National Overview

INTRODUCTION

The National Marine Fisheries Service (NMFS) is dedicated to the stewardship of living marine resources (LMR's). This is accomplished through science-based conservation and management, and the promotion of healthy ecosystems. As a steward, NMFS has an obligation to conserve, protect, and manage these resources in a way that ensures their continuation as functioning components of healthy marine ecosystems, affords economic opportunities, and enhances the quality of life for the American public.

In addition to its responsibilities within the U.S. Exclusive Economic Zone (EEZ), NMFS plays a supportive and advisory role in the management of LMR's in the coastal areas under state jurisdiction and provides scientific and policy leadership in the international arena. NMFS also implements international measures for the conservation and management of LMR's, as appropriate.

NMFS receives its stewardship responsibilities under a number of Federal laws. These include the Nation's primary fisheries law, the Magnuson Fishery Conservation and Management Act. This law was first passed in 1976, later reauthorized as the Magnuson-Stevens Fishery Conservation and Management Act in 1996, and reauthorized again on 12 January 2007 as the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (MSRA). The MSRA mandates strong action to conserve and manage fishery resources and requires NMFS to end overfishing by 2010 in all U.S. commercial and recreational fisheries, rebuild all overfished stocks, and conserve essential fish habitat.

Additional stewardship responsibilities come from the following statutes:

- The Endangered Species Act (ESA) provides for the conservation of species that are endangered or threatened throughout a significant portion of their range and the conservation of the ecosystems on which they depend.

- The Marine Mammal Protection Act (MMPA) regulates interactions with marine mammals and establishes a national policy to prevent marine mammal species and population stocks from declining beyond the point where they cease to be significant functioning elements of the ecosystems of which they are a part.

- The National Environmental Policy Act (NEPA) requires Federal agencies to analyze the potential effects of any proposed Federal action that would significantly affect historical, cultural, or natural aspects of the environment.

• The Federal Power Act (FPA) allows NMFS to minimize the effects of dam operations on anadromous fish, such as by prescribing fish passageways that bypass dams.

• The Lacey Act prohibits fish and wildlife transactions and activities that violate state, Federal, Native American tribal, or foreign laws.

• The Migratory Bird Treaty Act requires the reduction of impacts of fishing gear on sea birds, in cooperation with the U.S. Fish and Wildlife Service.

• The Fish and Wildlife Coordination Act (FWCA) requires all Federal agencies to consult with and give strong consideration to the views of the U.S. Fish and Wildlife Service, NMFS, and state wildlife agencies regarding the impacts on fish and wildlife of projects that propose to impound, divert, channel, or otherwise alter a body of water.


Kip Evans

Black rockfish in a West Coast kelp forest.

The U.S. EEZ starts at 3 nautical miles (n.mi.) and extends to 200 n.mi.[1] seaward of the 48 contiguous states, Alaska, Hawaii, and U.S.-affiliated islands of the Caribbean and western Central Pacific Ocean (Figure 1). It is the largest EEZ in the world, covering 3.36 million square n.mi., or 1.7 times the area of the U.S. continental landmass (FAO, 2005). Jurisdiction over waters from 0 to 3 n.mi. offshore belongs to the coastal states, interstate fisheries management commissions (which coordinate state actions), and even counties or municipalities. International waters outside the U.S. EEZ are generally managed by applicable international laws and multilateral agreements among sovereign governments.

Eight regional Fishery Management Councils (FMC's; see Appendix 2) work in partnership with NMFS to manage LMR's and prepare Fishery Management Plans (FMP's). FMC's represent diverse interests through their members, who are nominated by state governors in each region and appointed by the Secretary of Commerce. The Secretary of Commerce oversees the FMC's and their development of fisheries regulations and is ultimately responsible for the management and conservation of LMR's in the U.S. EEZ; if the FMC's fail to act or are unable to act on an FMP or fishery problem in a timely manner, the Secretary must develop a Secretarial FMP. The Secretary of Commerce also has management authority for Atlantic highly migratory species and is responsible for the preparation of FMP's to manage these stocks; the Secretary also oversees implementation of international requirements related to fisheries.

Fishery management plans specify how fisheries will be managed, and are developed through extensive consultations with state and Federal agencies, affected industry sectors, public interest groups, and international science and management organizations where appropriate. The MSRA contains 10 National Standards to guide development of FMP's, taking into consideration the social, economic, biological, and environmental factors associated with fisheries. NMFS, state, and commission programs collect and analyze much of the fisheries data used by managers. Federal law requires that managers use the "best science available" to make management decisions.

Our Living Oceans 6th Edition (*OLO 6th Edition*) covers the majority of LMR's that are of in-

[1]The U.S. EEZ extends from 9 n.mi. to 200 n.mi. off the shores of Texas, the Gulf Coast of Florida, and Puerto Rico.

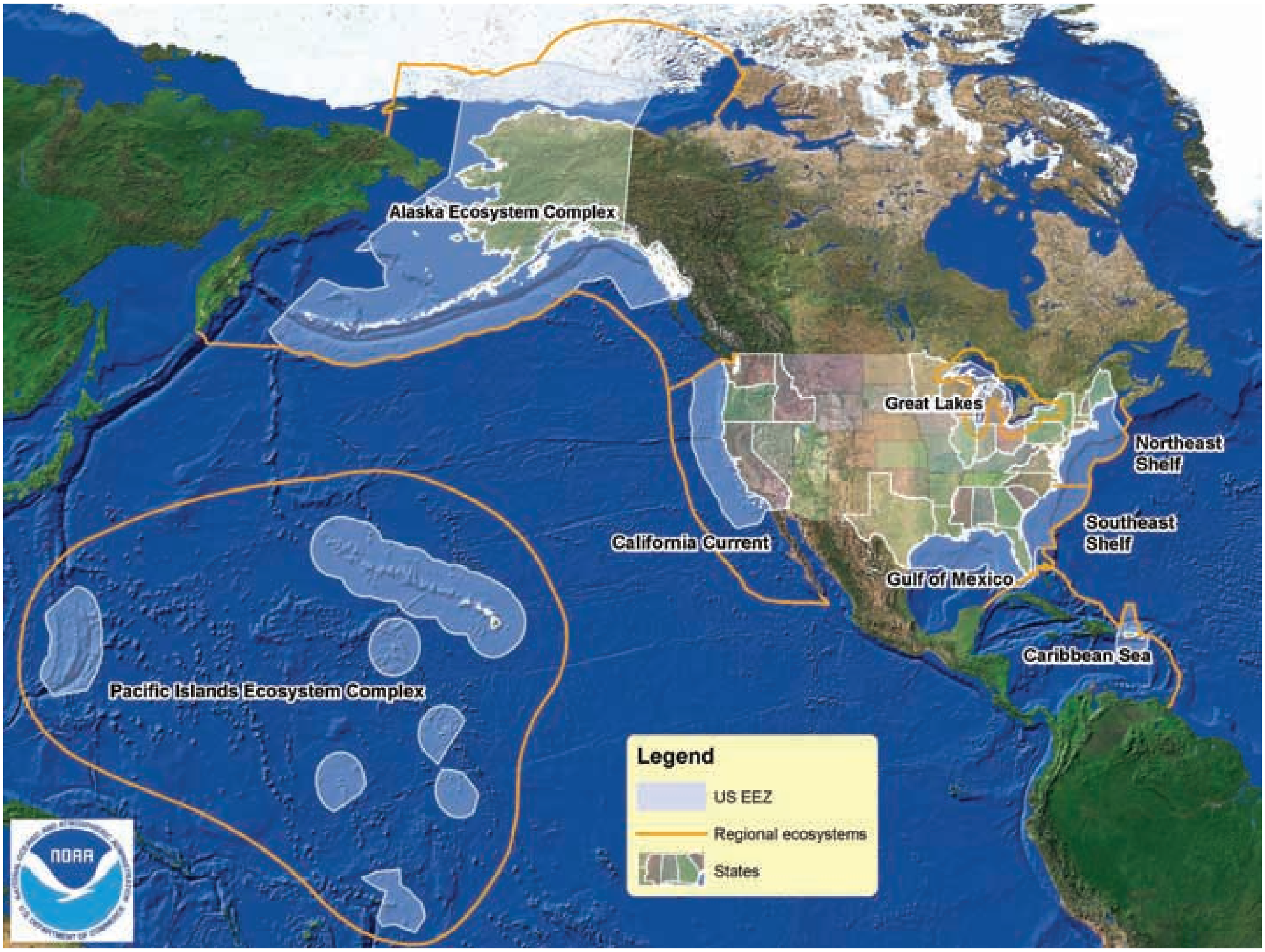

Figure 1

Our Living Oceans 6th Edition divides the U.S. Exclusive Economic Zone into seven Regional Ecosystems plus international/highly migratory species for the purpose of reporting the status of U.S. living marine resources. An eighth Regional Ecosystem designated by NOAA, the Great Lakes, is not covered. Map courtesy of Tim Haverland, NMFS.

terest to the United States for commercial, recreational, subsistence, and aesthetic or intrinsic reasons. The volume reports on the biological status of U.S. fishery resources, presents information on current and sustainable yields, in addition to current harvest rate and stock status relative to prescribed thresholds, and discusses significant management issues. Finally, the status of U.S. stocks of marine mammals and sea turtles is summarized.

Although a short discussion on the status of selected nearshore species has been included in previous editions of *Our Living Oceans*, no nearshore unit is included here. Many nearshore species provide the basis for locally important commercial and recreational fisheries, but these coastal and estuarine species are under the control of coastal states and their local governments, and NMFS does not have direct responsibility inshore of 3 n.mi. NMFS and the FMC's do coordinate with the states on the management of some large-scale fisheries, and certain nearshore resources such as anchovy, sardine, and some herrings are included in Federal FMP's. Because the composition of nearshore resources is diverse and management is shared among many coastal states and other local authorities, a comprehensive treatment of them has not been attempted in this report. However, some large-scale nearshore fisheries of national interest are reported.

Much of the information in this report comes from peer-reviewed stock assessment reports and publications. These sources form the scientific basis for management. Some stock assessments provide complete information necessary to judge stock status and the magnitude of current and sustainable fishery yield. When information is inadequate, the stock or fishery status is classified as unknown. In such cases, current and sustainable yield may be estimated from the most recent catch statistics. More detailed information can be obtained from regional reports produced by NMFS fisheries science centers (Appendix 3) and from state natural resource agencies.

Reauthorization of the Magnuson-Stevens Act

The Magnuson Fishery Conservation and Management Act (1976 Act) was first adopted in 1976 to govern fishing activities in Federal waters. Most notably, the 1976 Act aided in the development of the domestic fishing industry by phasing out foreign fishing, and it created the system of regional fishery management councils to govern domestic fishing activities and conservation efforts. The 1976 Act was reauthorized in 1996 (MSA) and gave NMFS the initial legal tools necessary to begin slowing fisheries expansion and stop the overcapitalization of U.S. fisheries. Since then, progress has been made towards rebuilding overfished stocks, but NMFS needed stronger laws to enable it to stop overfishing and accelerate rebuilding.

The Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 (MSRA) was signed into law by President George W. Bush on 12 January 2007. The MSRA guides U.S. ocean and fisheries policy and gives NMFS the authority to manage the Nation's $62 billion fishing industries. Passage of the bill followed many years of hard work and much debate and compromise between the House, Senate, Administration, conservation groups, and the fishing industry to find common ground in their shared goal to maintain strong fishing industries and healthy marine ecosystems. The legislation is an important step for the United States to rebuild our Nation's fisheries and will allow our fishermen to utilize all available tools to fish safely and economically.

The MSRA will end overfishing in the United States, help rebuild overfished stocks, and advance international cooperation and ocean stewardship. One of the centerpieces of the legislation is a firm deadline to end overfishing in the United States by 2010. This is achieved by directing the regional FMC's to establish Annual Catch Limits (ACL's) by 2010 for Federally managed fish stocks currently undergoing overfishing and by 2011 for all other Federally managed fish stocks. ACL's are required to be set within the range of scientific recommendations—currently, most fishery managers abide by this principle, but this is not always the case. See Feature Article 1 for more information on ending overfishing.

MSRA GOALS

- End overfishing
- Help rebuild overfished stocks
- Promote market-based management approaches
- Advance the state of fisheries science and its role in decisionmaking
- Enhance international cooperation and ocean stewardship
- Strengthen enforcement of fisheries laws
- Improve monitoring of recreational fisheries

The MSRA also supports a number of other priorities to move towards sustainable fisheries in the United States. Among these is the use of market-based incentives to sustainably manage U.S. fish stocks: the MSRA aims to double the number of limited access privilege programs by the year 2010. Increasing the number of these programs will end the race for fish, improve the quality of catches, raise profits for fishermen, and increase safety. Strengthening enforcement of U.S. fishing laws is also a key piece of the new legislation. The MSRA expands cooperation between state and Federal officials to ensure that fishing laws are fully enforced and encourages the use of the latest technology in vessel monitoring to aid in real-time tracking of fishing boats. In addition, ecosystems are an important part of the MSRA, which improves information and decisions about the state of ocean ecosystems by creating several programs to improve the quality of information used by fishery managers.

Ecosystem Approaches to Management

As problems associated with decreasing natural populations and marine biodiversity become better defined and recognized, increasing calls are being made for new approaches to management. Although traditional fisheries management has worked well in some situations, a need exists for managers to move past single-species resource management and consider the many needs and interconnections between biodiversity and human uses. Ecosystem-based management fills this need by using an integrated approach to management that considers all elements of an ecosystem, including the role of humans. In the marine environment, an ecosystem approach to fisheries management (EAFM) extends the conventional principles and practices of fisheries management to cover the ecosystem as a whole.

John Butler, SWFSC

Healthy habitat is important to the health of many living marine resources.

Ecosystems are geographically specified systems of organisms, their environment, and the processes that control their dynamics. Humans, their institutions, and the benefits they derive from the ocean are all integral parts of marine ecosystems. Thinking of the ocean and its life as an ecosystem provides a more realistic view of the underlying causes and effects of changes in living marine resources. To understand a marine ecosystem, many factors need to be considered, including climate and oceanography, species habitat requirements, the biology of all of the organisms in the system from the phytoplankton at the base of the food web to the top predators, and the connections that link all of these parts.

An ecosystem approach to management is a geographically specified and adaptive process that takes account of ecosystem knowledge and uncertainties, considers multiple external influences, and strives to balance diverse societal objectives. This kind of approach allows managers to consider the effects of multiple factors and their interactions. For management to be effective, relevant geographic management areas must be defined according to ecosystem rather than political boundaries. The goals of ecosystem-based management include conservation and management of species, minimization of bycatch (and discards), consideration of tradeoffs, accounting for feedback effects, maintenance of ecosystem productivity, balancing ecosystem structure, and accounting for climate variability. The benefits of ecosystem-based management are more sustainable fisheries, healthy marine ecosystems, and economically healthy coastal communities.

A wide variety of human activities may affect marine ecosystems, including fishing, coastal

GOALS OF ECOSYSTEM-BASED MANAGEMENT

- Conservation and management of species
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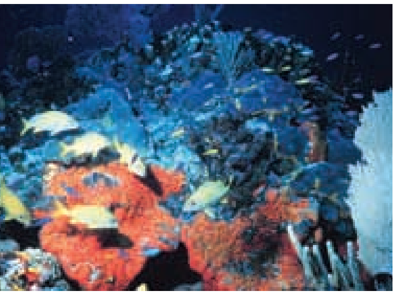
- Maintenance of ecosystem productivity
- Balancing ecosystem structure
- Accounting for climate variability

development, pollution, shipping, and oil and gas extraction. Human-induced climate change may also affect marine ecosystems. The ecosystem-level issues most relevant to fisheries management are the conservation and management of target and non-target species, maintenance of marine biodiversity, balancing competing uses between fisheries and other user groups, accounting for feedback effects (e.g. predator–prey interactions and habitat effects of fishing gear), maintaining ecosystem productivity and balanced trophic structure, and use of adaptive approaches in management. A comprehensive ecosystem approach to fisheries management (EAFM) requires managers to consider all interactions between a target stock and its predators, competitors, and prey species. Other factors such as the effects of weather and climate on fisheries biology and ecology, the effects of fishing on fish stocks and their habitat, and the complex interactions between fishes and their habitat must also be considered. However, the approach does not need to be endlessly complicated—an initial step might require only that managers consider how the harvesting of one species may impact co-occurring species in the ecosystem. Such steps have already been taken in the management of many U.S. LMR's.

Important building blocks for an EAFM already exist within the current NMFS management structure. These include provisions for protecting essential fish habitat (EFH), reducing bycatch, and elements related to overall conservation goals under the MSA and for protecting non-target species under the MMPA and ESA. Although a number of provisions of the MSA are directly related to the objectives of an EAFM, its measures may be more relevant to the management of recovering resources but less so for optimizing among multiple conflicting uses of rebuilt ecosystems. Passage of the MSRA strengthens existing ecosystem provisions in previous mandates and additionally authorizes FMP's to include measures to conserve both target and non-target species as well as habitats, considering the ecological factors affecting fishery populations.


NOAA

An ecosystem approach to fisheries management takes into account multiple factors in addition to the abundance of target stocks, such as species interactions and habitat quality.

NMFS and the FMC's have already made significant progress in integrating ecosystem considerations into fisheries management. NOAA has designated eight Regional Ecosystems (RE's) to guide and coordinate research and management decisions (Figure 1). Additionally, NMFS has begun working with the FMC's to develop voluntary Fisheries Ecosystem Plans (FEP's). FEP's are umbrella documents that provide Council members with a clear description and understanding of the fundamental physical, biological, and human/institutional aspects of ecosystems within which fisheries are managed, and direct how that information should be used in FMP's. A single FEP developed by each Council for the ecosystem under its jurisdiction will set policies for the development and implementation of management options. Because issues of optimality, particularly for rebuilt resources and ecosystems, are less well described under the MSRA due to its focus on rebuilding, FEP's appear to have utility in addressing some issues that are not addressed fully under existing management measures. They may help FMC's achieve the maximum cumulative societal benefits from ecosystems by considering the interactions among stocks (while fishing all stocks at their single-species optima may not result in overfishing of target stocks, the resulting suite of cumulative benefits from an ecosystem may not be maximized).

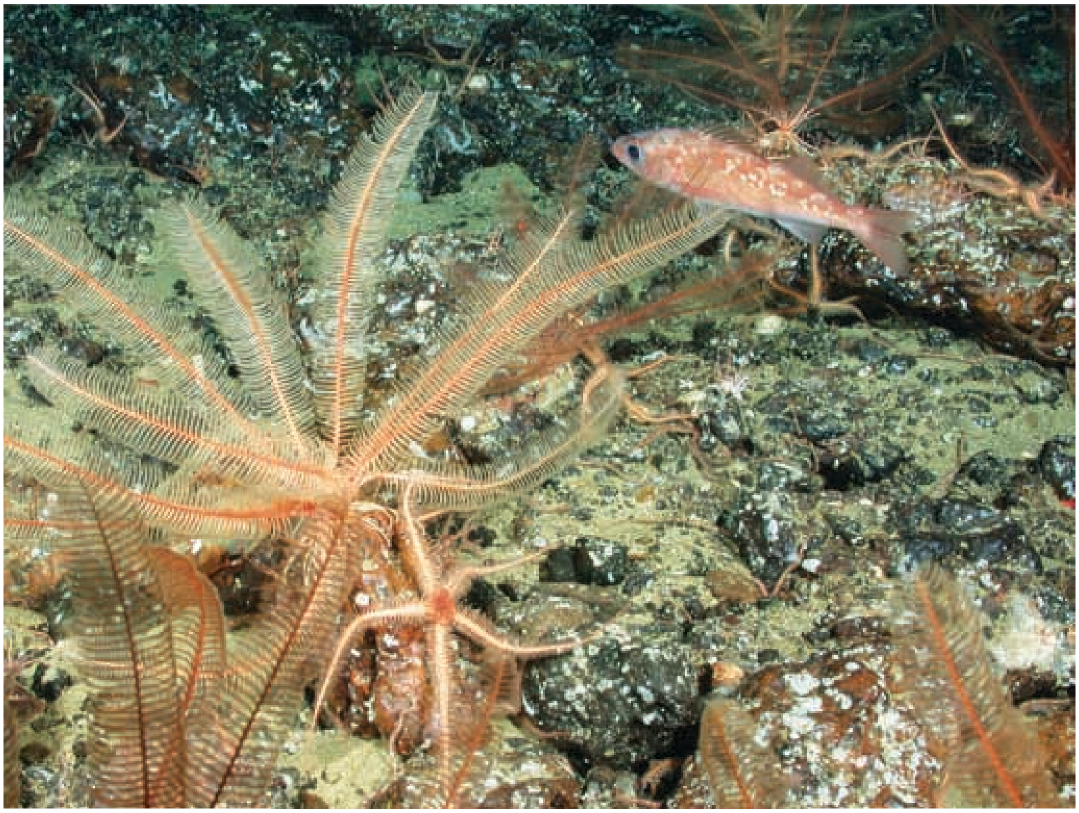
A number of cases from around the country emphasize the importance of considering ecosystem-level issues, as well as provide examples of the work that NMFS is doing to advance an EAFM. In Alaska, the North Pacific FMC already accounts for many ecosystem considerations in its management approach, including environment and climate regimes, the effects of fishing on habitat, non-fishing impacts on living marine resources, bycatch management, management of protected resources, uncertainty and risk in fishery management decisions, and research needs. To support the management needs of the North Pacific FMC, scientists at the Alaska Fisheries Science Center (AFSC) conduct annual or biennial stock assessments for both target and some non-target stocks and stock complexes. Stock assessments include ecosystem considerations such as investigations of the relationship between catchability and environmental factors; the effect of regime shifts on stock recruit relationships; results of ecosystem models; linkages between species; and habitat characteristics. Stock assessment reports for North Pacific stocks also include a full review of ecosystem status and trends, including climate, human influences, and biological trends. Additionally, the AFSC conducts a large amount of ecosystem research to support the shift to EAFM. For example, multidisciplinary research in the Bering Sea uses wind transport models to explain and predict recruitment patterns of winter-spawning flatfish species. The AFSC researches the effects of climate on fishery production; this research is currently expanding to consider the role of sea ice on population productivity and the consequences of reduced sea ice coverage due to climate change.

