,500	16,000	16,000	Under	Above

[1]1989-91 average (including foreign and recreational catches).
[2]Includes more than 100 t of foreign landings (primarily Canadian).
[3]Includes more than 100 t of recreational landings.
[4]For mackerel, U.S. landings are only 26,600 t (47%) of the RAY.
[5]Provisional LTPY's, based on historical landings patterns.

ISSUES

Scientific Advice and Adequacy of Assessments

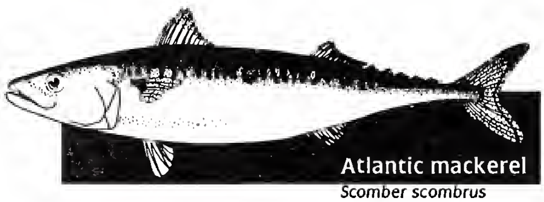
Although historical data on catches and fishing effort are adequate for assessment purposes, stock assessments for northeast pelagic resources are still relatively imprecise, owing to the highly variable trawl survey indices, the short life span of some stocks (squids and butterfish), and low exploitation rates of some species. More precise assessments will require the development of hydroacoustic sampling of pelagic biomass, combined with trawling surveys to separate species components of the pelagic resource. More precise assessments for short-lived stocks will depend on the availability of more appropriate survey and commercial performance data.

Underutilized Species

All the pelagic stocks except bluefish are considered underutilized. Present commercial landings are well below CPY's, for the complex of stocks CPY's exceed RAY's by 284% (473,400 t). Current stock sizes of these underutilized stocks are somewhat uncertain (see above), but nevertheless yield potentials substantially exceed current landings, even if conservative stock size calculations are assumed.

Bycatch and Multispecies Interactions

Concentrations of schooling fish such as the northeast pelagics are utilized by an array of predatory fishes, marine mammals, and birds. In winter months, fisheries directed for Atlantic mackerel, herring, and squids take some marine mammals including pilot whales and common dolphins. Intensification of these pelagic fisheries to take advantage of these underutilized resources may result in greater marine mammal kills.



Atlantic mackerel
Scomber scombrus

Current large stock sizes of these pelagic resources may be resulting in increased predation on larval fishes, particularly due to mackerel predation on Georges Bank and in southern New England in late winter and spring when larvae of many groundfish species are present. The potential impacts of current high stock sizes of pelagic resources on recovery prospects for groundfish are unknown.

INTRODUCTION

The anadromous species of the Atlantic seaboard are a diverse group, including river herrings (alewife, blueback herring, and hickory shad), American shad, striped bass, Atlantic salmon, sturgeons (Atlantic and shortnosed), and rainbow smelt. Regulation of these stocks is likewise diverse: ASMFC has implemented an FMP for river herrings and American shad, while shortnosed sturgeon is managed under a recovery plan prepared under the Endangered Species Act. Atlantic salmon are regulated by a New England Council FMP and under the auspices of the North Atlantic Salmon Conservation Organization (NASCO). Striped bass are regulated under an ASMFC FMP and special congressional authority under the Striped Bass Conservation Act (implemented by NMFS and USFWS). Current commercial landings of Atlantic anadromous species (Table 3-1; Fig. 3-1, 3-2) are only about 3,800 t, far below historical levels. Several of the species are or were of major recreational importance to the region (including American shad, striped bass, and Atlantic salmon).

Landings of Atlantic anadromous species have declined greatly in recent years. River herring catches peaked in the 1960's at about 27,000 t coastwide, but have since declined to less than 2,000 t annually. Likewise, commercial landings of American shad had a recent peak of 3,000 t in 1970, but are only about 1,000 t now. Striped bass commercial landings were over 6,000 t in 1973, but decreased to less than 1,000 t by 1985, where they have remained. Recent trends in catches of Atlantic salmon are down (to about 6,000 fish), following catches of over 10,000 fish in the 1980's.

Table 3-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of Atlantic anadromous fisheries. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituted.

Long-term potential yield (LTPY) =	3,773 t
Current potential yield (CPY) =	3,773 t
Recent average yield (RAY)[1] =	3,773 t

Species	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Alewife	1,200	Unknown	Unknown	Variable by river	Variable
American shad	1,100	Unknown	Unknown	Variable by river	Variable
Striped bass[2]	1,400	Unknown	Unknown	Full	Near
Sturgeons	73	Unknown	Unknown	Variable by river	Below
Atlantic salmon	(5,000)[3]	500[4]	Unknown	Over	Below

[1]1989-91 average (including foreign and recreational catches).
[2]Includes significant recreational landings.
[3]Atlantic salmon RAY in numbers of fish, primarily intercepted in distant-water commercial fisheries.
[4]Atlantic salmon CPY in numbers for U.S. waters only

SPECIES AND STATUS

Unlike most of the northeast's offshore fishes, Atlantic anadromous stocks have been heavily influenced by nonfishing human activities in the coastal zone. Damming of rivers preventing occupation of former spawning grounds was a major factor in the decline of Atlantic salmon, sturgeons, river herrings, and shad. Environmental contamination is implicated in the declines of several species. Today, not only are these species threatened by coastal pollution and development, but interception fisheries (sometimes far from the spawning grounds) by foreign fishermen hinder the recovery of some species.

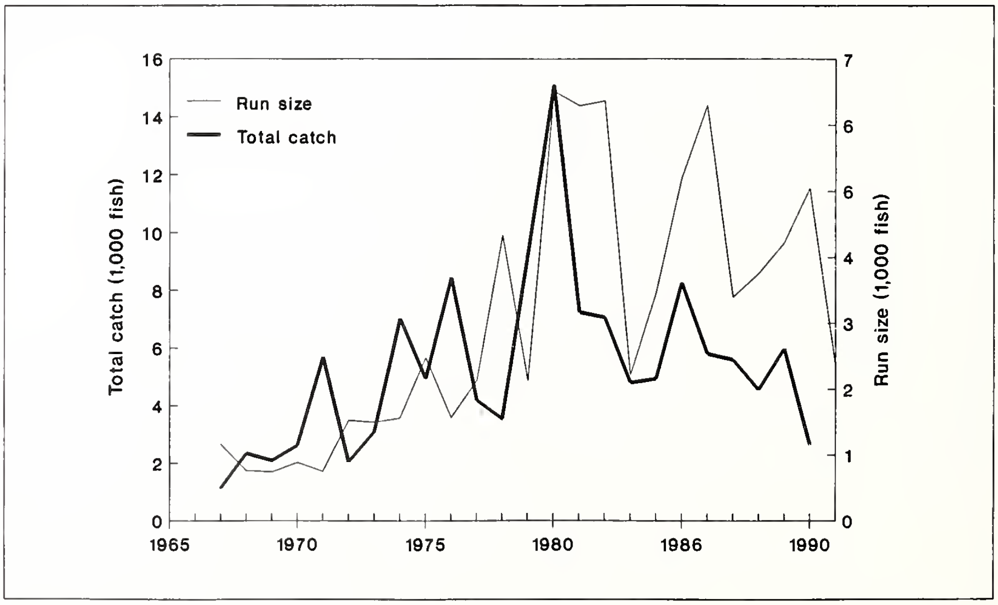
Alosa sapidissima

Atlantic Salmon

Atlantic salmon historically spawned in large river systems throughout New England. As a consequence of industrial and agricultural development, most of the runs native to New England have been extirpated. Today, the only self-supporting U.S. salmon runs are in Maine. Restoration efforts, in the form of stocking and fish passage construction, are underway in the Connecticut, Pawcatuck, Merrimack, and Penobscot rivers. Atlantic salmon migrate to sea after 2 or 3 years in U.S. rivers. While at sea they generally undergo extensive migrations to Canadian, Greenland, and international waters.

The sizes of Atlantic salmon spawning runs in Maine rivers are given with the estimated U.S. and distant-water catches, in Figure 3-1. Fisheries in U.S. waters are limited to angling in Maine. Salmon kept by anglers have averaged 380 fish in recent years, which represents approximately 10% exploitation of the run to Maine rivers. Distant-water fisheries (the commercial gillnet fisheries in Canada and Greenland) have been evaluated by extensive tagging of U.S. origin fish. Harvest estimates from tagging studies put exploitation rates of U.S. fish at between 60 and 80% in these oceanic fisheries. These commercial oceanic fisheries are regulated under the auspices of NASCO. Canadian interception fisheries have been regulated by time-area restrictions and quotas; beginning in 1992, the fishery in Newfoundland was closed for a 5-year period. The Greenland fishery is quota controlled.

Figure 3-1.—Estimated sizes of spawning runs of Atlantic salmon to Maine rivers (numbers of fish) and the total catch by U.S. anglers and foreign commercial fishermen of fish from those rivers, 1967-91. The foreign salmon catch is estimated from data on tagged and recaptured salmon.



Striped Bass

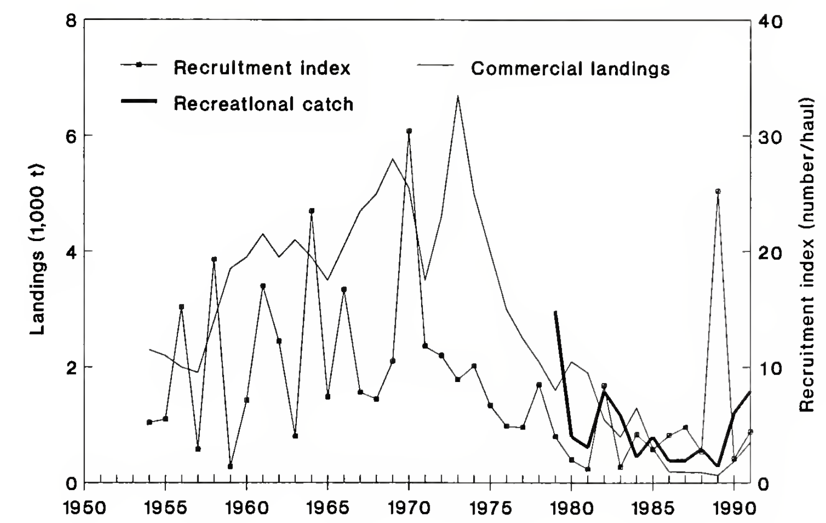
Three primary stocks of striped bass occur along the Atlantic coast: Hudson River, Chesapeake Bay, and Roanoke River (N.C.). Striped bass stocks historically have supported important commercial and recreational fisheries, with recreational harvests often equalling or exceeding commercial landings (Fig. 3-2). Com- mercial fishermen use a variety of gears including haul seines, trawls, pound and gill nets, and hook-and-line. Commercial landings peaked in 1973, and then began a precipitous decline. The declining landings coupled with consistently poor recruitment in the Chesapeake Bay provided an impetus for highly restrictive management actions taken by ASMFC in the mid-1980's. Additionally, the U.S. Congress passed the Striped Bass Conservation Act (SBCA), empowering the Departments of Commerce and Interior to impose a moratorium on striped bass fishing in any state which ASMFC found not in compliance with its FMP.

In 1989 high recruitment in the Chesapeake Bay (Fig. 3-2) triggered a

. . . Striped Bass

slight relaxation of management restrictions and allowed increased fishing pressure on migratory Atlantic striped bass stocks, beginning in 1990. The fisheries are being closely monitored and remain severely restricted. Modeling studies indicate that stocks should continue to recover if fishing annually removes 22% or less of the legal-sized fish.

Figure 3-2.—Striped bass catches in commercial and recreational fisheries, and the recruitment index (Maryland "seine index") of young striped bass abundance in the Chesapeake Bay, 1954-91. The recruitment index in the average catch per seine haul.



ISSUES

Transboundary Stocks and Jurisdiction

The interception of U.S.-origin salmon in commercial fisheries off Canada and West Greenland represents a major impediment to the restoration of runs and salmon fisheries in the United States. Currently, that catch of U.S.-origin fish is about 10 times the U.S. recreational catch.

Habitat Concerns

The difficulty of the passage of sea-bound Atlantic salmon smolts and returning adults around dams hampers restoration of wild-run spawning salmon in many rivers. Additionally, many riverine habitats which historically produced juvenile salmon are too degraded to support salmon reproduction. A scenario of long-term climate change may also have considerable influence on Atlantic salmon throughout its range, since juvenile survival and adult feeding distributions appear to be mediated by the distribution of seawater temperatures. Additionally, warmer sea temperatures may negatively influence reproduction in U.S. rivers, which are at the extreme southern limit of the species' range.

Another concern is the effect of poor water quality on larval striped bass survival in Chesapeake Bay. Restrictive management measures have been successful in rebuilding the severely depleted spawning stocks in the Bay. However, if poor water quality prohibits survival of young bass, striped bass restoration will remain threatened. Similarly, river water quality may be an impediment to the maintenance of other anadromous fish stocks.

Management Concerns

An issue of particular concern for striped bass is the potential impact of hook-and-release fishing. Angling effort for striped bass currently far exceeds commercial fishing effort, and during the late 1980's, over 90% of the recreational catch was released alive. If survival rates of hooked and released striped bass are low, then hooking mortality may seriously compromise the conservation benefit of high minimum sizes.

INTRODUCTION

Offshore fisheries for crustaceans and bivalve mollusks are among the most valuable of the region's fisheries. In 1991, landings of American lobster (28,700 t) and sea scallop (22,300 t), were valued at $165 million and $159 million, respectively (Table 4-1). The combined value of these two fisheries alone exceeds that for all offshore finfish fisheries in the region. Additionally, landings of surf clam, ocean quahog and northern shrimp contributed a total of $55 million to the value of the region's fisheries in 1991. These are generally single-species fisheries; only the sea scallop and northern shrimp fisheries generate significant bycatch. Four separate fishery management regimes regulate the harvest of these species: The surf clam/ocean quahog FMP of the Mid-Atlantic Fishery Management Council (MAFMC) and the sea scallop FMP of the New England Fishery Management Council (NEFMC) are Federal plans. The northern shrimp fishery is regulated by the Atlantic States Marine Fisheries Commission (ASMFC). American lobsters in territorial waters are regulated by individual states; a comprehensive inshore/offshore management framework is currently under development by the ASMFC and the NEFMC.

Table 4-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of northeast invertebrate fisheries. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum.

Long-term potential yield (LTPY) = 100,200 t
Current potential yield (CPY) = 104,700 t
Recent average yield (RAY)[1] = 105,300 t (100,000 t, U.S. only)

Species	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Surf clam[2]	31,100	32,600	Unknown	Full	Above
American lobster	26,800	27,600	Unknown	Over	Above
Ocean quahog[2]	22,200	22,700	22,700	Full	Near
Sea scallop[2, 3]	21,400	17,400	13,300	Over	Near
Northern shrimp	3,800	4,400	4,000[4]	Full	Near

[1]1989-91 average.
[2]Data for bivalve species are in shucked meat weights.
[3]Transboundary stock with Canada who harvest 25% (5,300 t) of RAY.
[4]Provisional LTPY, based on historical landings patterns.

SPECIES AND STATUS

American Lobster

Lobsters are partially regulated under an FMP of the NEFMC. Because most lobster landings come from state territorial waters, state regulations apply to most catches. American lobster populations are regulated primarily by minimum carapace length or "gauge", currently set at 3.25" (83 mm). Fishing mortality rates for both inshore and offshore populations greatly exceed the fishing rates resulting in maximum cohort yields. The management strategy of increasing the minimum size for landed lobsters is intended to increase average egg production for each new lobster entering the breeding population, since a large fraction of all lobsters landed are juveniles. Because of recent increases in lobster recruitment, short-term losses in yield due to gauge increases have not resulted in diminished landings, even though effort is near record levels in some areas (Fig. 4-1). A program of increases in minimum legal sizes has been suspended, pending the development of a comprehensive fishery management plan for inshore and offshore components of the resource.

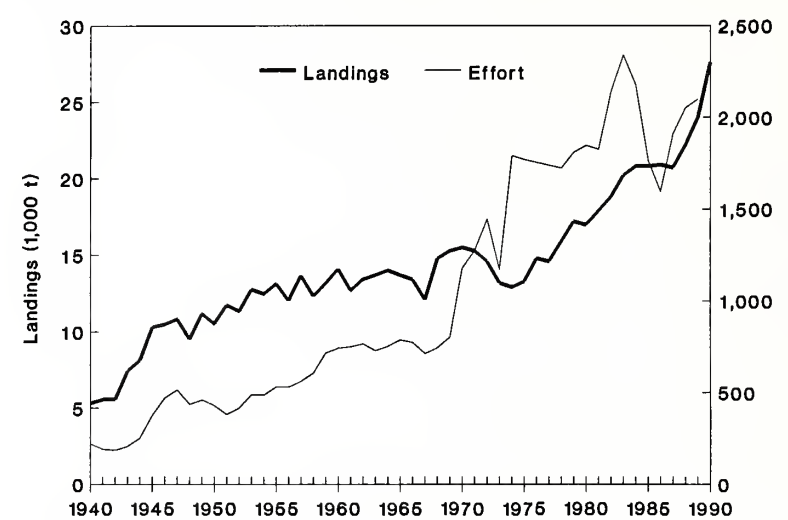


Figure 4-1.—U.S. American lobster landings, 1940-91, and the number of lobster traps fished in Maine coastal waters during that period. In 1990, Maine produced 47% of the U.S. landings of the species.

Sea Scallop

Sea scallops are harvested on the continental shelf from the Virginia Capes to the Hague Line (which separates U.S. and Canadian portions of Georges Bank) and in the Gulf of Maine. Canadian landings on Georges Bank represent a significant fraction of the total (Fig. 4-2). Sea scallops are harvested primarily with a dredge; small quantities of landings are derived with otter trawl nets and by divers (in the Gulf of Maine). The sea scallop FMP of the New England Council regulates the fishery primarily on the basis of maximum meat count regulations (numbers of scallop meats per pound) intended to minimize the catch of small animals. Historically, landings of sea scallops have fluctuated greatly in response to recruitment variability and changing effort patterns by U.S. and Canadian fishermen. Sea scallop populations are characterized by great variability in annual production and little relationship to the annual productivity of the Mid-Atlantic Bight and Georges Bank. Several recent good years have resulted in record high U.S. landings in 1990 and 1991 and a

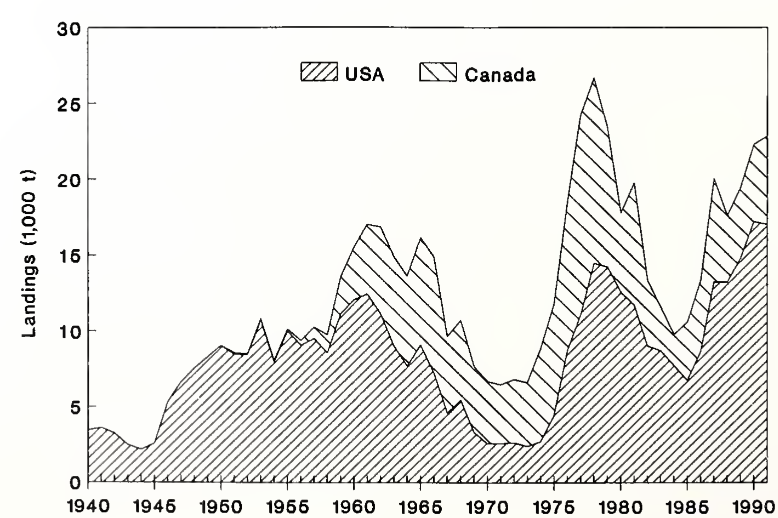


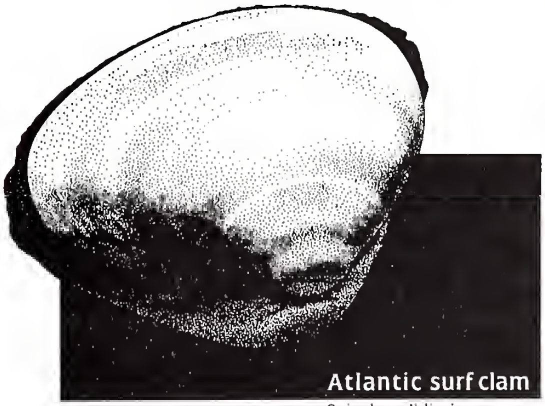
Figure 4-2.—U.S. and Canadian landings of Atlantic sea scallops in the northeastern U.S. and southeastern Canadian waters, 1940-91.

. . . Sea Scallop

significant increase in sea scallop fishing effort in recent years. Under the current meat count regulations, sea scallops are partially vulnerable to the fishery at age 3 and fully vulnerable at age 4. Over 60% of age 4 and older scallops are harvested each year. Given the rapid growth, low natural mortality rates, and early age of vulnerability to the fishery of this species, considerable yield is currently being lost to growth overfishing (harvesting scallops while they are still growing very rapidly). The current high harvest rate is thought to be unsustainable in the long term.

Surf Clam and Ocean Quahog

Surf clam and ocean quahog are harvested with hydraulic dredging vessels; the majority of EEZ landings occur off New Jersey and the Delmarva Peninsula. Small quantities of surf clam and ocean quahog are landed from southern New England and the Gulf of Maine. Fisheries for these species are currently closed on Georges Bank due to paralytic shellfish poisoning (PSP) contamination. Surf clam and ocean quahog are managed under the an FMP of the MAFMC. The primary management measure is a system of individual transferable quotas (ITQ's) allocated on the basis of historical participation in the fisheries. Surf clam landings increased steadily during the 1960's and early 1970's, peaking in 1974. Subsequently, a succession of poor year classes, combined with a large die-off of the surf clam resource off the New Jersey coast in 1976 led to very low stock biomass and resulting landings. Beginning in 1977, the FMP has regulated total annual surf clam landings from the EEZ (where most landings are derived), and has addressed the significant overcapitalization in the fishery. Large year classes spawned in 1976 and 1977 off New Jersey and the Delmarva Peninsula now comprise the bulk of the harvestable biomass of the stock. Under current harvest rates (less than 10% per year) there is sufficient harvestable biomass to support quotas well into the 1990's.



Atlantic surf clam
Spisula solidissima

Ocean quahog landings increased rapidly as the surf clam resource collapsed in the mid-1970's, and a market substitute for processed clam products was needed. Ocean quahogs inhabit relatively deep waters of the Mid-Atlantic continental shelf and on Georges Bank. In the Gulf of Maine they are found relatively close to shore in the cooler waters. The species is extremely slow growing, and ages in excess of 100 years are common in the populations (particularly in the Mid-Atlantic region). Current annual landings have been maintained at <2% of the estimated standing stock of the species, recognizing its limited annual productivity.

Northern Shrimp

Northern shrimp are harvested exclusively from the Gulf of Maine in small-mesh trawl fisheries. Northern shrimp are at the southern extent of their geographical range in U.S. waters. ASMFC regulates the northern shrimp fishery in the Gulf of Maine; regulations control the length of the harvesting season (December to May) and the gear to be used.

ISSUES

Management Concerns

The overutilization of the sea scallop stocks is resulting in a substantial loss of yield in the short term and endangering the long-term productivity of the resource. The NEFMC is developing an FMP amendment aimed at reducing the rate of fishing on sea scallop. Measures are likely to include provisions to reduce fishing effort and perhaps a removal of the meat count requirement. The current meat count regulations do little to control the overall rate of fishing mortality, but do offer some protection to young scallops.

American lobster management is complicated by the international trade in live lobsters between Canada and the United States. Conformity of imports with U.S. minimum gauge limits is a major political issue. Despite recent landings increases, the fishery is predominantly supported by lobsters at the legal size limit which is a serious problem for the long-term health and stability of these fisheries. The occurrence of poor reproduction in any one year would result in a major downturn in the fishery, since there are few older animals from previous year's spawning left to harvest.

Bycatch and Multispecies Interactions

The trawl fishery for northern shrimp has, in the past, generated considerable bycatch and associated discard of groundfish in the Gulf of Maine region. Growing concern over the fate of groundfish resources has led to the adoption of a fish excluding device (the "Nordmore Grate") as a condition of participation in this fishery. Sea sampling effort has been directed to this fishery to determine the impact of use of this technology on groundfish bycatch rates. Bycatch of goosefish in the sea scallop fishery has come under increased scrutiny as a source of fishing mortality on the goosefish stock, and particularly on very small fish.

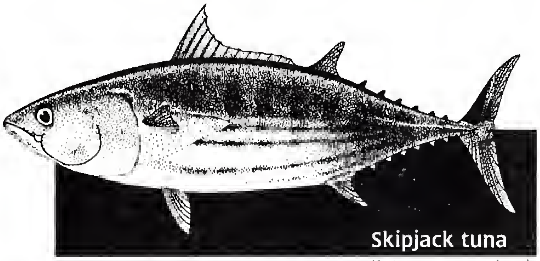
Progress

An important issue in the surf clam-ocean quahog fishery is the implementation of an ITQ system; this has obviated the need for complex restrictions on the amount of effort and times each surf clam vessel could fish. The total surf clam fleet has been reduced substantially since implementation of the ITQ system—from about 160 to less than 100 vessels in the first year alone. In the future there is likely to be further consolidation of fishing with a smaller number of vessels, as well as construction of new and more efficient vessels to reduce overhead.

Considerable progress in assessment of exploited invertebrate stocks of the northeast region has been made in the past year using newly developed methods. For the first time, an integrated assessment of combined inshore/offshore lobster stocks was undertaken by NMFS and state scientists in 1991-92.

INTRODUCTION

Oceanic pelagics are highly migratory species that include swordfish, bluefin tuna, yellowfin tuna, bigeye tuna, albacore, skipjack tuna, blue and white marlin, sailfish, longbill spearfish, and other minor fishes. In the Atlantic Ocean, swordfish and bluefin tuna have long provided important fisheries, while in recent years yellowfin tuna have increased in importance to U.S. fishermen. Many recreational anglers target blue marlin, white marlin, and sailfish in U.S. waters and occasionally longbill spearfish. Commercial fishing for these billfish species in U.S. waters is now banned; however, they may be accidentally caught on tuna and swordfish longlines.



Skipjack tuna
Katsuwonus pelamis

Since Atlantic oceanic pelagics migrate widely and are harvested over broad oceanic areas by U.S. and foreign fishermen, both national and international management are necessary. In all cases, stock assessments based on aggregate data provide the bases for regulations. U.S. fleets fish in the northwestern Atlantic Ocean, Caribbean Sea, and Gulf of Mexico. When in U.S. jurisdiction, the fleets may be regulated under the Magnuson Fishery Conservation and Management Act (MFCMA) as well as international agreements through the International Commission for the Conservation of Atlantic Tunas (ICCAT). U.S. fishery management plans have been developed for swordfish, blue marlin, white marlin, sailfish, and spearfish under the MFCMA. Bluefin tuna fishing has been regulated for nearly a decade under international regulations, and international regulations are being developed for swordfish fishing on the high seas.

SPECIES AND STATUS

From the early 1960's through 1977, U.S. fishermen averaged about 5,000 t per year (2,000-12,000 t/year) of oceanic pelagics (Fig. 5-1). Since 1978, U.S. fishermen have caught 8,000 t or more per year, and during 1988-90 they averaged 16,512 t/year. However, the estimated current potential yield of oceanic pelagics is 11,519 t/year, and the long-term potential yield to the U.S. fleet is estimated at 24,667 t/year (Table 5-1).

Since 1960, the top species in the U.S. harvest has shifted from bluefin tuna to swordfish to yellowfin tuna (Fig. 5-1) as each species became increasingly overutilized. During 1961-73, bluefin tuna represented 45-80% of the U.S. western Atlantic catch. But since 1977, the percentage has dropped to less than 10%, reflecting the crash in the bluefin tuna population (Fig. 5-1), catch restrictions, and the increasing harvests of alternate species. During 1961-73, swordfish represented 5-20% of the U.S. catch, rose to 60% in 1982, but has since dropped to about 33% (Fig. 5-1). During 1961-83, the percentage of yellowfin tuna in the U.S. North Atlantic catch was usually less than 10%, but that has since risen to 45%.

The U.S. dockside value of these fishes soared from about $20 million (early 1980's) to over $100 million in 1988. During 1987-89, the average annual dockside value was $96.5 million.

Angler harvests of large pelagic fishes are hard to tally because their catch is comparatively small. Also, tagging and releasing of some species have grown in recent years, so fewer are landed. The average annual catch by recreational anglers for 1987-89 is conservatively estimated at 1,900 t. Fishing tournament surveys indicate a substantial increase in billfish fishing since 1972, though there are no precise data on these recreational anglers. Billfish tournament growth in some southern states indicates a fivefold to tenfold increase in this fishery since 1972. More data are needed, however, to quantify the recreational fishery trends for these fishes in the U.S. Atlantic and Gulf waters.

At least two Atlantic pelagic species are far overutilized. Recent swordfish harvests have heightened the risk of a population

... SPECIES AND STATUS

collapse: Though international swordfish protection rules have been adopted, they may not prevent serious production losses. Bluefin tuna have been overharvested, the stocks severely depleted, and as a result the harvest of this valuable species has been restricted since 1982. In spite of the current restrictions, there has been no apparent increase in adult numbers.

Figure 5-1.—U.S. landings of tunas, swordfish, marlins, sailfish, and spearfish from the western North Atlantic Ocean, and the percentage of the total landings made up of the primary species (bluefin and yellowfin tuna and swordfish), 1961-91.

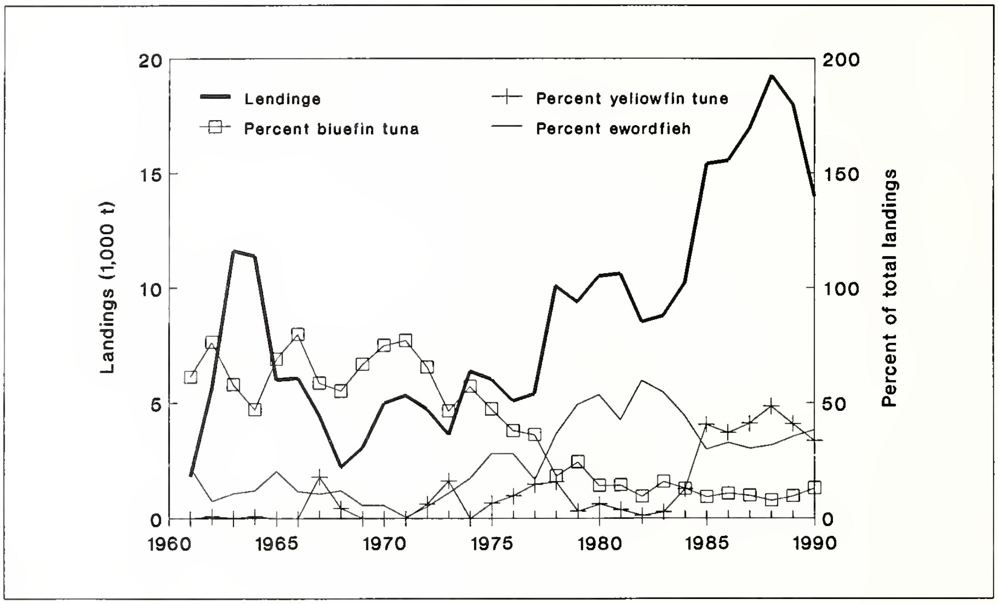


Table 5-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of Atlantic highly migratory pelagic species. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituteo.

Long-term potential yield (LTPY)[1] = 24,667 t
Current potential yield (CPY)[1] = 11,519 t
Recent average yield (RAY)[1, 2] = 16,512 t

Species and area	Yield (t) RAY[2, 3]	CPY[2]	LTPY[2]	Status of utilization	Status of stock level
Bigeye tuna (Atlantic)	63,233	Unknown	71,400	Under	Above
Albacore (N. Atlantic)	33,433	Unknown	48,000	Moderate to full	Near
Yellowfin tuna (W. Atlantic)	27,233	Unknown	33,000	Unknown	Unknown
Skipjack tuna (W. Atlantic)	22,500	Unknown	33,000	Possibly full	Near
Swordfish (N. Atlantic)	17,182	5,300	13,700	Over	Below
Bluefin tuna (W. Atlantic)	2,874	1,400	11,000	Over	Below
Billfishes					
Blue marlin (N. Atlantic)	1,086	Unknown	2,400	Full	Below
White marlin (N. Atlantic)	262	Unknown	Unknown	Unknown	Unknown
Sailfish (W. Atlantic	677	Unknown	Unknown	Unknown	Unknown
Other tunas (Atlantic)	58,500	Unknown	Unknown	Unknown	Unknown

[1]Total LTPY, CPY, and RAY based only on the U.S. portion of the yield under present fishing patterns.

[2]1988-90 average.

[3]Individual LTPY's, CPY's, and RAY's based on entire stock, regardless of harvesting nation.

ISSUES

Transboundary Stocks

Regulation of species that migrate across international boundaries is always difficult. Domestic regulation without international agreements is inherently limited, but international agreements can be difficult to achieve. The latter is particularly true if the primary fishing nations cannot agree on fishing and conservation objectives. Some nations see such rules as too restrictive of short-term gains, while others see them as too lax for long-term conservation.

Bycatch and Multispecies Interactions

Marlin and sailfish bycatches in tuna and swordfish fisheries are a major concern, especially as commercial fisheries move onto concentrations of billfishes important to recreational anglers.

Expansion of the U.S. longline fishery for Gulf yellowfin tuna and Spanish longline fishing in the tropical eastern Atlantic have heightened concern for distressed Atlantic tunas, swordfish, and the billfishes sought by recreational anglers.

Bycatch and Multispecies Interactions

A new Highly Migratory Species Division has been established at NMFS headquarters to coordinate management of these stocks with the regions, councils, and ICCAT commissioners. In 1992 catch quotas for swordfish were implemented to reflect new resource assessments by ICCAT under the Atlantic Tunas Convention Act. Bluefin tuna regulations on bycatch, angler caught bag limits, and seasonal closures have been modified in efforts to meet ICCAT recommendations to reduce the harvest by 10% per year. To improve monitoring of the fishery, the angling survey was expanded significantly to cover as much of the fleet as possible. Both private and charter vessels were included and quota monitoring improved accordingly.

INTRODUCTION

About 350 species of sharks are known worldwide. Of those, 72 frequent waters of the U.S. Atlantic, Gulf of Mexico, Puerto Rico, and U.S. Virgin Islands. For many years sharks were fished moderately and only in limited coastal areas. In recent years, however, large coastal sharks have been intensively fished over broad geographic areas. Sharks were first fished primarily for their livers (for vitamin A) and hides (for leather). Other minor products were fresh and salted meat, dried fins for Oriental sharkfin soup, and fish meal. The appearance of low-cost, synthetic vitamin A ended some of the small shark fisheries in 1950, and there was little demand for shark flesh or other products in the United States before 1970. In the 1980's, however, shark has become popular due to better handling, marketing, promotion, and an economy favoring low-cost shark over more expensive fish (Fig. 6-1).

Shark fishery management regulations are in preparation. A Secretarial shark fishery management plan is being developed by the National Marine Fisheries Service for the Secretary of Commerce.

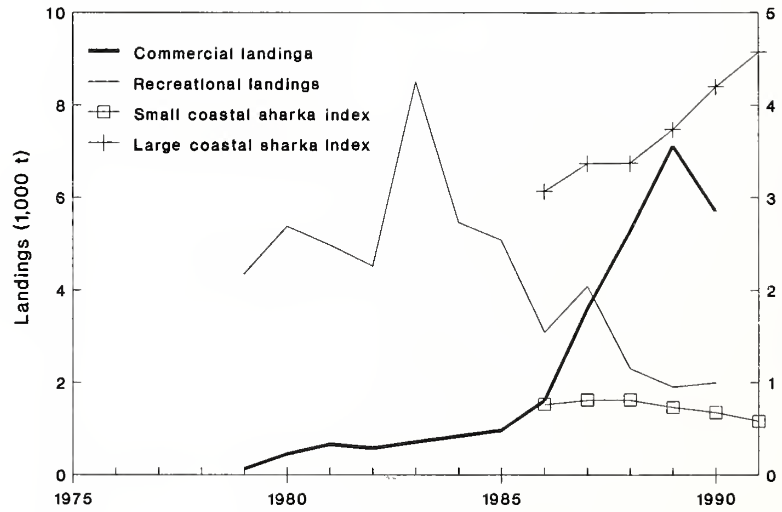


Figure 6-1.—U.S. commercial and recreational landings and abundance indices of large and small coastal Atlantic sharks, 1979-90.

SPECIES AND STATUS

Under the Magnuson Fishery Conservation and Management Act (MFCMA), U.S. Atlantic sharks have been divided into three management groups (Table 6-1): 1) Large coastal sharks (white, tiger, lemon, smooth and great hammerhead, basking, whale, blacktip, sandbar, reef, dusky, spinner, silky, bull, bignose, Galapagos, night, ragged tooth, nurse, and scalloped); 2) small coastal sharks (Atlantic and Caribbean sharpnose, finetooth, blacknose, bonnethead, and Atlantic angel); and 3) pelagic sharks (longfin and shortfin mako, blue, porbeagle, thresher, bigeye thresher, oceanic whitetip, sevengill, sixgill, and bigeye sixgill).

Both U.S. recreational and commercial shark fishermen seek coastal sharks along the Atlantic seaboard. Pelagic sharks are targeted by tournament anglers, particularly off the Mid-Atlantic states, and are incidentally caught by swordfish and tuna longliners. The dockside value of the commercial shark fisheries has averaged about $7 million annually in recent years.

Anglers fish for sharks on both tournament and nontournament trips, the latter being the more prevalent. Nontournament anglers usually catch small coastal sharks that are generally not targeted by commercial fisheries. However, commercial and recreational fishermen can affect the shark

. . . SPECIES AND STATUS

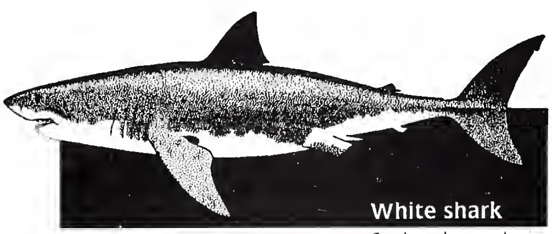
fishing of each other. The Gulf shrimp fishery catches and discards many small coastal sharks (mostly sharpnose). Also, headboat anglers depend on blacktip sharks, a species seasonally taken by longline and drift gillnet fishermen. Many southern shark tournament anglers also fish for the same large coastal species taken by commercial fishermen. Tournament anglers farther north (Mid-Atlantic states and southern New England) fish for shortfin mako and blue sharks that are caught incidentally by large pelagic longline fisheries. In another twist, sharks taken by anglers along the Atlantic and Gulf coasts are often sold to commercial fish buyers (in 1986 about 9% of the "commercial" landings were taken by rod-and-reel fishermen).

Meanwhile, a mobile longline fishery targets large coastal sharks in both Atlantic and Gulf waters, taking several species important to anglers. Fish buyers prefer sharks of 15-50 pounds (dressed weight), but larger sharks may be killed just for their fins.

Other boats use gill nets, including drift gill nets, for blacktip shark near shore in late summer and early autumn. Gulf snapper-grouper boats, particularly bottom longliners, also land sharks. Many sharks caught by Gulf shrimp trawlers are discarded at sea (though fins may be saved), but large valuable sharks are kept and sold.

Many sharks are also caught in the pelagic swordfish and tuna longline fishery. Worth little or nothing, most of these sharks are discarded at sea, though shortfin mako are regularly landed owing to their market value.

The data available on shark fisheries is very limited. Many species are landed and classified only as "shark" by fishermen and dealers in the market. To overcome some of these data deficiencies, newly developed assessment models were applied to the data available to generate assessment information by group: Large coastal sharks are considered overutilized; small coastal sharks are considered underutilized. There is insufficient information to assess the status of pelagic sharks.



White shark
Carcharodon carcharias

Table 6-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of Atlantic sharks. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituted.

Long-term potential yield (LTPY) =	9,730 t
Current potential yield (CPY) =	7,630 t
Recent average yield (RAY)[1] =	9,530 t

Species and area	Yield (t) RAY[2, 3]	CPY[2]	LTPY[2]	Status of utilization	Status of stock level
Large coastal sharks[2]	3,800	1,900	3,400	Over	Below
Small coastal sharks[3, 4]	3,000	3,000	3,600	Under	Above
Pelagic sharks[5]	2,730	Unknown	Unknown	Unknown	Unknown

[1]1988-90 average.

[2]Includes sandbar, reef, blacktip, dusky, spinner, silky, bull, bignose, Galapagos, night, tiger, lemon, ragged tooth, nurse, scalloped, smooth and great hammerhead, whale, basking, and white sharks.

[3]Includes Atlantic and Caribbean sharpnose, finetooth, blacknose, bonnethead, and Atlantic angel sharks.

[4]Almost all of the small coastal shark yield is caught as bycatch in the Gulf shrimp fishery and discarded at sea.

[5]Includes longfin and shortfin mako, blue, porbeagle, thresher, bigeye thresher, oceanic whitetip, sevengill, sixgill, and bigeye sixgill sharks.

ISSUES

Scientific Information and Adequacy of Assessments

Many species of shark are fished and many are difficult to distinguish. The market generally does not categorize sharks by species. This complicates scientific analysis although assessments for groups of species have been made. There is a critical lack of data on shark numbers, biology, distribution, life history, and harvest. Without such data, it is difficult to assess the status of particular species.

Management Concerns

Stock size concerns: Recreational and commercial fishermen have both voiced concern about declining shark populations. Since sharks grow and reproduce slowly, they are vulnerable to overfishing.

A common commercial fishing practice is to remove only the fins from a shark and discard the carcass overboard. Finning is criticized by the public in general as being both cruel and wasteful.

