U.S. COMMISSION ON OCEAN POLICY

PART VI
OCEAN VALUE AND VITALITY: ENHANCING THE USE AND PROTECTION OF OCEAN RESOURCES

CHAPTER 19: ACHIEVING SUSTAINABLE FISHERIES

The current fishery management regime's emphasis on local participation, coupling of science and management, and regional flexibility are laudable. Nevertheless, the last thirty years have witnessed overexploitation of many fish stocks, degradation of habitats, and negative consequences for too many ecosystems and fishing communities. To ensure the long-term sustainability of U.S. fisheries, maximize social and economic benefits, and reinforce the principle that living marine resources are held in public trust for the benefit of all U.S. citizens, fishery management must be improved. While ultimately the management of fisheries should move toward a more ecosystem-based approach, specific reforms can produce some immediate improvements. These include increasing the role of science by separating allocation and assessment, better integration of ecosystem science, data collection, and processing with management and enforcement, and exploring the use of dedicated access privileges. Finally, improved regional coordination and planning will help put fishery management in the broader context of ocean and coastal management.

CONTEMPLATING THIRTY YEARS OF FISHERY MANAGEMENT

When the Stratton Commission report was released in 1969, marine fisheries were largely unregulated and coastal states had primary responsibility for fishery management. The U.S. fishing industry was behind much of the world both in harvesting fish and technical sophistication. Distant fishing nations, such as the then Soviet Union, Spain, and Japan, dominated harvests on the coasts of North America, fishing just outside the 3 nautical mile limit of U.S. territorial waters.

But fishery harvests around the world were increasing in the 1960s, and many people believed they would continue to increase indefinitely. The Stratton Commission predicted that enhanced technology and intensified exploitation of new species could eventually increase worldwide landings from 60 million metric tons in 1966 to 440–550 million tons.[1] That Commission saw fisheries as an area of immense opportunity, and called for the expansion of U.S. fishing capability. Unfortunately, events over the next few decades showed these predictions to be overly optimistic.

In 1970, landings of Peruvian anchoveta, the largest fishery in the world, fell by 10 million metric tons in one year—at the time, roughly 10 percent of world fishery landings.[2] Although El Niño conditions in the Pacific Ocean are often cited as the cause, many scientists believe the collapse was exacerbated by excessive fishing effort. The following two decades also saw the North Atlantic cod fisheries drastically decline; in the 1990s, Canada completely shut down its cod fishery. Instead of being able to expand worldwide fish landings by eight to ten times, as predicted by the Stratton Commission, it now appears that fish landings were already at or near their peak in the late 1960s.

In 1976, Congress approved the Magnuson–Stevens Fishery Conservation and Management Act (hereinafter, the Act or the Magnuson-Stevens Act) to manage and assert U.S. control over fishery resources within 200

nautical miles of the coast, later designated as the U.S. exclusive economic zone (EEZ). Eight Regional Fishery Management Councils (RFMCs) were created to develop management plans for fisheries in federal waters. The Act required regional plans to be consistent with broad national guidelines, such as the prevention of overfishing and the requirement to use the best available science, but otherwise granted considerable flexibility to the RFMCs. The Act mistakenly assumed that once foreign fishing fleets were removed from U.S. waters, major fishery management problems would be over.

In subsequent years, the domestic fishing industry rushed to enlarge its capacity to catch fish. New technologies were developed while programs such as the Capital Construction Fund and Fishing Vessel Obligation Guarantee Program provided incentives for U.S. fishermen to upgrade or buy new vessels. This led to an unprecedented and unforeseen expansion of U.S. fishing power.

Most of the abundant stocks available to be caught by American fleets were in the North Pacific. In other areas, fish stocks—although still viable—had already been depleted by foreign fleets. The regional flexibility that had been seen as a great strength of the new law now showed its downside as some RFMCs set unsustainable harvest levels, leading to the collapse or near-collapse of several important fisheries.

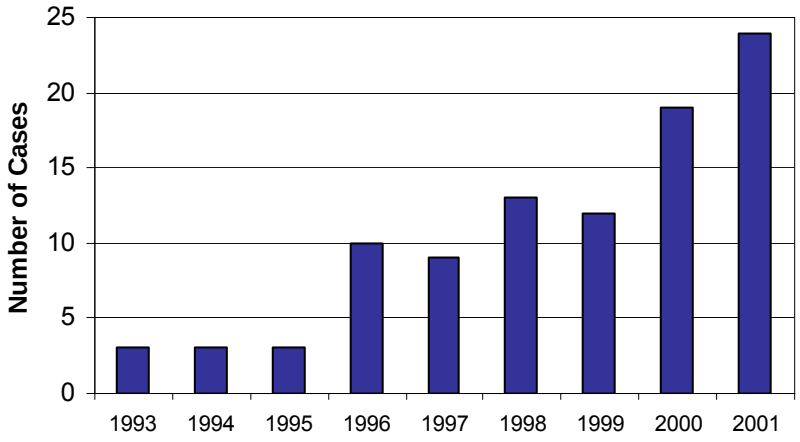
Another unforeseen and unfortunate consequence of the new management regime was the development of an adversarial relationship between fishermen and government scientists and managers. Because assessments indicated that many stocks were already depleted, scientists urged reductions in catches. Many fishermen however, having made substantial capital investments in boats and gear, resisted these findings and instead raised doubts about the credibility of the assessments. The RFMCs frequently made decisions that supported the fishermen by downplaying scientific advice and increasing catch limits. As a result, in most regions, stocks continued to decline throughout the 1980s.

Contention grew, and the 1990s were characterized by a dramatic increase in litigation, crisis-driven decision making, and management through court orders and congressional intervention (Figure 19.1). As of January 2002, more than 110 lawsuits were pending against the National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS). And between 1990 and 2000, the National Research Council conducted ten studies aimed at resolving disputes in fishery management.

On a more positive note, the 1990s also witnessed some signs of recovery. Atlantic striped bass were declared recovered in 1995, many New England groundfish species began to come back, and summer flounder stocks in the Mid-Atlantic started to increase.

A 2002 study by the National Academy of Public Administration concluded that the U.S. fishery management system was in disarray and recommended that the U.S. Commission on Ocean Policy explore the need for major changes in the fishery management system. [3] While amendments to the Magnuson–Stevens Act have helped reverse fishery declines, additional changes will be necessary to manage fisheries in a sustainable manner over the long term.

Figure 19.1. Fishery Litigation Grows as Interests Clash



From 1993 to 2001, the number of cases brought against the National Marine Fisheries Service increased eight fold. A major cause of new cases during this time was disputes about the validity of stock assessments and resulting catch limits.
Source: National Academy of Public Administration. *Courts, Congress, and Constituencies: Managing Fisheries by Default*. Washington, DC, July 2002.

BUILDING SUSTAINABLE FISHERIES BASED ON SOUND SCIENCE

The Value of Science for Wise Management

Accurate, reliable science is critical to the successful management of fisheries. Two kinds of data are collected to support fisheries science. *Fishery-dependent* data are collected as part of normal fishing activities and include recreational and commercial catch and landings records, dealer reports, and onboard observer data. Observers on fishing vessels provide a variety of useful fishery-dependent data concerning harvest methods and the bycatch of fish and prohibited species, such as turtles and marine mammals. *Fishery-independent* data are collected outside of normal fishing activities, typically through scientifically-designed surveys conducted by specialized research vessels.

Using available data as input, computer models produce stock assessments that estimate the size and characteristics of a certain fish population. Based on these assessments, and an understanding of the biology of that species, scientists can then predict the effects of different levels of fishing intensity on the population. Fishery managers must then determine how, when, where, and—most importantly—how many fish may be caught.

Although fishery data collection and stock assessment models can always be improved, a lack of adequate scientific information has not been the main culprit in most instances of overfishing. The Mid-Atlantic and New England RFMCs, which managed fourteen of the thirty-three stocks that experienced overfishing in 2001, have some of the best scientific support in the world. A 2002 National Research Council report concluded that the problem in most cases of overfishing was that the RFMCs disregarded or downplayed valid scientific information when setting harvest guidelines.[4] Neither NMFS nor the Secretary of Commerce used their authority to prevent the RFMCs from taking such actions.

The Magnuson–Stevens Act requires each RFMC to establish and maintain a scientific and statistical committee (SSC) to provide "the best scientific information available" and assist in the development of fishery management plans. However, the Act does not require the RFMCs to follow the advice of the SSCs.

Social, economic, and political considerations have often led the councils to downplay the best available scientific information, resulting in overfishing and the slow recovery of overfished stocks. In addition, the selection of SSC members is generally up to each RFMC. No process is in place for ensuring that SSC members have the proper scientific credentials and are free from conflicts of interest. Although some councils do assemble highly respected SSCs and follow their advice, the public and the fishing community should be confident this is the case in all regions.

Recommendation 19–1. Congress should amend the Magnuson–Stevens Fishery Conservation and Management Act and related statutes to require Regional Fishery Management Councils (RFMCs) and interstate fisheries commissions to rely on their Scientific and Statistical Committees (SSCs), incorporating SSC findings and advice into the decision-making process. In keeping with this stronger role, SSC members should meet more stringent scientific and conflict of interest requirements, and receive compensation.

To ensure a strengthened SSC:

- *each RFMC should nominate candidates for service on its SSC. Nominees will typically be scientists with strong technical credentials and experience, selected from federal or state governments or academia. Private sector scientists who are technically qualified may also be nominated if they meet the conflict of interest requirements.*
- *no individual should be allowed to serve on an SSC if he or she is formally or financially affiliated with any harvesting or processing sector.*
- *the National Oceanic and Atmospheric Administration (NOAA) should evaluate the qualifications and potential conflicts of interest of SSC nominees through an independent review process designed by a credible, scientific organization. Ultimately, SSC appointments should be approved by the NOAA Administrator.*
- *SSC members should serve for fixed terms to allow for rotation and new members over time.*
- *like RFMC members, participants in the SSC (or their home institutions) should be compensated for time spent on RFMC business.*

Separating Scientific and Management Decisions

One of the strengths of the U.S. fishery management system is its flexibility in allowing different regions to determine who can fish, as well as how, where, and when. These are called allocation decisions. But the question of how many fish can be sustainably harvested (the assessment decisions) should be insulated from political pressures.

Because of their knowledge of the fisheries and communities in their region, RFMC members are best suited to make decisions about allocation of the available harvest and other issues related to the operations of regional fisheries. However, scientific decisions are more appropriately made by the SSCs created to support the RFMCs. Scientific decisions include stock assessments and determinations of allowable biological catch–the maximum amount of fish that can be harvested without adversely affecting recruitment or other key biological components of the fish population.

While determining allowable biological catch is a scientific question, it must be informed and guided by long-term objectives set by managers for both the fishery and the ecosystem. The role of scientific information should be as strong as possible in fishery management and subject to the least possible political influence.

For this reason, many fishery managers and analysts have recommended separating scientific assessment decisions from the more political allocation decisions. While not required by law, some RFMCs have already taken this step. For example, the North Pacific council has a history of setting harvest levels at or below the level recommended by its SSC. Many policy makers believe this practice is largely responsible for the successful management of the fisheries in that region.

Recommendation 19–2. Scientific and Statistical Committees (SSCs) should be required to supply Regional Fishery Management Councils (RFMCs) with the scientific information necessary to make fishery management decisions. Such information could include reports on stock status and health, socioeconomic impacts of management measures, sustainability of fishing practices, and habitat status. In particular, the SSCs should determine allowable biological catch based on the best scientific information available to them.

Recommendation 19-3. Each Regional Fishery Management Council should be required to set harvest limits at or below the allowable biological catch determined by its Scientific and Statistical Committee. The councils should begin immediately to follow this practice, which need to be codified at the next opportunity in amendments to the Magnuson–Stevens Fishery Conservation and Management Act.

The Need for Independent Review

Independent review is the hallmark of the scientific process, providing assurance that appropriate procedures for data collection and analysis have been used. Typically such reviews are conducted by scientists with expertise similar to those who have done the work; thus the process is called peer review.

Many of those affected by RFMC decisions have questioned the adequacy of the scientific information on which those decisions were based. Although scientific findings are always easier to accept when they bring good news, the lack of a standardized, independent, and transparent review process in all regions has added to the level of distrust. Many of the RFMCs and interstate commissions with management responsibilities currently apply the peer review process sporadically. The North Pacific, New England and Mid-Atlantic regions have long-standing peer review programs. Other RFMCs use an external peer review process only when results are expected to be controversial. In some cases where scientific information is reviewed, the reviewers have not been perceived as independent, a critical feature of the process.

The National Research Council (NRC) has conducted a number of reviews of NMFS science. However, the NRC cannot be called upon to review every scientific decision, particularly stock assessments, at the rate they are generated for the RFMCs. An interesting model for external scientific review is the Center for Independent Experts that was established by NMFS in 1998 to conduct reviews of fisheries-related science. Although NMFS pays for its operation, the center is currently based at the University of Miami and is completely insulated from NMFS once it initiates a peer review. Although the center's experts have examined a number of controversial topics, their reviews have so far been less subject to challenge than internal NMFS peer reviews.

Recommendation 19–4. The National Marine Fisheries Service, working with the Regional Fishery Management Councils and the interstate fisheries commissions, should develop a process for independent review of the scientific information generated by the Scientific and Statistical Committees in all regions.

The process should include three distinct procedures:

- *a standard review, undertaken annually by regional scientists, to ensure that the correct data and models are being used.*
- *an enhanced review to evaluate the models and assessment procedures. To ensure that these reviews are independent, a significant proportion of the reviewers should come from outside the region and be selected by a group such as the Center for Independent Experts. These types of reviews would be conducted on a three- to five-year cycle, or as needed, to help ensure that the latest methods and approaches are being used.*
- *an expedited review to be used when results are extremely controversial or when the normal review process would be too slow. In these cases, all reviewers should be selected by a group such as the Center for Independent Experts.*

As these review procedures are implemented and become a regular part of the fishery management process, NMFS, the RFMCs, and states should be able to develop routine quality assurance steps and standards to be applied to all stock assessments and other scientific input to the fisheries process. A certification procedure for stock assessment scientists will help ensure implementation of these standards.

Using Default Measures to Ensure Progress

The difficult process of establishing allowable biological catch, and then determining allocations based on that figure, can result in lengthy delays in developing or revising fishery management plans. The Magnuson–Stevens Act does not require RFMCs to submit a new or revised plan to NOAA on any specific schedule. As a result, council delays can lead to a fishery having no management measures in place or relying on outdated, inadequate plans. When that happens, the RFMCs are not penalized; instead, the adverse consequences are all borne by the fishery resource. There are two possible sources of delay: SSC difficulties in reaching agreement on allowable biological catch and RFMC delays in submitting management plans to NOAA for approval.

The science behind stock assessments is complex and constantly evolving. By nature and training, many scientists are reluctant to declare a definitive numerical conclusion in the face of inevitable uncertainty. And yet, decisions must be made. By joining an SSC, scientists must accept the necessity of giving the best advice possible within a real-world timeframe.

Delays in formulating management plans within the RFMC can be more intractable. Under the current system, RFMCs can simply avoid difficult decisions by postponing development of plans. While the councils cannot be sued for their slowness, NMFS can be. In fact, an increasing number of lawsuits are prompted by delays in management actions, particularly for plans to end overfishing.

The very possibility of extended delays puts pressure on NMFS to recommend approval of inadequate management plans. Based on a recommendation from NMFS, the Secretary of Commerce may approve, partly reject, or reject a plan, but may not amend it. As part of its recommendation, NMFS is aware that rejection of a plan could result in no conservation measures being in place until the RFMC agrees on a revised plan—a process that could take many months.

Although the Secretary of Commerce can legally choose to develop a fishery management plan within the agency instead of waiting for a regional council to do so, this is almost always impractical. Since Congress clearly desired RFMCs to have the lead in fishery management, the Secretary can either enter into a protracted, contentious, and politicized process to develop a departmental plan, or continue to wait for the RFMC to act. Under either scenario, the resource may remain unprotected for an extended period of time.

Indecision on the part of SSCs or RFMCs, for whatever cause, should not delay measures to ensure the long-term health and economic viability of a fishery. By setting clear deadlines for action, and activating established default measures if a deadline is missed, the roles of the different entities can be maintained without sacrificing the resource.

Recommendation 19–5. Each Regional Fishery Management Council should set a deadline for its Scientific and Statistical Committee (SSC) to determine allowable biological catch. If the SSC does not meet that deadline, the National Marine Fisheries Service Regional Science Director should set the allowable biological catch for that fishery.

Recommendation 19–6. Once allowable biological catch is determined, whether by the Scientific and Statistical Committee or the National Marine Fisheries Service (NMFS) Regional Science Director, the Regional Fishery Management Council should propose a fishery management plan in time for adequate review and approval by NMFS. If the plan is not presented in a timely fashion, all fishing on that stock should be suspended until NMFS can review the adequacy of the management plan.

Making Research Relevant

As noted above, independent reviews have generally concluded that NMFS stock assessment programs are technically sound and highly credible. However, improvements could be made to better serve the RFMCs' information needs, support recreational fisheries, and expand opportunities for cooperative research to involve scientists and fishermen in joint projects.

RFMC Input on Research Priorities

RFMC members need access to reliable information to do their jobs. The NMFS science program has done well in providing biological information to manage single species. However, the research program is less well positioned to answer many other pressing questions.[5] Generally, questions that involve interactions among fisheries, habitat, and other protected species, as well as social science and economic questions, have received less attention than traditional stock assessment science and fishery biology. [6, 7] The move toward ecosystem-based management, including considerations such as essential fish habitat, highlights these shortcomings. As the agency charged with responsibility for federal fishery management, NMFS should ensure that its research agenda supports the information needs of the RFMCs.

Recommendation 19–7. The Regional Fishery Management Councils and their Scientific and Statistical Committees should develop an annual, prioritized list of management information needs and provide it to the National Marine Fisheries Service (NMFS). NMFS should incorporate these needs to the maximum extent possible in designing its research, analysis, and data collection programs.

The lists of RFMC information needs will also be of great value to the regional ocean information programs discussed in Chapter 5, which would be responsible for crafting regional research strategies to meet management needs. Fisheries research and data requirements should also be included as an integral part of planning for the Integrated Ocean Observing System discussed in Chapter 26.

Data Needs for Recreational Fisheries

Recreational fishing is an important part of the culture and economy of many coastal communities. In 2002, an estimated 9.1 million saltwater recreational fishermen spent over $20 billion and supported almost 300,000 jobs.[8]

Recreational fishing has many impacts on fishery resources. On the beneficial side, the increasing number of catch-and-release programs has been associated with helping some stocks recover. In addition, the Ethical Angler program, a voluntary code developed with cooperation between NMFS and constituent groups, promotes a stewardship ethic among recreational fishermen on behalf of the entire marine environment. On the other hand, recreational fishermen can contribute significantly to the overall mortality of certain stocks. For example, in 2001, recreational anglers landed over 19 million pounds of striped bass on the East Coast, three times the amount caught by the commercial sector.[9]

Despite the economic and ecological importance of recreational fishing, much less data are collected in this area than for commercial fisheries. The NMFS Marine Recreational Fisheries Statistics Survey, the primary recreational data collection program, is accomplished using two methods: an intercept survey, where fishermen are interviewed at coastal fishing ports, and a random telephone survey of all coastal households. The telephone survey results could be greatly improved if the sample of individuals called could be drawn from a list of licensed recreational fishermen rather than all coastal households. This would require coastal states and the federal government to require licenses for all saltwater anglers.

Although the existing survey methodology is adequate for long term tracking of recreational fishing trends, it has proven less useful for in-season management. For example, on the East Coast, the lack of in-season tracking of catches by recreational fishermen has led to the chronic overharvesting of summer flounder.[10] Due to the increasing popularity of marine recreational fishing, and its growing proportion of the total catch in some fisheries, it will be critical to collect timely data in this sector to allow for sustainable management of fisheries.

Recommendation 19–8. The National Marine Fisheries Service, working with states and interstate fisheries commissions, should require all saltwater anglers to purchase licenses to improve in-season data collection on recreational fishing. Priority should be given to fisheries in which recreational fishing is responsible for a large part of the catch, or in which recreational fishermen regularly exceed their allocated quota.

The Value of Cooperative Research

Involving fishermen in the research process, referred to as cooperative research, is a promising approach that can produce benefits for the fishermen, the scientists, and ultimately the management process. Underutilized fishing vessels can provide cost-effective research platforms to expand the scope of data gathering and create an additional source of income for fishing communities waiting for stocks to recover. Fishing vessels are usually significantly less expensive to operate than traditional research vessels, while still suitable for many types of research. Scientists can also benefit from the knowledge and experience gained by fishermen during years at sea.

Increased interaction and rapport between fishermen and fishery scientists is another benefit of cooperative research. In many regions of the country, fishermen are skeptical of the science and analysis used to support fisheries management. Until the 1990s, scientists rarely included fishermen in either the design or data collection phases of their research. This has fed the perception in fishing communities that scientists do not understand fishing and do not value the experiences of fishermen. Greater involvement of fishermen in research programs appears to have been successful in reversing this perception and promoting better understanding between fishermen and scientists.

In 1977, when NMFS stock assessments indicated that bowhead whales off Alaska's North Slope were at extremely low levels, the International Whaling Commission proposed a ban on all whaling, including that done for subsistence. The indigenous whaling community, convinced that the assessment had under-counted whales, provided NMFS scientists with additional information on whale locations and migration patterns based on traditional knowledge. The scientists revised their survey protocols to incorporate this new information, determined that they had in fact underestimated the whale population, and allowed the subsistence harvest to continue.

Similarly, in 1999, initial estimates indicated that Atlantic monkfish were severely overfished and a management plan was created to curtail fishing and rebuild the stock. When fishermen contended that the NMFS survey was missing significant stocks of monkfish in deeper waters, NMFS initiated a cooperative

research program to investigate. The results indicated that monkfish were indeed present in significant numbers in deeper waters, allowing managers to reduce the severity of catch restrictions.

In both of these examples, anecdotal or traditional information was not unconditionally accepted. Instead, scientists used data from fishermen as the basis for further investigation. Scientists can benefit from fishermen's experience by incorporating their suggestions into the design of research programs. At the same time, fishermen need to realize that informal information can only be used in decision making after it has been tested and verified according to a methodical, scientific process.

Cooperative research has the potential to be applied quite broadly. Although fishery-specific research, particularly experiments with new or modified gear types, is the most obvious application, others should be considered. The RFMC lists of information needs, suggested above in Recommendation 19–6, will be helpful in selecting topics for cooperative research. For example, NOAA should organize its oceanographic research programs to take advantage of cooperative opportunities, as should scientists conducting economic or social science research related to oceans and coasts.

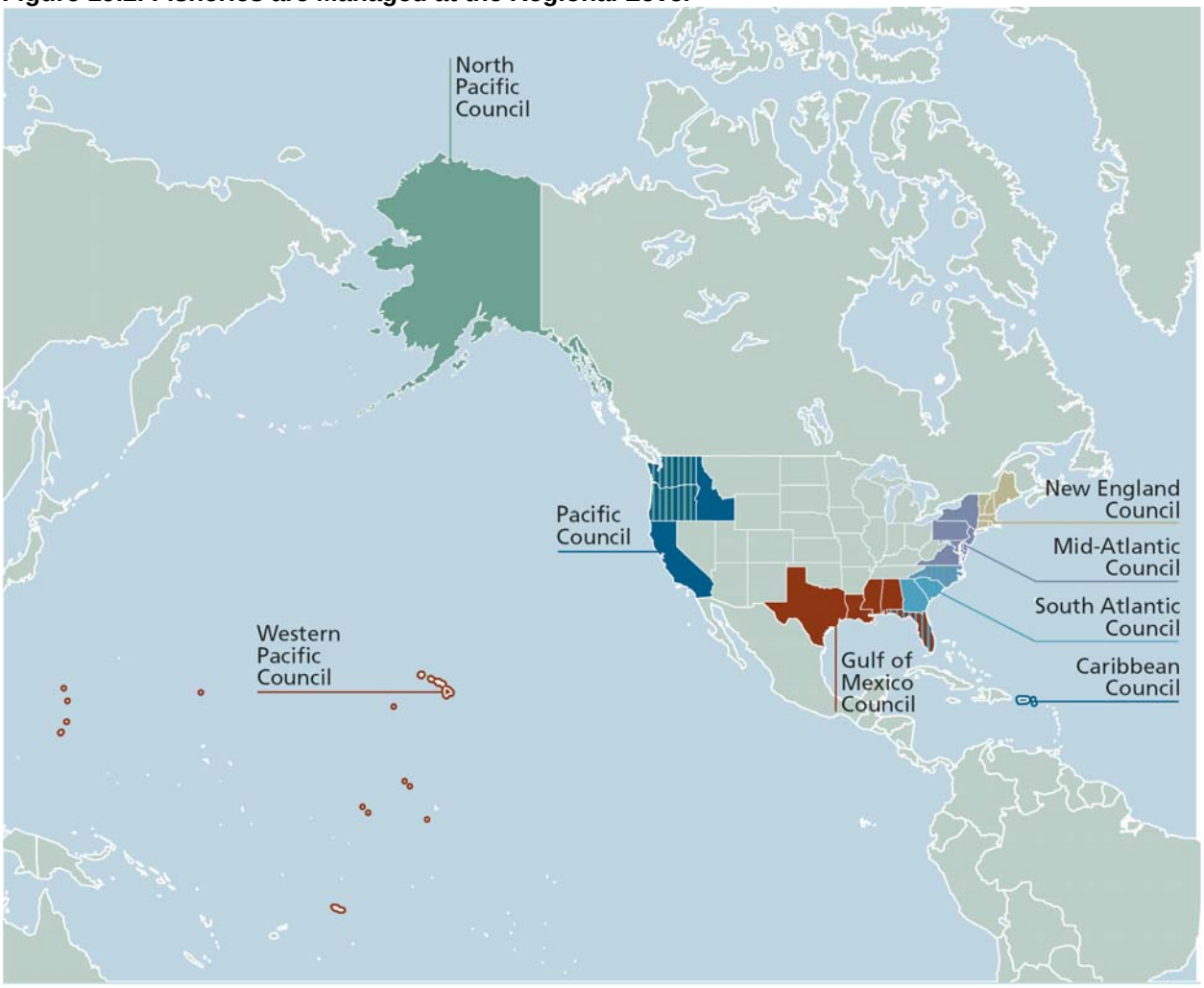
Recommendation 19–9. Congress should increase support for an expanded, regionally-based cooperative research program in the National Oceanic and Atmospheric Administration (NOAA) that coordinates and funds collaborative projects among scientists and commercial and recreational fishermen. NOAA should develop a process for external evaluation and ranking of all cooperative research proposals to ensure the most worthwhile projects are funded, the most capable performers are undertaking the research, and the information produced is both scientifically credible and useful to managers.

STRENGTHENING FISHERY GOVERNANCE

Clarifying Fishery Management Authority and Jurisdiction

In 1976, the Magnuson–Stevens Act greatly expanded the federal government's marine fishery management jurisdiction from the seaward boundary of state waters out to 200 nautical miles from the coast. Known as the Fisheries Conservation Zone, this newly created area was later subsumed into the EEZ. In general, marine fishery management jurisdiction is divided among the states, three interstate fisheries commissions, eight RFMCs, and the federal government. The RFMCs develop management plans for fisheries within their portion of the EEZ (Figure 19.2). Based on advisory group recommendations, NMFS develops and implements plans for highly migratory species (including tuna, swordfish, billfish, and sharks) within the EEZ in the Atlantic, Gulf of Mexico, and Caribbean regions. In the Pacific, the RFMCs or states include highly migratory species in their management plans.