CMDR John Bortniak, NOAA Corps

A sablefish tagging research cruise in Alaska to support ecosystem research and sablefish stock assessments.

The Northeast Fisheries Science Center (NEFSC) also conducts a great deal of ecosystem-based research. The NEFSC has had an integrated ocean observation system in place for many decades, as a basis for understanding changes in marine ecosystems in response to natural and human-related factors. The NEFSC Observing System is a broad-based monitoring program that draws on many different instruments and sampling systems and encompasses the physics, chemistry, and biology of the seas as well as the human dimension. Data from the observing system as well as from other NEFSC scientific studies support the New England and Mid-Atlantic FMC's and their programs to conserve and manage living marine resources of the Northeast Shelf Ecosystem. In particular, NEFSC ecosystem research has been useful in supporting the New England FMC's Ecosystem Pilot Project, which is introducing EAFM concepts to the Council and public, and exploring options for developing an FEP for the Northeast Shelf Ecosystem. Additionally, the NEFSC is leading an effort to develop a suite of ecosystem indicators that can be used across regions to track the health and status of ecosystems.

There is also much ecosystem-related research in the Northwest Region. The Science for Ecosystem-Based Management Initiative at the Northwest Fisheries Science Center (NWFSC) examines the ecological interactions and processes necessary to sustain ecosystem structure, composition, and function where fish and fisheries coexist. By understanding the factors that sustain the ecosystem, scientists will be able to provide managers with the scientific advice needed to inform an EAFM for groundfish in the Pacific Northwest. The research initiative at the NWFSC addresses five research foci to guide EAFM: 1) interactions of target species with predators,



One focus of ecosystem research at the Northwest Fisheries Science Center is on the interactions between fish and their habitat.

competitors, and prey species; 2) effects of weather and climate on target species and their ecological communities; 3) effects of fishing on marine ecosystems and fish habitat; 4) interactions between fish and their habitat; and 5) use of marine protected areas (MPA's) as a fishery conservation and management tool.

The move to an EAFM is an incremental and ongoing process, and NMFS continues to support the effort through research, scientific support, proposed legislation, management efforts, and outreach. As ecosystem information and understanding improves over time, the shift from traditional single-species fisheries management to a more holistic EAFM will become more possible and accepted. NMFS continues to work with the regional FMC's to apply ecosystem principles to the management process, and to adopt precautionary and proactive management plans. The significant ecosystem research currently being conducted by NOAA, including expanding ocean observation systems, will support these efforts.

CONTENTS

Part 1 of this report is a national overview of significant LMR's and their fisheries. It includes this introduction, a brief review of common fisheries terms, LMR summaries and trends organized by Regional Ecosystem (RE), and a discussion of issues of national concern and near-term outlook.

Part 2 contains four feature articles—a discussion of overfishing and NMFS' efforts to end overfishing in U.S. fisheries, a look at how NMFS scientists are improving fisheries science with advanced sampling technologies, an assessment of the deep sea coral communities of the United States, and an examination of NMFS' cooperative and proactive approaches to implementation of the Endangered Species Act.

Part 3 presents in greater detail the biological status of LMR's in 24 units that describe important species linked geographically, ecologically, or by characteristics of their fisheries.

Part 4 consists of appendices containing acknowledgements; a list of regional FMC's and their FMP's; a list of the principal NMFS facilities; a summary of stock assessment principles and terms; a list of scientific and associated common names of species covered in this report; a list of acronyms and abbreviations; and a list of species under NMFS jurisdiction currently protected under the ESA.

COMMON TERMS

Explanations of most of the technical terms and phrases used in this report can be found in Appendix 4; the most important are briefly described here.

Stock ideally refers to a biologically distinct group of organisms that are genetically related or reproductively isolated from other segments of a larger population. However, a stock unit defined for management purposes may not necessarily correspond to a discrete genetic unit and can include all the individuals of a species or several co-occurring species within a geographical area as one fishery stock when it is impractical to differentiate between them.

Recent average yield (RAY) is the total catch, including commercial landings, recreational landings, and discards, averaged over the most recent 3-year period of workable data, usually 2004–06 unless otherwise noted.

Current yield (CY)[2] is the potential catch that can be taken, depending on current stock abundance and prevailing ecosystem considerations. CY is analogous to acceptable biological catch (ABC) that is specified in some FMP's. ABC, where specified, usually represents the upper limit of CY.

Maximum sustainable yield (MSY)[2] is the maximum long-term average catch that can be achieved from the resource.

NOAA

Henry B. Bigelow, the second of four technologically advanced fishery survey vessels currently being added to the NOAA fleet. These new vessels feature a low acoustic radiated noise profile to help scientists quietly monitor fish and protected species without affecting their behavior, scientific sonar systems to measure fish biomass in the water column, dynamic ship positioning to maintain a fixed station location in the ocean, and multibeam sonar systems to map and provide information about the seafloor.

[2]For some stocks, CY and MSY may be unknown. For the purpose of reporting total CY and MSY across resources within the various fishery units and for the Nation as a whole, if CY was unknown RAY was substituted when calculating a unit, regional, or national total CY. If MSY was unknown, CY was substituted, or failing that, RAY was substituted in calculating totals.

Harvest rate[3] describes a stock's harvest level relative to a prescribed fishing mortality (harvest) threshold defined in the FMP. This rate is expressed as overfishing, not overfishing, unknown, or undefined. A stock is experiencing overfishing when it is being harvested above the prescribed fishing mortality rate threshold (defined as less than or equal to F_{MSY}, the fishing mortality rate that would produce MSY); a stock is undefined when no threshold has yet been defined in the FMP.

Allen Shimada, NMFS

Juvenile yellowfin tuna captured for physiological studies of heart function.

Stock status[4] defines a stock's size relative to a prescribed biomass threshold. Status is expressed as overfished, rebuilding, not overfished, approaching overfished, unknown, or undefined. A stock is overfished when its biomass is below the prescribed threshold amount (defined as ½B_{MSY} in many FMP's). Stocks classified as approaching overfished are estimated to become overfished within 2 years. Rebuilding stocks have recovered to above their overfished threshold level under a stock rebuilding plan and are no longer considered overfished, but are still below the biomass target level. A stock status is undefined when no threshold has yet been defined in the FMP.

Stock level relative to B_{MSY}[5] is a measure of the stock's biological status. The current abundance level of the stock is compared to the biomass that, on average, would support the MSY (B_{MSY}). This level is expressed as below, near, above, or unknown relative to the abundance level that would produce MSY. The concept of B_{MSY} is similar to the Optimum Sustainable Population (OSP) level used in marine mammal stock assessments.

Threatened or **endangered** are terms specifically defined under the ESA. A species is considered endangered if it is in danger of extinction throughout a significant portion of its range; it is threatened if it is likely to become an endangered species within the foreseeable future.

Potential biological removal (PBR) is a concept that establishes a quantitative process for setting levels of take such that marine mammal stocks will equilibrate within their OSP. PBR (calculated as number of animals) is the sustainable removal level defined by the MMPA 1994 Amendments. Stocks for which bycatch levels exceed PBR are classified as **strategic** (stocks listed as **depleted** under the MMPA, or threatened or endangered under the ESA, are also considered strategic regardless of the level of take).

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[3]Harvest rate in *OLO 6th Edition* aligns with the overfishing classifications in NMFS' *2008 Status of U.S. Fisheries, First Quarter Update* status tables (available online at http://www.nmfs.noaa.gov/sfa/statusoffisheries/SOSmain.htm). Because the list of stocks considered and the stock units used for classifying harvest rate may differ from those used to officially track overfishing status, not all stocks included in this publication have a harvest rate status determination listed or are included in Table 3.

[4]Stock status in *OLO 6th Edition* aligns with the overfished classifications in NMFS' *2008 Status of U.S. Fisheries, First Quarter Update* status tables (available online at http://www.nmfs.noaa.gov/sfa/statusoffisheries/SOSmain.htm). Because the list of stocks considered and the stock units used for classifying stock status may differ from those used to officially track overfished status, not all stocks included in this publication have a stock status determination listed or are included in Table 4.

[5]Although both compare current biomass levels to a biomass threshold to determine the health of the stock, there is not a one-to-one correspondence between the stock level relative to B_{MSY} and overfished stock status classifications. While the first metric (stock level) compares biomass directly to B_{MSY}, stock status compares biomass to a threshold defined in the FMP, which may be some fraction of B_{MSY} (if known), a fraction of the estimated unfished biomass, or some other level.

U.S. FISHERIES PRODUCTION AND STATUS

The United States is one of the most productive fishing nations, ranking third in the world for fisheries landings in 2004, the most recent year surveyed by the Food and Agriculture Organization (FAO) of the United Nations (FAO Fisheries and Aquaculture Department, 2007). The 2004 U.S. catch of 5.0 million metric tons (t) was just over 5% of the world's total production of capture fisheries products in that year. The United States is the fourth-largest exporter of fishery products, exporting $3.8 billion worth in 2004. Despite these large exports, the United States ranks second in value for world imports; the nearly $12 billion of fishery products imported in 2004 accounted for about 16% of the $75 billion world trade. The United States is also the tenth-largest aquaculture producer, producing 606,549 t in 2004 and showing an estimated 10.4% annual growth rate in production.

The productivity of Federally managed fishery resources utilized by the United States is expressed as RAY, CY, and MSY (Table 1; Figure 2). Some stocks range beyond the boundaries of the U.S. EEZ, and the United States shares productivity with other fishing nations. For these

Table 1
Productivity in metric tons (t) of fisheries resources utilized by the United States.

Unit number and fishery	Total productivity (t) over the entire range of the stock			Prorated productivity (t) within the U.S. EEZ	
	Total recent average yield (RAY)[1]	Total current yield (CY)	Total sustainable yield (MSY)	U.S. RAY	U.S. MSY
1. Northeast demersal[2]	162,034	192,926	306,234	147,168	263,977
2. Northeast pelagic	229,633	550,461	406,065	160,335	336,766
3. Atlantic anadromous[2]	16,633	16,633	17,127	16,633	17,127
4. Northeast invertebrate[2]	155,316	169,407	205,456	126,600	167,470
5. Atlantic highly migratory pelagic[2]	290,221	282,190	322,731	18,569	24,760
6. Atlantic shark[3]					
7. Atlantic and Gulf of Mexico coastal pelagic[2]	17,482	18,959	18,473	17,482	18,473
8. Atlantic, Gulf of Mexico, and Caribbean reef fish[2]	24,253	23,416	37,145	24,253	37,145
9. Southeast drum and croaker[2]	40,994	40,994	77,801	40,994	77,801
10. Southeast menhaden	652,000	652,000	909,000	652,000	909,000
11. Southeast and Caribbean invertebrate	127,961	127,961	128,712	127,961	128,712
12. Pacific Coast salmon	21,110	33,312	33,312	21,110	33,312
13. Alaska salmon	377,449	317,900	317,900	377,449	317,900
14. Pacific Coast and Alaska pelagic	279,177	295,930	448,933	216,742	372,438
15. Pacific Coast groundfish	388,403	458,660	682,238	288,605	531,607
16. Western Pacific invertebrate[2,4]	0	0	0	0	0
17. Western Pacific bottomfish and groundfish[5]	317	424	2,628	317	2,628
18. Pacific highly migratory pelagic[6]	2,926,372	2,960,401	4,422,354	145,596	258,628
19. Alaska groundfish	2,228,226	3,210,397	3,856,508	2,219,202	3,849,508
20. Alaska shellfish	26,101	30,853	192,138	26,101	192,138
Total	7,963,682	9,382,824	12,384,755	4,627,117	7,539,390

[1]2004–06 average, unless otherwise noted.

[2]Total MSY is unknown due to unknown values for individual stocks; value shown is based on CY values where available, or on RAY.

[3]RAY for Atlantic sharks is expressed in thousands of fish instead of metric tons and cannot be converted to weights, so totals for this Unit have been excluded from this and other National Overview summary tables.

[4]Lobster fishery in the Northwestern Hawaiian Islands has been closed since 2000.

[5]RAY is 2002–04 average for Hawaii and 2003–05 for other island areas.

[6]A majority of the U.S. RAY is caught outside of the U.S. EEZ.

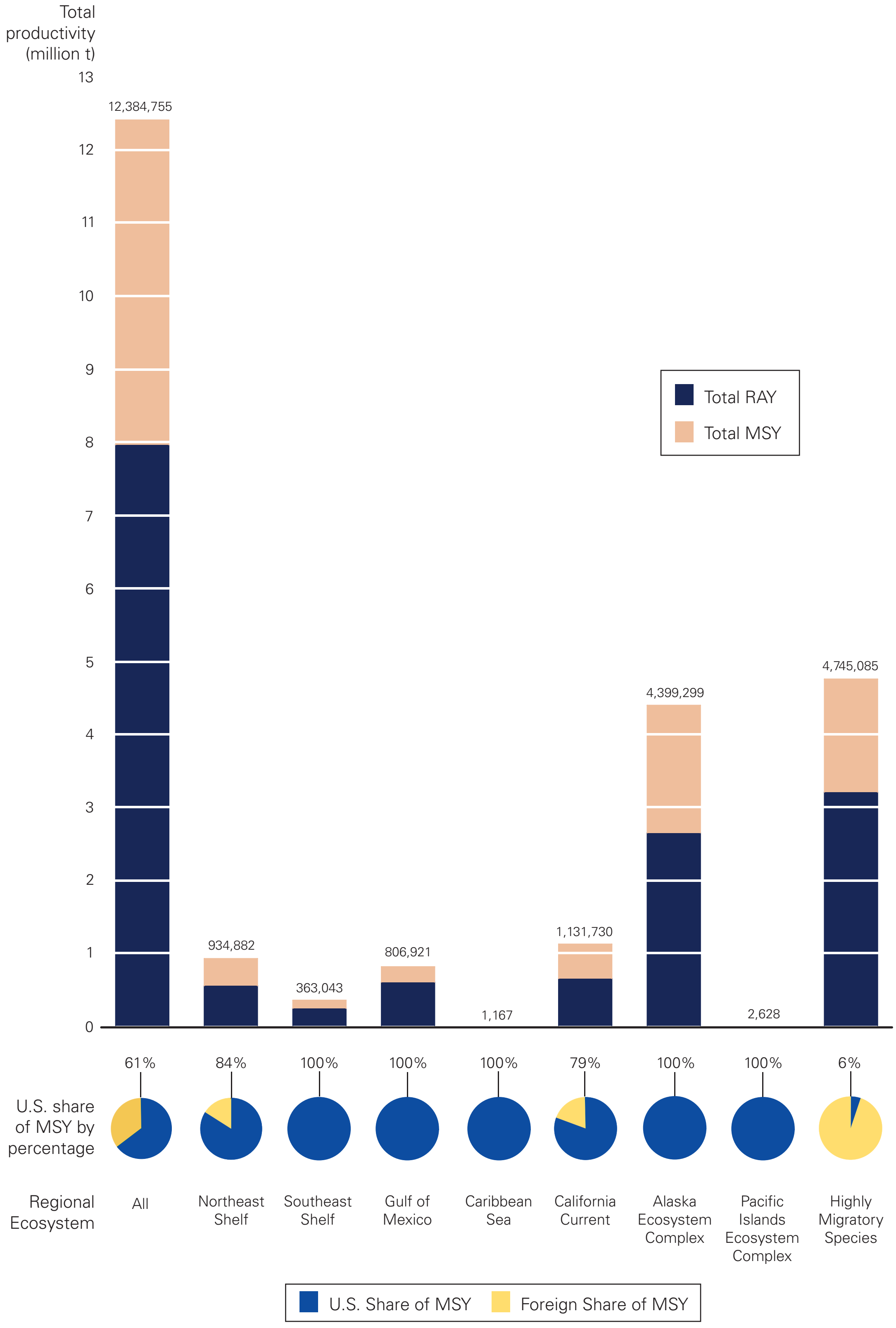

Figure 2

Total recent average yield (RAY, dark blue bars), maximum sustainable yield (MSY, peach bars), and U.S. prorated share of fisheries resources (blue pie slices), in metric tons (t) and by percentage.

transboundary stocks, *OLO 6th Edition* reports both total productivity and the prorated U.S. share of the stocks based on the ratio of the U.S. RAY to total RAY. The U.S. RAY for these stocks is primarily taken within the U.S. EEZ.

The total MSY of all U.S. fishery resources, across their entire range, is estimated to be 12,384,755 t (Table 1; Figure 2). Total CY is 9,382,824 t, indicating that the present productivity of U.S. stocks is about 24% below the long-term sustainable yield. The recent productivity (76% of MSY) is somewhat lower than the productivity reported in *Our Living Oceans 1999*[6] (86% of MSY; NMFS, 1999). Total RAY for 2004–06 (unless otherwise noted) was 7,963,682 t, or 36% below the MSY.

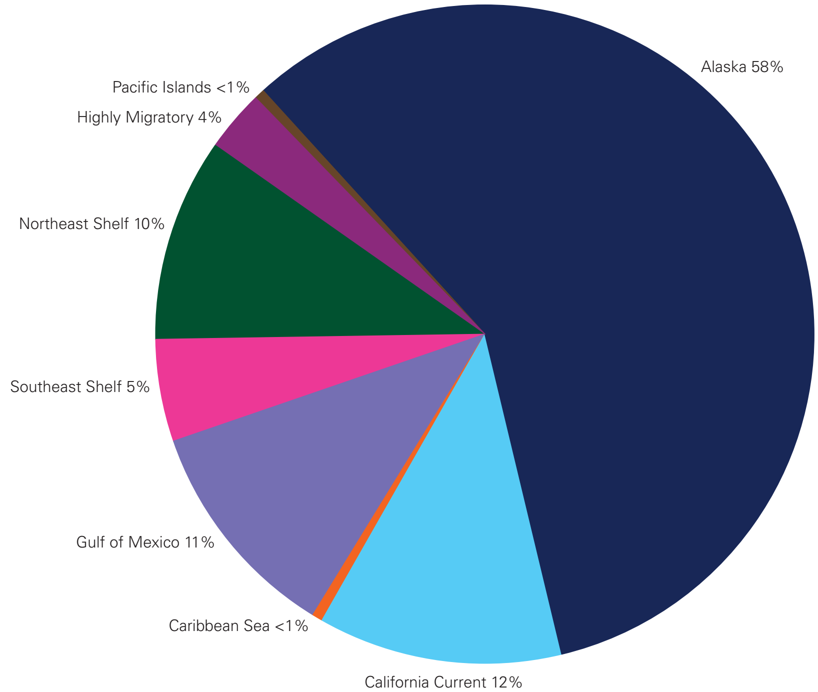

Figure 3
Apportionment of maximum sustainable yield, by Regional Ecosystem, of the U.S. prorated share of fisheries resources.

Considering only the U.S. prorated share of fisheries resources, the U.S. MSY (7,539,390 t) accounts for 61% of the total MSY. The distribution of U.S. MSY by Regional Ecosystem (RE) is 10% for the Northeast Shelf, 5% for the Southeast Shelf, 11% for the Gulf of Mexico, <1% for the Caribbean Sea, 12% for the California Current, 58% for the Alaska Ecosystem Complex, <1% for the Pacific Islands Ecosystem Complex, and 4% for Highly Migratory Species (Table 2; Figure 3).