Progress

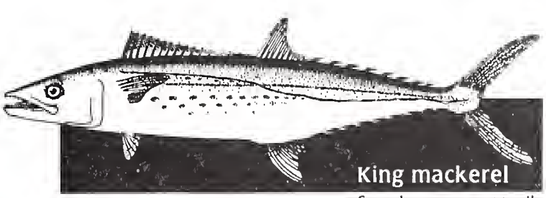
A new fishery management plan has been developed by NMFS for sharks. It regulates commercial and recreational shark fishing to prevent overfishing, rebuild currently overfished stocks, and improve data collection and monitoring. The FMP was released for public comment in 1992 and is being revised in light of the extensive comments received and new fishery data which has been made available by fishermen and processors.

INTRODUCTION

Coastal pelagic fishes include king mackerel, Spanish mackerel, cero, dolphin (common and pompano), and cobia. These species range in coastal and continental shelf waters from the northeastern United States through the Gulf of Mexico, and as far south as Brazil. Coastal pelagics are generally fast swimmers that school and feed voraciously, grow rapidly, mature early, and spawn for extended periods.

U.S. and Mexican commercial fishermen have fished Spanish mackerel since the 1850's and king mackerel since the 1880's. The Spanish mackerel fishery began off New York and New Jersey but shifted southward through the decades to the southern U.S. Atlantic and Gulf of Mexico. In 1990, over 90% of the commercial catch was landed in Florida. Although early commercial fisheries harvested Spanish mackerel by hook and line, nearly all the commercial catch essentially is by run-around gill net. A recreational fishery also exists for Spanish mackerel and accounts for about half of all the Spanish mackerel landed.

King mackerel are commercially fished from Chesapeake Bay southward. Four major production areas exist: North Carolina; New Smryna Beach, Fla. to Palm Beach, Fla.; the Florida Keys; and Naples, Fla. A fifth area, Grande Isle, La., existed in the early 1980's, and the area was believed to harbor older females that served as a major spawning population for Gulf king mackerel. Fishing mortality was believed to be very high on these fish during the late 1970's and early 1980's, but few fish are now taken in this region, and it no longer contributes significantly to the fishery. The commercial king mackerel fishery through the years has employed gill nets, troll lines, handlines, purse seines, otter trawls, and pound nets. King mackerel sport fisheries exist off many southeastern states throughout the year. Commercial yields were mostly unregulated until the 1980's, and recreational landings are thought to have been reduced by an expanding commercial net fishery in the 1970's.


King mackerel
Scomberomorus cavalla

Coastal pelagics are managed under the joint Coastal Migratory Pelagic Resources Fishery Management Plan and regulations adopted by the South Atlantic and Gulf of Mexico Fishery Management Councils. Total allowable catch quotas are established for two distinct migratory groups: Gulf Migratory Group and Atlantic Migratory Group. Allowable biological catches are defined for separate geographical areas within the Gulf group and for separate user groups. Quota management began in the 1985-86 fishing year, and at present both commercial and charterboat operators must hold permits to fish king mackerel, Spanish mackerel, or other coastal pelagics. Recreational catches are regulated by creel and size limits. In addition to quota limits, commercial catches are under minimum size restrictions, and in some states, daily landing limits and/or trip limits apply. Although Mexican catches are thought to be large, only U.S. fishermen are currently regulated.

SPECIES AND STATUS

Recreational fishermen caught 8,000-17,000 t/year of coastal pelagic species and commercial fishermen caught 5,000-10,000 t/year during 1979-91 (Fig. 7-1). King and Spanish mackerel account for about 90% of all coastal pelagic species harvested. In addition to king and Spanish mackerel, Atlantic dolphin and cobia contributed significantly to the total recreational yield of coastal pelagics. Some cobia are incidentally caught by commercial mackerel fishermen. Cero are relatively unimportant and are usually taken in other fisheries. In general, cero do not form large schools and thus are more difficult to target as a single species.

As a group, coastal pelagics yield only about 53% of its long-term potential (Table 7-1), and many species are fished near or over maximum production levels. Three of the four mackerel stocks are overexploited and have been under a rigid rebuilding schedule since 1983.

The Gulf king mackerel stock is believed to have a large long-term potential, but it is severely depleted. Recent average annual

. . . SPECIES AND STATUS

production is at 25% of its maximum level, and major stock reductions were due to excessive harvests from the late 1970's through the early 1980's. Liberal fishing rules and sparse data hampered conservation until 1986.

The Atlantic king mackerel group is near maximum production. Spanish mackerel is below maximum production but is recovering. The status of cobia and dolphin in the southeastern Atlantic is unclear. Recent information suggests that the cobia resource in the Gulf of Mexico might be approaching full exploitation. They are mostly caught by anglers, but data needed to assess long-term production is limited.

Figure 7-1.—Atlantic coast migratory pelagic fish landings and abundance (biomass) indices for king and Spanish mackerels, 1979-90.

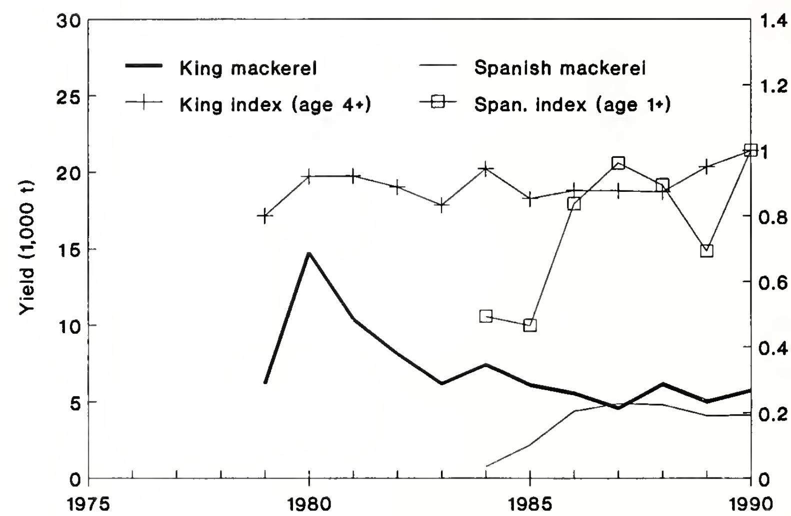


Table 7-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of Atlantic coastal migratory pelagic species. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituted.

Long-term potential yield (LTPY) =	27,374 t
Current potential yield (CPY) =	18,837 t
Recent average yield (RAY)[1] =	15,838 t

Species and area	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Dolphin	4,430	Unknown	Unknown	Unknown	Unknown
King mackerel					
Gulf of Mexico	2,622	2,040	9,750	Over	Below
Atlantic	2,969	4,533	3,632	Under	Above
Spanish mackerel					
Gulf of Mexico	1,979	3,626	5,535	Over	Near
Atlantic	2,576	2,946	3,702	Over	Near
Cobia	1,240	Unknown	Unknown	Unknown	Unknown
Cero mackerel	22	Unknown	Unknown	Unknown	Unknown

[1]1988-91 average.

ISSUES

Transboundary Stocks and Jurisdiction

Coastal pelagic species will continue to require the coordination of Federal, state, and international regulatory actions to accommodate the migratory behavior of the mackerels. In the future, determination of the status of the western Gulf of Mexico resource will require an increase in the information base of Mexican catches and biological data.

Allocation

Allocation of the yield between recreational and commercial users remains an important issue. Future allocation decisions will require an increase in the precision and accuracy of user specific harvest levels and in the spatial segregation of the resource.

INTRODUCTION

"Reef fish" include species that prefer coral reefs, artificial structures or other hard bottom areas, and tilefishes that prefer sandy bottom areas. They range along the coast to a depth about 150 m, depending on the species and region. Reef fish fisheries vary greatly by location and species; they are extremely complex and have many users: Commercial, artisanal, recreational, and scientific. Anglers specialize in fishing for food, sport, and trophies, and they operate from charterboats, headboats, private boats, and shore, using fish traps, hook and line, longlines, bandit rigs, spears, trammel nets, and barrier nets.

Fisheries for reef fish species are closely associated with fisheries for other reef fisheries including spiny lobster, conch, stone crab, corals, "live" rock, and ornamental aquarium species. Nonconsumptive uses of reef resources (e.g., ecotourism, sport diving, education, and scientific research) are also economically important and can conflict with traditional commercial and recreational fisheries. Although reef fish have been caught for centuries, good statistical data for most areas began in the late 1970's when recreational fishery surveys were started. Fishery data collection remains difficult because of the existence of diverse user groups, broad geographical areas, and many ports where fish are landed. Fishing pressure has increased with growing human populations, greater demands for fishery products, and technological improvements, such as longlines, wire fish traps, electronic fish finders, and navigational aids.

Reef fisheries vary widely by area. In most cases, the current and long-term potential yields are unknown, though for many species they are probably higher than present average yields would indicate (Table 8-1). For example, the recent Puerto Rican 3-year average landings for most species were only a small fraction of the highest reported annual landings. In many cases, data are not available by species, fishery component, or area. Statistics are confounded because species are easily misidentified owing to similar appearances.

The reef fish management unit includes about 100 species (excluding those for the marine aquarium trade). In the southeastern U.S. region, the unit is managed by the South Atlantic Fishery Management Council, Gulf of Mexico Fishery Management Council, and the Caribbean Fishery Management Council for the EEZ, and eight states, the U.S. Virgin Islands, and Puerto Rico for territorial waters.

In the Gulf of Mexico, the Reef Fish Fishery Management Plan prohibits the use of fish traps, roller trawls, and powerheads on spearguns within an inshore stressed area; places a 33 cm total length minimum size limit on red snapper (with some exceptions); and imposes data reporting requirements. A threshold harvest rate was established as a basis to measure overfishing. Amendment 1 in 1990 implemented a 5 fish recreational bag limit, a 5,000 t commercial quota, and an 800 t deep-water quota. Other regulations included a ban on the harvest of jewfish, additional flexibility in management by allowing the target date for rebuilding to be changed depending on scientific information, a revised target year of 2007 for rebuilding the red snapper stock, and changes in classification of shallow- and deep-water grouper.

In the southern U.S. Atlantic, the Snapper-Grouper Fishery Management Plan emphasizes minimum size limits and commercial quotas. Seasonal closures exist and the taking of jewfish or Nassau grouper is prohibited. Various gears are restricted, including a prohibition of roller trawls and fish traps with the exception of sea bass traps. Certain commercial fishing methods are prohibited in designated special management zones around some artificial reefs. An Individual Transferable Quota (ITQ) system has been established for commercial wreckfish fishermen. It is based on historic trends and provides the fishermen with a quota that can be taken any time during the season or bartered or sold to another fisherman.

In the U.S. Caribbean, the Fishery Management Plan for the Shallow Water Reef Fish Fishery of Puerto Rico established regulations to rebuild declining reef fish stocks in the EEZ and reduce conflicts among fishermen. It established criteria for the construction of fish traps, required owner identification and marking of gear and boats; prohibited the hauling of or tampering with another person's traps

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without the owner's written consent; prohibited the use of poisons, drugs, other chemicals, and explosives for the taking of reef fish; and established a minimum size limit on the harvest of yellowtail snapper and Nassau grouper. Additional regulatory amendments have been designed to protect and rebuild the stocks.

Table 8-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of Atlantic, Gulf of Mexico, and Caribbean reef fishes. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituted.

Long-term potential yield (LTPY)[1] = 41,404 t
Current potential yield (CPY)[1] = 28,065 t
Recent average yield (RAY)[2] = 35,186 t

Area and species	Yield (t) RAY[2]	CPY[1]	LTPY[1]	Status of utilization	Status of stock level
Gulf of Mexico					
Red snapper	2,228	1,800	15,000	Over	Below
Red grouper	3,862	Unknown	Unknown	Unknown	Unknown
Nassau grouper and jewfish[3]	73	0	Unknown	Over	Below
Shallow groupers (7 species)	2,222	Unknown	Unknown	Over	Unknown
Other groupers (5 species)	624	Unknown	Unknown	Unknown	Unknown
Other snappers (14 species)	4,222	Unknown	Unknown	Unknown	Unknown
Porgies (6 species)	3,798	Unknown	Unknown	Unknown	Unknown
Amberjacks (2 species)	2,283	Unknown	Unknown	Unknown	Unknown
Grunts (3 species)	1,228	Unknown	Unknown	Unknown	Unknown
Sea basses (3 species)	678	Unknown	Unknown	Unknown	Unknown
Others (16 species)	4,418	Unknown	Unknown	Unknown	Unknown
Atlantic					
Wreckfish	1,100	Unknown	Unknown	Full	Near
Vermilion snapper	550	Unknown	Unknown	Over	Below
Red snapper	195	Unknown	Unknown	Over	Below
Red porgy	346	Unknown	450	Over	Below
Nassau grouper and jewfish[3]	7	0	Unknown	Over	Below
Other groupers (16 species)	1,323	Unknown	Unknown	Over	Below
Sea basses (3 species)	1,040	Unknown	Unknown	Unknown	Unknown
Other snappers (12 species)	708	Unknown	Unknown	Over	Below
Amberjacks (2 species)	887	Unknown	Unknown	Unknown	Unknown
Other porgies (8 species)	844	Unknown	Unknown	Unknown	Unknown
Grunts (11 species)	427	Unknown	Unknown	Unknown	Unknown
Others (12 species)	1,507	Unknown	Unknown	Unknown	Unknown
Caribbean					
Nassau grouper and jewfish[3]	0	0	Unknown	Over	Below
Snappers (10 species)	224	Unknown	Unknown	Unknown	Unknown
Other groupers (6 species)	55	Unknown	Unknown	Unknown	Unknown
Grunts (5 species)	49	Unknown	Unknown	Unknown	Unknown
Others (50 species)	287	Unknown	Unknown	Unknown	Unknown

[1]LTPY is probably greatly understimated and CPY overestimated; although potential production estimates are not available for most species groups, many are probably overutilized.
[2]1989-91 average.
[3]A total fishing prohibition has been imposed or is being considered.

SPECIES AND STATUS

More than 100 reef fishes are important to commercial or sport fishermen (Table 8-1). While landings and value for individual species are not large, reef fishes overall produce significant landings and values (Fig. 8-1, 8-2). Recent average commercial catches for the U.S. Atlantic and Gulf have been about 9,000 t with a dockside value of $48 million. Sport fishermen make more than 20 million angler-trips annually.

Reef fishes are vulnerable to overfishing owing to their long lives, slow growth, ease of capture, large body size, delayed reproduction, and other factors. Most are probably either fully utilized or overutilized (Table 8-1). Red snapper, traditionally the most important Gulf reef fish, is overutilized in part as a result of its incidental

... SPECIES AND STATUS

catch by the shrimp fishery. Eight of the ten major species in the Atlantic headboat fishery show significant size declines since 1972. In the Caribbean, such traditional fishery mainstays as Nassau grouper have practically disappeared, and total landings of species of more recent importance like the red hind have declined since the late 1970's (Fig. 8-3). Landings of amberjack, lane snapper, vermilion snapper, and similar species have increased as catches of traditional species have declined.

Figure 8-1.—Recreational and commercial reef fish landings from the Gulf of Mexico and the index of abundance of young red snappers, 1979-91.

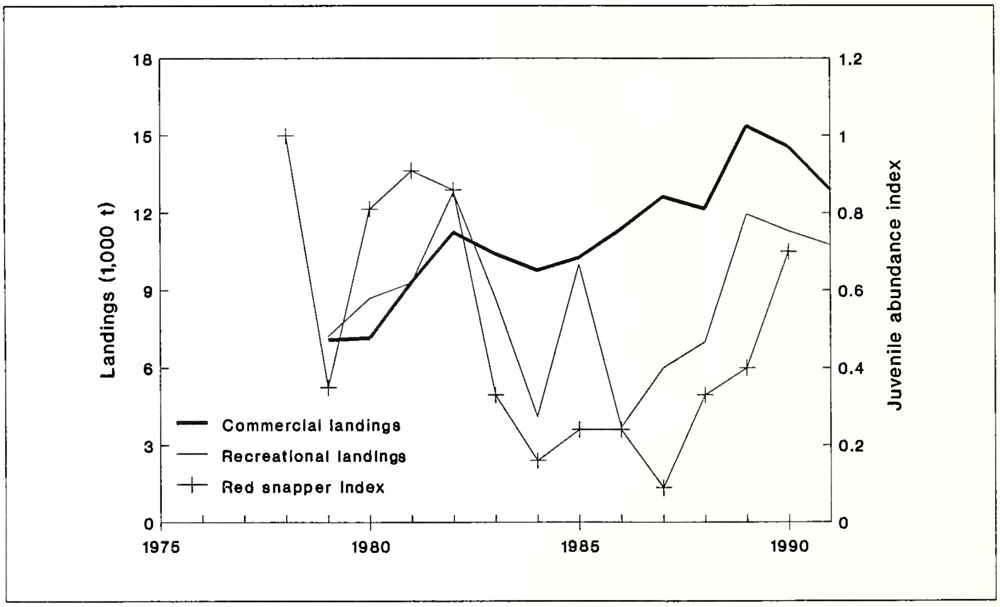


Figure 8-2.—Recreational and commercial reef fish landings from the southeastern U.S. Atlantic coast and the index of abundance (average weight) of gag grouper, 1979-91.

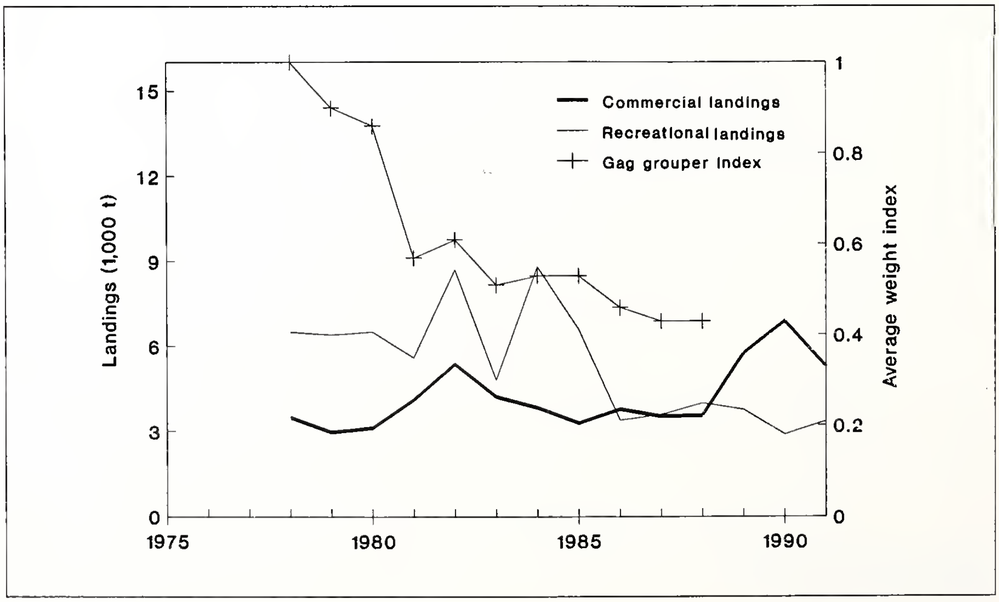
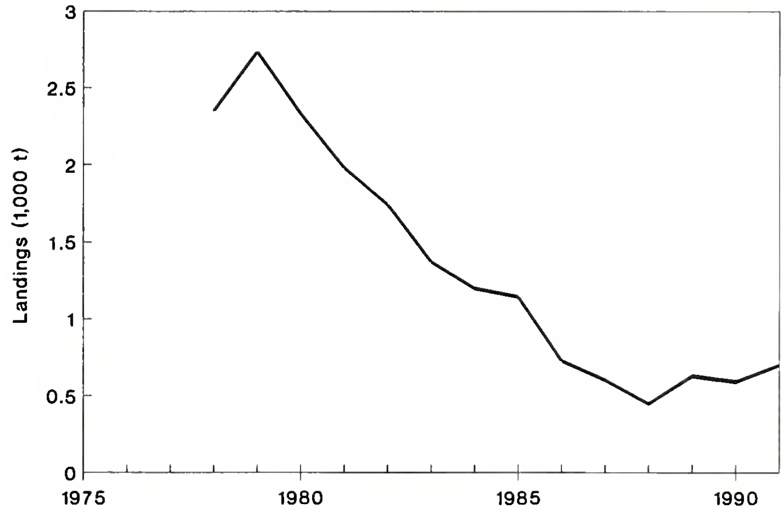


Figure 8-3.—U.S. reef fish landings from Caribbean waters, 1978-91.



ISSUES

Bycatch and Multispecies Interactions

Reef fish form a complex, diverse multispecies system. The long-term harvesting effects on reefs are not well understood, requiring cautious management controls of targeted fisheries as well as bycatch (see Spotlight 2). Major bycatch issues currently occur with the capture and discarding of red snapper by vessels fishing for shrimp with small-mesh nets. This bycatch problem means that, in order to meet the rebuilding goals for the stock, targeted harvests must be even more tightly restricted. Bycatch of other species may pose similar difficulties as will the capture of undersized fish, even if they are released. The mortality rate of released fish is poorly known.

Scientific Information and Adequacy of Assessments

Several stocks of reef fish are currently depleted and need to be rebuilt (e.g., jewfish, Nassau grouper). A variety of management measures need to be explored, including the use of artificial reefs and the effectiveness of marine parks and reserves to protect spawning areas.

There are a number of important outstanding scientific issues which need to be addressed to improve the advice for management. The long-term potential yield for many of the reef fish species in not known. Data on catch and the identification of species is inadequate for many stocks and needs to be obtained on a routine basis to prepare stock assessment advice. Additional life history and biological data is needed to better understand this complex of species.

Allocation

Reef fish resources are utilized by a wide range of groups. Commercial and recreational fishermen may come into conflict with one another as well as with other users such as ecotourists. Balancing the interests of these groups is an important management issue.

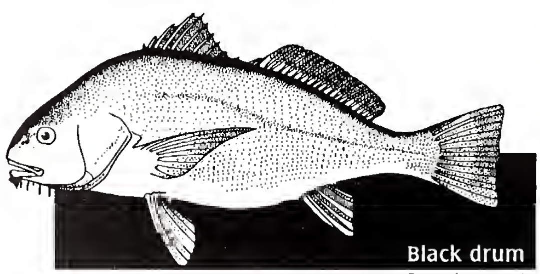
Progress

An individual transferable quota system was implemented for wreckfish in April 1992. Of the original 49 shareholders, 37 remained by August with shares holding their value and fish prices improved.

INTRODUCTION

Important species in this unit are the Atlantic croaker, spot, red drum, black drum, kingfishes (whiting), spotted seatrout, and other seatrouts. The drum family includes several commercially and recreationally important fishes that have been harvested since at least the late 1800's when commercial landings were first estimated. Other fisheries are much more recent. A classic example it the popularity of "blackened redfish" in the 1980's which stimulated a significant demand for red drum so that in a few years the stock was seriously depleted.

Most drum and croaker are harvested in state waters and are therefore under state management. In recent years, several states have set regulations favoring recreational use of some species, such as the red drum.



Black drum
Pogonias cromis

Commercial adult red drum purse seining in Federal waters of the Gulf of Mexico developed rapidly in the middle 1980's as demand grew for "blackened redfish." Before that, nearly all red drum were harvested in nearshore state waters as juveniles. But as the offshore fishery developed, it became clear that the schooling adult redfish were extremely vulnerable to heavy harvests. Analyses showed that long-term potential yields for this fishery required limiting the harvest of the larger adult fish. In addition, greater inshore redfish catches by recreational and commercial fishermen, complicated by other factors, had cut the number of young fish that could have replenished offshore adult stocks.

Eventually a Red Drum Fishery Management Plan was developed for Gulf and, later, Atlantic waters. Both plans ban red drum fishing in Federal waters until the adult population increases in size. This effectively bars a significant adult red drum fishery in Federal waters as long as state rules favor substantial inshore fishing for young red drum. State actions so far have preserved inshore harvests and allocated most or all of the catch to sport fishermen.

SPECIES AND STATUS

Commercial drum landings peaked in 1956 at over 32,000 t, more than 20,000 t above the 1953 level. That great increase was stimulated by development of the pet food industry in the northern Gulf of Mexico. Atlantic croaker was sought for pet food as well, and about 76% of the associated landings were croaker and sand and silver seatrout. This pet food catch was reported with the "industrial fishery" data after 1956, and estimates of its size and value have since been unavailable. Status and potential yields for these species are given in Table 9-1.

The catch value of this group for human consumption was about $10 million in 1978. This increased to about $22 million in 1986, largely as a result of an increase in the price of the fish.

The overall sport catch of these species has been about equal to the commercial harvest for human consumption (Fig. 9-1).

ISSUES

Bycatch and Multispecies Interactions

Efficient and economical means of reducing the bycatch of finfish in the shrimp fishery must be developed. Large numbers of Atlantic croaker, spot, and sand and silver seatrout are caught and killed in shrimp trawls. Estimates of the 1972-89 bycatch in the Gulf's offshore shrimp fishery averaged about 500 million spot, 1 billion seatrout, and 7.5 billion croaker. These species constitute the bulk of the offshore bycatch of finfish which averaged about 175,000 t during the 1980's.

Figure 9-1.—U.S. drum and groundfish landings from southeastern U.S. coastal waters and the red drum recruitment index for the Gulf of Mexico, 1970-91.

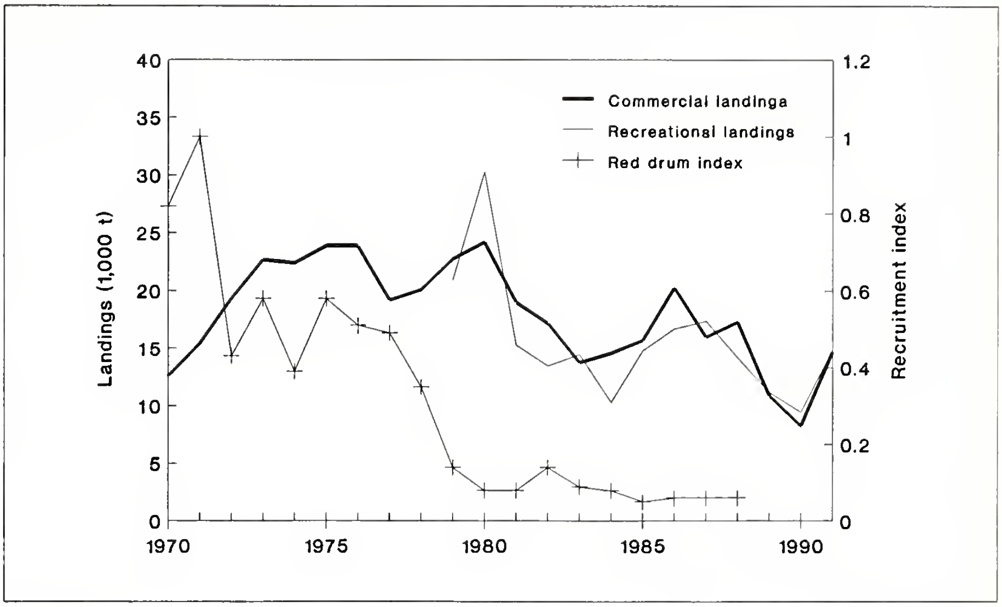


Table 9-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of drum, croaker, and related species. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CFY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituted.

Long-term potential yield (LTPY)[1] = 75,934 t
Current potential yield (CPY)[1] = 25,808 t
Recent average yield (RAY)[2] = 25,808 t

	Yield (t)			Status of	Status of
Species and area	RAY[2]	CPY[1]	LTPY[1]	utilization	stock level
Black drum	6,128	Unknown	Unknown	Unknown	Unknown
Atlantic croaker	4,946	Unknown	50,000	Over	Below
Spot	3,336	Unknown	Unknown	Unknown	Unknown
Red drum					
Gulf of Mexico	2,828	2,828	7,900	Over	Below
Atlantic	626	Unknown	Unknown	Over	Below
Seatrouts	6,250	Unknown	Unknown	Unknown	Unknown
Kingfishes (whiting)	1,694	Unknown	Unknown	Unknown	Unknown

[1]LTPY is probably underestimated and CPY overestimated; although potential production estimates are not available for some species groups, it is expected that they may be overutilized.
[2]1988-90 average.

INTRODUCTION

Menhaden are a herring-like species found in coastal and estuarine waters of the U.S. Atlantic and Gulf of Mexico. They form large schools at the surface which are located and fished for the production of fish meal, oil, and soluble proteins. The fishery is vertically integrated, generally with company-owned vessels, spotter aircraft, and processing plants. An active baitfish fishery along the Atlantic and Gulf coasts harvests about 5% of the amount landed by the industrial fishery. These fisheries are managed by individual states through the Atlantic States Marine Fisheries Commission (ASMFC) and the Gulf States Marine Fisheries Commission (GSMFC). Menhaden are food for many other fishes and sea birds.

In the Gulf of Mexico, Gulf butterfish have been a component of the catch in the industrial bottomfish and shrimp fisheries, and were either discarded or processed for pet food or fish meal. In 1986, a directed bottom trawl fishery for Gulf butterfish started with the arrival of New England freezer trawlers. The New England vessels fished in the Gulf during the springs of 1986 and 1987, the spring and summer of 1988, and briefly during the spring of 1988. In 1987, several vessels experimented with fishing for Gulf butterfish. These early trips led to major refits of a number of shrimp trawlers and one purse seiner in 1988. At one point in 1988, 15 vessels were engaged in the directed fishery for butterfish. The market for Gulf butterfish was saturated early during the summer of 1988. As a result, the New England vessels returned north, and most of the Gulf vessels switched back to shrimping. The directed fishery for Gulf butterfish continued in 1989, 1990, and 1991, with one or two Gulf vessels targeting butterfish. Gulf butterfish are assessed as a single stock, and the fishery is not under management rules.

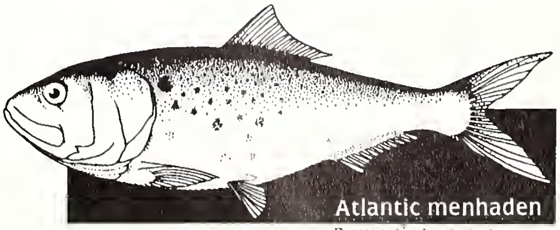
SPECIES AND STATUS

Menhaden are specific to the Atlantic and Gulf of Mexico. In the U.S. Atlantic, the resource is overutilized with a long-term potential yield of 480,000 t per year and a recent average yield of 345,000 t per year. In the Gulf of Mexico, the menhaden resource is fully utilized with a long-term potential yield of 660,000 t and a recent average yield of 575,000 t. Gulf butterfish is underutilized with a long-term potential yield of 26,500 t and a recent average yield of 19,700 t.

Atlantic Menhaden

Atlantic menhaden are found from Nova Scotia, Can., to West Palm Beach, Fla. As coastal waters warm in April and May, large surface schools form along the coasts of Florida, Georgia, and the Carolinas. The schools move slowly northward, stratifying by age and size during the summer, with the older and larger fish generally moving farther north. The southward migration begins in early fall with surface schools disappearing in late December or early January off the Carolinas. Atlantic menhaden may live 10 years, but most fish caught are 3 years of age or younger.

Menhaden landings rose during the 1940's and early 1950's and peaked at 712,100 t in 1956. Landings remained high during the late 1950's and early 1960's, dropped precipitously during the middle 1960's, and remained low, bottoming out at 161,600 t in 1969 (Fig. 10-1). Since 1970, landings have improved but not to the levels of the late 1950's. A recent peak of 418,600 t occurred in 1983, even though recruitment to age 1 is comparable with the 1950's. The commercial value of Atlantic menhaden for 1986-90 averaged $32.8 million per year.



Atlantic menhaden

Brevoortia tyrannus

In 1990, just a few menhaden reduction or processing plants were in operation, located in Beaufort, N.C.; Reedville, Va.; coastal Maine (one Russian factory ship as part of an internal-waters processing agreement); and New Brunswick, Can.

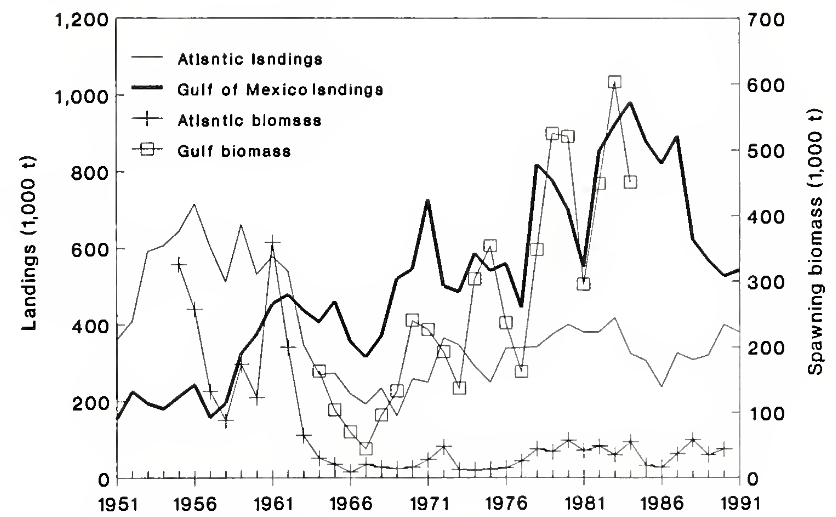
The stock collapse in the 1960's drove fishing effort southward to North Carolina and Virginia where menhaden are generally younger and smaller than those in the

. . . Atlantic Menhaden

north. Overutilization owing to "growth overfishing" (catching too many fish before they grow to full size) has been a prime management concern for this stock, but spawning stock size also has remained low since 1962. A management plan written in 1982 by the ASMFC was not adopted by all states, and the Commission is rewriting it.

Gulf menhaden are found from Mexico's Yucatan Peninsula to Tampa Bay, Fla. They form large surface schools that appear in the nearshore Gulf waters from April to November. Although no extensive coastwide migrations are known, there is evidence that older fish move toward the Mississippi River Delta. Gulf menhaden may live to age 5, but most of those landed are ages 1 and 2. In 1990, active Gulf menhaden reduction plants were located in Moss Point, Miss., and in Empire, Dulac, Morgan City, Intracoastal City, and Cameron, La.

Figure 10-1.—U.S. menhaden landings and spawning biomass from the Gulf of Mexico and southeastern Atlantic coast, 1951-91.



Gulf Menhaden

Historically, landings rose from the beginning of the fishery, after World War II, to a peak of 982,800 t in 1984 (Fig. 10-1). Landings were generally high during the middle 1980's (greater than 800,000 t for 1982-87), but they declined steeply from 894,200 t to 528,300 t between 1987 and 1990. The commercial value of Gulf menhaden for 1986-90 averaged $63.6 million per year.

Because this species is short lived and has a high natural mortality, "growth overfishing" has not been a major concern. Management coordinated through the GSMFC consists of a 6-month fishing season (mid-April through mid-October) and closure of inside waters across the northern Gulf of Mexico.

Gulf Butterfish

Total catch of Gulf butterfish in 1991 was 19,490 t (Fig. 10-2), about the average annual catch for the 1986-91 period of 19,700 t. Incidentally captured butterfish by the offshore Gulf of Mexico shrimp fleet has comprised from 80% to 97% of the total annual catch since 1986. Length composition data indicate that annual catch is dominated by age 1 fish, with few age 0 and age 2+ fish.

The current and long-term potential yields are estimated at 26,500 t for Gulf butterfish. The recent average annual yield is 19,586 t (Table 10-1).

Figure 10-2.—U.S. butterfish landings and index for the Gulf of Mexico, 1980-1991.

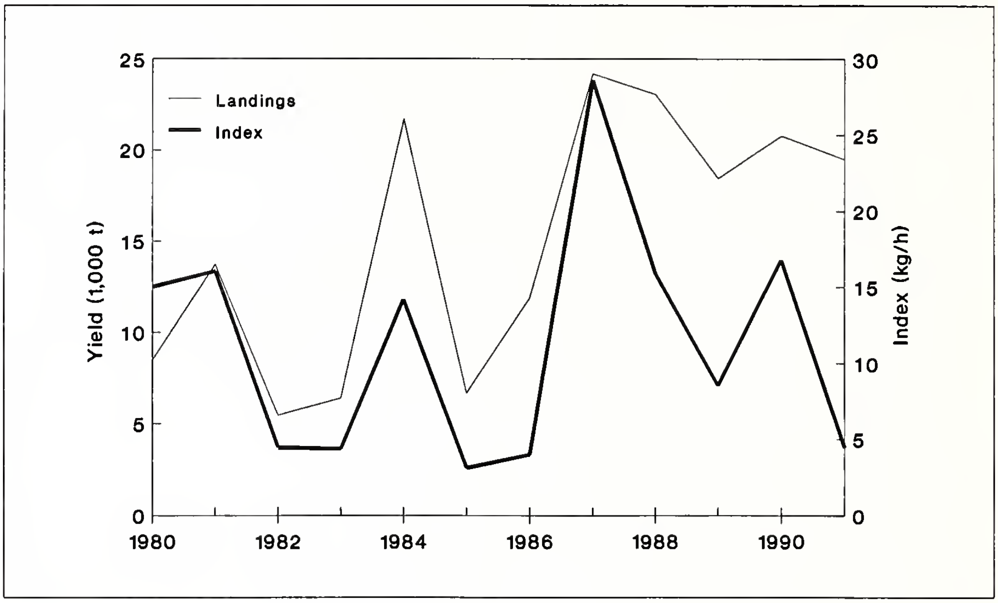


Table 10-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of southeastern menhaden and butterfish. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY) = 1,166,500 t
Current potential yield (CPY) = 946,500 t
Recent average yield (RAY)[1] = 939,586 t

Species and area	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Menhaden					
Gulf of Mexico	550,000	550,000	660,000	Full	Near
Atlantic	370,000	370,000	480,000	Over	Below
Gulf butterfish	19,586	26,500	26,500	Full	Near

[1]1989-91 average.

ISSUES

Management Concerns

The ASMFC FMP for Atlantic menhaden needs to be implemented to manage this resource. There is a demand to harvest menhaden as soon as they become available to the fishery. This practice, known as growth overfishing, reduces the opportunity for greater weight production.

Transboundary Stocks and Jurisdiction

Because this resource migrates long distances along the coast, interstate coordination of menhaden management is required for Atlantic menhaden along the U.S. Atlantic coast and Gulf menhaden along the northern Gulf of Mexico through the marine fisheries commissions.

Bycatch and Multispecies Interactions

The importance of menhaden as prey for other species needs consideration with respect to multispecies resource management.

The most important issue for Gulf butterfish is the volume of bycatch taken in the Gulf of Mexico shrimp trawl fishery.

INTRODUCTION

Important recreational and commercial marine invertebrates in the southeastern United States include shrimp, spiny lobster, stone crab, conch, and coral (Table 11-1). Some fisheries, as for coral, are almost nonexistent. Others, like the penaeid shrimp fishery, are both extensive and extremely valuable: Shrimp are one of the most valuable U.S. fisheries based on ex-vessel value. Some fisheries, such as those for spiny lobster and stone crab, have only moderate value on a national basis, but are very important regionally. Because of the diversity in species, fisheries, geographic locations, yields, values, etc., each species group in the marine invertebrates must be examined separately for proper perspective.

Penaeid shrimp have been fished commercially since the late 1800's. The first fishery used long seines in shallow water, until the otter trawl, introduced in 1915, extended shrimping to deeper waters. At first, most vessels towed one large trawl, sometimes 120 feet wide at the mouth. Soon, a two-trawl arrangement (each about 40-75 feet wide at the mouth) was found more effective. Some shrimpers began using a twin-trawl system which towed four trawls of about 40 feet wide at the mouth. The twin-trawl system is now the most common gear on commercial offshore shrimpers.

Regulations in the Gulf of Mexico shrimp FMP restrict shrimping by closing two shrimping grounds. There is a closure of fishing grounds off Texas for brown shrimp and a closure off Florida for pink shrimp. Also, there are size limits on white shrimp caught in Federal waters and landed in Louisiana. These regulations strive to improve the monetary value of the shrimp fishery.

In the South Atlantic, white shrimp stocks are centered off the Georgia and South Carolina coasts. Brown shrimp are

Table 11-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of southeast and Caribbean species. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituted.

Long-term potential yield (LTPY) = 126,632 t
Current potential yield (CPY) = 120,025 t
Recent average yield (RAY)[1] = 126,960 t

Species and area	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Shrimp					
Brown					
Gulf of Mexico	69,444	Unknown	63,001[2]	Over	Near
Atlantic	4,329	Unknown	3,974	Over	Near
White					
Gulf of Mexico	29,463	Unknown	34,403[2]	Over	Near
Atlantic	6,714	Unknown	5,188	Over	Near
Pink					
Gulf of Mexico	5,454	Unknown	7,877[2]	Over	Below
Atlantic	1,172	Unknown	1,052	Over	Near
Royal red	143	Unknown	Unknown	Unknown	Unknown
Seabob	2,269	Unknown	Unknown	Unknown	Unknown
Rock	3,419	Unknown	Unknown	Unknown	Unknown
Spiny lobster					
Southeast U.S.[3]	3,099	2,400	3,565	Over	Below
Caribbean	135	Unknown	Unknown	Unknown	Unknown
Stone crab[4]	1,264	1,121	976	Full	Near
Queen conch[5]	55	55	Unknown	Over	Below
Coral[6]	0	0	Unknown	Unknown	Unknown

[1]1989-91 average.

[2]Long-term potential of brown, white, and pink shrimp based upon last observed 10-year average annual yield (1982-91).

[3]Yields based upon commercial catches; recreational catch is unknown but may be significant.

[4]Yields are in tons of claws; declawed crabs regenerate new claws.

[5]Landings from Puerto Rico. Fishing prohibited in Florida and U.S. Virgin Islands.

[6]Coral harvests prohibited except for a small take allowed for use in aquarium and pharmaceutical industries.

... INTRODUCTION

centered off the North and South Carolina coasts. The Atlantic fishery is much smaller than in the Gulf and currently is not managed under a federal FMP.

