Managing Marine Fisheries

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Pew Oceans Commission
Workshop on Marine Fishery Management

PEW OCEANS COMMISSION

Front and Back Cover: *A blue shark swiftly slashes through a school of mackerel in waters of the Pacific near San Diego, California.*

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Foreword

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Since May 2000, the Pew Oceans Commission—an independent group of American leaders—has conducted a national dialogue on policy changes needed to restore and protect living marine resources in coastal waters of the United States. The Commission is currently gathering information from citizens around the country and reviewing the best scientific information available before it develops formal recommendations that it will present to Congress, the President, and the nation in early 2003.

To assist in its deliberations, the Commission has contracted with a number of distinguished scientific and technical experts to prepare a series of reports outlining some of the major threats to ocean and coastal resources. The authors review the latest information and offer recommendations on how best to address the ecological, economic, political, or social problems they identify. Among the issues of critical concern: marine pollution, aquaculture, introduced species, coastal development, marine reserves, the economics and ecology of fishing, and fishery management.

This report addresses how well the United States' fishery management laws, institutions, and policies are working to protect the nation's living marine resources, and makes recommendations for their reform. Unlike the other Commission-sponsored reports, this publication consists of several short papers from a number of authors. These authors bring a wide range of experience and expertise and provide the Commission and other interested parties with a wealth of insightful and diverse views.

It is the intention of the Commission to use the findings and recommendations in this and other reports as important resources as it develops the recommendations for its final report. The scientific reports published by the Pew Oceans Commission express the views of the independent authors and are not intended to speak for the Commission itself.

The scientific reports do not constitute the Commission's sole sources of information. Over the last twenty months, the Commission has held public hearings and conducted focus groups throughout U.S. regions affecting the health of coastal ecosystems. Members of the Commission have heard from representatives with commercial and recreational fishing interests, fishermen, individuals from nongovernmental organizations, and officials from every level of government.

The Commission continues to welcome the input of stakeholders and other interested parties as it moves toward drafting recommendations for its final report. Even after the Commission has issued its findings, the information gathered in this series of reports will serve as a continuing valuable resource for those dedicated to restoring the health of our oceans and our living marine resources.

Pew Oceans Commission Chair, Leon Panetta, (left) talks to lobsterman Bob Baines during a visit to Spruce Head, Maine.

Introduction

America's oceans are a natural treasure and part of the nation's public trust. We are drawn to their shores to live, work, and play. For centuries, fishermen have worked the oceans to bring fresh seafood to our tables. They contribute to the economic health of our coastal cities. As America's oldest industry, fishing has always been among the most challenging professions. However, today's fishermen and fishery managers face growing challenges that threaten ecosystems and livelihoods.

It has been more than thirty years since the nation last reviewed how best to conserve and manage the diverse and productive ocean environment. Since that time the state of our oceans has declined. Today's environmental, economic, and policy challenges often exceed the capacity of existing ocean and coastal management regimes.

Pollution and poorly planned coastal development degrade coastal and estuarine nursery habitats. Introduced species disrupt coastal ecosystems. Unsustainable fishing practices deplete valuable fish populations, resulting in social and economic dislocation, reduced biodiversity, and altered marine ecosystems. This report focuses on the challenges facing marine fishery management in the United States.

After thirty years of federal fishery management, a growing erosion of confidence among constituents and the American public has led to widespread calls for fundamental changes in the management of living marine resources.

The Pew Oceans Commission is dedicated to improving management of our oceans and coasts and sustaining fishing communities. Commission members have spoken with hundreds of fishermen from communities in Maine, Alaska, and California. They traveled to the Louisiana bayou and the Hawaiian Islands. They listened to fishermen in Maryland, New Hampshire, South Carolina, and the state of Washington, who are concerned about their futures. (Summaries of these meetings are available online at **www.pewoceans.org.**)

In addition to its discussions with America's fishermen, the Commission has consulted with leading scientists, environmentalists, as well as fishery managers and other government officials. To better understand and explore the realities facing fisheries and fishermen, it has commissioned a series of three reports. The reports will be available on our website (www.pewoceans.org) as downloadable PDFs.

The *Ecological Effects of Fishing in Marine Ecosystems of the United States* chronicles sometimes severe and generally unintended ecological effects that can be wrought by unsustainable fishing practices. *Socioeconomic Perspectives on Marine Fisheries in the United States* details the significant social and economic trends fishermen and the fishing industry face.

To produce this report, *Managing Marine Fisheries in the United States,* the Commission assembled a distinguished group of economists,

scientists, and other fisheries experts to participate in a workshop in July 2001. The Commission asked participants to explore the key issues of fishery management. This report includes the papers prepared for the workshop.

Burr Heneman, Monica Goldberg, and **Richard Hildreth** review the existing legal framework for managing federal fisheries. **Seth Macinko** and **Timothy Hennessey** look at traditional and emerging fishery management tools. **David Allison, Harry Scheiber,** and **Michael Orbach** challenge the current institutional structures and offer new models. **Daniel Bromley** and **Susan Hanna** explore the economics of fishery management. And **Marc Miller, Timothy Ragen, George Boehlert,** and **Ellen Pikitch** consider new ways to improve the science that supports fishery management decisions.

The participants find that the current U.S. fishery management system is not working well for a variety of reasons. Many recommend changes in the philosophy and structure of management and the economic organization of the industry. The Pew Oceans Commission did not expect consensus on which changes are needed or how such changes may be implemented. Nonetheless, the workshop participants do find common ground defining certain problems and delineating questions that need further deliberation. There is also broad agreement on the types of changes needed in many cases, but the participants offer differing suggestions on how to bring about that change.

The papers in this report provide an opportunity to hear from a diverse set of individuals with expertise and experience in marine fishery management. Their varied voices come through loud and clear. The Pew Oceans Commission believes that such an open and thoughtful review of the key issues will serve as an important springboard for further discussion, analysis, and action.

Pew Oceans Commission Workshop on Marine Fishery Management

The Commission asked each participant in the workshop to prepare a presentation on a specific topic, answering the following questions to elicit responses focused on issues of particular concern in fisheries management:

Statutory Authority and Objectives: Do the federal fisheries laws identify the right objectives and include sufficient authority to reach those objectives? Do state laws? International agreements?

Fishery Management Tools: Is the existing suite of management tools (limits on effort, gear, catch) adequate to accomplish stated objectives? How much can each tool achieve? Are there other tools that should be used? How should managers handle the socioeconomic impacts of regulations?

Institutional Structure: Is the fisheries management structure appropriate to the task in federal waters? In state waters? On the high seas?

Economic Structure: In what ways does the economic structure of a fishery produce externalities that require government regulation? Does the existing economic structure need modification?
If so, what modifications are needed? How should adverse socioeconomic impacts be handled?

Adequacy and Use of Scientific Information: Do managers have access to the information they need to make supportable decisions? Is the way in which scientific information is used adequate to support the decisions fishery managers need to make?

Federal Fishery Laws: New Model Needed to Sustain Fisheries and Ecosystems

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Summary

The primary goal of fishery management should be one of creating a system that maintains fisheries at high levels while avoiding adverse effects on the marine environment and supporting important nonconsumptive uses. Achieving such an ecosystem-based approach to fishery management with existing federal laws will be difficult. This paper examines some fundamental shortcomings of the federal fishery management system, describes the management framework California adopted in the Marine Life Management Act of 1998 (MLMA), and recommends changes to the federal system. The MLMA represents a substantial step toward a coherent, ecosystem-based approach to managing the state's marine life, including fisheries.

Federal Legal Authorities and Agency Responsibilities

The federal legal authorities relevant to fishery management are drawn from at least seven narrowly focused laws. The laws are not coordinated with one another, and they assign administrative responsibility to at least seven federal agencies or their subdivisions, creating an incoherent and chaotic approach to managing marine life, fisheries, and other ocean resources.