[6] *OLO '99* used slightly different terminology than the current edition: current potential yield (CPY), equivalent to CY; and long-term potential yield (LTPY), equivalent to MSY. See the Recent Trends for Fisheries section on p. 35 for more information.

Table 2
Productivity, by Regional Ecosystem and in metric tons (t), of fisheries resources utilized by the United States.

	Total productivity (t) over the entire range of the stock			Prorated productivity (t) within the U.S. EEZ	
Regional Ecosystem	Total recent average yield (RAY)[1]	Total current yield (CY)	Total sustainable yield (MSY)	U.S. RAY	U.S. MSY
Northeast Shelf	563,616	929,427	934,882	450,736	785,340
Southeast Shelf[2]	255,939	256,554	363,043	255,939	363,043
Gulf of Mexico[2]	605,584	605,609	806,921	605,584	806,921
Caribbean Sea	1,167	1,167	1,167	1,167	1,167
California Current	658,030	756,039	1,131,730	486,773	897,604
Alaska Ecosystem Complex	2,662,436	3,591,013	4,399,299	2,662,436	4,399,299
Pac. Islands Ecosystem Complex	317	424	2,628	317	2,628
Highly Migratory Species	3,216,593	3,242,591	4,745,085	164,165	283,388
Total	7,963,682	9,383,824	12,384,755	4,627,117	7,539,390

[1] 2004–06 average.

[2] Values exclude totals for Unit 6, Atlantic sharks; RAY for this Unit is expressed in thousands of fish instead of metric tons and cannot be converted to weights.

The U.S. RAY is 4,627,117 t, or 61% of the estimated U.S. MSY. The missing 39% was not realized due to a combination of some underutilized stocks, some overfished stocks that cannot be fished at MSY levels due to low population abundance, and some stocks that are rebuilding from past overfishing and are therefore not currently producing at their MSY levels. By RE, 10% of U.S. RAY comes from the Northeast Shelf, 6% from the Southeast Shelf, 13% from the Gulf of Mexico, <1% from the Caribbean Sea, 10% from the California Current, 58% from the Alaska Ecosystem Complex, <1% from the Pacific Islands Ecosystem Complex, and 4% from Highly Migratory Species (Table 2).

Harvest Rate

Harvest rate compares the current level of fishing pressure to a prescribed fishing mortality (harvest) threshold to determine if a stock is experiencing overfishing. Of the 217 *OLO* stocks that have harvest rates available,[7] 14% are classified as experiencing overfishing, 65% are not experiencing overfishing, 1% are undefined (i.e. have no fishing mortality threshold defined in their FMP's), and 19% are unknown[8] (Table 3, Figure 4). Known-status stocks account for 79%

[7]Not all stocks listed in *Our Living Oceans* have harvest rates available; those stocks that do not have a harvest rate available are omitted from harvest rate calculations.

[8]Although the harvest rates listed in *OLO 6th Edition* match the overfishing determinations listed in NMFS' *2008 Status of U.S. Fisheries, First Quarter Update* status tables, the list of stocks considered differs between the two publications and the summary calculations listed in the National Overview may not match those listed in the *First Quarter Update* or those appearing in the feature article on ending overfishing that is in this report.

Table 3

Harvest rate of U.S. fisheries resources (see text footnote 8).

	Harvest rate of the resource				
Unit number and fishery	Overfishing	Not overfishing	Undefined[1]	Unknown	Total
1. Northeast demersal	10	17	1	4	32
2. Northeast pelagic	0	4	0	0	4
3. Atlantic anadromous	0	3	0	2	5
4. Northeast invertebrate	0	7	0	0	7
5. Atlantic highly migratory pelagic	5	3	0	1	9
6. Atlantic shark	3	5	0	5	13
7. Atlantic and Gulf of Mexico coastal pelagic	0	6	0	0	6
8. Atlantic, Gulf of Mexico, and Caribbean reef fish	9	6	0	1	16
9. Southeast drum and croaker	1	1	0	1	3
10. Southeast menhaden	0	1	0	0	1
11. Southeast and Caribbean invertebrate	1	10	2	2	15
12. Pacific Coast salmon[2]	0	0	0	0	0
13. Alaska salmon	0	1	0	0	1
14. Pacific Coast and Alaska pelagic	0	3	0	1	4
15. Pacific Coast groundfish	0	22	0	1	23
16. Western Pacific invertebrate	0	1	0	0	1
17. Western Pacific bottomfish and groundfish	0	4	0	1	5
18. Pacific highly migratory pelagic	2	7	0	11	20
19. Alaska groundfish	0	30	0	0	30
20. Alaska shellfish	0	11	0	11	22
Total	31	142	3	41	217
Percentage of total	14%	65%	1%	19%	
Percentage of 173 "known"stocks	18%	82%			

[1]Stocks categorized as "undefined" have no overfishing limit defined in their Fishery Management Plan.

[2]Harvest rates are determined for individual runs of Pacific Coast salmon and are not available for the coast-wide stocks.

of the total; of these, 18% are classified as experiencing overfishing, while a majority (82%) are not experiencing overfishing. The fisheries with the most instances of overfishing are Unit 1 (10 stocks of Northeast demersal species), Unit 5 (five stocks of Atlantic highly migratory pelagic species), and Unit 8 (nine stocks of Atlantic, Gulf of Mexico, and Caribbean reef fishes), although overfishing is occurring in a number of other fisheries as well.

Stock Status

Stock status compares current stock biomass to a prescribed biomass threshold defined in the FMP to determine a stock's health (i.e. if it is overfished or not). Classifications for the 217 *OLO* stocks with stock status determinations available[9] are summarized in Table 4. Of these, 19% are overfished, 6%

[9]Not all stocks listed in *Our Living Oceans* have a stock status available; those stocks that do not have a stock status available are omitted from calculations.

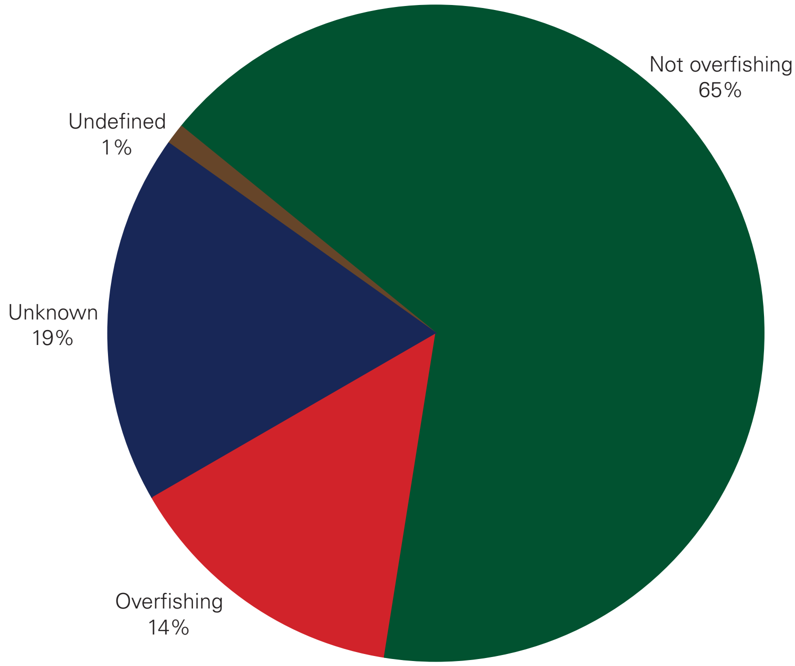

Figure 4

Stocks classified by their harvest rate (see text footnote 8).

Table 4

Stock status of U.S. fisheries resources (see text footnote 10).

Unit number and fishery	Stock status of the resource: Overfished	Rebuilding[1]	Not overfished	Appr. overfished	Undefined[2]	Unknown	Total
1. Northeast demersal	17	5	8	0	0	2	32
2. Northeast pelagic	1	1	2	0	0	0	4
3. Atlantic anadromous	2	0	1	0	0	2	5
4. Northeast invertebrate	0	0	5	0	0	2	7
5. Atlantic highly migratory pelagic	5	2	0	1	0	1	9
6. Atlantic shark	3	0	5	0	0	5	13
7. Atlantic and Gulf of Mexico coastal pelagic	0	1	5	0	0	0	6
8. Atlantic, Gulf of Mexico, and Caribbean reef fish	5	0	3	1	2	5	16
9. Southeast drum and croaker	0	0	0	0	1	2	3
10. Southeast menhaden	0	0	1	0	0	0	1
11. Southeast and Caribbean invertebrate	2	0	6	0	3	4	15
12. Pacific Coast salmon[3]	0	0	0	0	0	0	0
13. Alaska salmon	0	0	1	0	0	0	1
14. Pacific Coast and Alaska pelagic	0	0	2	0	1	1	4
15. Pacific Coast groundfish	4	3	14	0	0	2	23
16. Western Pacific invertebrate	0	0	0	0	0	1	1
17. Western Pacific bottomfish and groundfish	1	0	4	0	0	0	5
18. Pacific highly migratory pelagic	0	0	9	0	0	11	20
19. Alaska groundfish	0	0	20	0	10	0	30
20. Alaska shellfish	1	2	3	0	16	0	22
Total of units 1–20	41	14	89	2	33	38	217
Percentage of total	19%	6%	41%	1%	15%	18%	
Percentage of 146 "known" stocks	28%	10%	61%	1%			

[1]Stocks categorized as "rebuilding" have rebuilt to above the overfished threshold but not yet rebuilt to their targets under the rebuilding program.
[2]Stocks categorized as "undefined" have no biomass threshold defined in their Fishery Management Plan.
[3]Stock status is determined for individual runs of Pacific Coast salmon and is not available for the coast-wide stocks.

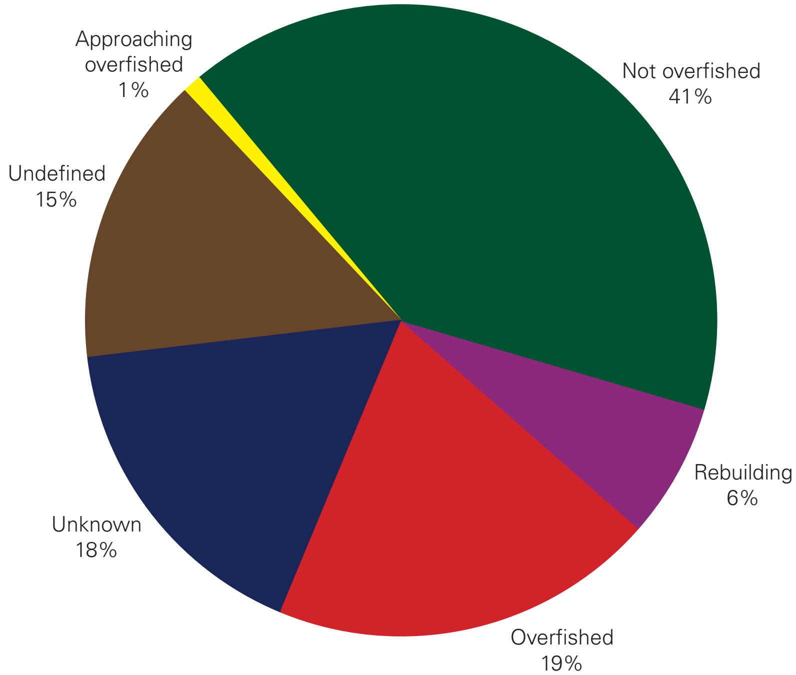

Figure 5
Stocks classified by their stock status (see text footnote 10).

are rebuilding, 41% are not overfished, <1% are approaching overfished, 15% are undefined, and 18% are unknown[10] (Figure 5). Of the 146 known stocks, 28% are overfished, 10% are rebuilding, 1% are approaching overfished, and 61% are not overfished. The majority of overfished stocks occur in Unit 1 (5 rebuilding and 17 overfished stocks of northeast demersal species), Unit 5 (two stocks rebuilding and five overfished among Atlantic highly migratory pelagic species), Unit 8 (five stocks overfished and one approaching overfished among Atlantic, Gulf of Mexico, and Caribbean reef fishes), and Unit 15 (three stocks rebuilding and four overfished among Pacific Coast groundfishes). A majority of the stocks classified as overfished are currently under rebuilding plans but have not yet been rebuilt to above the overfished threshold.

[10]Although the stock statuses listed in *OLO 6th Edition* match the overfishing determinations listed in NMFS' *2008 Status of U.S. Fisheries, First Quarter Update* status tables, the list of stocks considered differs between the two publications and the summary calculations listed in the National Overview may not match those listed in the *First Quarter Update*.

William B. Folsom, NMFS

Several stocks of Atlantic highly migratory species are classified as overfished, including the blue marlin.

FISHERY RESOURCE STATUS RELATIVE TO FISHING MORTALITY AND BIOMASS TARGETS

Stock Level Relative to B_{MSY}

One of the metrics used to measure the health of fisheries stocks is the current level of a stock's biomass relative to the biomass that would produce the MSY (B_{MSY}). The 283 stocks[11] covered in *OLO 6th Edition* are 22% below, 14% near, 20% above, and 43% unknown relative to B_{MSY} (Table 5, Figure 6). Although a large number (122) of stocks are classified as unknown,[12] many of these are not dominant in fisheries or ecosystems and this category contributes only a small proportion of the U.S. RAY.

Of the 161 known stocks, a relatively high percentage (39% or 63 stocks) are below levels that would produce the MSY. Many of these low-abundance cases are in Unit 1 (23 stocks of Northeast demersal species) and Unit 8 (eight stocks of Atlantic, Gulf of Mexico, and Caribbean reef fishes). A few cases of low abundance can be found in all regions. The remaining stocks (98 of 161 known-status stocks) are classified as 25% near and 35% above B_{MSY}. Assuming that stocks near or above B_{MSY} are healthy, about 60% of known-status stocks are at healthy abundance levels.

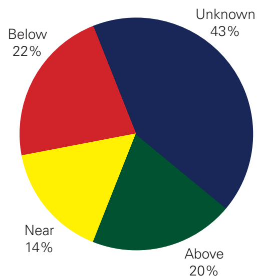

Figure 6
The percentage of stocks that are above, near, below, or unknown relative to the biomass level that would produce the maximum sustainable yield (B_{MSY}).

[11]This is the total number of stocks and stock groups listed in Units 1–20.
[12]Stocks that did not have a reported stock level were counted as unknown.

Table 5
Stock levels relative to the biomass producing the maximum sustainable yield (B_{MSY}) of U.S. fisheries resources.

Unit number and fishery	Stock level relative to B_{MSY}: Below	Near	Above	Unknown[1]	Total
1. Northeast demersal	23	2	3	8	36
2. Northeast pelagic	2	0	2	0	4
3. Atlantic anadromous	4	0	0	1	5
4. Northeast invertebrate	0	0	3	5	8
5. Atlantic highly migratory pelagic	3	4	0	3	10
6. Atlantic shark	3	0	6	5	14
7. Atlantic and Gulf of Mexico coastal pelagic	1	1	0	4	6
8. Atlantic, Gulf of Mexico, and Caribbean reef fish	8	1	0	24	33
9. Southeast drum and croaker	3	0	0	4	7
10. Southeast menhaden	0	0	1	1	2
11. Southeast and Caribbean invertebrate	1	8	0	7	16
12. Pacific Coast salmon	0	5	0	0	5
13. Alaska salmon	2	0	3	0	5
14. Pacific Coast and Alaska pelagic	0	2	2	4	8
15. Pacific Coast groundfish	5	6	11	5	27
16. Western Pacific invertebrate	0	0	0	1	1
17. Western Pacific bottomfish and groundfish	2	3	2	3	10
18. Pacific highly migratory pelagic	1	3	5	12	21
19. Alaska groundfish	3	6	19	12	40
20. Alaska shellfish	2	0	0	23	25
Total of units 1–20	63	41	57	122	283
Percentage of total	22%	14%	20%	43%	
Percentage of 161 "known" stocks	39%	25%	35%		

[1]Category includes stocks whose status is listed as "undefined" or "variable."

Fishing Mortality and Resource Biomass Relative to Target Levels

Another metric used to measure the condition of fisheries stocks compares the status of living marine resources relative to general fishing mortality and biomass targets. Current fishing mortality rates (F) are compared to the fishing mortality rate that would produce the MSY (F_{MSY}), and current biomass (B) is compared to the biomass necessary to produce the MSY (B_{MSY}). This analysis is similar to looking at harvest rate and stock status definitions, but allows for a more quantitative examination.

When comparing F and B targets in tandem, there are four states in which a stock can exist[13] (Figure 7):

1) currently experiencing overfishing ($F/F_{MSY}>1$) but not overfished at this time ($B/B_{MSY}>0.5$);
2) not experiencing overfishing ($F/F_{MSY}<1$) and not overfished ($B/B_{MSY}>0.5$);
3) not experiencing overfishing ($F/F_{MSY}<1$) but overfished ($B/B_{MSY}<0.5$); and
4) experiencing overfishing ($F/F_{MSY}>1$) and overfished ($B/B_{MSY}<0.5$).

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[13]These are general definitions and may not match the legal overfished and overfishing status determination criteria specified in the FMP.

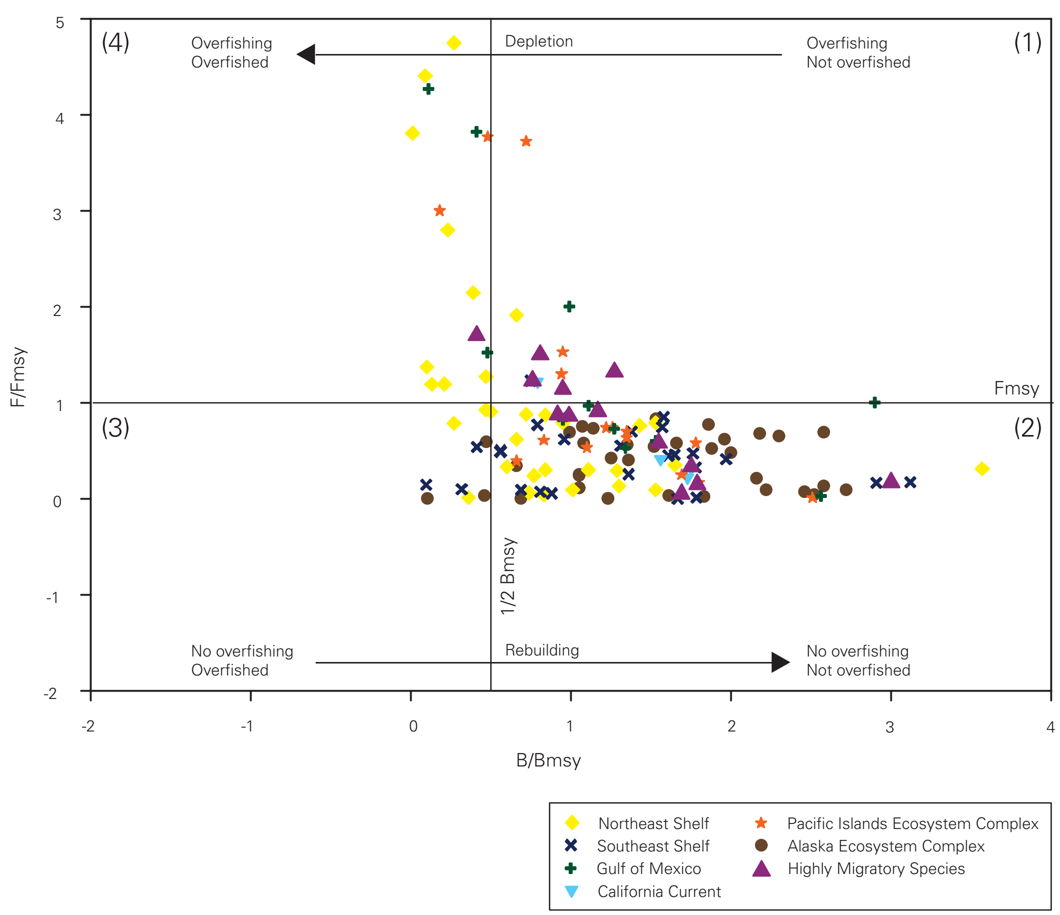


Figure 7
Current status of U.S. living marine resources relative to fishing mortality and biomass targets, by regional ecosystem.

States 1 and 3 are transitional in nature. Stocks can rarely persist in State 1 because stocks cannot support continued overfishing without experiencing negative effects on population abundance. State 3 represents a rebuilding phase where stock abundance levels have been negatively affected by previous high fishing mortality rates and are now being managed to allow the stock abundance to recover to sustainable population levels. Sufficient data are available to define the resource status relative to *F* and *B* target levels for 140 U.S. stocks and a majority of stocks are healthy (Figure 7). Of the 140 stocks, 101 are not experiencing overfishing and are not overfished, nine are not experiencing overfishing but are overfished (rebuilding), 12 are experiencing overfishing but are not overfished, and 18 are experiencing overfishing and are overfished.