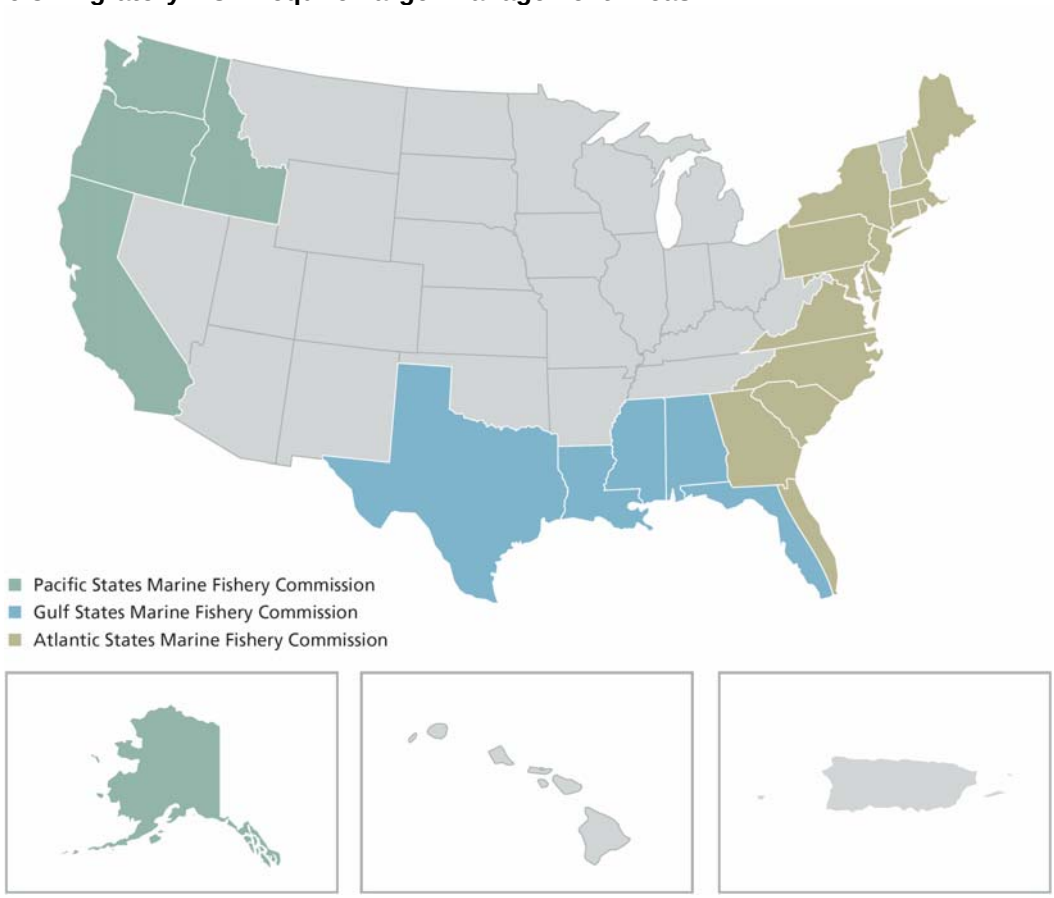
Figure 19.2. Fisheries are Managed at the Regional Level



The Magnuson-Stevens Fishery Conservation and Management Act of 1976 created eight regional fishery councils to manage the harvest of living marine resources within each region. The councils are responsible for sustainable development of domestic fisheries and link the fishing community more directly to the management process. Several states belong to more than one council. For example, Oregon and Washington are members of both the Pacific Council and North Pacific Council.

Each coastal state has authority over fisheries that occur only in that state's waters, while interstate fisheries commissions can develop management plans for fisheries that occur primarily in state waters but cross the boundaries of many states (Figure 19.3).

Figure 19.3. Migratory Fish Require Larger Management Areas



The three interstate marine fisheries commissions are critical to managing and conserving migratory fish that traverse the jurisdictional waters of multiple states.

Interstate Fisheries Commissions

For most of their history, the Atlantic States and Gulf States Marine Fisheries Commissions provided forums for assembling interstate catch statistics and designing fishery management plans to conserve and sustain fish stocks. State compliance with these plans was voluntary. The Gulf States Commission's plans remain voluntary, but the Atlantic Coastal Fisheries Cooperative Management Act of 1994 authorized the Secretary of Commerce to close fisheries that the Atlantic States Commission determined are out of compliance with its management plan. The Pacific States Marine Fisheries Commission is primarily a research coordination agency that provides a forum for discussing interstate fishery issues.

The Great Lakes Fishery Commission, established by agreement between Canada and the United States in 1955, develops coordinated research programs and recommends measures to maximize productivity of Great Lakes fisheries. It also oversees a program to eradicate or minimize sea lamprey populations in the Great Lakes.

Recommendation 19–10. Congress should develop new statutory authority, similar to the Atlantic Coastal Fisheries Cooperative Management Act, to support and empower the Gulf States and Pacific States Fisheries Management Commissions. All interstate management plans should adhere to the national standards in the Magnuson–Stevens Fishery Conservation and Management Act and the

federal guidelines implementing these standards. States should participate in guideline development to ensure they are relevant to interstate plans.

Clarifying Lead Authorities for Joint Planning Purposes

Dividing the natural world into neat management units is never easy, and fish populations are no exception. Although a few fish species remain in one area for most of their lives, others are highly mobile and cross federal, state, and interstate boundaries. The lack of effective mechanisms for coordination and cooperation among the many fishery management entities exacerbates the problem of managing transboundary stocks.

The existing jurisdictional structure requires the development of joint plans, primarily in the Atlantic, by two or more RFMCs, and by the states and RFMCs. In most cases, each entity in the joint planning process has equivalent authority. This joint planning process has generally been inefficient. Joint plans take longer to approve and amend, causing delays in needed conservation measures. In addition, the varied jurisdictions create confusion for fishermen and the public about who is in charge of management and enforcement. Changes are needed to reduce the jurisdictional confusion in marine fishery management and improve cooperation among the states, interstate commissions, RFMCs, and the federal government.

Recommendation 19–11. When a fish stock crosses administrative boundaries, Congress should clearly assign fishery management jurisdiction and authority. For each fishery management plan, a state, Regional Fishery Management Council (RFMC), interstate fisheries commission, or the National Oceanic and Atmospheric Administration (NOAA) should be established as the lead authority. That designation should be based primarily on the proportion of catch associated with each management authority. However, once designated, management authority should not shift based on annual changes in landings.

Specifically, fishery management jurisdiction and authority should be addressed as follows:

- *for interjurisdictional fisheries that occur primarily within state waters, interstate fisheries commissions should take the management lead within both state waters and the exclusive economic zone. For the Atlantic Coast, this could be implemented using authorities provided in the Atlantic Coastal Fisheries Cooperative Management Act. The Great Lakes Fishery Commission should continue to oversee Great Lakes fisheries.*
- *for fisheries that occur primarily in the exclusive economic zone, one RFMC should be responsible for developing the plan. For fisheries that are shared substantially among the jurisdictions of two or more RFMCs, the RFMCs should designate a lead. If the RFMCs are unable to agree, the NOAA Administrator should designate the lead RFMC.*
- *no changes are recommended in jurisdiction for management of highly migratory species.*
- *for any other disputes regarding jurisdiction, the NOAA Administrator should designate the lead authority.*

Improving the Regional Fishery Management Councils

Building on Success

Much of the criticism of fishery management has been directed at the RFMCs. Every council except the North Pacific and Western Pacific has jurisdiction over stocks that are being overfished, and all oversee stocks that have been overfished in the past. The North Pacific RFMC appears to be working well in most facets of its management responsibility. Of the 82 stocks under its jurisdiction with sufficient information to assess, none was classified as overfished in 2001 and only 2 stocks are at levels of abundance that indicate past overfishing. For the remaining seven RFMCs, of the 147 stocks with sufficient information to assess, 33 (22 percent) were being overfished in 2001, and 50 are at levels of abundance that indicate past overfishing. [11]

Despite this mixed record, several aspects of the existing RFMC system echo the major themes outlined in this report: a regional approach to management based on geographically defined ecosystems; a management process that requires local participation; and the incorporation of science-based, peer-reviewed information in the development of management plans. The following recommendations seek to strengthen the management process for all RFMCs, while maintaining the positive features of the system and building on the successes some have achieved.

Broadening Council Membership

The Magnuson–Stevens Act states that the Secretary of Commerce must "to the extent practicable, ensure a fair and balanced apportionment … of the active participants" on the RFMCs. However, the Secretary can only choose RFMC members from the slate of candidates forwarded by the governors. The governors themselves are under no legal obligation to put forth a fair and balanced slate of candidates. Under the Act, their only obligation is to ensure that each candidate is "knowledgeable regarding the conservation and management, or the commercial or recreational harvest, of the fishery resources of the geographical area concerned." This loophole has resulted in uneven representation on some RFMCs.

The governors are not required to recommend candidates from outside the fish harvesting industry, such as consumer groups, academia, subsistence fishermen, or environmental organizations, although these perspectives could help achieve a more balanced management regime. As it stands, the fishing industry representatives who make up the majority of RFMC members may tend to favor economic interests over the long-term sustainability of the stocks. The relatively narrow representation on RFMCs may also fuel legal challenges to fishery management plans based on allegations of conflict of interest—although it should be noted that industry groups challenge fishery management decisions as frequently as public interest groups.

Amendments are needed to ensure that RFMC membership is balanced among competing user groups and other interested parties, and that fishery management plans reflect a broad, long-term view of the public's interests. Identifying the best mix will require knowledge of the federal fishery management process and an understanding of other factors affecting ocean ecosystems. This expertise resides in the NOAA Administrator, not the Secretary of Commerce who is currently responsible for appointing RFMC members.

Recommendation 19–12. Congress should amend the Magnuson–Stevens Fishery Conservation and Management Act to require governors to submit a broad slate of candidates for each vacancy of an appointed Regional Fishery Management Council seat. The slate should include at least two representatives each from the commercial fishing industry, the recreational fishing sector, and the general public.

Recommendation 19–13. Congress should give the Administrator of the National Oceanic and Atmospheric Administration responsibility for appointing Regional Fishery Management Council members with the goal of creating councils that are knowledgeable, fair, and reflect a broad range of interests.

Training New Council Members

Fishery management demands expertise in biology, economics, public policy, and other disciplines. Although RFMC members are required to be knowledgeable about the fishery resources in their region, very few come into the process with resource management experience or scientific training. As Julie Morris, a member of the Gulf of Mexico council, said in testimony before the Commission (Appendix 2), "When I first began working with marine fisheries, the concept of 'spawning potential ratios' was difficult to understand. Now, after six

months, I'm still struggling to understand the concepts of optimum yield, biomass at maximum sustainable yield, minimum stock size threshold, and how they all fit together to determine the allowable catch."

NMFS offers a training course for new RFMC members, but they are not required to attend—and many do not. Friction between NMFS and some RFMC members has added to skepticism about the value of this training. As a result, council members often make important decisions affecting fishermen, fishing communities, and fishery resources without an adequate understanding of all relevant scientific, economic, social, and legal information.

Recommendation 19–14. The National Marine Fisheries Service (NMFS) should require all newly appointed Regional Fishery Management Council (RFMC) members to complete a training course within six months of their appointment. NMFS should contract with an external organization to develop and implement this training course and Congress should provide adequate funding. Members who have not completed the training may participate in RFMC meetings, but may not vote.

The training course should:

- *cover a variety of topics including: fishery science and basic stock assessment; social science and fishery economics; the legal requirements of the Magnuson–Stevens Fishery Conservation and Management Act, the National Environmental Policy Act, the Administrative Procedures Act, and other relevant laws or regulations; conflict of interest policies for RFMC members; and the public process involved in developing fishery management plans.*
- *be open to current RFMC members and other participants in the process as space permits.*

ENDING THE RACE FOR FISH

U.S. fishery management has historically made use of access systems—whether open or limited—that promote an unsustainable "race for the fish." This approach has produced serious resource conservation problems in many U.S. fisheries and must be changed.

Traditional Management Approaches

Until the end of the 20th century, most U.S. fisheries allowed access to anyone who wanted to fish. There were few, if any, limits other than the usually nominal cost of a permit and possession of the necessary fishing gear. In profitable fisheries, this led to ever-increasing numbers of entrants, with ever-increasing pressure being put on the fishery resource.

Recognizing the dangers posed by overfishing, managers began to regulate fishermen by placing controls either on input or output. Input controls include such measures as closing access to fisheries by limiting permits, specifying the allowable types and amounts of gear and methods, and limiting available fishing areas or seasons. Output controls include setting total allowable catch (the amount of fish that may be taken by the entire fleet per fishing season), bycatch limits (numbers of non-targeted species captured), and trip or bag limits for individual fishermen.

These management techniques create incentives for fishermen to develop better gear or to devise new methods that allow them to catch more fish, and to do so faster than other fishermen, before any overall limit is reached. They provide no incentive for individual fishermen to conserve fish, because any fish not caught is likely to be scooped up by someone else. This race for fish created an unfortunate cat-and-mouse chase.

In response to each new measure designed to limit fishing effort, fishermen developed new fishing methods that, although legal, undermined the goal of reaching sustainable harvest levels. This prompted managers to

promulgate more restrictive measures and fishermen to develop more ingenious methods to work around them. For example, if managers limited the length of the boat, fishermen increased its width to hold more catch. If managers then limited the width, fishermen installed bigger motors to allow them to get back and forth from fishing grounds faster. If managers limited engine horsepower, fishermen used secondary boats to offload their catch while they kept on fishing.

One input control many managers turned to was limiting fishing days for each fisherman or for an entire fleet. In response, many fishermen found ways to increase their fishing effort during the shorter season. In New England, the multispecies groundfish fishery shrank from a year-round fishery to less than a hundred days at sea per fisherman, with recent proposals for even lower limits. In the historically year-round halibut/sablefish fishery in the Gulf of Alaska, the fishing season dwindled to less than a week by the early 1990s.

In addition to conservation concerns, the race for fish can create safety problems. Faced by a sharply curtailed amount of time in which to harvest, fishermen often feel compelled to operate in unsafe weather conditions while loading their boats to capacity and beyond.

The constant race for fish, and the increasingly adversarial relationship between fishermen and managers, created intense pressures. Fishermen fished harder for smaller returns and managers hesitated to further reduce catch limits, fearing political and economic consequences. These pressures have been identified by many as a contributing factor in the decline of several fish stocks, notably the New England groundfish fishery.[12]

For reasons of tradition or culture, most managers hesitated to limit the number of new entrants to a fishery. However, the ineffectiveness of other controls eventually did lead managers in some fisheries to control access, for example by limiting the number of available permits.

Dedicated Access Privileges

To solve the problems described above, managers began exploring dedicated access privileges, a novel form of output control whereby an individual fisherman, community, or other entity is granted the privilege to catch a specified portion of the total allowable catch. With this assurance in place, there would no longer be an incentive for fishermen to fish harder and faster because each could only catch his or her share of the total. The incentive would then be to catch the full share at a low cost and sell the best quality fish at the highest obtainable price.

There are several different types of dedicated access privileges:

- *Individual fishing quotas* (IFQs) allow each eligible fisherman to catch a specified portion of the total allowable catch. When the assigned portions can be sold or transferred to other fishermen, they are called individual transferable quotas (ITQs).
- *Community quotas* grant a specified portion of the allowable catch to a community. The community then decides how to allocate the catch. For example, the Community Development Quota Program in Alaska granted remote villages a portion of the total allowable catch to enhance fishery-based economic development.
- *Cooperatives* split the available quota among various fishing and processing entities within a fishery via contractual agreements.
- *Geographically based programs* give an individual or group dedicated access to the fish within a specific area of the ocean.

Many other variations and combinations of dedicated access privileges are possible. Dedicated access programs can provide substantial benefits in addition to ending the race for fish. Consumers benefit because fresh, rather than frozen, fish are available for most of the year. Many believe that these programs will enhance safety because fishermen will no longer have to go out in bad weather and the U.S. Coast Guard will not be overwhelmed by thousands of fishermen operating in small areas or during a compressed season. Fishermen can develop better long-range business plans because they can more accurately anticipate their annual catch and are less likely to over-invest in boats and gear. They can also fish more carefully, minimizing gear loss and bycatch of protected and other non-targeted species. Finally, these programs allow fishermen and managers to work cooperatively instead of in conflict.

Dedicated Access Privileges: A Better Description

In this chapter, the Commission recommends steps to end the race for fish through the use of "dedicated access privileges." While this term is not new, it is not yet in wide use. More commonly used are the terms "rights-based management," "individual transferable quotas" (ITQs) or "individual fishing quotas" (IFQs). None is satisfactory as a general term.

"Rights-based management" implies granting to an individual the "right" to fish. However, U.S. fishermen do not now and will never have inalienable rights to fish because the fisheries resources of the United States belong to all people of the United States. Under current law, fishermen are granted a privilege to fish, subject to certain conditions. Because this privilege can be taken away, it is not a right.

The second two terms, ITQs and IFQs, are too narrow for general application. Both terms describe specific kinds of dedicated access privileges. Their general use has caused confusion, creating the impression that ITQs or IFQs are the only tools that can end the race for fish. In many areas, particularly along the east coast, the term ITQ has gained a negative connotation as the result of events in the surf clam/ocean quahog ITQ program. In addition, both terms imply that individual fishermen own a share of a public resource.

The term dedicated access privileges is preferable for several reasons. First, it highlights the fact that fishing is a privilege, not a right. Second, it is an umbrella term that includes access privileges assigned to individuals (ITQs; IFQs; individual gear quotas), as well as to groups or communities (community development quotas; cooperatives; area-based quotas, community-based quotas). Finally, it reflects the fact that the dedicated privilege being granted is *access* to the fish, rather than the fish themselves.

Currently, four U.S. fisheries grant dedicated access privileges: the surf clam/ocean quahog fishery in the Mid-Atlantic (ITQ); the wreckfish fishery in the South Atlantic (ITQ); the halibut/sablefish fishery in the North Pacific (ITQ); and the Bering Sea pollock fishery in the North Pacific (co-op). Many other countries, including New Zealand, Australia, and Iceland, rely heavily on dedicated access regimes for fishery management.

But dedicated access regimes are not without their drawbacks. After the ITQ program began in the Mid-Atlantic surf clam/ocean quahog fishery, fleet size shrank from 128 vessels to 59 vessels in two years because many fishermen decided to simply sell their share of the harvest to outside investors. By 1995, very few owner-operators were left in the fishery, and the largest holders of fishing quotas were a bank and an accounting firm. To many observers, this turned the working fishermen into the equivalent of sharecroppers for absentee landlords.[13]

Based largely on that experience, many fishermen, especially in New England, opposed any effort to explore ITQs. Some RFMC members also questioned the enforceability of dedicated access privileges in multispecies fisheries with large numbers of participants or many ports of landing. Public interest groups also expressed

concerns, although for very different reasons. They felt that granting fishermen exclusive access to harvest, buy, or sell a portion of the overall catch appeared to create an individual property right to a public resource, although all existing dedicated access programs in the U.S. clearly state that granting an individual access to a portion of the catch does not confer a right to any fish before it is harvested.

In response to such concerns, the 1996 amendments to the Magnuson–Stevens Act created a moratorium on further development of IFQ programs, pending consideration by the National Academy of Sciences. The resulting National Research Council study concluded that IFQ programs are in fact a promising management option that RFMCs should consider.[14] Examples of carefully designed dedicated access programs in the United States and elsewhere show that it is possible to overcome most of the concerns raised about them. During the development of the Alaska halibut/sablefish dedicated access program, concerns were raised about the socioeconomic impacts of individual fishing quotas on communities. As a result, the North Pacific RFMC customized the program to account for vessel size and type, placed a one percent cap on the share of quota any one person or entity could control, and prohibited absentee ownership to ensure quotas would remain in the hands of working fishermen. Halibut and sablefish fishermen, previously skeptical, are now among the program's biggest supporters. This illustrates the value of taking potential socioeconomic ramifications and other stakeholder concerns into account during the design phase of any dedicated access program.

Even though the Magnuson–Stevens Act moratorium on individual fishing quotas has expired and the National Research Council study endorsed this as a viable approach, most RFMCs will remain unwilling to spend time and effort developing dedicated access programs until they are sure Congress will not overrule them.

Recommendation 19–15. Congress should amend the Magnuson–Stevens Fishery Conservation and Management Act to affirm that fishery managers are authorized to institute dedicated access privileges. Congress should direct the National Marine Fisheries Service to issue national guidelines for dedicated access privileges that allow for regional flexibility in implementation. Every federal, interstate, and state fishery management entity should consider the potential benefits of adopting such programs.

At a minimum, the national guidelines should require dedicated access programs to:

- *specify the biological, social, and economic goals of the plan; recipient groups designated for the initial quota shares; and data collection protocols.*
- *provide for periodic reviews of the plan to determine progress in meeting goals.*
- *assign quota shares for a limited period of time to reduce confusion concerning public ownership of living marine resources, allow managers flexibility to manage fisheries adaptively, and provide stability to fishermen for investment decisions.*
- *mandate fees for exclusive access based on a percentage of quota shares held. These user fees should be used to support ecosystem-based management. Fee waivers, reductions or phase-in schedules should be allowed until a fishery is declared recovered or fishermen's profits increase.*
- *include measures, such as community-based quota shares or quota share ownership caps, to lessen the potential harm to fishing communities during the transition to dedicated access privileges.*
- *hold a referendum among all permitted commercial fishermen after adequate public discussion and close consultation with all affected stakeholders, to ensure acceptance of a dedicated access plan prior to final Regional Fishery Management Council approval.*

Reducing Overcapitalization of Fishing Fleets

As discussed above, the race for fish pushes fishermen to invest more and more capital to buy bigger, faster boats, new gear and additional labor. These investments are perceived as essential to stay alive in the race for

fewer and fewer fish, not necessarily to make the business more efficient. The inevitable result is economic decline, with more vessels pursuing a shrinking resource. If managers respond by further lowering the total allowable catch, costs rise even more while average revenues drop.

Over the past three decades, federal programs to subsidize the purchase or upgrade of fishing vessels have resulted in U.S. fishing capacity that far exceeds the available catch. For example, the Capital Construction Fund allowed fishermen to create tax-free accounts to repair or construct vessels, and the Fishing Vessel Obligation Guarantee Program provided long-term credit for fishing vessels and related facilities. The challenge now goes beyond removing subsidies and incentives that promote overcapitalization; it will also take a sustained effort to reduce the excess capacity already in place.

Past capacity reduction efforts, such as the New England groundfish buyout program in the early 1990s, have been effective at removing capacity from the fleet. However, their initial success was undermined when new fishermen and boats were allowed to replace those that had been retired. A new federal program, the Fishing Capacity Reduction Program, has been criticized as being too bureaucratic and slow.

Two types of management regimes can ensure that a capacity reduction program has lasting results: (1) dedicated access programs which, by definition, limit overall effort in a fishery; and (2) restrictive regimes that freeze the number of active fishermen and prohibit any changes to fishing methods or gear until a fishery has been declared recovered. The second option would be difficult to enforce and could meet with strong resistance from fishermen and managers. Yet steps must be taken to end the inefficient and counter-productive over-investment in fishing vessels and gear.

Recommendation 19–16. Congress should repeal the Fisheries Finance Program (formerly the Fishing Vessel Obligation Guarantee Program), the Capital Construction Fund, and other programs that encourage overcapitalization in fisheries. The National Oceanic and Atmospheric Administration (NOAA) should implement programs to permanently reduce fishing capacity to sustainable levels.

Reducing overcapitalization in fisheries will be assisted by the following:

- *to the maximum extent practicable, capacity reduction programs should be funded by those who profit from them—the fishermen remaining in the fishery.*
- *federal contributions to capacity reduction programs should only be made where additional effort is prohibited from entering the fishery. The highest priority for public funding of capacity reduction should be given to fisheries that grant dedicated access privileges to participants.*
- *NOAA should monitor capacity reduction programs to ensure they meet their objectives.*
- *fishermen should be allowed to transfer existing Capital Construction Fund accounts into IRAs or other appropriate financial instruments.*

IMPROVING FISHERY ENFORCEMENT

Enforcement of fishing restrictions is essential to allow fishery resources to be economically harvested and protected for future generations. However, increasing pressures on agencies hinder effective enforcement and delay the evolution of fishery management plans toward a more ecosystem-based approach. For example, area closures put greater demands on enforcement agencies that must patrol larger, more widely dispersed areas. Redirection of existing enforcement resources for homeland security and the reduction of state personnel due to budget cuts also hamper fisheries enforcement. If this gap between needs and resources is to be narrowed, the agencies tasked with enforcing fishery management plans must apply resources and

technology in innovative ways, such as through enhanced vessel monitoring technologies, expanded cooperation between enforcement agencies, and strengthened public education and outreach.

Fishery Enforcement Mechanisms

The two federal agencies with primary roles in enforcing marine fishery regulations are NMFS and the Coast Guard. Under the authority of the Magnuson–Stevens Act, these agencies enforce conservation and management plans for federally regulated fishery resources in the 200 nautical mile EEZ. The Coast Guard also enforces applicable international agreements in waters beyond the U.S. EEZ.

The Coast Guard employs personnel, vessels, aircraft, communications and support systems to maintain a law enforcement presence in the EEZ and on the high seas. Agents from NMFS' Office of Law Enforcement conduct dockside inspections, investigate civil and criminal violations, seize illegal property and contraband, and seek to prevent unlawful trafficking in marine wildlife products. State enforcement personnel enforce state fishery plans in their own waters and federal plans if there is a cooperative agreement.

Both the Coast Guard and NMFS enforcement representatives participate in the RFMC process. The Coast Guard and NMFS also cooperate with state enforcement agencies to pool limited assets and reduce duplication of effort.

Enforcement Partnerships

New partnerships and enhanced cooperation are basic elements of the Coast Guard and NMFS fishery enforcement strategic plans. Cooperative enforcement agreements among federal, state, tribal, interstate, and international organizations will be essential as ecosystem-based or area-based management becomes more prevalent and as the Coast Guard assumes additional homeland security responsibilities.

Cooperative Enforcement Programs

One of the most successful existing partnership programs is the Cooperative Enforcement Program between NMFS and state agencies. In this program, state enforcement officers are deputized to enforce state and federal fishery management plans for commercial and recreational fisheries. Through Joint Enforcement Agreements (JEAs), NMFS provides federal funds for state involvement which are then matched by the states, providing an opportunity to enlarge the overall pool of enforcement resources. JEAs have also led to significant progress in creating uniform enforcement databases, identifying regional and local fishery enforcement priorities, and extending coordination to other areas, such as investigations.

Twenty-three coastal states and territories have entered into JEA partnerships with NMFS. From 1998 to 2000, following implementation of the JEA with South Carolina, state patrol officers logged over 1,095 hours conducting federal enforcement from the edge of state waters to 70 nautical miles offshore. Their patrols uncovered 172 cases of fisheries violations in the EEZ or on vessels returning from the EEZ, as well as many additional cases of boating safety and permit violations.[15] JEAs are particularly effective because state agents are familiar with local waters, know when and where enforcement infractions are likely to occur, and provide opportunities for significant public outreach and education.

Although the Coast Guard is not currently a signatory to these cooperative NMFS–state agreements, Coast Guard participation would be valuable, particularly during the development of enforcement plans and priorities, and would help assure commitment of Coast Guard resources to joint enforcement efforts.

Despite the JEA program's advantages in leveraging resources and enhancing cooperation, its federal funding was reduced from approximately $15 million in fiscal year 2001 to $7 million in the fiscal year 2002 and 2003 budgets. The reduced federal funding led to smaller state matching appropriations and, ultimately, a reduction in enforcement personnel.

Recommendation 19–17. Congress should increase funding for Joint Enforcement Agreements to implement cooperative fisheries enforcement programs between the National Marine Fisheries Service and state marine enforcement agencies. The U.S. Coast Guard should be included as an important participant in such agreements.

Cooperative Federal Enforcement

There are also significant opportunities to strengthen cooperation at the federal level between NMFS and the Coast Guard. Currently, each agency has its own strategic plan, goals and objectives for enforcement of federal fisheries laws. At the regional and local levels, the degree of cooperation is uneven and can vary considerably over time, even within the same geographic area.

At the national level, a jointly developed strategic plan for federal fisheries enforcement can provide a framework for prioritizing common goals and identifying cooperative enforcement policies. At the regional level, existing agency training centers can be given a broader role as forums for NMFS, Coast Guard, and state enforcement personnel to share information specific to a particular fishery, and to identify opportunities for more effective resource utilization. At the regional and local levels, a stronger and more consistent process can be developed for joint planning and implementation of fishery enforcement operations. Strengthening the national, regional, and local frameworks should lead to better resource utilization and fisheries enforcement.

Recommendation 19–18. The National Marine Fisheries Service and the U.S. Coast Guard should strengthen cooperative enforcement efforts at the national level by developing a unified strategic plan for fisheries enforcement that includes significantly increased joint training, and at the regional and local levels, by developing a stronger and more consistent process for sharing information and coordinating enforcement.