Spiny lobster are managed under a joint FMP, coordinated with regulations by the State of Florida. Current regulations specify a 3-inch minimum carapace length, a closed season from 1 April to 5 August, protection of egg-bearing females, closure of some nursery areas, recreational bag limits, and a controversial two-day "sport" season.

Caribbean spiny lobsters are caught primarily by fish traps, lobster traps, and divers. The Caribbean Fishery Management Council's (CFMC) spiny lobster FMP includes the Federal waters of Puerto Rico and the U.S. Virgin Islands. The Federal plan is based on a 3.5-inch minimum carapace length and protection of young egg-bearing lobsters.

The conch fishery targets the queen conch but also uses other species. Most conch are taken by divers, and the resource can be easily depleted. Conch are currently protected in state and Federal waters off Florida and in the territorial waters of the U.S. Virgin Islands. An FMP is being developed for the Federal waters off Puerto Rico and the U.S. Virgin Islands by the CFMC.

Corals are managed as two groups, hard and soft. Because they are generally slow growing and provide critical habitat for many fishes, hard corals are protected except for very small collections taken by permit for research and educational purposes. The regulations are based on the fact that their value as habitat is far more important than their commercial use.

Soft corals include gorgonians and sea fans. Some gorgonians are taken (about 50,000 colonies per year) for the aquarium and pharmaceutical industries. Growth potential for most species is considered limited. Sea fans are completely protected except for research and educational use by permit.

Stone crabs are caught mainly in southern Florida, though some are landed farther north along Florida's west coast. The Gulf of Mexico stone crab FMP, approved in September 1979, generally extended Florida's regulations into the EEZ. These regulations are based on a minimum claw size of 2.75 inches, biodegradable trap panels, protection of egg-bearing females, and closed seasons. Minimum size regulations assure that crabs have reproduced at least once before being caught.

SPECIES AND STATUS

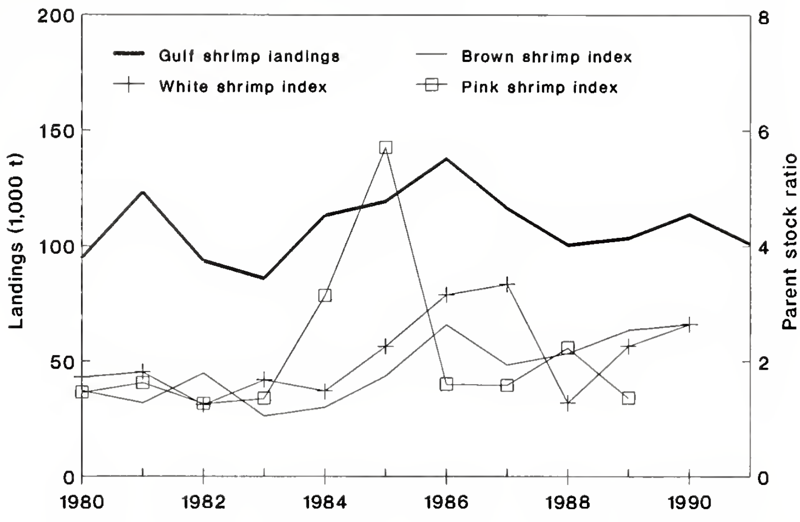
Shrimp

Brown, white, and pink shrimps account for 89% of the total Gulf of Mexico shrimp catch. In 1991 alone, these three important species produced 100,872 t valued at over $417 million (Fig. 11-1). They are found in all U.S. Gulf waters inside 60 fathoms (fm). Most of the offshore brown shrimp catch is taken at 11-20 fm depths, white shrimp are caught in 5 fm or less, and pink shrimp in 11-15 fm. Brown shrimp are most abundant off the Texas/Louisiana coast, and the greatest concentration of pink shrimp is off southwestern Florida. In the South Atlantic, white and pink shrimp landings are about 20% of their Gulf counterparts, while brown shrimp are less than 10% of the Gulf yield. Current, recent, and long-term potential yields for these species are given in Table 11-1.

Gulf brown and white shrimp catches have increased significantly over the past 30 years. Pink shrimp catches were stable until about 1985, then they declined in recent seasons and are now at an all-time low. Numbers of young shrimp for each species entering the fisheries have generally reflected the level of catch. The commercial shrimp are harvested at maximum levels. The fishery is believed to have more boats and gear than needed (i.e., reducing fishing effort would not significantly reduce the shrimp catch). Reducing the bycatch of the shrimp industry, however, would help protect finfish resources.

The number of young brown shrimp produced per parent has increased significantly, but not for white and pink shrimp (Fig. 11-1). The brown shrimp increase appears related to marsh alterations. Coastal sinking and a sea-level rise in the northwestern Gulf inundates intertidal marshes longer, allowing the shrimp to feed for longer periods within the marsh area. In the Gulf, both factors have also expanded estuarine areas, created more marsh edges, and provided more

Figure 11-1.—U.S. shrimp landings from the Gulf of Mexico, 1980-91, and the parent stock abundance indices for brown, white, and pink shrimp.



. . . Shrimp

protection from predators. As a result, the nursery function of those marshes has been greatly magnified and brown shrimp production has expanded. However, continued subsidence will lead to marsh deterioration and an ultimate loss of supporting wetlands, and current high fishery yields may not be indefinitely sustainable.

Spiny Lobster

Annual Florida spiny lobster landings were fairly stable during the 1980's, running about 2,700 t from the Gulf of Mexico, but yielding record landings in 1989 of 3,200 t, valued at about $20 million. On Florida's Atlantic coast, landings have averaged 230 t, valued at $2 million. The fishery is considered "overcapitalized," with about 500,000 lobster traps in use. Half that number of traps would provide the same catch. Fishermen use live undersized lobster to "seed" traps, but owing to a high mortality rate for these baits, about 30-50% of the potential yield is lost. The recreational fishery is large at the beginning of the season, but its total harvest is unknown.

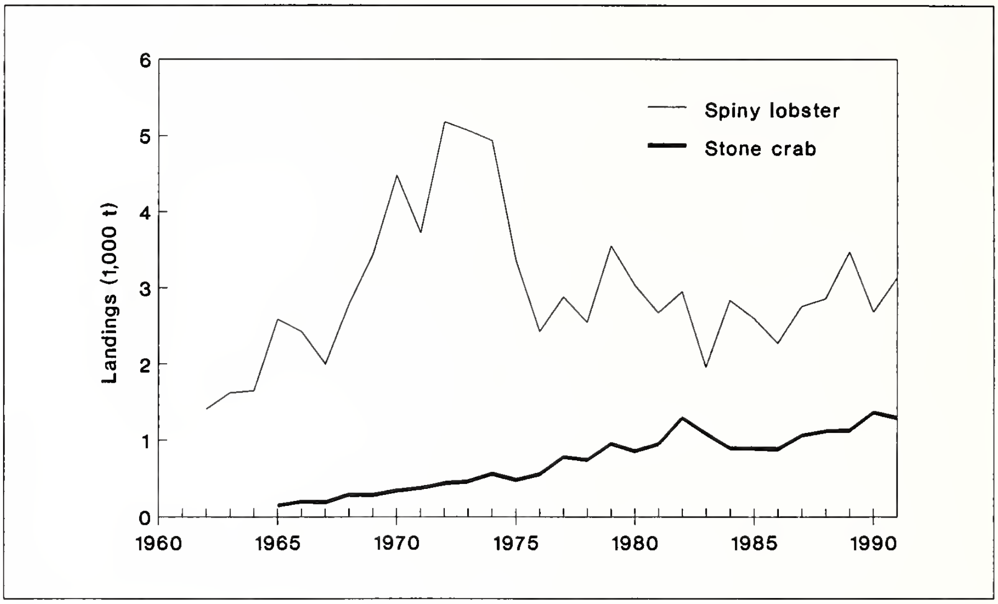
Spiny lobster larvae may drift at sea for 9 months, and thus identification of their source or parent stock is almost impossible; however, we need to know far more about their origins and movements to improve our management of them.

Annual spiny lobster landings for Puerto Rico have averaged 144 t over the past 23 years, varying from 108 t in 1972 to a high of 233 t in 1979, then declining to a low of 65 t in 1988. No precise data are available on fishing effort, but the Puerto Rican stock appears to be overutilized. U.S. Virgin Islands landings for 1980-88 were fairly stable, averaging 19 t.

Stone Crab

Annual catches of stone crab (claw weight) varied from 1,200 to 1,400 t in the Gulf of Mexico through the 1980's. Recent annual values average $12-15 million. Atlantic coast landings average around 34 t, worth $120,000. The number of crab traps set increased from 295,000 in 1979-80 to 567,000 in 1984-85 but have been relatively stable in recent years, though estimated seasonal trap hauls (fishing effort) increased from 3.6 million in 1985 to 4.8 million in 1987. Thus, more of the total landings were harvested earlier, and this shortened the effective length of the fishing season. It is unlikely, however, that recent maximum production figures can be sustained on a long-term basis.

Figure 11-2.—Landings from the southeastern U.S. coastal waters of spiny lobster, 1961-91, and stone crab, 1965-91.



ISSUES

Habitat Concerns

Estuarine and marsh loss remove critical habitat for young shrimp. Additional studies are needed to further assess the impacts of man-induced changes in quantities of habitat, environmental conditions, predator abundance, and pollution in the nursery areas. Florida spiny lobsters depend on reef habitat and shallow-water algal flats for feeding and reproduction. These habitat needs may conflict with expanding coastal developments. The productivity of stone crabs in Florida Bay is related to water quality and flow through the Everglades. Specific water requirements need to be identified and maintained through Everglades water management. A unified program to integrate and study the effects of environmental alterations, fishing technology, regulations, and economic factors on shrimp, lobster, and crab production and restoration is needed, particularly in the reef habitats of south Florida. Steps need to be taken to mitigate or restore lost estuarine habitats.

Transboundary Stocks and Jurisdiction

Spiny lobster stocks in Florida could be of Caribbean origin and swept into the region by currents of the Gulf Stream. Another hypothesis is that they could be comprised of a number of different spawning stocks. The actual sources of all Florida and Caribbean lobster stocks (both U.S. and foreign) need to be identified and international management established to prevent overharvesting.

Management Concerns

Many small spiny lobsters are caught in the Puerto Rican fishery. If these lobsters were allowed to grow to a larger size before harvest, there would be a substantial increase in yield by weight. Modification of the traps to allow more of the small lobsters to escape and implementation of a minimum size rule need to be investigated. Small lobsters are sometimes used to bait traps in the lobster fishery. This practice is wasteful and hinders rebuilding the stock.

A continuing gear conflict between stone crab trappers and shrimp trawlers off southwestern Florida has been mostly resolved in the EEZ with a line separating the fishing areas and seasonal closure areas. This approach needs continued monitoring to gauge its success and prevent renewal of conflicts.

The shrimp fisheries are currently overcapitalized, with more fishing effort being expended than needed to harvest the resource. In addition, harvesting of small shrimp inshore is sacrificing yield and value of the catch by cutting short growth.

Bycatch and Multispecies Interactions

Shrimp fisheries are small mesh nets and can harvest non-target species such as red snappers, croakers, sea trouts, and sea turtles. For the fish, this harvest is often of juveniles and may be a major source of mortality on these young fish. Some fish caught by shrimpers are currently at low stock levels. This bycatch may slow or prevent recovery if not mitigated.

The turtles are all listed as endangered or threatened under the ESA. Shrimp vessels have been required to use turtle excluder devices in their nets during certain times of the year since 1988 to avoid capturing sea turtles and thus protect the stocks.

Progress

NMFS and the fishing industry have been working together to prepare a research plan to address the problems of finfish bycatch by shrimp fisheries in the Gulf of Mexico and South Atlantic.

INTRODUCTION

Pacific salmon support important traditional commercial and recreational fisheries in Washington, Oregon, and California. They are an integral part of the culture and heritage of the Pacific Northwest and have been harvested since time immemorial by Indian tribes. Pacific salmon are anadromous, spawning in streams or lakes and migrating to the ocean, often travelling hundreds of miles offshore. Upon reaching maturity, they return to their home stream to spawn, completing their life cycle.

Recent yearly commercial salmon landings have been valued at about $140 million at dockside. If recreationally caught fish are valued at $20.00 each, the average annual recreational catch for 1987-90 was worth over $24 million. Some economists think a substantially higher unit value for recreationally caught fish would be more realistic.

Salmon management is complex, involving many stocks from various rivers and several management jurisdictions: The U.S.-Canada Pacific Salmon Commission (PSC), state fishery agencies, Indian management entities, and the Pacific Fishery Management Council (PFMC). Two species (chinook and coho) are managed by the PMFC's fishery management plan (FMP). The other three species (sockeye, pink, and chum) are managed primarily by the PSC and state and tribal fishery agencies.

SPECIES AND STATUS

There are five species of Pacific salmon: Chinook, coho, sockeye, pink, and chum. Salmon runs are highly variable in abundance. Catches during 1960-91 fluctuated widely (Fig. 12-1, 12-2, 12-3) owing to varying survival rates of the fish at sea. For example, El Niño, an unusual warm ocean condition (see Spotlight 1), devastated chinook and coho salmon stocks in 1983-85, and both species have recently had poor ocean survival. Though pink, chum, and sockeye salmon catches probably will not change much from recent yearly averages, better coho survival could help them approach their long-term average production. After excellent survival rates and returns in 1988, chinook production has dropped dramatically, and reduced returns and catches are expected.

Several agencies hope to double production of certain Columbia River chinook stocks. Still, for all five species of salmon, there is more fishing gear than needed to harvest them, and strict limitations are required to protect the stocks. Thus, all species are considered overutilized.

Figure 12-1.—Recreational and commercial chinook salmon landings (thousands of fish) in Oregon, Washington, and California, 1960-91.

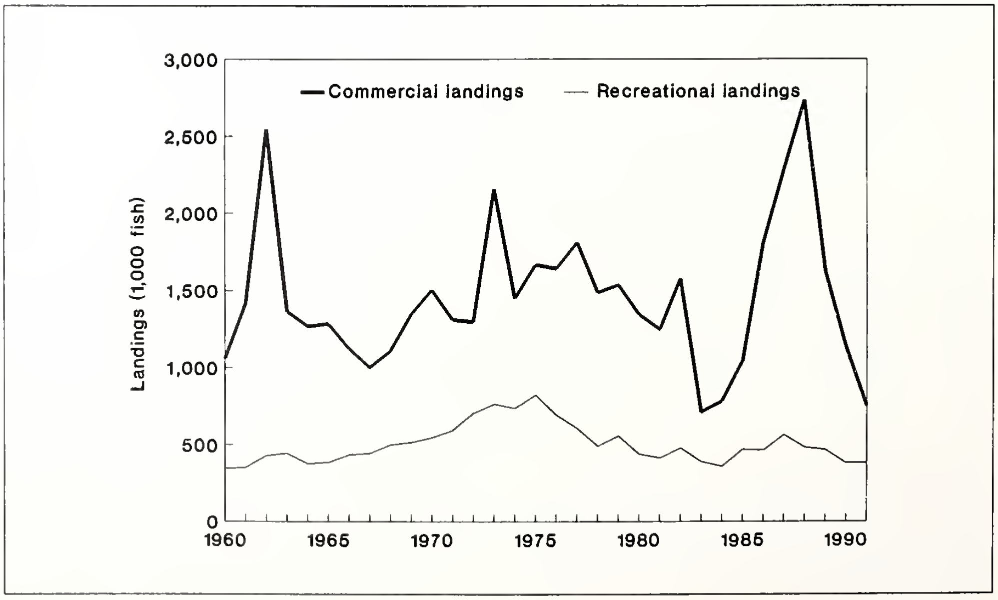


Figure 12-2.—Recreational and commercial coho salmon landings (thousands of fish) in Oregon, Washington, and California, 1960-91.

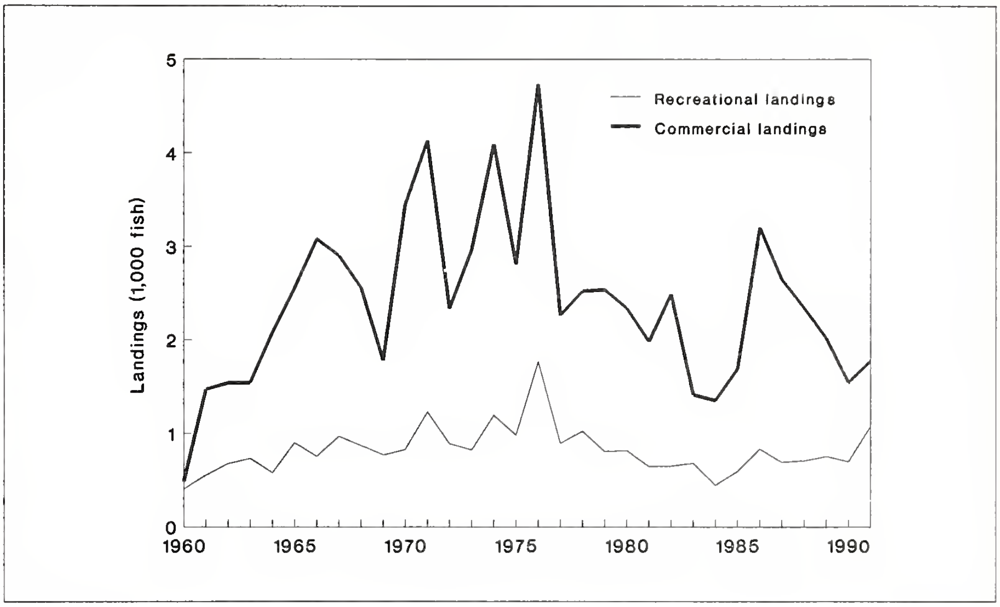


Figure 12-3.—Combined commercial and recreational landings of pink, sockeye, and chum salmon (thousands of fish) in Oregon, Washington, and California, 1960-91.

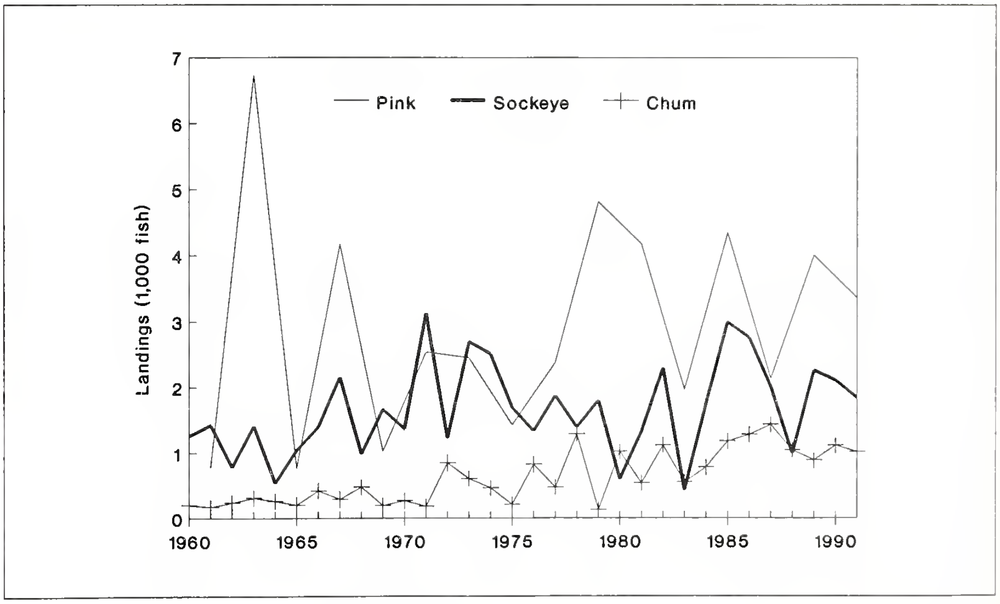


Table 12-1.—Recent average, current potential, and long-term potential yields (in numbers of salmon), and status of utilization and stock levels of salmon in the Pacific coast fishery. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY) = 11,806,000
Current potential yield (CPY) = 11,806,000
Recent average yield (RAY)[1] = 10,533,000

	Yield (no. of salmon)			Status of	Status of
Species	RAY[1]	CPY	LTPY[2]	utilization	stock level
Chinook	1,579,000	2,274,000	2,274,000[2]	Over	Below
Coho	2,693,000	3,231,000	3,231,000	Over	Near
Pink	3,165,000	3,496,000	3,496,000	Over	Above
Sockeye	2,089,000	1,788,000	1,788,000	Over	Near
Chum	1,007,000	1,017,000	1,017,000	Over	Near

[1]Average is for 1989-91 except for pink, which is a 1987-89-91 average.

[2]Long-term goals for some stocks include doubling of production, primarily through large-scale improvements in freshwater habitat. If successful, this would dramatically increase LTPY.

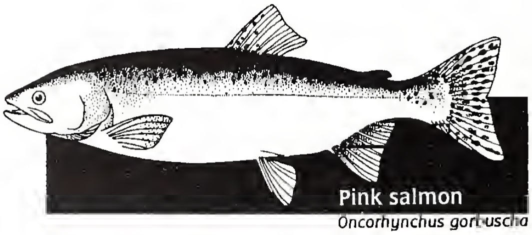
Chinook and Coho Salmon

Ocean fisheries for these species are managed by the PFMC. The decline in the ocean coho catch during the past 20 years, particularly off Washington, is largely due to a shift in catch to "inside fisheries," like Puget Sound, in compliance with Judge George Boldt's Federal court ruling in the early 1970's that Washington treaty Indians are entitled to up to 50% of the catch of salmon migrating through their usual and accustomed tribal fishing areas.

Most ocean chinook are caught by the commercial troll fishery, whereas an increasing share of the ocean catch of coho is being allocated to sport fishermen. Annual catch quotas now limit the entire coho catch off Washington, Oregon, and California, and the chinook catch off Washington and Oregon (north of Cape Falcon). In 1991, 3,791 vessels took part in the ocean troll fishery. This was 17% less than in 1990 and 29% less than 1989. Total ex-vessel revenue also declined dramatically in 1991 when compared to 1976-90 real dollar values: 59% lower in California, 79% lower in Oregon, and 83% lower in Washington. For the sport fishery, the number of recreational trips declined 24% from 658,000 in 1990 to 499,000 in 1991.

Sockeye, Pink, and Chum Salmon

Sockeye and pink salmon catches in Washington are composed largely of fish migrating to Canada's Fraser River. Although recent Fraser River salmon runs have been extremely large, their U.S. catch is limited under the U.S.-Canada Salmon Treaty of 1985. U.S. stocks of pink, sockeye, and chum salmon, although limited in range and size, appear to be fairly stable.



Pink salmon
Oncorhynchus gorbuscha

ISSUES

Habitat Concerns

Worsening freshwater spawning habitat has been a major cause of the salmon decline. This includes siltation problems and, particularly, the lack of water for spawning and fish passage. For example, Columbia River hydroelectric dams have caused serious fish passage problems, and conflicts have thus grown between fish needs for water, farm irrigation demands, and hydropower needs.

Owing to habitat losses, the Sacramento winter-run chinook was listed as threatened under the Endangered Species Act (ESA) in 1990. In 1991, the Snake River sockeye stock was listed as endangered under the ESA.

The drought conditions in California for the past several years have severely impacted chinook stocks in that area. The 1992 run to the Klamath River was expected to be at an all time low level of abundance and caused the PFMC to consider very severe ocean fishery regulations in 1992.

Wild vs. Hatchery Stocks

Increased production by salmon hatcheries, particularly of chinook and coho, has raised concerns about the relationship between natural (wild) and hatchery-produced fish. Though hatchery fish supplement natural production, they also compete with or even replace wild salmon. This potential problem must be addressed when trying to increase depressed wild salmon runs.

Transboundary Stocks and Jurisdiction

Salmon migrate over great distances where they can be intercepted by many different fishermen from different nations. The problem of allocation and interception is compounded by dwindling stocks. The problems are resolved as they arise by the affected jurisdictions set up to resolve the issues. For example, the U.S.-Canada Salmon Commission has been set up to address the allocation of catch between the United States and Canada. Conflicts between treaty Indian and non-Indian fishermen do arise and have often been addressed by the Courts. The Boldt decision has set the foundation for catch sharing between the user groups. However, lack of agreement over Indian catch allowances make the setting of salmon fishing regulations by the PFMC a challenge. In Washington, a Federal court ruling that salmon must be managed to protect the smallest or the weakest stock has curtailed ocean catches in recent years.

Bycatch and Multispecies Interactions

Some salmon, mainly chinook, are incidentally caught at sea in the Pacific whiting fishery. Though the number taken is small compared with catches in other fisheries, this catch becomes a politically sensitive issue when ocean salmon fisheries are severely restricted, as in 1991 when toll fishing was prohibited in certain coastal areas.

Progress

Two stocks of chinook salmon in the Snake River have been listed as threatened under the ESA. Recovery plans are being drafted by NMFS in cooperation with various management and user groups for these chinook stocks as well as endangered Snake River sockeye salmon and threatened Sacramento chinook. Draft plans should be available in early 1993. In addition, the Pacific Northwest Power Council has developed a strategic plan for salmon restoration and management in northwest rivers. The plan incorporates the interests of a wide range of groups within the region and may go a long way towards improving the status of salmon resources.

INTRODUCTION

Pacific salmon have long been harvested off Alaska. Today, salmon fisheries provide the state's largest nongovernmental source of employment. They also provide important recreational opportunities and are an integral part of Alaska's Native culture and heritage.

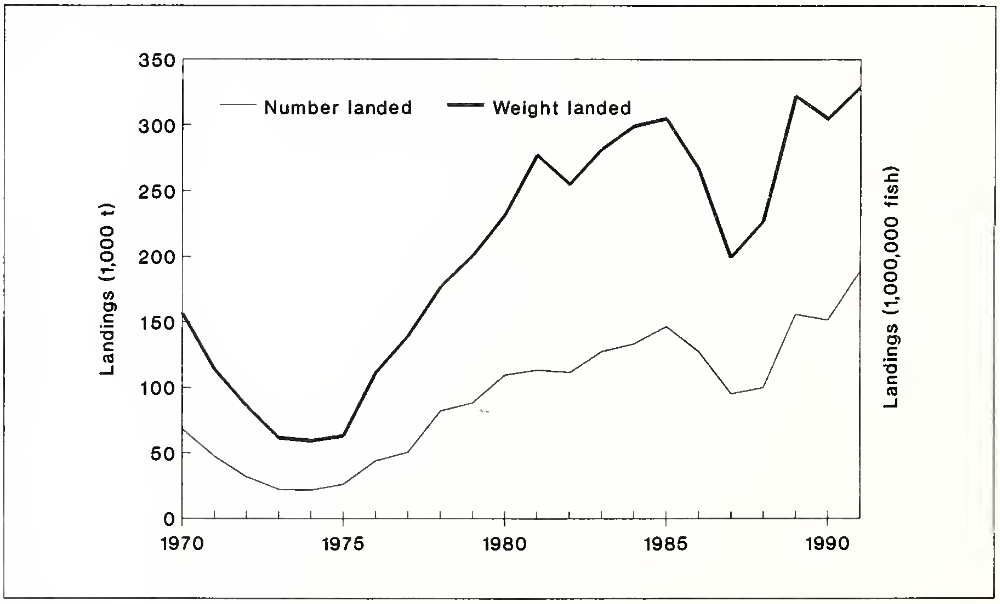
Alaska salmon catches have been highly variable (Fig. 13-1). The all-time peak catch of 189 million fish was taken in 1991. Sport harvest of salmon totaled about 909,000 fish in all waters in 1990.

The value of the 1991 statewide catch (329,207 t) has been estimated at $310 million, considerably less than the $540 million ex-vessel value of the 1990 harvest.

Alaska's 34,000-mile coast is nearly two-thirds the length of the coastline of the "lower 48" states. Salmon management in such a vast area requires a complex mixture of domestic and international bodies, treaties, regulations, and agreements. Federal and state agencies participate in the North Pacific Fisheries Management Council (NPFMC). Salmon management is also negotiated with Canada in the Pacific Salmon Commission, with Canada and Japan in the International North Pacific Fisheries Commission (INPFC), and via bilateral and multilateral talks and negotiations with Taiwan and the Republic of Korea.

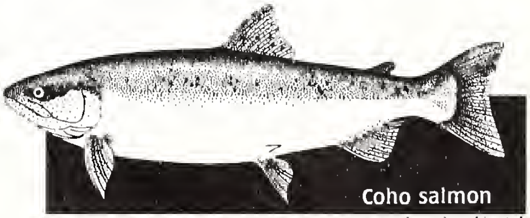
Management in the EEZ (3-200 miles offshore) is the responsibility of the NMFS and the NPFMC. The Council leaves to the INPFC the management of foreign salmon fisheries in the EEZ west of long. 175°E. The Alaska Department of Fish and Game (ADF&G) manages all fisheries in state waters.

Figure 13-1.—Alaska salmon landings, 1970-91.



SPECIES AND STATUS

Pacific salmon are anadromous species that spend a portion of their life (1-7 years) at sea and return to freshwater streams to spawn and die. From their freshwater spawning grounds, the young salmon may migrate thousands of miles out to sea beyond the U.S. Exclusive Economic Zone (EEZ) before returning to spawn.


Coho salmon
Oncorhynchus kisutch

Alaska's five salmon species (chinook, coho, chum, sockeye, and pink) are fully utilized, and stocks generally have rebuilt to or beyond previous high levels (Table 13-1). Research has been extensive on all aspects of salmon life history and and the information has been used to regulate escapement size and catch numbers by

. . . SPECIES AND STATUS

season and area.

Some salmon may be locally overutilized. In Bristol Bay, chinook catches in 1990 and 1991 were far below the recent 20-year average harvest of 117,000 fish (28% and 31%). In the lower Yukon River area, chinook catches are about 21% below average. Meanwhile, even-year pink salmon in Bristol Bay are far below 1970-90 harvests, and wild sockeye and chum salmon in Prince William Sound have declined.

Table 13-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of Alaska salmon. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY) = 278,226 t
Current potential yield (CPY) = 278,226 t
Recent average yield (RAY)[1] = 318,104 t

Species	Yield (t)			Status of utilization	Status of stock level
	RAY[1]	CPY	LTPY		
Pink	144,054	113,897	113,897	Full	Above
Sockeye	125,950	104,854	104,854	Full	Above
Chum	28,694	38,300	38,300	Full	Near
Coho	14,696	15,459	15,459	Full	Near
Chinook	4,710	5,716	5,716	Full	Below

[1] 1989-91 average.

ISSUES

Bycatch and Multispecies Interactions

Two types of high-seas driftnet fisheries impact Alaska's salmon resources: A legal fishery by Japan and an illegal fishery by driftnetters from different countries. The legal fishery by Japan that is conducted under the authority of the INPFC is scheduled for termination at the end of 1992.

Chinook salmon catches by U.S. groundfish fisheries in the Bering Sea and the Gulf of Alaska are another problem. About 36,000 chinooks were taken incidentally in the trawl fishery from all areas in 1991. The problem is being addressed by the North Pacific Fishery Management Council through time-area closures and bycatch limits set for the groundfish fisheries.

Habitat Concerns

Logging, mining, and industrial and urban development can often degrade salmon habitat. Though large areas of Alaska's wetlands are presently undisturbed and pristine and provide critical salmon habitat, logging activities have affected about 100,000 acres of stream-side habitat and 3,000 miles of streams. From 1981 to 1988, development was permited on about 41,000 acres of wetlands. The State of Alaska is exempt from many provisions of the Environmental Protection Agency policy on wetlands development under the President's 1991 Plan for Protecting Wetlands which allows Alaska to minimize development impacts. Very little information is available on the value of Alaska's vast wetlands as fish habitat.

Progress

The high-seas squid driftnet fisheries of Japan, Korea, Taiwan, and China are suspected of taking large numbers of North American salmon. Over 750 vessels fish an area of the North Pacific Ocean larger than our conterminus 48 states. Some of the vessels set 30 miles of gillnet a night. Protecting salmon from these fisheries is hampered by low enforcement in the past; but under United Nations General Resolution 46-215, large-scale driftnetting will be banned by the end of 1992.

INTRODUCTION

Several stocks of pelagic fish along the Pacific and Alaska coasts provide important sources of food, bait, and industrial fishery products. Major stocks include Northern anchovy, Pacific sardine, jack and Pacific mackerels, and Pacific herring (Table 14-1).

The U.S. anchovy fishery is managed under the Northern Anchovy Fishery Management Plan (FMP), while Pacific sardine, jack mackerel, and Pacific (chub) mackerel are managed by the State of California. All four species, which are harvested by purse seiners off California and Baja California will eventually be managed by the coastal pelagics FMP now being developed.

During the 1930's and early 1940's, Pacific sardines supported the largest fishery in the western hemisphere (25% of all fish landed in the United States). Sardine abundance and catches declined after World War II, and the stock finally collapsed in the early 1960's bringing about a complete moratorium on the fishery beginning in the 1967-68 season. The sardine stock has recently begun to show signs of improvement (Table 14-1), and a small fishery for them has been allowed since 1986.

In 1946, U.S. processors began to can anchovies in quantity, as a substitute for the failing sardine fishery. Anchovy canning declined in the late 1950's. In 1965, due to an increase in anchovy biomass, the California Fish and Game Commission authorized a 75,000 t harvest solely for reduction (conversion to meal, oil, and soluble protein).

The southern California jack mackerel stock has been fished since the late 1940's, when it was also substituted for the dwindling sardine stocks. Jack mackerel are utilized by the fishery in about the same manner as Pacific (chub) mackerel, but they are harder to catch, less valuable, and taken in smaller quantities. Recently, there has been some interest in developing an offshore fishery for this underutilized resource.

Pacific (chub) mackerel supports one of California's more important fisheries and has been the mainstay of the purse seine fleet in recent years. The fishery started in the late 1920's, rose to its peak in 1935, declined in 1953, and in 1967 the fishery hit an all-time low. Strong year-classes appeared in the late 1970's, and abundance increased dramatically after 1977. Abundance is thought to be declining at present, however. Pacific (chub) mackerel are harvested by commercial fisheries in California and Mexico and sold fresh, canned for human consumption and pet food, and also reduced to fish meal and oil.

Herrings are fished in Alaska state waters and 20 separate herring fisheries are regulated and monitored by the Alaska Department of Fish and Game (ADF&G). Since the early 1970's, fishermen have concentrated on harvesting roe-herring, though some are taken for bait. Herrings were harvested in the eastern Bering Sea EEZ by foreign fisheries from 1959 to 1980 when allocations ended, prohibiting herring harvests in Federal waters.

Table 14-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of Pacific coast and Alaska pelagic species. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY) = 543,100 t
Current potential yield (CPY) = 231,100 t
Recent average yield (RAY)[1] = 120,400 t

Species and area	Yield (t) RAY	CPY	LTPY	Status of utilization	Status of stock level
Northern anchovy	7,997[1]	7,000	120,000	Full	Near
Pacific sardine	3,511[1]	10,000	250,000	Full	Below
Jack mackerel	8,766[1]	52,600	100,000	Under	Near
Pacific mackerel	32,907[1]	28,000	28,000	Full	Near
Pacific herring Gulf of Alaska	23,120	28,200	Unknown	Full	Near
Pacific herring Bering Sea	15,715	16,900	Unknown	Full	Near

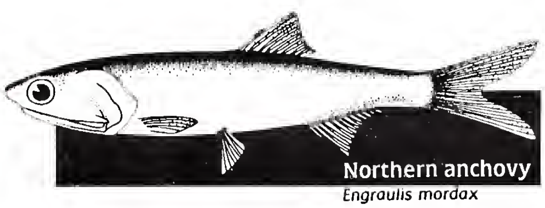
[1]Mexican harvests are typically as large or larger than U.S. harvests but were not included in calculation of RAY; 1989-91 average.

SPECIES AND STATUS

Northern Anchovy

The "central subpopulation" of the northern anchovy, which supports U.S. fisheries, has been fished in both California and Mexico for "reduction," bait (live or frozen) for anglers, fresh or canned fish for human consumption, animal food, and anchovy paste.

Anchovy landings in California (Fig. 14-1) have fluctuated between less than 10,000 t to nearly 150,000 t since the beginning of the fishery in response to market conditions. Since 1983, U.S. landings have been low (less than 10,000 t), and anchovies have been used mostly for live bait and other nonreduction uses. Anchovy biomass (Fig. 14-1) averaged 400,000 t during 1964-70, increased rapidly to 1,800,000 t in 1974, and declined to 490,000 t in 1978. Although total anchovy harvests since 1983 have been less than the theoretical maximum sustainable yield and the historical levels before 1983, abundance continues to decline slowly. Annual harvests declined dramatically after 1990 because the Mexican reduction fishery became unprofitable and ceased. No numerical limits are placed on the live-bait catch in the United States, but there is a 7,000 t quota for other nonreduction uses. Regulations also specify an optimum yield for the reduction fishery based on the biomass of spawning fish.



Engraulis mordax

The well-being of other species, especially the endangered brown pelican which feeds on northern anchovies, is important in anchovy management. Thus, there is a threshold in the optimum-yield formula for reduction fishing to prevent anchovy depletion and provide adequate forage for marine fishes, mammals, and birds. As a final safeguard against depletion, the management plan closes all fisheries in the second year if the spawning biomass falls below 50,000 t for two consecutive years; the closure continues in subsequent years until the spawning biomass equals or exceeds 50,000 t.

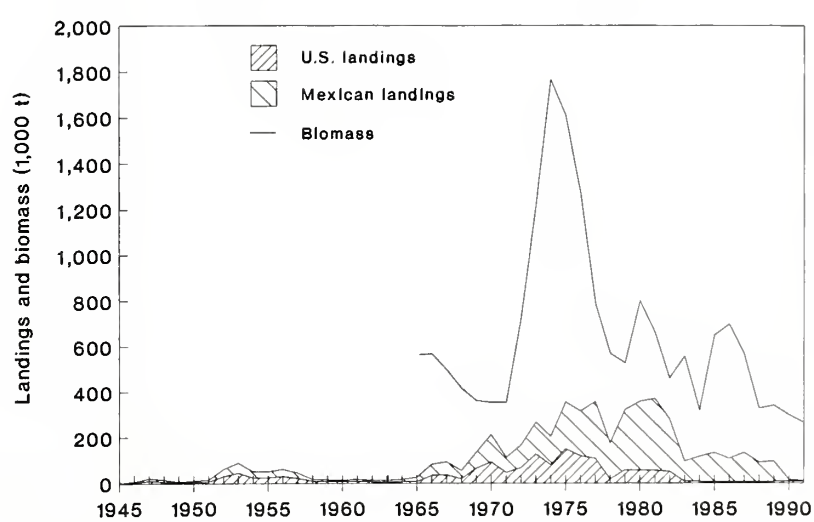


Figure 14-1.—Northern anchovy landings by U.S. and Mexican fleets during 1945-91, and biomass (age 1 and older) from 1964 to 1991.

Pacific Sardine

The California fishery for Pacific sardines dominated the landings of this species, but fisheries also existed off Oregon, Washington, and British Columbia when sardines were abundant (Fig. 14-2). In the past, sardines were harvested for fish meal, bait, and human consumption. Currently, there is no fish meal (reduction) fishery, but some sardines are taken for human consumption and bait. Pacific sardine numbers off southern California are now increasing. Since 1986, stock biomass has increased about 40%/year, and the current biomass is about 210,000 t. Commercial demand for sardines is strong, and as catch quotas grow, the fishery is expected to thrive. Beginning in 1986, only small annual quotas have been allowed for commercial harvest, but quota levels have begun to rise as biomass has increased.

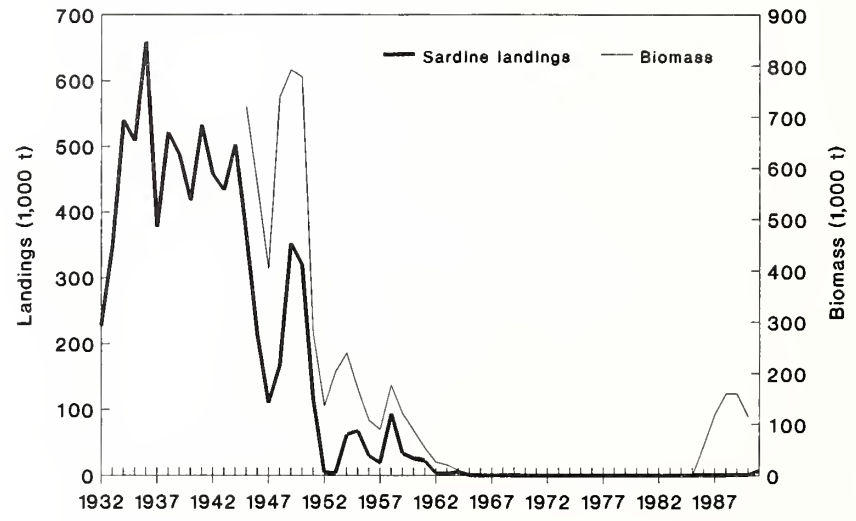


Figure 14-2.—U.S. Pacific sardine landings from the 1932-33 to the 1990-91 seasons and biomass (age 2 and older) from 1945 to 1990.

Jack Mackerel

While the jack mackerel and Pacific (or chub) mackerel are not identified separately on landing receipts and are considered commercially equivalent, the Pacific mackerel is discussed separately.

The large adult jack mackerel found offshore are sometimes caught incidentally by trawlers, particularly those targeting Pacific whiting. During the 1970's, foreign whiting trawlers may have caught 1,000-2,000 t annually, but foreign and joint-venture catches in the 1980's dropped to 100 t or less. The foreign trawl fisheries of the 1970's resulted in jack mackerel management being placed in the groundfish FMP and a bycatch quota of 12,000 t/year (north of lat. 39°N) was set. Restrictions on fishing for other groundfish species, like whiting, were thus avoided. In 1991, interest increased and the catch limit was raised to 52,000 t to allow a mackerel fishery to develop. While that fishery has not yet materialized, strong signs of commercial interest continue. The purse seine fishery for jack mackerel has continued at a low level. There is currently no catch limit.