PROTECTED RESOURCE STATUS

Marine Mammals

The Marine Mammal Protection Act of 1972 (Public Law 92-522, as amended in 1994 and 2007) requires the Secretary of Commerce and the Secretary of Interior to develop stock assessment reports (SAR's) for all marine mammal stocks found within U.S. waters. NMFS is responsible for assessing and managing stocks of whales, dolphins, porpoises, seals, sea lions, and fur seals, while the U.S. Fish and Wildlife Service (USFWS) has authority over stocks of Pacific walrus, Alaska polar bear, Alaska and Pacific Coast sea otter, and West Indian manatee.

Stock assessment reports must include, among other things, information on how a stock is defined, a minimum population estimate (N_{min}), the stock's current and maximum net productivity rate, current population trend, a calculation of potential biological removal (PBR), assessment of whether incidental fishery takes are "insignificant and approaching zero mortality and serious injury rate," and an assessment of whether the level of human-caused mortality and serious injury is likely to reduce the stock to below optimum sustainable population (OSP) or whether the stock should be classified as a strategic stock. Strategic stocks are stocks that are listed as endangered or threatened under the ESA or declining and likely to be listed in the foreseeable future, those designated as depleted under the MMPA (i.e. below OSP), and those for which human-caused mortality exceeds the PBR. SAR's are to be reviewed annually for strategic stocks and stocks that have new information available, and at least once every 3 years for all other stocks. Recent MMPA Amendments also require that take-reduction teams involving user groups and environmental groups be formed for each strategic stock, and charges them with developing plans to reduce takes below the PBR.

Dave Withrow

Harbor seals.

Stock assessment reports are produced by NMFS for 190 stocks of marine mammals across three regions—Alaska (36 stocks); the Pacific Ocean, including Hawaii (62 stocks); and the Atlantic Ocean, including the Gulf of Mexico (92 stocks; Table 6). Currently, 80 stocks under NMFS jurisdiction are classified as strategic, including 4 depleted stocks under the MMPA, 2 threatened and 25 endangered stocks under the ESA, 2 stocks for which the total annual mortality equals or exceeds the PBR, and 48 stocks for which the population status or fisheries-related mortality is uncertain.

Table 6
Status of marine mammals and sea turtles.

Unit number, area, and species	Number of stocks	Strategic	Endangered	Threatened	Depleted[1]
21. Alaska Region marine mammals	36	14	7	1	3
22. Pacific Region and Hawaii marine mammals	62	15	11	1	0
23. Atlantic Region and Gulf of Mexico marine mammals	92	51	7	0	1
Total	190	80	25	2	4
24. Sea turtles[2]	10		8	5	

[1]Stocks that are threatened or endangered under the ESA are also considered depleted under the MMPA, but not counted here.
[2]Some species of sea turtles include individual breeding populations with different ESA status.

There are sufficient long-term data to determine trends for 29 stocks (15%), with trends for the remaining stocks (85%) unknown (Table 7). Of the stocks with known trends, 6 are decreasing, 7 are stable, 2 are stable/increasing, and 14 are increasing. In the Alaska Region, 14 of 36 stocks have known trend status. The Pacific Region has made a significant improvement since the last *Our Living Oceans* (NMFS, 1999), when there were insufficient data to assign an abundance trend to any Pacific or Hawaiian marine mammal stock; now, 12 of 62 stocks have known abundance trends. In the Atlantic and Gulf of Mexico Region, only three stocks have known status, but all three stocks are increasing.

Table 7
Population trends of marine mammals.

Unit number, area, and species	Number of stocks	Decreasing	Stable	Stable/ Increasing	Increasing	Unknown
21. Alaska Region marine mammals	36	5	2	1	6	22
22. Pacific Region and Hawaii marine mammals	62	1	5	1	5	50
23. Atlantic Region and Gulf of Mexico marine mammals	92	0	0	0	3	89
Total	190	6	7	2	14	161

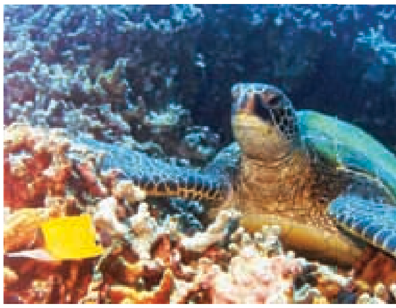
Sea Turtles


SEFSC Mississippi Laboratories

Captive turtle escaping from an experimental turtle excluder device (TED) during gear testing.

Six species of sea turtles 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 Sea and western Pacific Ocean. All six species are currently listed as either threatened or endangered under the ESA in both the Atlantic and Pacific Oceans (Table 6), and several species are endangered throughout their U.S. ranges. In the Atlantic Region, loggerhead turtle populations have been declining in recent years, while leatherbacks and green turtles appear to be increasing in the United States. Kemp's ridley turtles appear to be in the earliest stages of recovery under strict protection, including the requirement to use turtle excluder devices (TED's) in shrimp trawls in both the United States and Mexico and full protection of nesting turtles and their nests.

In the Pacific Region, loggerheads, leatherbacks, and green turtles have all shown dramatic declines at many locations, likely due to the harvest of eggs and adult turtles by humans in the case of leatherbacks and green turtles. Incidental mortality from fishing may also play a role in the decline of leatherbacks, and continues to threaten olive ridleys in the region as well. The status of hawksbill turtles in the Pacific Region is unknown, but the continued exploitation of hawksbills for their shells is an ongoing conservation concern.


Ursula Keuper-Bennett

Hawaiian green turtle.

Although much progress has been made toward reducing turtle injury and mortality in shrimp and bottomfish trawl gear through the use of TED's, the incidental capture of turtles in commercial fisheries remains the greatest concern. Capture in trawl, longline, and gillnet fisheries poses the greatest threats, although sea turtles are also taken and killed in poundnets and other types of fixed gear such as lobster and crab pots. Non-fishery interactions, such as propeller strikes and vessel collisions, also pose significant threats to sea turtles, especially in areas of high human population where recreational boat and commercial traffic is heavy and commercial ports are active. Additionally, a disease known as fibropapillomatosis that affects some species of sea turtles is emerging as a serious threat to the recovery of some populations.

REGIONAL ECOSYSTEM AND UNIT SUMMARIES

Northeast Shelf

Fisheries in the Northeast Shelf RE are grouped into demersal, pelagic, anadromous, and invertebrate resources. The combined MSY for the Northeast Shelf RE is 934,882 t; the U.S. share of this is 785,340 t (84%) due to sharing of transboundary resources with Canada (Table 8). The U.S. RAY (450,736 t) is about 57% of the U.S. MSY, primarily because a large number of stocks on the Northeast Shelf are below the biomass needed to produce MSY and fishing quotas have been reduced to help stocks rebuild to sustainable population abundances. The RAY for the Northeast Shelf excludes menhaden landed in the Northeast—these landings have been added to the data for Southeast menhaden (Unit 10) because they are an integral part of the South Atlantic menhaden stock.

The mixed-species groundfish fishery on the Northeast Shelf has traditionally been the most valuable fishery in this area, but profits have dropped while many northeast groundfishes recover from the effects of overfishing. Invertebrate fisheries are currently the most valuable fishery in the region; American lobster and sea scallop account for most of the value in these fisheries. Rec-

Table 8
Productivity in metric tons (t) of fisheries resources in the Northeast Shelf regional ecosystem.

Unit number and fishery	Total productivity (t) over the entire range of the stock: Total recent average yield (RAY)[1]	Total current yield (CY)	Total sustainable yield (MSY)	Prorated productivity (t) within the U.S. EEZ: U.S. RAY	U.S. MSY
1. Northeast demersal[2]	162,034	192,926	306,234	147,168	263,977
2. Northeast pelagic	229,633	550,461	406,065	160,335	336,766
3. Atlantic anadromous[2]	16,633	16,633	17,127	16,633	17,127
4. Northeast invertebrate[2]	155,316	169,407	205,456	126,600	167,470
Total	563,616	929,427	934,882	450,736	785,340

[1]2004–06 average.
[2]Total MSY is unknown due to unknown values for individual stocks; value shown is based on CY when available or on RAY.


OAR/NURP

American lobster in offshore Maine waters.

reational fisheries are also important to the region's economy, with species such as Atlantic cod, winter flounder, summer flounder, Atlantic mackerel, striped bass, bluefish, and bluefin tuna all being sought-after game fishes.

Demersal fishery resources on the Northeast Shelf (Unit 1) account for 33% of the total U.S. RAY and 34% of the U.S. MSY (Table 8). The U.S. RAY is presently 56% of the U.S. MSY for these stocks, primarily due to reductions in catch quotas while many stocks recover from overfishing. Many principal groundfish stocks were severely overfished previously, reaching record low levels of spawning stock biomass during the early 1990's. Although some stocks have since begun to rebuild, 23 demersal stocks remain below B_{MSY}, 22 are classified as overfished or rebuilding, and 10 are currently experiencing overfishing.

Measures currently in place to regulate demersal fisheries on the Northeast Shelf include effort control measures limiting allowable days at sea, coupled with closed areas, trip limits, and target levels for total allowable catch. In 2004, the New England FMC developed Amendment 13 to the Northeast Multispecies FMP to end overfishing and rebuild overfished stocks. The Amendment contained various effort-reduction measures, as well as measures to provide flexibility and business options for fishing permit holders. In 2006, Framework 42 adjusted rebuilding schedules for overfished stocks based on the results of stock assessments conducted in 2005. Amendment 16, currently under development by the New England FMC, will implement further rebuilding adjustments based on revised biological reference points and status of stocks through 2007.

Northeast pelagic fisheries resources (Unit 2) in general are somewhat underutilized; the U.S. RAY (160,335 t) is less than half of the U.S. MSY (Table 8). The combined MSY of the two most abundant pelagic species, Atlantic mackerel and herring, is more than 100,000 t higher than their combined RAY. Landings of these two species could likely be increased without jeopardizing stock productivity, though fishery expansion is limited by processing capacity, low export demand, and bycatch and ecosystem considerations. The other two pelagic species, bluefish and butterfish, are at low levels of abundance and below B_{MSY}; as a result, their respective RAY's are relatively low in comparison to MSY.


Jim Turek, NOAA Restoration Center

Alewife in the Nemasket River, Massachusetts.

Atlantic anadromous species (Unit 3) account for a very small proportion of Northeast Shelf fisheries, contributing only 4% of the U.S. RAY and 2% of the U.S. MSY (Table 8). The current RAY is higher than a decade ago but is still far below historic levels. All stocks with a known stock level are below B_{MSY}, and the harvest of Atlantic salmon and sturgeon is prohibited. Both species are considered Species of Concern[14] by NMFS, and the Gulf of Maine Distinct Population Segment of Atlantic salmon was listed as endangered under the ESA in 2000. The shortnose sturgeon is also listed as endangered and is managed under a recovery plan prepared under the ESA. As the landings of most anadromous species have notably declined in recent years, the aquaculture industry has grown greatly to fill the production void. Aquaculture production peaked in 2000 at 16,000 t, but has since declined due to changing aquaculture practices designed to reduce disease risks. Striped bass make up a majority of Northeast Shelf anadromous species landings and

[14]Species of Concern are species that NMFS has identified as having significant uncertainty regarding status and threats, and insufficient information is available to indicate a need to list the species under the ESA.

are a popular target of recreational fisheries. Following highly restrictive management actions in the 1980's, the stock was declared rebuilt in 1995 and has since been maintained at levels well above the threshold target biomass. Production of historically large year-classes in recent years should contribute to continued sustainable fisheries.

Northeast invertebrate fisheries resources (Unit 4) represent around a quarter of Northeast Shelf U.S. RAY and U.S. MSY. These fisheries are the Northeast's most valuable, contributing an average of $884 million ex-vessel annually in recent years. American lobster is the most important of the invertebrate fisheries resources, making up about 33% of the U.S. RAY and nearly half of the ex-vessel value. Sea scallops are also a significant fishery resource; landings and ex-vessel value are only slightly lower than for lobster. Most Northeast Shelf invertebrate stocks are considered to be healthy, with only a single stock (southern New England American lobster) classified as experiencing overfishing or overfished.

Southeast Shelf, Gulf of Mexico, and Caribbean Sea

The Southeast Shelf, Gulf of Mexico, and Caribbean Sea RE's share close proximity in the southeastern United States and a number of fishery stocks. Important fishery resources include Atlantic coastal sharks, coastal migratory pelagics, reef fishes, Sciaenids (drum and croaker), menhaden, and invertebrates. A conservative estimate of the total MSY for the three RE's combined is 1,171,131 t; the Southeast Shelf contributes 363,043 t to this total (Table 9), while the Gulf of Mexico makes up a majority of the rest (806,921 t; Table 10). The Caribbean Sea RE makes up a much smaller amount (1,167 t; Table 11). Values for Atlantic sharks have not been included in the totals listed here or throughout the National Overview because the RAY for these species is expressed in thousands of fish and cannot be converted to weights. The U.S. share of the MSY in the southeast is equal to the total MSY—although stock geographic areas do span international boundaries in this region, only the U.S. portion is reported here. The total RAY (also all U.S.) for the three RE's combined (862,690 t) makes up about 74% of the estimated MSY.

Matthew Gilligan

Additional data are needed on species such as nurse shark, seen above, before they can be assessed as a single species.

Table 9
Productivity in metric tons (t) of fisheries resources in the Southeast Shelf regional ecosystem.

Unit number and fishery	Total productivity (t) over the entire range of the stock: Total recent average yield (RAY)[1]	Total current yield (CY)	Total sustainable yield (MSY)	Prorated productivity (t) within the U.S. EEZ: U.S. RAY	U.S. MSY
6. Atlantic shark[2]					
7. Atlantic and Gulf of Mexico migratory pelagic[3]	10,179	10,696	10,328	10,179	10,328
8. Atlantic, Gulf of Mexico, and Caribbean reef fish[3]	6,142	6,240	7,691	6,142	7,691
9. Southeast drum and croaker[3]	31,046	31,046	65,822	31,046	65,822
10. Southeast menhaden	196,000	196,000	264,000	196,000	264,000
11. Southeast and Caribbean invertebrate	12,572	12,572	15,202	12,572	15,202
Total	255,939	256,554	363,043	255,939	363,043

[1]2004–06 average.
[2]Total RAY value for Atlantic sharks does not include prohibited shark species. RAY for Atlantic sharks is expressed in thousands of fish instead of metric tons and can not be converted to weights, so totals for this Unit have been excluded from this and other National Overview summary tables.
[3]Total MSY value is unknown due to unknown values for individual stocks; value shown is based on the CY when available, or the RAY.

Table 10

Productivity in metric tons (t) of fisheries resources in the Gulf of Mexico regional ecosystem.

Unit number and fishery	Total productivity (t) over the entire range of the stock: Total recent average yield (RAY)[1]	Total current yield (CY)	Total sustainable yield (MSY)	Prorated productivity (t) within the U.S. EEZ: U.S. RAY	U.S. MSY
6. Atlantic shark[2]					
7. Atlantic and Gulf of Mexico migratory pelagic[3]	7,303	8,263	8,145	7,303	8,145
8. Atlantic, Gulf of Mexico, and Caribbean reef fish[3]	17,177	16,242	28,520	17,177	28,520
9. Southeast drum and croaker[3]	9,948	9,948	11,979	9,948	11,979
10. Southeast menhaden	456,000	456,000	645,000	456,000	645,000
11. Southeast and Caribbean invertebrate	115,156	115,156	113,277	115,156	113,277
Total	605,584	605,609	806,921	605,584	806,921

[1]2004–06 average.

[2]RAY for Atlantic sharks is expressed in thousands of fish instead of metric tons and cannot be converted to weights, so totals for this Unit have been excluded from this and other National Overview summary tables.

[3]Total MSY value is unknown due to unknown values for individual stocks; value shown is based on CY when available, or on RAY.

Unit number and fishery	Total productivity (t) over the entire range of the stock: Total recent average yield (RAY)[1]	Total current yield (CY)	Total sustainable yield (MSY)	Prorated productivity (t) within the U.S. EEZ: U.S. RAY	U.S. MSY
8. Atlantic, Gulf of Mexico, and Caribbean reef fish[2]	934	934	934	934	934
11. Southeast and Caribbean invertebrate	233	233	233	233	233
Total	1,167	1,167	1,167	1,167	1,167

[1]2004–06 average.

[2]Total MSY value is unknown due to unknown values for individual stocks; value shown is based on CY when available, or on RAY.

Table 11

Productivity in metric tons (t) of fisheries resources in the Caribbean Sea regional ecosystem.

The RAY for Atlantic shark fisheries (Unit 6) is 1,271 thousands of fish (landings cannot be converted to weights) and represents a relatively small portion of landings in the Southeast Shelf and Gulf of Mexico RE's (pelagic shark species are discussed with the Highly Migratory Species). Although these species do not contribute heavily to landings in the southeast, they are important components of the ecosystem and are particularly vulnerable to the effects of overfishing due to their low reproductive capacity. Most sharks are assessed as part of several multispecies complexes, though improvements in data collection since *OLO '99* have allowed for some single species assessments to be conducted. Continued improvements in data collection will be required before additional stocks can be assessed on an individual basis; until then, aggregate management may result in excessive risk of overfishing on some species while other species may experience excessive regulation. A number of shark species have been declared prohibited species and can no longer be kept commercially or recreationally due to their rarity or susceptibility to exploitation. Three of these species, dusky, night, and sand tiger sharks, have been added to the NMFS Species of Concern list (see Appendix 7).

Coastal pelagic species (Unit 7) also account for only a small portion of southeast fisheries landings. However, coastal migratory species are popular components of recreational fisheries on the Southeast Shelf and in the Gulf of Mexico. These species are managed under a single FMP co-administered by the South Atlantic FMC and the Gulf of Mexico FMC. Several species (including dolphinfish and cobia) are primarily recreationally fished species, while both commercial fishermen and recreational anglers target other species. The division of total allowable catches (TAC's) between recreational and commercial fisheries remains an important issue for all of the coastal pelagic species. Improvements in the precision and accuracy of fishery-specific harvest levels and in the understanding of stock structure are needed to aid in future allocation decisions.

Reef fishes in the Southeast Shelf, Gulf of Mexico, and Caribbean Sea RE's (Unit 8) are a highly diverse group including more than 200 stocks of about 100 individual species. The RAY in the Gulf of Mexico (17,177 t; Table 10) is substantially larger than that in the South Atlantic (6,142 t; Table 9) or the Caribbean (934 t; Table 11). The status of many reef fish resources is unknown, and potential production estimates (CY and MSY) are not available for most species. In cases where CY and MSY estimates are available, they are likely higher than current RAY's would indicate, due to low stock abundances. Fishing pressure on reef fish resources continues to increase and is correlated with growing human populations, greater demand for fishery products, and technological improvements in fishing gear. This, combined with life history characteristics such as slow growth and late reproductive maturity, makes overfishing a continuing concern for reef fishes. Rebuilding plans are in place for all reef fishes classified as overfished, and some of these species (i.e. goliath grouper) are showing significant increases in population abundance. Collection of data necessary for adequate assessment and management in the reef fish fishery remains difficult due to the diversity of resource users, gears, and locations; data are often not available for individual species, fishery components, or areas. Additional or improved fishery-dependent and fishery-independent data would improve the accuracy of existing stock assessment models, and allow data-poor species to be assessed for the first time.


T. Potts, OAR/NURP/UNC

Gag grouper off the coastal Carolinas.

Fisheries for Sciaenid (drum and croaker; Unit 9) fishery resources in the southeastern United States have a long history dating back to the 1800's. These species are targeted in both recreational and commercial fisheries, with regulations on some stocks and in some areas heavily favoring recreational users. Much of the recreational fishing for drums and croakers occurs inshore of the 3-mile limit, in state waters, and management of these species is primarily by the coastal states. Allocation of resources between commercial and recreational fishing sectors remains an important issue in the management of drum and croaker fisheries. Sciaenids make up a majority of the finfish bycatch in southeast shrimp fisheries, and bycatch of these species is a major management issue in the Southeast Shelf and Gulf of Mexico RE's. Much of this bycatch is composed of juvenile fishes, and there is concern that mortality from shrimp bycatch may slow recovery of overfished stocks and reduce fishery yields.