Technology for Enforcement

Vessel Monitoring System

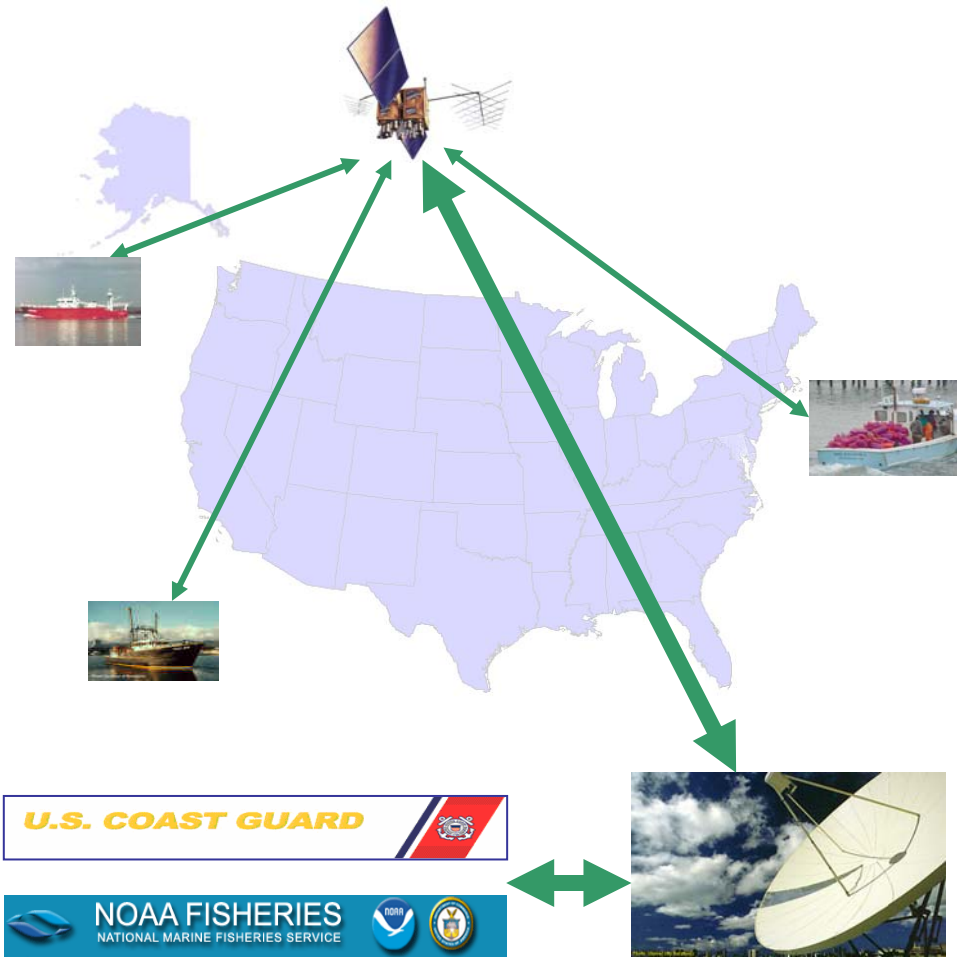
Vessel monitoring is now an accepted part of fishery management worldwide and is endorsed by the United Nations Food and Agriculture Organization's Code of Conduct for Responsible Fisheries. Since its initial implementation in 1988, the Vessel Monitoring System (VMS) has dramatically increased the effectiveness of limited fishery enforcement resources.

Ships equipped with VMS transmit accurate Global Positioning System data via satellite to monitoring centers ashore (Figure 19.4). This information identifies specific vessels and their precise locations. When fully implemented, the system can also provide information useful to law enforcement, maritime security, safety efforts, environmental protection, and resource management.

VMS can be configured for two-way communications to enable vessels to receive pertinent safety and enforcement information from observing parties onshore, such as weather alerts and safety broadcasts for vessels in potentially hazardous circumstances. In emergencies, the Coast Guard can pinpoint the location of a stricken vessel and communicate directly with it and other boats in the area through two-way VMS links. Two-way VMS allows fishermen to be in constant contact with other fishermen, enforcement personnel, and

fleet operators. Because their position can be verified, fishermen can remain on scene longer prior to fishery closures, rather than having to depart the area as is often currently required. The extension of VMS monitoring to state fisheries could also be useful, particularly for vessels wanting to operate legally in state waters adjacent to closed federal waters.

Figure 19.4. Monitoring Fisheries from Space



The Vessel Monitoring System (VMS) transmits Global Positioning System data from vessels to enforcement monitoring stations via satellite. VMS can also be configured for two-way transmission, allowing VMS personnel to send useful information to fishermen at sea.

Beyond the benefits to fishermen and the potential benefits to scientific research through the transmission of near real-time data, two-way VMS is a useful system for enforcement and management personnel. Enforcement personnel can protect resources by preventing potential fishery violations, and VMS can save the Coast Guard and NMFS time and money spent in enforcement actions. The system provides the Coast Guard and NMFS a broader awareness of ships as they approach restricted areas, enabling the agencies to inform a fishing vessel that it is about to enter a protected area. Sensors can also be added to fishing gear, allowing VMS to indicate when a vessel is actively fishing. Managers can also use VMS system capabilities for daily catch and effort information used in quota management, and can gather other data, such as temperature, depth, and salinity, to inform broader fishery management planning decisions.

The cost of VMS for fishing vessel owners is small relative to its many benefits. VMS equipment with two-way communications capabilities is available at a modest cost of several thousand dollars. Some current NMFS programs offer limited reimbursement for initial equipment purchase. In addition to the one-time installation costs, there are continuing, although modest, costs associated with data transmission.

Recommendation 19–19. The National Marine Fisheries Service, working with the Regional Fishery Management Councils, the U.S. Coast Guard, and other appropriate entities, should maximize the use of the Vessel Monitoring System (VMS) for fishery-related activities by requiring that VMS with two-way communication capability be phased in for all commercial fishing vessels receiving permits under federal fishery plans, including party and charter boats that carry recreational fishermen, incorporating VMS features that assist personnel in monitoring and responding to potential violations, and identifying state fisheries that could significantly benefit from VMS implementation.

Integrating VMS into a Data Collection and Dissemination System

Although NMFS is currently overseeing the development of the VMS fisheries enforcement infrastructure nationwide, VMS data are also being incorporated into a larger monitoring system that extends beyond fishery enforcement concerns. VMS data will be part of a multipurpose data collection and dissemination system that includes other Coast Guard data sources and provides a comprehensive picture of many offshore activities. The larger Coast Guard data system will support a variety of missions, such as maritime security, safety, search and rescue, law enforcement, and environmental protection (Chapter 16). The Coast Guard and NMFS will need to cooperate to establish uniform national policies and technical requirements for VMS information, while providing for regional flexibility.

Recommendation 19–20. The U.S. Coast Guard should be the lead organization in managing the integration of a fishery Vessel Monitoring System (VMS) database into the larger maritime operations database and should work with the National Marine Fisheries Service to ensure effective use of VMS data for monitoring and enforcement.

Using New Technologies for More Effective Enforcement

VMS presents just one of many opportunities to use technology for more effective enforcement. Fixed radars on platforms have been used successfully in particularly sensitive environmental areas close to shore, and satellites present additional opportunities for offshore monitoring. The advantage of these monitoring systems is that they identify vessel traffic and activity in a particular area so that enforcement resources can be sent to investigate only when circumstances warrant. Directed enforcement efforts are less costly than general enforcement patrols. Enforcement planning at all levels should include a continuing focus on identifying and funding new and emerging technologies that provide for more successful and cost-effective use of enforcement resources.

Improving Enforceability as Part of the Management Process

Clear, easily enforceable regulations are critical to the success of fishery management policies. A management regime that is—or is perceived by the public to be—impossible or exceptionally hard to enforce is unlikely to succeed. Of course, some management regimes are more difficult or costly to enforce than others. In particular, area closures with boundaries that are difficult to detect at sea are problematic and provide tenuous grounds for legal action. Enforcement difficulties are also generated by gear restrictions that require fishermen to haul out their gear for boarding officers to examine. As part of their effort to ensure sustainable fisheries, the RFMCs should pay particular attention to enforceability when drafting management plans.

MOVING TOWARD AN ECOSYSTEM-BASED MANAGEMENT APPROACH

In keeping with the overarching theme of this report, fishery managers should begin to move toward a more ecosystem-based management approach. This will provide direct benefits to the ecosystem and create a better mechanism for addressing apparent conflicts between socioeconomic and biological goals.

Linking Fisheries Management with other Regional Concerns

Several measures now in place have begun the transition to a more ecosystem-based approach to fishery management. Such an approach requires that we look beyond fisheries to consider interactions with other resources and activities.

The fishery regions were originally defined roughly along the lines of Large Marine Ecosystems and thus have the geographic reach necessary to encompass ecosystem concerns. In addition, all RFMCs have multispecies management plans that force the councils to look broadly at the ecosystem they manage. Despite these positive efforts, most RFMC multispecies fishery management plans now focus only on species assemblages that are commercially important, or those taken by particular types of gear. Little attention is given to species that, while commercially insignificant, are still important to the functioning of an ecosystem. New ecosystem-based measures are needed, such as studies of system components and interrelationships, assessment and ranking of dangers, and development of comprehensive management plans. These should carefully consider the relationship between fishery management measures and management of other sectors, including protected species, pollution control, and habitat conservation and restoration.

Fishery managers have also used marine protected areas to either promote stock recovery or, in some circumstances, prevent damage to special habitats. In addition, marine protected areas established for other purposes have benefited many fisheries. The initial steps in designing marine protected areas need to be improved. (For further discussion of marine protected areas, see Chapter 6.)

In some respects, the job of the RFMCs will change little with the move toward ecosystem-based management. The councils will retain broad responsibilities for managing fish populations and fishing activities, bearing in mind the interests of fishing communities. However, they will also need to interact regularly with other regional, state, and local entities with related responsibilities. For example, if an RFMC implements a scientifically sound fishery management plan, but the stock continues to decline due to other factors such as pollution, the problem could be raised at the regional level (as described in Chapter 5) with managers responsible for pollution control. On the other hand, if coastal managers develop a regulatory plan that could affect fisheries, they should be working with the RFMCs to understand the fishery-specific implications. There also should be changes in the way that management measures are evaluated to comply with NEPA. As regions implement an ecosystem-based management approach, environmental impact assessments should be based on a shared knowledge of the ecosystem across the planning entities. Rather than having the RFMC, NMFS, EPA, and the U.S. Army Corps of Engineers all prepare separate environmental impact statements, without sharing information on cumulative impacts, these analyses need to be combined to reduce duplication and improve the quality of ecosystem evaluations.

Ecosystem-based management will also bring changes to the RFMC process. As mentioned elsewhere in this chapter, fishery management plans have traditionally focused on single stocks, or at most, groupings of stocks that are commercially important. Managers usually set biomass or mortality rate goals, with little consideration of other characteristics of the stock, and even less of broader ecosystem concerns. With the move toward an ecosystem-based management approach, this will change.

Several recent reports have described the profound impacts that fishing industry activities can have on marine ecosystems, such as reducing the average size of individuals within a single stock or removing a high percentage of large predators like tuna and billfish.[16] By targeting some species and not others, fishermen can affect the balance and structure of ecosystems. In the Gulf of Maine, some scientists believe that the multispecies fishery has contributed to a re-structuring of that ecosystem from one dominated by groundfish to one dominated by dogfish and skates. Fishery managers need to take such impacts into account in developing management plans and amendments.

An ecosystem-based management approach will also allow managers to better consider the impacts of their plans on fishermen and the communities in which they live. Unfortunately, the amount of sociologic or economic information we have on fishermen and fishing communities is paltry. It is important to collect such data so managers can better understand the overall effects of the measures they take and the plans they approve. The more managers know about the social and economic factors influencing fishing behavior, the more success they will have in designing regulations that have the intended effect.

The 1996 amendments to the Magnuson-Stevens Act specifically recognize the need to consider the impact of fisheries management measures on fishing communities. Although NMFS has begun to improve its ability to describe and predict such impacts, further improvements in collecting and interpreting socioeconomic data are needed. To this end, the legal barriers that now exist to collecting some economic information from fishermen and processors should be reconsidered.

The move toward an ecosystem-based management approach will also allow the human and biological components of fisheries to be brought together through consideration and adoption of ecosystem goals and objectives. As discussed in Chapter 3, goal setting is an important but difficult part of ecosystem-based management. As in any system with multiple competing objectives, it will not be possible to meet every one.

In fisheries, the competition is usually between helping overfished stocks recover and preserving the short-term economic health of traditional fishing communities. Both goals are desirable but the measures required to achieve them often appear to be in conflict. Yet long-term economic health depends on healthy fish stocks. This may require a temporary reduction in fishing effort, with related short-term economic pain. The challenge is to devise a formula that rebuilds stocks at a reasonable rate without causing unacceptable economic hardships.

Scientists can help predict how quickly a stock will be replenished at different harvest levels, but there is no scientific basis for actually deciding what the appropriate rate of rebuilding should be. That is a judgment call, requiring managers to weigh the benefits of quickly restoring fish stocks to healthy and sustainable levels against the interim economic costs to the fishermen and communities involved. The task is complicated by the fact that even short-term hardships can drive fishermen permanently out of business. Ironically, the resultant pressure to go slow has sometimes led to continued overfishing…and even deeper and longer-term socioeconomic harm. An ecosystem-based management regime will inevitably require tough choices, but it does provide a comprehensive context within which those choices may be made.

The RFMCs should participate in a collaborative process to share their concerns and help shape regional goals and management plans. Because of their experience in dealing with diverse constituents and multiple objectives, the councils could be extremely helpful in developing a comprehensive ecosystem-based management approach in the regions.

In addition to integrating fishery issues into an overall regional perspective, the principles of ecosystem-based management can guide NMFS and the RFMCs in implementing two difficult provisions of the Magnuson–Stevens Act related to essential fish habitat and bycatch.

Essential Fish Habitat

As discussed in Chapter 11, maintaining healthy, functioning habitats is an essential element of an ecosystem-based management approach. The 1996 amendments to the Magnuson–Stevens Act included measures designed specifically to protect habitats important to managed species. Essential fish habitat (EFH) is defined in the Act as "those waters necessary to fish for spawning, breeding, or growth to maturity" and the RFMCs are required to "describe and identify essential fish habitat" for each fishery. However, it is not easy to determine which habitats are required by fish. With scant legislative guidance and little scientific information available on habitat requirements, RFMCs tended to be broad in their designations.

For example, in the case of Atlantic halibut, the New England RFMC designated the entire Gulf of Maine and almost all of Georges Bank as essential. The North Pacific council designated almost the entire EEZ below the Arctic Circle as essential for one species or another. But when everything is special, nothing is. The current methods have resulted in the designation of so much habitat that the original purpose of identifying areas that deserve focused attention has been lost.

Perhaps in recognition of this, NMFS designated a subset of EFH to be called "habitat areas of particular concern." These areas were defined in 2002 NMFS regulations as "discrete areas within essential fish habitat that either play especially important ecological roles in the life cycles of federally managed fish species or are especially vulnerable to degradation from fishing or other human activities." Less than one percent of the area initially designated as EFH has been further characterized as habitat areas of particular concern.

Two alternate approaches for determining critical habitat attempt to improve on the current one. Both look at habitat from an ecosystem perspective, instead of trying to identify habitat necessary for the survival of an individual species. The first approach uses the abundance of juveniles of several commercially important species as indicators of habitat preference.[17] It then uses a statistical method to locate the smallest total area that contains a sufficient amount of preferred habitat for all species of concern. The second approach expands on the first, by attempting to link species distribution with specific habitat types.[18]

Of course, the identification of important habitats is only the first step. Rather than focusing solely on protecting these habitats from fisheries impacts, NOAA should identify the full range of threats and work with other agencies to develop management plans that mitigate the activities posing the greatest risks. Ultimately, the process for designating and managing EFH should result in the protection of major fish species during vulnerable stages of their life history, while minimizing disruption to fisheries or other offshore uses. Like other resource management programs, any approach to protecting EFH must also be enforceable and reasonably simple to implement.

Recommendation 19–21. The National Marine Fisheries Service (NMFS) should change the designation of essential fish habitat from a species-by-species to a multispecies approach and, ultimately, to an ecosystem-based approach. The approach should draw upon existing efforts to identify important habitats and locate optimum-sized areas to protect vulnerable life-history stages of commercially important species. NMFS should work with other management entities to protect essential fish habitat when such areas fall outside their jurisdiction.

This effort should include:

- *well-documented, science-based analytical methods.*
- *consideration of ecologically valuable species that are not necessarily commercially important.*
- *an extensive research and development program to refine existing analytical methods and develop additional means to identify habitats critical to sustainability and biodiversity goals.*

Reducing Bycatch

The unintentional catch of non-targeted species by recreational and commercial fishermen, commonly known as "bycatch," is a major economic and ecological problem. One of the national standards of the Magnuson–Stevens Act states that fishery management plans should minimize bycatch to the greatest extent practicable. Reducing bycatch is a goal that everyone can support: for fishermen, bycatch decreases efficiency and costs money; for the environmental community and many others, bycatch is viewed as wasteful and harmful to the ecosystem; and, in the case of endangered species, bycatch can threaten a population's survival. Nevertheless, the total elimination of bycatch from a fishery is probably impossible, and too great a focus on bycatch could inhibit progress on other issues more important to ecosystem functioning.

The first requirement for addressing bycatch is better information. Existing fish stock assessments attempt to account for all sources of mortality for commercially targeted species; however, estimates of impacts on non-target species are lacking. An ecosystem-based management approach will require that mortality to all components of the system be estimated. Of course, cataloging all bycatch in every fishery would only be possible if an observer were placed on every fishing boat, a prohibitively expensive proposition. Instead, bycatch monitoring should be based on statistically significant sampling, using information gathered by fishermen and a selected number of observers.

NMFS, in cooperation with the RFMCs, has initiated a National Bycatch Strategy that moves in the right direction.[19] The strategy calls for the development of regional implementation plans to reduce bycatch, but only of specific commercially important species. As ecosystem-based management evolves, those implementing the National Bycatch Strategy will need to look more broadly at overall ecosystem impacts.

Recommendation 19–22. The National Marine Fisheries Service (NMFS) and Regional Fishery Management Councils should develop regional bycatch reduction plans that address broad ecosystem impacts of bycatch. Implementation of these plans will require NMFS to expand current efforts to collect data on bycatch, not only of commercially important species, but on all species captured by commercial and recreational fishermen. The selective use of observers should remain an important component of these efforts.

MANAGING INTERNATIONAL FISHERIES

The Status of International Fisheries

Intensive exploitation of fish populations at the international level is jeopardizing global marine life and the marine environment. An estimated seven out of ten fish stocks worldwide are being exploited at or beyond the level of sustainability.[20] Not unlike the U.S. situation, factors contributing to the rapid depletion of global fish stocks include:

- the open-access nature of high seas fisheries;
- excess fishing capacity, with global investments annually exceeding revenues by $14.5 to $54 billion;[21]
- widespread illegal practices, and difficulties in enforcing the law;
- ever more sophisticated fishing technology and gear;
- major government subsidies aimed at building up national fishing industries;
- bycatch of non-target species;
- high levels of discards, reaching approximately 20 percent of the total catch;[22]
- fishing practices that degrade habitat;
- inadequate understanding of how marine ecosystems function; and
- lack of monitoring data and poor statistics.

The Law of the Sea Framework

As noted in Chapter 2, the traditional freedom of the high seas was based on a belief that the ocean's bounty was inexhaustible and that humans would never be in a position to exploit much of it. As ocean resources grew in importance, and its vastness was conquered, these attitudes changed. In 1976, the United States asserted jurisdiction over fishery resources within 200 nautical miles from its shores. In 1982, the United Nations Convention on the Law of the Sea (LOS Convention) created EEZs extending generally out to 200 nautical miles from the shores of all coastal states.

In restricting what had previously been part of the high seas, the LOS Convention initially put more emphasis on national self-interest than on international cooperation in managing fish stocks. But many stocks transcend a single country's EEZ, including highly migratory stocks (like tuna) and those that migrate between fresh water and the open ocean (like salmon and eels). In the absence of international cooperation and some form of international governance, the community of nations could witness the classic "tragedy of the commons," leading to the potentially irreversible overexploitation of living marine resources.

International management challenges are exacerbated by the fact that the regulation of fishing on the high seas has traditionally been left to the nation under which a vessel is registered—the so-called flag state. As discussed in Chapter 16, flag state enforcement is extremely uneven and vessel owners can seek less stringent regulations and enforcement simply by reflagging their vessels.

Global Fishery Conservation Agreements

In the 1990s, the international community, working mainly through the United Nations Food and Agriculture Organization's (FAO's) Committee on Fisheries, began to address deficiencies in international fisheries management, with the United States playing a lead role. Two global agreements were reached that are binding on signatories: the FAO Compliance Agreement and the Fish Stocks Agreement. The FAO also adopted a number of voluntary measures that provide guidance to nations on managing fisheries. Although they do not have the force of law, these nonbinding instruments can influence national practices and customs, provide nations with flexibility in implementation, and make headway in the face of scientific or economic uncertainty.

The FAO Compliance Agreement

In 1993, the FAO adopted the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, known as the FAO Compliance Agreement. This agreement requires each participating flag state to:

- ensure that vessels flying its flag do not undermine international conservation measures;
- limit the right to harvest fish to those vessels it has affirmatively authorized;
- maintain a register of such authorized fishing vessels; and
- monitor catches and make such information available to the FAO.

The United States ratified the FAO Compliance Agreement in 1995, and it came into force in 2003, when a sufficient number of nations had signed. However, many major fishing countries—including Norway, Sweden, Mexico, Japan, Canada, and Argentina,—have still not ratified the Agreement and are, therefore, not bound by its provisions.

The Fish Stocks Agreement

At the 1992 United Nations Conference on Environment and Development (also known as the Earth Summit), the nations of the world recognized that the LOS Convention's appeal for international cooperation on straddling stocks and highly migratory species did not adequately address the global crisis in fisheries. The result was the 1995 United Nations Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (known as the Fish Stocks Agreement).

The Fish Stocks Agreement authorizes nonflag states to engage in compliance and enforcement activities for fishery violations on the high seas, including boarding, inspecting, and bringing a vessel to port. It also allows port states to inspect documents, fishing gear, and catch on board fishing vessels and to prohibit landings if a high seas catch has been taken in a manner that undermines regional or global conservation and management measures.

The Fish Stocks Agreement adopts a precautionary approach as the fundamental standard for managing shared fisheries and calls upon nations to agree on efficient and expeditious decision-making procedures within regional organizations. The United States was a leader in negotiating the Fish Stocks Agreement and in 1996 became the third nation to ratify it. The Agreement finally came into force in late 2001, although several major fishing nations, including Japan, Poland, Korea, and Taiwan, have not yet ratified it.

Recommendation 19–23. The U.S. Department of State, working with other appropriate entities, should encourage all countries to ratify the Fish Stocks Agreement and the United Nations Food and Agriculture Organization's Compliance Agreement. In particular, the United States should condition other nations' access to fishing resources within the U.S. exclusive economic zone on their ratification of these agreements. Other incentives should be developed by the United States and other signatory nations to encourage all nations to ratify and enforce these agreements.

The effective management and conservation of global marine species, and the enforcement of international treaties, require a combination of domestic, bilateral, regional, and international approaches. Although regulation of fisheries on the high seas is conducted within broad regions of the seas, the existing regional fishery organizations are generally weak. They lack adequate financial resources or enforcement capabilities, and allow member states to opt out of individual management measures they dislike.

The United States is a member of more than a dozen regional fishery commissions and related organizations concerned with straddling stocks or high seas living marine resources. These organizations undertake fishery research, adopt measures to conserve and manage the fisheries under their mandate, and attempt to reduce and regulate bycatch. They also develop policies for the conservation, sustainable use, and ecosystem-based management of living marine resources.

The work of regional fishery organizations must be paid for by their members. The cost of U.S. participation is set at roughly $20 million annually, although in fiscal year 2003, Congress did not appropriate the amount requested.

Recommendation 19–24. Congress should fully fund existing U.S. commitments to international fisheries management. The U.S. Department of State, working with the National Oceanic and Atmospheric Administration, should review and update regional and bilateral fishery agreements to which the United States is a party, to ensure full incorporation of the latest science and harmonize those agreements with the Fish Stocks Agreement.

Non-binding International Documents

The FAO has adopted a number of voluntary, nonbinding instruments, beginning in 1995 with the Code of Conduct for Responsible Fisheries (the Code). While acknowledging the diversity of national and cultural traditions, the Code sets out principles and standards for responsible practices in fisheries and aquaculture. Its purposes are to promote conservation of biodiversity, ecosystem-based management, and sustainable use of living marine resources. More specifically, the Code calls for use of the best scientific information, application of traditional knowledge where possible, adoption of an ecosystem-based and precautionary approach, effective flag state control, and participation in regional organizations.

More recently, the FAO has adopted a number of International Plans of Action that elaborate on the Code and address weaknesses in existing regulatory schemes involving such issues as the bycatch of seabirds and sharks. The International Plan of Action on illegal, unreported, and unregulated fishing, although emphasizing flag state responsibility, also calls upon regional organizations to play a role in monitoring, surveillance, and deployment of observers, and urges port state control. These International Plans of Action can be best implemented through corresponding National Plans of Action.

NOAA's fishery and technical experts helped develop criteria (since adopted by FAO and accepted as worldwide standards) for defining overcapacity in marine fisheries. Nevertheless, progress has been slow in persuading many nations to implement capacity reduction measures.

Recommendation 19–25. The National Oceanic and Atmospheric Administration, working with the U.S. Fish and Wildlife Service and the U.S. Department of State, should design a National Plan of Action for the United States that implements, and is consistent with, the International Plans of Action adopted by the United Nations Food and Agriculture Organization and its 1995 Code of Conduct for Responsible Fisheries. This National Plan should stress the importance of reducing bycatch of endangered species and marine mammals.

Recommendation 19–26. The international committee of the National Ocean Council (discussed in Chapter 29), should initiate a discussion to determine the most effective methods of encouraging other nations to implement the United Nations Food and Agriculture Organization's Code of Conduct for Responsible Fisheries and other Plans of Action and provide its findings to the U.S. Department of State and the National Ocean Council.

In particular, the international committee should suggest methods to encourage nations to:

- *join relevant regional fishery management organizations.*
- *implement and enforce regional agreements to which they are bound.*
- *reduce or eliminate illegal, unreported, and unregulated fishing by ships flying their flag.*
- *reduce their fishing fleet capacity, particularly on the high seas.*
- *reduce bycatch of non-targeted species, in particular endangered populations such as sea turtles and marine mammals, via the use of innovative gear and management methods (such as onboard observer programs).*

The international committee should consider potentially effective incentives such as greater access to U.S. markets, bilateral aid, debt forgiveness, subsidies, and preferential loans for cooperating nations, as well as disincentives for those that do not implement these agreements.

International Fisheries and Trade

Intentional and unintentional harm to marine mammals and endangered species remain major problems at the global level. Large populations of sea turtles, dolphins, sharks, and seabirds are unintentionally caught in the huge nets used by shrimp and tuna fishermen. And the global trade in endangered species continues.

In the 1990s the United States attempted to employ trade sanctions to combat damaging harvesting practices. Such sanctions can be very effective when the nation imposing them is a major importing market. In response to a recent U.S. initiative, but amid considerable dispute, the FAO established an informal consultative process to consider greater cooperation between its fishery management activities and the Convention on International Trade in Endangered Species of Wild Fauna and Flora, which regulates global trade in endangered species.

Not surprisingly, the World Trade Organization (WTO) generally discourages nations from taking unilateral trade action, arguing that it undermines free trade. But the WTO has also recognized that conservation can be a legitimate objective of trade policy. When the United States banned the import of certain shrimp products from nations whose harvesting practices resulted in a large bycatch of sea turtles, a complaint was filed at the WTO. Although the WTO ultimately ruled against the United States on procedural grounds, it affirmed that the ban served a legitimate conservation objective under the General Agreement on Tariffs and Trade. The United States should continue to press for the inclusion of environmental objectives—particularly those specified in international environmental agreements—as legitimate elements of trade policy.

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CHAPTER 20: PROTECTING MARINE MAMMALS AND ENDANGERED MARINE SPECIES

Protection for marine mammals and endangered or threatened species from direct impacts has increased since the enactment of the Marine Mammal Protection Act in 1972 and the Endangered Species Act in 1973. However, lack of scientific data, confusion about permitting requirements, and failure to adopt a more ecosystem-based management approach have created inconsistent and inefficient protection efforts, particularly from indirect and cumulative impacts. Consolidating and coordinating federal jurisdictional authorities, clarifying permitting and review requirements for activities that may impact marine mammals and endangered or threatened species, increasing scientific research and public education, and actively pursuing international measures to protect these species are all improvements that will promote better stewardship of marine mammals, endangered or threatened species, and the marine ecosystem.