Jack mackerel have a rather broad distribution, and their stocks consist of a wide variety of ages and sizes. This makes their assessment and management difficult. Mackerel stocks are thought to amount to about 1.5 million t, but their potential yield is little more than an educated guess. Development of more reliable estimates of stock size and potential yield awaits collection of more data on age structure and reproductive biology which could allow interpretation of existing egg and larval survey data. The PFMC has begun to transfer jack mackerel management from the Groundfish FMP to a new Coastal Pelagics FMP. This will allow both the southern California and the offshore mackerel fishery to be managed in the same plan.

Pacific or Chub Mackerel

The Pacific (chub) mackerel has a worldwide distribution in temperate and subtropical seas. In the eastern Pacific it ranges from central Mexico to southeastern Alaska, including the Gulf of California, being most abundant south of Point Conception, Calif. From 1980 to 1989, the California recreational catch averaged 1,462 t per year.

Pacific mackerel biomass declined from almost 400,000 t in the early 1930's to less than 100,000 t in the late 1940's and early 1950's. After a brief resurgence in the early 1960's, Pacific mackerel biomass declined to around 10,000 t (or lower) and remained low until strong year-classes appeared in the late 1970's.

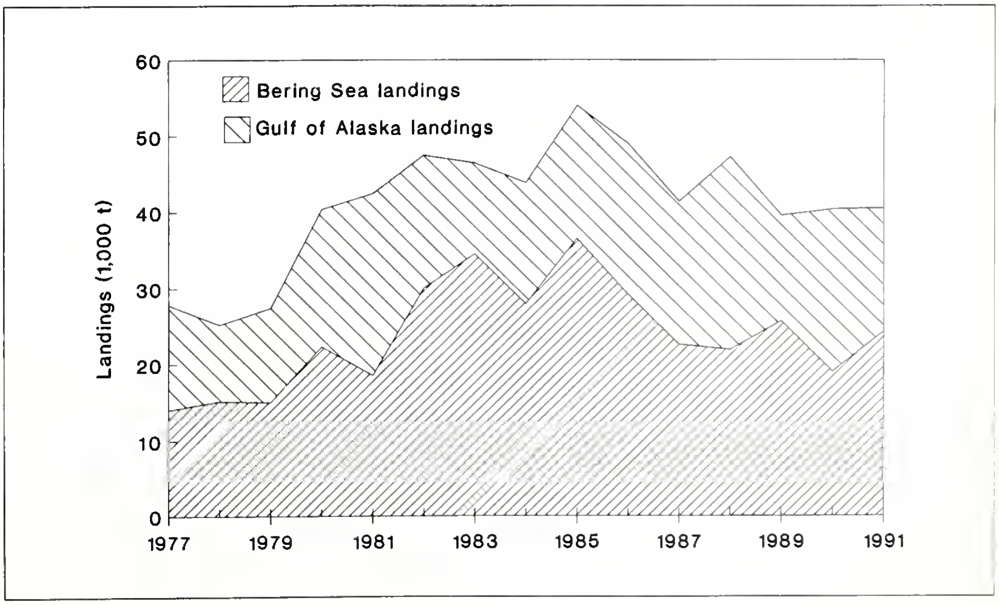
Abundance increased dramatically after 1977 and probably exceeded 200,000 t in every year during the 1980's. Biomass was estimated at about 240,000 t in 1989 but is thought to be declining at present. Analyses of fish-scale deposits in ocean bottom sediments in southern California indicate that the prolonged period of high mackerel biomass levels during the late 1970's and 1980's may have been unusual, and would only be expected to occur, on average, about once every 60 years. In 1985, it was estimated that Pacific mackerel might sustain average yields of from 26,000 to 29,000 t per year under management systems similar to that currently used to manage the stock by the State of California. The commercial catch is not currently restricted by a quota if the estimated biomass is greater than 135,000 t. If the biomass is between 18,000 and 135,000 t, then a quota equal to 30% of the biomass above 18,000 t is applied. If the biomass is below 18,000 t, then commercial fishing stops.

Pacific Herring

In 1990, the Pacific herring fishery harvested 40,700 t of herrings, valued at $27 million. Gulf of Alaska harvests have averaged 18,000 t since 1977 (Fig. 14-3). Bering Sea catches rose from 14,000 t in 1977 to peak at nearly 37,000 t in 1985. Since 1985, that catch has been declining. Herrings taken in the Bering Sea groundfish fishery cannot be retained but are counted as part of the catch. The herring bycatch averaged 2,000-4,000 t in the foreign and joint-venture fisheries, but may have been higher in the domestic trawl fishery.

Overall herring abundance in the Gulf of Alaska is at moderate to high levels, though some stocks are depressed or declining. A strong 1984 year-class is

Figure 14-3.—Pacific herring landings in the Gulf of Alaska and eastern Bering Sea, 1977-91.



. . . Pacific Herring

reported in most fisheries. Also, the very strong 1988 year-class reported in southeastern Alaska and Prince William Sound waters was expected to further boost Gulf of Alaska herring abundance in 1992.

Herrings have declined in the southeastern Bering Sea, but are stable or increasing in the northeastern Bering Sea. The 1977-78 year-classes were very strong and have sustained the fisheries through the 1980's. Historically, a strong year-class has occurred at 5- to 6-year intervals, but none occurred in the 1980's. Unless recruitment improves soon, declines are expected to continue in spawning areas south of Norton Sound. These declines would hurt Native American subsistence fisheries, inshore roe fisheries, and the Bering Sea groundfish fishery if the herring bycatch is high.

ISSUES

Transboundary Stocks and Jurisdiction

Mackerels, sardines, and anchovies are transboundary stocks exploited by both U.S. and Mexican fleets, but no bilateral management agreement has been reached. Harvest levels are increasing in Mexican waters, and the absence of a bilateral agreement is undermining management of the fisheries in U.S. waters.

Underutilized Species

Jack mackerel is an underutilized species, while the Pacific sardine is increasing in abundance after decades at low levels. These species may support an increased harvest by U.S. fishermen in the near future. Sardine management will require carefully balancing the need to rehabilitate the stock and immediate needs of fisheries.

Progress

The Pacific Fishery Management Council is drafting a new Fishery Management Plan for coastal pelagic species that will address management of Pacific sardine, Pacific mackerel, northern anchovy, and jack mackerel. The new FMP will likely involve some form of limited entry.

UNIT 15 PACIFIC COAST GROUNDFISH FISHERIES

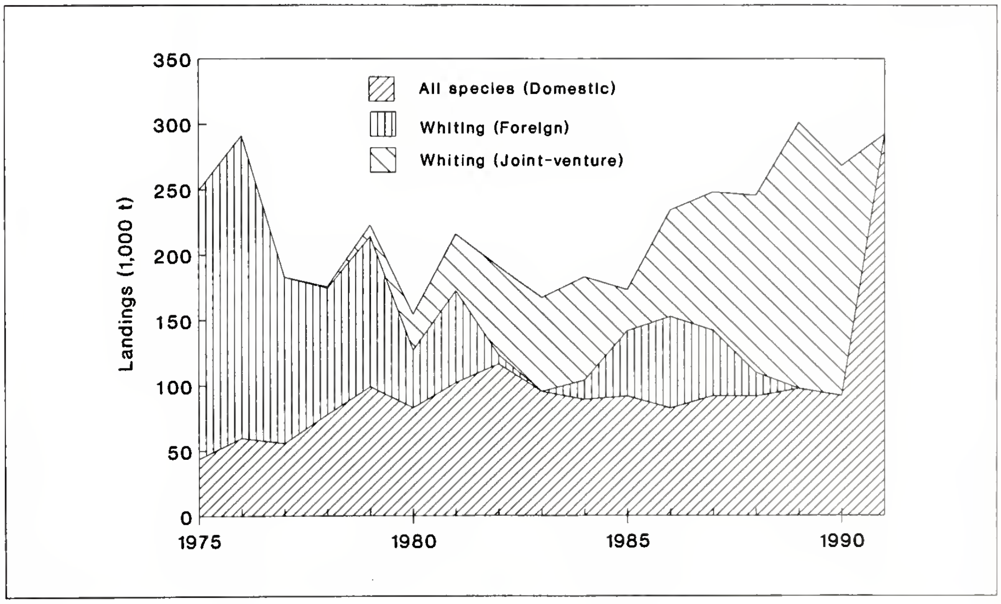
INTRODUCTION

The Pacific coast groundfish fishery includes 83 species managed by the Pacific Fishery Management Council (PFMC) off Washington, Oregon, and California. These groundfish, which include 12 species of flatfishes and 55 different rockfishes, are harvested commercially by trawl, trap, and hook-and-line gear. Sport fishermen operate from shore, private boats, and charter or commercial passenger fishing vessels.

The commercial catch of Pacific coast groundfishes by foreign and U.S. fishermen has changed greatly in recent years (Fig. 15-1). A foreign fishery for Pacific whiting (also called hake) began in the mid-1960's and peaked at 240,000 t in 1976. The catch declined as quotas were imposed and a joint-venture (U.S.-foreign) fishery began to develop. In 1989 the joint-venture fishery harvested 203,600 t and completely displaced the foreign Pacific whiting fishery. Since then the fisheries have become totally domestic operations. The total commercial groundfish catch was 292,000 t in 1991. Its ex-vessel value was $95 million. The important species harvested were Pacific whiting (290,600 t valued at $94.5 million), sablefish (9,500 t valued at $14.3 million) and Dover sole (18,200 t valued at $12.1 million). The summary information on yields and status of the stocks are listed in Table 15-1.

Various species of groundfish also support popular recreational fisheries off the Pacific Coast. Recent (1986) recreational catches were 13,900 t. Rockfish and lingcod were the most popular species, comprising about 42% of the recreational catch. The value of the recreational fishery has not been estimated.

Figure 15-1.—The 16-year trend in Pacific coast groundfish landings. Yield is partitioned into domestic shoreside landings of all species, foreign harvest of Pacific whiting, and joint venture harvest of Pacific whiting.



SPECIES AND STATUS

Most major west coast groundfishes are now fully harvested (Table 15-1), and recent catches have been controlled by annual quotas or trip limits. Many species can live a long time (50+ years if unfished) and can support only low harvest rates. Sablefish is such a species whose overall population is coming into equilibrium—that is, its current potential yields are approaching its long-term potential yield (Fig. 15-2). Dover sole, yellowtail rockfish, canary rockfish, and widow rockfish are near populations levels which will support high long-term sustainable yield. Pacific whiting reached full utilization in 1989 (Fig. 15-3). Its CPY is very close to its LTPY, but this is changing. The CPY for whiting will likely vary because this species has greater

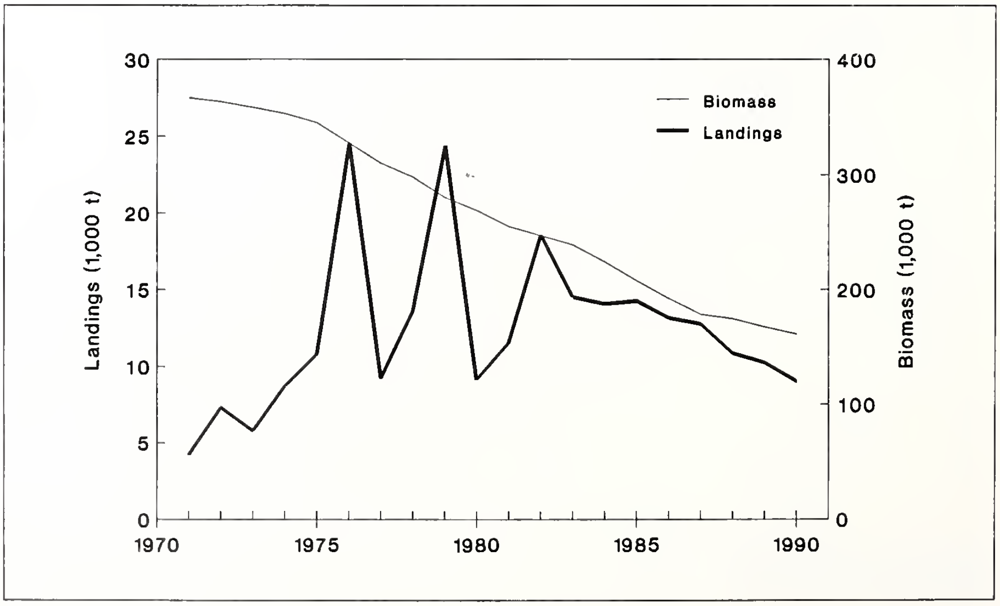
Table 15-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of Pacific coast groundfish. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituted.

Long-term potential yield (LTPY) = 361,638 t
Current potential yield (CPY) = 386,938 t
Recent average yield (RAY)[1] = 288,538 t

Species	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Pacific whiting[2]	201,734	232,000	226,000	Full	Near
Sablefish	9,568	8,900	8,700	Full	Near
Dover sole	17,564	19,400	16,300	Full	Near
English sole	2,163	1,900	4,500	Full	Unknown
Petrale sole	1,934	3,200	3,200	Unknown	Unknown
Thornyheads	8,193	7,000	Unknown	Unknown	Unknown
Widow rockfish	10,069	7,000	8,300	Full	Near
Bocaccio C-M-E[3]	1,600	800	2,400	Over	Below
Canary rockfish	2,034	2,900	3,500	Full	Near
Pacific ocean perch	1,277	0	2,500	Over	Below
Shortbelly rockfish	0	13,000	29,000	Under	Above
Yellowtail V-C[3]	4,182	4,300	4,200	Full	Near
Other rockfish C-M-E	10,174	Unknown	Unknown	Unknown	Unknown
Other rockfish V-C	4,011	4,500	Unknown	Unknown	Unknown
Lingcod	3,184	7,000	7,000	Unknown	Unknown
Pacific cod	1,687	3,200	Unknown	Unknown	Unknown
Jack mackerel	0	52,500	12,000	Under	Below
Other fish	9,164	Unknown	Unknown	Unknown	Unknown

[1]1989-91 average.
[2]U.S. landings only.
[3]All values are coastwide except V-C is Cape Blanco, Oreg., to U.S.-Canada border; C-M-E is U.S.-Mexican border to Cape Blanco, Oreg. Where a rockfish species is harvested outside the specified area, it is included with "Other rockfish."

Figure 15-2.—The 20-year trend in total catch (domestic and foreign) of sablefish in the U.S. EEZ and the estimated trend in biomass for ages 3 and older.

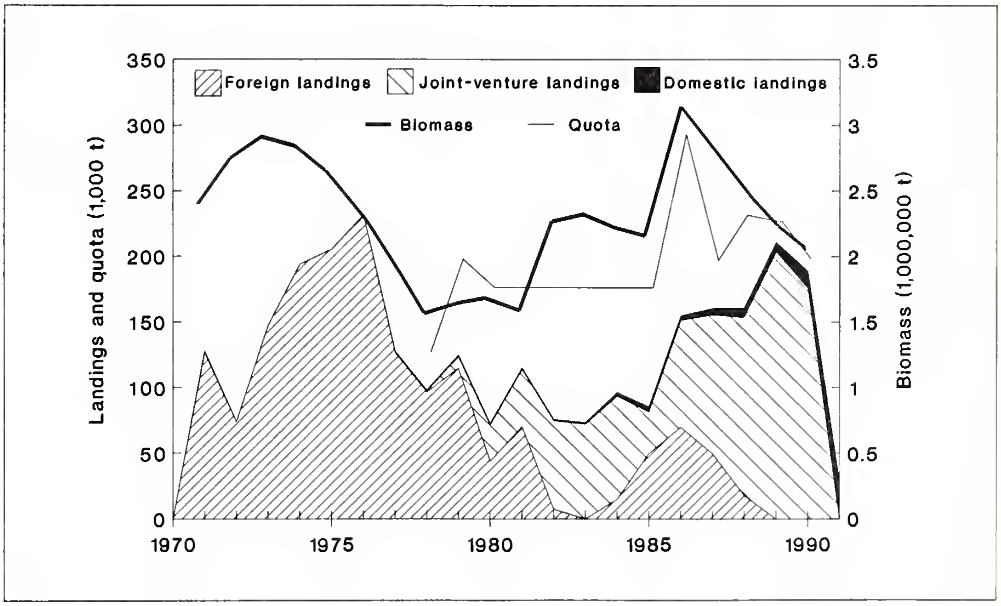


. . . SPECIES AND STATUS

short-term natural fluctuations than most other groundfish species. Shortbelly rockfish and jack mackerel are underutilized, but no market has yet developed for them.

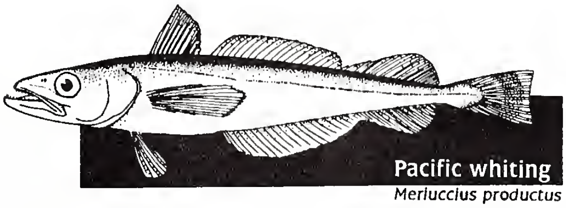
Pacific ocean perch and bocaccio are below population levels which will support their long-term potential yields. The long-lived perch was heavily fished by foreign nations in the 1960's and 1970's. Its population is slowly growing, and its CPY is zero, though some harvest is allowed as bycatch. Bocaccio is a southern species that has had several years of poor reproduction. The 1990 assessment showed that the harvest needed to be cut 50% to reduce the risk of further declines. Specific species assessments follow.

Figure 15-3.—The 20-year trend in domestic and foreign catch of Pacific whiting in the U.S. EEZ, total quota for harvest in the U.S. EEZ since 1978, and estimated trend in biomass for ages 2 and older.



Pacific Whiting

Pacific whiting stocks are well studied, with accurate ageing, hydroacoustic stock surveys, and an assessment model that analyzes all fishery and survey data while taking into account environmental effects on the stock. However, additional work is needed to improve 3-5 year ahead forecasts. The greatest management problems for this species are bycatch of salmon, allocation of catch between the United States and Canada, and allocation between onshore and offshore fisheries.



Merluccius productus

Sablefish

Sablefish stock assessment is hampered by lack of data. The size and age composition of the commercial catch has only been monitored since 1986, and trawl surveys at 100-700 fm have only been conducted in a small part of the species' wide range. Imprecise age and stock determinations must be clarified by further research. Other problems are catch allocations between trap and longline fishermen and incidental catches of sablefish by trawlers fishing for other species.

Dover Sole

Dover sole stock assessment suffers from the same lack of extensive, quantitative trawl survey data and similar stock mixing problems as sablefish. Although fishery catch and fishing effort data have been collected for several years, interpretation has been confounded by changing market conditions.

Other Flatfish

Important flatfish, other than Dover sole, are English and petrale soles and arrowtooth flounder. English and petrale soles have long histories of stable harvests, but they were last assessed in the mid-1980's. The arrowtooth flounder fishery has recently expanded in part of its range, and more research on them is needed.

Thornyhead

Thornyheads are harvested in deep water with sablefish and Dover sole. Their catch nearly tripled from 1987 to 1990 owing to increased demand. Data are not yet available for a full stock assessment, but the extremely long life of shortspine thornyheads indicates that their harvest rate must remain lower than sablefish and Dover sole.

Rockfish

Rockfish are also hard to assess. The age of the six major species caught has been well monitored, but more and better data are needed for accurate stock assessment. Better survey methods must be developed. Assessment of the 50+ lesser rockfish species will be an even bigger, but necessary, task.

ISSUES

Scientific Advice and Adequacy of Assessments

Assessment of the status of these groundfish stocks requires improved data on catches, extensive research surveys, and information on species interactions. Currently, only landed catch is monitored, but the fraction discarded at sea is poorly known. Information on discarding practices, obtained through observer programs for example (see Spotlight 2), would improve the monitoring of these stocks.

Bycatch and Multispecies Interactions

West Coast groundfish fisheries are characterized by a large number of species caught during a fishing trip. This complicates management because any action taken with respect to one species may adversely affect several others, either because of changes in fishing practices or due to biological interactions. Since all species can not withstand the same harvesting pressure, management controls need to be developed which adequately protect low productivity species while allowing full exploitation of high productivity species.

Allocation

Allocation of "available catch" to different groups is a difficult and controversial management problem. The Pacific Fishery Management Council must cope with a U.S.-Canada whiting allocation, onshore-offshore whiting allocation, fixed gear-trawl allocation of sablefish, and recreational-commercial competition for some rockfishes. Technical assessment of these issues generally rests on an economic analysis that rarely has adequate information on all sectors of the fishing industry. For some of these problems, individual transferable shares have been identified as a potential long-term solution which the Council has been exploring.

Management Concerns

Perhaps the most difficult problem is managing the excess harvesting capacity: There are simply too many boats and gear for the fish available. Today, more and more severe trip limits frustrate fishermen, managers, enforcement agents, and biologists alike, and are economically inefficient. Some alleviation of discard and enforcement problems has been achieved in 1992 by replacing some trip limits with biweekly cumulative vessel limits. A fishing license limitation program is being considered by the Pacific Fishery Management Council.

INTRODUCTION

Important invertebrate fisheries in the Western Pacific have included spiny and slipper lobsters and the gold, bamboo, and pink corals. The fisheries are relatively recent and range from the Hawaiian Islands EEZ (Fig. 16-1) to Guam, American Samoa, and various U.S. Pacific islands.

The lobster fishery began in 1977, and a Fishery Management Plan (FMP) was implemented in 1983. The Northwestern Hawaiian Islands (NWHI) are uninhabited, and there is no recreational fishery—all harvests are commercial. Commercial lobster vessels are all relatively large and carry about 800 traps which are used on 2-month-long fishing trips. Fishing effort from 1985 to 1990 was close to 1 million trap-hauls per year, about the level which achieves LPTY (Table 16-1). Eighty percent of the recent landings have been spiny lobster (Fig. 16-2). The fishery is managed by the Western Pacific Fishery Management Council (WPFMC).

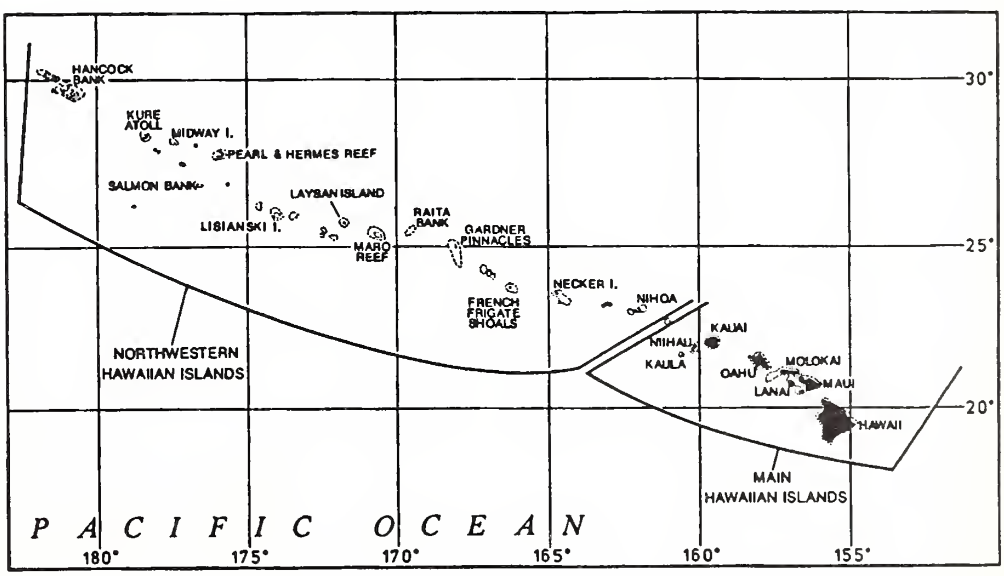
A short-lived (1974-79) fishery for several gold and bamboo corals and for pink coral existed off Makapu'u Point, Oahu, Hawaii. Since then, the prohibitive cost of fishing such difficult-to-harvest, deep-water corals has stifled U.S. exploitation. With the exception of one aborted attempt at Hancock Seamount in the Hawaiian EEZ in 1988, legal domestic harvesting of precious coral within the EEZ has been nonexistent for 12 years (Fig. 16-3). There are no recreational coral fisheries. Precious corals within the EEZ are managed under the Precious Coral FMP, set up in September 1983 by the WPFMC.

Table 16-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock level of Western Pacific invertebrate fisheries.

Species group	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Spiny and slipper lobsters	395	407	560	Full	Below

[1] 1989-91 average.

Figure16-1.—The main (MHI) and Northwestern (NWHI) Hawaiian Islands.



SPECIES AND STATUS

Lobster

Spiny and slipper lobsters are fished in the Western Pacific, primarily in the NWHI area (Fig. 16-1). They are not abundant outside this region.

The NWHI lobster landings and catch-per-unit-effort (CPUE) have dropped substantially since 1989 (Fig. 16-2). Concern that the NWHI lobsters were overexploited during 1990-91 prompted the WPFMC to close the fishery during May-November 1991. Fishing effort in 1991 was 296,000 trap-hauls. The revenue of the fishery in 1991 was $1 million, down from a high of $6 million in 1989. The lower landings and CPUE during 1990-91 were attributed to poor recruitment due to environmental events.

Coral

Fishing for coral is by regular or "experimental" fishing permit only. The FMP regulates precious coral fisheries within the EEZ management unit seaward of the MHI and NWHI, Guam, American Samoa, and the U.S. Pacific island possessions of Johnston Atoll, Kingman Reef, and Palmyra, Wake, Jarvis, Howland, and Baker Islands.

Figure 16-2.—Spiny and slipper lobster landings and fishing effort in Hawaii, 1977-91.

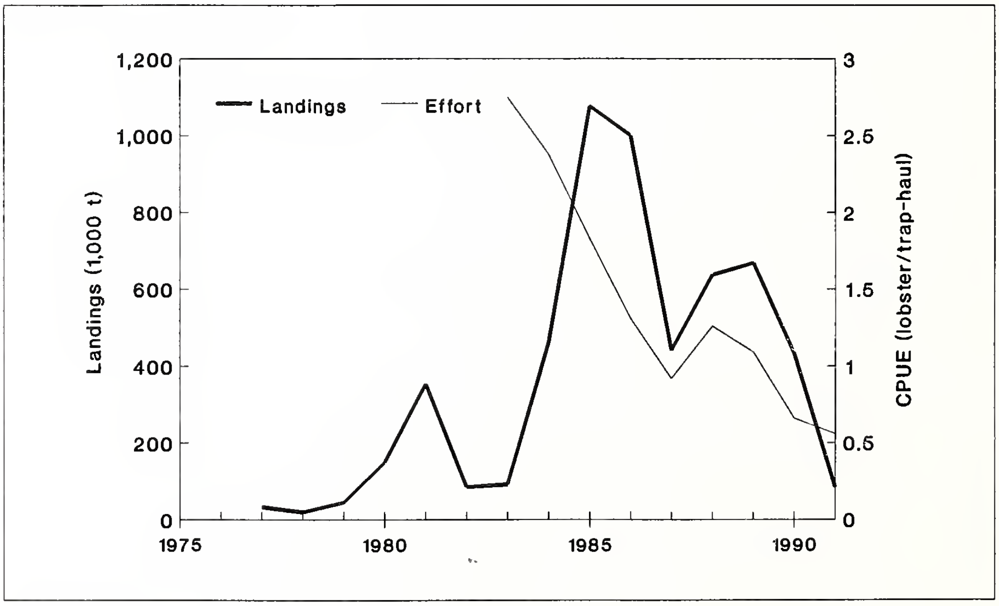
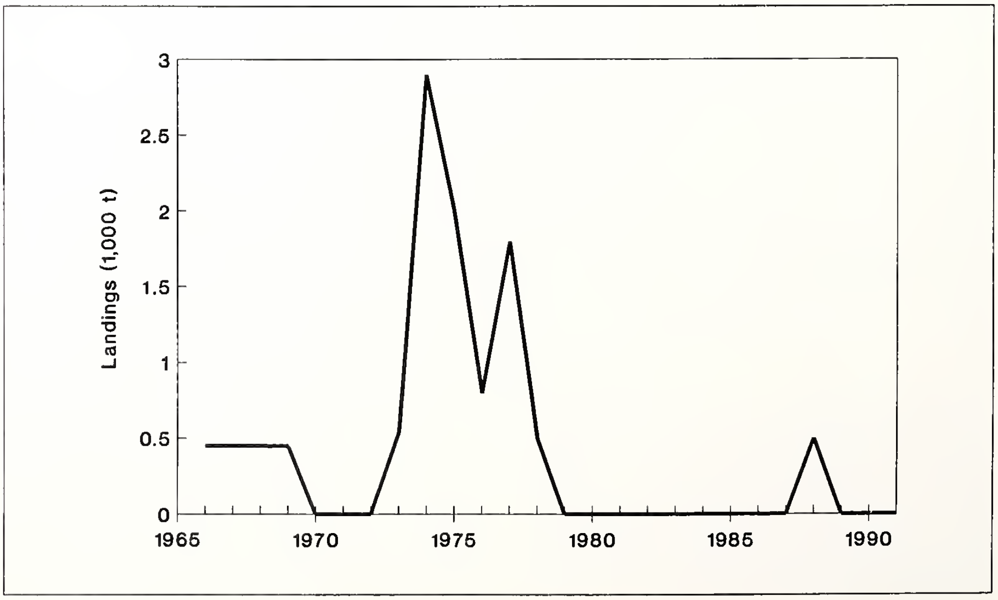


Figure 16-3.—Landings of precious corals from Hawaiian waters, 1966-91.



ISSUES

Scientific Advice and Adequacy of Assessments

Management of the spiny and slipper lobsters is difficult because the number of young lobsters entering the fishery each year varies widely. We need to know the cause of this variation so we can predict it. Preliminary research suggests that annual variation in current flow along the Hawaiian ridge may be the cause, but we need to pursue these studies to verify this hypothesis.

WESTERN PACIFIC BOTTOMFISH AND ARMORHEAD FISHERIES

INTRODUCTION

The bottomfish fishery geographically encompasses the Main Hawaiian Islands (MHI), the Northwest Hawaiian Islands (NWHI), the Territory of Guam, the Commonwealth of the Northern Marianas Islands (CNMI), and the Territory of American Samoa (Table 17-1). In contrast, the pelagic armorhead is fished on several undersea peaks called "seamounts."

The Guam, CNMI, Samoa, and MHI fisheries employ relatively small vessels on 1-day trips close to port; much of the catch is taken by either part-time or sport fishermen. In contrast, NWHI species are fished by full-time fishermen in relatively large vessels on trips of up to 10 days and far from port. Fishermen use the handlining technique in which a single weighted line with several baited hooks is raised and lowered with a powered reel. The bottomfish fisheries are managed jointly by the Western Pacific Fishery Management Council (WPFMC), Territories, Commonwealth, and State.

The armorhead was fished by the Japanese and, until some 15 years ago, by Soviet bottom trawlers. The catch peaked in 1972 with catch rates exceeding 60 t/hour but then dropped to very low levels. The combined population on all seamounts collapsed to about 0.5% of the 1972 level by the early 1980's (Fig. 17-1).

Table 17-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels of bottomfish and pelagic armorheads. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY) = 2,812 t
Current potential yield (CPY) = 819 t
Recent average yield (RAY)[1] = 558 t

Species and area	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Bottomfish					
MHI	404	404	274	Over	Below
NWHI	98	335	335	Under	Near
American Samoa	21	31	31	Under	Near
Guam	20	25	25	Under	Near
CNMI	15	24	24	Under	Near
Pelagic armorhead	0	0	2,123	Over	Below

[1] 1989-91 average.

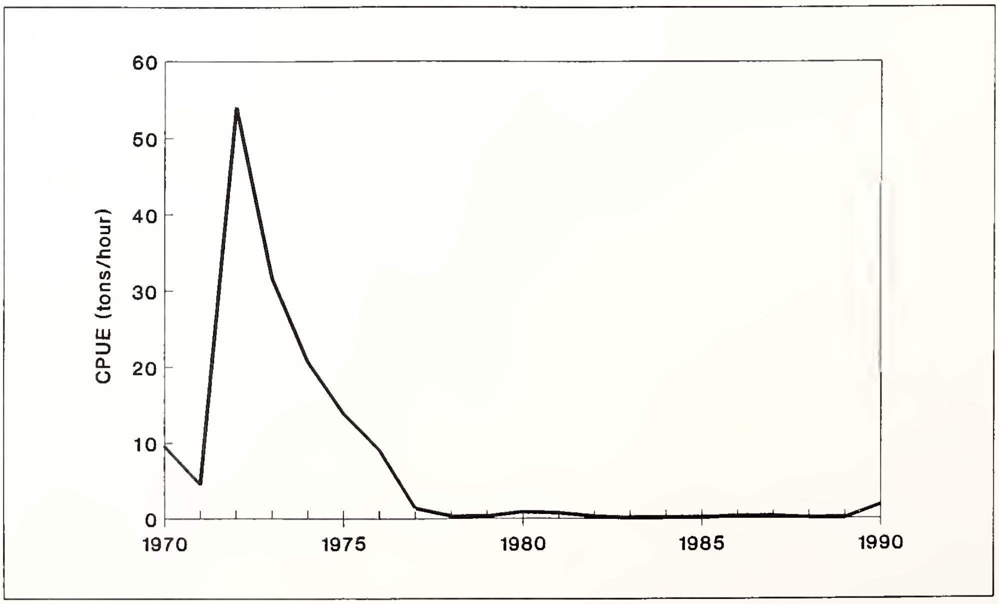


Figure 17-1.—Annual catch per unit of effort (CPUE) of pelagic armorhead taken by the commercial Japanese trawl fishery from central North Pacific seamounts, 1970-90.

. . . INTRODUCTION

The catch was regulated on Hancock seamounts in 1977 under a Preliminary Management Plan, but catches still declined and fishing was stopped in 1984. In 1986, under the bottomfish and seamount groundfish FMP, a 6-year fishing moratorium was imposed on the Hancock seamounts. This moratorium has recently (1992) been extended for an additional 6-year period.

SPECIES AND STATUS

Bottomfish

In Hawaii, the bottomfish species fished include several snappers, jacks, and groupers, while in the more tropical waters of Guam, CNMI, and Samoa the fishes include a more diverse assortment of species within the same families as well as several species of emperors. They are found on rock and coral bottoms at depths of 50-400 m.

Catch weight, size data, and fishing effort are collected for each species in the five areas. However, the sampling programs vary in scope between the areas. About 90% of the total catch is taken in Hawaii, nearly equally divided between the MHI and the NWHI (Fig. 17-2).

Stock assessments, though somewhat

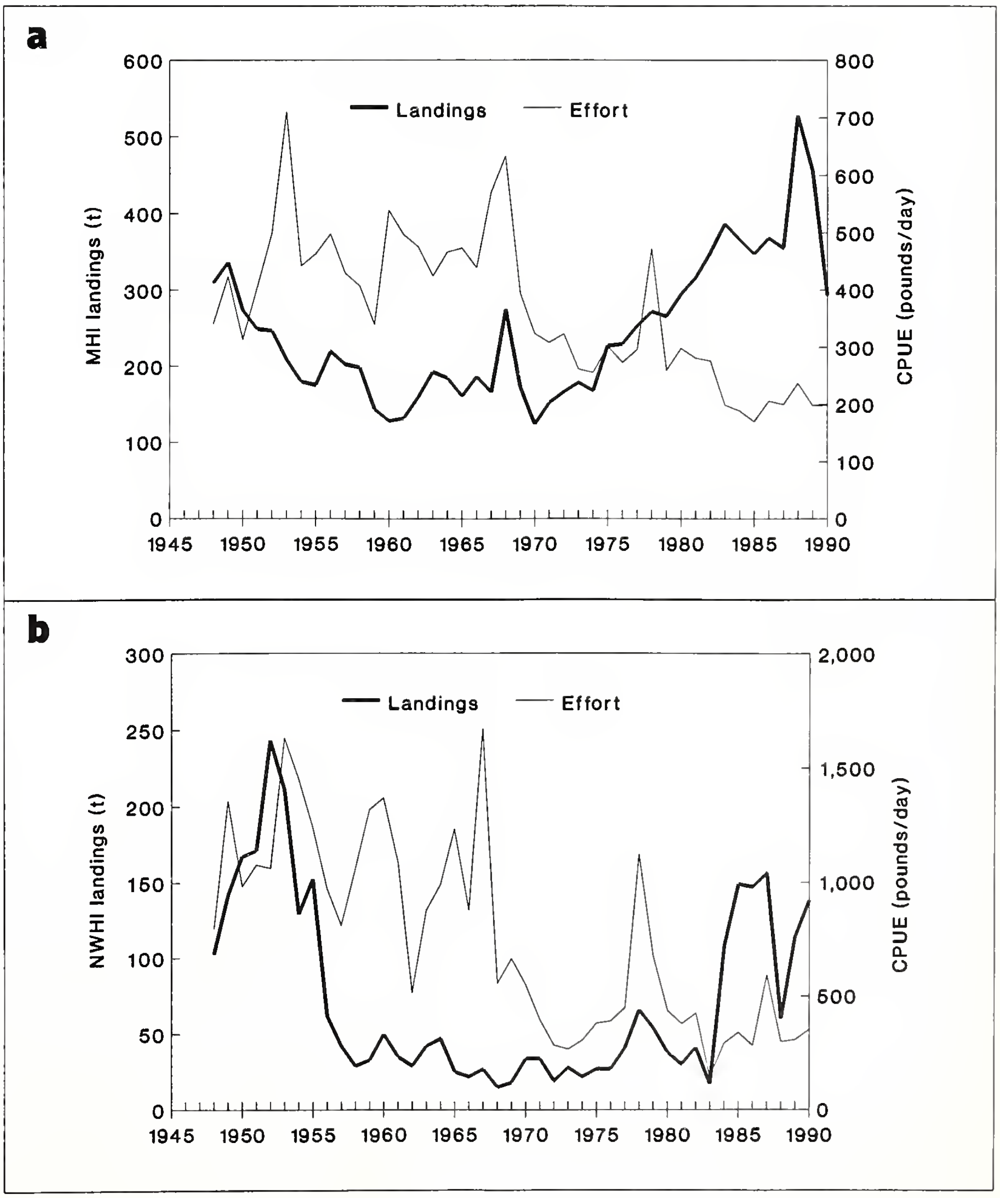


Figure 17-2.—U.S. landings and catch per unit of effort (CPUE) of bottomfish from fisheries off the a) main Hawaiian Islands (MHI) and b) Northwest Hawaiian Islands (NWHI), 1948-90.

. . . Bottomfish

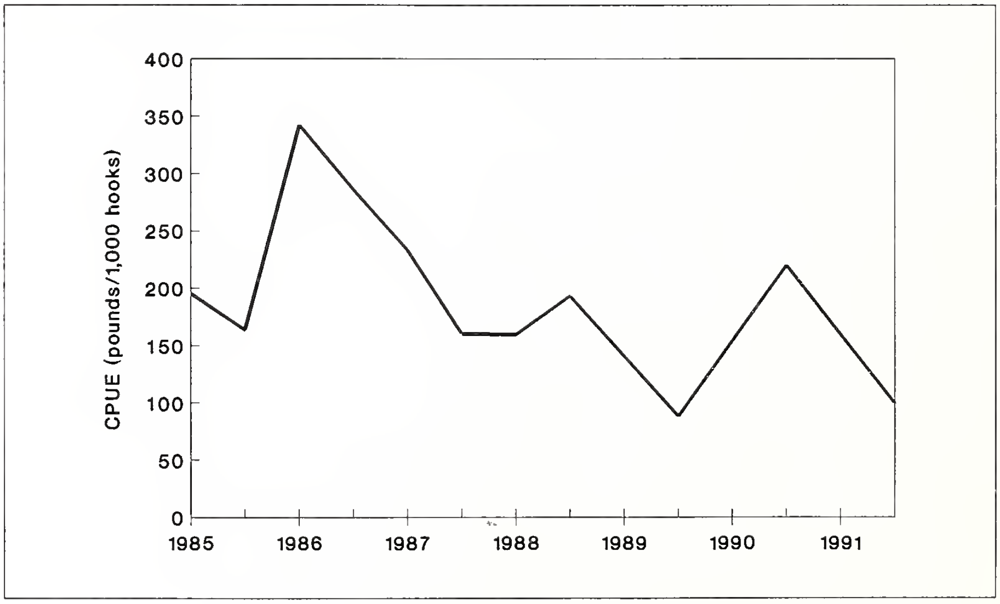
limited, indicate that the spawning stock of at least four major MHI species (opakapaka, ehu, onaga, and ulua) are at only 20-30% of original levels. Thus, overutilization is a concern, and the WPFMC has recommended some form of management.

Pelagic Armorhead

The seamount groundfish fishery targets just one species: The pelagic armorhead. It is fished on many of the undersea peaks of the northern Hawaiian Ridge and southern Emperor seamount chains, though only a small area, the Hancock seamounts, is within the U.S. EEZ. The long-term potential yield (Table 17-1) is 2,123 t, but further recovery is needed to achieve that level.

Standardized stock assessments began in 1985. Research cruises focus on the S.E. Hancock seamount and sample the armorhead stock with bottom longlines, calibrated against Japanese trawling. Catch rates vary but have not shown the increases expected after the fishing moratorium was implemented (Fig. 17-3). Closure of only the small U.S.-EEZ portion of the armorhead's distribution may not be sufficient to allow population recovery but it is the only portion of the habitat currently under management.

Figure 17-3.—Catch per unit of effort (CPUE) for pelagic armorhead taken on bottom longlines during research cruises to Southeast (SE) Hancock Seamount, 1985-91.