Menhaden (Unit 10) comprise about 78% of the MSY for the three southeast RE's. The Gulf menhaden resource is approximately 2.5 times larger than Atlantic menhaden, and contributes a majority of the total RAY and MSY for southeast menhaden fisheries. Atlantic menhaden is at a healthy abundance level and above B_{MSY}, but the status of Gulf menhaden is currently unknown. Because menhaden stocks migrate long distances across state boundaries, management

William B. Folsom

Nets equipped with turtle excluder devices and bycatch reduction devices hang from a shrimp trawler tied to a dock in South Carolina.

requires coordination through interstate marine fisheries commissions (the Atlantic States Marine Fisheries Commission, ASMFC; and Gulf States Marine Fisheries Commission, GSMFC). The most significant issue in menhaden management is the importance of menhaden to ecosystem health—as key forage for many fishes, marine mammals, and sea birds, menhaden form an important trophic link in coastal ecosystems. Current research is focusing on the management of forage and predator fish species at a multispecies level.

Shrimp are the most important of the southeastern United States invertebrate fisheries resources (Unit 11). The fishery for shrimp in the Gulf of Mexico is much larger than that on the Southeast Shelf. Overall, shrimp are one of the most valuable U.S. fisheries and lead the region's fisheries in value although they make up only 14% of the RAY for the three southeast RE's. All of the commercial shrimp species are currently harvested at the maximum level and until very recently, the shrimp fishery was believed to be overcapitalized (i.e. there were more boats and fishing gear than economically needed to catch the available harvest, and yields were not closely tied to effort). Bycatch of commercially important finfish and protected species such as sea turtles in the small-mesh trawl nets used by shrimpers is a major issue currently facing managers in the Southeast Shelf and Gulf of Mexico RE's. Progress has been made to address these issues through gear modifications (turtle excluder and bycatch reduction devices) and other controls, and efforts continue to further reduce bycatch. Other invertebrate fisheries, such as those for spiny lobster and stone crab, contribute a much smaller amount to landings and ex-vessel values, but are important on local or regional scales. However, information on invertebrate species other than commercial shrimp stocks is incomplete, and abundance and production estimates are unknown for many species.

California Current

Fisheries of the California Current RE include Pacific salmon, coastal pelagic species, groundfish, and Pacific halibut. Highly migratory species (summarized in a separate section below) and state-managed invertebrate species are also important components. California Current fisheries resources have an estimated prorated U.S. MSY of 897,604 t (Table 12). This value is 79% of the total MSY for the California Current, due to sharing of transboundary resources with Canada (Pacific hake and Pacific halibut) and Mexico (some coastal pelagic species). The U.S. RAY is 486,773 t, or 54% of the MSY, due in part to underutilization of some coastal pelagic species and low abundance levels of some groundfish stocks. Many stocks are near or above B_{MSY}, although several groundfish stocks are below B_{MSY}.

Pacific salmon (Unit 12) stocks make up a small proportion of California Current fisheries, accounting for about 4% of the prorated U.S. RAY and U.S. MSY (Table 12). The RAY is 63% of the MSY; this depressed production is partly due to generally unfavorable ocean conditions resulting in poor survival of salmon off the Pacific Coast since the late 1970's. Recently, it briefly appeared that ocean conditions were improving for salmon species, but by 2005 most indicators of ocean productivity in the California Current had returned to unfavorable levels. Because salmon depend on freshwater habitat for spawning and rearing of juveniles, management of the Pacific salmon resource is complex, involving many stocks originating from various rivers and jurisdictions and requiring coordination with many entities not directly involved in the manage-

Unit number and fishery	Total productivity (t) over the entire range of the stock: Total recent average yield (RAY)[1]	Total current yield (CY)	Total sustainable yield (MSY)	Prorated productivity (t) within the U.S. EEZ: U.S. RAY	U.S. MSY
12. Pacific Coast salmon	21,110	33,312	33,312	21,110	33,312
14. Pacific Coast pelagic	238,424	255,177	408,180	175,989	331,685
15. Pacific Coast groundfish	388,403	458,660	682,238	288,604	531,607
19. Pacific halibut (Pacific Coast)	10,093	8,890	8,000	1,069	1,000
Total	658,030	756,039	1,131,730	486,773	897,604

[1]2004–06 average.

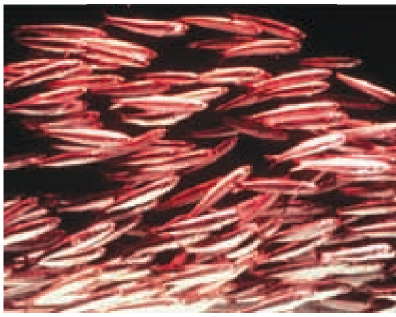
Table 12

Productivity in metric tons (t) of fisheries resources in the California Current regional ecosystem.

ment of fisheries. Fisheries management is also complicated by the mixing of hatchery and wild stocks on fishing grounds—depleted wild stocks may be taken as bycatch in fisheries that target hatchery-produced stocks. Each of the coast-wide stocks of Pacific salmon is considered to be near B_{MSY}, although the status of individual runs may differ. Some runs are severely depleted and have triggered ESA designations to protect listed stocks and prevent further declines. The need to reduce impacts on listed stocks and to provide adequate spawning escapement for healthier stocks has constrained allowable harvest rates on healthy stocks in recent years, causing declines in landings to be more pronounced than declines in abundance. Sharp declines in the abundance of most southern salmon stocks over the past 5 years led to a closure of all ocean salmon fisheries off the coasts of Oregon and California in 2008 (with the exception of one small recreational coho fishery for hatchery fish in Oregon). Additionally, commercial fishermen face declining prices driven by market competition from steadily increasing aquaculture production of salmon and record landings of wild salmon in Alaska, Japan, and Russia. The use of hatcheries to enhance fisheries production and mitigate habitat loss on the Pacific Coast continues to be a contentious issue and raises concerns about the interactions between hatchery and wild salmon.

The abundance of coastal pelagic species (Unit 14) typically fluctuates widely from year to year, and consequently, landings of these species also tend to fluctuate. Coastal pelagic species currently make up 36% of the California Current U.S. RAY and 37% of the U.S. MSY (Table 12). Several coastal pelagic species (including jack mackerel and northern anchovy) are currently underutilized, primarily due to a lack of commercial markets, causing the RAY for the fishery to be only about half of the MSY. These species could potentially support increased harvest by U.S. fishermen, but increased data and biological information are necessary to ensure sustainable management of the stocks if landings increase. Coastal pelagic species form an important component of the California Current ecosystem as forage for fish, mammals, and birds. Thus, the continued well-being of ecologically related species is an important factor in the management of these species. The Coastal Pelagic Species FMP specifies a threshold for optimum yield that both prevents resource depletion and provides adequate forage for other species in the California Current ecosystem. Recently another forage species, krill, was added to this FMP to assure control of any potential future fishery. The transboundary nature of many of these species is also an important issue for fisheries managers; sardine, anchovy, and mackerels are exploited by both U.S. and Mexican fleets, but no bilateral management agreements have been reached to coordinate management of the stocks. Harvest levels are currently increasing in Mexican waters, further evidencing the need for a governing bilateral agreement. The problem is confounded by

OAR/NURP



School of northern anchovy.

ongoing uncertainty regarding stock structure, distribution, and environmental influences on the highly dynamic populations of coastal pelagic species.

The California Current groundfish fishery (Unit 15) harvests a wide variety of bottom-associated species along the coast from Washington to California. Many stocks have ranges that extend into Canadian or Mexican waters. The groundfish fishery has undergone a number of striking changes in recent years, and currently the RAY is just over half of the MSY (Table 12) due to a variety of factors. Foremost among these is the diversity of the fishing complex, with some species overfished and other species underutilized due to lack of markets or harvest restrictions in place to protect rebuilding stocks. Nine groundfish stocks were declared overfished between 1999 and 2002, and implementation of rebuilding plans for these stocks has limited fishing opportunities throughout nearly all sectors of the fishery. Two overfished stocks (Pacific hake and lingcod) have since been declared rebuilt, but rebuilding for other overfished stocks is expected to take decades due to low productivity of the species. To assist in this rebuilding, major portions of the Continental Shelf off the U.S. West Coast have been closed to fishing since September of 2003, further limiting fishing opportunities. These factors have combined to result in historically low allowable harvest levels. However, many strides have been made to improve management of the groundfish fishery, including implementation of a coastwide observer program to monitor bycatch, expansion of groundfish resource surveys, completion of several fleet capacity reduction programs, identification of Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPC's), and implementation of coastwide conservation areas to protect overfished species and EFH.


V. O'Connell, ADFG, OAR/NURP

The Pacific Coast stock of lingcod was declared overfished in 1999, but has since been reclassified as rebuilt.

Alaska Ecosystem Complex

The Alaska Ecosystem Complex dominates all other U.S. RE's in fisheries landings (57% of the total U.S. RAY) and the tonnage that could be obtained in the long term (58% of the total U.S. MSY; Table 13). Major fisheries resources in Alaska include Pacific salmon, small pelagic species, Pacific halibut, groundfish, and shellfish. The combined MSY for all Alaska stocks is 4,399,299 t (all U.S. share). Current catch levels are substantially below the MSY levels because many resources, especially flatfishes, are underutilized, and long-standing optimum yield caps are in place to reduce risk and ensure ecosystem health.

Harvests of Alaska salmon (Unit 13) in recent years have remained favorable, with landings in 2005 reaching a new all-time harvest level of 222 million salmon. Catches in 2006 and 2007 were slightly lower, but still well above the long-term average. Although abundances of some individual salmon runs in Alaska are down, many runs continue to be successful, contributing to a RAY that was slightly above the MSY. An inverse production regime pattern associated with abundance levels of West Coast and Alaska salmon, along with some changes in environmental conditions, raised concerns that Alaska salmon catches would decline, but recent catch histories show no conclusive evidence of such a decline. However, the value of the Alaska salmon catch has declined significantly in recent years due to a number of worldwide factors. Foremost among these is a rising trend in world salmon production, mainly due to the rapid growth of salmon aquaculture, but also resulting from worldwide record catches of wild salmon (including fish produced from hatcheries and ocean ranching programs) in Alaska, Japan, and Russia.


David Csepp

The stern view of an Alaskan trawler.

Unit number and fishery	Total productivity (t) over the entire range of the stock: Total recent average yield (RAY)[1]	Total current yield (CY)	Total sustainable yield (MSY)	Prorated productivity (t) within the U.S. EEZ: U.S. RAY	U.S. MSY
13. Alaska salmon	377,449	317,900	317,900	377,449	317,900
14. Alaska pelagic	40,753	40,753	40,753	40,753	40,753
19. Alaska groundfish (total)	2,218,133	3,201,507	3,848,508	2,218,133	3,848,508
Bering Sea and Aleutian Islands	1,981,062	2,676,035	3,188,973	1,981,062	3,188,973
Gulf of Alaska	188,039	480,271	604,535	188,039	604,535
Pacific halibut (Alaska)	49,032	45,201	55,000	49,032	55,000
20. Alaska shellfish	26,101	30,853	192,138	26,101	192,138
Total	2,662,436	3,591,013	4,399,299	2,662,436	4,399,299

[1]2004–06 average.

Table 13

Productivity in metric tons (t) of fisheries resources in the Alaska Ecosystem Complex regional ecosystem.

Pacific herring (Unit 14) is the major pelagic species harvested in Alaska and produced a RAY of 40,753 t in the Gulf of Alaska and Bering Sea combined. The fishery occurs within state waters and is therefore managed by the Alaska Department of Fish and Game. Both stocks of Pacific herring in Alaska are thought to be near B_{MSY} and in a relatively stable condition, although estimates of their production potential are not available. As with many small pelagic species, herring abundance tends to fluctuate widely.

Pacific halibut (Unit 19) support an important traditional fishery for both the United States and Canada along the West Coast and in Alaska. Pacific halibut are thought to represent one large, interrelated stock and are managed throughout their entire range by a bilateral treaty between the United States and Canada and through research and regulation recommendations from the International Pacific Halibut Commission (IPHC). The center of abundance for Pacific halibut is the Gulf of Alaska; the two Alaskan management units account for a majority of halibut landings (RAY): 98% of the U.S. subtotal and 83% of the coastwide total. Recently, the Alaskan halibut fishery moved from an open-access fishery with a short derby-style fishing season to an Individual Fishing Quota (IFQ) fishery with a nearly 8-month-long season. Under the new fishing regulations, there has been an overall decline in the size of the halibut fleet, and most components of the fishery have been very successful in recent years. The halibut resource is considered healthy, with both Alaska management units above their respective B_{MSY} levels, and total catch near record levels.

Dan Rafla, IPHC

A Pacific halibut is hauled aboard the F/V *Bold Pursuit* in the eastern Gulf of Alaska.

One of the greatest successes of the 1976 Act has been the development of domestic groundfish fisheries off Alaska. Until its implementation in 1977, Alaska's groundfish fisheries were dominated by foreign vessels (with the exception of the U.S. fishery for Pacific halibut). However, under the new management regime the U.S. fleet has largely replaced foreign fishing fleets in U.S. EEZ waters off Alaska. The Alaska groundfish fishery is the largest fishery by volume in the U.S. EEZ.

Groundfish landings in the eastern Bering Sea and Aleutian Islands (BSAI) region (Unit 19) account for about 74% of the total Alaska RAY and 72% of the MSY (Table 13). Due to the high abundance (above B_{MSY}) of many stocks, the CY is nearly 1 million t higher than the RAY. However, the RAY of BSAI groundfish is currently only 62% of the MSY level because catch quotas

China rockfish.

have been capped at an optimal yield (OY) limit of 2 million t set in the BSAI Groundfish FMP to prevent harvesting of the full CY. Landings in the Alaska groundfish fisheries are dominated by walleye pollock; Pacific cod, flatfishes (especially yellowfin sole and rock sole), Atka mackerel, and rockfishes are also important. Walleye pollock in the BSAI region are highly productive, and yield the largest catch of any single species in the U.S. EEZ. Flatfish stocks in general are underutilized in the BSAI region, both because of the 2 million t OY cap and the need to prevent bycatch of prohibited species such as Pacific halibut, salmon, and king and Tanner crabs in flatfish trawl fisheries. Incidental take of prohibited species and allocation issues between user groups are important problems in the management of BSAI groundfish fisheries. Ecosystem considerations and marine mammal interactions with fish and fisheries are also important management issues in Alaska. Fisheries put marine mammals and sea birds at risk for incidental interactions with fishing gear and also compete for prey items that they depend on for food; the OY cap reduces these impacts on the ecosystem. The impact of fish removals has been implicated as a factor in the decline of Steller sea lion populations[15] in Alaskan waters. Because Steller sea lions feed on pollock, Atka mackerel, and Pacific cod, these groundfish fisheries are now carefully regulated to reduce adverse impacts near Steller sea lion rookeries.

Gulf of Alaska (GOA) groundfish (Unit 19) make up a much smaller proportion of the total Alaska RAY (7%) and MSY (14%; Table 13). The GOA RAY is currently only 39% of the CY, mainly due to underutilization of abundant flatfish species that are not fully harvested in order to prevent exceeding bycatch limits set for Pacific halibut. Important species in the GOA groundfish fishery include walleye pollock, Pacific cod, flatfishes, and rockfishes. Pollock in the GOA are currently estimated to be at their lowest known abundance levels. The pollock fishery is carefully managed due to concerns about the impact of fisheries on Steller sea lions in the area, and harvest rates have never exceeded 15%, so it is thought that variation in population abundance is related primarily to environmental forcing. Populations of Pacific cod, flatfishes, and rockfishes are all considered to be in good condition due to favorable conditions and precautionary management practices.

Crabs, including king, Tanner, and snow, dominate Alaska shellfish fisheries. A majority of shellfish production comes from the Bering Sea, which contributes a majority of king crab landings and all snow crab landings. Shellfish fisheries in Alaska are highly valued and generated an estimated $153 million in ex-vessel revenue in 2006. The RAY (26,101 t) is only slightly below the estimated CY, but well below the MSY value of 192,138 t (derived from historical data). This difference is largely due to depressed stock levels for several species and low harvest limits while stocks are rebuilding. The fishery for Tanner crab was closed in 1997 due to continued decreases in population abundance and landings, but abundance has increased, especially in the past two years, and abundance is now above the B_{MSY} level. King crab landings dropped steeply in the early 1980's and have remained low, while snow crab catches have decreased in recent years due to low stock abundance. However, some stocks of king and snow crabs are showing signs of increases. Shrimp resources, which make a minor contribution to Alaska shellfish fisheries, also remain depressed.

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[15]The eastern Pacific population is classified as threatened, while the western U.S. Pacific population is endangered under the ESA. See Unit 21 for more information.

Pacific Islands Ecosystem Complex

The Pacific Islands Ecosystem Complex stretches across the central and western Pacific and includes the Main Hawaiian Islands (MHI), the Northwestern Hawaiian Islands (NWHI), and the U.S.-affiliated islands of American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands (CNMI; Figure 1). The area is made up of tropical and subtropical island waters with a high diversity of species, but relatively low sustainable yields due to limited ocean nutrients. Although catches are low compared to some mainland fisheries, Pacific Islands fisheries are highly valued and are important culturally and socially in Hawaii and the outer islands.

Fisheries resources of the Pacific Islands Ecosystem Complex include invertebrates, bottomfishes, and seamount groundfishes. The U.S. RAY for the region is 317 t (equal to the total RAY), which is 12% of the U.S. MSY level (Table 14). The MSY level is not well understood due to uncertainty in the estimates for lobsters and groundfishes. The considerable difference between RAY and MSY is due to the moratorium on fishing for seamount groundfishes, which make up an estimated 2,123 t of the total MSY.

© B. Mundy

Scaly slipper lobster in the Northwestern Hawaiian Islands.

The most important invertebrate fisheries in the Pacific Islands Ecosystem Complex are for spiny and slipper lobsters (Unit 16). These species were fished primarily in the NWHI until 2000, when the NWHI fishery for lobsters was closed as a precautionary measure due to uncertainty about the status of the lobster stocks. In December 2000, President William J. Clinton established the NWHI Coral Reef Ecosystem Reserve, which established reserve preservation areas in which fishing activities were prohibited. President George W. Bush designated the area a National Monument in 2006, forever protecting this unique and remote ecosystem. Research since the 2000 fishery closure has indicated that spiny lobster populations in the NWHI constitute a metapopulation and that a variety of anthropogenic and biotic factors contributed to their decline. Additionally, it appears that as spiny lobsters were removed, slipper lobster populations expanded to fill habitats formerly occupied by spiny lobsters; this may affect the ability of spiny lobster stocks to rebound (although recent increases have been seen in certain locations). The fishery for precious coral was reinitiated in 1999 for the first time since the 1970's, and ended in 2001. The fishery remains open, though no harvesting is occurring due to the high cost of operations and the low price of coral. The biological information needed for the management of precious coral remains limited, and warrants further attention.

Table 14

Productivity in metric tons (t) of fisheries resources in the Pacific Islands Ecosystem Complex regional ecosystem.

	Total productivity (t) over the entire range of the stock			Prorated productivity (t) within the U.S. EEZ	
Unit number and fishery	Total recent average yield (RAY)[1]	Total current yield (CY)	Total sustainable yield (MSY)	U.S. RAY	U.S. MSY
16. Western Pacific invertebrate[2]	0	0	0	0	0
17. Western Pacific bottomfish and groundfish[3]	317	424	2,628	317	2,628
Total	317	424	2,628	317	2,628

[1]2004–06 average, unless otherwise noted.

[2]Total MSY is unknown due to unknown values for individual stocks; value shown is based on CY when available, or on RAY. Lobster fishery in the Northwestern Hawaiian Islands has been closed since 2000.

[3]RAY is 2002–04 average for Hawaii and 2003–05 for other island areas.

Bottomfishes (Unit 17) are harvested from a variety of rock and coral habitats around the Hawaiian Islands and western Pacific Islands. Across the region, the RAY for bottomfishes is 75% of the CY due to underutilization of some stocks and low abundance levels of others. Although no bottomfish stocks are classified as overfished, it is thought that overfishing is occurring in some areas of the Hawaiian Islands, and the Western Pacific Fishery Management Council has recommended that the State of Hawaii take action to prevent overfishing because the bottomfish fishery and bottomfish habitat are predominantly within state waters. The MHI stock of bottomfishes is currently below B_{MSY}, and assessments indicate that the biomass of some important species within this complex is at 5–30% of unfished levels due to excess harvest. The primary management concern for the Western Pacific bottomfish fishery is the adequacy of the biological and catch data collected—the reproductive biology of many of the important species in American Samoa, Guam, and CNMI is unknown and the spawning stock cannot be computed, leading to unreliable status determinations.


Hawaiian Undersea Research Laboratory

Onaga and boarfish at a depth of 200 m off Oahu in the Main Hawaiian Islands.