In addition, the various federal laws ignore most marine life. Except for general references in the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) and the Marine Mammal Protection Act, none of the legislation applies to stewardship of all marine life and ecosystems. Explicit policies are limited to marine mammals, seabirds, endangered and threatened species, species that are the targets of fisheries, and damage to marine habitat caused by fishing. This list covers important concerns but still adds up to piecemeal management that ignores most ecosystem considerations and the vast majority of marine species.

Magnuson-Stevens Fishery Conservation and Management Act and the Sustainable Fisheries Act Amendments of 1996

The Magnuson-Stevens Act governs the federal fishery management system. Its fundamental ecosystem stewardship policy is general and permissive, lacking both specificity and mandates. The act contains few requirements for conservation of ecosystems, and its most explicit conservation policies are modest: minimizing bycatch, mortality of discarded marine life, and adverse effects of fishing on habitat, as well as preventing or recovering from overfishing. In contrast, the act includes specific policy and mandates to address socioeconomic concerns.

"The effects of fishing pressure and of dramatic, often unpredicted changes in the marine environment usually have been invisible until after a fishery is in trouble."

Fishery management plans (FMPs), for example, must include fishery impact statements that assess the effects of conservation and management measures on fishery participants and communities; there are no similar requirements to describe the known or likely effects of the fishery on the marine environment.

The 1996 amendments to the Magnuson-Stevens Act are known as the Sustainable Fisheries Act, though the word "sustainable" appears only in the term "maximum sustainable yield" (MSY). MSY and optimum yield (OY) are the primary management standards built into the act—the foundation on which conservation and management rest. Yet, the dismal record of applying MSY/OY gives the approach little credibility. One recent critique of MSY states:

> *Biological reference points such as MSY may be meaningless for species of limited mobility, species with complex life histories, mixed stock fisheries, or stocks with long-term changes in productivity...Indeed, managing a fishery with MSY in the face of decadal environmental events such as [El Niño/Southern Oscillation] may be similar to farming while taking into account Dust Bowl events on a decadal scale (Mangel et al., in press).*

One can fairly ask what species and stocks are left for which MSY is *not* "meaningless."

There are three fundamental problems with the MSY/OY approach as fishery managers have applied it. First, there is an inherent, dangerous contradiction between "maximum" and "sustainable." Sustainability is a sensible management objective: stewardship into the indefinite future should be part of any reasonable management strategy. Adding "maximum" to the equation, however, creates an incentive to allow short-term considerations and ignorance of marine systems to cancel out the long-term promise of sustainability. When "maximum" is combined with "sustainable," the emphasis shifts from sustaining both a fishery and an ecosystem to a narrow fishery production model that ignores the ecosystem. The long list of officially overfished United States fisheries is powerful evidence that, in practice, fishery managers have heeded the "maximum" in MSY more often than the "sustainable" mandate.

Second, "maximum" suggests that it is safe to fish right up to the edge of trouble. It assumes knowledge of marine systems that does not exist and likely never will. The effects of fishing pressure and of dramatic, often unpredicted changes in the marine environment usually have been invisible until after a fishery is in trouble.

Finally, MSY looks through the wrong end of the telescope: it poses the question, How few fish can fishers leave in the ocean with reasonable confidence of having a fishery for the next year or two? In calculating an allowable catch, MSY begins with a large number and requires justification for reductions in the catch—whether for uncertainty, ecological factors, or other reasons. If the burden of proof were shifted to a precautionary approach that

reflects our ignorance of most fisheries and marine systems, calculation of an allowable catch would start with a low number and additional amounts would need justification.

Decision-makers in the system created by the Magnuson-Stevens Act—those who staff the state and federal agencies and who sit on the regional fishery management councils—generally are limited to fishery managers and sport and commercial fishery participants. They rarely focus on the act's subtle nod to "protection of marine ecosystems." Though the act's general purposes state an intent to "enable the States, the fishing industry, consumer and environmental organizations, and other interested groups" to participate in the management process, the specifics tilt toward fishery participants and socioeconomic interests. For example, the act requires that governors, who provide the secretary of commerce with nominees for appointment to the councils, not submit those lists unless they have "first consulted with representatives of the commercial and recreational fishing interests of the State." There is no requirement for consultation with marine ecologists, consumer groups, or marine conservation organizations.

California's Marine Life Management Act

The state of California, in adopting the reforms of the Marine Life Management Act (MLMA) in 1999, sought to avoid the shortcomings of the Magnuson-Stevens Act and previous California fisheries management regimes. The MLMA sets policy for all marine life management, not just fisheries management, encouraging an ecosystem-based approach to management that is further reinforced in explicit policies. The MLMA gives policy authority to one commission and implementation responsibility to one department. Unlike the federal councils, the policy commission is composed of generalists in natural resource management, not interest group representatives or agency staff. The MLMA's management policies protect living marine resources by conserving the health and diversity of marine ecosystems, allowing only sustainable uses of marine living resources and recognizing the importance of nonconsumptive values and uses of marine living resources, as well as the importance of sustainable sport and commercial fisheries to the economy and culture of California.

"Sustainable" is defined in the MLMA as applying to both fisheries and the ecosystems that sustain them. In this law, sustainability means continuous replacement of resources, taking into account fluctuations in abundance and environmental variability, as well as maintaining biological diversity and securing the fullest possible range of present and long-term economic, social, and ecological benefits. The MLMA does *not* require balancing of use and conservation. Many natural resource management laws do require such a balance, encouraging decisions based on short-term economic considerations. The act clearly gives the highest priority to protecting future values, whether ecological or economic.

"'Sustainable' is defined in the MLMA as applying to both fisheries and the ecosystems that sustain them."

"Management of fisheries, marine mammals, and other marine life requires a unified, ecosystem-based approach."

Implementation of the MLMA is in the early stages, but there are indications of a significant change in direction. For example, the first fishery management plan drafted by the state—the nearshore finfish (primarily live fish) fishery FMP mandated by the MLMA—includes measures that apply a precautionary approach and also fulfill the ecosystem health and nonconsumptive use mandates of the act. For further information on the MLMA, see the *Guide to California's Marine Life Management Act* (Weber and Heneman, 2000).

Recommendations for the Federal Fisheries Management System

The substantial shortcomings of the Magnuson-Stevens Act management system were instructive in the development of California's MLMA. They can also be useful for designing similar reforms to rationalize federal marine life management. Reform of the federal fisheries management system should meet four objectives:

- Management of fisheries, marine mammals, and other marine life requires a unified, ecosystem-based approach.
- Marine life management, including fisheries management, should be mandated to conserve healthy marine ecosystems, allow only sustainable uses, and recognize nonconsumptive uses and values.
- For better coordination and greater accountability, one agency should have responsibility for marine life management (including fisheries), and that should be the only responsibility of that agency.
- Federal marine life management should make it easy for all interested members of the public and regulated communities to participate in decision-making.

The following recommendations summarize one such approach.

- ***Basic marine life management policies***
  Incorporate basic marine life management policies into an umbrella act that encompasses existing legal authorities, such as the Magnuson-Stevens Act and the other fragmented federal marine legislation. Include long-term sustainability, precaution, maintenance of ecosystem health, and concern for nonconsumptive uses and values as basic mandates.
- ***MSY/OY***
  Amend the Magnuson-Stevens Act to remove MSY/OY as the primary management standard for fisheries, substituting the basic sustainability mandates from the first recommendation.
- ***Integrated agency responsibility***
  Create a truly unified ocean management or marine life management unit within the National Oceanic and Atmospheric Administration (NOAA) that has the lead responsibility for implementing the basic marine life management policies from the first recommendation, as well as the Magnuson-Stevens Act and other appropriate legislation. That unit would be formed from a reorganization of the National Marine Fisheries Service and other relevant existing

divisions of NOAA. Marine staff from agencies such as the U.S. Geological Survey might also be included. Amend the Magnuson-Stevens Act and the other existing legal authorities to give more authority for all federal marine life management (including fisheries) to that agency. Retain regional offices for decentralized implementation of all the basic marine life management policies (not just fisheries management).