ASSESSING THE THREATS TO MARINE POPULATIONS

Because of their intelligence, visibility and frequent interactions with humans, marine mammals hold a special place in the minds of most people. Little wonder, then, that mammals are afforded a higher level of protection than fish or other marine organisms. They are, however, affected and harmed by a wide range of human activities.

The biggest threat to marine mammals worldwide today is their accidental capture or entanglement in fishing gear (known as "bycatch"), killing hundreds of thousands of animals a year.[1] Dolphins, porpoises and small whales often drown when tangled in a net or a fishing line because they are not able to surface for air. Even large whales can become entangled and tow nets or other gear for long periods, leading to the mammal's injury, exhaustion, or death. (These issues are also discussed in Chapter 18 on marine debris and Chapter 19 on fisheries management.)

Historically, commercial harvesting contributed to major declines in the populations of marine mammals but only a few nations still allow hunting for purposes other than subsistence. Hunters from those nations continue to kill hundreds of thousands of whales, dolphins, and other marine mammals each year while legal subsistence hunting accounts for thousands more.

Like pedestrians in the city, marine mammals are vulnerable to ship traffic at sea, especially in areas crowded by commercial and recreational vessels. North Atlantic right whales are particularly susceptible to collisions with vessels in busy East Coast corridors, while manatees are frequently struck by boats in shallow waters near Florida. Several hundred animals are wounded or killed by such interactions every year.

Other possible causes of mortality include the indirect effects of climate change, introduction of new diseases, and ecosystem changes such as algal blooms. These factors may cause several thousand additional deaths each year.

Although pollution rarely kills marine creatures immediately, it can impair their health, harm their reproductive potential, and eventually lead to their death. Chemicals in fertilizers, pesticides, pharmaceuticals, and other materials can accumulate in the tissues of these animals, especially those with long life spans, such as sea turtles. Ingestion of ocean debris and entanglement in plastic trash are additional dangers for marine mammals, sea turtles, and sea birds.

Marine mammal populations may also be disturbed by noise from shipping, oil and gas exploration, ocean drilling, naval operations, oceanographic and geophysical research, and similar activities. In the last ten years, considerable publicity has surrounded the deaths of marine mammals in close proximity to U.S. naval operations and geophysical research vessels. Unfortunately, very little is known about marine mammal hearing, making it difficult to assess the potential bio-physical impacts of noise on marine animals.

The threats to endangered marine species such as sea turtles and sea birds are myriad and not easily categorized. One factor that is common to declines in many species is the destruction or degradation of their natural habitat. Thus the successful recovery of a species depends to a large degree on protection or restoration of this habitat.

REVIEWING AUTHORITIES AND RESPONSIBILITIES

The early 1970s witnessed the passage of several landmark environmental laws in the United States. Many of these statutes affected marine mammals and other protected species indirectly, but two were focused specifically on the conservation and protection of these animals.

The Marine Mammal Protection Act

The 1972 Marine Mammal Protection Act (MMPA) was passed by Congress in response to public concerns about the incidental deaths of hundreds of thousands of dolphins each year associated with tuna fisheries, the hunting of seals for fur, and the continuing commercial harvest of whales despite controls by the International Whaling Commission. The MMPA, with limited exceptions, prohibits the hunting, killing, or harassment of marine mammals.

The MMPA divides federal jurisdiction over marine mammals between two agencies. The National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS) manages the vast majority of marine mammals, including whales, dolphins, porpoises, seals, and sea lions. The U.S. Department of the Interior's (DOI's) U.S. Fish and Wildlife Service (USFWS) manages five species: polar bears, walrus, sea otters, manatees, and dugongs.

The MMPA also established the independent Marine Mammal Commission (MMC). The MMC is charged with reviewing and making recommendations on domestic and international actions and policies of all federal agencies with respect to marine mammal protection and conservation. It also manages and funds a research program to support management activities. Although the Commission's independence has been essential to its functioning, creation of the National Ocean Council will provide it with a venue to coordinate with other federal agencies involved in marine mammal research and management. According to the MMC, most marine mammal stocks in U.S. waters, and many others around the world, are in better condition now than before passage of the MMPA.[2]

Recommendation 20–1. Congress should amend the Marine Mammal Protection Act to require the Marine Mammal Commission to coordinate with all the relevant federal agencies through the National Ocean Council (NOC) while remaining independent. The NOC should consider whether there is a need for similar oversight bodies for other marine animals whose populations are at risk.

The Endangered Species Act

In 1973, the Endangered Species Act (ESA) was enacted to conserve endangered and threatened species and the ecosystems upon which they depend. The new law vastly strengthened earlier measures directed at the same problem. The public was broadly supportive of the Act due to the well-publicized declines of well-known species such as the bald eagle. A 1999 public opinion survey indicated that public support for the protection of biodiversity continues.[3]

Under the ESA, the federal government is responsible for listing species as "endangered" or "threatened" based on population size and trends. This responsibility is divided between the USFWS, primarily responsible for terrestrial organisms, and NMFS, primarily responsible for marine and anadromous species. The law includes powerful prohibitions against any action that harms a listed animal. The law, with limited exceptions, prohibits federal agencies from authorizing, funding, or carrying out any action that would jeopardize a member of a listed species or destroy its critical habitat and requires them to undertake conservation programs. To promote state action, matching federal funds were authorized for states willing to enter into approved cooperative agreements.

Currently, there are 1,509 species listed as endangered and 345 species listed as threatened by USFWS, while NMFS has listed 19 species as endangered and 12 as threatened. It is impossible to precisely quantify the overall biological impact of the ESA. However, a 1995 National Research Council (NRC) report concluded that the ESA has successfully prevented species from becoming extinct.[4] The rigorous provisions of the ESA work as a safety net to help species survive once they have declined to the level that listing is warranted. Because of this, the NRC did not recommend wholesale changes to ESA implementation. It did, however, point out that the ESA has been less effective in preventing species from declining to levels that require listing in the first place.

The NRC also observed that, although one purpose of the ESA is to conserve ecosystems, the Act itself includes little specific guidance in this area. To fix this, the NRC recommended a focus on broader rehabilitation of ecosystem functions, as part of a move toward ecosystem-based management. Maintaining healthy, functioning ecosystems can help prevent species from becoming threatened or endangered and avoid some of the economic disruption that results when drastic measures must be taken to protect an endangered species. The NRC report also concluded that the federal focus of the ESA should be broadened to include other layers of government and nongovernmental interests as well. Of course, humans themselves are part of the ecosystem and comprehensive management plans should account for both species conservation and human uses.

IDENTIFYING AND OVERCOMING GAPS IN PROTECTION

Several changes are needed in federal law to enhance marine mammal and endangered species protection. The split of management jurisdiction between two federal agencies, confusion over the requirements of permit applications and approvals, and the lack of clarity in the definition of legal terms are all issues that should be addressed.

Jurisdictional Confusion

As noted, the management of marine mammals and endangered species is currently divided between NMFS and USFWS. In the case of marine mammals, this split was intended to be temporary and makes little sense. In the case of endangered species, the split is more logical, but better coordination and clarity are still needed.

The original congressional committee reports that accompanied the MMPA in 1972 show that Congress did not intend marine mammal jurisdiction to be permanently divided between NOAA and USFWS.[5,6] Rather, House and Senate committees anticipated the creation of a new Department of Natural Resources that would combine NOAA and USFWS. The report stated that if the proposed new department did not become a reality, they would reexamine the question of jurisdiction and consider placing the entire marine mammal program within a single department. Nevertheless, the jurisdictional split remains today.

The division of endangered species jurisdiction appears reasonable because of the expertise of each agency: NMFS has jurisdiction over marine and anadromous species and DOI has jurisdiction over terrestrial and freshwater species. But ecosystems do not recognize these distinctions. When some species of salmon were listed under the ESA in the 1980s and 1990s, most of the causes for their decline were land-based or freshwater in origin, requiring significant coordination between NMFS and USFWS, as well as other agencies. This coordination has not been entirely effective and improved oversight of the relationship between NMFS and USFWS is needed to clarify areas of responsibility and reduce conflicts.

Recommendation 20–2. Congress should amend the Marine Mammal Protection Act to place the protection of all marine mammals within the jurisdiction of the National Oceanic and Atmospheric Administration.

Recommendation 20–3. The National Ocean Council should improve coordination between the National Marine Fisheries Service and U.S. Fish and Wildlife Service with respect to the implementation of the Endangered Species Act, particularly for anadromous species or when land-based activities have significant impacts on marine species.

Unclear Permitting and Review Standards

A *take* is a term used in the MMPA and ESA to define an activity that results in the death or injury of a marine mammal or a member of an endangered species. After much litigation and scrutiny, the interpretation of this term under the ESA appears fairly clear to both managers and the public. This is not the case for the MMPA.

The MMPA prohibits the taking or importation of marine mammals and marine mammal products unless that action falls under one of the law's exemptions, such as a taking for the purpose of education, conservation, or scientific research. Exemptions are also allowed for Native Alaskans, who may take marine mammals for subsistence or for creating authentic native handicrafts and clothing.

Outside these narrow exemptions, the MMPA authorizes the issuance of permits for the unintentional and incidental taking of small numbers of marine mammals provided it has only a negligible impact on the species. This provision has been problematic because terms such as *small numbers* and *negligible impact* are not defined in the Act, resulting in a lack of clarity about when a permit is necessary and under what circumstances it should be granted.

Recommendation 20–4. Congress should amend the Marine Mammal Protection Act to require the National Oceanic and Atmospheric Administration to more clearly specify categories of activities that are allowed without a permit, those that require a permit, and those that are prohibited.

The Meaning of Harassment

Under the MMPA, the term *harassment* is an essential element in determining whether a small-take permit can be granted. Amendments to the Act in 1994 split the definition of harassment into two categories. Harassment is currently defined in law as any act of pursuit, torment, or annoyance that:

- has the potential to injure a marine mammal or marine mammal stock in the wild (level A harassment), or
- has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (level B harassment).

The apparent intent of this definition was to distinguish activities likely to have significant effects from activities such as marine mammal research that, although perceptible to the animals, are not likely to result in significant disturbance. However, NOAA and USFWS have had difficulties implementing the 1994 definition which has led to public uncertainty with respect to its implications. The lack of clarity means that almost any commercial, recreational, or scientific activity that is noticed by a marine mammal might be defined as harassment. Paradoxically, this uncertainty has provided *less* protection; neither agency has ever brought an enforcement case under the new definition. In fact, both agencies argue that the confusion limits their ability to regulate even potentially harmful activities.

A 2000 National Research Council report concluded that the intent of the MMPA was not to regulate activities that result in minor changes in behavior.[7] The report recommended that level B harassment be redefined to focus on "meaningful disruptions to biologically significant activities." Another National Research Council study currently underway is investigating what behaviors should be considered biologically significant and what research might be needed to implement the revised definition.

Recommendation 20–5. Congress should amend the Marine Mammal Protection Act to revise the definition of harassment to cover only activities that meaningfully disrupt behaviors that are significant to the survival and reproduction of marine mammals.

The Promise of Programmatic Permitting

In spite of the confusion about MMPA wording, NMFS and USFWS have had to issue regulations and make case-by-case decisions on permit and authorization applications. Considerable deference has been given to the professional judgment of agency personnel regarding which activities are permissible. Both agencies have qualified and dedicated people reviewing applications, but the process is necessarily subjective and a personnel change can mean the difference between approval and denial of similar permits. This case-by-case decision making has led to inconsistencies, a lack of clear standards, and uncertain protection for marine mammals.

Most permit applications are processed according to the same procedures, regardless of the level of potential harm to marine mammals. As a result, limited agency resources can be wasted reviewing relatively insignificant permit applications, while insufficient attention is paid to more worrisome activities. A shift to programmatic permitting would enable more proactive and efficient handling of the bulk of permit applications, while reducing the costs and burdens on agency personnel.

Programmatic permitting would allow for quick approval of activities on a defined list, specifying broad parameters within which those activities could occur. A programmatic permit could also include required mitigation and data collection measures, such as requiring that whale-watching boats keep at a certain distance from the animals and maintain records of species observed and their locations.

In addition to streamlining permitting, clear and consistent enforcement is needed to ensure compliance with permit conditions, and penalties must be stiff enough to discourage anyone tempted to disregard those conditions.

Recommendation 20–6. The National Marine Fisheries Service and the U.S. Fish and Wildlife Service should implement programmatic permitting for activities that affect marine mammals, wherever possible. More resource intensive case-by-case permitting should be reserved for unique activities or where circumstances indicate a greater likelihood of harm to marine mammals. The National Ocean Council should create an interagency team to recommend activities appropriate for programmatic permitting, those that are inappropriate, and those that are potentially appropriate pending additional scientific information. Enforcement efforts should also be strengthened and the adequacy of penalties reviewed.

To carry this out:

- *the interagency team should include representatives from the National Oceanic and Atmospheric Administration, National Science Foundation, U.S. Army Corps of Engineers, Minerals Management Service, and U.S. Navy, with input from the Marine Mammal Commission.*
- *programmatic permits should be subject to periodic review, be updated to incorporate the best available science, and remain valid for a limited time to ensure that current permittees are bound by any changes.*

While programmatic permitting would reduce much of the uncertainty about whether a permit is required, some cases will continue to be unclear. Potential permittees should approach the regulatory agencies as soon as a question arises about possible interactions with marine mammals. In particular, the potential impacts of new ocean technologies on marine mammals should be considered and the permit application process started early in the developmental stages.

Communication must also be improved so that permitting agencies have sufficient time and resources to meet their responsibilities while the action agency or permit applicant can be sure that decisions will be made in a confidential, timely and consistent manner. This has been a particular problem in the past with regard to naval exercises and oceanographic research activities.

EXPANDING RESEARCH AND EDUCATION

Although much more is known about marine animals today than even a decade ago, scientists still do not understand the life history or physiology of most marine mammal species. Because the decline of such populations tends to be caused by multiple environmental factors, enhanced research on a range of subjects is necessary to find ways to reduce the harmful effects of human activities and to implement effective ecosystem-based management plans.

Understanding Behavior and Human Impacts

Minimizing disruptions to the most important life stages of marine mammals will aid in their survival. To maximize reproductive rates in declining populations, more needs to be learned about breeding grounds and essential habitat. If information were available that showed a particular species could benefit from higher levels of protection during times of mating or birth, management practices could evolve accordingly. Actions could include temporarily closing fisheries that overlap with these activities or requiring vessel traffic to slow down or avoid critical areas. Knowledge of migration patterns and feeding locations is also critical to maintaining healthy populations.

While many human activities can harm individual marine animals, the extent to which humans affect the long-term status of protected species is poorly understood. Coastal development, offshore oil and gas exploration, vessel traffic, military activities, and marine debris all have the potential to threaten protected populations. Understanding the danger of these activities relative to bycatch, hunting, and natural predation is critical to focus attention, research, and enforcement efforts where it is most needed.

Point and nonpoint source pollution threaten the health of all ocean organisms. Much more study is needed about the effects of contaminants, especially on marine mammals' immune functions, and the possible results of exposure to human pathogens and toxic algal blooms. In addition, the differing impacts of chronic versus acute exposures need to be measured—long-term exposure to relatively low levels of some pollutants may be more damaging to a population's continued success than a single, high-impact event.

Increased research into the biological, chemical, and psychological stresses to marine mammal and other protected species populations will allow for more comprehensive, ecosystem-based management. Furthermore, for activities where interaction with protected populations is likely and unavoidable, better scientific data will lead to more effective permitting procedures.

Recommendation 20–7. The National Oceanic and Atmospheric Administration and the U.S. Department of the Interior should promote an expanded research, technology, and engineering program, coordinated through the National Ocean Council, to examine and mitigate the effects of human activities on marine mammals and endangered species.

Effects of Noise on Marine Mammals

One particular area that requires better understanding is the effect of sound on marine mammals. Many marine mammals use sound to communicate, navigate, feed, and sense their surroundings. These natural behaviors can be disrupted when other sounds interfere. In the ocean, sound emanates from a variety of sources, both natural (e.g., storms, volcanic eruptions, and earthquakes) and human-generated (e.g., shipping, scientific and commercial surveys, and commercial and military sonar).

Scientists know relatively little about the biological, psychological, and behavioral changes in marine mammals that are caused by human-generated sound. Activities such as commercial shipping, construction, geological exploration, and sonar certainly can produce noises intense enough to elicit reactions from marine mammals. However, due to the complexity of the biological and physical interactions being studied, and the difficulty of conducting studies on marine mammals, many important questions remain unanswered.[8] For example, the scientific community currently understands very little about marine mammal hearing and how these animals react to sound. It is not known whether health and behavioral problems will arise only from acute exposures to very loud sound, or whether chronic exposure to lower-intensity sounds (such as passing ship traffic) may also result in long-term effects.

Currently, the U.S. Navy and, to a lesser extent, the Minerals Management Service, are the only federal agencies with significant marine mammal acoustic research programs, including studies to examine the impact of noise on marine mammals. Expanded research efforts and data dissemination are needed to understand marine mammal interactions with sound and reduce or prevent the negative impacts of human-generated noise on these animals.

Recommendation 20–8. Congress should expand federal funding for research into ocean acoustics and the potential impacts of noise on marine mammals. This funding should be distributed across several agencies, including the National Science Foundation, U.S. Geological Survey, and Minerals Management Service, to decrease the reliance on U.S. Navy research in this area. The research programs should be well coordinated across the government and examine a range of issues relating to noise generated by scientific, commercial, and operational activities.

Public Education and Outreach

The general public increasingly has opportunities to come into contact with marine mammals through diving, aquarium shows, and similar activities. These interactions can increase public awareness and sensitivity about the needs and vulnerabilities of these animals and how human activities can affect them. Aquariums and other marine mammal exhibitors can also showcase how larger environmental issues affect marine mammals and the ecosystems on which they rely.

While human contact with marine mammals raises public awareness, there is also growing concern about activities such as feeding programs, whale-watching excursions, and facilities that allow humans to swim with captive dolphins. For example, feeding programs in the open ocean, most prevalent in Florida and Hawaii, can disrupt natural behaviors and expose animals to harm by decreasing their natural fear of humans.[9] Education programs should point out the harm that too much human interaction with marine mammals can inadvertently cause.

APPLYING ECOSYSTEM-BASED MANAGEMENT PRINCIPLES

The purpose of ecosystem-based management approaches is to recognize the full nature of ocean and coastal systems and to allow for better coordination of management actions, reduce duplication and conflicts, and take full advantage of available resources. As they are implemented, ecosystem-based management practices can enhance the protection of marine mammals and endangered species.

Domestic Action

The MMPA and ESA currently provide powerful statutory and regulatory tools to address direct impacts to marine mammals and endangered species. However, mechanisms are not in place for handling broad, long-term threats and concerns. The basic tenets of ecosystem-based management require an assessment of all important components and processes in a system, and evaluation of all potential threats. Improved scientific assessments will allow managers to create ecosystem-based management plans, an essential part of which would describe threats to marine mammals and other protected species. Once an ecosystem is analyzed, managers can prioritize protection efforts, addressing the most critical risks first.

For marine mammals, hunting and fisheries bycatch would be at the top of the list; for endangered species, habitat destruction would be a likely focus. Unfortunately, attention has centered instead on high-profile lower impact issues, such as the possible effect of ocean noise on marine mammals. Part of the explanation for the misdirected focus is the huge disparity between what we know about the biology and ecology of marine species and what remains to be learned. In particular, the lack of baseline data on marine mammal biology coupled with limited stock assessment data make it difficult to evaluate population abundance and trends or distinguish management successes and failures.

The listing of several salmon species as endangered and threatened shows both the promise and the difficulty of moving toward an ecosystem-based management approach. The threat of large-scale economic disruptions in the Pacific Northwest has led many state, local, and tribal entities to push for a more collaborative, ecosystem-based management approach to avoid severe federal sanctions under the ESA. However, initial results have shown that the federal government needs to do a better job of supporting and encouraging these efforts. Recommendations in Chapter 3 on ecosystem-based management and in Chapter 5 on the benefits of a regional approach should help.

International Coordination

Expanding the concept of ecosystem-based management to its logical conclusion will require us to address impacts that occur beyond U.S. waters. For many of the marine species discussed in this chapter, the

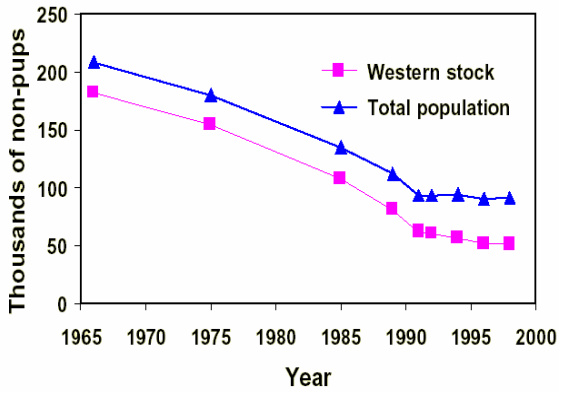
ecosystem in which they live encompasses the high seas and also the waters of many other countries around the world. In order to address impacts to these species throughout their ecosystem, the United States will need to use international agreements and other diplomatic means to strengthen protections for species beyond our own waters. For example, the development of bycatch reduction methods for U.S. fishermen should be complemented by efforts to get foreign fishermen to implement similar methods. This comprehensive approach makes sense from a conservation perspective and creates a more level playing field for U.S. and foreign fishermen. The U.S. Department of State, working with NOAA and DOI, should continue to actively pursue efforts to reduce the impacts of human activities on marine species at risk in international and foreign waters.

Making a Case for Ecosystem-based Management: The Steller Sea Lion

The story of the Steller sea lion illustrates the conflicts that can arise between human activities and protection of marine mammals. The Steller sea lion is the largest of the sea lions and is found along coastal areas of the northern Pacific Rim. Its primary sources of food are groundfish, including pollock and mackerel, and cephalopods, including octopus and squid. Since the mid-1970s, the western population near Alaska has declined by about 85 percent (Figure 20.1).[10] Analyses indicate that the decline may be due in part to environmental changes, legal and illegal hunting, predation by killer whales, competition with fishermen for food, and incidental catch in fisheries. A 2003 report by the National Research Council found that none of these causes could be ruled out and called for scientifically-designed adaptive management experiments to find out more.[11]

Under the Marine Mammal Protection Act, the national Marine Fisheries Service (NMFS) is responsible for managing Steller sea lions. It is also the agency responsible for management of Alaskan fisheries, resulting in potential statutory conflicts. In 1991, a number of environmental groups sued NMFS for failing to take into account the potential role of Alaskan fisheries in the decline of the Steller sea lion. After years of litigation, the problem has yet to be resolved to the satisfaction of any of the litigants. In addition, Steller sea lions were listed under the Endangered Species Act (the western population as endangered and the eastern as threatened) adding that statute's requirements to the mix.

Figure 20.1. Sea Lion Populations in Danger



Even though Steller sea lions have been protected since the early 1970s, the Alaskan populations of animals over one year old (non-pups) have continued to decline, particularly those located along the Aleutian Islands. This decline cannot be traced to a single cause, underscoring the need for an ecosystem-based approach to protect these animals.
Source: National Oceanic and Atmospheric Administration. <http://stellersealions.noaa.gov/> (Accessed January, 2004).

The continued decline of the Steller sea lion population highlights the importance of moving toward an ecosystem-based management approach, where such factors as predators, quality and quantity of food, essential habitat, and incidental catch are all weighed when deciding the best course of action for protection of a species. In addition, a more ecosystem-based focus would have identified the problem much more quickly, enabling managers and scientists to develop a more comprehensive and timely research strategy to determine the various causes of the decline and develop a management regime to address the problems. Instead, the situation was allowed to reach a crisis stage, requiring emergency measures.

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[10] Marine Mammal Commission. *Annual Report to Congress*. Washington, DC, 2002.
[11] National Research Council. *The Decline of the Steller Sea Lion in Alaskan Waters: Untangling Food Webs and Fishing Nets*. Washington, DC: National Academy Press, 2003.

CHAPTER 21: PRESERVING CORAL REEFS AND OTHER CORAL COMMUNITIES

Coral reefs and other coral communities are beautiful and diverse, as well as biologically and economically valuable. In addition to well-known tropical coral reefs, coral communities can also be found in deep waters and at high latitudes. Increasingly, coral reefs and other coral communities are facing threats from a number of natural and human-induced causes. To conserve these unique ecosystems, comprehensive coral reef protection and management legislation is needed to address research, protection, and restoration of coral ecosystems. A strengthened U.S. Coral Reef Task Force should lead and coordinate federal coral management efforts. The United States must continue to be a leader in coral management at the international level, including promoting the development of international standards for sustainable harvesting of coral reef resources. Finally, improved research and data collection are critical to better understand coral ecosystems and the impacts of human activities on them.

ASSESSING THE STATUS OF CORAL ECOSYSTEMS

Coral reefs are formed from layers of calcium carbonate deposited over time by colonies of individual corals. These reefs provide homes for tens of thousands of species of marine plants and animals, making them among the world's most diverse and productive habitats. Nearly one-third of all fish species live on coral reefs,[1] while other species depend on the reefs and nearby seagrass beds and mangrove forests for critical stages of their life cycles.

The Distribution of Coral Ecosystems

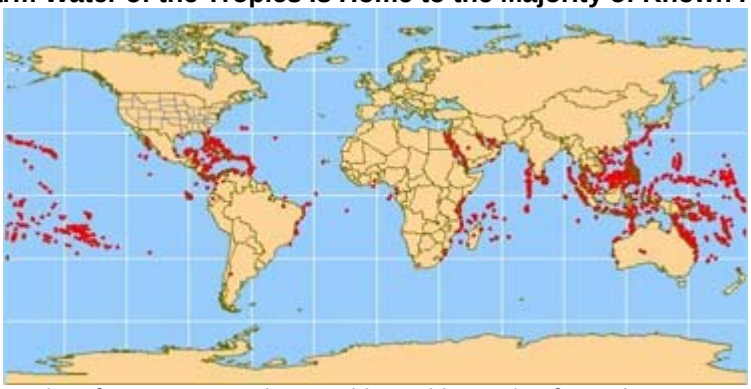
Most coral reefs are found in shallow, clear ocean waters in tropical and semitropical areas. These warm-water corals derive significant food and energy from photosynthetic algae that live in symbiosis with the corals. Warm-water corals have raised intense interest in the last decade because of their apparent sensitivity to climate variability.

Other corals that do not depend directly on sunlight can form reef-like structures or banks at depths from one-hundred feet to more than three miles below the ocean's surface. While little is known about these deep-water structures, many scientists believe that their biological diversity may rival that of coral communities in warmer, shallower waters.[2]

Coral reefs are found in the waters of more than one-hundred countries, including the United States (Figure 21.1). They are particularly abundant in the South Pacific; Indonesian waters are estimated to include the largest proportion of corals, approximately 18 percent of the global total. U.S. waters include 1–2 percent of global warm-water corals.[3] Deep-water corals have been found around the globe, although little is known about their actual extent.

The National Oceanic and Atmospheric Administration (NOAA) estimates that U.S. coral reefs cover approximately 7,600 square miles. These reefs can be found in western Atlantic and Caribbean waters off Florida, Puerto Rico, the U.S. Virgin Islands, the Navassa Island National Wildlife Refuge (a small U.S. island territory near Haiti), and in the Pacific Ocean near Hawaii, American Samoa, Guam, the Commonwealth of the Northern Mariana Islands, and several remote, unincorporated Pacific island areas. Estimates of coral reef extent in the Pacific Freely Associated States (Palau, the Federated States of Micronesia, and the Marshall Islands) range from 4,500 to 31,500 square miles.[4]

Figure 21.1. The Warm Water of the Tropics Is Home to the Majority of Known Reefs



The locations of major coral reefs are seen as dots on this world map (reef area is not to scale). Most of the world's known reefs are found in tropical and semitropical waters, between 30° north and 30° south latitudes, although scientists have only begun to explore other cold-water coral communities.
Source: National Oceanic and Atmospheric Administration. <http://www.coris.noaa.gov> (Accessed January, 2004).

The Value of Coral Ecosystems

Coral reefs are valued for their rich biological diversity as well as for the important ecosystem functions they serve. Reefs buffer shorelines from storms and erosion and provide homes, food, and nursery areas for tens of thousands of species of marine life. They are also the basis of thriving commercial and recreational fishing and tourism industries, and have the potential to provide beneficial medical applications. Coral reef ecosystems are estimated to provide a worldwide total of $375 billion a year in goods and services, with approximately 500 million people dependent on these ecosystems for food, materials, or income.[5] In 2001, coral reefs in the Florida Keys alone supported $105 million in income and more than 8,000 jobs.[6] Further, approximately one-half of all federally managed commercial fish species depend on coral reefs for at least part of their life cycle.[7]

Many people also value coral reefs for their unique aesthetic and cultural value. Coral reefs are an important part of the heritage of many countries, and the use of reef resources is integral to the social fabric of coastal communities. As one of the longest-lived and most beautiful ecosystems on Earth, their intrinsic value is incalculable.