The fishery for seamount groundfishes (Unit 17) occurs on the summits and slopes of submerged seamounts along the southern Emperor–northern Hawaiian Ridge. The only area under U.S. jurisdiction is Hancock Seamount, which accounts for less than 5% of the total fishing grounds. Pelagic armorhead is the most important species of seamount groundfish, and fishing has been prohibited at Hancock Seamount since 1984 to allow the stock to recover after foreign catch rates declined to low levels. The current fishing moratorium extends at least through 2010, but the stock has yet to show any signs of recovery even after 20+ years of closures. It is likely that closure of only the small U.S. EEZ portion of the armorhead's demersal habitat is not sufficient to allow for population recovery; Hancock Seamount remains the only portion of the fishery currently under management. The primary issue for seamount groundfishes is how to implement some form of cooperative international management that will provide conditions conducive to stock rebuilding, but no progress has yet been made.

Highly Migratory Species

Highly migratory species include species that migrate great distances across the Atlantic or Pacific Oceans and are harvested widely by both U.S. and foreign fishermen. Fishing for highly migratory stocks occurs within the U.S. EEZ, on the high seas, and within the EEZ's of other nations. These transboundary fishery resources hold considerable interest internationally, with high collective importance and value to foreign nations and U.S. fleets fishing within and beyond the U.S. EEZ. Management of highly migratory stocks is complicated and requires a good deal of international coordination and cooperation. Regulations enforced by only one of the many nations that harvest these stocks will likely do little to manage the overall status of the stock and fishery as a whole.

Atlantic highly migratory pelagic species (Unit 5) include several species of tunas, swordfish, marlins, other billfishes, and other tuna relatives; also included in this discussion are the pelagic sharks (Unit 6). These species form important components of domestic fisheries along the U.S. Atlantic Coast. International management efforts for these stocks are coordinated by the International Commission for the Conservation of Atlantic Tunas (ICCAT). Landings by U.S. fishermen have been declining steadily since the late 1980's. Currently, the U.S. RAY accounts for

Unit number and fishery	Total productivity (t) over the entire range of the stock: Total recent average yield (RAY)[1]	Total current yield (CY)	Total sustainable yield (MSY)	Prorated productivity (t) within the U.S. EEZ: U.S. RAY	U.S. MSY
5. Atlantic highly migratory pelagic[2]	290,221	282,190	332,731	18,569	24,760
6. Pelagic sharks[3]					
18. Pacific highly migratory pelagic	2,926,372	2,960,401	4,422,354	145,596	258,628
Total	3,216,593	3,242,591	4,745,085	164,165	283,388

[1]2004–06 average.

[2]Total MSY is unknown due to unknown values for individual stocks; value shown is based on CY when available, or on RAY.

[3]RAY for Atlantic sharks is expressed in thousands of fish instead of metric tons and cannot be converted to weights, so totals for this Unit have been excluded from this and other National Overview summary tables.

Table 15

Productivity in metric tons (t) of highly migratory species fisheries resources utilized by the United States.

only 6% of the total RAY for migratory species over the range of their distribution (Table 15), indicating the significant role of foreign fisheries and the need for both national and international management measures. Many Atlantic migratory species are currently at low abundance levels and classified as both experiencing overfishing and overfished. The Consolidated Atlantic Highly Migratory Species FMP addresses rebuilding and overfishing for depleted stocks, but only has jurisdiction over the U.S. portion of the fisheries.

Pacific highly migratory stocks (Unit 18) such as tunas, billfishes, and sharks range the high seas and often migrate across multiple management jurisdictions in the Pacific Ocean. These stocks support some of the most valuable fisheries in the world. Tunas make up the major catch component of highly migratory fisheries. The combined MSY of these stocks throughout their migratory range is 4,422,354 t, but the U.S. prorated share of the MSY is only 6% of that (258,628 t; Table 15). The status of most tuna stocks is relatively well known, with only one stock (Eastern Pacific bigeye tuna) below B_{MSY}; however, three tuna stocks (Eastern Pacific skipjack tuna, South Pacific albacore, and Pacific bluefin tuna) continue to have an unknown status relative to the biomass that would support the MSY. Less is known about the status of other species, although stocks that do have sufficient information appear to be healthy. International coordination for the management of Pacific tuna fisheries is carried out by the Inter-American Tropical Tuna Commission (IATTC), in which the United States is a member country. In addition to the problem of unknown population status for some highly migratory stocks, a management issue of increasing concern is the growth of total fleet fishing capacity in the Pacific. Many stocks are believed to already be harvested at or above sustainable levels, and the economic effects of overcapacity are becoming more evident. Closely related to overcapacity is the problem of illegal, unreported, and unregulated (IUU) fishing by vessels operating outside the control of regional management regimes.

NOAA

Juvenile albacore being brought aboard in the U.S. troll fishery.

RECENT TRENDS FOR FISHERIES

Successive editions of *Our Living Oceans* have sought to maintain consistency in the way stocks are classified and in the way data are reported, in order to provide a basis for examining overall trends in the health of fishery resources. However, some changes have been introduced into this new edition of *Our Living Oceans* to reflect the way that data are currently being collected for stocks and to more closely align with how stocks are tracked and reported in the annual *Status of U.S. Fisheries* as mandated by the MSA. Changes in the stock status tables include: stocks have been broken out by geographic area where information is available; Current Yield replaces Current Potential Yield (CPY) in *OLO '99*; Sustainable Yield replaces Long Term Potential Yield (LTPY) in *OLO '99*; Stock Level Relative to B_{MSY} replaces Stock Level Relative to LTPY in *OLO '99*; and Harvest Rate and Stock Status (equivalent to overfishing and overfished determinations in the *Status of U.S. Fisheries*) replace Fishery Utilization Level in *OLO '99*.

Yellowfin tuna awaiting sale at the Honolulu fish auction.

An examination of recent trends is presented here by comparing equivalent data reported in *OLO '99* and *OLO 6th Edition*. These editions pertain to stock status averaged over 1995–97 and 2004–06, respectively. Comparisons provide an idea of trends over a 9- to 11-year timeframe. Readers wishing to obtain a more detailed accounting of interannual changes for stocks of interest should refer to the references listed at the end of each species unit or consult stock assessment reports, which may be obtained electronically from Fishery Management Council websites listed in Appendix 2.

Stock Level

Stock level relative to B_{MSY} is a measure of how current fish stock abundance compares to the stock size that, on average, would support the MSY. Generally, management actions seek to prevent stock abundance from falling below B_{MSY}, and to rebuild stocks that have fallen below this level. Between *OLO '99* and *OLO 6th Edition*, the status of 20 stocks had improved: 14 moved from Below B_{MSY} to Near B_{MSY} and 6 moved from Below B_{MSY} to Above B_{MSY} (Table 16). Although 8 stocks moved from Near or Above to Below B_{MSY}, in aggregate these changes are positive, and resulted in a net reduction of stocks Below B_{MSY}. Although rebuilding of overfished stocks can sometimes take many years depending on the stock's intrinsic natural capacity to grow, its initial level of depletion, the specific management measures in place, and other factors, it would appear that the process of rebuilding overfished stocks is underway. Less positive news is that the number of stocks with unknown stock level status has increased, with 2 stocks becoming known and 41 stocks being reclassified as unknown. The reasons for a stock being reclassified as unknown vary

Table 16

Changes in stock level relative to B_{MSY} between *OLO '99* and *OLO 6th Edition* (Units 1–20).[1]

Total number of stocks by stock level status relative to B_{MSY} in *OLO '99*		Number of stocks by stock level status relative to B_{MSY} in *OLO 6th Edition*			
Stock level status (1999)	Total	Below (and change)	Near (and change)	Above (and change)	Unknown (and change)
Below	72	35 (–37)	14 (+14)	6 (+6)	17 (+17)
Near	60	5 (+5)	20 (–40)	16 (+16)	19 (+19)
Above	24	3 (+3)	2 (+2)	12 (–12)	7 (+7)
Unknown	41	0 (0)	0 (0)	2 (+2)	39 (–2)
Total	197	43 (–29)	36 (–24)	36 (+12)	82 (+41)

[1]This table shows the number of stocks in each *OLO '99* category (Below, Near, Above, and Unknown) that have stayed in the same category or shifted to a different category in *OLO 6th Edition*. These comparisons can be interpreted as changes between the mid 1990's and the mid 2000's. Only stocks appearing in both *OLO '99* and *OLO 6th Edition* are included in this summary. Entries of Variable and Unidentified have been counted as Unknown.

and may include a number of factors, including 1) improved stock assessment review processes that have increased expectations about the data that are needed to gain sufficient knowledge of a stock's status and ensure the best science available is used to manage it; 2) better recognition of the uncertainty associated with determining target abundance levels due to environmental variables and other ecosystem factors; and 3) the challenges associated with maintaining adequate data streams for all stocks.

Recent Yields

Overall, the U.S. share of the fishery resources reported in Units 1–20 has held fairly steady in recent years, decreasing just 1% between the time periods considered by *OLO '99* and *OLO 6th Edition*. This corresponds to a decrease of 39,702 t in the U.S. RAY (Table 17). This corresponds to an overall increase in the total RAY (10%), but a decrease in the U.S. share, mainly of Pacific highly migratory pelagic fisheries. Although the overall level has been relatively steady, some individual fisheries have experienced increases or decreases. The largest increases in terms of tonnage occurred for Alaska groundfish fisheries (156,930 t) and Pacific Coast and Alaska pelagic fisheries (52,784 t). In terms of percentage, Atlantic anadromous fisheries also had a large increase (77%). Large tonnage declines occurred for Southeast menhaden fisheries (–208,000 t) and Pacific highly migratory pelagic fisheries (–108,158 t). Large percentage decreases were experienced by Western Pacific invertebrates (–100% due to fishery closure) and Alaska shellfish (–50%).

Unit number and fishery	U.S. RAY *OLO '99*	U.S. RAY *OLO 6th Edition*	Change (t)	Change (%)
1. Northeast demersal[1]	142,215	146,324	4,109	3%
2. Northeast pelagic	121,300	160,335	39,035	32%
3. Atlantic anadromous	9,408	16,633	7,225	77%
4. Northeast invertebrate	127,200	126,600	–600	0%
5. Atlantic highly migratory pelagic	18,300	18,569	269	1%
6. Atlantic shark[2]				
7. Atlantic and Gulf of Mexico migratory pelagic[1]	15,432	17,482	2,050	13%
8. Atlantic, Gulf of Mexico, and Caribbean reef fish	24,739	24,253	–486	–2%
9. Southeast drum and croaker	33,623	40,994	7,371	22%
10. Southeast menhaden	860,000	652,000	–208,000	–24%
11. Southeast and Caribbean invertebrate[1]	119,376	127,784	8,408	7%
12. Pacific Coast salmon	17,304	21,110	3,806	22%
13. Alaska salmon	376,100	377,449	1,349	0%
14. Pacific Coast and Alaska pelagic[1]	112,500	165,284	52,784	47%
15. Pacific Coast groundfish	268,085	288,605	20,520	8%
16. Western Pacific invertebrate	109	0	–109	–100%
17. Western Pacific bottomfish and armorhead	492	317	–175	–36%
18. Pacific highly migratory pelagic[1]	253,606	145,448	–108,158	–43%
19. Alaska groundfish	2,026,272	2,219,202	156,930	8%
20. Alaska shellfish	52,131	26,101	–26,030	–50%
Total	4,614,192	4,574,490	–39,702	–1%

[1]Some stocks were not listed in both reports. For comparability, these RAY totals exclude the following: hagfish, Unit 1, *OLO 6th Edition*; cero mackerel, Unit 7, *OLO '99*; Gulf of Mexico grunts, Unit 8, *OLO 6th Edition*; golden crab, Unit 11, *OLO 6th Edition*; market squid, Unit 14, *OLO 6th Edition*; and bluefin tuna, Unit 18, *OLO 6th Edition*.

[2]RAY for Atlantic sharks is expressed in thousands of fish instead of metric tons and cannot be converted to weights, so totals for this Unit have been excluded from this and other National Overview summary tables.

Table 17

Comparison of U.S. recent average yield (RAY) in metric tons (t) reported by *OLO '99* and *OLO 6th Edition*.

Stock	Regional Ecosystem	*OLO* Unit	U.S. RAY *OLO '99*	U.S. RAY *OLO 6th Edition*	Change (t)	Change (%)	Stock level relative to B_{MSY}
American plaice	Northeast Shelf	1	4,300	1,627	–2,673	–62%	Below
Cusk	Northeast Shelf	1	600	78	–522	–87%	Unknown
Red hake	Northeast Shelf	1	1,400	519	–881	–63%	Unknown
Silver hake	Northeast Shelf	1	15,500	6,941	–8,559	–55%	Below
Spiny dogfish	Northeast Shelf	1	23,900	6,451	–17,449	–73%	Undefined
Weakfish	Northeast Shelf	1	4,200	1,013	–3,187	–76%	Unknown
Wolffishes	Northeast Shelf	1	400	106	–294	–74%	Unknown
Northern shrimp	Northeast Shelf	4	7,600	2,199	–5,401	–71%	Unknown
Amberjacks—South Atlantic	Southeast Shelf	8	1,078	382	–696	–65%	Unknown
Red porgy—South Atlantic	Southeast Shelf	8	236	47	–189	–80%	Below
Wreckfish—South Atlantic	Southeast Shelf	8	349	71	–278	–80%	Unknown
Rock shrimp	Gulf of Mexico	11	6,240	2,189	–4,051	–65%	Unknown
Seabob shrimp	Gulf of Mexico	11	3,947	1,149	–2,798	–71%	Unknown
Stone crab	Gulf of Mexico	11	2,961	1,177	–1,784	–60%	Near
Pink salmon	California Current	12	3,931	1,846	–2,085	–53%	Near
Chub mackerel	California Current	14	20,000	6,433	–13,567	–68%	Above
Jack mackerel	California Current	14	2,000	705	–1,295	–65%	Unknown
Pacific herring—Pacific Coast	California Current	14	6,000	85	–5,915	–99%	Unknown
Bocaccio	California Current	15	863	81	–782	–91%	Below
Canary rockfish	California Current	15	1,054	55	–999	–95%	Near
Chilipepper	California Current	15	1,846	125	–1,721	–93%	Above
Lingcod	California Current	15	1,966	821	–1,145	–58%	Above
Other rockfishes	California Current	15	7,766	3,113	–4,653	–60%	Unknown
Pacific ocean perch	California Current	15	800	104	–696	–87%	Below
Shortbelly rockfish	California Current	15	38	11	–27	–71%	Above
Thornyhead rockfishes	California Current	15	6,514	1,605	–4,909	–75%	Above
Widow rockfish	California Current	15	6,426	196	–6,230	–97%	Near
Yellowtail rockfish	California Current	15	4,073	840	–3,233	–79%	Above
Bottomfishes—CNMI	Pacific Islands	16	17	6	–11	–65%	Above
Greenland halibut—BSAI	Alaska	19	7,400	2,247	–5,153	–70%	Above
Sea snails	Alaska	20	1,414	0	–1,414	–100%	Unknown
Snow crab	Alaska	20	39,053	12,976	–26,077	–67%	Below
White marlin—Atlantic	Highly Migratory	6	1,600	400	–1,200	–75%	Below

Table 18

Comparison of recent average yield (RAY; U.S. share only except for highly migratory stocks from Units 5 and 18, which have a very high percentage of non-U.S. landings) between *OLO '99* and *OLO 6th Edition*. Only stocks with RAY changes greater than –50% are listed. RAY is in metric tons (t). Not included here are those stocks which have been closed to fishing: Atlantic salmon, Atlantic sturgeon, goliath and Nassau groupers throughout their range, and spiny and slipper lobsters in the NWHI. Atlantic sharks (Unit 6) are also excluded because RAY for these stocks is expressed in thousands of fish instead of metric tons and cannot be converted to weights. CNMI = Commonwealth of the Northern Mariana Islands; BSAI = Bering Sea and Aleutian Islands.

Table 18 lists individual stocks for which RAY decreased by 50% or more between *OLO '99* and *OLO 6th Edition*. These stocks are distributed around the country and are found in every RE except the Caribbean Sea, although more stocks from the Northeast Shelf and California Current had substantial decreases. In terms of tonnage, the largest decrease in RAY was for snow crab (–26,077 t). Snow crab and several other Alaska crab stocks are currently at low abundance levels, so lower harvest allowances have been set to allow the stocks to rebuild to healthy levels. Other stocks that experienced large decreases in tonnage included spiny dogfish (–17,449 t), as a result of recent restrictions on dogfish landings, and Pacific chub mackerel (–13,567 t), due mainly to a lack of commercial markets. Many stocks have experienced large percentage declines

Stock	Regional Ecosystem	*OLO* Unit	U.S. RAY *OLO '99*	U.S. RAY *OLO 6th Edition*	Change (t)	Change (%)	Stock level relative to B_{MSY}
Haddock	Northeast Shelf	1	900	8,836	7,936	882%	Below
Ocean pout	Northeast Shelf	1	60	294	234	390%	Below
Pollock	Northeast Shelf	1	3,800	6,190	2,390	63%	Below
Scup	Northeast Shelf	1	3,300	6,955	3,655	111%	Below
Skates	Northeast Shelf	1	10,700	41,575	30,875	289%	Undefined
Yellowtail flounder	Northeast Shelf	1	2,400	5,250	2,850	119%	Below
Atlantic mackerel	Northeast Shelf	2	14,600	52,455	37,855	259%	Above
Striped bass	Northeast Shelf	3	8,300	15,933	7,633	92%	Below
Red deepsea crab	Northeast Shelf	4	1,000	1,923	923	92%	Unknown
Sea scallop	Northeast Shelf	4	7,100	28,716	21,616	304%	Above
Other porgies—South Atlantic	Southeast Shelf	8	67	989	922	1,376%	Unknown
Atlantic croaker	Southeast Shelf	9	7,657	15,224	7,567	99%	Below
White shrimp—Gulf of Mexico	Gulf of Mexico	11	28,942	51,995	23,053	80%	Near
Chum salmon	California Current	12	2,768	6,170	3,402	123%	Near
Coho salmon	California Current	12	1,421	3,127	1,706	120%	Near
Northern anchovy	California Current	14	4,000	11,641	7,641	191%	Unknown
Pacific sardine	California Current	14	35,000	105,667	70,667	202%	Above
Arrowtooth flounder	California Current	15	2,257	4,160	1,903	84%	Above
Other groundfishes	California Current	15	1,693	5,115	3,422	202%	Unknown
Pacific cod	California Current	15	515	898	383	74%	Unknown
Pacific halibut—U.S. Pacific Coast	California Current	19	570	1,069	499	88%	Near
Pacific herring—Gulf of Alaska	Alaska	19	11,500	17,212	5,712	50%	Near
Bigeye tuna	Highly migratory	18	132,615	240,823	117,208	95%	Unknown
Skipjack tuna—Central Western Pacific	Highly migratory	18	950,527	1,494,421	543,894	57%	Above
Skipjack tuna—Eastern Pacific	Highly migratory	18	135,967	274,974	139,007	102%	Unknown
Wahoo	Highly migratory	18	160	831	671	419%	Unknown

Table 19

Comparison of recent average yield (RAY; U.S. share only except for highly migratory stocks from Units 5 and 18, which have a very high percentage of non-U.S. landings) between *OLO '99* and *OLO 6th Edition*. Only stocks with RAY changes greater than +50% are listed. RAY is in metric tons (t). Atlantic sharks (Unit 6) were not considered for this analysis because RAY for these stocks is expressed in thousands of fish instead of metric tons and cannot be converted to weights.

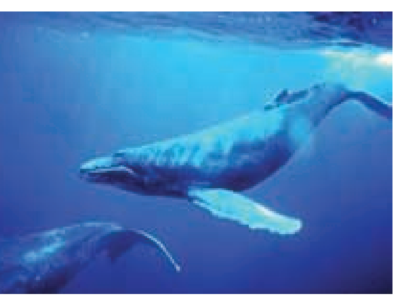
in RAY, although the absolute magnitude of the landings is small. Stocks on the Northeast Shelf have seen decreased landings in recent years due to harvest restrictions designed to allow stocks to rebuild. In the California Current, some of the stocks have decreased RAY's due to stock rebuilding, while others could support higher catch levels but are restricted due to co-occurrence with overfished stocks. Overall, 33 stocks (excluding those stocks for which fisheries have been entirely closed) experienced a decrease in RAY greater than 50%, accounting for a decrease of 129,874 t since *OLO '99*.

Table 19 lists stock groups that experienced a RAY increase of 50% or greater between the publication of *OLO '99* and *OLO 6th Edition*. Many of the stocks showing increases are from the Northeast Shelf or California Current; the others are spread around the other RE's, although there are none found in the Caribbean Sea or Pacific Islands Ecosystem Complex. In terms of tonnage, the largest increases in RAY were seen for several Pacific highly migratory species: skipjack tuna (543,894 t for the Central Western Pacific stock; 139,007 t for the Eastern Pacific stock) and bigeye tuna (108,208 t for both Pacific stocks combined). Skipjack tuna are currently the volume leader in Pacific fisheries for highly migratory species, and the stocks are believed to be underutilized, although MSY and the biomass relative to B_{MSY} are unknown for the Eastern Pacific stock (the Central Western Pacific stock is above B_{MSY}). Bigeye tuna are a highly migratory stock fished by several nations; the stock is experiencing overfishing and the eastern Pacific population is below B_{MSY}. Other tonnage increases were less substantial, but some stocks experienced large percentage increases in RAY. Some of these increases are due to improved management measures and reduced harvest restrictions on stocks as they rebuild to sustainable population levels. In total, 26 stocks showed an increase in RAY greater than 50%, accounting for a 1,034,624 t increase between *OLO '99* and *OLO 6th Edition*.