- ***Regional councils***
  Create regional marine life management advisory councils that correspond to the agency regions. Make the councils more inclusive by adding additional constituent interests (coastal tourism and recreation, nonconsumptive interests, conservation, and consumers). Subcommittees of the councils can address specialized concerns, including fisheries management.

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U.S. and International Fisheries Law: The Role of Sustainability, Biodiversity Protection, Externality Internalization, and Precaution

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Summary

Four norms of environmentally responsible conduct—sustainability, biodiversity protection, externality internalization, and a precautionary approach to resource use—are particularly relevant to United States fishery management. The following review highlights the role of these norms in global, multilateral, and bilateral fisheries agreements to which the U.S. is a party. It also discusses the influence of the norms on the drafting and implementation of the Sustainable Fisheries Act (SFA), as well as the federal courts' mixed support for rigorous implementation of the SFA's mandates. Seven possible statutory changes that would further enhance implementation of the SFA's mandates are presented as a basis for further discussion.

Global Fishery Framework

President Bill Clinton presented the 1982 United Nations Convention on the Law of the Sea (UNCLOS) to the U.S. Senate in October 1994, but the Senate has yet to act. Pending Senate action, most, if not all, of the UNCLOS fisheries provisions are binding on the U.S. as customary international law and are enforceable in U.S. courts (*United States,* 1997). However, UNCLOS's extensive dispute resolution provisions, including the International Tribunal for the Law of the Sea, which recently rendered important decisions in some international fishery management disputes (Kwiatkowska, 2000; Oxman and Bantz, 2000), are not customary international law and thus not available to the U.S.

The U.S. ratified the 1995 U.N. Fish Stocks Agreement, which mandates a precautionary approach to fishery management that protects biodiversity and minimizes bycatch. The U.S. also adopted the U.N. Food and Agriculture Organization (FAO) Code of Conduct for Responsible Fisheries and ratified the 1993 FAO Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, which has yet to go into force, but which the U.S. implemented through the Sustainable Fisheries Act. The FAO also adopted a voluntary Plan of Action for the Management of Fishing Capacity, which calls on countries to develop national plans to manage and, as necessary, reduce fishing capacity by 2005 and develop indicators of sustainable fisheries development (Garcia et al., 2000; Potts and Haward, 2001).

As defined in Article 2 of the 1992 U.N. Convention on Biological Diversity (signed but not yet ratified by the U.S.), "'sustainable use' means the use of components of biological

* The assistance of Ocean and Coastal Law Center staff members Dianne Bass and Andrea Coffman is gratefully acknowledged.

diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations." Pending ratification of the convention, the 1969 Vienna Convention on the Law of Treaties obligates the U.S. not to undercut the biological diversity convention (Weymuller, 2001).

The 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora, which generally prohibits international trade in listed species and to which the U.S. is a party, lists a few fish species threatened with biological extinction, but most are not of commercial significance.

U.S. Multilateral Fisheries Agreements

The U.S. is party to several important regional fishery management agreements, many implemented domestically through federal legislation (NOAA, 1998).

Examples include a new convention, signed in September 2000 by the U.S., Australia, and twelve Pacific island nations, for the management of western and central Pacific tuna and other highly migratory fish stocks (Campbell, 2000; Ward et al., 2000). The convention incorporates many of the management principles contained in the U.N. Fish Stocks Agreement. It will likely take several years for the signing nations to ratify the convention and for it to come into force.

The U.S. recently ratified the 1998 Agreement on the International Dolphin Conservation Program, designed to limit the incidental take of dolphins in the eastern Pacific tuna fishery (Hedley, 2001). The International Dolphin Conservation Program Act implemented the agreement, which went into force in February 1999 (*Defenders of Wildlife,* 2000). The U.S. signed the 1996 Inter-American Convention for the Protection and Conservation of Sea Turtles, designed to minimize the incidental take of sea turtles in shrimp fisheries with the use of turtle excluder devices (Naro-Maciel, 1998). The turtle convention is especially notable for the specific commitments in Annex II to protect sea turtle habitat and in Article XV to comply with World Trade Organization (WTO) agreements.

Both the dolphin and sea turtle conventions are multilateral responses to incidental take issues that the U.S. had pursued unilaterally through congressionally authorized trade sanctions until the adverse WTO decisions in the tuna-dolphin and shrimp-turtle cases (McLaughlin, 1999). The WTO decisions raised questions about unilateral U.S. trade sanctions against nations violating other international and U.S. policies designed to promote sustainable fishing, such as drift-net prohibitions (*Humane Society,* 2001).

A principal message of these cases is that the WTO is more likely to uphold trade sanctions based on multilateral agreements. The dolphin and sea turtle conventions could serve as models for the negotiation of international agreements to utilize U.S. standards for reducing the bycatch of nontargeted fish, as author-

"…'"sustainable use' means the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations."

ized by the SFA [16 U.S.C.§ 1822(h)].

The U.S. is party to several regional regimes now facing enforcement challenges, especially against nonmembers (Bederman, 2000; Plé, 2000). One example is the Convention on the Conservation of Antarctic Marine Living Resources, implemented by the Antarctic Marine Living Resources Convention Act, which takes an ecosystem approach to managing Southern Ocean living resources and utilizes a precautionary approach to fisheries management (Parkes, 2000; Rayfuse and Wilder, 2000). With respect to U.S. flag vessels, the U.S. courts have shown mixed support for aggressive regulatory actions to close enforcement gaps, such as enforcement of convention requirements for vessel monitoring systems (Carr, 1999; *Blue Water Fisherman's Association,* 2000).

The U.S. is party to the South Pacific convention prohibiting drift-net fishing. Rather than regulating the use of drift nets, the parties absolutely prohibited their use based on fragmentary information about their impacts (Burke, 2000; Johnston and VanderZwaag, 2000).

Bilateral Agreements

The U.S. is party to more than twenty bilateral fisheries agreements. However, with the phase-out of foreign fishing in the U.S. Exclusive Economic Zone (EEZ), most of these agreements are not of much importance. The remaining agreements of significance are with Canada, such as the 1985 Pacific Salmon Treaty, and with Russia, such as the 1996 Agreement on the Conservation of Straddling Fish Stocks in the Central Part of the Sea of Okhotsk. Despite some implementation difficulties, several fisheries governed by these agreements appear to be managed in a more sustainable manner now than in the past. Preventing overfishing is a principal goal of both the 1985 salmon treaty and the 1999 agreement implementing it, which includes specific commitments to restore salmon habitat (Weymuller, 2001). The other bilateral agreements are not particularly innovative with respect to implementing the international norms of sustainability, biodiversity protection, externality internalization, and precaution.

Domestic U.S. Law

The SFA's amendments to the Magnuson-Stevens Fishery Conservation and Management Act authorize the use of a precautionary approach to overfishing but do not allow the collection of economic rent. The SFA aims to reduce bycatch, prohibits wasteful practices like shark finning, and requires rebuilding of overfished stocks. However, Congress extended a moratorium on individual fishing quotas (IFQs) to limit entry in overfished fisheries until October 2002 [16 U.S.C. § 1853(d)], despite a National Research Council report endorsing IFQs in appropriate circumstances (National Research Council, 1999b).

The SFA, supported with extensive regulatory guidance from the National Marine Fisheries Service (NMFS), is beginning to have significant impacts on the regional fishery

management councils' fishery management plans (FMPs), the review of FMPs by NMFS, the Department of Commerce's review and approval of FMPs, and the reviews by federal courts of the validity of regulations implementing FMPs (Fletcher, 2001). Judicial support for avoiding overfishing and rebuilding overfished stocks has been particularly impressive (*Natural Resources Defense Council,* 2000). One can predict similar judicial support for the rigorous implementation of the SFA's bycatch reduction (*A.M.L. International,* 2000), essential fish habitat (*American Oceans Campaign,* 2000), and new fishing gear management mandates. Some regional councils are implementing these mandates by including marine reserves or "no-take zones" in FMPs (*Greenpeace,* 2000). These techniques are the foundation for FMPs, under which future fishing will be more sustainable with respect to the target species and their habitats and ecosystems, including predator and prey species (Jarman et al., 1994; Macpherson, 2001; NRC, 1999a). Such ecosystem-inclusive plans could pose special challenges in the judicial review process (In re the Water Use Permit Applications, 2000).