Threats to Coral Ecosystems

Coral reefs are declining at a disturbing pace.[8] The causes of this decline are varied, particularly for warm-water reefs. Many scientists believe that excessive fishing pressure has been the primary threat to coral ecosystems for decades.[9] However, pollution and runoff from coastal areas also deprive reefs of life-sustaining light and oxygen, and elevated sea surface temperatures are causing increasingly frequent episodes of coral bleaching and appear to be exacerbating other coral disease outbreaks.[10] Although little is known about the condition of the world's deep-water coral communities, extensive damage has been documented in some areas, with fishing activities suspected as being the largest human-related threat.[11]

Worldwide, no pristine, undamaged warm-water coral reefs remain, and one-third of the world's identified reefs are severely damaged.[12] In the United States, every warm-water reef system has suffered varying degrees of impacts from natural and human disturbances. Only the coral reefs in the Northwest Hawaiian Islands are in near-pristine condition, although they too have begun to show signs of damage, particularly from marine debris. In the U.S waters of the south Atlantic, Gulf of Mexico, and Caribbean, two-thirds of reef fish species are overfished. In addition, during the 1990s, white band disease killed 90–96 percent of the most common nearshore species of corals.[13]

Coral communities have existed for millions of years and have developed mechanisms to cope with natural threats such as hurricanes, landslides, and predation. Often, when one part of a coral community is damaged, the overall functioning of the coral reef ecosystem is sustained by other, untouched communities that are able to repopulate damaged areas. However, the point is fast approaching where this natural cycle of repair may not be able to keep pace with the increasing rate of damage. Without immediate and large-scale protection from the cumulative impacts of a multitude of human activities, many reefs, particularly those located near heavily populated coastal areas, may soon be irretrievably harmed.[14]

MANAGING U.S. CORAL RESOURCES

Federal Agency Roles and Responsibilities

Although a number of longstanding environmental laws can be applied to the protection of coral reefs, the first legislation specifically targeted at coral reef issues, the Coral Reef Conservation Act, was passed in 2000. The Act focuses primarily on NOAA activities, requiring the agency to develop a national coral reef action strategy, initiate a matching grants program for reef conservation, and create a conservation fund to encourage public–private partnerships.

The Marine Protection, Research, and Sanctuaries Act (MPRSA) also provides protection for many coral reefs by authorizing NOAA to designate areas as marine sanctuaries and promulgate regulations for the conservation and management of those areas. Since the Act was passed in 1972, thirteen sanctuaries have been designated, several of which contain coral communities. Coral research, monitoring, and management activities are conducted in these sanctuaries, as well as in the Northwestern Hawaiian Islands Coral Reef Ecosystem Reserve, which is currently under consideration to become the nation's fourteenth sanctuary.

The MPRSA includes a provision that allows NOAA to fund repairs to damaged habitats within sanctuaries, with cost recovery from responsible parties. However, the Act only allows funding for projects to repair immediate damage. For example, if a ship hits a reef, funds may be used to repair the damaged site, but not to install navigational aids to prevent other ships from damaging the reef in the future. Further, the funds cannot be used to remedy long-term chronic damages from pollution, nutrient overloading, or disease.

Other federal laws that are used to manage and protect coral reef resources include the following (a description of these and other federal statutes are included in Appendix D):

- The Magnuson–Stevens Fishery Conservation and Management Act, which allows for management of coral harvest and provides limited protections for corals if they are designated as "essential fish habitat."
- The Coastal Zone Management Act, which provides for management of shoreline areas that may include coral reefs.
- The Clean Water Act, which regulates the discharge of dredged or fill materials into U.S. waters.
- The Sikes Act, which requires the U.S. Department of Defense to provide for conservation and rehabilitation of natural resources on military installations, which in some locations include corals.
- The Endangered Species Act, National Environmental Policy Act, and Lacey Act, all of which contain some provisions that can be applied to the protection of corals.

Responsibility for implementing these and other laws with implications for coral reef management is shared by a number of federal agencies. For example, the U.S. Environmental Protection Agency and the U.S. Department of Agriculture have regulatory and management responsibilities related to pollution from land-based sources. NOAA has the authority to regulate fishing in coral reef ecosystems. And action on global climate change is under the purview of many agencies, including the U.S. Department of Energy and the U.S. Department of State.

Interagency and Intergovernmental Coral Reef Management Initiatives

The U.S. Coral Reef Task Force

The U.S. Coral Reef Task Force was created by Executive Order in 1998 with the purpose of improving coordination among the many agencies that manage various aspects of the nation's coral reef resources. Task force responsibilities include developing strategies to map and monitor U.S. coral reefs, studying the causes of and recommending solutions for coral reef degradation, and promoting conservation and sustainable use of coral reefs at the international level. Several broad action plans have been developed by the task force, although not all have been implemented.

The task force, which is co-chaired by the U.S. Departments of the Interior and Commerce, works primarily through consensus building among its member federal agencies and state and territorial government representatives. Two notable absences from the task force are the Department of Energy and the U.S. Army Corps of Engineers (USACE). The Department of Energy is actively involved in investigating the impact of global climate change on coral reefs. In addition, coral reefs are affected by many USACE projects, such as the construction of inland and shore structures, beach nourishment programs, and mooring permits.

The U.S. All Islands Coral Reef Initiative

The U.S. All Islands Coral Reef Initiative, a cooperative effort among Hawaii, American Samoa, Guam, the Commonwealth of Northern Mariana Islands, Puerto Rico, and the U.S. Virgin Islands, is working to improve the management of coral reefs in island areas. Regional approaches that incorporate traditional knowledge are of particular interest to these islands, many of which share common cultural concerns about coral reef resources and manage similar threats, such as erosion, sea level rise, and degraded water quality.

Improving the Management of U.S. Coral Resources

Despite recent management efforts, the health of coral reef ecosystems is continuing to decline at a rapid pace, demanding that further action be taken to overcome gaps and inefficiencies in the existing patchwork of laws, regulations, and agency programs. An improved governance regime is needed to better respond to coral reef management priorities at all levels (local, state, territorial, regional, and national), improve coordination among agencies, facilitate regional approaches, and implement national action on coral reefs. This regime should build on existing ideas and strategies of the U.S. Coral Reef Task Force, the U.S. All Islands Coral Reef Initiative, the Coral Reef Conservation Act, and the Marine Protection, Research, and Sanctuaries Act and task federal agencies with promulgation and enforcement of effective regulations to protect coral reef resources. Concerted support among all levels of government and increased public awareness are also essential for successfully implementing improved management strategies to achieve and sustain healthy coral reef ecosystems.

Recommendation 21–1. Congress should pass, and provide sustained funding for, a Coral Protection and Management Act that covers research, protection, and restoration of coral ecosystems.

This legislation should include the following elements:

- *support for mapping, monitoring, and research programs primarily through the National Oceanic and Atmospheric Administration and the U.S. Coral Reef Task Force.*
- *support for new research and assessment activities to fill critical information gaps, to be carried out in partnership with the academic research community.*
- *liability provisions for damages to coral reefs similar to those in the Marine Protection, Research, and Sanctuaries Act, but with greater flexibility to use funds in a manner that provides maximum short- and long-term benefits to the reef.*
- *support for outreach activities to educate the public about coral conservation and reduce human impacts.*
- *support for U.S. involvement, particularly through the sharing of scientific and management expertise, in bilateral, regional, and international coral reef management programs.*

In addition to new legislation directed specifically at improving the management of the nation's coral reef resources, a strengthened U.S. Coral Reef Task Force is needed to improve collaborative efforts at reducing the threats to these resources.

Recommendation 21–2. Congress should codify and strengthen the U.S. Coral Reef Task Force and place it under the oversight of the National Ocean Council.

The task force should be strengthened in the following ways:

- *Task force responsibilities should be expanded to include both warm-water and deep-water coral communities.*
- *the U.S. Department of Energy and the U.S. Army Corps of Engineers should be added as members of the task force.*
- *the task force should coordinate the development of regional ecosystem-based plans to address the impacts of nonpoint source pollution, fishing, and other activities on coral reef resources.*
- *the U.S. Environmental Protection Agency and the U.S. Department of Agriculture should work together to implement any pollution reduction goals developed by the task force.*
- *the National Oceanic and Atmospheric Administration, in consultation with Regional Fishery Management Councils, should implement any task force recommendations for reducing the effects of fishing on corals.*

Promoting International Coral Reef Initiatives

The United States has been a leader in the management of coral reef ecosystems at the international level. The State Department, NOAA, the U.S. Agency for International Development, and the U.S. Fish and Wildlife Service contribute significantly to building enhanced management capacity in developing countries through direct funding and through training in areas such as research, enforcement, management procedures, and environmentally sustainable harvesting techniques.

The United States also participates in many international initiatives that protect coral reef resources, including the Convention on International Trade in Endangered Species (CITES), an international agreement designed to protect species from over-exploitation by prohibiting trade with countries that cannot certify that their harvest of these species is not detrimental to their survival. Over 2,000 species of coral are listed under CITES. The International Coral Reef Initiative (ICRI) was developed in 1994 as an informal mechanism to develop the best strategies for conserving the world's coral reef resources. ICRI membership is made up of over eighty developing countries, donor countries, and development banks, international environmental and development agencies, scientific associations, the private sector, and nongovernmental organizations. ICRI's Global Coral Reef Monitoring Network has published the only global estimates of coral reef coverage and status, although the accuracy of these estimates could be improved.[15]

Creating More Sustainable Harvesting Practices

As the world's largest importer of ornamental coral reef resources,[16] the United States has a particular responsibility to help eliminate destructive harvesting practices and ensure the sustainable use of these resources. Many of these resources are harvested by methods that destroy reefs and overexploit ornamental species. A balance is needed between sustaining the legitimate trade in ornamental resources and sustaining the health and survival of the world's coral reef resources.

The Tropical Forest Conservation Act of 1998 offers a potential model for the role of the United States in curbing destructive harvesting practices. The Act authorizes the President to reduce debt owed to the United States if a developing country establishes a tropical forest management program and uses funds freed from the debt reduction agreement to support tropical forest conservation. Applying this type of program to the management of international coral reef resources could greatly enhance the ability of the United States to promote stewardship and conservation of coral reef ecosystems around the world.

Recommendation 21–3. The National Oceanic and Atmospheric Administration should develop national standards—and promote international standards—to ensure that coral reef resources that are collected, imported, or marketed are harvested in a sustainable manner. The U.S. Department of State should implement incentive programs to encourage international compliance with these standards.

IMPROVING UNDERSTANDING OF CORAL ECOSYSTEMS

Improved research and data collection activities are needed to better understand coral reef ecosystems and the impact of human activities on these ecosystems. The Integrated Ocean Observing System (IOOS), discussed in Chapter 26, is intended to become an integrated and continuous monitoring system encompassing all ocean environments, including coral communities. More finely tuned measurements of temperature and currents—and corresponding changes in coral communities—will allow scientists to understand and better predict the impacts of global climate change and other natural and human-induced events on coral communities. In addition, NOAA is working on a set of comprehensive maps of U.S. coral reefs that will incorporate an assessment of the current status of these reefs.

As the IOOS and other data collection programs (including the regional ocean information programs discussed in Chapter 5) move forward, the U.S. Coral Reef Task Force can provide guidance on information needs. This new information can then support further ecosystem-based research and management plans.

Recommendation 21–4. The U.S. Coral Reef Task Force should identify critical research and data needs related to coral reef ecosystems. These needs should guide agency research funding and be incorporated into the design and implementation of the Integrated Ocean Observing System.

The task force should:

- *develop regional, ecosystem-based research plans designed to protect and restore coral reef ecosystems, including deep-water coral communities.*
- *coordinate its efforts with the regional ocean information programs.*

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[16] National Oceanic and Atmospheric Administration. *A National Coral Reef Action Strategy. Report to Congress on Implementation of the Coral Reef Conservation Act of 2000 and the National Action Plan to Conserve Coral Reefs in 2002–2003*. Silver Spring, MD, June 2002.

CHAPTER 22: SETTING A COURSE FOR SUSTAINABLE MARINE AQUACULTURE

As world consumption of seafood continues to increase, the farming of marine species has become a rapidly growing domestic and international industry. There are, however, a number of challenges that this industry presents. Nearshore marine aquaculture activities are affected by increasing population and development pressures and confusing or overlapping laws, regulations, and jurisdictions. Aquaculture operations in offshore waters lack a clear regulatory regime, and questions about exclusive access have created an environment of uncertainty that is detrimental to investment in this industry. Also of concern are potential threats to the environment and to native fish populations, and conflicts between aquaculture and other uses of the nation's ocean and coastal waters. A lead federal agency with an office dedicated to marine aquaculture is needed to address jurisdictional issues and to ensure the development of an economically and environmentally sound marine aquaculture industry.

ACKNOWLEDGING THE GROWING SIGNIFICANCE OF MARINE AQUACULTURE

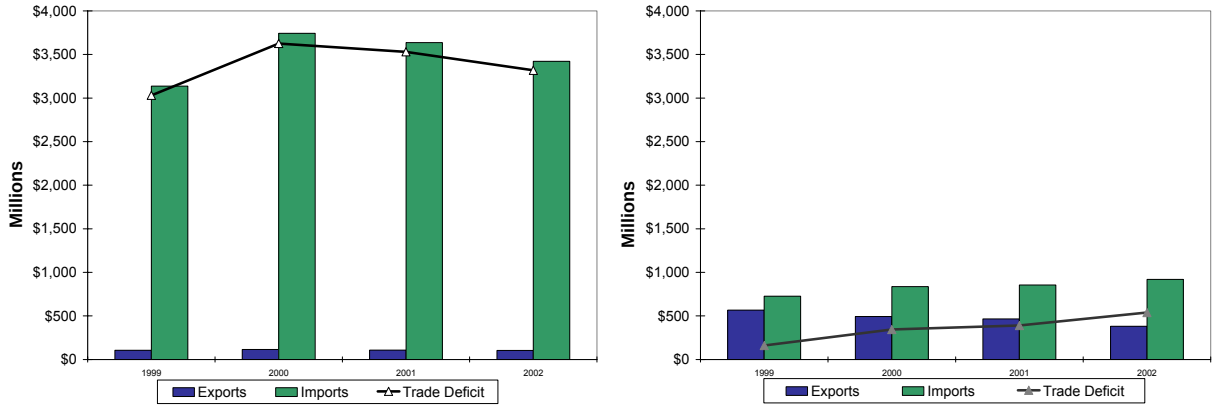
As traditional harvest fisheries have approached and exceeded sustainable levels, the farming of fish, shellfish, and aquatic plants in marine and fresh waters has become a burgeoning global industry. These animals can be raised in everything from nearly natural environments to enclosed structures, such as ponds, cages, and tanks, where they are fed and treated to maximize their growth rate.

In the United States, the demand for seafood continues to grow as expanding numbers of Americans seek healthier diets. During the 1980s and 1990s, the value of U.S. aquaculture production rose by about 400 percent, to almost $1 billion. This figure includes freshwater and marine finfish and shellfish, baitfish, and ornamental fish for sale to aquariums.[1] Along with fish farmers themselves, the aquaculture industry supports an infrastructure of feed mills, processing plants, and equipment manufacturers. There is great potential for marine aquaculture to become an even more important source of seafood for the U.S. market and a way to help reduce the nation's seafood trade deficit of $7 billion a year (Figure 22.1).[2]

ADDRESSING ENVIRONMENTAL IMPACTS OF AQUACULTURE

National management of marine aquaculture activities should minimize potential environmental impacts. These impacts include the spread of disease among fish populations, genetic contamination and competition between farmed and native stocks, and effects from aquaculture operations on water quality, wetlands, and other natural habitats. Fish waste, dead fish, uneaten food, and the antibiotics and hormones used to promote growth in captivity may contaminate the water around aquaculture facilities and harm surrounding ecosystems. Marine mammals, attracted by the food source, can become entangled in nets. There are also concerns about the increased demand for fishmeal used to feed farm-raised carnivorous fish. Obtaining fishmeal from traditional wild harvest practices may increase the pressure on fisheries that are already fully exploited. Extensive research is underway by the aquaculture community to determine how to decrease this demand.

Figure 22.1. The United States Imports More Seafood than it Exports



The dollar values of U.S. imports and exports for both shrimp and salmon illustrate the trade deficits caused by the nation's inability to harvest or culture enough seafood to meet consumer demand. Increasing aquaculture activities could help to reduce the nation's dependence on foreign seafood.

Source: U.S. Department of Agriculture, Economic Research Service. *Aquaculture Outlook 2003*. LDP-AQS-17. Washington, DC, March 14, 2003.

Another issue of increasing concern is the possible introduction of non-native species (intentionally or unintentionally) through marine aquaculture operations. In the United States, many cultured marine species are not native to the area where they are being farmed. In these cases, there is the possibility that foreign or genetically-modified species, or their reproductive offspring, may escape and potentially compete or reproduce with wild populations, resulting in unpredictable changes to ecological, biological, and behavioral characteristics. Where non-native species come in contact with already depleted fish or shellfish stocks, recovery efforts may be hampered.

Potential problems associated with the introduction of non-native species are illustrated in the case of the Atlantic salmon, which is one of the most widely farmed fish species in the United States and around the world. Escaped farm-bred salmon, which differ genetically from species of wild Atlantic salmon, have the potential to both compete with native salmon species (at least one of which has been listed as threatened or endangered under the Endangered Species Act) for limited resources, interbreed with native species causing changes in the gene pool, and spread disease. Infectious salmon anemia and sea lice, which are widespread in European salmon aquaculture facilities, have recently appeared in North American operations.[3]

Another example, discussed in more detail in Chapter 17, is the proposed farming of a non-native oyster species from China in Chesapeake Bay tributaries. This Chinese oyster appears to be resistant to the diseases plaguing the native species. However, a 2003 National Research Council report raised serious questions about the possible ramifications of such an introduction.[4] It is now up to state officials to decide what is best for the Bay, in both the short- and long-term, with little science or law to guide them.[5] Ironically, the steep decline in the Bay's native oyster population was caused in part by a disease introduced in the 1950s during a previous attempt to establish a non-native oyster species.

DEALING WITH UNCERTAINTIES IN THE EXISTING MANAGEMENT STRUCTURE

The potential contribution of marine aquaculture to the nation's economic growth and to meeting the increasing demand for seafood is impeded by its current management framework, which is characterized by complex, inconsistent, and overlapping policy and regulatory regimes administered by numerous state and federal agencies.

Federal Involvement

Federal agencies directly or indirectly involved in regulating marine aquaculture include the U.S. Departments of Agriculture and the Interior, the National Oceanic and Atmospheric Administration (NOAA), the U.S. Army Corps of Engineers (USACE), the U.S. Coast Guard, and the U.S. Environmental Protection Agency (EPA). The responsibilities of these agencies range from protecting water quality and other environmental issues, to navigation, to food safety concerns, to interactions with federal fishery management plans. The jumble of authorities makes it difficult for those involved in aquaculture activities to know what permits are needed and to be able to comply with all of the relevant rules governing their operations.

Because nearly all marine aquaculture activities operating today are located in nearshore waters under state jurisdiction, the majority of laws and regulations that authorize, permit, or control these activities are found at the state level and are not designed to address offshore aquaculture activities in federal waters.

Marine Aquaculture in Offshore Areas

As competition for space in nearshore areas intensifies, the marine aquaculture industry is looking increasingly toward opportunities in federal offshore waters. The nation's first commercial open ocean aquaculture operation began in 2001, when ownership of a public project in Hawaiian waters was transferred to a private firm. Other offshore aquaculture activities—most of which are in the pilot project stage—include the operation of a net pen adjacent to an oil platform in the Gulf of Mexico, and federally sponsored experiments off the coasts of Massachusetts and Hawaii.

The expansion of aquaculture activities into offshore waters provides potential benefits as well as additional concerns. Locating marine aquaculture activities farther offshore may reduce the visibility of these activities from land, be less intrusive to fisheries and recreational activities, and have fewer environmental impacts than activities located in nearshore areas. However, the logistics associated with operating offshore facilities are also more difficult, requiring long transit times for workers and supplies and other technical complications. Offshore aquaculture structures must also be designed to withstand the effects of extreme winds, waves, and temperatures, and be positioned in a way that does not create a hazard to navigation.

The Current Regulatory Conundrum

The Outer Continental Shelf Lands Act confirmed federal jurisdiction over non-living resources beyond three nautical miles from shore and authorized the Secretary of the Interior to create a legal regime—including leasing rights, fees, and revenue-sharing requirements—for oil, gas, sulfur, and other mineral resources. The Act, however, does not cover other commercial activities in federal waters, such as aquaculture. The Coastal Zone Management Act grants states the right—under prescribed circumstances—to review and raise objections to federally permitted activities beyond state waters, but the Secretary of Commerce may override the state's objection. Moreover, as described above, numerous federal agencies are directly or indirectly involved in implementing laws associated with various aspects of offshore activities, including marine aquaculture.

In 1980, Congress passed the National Aquaculture Act stating that it is in the national interest to encourage the development of aquaculture in the United States and calling for a national aquaculture development plan. The Act required the Secretaries of Agriculture, Commerce, and the Interior to prepare a report on federal laws and regulations that restrict the development of commercial aquaculture operations and submit the report to Congress with recommendations on how to remove unnecessarily burdensome regulatory barriers. However, no comprehensive and streamlined regulatory regime has been developed.

This does not mean that no regulatory requirements exist for offshore aquaculture: prospective operators of an aquaculture facility on the outer Continental Shelf (OCS) can apply to USACE for a permit pursuant to Section 10 of the Rivers and Harbors Act; EPA has authority pursuant to the Clean Water Act to regulate

effluent and other discharges from most aquaculture facilities on the OCS; the National Marine Fisheries Service and the U.S. Fish and Wildlife Service have authority to regulate offshore aquaculture facilities with respect to activities involving the Marine Mammal Protection Act and the Endangered Species Act; the Coast Guard has authority to require lights and signals and establish a safety zone to protect the facility and other users of the offshore waters; and coastal states may have and exercise "federal consistency" authority pursuant to the Coastal Zone Management Act.

Another potential legal impediment, which increases the legal and economic risk for offshore aquaculture, is NOAA's assertion, through an agency legal opinion, that aquaculture facilities in the exclusive economic zone are subject to the Magnuson-Stevens Fishery Conservation and Management Act if the aquaculture operation uses any harvesting or support vessel. While the Magnuson-Stevens Act may not have been intended as a vehicle for managing marine aquaculture, such assertion of authority by NOAA contributes to an already muddled management regime.

As a result of this inconsistent mix of laws and regulations, applicants have no guarantee of exclusive use of space in offshore areas, private capital is difficult to obtain, insurance companies do not provide coverage, and banks are unwilling to accept the unknown risks involved. Enhanced predictability is needed, as is the elimination of unnecessary hurdles and the reduction of potential conflicts with other commercial and recreational users of offshore areas and resources. (More information about developing a framework for managing multiple activities in federal waters, including aquaculture, is found in Chapter 6.)

DEVELOPING A NEW MARINE AQUACULTURE MANAGEMENT FRAMEWORK

For the marine aquaculture industry to reach its full potential, the United States should develop a coordinated and consistent policy, regulatory, and management framework. Federal and state agencies, with full participation by the industry, will need to implement the new framework, and the academic community will be called upon to provide scientific and engineering support to ensure that marine aquaculture activities are ecologically and economically sustainable. This framework must be flexible and responsive to changes in the industry. Finally, development of a national aquaculture management framework must be considered within the context of overall ocean policy development, taking into account other traditional, existing, and proposed uses of the nation's ocean resources.

Coordinated Action

The inherent differences between land-based, closed-system aquaculture operations and marine-based operations should be acknowledged in any new legislation and in the new management framework. The respective roles of the federal agencies involved with the marine aquaculture industry must also be clarified, duplicative or outdated laws and regulations eliminated, and marine aquaculture policies, programs, and practices coordinated. In addition, a lead federal agency is needed to act as the main interface with industry and overseer of the government's public trust responsibilities.

The National Aquaculture Act of 1980 established the Joint Subcommittee on Aquaculture (JSA) within the National Science and Technology Council (NSTC) structure. The JSA coordinates federal agency activities, ensures communication among the agencies, and provides recommendations for national aquaculture policy. Members of the JSA include: the Secretaries of the Departments of Agriculture (permanent chair), Commerce, the Interior, Energy, and Health and Human Services; the Administrators of the Environmental Protection Agency, the Small Business Administration and the U.S. Agency for International Development; the Chair of the Tennessee Valley Authority; and the Director of the National Science Foundation. This kind of coordination is very much needed, although the issues to be addressed go far beyond the purview of the NSTC. Close coordination will be needed between JSA and the National Ocean Council.

Recommendation 22–1. Congress should amend the National Aquaculture Act to designate the National Oceanic and Atmospheric Administration (NOAA) as the lead federal agency for

implementing a national policy for environmentally and economically sustainable marine aquaculture and create an Office of Sustainable Marine Aquaculture in NOAA.

Implementation

In overseeing marine aquaculture activities, including evaluating and approving offshore aquaculture operations, NOAA will need to practice wise stewardship of ocean resources and weigh the needs of a variety of stakeholders. At the same time, offshore aquaculture operators will need assurance that they can have exclusive access to certain waters for specific periods of time to secure financial investments.

These goals can best be achieved through the development and implementation of a leasing system for the water column and ocean bottom that protects marine resources and environments, offers adequate exclusivity to aquaculture operations, and institutes a system of revenue collection that acknowledge the public interest in ocean space and resources. The leasing system will also need to specify details, such as applicant eligibility and the acceptable scope, size, duration, and degree of exclusivity for facilities. Competing uses of ocean and coastal areas, and the potential for impacts from aquaculture on other ocean uses, must also be considered. A comprehensive leasing system will also reduce duplicative information collection by different agencies, and facilitate coordinated federal responses.

Enhanced coordination is also needed between federal and state aquaculture policies and regulations to provide consistency to the industry and to adequately manage potential impacts that cross jurisdictional lines, such as the spread of disease. Significant state participation and input is needed in the development and implementation of a new national management framework, which should include guidelines and regulations that are complementary at the federal and state levels.

Recommendation 22–2. The National Oceanic and Atmospheric Administration's new Office of Sustainable Marine Aquaculture should be responsible for developing a comprehensive, environmentally-sound permitting, leasing, and regulatory program for marine aquaculture.

The permitting and leasing system and implementing regulations should:

- *reflect a balance between economic and environmental objectives consistent with national and regional goals.*
- *be coordinated with guidelines and regulations developed at the state level.*
- *include a system for the assessment and collection of a reasonable portion of the resource rent generated from marine aquaculture projects that use ocean resources held in public trust.*
- *include the development of a single, multi-agency permit application for proposed marine aquaculture operations.*
- *include a permit review process that includes public notice and an opportunity for state, local and public comment.*
- *require applicants to post a bond to ensure that any later performance problems will be remedied and that abandoned facilities will be safely removed at no additional cost to the taxpayers.*
- *require the development, dissemination, and adoption by industry of best management practices that are adaptable to new research and technology advances.*
- *be well coordinated with other activities in federal waters, as described in Chapter 6.*

INCREASING THE KNOWLEDGE BASE

Enhanced investments in research, demonstration projects, and technical assistance can speed the development of a responsible and sustainable marine aquaculture industry. Science-based information can help the industry address environmental issues, conduct risk assessments, develop technology, select species, and improve best management practices. It is also vital for developing fair and reasonable policies, regulations, and management measures.

In the last two decades, the number of research and monitoring programs related to aquaculture has surged. Much of the work conducted worldwide has focused on the effects of open-water, net-pen culture on the environment. In the United States, early research efforts focused on fish hatchery effluents and catfish ponds.

As the domestic industry has diversified, so has the scope of research efforts, with major federal investments to examine the impacts of marine shrimp-pond and salmon net-pen cultures, as well as issues concerning aquaculture feeds, species introductions, the use of chemicals and pharmaceuticals, and effluent controls.

Most of the federal research to support marine aquaculture has been carried out under the auspices of NOAA's National Sea Grant College Program, which funds primarily university-based research. Results are used by educators and outreach specialists to improve resource management and address development and conservation issues. Sea Grant-funded information is also used to increase the knowledge base of industry, government agencies, and the public.