Many of the stocks (37%) with known status listed in Table 18 that experienced declines in landings are below the biomass level that would support the MSY. This indicates that landings for a significant portion of the stocks listed on the table decreased because their population sizes can no longer support historical catch levels. However, the rest of the known-status stocks experiencing RAY decreases are at healthy population levels. Declines in RAY for these stocks may be a result of a lack of commercial markets, shifts in fishing effort, or management restrictions to prevent bycatch of overfished co-occurring stocks that are overfished and rebuilding. Decreases in RAY may also be seen in healthy stocks as population abundance moves from above B_{MSY} to B_{MSY}. Unfortunately, a large number of stocks (42%) experiencing a large decrease in RAY had an unknown or undefined stock level, indicating the need for improved data collection and additional stock assessment efforts. About half of the stocks with known stock levels that experienced an increase in RAY had healthy population abundance levels; some of the increases seen for stocks classified as below B_{MSY} are due to easing of catch restrictions as the populations rebuild toward sustainable levels (the case for several stocks of Northeast groundfish). About 35% of the stocks with substantial RAY increases have unknown stock levels, indicating the need for cautious management of these stocks as fisheries for them increase.

RECENT TRENDS FOR PROTECTED RESOURCES

Since the last *OLO* report in 1999, the quality of stock assessments for protected resources such as marine mammals and sea turtles has continued to improve. *OLO '99* reported on 145 stocks of marine mammals and assigned trends to 12% of the stocks. *OLO 6th Edition* reports on a total of 190 marine mammal stocks, and assigns trends to 15% of the stocks (a gain of 11 stocks with assigned trends, relative to *OLO '99*). The largest improvements have been in the Pacific Ocean, where in 1999 authors were not able to assign population trends to any stocks (except for sea turtles), and now a total of 12 marine mammal stocks have known trends.


Louis M. Herman

Humpback whales, Hawaiian Islands Humpback Whale National Marine Sanctuary.

Marine Mammals

Recent stock assessments in Alaska show continued increases for bowhead whales, gray whales, and central North Pacific humpback whales. The Eastern Pacific stock of Steller sea lion also continues to increase, and the Western U.S. Pacific stock of Steller sea lion has showed increases in annual census counts since 2000—the first region-wide increase for that stock since standardized surveys began in the 1970's. These increases suggest a change in trend for the endangered stock, which is now considered to be stable. Other improvements in the Alaska Region include improved population trends for Bristol Bay beluga; trends for Cook Inlet beluga, fin whale, and eastern North Pacific Northern Resident killer whale going from unknown to known; stocks of killer whales increasing from two to five stocks; and the addition of known values for population or mortality estimates for several stocks. Additionally, the North Pacific right whale was recognized as a separate species from the North Atlantic right whale in 2000 and classified as endangered under the ESA. Between *OLO '99* and *OLO 6th Edition*, three stocks (Beaufort Sea beluga, southeast Alaska harbor seal, and spotted seal) went from known status to unknown, northern fur seal went from stable to decreasing, Cook Inlet beluga was classified as depleted, and three stocks were reclassified as strategic (as well as the addition of a new strategic stock, AT1 Transient killer whales).

Brent Stewart

The status of spotted seal and two other stocks in Alaska went from known to unknown between *OLO '99* and *OLO 6th Edition.*

In the Pacific region and Hawaii, a good amount of progress has been made since the last *OLO*. In *OLO '99*, no population trends were available for marine mammal stocks, but now 12 stocks have known trends. Five new stocks have been added to the Hawaii area of the Pacific, and the stock structure for harbor porpoises has been refined and now contains six stocks instead of four. New estimates have been made for a number of stocks that previously had unknown population or mortality values, and one stock (CA/OR/WA short-finned pilot whale) is no longer considered a strategic stock. Unfortunately, the Eastern North Pacific Southern Resident killer whale (found principally in Puget Sound) is now considered strategic and was also recently classified as endangered under the ESA.

In the Atlantic region and Gulf of Mexico, three new stocks have been added in the western North Atlantic, and the stock structure of bottlenose dolphin in the Gulf of Mexico has been refined. Since *OLO '99*, nine stocks have moved from strategic to not strategic status, while four moved from not strategic to strategic—a net gain of five fewer non-strategic stocks. In the Atlantic region, less progress has been seen in terms of defining abundance trends for marine mammal stocks. No new trends have been added, and two stocks with previously known trends are now unknown. Of the greatest concern in the Atlantic region is the North Atlantic right whale, which continues to show no sustained population growth despite six decades of protection.

Sea Turtles

Of the seven species of sea turtles found worldwide, six species are found in U.S. waters and all are currently listed as either threatened or endangered under the ESA. Authority to conserve and protect sea turtles is shared by NMFS (responsible for turtles while in the marine environment) and USFWS (jurisdiction over nesting beaches and turtles on land). A lack of historical abundance data makes it difficult to fully understand current population dynamics, but standardized surveys of selected nesting beaches that began in the 1980's (1973 for Hawaiian green turtles) provide an indication of whether turtle relative abundances are declining, stable, or increasing.

In the Atlantic Ocean, southeast U.S. nesting populations of green turtles seem to be increasing, but are not genetically distinct from other nesting populations. The Kemp's ridley turtle, after dramatic earlier declines, appears to be in the earliest stages of recovery under strict protection (including full protection of nesting females and required use of turtle excluder devices).

Hawksbill turtle off the coast of Florida.

Other species in the Atlantic are not faring as well as the green and Kemp's ridley. Leatherback turtle nesting populations in the United States are stable but small in number, but the status and trends of larger populations in the Guianas and Trinidad are unclear. The Florida subpopulation of loggerhead turtle is in decline.

Sea turtles in the Pacific Ocean face continued threats, and some species are currently experiencing serious population declines. Although the olive ridley does not nest on any U.S. beaches, it faces continued threats in U.S. and other waters from incidental capture in trawl and longline fisheries. The loggerhead has two primary nesting locations in the Pacific Ocean—Japan and eastern Australia; current nesting and foraging data from eastern Australia indicate a severe decline for the species. Serious declines are also occurring for leatherback turtles at all major nesting beaches throughout the Pacific, primarily due to the overharvest of eggs, direct harvest of adult turtles, and incidental mortality from fishing. The exploitation of hawksbill turtles for their shells remains an ongoing concern for the conservation of the species; a recent decision by Japan to end the import of hawksbill shells was an important conservation achievement. The degradation and destruction of coral reefs important to hawksbills for food and habitat is also a major threat to their recovery. Green turtles have shown continued population increases in the Northwestern Hawaiian Islands due to reduced human-caused mortality under ESA protection, but populations in many other Pacific Island areas continue to decrease as a result of the harvest of eggs and adults by humans.

ISSUES OF NATIONAL CONCERN

The management of living marine resources is complex and involves many considerations, including biology, economics, sociology, and politics. Changing conditions require resource managers to continually make adjustments to management schemes, even in regions and fisheries that are currently at healthy abundance levels with catches near their sustainable yield levels. In order to increase the long-term benefits from those stocks that are currently overfished, the difficult issues and practices that have led to the overfished status must be confronted. In each of the 24 units in this report, the major issues affecting the resources and their management are raised. Although each unit has its own unique issues affecting the management of its resources, some issues are common across many LMR's or important at the National level and are discussed below.

Fishing is prohibited on all three stocks of Nassau grouper (South Atlantic, Gulf of Mexico, and Caribbean) to allow the stocks to rebuild.

Stock Rebuilding and Recovery

The goal of fisheries management is conservation of living marine resources for maximum societal benefits. A stock that is depleted (i.e. below B_{MSY}) or overfished cannot be fully utilized until it has been rebuilt, and management restrictions must remain in place while rebuilding is occurring. The list of stocks that are overfished or below B_{MSY} includes some of our Nation's most valuable fishery resources, including New England groundfishes, several pelagic highly migratory fish stocks (including Atlantic albacore, bluefin tuna, bigeye tuna, several billfishes, and eastern Pacific bigeye tuna), several Southeast reef fishes, some Pacific Coast groundfish stocks, and crabs and groundfishes in Alaska (Table 20). The Northeast Region presents the largest number of depleted stocks (see Tables 4 and 5), although examples of resource depletion can be found in

Stock	Regional ecosystem	*OLO* unit	Recent average yield (RAY)	Sustainable yield (MSY)	Change (t)	Change (%)
Acadian redfish	Northeast Shelf	1	487	8,200	7,713	1,584%
American plaice	Northeast Shelf	1	1,627	4,900	3,273	201%
Atlantic cod—coastwide	Northeast Shelf	1	8,852	41,226	32,374	366%
Atlantic halibut	Northeast Shelf	1	14	175	161	1,150%
Haddock—coastwide	Northeast Shelf	1	8,836	26,593	17,757	201%
Ocean pout	Northeast Shelf	1	294	1,500	1,206	410%
Pollock	Northeast Shelf	1	6,190	13,861	7,671	124%
Red hake—Gulf of Maine/N. Georges Bank	Northeast Shelf	1	165	2,000	1,835	1,112%
Silver hake—Gulf of Maine/N. Georges Bank	Northeast Shelf	1	466	Unknown	Unknown	Unknown
Silver hake—S. Georges Bank/Mid-Atlantic	Northeast Shelf	1	6,475	Unknown	Unknown	Unknown
White hake	Northeast Shelf	1	2,543	4,069	1,526	60%
Windowpane—S. New England/Mid-Atlantic	Northeast Shelf	1	385	900	515	134%
Winter flounder—coastwide	Northeast Shelf	1	5,407	14,942	9,535	176%
Yellowtail flounder—coastwide	Northeast Shelf	1	5,250	25,401	20,151	384%
Spiny dogfish	Northeast Shelf	1	6,451	Unknown	Unknown	Unknown
Black sea bass	Northeast Shelf	1	2,200	Unknown	Unknown	Unknown
Goosefish—northern stock	Northeast Shelf	1	10,800	Unknown	Unknown	Unknown
Goosefish—southern stock	Northeast Shelf	1	10,500	Unknown	Unknown	Unknown
Scup	Northeast Shelf	1	6,955	Unknown	Unknown	Unknown
Summer flounder	Northeast Shelf	1	13,484	21,444	7,960	59%
Tilefish	Northeast Shelf	1	918	2,000	1,082	118%
Bluefish	Northeast Shelf	2	9,706	51,890	42,184	435%
Butterfish	Northeast Shelf	2	1,468	12,175	10,707	729%
American shad	Northeast Shelf	3	367	Unknown	Unknown	Unknown
Atlantic salmon	Northeast Shelf	3	0	Unknown	Unknown	Unknown
Atlantic sturgeon	Northeast Shelf	3	0	Unknown	Unknown	Unknown
Striped bass	Northeast Shelf	3	15,933	16,427	494	3%
Black sea bass	Southeast Shelf	8	770	1,730	960	125%
Goliath grouper	Southeast Shelf	8	0	Unknown	Unknown	Unknown
Nassau grouper	Southeast Shelf	8	0	Unknown	Unknown	Unknown
Red porgy	Southeast Shelf	8	47	450	403	857%
Snowy grouper	Southeast Shelf	8	130	142	12	9%
Other groupers	Southeast Shelf	8	489	Unknown	Unknown	Unknown
Atlantic croaker	Southeast Shelf	9	15,224	50,000	34,776	228%
Red drum	Southeast Shelf	9	709	Unknown	Unknown	Unknown
Pink shrimp	Southeast Shelf	11	551	786	235	43%

Table 20

Potential gains in yield in metric tons (t) from rebuilding stocks currently classified as either overfished/rebuilding or below B_{MSY}. Values are the U.S. share only, except for Highly Migratory Species. When a range of values is available for the MSY estimate, the lower end of the range is used to calculate totals. Atlantic sharks (Unit 6) were not considered for this analysis because RAY for these stocks is expressed in thousands of fish instead of metric tons and cannot be converted to weights. (Table continued on next page.)

all other Regions. Table 20 indicates that if stocks currently classified as overfished, rebuilding, or below B_{MSY} were rebuilt to healthy population levels (i.e. B_{MSY}), U.S. fishery yields could potentially increase up to 23% over recent yields. This is a conservative estimate, using the lower end of ranges and the RAY when MSY is unknown, but it illustrates the consequences to fishery yield of depleted fishery stocks.

Stock	Regional Ecosystem	*OLO* unit	Recent average yield (RAY)	Sustainable yield (MSY)	Change (t)	Change (%)
King mackerel—Gulf group	Gulf of Mexico	7	4,434	5,183	749	17%
Red snapper—Gulf of Mexico	Gulf of Mexico	8	3,657	15,000	11,343	310%
Red drum—Gulf of Mexico	Gulf of Mexico	9	5,869	7,900	2,031	35%
Nassau grouper—Caribbean	Caribbean	8	0	Unknown	Unknown	Unknown
Queen conch	Caribbean	11	110	Unknown	Unknown	Unknown
Chinook salmon	California Current	12	5,106	5,200	94	2%
Coho salmon	California Current	12	15,642	17,600	1,958	13%
Bocaccio	California Current	15	81	1,974	1,893	2,337%
Canary rockfish	California Current	15	55	1,574	1,519	2,762%
Cowcod	California Current	15	2	61	59	2,950%
Darkblotched rockfish	California Current	15	186	621	435	234%
Pacific ocean perch	California Current	15	104	1,411	1,307	1,257%
Widow rockfish	California Current	15	196	2,000	1,804	920%
Yelloweye rockfish	California Current	15	15	44	29	193%
Pacific cod—Bering Sea and Aleutian Islands	Alaska Ecosystem	19	208,717	207,000	–1,717	–1%
Walleye pollock—Eastern Bering Sea	Alaska Ecosystem	19	1,483,411	1,640,000	156,589	11%
Walleye pollock—Gulf of Alaska	Alaska Ecosystem	19	72,262	95,429	23,167	32%
Blue king crab—Pribilof Islands	Alaska Ecosystem	20	0	1,179	1,179	NA
Blue king crab—Saint Matthews Island	Alaska Ecosystem	20	0	1,995	1,995	NA
Snow crab	Alaska Ecosystem	20	12,976	125,397	112,421	866%
Shrimp	Alaska Ecosystem	20	853	14,722	13,869	1,626%
Bottomfishes—Hawaiian Islands	Pacific Islands Ecosystem	17	274	368	94	34%
Seamount Groundfishes	Pacific Islands Ecosystem	17	0	2,123	2,123	NA
Albacore—North Atlantic	Highly Migratory Species	5	32,400	26,800–34,100	–5,600	–17%
Bigeye tuna—Atlantic	Highly Migratory Species	5	74,500	68,000–99,000	–6,500	–9%
Blue marlin—Atlantic	Highly Migratory Species	5	2,500	Unknown	Unknown	Unknown
Bluefin tuna—Western Atlantic	Highly Migratory Species	5	1,900	3,000–3,400	1,100	58%
Sailfish—Western Atlantic	Highly Migratory Species	5	900	Unknown	Unknown	Unknown
Swordfish—North Atlantic	Highly Migratory Species	5	12,000	12,800–14,790	800	7%
White marlin—Atlantic	Highly Migratory Species	5	400	Unknown	Unknown	Unknown
Bigeye tuna—Eastern Pacific	Highly Migratory Species	18	109,987	81,350	–28,637	–26%
Subtotal for "known" MSY			2,142,908	2,639,542	496,634	23%
Subtotal for "known" MSY excluding HMS			1,912,121	2,447,592	535,471	28%
Total			2,192,230	2,688,864	496,634	23%

Table 20

Continued from previous page.

In many fisheries with overfished stocks, rebuilding of stocks is the most pressing issue. The MSRA requires that FMC's (or the Secretary of Commerce, when necessary) develop rebuilding plans for overfished stocks to rebuild the stocks as quickly as possible. For some stocks, rebuilding may occur over a few years, but for others rebuilding may take decades. The amount of time required to rebuild a stock depends on the species' longevity and growth potential, environmental conditions, and on the management controls put into place (which may be affected to a limited extent by economic and social considerations).

Implementation of rebuilding plans can sharply curtail fishing opportunities not only for overfished species, but also for co-occurring species, affecting multiple sectors of a fishery. In the short term, fishermen may see allowable harvests and landings in some fisheries drop to near-historic lows during rebuilding, as catch quotas are reduced to allow overfished species to rebuild to sustainable stock levels. However, there are many benefits that can be gained from rebuilding overfished stocks. The economic benefits from restoring depleted stocks to healthy levels are apparent to the commercial and recreational fishing industries and to fishing communities. The benefits to the Nation of restoring important components of ecosystems and the functions associated with healthy ecosystems are more difficult to quantify.

Stock recovery and conservation is also a vital issue for protected species. Of the 190 marine mammal stocks found in U.S. waters, 27 are listed as threatened or endangered under the ESA and an additional 4 stocks are classified as depleted under the MMPA. All sea turtle stocks are listed under the ESA, as well as a number of other stocks, including several Pacific salmon stocks, other anadromous and marine fish stocks, several invertebrate stocks, and one marine plant (Johnson's sea grass). As one means of recovering protected species, the ESA requires development of recovery plans for all species listed as threatened or endangered; these plans help to organize and guide the recovery process. A wide variety of methods are in use to recover protected species around the country. These include measures to reduce interaction with, and bycatch in, commercial and recreational fisheries, such as time and area closures and gear restrictions or modifications; measures to reduce mortality and serious injury associated with other human activities (ship collisions, etc.); research to increase available information on protected species biology, ecology, habitat requirements, and threats; and measures to protect, conserve, and rehabilitate critical habitat used by protected species. Recovery of protected species not only restores vital ecosystem functions and the intrinsic value associated with these species, but also can lead to delisting of species and a reduction in the management restrictions in place to recover the stock.

Recreational Fishing

Marine recreational fishing supports nearly 350,000 jobs and generates $30.5 billion annually in the United States. It is the top outdoor recreational sport, attracting 17 million saltwater anglers in the U.S. EEZ. In every region of the United States, sport fishing is a popular pursuit, attracting an ever-increasing number of users and contributing millions of dollars to local economies. Because recreational fishing is so popular in the United States, keeping track of recreational fishermen and their catches is an important part of managing our Nation's fisheries. High quality marine recreational fisheries statistics are required by law and are necessary for effective, fair, and responsible management of fishery resources. Improving marine recreational fisheries statistics will also increase recreational fishing opportunities for Americans, enhance and protect stocks, improve the economy, and promote the best use of the resources of the Nation.


Mary Hollinger, NOAA/NODC

Two young anglers with their striped bass catch in Chesapeake Bay, Maryland.

NMFS has a Recreational Fisheries Statistics Program whose mission is to provide accurate, precise, and timely fisheries-dependent information for U.S. marine waters through the coordination and administration of recreational fishing surveys nationwide. The Program has historically collected information on participation, effort, and catch through its Marine Recreational Fisheries Statistics Survey (MRFSS). Economic questions were also added to the MRFSS to allow NMFS to estimate the economic impacts of marine recreational fishing in addition to the other data currently collected.

In April 2006 the National Research Council (NRC) completed a review of recreational data collection programs at the request of NMFS and found that improvements could be made to MRFSS to increase the quality and accuracy of its information (NRC, 2006). The report iden-


Charles Gardner, NMFS

Measuring a pair of banded rudderfish during a NMFS Marine Recreational Fisheries Statistics Survey.

tified a number of potential problems with the sampling and estimation designs employed in the current surveys and questioned the adequacy of the existing surveys to provide the statistics needed to support accurate stock assessments and appropriate fishery management decisions. In the report, the NRC recommended that current surveys be redesigned to improve their effectiveness, the appropriateness of their sampling procedures, their applicability to various kinds of management decisions, and their usefulness for social and economic analyses.

NMFS has taken the recommendations of the NRC report very seriously and, working together with the interstate marine fisheries commissions, state agencies, regional fishery management councils, and constituents, has already begun the process of responding to the recommendations and making the changes necessary to develop a credible and usable data collection program. The existing MRFSS program will be phased out over the next several years and a new program, the Marine Recreational Information Program (MRIP), will replace it. The MRIP is designed to improve the collection and analysis of marine recreational fishing data. Its surveys will better answer fundamental questions important to resource management, such as who is fishing and what is being caught. The MRIP will ultimately help policymakers gain a more complete understanding of the role of recreational fishing in the conservation of living marine resources and marine ecosystems. In January 2009, NMFS will deliver a comprehensive report to Congress on the MRIP and its status.