Reauthorization of the Magnuson-Stevens Act is before the 107th Congress. To support implementation of the 1996 SFA mandates, Congress should consider four amendments:

1. Provide explicit authorization for marine reserves or "no-take zones" in FMPs.
2. Repeal the moratorium on IFQs.
3. Authorize the collection of economic rent.
4. Include a citizen lawsuit provision, such as the one in the Endangered Species Act and most other major federal environmental statutes.

In addition, Congress should study possible changes to current federal-state fishery management roles, which give states a very prominent role. Unfortunately, current laws largely ignore the fact that approximately 90 percent of fisheries resources off U.S. coasts are interjurisdictional, i.e., they migrate across state lateral boundaries, other nations' maritime boundaries, or the federal-state boundary. The regional council scheme, as created in the Magnuson-Stevens Act, reduces, but does not eliminate, the significance of state lateral boundaries and the federal-state boundary. As suggested by experiences in Australia (Garcia et al., 2000; Hildreth, 1991b; Potts and Haward, 2001) and Canada (Hildreth, 1991a; Bergin et al., 1996), more unified management on both sides of the three-mile line* is necessary and could be accomplished by extending the regional council system landward and coupling it with increased federal regulation of recreational fishing. In addition, the Magnuson-Stevens Act's landward limit on foreign fishing in the U.S. EEZ could be moved out from coastal state boundaries to the seaward edge of the U.S. twelve-mile territorial sea in accordance with UNCLOS (Ballweber and Hildreth, 1991).

Finally, the Magnuson-Stevens Act's claim to U.S.-origin anadromous fish beyond the U.S. EEZ (except when they are in another

"…more unified management on both sides of the three-mile line is necessary and could be accomplished by extending the regional council system landward and coupling it with increased federal regulation of recreational fishing."

* Ocean jurisdiction is split between the state and federal governments. The state governs waters between 0 and 3 miles; the federal government manages waters from 3 to 200 miles.

nation's EEZ or territorial sea) conflicts with UNCLOS mandates for international cooperation and needs to be amended.

All changes to U.S. fisheries statutes and implementing regulations must be continuously monitored for their consistency with customary international law and treaties to which the U.S. is a party, because of U.S. doctrine that later statutes and regulations conflicting with earlier treaties are effective for purposes of domestic U.S. law (*United States,* 1982).

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Optimum Yield: A Goal Honored in the Breach

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Summary

Laws governing fishery management provide adequate authority for managers to accomplish the conservation goals set forth in the statutes. Although the Magnuson-Stevens Fishery Conservation and Management Act sets optimum yield as the goal for fisheries management, fishery managers almost always set maximum sustainable yield as the goal. This approach has wide-ranging environmental, economic, and social costs.

Optimum Yield is the Appropriate Goal

A quarter century after the enactment of the original Fishery Conservation and Management Act, overfishing continues to take its toll on marine fisheries in the United States. The National Marine Fisheries Service (NMFS) classifies approximately 40 percent of the fish species whose population status is known as either overfished or approaching that condition (NMFS, 2001). Under these circumstances, one may reasonably ask whether the statutes governing fishery management set the proper goals and provide adequate legal authority for managers to accomplish those goals.

The principal federal statute governing marine fisheries, now titled the Magnuson-Stevens Fishery Conservation and Management Act, sets optimum yield (OY) as the goal for fisheries management [16 U.S.C. § 1851(a)(1)]. OY is indeed the proper goal for fishery management. As defined by the statute, OY takes into account ecosystem, social, and economic considerations [*Id.* § 1802(28)]. Further, the act both gives NMFS the tools to achieve OY and requires the agency to do so [*Id.* §§ 1854(a), (c), 1851(a)(1); *Natural Resources Defense Council,* 2000]. Nevertheless, as the result of intense political pressure to permit as much fishing as possible, fishery managers virtually always seek to achieve maximum sustainable yield (MSY) rather than OY, and their management actions often permit yields higher than even MSY.

Despite the clear language of the statute, NMFS and the regional fishery management councils are sacrificing environmental, economic, and social benefits for the short-term economic gains of the fishing interests that dominate membership on the councils. As with many other fishery management problems, the disconnect between the statutory goals and the on-the-water reality illustrates the fact that unless policymakers close every loophole so that litigation can force the agency to do the right thing, NMFS will continue to allow too much fishing.

Optimum Yield Should Reflect Ecological, Economic, and Social Considerations

Many of the central tenets of the Magnuson-

Stevens Act are set forth in ten national standards [16 U.S.C. § 1851(a)]. The first national standard unequivocally requires all conservation and management measures to "prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry" [*Id.* § 1851(a)(1)]. The Magnuson-Stevens Act defines "optimum" as the amount of fish that "will provide the greatest overall benefit to the Nation…taking into account the protection of marine ecosystems" [16 U.S.C. § 1802(28)(A)]. The definition further provides that OY also must be "prescribed as such on the basis of maximum sustainable yield from the fishery, ***as reduced by*** any relevant economic, social, or ecological factor" [*Id.* § 1802(28)(B); (emphasis added)]. OY for overfished fisheries must also "provide[] for rebuilding to a level consistent with producing the maximum sustainable yield in such fishery" [*Id.* § 1802(28)(C)].

Taken together, the various provisions of this definition mean that OY is at most MSY, reduced as necessary to protect ecosystems, maximize economic and social returns, and rebuild overfished fisheries. The 1996 amendments to the Magnuson-Stevens Act materially improved this definition by making MSY the absolute highest number of fish that could be considered OY. Before that change, NMFS had permitted yields above MSY for the purpose of short-term economic gain (*Northwest Environmental Defense Center,* 1992).

While the Magnuson-Stevens Act absolutely requires that OY be no more than MSY, the statute strongly indicates that OY should be less than MSY for ecosystem protection, economic, or social reasons. Indeed, the proper OY will virtually always be below MSY. Equating MSY with OY suggests that catching the absolute maximum possible sustainable yield will protect the ecosystem. This is not often the case. For example, many commercially harvested fish, such as herring, serve as an important food source for other species (65 Fed. Reg. 77450, 77459-77460, Dec. 11, 2000). Other species play significant ecosystem roles as predators. Taking less than the absolute MSY from the fishery may guard against unexpected changes in the ecosystem that result from events such as global warming or El Niño. Moreover, the widespread use of nonselective gears to catch high yields has significant environmental repercussions in the form of high levels of bycatch and habitat destruction. According to the statutory definition, these "ecological factor[s]" should serve to reduce the amount of yield that can be considered optimum in a given fishery [16 U.S.C. § 1802(28)(B)]. Indeed, proper formulation of OY could be the first step toward bringing ecosystem considerations into fishery management.

"Taking less than the absolute MSY from the fishery may guard against unexpected changes in the ecosystem that result from events such as global warming or El Niño."

Ironically, in their quest to increase short-term economic gain by maximizing yield from every fishery, fishery managers actually forego the higher long-term economic returns that result from allowing fishers to catch maximum economic yield (MEY). MSY represents the maximum amount of fish that fishers may catch on a biologically sustainable basis. Fishers must expend significant amounts of

time and resources to catch such a large amount of fish. When the population is higher, and the amount of fish caught lower, the fish are easier to catch and the yield per dollar spent is higher. Thus, it is widely recognized that unless fishing is costless, which it never is, MEY is always less than MSY (NRC, 1999).