ISSUES

Scientific Advice and Adequacy of Assessments

Adequacy of the biological and catch data collected is a primary management concern for the Western Pacific bottomfish fishery. For example, the reproduction of many of the important species in Guam, CNMI, and Samoa is unknown, and spawning numbers cannot be computed.

Transboundary Stocks and Jurisdiction

The primary issue now for the pelagic armorhead and its seamount fishery is how to halt the armorhead harvest outside the U.S. EEZ via some form of international agreement so the stock can recover.

Management Concerns

The spawning stocks of at least four important MHI fishes (opakapaka, ehu, onaga, and ulua) appear to be at about 20-30% of original levels. Thus, overutilization is a concern and management has been recommended by the WPFMC.

PACIFIC HIGHLY MIGRATORY PELAGIC FISHERIES

INTRODUCTION

The fishes in this group range the high seas and often are outside U.S. fisheries management jurisdiction. The status of several is either precarious or unknown. Some species are sought vigorously by both commercial and sport fishermen.

During 1970-80, the Eastern Tropical Pacific (ETP) tuna fishery was expanding and was dominated by the United States. Fishing became less profitable in the 1980's, and many U.S. fishermen quit or moved to the Central Western Pacific (CWP) leaving Mexico, with over 50 purse seiners, the dominant fleet in the ETP. U.S. vessels decreased to about 10 in 1990-91 in response to dolphin mortality concerns. Purse seiners (all countries) in the ETP in 1991 numbered over 125.

Currently, there is no international tuna management in the ETP; each coastal nation regulates fishing within its own EEZ. Until 1980 the Inter-American Tropical Tuna Commission (IATTC) regulated the international fishery with catch quotas. Since then, IATTC regulations have been suspended because Mexico is not a Commission member.

Also, there is no overall resource management program in the CWP, though the Forum Fisheries Agency (FFA), which represents the concerned South Pacific island nations, has instituted a licensing program for foreign (distant-water) fishing fleets through access agreements. The U.S. fleet is currently limited to 50 purse seiners in the FFA region under an access agreement (South Pacific Regional Tuna Treaty).

Presently, there are no management regimes for the North or South Pacific albacore fisheries. In the South Pacific, multilateral discussions between Pacific island nations and distant-water fishing nations, including the United States, were held to explore various management schemes. Following the demise of drift gillnet fishing in the South Pacific, these negotiations were suspended in 1992 due to lack of further interest.

U.S. billfish fisheries (except for swordfish) are generally dwarfed by foreign fisheries (mostly longline and drift gillnet). There is no international authority managing these species in the Pacific. U.S. management authority rests with the Western Pacific Regional Fishery Management Council for Hawaiian and Western Pacific waters, and with the Pacific Fishery Management Council for North American waters (although the latter has delegated management to the State of California for swordfish, striped marlin, and some sharks).

SPECIES AND STATUS

"Highly migratory" pelagic species include tropical tunas (yellowfin, bigeye, and skipjack), albacore, billfishes, sharks, and other large pelagic fishes. Most are caught commercially, but some, especially certain billfishes, support important recreational fisheries as well.

Tropical Tunas

Longline gear is used to catch yellowfin and bigeye tunas across the Pacific, whereas the purse seine is the primary gear in the ETP and the CWP regions for capture of yellowfin and skipjack tunas.

Fishing in both the ETP and CWP is conducted generally between lat. 20°N and 20°S. Mexico is the primary fishing nation in the ETP. Others include the United States, Vanuatu, Venezuela, and some other coastal nations. Major fishing nations in the CWP are the United States, Japan, the Republic of Korea, and Taiwan. Current, recent, and long-term potential yields for the various species are given in Table 18-1.

Gears used in the CWP fishery include purse seine, ring net, handline, pole-and-line, and longline. Purse seiners, dominated by United States and Japanese fleets, but currently challenged by the fleets of Korea and Taiwan, take 30-50% of the yellowfin tuna catch. In 1989 the total number of purse seiners in the CWP was more

. . . Tropical Tunas

than 120. In 1990-91 about 50 U.S. seiners operated in the CWP.

About 90% of the Pacific yellowfin tuna catch is taken by purse seine, pole-and-line, longline, and handline. Purse seiners account for 30-50% of the catch. Virtually all skipjack tuna is taken by pole-and-line and purse seine. Most of the bigeye tuna catch is taken by longline gear.

More skipjack tuna are caught than any other tunas. Recent average yield (RAY) of Pacific skipjack tuna by U.S. and foreign fleets is 767,000 t from the CWP (Fig. 18-1) and 87,000 t from the ETP; angler catches are small. The species is believed underutilized, though the long-term potential yield (LTPY) is unknown. The annual dockside value of the Pacific skipjack tuna catch is about $680 million, and for yellowfin tuna it is well in excess of $450 million. These figures are based on a conservative dockside price of $800/t for both species.

The recent average yield of yellowfin tuna for the entire Pacific is about 560,000 t (Table 18-1), distributed about equally between the ETP and the CWP (Fig. 18-2). Recent assessments of yellowfin tuna indicate that the LTPY for the ETP is about 250,000 t, making this resource fully utilized. The LTPY for the CWP is unknown because a comprehensive analysis of potential yield has not been performed. However, catch rates are fairly steady, and preliminary analyses of stock condition suggest that the fishery may be nearing full production.

Table 18-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels for Pacific highly migratory species. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum. If the species' CPY is unknown, the species' RAY is substituted.

Long-term potential yield (LTPY) = 1,649,928 t
Current potential yield (CPY) = 1,569,261 t
Recent average yield (RAY)[1, 2] = 1,601,261 t (430,061 t, U.S. landings)

Species and area	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Yellowfin tuna (CWP[3])	280,000	Unknown	Unknown	Unknown	Near
Yellowfin tuna (ETP[4])	282,000	250,000	250,000	Full	Near
Skipjack tuna (CWP)	767,000	Unknown	Unknown	Under	Near
Skipjack tuna (ETP)	87,000	Unknown	Unknown	Under	Near
Albacore (North Pacific)	46,000	Unknown	120,000	Over	Below
Albacore (South Pacific)	43,000	Unknown	Unknown	Unknown	Near
Blue marlin	18,742	Unknown	23,500	Over	Below
Black marlin	1,765	Unknown	1,765	Unknown	Near
Striped marlin	14,951	Unknown	16,000	Under	Near
Sailfish and shortbill spearfish	4,392	Unknown	Unknown	Unknown	Near
Swordfish	24,140	Unknown	25,000	Unknown	Near
Wahoo	101	Unknown	Unknown	Unknown	Near
Mahimahi	23,539	Unknown	Unknown	Unknown	Near
Pompano	Unknown	Unknown	Unknown	Unknown	Unknown
Requiem sharks	8,137	Unknown	Unknown	Unknown	Unknown
Thresher sharks	268	Unknown	Unknown	Unknown	Below
Hammerhead sharks	0	Unknown	Unknown	Unknown	Unknown
Mackerel sharks	226	Unknown	Unknown	Unknown	Unknown

[1]1988-90 average; 1987-89 for yellowfin and skipjack tunas.
[2]Includes U.S. and foreign landings.
[3]CWP=Central-Western Pacific Ocean.
[4]ETP=Eastern Tropical Pacific Ocean.

Figure 18-1.—U.S. and foreign skipjack tuna landings from the Pacific Ocean, the eastern tropical Pacific (ETP), and the central-western Pacific (CWP), 1970-90.

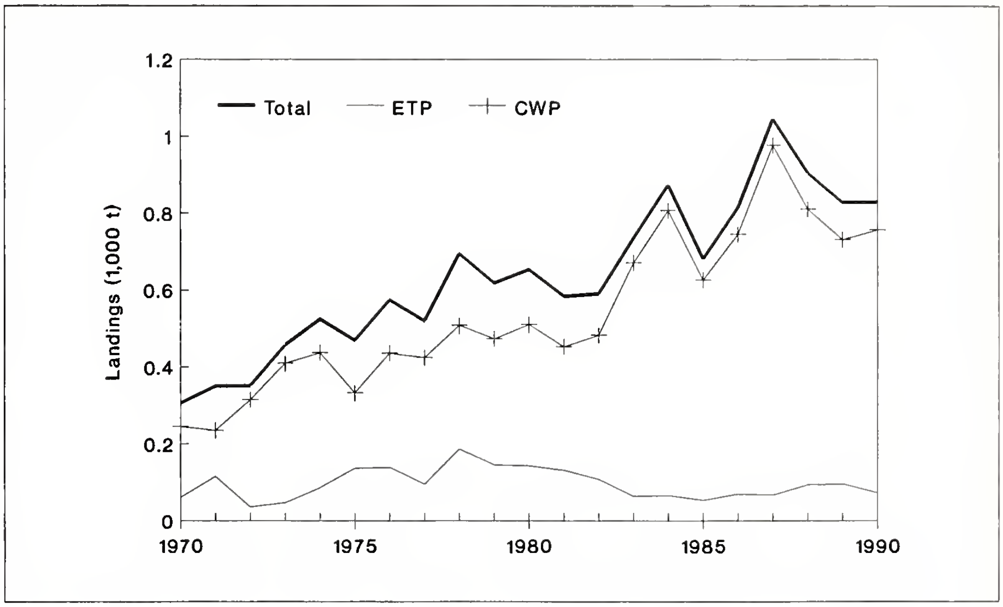
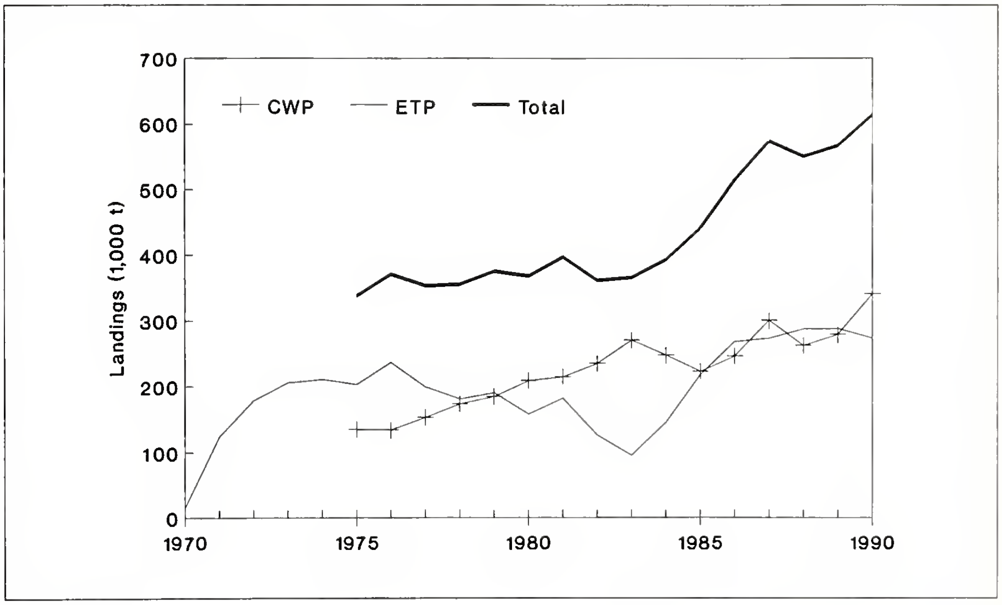


Figure 18-2.—U.S. and foreign yellowfin tuna landings from the Pacific Ocean, the eastern tropical Pacific (ETP), and the central-western Pacific (CWP), 1970-90.



Albacore

North Pacific albacore is fished from the northern limits of the North Pacific Transition Zone (NPTZ) to about lat. 15°N, and from Japan to North America. In the South Pacific, it is fished from about lat. 15°S to the southern limits of the Subtropical Convergence Zone (STCZ) and from South America to Australia.

In the North Pacific, albacore is fished primarily by longline, pole-and-line, drift gillnet, and trolling. Longline gear is used in the lower latitudes, and accounts for about 20-25% of the current catches. The surface fisheries (pole-and-line, drift gillnet, troll) operate in the higher latitudes of the NPTZ and account for 75-80% of the catches. The U.S. fishery in the North Pacific extends from the middle of the North Pacific to North America and uses between 500 and 2,000 vessels. Based on a dockside value of $2,200/t, the annual value of the Pacific albacore catch is about $195 million.

South Pacific albacore is fished primarily

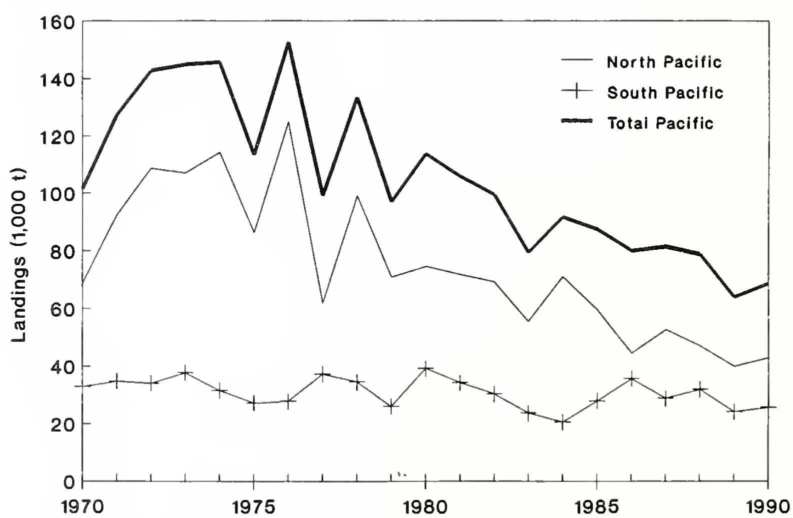
. . . Albacore

by longline and trolling. As in the north, longliners operate nearer the equator. Surface gear is fished in the Tasman Sea and in the STCZ at about long. 160°W. In 1990, about 60 U.S. trollers fished the South Pacific.

The Pacific albacore (both the north and south stocks) has a long history of exploitation (Fig. 18-3). Recent development of a large surface fishery in the South Pacific, in addition to the longline fishery, has changed the previous stock assessments from "fully exploited," under a longline-only fishery, to "unknown." No LTPY has yet been estimated, but a comprehensive assessment is needed due to the rapid expansion of the troll fishery and termination of the driftnet fishery in 1991.

In the North Pacific, the total catch, catch rates, and fishing effort in the U.S. troll fishery and the Japanese pole-and-line fishery have all been declining (Fig. 18-3). Previous assessments estimated LTPY near 120,000 t and stock production at or above LTPY in the 1970's. This high production, coupled with the recent addition of a drift gillnet fishery (for which statistics are incomplete), is probably overutilizing the stock.

Figure 18-3.—U.S. and foreign albacore landings from the Pacific Ocean, the North Pacific, and the South Pacific, 1970-90.



Billfish and Other Species

Species included here are the blue, black, and striped marlins; swordfish, sailfish, shortbill spearfish, wahoo, mahimahi (dolphin fish), pompano, and several oceanic sharks (requiem, thresher, hammerhead, and mackerel). They generally range from North America to Asia and between the North and South Pacific STCZ's. They are generally more abundant near islands, continental slopes, seamounts, and oceanic fronts, and many are important to local economies; they are caught by foreign and U.S. fishermen, both sport and commercial.

U.S. commercial fishing gears include drift gillnets, handlines, harpoons, longline, trolling, and rod-and-reel. Anglers use only rod-and-reel. Swordfish and thresher sharks are taken by longline around the Hawaiian Islands and by harpoon and drift gillnet off North America.

Because of the many species in this billfishes and sharks category, no precise value can be calculated for the annual catch. However, the catch of swordfish and blue and striped marlins alone are each valued in excess of $2,000/t, with swordfish fetching $6-8,000/t.

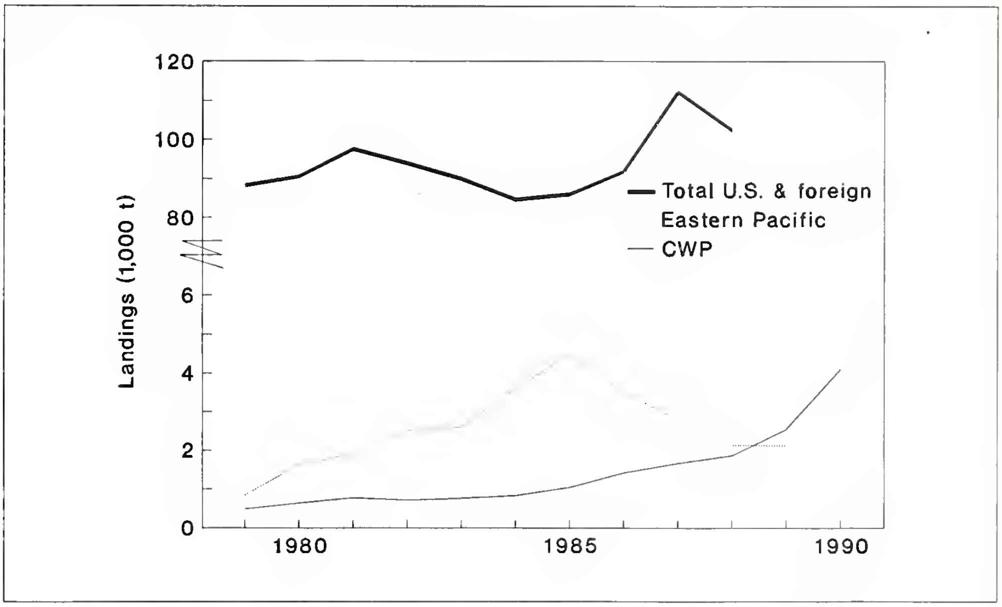
Catches of billfish and other species (Fig. 18-4) have been relatively constant, near 90,000 t per year, with a slight increase in the most recent years (Table 18-1). Four

. . . Billfish and Other Species

species dominate the "other" catches: Blue and striped marlins, swordfish, and mahimahi.

The status of most species' stocks is unknown or uncertain. Assessments using data through 1985 indicated that swordfish and striped marlin were utilized slightly below LTPY, and blue marlin was fished above LTPY; however, new data are needed to confirm or dispute these findings.

Figure 18-4.—Total U.S. and foreign landings of billfish and other pelagic migratory fish from the Pacific Ocean, 1979-88, and the U.S. landings from the eastern Pacific, 1979-89, and the central-western Pacific (CWP), 1979-90.



ISSUES

Management Concerns

The primary issue for the management of Pacific tropical tunas is the lack of consensus on a comprehensive plan for gathering and reporting statistics and for setting up a conservation and management group to represent all interests. The lack of data is critical and prevents conducting an accurate tuna assessment, developing informed management options, and preparing pragmatic advice for rational exploitation of the resource.

Within the U.S. EEZ of the central and western Pacific, including Hawaii, American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands, the Western Pacific Regional Fishery Management Council has developed, and the Secretary has approved, a Fishery Management Plan (FMP) for pelagic species. The FMP specifically addresses concerns about the expanded Hawaii longline fleet and the potential for interactions between longliners, trollers, and handliners by placing a cap on the number of permits issued to longliners and establishing nearshore zones closed to longlining. At the Council's behest, NMFS implemented a mandatory logbook and reporting system in the region's domestic longline fleet to collect statistics for fishery monitoring. Research is underway to analyze the fishery statistics and evaluate the effectiveness of the longline fleet limits.

High-seas drift gillnet fisheries have taken a dominant share of the North Pacific albacore catch in recent years. The full impact of the driftnet gear on the stock is not yet clear; however, data from the fisheries are being collected. In the South Pacific, the interaction between the established longline fishery and a rapidly growing surface fishery (predominantly U.S.) needs attention, particularly if allocation of available yield between the fisheries becomes an issue. The scope, structure, and organization of a multilateral management regime is another issue which needs attention.

The North Pacific albacore stock appears to be overutilized, possibly due to heavy catches by drift gillnets. Further data collection and an evaluation of the effects of the drift gillnet fishery and other factors, including environmental changes, are

... Management Concerns

urgently needed. Creation of an international forum to manage the stock is another issue that needs attention, particularly if the fishing nations want to reap the benefits of a recovered stock.

Our scientists recognize that at least one billfish species, the Indo-Pacific blue marlin is, and has been, depleted over its range and no management mechanism exists to rebuild the stock. Similarly, thresher sharks taken in the west coast drift gillnet fishery may need protection from overexploitation.

Scientific Advice and Adequacy of Assessments

Population levels of the billfishes and other species are either unknown or out of date: There is no international mechanism to collect fishery data on the Pacific-wide stocks, including those portions of the stocks that range in the U.S. EEZ. Basic biological data (beyond catches) are also lacking or grossly inadequate for most of these species. This limits determination of the current condition of the stocks. Bycatch of these species by drift gillnets and in other fisheries is another issue. Often these catches go unreported.

The impacts of the increased U.S. longline fleet in the Hawaiian EEZ and the Central Pacific high seas on swordfish and other resources are unknown, but the catches are being monitored and research is underway to better assess the stocks. The incidental take of endangered Hawaiian monk seals by Hawaiian longline vessels was also a concern. This problem has been addressed by the Western Pacific Regional Fishery Management Council through a strict prohibition of longlining within a 50-mile area surrounding the Northwestern Hawaiian Islands.

INTRODUCTION

The North Pacific (Fig. 19-1) is one of the most productive oceans, supporting many of the world's largest populations of groundfish, salmon, crabs, marine mammals, and seabirds. Large-scale commercial fisheries for groundfish in Alaska waters were developed and dominated by foreign fleets from the early 1950's until the Magnuson Fishery Conservation and Management Act (MFCMA) was passed in 1976. This act produced one of the great success stories for development of a U.S. groundfish industry.

Though foreign fisheries dominated through 1983 (and were important through 1986), joint ventures between U.S. fishermen and foreign companies eventually replaced them as experience was gained. Later, even the joint ventures were superseded by domestic fishermen and processors.

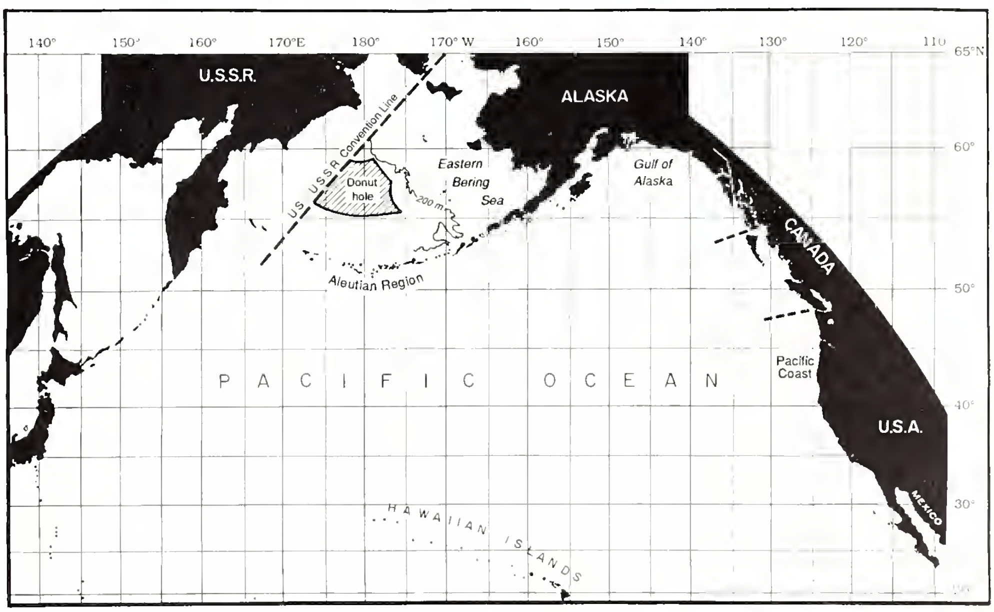
Alaska's groundfish fisheries are managed by two fishery management plans, one for the Bering Sea/Aleutians and the other for the Gulf of Alaska. Thus they are under constant watch by the North Pacific Fishery Management Council (NPFMC).

Pacific halibut has been fished commercially since the late 1800's; it is now targeted only with longline gear, though other gear types incidentally catch some halibut. There is an active recreational fishery as well, and about 3,700 t are landed by anglers.

Halibut is found from the Bering Sea to Oregon, though the center of abundance is in the Gulf of Alaska. The resource is considered as one large interrelated stock but is regulated by subareas with catch quotas and time-area closures.

The Pacific halibut is managed under treaty between the United States and Canada, and primary assessment and management recommendations are provided by the International Pacific Halibut Commission (IPHC).

Figure 19-1.—The North Pacific Ocean.



SPECIES AND STATUS

Pacific Halibut

In 1991, nearly 34,381 t of Pacific halibut were landed commercially (30,057 t in the United States and 4,324 t in Canada) (Fig. 19-2) valued at $110.5 million. About 2,000 t were wasted owing to fishing by lost gear and discard, and 10,000 t were lost to incidental catches by fishermen targeting other species (regulations do not permit halibut bycatch to be landed). Over 6,100 U.S. vessels were licensed for the commercial halibut fishery, as were 435 Canadian vessels.

Halibut stocks are assessed annually, and the fishable population apparently peaked at 200,000 t in 1986-88 after a rebuilding period (Fig. 19-2). The population has since declined at about 5%/year. Some decline is still expected, but halibut numbers remain fairly high by historical standards. The species is fully utilized (Table 19-1).

Figure 19-2.—Landings and abundance trends for Pacific halibut in the North Pacific Ocean for U.S. commercial and recreational fisheries and the Canadian fishery, 1980-91.

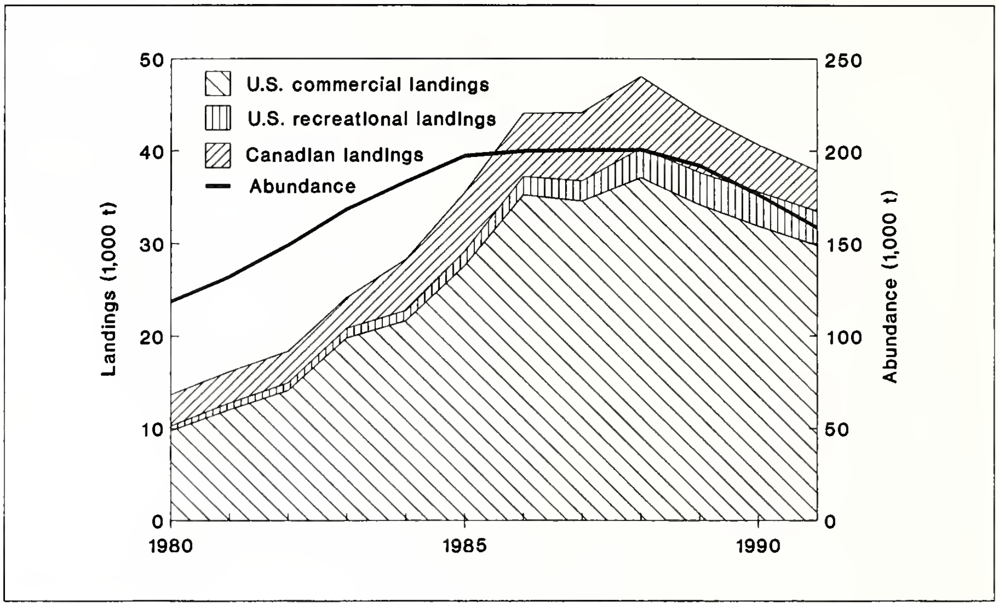


Table 19-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels for Pacific halibut. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY)[1] =	20,000 t
Current potential yield (CPY)[1] =	33,500 t
Recent average yield (RAY)[2] =	39,250 t

Region	Yield (t) RAY[2]	CPY[1]	LTPY[1]	Status of utilization	Status of stock level
Bering Sea-Aleutian Islands	3,200	2,800	1,700	Full	Near
Gulf of Alaska	29,900	25,900	15,400	Full	Near
Off Pacific coast[3]	250	300	200	Full	Near
Off Canadian Pacific coast	5,900	4,500	2,700	Full	Near

[1]Does not include 16,000 t for sport catch, bycatch, and waste.
[2]1988-91 average.
[3]California, Oregon, and Washington.

Bering Sea-Aleutian Islands Groundfish

The average eastern Bering Sea-Aleutian Islands groundfish catch during 1989-91 was about 1.7 million t (Table 19-2; Fig. 19-3). The total catch in 1991 was 1.5 million t, valued at $389 million (ex-vessel). The dominant species harvested in 1991 were walleye pollock (1.2 million t valued at $233 million); Pacific cod (177,300 t valued at $90 million), and yellowfin sole (84,000 t valued at $31.5 million).

Groundfish populations have been maintained at high levels under the MFCMA. Their long-term potential yield (LTPY) is about 3.0 million t. The current potential yield (CPY) of 2.77 million t for 1991 is slightly below LTPY. This potential has not been fully utilized because catch quotas cannot exceed the optimum yield (OY). The OY has been conservatively set below CPY, at 2.0 million t out of consideration for both socioeconomic factors and biological yield potential.

Walleye Pollock: Pollock produce the largest catch of any single species inhabiting the U.S. EEZ. The three main stocks, in decreasing order of abundance, are: Eastern Bering Sea (EBS) stock, Aleutian Basin (AB) stock, and the Aleutian Islands (AI) stock. The EBS stock is moderately high (above the level that produces LTPY) and is now fully utilized.

Another large pollock fishery lies outside the U.S. and Russian EEZ's in the "donut

Figure 19-3.—Landings and abundance trends for groundfish resources in the Bering Sea/Aleutian Islands region for the foreign, joint-venture, and U.S. fisheries, 1976-91.

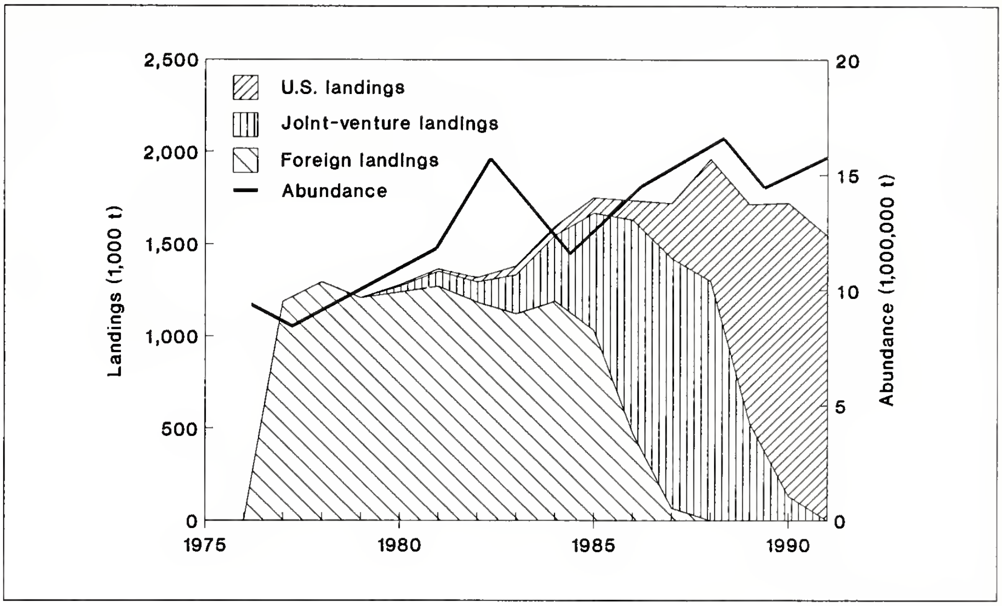


Table 19-2.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock level for Bering Sea-Aleutian Islands groundfish. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's. Where the species' LTPY is unknown, the species' CPY is substituted in the sum.

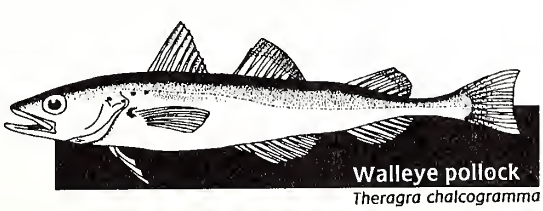
Long-term potential yield (LTPY) = 2,998,685 t
Current potential yield (CPY) = 2,773,355 t
Recent average yield (RAY)[1] = 1,661,766 t

	Yield (t)			Status of	Status of
Species	RAY[1]	CPY	LTPY	utilization	stock level
Pollock	1,277,200	1,566,600	2,020,000	Full	Near
Pacific cod	172,200	182,000	Unknown	Full	Near
Yellowfin sole	106,100	372,000	268,000	Full	Near
Greenland turbot	6,400	7,000	25,200	Full	Below
Arrowtooth flounder	5,600	82,300	59,000	Under	Above
Rock sole	31,600	260,800	164,000	Under	Above
Other flatfish	18,400	199,600	144,000	Under	Above
Sablefish	4,100	4,400	12,200	Full	Near
Pacific ocean perch	12,400	23,530	17,060	Full	Near
Other rockfish	800	1,325	Unknown	Full	Near
Atka mackerel	21,100	43,000	Unknown	Full	Above
Other fish	4,200	30,800	72,900	Under	Above

[1] 1989-91 average.

. . . Bering Sea-Aleutian Islands Groundfish

hole" of the central Bering Sea (Fig. 19-1). This fishery is dominated by Japan, Russia, Poland, China, and the Republic of Korea. The fishery targets the AB pollock stock during its migration through the



Theragra chalcogramma

donut hole area. Catches from this stock appear far too high. Although the status of the AB stock is not well known, it appears to be declining rapidly.

Pacific Cod: Pacific cod abundance remained high and stable throughout the 1980's. However, the 1990 and 1991 surveys showed a combined 45% drop in biomass relative to 1989. This decline and poor recruitment over the past 3 years may be due to changing environmental conditions or ecological relationships. The cod stock is fully utilized.

... Bering Sea-Aleutian Islands Groundfish

Flatfishes: Yellowfin sole is the most abundant of the flatfishes. During the 1950's, yellowfin sole was the major trawling target, but it now ranks behind both pollock and Pacific cod. Yellowfin sole is fully utilized. Greenland turbot, the only depressed flatfish stock, is expected to decline further during the mid-1990's owing to poor spawning success in the 1980's. It is considered fully utilized.

All other flatfish species are in good-to-excellent condition. Populations continue to be high and increasing for arrowtooth flounder and high and stable for rock sole, flathead sole, Alaska plaice, and other flatfishes. The rock sole is now the second-most abundant of the flatfishes, increasing substantially from 1980. It is underutilized, as are some other flatfishes. Trawl catches are restricted to prevent excessive incidental catches of Pacific halibut and king and tanner crabs.

Sablefish: Sablefish or blackcod is a valuable species caught mostly with longline and pot gear below the depths fished by trawlers. Sablefish is considered to be a single stock from the Bering Sea-Aleutian Islands (BSAI) region to the Gulf of Alaska. The BSAI population declined substantially in 1990, partly due to migration into the Gulf of Alaska. Current abundance is low to average, and recruitment has been relatively weak. The sablefish is fully utilized.

Rockfishes: Rockfishes are assessed and managed as two major groups: Pacific ocean perch (POP) and "other rockfish." The POP group consists of the true Pacific ocean perch and four other red rockfish species. POP abundance dropped sharply owing to intensive foreign fisheries in the 1960's and remained low into the early 1980's. In recent years, catch levels have been set well below CPY to help rebuild the stocks. The POP group is now recovering and is considered fully utilized.

The "other rockfish" group includes two thornyhead species and about 30 other rockfish species not included in the POP group. Little is known about them, but they are considered fully utilized.

Atka Mackerel: The Atka mackerel stock occurs mainly in the Aleutian region. Previously, CPY for this species had been set conservatively because of uncertainty regarding the abundance estimate provided by the 1986 Aleutian trawl survey. However, the 1991 survey confirmed the 1986 estimate, and CPY for 1992 was raised accordingly. The stock is considered fully utilized.

Other Species: In recent years, "other species" catches have represented 1% or less of the total groundfish catch. Sculpins and skates probably constitute most of this resource, but the abundance of pelagic squids, smelts, and sharks is largely unknown. Owing to insufficient data, the LTPY for "other species" is unknown. The CPY has been set at the average catch level.

Gulf of Alaska Groundfish

Gulf of Alaska groundfish catches have ranged from a low of 135,400 t in 1978 to a high of 352,800 t in 1984 (Fig. 19-4), with pollock dominant, followed by Pacific cod and sablefish. The 1991 groundfish catches were valued at $133 million (ex-vessel value). Sablefish comprised about 40% ($53.2 million) of the total Gulf value. Other major revenue-producing species that year were Pacific cod ($41.8 million), pollock ($21.4 million), and rockfish $15.9 million).

Groundfish abundance in the Gulf of Alaska has been relatively stable, rising slowly from 1984. Arrowtooth flounder is most abundant, followed by pollock and Pacific cod. In 1991, arrowtooth flounder comprised 1.8 million t of the Gulf groundfish biomass (4.5 million t); pollock, 0.8 million t; and Pacific cod, 0.4 million t. The estimated LTPY for Gulf of Alaska groundfish is 413,413 t (Table 19-3). The CPY is 656,604 t, which contrasts with the RAY of 202,309 t. The wide disparity between the CPY and the RAY is because groundfish fishing is restricted to reduce incidental catches of Pacific halibut.

Pollock and Pacific Cod: Pollock appears to be at a moderate population level and is considered fully utilized. Pacific cod are abundant and fully utilized, but are expected to decline. Reproduction has not kept pace with natural and fishing losses.

Figure 19-4.—Landings and abundance trends for groundfish resources in the Gulf of Alaska region for the foreign, joint-venture, and U.S. fisheries, 1976-91.

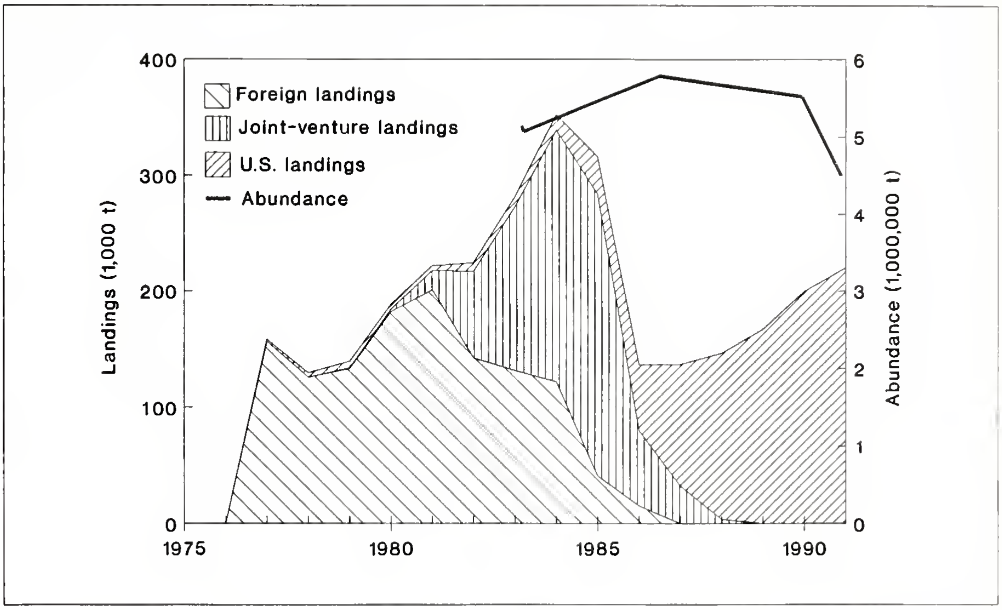


Table 19-3.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock level for Gulf of Alaska groundfish. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY) =	413,413 t
Current potential yield (CPY) =	656,604 t
Recent average yield (RAY)[1] =	202,308 t

	Yield (t)			Status of	Status of
Species	RAY[1]	CPY	LTPY	utilization	stock level
Pollock	77,425	99,400	151,000	Full	Below
Pacific cod	65,849	63,500	377,800	Full	Above
Flatfish	13,548	441,920	168,557	Under	Above
Sablefish	21,741	20,800	23,500	Full	Above
Slope rockfish	15,087	21,750	21,350	Full	Below
Thornyhead rockfish	1,981	1,798	3,750	Unknown	Below
Pelagic shelf rockfish	1,179	6,886	6,886	Full	Unknown
Demersal shelf rockfish	498	550	550	Full	Unknown

[1] 1989-91 average.

... Gulf of Alaska Groundfish

Flatfish, Sablefish, and Rockfish: Flatfish are in general very abundant, largely owing to great increases in arrowtooth flounder. Flatfish are managed as deep-water and shallow-water groups, while flathead sole and arrowtooth flounder are managed as separate categories.

Sablefish are abundant and are in good condition, though they are projected to decline due to low recruitment. They are fully utilized.

"Slope" rockfish, those inhabiting the outer edge of the continental shelf down to the abyssal plain, are at low levels. They grow slowly and are long-lived, and may be showing signs of improved recruitment. They are considered fully utilized. The principal species in this group, Pacific ocean perch, shortraker rockfish, and rougheye rockfish, are highly valued and are in a separate management category. Thornyhead rockfishes are also believed to be at a low level and decreasing. The population of pelagic shelf rockfishes is unknown and needs further research. Demersal shelf rockfish abundance is considered to be at a low level.

ISSUES

Transboundary Stocks and Jurisdiction

The large unregulated foreign pollock fishery in the "donut hole" of the Bering Sea (Fig. 19-1) is a major concern as it targets U.S. and Russian stocks as they migrate through international waters. Another major concern is the lack of data to determine the status of the stocks outside the U.S. EEZ. Several international meetings have been organized to develop cooperative research and management of the fishery. The nations involved have begun to cooperate on research and slowly cut back on the number of fishing vessels.

Bycatch and Multispecies Interactions

Marine mammal interactions with fish and fisheries are a growing concern. Steller sea lions are listed as threatened under the Endangered Species Act, and groundfish fisheries have been modified to reduce the impact on them. Pollock provide food for sea lions, and some fishing has occurred near rookeries; however, there is a lack of data to show a direct cause-and-effect relationship between the pollock fishery and the decline of the sea lions.