Recommendation 22–3. Congress should increase funding for expanded marine aquaculture research, development, training, extension, and technology transfer programs in the National Oceanic and Atmospheric Administration. The Office of Sustainable Marine Aquaculture should set priorities for the research and technology programs, in close collaboration with academic, business, and other stakeholders.

PROMOTING INTERNATIONAL IMPROVEMENTS AND COOPERATION

An estimated one billion people worldwide rely on fish as their primary source of animal protein. This demand will continue to rise as human populations increase and wild stocks around the world are depleted. Aquaculture has been growing almost six times faster in developing countries than in developed countries. The United Nations Food and Agriculture Organization (FAO) estimates that by 2030 more than half of the fish consumed globally will be produced through aquaculture.[6]

While the majority of international aquaculture occurs in inland and coastal areas, interest in offshore operations is also growing. There are even proposals to establish aquaculture operations on the high seas (see Chapter 29 for a discussion of emerging international ocean-related management challenges). This new interest is accompanied by growing concerns about the potential environmental impacts of offshore operations. The use of non-native species for aquaculture also poses ecological risks, particularly in view of the absence of regulations and enforcement in many countries. Global policies on prevention, containment, monitoring and risk assessments are needed to prevent the spread of invasive species and ensure that industries operate sustainably.

Efforts are underway at FAO to assess the possible environmental implications of booming aquaculture operations around the world and to develop appropriate protocols for use by government and industry. In the meantime, FAO's non-binding Code of Conduct for Responsible Fisheries includes a number of aquaculture provisions. The Code calls for: appropriate assessments and monitoring to minimize adverse impacts from discharges of effluents, waste, drugs and chemicals; consultation with neighboring countries prior to the introduction of nonnative species; conservation of genetic diversity; and responsible choices of species, siting and management. These guidelines are excellent but their implementation will require much stronger national commitments.

Recommendation 22–4. The United States should work with the United Nations Food and Agriculture Organization to encourage and facilitate worldwide adherence to the aquaculture provisions of the Code of Conduct for Responsible Fisheries.

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[1] U.S. Department of Agriculture, Economic Research Service. "Briefing Room: Aquaculture Overview." <http://www.ers.usda.gov/briefing/aquaculture /overview.htm> Accessed October 21, 2003.
[2] National Marine Fisheries Service. *Fisheries of the United States 2002*. Silver Spring, MD: National Oceanic and Atmospheric Administration, September 2003.
[3] Goldburg, R.J., M.S. Elliot, and R.L. Naylor. *Marine Aquaculture in the United States: Environmental Impacts and Policy Options.* Arlington, VA: Pew Oceans Commission, 2001.
[4] National Research Council. *Non-native Oysters in the Chesapeake Bay*. Washington, DC: National Academy Press, 2003.
[5] Blankenship, K. "State, Federal Roles in Oyster Introduction Pondered." *Bay Journal* 13, no. 7 (October 2003).
[6] Food and Agriculture Organization of the United Nations. *The State of the World Fisheries and Aquaculture.* Rome, Italy, 2000.

CHAPTER 23: CONNECTING THE OCEANS AND HUMAN HEALTH

While marine animals and plants are most commonly used as sources of food, they also produce a vast array of chemical compounds that can be developed into products with beneficial medical and industrial uses. However, marine organisms such as bacteria, algae, and viruses can also be sources of human illness. Although these microorganisms exist naturally in the ocean, human actions can lead to ocean conditions that greatly increase their growth, harming the health of humans, marine species, and ecosystems. Significant investment must be put into developing a coordinated national research effort to better understand the links between the oceans and human health, with research aimed at discovering new drugs and other useful products derived from marine organisms, and detecting and mitigating outbreaks of disease and other harmful conditions. Efforts must also be aimed at improving public awareness about how pollution and waste can contribute to the spread of seafood contamination and disease and can decrease the diversity of species that provide new bioproducts.

UNDERSTANDING THE LINKS BETWEEN THE OCEANS AND HUMAN HEALTH

While the topics generally included under the umbrella of Oceans and Human Health, such as harmful algal blooms and pharmaceutical development, may at first seem to be unrelated, they are actually inextricably linked. The health of marine ecosystems is affected by human activities such as pollution, global warming, and fishing. But in addition, human health depends on thriving ocean ecosystems. A better understanding about the many ways marine organisms affect human health, both for good by providing drugs and bioproducts, and for bad by causing human ailments, is needed.

The oceans sustain human health and well-being by providing food resources and absorbing waste from areas of human habitation. For many years the ocean's carrying capacity for meeting both these needs was assumed to be limitless. As we know today, this is not true. Scientists have reported that excessive human releases of nutrients and pollution into the ocean, and a subtle, yet measurable, rise in ocean surface temperatures are causing an increase in pathogens, primarily bacteria and viruses.[1,2] These environmental conditions can also cause certain species of microscopic algae to become concentrated in specific areas. Some of these organisms are capable of producing toxins that are released into the water and air, and become concentrated in tissues of fish and shellfish. When these toxins are ingested or inhaled by humans, they present health risks ranging from annoying to deadly.

On the other hand, thousands of new biochemicals have been discovered in marine organisms such as sponges, soft corals, mollusks, bacteria, and algae. Furthermore, scientists believe only a fraction of the organisms that live in the ocean have been documented, underscoring the vast potential of the oceans as a source of new chemicals.[3] These natural products can be developed not only as pharmaceuticals, but also as nutritional supplements, medical diagnostics, cosmetics, agricultural chemicals (pesticides and herbicides), enzymes and chemical probes for disease research, and many other applications. Based on existing

pharmaceutical products, each of these classes of marine-derived bioproducts has a potential multibillion-dollar annual market value.

A 1999 National Research Council (NRC) report recommended a renewed effort to understand the health of the ocean, its effects on human health, and possible future health threats.[4] In a 2002 report, the NRC also emphasized the beneficial value of marine biodiversity to human health, noting that underexplored environments and organisms – such as deep-sea environments and marine microorganisms – provide exciting opportunities for discovery of novel chemicals.[5]

Currently two national programs exist that are designed to enhance our understanding of the ocean's role in human health. The first is a joint program between the National Institute of Environmental Health Sciences (NIEHS) and the National Science Foundation (NSF) called the Centers for Oceans and Human Health. The centers promote interdisciplinary collaborations among biomedical and ocean scientists, with the goal of improving knowledge about the impacts of the oceans on human health. The second is the National Oceanic and Atmospheric Administration's (NOAA's) Ocean and Health Initiative, which will coordinate agency activities and focus funding on ocean and health issues such as infectious diseases, harmful algal blooms, environmental indicators, climate, weather and coastal hazards, and marine biomedicine.

In addition to these broad interdisciplinary programs, several other existing programs are focused on one or more specific subtopics. For example, ECOHAB (Ecology and Oceanography of Harmful Algal Blooms), a program created by NOAA and NSF, provides a scientific framework designed to increase our understanding of the fundamental processes leading to harmful algal blooms. Other agencies, including the Centers for Disease Control (CDC), U.S. Environmental Protection Agency (EPA), and Food and Drug Administration (FDA), administer programs that address different aspects of the links between the oceans and human health.

MAXIMIZING THE BENEFICIAL USES OF MARINE-DERIVED BIOPRODUCTS

The marine environment constitutes the greatest source of biological diversity on the planet. Representatives of every phylum are found in the world's oceans, and more than 200,000 known species of invertebrates and algae have been documented. With so many organisms competing for survival in the challenging ocean environment, it is not surprising that many organisms produce chemicals that provide some ecological advantage. Animals and plants synthesize natural biochemicals to repel predators, compete for space to grow, and locate potential mates. Scientists have shown that these chemicals can also be developed as human pharmaceuticals and used for other biomedical and industrial applications.

Despite the potential benefits, the U.S. investment in marine biotechnology is relatively small. Japan, the world leader in marine biotechnology, has spent between $900 million and $1 billion a year for the last decade and has said it intends to significantly increase this investment in the future. About 80 percent of the Japanese investment comes from industry, with the remainder from government. By contrast, U.S. public investment in marine biotechnology research and development in 1996 was around $55 million, and U.S. industry investment is estimated at approximately $100 million annually. Yet even with this limited funding, U.S. marine biotechnology efforts since 1983 have resulted in more than 170 U.S. patents, with close to 100 new compounds being patented between 1996 and 1999.[6]

Specific Applications

Pharmaceuticals

Since the 1970s, scientists have been isolating and characterizing molecules from ocean organisms that have unique chemical structures and bioactivities. In recent years, several of these compounds have undergone clinical testing in the United States as potential treatments for cancer. Progress has also been made in finding treatments for other human ailments, such as infectious diseases, multiple sclerosis, Alzheimer's, chronic pain, and arthritis (Table 23.1).

Table 23.1 Drugs from the Sea
This table highlights some of the chemicals and biological materials isolated from marine organisms that are already in use or are being developed.

Application	Original Source	Status
Pharmaceuticals		
Anti-viral drugs (herpes infections)	Sponge, *Cryptotethya crypta*	Commercially available
Anti-cancer drug (non-Hodgkin's Lymphoma)	Sponge, *Cryptotethya crypta*	Commercially available
Anti-cancer drug	Bryozoan, *Bugula neritina*	Phase II clinical trials
Anti-cancer drug (mitotic inhibitor)	Sea hare, *Dolabella auricularia*	Phase I clinical trials
Anti-cancer drug (tumor-cell DNA disruptor)	Tunicate, *Ecteinascidia turbinata*	Phase III clinical trials
Anti-cancer drug	Tunicate, *Aplidium albicans*	Advanced preclinical trials
Anti-cancer drug	Gastropod, *Elysia rubefescens*	Advanced preclinical trials
Anti-cancer drug (microtubule stabilizer)	Sponge, *Discodermia dissoluta*	Phase I clinical trials
Anti-cancer drug	Sponge, *Lissodendoryx* sp.	Advanced preclinical trials
Anti-cancer drug	Actinomycete, *Micromonospora marina*	Advanced preclinical trials
Anti-cancer drug (G2 checkpoint inhibitor)	Tunicate, *Didemnum granulatum*	In development
Anti-cancer drug	Sponge, *Jaspis* sp.	In development
Anti-inflammatory agent	Marine fungus	In development
Anti-fungal agent	Sponge, *Trachycladus*	In development
Anti-tuberculosis agent	Sea whip, *Pseudopterogorgia*	In development
Anti-HIV virus agent	Ascidian (tunicate)	In development
Anti-malarial agent	Sponge, *Cymbastela*	In development
Anti-dengue virus agent	Marine crinoid	In development
Molecular Probes		
Phosphatase inhibitor	Dinoflagellate	Commercially available
Phospholipase A_2 inhibitor	Sponge, *Luffariella variabilis*	Commercially available
Bioluminescent calcium indicator	Bioluminescent jellyfish, *Aequora victoria*	Commercially available
Reporter gene	Bioluminescent jellyfish, *Aequora victoria*	Commercially available
Medical Devices		
Orthopedic and cosmetic surgical implants	Coral, mollusc, echinoderm skeletons	Commercially available
Diagnostics		
Detection of endotoxins (LPS)	Horseshoe crab	Commercially available
Enzymes		
Polymerase chain-reaction enzyme	Deep-sea hydrothermal vent bacterium	Commercially available
Nutritional Supplements		
Polyunsaturated fatty acids used in food additives	Microalgae	Commercially available
Pigments		
Conjugated antibodies used in basic research and diagnostics	Red algae	Commercially available
Cosmetic Additives		
Cosmetic (anti-inflammatory)	Caribbean gorgonian, *Pseudopterogorgia elisabethae*	Commercially available

Source data combined from:
Pomponi, Shirley A. "The bioprocess-technological potential of the sea." *J. Biotechnology*, 70 (1999): 5-13.
Pomponi, Shirley A. "The oceans and human health: the discovery and development of marine-derived drugs." *Oceanography*, 14 (2001): 78-87.
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Jordan, M.J. and Leslie Wilson. "Mining the Ocean's Pharmacological Riches: A Lesson from Taxol and Vinca Alkaloids." In *Marine Biotechnology in the 21st Century*. Washington, DC: National Academy Press, 2001.

Molecular Probes

Several marine-derived compounds, explored initially as potential pharmaceuticals, are available commercially as molecular probes. These probes are special chemical compounds that researchers can use to study important biochemical processes. Their value in resolving the complexities of diseases has often outweighed their economic and medicinal value as commercial pharmaceuticals. Moreover, molecular probes often offer attractive opportunities for commercialization, with revenues generated in a shorter time than pharmaceuticals because lengthy regulatory approvals are not required for research that does not involve human subjects.

Nutrients

Marine-derived nutritional supplements, or "nutraceuticals," present a relatively new opportunity for research and development in the application of natural marine products to human health issues. Nutritional supplements from plants have been used for years, including commonly known products such as St. John's wort, ginseng, and echinacea. A few products from marine sources are also commercially available such as xanthophylls from algae, which are used in nutritional supplements and vitamins for their antioxidant properties. Although the use of marine natural products in nutritional supplements is limited at this time, it represents a large potential market.

Special Focus on Microbial Diversity

Microorganisms comprise a larger biomass than any other form of life on Earth. In addition, they are the most diverse group of organisms on the planet, having evolved to be able to survive in almost all environments. In the ocean they are the basis for food webs, even in areas that would not normally be capable of sustaining life.

For example, in the deep ocean environment with no light and few nutrients, chemosynthetic bacteria thrive on the methane present in frozen gas hydrates. Near deep-sea hydrothermal vents where temperatures can rise to over 300 degrees Celsius, bacteria are capable of using hydrogen sulfide and carbon dioxide as their only nutrients and producing enough organic compounds to support whole vent communities, including tubeworms, fish, crabs, shrimp, clams, and anemones.

However, microorganisms have not evolved simply to synthesize molecules for food; they have also been shown to produce a wide array of chemicals for other purposes. Understanding how these organisms survive, both individually and symbiotically, and why they produce such unique chemistry is essential to understanding their therapeutic and technological potential. Yet, only a small percentage of these organisms have been documented, largely due to difficulties in culturing organisms from such unique habitats. An expanded search for new microbes in the ocean based on cooperation among a number of multidisciplinary government programs could yield exciting results.

Industrial Uses

In additional to medicinal uses, chemicals produced by marine organisms have a wide array of industrial applications. For example, marine organisms, such as limpets, produce adhesive proteins that hold them strongly to surfaces against the pull of tides and waves. Currently, researchers are examining the chemistry of these adhesives to produce new glues that work in wet environments. Some cold water marine microorganisms are being studied because of chemicals they produce that can be used as detergents. These chemicals could help produce commercial detergents that are more effective in cold water. Many sedentary marine organisms produce anti-fouling chemicals that prevent algae and bacteria from clinging to their surfaces. Researchers are investigating these chemicals as potential paint additives for ship hulls. If effective, these chemicals could reduce the need for traditional anti-fouling paints that contain high levels of tin and

other heavy metals, which can contaminate bottom sediments. Several other applications of marine-derived substances are currently in development, such as reaction enzyme catalysts and biochemicals used for detoxifying chlorinated hydrocarbons and other pollutants.

Encouraging Interdisciplinary Marine Biomedical Research

Past U.S. efforts to discover marine biomedicines were of the collect-and-test type, with little attention given to the evolutionary, environmental, and molecular biology of the species being tested. However, to realize the greatest rewards for research investments, each species' ecological, genetic, and physiological information should be examined to understand how they adapt to environmental conditions. The unique diversity and adaptations of marine life can help scientists understand the evolutionary development of biochemical signals that regulate cell cycles and control resistance against diseases and infections.

Historically, structural limitations inherent in the federal agencies made it difficult to undertake truly multidisciplinary science. NSF restricted funding for biomedical research because it is covered by the National Institutes of Health (NIH), creating difficulties in establishing combined environmental and biomedical research programs. Likewise, NIH has generally supported direct medical research, thus precluding ancillary studies of systematics, ecology, and species distributions. Until a few years ago, the NIH's ocean pharmaceutical programs had been very narrow, focusing almost exclusively on discovering and developing new anti-cancer drugs. Thus, the very structure of the federal scientific support system has been counterproductive to establishing the type of multidisciplinary programs required to advance the broader field of marine natural product discovery and development.

Based on recommendation from the National Research Council and others, in the last two years new approaches for supporting marine bioproduct development have been established that allow the necessary cross-disciplinary research to occur, including the NIEHS–NSF and NOAA programs mentioned earlier. However, increased participation and cooperation from other federal agencies**,** including EPA, the Office of Naval Research (ONR), the National Aeronautics and Space Administration (NASA), CDC, FDA, and the Minerals Management Service (MMS), each of which brings particular expertise and perspectives, will also be helpful.

Recommendation 23–1. The National Oceanic and Atmospheric Administration, National Science Foundation, National Institute of Environmental Health Sciences, and other appropriate entities should support expanded research and development efforts to encourage multidisciplinary studies of the evolution, ecology, chemistry, and molecular biology of marine species, discover potential marine bioproducts, and develop practical compounds, through both competitively awarded grants and support of federally designated centers.

These efforts should include:

- *a strong focus on discovering new marine microorganisms, visiting poorly sampled areas of the marine environment, and studying species that inhabit harsh environments.*
- *encouragement for private-sector investments and partnerships in marine biotechnology research and development to speed the creation of commercially available marine bioproducts.*

Managing Marine Bioproduct Discovery and Development

Based on the potentially large health benefits to society, the federal government should encourage and support the search for new bioproducts from marine organisms, known as bioprospecting. However, before wide-scale bioprospecting proceeds in federal waters, requirements need to be established to minimize

environmental impacts. Planning and oversight will help ensure that public resources are not exploited solely for private gain and will help protect resources for future generations.

Individual states can regulate the collection of marine organisms quite differently, sometimes requiring an array of research permits to collect organisms, and licenses to gain access to particular areas. Regulations that ban the removal of specific organisms, such as corals and other sensitive species, often exist in both state and federal protected areas. In protected federal waters, such as national marine sanctuaries, research permits are required for all collections. However, bioprospecting outside state waters and federal protected areas is unrestricted, except for certain species subject to regulation under existing legislation, such as the Endangered Species Act. Both U.S. and foreign researchers, academic and commercial, are free to collect a wide range of living marine organisms without purchasing a permit and without sharing any profits from resulting products.

On land, the National Park Service has successfully asserted the government's right to enter into benefit sharing agreements in connection with substances harvested for commercial purposes in Yellowstone National Park. The National Park Service is in the process of conducting a full environmental impact statement on the use of such agreements for benefit sharing in other parks. This practice could serve as a model for the management of bioprospecting in U.S. waters.

A comprehensive national ocean policy should contain appropriate permitting and licensing regulations for bioprospecting in federal waters to protect public resources while encouraging future research. Furthermore, when allocating use of federal ocean areas for bioprospecting, it is important that consideration be given to the other potential uses of those areas, including oil and gas exploration, renewable energy, aquaculture, or mining. (The governance and coordination of offshore uses is discussed in detail in Chapter 6.)

REDUCING THE NEGATIVE HEALTH IMPACTS OF MARINE MICROORGANISMS

A host of microorganisms exist in marine waters, filling their roles in the ecosystem and generally causing no problems to humans. However, environmental factors such as climate change can affect the number and distribution of marine pathogens and human activities can produce even greater fluctuations that threaten the human health and the marine ecosystems they depend on for food, medicine, and other products.

Harmful Algal Blooms

The term harmful algal bloom (HAB) is used to describe destructive concentrations of particular algal species in ocean waters. These blooms are sometimes called red tides because the high algal density can make the ocean surface appear red, but the surface may also be green, yellow, or brown, depending on the type of algae present.

The Nature of the Problem

The underlying physical, chemical, and biological causes for most harmful algal blooms are not well understood, but an increase in distribution, incidence, duration, and severity of HABs has been documented within recent decades (Figure 23.2). Research is needed to understand why blooms form in a specific area, how they are transported, and what causes them to persist. In many areas, increases in nutrients in coastal waters, from point and nonpoint sources of pollution, and higher numbers of invasive species released from ships' ballast water mirror the increase in HAB events, suggesting a possible causal connection.[7, 8] However, others have suggested that the apparent increase in HAB events is simply a result of more frequent and effective monitoring.

HABs can produce high concentrations of potent toxins in ocean waters. When these toxins are concentrated in fish and other seafood consumed by humans, they can lead to paralytic, diarrhetic, neurotoxic, or amnesic shellfish poisoning. Most of these toxins cause harm only if ingested; however, some enter the air from sea

spray and can cause mild to severe respiratory illnesses when inhaled. These health effects are not restricted to human populations; fish, birds, and marine mammals often fall victim to red tide poisoning.

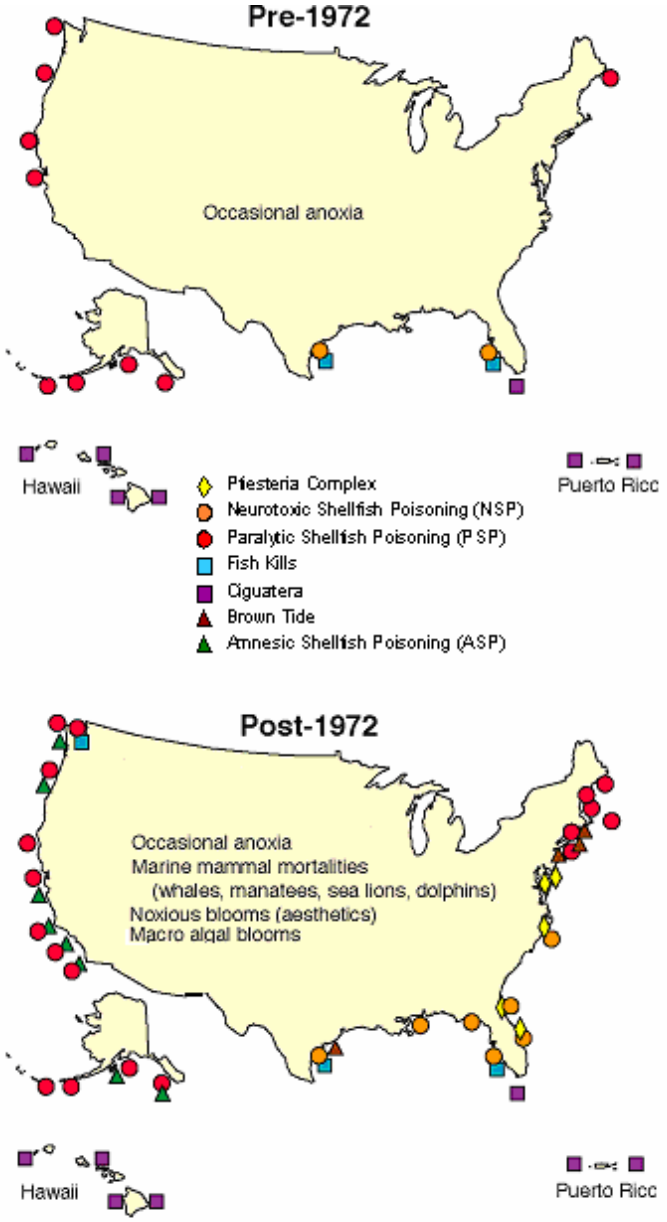
Annually, HABs are believed to cost the nation's fishing and tourism industries more than $50 million directly, with a likely multiplier effect that pushes the total economic loss to $100 million.[9, 10] This effect can be catastrophic to low-income fishing communities, as witnessed in Maryland in 1997 during an outbreak of *Pfiesteria piscicida* (a species of dinoflagellate) associated with widespread fish kills.[11] Tourism was hurt by news coverage of seafood poisonings, and reports of red tides had a swift and chilling effect on oceanside resort visits, beach-going, and boating. Aquaculture can also be severely damaged by HABs, which can cause rapid fish kills and result in harvesting moratoria.

HABs are of particular concern in areas where the water contains high concentrations of dissolved nutrients. These areas are incubators for many types of algal blooms, nontoxic as well as toxic. The nutrients create conditions for rapid growth of large and dense algal blooms. When the algae die, their decomposition consumes the dissolved oxygen that other organisms need for survival.

Improving Understanding, Detection, and Prevention

HABs constitute significant threats to the ecology and economy of coastal areas. While the preferred course of action is prevention, effective treatments will often be needed and the current availability of biological, chemical, or physical treatments is extremely limited. The ecology of each bloom is different, and the required environmental conditions are not completely understood for any algal species.

Figure 23.2 Harmful Algal Blooms Are on the Rise in All U.S. Waters



Harmful Algal Bloom outbreaks have become more prevalent over the past thirty years, almost tripling the number detected prior to 1972.

Map courtesy of the National Office for Marine Biotoxins and Harmful Algal Blooms, Woods Hole Oceanographic Institution, Woods Hole, MA.

The most likely and immediate solution for reducing the number and severity of HABs is to control nutrient inputs to coastal waters. (Nutrient pollution is further discussed in Chapter 14.) Prevention may also be strengthened through careful facility

siting decisions and tighter controls on invasive species. However, for better long-term management, a comprehensive investigation of the biology and ecology of HABs will be needed to increase our understanding of options for prevention, prediction, and control.

Better coordination would help leverage the relatively few but successful HAB research programs currently being supported by the federal government (such as ECOHAB; MERHAB—monitoring and event response for harmful algal blooms; NOAA's National Marine Biotoxin program and HAB sensor development and forecasting programs; and efforts supported by the CDC, states, and others).

Improved monitoring techniques are also essential in mitigating the harmful impacts of HABs. Sampling directly from the natural environment can help researchers compile an overall HAB picture, laying the foundation for predictive modeling and forecasting. Numerous monitoring programs already exist, many of which are funded by state governments. However, routine field sampling, combined with laboratory analysis, is expensive and time consuming, and becomes more so as greater numbers of toxins and pathogens are discovered over greater geographic areas. A well-coordinated federal effort is needed to support the state and regional implementation of monitoring and mitigation capabilities as they are developed. (See Chapter 15 for a broader discussion of water quality monitoring needs.)

To cover larger areas, monitoring data collected from remote sensing platforms will become essential. NOAA is currently developing and testing techniques to forecast HAB occurrence and movement using satellite sensors. The complementary development and deployment of satellites and moored sensors will provide even greater coverage, cross-referenced groundtruthing, and more frequent site-specific sampling. These elements will add up to better data sets for monitoring of HABs. As more data is collected on HAB occurrences, researchers will be able to more accurately predict future outbreaks by using advanced computer models and taking into account the physical and biological conditions leading to HABs.

Marine Bacteria and Viruses

Bacteria and viruses are present everywhere in the ocean; in fact, each milliliter of seawater contains on average 1 million bacteria and 10 million viruses. While only a small percentage of these organisms cause disease in humans, they pose a significant health risk. Humans become exposed to harmful bacteria and viruses primarily by eating contaminated seafood (especially raw seafood) and by direct intake of seawater.

Many, if not most, occurrences of high concentrations of pathogens in the ocean are the direct result of land-based human activities. Pollution and urban runoff lead to nutrient-rich coastal and ocean waters that provide ideal conditions for the growth and reproduction of these microorganisms. With ever-increasing numbers of people living in coastal areas, along coastal watersheds, or inland along rivers that ultimately drain into the ocean, waste and pollution has increased to a level that creates negative environmental and human health-related consequences.

A comprehensive and integrated research effort is needed to further explore the relationship between human releases of inorganic and organic nutrients to coastal waters and the growth of pathogenic microorganisms in the ocean. Rapid monitoring and identification methods need to be developed so officials can warn populations at risk when unhealthy conditions are present. Integration of these new methods into moored biological sensors and the Integrated Ocean Observing System (IOOS) would allow for continuous data collection, and be especially helpful in areas of high recreational or seafood harvesting activity. This effort must include the participation of state, regional, tribal, and local organizations to implement localized monitoring programs and address public education issues associated with marine bacteria and viruses.

Contaminated Seafood

Contaminated seafood is one of the most frequent causes of human diseases contracted from the ocean, including both pathogenic contamination and chemical contamination. Chemicals such as mercury and dioxins, that exist as environmental contaminants and are concentrated in fish through bioaccumulation, continue to be a health concern for humans, especially in terms of reproductive and developmental problems. In addition, harmful algal blooms and pathogen outbreaks are becoming more common in local waters, increasing the risk of seafood contamination.