The recently passed MSRA requires additional improvements to the collection of marine recreational fisheries data. The MSRA requires the Secretary of Commerce to establish and implement a regionally based saltwater angler registry program to track recreational fishermen in each of the eight fishery management regions. A proposed rule for the new Saltwater Angler Registration Program was released in June 2008. Such a registry program is deemed necessary because 1) accurately counting the United States' marine anglers is widely acknowledged as being a necessary step towards improving Federal fisheries management; and 2) the existing state-based system of fishing licenses is incomplete, which hampers enumeration of this important user group and subsequent collection of angler information for fisheries management. The Federal program will provide for registration (including identification and contact information) of individuals engaging in recreational fishing in the U.S. EEZ for anadromous species, or for Continental Shelf fishery resources beyond the EEZ; and if appropriate, will provide for the registration (including ownership, operator, and identification) of vessels used in these fishing activities. The resulting regionally based registry programs will be used to support more efficient statistical surveys of recreational fishing.


Paula Whitfield, NOAA

Marine protected areas protect species and the habitats they depend on, such as this seagrass bed.

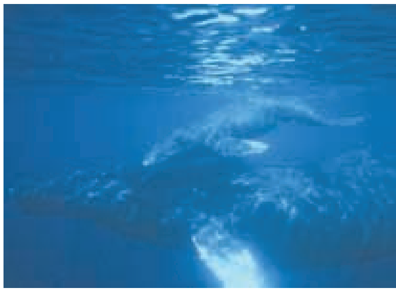
Place-based Management

Place-based management is a broad term that refers to a range of management tools, including fishery management zones, marine reserves, and marine protected areas (MPA's). Sometimes the terms "marine reserve" and "MPA" are confused or used interchangeably, but these are actually different kinds of management zones. Marine reserves are relatively rare "no-take" areas that prohibit all extractive uses and are designed to protect spawning or nursery grounds or to protect ecologically important habitats. MPA is an umbrella term that encompasses a wide variety of place-based approaches to marine management and includes multiple-use conservation areas that may permit both consumptive and non-consumptive uses such as fishing, diving, boating, and swimming. Multiple-use MPA's allow managers to protect ecosystems and, at times, support sustainable fisheries while allowing other user groups to enjoy the resource. Gear restrictions or zoning schemes are sometimes used in MPA's to manage potentially harmful activities like fishing, or to restrict them to appropriate habitats and/or seasons. Fishery management zones include area closures that may be gear- or species-specific and may be temporary, seasonal, or permanent.

The term "MPA" may be relatively new, but the use of place-based management is not. Resource managers have used place-based management tools for decades to manage living marine resources in the United States. Examples include the Nation's 13 National Marine Sanctuaries, the recently designated Papahānaumokuākea Marine National Monument in the Northwestern Hawaiian Islands, dozens of fishery management zones administered by NMFS, and many smaller MPA's and marine reserves around the United States. The first National Marine Sanctuary was established in 1975, and the use of fishery management zones as a management tool by fishery managers has a long history in the United States.

Although place-based management is not new, the use of these management tools, especially MPA's, is gaining a new emphasis. Traditional management measures have failed to prevent stock depletion in some fisheries, and managers are increasingly being tasked with protecting habitat, particularly from the effects of certain types of fishing gear. Place-based management tools can be used to enhance rebuilding of overfished stocks and protect habitat, and may be combined with other management tools such as effort controls and gear restrictions to achieve conservation and management goals. Place-based management can also contribute to the conservation and recovery of protected species, and is useful for protecting the critical habitat of endangered and threatened species. Because ecosystem-wide processes can be managed in an MPA, these areas are ideal for contributing to an EAFM. Many existing examples of EAFM include MPA's as important tools for the conservation and management of living marine resources and their ecosystems. In May of 2000, Executive Order 13158 on Marine Protected Areas was issued, emphasizing the emerging importance of MPA's as a tool for the conservation and management of living marine resources in the United States. The Executive Order (EO) directs Federal agencies to work with government and non-governmental partners to increase protection and sustainable use of ocean resources by strengthening and expanding a national system of MPA's.

Dave Glickman



Marine protected areas can be created to protect a variety of fishery stocks, protected species, habitats, or life history stages. The Hawaiian Islands Humpback Whale National Marine Sanctuary protects breeding humpback whales and their young in important tropical wintering habitats around Hawaii.

Place-based management is used to complement traditional management measures in many areas to conserve and protect living marine resources. Management actions implemented by NMFS to protect endangered Steller sea lions in Alaska include setting no-entry buffer zones around rookeries to prevent human disturbance of sea lions and a prohibition on groundfish trawling within 10–20 n.mi. of certain rookeries to minimize competition for fish between commercial fisheries and sea lions. The Hawaiian Islands Humpback Whale National Marine Sanctuary was created to protect endangered humpback whales and their breeding grounds in Hawaii. The North Pacific and South Atlantic FMC's use a variety of spatial management zones in addition to traditional management measures to manage their fisheries resources; the South Atlantic FMC is also currently considering MPA's as a management tool to conserve deepwater snapper-grouper species. Similarly, the Gulf Reeffish FMP developed by the Gulf of Mexico FMC includes several MPA's in its regulations. In the Northeast, three large areas have been closed since the mid 1990's to protect and help rebuild depleted groundfishes; these closed areas have been used in combination with traditional management restrictions to manage the stocks. The closed areas in the Northeast also benefited the Atlantic sea scallop stock and fishery, increasing stock biomass and leading to large increases in scallop landings and revenues when the areas were reopened to scallop harvest. Because of the benefits to the scallop fishery, the Sea Scallop FMP has been amended to include rotational area management to close some fishing areas to allow young scallops to grow, and to shift effort toward larger scallops with the highest meat yields.

John Butler, SWFSC

A variety of marine reserves and marine protected areas have been created on the West Coast to protect species such as these whitespeckled and starry rockfishes.

The West Coast is currently at the forefront of place-based management activity in the United States, and has a growing network of multiple-use conservation areas and reserves supported by strong science and stakeholder input. Major portions of the Continental Shelf off the U.S. West Coast have been closed to fishing since 2003, in addition to several rockfish conservation areas implemented the same year to protect overfished species. Additionally, in 2006, Federal regulations introduced a network of 51 MPA's to protect West Coast groundfish EFH from fishing gear impacts. This network will serve as a pilot project for the national MPA system described in EO 13158; its goals are to facilitate the effective use of MPA's as an ecosystem management tool to conserve and protect living marine resources and their habitats, and to inform the development of a regionally-based national system of MPA's. The coastal states (California, Oregon, and Washington) are also adopting networks of marine managed areas to conserve and protect habitat and marine populations inshore of the Federal EEZ. California is leading the way with its Marine Life Protection Act Initiative, which divides the coast of California into five study regions and is implementing MPA networks in each region; so far, the State has adopted 29 new management areas in the central coast study region, and the planning process for the north central coast is nearly complete.

Limited Access Privilege Programs

After the initial passage of the 1976 Act, domestic fisheries rapidly expanded in U.S. waters to replace the excluded foreign fleets. This combined with advances in technology over the past 30 years that have allowed fishing vessels to harvest more quickly and efficiently has caused fleets in some fisheries to expand beyond sustainable levels. When there are too many vessels present in a fishery than are necessary to harvest the resource, this is termed overcapacity. Many fisheries throughout the Nation are currently experiencing overcapacity. Overcapacity leads to a number of problems, including exacerbating overfishing, increasing safety concerns, gear conflicts and allocation issues, and reducing the economic viability of fisheries and creating market gluts. Overcapacity often can lead to greater fishing restrictions.

One solution to the overcapacity problem is the implementation of limited access privilege programs (LAPP's; also called dedicated access privilege) such as individual transferable quota (ITQ) and individual fishing quota (IFQ) programs. LAPP's typically work by allocating a percentage of the total allowable catch for the fishery to each qualifying individual or business entity. Allocation can be accomplished in several different ways, but is usually based on the historical landings associated with a permit or vessel; other considerations may include allocating a portion of the quota equally among qualifying fishermen. In many cases, it is prohibitively expensive for new participants not originally allocated quotas to enter the fishery once allocation has taken place, effectively solving the overcapacity issue. However, LAPP's often have a small amount of quota set aside for distribution to or purchase by new entrants and/or non-qualifying small-scale fishermen.

The MSRA contains language supporting the development of LAPP's in U.S. fisheries and provides specific guidelines and requirements for the implementation of such programs. LAPP's should promote conservation and management goals, and the MSRA specifies that such programs must assist in the rebuilding of a stock if established in a fishery that is overfished or subject to a rebuilding plan, or contribute to reducing capacity if established in a fishery that is determined to have overcapacity. LAPP's also must promote fishing safety and social and economic benefits in addition to their fishery conservation and management goals.

There are many benefits of LAPP's. Foremost among these are achieving conservation goals such as reducing fishing mortality and increasing stock size to sustainable levels. However, there are many direct benefits to fishermen as well. By reducing overcapacity, LAPP's result in more efficient and more sustainable fisheries. LAPP's also increase safety for fishermen, especially in fisheries where derby fishing[16] existed prior to implementation of the LAPP. The increased flexibility for fishermen to fish during a longer fishing season prevents market gluts, which combines with greater control over product quality to increase profitability of fisheries. Additionally, LAPP's increase the level of individual accountability, and encourage greater levels of responsibility and stewardship.

Limited access privilege programs may also have some drawbacks as well. Market transfers can redistribute fishery infrastructure, impacting local economies and coastal communities dependent on fisheries. Similarly, concentration of quota ownership can concentrate fishery resource usage. Creation of LAPP's may also create a situation where new entrants or those who did not receive an allocation have difficulty entering the fishery due to the cost of quota shares. Additional rules or special programs built into the LAPP either at implementation or after implementation can often mitigate any potential negative impacts.

Limited access privilege programs have already been implemented in a total of 12 U.S. fisheries. Alaska leads the way with six current LAPP's; other programs exist in the Northeast Shelf, Gulf of Mexico, and California Current RE's. Five additional LAPP's are currently planned for the tilefish, Atlantic sea scallop, Gulf of Mexico grouper, South Atlantic snapper-grouper, and the West Coast groundfish trawl fisheries. The Atlantic surfclam and ocean quahog fishery in the Mid-Atlantic is one of the oldest LAPP's in the United States, operating under an ITQ system enacted in 1990; the ITQ system has successfully rationalized harvesting capacity, promoted higher profitability, and helped to reduce fishing mortality. In Alaska, the halibut fishery moved from an open access fishery with a short fishing season to a nearly 8-month-long season under an IFQ program; under IFQ, the resource has been healthy while the total catch has been near record levels, and most components of the fishery have been very successful in recent years. The crab fisheries in Alaska just recently underwent the Crab Rationalization Program, in which crab resources were allocated among harvesters (as IFQ's), processors (as individual processing quotas,

Aleksey Zuyev, Murmansk Marine Biological Institute

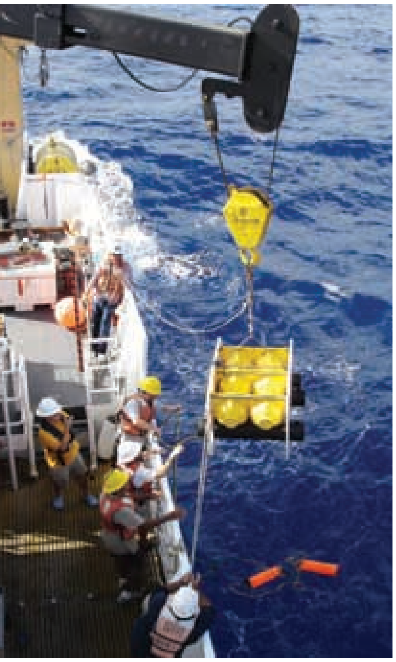
King and Tanner crab fisheries in the Bering Sea have recently entered the Crab Rationalization Program, which allocated crab resources among harvesters, processors, and coastal communities. The Program is a limited access system that addresses conservation and management issues associated with the previous derby fishery, reduces bycatch and associated discard mortality, and increases the safety of crab fishermen by ending the "race for fish."

[16]A fishery of brief duration during which fishermen race to take as much catch as they can before the fishery closes.

or IPQ's), and local communities (as community development quotas, or CDQ's). The Crab Rationalization Program addresses conservation and management issues associated with the previous derby fishery, reduces bycatch and associated discard mortality, and increases the safety of crab fishermen by ending the "race for fish." An ITQ program in the South Atlantic wreckfish fishery, established under the South Atlantic Reeffish FMP, has stabilized management of that resource while assuring fishermen a stable, reasonable price.

Scientific Advice and Adequacy of Assessments

Timely, precise, and comprehensive scientific advice serves as the basis for preventing overfishing and rebuilding overfished stocks, guiding and tracking recovery of protected resources, and enveloping fisheries management in a more holistic approach for an EAFM. NMFS is mandated by legislation and guided by executive order to provide the best scientific information available[17] for stewardship of the Nation's living marine resources. The MMPA established three independent regional scientific review groups to advise and report on the status of marine mammals in Alaskan waters, along the Pacific Coast (including Hawaii), and along the Atlantic Coast (including the Gulf of Mexico) and requires evaluation of the interactions between marine mammals and commercial fisheries. The ESA requires the designation of critical habitat for endangered and threatened species, the development of recovery plans and long-term conservation plans, and authorizes research to learn more about protected species. The recently passed MSRA increases NMFS' responsibilities for marine fisheries stocks by requiring greater use of science in the fishery management process and authorizing the establishment of a peer review process to strengthen the scientific information used to advise the FMC's about the conservation and management of fisheries.



Allen Shimada, NMFS

Advanced scientific technologies such as this acoustic buoy being deployed from the NOAA ship *Oscar Elton Sette* help to collect environmental data used in stock assessments.

The National Marine Fisheries Service's living marine resource and essential habitat assessments provide the basis for scientific advice to management. The provision of the best scientific information for the management of fisheries involves collecting and evaluating relevant data; analyzing those data by using an assessment model of the stock and its fishery; subjecting the data, methods, and assessment results to a peer-review process; and delivering the results of the assessment to the FMC and other clients. A fully adequate fish stock assessment provides estimates of historical, current, and future abundance of the stock and mortality caused by fishing; in other terms, it provides the necessary information to determine if overfishing is occurring and if the stock has become depleted. Data sources for stock assessments include fishery-dependent data collected from fishermen, processors and observers, and fishery-independent data collected through at-sea resource surveys conducted by NOAA Fisheries Survey Vessels (FSV's) and program-chartered fishing vessels. A National Research Council review in 1998 determined that fishery-independent surveys are the most reliable source of information on trends in fish abundance (NRC, 1998). NOAA's multiyear initiative to modernize and replace its aging fleet of FSV's is a key component to improving NMFS' fishery-independent data collection and providing multidisciplinary capabilities to simultaneously collect biological, environmental, and ecosystem-level data. Such

[17]In the United States, use of the term "best scientific information available" and related terms originated in MMPA legislation, in later amendments to the ESA, and in establishing management standards for marine fisheries in the original 1976 Act, carried through in the reauthorized MSA and refined in the MSRA.

Wayne Hoggard, NMFS

The launch of the NOAA Ship *Bell M. Shimada*, the fourth in a series of new state-of-the-art fishery survey vessels for the NOAA fleet. The ship, designed to conduct both fisheries and oceanographic research, is one of the most technologically advanced survey vessels in the world. Once operational, the *Shimada* will support NMFS' living marine stewardship and ecosystem management requirements in the California Current and adjacent international waters of the eastern tropical Pacific Ocean.

multidisciplinary approaches are necessary to support ecosystem-based management, which requires additional information beyond target species abundance trends.

Stock assessments also provide information on the health of marine mammals and other protected resources. The MMPA requires that Stock Assessment Reports be prepared at least every 3 years for all cetacean and pinniped stocks in U.S. waters. The data used to assess protected species includes fishery-dependent data on fishery interactions with protected species, biological research conducted by NMFS scientists, and surveys performed aboard NOAA FSV's. The information in protected resource assessments is necessary to design effective and efficient conservation and recovery programs.

Many stocks still lack adequate assessment advice about their current status, which diminishes NMFS's ability to sufficiently manage these stocks (i.e. select appropriate thresholds or limits and determine status). Of the stocks reported in Units 1–20, 18% have unknown harvest rates (Table 3) and 17% have unknown stock statuses (Table 4). A number of stocks are still classified as having undefined harvest rates or stock status, meaning that no thresholds have been set in the FMP to measure current fishing mortality or biomass levels against. Although these stocks account for only a small proportion of the total RAY, they include stocks that support important local fisheries and important ecosystem components such as sharks and several pelagic species. Of the marine mammal stocks listed in Units 21–23, 35% have no minimum population estimate (N_{min}) available, 44% have unknown values for potential biological removal (PBR) or total annual human-caused mortality, and 85% do not have population trends available. In most cases, data availability is much more limiting at this point than assessment theory, models, or computation capacity. To improve scientific advice to management, more comprehensive data

Fishery scientists process the catch aboard a chartered fishing vessel in a survey of Gulf of Alaska groundfish stocks.

collection, better species identification and stock delineation, and additional biological research is needed to enable the assessment of additional stocks.

The practical consequence of NMFS' mandate to provide the best science information available is that NMFS has the responsibility to improve scientific information for better decision making. Improved data collection for many stocks will be necessary before there is sufficient information available to assess these stocks. For some fisheries stocks, such as many shark and reef fish species in the Atlantic and Pacific, species-specific catch data are needed to move from multispecies complex assessments to adequate assessments completed on an individual stock basis. Other stocks will need additional fishery-independent surveys to provide data for assessments; an example is some of the nearshore rockfish species on the U.S. West Coast that cannot be adequately sampled with traditional techniques because of their rocky habitats. Additionally, the requirements for the next generation of fish and protected resource stock assessments will necessitate continued improvements to data and refinements to models to allow managers to emphasize ecosystem considerations such as multispecies interactions, trophic structure, environmental effects, fisheries oceanography, socioeconomic use data, and spatial and seasonal analyses.

Although there is still a need for improved data collection to support stock assessments and advice to management, substantial advances have been made toward improving the adequacy of assessments. Improving data collection is a top priority in order to improve the quality of scientific advice to management. Data collection improvements are being achieved through a number of programs, including increased cooperative research programs with university and fishing industry partners; increased observer coverage; improved recreational fishing surveys; higher quality fishery-independent surveys being conducted on the new state-of-the-art NOAA Fishery Survey Vessels (FSV's); and outreach efforts to improve species identification and reporting from commercial fishermen. Such improvements in data collection have led to new insights into the biology of some species that have allowed for more precise stock assessments. Additionally, improvements in data collection for some stock complexes have allowed for some stocks to be assessed as single species independent of the rest of the complex. New technologies are also playing an important role in enhancing NMFS' capacity to provide more efficient and accurate population surveys (see Feature Article "Improving Fisheries with Advanced Sampling Technologies" for more information).

OUTLOOK

The recent reauthorization of the MSA highlights the main issues facing living marine resource management in the United States in the 21st century. The movement towards ecosystem approaches to management, ending overfishing, rebuilding overfished stocks to healthy and sustainable levels, improving data collection and the quality of scientific advice for management, and developing new approaches to meet these goals are currently some of the most important issues of national concern.

Substantial advances have been made since the first *Our Living Oceans* was published in 1991. However, because each stock and each fishery is unique, the progress made towards resolving the problems facing them as a whole may seem slow. Additionally, our oceans and living marine resources face ever-increasing pressures from intensifying fishing effort and technological advances allowing for more efficient harvests, increasing demand for seafood products and recreational fishing experiences, habitat pressures from urbanization of coastal zones and population growth, and the long-term effects of climate change. These increasing pressures act to balance out some of the forward progress that has been made and create additional challenges for scientists and managers working to conserve and protect the Nation's LMR's.

John Butler, SWFSC

A school of pygmy rockfish.

The outlook for the Nation's living marine resources depends in good part on the management actions that are being taken at present. The MSRA gives NMFS and the FMC's powerful new tools to end overfishing, reduce overcapacity, and accelerate the rebuilding of depleted stocks. Additionally it encourages movement toward ecosystem-based management, which will allow for a more holistic approach to managing fisheries and the marine ecosystems they are an integral part of. Substantial progress toward implementation of the MSRA management measures has already been made, but the success of these new management tools depends on continued progress and effective implementation in the foreseeable future. Losses in yield may occur as an immediate cost of rebuilding some overfished stocks, but these are expected to last only in the short-term. Judging from the remarkable ability of many stocks to recover from overfishing, the outlook is very positive over the long term regarding the potential for higher sustainable yields from healthy stocks.

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