The incidental catch of Pacific halibut and king and tanner crabs off Alaska now curtails expansion of the groundfish fisheries. When halibut and crab bycatch limits are reached, the groundfish fisheries are closed, usually before harvesting the entire groundfish quotas. Various incentive programs are being tested to control bycatches while improving the groundfish harvest.

Allocation

As the domestic groundfish fisheries are now fully developed and probably overcapitalized, allocation disputes between user groups have been exacerbated. These problems include inshore vs. offshore fisheries, longliner vs. trawler, and conflicts with respect to bycatch of halibut. The NPFMC has been developing FMP amendment proposals to mitigate the problems. Recent FMP amendments have made explicit allocations to inshore and offshore sectors of the industry, but further work is needed on all of these issues.

Progress

The need for additional data on bycatch and discarding practices as well as a number of other aspects of fishing operations has led to the development of an extensive observer program on domestic groundfish vessels off Alaska. The industry has accepted and supported observer coverage, although observer costs and operational difficulties occasionally cause problems. These additional data should improve the scientific advice for the development of better management.

Recently a two-year moratorium on fishing in the unregulated "donut hole" was agreed to by the United States and the nations involved in this fishery (Poland, Russia, Korea, Japan, and China). The agreement, which takes affect in January 1993, allows fishing by monitoring vessels only to keep track of the status of the resource. This moratorium should help prevent further declines in this portion of the stock.

INTRODUCTION

Exploratory crab and shrimp fishing began off Alaska during the 1940's and 1950's. The first major domestic king crab fishery began in the 1960's off Kodiak Island, later expanding to the Aleutian Islands and Bering Sea. Domestic tanner crab fisheries became important during the 1970's, as did the shrimp fisheries of the Gulf of Alaska. A Japanese snail fishery developed in the Bering Sea during the 1970's but ended in 1987.

The king, tanner crab, and shrimp fisheries are managed primarily by the State of Alaska with input from a Federal FMP for the Bering Sea and Aleutian Island stocks of crabs. The snails are covered by a Federal Preliminary Fishery Management Plan (PFMP).

SPECIES AND STATUS

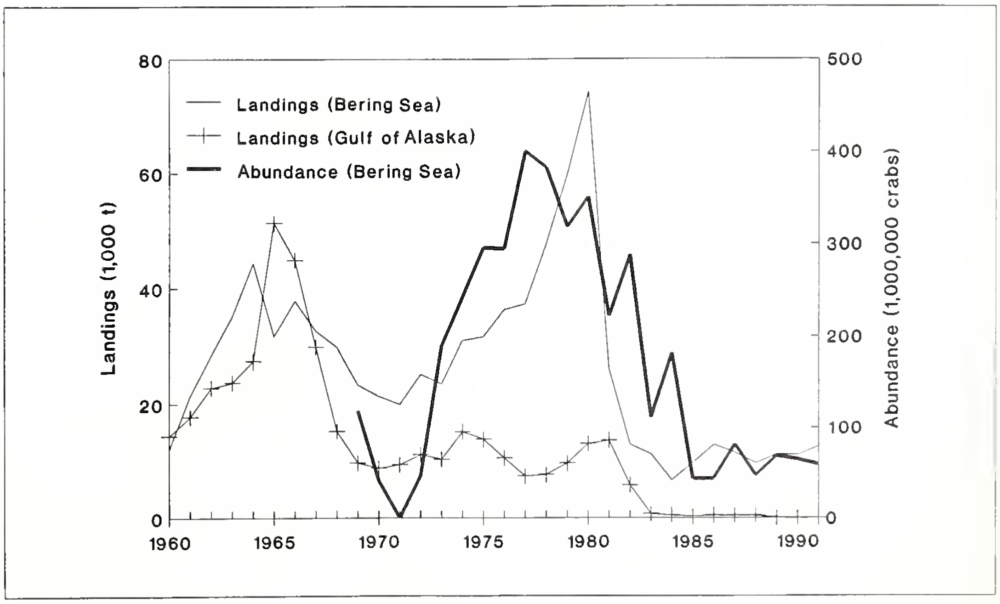
Crab

Three species of king crabs (red, blue, and golden or brown) and two species of tanner crabs (bairdi and opilio) are harvested commercially off Alaska. The annual dockside value of Alaska king and tanner crab fisheries in 1991 was $343 million. All-time high tanner crab landings made up 76%, or $260 million of the total value. Almost all (98%) of the tanner crab value production came from the Bering Sea, where the snow crab (opilio) comprised 77% of the value. Virtually all king crab landings came from the Bering Sea-Aleutian Islands (BSAI) in 1991. Total ex-vessel value of this production was $83 million, compared to the 1978-91 average of $115 million. Red king crab made up 66% and brown king crab contributed 23% of the landed value.

About 250 vessels, mostly large and modern and each fishing an average of 250-300 pots, make up the BSAI crab fleet. Over 400 vessels harvest crabs in the Gulf of Alaska, although there is considerable vessel overlap between the areas. Catches are restricted by quotas, seasons, and size and sex limits. Fishing seasons are set at times which avoid molting, mating, and softshell periods, both to protect crab resources and to improve product quality. Limits on the number of pots per vessel are in effect in most areas of the Gulf. Vessels are also restricted by the number of management areas they may fish in any given year. Vessels which both catch and process crabs are required to have observers throughout the season to monitor the catch and compliance with regulations.

Catch and abundance trends for king crabs fluctuated during 1960-91 (Fig. 20-1). After a 1964-66 peak, declines were evident. Until 1967, Japanese and Soviet fisheries dominated Bering Sea landings, but those fisheries were phased out during bilateral negotiations until foreign fishing ceased in 1974. During the late 1970's, domestic catches built to record levels in

Figure 20-1.—King crab landings and abundance for the Bering Sea and Gulf of Alaska, 1960-91.



. . . Crab

the Bering Sea, peaking at 74,000 t in 1980. Gulf catches varied at a relatively low level for a decade before dropping lower yet in 1983. Almost all Gulf of Alaska king crab fisheries have been closed since 1983. In the Bering Sea, catches dropped precipitously in 1981, followed by further declines to a low in 1983. Since then, there has been a gradual increase in the catch.

Bering Sea-Aleutian Islands tanner crab catches are largest in the eastern Bering Sea (Fig. 20-2). The 1965-75 period was a developmental phase. During 1975-85, the catch peaked at about 49,000 t in 1979 and then declined. Since 1984, the catch has increased, reaching about 167,000 t in 1991. Abundance trends for the eastern Bering Sea stocks indicate that the bairdi stock declined from a relatively high level in the late 1970's to a low in 1985. Since then, the Bering Sea bairdi stock has recovered and is currently approaching its former level. From a low in 1985, the opilio stock has rebounded sharply and is approaching an all-time high level. The catch in the Gulf of Alaska, composed exclusively of bairdi, reached peak levels during the 1970's, following a developmental phase in the late 1960's. Since 1979, the Gulf of Alaska catch has declined.

Information on CPY and LTPY (Table 20-1) is lacking for king and tanner crabs; thus the values in that table were derived from historical average catches. Alaska crabs can be designated as fully utilized relative to yields of legal-sized males. Since female crabs are not landed it seems likely that most crab stocks could be designated as underutilized, in terms of existing fishing mortality on the reproductive stocks.

Figure 20-2.—Tanner crab landings and abundance from the Bering Sea and Gulf of Alaska, 1960-91, and abundance of two species of tanner crab, 1976-91.

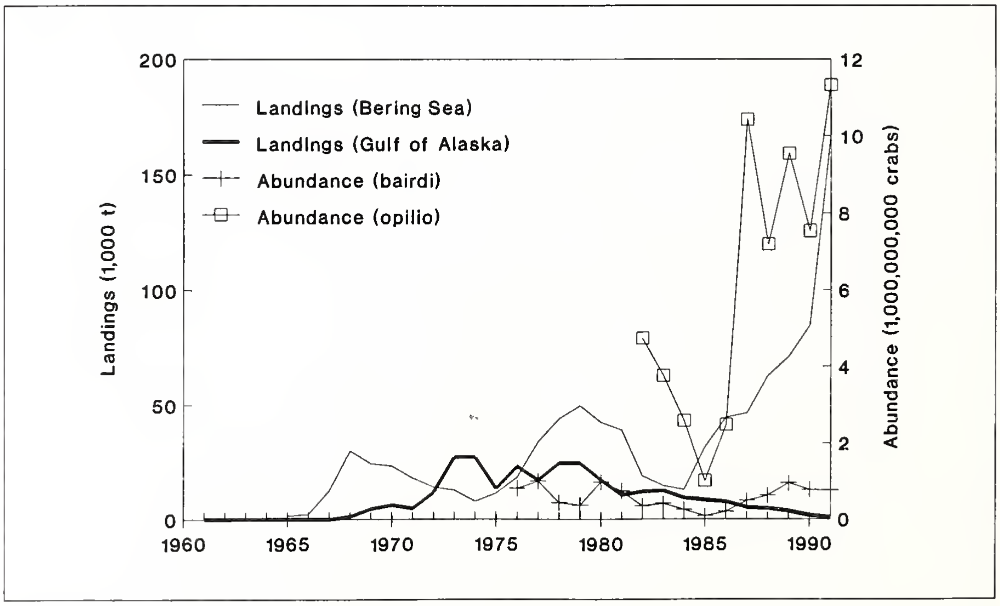


Table 20-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock level for Alaska shellfish resources. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY) = 111,638 t
Current potential yield (CPY) = 123,821 t
Recent average yield (RAY)[1] = 123,821 t

Species group	Yield (t) RAY[1]	CPY	LTPY	Status of utilization	Status of stock level
Tanner crabs	109,910	109,910	53,060	Full	Above
King crabs	11,740	11,740	31,230	Full	Below
Shrimp	340	340	22,582	Unknown	Below
Snails[2]	1,831	1,831	4,766	Under	Unknown

[1] 1989-91 average.
[2] RAY and CPY data = 1985-87 average catch; LTPY data = 1971-87 average.

Shrimp and Sea Snail

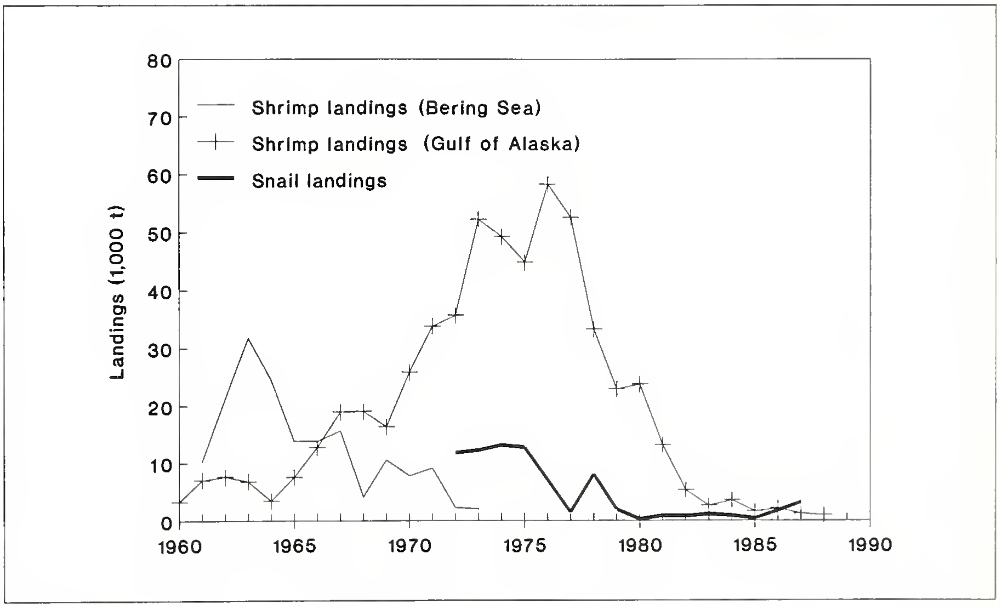
The U.S. shrimp fishery in Alaska waters is at a low level. The western Gulf of Alaska has been the main area of operation. During the 1970's, when the fishery was more productive, 50-100 vessels trawled for shrimp at Kodiak and along the Alaska Peninsula. Five species of shrimp contribute to Alaskan landings, of which the northern pink shrimp is most important.

Shrimp landings in the Gulf of Alaska during 1960-90 (Fig. 20-3) show that catches rose steadily to about 58,000 t in 1976 and then declined precipitously. Since 1988, negligible amounts of shrimp have been landed from western Alaska waters. During 1960-90, the dockside value of western shrimp fisheries averaged $4 million annually and yielded a peak value of $14 million in 1977. Shrimp catches by the U.S.S.R. and Japan in the Bering Sea peaked at 32,000 t in 1963, and gradually declined thereafter, until the fishery ended in 1973.

As with crabs, the potential yields of Alaska shrimp stocks are not well understood and have been equated to recent catches. Shrimp are managed by regulating the catch levels according to the level of the stocks. In addition, spring "egg hatch" closures are used to protect breeding stocks.

The Japanese snail fishery, conducted from about 1971 until ending in 1987, reached a peak of some 13,000 t in 1974. Catches averaged about 4,800 t during 1971-87. The snail stocks of the Bering Sea are not currently fished. RAY and CPY equal the 1985-87 average catch and LTPY equals the 1971-87 average.

Figure 20-3.—Shrimp landings from the Bering Sea and Gulf of Alaska, 1960-88, and snail landings from the Bering Sea, 1972-87.



ISSUES

Bycatch and Multispecies Interactions

The bycatch of crabs in trawl and pot fisheries is a major issue. Not only is bycatch an allocation problem, the unknown mortality of crabs discarded from trawl and pot gear could have a biological impact on crab stocks. When crab numbers are low, such bycatch mortalities, coupled with directed fishing mortality, could impose unacceptable risks to stock recovery. Bycatch limits for king and tanner crabs have been placed on groundfish fisheries by the NPFMC.

Scientific Advice and Adequacy of Assessments

Basic life history information, including growth rates, mortality rates, reproductive cycles, food habits, habitat requirements, and predator-prey relationships, is frequently lacking for Alaska shellfish stocks. This is particularly true of the underutilized resources such as mollusks, crangonid shrimps, octopuses, squids, sea urchins, and snails. For example, Bering Sea snail stocks represent a latent resource for which markets have existed in the past, but little is known of their numbers, productivity, or potential yield. More surveys are needed to improve the information base.

These shellfisheries have been marked by major ups and downs in production (Fig. 20-1, 20-2, 20-3) and major perturbations in the shellfish industry. A management policy of maintaining catch stability has evolved, at least for crab stocks. Due to variable survival of young crabs, little can be done to stabilize fluctuations of the crab stocks themselves. Relatively low exploitation rates are used to stabilize the annual catch by reserving portions of strong incoming year classes of young crabs for future fishing seasons. This strategy has met with limited success. More effort should be placed on the problems of long-term prediction of population changes, of the effect of harvesting female crabs on population fluctuation, and of the effects of discard mortality in pot and trawl fisheries. More study is also required regarding the underlying reasons for shellfish population fluctuations, including relationships between predator (cod and pollock) and prey (shrimp) abundance. Other ecological conditions that lead to strong or weak year classes, such as those influencing larval survival, are also poorly understood.

NEARSHORE FISHERIES

INTRODUCTION

Many U.S. coastal and estuarine species provide important recreational and commercial fisheries that are not Federally managed. This diverse Unit includes highly prized gamefishes like tarpon, bonefish, permit, and snook, as well as tautog, surfperches, and Florida pompano. It also includes small fishes used for bait, food, or processing into oil and meal, such as mullet, smelts, eulachon, ballyhoo, sardines, and herrings. Valuable invertebrates like the Dungeness, blue, rock, and Jonah crabs; Pacific shrimps, abalones, hard and softshell clams, bay scallops, and oysters are also in this group.

For 1989-91, the average annual value of the commercial components of the species in Table 21-1 was about $376 million. No separate values are available for the recreational fisheries, but they are certainly significant, especially to many coastal economies.

Table 21-1.—Recent average, current potential, and long-term potential yields in metric tons (t), and status of utilization and stock levels for nearshore fisheries resources. The LTPY, CPY, and RAY for the unit equals the sum of the species' LTPY's, CPY's, and RAY's.

Long-term potential yield (LTPY) = Unknown
Current potential yield (CPY) = Unknown
Recent average yield (RAY)[1] = 225,185 t
Recent value of commercial landings[1] = $375.6 million
Recent recreational participation = Unknown

Species	Yield (t)			Status of utilization	Status of stock level
	RAY[1]	CPY	LTPY		
Blue crab	95,350[2]	Unknown	Unknown	Full	Near
Pacific shrimp	27,887[2]	Unknown	Unknown	Full	Unknown
Sea urchins (Pacific)	23,755[2]	Unknown	Unknown	Unknown	Unknown
Mullets	14,372[2]	Unknown	Unknown	Unknown	Unknown
Dungeness crab	14,320[2]	Unknown	Unknown	Full	Near
Oyster (Atlantic)	9,435[2]	Unknown	Unknown	Over	Below
Sea urchins (Atlantic)	6,563[2]	Unknown	Unknown	Unknown	Unknown
Oyster (Pacific)	4,321[2]	Unknown	Unknown	Unknown	Unknown
Atlantic hard clams	4,308[2]	Unknown	Unknown	Over	Below
Atlantic thread herring	3,784	Unknown	Unknown	Unknown	Unknown
Blue mussel	3,667[2]	Unknown	Unknown	Unknown	Near
Tautog	3,515	Unknown	Unknown	Unknown	Unknown
Softshell clam	2,509[2]	Unknown	Unknown	Full	Below
Ladyfish	2,067	Unknown	Unknown	Unknown	Unknown
Other shads, herrings	1,876	Unknown	Unknown	Over	Below
Eulachon	1,325[2]	Unknown	Unknown	Unknown	Below
Calico scallop	1,210[2]	Unknown	Unknown	Full	Unknown
Spanish sardine	996	Unknown	Unknown	Unknown	Unknown
Jonah crab	660[2]	Unknown	Unknown	Unknown	Unknown
American eel	545	Unknown	Unknown	Unknown	Unknown
Ballyhoo	525[2]	Unknown	Unknown	Unknown	Unknown
Pacific hard clams	443[2]	Unknown	Unknown	Full	Below
Surfperches	392	Unknown	Unknown	Unknown	Unknown
Rock crab	372[2]	Unknown	Unknown	Unknown	Unknown
Florida pompano	357	Unknown	Unknown	Unknown	Unknown
Bay scallop	189[2]	Unknown	Unknown	Over	Below
Snook	139[3]	Unknown	Unknown	Over	Below
Abalones	133[2]	Unknown	Unknown	Over	Below
Surf smelt	95	Unknown	Unknown	Unknown	Unknown
Permit	66[3]	Unknown	Unknown	Unknown	Unknown
California corbina	10[3]	Unknown	Unknown	Over	Below
Tarpon	Unknown[4]	Unknown	Unknown	Unknown	Unknown
Bonefish	Unknown[4]	Unknown	Unknown	Unknown	Unknown
Striped bass (Pacific)	Unknown[4]	Unknown	Unknown	Over	Below
Pacific razor clam	Unknown[5]	Unknown	Unknown	Over	Below
Pismo clam	Unknown[5]	Unknown	Unknown	Over	Below

[1]Based on 1989-1991 average landings or most recent 3-year average.
[2]Commercial landings only.
[3]Recreational landings only.
[4]Not available or not meaningful due to catch-and-release nature of fishery or relatively infrequent landings.
[5]Not available.

SPECIES AND STATUS

Most species in this group (Table 21-1) live near shore during much or all of their lives. Some, like the shads, herrings, smelts, and Pacific striped bass, are anadromous, ascending fresh water to spawn but spending their adult lives in estuaries or at sea. In contrast, the American eel lives much of its life in fresh or brackish water but migrates far offshore to spawn in the Sargasso Sea (deep North Atlantic, beyond the Gulf Stream).

These species are widely distributed. Bay scallops, hard and softshell clams, and rock and Jonah crabs are among the important fishery resources of the northeastern United States. Shads, herrings, sardines, mullets, Florida pompano, and calico scallops are fished primarily along the middle and southern U.S. Atlantic coast and in the Gulf of Mexico. Many of the gamefishes are particularly valuable to the Florida economy, while invertebrates, like the blue crab and Atlantic oyster, support major fisheries from the Gulf to Chesapeake Bay.

Corvina and striped bass are important sport fishes in California waters, while surfperches are fished along much of the U.S. west coast. Other species like abalones, clams (hard, Pismo, razor), eulachon, and surf smelt support both recreational and commercial west coast fisheries. In the Pacific Northwest and southern Alaska, Dungeness crabs, Pacific oysters, and Pacific shrimps support valuable commercial fisheries.

Bonefish, tarpon, snook, and permit are sought primarily by sport fishermen who often employ professional guides. Other popular recreational fishes, such as the surfperches and tautog, are caught primarily from the beach or small boats. The small baitfishes and food fishes are harvested by both recreational and commercial fishermen using cast nets, gill nets, seines, dip nets, and pound nets; the southern Florida ballyhoo fishery supplies bait to the charterboat industry.

Many methods are also used to harvest the invertebrate species. Commercial and sport divers gather abalones, particularly in southern and central California; fishermen in small boats dive, dredge, and tong for oysters and rake hard clams; recreational clammers dig Pismo clams on sandy beaches in central California and razor clams in the Pacific Northwest; trawlers and divers take sea urchins off the New England and northern Pacific coasts; and commercial and recreational crabbers fish with pots, traps, trotlines, dredges, and dip nets for blue, rock, and Jonah crabs on the Atlantic coast and for Dungeness crabs on the Pacific coast. Pacific shrimps are harvested with pots and trawls. Other species, such as blue mussels, are both cultured and harvested from the wild.

The number of participants in these nearshore fisheries is difficult to assess because of their diversity. There is no doubt, however, that millions of recreational and commercial fishermen seek these resources; there are, for example, an estimated 600,000+ recreational razor clam diggers in Washington alone.

In general, landings for many of these species have declined in recent years (Fig. 21-1, 21-2, 21-3, 21-4). Atlantic hard clam, softshell clam, bay scallop, and abalone landings were substantially lower in the 1980's than in the previous three decades. Atlantic oyster landings fell sharply in the late 1980's, and Chesapeake Bay stocks are considered severely depleted. After peaking in the 1970's, Pacific shrimp landings fell off in the 1980's, primarily because of reduced Alaska landings. Dungeness and blue crab landings, though cyclical, appear to have withstood harvesting pressures well through the 40-year period examined.

Because these species frequent nearshore waters, they are not included in Federal fishery management plans; some are managed under regional, state, and/or local authority. Typically, size limits are used to protect molluscan and crustacean resources from overutilization, whereas gear restrictions are the most common management measures used for the finfishes in this group. Area closures, bag limits, and catch quotas are also employed, particularly for shellfish. Interstate Fishery Management Commission plans have been developed for such Chesapeake Bay species as the oyster and blue crab to try to achieve consistent management between states. Some states, notably Florida and California, have prohibited all commercial

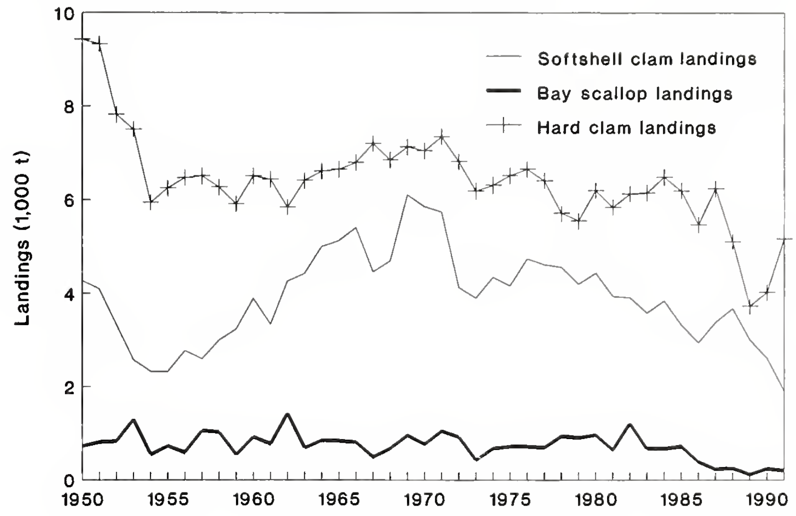


Figure 21-1.—Commercial landings of hard and softshell clams and bay scallops from the southeastern U.S. coast, 1950-91.

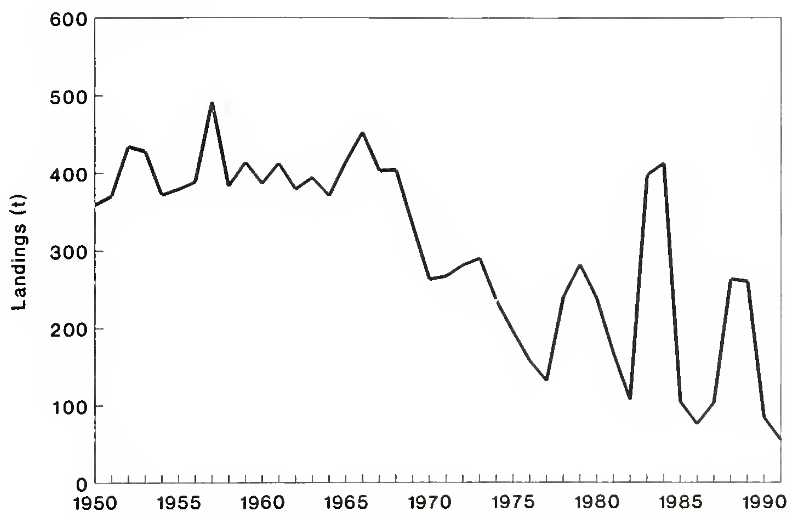


Figure 21-2.—Commercial abalone landings from the U.S. Pacific coast, 1950-91.

harvest of certain species by designating them as gamefishes.

It is difficult to assess the status of these stocks throughout their ranges because they are under varied management and data collection systems; though individual states may collect data and assess stocks of several of these species, comprehensive assessments are scarce. Many of the species in Table 21-1 are probably overexploited, at least in part of their ranges, as with the Chesapeake Bay oyster. Others, like many of the herrings, are difficult to assess because the data on abundance and stock structure are sparse, dispersed, or nonexistent. Stock levels of many of these species are below their historical averages. Whereas relatively good biological data exist for species such as oysters and blue crabs, they are incomplete for many species in this unit.

The recent annual yield of the species in this unit is conservatively estimated at more than 225,000 t. Table 21-1 presents the best data available, though the yields are probably low for many species because

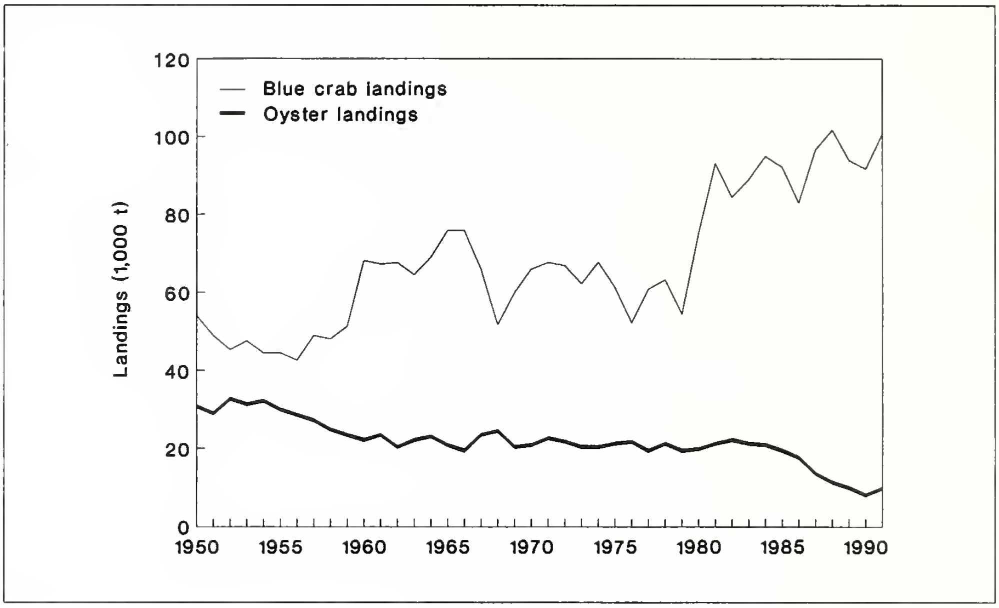


Figure 21-3.—Commercial blue crab and oyster landings from the southeastern U.S. coast, 1950-91.

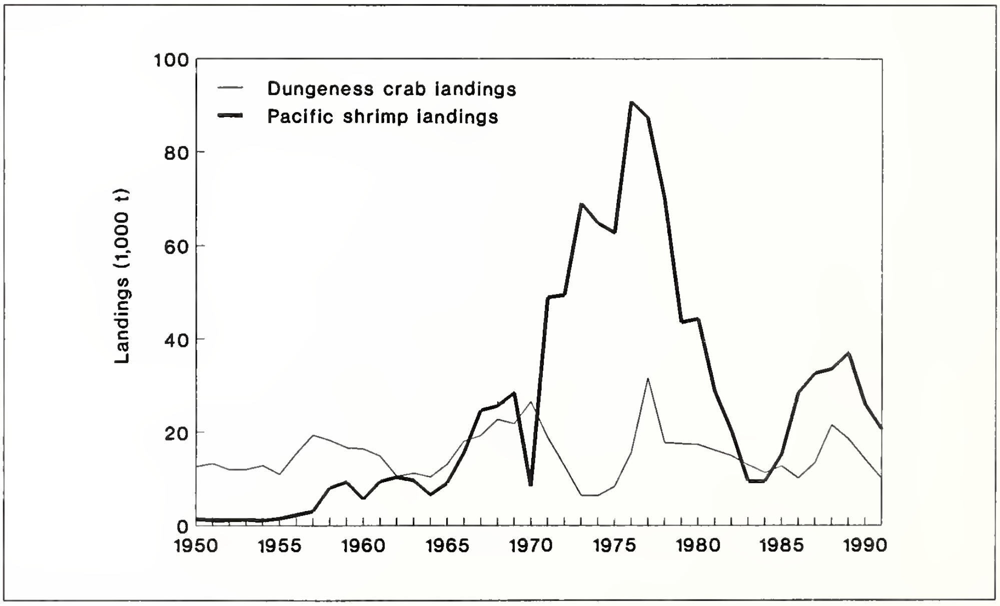


Figure 21-4.—Commercial Dungeness crab and Pacific shrimp landings from Oregon, California, and Washington, 1950-91.

separate landings data are not always reported (many of the baitfishes are lumped into other categories, for example). Furthermore, data on sport catches are not available for many of these species, particularly the invertebrates. Recreational aspects of some of these fisheries are very large; Chesapeake Bay sport crabbers alone caught an estimated 19,000 t of blue crabs in 1983 and 9,800 t in 1988, or 44% and 32.1% of the total harvests, respectively. Some species, such as tarpon and bonefish, are sought primarily for sport and usually released alive; consequently, few or no landings data for them are reported even though they provide significant local and regional economic benefits.

ISSUES

Habitat Concerns

Because of their reliance on nearshore habitats (i.e., estuaries, reefs, mangroves, etc.) species in this group are particularly susceptible to habitat loss, pollution, changes in freshwater flows, siltation, and other environmental problems. Pacific striped bass have been hurt by habitat degradation and salinity changes in the San Francisco Bay estuary; Chesapeake Bay species, such as river herrings and hickory shad, have declined drastically in recent years due to pollution, waterflow changes and habitat degradation; and Atlantic coast and Gulf of Mexico oyster and hard clam harvests have been severely reduced by pollution, disease, salinity changes, and habitat losses. More than half of the Nation's original acreage of coastal wetland marshes have disappeared and dramatic declines in seagrass beds have occurred. Louisiana alone loses an estimated 35,200 acres of coastal wetlands habitat each year.

Because many shellfish fisheries are close to large population areas, the likelihood of pollution problems is high; fishing closures due to shellfish bed contamination cause large economic losses each year. In addition to direct pollution impacts, excessive nutrient loads may increase toxic plankton blooms that cause red tides and paralytic shellfish poisoning. Mosquito control spraying near populated areas, such as in southern Florida, may result in death of juveniles in important nursery areas. Environmental stresses also make fish more susceptible to diseases and parasites, either killing them outright or making them difficult or impossible to market. The diseases MSX and "dermo" have destroyed millions of bushels of oysters in Delaware and Chesapeake Bays since 1958, spreading in the late 1980's to coastal North Carolina where similar devastation has occurred.

Management Concerns

Overharvesting has been at least partially responsible for depleting such species as Pacific razor clams, Pismo clams, abalones, oysters, Pacific shrimp, and snook. Marine mammals also feed on some of these species and may compete with fishermen; for example, sea otters on the Pacific coast have depleted abalone and sea urchin stocks in parts of California.

UNIT 22 ATLANTIC MARINE MAMMALS

INTRODUCTION

Marine mammals have been important in the northeastern United States historically both as targets for commercial harvests and in ecological interactions with commercial fisheries. Some scientific attention was given to east coast marine mammals as early as 1851 when Matthew Maury of the U.S. Navy's Depot of Charts and Instruments published his whale charts based upon whalers logs and records of sightings. The U.S. Fish Commission gave more attention to marine mammals after its creation in 1871, commissioning, for example, Starbuck's 1878 "History of the American Whale Fishery." The omnibus series titled "The Fisheries and Fishing Industries of the United States" by G. B. Goode in 1884 describes fisheries for the great whales as well as smaller whales (e.g. pilot whales, bottlenose dolphins, and bottlenose whale) in the North Atlantic.

In addition to these direct fisheries, there was also interest in the indirect effects of marine mammals on other fisheries. Goode also described the destructiveness of marine mammals to fisheries, a theme that the U.S. Commissioner of Fisheries used in 1889 in supporting a fish meal factory to be built in Woods Hole. The commissioner speculated that the 20 tons of predatory fishes such as porpoises, skates, and dogfish that the proposed factory would process annually "should present a marked influence upon the supply of edible fishes." The interest of the U.S. Fish Commission was primarily in terms of fisheries, and little biological study appears to have been done of marine mammals in this region beyond the taxonomic studies of Frederick True starting in the 1880's. For example, he provided written instructions to the lighthouse keepers on "the best means of collecting and preserving specimens of whales and porpoises."

With the declining importance of the U.S. harvests of east coast species of marine mammals in the late 1800's and early 1900's the incentive for systematic scientific study of the species inhabiting the northeastern U.S. declined. In the 1930's and 1940's, Remington Kellogg at the Smithsonian and William Schevill at Harvard undertook taxonomic studies, but it wasn't until the late 1940's that cetacean biology began to be investigated more systematically. Then Schevill began a series of investigations at the Woods Hole Oceanographic Institution of cetacean acoustics that are still continuing. In the early 1970's, several other researchers began studying marine mammals in this region. The results of this earlier work was addressed in 1979 when the U.S. Marine Mammal Commission sponsored a workshop to help define research needed for the study of marine mammals on the U.S. east and Gulf coasts.

That workshop set a research agenda that was immediately addressed by agencies such as the Minerals Management Service (MMS) and the National Marine Fisheries Service (NMFS). During the 1980's, several institutions in the northeast developed active research programs which have resulted in a body of knowledge that is being drawn upon in developing management approaches for several critical marine mammal issues in the region.

SPECIES AND STATUS

Thirty-six species of marine mammals range the U.S. Atlantic and Gulf of Mexico waters (33 whales, dolphins, and porpoises, two seal species, and one manatee). Their status is poorly known, but some, like the northern right whale, Mid-Atlantic coastal bottlenose dolphin, and harbor porpoise, are under stresses that may affect their survival.

Table 22-1 summarizes what is known about the status and trends of several Atlantic marine mammals. Brief summaries below for selected species give additional data on distribution, current and historical abundance, and population trends.

Table 22-1.—Stock assessments of selected marine mammals in U.S. waters of the North Atlantic Ocean.

Species and area	Abundance	Status	Trends	Status in U.S. waters
Fin whale (Eastern U.S.)	5,200	Unknown	Unknown	E[1]
Humpback whale (N.W. Atlantic)	5,500 (2,888-8,112)[2]	Possibly 65% of its population size in about 1850.	Unknown	E
Northern right whale (N.W. Atlantic)	350	Probably <5% of its size before 1600.	Unknown	E
Pilot whale (N.W. Atlantic)	11,200 (3,249-19,151)[2]	Unknown	Unknown	
Bottlenose dolphin (Northeast U.S.)	600? (10,000-13,000)[3]	Coastal type possibly declined by 50% in 1987-88.	Unknown	
(U.S. Gulf of Mexico)	(35,000-45,000)[3]	Offshore and coastal types	Stable	
Whitesided dolphin (N.W. Atlantic)	27,600 (17,254-37,946)[2]	Unknown	Unknown	
Spotted dolphin (N. Carolina)	200	Unknown	Unknown	
Harbor porpoise (N.W. Atlantic)	45,000 (19,000-80,000)[2]	Unknown	Unknown	P[4]
Harbor seal	12,900	Unknown	Increasing?	
Beaked whales	Unknown	Unknown	Unknown	

[1]E = Listed as endangered under the Endangered Species Act.
[2]95% confidence interval.
[3]Rough range.
[4]P = Proposed for listing under the Endangered Species Act.

Bottlenose Dolphin

The number of stocks of bottlenose dolphins is unknown, although there appear to be offshore and coastal types, possibly forming two distinct populations. There are no comprehensive population estimates, but abundance in the Gulf of Mexico is estimated at 14,000 in waters of 100 fm or less. Aerial surveys between Cape Hatteras and Nova Scotia in 1979-82 suggest a northeast U.S. population of 10,000-13,000 individuals. However, a large die-off of bottlenose dolphins in 1987-88 may have resulted in a 50% or greater decline in the nearshore or coastal types. A survey of that type from New Jersey to Cape Hatteras in 1987 found about 1,050-7,500.

Pilot Whale

Two species of pilot whales occur in the North Atlantic, the short-finned pilot whale in the south and the long-finned in the north. The two species overlap seasonally in the Mid-Atlantic region of the western North Atlantic. The long-finned pilot whale occurs northward into Canadian and Greenland waters, and eastward to Europe; it is subject to an ongoing harvest around the Faroe Islands and incidental capture in several fisheries in U.S. and Canadian waters. The short-finned pilot whale may be subject to a low level of bycatch in several U.S. fisheries. Population structure and general life history of both species is very poorly known. Abundance has been estimated for the long-finned pilot whale in the eastern North Atlantic (750,000) and for the continental shelf region of the western North Atlantic (roughly 11,000).

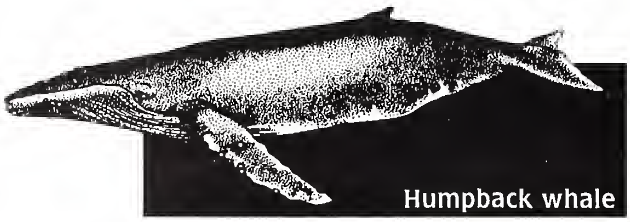
Fin Whale

Fin whales, listed as endangered under the ESA, are probably the most numerous large cetacean in temperate waters of the western North Atlantic Ocean. They range widely throughout the continental shelf in all seasons, but most sightings occur between Cape Cod and the southwest Gulf of Maine. Stock structure and total abundance are unknown. An estimate of abundance off the northeast coast in 1979-82 was 5,200 in spring and 1,500 in winter.

Important research and management questions are whether separate stocks exist, the location of calving grounds and annual calf production, and the location of the wintering grounds for the northwest Atlantic population.

Humpback Whale

The humpback whale is listed as endangered, and summers in the Gulf of Maine, Gulf of St. Lawrence, and the waters of Newfoundland-Labrador, west Greenland, Iceland, and Norway. Along the northeast coast, humpbacks frequent the Great South Channel, Georges Bank, Stellwagen Bank, and Jeffreys Ledge during summer. The estimated total population is about 5,500 whales. A minimum estimate of the population prior to commercial whaling (about 1865) was 4,400-4,700 humpbacks.


Humpback whale
Megaptera novaeangliae

Entanglement with fishing gear and sporadic toxin-induced die-offs are prob-lems for the species. A yet unexplained development in recent years has been in-creased summer sightings of young humpbacks in the Mid-Atlantic region—generally in the areas of the Chesapeake and Delaware bays.

Right Whale

Northern right whales occur on the continental shelf from Florida to Nova Scotia. The endangered western North Atlantic stock is the only northern hemisphere right whale population with a significant number of individuals (300-350)—the other stocks being virtually extinct. The pre-eighteenth century population may have been as high as 10,000, and, if so, the current population is more than 95% depleted.

Individual identification, satellite tagging, genetic analysis, and the use of airships (blimps) and video cameras to document behavior are new research methods which have been applied in recent years. Many questions, however, remain. Among them are the location of a summering grounds for 30% of the population and wintering grounds for 80% of the population. Human impacts (net entanglement and ship strikes) are affecting some 60% of the population and may be inhibiting recovery.

Harbor Porpoise

The northwestern Atlantic harbor porpoise is found from Newfoundland to Florida. It is hypothesized that there are three populations: Newfoundland, Gulf of St. Lawrence, and Gulf of Maine-Bay of Fundy. However, there is not enough evidence to test this hypothesis against the alternative of a single population. Little is known about the seasonal movements of this species, except for the presence of summer aggregations in the Gulf of Maine, Gulf of St. Lawrence, and the east coast of Newfoundland. The 1991 population estimate of the Gulf of Maine population is 45,000 (95% CI: 19,000-80,000). No useful estimates of abundance for the other populations exist. The best estimates of bycatch by the U.S. Gulf of Maine sink gillnet fishery in 1990 and 1991 are 2,400 (95% CI: 1,600-3,500) and 1,700 (95% CI: 1,100-2,500). These estimates do not include bycatch from fisheries south of Cape Cod or north of the U.S. border. The estimated bycatch of the other two populations is largely unknown, though some data does exist.