Aside from domestic sources, Americans are importing more seafood than ever before.[12] These imports often come from countries whose public health and food handling standards are lower than in the United States. Although the Food and Drug Administration requires that importers to the United States meet federal standards, there is evidence that foreign counties do not always comply with these agreements, increasing the risk of spreading disease through improperly processed and handled seafood.[13] Federal law also bars seafood containing drugs from entering the country, but the FDA currently only screens about 2 percent of the four billion pounds of seafood imported each year, and screens for only five chemicals out of the more than thirty used in foreign aquaculture. While other countries have barred salmon shipments that test positive for such drugs as malachite green (a fungicide) and oxytetracycline (an antibiotic), the United States does not currently test salmon imports for these chemicals.[14]

Domestic aquaculture may provide a way to decrease U.S. dependence on imported seafood. However, cultured organisms are generally exposed to more diseases than wild stocks due to over-crowding in the fish pens. The use of antibiotics and other drugs to protect farmed fish against disease is a problem that will also need to be addressed in the United States. (The potential and problems of aquaculture are discussed further in Chapter 22.)

To protect the safety of the nation's seafood, rapid, accurate, and cost-effective means for detecting pathogens and toxins in seafood are needed. As these techniques are developed they can be incorporated into seafood safety surveillance efforts, particularly inspections of imported seafood and aquaculture products.

Implications of Global Climate Change

In addition to the direct effects of human activities, marine microorganisms' survival and persistence are also strongly affected by environmental factors. In particular, global climate change has the potential to significantly alter the distribution of microorganisms in the ocean. Pathogens now limited to tropical waters could move toward the poles as sea-surface temperatures rise.

For example, the bacterium that causes cholera (*Vibrio cholerae*) has been implicated in disease outbreaks fueled by the warming of coastal surface water temperatures. The intrusion of these warmer, infected waters into rivers can eventually lead to mixing with waters used for drinking and public hygiene. An indirect relationship has also been noted between climate change phenomena associated with the Bay of Bengal and the incidence of cholera in Bangladesh. As the temperature in the Bay of Bengal increased, plankton growth accelerated, which in turn created ideal growth conditions for bacteria such as *Vibrio cholerae.*[15]

Mass mortalities due to disease outbreaks have already affected major life forms in the ocean. The frequency of epidemics and the number of new diseases in corals and marine mammals have increased. It is hypothesized that some of these outbreaks are linked to climate change. Not only are new pathogens possibly present due to changes in water temperature, but temperature changes can also stress marine organisms, making it harder for them to fight infections.[16] More research is needed to understand the links among climate change, pollution, marine pathogens and the mechanisms of disease resistance in marine organisms.

Progress through Research and Education

Research Needs

Better understanding about the links between oceans and human health will require a commitment of research funds to discover the fundamental processes controlling the spread and impacts of marine microorganisms and viruses. In addition, closer collaboration between academic and private sector scientists and federal agencies (including NIH, NSF, NOAA, EPA, ONR, NASA, CDC, FDA, and MMS) will be needed to better examine these issues.

Recommendation 23–2. The National Oceanic and Atmospheric Administration, National Science Foundation, National Institute of Environmental Health Sciences, and other appropriate entities should support expanded research efforts in marine microbiology and virology.

These efforts should include:

- *the discovery, documentation, and description of new marine bacteria, algae, and viruses and the determination of their potential negative effects on the health of humans and marine organisms.*
- *the elucidation of the complex inter-relations, pathways, and causal effects of marine pollution, harmful algal blooms, ecosystem degradation and alteration, emerging marine diseases, and climate change in disease events.*

New knowledge and technologies are needed to detect and mitigate microbial pathogens. These methods must be quick and accurate so that information can be communicated to resource managers and the coastal community in a timely manner. As they are developed, technologies need to be integrated into biological and biochemical sensors that can continuously monitor high-risk sites. It is important that site-specific sensor data and satellite sensor data be incorporated into the IOOS. (The development of chemical and biological sensors and their integration into the IOOS is further discussed in Chapters 26 and 27.) Furthermore, federal and private support will be needed for developing monitoring and mitigation technologies to be implemented at the state level.

Recommendation 23–3. The National Oceanic and Atmospheric Administration, National Science Foundation, National Institute of Environmental Health Sciences, and other appropriate entities should support the development and implementation of improved methods for monitoring and identifying pathogens and chemical toxins in ocean waters and organisms.

This should include:

- *developing accurate and cost-effective methods for detecting pathogens, contaminants, and toxins in seafood for use by both state and federal inspectors.*
- *monitoring and assessing pollution inputs, ecosystem health, and human health impacts.*
- *developing new tools for measuring human and environmental health indicators in the marine environment.*
- *developing models and strategies for predicting and mitigating pollutant loadings, harmful algal blooms, and infectious disease potential in the marine environment.*
- *developing* in situ *and space-based sensing methods and incorporating them as a sustained operational component of the national Integrated Ocean Observing System.*

Public Education and Outreach

Pollution education campaigns have generally focused on the impacts of pollution on marine animals. Signs stenciled on storm drains remind people that dolphins live downstream. However, additional attention should be given to the fact that human food supplies and recreational areas are also downstream. Reductions in pollution from urban area runoff, sewage outflows, agricultural pesticides, and many other sources are needed

to avoid creating harmful conditions in the oceans and the best way to start is with a higher level of public education.

Education campaigns should also continue to inform people of the potential risks some fish and shellfish pose to their health because of the bacteria, viruses, or chemicals they carry. These programs should incorporate messages that seafood may be contaminated even when no visible algal bloom is present and conversely that some unattractive algal blooms are not harmful.

INCREASING FEDERAL COORDINATION ON OCEANS AND HUMAN HEALTH

Several existing programs, including the NIEHS–NSF and NOAA programs, could form the nucleus of a fully integrated, national oceans and human health program. Most of these programs already involve significant interagency cooperation, which is essential for effectively addressing issues that cross federal agencies' jurisdictional lines and for coordinating multidisciplinary biomedical research. Any truly national effort to address the varied roles of the oceans in human health will cross many federal jurisdictions, including environmental regulation, coastal management, basic and applied research, biosecurity, and homeland security.

Recommendation 23–4. Congress should establish and fund a national, multi-agency Oceans and Human Health Initiative to coordinate, direct, and fund research and monitoring programs.

The National Ocean Council should oversee the interagency Oceans and Human Health Initiative, and should review existing interagency programs and suggest areas where coordination could be improved. The NOAA Ocean and Health Initiative should be coordinated with the NIEHS–NSF Centers for Oceans and Human Health program as the basis of the federal program and should be permanently funded. To achieve the goals set forth in this chapter, funding should be double the current combined funding level for the NIEHS-NSF Centers for Ocean and Human Health program and the NOAA Ocean and Health Initiative, resulting in total funding of at least $28 million a year for the new initiative.

NOAA should be the lead agency in charge of coordinating interagency public information, outreach, and risk assessment efforts. Research funding awarded through the national program should be subject to a stringent peer review process with federal, state, academic, and private-sector investigators eligible to compete for funding.

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CHAPTER 24:
MANAGING OFFSHORE ENERGY AND OTHER MINERAL RESOURCES

Chapter 6 addressed the complexities associated with developing a coordinated offshore management regime and recommended one that is among other characteristics: comprehensive, transparent, and predictable; brings a fair return to the public; and promotes a balance between economic and environmental considerations. Activities related to the management of nonliving resources in federal waters are inextricably linked to many of the fundamental policy questions raised by that discussion. From the politically contentious but administratively mature outer Continental Shelf (OCS) oil and gas program to the new and emerging offshore uses that lack coordinated and comprehensive regimes, much can be learned. But much still needs to be understood about what it may take to develop a system that unlocks the treasures of the sea while protecting the marine environment and providing all affected parties a voice in the decisions that manage that process.

EXERCISING JURISDICTION OVER NONLIVING RESOURCES IN FEDERAL WATERS

In addition to its responsibilities for living marine resources, the federal government also exercises jurisdiction over nonliving resources, energy and other minerals located in the waters and seabed of the more than 1.7 billion acres of the outer Continental Shelf (OCS). Offshore oil and gas development has the most mature and broadest management structure of all such resources. It also has the longest and richest history, one characterized by major changes to the underlying law that established the more comprehensive administrative regime, as well as intense political conflict resulting from divisions among stakeholders and tensions inherent in American federalism. The development of other ocean energy resources—some of which are newly emerging technologies—have differing levels of management, but none are currently making any noteworthy contributions to domestic production numbers. Historically, there also have been varying expressions of commercial interest in non-energy minerals in the U.S. exclusive economic zone (EEZ), but only sand and gravel have been used in recent years by coastal states and communities, because of a change which eased access to those resources.

MANAGING OFFSHORE OIL AND GAS RESOURCES

As noted in Chapter 2, from its beginning the federal offshore oil and gas program faced controversy over ownership issues, as states unsuccessfully sued the federal government over control of offshore waters. Once that issue was settled legislatively, there was a short but relatively stress-free period. Conflict, however, soon emerged over issues of management, environmental risks, and the costs and benefits of energy exploration and production on the OCS that continues to this day. Proponents point to the program's contributions to the nation's energy supplies and economy, significant improvements in its safety and environmental record, and noteworthy technological achievements. Opponents argue that offshore oil activities harm coastal communities economically and the marine environment unacceptably. The ongoing debate is carried out in the halls of Congress, federal agencies, state and local governments, trade associations, and nongovernmental

organizations. OCS oil and gas development is a classic example of the politics of multiple use resource management, including federal-state tensions, competing user issues, arguments over the interpretation of data, and disagreements concerning tolerable levels of risk.

Despite its political problems, which are best understood through an awareness of the historical context associated with it, today the OCS oil and gas program has a well institutionalized and reasonably comprehensive management regime. While not without its critics, the program seeks to balance the many competing interests involved in offshore energy activity, requires state and local government input in federal decisions, and specifies detailed procedures to be followed by those seeking offshore leases. It also manages the various processes associated with access to non-energy minerals on the OCS.

Energy development in federal waters is big business and has become an important part of the fabric of the U.S. ocean policy mix. Most observers agree that the federal OCS oil and gas program benefits America by helping to meet energy needs, creating thousands of jobs, and contributing billions of dollars to the U.S. Treasury. Despite the limited offshore geographic area from which production flows and in which leasing is authorized, the amount of oil and gas production from the OCS is significant. In 2002 and 2003, federal offshore waters produced more than 600 million barrels of oil annually[1] and about 4.5 trillion cubic feet of natural gas.[2]

From a Quiet Beginning to Prohibitions on Leasing

In 1953, Congress enacted the Submerged Lands Act, which codified coastal states' jurisdiction off their shores out to three nautical miles (or, for historic reasons, nine nautical miles for Texas and the Gulf coast of Florida). That same year, regulation of OCS oil and gas activity seaward of state submerged lands was vested in the Secretary of the Interior with the passage of the Outer Continental Shelf Lands Act (OCSLA), which established federal jurisdiction over the OCS for the purpose of mineral leasing. For a period of some fifteen years, the offshore energy program was relatively quiet, being confined largely to leasing off of Louisiana and Texas. In the late sixties, however, the relative peace on the OCS would be dramatically changed.

As discussed in Chapter 2, the 1969 Santa Barbara blowout took place during an era of rapidly expanding environmental awareness and helped spur the enactment of numerous major environmental laws, including the National Environmental Policy Act (NEPA), the Coastal Zone Management Act (CZMA), the Marine Mammal Protection Act (MMPA), and the Marine Protection, Research, and Sanctuaries Act (MPRSA).

Just as the nation's environmental consciousness rose, so too did recognition of the need for secure supplies of oil and gas. Also, as noted in Chapter 2, the 1973 Arab oil embargo prompted President Nixon to announce plans to lease ten million OCS acres in 1975, an area equal to the entire amount leased prior to that time. Sales were scheduled not only in areas of earlier OCS activity, but also along the Atlantic and Pacific coasts. The result was a nationwide debate that raged through the remainder of the decade, pitting the oil and gas industry and its allies against various representatives of coastal states, commercial and sport fishing interests, and environmental organizations.

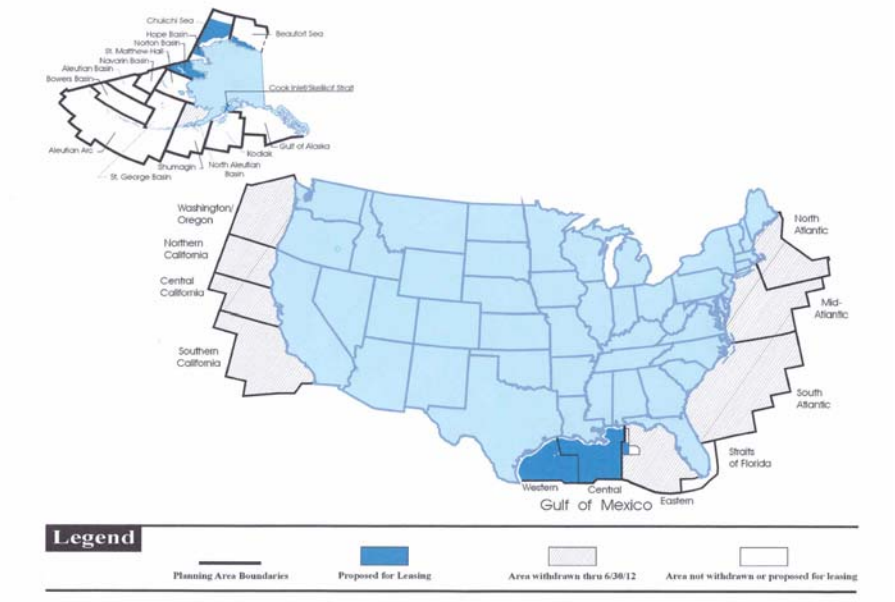
Congress responded to this debate by virtually rewriting the OCSLA in 1978, requiring the Secretary of the Interior to balance the nation's needs for energy with the protection of human, marine, and coastal environments, make certain that the concerns of coastal states and competing users were taken into account, and ensure that some of the newly enacted environmental laws were integrated into the OCS process. However, before regulations and procedures could be fully developed to support the amended law, in the early 1980s the Reagan administration proposed to terminate funding for the Coastal Zone Management Act (CZMA) and its Coastal Energy Impact Program(CEIP). The CEIP was specifically designed during the debate over the OCSLA amendments to provide grants and loans to coastal states to deal with the environmental effects occasioned by OCS activities. At the same time these budget cuts were put forward, the Secretary of the Interior was pursuing an aggressive offshore program that would make one billion acres

available for oil and gas leasing over the ensuing five years. Thus began the modern day version of the battle over offshore oil, one that has endured for over two decades and has included major legislative and executive branch negotiations, actions to restrict leasing in so-called "frontier" areas, Supreme Court cases, federal-state battles over administrative procedures and the sharing of revenues, and the buyback of some OCS leases by the federal government.

In its initial reaction to the proposed budget cuts, Congress was able to save the CZMA, but not the CEIP. It then turned its attention to restricting and ultimately prohibiting a substantial part of the OCS leasing schedule of the U.S. Department of the Interior (DOI). Using its appropriations process in 1982, Congress put four basins offshore northern California off limits to leasing. For the next few years, every annual DOI funding bill included leasing prohibitions on additional regions until practically all offshore planning areas outside of the Gulf of Mexico and Alaska were excluded.

Additionally, Presidents have expanded on congressional action, providing longer term restrictions than those covered in annual appropriations bills. In 1990, President Bush withdrew areas offshore California, southern Florida, the North Atlantic states, Washington, and Oregon from leasing consideration until after 2000. A few years later, the Clinton Administration added additional areas to the restricted list, extended all of the withdrawals until 2012, and included a permanent prohibition on leasing in national marine sanctuaries. These presidential and congressional actions have removed some 610 million acres from leasing consideration and effectively limited access to the OCS program to the central and western Gulf of Mexico (95 percent of offshore production), a small portion of the eastern Gulf, and virtually all areas off Alaska (Figure 24.1).

Figure 24.1. Offshore Oil and Gas Leasing has been Limited to a Few Planning Areas



Shown above are the outer Continental Shelf planning areas in the Minerals Management Service's 2002-2007 leasing program. The entire West Coast and almost all of the East Coast have been restricted from leasing through 2012, leaving only areas of the central and western Gulf of Mexico (and a small area of the eastern Gulf) and virtually all areas off the Alaskan coast available for development.
Figure Courtesy of Minerals Management Service, Department of the Interior, Washington, DC.

The OCS Leasing, Exploration, and Development Process

As already noted, the OCSLA is a relatively comprehensive resource management statute. Besides authorizing the Secretary of the Interior to hold competitive lease sales for offshore tracts, regulate and oversee lease activities, and encourage efficient, safe, and diligent production, the law specifies the steps potential lessees

must take to bid on offshore tracts and the process that occurs after receiving a lease. For example, the OCSLA requires consultation with coastal states and localities at a number of points in the federal offshore decision-making process, including during the development of a five-year leasing program, individual lease sale delineations, exploration and development-production plans, and environmental studies and oil and gas information programs. Further, the law carries provisions on offshore safety regulations, citizen suits and judicial review, enforcement authority, the applicability of NEPA, geological and geophysical exploration, export limitations, documentation requirements for offshore vessels and rigs, and numerous opportunities to address other environmental issues.

DOI's Minerals Management Service (MMS) characterizes its administration of the OCSLA as being "process rich" (Figure 24.2). Through the initial years of promulgating regulations to implement the 1978 amendments, and through litigation about the meaning of certain provisions, the current OCS leasing and development program is one that is, on balance, coherent and reasonably predictable. Although the comprehensiveness of the program has not precluded the political battles noted above nor avoided restrictions on leasing in frontier areas, in those areas of the nation where offshore development is accepted, the internal administrative process is well known and understood by those who invest in offshore leases and those who choose to observe and comment on such activity. The OCSLA is replete with references to the applicability of other statutes and the authority of other departments in the oil and gas process, and presents a clearer roadmap than most other offshore resource management laws or programs.

After an initial bumpy start in the implementation of major amendments to its basic law, the problems encountered by the offshore oil and gas program today are generally external to its day-to-day administration and regulatory requirements. Although a number of different variables have to be taken into consideration in crafting a regime for other ocean uses, the scope and comprehensiveness of the OCS oil and gas program can be a model for the management of a wide variety of offshore activities.

Trends in Domestic Offshore Oil and Gas Production

Currently, energy development in federal waters accounts for more than 30 percent of domestic oil production and 25 percent of natural gas. Further, the offshore areas of the United States contain an estimated 60 percent of the oil and natural gas yet to be discovered domestically.[3]

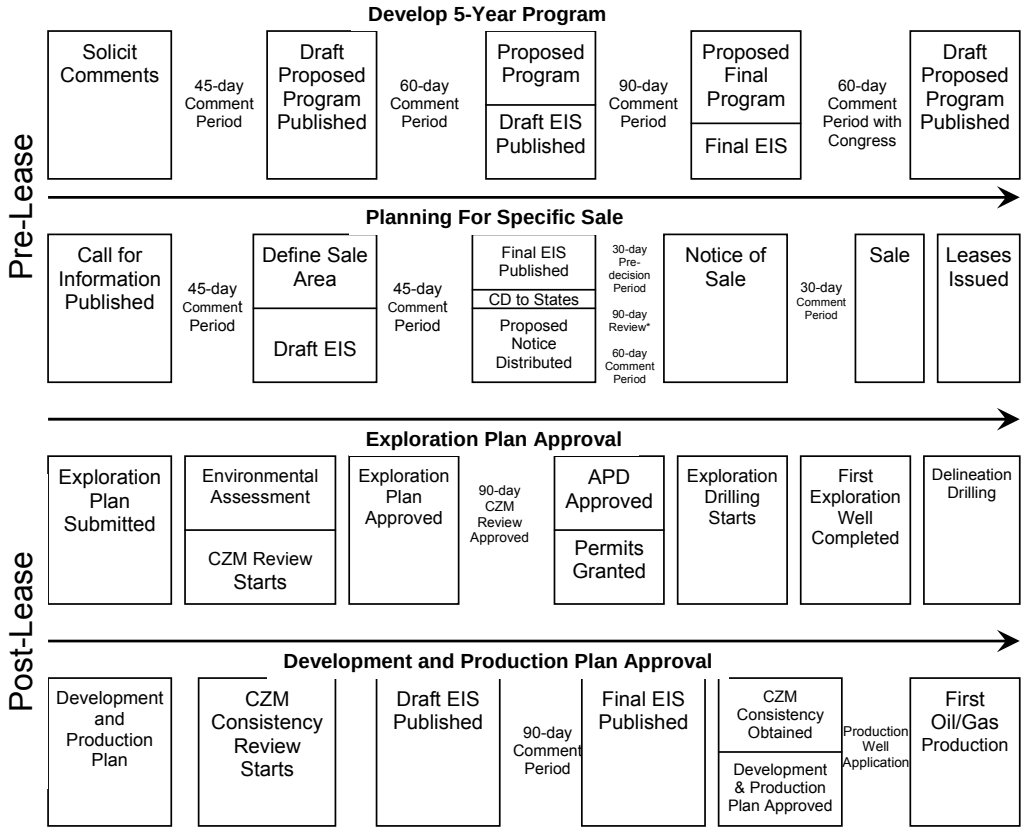
Virtually all (more than 95 percent) of U.S. offshore oil and gas production takes place in the western and central Gulf of Mexico, where there is an established infrastructure and general public acceptability. There is still some offshore production in Southern California and limited leasing and exploration in federal waters off Alaska. The first oil production from a joint federal-state lease in the Beaufort Sea (Alaska) commenced in 2001.

The importance of offshore oil and natural gas to the nation's total energy portfolio is expected to increase. The U.S. Energy Information Administration projects the United States will need about 35–40 percent more natural gas and about 45 percent more oil by 2025 to meet demand, even as new energy conservation measures are mandated and efforts to develop alternative power sources continue.[4] Government and industry experts are concerned that rising demand for and limited supplies of natural gas will continue to boost heating and electricity costs, affecting homeowners and a range of major industries. Nearly all U.S. electric-generating plants built since 1998 are fueled by natural gas.

Rise in Deep-water Oil Production

Although production in the Gulf's heavily leased shallow waters has been steadily declining, production in the Gulf's deeper waters (more than 1,000 feet), which tend to produce more oil than natural gas, increased by 276 percent between 1996 and 2000.[5] In part, this growth was attributable to technological breakthroughs, the

Figure 24.2. A "Process Rich" but Clear Path to Offshore Leasing, Exploration, and Development Activities



Abbreviations:
- APD: Application for Permit to Drill
- CD: Consistency Determination
- CZM: Coastal Zone Management
- EIS: Environmental Impact Statement

* Includes 60-day Comment Period and 15-day automatic extension. Unless State concurs, no decision can be made until 90 days after beginning of State review.

The process by which companies and other stakeholders comment on proposed sales and lease, explore, and develop the outer Continental Shelf is clearly defined in the Outer Continental Shelf Lands Act. Although there are many steps involved, its comprehensiveness and transparency not only set out clear comment periods for coastal states and other interested stakeholders, but also provide companies greater predictability about the procedures they must follow to receive approval for their exploration and production work.

Figure Courtesy of Minerals Management Service, Department of the Interior, Washington, DC

relative stabilization of crude oil prices, and the enactment of legislation in 1995 granting various levels of royalty relief to lessees willing to make the risky investment in the Gulf's deeper waters. Deep-water oil production now accounts for more than half of the Gulf's total production.[6] Additionally, the technology for ultra–deep-water development continues to advance with the drilling of a number of exploratory and production wells in water depths greater than 7,000 feet. Recently, a world record exploratory well was drilled in 10,000 feet of water.

A Promising Future for Natural Gas from Shallow Water

MMS estimates there is up to 55 trillion cubic feet (tcf) of natural gas available for production in the deep shelf areas of the Gulf (15,000 feet below the seabed but in shallow-water depths of less than 656 feet). This estimate is 175 percent greater than the previous projection of 20 tcf just a few years ago. This is a hopeful sign of additional sources of natural gas to meet a portion of the nation's future needs. Natural gas production from this deep shelf area of the Gulf increased from a relatively low 284 billion cubic feet (bcf) in

2000 to 421 bcf in 2002. This 2-year, 50 percent increase follows immediately after a 3-year, 21 percent decrease between 1997 and 2000.[7] To bolster industry interest in this high-cost deep drilling area, in 2001, MMS instituted a program of deep shelf royalty relief for natural gas production. This economic incentive, combined with more sophisticated cost-effective technology, improved seismic data, better understanding of the potential from the deep shelf, and increased public demand, is likely to provide the impetus for even further accelerated natural gas production from the OCS.

Federal Revenues from Offshore Oil and Gas Leasing and Production

The federal government receives substantial sums of revenue from energy companies for offshore oil and gas leasing and production. OCS lessees make three categories of payments: bonus bids when a lease is issued, rental payments before a lease produces, and royalties on any production from the lease. In the half century of the oil and gas program's existence, between 1953 and 2002, it has contributed approximately $145 billion in federal revenues.[8] In recent years, the revenues generated from offshore energy activity have averaged $4–$5 billion annually (Table 24.3). Although most of the revenues have been deposited directly into the U.S. Treasury, a significant portion has gone to the Land and Water Conservation Fund and the National Historic Preservation Fund.

Table 24.3. Federal Revenues from Offshore Mineral Development
Significant funds are paid into the U.S. Treasury each year from outer Continental Shelf (OCS) bonuses, royalties, and rents. This money is used in part to help support federal conservation and preservation programs and a small amount generated from near shore development is shared with some OCS producing states.

Year	Oil and Gas Royalties	Bonuses, Rents and Other Revenue	Total by Year
1997	$3,444,561,989	$1,814,666,046	$5,259,228,035
1998	$2,703,722,873	$1,618,914,459	$4,322,637,332
1999	$2,611,742,229	$576,646,226	$3,188,388,455
2000	$4,094,576,078	$1,115,086,564	$5,209,662,642
2001	$5,448,825,260	$1,056,762,550	$6,505,590,810
Total	**$18,303,428,429**	**$6,182,075,845**	**$24,485,504,274**

Source: Minerals Management Service, Department of Interior. <http://www.mrm.mms.gov/Stats/pdfdocs/coll_off.pdf> (Accessed March, 2004). Year 2001 data courtesy of MMS Revenue Management Office, Lakewood, CO.

A Question of Equity: Sharing OCS Receipts with Coastal States

Mineral resources on federal land, whether onshore or offshore, benefit the nation as a whole. The primary law governing onshore mineral development is the Mineral Leasing Act (MLA), and the comparable law for offshore minerals is the OCSLA. These two statutes are analogous in many ways except for one – the sharing of revenues with states. Under the MLA, each of the lower 48 states directly receives 50 percent of all mineral leasing revenues from public lands within its boundaries and an additional 40 percent through the Reclamation Fund; the state of Alaska receives 90 percent directly. Also, there is a broad array of additional federal land onshore receipts sharing programs, including the National Forest Receipts Program, the Taylor Grazing Act, and others. Eligible uses of the shared receipts vary widely. Some programs require that the funds be used by the recipient jurisdiction for specific purposes such as schools, roads, or land and resource improvements, while others allow the states more discretion.

Furthermore, once leased under the MLA or some other land management statutes, federal onshore lands are generally subject to most state and local taxes; the most noteworthy in many cases is the ability of states to levy severance taxes from minerals developed on federal lands within their borders. Additionally, if local governments lose property tax revenue because of the existence of federal lands, there are a variety of federal agency programs that provide localities with payments in lieu of taxes.

In contrast, the OCSLA specifically prohibits the applicability of state taxes to the OCS. Moreover, there is no comparable general offshore revenue sharing program like the MLA for coastal states. Proponents of such an initiative argue that although the energy development occurs in federal waters outside of coastal state boundaries, many of the impacts resulting from such activity occur locally, in and near the states' coastal zones. They contend that affected states and communities should receive assistance in coping with the costs of facilitating offshore development, including actions to minimize the risk of environmental damage. Officials in the executive branch have traditionally opposed revenue sharing, largely because of the potential loss to the federal treasury.

For decades, Congress has debated proposals to enact a general OCS revenue sharing statute—including the Coastal Energy Impact Program in the mid-1970s—to help states address the effects of offshore production and remedy the apparent inconsistency with onshore mineral development. Disputes over the fair division of revenues from resources discovered in fields that straddle state and federal submerged lands were resolved in 1986. In that year, Congress amended the OCSLA to require that 27 percent of revenues from federal leasing and production activity within three nautical miles seaward of the federal–state offshore boundary be given to the affected state. Through the release of money that was being held in escrow, the awarding of past payments owed to the states, and subsequent entitlement to 27 percent of current and future royalties from the three-mile area, the seven OCS "producing" states have received slightly more than $3 billion since 1986. Currently, this program provides only some $50-60 million annually to such states. In fiscal year 2001, Congress authorized and appropriated $142 million for a Coastal Impact Assistance Program to be allocated among the producing states by the National Oceanic and Atmospheric Administration (NOAA). However, this was a one-year authorization, and no further funding has been provided.