Social considerations likewise can mitigate in favor of setting OY below MSY. To the extent that small-boat fishers have more success using fewer resources when fish populations are high, lower OY can serve social needs by preserving small-boat fishers and the communities that depend on them. Further, social benefits result from the improved recreational success that occurs when fish populations are higher, as recognized as long ago as the mid-1970s (Roedel, 1975). These social benefits also indicate that OY should be set below MSY.

In sum, economic and social factors, as well as ecosystem considerations, argue in favor of OY being lower than MSY. Further, the Magnuson-Stevens Act requires that every conservation and management measure prevent overfishing and achieve OY, thus setting the right goal for federal fishery managers and requiring them to reach it.

"Despite the clear intent of the Magnuson-Stevens Act, NMFS routinely declines to take affirmative action even when doing so would provide significant conservation benefits."

NMFS Has Tools to Achieve Proper OY

The Magnuson-Stevens Act also gives NMFS the power to set the proper OY in each fishery when the councils fail to do so. As an initial matter, the agency can disapprove fishery management plans (FMPs), FMP amendments, and regulations that set OY at MSY and can instruct the councils to lower the OY figure [16 U.S.C. § 1854(a)(3)(C)]. At present, NMFS usually approves these documents.

As though the ability to disapprove FMPs, amendments, and regulations is not a powerful tool, NMFS officials and their defenders sometimes point to the statute's provision that the secretary of commerce may only approve, partially approve, or disapprove these documents in order to support their view that NMFS lacks the power to take proactive management steps [*Id.* § 1854(a)(3)]. The act belies this assertion, providing that if councils "fail to submit a revised…plan or amendment" after the secretary disapproves one, he may prepare one of his own [*Id.* § 1854(c)(1)(B)]. Moreover, if the councils do not draft a necessary FMP or amendment within a reasonable period of time, the secretary may act independently [*Id.* § 1854(c)(1)(A)]. Finally, the secretary may also promulgate regulations to implement an FMP or amendment that he has drafted [*Id.* § 1854(c)(5), (6)]. Plainly, the tools exist to permit NMFS to set the proper OY.

NMFS Lacks the Will to Take Proactive Conservation Steps

Despite the clear intent of the Magnuson-Stevens Act, NMFS routinely declines to take affirmative action even when doing so would provide significant conservation benefits. For example, NMFS identified scup as an overfished species in the agency's first Report to Congress (NMFS, 1997), and NMFS disapproved the Mid-Atlantic Fishery Management Council's scup rebuilding plan in fall 1999 (64 Fed. Reg. 57587, Oct. 26, 1990) because the bycatch provision was not adequate

and there was only a minimal probability that the plan would lead to scup rebuilding within ten years. The Magnuson-Stevens Act contains no deadline for the councils to resubmit an amendment to a plan that NMFS has disapproved, but it does require the agency to write its own rebuilding plan for overfished species if a council does not submit a plan within one year after NMFS designates the species as overfished [16 U.S.C. § 1854(e)(5)]. Despite clear authority for NMFS to take independent action (albeit without an explicit deadline), no scup rebuilding plan exists more than two years after the agency rejected the council's rebuilding plan, despite the species' extremely low biomass and the high bycatch of scup in other fisheries. Experience shows that without an unambiguous, binding deadline that can be enforced through litigation, NMFS does not use the authority that it has to achieve the conservation goals of the Magnuson-Stevens Act.

Similarly, virtually all FMPs drafted by the councils and approved by NMFS set OY at MSY, despite the environmental, economic, and social benefits that could accrue from setting OY below MSY. Councils and NMFS forego the benefits of a lower OY (and deny those benefits to U.S. taxpayers and consumers) because they lack the will to resist the pressure to produce maximum yield rather than optimum benefits. Once again, fishery managers adhere to only the most explicit statutory requirement.

Solutions

Some loopholes in the statute are relatively easy to fix. For example, the statute should be amended to require, not simply authorize, NMFS to draft and implement a rebuilding plan (or any other necessary FMP or amendment) for an overfished species if the agency rejects the plan submitted by the relevant council and the council does not submit an adequate revised plan within a reasonable period of time spelled out in the law. In most cases, this period should be quite short—perhaps three months.

Other problems are more fundamental. In particular, when and to what degree OY should be set below MSY depends on the status of and information concerning an individual fish species. Hard and fast rules would be difficult, if not impossible, to articulate in advance. Therefore, NMFS and the councils need to exercise some degree of judgment in setting OY. It would help to shift the burden of proof by requiring managers to explain why it is appropriate to equate OY with MSY despite the costs inherent in that approach.

To address the problem of not achieving true OY, however, the culture of fishery management must change from one that seeks to produce as much yield as possible in any given fishing year to one that seeks to achieve sustainable, healthy ecosystems. Accomplishing this change of focus will probably require modifying the institutions of fishery management themselves, so that the fishing interests on the councils cannot operate like the fox guarding the henhouse. Until such fundamental reform occurs, however, in almost all cases federal fishery managers will focus on conservation only to the degree that they are forced to do so by explicit terms of federal law that are enforceable in court.

"…the culture of fishery management must change from one that seeks to produce as much yield as possible in any given fishing year to one that seeks to achieve sustainable, healthy ecosystems."

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Fishery Management Tools: 11 Questions and Some Partial Answers/Thoughts

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Summary

There are a number of traditional and alternative fishery management tools. Determining which tools to use or how to measure the effectiveness of tools that are in place depends upon how the goals of fishery management are defined. If the United States moves away from single-species management to an ecosystem-based approach, fishery managers will need to look closely at how new and existing management tools can be used effectively to meet new objectives and to permit new objectives to evolve.

Introduction

This paper addresses key issues regarding the adequacy and effectiveness of fishery management tools through a question-and-answer format. Table One lists conventional or usual implements in the fishery management tool kit. For the purposes of this discussion, basic familiarity with the tools listed in Table One is assumed. Previously published papers discuss known problems and benefits of these tools (OECD, 1997; NRC, 1999a).

1) If Table One represents the usual tools, are there "unusual" tools of fisheries management?

Answer: Yes. Alternative tools include:

- marine protected areas (MPAs);
- trusts;
- auctions/royalty schemes;
- community quotas;
- cooperatives;
- co-management;
- ecosystem-based management; and
- ideology.

The idea of trusts as an alternative tool warrants clarification. There is much talk these days of "public trust" in fishery management as well as talk of the Public Trust Doctrine. The former is often a vague concept, while the latter is quite specific (Sax, 1970). The "trusts" referenced above as a potential tool for fishery management refers to a third concept—"conservation trusts" (Fairfax and Guenzler, 2001;

Table One

Common Fishery Management Tools

Output Controls	Input Controls	Technical Measures
Total Allowable Catch (TAC)	Limited Licenses	Size and Sex Selectivity
Individual Fishing Quotas (IFQs) and Individual Transferable Quotas (ITQs)	Individual Effort Quotas	Time Closures
Vessel Catch Limits	Other Gear and Vessel Restrictions	Area Closures

Source: OECD, 1997.

Barnes, 2001; Souder and Fairfax, 1996). Conservation trusts meld conventional trusts—arrangements in which a group of trustees is held accountable for the performance of the trust—to resource conservation interests.

"Statements of goals and objectives are present in all fishery management plans (FMPs) and FMP amendments produced by the regional fishery management councils but these goals and objectives are diverse and often conflicting."

2) Are the usual tools adequate?

Answer: At one level, the convening of the Pew Oceans Commission's fishery management workshop suggests significant concerns that the tools currently employed in fishery management are not adequate or that the manner in which they are employed is not adequate. However, this question simply raises another question: Adequate under what conditions and for what objective or goal? To assess the adequacy of tools requires a clear articulation of goals and objectives.

3) What are the goals of fishery management against which tools should be assessed?