Harbor Seal

Harbor seals are year-round residents of Maine and eastern Canada, and some of them overwinter in southern New England (SNE). Harbor seal numbers have apparently increased in recent years for unknown reasons, and a 1986 count found 12,900 in Maine. Also, in 1986 approximately 4,000 animals overwintered in SNE waters. Bycatch levels are relatively low, and major concerns are competition with fisheries and periodic disease outbreaks.

Beaked Whales

There are four species of beaked whales in the northwest Atlantic, however little is known on their distribution, biology, and population structures. Based on cetacean surveys conducted during the early 1980's and 1990's, these species are distributed along the shelf edge (2,000 m), principally along the southern edge of Georges Bank. In addition, beaked whale sightings were associated with oceanographic fronts and Gulf Stream meanders. Population estimates for these species are not available. Determination of minimum abundance estimates will require substantial survey effort in shelf-edge waters and waters seaward to at least the Gulf Stream off the northeast U.S. and eastern Canada coasts.

ISSUES

Bycatch and Multispecies Interactions

The bycatch of harbor porpoise in sink gillnet fisheries in U.S. and Canadian waters appears to be large relative to likely levels of natural production for this species. The magnitude of this bycatch and the abundance of this species were reviewed in an international scientific workshop in May 1992, and it was recommended that the bycatch should be reduced. Three methods for accomplishing this have been identified: Setting maximum catch limits annually, setting time and area closures, and modification of the sink gillnet fishing gear. Evaluation of these options and research necessary to actually implement one or more of them are of high priority. Bycatch of other species in this region is lower than that for harbor porpoise, but its significance is not known because of uncertainties about abundance of those species. Of especial concern is the bycatch of several species of beaked whales in the U.S. drift gillnet fishery for swordfish.

Marine mammal populations have generally been increasing in recent years, and their increasing populations must be consuming more food than previously. In addition, increasing marine mammal predation combined with increasing fishing activity may have long-term impacts on declining northeastern U.S. demersal fishery resources. On the other hand, stocks of some pelagic species such as Atlantic mackerel, Atlantic herring, and squid have been increasing in abundance in recent years, and certain marine mammals appear to depend on these stocks. The net effect of these changing fishery resource levels and the increasing abundance of marine mammals is an area of increasing concern.

For example, fin whales comprise between 31% and 47% of the cetacean standing stock over the eastern U.S. continental shelf. For the total fin whale population, the annual prey consumption is estimated at 646,000 tons. Of the cetaceans off the northeastern United States, the fin whale has the largest standing stock and the largest food requirements, and is therefore assumed to have the largest impact on the ecosystem. Recent data suggests that changes in both abundance, distribution, and prey species of fin whales are likely. Periodic updates of this information is therefore important.

Similarly, the increasing abundance and more southerly distribution of harbor seals, as well as other pinnipeds such as gray seals which have large populations in Canadian waters, have been identified as possibly having a negative impact on commercial fishery resources such as American lobsters and Atlantic salmon.

The role of commercial fisheries on the recovery of northern right whales is presently uncertain. For example, more than 60% of living North Atlantic right whales have scars and wounds resulting from entanglement with fishing gear or propeller strikes. Fishing activities have also been implicated in a number of right whale mortalities.

Recovery of Protected Species

Over the past year Endangered Species Recovery Plans have been completed for the humpback and the right whales in this region. These plans outline comprehensive management and research agendas that would take initial steps toward ensuring the recovery of these species. Critical issues for both species are bycatch and entanglement in fishing gear. For the humpback whale, bycatch occurs especially in Canadian waters, making it important to determine the genetic relationship between animals in U.S. and Canadian waters to assess the affects of this bycatch.

As described, in addition to entanglement, the right whale appears to be prone to collisions with ships, which may kill or seriously injure individuals. The mitigation of these human impacts on right whales is listed as the main Priority One Item in the Implementation Schedule of the national Right Whale Recovery Plan. This topic was also seen as a top priority by participants in the Right Whale Workshop convened by NOAA/NMFS in Silver Spring, Maryland, in April 1992.

During the past decade, mass strandings of harbor seals, pilot whales, bottlenose dolphins, and humpback whales have occurred along the U.S. east coast. The harbor seal population is subject to influenza outbreaks; some 350 animals died in New England waters from this virus in 1980. In recent years, 100-300 pinnipeds, mostly harbor seals, have stranded annually in the northeast region. From 13 to 97 pilot whales per year have stranded off Cape Cod since 1981. Northeast stranding response groups have been successful in assisting some of these beached animals back into open water. Fourteen humpback whales apparently died of a "red tide" toxin near Cape Cod in late 1987, and seven other young animals stranded and died for unknown reasons. It is unlikely that these strandings have had a significant impact on these species, based on current population estimates. Stranding of bottlenose dolphins along the U.S. southeast to Mid-Atlantic coast during the late 1980's may have resulted in a 50% or greater decline in the Mid-Atlantic nearshore population.

Strandings of North Atlantic right whales are infrequent. But because of the endangered status of the species and the critically low population levels, data from the strandings that do occur is vital. It is therefore unfortunate that more than half of the stranded right whales since 1988 were not necropsied. The stranding network and the protocols are presently being upgraded so that future right whale strandings will not go unstudied.

Progress

The research program on marine mammals in the northeast U.S. which was begun by NMFS in 1980, and expanded substantially in 1987, has resulted in significant improvements in our knowledge of these species. Most recent progress has focused on three areas: Estimates of distribution and abundance, estimates of total bycatch, and estimation of vital rates.

Surveys conducted since 1990 have established the relationship of the distribution of several species of toothed whales to the Gulf Stream wall and warm core rings and have confirmed the strong relationship to the continental shelf break. Revised estimates of abundance for these species are being developed. Surveys of harbor porpoise conducted since 1987 have mapped their summer distribution pattern, and have allowed development and testing of sighting survey methods for estimates of absolute abundance.

A coordinated international multi-investigator study, Years of the North Atlantic Humpback Whale (YONAH), is underway for 1992-95. At the conclusion of the project, the geographic distribution, abundance, behavior, and genetic structure of North Atlantic humpback whales will be known more precisely and reliably than has ever been possible for any pelagic whale species in an entire ocean basin. The project will be a model for the foundation studies required for comprehensive understanding, conservation, and management of a cetacean species.

A multi-agency, multi-investigator effort to study right whales on their wintering and calving grounds off the southeastern U.S. and to develop a program to mitigate the

. . . Progress

impact of human interference with right whales has been underway since 1988. The results are expected to provide a model for efforts aimed at assisting the recovery of endangered species.

A program of placing observers aboard commercial fishing vessels has resulted in new estimates of bycatch rates of harbor porpoise and other species. By combining these with estimates of total fishing effort in several fisheries based on a previously existing port sampling program, estimates of total bycatch have been made. These have been completed for harbor porpoise and are being developed for other species. These data collection programs are also enabling development of an understanding of seasonal bycatch patterns which may provide a basis for seasonal and area controls on fisheries to reduce the bycatch.

Biological sampling of the marine mammals killed in commercial fishing operations has been conducted with a very high degree of cooperation from fishermen. These samples are being analyzed in conjunction with samples from other regions to determine population structure and net reproductive rates. For example, recent results suggest that harbor porpoise from across the North Atlantic are more closely related than those in other regions and that the natural mortality rates of pilot whales are high for young and older animals but very low for middle-aged animals.

INTRODUCTION

Before passage of the Marine Mammal Protection Act (MMPA) of 1972 and the Endangered Species Act (ESA) of 1973 the only protective measures for marine mammals were through the International Whaling Commission (IWC) for certain depleted large whales.

In 1791, New England whalers first rounded Cape Horn, and by 1820 they had pressed on to Hawaii where they began to take on provisions and recruit men for their northern summers in bowhead whale rich Alaskan waters. An average bowhead yielded 100 barrels of oil, making the area attractive to whalers, even though over 100 whaling ships were lost between 1826 and 1900 due to crude charts and icy Alaskan waters.

California's whaling industry is documented back to the mid 1850's when shore whaling stations were set up, ranging from the state's northernmost border at Crescent City south to San Diego. With a hunting range of about 10 miles, they harvested only whales frequenting the nearshore waters. The northern stations hunted humpback whales at first, but included gray whales in short order; southern stations took advantage of the regular southward migration patterns of the gray whales.

Sea lions, reported to be abundant along the California coast and offshore islands before 1860, were also exploited for food, oil, and clothing. From 1860 to 1870, thousands were harvested for oil. In 1915 and 1916, a bounty of $2.00 each was paid on 4,074 sea lions. From the late 1920's until passage of the MMPA in 1972, commercial and sport fishermen were allowed to kill sea lions that interfered with their fishing operations.

The Hawaiian monk seal is thought to have been abundant when Europeans discovered the Hawaiian Islands. However, overexploitation made this seal the endangered species it is today.

All marine mammals are now protected by the MMPA and by the ESA. Other management responsibilities are addressed in the Magnuson Fishery Conservation and Management Act (MFCMA) of 1976, which extends the jurisdiction of the MMPA throughout the U.S. exclusive economic zone, and the Whale Conservation Act of 1976, which was intended to further aid the recovery of whales.

SPECIES AND STATUS

At least forty-two species of marine mammals occur in U.S. Pacific waters (31 whales, dolphins, and porpoises, and 11 species of seals and sea lions). Fourteen are commonly seen along the coast (gray whale, bottlenose dolphin, harbor seal, and others), whereas the 28 others frequent offshore or remote island waters (beaked whales, ribbon seal, Hawaiian monk seal, and others), or are severely reduced in numbers and thus seldom seen (blue whale, North Pacific right whale, Guadalupe fur seal, for example).

Table 23-1 summarizes what is known about the status and trends of several Pacific marine mammals. Brief discussions below for selected species give additional data on distribution, current and historical abundance, and population trends.

Eastern Tropical Pacific (ETP) Dolphins

At least four species (13 stocks) of dolphins are incidentally taken in the international fishery for yellowfin tuna in the tropical Pacific waters off Mexico and Central America (about 25,000 were killed in 1991). Because those four species also occur in U.S. waters, and because the United States is the major market for the fishery, NMFS has assessed the dolphin populations.

The northern stock of spotted dolphins is estimated at 1,515,500 and the southern stock at 268,000 (1985-89) based on analysis of research vessel data. Dolphin sightings, based on tuna vessel observer data, suggest that both stocks declined in the 1970's, but have been relatively stable in the 1980's. Eastern spinner dolphins number 589,000, while whitebelly spinner dolphin stocks number about 994,000. Stock specific estimates of common dolphin abundance were based on too few sightings and are considered unreliable. Both spinner dolphin stocks have been stable since 1976. Striped dolphin abundance is estimated to be 1,485,940.

Table 23-1.—Stock assessments of selected marine mammals in U.S. North Pacific Ocean waters.

Species and area	Abundance	Status	Trends	Status in U.S. waters
Bowhead whale (W. Arctic)	7,500 (6,400-9,200)[1]	Current population size is 40.9% (38.0-42.0%) of the 1848 population size.	Increasing at 3.1% (0.1-6.2%)/year, 1978-88	E[2]
Gray whale (N.E. Pacific)	21,113 (19,737-22,489)[1]	Fully recovered and now equal or more abundant than known since 1846.	Increasing at 3.2% (2.3-4.2%)/year 1968-88	E[3]
Humpback whale (E. Pacific)	1,398-2,040	Probably less than 15% of abundance prior to 1850.	Unknown	E
Harbor porpoise		Unknown	Unknown	
(Alaska)	Unknown			
(California)	4,924			
(Inland Washington)	975			
(Oregon/Washington)	4,000			
Hawaiian monk seal	<1,500	Unknown. Small remnant, monotypic species.	Unknown. Pup counts declining.	E
Northern fur seal (Pribilof Islands)	<871,000	Current level is <40% of the population in the mid-1950's.	No significant trend since 1983 on St. Paul.	D[4]
(San Miguel)	4,000		Increasing	
Steller sea lion (N. Pacific)	42,000	Currently 22% of size in the late 1950's.	Declining at 4.2%/year, 1960-91.	T[5]
California sea lion (California-Washington)	110,000	Unknown, but believed to be at or above 33% of K	Increasing at 4.7%/year, 1975-90.	
Harbor seal		Unknown	Increasing?	
(Alaska)	63,000		Declining	
(California)	20,000		Increasing	
(Oregon-Washington)	20,275		Increasing	
(Puget Sound)	10,000		Increasing	
ETP Dolphins				
N. offshore spotted	1,515,000 (732,280-2,297,400)[1]	Unknown	Stable (1985-90) based on analysis of tuna vessel observer data (TVOD)	
S. offshore spotted	268,000 (32,120-502,760)[1]	Unknown	Possible increase (1985-1990) based on analysis of TVOD	
E. spinner	589,000 (379,870-797,170)[1]	Unknown	Stable (1985-90) based on analysis of TVOD	
Whitebelly spinner	994,000 (446,400-1,541,000)[1]	Unknown	Stable (1985-90) based on analysis of TVOD	
N. common	468,000	Unknown	Stable (1985-90) based on analysis of TVOD	
Cent. common	594,000	Unknown	Stable (1985-90) based on analysis of TVOD	
S. common	2,118,000	Unknown	Stable (1985-90) based on analysis of TVOD	
Common (pooled)	3,178,080 (747,190-5,610,970)[1]	Unknown	Stable (1985-90) based on analysis of TVOD	
N. striped	172,000 (40,970-303,830)[1]	Unknown	Stable (1986-90) based on analysis of research vessel observer data (RVOD)	
S. striped	1,314,000 (693,530-1,933,510)[1]	Unknown	Stable (1986-90) based on analysis of RVOD	

[1]95% confidence interval.
[2]E = Listed under the Endangered Species Act as endangered.
[3] The California stock of gray whales are proposed to be removed from the list of endangered species.
[4]D = Listed under the Marine Mammal Protection Act as depleted.
[5]T = Listed under the Endangered Species Act as threatened.

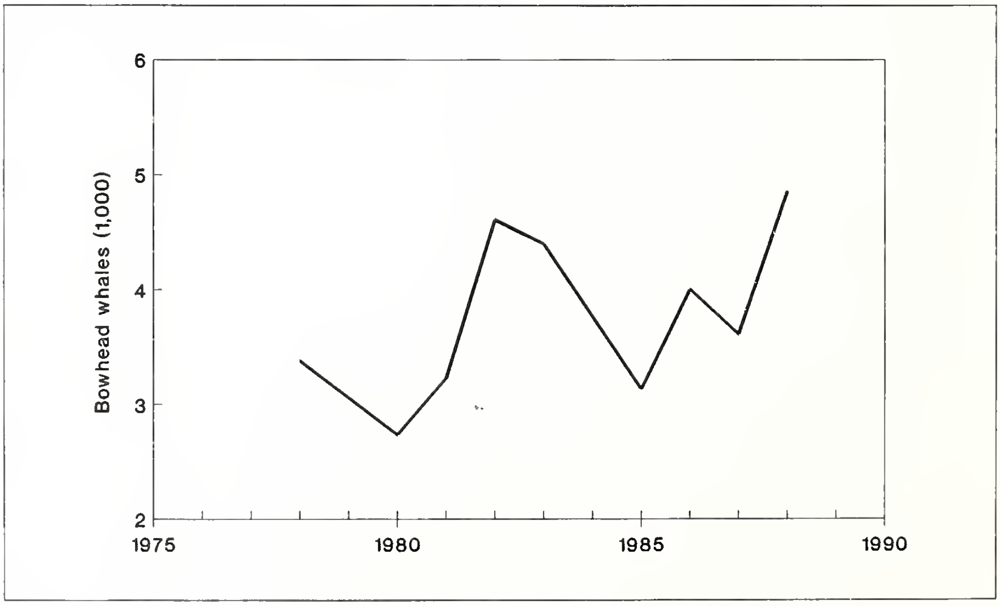
. . . Harbor Porpoise

Harbor porpoise range throughout North American coastal waters. Surveys to determine abundance have been conducted off California since 1984, and periodically off Oregon and Washington. Harbor porpoise tend to concentrate at the mouth of the Columbia River and at many other bays. Estimates of abundance are 11,100 in California (3,274 in central California alone which is 30-97% of the carrying capacity). About 700–1,000 range Washington's north coast. The species was once abundant in Washington's inland waters but is rare there now. The kill of harbor porpoise due to fisheries in California in the 1990-91 fishing season was 62 animals. All animals were taken by the setnet fishery for halibut and rockfish in central California.

Bowhead Whale

The endangered bowhead whale has ranged as far as the polar ice fields of the Northern Hemisphere. Total pre-whaling abundance is believed to be 12,000-18,000, but by 1900 it was probably in the low thousands. In the U.S. western Arctic, 18,650 bowheads were killed by Yankee whalers between 1848 and 1914 from a population estimated at less than 20,000. The take by Alaska Eskimos has averaged 20-40 whales per year since 1914. The present population, 7,500, is about 40-60% of its 1848 carrying capacity. The stock has been increasing since commercial whaling ended and has grown by 3.1%/year since 1978 (Fig. 23-1).

Figure 23-1.—Actual count of bowhead whales, 1978-88.



Gray Whale

Still listed under ESA as endangered are the two stocks of North Pacific gray whales. The eastern North Pacific or "California" stock was heavily exploited by Yankee whalers in the last half of the 19th century. The present stock size, 21,113, is equal to or larger than the size of the 1846 population of 15,000-20,000. Population growth rate is 3.2%/year despite a Soviet subsistence catch of 167 whales per year (Fig. 23-2). In light of this recovery, the Secretary of Commerce has recommended the stock's removal from the ESA's list of endangered and threatened wildlife.

Humpback Whale

The endangered humpbacks in the eastern North Pacific Ocean migrate between the subtropical waters of Hawaii and coastal Mexico during the calving season and the temperate and subarctic waters of northern California and Alaska where they feed. The population is estimated at 1,300-2,000. Pre-whaling numbers (ca. 1850) were about 15,000, but this may have included humpbacks from the western North Pacific Ocean. No information exists on population trends.

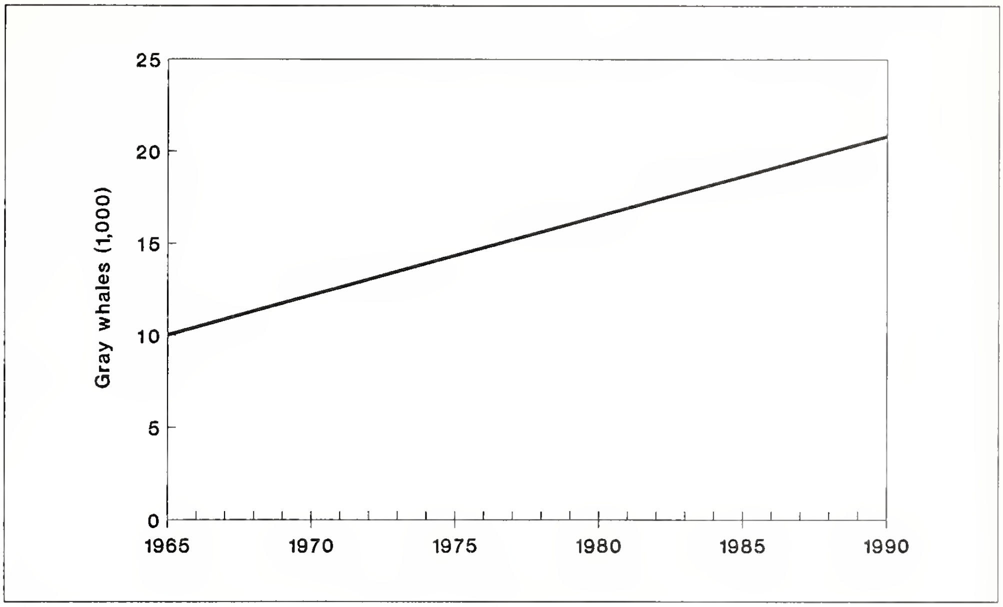


Figure 23-2.—Estimated population of gray whales, 1965-90.

Northern Sea Lion

The northern or Steller sea lion, classified as threatened under the ESA, ranges coastal waters of the North Pacific Ocean from California to Japan. The species has declined sharply throughout its range in just the last 20 years, and it is now well below its optimum level. The number of adults and juveniles in U.S. waters crashed from 154,000 in 1960 to 42,000 in 1990. Most of this 73% decline occurred in Alaskan waters between Kenai and Kiska, where sea lion counts declined from 105,289 in 1959 to 20,000 in 1991 (Fig. 23-3). The decline in Alaska is believed to be due to a combination of incidental kills in fisheries, illegal shooting, changes in the numbers and/or quality of prey, and possibly other unidentified factors. The Steller sea lion population off Washington and Oregon is low but stable at about 3,000, but in California they have slowly declined since the 1950's to about 2,000.

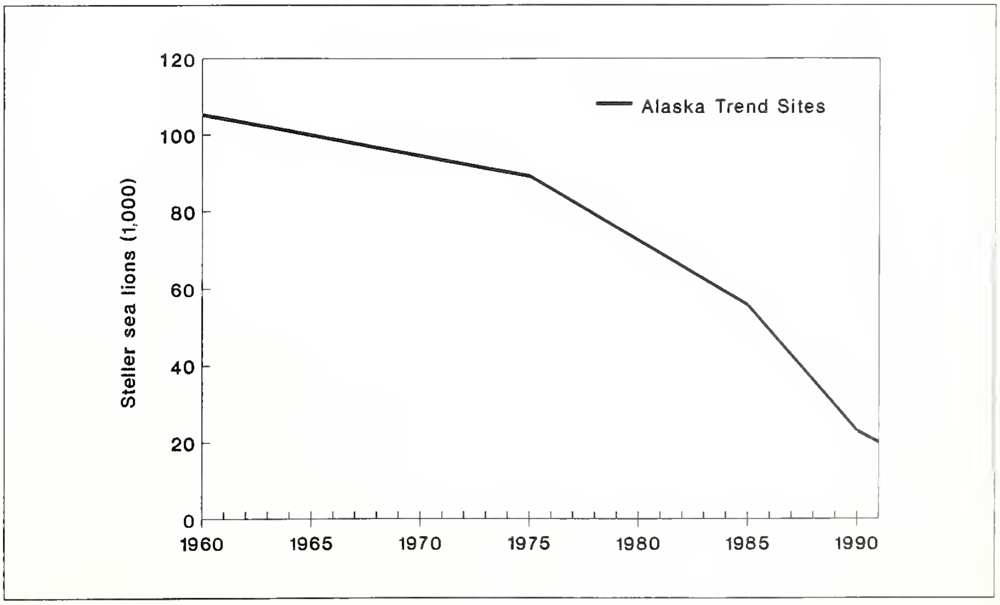


Figure 23-3.—Estimated population trends of northern sea lions in Alaska for the region Kenai to Kiska.

Northern Fur Seal

The northern fur seal of the North Pacific Ocean, considered depleted under the MMPA, ranges across subarctic Pacific Rim waters from California to Japan. It numbered 1.2 million in 1983 with 871,000 in U.S. waters. The major U.S. breeding population is on Alaska's Pribilof Islands of St. Paul and St. George. Production on the Pribilof Islands dropped more than 60% between 1955 and 1980, but has since been stable. On St. George Island, production has continued to decline about 6%/year since 1970 (Fig. 23-4). Small U.S. breeding populations are also found on Alaska's Bogoslof Island (1,500), and California's San Miguel Island (4,000).

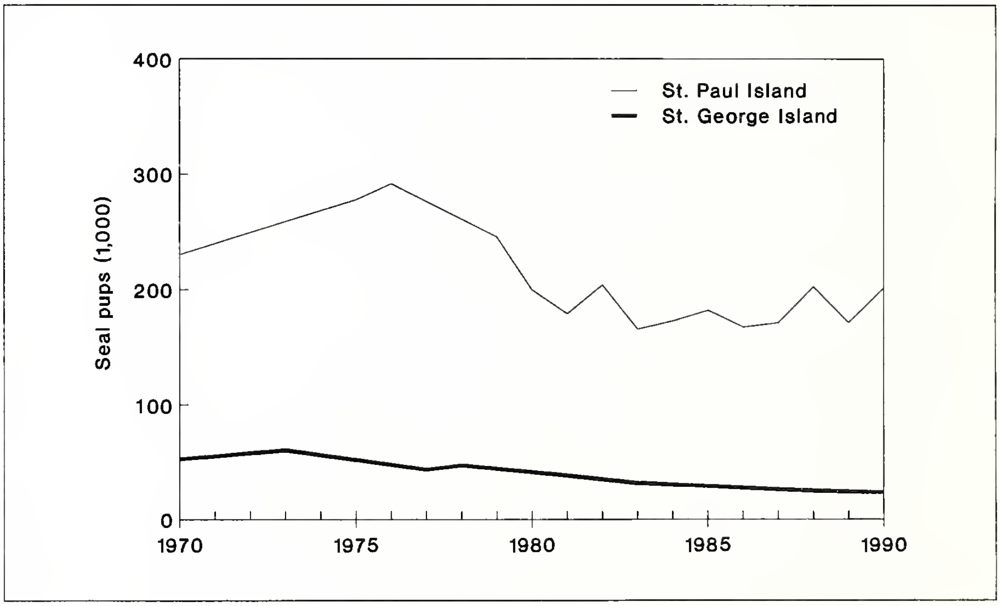


Figure 23-4.—Northern fur seal pup counts on St. Paul and St. George islands, Alaska, 1970-90.

California Sea Lion

The California sea lion has three subspecies living on the U.S. west coast and British Columbia, in the Galapagos Islands, and in Japan. Between Mexico and British Columbia the population is likely to exceed 175,000 animals at this time. Annual pup production in 1990 exceeded 25,000. The U.S. population is currently increasing at about 5% per year. The documented fishery-caused mortality in the 1990-91 fishing season was 2,487 animals in the setnet fishery and 92 animals in the driftnet fishery (Fig. 23-5). Annual production of 16,000-17,000 pups on the California Channel islands in 1986 corresponds to a population size of about 87,000 animals.

Harbor Seal

The Pacific harbor seal ranges from Mexico to Japan, and populations south of Alaska are thought to be increasing. California's minimum population of 20,000 is probably below optimum. The population in Washington and Oregon is about 23,500. There are no reliable estimates for Alaska, but on Tugidak Island the population has declined by more than 60% since the early 1970's. If this is typical, then the Alaska population is depleted and below optimum levels.

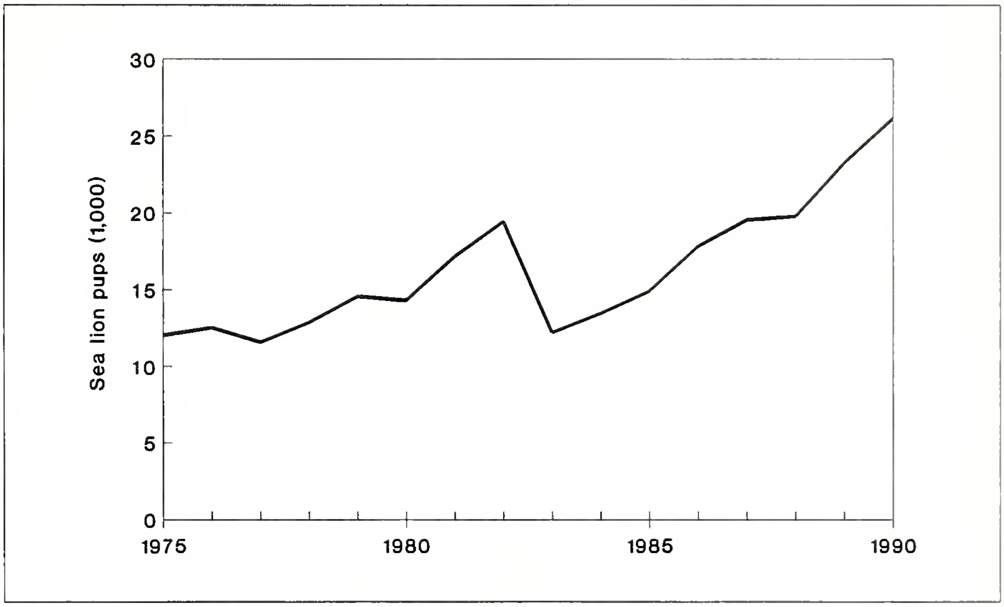


Figure 23-5.—California sea lion pup counts on the Channel Islands, 1975-90.

Hawaiian Monk Seal

Considered endangered under the ESA, the monk seal is limited to the small islands and atolls of the 1,100-mile Hawaiian Archipelago. In 1988, the total population was about 1,500 animals, a 60% decline since 1958. In addition, the monk seals at French Frigate Shoals have decreased by at least 25-40% since 1989. Average counts (including pups) at the five major breeding sites increased from 468 to 639 during 1983-87 but dropped to 480 in 1991. Pup production increased during 1983-88 but dropped 35% in 1990 and recovered only slightly in 1991 (Fig. 23-6).

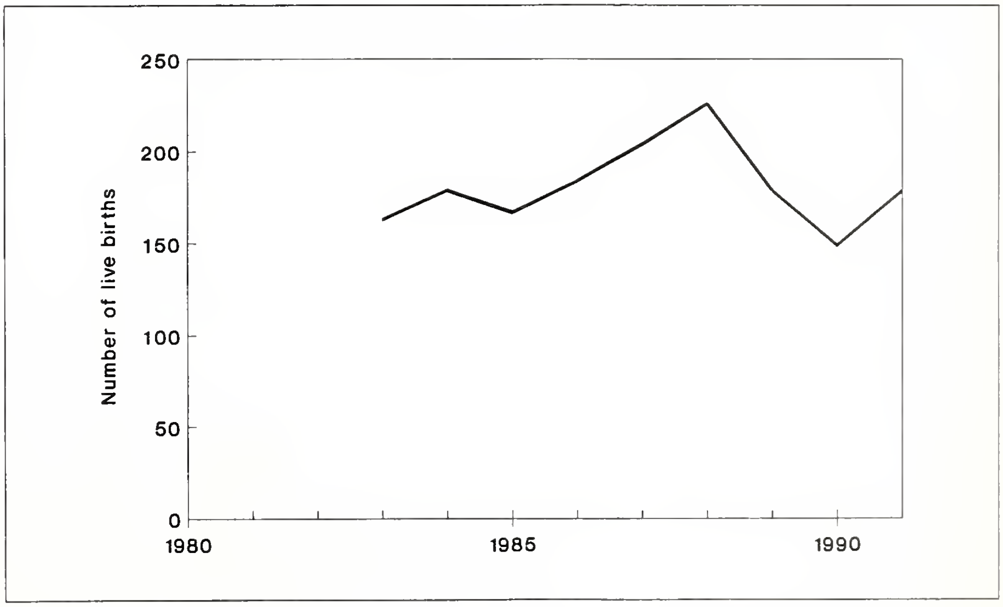


Figure 23-6.—Hawaiian monk seal live births, 1983-91.

ISSUES

Studies of marine mammal populations have focused on four primary questions: 1) Have fisheries interactions and other human-related activities directly harmed marine mammals or significantly altered the carrying capacity of the marine ecosystem for them; 2) Are the depleted marine mammals recovering, and have the best steps been taken to speed their recovery; 3) What actions are necessary to minimize potential conflicts between the ESA, MMPA, MFCMA, and other Federal laws on marine resources and fisheries management; and 4) How can marine mammal populations be monitored in the face of environmental variability?

Specific concerns in light of these research issues are discussed below.

Bycatch and Multispecies Interactions

El Niño events in California (see Spotlight 1) are often associated with increased interactions between California sea lions and fisheries. This seems to be related to a change in forage conditions for sea lions during El Niño events, where sea lions tend to feed more heavily on fish caught by commercial and recreational fishermen. Given the increased number of California sea lions at this time, this El Niño could result in major problems for west coast fishermen unless methods for minimizing this interaction are developed in the near future.

Another issue involves competition for food. U.S. and foreign commercial fisheries have been operating in the eastern North Pacific for more than 100 years, and fish catches have been sustained there for many decades. Some fish populations, however, have collapsed and are no longer commercially viable, such as the California sardine. The impact of removing millions of fish and shellfish from the marine ecosystem each year on the marine mammals that also eat them is unknown.


California sea lion
Zalophus californianus

Incidental killing of marine mammals is another important issue. In recent years, the fishery-caused mortality of spotted, spinner, and common dolphins has been reduced dramatically relative to mortality levels in 1986. In 1991, the kill of dolphins in the ETP, expressed as a percentage of population size, was less than 2% for all the stocks. This level of mortality is considered sustainable. Still, incidental mortality in 1991 likely exceeded 20,000 animals. An international regime is currently being developed by nations that purse seine for tunas in the ETP with the goal of eliminating dolphin mortality entirely over the next few years.

The harbor porpoise kill in California's fisheries declined from 200-300/year in the mid-1980's to less than 100/year after gillnet fishing ceased. The harbor porpoise kill by the Makah Indian tribal setnet salmon fishery off the north coast of Washington declined from over 100 in 1987-88 to 13 in 1990 when the fishing effort was reduced.

The known kill of Steller sea lions in Alaska fisheries has declined from over 1,400 in 1982 to 23 in 1990. The numbers killed in other fisheries is believed to be even smaller.

Observed marine mammal kills in the foreign high-seas squid fishery in 1989 (only 4% of the fishery was monitored) numbered 455 northern right whale dolphins, 254 white-sided dolphins, 208 fur seals, 141 dall porpoises, 10 common dolphins, and 52 unidentified dolphins. One fur seal was reported killed in U.S. fisheries in 1990.

Recovery of Protected Species

Eleven U.S. west coast marine mammal species are listed as endangered or threatened under the ESA. Though the data are limited, right whales in the eastern North Pacific Ocean are at a critically low level: Only 5-7 sightings have been made in the past 25 years. There are far too few data on other species, such as blue and humpback whales, to judge whether any recovery is taking place. Gray whales have recovered to near levels estimated for the mid-1800's. California sea lions, northern elephant seals, and harbor seal populations along the west coast are also increasing. Some human activities may, however, be affecting the recovery of some species. For example, adult female humpback whales with calves have apparently been abandoning traditional nearshore calving and calf rearing habitat near Maui, Hawaii, owing to repeated human interference or contact. Recovery plan action will provide a way to gauge progress in the restoration of endangered and threatened resources.

Scientific Advice and Adequacy of Assessments

Some northern pinniped populations, such as Steller sea lion, northern fur seal, and harbor seal, have declined in the last 20 years. During the same period, other pinniped populations farther south along the west coast have increased, such as harbor seal, California sea lion, northern fur seal, and northern elephant seal. Growing marine mammal populations will raise different fishery management concerns. The biological information needed to assess and manage these problems is generally lacking.

Marine mammal populations need to be monitored on a regular basis. However, annual changes in environmental conditions make monitoring more difficult. For example, large-scale oceanographic changes associated with El Niño conditions affect the distributions of whales. Because of the expense involved, many of the marine mammal populations are monitored only once every 2-5 years. Generally, precision of marine mammal population estimates are such that changes in population size must be on the order of 20-50% to be detectable, but management advice is often needed before such large changes occur.

UNIT 24 SEA TURTLES

INTRODUCTION

Sea turtles are highly migratory and ply the world's oceans. Under the Endangered Species Act of 1973, all marine turtles are listed either as endangered or threatened (Table 24-1). The NMFS has authority to protect and conserve marine turtles in the seas and the U.S. Fish and Wildlife Service maintains authority while turtles are on land.

The Kemp's ridley, hawksbill, and leatherback turtles are listed as endangered throughout their ranges. The loggerhead and olive ridley turtles are listed as threatened throughout their U.S. ranges, as is the green turtle, except the Florida nesting population which is listed as endangered.

Table 24-1.—Annual number of female sea turtles nesting on U.S. beaches.

Area and species	Number of nesting females: Historic level	Current level	Current trend	Status in U.S.
Atlantic				
Loggerhead	Unknown	18,000-21,000	Stable	T[1]
Green	Unknown	600-800	Increasing	T, E[2]
Kemp's ridley	40,000	700[3]	Declining[4]	E
Leatherback	Unknown	Unknown	Unknown	E
Hawksbill	Unknown	Unknown	Declining	E
Pacific				
Loggerhead	Unknown	Unknown	Unknown	T
Green	10,000[5]	2,200[5]	Increasing[6]	T
Olive ridley	Unknown	Unknown	Unknown	T
Leatherback	Unknown	Unknown	Unknown	E
Hawksbill	Unknown	75[7]	Unknown	E

[1]T = Listed under the Endangered Species Act as threatened.

[2] Listed under the Endangered Species Act as endangered in Florida; threatened in the U.S. Atlantic and Pacific.

[3]Using 1.5 nests/female.

[4]Declining at an average rate of 3%/year since 1978.

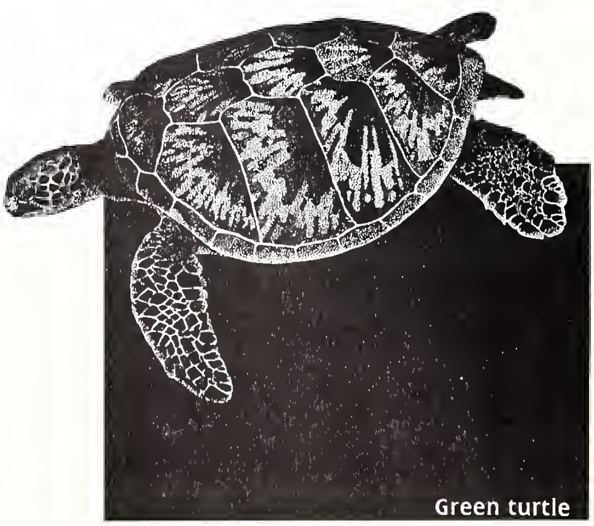
[5]Historical level for Hawaii only; current level is 2,000 in Hawaii and 100-300 in American Samoa; current level in Guam is unknown.

[6]Trend in Hawaii only, monitored at French Frigate Shoals; however, great concern exists over increasing frequency of fibropapilloma disease in all Hawaiian green turtles.

[7]Current abundance in Hawaii; current abundance in Guam and American Samoa is unknown.

SPECIES AND STATUS

The Pacific species are loggerhead, green, leatherback, hawksbill, and olive ridley turtles. All are also found in the Atlantic Ocean, but the olive ridley does not enter U.S. waters. In Hawaiian waters, the green and hawksbill are most abundant. Off the U.S. west coast, the loggerhead, leatherback, and olive ridley turtles are most commonly reported.



Green turtle
Chelonia mydas

Historical data on sea turtle numbers are limited. In addition, the length of time that data have been collected has been short when compared with the long life and low reproductive rate of all turtle species. It is difficult to assess the long-term status of sea turtles owing to the limited data.

The 1982-84 number of loggerhead nesting females from North Carolina to Florida was 18,000-21,000 (Table 24-1). Most nest along Florida's east coast where nest numbers have been stable for 5 years. Only about 700 female Kemp's ridley turtles nest along a limited portion of Mexico's

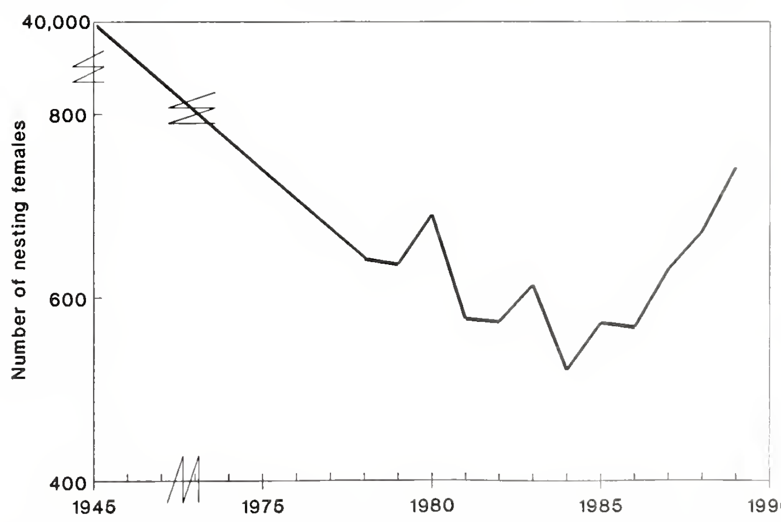
... SPECIES AND STATUS

Atlantic coast. In 1947, on a single day, 40,000 females were seen nesting on one beach alone. The documented decline in the Kemp's ridley is probably indicative of similar population trends for other sea turtles, though the periods of their various declines may have differed (Fig. 24-1).

Historically, the green sea turtle has supported large fisheries along the Florida and Texas coasts, although its nesting on U.S. beaches has probably always been limited. In the late 1800's, 2,000 females reportedly nested at Key West, Fla. Currently, perhaps 600-800 green turtles nest along the Florida coast. However, it appears that the number of juvenile and subadult turtles in Florida's inshore waters has recently returned to historic levels. There are no historical estimates for the numbers of hawksbill or leatherback turtles nesting on U.S. Caribbean beaches. The hawksbill has been heavily exploited, and continued trade of products from this species suggests that further declines are possible. The trend over time of the leatherback turtle in U.S. waters is unknown.

Since 1973, Hawaiian surveys of nesting green turtles indicate that the adult population may currently number about 2,000 and that it is gradually increasing. No accurate historical record of green turtle populations exists. Despite an apparent increase in the nesting population, there is growing concern that fibropapilloma disease, which has affected green turtles of all ages in many inshore feeding and resting areas, may seriously curtail population recovery. The Hawaiian hawksbill turtle population is very small; only 12-15 nests are recorded each year. In Hawaii, little is known of the species' reproductive biology or population trends.