Enhancing the Federal-State Ocean and Coastal Partnership

In various parts of this report, recommendations are made not only to strengthen the coordination of ocean policy and agency organization at the federal level, but also the involvement of non-federal governmental and nongovernmental stakeholders through a formal mechanism of a presidential council of advisors, regional ocean councils, and other less formal structures. In effect, the time has come for a new ocean and coastal partnership between the federal government and state, local, and tribal governments. This partnership should include a recognition that much of the responsibility for the management of the nation's ocean and coastal resources rests with coastal state and local governments. In fact, that recognition is the foundation of the CZMA, permeates many other natural resource management programs, and is specifically acknowledged in Chapter 30.

As the federal-state ocean and coastal partnership began to evolve, the nation determined that the activities associated with development of nonrenewable resources should not be pursued at the expense of the long-term health of renewable resources. That is why the OCSLA, the CZMA, and other applicable federal statutes call for the balanced management of offshore oil and gas, the protection of the ocean and coastal environment, and the involvement of state and local governments. The day will come when oil and gas will no longer be found or developed in the nation's submerged lands, but if the proper policies are pursued, the renewable resources of the estuaries, coasts, oceans, and Great Lakes, and the economic activities that depend upon them, will remain healthy and strong.

To make certain that the federal-state partnership is strengthened and that critical marine ecosystems are protected, more investment of the resource rents generated from OCS energy leasing and production into the sustainability of ocean and coastal resources is necessary. Specifically, some portion of the revenues received by the federal government annually for the leasing and extraction of *nonrenewable* offshore resources need to be allocated to all coastal states for programs and efforts to enhance the conservation and sustainable development of *renewable* ocean and coastal resources. A larger portion of the allocation will need to be granted to the OCS-producing states to help them address the environmental and socioeconomic impacts

from offshore oil and gas-related activity. None of the programs that currently receive revenues from OCS oil and gas activity should be adversely affected by this allocation.

Recommendation 24–1. Congress, with input from the National Ocean Council, should ensure that a portion of the revenues that the federal government receives from the leasing and extraction of outer Continental Shelf (OCS) oil and gas is invested in the conservation and sustainable development of renewable ocean and coastal resources through grants to all coastal states. States off whose coasts OCS oil and gas is produced should receive a larger share of such portion to compensate them for the costs of addressing the environmental and socioeconomic impacts of energy activity in adjacent federal waters.

State Involvement in OCS Oil and Gas Decision-making

The partnership between the federal and state governments with respect to activities in federal waters should involve more than the sharing of some revenues. The central role of states in the new ocean policy framework is addressed in practically every chapter of this report. For example, Chapter 6 specifically calls for a more robust federal-regional-state dialogue in the building of coordinated offshore management regime. Chapter 9 addresses the link between coastal and offshore management, including the role of the federal consistency provision of the CZMA, despite some disagreements between levels of government, in enhancing cooperative federalism.

With respect to offshore oil and gas, the 1978 amendments to the OCSLA were intended, among many purposes, to bring state and local governments into much clearer and statutorily specified consultative roles at various points in DOI's decision-making process. Further, the amendments made clear that the federal consistency provision of the CZMA applied to exploration, development, and production plans submitted to the Secretary of the Interior under the OCSLA. (For further information, see the box on "The Federal Consistency Provision and Offshore Oil and Gas Development.")

Environmental Issues Related to Offshore Oil and Gas Production

As with most industrial development activities, along with the economic and energy-related benefits of OCS oil and gas production are actual and perceived risks to the environment, coastal communities, and competing users. Since the 1969 Santa Barbara blowout, the U.S. oil industry's environmental and safety record has improved significantly, as has the regulatory regime of DOI. Today, safety stipulations are more stringent, technologies are vastly improved, inspections are regular and frequent, and oil spill response capabilities are in place. Nevertheless, there remain numerous environmental issues associated with the development and production of oil and gas from the OCS. Foremost among these are:

- physical damage to coastal wetlands and other fragile areas by OCS-related onshore infrastructure and pipelines.
- physical disruption of and damage to bottom-dwelling marine communities.
- discharge of contaminants and toxic pollutants present in drilling muds and cuttings and in produced waters.
- emissions of pollutants from fixed facilities, vessels, and helicopters.
- seismic exploration and production noise impacts on marine mammals and fish and other wildlife.
- immediate and long-term ecological effects of large oil spills.
- chronic, low-level impacts on natural and human environments.
- cumulative impacts on the marine, coastal, and human environments.

The most obvious of these risks and the one most commonly cited, is the potential for oil spills including drill rig blowouts, pipeline spills, and chronic releases from production platforms. The impacts of large oil spills can last from years to decades, particularly in critical habitats, such as wetlands and coral reefs.

The Federal Consistency Provision and Offshore Oil and Gas Development

The application of the federal consistency provision of the CZMA to offshore energy development has been among the most contentious issues among the federal government, coastal state governments, and OCS lessees. In the mid 1970's, Congress amended the original version of the federal consistency provision to add a section that explicitly covered certain OCS activities. Of the thousands of exploration and development plans submitted by oil and gas companies over the years and approved by MMS, states have concurred with the consistency of such plans with their state coastal management program in virtually all of the cases. But there have been a handful in which states have objected and these are generally cases of high visibility, of which fifteen have been appealed to the Secretary of Commerce. These appeals resulted in fourteen decisions by the Secretary, half of which overrode the state's objection and half did not.

In a case that reached the highest court in the land in 1984, the U.S. Supreme Court held that OCS lease sales were not subject to the consistency provision of the CZMA. In 1990, Congress enacted a law which reversed the decision, clarified that such sales are subject to a state consistency review, and made a number of other changes to the interpretation of the federal consistency provision that resulted in a lengthy rule-making process by NOAA. The final rule was published in 2000.

In 2001, the Vice President submitted the National Energy Policy report of the National Energy Policy Development Group to the President.[9] The report contained a section on the OCSLA, as administered by MMS, and the CZMA, as carried out by NOAA. It noted that the effectiveness of these programs is "sometimes lost through a lack of clearly defined requirements and information needs from federal and state entities, as well as uncertain deadlines during the process." The report recommended that the Secretaries of Commerce and the Interior reexamine the legal and policy regimes to see if changes were needed regarding energy activities in the coastal zone and the OCS.

In 2003, after a series of negotiations between the two departments, the Department of Commerce published a proposed rule addressing the information needs of states, coordination of timing requirements between the OCSLA and the CZMA, definitive time limits on the Secretary of Commerce's appeals process, and additional procedural matters. (For a more detailed discussion of the OCS-specific federal consistency provisions of the CZMA and the issues related to their implementation, including a history of related litigation, see Appendix 6.)

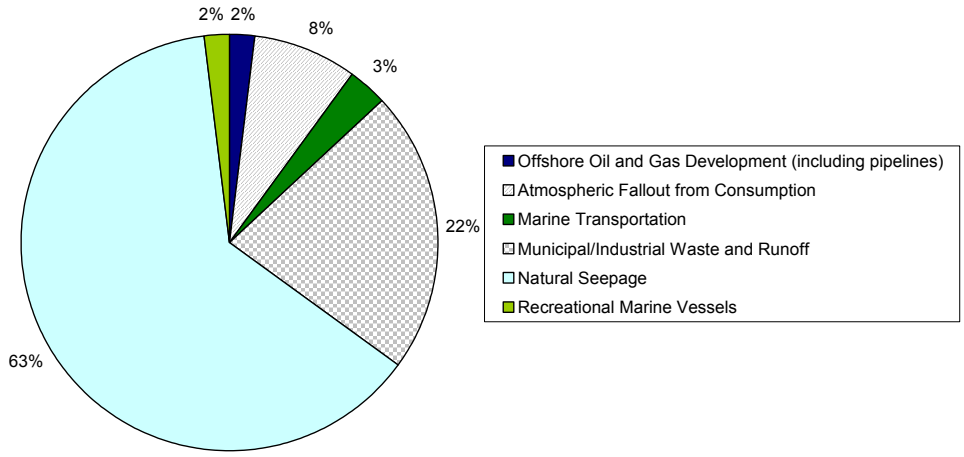
According to MMS, 97 percent of OCS spills are one barrel or less in volume and U.S. OCS offshore facilities and pipelines accounted for only 2 percent of the volume of oil released into U.S. waters for the period 1985-2001 (Figure 24.4).[10] The total volume and number of such spills over that period have been significantly declining due to industry safety practices and improved spill prevention technology. By comparison, the National Research Council estimated that 690,000 barrels of oil enter North American ocean waters each year from land-based human activities, and another 1,118,000 barrels result from natural seeps emanating from the seafloor.[11]

However, spills from aging pipelines are a continuing concern. Since 1981, the volume of oil spilled from OCS pipelines is four to five times greater than that from OCS platforms (Figure 24.5).[12] Long-term exposure to weather and marine conditions make pipelines older than 25 years considerably more susceptible to spills and leaks as a result of stress fractures and material fatigue. Also, these older pipelines do not incorporate the advanced oil spill detection and prevention technology that has been developed in more recent years.

MMS's Environmental Studies Program (ESP) is a major source of information about the impacts of OCS oil and gas activities on the human, marine, and coastal environments. Since 1986, annual funding for the program has decreased, in real dollars, from a high of $56 million to approximately $18 million in 2003. Even accounting for the contraction in the areas available for leasing, the erosion in ESP funding has occurred at a time when more and better information, not less, is needed. There continues to be a need to better

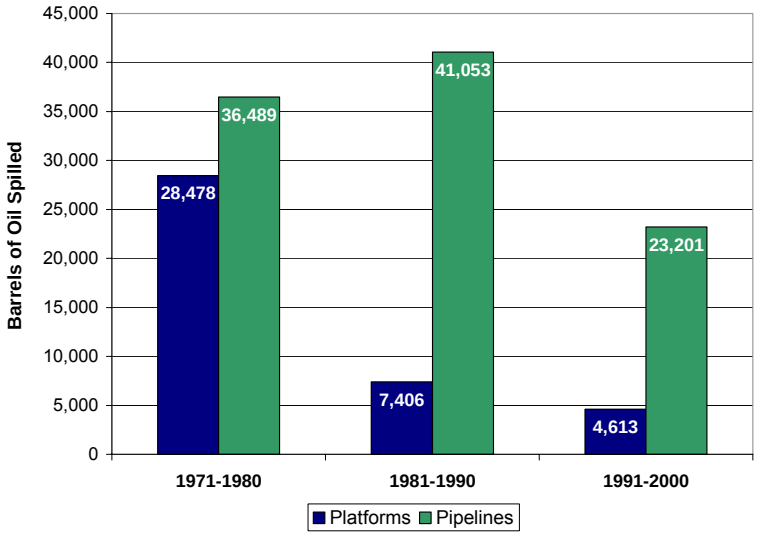
understand the cumulative and long-term impacts of OCS oil and gas development, especially in the area of low levels of persistent organic and inorganic chemicals, and their cumulative or synergistic effects.

Figure 24.4. Sources of Oil in the North American Marine Environment



Offshore oil and gas development contributes only 2 percent of the 1.8 million of barrels of oil released into North American waters each year. Natural seepage from the sea floor is by far the largest input, while runoff and waste from human land-based activities contribute roughly a quarter of the oil present in the marine environment. When calculated worldwide, the oil released from offshore oil and gas development still only accounts for 4 percent of the total 8.9 million barrels. (One barrel is equal to 42 gallons.)
Source: Minerals Management Service. *OCS Oil Spill Facts*, 2002. <http://www.mms.gov/stats/PDFs/2002_OilSpillFacts.pdf> (Accessed March, 2004).

Figure 24.5. Aging Pipelines are a Leading Source of Oil Leaks from OCS Infrastructure



In the last thirty years, the amount of oil spilled from OCS platforms and pipelines has continued to decrease. However, the increasing disparity between the number of barrels spilled from platforms versus pipelines indicates that the pipeline infrastructure—which is more exposed to the effects of weather and saltwater—needs updating to prevent future spills.
Source: Minerals Management Service. *OCS Oil Spill Facts*, 2002. <http://www.mms.gov/stats/PDFs/2002_OilSpillFacts.pdf> (Accessed March, 2004).

Also, as noted, OCS oil and gas exploratory activities in the Gulf of Mexico are now occurring in water depths approaching 10,000 feet with projections that the industry will achieve 15,000 feet drilling capabilities within the next decade. The technological ability to conduct oil and gas activities in ever deeper waters on the OCS places a significant and important responsibility on MMS to collect the essential environmental deep-

water data necessary for it and other agencies to make informed management and policy decisions on exploration and production activities at those depths. Thus, as our knowledge base increases and the industry expands its activities further offshore and into deeper waters, new environmental issues are emerging that cannot all be adequately addressed under the current ESP budget.

Recommendation 24–2. The U.S. Department of the Interior should reverse recent budgetary trends and increase funding for the Minerals Management Service's Environmental Studies Program.

Increased funding should be used for:

- *conducting long-term environmental monitoring at appropriate outer Continental Shelf (OCS) sites to better understand cumulative, low-level, and chronic impacts of OCS oil and gas activities on the natural and human environments.*
- *working with state environmental agencies and industry to evaluate the risks to the marine environment posed by the aging offshore and onshore pipelines in the Gulf of Mexico.*

Opportunities for Sharing Ocean Observation Information and Resources

Floating drilling rigs and production platforms are able to maintain position over the tops of wells thousands of feet below without the need for mooring or permanent structures. Dynamic positioning systems compensate for wind, waves, or currents to keep the vessel stationary relative to the seabed, and new hull designs maintain stability. Three- and four-dimensional subsurface images allow operators to obtain a better idea of how a reservoir behaves and increase the likelihood of drilling success. And the use of horizontal and directional drilling creates more flexibility in deciding where to site offshore platforms.

The movement of oil and natural gas exploration, development, and production activities further offshore into deeper waters and into more harsh marine environments, such as the Arctic, affords an excellent opportunity for incorporating the industry's offshore infrastructure into the national Integrated Ocean Observing System (IOOS), as discussed in Chapter 26. In addition to its offshore infrastructure, the industry has great technological capacity for collecting, assimilating, and analyzing environmental data of direct importance to the IOOS. The U.S. offshore industry has a history of partnering with ocean scientists by allowing them to use production platforms for mounting environmental sensors, and in some cases, collecting and providing them with environmental data and information. The industry would benefit from partnering in the IOOS as a user of the system's data and information products and by being involved in its design, implementation, and future enhancement.

Recommendation 24–3. The National Oceanic and Atmospheric Administration, working with the Minerals Management Service and the offshore oil and gas industry, should establish a partnership that will allow the use of industry resources, including pipelines, platforms, vessels, and research and monitoring programs, as part of the Integrated Ocean Observing System (IOOS).

Specifically, this partnership should:

- *facilitate the transfer of nonproprietary data to research and academic institutions while protecting the security of proprietary data and meeting other safety, environmental, and economic concerns.*
- *include the offshore oil and gas industry as an integral partner in the design, implementation, and operation of the IOOS, notably in the regional observing systems in areas where offshore oil and gas activities occur.*

ASSESSING THE POTENTIAL OF OFFSHORE METHANE HYDRATES

Conventional oil and gas are not the only fossil-based fuel sources located beneath ocean floors. Methane hydrates are solid, ice-like structures composed of water and natural gas. They occur naturally in areas of the world where methane and water can combine at appropriate conditions of temperature and pressure, such as in thick sediments of deep ocean basins, at water depths greater than 500 meters.

The estimated amount of natural gas in the gas hydrate accumulations of the world greatly exceeds the volume of all known conventional gas resources.[13] A 1995 U.S. Geological Survey (USGS) estimate of both marine and Arctic hydrate resources revealed the immense energy potential of hydrates in the United States.[14] These deposits have been identified in Alaska, the east and west coasts of the United States, and in the Gulf of Mexico. USGS estimated that the methane hydrates in U.S. waters hold a mean value of 320,000 trillion cubic feet of natural gas, although subsequent refinements of the data have suggested that the estimate is a slightly more conservative 200,000 trillion cubic feet.[15] Even this more conservative estimate is enough to supply all of the nation's energy needs for more than 2,000 years at current rates of use.[16]

However, there is still no known practical and safe way to develop the gas and it is clear that much more information is needed to determine whether significant technical obstacles can be overcome to enable methane hydrates to become a commercially viable and environmentally acceptable source of energy.

In the United States, federal research concerning methane hydrates has been underway since 1982, was intensified in 1997-98, and received further emphasis with the passage of the Methane Hydrate Research and Development Act in 2000. That Act established an interagency coordination mechanism that includes the Departments of Energy, Commerce, Defense, and the Interior, and the National Science Foundation, and directed the National Research Council (NRC) to conduct a study on the status of research and development work on methane hydrates. The NRC study is scheduled for release in September 2004.

Recommendation 24–4. The National Ocean Council (NOC), working with the U.S. Department of Energy and other appropriate entities, should review the status of methane hydrates research and development and seek to determine whether methane hydrates can contribute significantly to meeting the nation's long-term energy needs. If such contribution looks promising, the NOC should determine how much the current investment in methane hydrates research and development efforts should be increased, and whether a comprehensive management regime for private industry access to methane hydrates deposits is needed.

DEVELOPING OFFSHORE RENEWABLE ENERGY RESOURCES

Environmental, economic, and security concerns have heightened interest among many policy makers and the public in renewable sources of energy. Although offshore areas currently contribute little to the nation's supply of renewable energy, the potential is significant and could include offshore wind turbines, mechanical devices driven by waves, tides, or currents, and ocean thermal energy conversion, which uses the temperature difference between warm surface and cold deep ocean waters to generate electricity.

Offshore Wind Energy Development

While the offshore wind power industry is still in its infancy in the United States, it is being stimulated by improved technology and federal tax credits that have made it more attractive commercially. Additionally, developers are looking increasingly to the lead of European countries such as Denmark, the United Kingdom, and Germany, where growing numbers of offshore projects are being licensed.

In fact, the United States already has a wind energy management program applicable on some federal lands onshore. This comprehensive program carried out by DOI's Bureau of Land Management, under broad authority provided by the Federal Land Policy and Management Act.

Conversely, there is no comprehensive and coordinated federal regime in place to regulate offshore wind energy development or to convey property rights to use the public space of the OCS for this purpose. In the absence of a specific regime, the U.S. Army Corps of Engineers (USACE) is the lead federal agency responsible for reviewing and granting a permit for this activity. Its authority, however, is based on Section 10

of the Rivers and Harbors Act, which, although it has a public interest requirement, primarily regulates obstructions to navigation, including approval of any device attached to the seafloor.

In reviewing a proposed project under Section 10, the USACE is required by the National Environmental Policy Act to consult other federal agencies. Depending on the circumstances, these agencies and authorities may include:

- The U.S. Coast Guard, which regulates navigation under several federal statutes.
- The Federal Aviation Administration, which regulates objects that may affect navigable airspace pursuant to the Federal Aviation Act.
- The U.S. Environmental Protection Agency, which may conduct a review for potential environmental impacts of a project pursuant to the Clean Water Act and Clean Air Act.
- The National Marine Fisheries Service, which may review projects for potential impacts to fishery resources pursuant to the Magnuson-Stevens Fishery Conservation and Management Act. In addition, NMFS review includes assessing potential impacts to endangered or threatened species under the Endangered Species Act or the Marine Mammal Protection Act.
- The U.S. Fish and Wildlife Service, which may review projects for potential impacts to endangered species or marine mammals under its jurisdiction pursuant to the Endangered Species Act or the Marine Mammal Protection Act.
- In addition, depending on its location, a wind energy project or at least the Section 10 permit may be subject to review by one or more state coastal management programs in accordance with the CZMA federal consistency provisions.

The Section 10 review process stands in stark contrast both to the well established DOI regulatory program for onshore wind energy and, in the marine setting, to the robust regulatory program for offshore oil and gas that has developed under the OCSLA. Using the Section 10 process as the primary regulatory vehicle for offshore wind energy development is inadequate for a number of reasons. First and foremost, it cannot grant leases or exclusive rights to use and occupy space on the OCS. It is not based on a comprehensive and coordinated planning process for determining when, where, and how this activity should take place. It also lacks the ability to assess a reasonable resource rent for the public space occupied or a fee or royalty for the energy generated. In other words, it lacks the management comprehensiveness that is needed to take into account a broad range of issues, including other ocean uses in the proposed area and the consideration of a coherent policy and process to guide offshore energy development.

A Mighty Wind Blows in Cape Cod

The first proposal for offshore wind energy development in the United States is testing the ability of the federal system to manage this emerging industry. The proposal calls for use of approximately 23 square miles of Nantucket Sound, some 5.5 nautical miles off the coast of Cape Cod, Massachusetts. It would consist of 170 wind turbines, each of which would be sunk into the ocean floor and reach up to 420 feet above the ocean surface. The project would generate an annual average of approximately 160 megawatts of electrical power.[17]

This project has divided local citizens, elected officials, environmentalists, business interests, and other stakeholders. Supporters cite the project's potential to reduce pollution, global warming, and reliance on foreign oil, while opponents warn of bird deaths, harm to tourism, interference with commercial and sports fishing, and obstructed views.

Despite the controversy, the project is proceeding through the Section 10 review process. In the meantime, proposals for offshore wind development projects up and down the East Coast are proliferating.

Wave Energy Conversion—Current and Tidal

Various technologies have been proposed to use wave or tidal energy, usually to produce electricity. The wave energy technologies for offshore use include floating or pitching devices placed on the surface of the water that convert the horizontal or vertical movement of the wave into mechanical energy that is used to drive a turbine. Currently, the offshore wave, tidal, and current energy industry is in its infancy. Only a small proportion of the technologies have been tested and evaluated.[18] Nonetheless, some projects are moving forward in the United States, including one to install electricity-producing wave-energy buoys more than three nautical miles offshore Washington State, in the Olympic Coast National Marine Sanctuary. Internationally, there is considerable interest in wave, tidal, and current energy, but the projects are almost all in the research and development stage.

The Federal Energy Regulatory Commission (FERC) asserts jurisdiction, under the Federal Power Act (FPA), over private, municipal, and state (not federal) hydropower projects seaward to 12 nautical miles. FERC has formally asserted jurisdiction over the Washington State project, and is likely to assert jurisdiction over all forms of wave or tidal or current energy projects whose output is electricity, from the shoreline out to 12 nautical miles offshore, on the basis that they are "hydropower" projects under the FPA.

Although in issuing a license for a wave, current, or tidal project FERC is directed by the FPA to equally consider environmental and energy concerns, it is not an agency with a broad ocean management mission. As with wind energy, several other federal laws may apply to ocean wave projects. For example, NEPA, the federal consistency provision of the CZMA, the National Historic Preservation Act, and the Fish and Wildlife Coordination Act may apply, as may the consultation provisions of the Endangered Species Act and the Marine Mammal Protection Act. But there is no comprehensive law that makes clear which of these individual laws may be applicable, nor is there any indication that overall coordination is a goal, thus leaving implementation, again, to mixed federal authorities.

Ocean Thermal Energy Conversion

The surface waters of the world's tropical oceans store immense quantities of solar energy. Ocean thermal energy conversion (OTEC) technology could provide an economically efficient way to tap this resource to produce electric power and other products. The U.S. government spent over $200 million dollars in OTEC research and development from the 1970s to the early 1990s that produced useful technical information but did not result in a commercially viable technology. [19]

Early optimism about the potential of OTEC led to the enactment of the Ocean Thermal Energy Conversion Act of 1980, and the creation of a coordinated framework and licensing regime for managing that activity if and when economic considerations permitted. NOAA issued regulations to implement the Act, but because of investor risk for this capital-intensive technology and relatively low fossil fuel prices, no license applications were ever received and NOAA subsequently rescinded the regulations in 1996. Thus, the United States currently has no administrative regulatory structure to license commercial OTEC operations.

Comprehensive Management for Offshore Renewable Energy

Offshore renewable technologies will continue to be studied as a means of reducing U.S. reliance on potentially unstable supplies of foreign oil, diversifying the nation's energy mix, and providing more environmentally benign sources of energy. Similar to offshore aquaculture described in Chapter 22, the offshore renewable processes described in this section present obvious examples of the shortcomings in federal authority when it comes to regulating specific new and emerging offshore activities. As long as federal agencies are forced to bootstrap their authorities to address these activities, the nation runs the risk of unresolved conflicts, unnecessary delays, and uncertain procedures. What is urgently needed is a comprehensive offshore management regime, developed by the National Ocean Council, which is designed to review all offshore uses in a greater planning context (see Chapter 6). A coherent and predictable federal

management process for offshore renewable resources that is able to weigh the benefits to the nation's energy future against the potential adverse effects on other ocean users, marine life, and the ocean's natural processes, should be fully integrated into the broader management regime.

Recommendation 24–5. Congress, with input from the National Ocean Council, should enact legislation providing for the comprehensive management of offshore renewable energy development as part of a coordinated offshore management regime.

Specifically, this legislation should:

- *streamline the process for licensing, leasing, and permitting renewable energy facilities in U.S. waters.*
- *subsume existing statutes, such as the Ocean Thermal Energy Conversion Act, and should be based on the premise that the oceans are a public resource.*
- *ensure that the public receives a fair return from the use of that resource and development rights are allocated through an open, transparent process that takes into account state, local, and public concerns.*

MANAGING OTHER MARINE MINERALS

The ocean floor within the U.S. EEZ contains vast quantities of valuable minerals other than oil and gas, but the economics of recovering them, especially in areas far offshore, are not welcoming. These resources include more than two trillion cubic meters of sand and gravel reserves on the Atlantic shelf of the OCS alone, enormous phosphate deposits off the East Coast from North Carolina to northern Florida, titanium-rich heavy mineral sands from New Jersey to Florida, manganese nodules from South Carolina to Georgia, gold deposits off of Alaska, polymetallic sulfides off of Oregon, barite resources off of southern California, and quantities of cobalt and platinum in Hawaii. It is likely that substantial amounts of other valuable minerals will be identified in the future as exploration proceeds. Access to these minerals for commercial recovery, including offshore sand and gravel for use as construction aggregate, is through the competitive leasing process of the OCSLA.

In 1994, Congress authorized coastal communities to use sand and gravel from the OCS for public works projects without going through the statute's bidding process. Since then, MMS has used this authority to allow federal, state, and local agencies to mine OCS sand to protect shorelines, nourish beaches, and restore wetlands. Between 1995 and 2004, MMS provided over 20 million cubic yards of OCS sand for 14 coastal projects.[20] Louisiana alone is expected to seek millions of cubic yards of OCS sand for various barrier island restoration projects and levee systems.[21]

The depletion of OCS sand in state waters after decades of excavation, and growing environmental opposition to the activity in areas close to shore are exacerbated by the acceleration of erosion, ever-expanding coastal populations, and on the increasing vulnerability of fragile beaches, exposed beachfront property, and coastal-dependent industries to coastal storms. With the need for sand increasing and its availability in state waters decreasing, the OCS provides the obvious remedy. It is not, however, a remedy without associated problems.

MMS has numerous environmental studies underway or planned to evaluate the effects of OCS dredging on the marine and coastal environment and to identify ways to eliminate or mitigate harmful impacts. There remains, nevertheless, significant uncertainty about the long-term, cumulative impacts of sand and gravel mining on ocean systems and marine life. Changes in bathymetry can affect waves and currents in a manner that could increase shoreline erosion. Alterations to the ocean bottom can affect repopulation of the benthic community, cause increased turbidity, damage submerged resources such as historic shipwrecks, and kill marine organisms, including fish. For economic reasons, the demand for sand and gravel leases will most likely concentrate on OCS areas that are relatively close to shore. Some environmentalists and fishing representatives have opposed mining in state waters and may well oppose similar projects in adjacent federal waters.

A vital component of a national strategy to manage mineral resources located on the OCS is the need for an overall assessment of: (1) the nation's OCS mineral endowment (sand and gravel, as well as other strategic minerals vital to the long-term security of the nation); (2) the need for those resources (highest and best uses); (3) the long-term environmental impacts associated with use of those resources and; (4) the multiple-use implications of other uses of the OCS (including wind farms, cables, and pipelines). While resource managers have identified large volumes of sand off the nation's shores, the ultimate volumes that may be recovered remain unknown. Sand and gravel resources from the OCS are key to protecting the nation's shores and wetlands and to supplementing ever-diminishing onshore supplies of aggregate to support construction activities.

Recommendation 24–6. The Minerals Management Service should systematically identify the nation's offshore non-energy mineral resources and conduct the necessary cost-benefit, long-term security, and environmental studies to create a national program that ensures the best uses of those resources.

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