Answer: It is not clear. Statements of goals and objectives are present in all fishery management plans (FMPs) and FMP amendments produced by the regional fishery management councils but these goals and objectives are diverse and often conflicting. A recent National Research Council (NRC) report attempted to sort through the confusion over goals by providing a statement of "first principles" of fishery management derived from current U.S. law:

- Conservation and sustainability of biological resources have a high priority.
- Management programs must take careful account of the social context of fisheries, especially the role of communities and the importance of fishing as both a tradition and a profession.
- When harvests take place, they should maximize the net benefits (benefits minus cost) that society receives from their use.
- Management programs must consider equity, fairness, and the distribution of the benefits derived from marine resources (NRC, 1999a).

In addition, the NRC articulated one additional commitment derived from common law trust principles: the public should be compensated for any private, exclusive use of public trust resources.

Even with this condensed list, the problem of multi-objective management leading to difficult/impossible evaluations still exists. Frequently there are inherent conflicts between the multiple objectives (Healey and Hennessey, 1998; Hennessey and Healey, 2000).

4) Sustainability seems to be a goal. If that is the focus, is it possible to evaluate the tools?

Answer: Perhaps, but sustainability is multi-dimensional concept. For example, A.T. Charles argues that sustainability has four dimensions: ecological, socioeconomic, community, and institutional (Charles, 1994). He suggests certain critical questions associated with each of these dimensions should be

addressed in the evaluative process:

- Are exploitation levels on directed species such that ecosystem resilience is maintained?
- Are impacts on the ecosystem as a whole reasonably understood to maintain resilience?
- Are the current and projected levels of distributional equity in the system sufficient?
- Are the measures likely to increase the long-term stability of the affected communities? Are traditional value systems of importance to the community maintained?
- Will the long-term capabilities of corresponding institutions be increased?

Charles's view is only one perspective, but to read this list is to realize just how divergent assessments might be according to interpretations of "sustainability." The list also compels an appreciation of how much one's disciplinary and theoretical background influences the assessment process. In conclusion, multiple objectives or multiple perspectives on these objectives make assessment of even a single tool difficult, as discussed next.

5) Isn't there an emerging consensus that IFQs represent the last best hope for fisheries management?

Answer: IFQs present an interesting example of the problem of multi-objective assessment. Many recent studies do indeed document the ample promise of IFQs (OECD, 1997 and NRC, 1999a). Foremost among benefits cited are the amelioration of the so-called race for fish and reduction in fleet overcapacity. Conversely, these studies list continuing concerns over the fairness of initial allocations, enforcement and compliance, and the gifting of a public resource. The NRC study of IFQs (NRC, 1999a) found that IFQs will have a high probability of success when certain conditions exist:

- The TAC can be specified with reasonable certainty.
- The policy goals are to improve economic efficiency and reduce the number of firms.
- Vessels and people in the fishery are given high priority.
- There is broad stakeholder support for IFQs.
- Adequate data is collected.
- There is cost-effective monitoring and enforcement.
- The likelihood of spillovers from fishing activities into other fisheries is minimized.

As this list implies, success depends on the situation.

The literature on IFQs exhibits a wide divergence of assessments of IFQs, even in the face of seemingly similar empirical outcomes. The divergence of opinion is present even within single documents (e.g., the executive summary, the full body, and the individual country case studies in the NRC study of IFQs are almost three different assessments of IFQs). This divergence is the product of fundamentally different perspectives regarding the end goals of fisheries management.

Ironically, some former proponents of IFQs are now turning toward an alternative—

"The literature on IFQs exhibits a wide divergence of assessments of IFQs, even in the face of seemingly similar empirical outcomes."

fishing "cooperatives"—precisely because of divergent assessments of objectives involving efficiency versus equity and disputes over who are the rightful stakeholders in the North Pacific region (Criddle and Macinko, 2000).

"Perhaps lack of attention to wide variations in the *practice* of TAC-based management contributes to these contradictory assessments of TACs."

6) Are TACs evil? Necessary? A necessary evil?

Answer: The answer seems to be all of the above. In accounts as divergent as those found in OECD (1997) and Oliver (2001), TACs are regarded as the root source of frenetic racing for larger individual shares of the TAC and discarding of unwanted or impermissible catches and, alternatively, as the essential foundation of scientific fishery management. Perhaps lack of attention to wide variations in the *practice* of TAC-based management contributes to these contradictory assessments of TACs. The NRC noted, "it is extremely difficult to guarantee that conservation objectives will be satisfied by a given numerical TAC or by an IFQ program based on such a TAC…. The risk of overfishing is greater with no TAC than with a precautionary TAC" (NRC, 1999a).

7) Is there anything that these conventional tools are known to be good for?

Answer: Yes. The Councils use these tools in various combinations to allocate economic opportunities to selected recipients.

8) What about "rights-based" fishing and the promotion of stewardship?

Answer: The "rights-based" fishing literature can be divided into two distinct groups. Proponents of what can be called the weak program of rights-based fishing acknowledge that under U.S. law, allegedly rights-based tools such as IFQs are not private property rights but then write extensively about the benefits of IFQs that spring from their status as private property rights. The weak program is thus logically inconsistent.

In contrast, proponents of the strong program of rights-based fishing insist that IFQs do involve private property rights, but the rights are limited to a share of the TAC, and do not extend to the fishery resource itself. Proponents of the strong program of rights-based fishing assert that in order for effective stewardship to materialize, private property rights in actual fish and, ultimately, in the marine environment itself, must exist:

> Of course, private quotas are only harvesting rights. They apply after a TAC has been set. Thus, a quota cannot dispense with some outside means of determining each year's TAC. Neither can they take over other aspects of managing the fishstock and its predators and preys; nor of protecting its environment. This requires sole ownership…(Scott, 1989).

> [I]ndividual permanent catch quotas of a regulator-determined TAC are only a stage in the development of management from licensing to private rights. This evolution can be expected to continue until the owner has a share in management deci-

sions regarding the catch; and, further still, until he has an owner's share in management of the biomass and its environment (Scott, 1989).

The irony of the push toward rights-based fishing is that it fundamentally proposes to solve a problem afflicting a publicly owned resource by converting that resource to private ownership. Other authors provide additional examples of the arguments for rights-based fishing (Shotton, 2000; Árnason, 2000; Scott, 2000). This potential public-into-private conversion raises a question about the appropriate public policy process for making a decision on such a conversion in ownership.

Is it necessary to convert public assets into private assets in order to solve current fisheries management problems? The experience of the U.S. suggests that the answer is an emphatic no. It is clear in the U.S. that IFQs are merely a permit not a property right. It is also clear that IFQs ameliorate some of the severe economic distortions that derby fisheries entail. Therefore, given that IFQs really are not private property rights, private property rights must not be necessary to effect the positive changes associated with IFQs. The focus of policy debates should thus be on options for altering incentives so as to alleviate racing rather than repetitious exhortations about property rights. IFQs, community quotas (NRC, 1999b), and cooperatives are all important tools because of the nature of the permitted catching opportunities—not property rights—that they entail.

Stewardship is wrapped up in the dispute over public versus private ownership and ideology is clearly on display as a management tool itself. As the NRC observed, "Much of the political support for IFQs is similarly driven by faith in the assumption that privatization will foster ecological sensibility" (NRC, 1999a). Again, different parties offer widely divergent assessments. For those who believe that public ownership of natural resources is still embraced as a national policy (an embrace recently confirmed in range management by the Supreme Court (*Public Lands Council,* 2000; Macinko and Raymond, 2001), stewardship of publicly owned resources must be a responsibility of that owning public, effected through public resource management agencies. To the rights-based school, stewardship of publicly owned resources is an oxymoron, resolved only by privatization. Thus, there is another linkage between tools and objectives: If public (or private) ownership is a desired end, then tools should be selected, implemented, and evaluated with a focus on their contribution to the assertion of public (or private) ownership.

"The irony of the push toward rights-based fishing is that it fundamentally proposes to solve a problem afflicting a publicly owned resource by converting that resource to private ownership."

9) Are the effect(s) of these tools on the human component of fisheries known?