Figure 24-1.—Number of nesting females of Kemp's ridley sea turtles, 1945 and 1978-89.



ISSUES

Bycatch and Multispecies Interactions

In the North Pacific there are concerns about sea turtle deaths in the high-seas driftnet fisheries. Turtle bycatch rates are being monitored on driftnet vessels by U.S., Canadian, Japanese, Korean, and Taiwanese scientific observers. The effect of these driftnet fisheries on U.S. sea turtle populations is unknown, but the United Nations has agreed to end high-seas driftnet fishing.

Turtles are also killed when accidentally caught in other fisheries. As many as 10,000 sea turtles may be taken annually in shrimp trawls. Turtle excluder devices (TED's) have been developed and, when attached to shrimp trawls, enhance turtle safety by releasing them. TED's reduce the turtle kill by shrimp trawls by 97%, and their

. . . Bycatch and Multispecies Interactions

use is mandated for most shrimp fishing areas. Studies indicate that the use of TED's has reduced shrimp catches only about 5-15%. Shrimpers are concerned about even these small losses, which, in part, reflect poor economic conditions in the shrimp fishery.

Habitat Concerns

Coastal development is reducing nesting, egg incubation, and foraging habitats. Floating tar balls and plastics, if eaten, can harm or kill sea turtles. The magnitude of these problems is not fully known, but they occur worldwide, and international cooperation for marine turtle protection and recovery is needed.

Part 3: APPENDICES

APPENDIX 1 ACKNOWLEDGMENTS

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The following National Marine Fisheries Service personnel produced this report: Editors were W. L. Hobart and Andrew Rosenberg, assisted by Sharyn Matriotti and Nancy Peacock. Shelley Arenas completed the desktop publishing with assistance from Jacki Geiger. Design, layout, and the front cover art was by Harold Spiess.

APPENDIX 2 FISHERY MANAGEMENT COUNCILS AND FISHERY MANAGEMENT PLANS

NEW ENGLAND FISHERY MANAGEMENT COUNCIL

American Lobster Fishery Management Plan

Fishery Management Plan for the Northeast Multispecies Fishery

Fishery Management Plan for Atlantic Sea Scallops

Atlantic Salmon Fishery Management Plan

MID-ATLANTIC FISHERY MANAGEMENT COUNCIL

Fishery Management Plan for Atlantic Mackerel, Squid, and Butterfish Fisheries

Fishery Management Plan for Atlantic Surf Clam and Ocean Quahog Fisheries

Fishery Management Plan for Atlantic Bluefish

Fishery Management Plan for Summer Flounder

SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL

Fishery Management Plan for the Snapper-Grouper Fishery of the South Atlantic Region

Atlantic Coast Red Drum Fishery Management Plan

GULF OF MEXICO FISHERY MANAGEMENT COUNCIL

Fishery Management Plan for the Spiny Lobster Fishery of the Gulf of Mexico and South Atlantic

Fishery Management Plan for the Stone Crab Fishery of the Gulf of Mexico

Fishery Management Plan for the Shrimp Fishery of the Gulf of Mexico

Fishery Management Plan for Coastal Migratory Pelagic Resources of the Gulf of Mexico and South Atlantic

Fishery Management Plan for Coral and Coral Reefs in the Gulf of Mexico and South Atlantic Fishery Management Plan for the Reef Fish Resources of the Gulf of Mexico

Fishery Management Plan for the Red Drum Fishery of the Gulf of Mexico

CARIBBEAN FISHERY MANAGEMENT COUNCIL

Fishery Management Plan for the Spiny Lobster Fishery of Puerto Rico and the U.S. Virgin Islands

Fishery Management Plan for the Shallow Water Reef Fish Fishery of Puerto Rico and the U.S. Virgin Islands

PACIFIC FISHERY MANAGEMENT COUNCIL

Fishery Management Plan for the Groundfish Fishery off Washington, Oregon, and California

Northern Anchovy Fishery Management Plan

Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the Coasts of Washington, Oregon, and California

WESTERN PACIFIC FISHERY MANAGEMENT COUNCIL

Fishery Management Plan for the Crustacean Fishery of the Western Pacific Region

Fishery Management Plan for the Precious Corals Fisheries of the Western Pacific Region

Fishery Management Plan for the Bottomfish and Seamount Groundfish Fisheries of the Western Pacific Region

Fishery Management Plan for the Pelagic Fisheries of the Western Pacific Region

NORTH PACIFIC FISHERY MANAGEMENT COUNCIL

Fishery Management Plan for Groundfish of the Gulf of Alaska

Fishery Management Plan for the High Seas Salmon Fishery off the Coast of Alaska East of 175 Degrees East Longitude

Fishery Management Plan for the Groundfish Fishery of the Bering Sea and Aleutian Islands Area

Bering Sea/Aleutian Islands King and Tanner Crab Fishery Management Plan

SECRETARIAL PLANS

Fishery Management Plan for Atlantic Swordfish

Fishery Management Plan for Atlantic Billfishes

LIST OF FMP AMENDMENTS IMPLEMENTED 1 OCTOBER 1991 THROUGH 30 SEPTEMBER 1992

FMP for the Pelagic Fisheries of the Western Pacific Region; Amendment 3.
Final rule published 10/18/91; 56 FR 52214.

Prohibited longline fishing within 50 nautical miles of certain Northwestern Hawaiian Islands and corridors between them to provide a protected species zone around the centers of activity of the endangered Hawaiian monk seal and established a process for adjusting the size of the protected species zone and/or changing the conservation and management measures to conserve Hawaiian monk seals and other protected species in the area.

FMP for the Pelagic Fisheries of the Western Pacific Region; Amendment 4.
Final rule published 10/16/91; 56 FR 51849.

Extended until April 1994, a moratorium on the issuance of new permits to participate in the Hawaii-based longline fishery to provide a period of stability for the fishery so that the Western Pacific Fishery Management Council and NMFS can complete a comprehensive, long-term management regime.

FMP for the Pelagic Fisheries of the Western Pacific Region; Amendment 5.
Final rule published 3/4/92; 57 FR 7661.

Prohibited longline fishing within 75 n.mi. of the islands of Oahu, Kauai, Niihau, and Kaula; within 50 n.mi. of the islands of Hawaii, Maui, Kahoolawe, Lanai, and Molokai; and around Guam and its offshore banks to prevent gear conflicts between longline vessels and troll/handline vessels engaged in the pelagic fisheries.

FMP for the Snapper-Grouper Fishery of the South Atlantic; Amendment 4.
Final rule published 10/31/91; 56 FR 56016.

Made extensive revisions to the regulations to prevent overfishing of the snapper-grouper resource, rebuild species that are overfished, collect necessary data for management, provide for a flexible management system that minimizes regulatory delays and rapidly adapts to changes in resource abundance, new information, and changes in fishing patterns; reduce user conflicts, minimize habitat damage, and promote public comprehension of, voluntary compliance with, and enforcement of snapper-grouper management measures.

FMP for the Snapper-Grouper Fishery of the South Atlantic; Amendment 5.
Final rule published 3/5/92; 57 FR 7886.

Implemented a limited entry program for the wreckfish sector of the snapper-grouper fishery, consisting of transferable percentage shares of the annual total allowable catch of wreckfish and annual individual transferable quotas (ITQ's), and made other regulatory changes to manage the wreckfish sector of the snapper-grouper fishery so that its long-term economic viability will be preserved.

FMP for Groundfish of the Gulf of Alaska; Amendment 22
and
FMP for Groundfish of the Bering Sea and Aleutian Islands Area; Amendment 17.
Final rule published 3/26/92; 57 FR 10430.

... LIST OF FMP AMENDMENTS IMPLEMENTED 1 OCTOBER 1991 THROUGH 30 SEPTEMBER 1992

Established a new management subarea and area closures around walrus haulout sites in the BSAI, removed Statistical Area 68 in the GOA, and authorized the Director, Alaska Region, NMFS, to issue experimental fishing permits in the GOA and/or BSAI.

FMP for Groundfish of the Gulf of Alaska; Amendment 23
and
FMP for Groundfish of the Bering Sea and Aleutian Islands Area; Amendment 18.
Final rule published 6/3/92; 57 FR 23321 (partial approval).

Allocated Pacific cod and pollock between inshore and offshore components of the groundfish fishery in the GOA, and temporarily allocated pollock between inshore and offshore components in the BSAI. Temporarily established a catcher vessel operational area in the BSAI within which the offshore component is prohibited from conducting fishing operations for pollock during the second seasonal allowance (i.e., the "B" season). A Western Alaska Community Development Quota (CDQ) program was approved to help develop commercial fisheries in communities on the Bering Sea coast.

FMP for Groundfish of the Gulf of Alaska; Amendment 24
and
FMP for Groundfish of the Bering Sea and Aleutian Islands Area; Amendment 19.
Final rule expected September 1992; proposed rule published 5/29/92; 57 FR 22695.

Establishes 1992 halibut bycatch limits for trawl and nontrawl gear in the BSAI and authorizes amendments to regulations that would provide for inseason time/area closures to further reduce prohibited species bycatch rates. Authorizes revisions to measures applicable to the management and monitoring of prohibited species bycatch amounts and the vessel incentive program to reduce prohibited species bycatch rates.

FMP for Groundfish of the Gulf of Alaska; Amendment 25
and
FMP for Groundfish of the Bering Sea and Aleutian Islands Area; Amendment 20.
Final rule published 1/23/92; 57 FR 2683.

Authorizes regulations to protect marine mammal populations; prohibited trawling year-round within 10 n.mi. of 37 Steller sea lion rookeries in the GOA and BSAI; expanded the prohibited zone to 20 n.mi. for five rookeries from 1 January through 15 April each year; established new GOA pollock management districts; and imposed a limit on the amount of an excess pollock seasonal harvest that may be taken in a quarter in each district.

FMP for the Crustacean Fisheries of the Western Pacific Region; Amendment 7.
Final rule published 3/26/92; 57 FR 10437.

Established a limited access program for the lobster fishery of the Northwestern Hawaiian Islands, with vessel permit eligibility based on historical participation in the fishery; permits are transferable. Trap limits were established to further control effort. Established an annual closed season and an annual quota based on the condition of stocks and additional reporting requirements to ensure adequate data to monitor and carry out the limited access and conservation measures.

FMP for the Reef Fish Resources of the Gulf of Mexico; Amendment 4.
Final rule published 4/8/92; 57 FR 11914.

Added almaco jack and banded rudderfish to the management unit; specified that scamp are counted against the shallow-water grouper quota until that quota is reached, after which scamp are counted against the deep-water grouper quota; established a 3-year moratorium on additional commercial permits in the fishery, with allowances for permit transfers and sales of permitted vessels, while a more comprehensive limited access system is developed; commencing with commercial permits for 1993, allows the earned income requirement to be met in either of the 2 years preceding the permit application; and made other regulatory changes.

FMP for the Summer Flounder Fishery; Amendment 2.
Final rule expected September, 1992; proposed rule published 6/10/92; 57 FR 24577.

Contains measures to reduce the fishing mortality rate enough to rebuild the severely depleted stock of summer flounder. Includes annual quotas for the commercial fishery allocated on a state-by-state basis, minimum mesh size for trawl gear, seasonal restriction for the recreational fishery, bag limits on a trip basis for the recreational fishery, minimum fish size requirements for the commercial and recreational fisheries, a 5-year moratorium on entry into the commercial fishery, dealer permits, mandatory logbook reporting by permitted dealers (weekly), prohibition on sale of summer flounder caught by the recreational fishery, and authorization to collect application fees for charter, party, and commercial vessel permits and dealer permits. Contains measures designed to protect endangered and threatened sea turtles, especially to reduce the likelihood of incidental catch or injury to sea turtles in the winter trawl fishery for summer flounder.

FMP for the Red Drum Fishery of the Gulf of Mexico; Amendment 3.
Final rule expected September 1992; proposed rule published 6/16/92; 57 FR 26814.

Simplifies the regulations by removing administrative procedures not applicable to the conduct of the red drum fishery, to comply with a ruling by the U.S. District Court for the District of Columbia, and to ease an unnecessarily burdensome requirement for stock assessments, panel reports, and findings regarding ABC and TAC.

FMP for the Pacific Coast Groundfish Fishery; Amendment 6.
Final rule expected September 1992; proposed rule published 7/22/92; 57 FR 32499.

Establishes a license limitation limited entry program for the commercial groundfish fishery based on the issuance of gear-specific Federal permits to promote conservation and improve stability and economic viability of the fishery industry, by limiting or reducing harvesting capacity.

FMP for American Lobster; Amendment 4.
Final rule published 1/3/92; 57 FR 214.

Reduced the minimum carapace size for American lobster to $3\frac{1}{4}$ inches (8.26 cm), delayed further increases in the minimum size until 2 years after the implementation of the amendment, and modified the minimum dimensions of the escape vent to be consistent with the minimum carapace size to restore uniformity among the Federal and state size limits.

FMP for the Atlantic Mackerel, Squid, and Butterfish Fisheries of the Northwest Atlantic Ocean; Amendment 4.
Final rule published 1/7/92; 57 FR 2683.

Allows annual catch specifications to be established for up to 3 years, eliminated the existing foreign fishing "windows" and allows the Director, Northeast Region, NMFS, to limit times and areas in which foreign directed fishing may occur, and allows the Assistant Administrator for Fisheries, NOAA, to impose special conditions on joint ventures and directed foreign fishing, including the requirement that owners and operators of foreign vessels purchase domestic-harvested and processed fish in relation to the allocation of the total allowable level of foreign fishing to the Nation of the flag vessel. Revised the definition of overfishing for Atlantic mackerel.

APPENDIX 3 COMMON AND SCIENTIFIC NAMES OF SPECIES COVERED IN THIS REPORT[1]

UNIT 1: NORTHEAST DEMERSAL FISHERIES

Principal Groundfish and Flounders
- Atlantic cod, *Gadus morhua*
- Haddock, *Melanogrammus aeglefinus*
- Pollock, *Pollachius virens*
- Redfish, *Sebastes marinus*
- Silver hake, *Merluccius bilinearis*
- Red hake, *Urophycis chuss*
- Yellowtail flounder, *Limanda ferruginea*
- Winter flounder, *Pseudopleuronectes americanus*
- Summer flounder, *Paralichthys dentatus*
- Witch flounder, *Glyptocephalus cynoglossus*
- American plaice, *Hippoglossoides platessoides*
- Windowpane, *Scophthalmus aquosus*

Skates and Spiny Dogfish
- Spiny dogfish, *Squalus acanthias*
- Skates, *Raja* spp.

Other Finfish
- White hake, *Urophycis tenuis*
- Goosefish, *Lophius americanus*
- Cusk, *Brosme brosme*
- Ocean pout, *Macrozoarces americanus*
- Sculpins, Family Cottidae
- Searobins, Family Triglidae
- Scup, *Stenotomus chrysops*
- Tilefish, *Lopholatilus chamaeleonticeps*
- Wolffishes, *Anarhichas* spp.
- Atlantic argentine, *Argentina silus*
- Black sea bass, *Centropristis striata*
- Smooth dogfish, *Mustelus canis*
- Spot, *Leiostomus xanthurus*
- Weakfish, *Cynoscion regalis*
- Atlantic halibut, *Hippoglossus hippoglossus*

UNIT 2: NORTHEAST PELAGIC FISHERIES

Atlantic (sea) herring, *Clupea harengus*
Atlantic mackerel, *Scomber scombrus*
Butterfish, *Peprilus triacanthus*
Bluefish, *Pomatomus saltatrix*
Long-finned squid, *Loligo pealei*
Short-finned squid, *Illex illecebrosus*

UNIT 3: ATLANTIC ANADROMOUS FISHERIES

Atlantic salmon, *Salmo salar*
American shad, *Alosa sapidissima*
River herring (alewife), *Alosa pseudoharengus*
Striped bass, *Morone saxatilis*
Atlantic sturgeon, *Acipenser oxyrhynchus*

UNIT 4: NORTHEAST INVERTEBRATE FISHERIES

Sea scallop, *Placopecten magellanicus*
American lobster, *Homarus americanus*
Surf clam, *Spisula solidissima*
Ocean quahog, *Arctica islandica*
Northern shrimp, *Pandalus borealis*

UNIT 5: ATLANTIC HIGHLY MIGRATORY PELAGIC FISHERIES

Atlantic swordfish, *Xiphias gladius*

Billfishes
- Sailfish, *Istiophorus platypterus*
- Blue marlin, *Makaira nigricans*
- White marlin, *Tetrapturus albidus*
- Longbill spearfish, *Tetrapturus pfluegeri*
- Atlantic bluefin tuna, *Thunnus thynnus*

Other Tunas
- Albacore, *Thunnus alalunga*
- Bigeye tuna, *Thunnus obesus*
- Blackfin tuna, *Thunnus atlanticus*
- Yellowfin tuna, *Thunnus albacares*
- Little tunny, *Euthynnus alletteratus*
- Skipjack tuna, *Euthynnus pelamis*
- Bullet tuna, *Auxis rochei*
- Frigate tuna, *Auxis thazard*

[1]Species are listed by the Unit in which they are found. Not all are mentioned in the text since many are grouped together for management purposes under one category (i.e, pelagic fishery, groundfish fishery).

UNIT 6: ATLANTIC SHARK FISHERIES

Pelagic Sharks
- Thresher shark, *Alopias vulpinus*
- Bigeye thresher, *Alopias superciliosus*
- Oceanic whitetip shark, *Carcharhinus longimanus*
- Sevengill shark, *Heptrachias perlo*
- Sixgill shark, *Hexanchus griseus*
- Bigeye sixgill shark, *Hexanchus vitulus*
- Shortfin mako, *Isurus oxyrinchus*
- Longfin mako, *Isurus paucus*
- Porbeagle, *Lamna nasus*
- Blue shark, *Prionace glauca*

Large Coastal Sharks
- Sandbar shark, *Carcharhinus plumbeus*
- Reef shark, *Carcharhinus perezi*
- Blacktip shark, *Carcharhinus limbatus*
- Dusky shark, *Carcharhinus obscurus*
- Spinner shark, *Carcharhinus brevipinna*
- Silky shark, *Carcharhinus falciformis*
- Bull shark, *Carcharhinus leucas*
- Bignose shark, *Carcharhinus altimus*
- Galapagos shark, *Carcharhinus galapagensis*
- Night shark, *Carcharhinus signatus*
- White shark, *Carcharodon carcharias*
- Basking shark, *Cetorhinus maximus*
- Tiger shark, *Galeocerdo cuvieri*
- Nurse shark, *Ginglymostoma cirratum*
- Lemon shark, *Negaprion brevirostris*
- Ragged-tooth shark, *Odontaspis ferox*
- Whale shark, *Rhincodon typus*
- Scalloped hammerhead, *Sphyrna lewini*
- Great hammerhead, *Sphyrna mokarran*
- Smooth hammerhead, *Sphyrna zygaena*

Small Coastal Sharks
- Finetooth shark, *Carcharhinus isodon*
- Blacknose shark, *Carcharhinus acronotus*
- Atlantic sharpnose shark, *Rhizoprionodon terraenovae*
- Caribbean sharpnose shark, *Rhizoprionodon porosus*
- Bonnethead, *Sphyrna tiburo*
- Atlantic angel shark, *Squatina dumerili*

UNIT 7: ATLANTIC COASTAL MIGRATORY PELAGIC FISHERIES

King mackerel (Gulf/Atlantic), *Scomberomorus cavalla*
Spanish mackerel (Gulf/Atlantic), *Scomberomorus maculatus*
Cobia, *Rachycentron canadum*
Cero (mackerel), *Scomberomorus regalis*
Dolphin, *Coryphaena hippurus*

UNIT 8: ATLANTIC/GULF OF MEXICO/CARIBBEAN REEF FISH FISHERIES

Black snapper, *Apsilus dentatus*
Queen snapper, *Etelis oculatus*
Mutton snapper, *Lutjanus analis*
Schoolmaster, *Lutjanus apodus*
Blackfin snapper, *Lutjanus buccanella*
Red snapper, *Lutjanus campechanus*
Cubera snapper, *Lutjanus cyanopterus*
Gray snapper, *Lutjanus griseus*
Mahogany snapper, *Lutjanus mahogoni*
Dog snapper, *Lutjanus jocu*
Lane snapper, *Lutjanus synagris*
Silk snapper, *Lutjanus vivanus*
Yellowtail snapper, *Ocyurus chrysurus*
Vermilion snapper, *Rhomboplites aurorubens*
Wenchman, *Pristipomoides aquilonaris*
Voraz, *Pristipomoides macrophthalmus*
Bank sea bass, *Centropristis ocyurus*
Rock sea bass, *Centropristis philadelphica*
Black sea bass, *Centropristis striata*
Dwarf sand perch, *Diplectrum bivittatum*
Sand perch, *Diplectrum formosum*
Rock hind, *Epinephelus adscensionis*
Graysby, *Epinephelus cruentatus*
Speckled hind, *Epinephelus drummondhayi*
Yellowedge grouper, *Epinephelus flavolimbatus*
Coney, *Epinephelus fulvus*
Red hind, *Epinephelus guttatus*
Jewfish, *Epinephelus itajara*
Red grouper, *Epinephelus morio*
Misty grouper, *Epinephelus mystacinus*
Warsaw grouper, *Epinephelus nigritus*
Snowy grouper, *Epinephelus niveatus*
Nassau grouper, *Epinephelus striatus*

. . . ATLANTIC/GULF OF MEXICO/CARIBBEAN REEF FISH FISHERIES

Black grouper, *Mycteroperca bonaci*
Yellowmouth grouper, *Mycteroperca interstitialis*
Gag, *Mycteroperca microlepis*
Scamp, *Mycteroperca phenax*
Tiger grouper, *Mycteroperca tigris*
Yellowfin grouper, *Mycteroperca venenosa*
Wreckfish, *Polyprion americanus*
Sheepshead, *Archosargus probatocephalus*
Sea bream, *Archosargus rhomboidalis*
Grass porgy, *Calamus arctifrons*
Jolthead porgy, *Calamus bajonado*
Saucereye porgy, *Calamus calamus*
Whitebone porgy, *Calamus leucosteus*
Knobbed porgy, *Calamus nodosus*
Sheepshead porgy, *Calamus penna*
Pluma, *Calamus pennatula*
Littlehead porgy, *Calamus proridens*
Pinfish, *Lagodon rhomboides*
Red porgy, *Pagrus pagrus*
Longspine porgy, *Stenotomus caprinus*
Scup, *Stenotomus chrysops*
Black margate, *Anisotremus surinamensis*
Porkfish, *Anisotremus virginicus*
Margate, *Haemulon album*
Tomtate, *Haemulon aurolineatum*
Smallmouth grunt, *Haemulon chrysargyreum*
French grunt, *Haemulon flavolineatum*
Spanish grunt, *Haemulon macrostomum*
Cottonwick, *Haemulon melanurum*
Sailors choice, *Haemulon parrai*
White grunt, *Haemulon plumieri*
Bluestriped grunt, *Haemulon sciurus*
Pigfish, *Orthopristis chrysoptera*
Goldface tilefish, *Caulolatilus chrysops*
Blackline tilefish, *Caulolatilus cyanops*
Anchor tilefish, *Caulolatilus intermedius*
Blueline (grey) tilefish, *Caulolatilus microps*
Tilefish (golden), *Lopholatilus chamaeleonticeps*
Sand tilefish, *Malacanthus plumieri*
Gray triggerfish, *Balistes capriscus*
Queen triggerfish, *Balistes vetula*
Ocean triggerfish, *Canthidermis sufflamen*
Black durgon, *Melichthys niger*
Sargassum triggerfish, *Xanthichthys ringens*
Spanish hogfish, *Bodianus rufus*
Hogfish, *Lachnolaimus maximus*
Puddingwife, *Halichoeres radiatus*
Pearly razorfish, *Hemipteronotus novacula*
Yellow jack, *Caranx bartholomaei*
Blue runner, *Caranx crysos*
Crevalle jack, *Caranx hippos*
Horse-eye jack, *Caranx latus*
Black jack, *Caranx lugubris*
Bar jack, *Caranx ruber*
Greater amberjack, *Seriola dumerili*
Lesser amberjack, *Seriola fasciata*
Almaco jack, *Seriola rivoliana*
Squirrelfish, *Holocentrus adscensionis*
Longspine squirrelfish, *Holocentrus rufus*
Yellow goatfish, *Mulloidichthys martinicus*
Spotted goatfish, *Pseudopeneus maculatus*
Foureye butterflyfish, *Chaetodon capistratus*
Spotfin butterflyfish, *Chaetodon ocellatus*
Banded butterflyfish, *Chaetodon striatus*
Queen angelfish, *Holacanthus ciliaris*
Rock beauty, *Holacanthus tricolor*
Gray angelfish, *Pomacanthus arcuatus*
French angelfish, *Pomacanthus paru*
Midnight parrotfish, *Scarus coelestinus*
Blue parrotfish, *Scarus coeruleus*
Striped parrotfish, *Scarus croicensis*
Rainbow parrotfish, *Scarus quacamaia*
Princess parrotfish, *Scarus taeniopterus*
Queen parrotfish, *Scarus vetula*
Redband parrotfish, *Sparisoma aurofrenatum*
Redtail parrotfish, *Sparisoma chrysopterum*
Stoplight parrotfish, *Sparisoma viride*
Ocean surgeonfish, *Acanthurus chirurgus*
Doctorfish, *Acanthurus bahianus*
Blue tang, *Acanthurus coeruleus*
Spotted trunkfish, *Lactophrys bicaudalis*
Honeycomb cowfish, *Lactophrys polygonia*
Scrawled cowfish, *Lactophrys quadricornis*
Trunkfish, *Lactophrys trigonus*
Smooth trunkfish, *Lactophrys triqueter*

UNIT 9: SOUTHEAST DRUM AND CROAKER FISHERIES	Red drum, *Sciaenops ocellatus* Spotted seatrout, *Cynoscion nebulosus* Silver seatrout, *Cynoscion nothus* Sand seatrout, *Cynoscion arenarius* Spot, *Leiostomus xanthurus* Atlantic croaker, *Micropogonias undulatus*	Black drum, *Pogonias cromis* Southern kingfish, *Menticirrhus americanus* Gulf kingfish, *Menticirrhus littoralis* Northern kingfish, *Menticirrhus saxatilis*
UNIT 10: SOUTHEAST MENHADEN AND BUTTERFISH FISHERIES	Atlantic menhaden, *Brevoortia tyrannus* Gulf menhaden, *Brevoortia patronus*	Gulf butterfish, *Peprilus burti*
UNIT 11: SOUTHEAST/ CARIBBEAN INVERTEBRATE FISHERIES	Spiny Lobsters/Stone Crabs Spiny lobster (SE/Caribbean), *Panulirus argus* Slipper lobster, *Scyllarides nodifer* Stone crab, *Menippe mercenaria* Shrimp Brown shrimp, *Penaeus aztecus* White shrimp, *Penaeus setiferus*	Pink shrimp, *Penaeus duorarum* Royal red shrimp, *Hymenopenaeus robustus* Seabobs, *Xiphopenaeus kroyeri* Rock shrimp, *Sicyonia brevirostris* Others Queen conch, *Strombus gigas* Corals
UNIT 12: PACIFIC COAST SALMON FISHERIES	Chinook salmon, *Oncorhynchus tshawytscha* Coho salmon, *Oncorhynchus kisutch*	Pink salmon, *Oncorhynchus gorbuscha* Sockeye salmon, *Oncorhynchus nerka* Chum salmon, *Oncorhynchus keta*
UNIT 13: ALASKA SALMON FISHERIES	Chinook salmon, *Oncorhynchus tshawytscha* Coho salmon, *Oncorhynchus kisutch*	Pink salmon, *Oncorhynchus gorbuscha* Sockeye salmon, *Oncorhynchus nerka* Chum salmon, *Oncorhynchus keta*
UNIT 14: PACIFIC COAST AND ALASKA PELAGIC FISHERIES	Northern anchovy, *Engraulis mordax* Pacific herring (Alaska), *Clupea harengus pallasi*	Pacific (California) sardine, *Sardinops sagax* Jack mackerel, *Trachurus symmetricus*
UNIT 15: PACIFIC COAST GROUNDFISH FISHERIES	Pacific hake (whiting), *Merluccius productus* Sablefish, *Anoplopoma fimbria* Dover sole, *Microstomus pacificus* Thornyheads Shortspine thornyhead, *Sebastolobus alascanus*	Longspine thornyhead, *Sebastolobus altivelis* Rockfish Aurora rockfish, *Sebastes aurora* Bank rockfish, *Sebastes rufus* Black-and-yellow rockfish, *Sebastes chrysomelas*

. . . PACIFIC COAST GROUNDFISH FISHERIES

Rockfish (cont.)
- Blackgill rockfish, *Sebastes melanostomus*
- Blue rockfish, *Sebastes mystinus*
- Bocaccio, *Sebastes paucispinis*
- Bronzespotted rockfish, *Sebastes gilli*
- Brown rockfish, *Sebastes auriculatus*
- Calico rockfish, *Sebastes dalli*
- Canary rockfish, *Sebastes pinniger*
- Chilipepper, *Sebastes goodei*
- China rockfish, *Sebastes nebulosus*
- Copper rockfish, *Sebastes caurinus*
- Cowcod, *Sebastes levis*
- Darkblotched rockfish, *Sebastes crameri*
- Dusty rockfish, *Sebastes ciliatus*
- Flag rockfish, *Sebastes rubrivinctus*
- Gopher rockfish, *Sebastes carnatus*
- Grass rockfish, *Sebastes rastrelliger*
- Greenblotched rockfish, *Sebastes rosenblatti*
- Greenspotted rockfish, *Sebastes chlorostictus*
- Greenstriped rockfish, *Sebastes elongatus*
- Harlequin rockfish, *Sebastes variegatus*
- Honeycomb rockfish, *Sebastes umbrosus*
- Kelp rockfish, *Sebastes atrovirens*
- Mexican rockfish, *Sebastes macdonaldi*
- Olive rockfish, *Sebastes serranoides*
- Pacific ocean perch, *Sebastes alutus*
- Pink rockfish, *Sebastes eos*
- Quillback rockfish, *Sebastes maliger*
- Redbanded rockfish, *Sebastes babcocki*
- Redstripe rockfish, *Sebastes proriger*
- Rosethorn rockfish, *Sebastes helvomaculatus*
- Rosy rockfish, *Sebastes rosaceus*
- Rougheye rockfish, *Sebastes aleutianus*
- Sharpchin rockfish, *Sebastes zacentrus*
- Shortbelly rockfish, *Sebastes jordani*
- Silvergray rockfish, *Sebastes brevispinis*
- Speckled rockfish, *Sebastes ovalis*
- Splitnose rockfish, *Sebastes diploproa*
- Squarespot rockfish, *Sebastes hopkinsi*
- Stripetail rockfish, *Sebastes saxicola*
- Tiger rockfish, *Sebastes nigrocinctus*
- Treefish, *Sebastes serriceps*
- Vermilion rockfish, *Sebastes miniatus*
- Widow rockfish, *Sebastes entomelas*
- Yelloweye rockfish, *Sebastes ruberrimus*
- Yellowmouth rockfish, *Sebastes reedi*
- Yellowtail rockfish, *Sebastes flavidus*

Other Flatfishes
- Arrowtooth flounder, *Atheresthes stomias*
- Butter sole, *Pleuronectes isolepis*
- English sole, *Pleuronectes vetulus*
- Flathead sole, *Hippoglossoides elassodon*
- Pacific sanddab, *Citharichthys sordidus*
- Petrale sole, *Eopsetta jordani*
- Rex sole, *Errex zachirus*
- Rock sole, *Pleuronectes bilineata*
- Sand sole, *Psettichthys melanostictus*
- Starry flounder, *Platichthys stellatus*

Others
- Leopard shark, *Triakis semifasciata*
- Soupfin shark, *Galeorhinus zyopterus*
- Spiny dogfish, *Squalus acanthias*
- Big skate, *Raja binoculata*
- California skate, *Raja inornata*
- Longnose skate, *Raja rhina*
- Spotted ratfish, *Hydrolagus colliei*
- Finescale codling, *Antimora microlepis*
- Pacific rattail, *Coryphaenoides acrolepis*
- Cabezon, *Scorpaenichthys marmoratus*
- Kelp greenling, *Hexagrammos decagrammus*
- Lingcod, *Ophiodon elongatus*
- Pacific cod, *Gadus macrocephalus*
- California scorpionfish, *Scorpaena guttata*

UNIT 16: WESTERN PACIFIC INVERTEBRATE FISHERIES

- Spiny lobster, *Panulirus marginatus*
- Slipper lobster, *Panulirus penicillatus*
- Precious corals, Family Scyllaridae

UNIT 17: WESTERN PACIFIC BOTTOMFISH AND ARMORHEAD FISHERIES

Reef Fishes
- Silverjaw jobfish, *Aphareus rutilans*
- Gray jobfish, *Aprion virescens*
- Squirrelfish snapper, *Etelis carbunculus*
- Longtail snapper, *Etelis coruscans*
- Bluestripe snapper, *Lutjanus kasmira*
- Yellowtail snapper, *Pristipomoides auricilla*
- Pink snapper, *Pristipomoides filamentosus*
- Yelloweye snapper, *Pristipomoides flavipinnus*
- Snapper, *Pristipomoides sieboldii, Pristipomoides zonatus*
- Giant trevally, *Caranx ignoblis*
- Black jack, *Caranx lugubris*
- Thick lipped trevally, *Pseudocaranx dentex*
- Amberjack, *Seriola dumerili*
- Blacktip grouper, *Epinephelus fasciatus*
- Seabass, *Epinephelus quernus*
- Lunartail grouper, *Variola louti*
- Ambon emperor, *Lethrinus amboinensis*
- Redgill emperor, *Lethrinus rubrioperculatus*

Seamount Fishes
- Armorhead, *Pentaceros richardsoni*
- Alfonsin, *Beryx splendens*
- Raftfish, *Hyperoglyphe japonica*

UNIT 18: PACIFIC HIGHLY MIGRATORY PELAGIC FISHERIES

Swordfish, *Xiphias gladius*
Blue marlin, *Makaira nigricans*
Striped marlin, *Tetrapturus audax*
Albacore (North & South), *Thunnus alalunga*
Bigeye tuna, *Thunnus obesus*
Yellowfin tuna, *Thunnus albacares*
Other Pelagics
- Sailfish, *Istiophorus platypterus*
- Black marlin, *Makaira indica*
- Shortbill spearfish, *Tetrapturus angustirostris*
- Dolphin (mahimahi), *Coryphaena hippurus*
- Pompano dolphin, *Coryphaena equisetis*
- Oceanic sharks, Families—Carcharhinidae, Alopiidae, Sphyrnidae, and Lamnidae
- Wahoo, *Acanthocybium solanderi*

UNIT 19: ALASKA GROUNDFISH FISHERIES

Walleye (Alaska) pollock, *Theragra chalcogramma*
Pacific cod, *Gadus macrocephalus*
Sablefish, *Anoplopoma fimbria*
Yellowfin sole, *Pleuronectes asper*
Pacific halibut, *Hippoglossus stenolepis*
Other Flatfishes
- Arrowtooth flounder, *Atheresthes stomias*
- Greenland halibut, *Reinhardtius hippoglossoides*
- Rock sole, *Pleuronectes bilineata*
- Flathead sole, *Hippoglossoides elassodon*
- Alaska plaice, *Pleuronectes quadrituberculatus*
- Rex sole, *Errex zachirus*
- Butter sole, *Pleuronectes isolepis*
- Longhead dab, *Pleuronectes proboscidens*
- Dover sole, *Microstomus pacificus*
- Starry flounder, *Platichthys stellatus*

Rockfishes
- Pacific ocean perch, *Sebastes alutus*
- Thornyhead rockfish, *Sebastolobus* spp.
- Rougheye rockfish, *Sebastes aleutianus*
- Dusky rockfish, *Sebastes ciliatus*
- Northern rockfish, *Sebastes polyspinis*
- Shortspine thornyhead, *Sebastes alascanus*
- Shortraker rockfish, *Sebastes borealis*
- Darkblotched rockfish, *Sebastes crameri*
- Sharpchin rockfish, *Sebastes zacentrus*
- Yelloweye rockfish, *Sebastes ruberrimus*
- Blue rockfish, *Sebastes mystinus*

Others
- Atka mackerel, *Pleurogrammus monopterygius*
- Rattail, *Coryphaenoides* sp.
- Skates, *Raja* spp.
- Squids, Sepioid and Teuthoid
- Octopus, Octopoda

UNIT 20: ALASKA SHELLFISH FISHERIES

King crabs
- Red king crab, *Paralithodes camtschatica*
- Blue king crab, *Paralithodes platypus*
- Golden (brown) king crab, *Lithodes aequispina*

Tanner crabs, *Chionecetes bairdi, Chionecetes opilio*

Sea Snails, *Neptunea pribiloffensis, Neptunea heros, Neptunea lyrata, Neptunea ventricosa, Neptunea oregonensis, Buccinum angulossum, Buccinum plectrum, Buccinum scalariforme, Buccinum polare, Volutopsius middindorffii, Volutopsius fragilis, Plicifusus kroyeri, Pyrulofusus deformis*

UNIT 21: NEARSHORE FISHERIES

Tarpon, *Megalops atlanticus*
Ladyfish, *Elops saurus*
Bonefish, *Albula vulpes*
American eel, *Anguilla rostrata*
Other shads, herrings, *Alosa aestivalis, Alosa alabamae, Alosa mediocris, Dorosoma cepedianum, Dorosoma petenense, Etrumeus teres, Harengula clupeola, Harengula humeralis, Harengula jaguana*
Atlantic thread herring, *Opisthonema oglinum*
Spanish sardine, *Sardinella aurita*
Surf smelt, *Hypomesus pretiosus*
Eulachon, *Thaleichthys pacificus*
Ballyhoo, *Hemiramphus brasiliensis*
Common snook, *Centropomus undecimalis*
Striped bass (Pacific), *Morone saxatilis*
Florida pompano, *Trachinotus carolinus*
Permit, *Trachinotus falcatus*
California corbina, *Menticirrhus undulatus*
Surfperches, Family Embiotocidae
Mullets, Family Mugilidae
Tautog, *Tautoga onitis*
Abalone, *Haliotis* spp.
Pacific shrimps, Family Pandalidae
Dungeness crab, *Cancer magister*
Rock crab, *Cancer irroratus*
Jonah crab, *Cancer borealis*
Blue crab, *Callinectes sapidus*
Blue mussel, *Mytilus edulis*
Pacific razor clam, *Siliqua patula*
Pismo clam, *Tivela stultorum*
Pacific hard clams, Family Veneridae
Atlantic hard clam, *Mercenaria mercenaria*
Softshell clam, *Mya arenaria*
Bay scallop, *Argopecten irradians*
Calico scallop, *Argopecten gibbus*
Oyster (Atlantic), *Crassostrea virginica*
Oyster (Pacific), *Crassostrea gigas*
Sea urchins, *Strongylocentrotus* spp.

UNIT 22: ATLANTIC MARINE MAMMALS

Right whale, *Eubalaena glacialis*
Humpback whale, *Megaptera novaeangliae*
Longfin pilot whale, *Globicephala melas*
Shortfin pilot whale, *Globicephala macrorhynchus*
Harbor porpoise, *Phocoena phocoena*
Bottlenose dolphin, *Tursiops truncatus*
Harbor seal, *Phoca vitulina*

Other Marine Mammals
- Fin whale, *Balaenoptera physalus*
- Whitesided dolphin, *Lagenorhynchus acutus*
- Striped dolphin, *Stenella coeruleoalba*
- Spotted dolphin (Atlantic), *Stenella plagiodon*
- Beaked whales, *Mesoplodon* spp.

UNIT 23: PACIFIC MARINE MAMMALS

Eastern Tropical Pacific Porpoises
- Spinner dolphin, *Stenella longirostris*
- Spotted dolphin (Pacific), *Stenella attenuata*
- Striped dolphin, *Stenella coeruleoalba*
- Common dolphin, *Delphinus delphis*

Bowhead whale, *Balaena mysticetus*
Gray whale, *Eschrichtius robustus*
Humpback whale, *Megaptera novaeangliae*
Northern (Steller) sea lion, *Eumetopias jubatus*
Northern fur seal, *Callorhinus ursinus*
Hawaiian monk seal, *Monachus schauinslandi*
California sea lion, *Zalophus californianus*

Other Marine Mammals
- Dall's porpoise, *Phocoenoides dalli*
- Harbor porpoise, *Phocoena phocoena*

. . . PACIFIC MARINE MAMMALS

Other Marine Mammals (cont.)
Northern right-whale dolphin, *Lissodelphis borealis*
Whitesided dolphin, *Lagenorhynchus obliquidens*
Harbor seal, *Phoca vitulina*

UNIT 24: SEA TURTLES

Kemp's ridley sea turtle, *Lepidochelys kempi*
Olive ridley sea turtle, *Lepidochelys olivacea*
Leatherback sea turtle, *Dermochelys coriacea*
Green sea turtle, *Chelonia mydas*
Loggerhead sea turtle, *Caretta caretta*
Hawksbill sea turtle, *Eretmochelys imbricata*

Appendix Table 1.– Percentage of LTPY from each unit attributed to each region. This apportionment is used to calculate region yield and value for Figure 2. The percentages are calculated based on landings data from 1989 to 1991.

Unit	Northeast	Southeast	Coastal Pacific	Oceanic Pacific	Alaska
1	100%				
2	100				
3	100				
4	100				
5	50	50%			
6		100			
7		100			
8		100			
9		100			
10	33	67			
11		100			
12			100%		
13					100%
14			100		
15			100		
16				100%	
17				100	
18				100	
19					100
20					100
21	25	50	25		

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