Answer: No. Given that one characteristic of science is pre- and post-test analysis, one can conclude that fishery management (at least in terms of the human component) is a decidedly pre-scientific activity.

10) How does the growing interest in ecosystem management or ecosystem-based management relate to this consideration of fishery management tools?

Answer: Fisheries are managed under conditions of uncertainty derived from an incomplete understanding of fishery population dynamics, interactions among species, effects of environmental conditions, and, perhaps most importantly, the effects of human actions. Given these circumstances, many experts have recommended movement from single-species management to ecosystem-based approaches in order to achieve sustainable fisheries (Ludwig et al., 1993; Safina, 1995; NRC, 1999c).

"A future featuring ecosystem-based management may require significantly more flexibility and adaptability than is suggested by current policies of single-species based management and industry entitlements."

Ecosystem-based policy models should include both fishery production and ecosystem goods and services and should acknowledge that many segments of society have varied and often conflicting goals that must be considered in order to attain sustainability. Moreover, some argue that fishery managers must directly confront the uncertainties cited above. Tools must be explicitly treated as hypotheses (i.e., as if/then propositions, such as "if managers use 'x,' then 'y' is the expected result") and tested using an adaptive management approach to learn by doing (Walters, 1986; Walters and Holling, 1990; NRC, 1994). Unfortunately, neither ecosystem-based management nor adaptive management has been incorporated into the actual operations of fisheries management. Instead, they serve as a set of heuristics for managers and scholars (Lee, 1993; Gunderson et al., 1995).

While not yet operational, ecosystem-based management inherently requires flexibility and adaptability—characteristics that have implications for the selection and implementation of tools. Many of the current tools are predicated upon single-species management approaches and many promote specialization within industry. There is reason to question whether these underpinnings and tendencies will assist or obstruct a future transition to ecosystem-based management. As one scholar observed:

> What happens when—not if—fisheries management is drawn into a more holistic, ecosystem-based approach demanding different answers to a very different set of questions which quota-management systems cannot answer? How then does one dismantle a system in which very considerable private capital has been invested and in which the public sector has very little stake? (Symes, 2000)

A future featuring ecosystem-based management may require significantly more flexibility and adaptability than is suggested by current policies of single-species based management and industry entitlements.

Finally, it seems that much of the thinking about the relationship between ecosystem management and fishery management has been improperly ordered. That is, fishery management is more likely a tool of ecosystem management rather than vice versa. Thus, one would expect to see an ecosystem management plan feature a chapter or an appendix on the fishery management component rather than

the current reverse practice of appending an ecosystem management chapter onto the annual stock assessment and fishery evaluation (SAFE) documents.

11) Where is the dividing line between co-management as a tool and regulatory capture?

Answer: There is growing emphasis on co-management and devolution of policymaking authority down to local levels. This emphasis is often coupled with a companion emphasis on rights-based fishing (NRC, 1999a). At the same time, others voice concern that the regional council system (a deliberate exercise in devolution of authority) represents a proverbial "fox guarding the henhouse" scenario. It is not clear where the boundary line alluded to in the question lies, but it is an important issue for the Pew Oceans Commission to confront as it rethinks fishery management.

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Problems with U.S. Ocean Governance and Institutional Structures: The Impact on Waters, Fish, and Fisheries in the U.S. Exclusive Economic Zone

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Summary

The Magnuson-Stevens Fishery Management and Conservation Act is a failed experiment that has led to the destruction of United States coastal fisheries. The fishery management system created by the Magnuson-Stevens Act is plagued by a conflict of interest that provides substantial power to fishing interests but little to scientists and conservationists. The system is so one-sided that even when the federal executive branch supports sustainable fishing policies, it cannot overcome the interests of industry. It is time for a new organic act for ocean governance, which would bring all coastal and oceans issues, including marine fish and fisheries, into one new cabinet-level department.

The Problem

Commercial fishing plays a large part in the destruction of the marine ecosystems within the U.S. Exclusive Economic Zone (EEZ). In pursuit of short-term economic gains, fishery managers have allowed fishing in excess of the levels that can maintain healthy ecosystems.

Twenty-five years after the passage of the original Fishery Conservation and Management Act, the National Marine Fisheries Service (NMFS) does not know the population status of all of the target fish, let alone the status of marine wildlife that industry has yet to target. Bottom-tending trawl and dredge fishing gear drags across the ocean floor, ripping and scraping entire sections of the seafloor raw as often as six times every year. Yet, every one of the eight regional fishery management councils has virtually ignored its authority (and responsibility) under the Sustainable Fisheries Act to determine and minimize the impact of fishing on essential fish habitat.

The nets and longlines of vessels pursuing relatively short-lived fish and crustaceans like shrimp, whiting, pollock, cod, mackerel, and menhaden sweep up skates, sharks, some species of Pacific and North Pacific rockfish, and other long-lived species. Rather than reducing bycatch as required under any rational reading of fishery laws, managers allow conversion of bycatch into fish meal and fish oil so that industry and managers alike can claim bycatch reductions without reducing the catch by even a single unintended fish.

When scientists propose standards that present a clearer and more understandable means of determining when fish populations are overfished or depleted than the standards currently in use, the industry and regulators argue successfully that these proposed standards should not be adopted because too many valuable commercial species could be declared overfished and subjected to catch restrictions.

"The takeover by the U.S. was to be the silver bullet ensuring the conservation of marine resources."

The ocean ecosystem is resilient. Frequently, though, when populations of prey fish such as sardines, squid, or herring begin to rebound—in turn giving the ecosystem itself an opportunity to rebound—fishery managers are quick to initiate, renew, or expand targeting of recovering fish populations.

Some Suggested Changes Won't Work

The range of purported causes of the problems in fishery management and the proposed remedies abound. Some argue that the Magnuson-Stevens Act is adequate to ensure conservation of marine resources, but sufficient implementation could occur only with the following changes:

1. The appropriate agencies receive enough money to develop and enforce regulations to implement the law.
2. Environmental organizations participate in all meetings of the eight regional fishery management councils, the meetings of assorted fisheries commissions, and local and regional meetings of NMFS and the National Oceanic and Atmospheric Administration (NOAA).
3. The number of lawyers in environmental law offices doubles and focuses exclusively on fisheries.
4. One or two more members of the U.S. Senate or House of Representatives vote to insert special interest provisions to provide exceptions to existing laws and regulations.
5. The government gives the exclusive right to catch and sell fish (and to sell the right to catch and sell fish) to those who have been most effective at catching fish.

The first four of these changes assume that the language, implementation, or enforcement of the act's provisions are broken. The changes would be helpful and should be kept as short-term goals. Although they reflect efforts to accomplish incremental modifications to a system that is proven not to work, far more than incremental change is necessary.

The fifth proposal, known as individual fishing quotas (IFQs), is the latest example of managers looking for a "silver bullet" because they are unwilling or unable to set limits on catch, systematically reduce bycatch, or protect fish habitat, therefore managing fish, fisheries, and the U.S. ocean territory for the long-term health of ocean ecosystems.

Conflicts of Interests and Regulatory Capture Built into the System

The Magnuson-Stevens Act is not broken. It is operating much as it was designed to operate. It is, however, a failed experiment in allowing the most active participants in an industry exploiting a public trust resource to manage and regulate that resource. The act's authors intended to promote U.S.-based fishing and to capture for the U.S. economy the economic value of the exploitation of living marine resources in waters off the U.S coast. The takeover by the U.S. was to be the silver bullet ensuring the conservation of marine resources.

Proponents of the act believed that the U.S. fishing industry would act in its own long-term business interest by conserving and wisely using those resources. The original intent of the act's drafters was to have the councils make

all policy and management decisions. Though that intent was frustrated by a U.S. Department of Justice decision that such authority was impermissible, the devolution of authority from NMFS and the secretary of commerce to the councils is not so much an indication of a failure in implementation as it is a demonstration of the power of the industry's well-crafted agenda to overcome obstacles.

The restoration of the authority of NMFS and the secretary of commerce, however, would not measurably improve the management of U.S. fisheries. Many of the elders of NMFS and the Department of Commerce are direct cultural descendants of the Bureau of Commercial Fisheries, which managed fisheries before NMFS, and even many of the newest managers at NMFS are poster children for the regulatory capture of an agency by the regulated industry. The argument that the act allows regulators to move toward effective ecosystem-based ocean or fisheries management is overwhelmed by the fact that institutional constraints are far more likely to continue preventing the creation of such management within NMFS.

Several political and institutional factors exacerbate the problem of self-serving regulators. The design of the council system ensures that user groups dominate membership of the councils and their advisory bodies. The placement of NOAA and NMFS in the Department of Commerce, arguably the most political of the cabinet departments, reinforces the priority of commerce over conservation and short-term exploitation of ocean resources over ecosystem protection. Effective long-term conservation of the public trust ocean resources of the U.S. is not likely to occur under the Department of Commerce. That is true even when the secretary is committed to protecting biodiversity and ecosystem health.

The charge for integrated ecosystem management of fish, fisheries, and oceans was clear when then-Secretary of Commerce Ron Brown stated before a House of Representatives committee in 1993, "NOAA is fully committed not only to the conservation of marine and anadromous species that are endangered or threatened with extinction, but also the conservation of all marine wildlife and the ecosystems on which they depend" (Brown, 1993)

"Effective long-term conservation of the public trust ocean resources of the U.S. is not likely to occur under the Department of Commerce."

Almost a decade later, the dead zone in the Gulf of Mexico has grown, the number of overfished and depleted fish species has increased, and there is little knowledge about the population status of any species of non-commercial fish. For the first time, scientists have declared non-anadromous marine fish candidates for extinction. The futures of populations of fish, turtles, seabirds, and marine mammals depend on administration of the Endangered Species Act, environmental lawyers, and the federal courts.

This is the best the Department of Commerce and NMFS can do even with the full support of the secretary. Such is the power of regulatory capture by the industry and the result of a failed experiment in self-regulation of industry.

A workable fishery policy and the abandonment of outmoded, counter-productive fishery management theories will come only in the context of a workable and comprehensive

ocean policy. Effective fishery management will come only in the context of effective overall management of U.S. coastal and marine waters. It is worth considering what such an effective management system would require and the basis for believing that, given the institutional impediments to incremental change in existing structures and policies, a revolutionary restructuring is possible.

"It is reasonable, achievable, and necessary to initiate the drafting of, advocacy for, and passage of a new organic act for ocean governance...."

Recommendations for Action

It is reasonable, achievable, and necessary to initiate the drafting of, advocacy for, and passage of a new organic act for ocean governance, which would bring all coastal and oceans issues—including marine fish and fisheries—into one new cabinet-level department.

The new department would establish regional entities, subject to the Federal Advisory Committee Act, to replace or supersede the councils' authority and be responsible for all decisions other than allocation of total allowable catch of target species.

At a minimum, the passage of an organic act should achieve the following goals:

1. Overtly recognize and declare that marine resources are public trust resources and will be managed and cared for as such.
2. Incorporate management responsibility for the entire ocean zone—from high-tide line to the outer boundary of the EEZ—within the department, in cooperation with individual state authorities acting as members of the new regional fishery/ocean management entities.
3. Mandate the use of the most selective, least destructive fishing gear capable of safe and economic capture of the target species.
4. Require ecosystem management with consideration of the implications of such management on individual target species.
5. Abandon the use of maximum sustainable yield and investigate the appropriate level of fishing allowable with regard to each target fishery, considering the use of precautionary and ecosystem-based management.
6. Abandon agriculture language, such as "harvest" and "stock," and replace it with words descriptive of ocean wildlife, such as "catch" and "population."
7. Apply the precautionary approach to marine ecosystem management, including fishery management, and shift the burden of proof from the managing agency to the fishing entity.
8. Establish a user-fee system that generates sufficient revenues to support fishery management, research, and enforcement to the extent that such activities benefit the resource users.
9. Require one hundred percent observer coverage, or the electronic or mechanical equivalent, aboard all fishing vessels. Regional policy bodies could exempt those with demonstrated adherence to fishery rules and regulations.

It Can Be Done

It is not only possible but it is also likely that the institutional impediments to such significant

change in governance will be overcome.

Thomas S. Kuhn pointed out that scientific revolutions are preceded by a crisis in an established scientific paradigm. Once the crisis is recognized, the movement toward the new paradigm is inevitable (Kuhn, 1970). Likewise, the recognition of the worldwide crisis in ocean and fishery management that began in the early 1990s and generated the shift in focus of the Magnuson-Stevens Act from exploitation to conservation continues to build. Recent papers demonstrate both that the paradigm used by Bureau of Commercial Fishing is in continued crisis and, more importantly, scientists are becoming more comfortable pointing out that existing ocean and fishery "management" has failed.

With these changes comes the need to create a new context for building a successful fishery science and management strategy. Growing numbers in the science and conservation communities are calling for major changes in the governance of the oceans and a management structure that will comply with not only the nominal endorsement of international conservation standards but also with the intent of those standards to accomplish healthy ocean ecosystems and sustainable marine populations.

Bipartisan public support for environmental conservation promises accomplishment of such a lofty goal. Millions of Americans will support efforts to protect the integrity of U.S. ocean resources. The Marine Fish Conservation Network alone has nearly five million members. To the extent that the American public sees restoring the oceans through the creation of this new department as the critical environmental issue that it is, it will join in the effort to see that the creation of the department becomes a reality.

"Millions of Americans will support efforts to protect the integrity of U.S. ocean resources."

There are several recent examples of committed conservationists and scientists overcoming overwhelming odds and political opposition to gain significant improvements in the management of public trust resources. The efforts of a small group of Alaskans led to the passage of the Tongass Timber Reform Act, despite much industry and agency opposition and early skepticism among their environmental allies. Similar initiatives by activists undaunted by opposition and challenges to their arguments led to the establishment of a wilderness area in Utah and even to the passage of the Sustainable Fisheries Act.

The first step to real reform may always be the most difficult but, for all the reasons mentioned here and more, this is the time and the commission to take that first step.

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Bringing the Community Back In: The Next Step in Fishery Management

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Summary

The failures of national fishery law since the adoption of the original Fishery Management and Conservation Act twenty-five years ago point to the need for significant reforms. Community interests, now defined and pursued parochially by the management bodies established in the act, require a renewed commitment to transparency and fairness and a redefinition of "community" in broader, national terms. Success in "bringing the community back in" requires proceeding toward reform on a basis that not only defines "public interest" in terms that transcend both localism or regionalism, but also defines it in terms that account for emerging, international scientific principles and resource-management norms.

The Need for Change

Enactment of the Fishery Conservation and Management Act of 1976 (later amended and renamed the Magnuson-Stevens Act) was a radical departure for U.S. ocean-resources law and policy. The act marked the first time Congress occupied this policy area for all American offshore waters, asserting national authority in a comprehensive way. Thus, changes of enormous magnitude in the management structure and policies for U.S. fisheries have occurred in a remarkably short period of time. It is a mistake to regard the Magnuson-Stevens Act as amended since 1976 as traditional, and therefore sacred, with regard to the organizational structure it established, the scientific management principles it mandated, or the rationales used to defend and perpetuate it. A quarter century's experience should be regarded as an extended experiment. The act, even as revised in the Sustainable Fisheries Act (SFA), is not holy writ, no matter how insistently it is represented that way by interested parties.

The crisis of the U.S. offshore fisheries has deepened and accelerated in the brief period since 1976, and the loss of the nation's marine fishery stocks is largely the product of the federal law's failures. Those who defend the status quo are among the interests principally responsible for using the act and its implementing bodies in ways that have wrought havoc with the fish stocks.

In the face of current dangers of depletion, it is imperative that fisheries stakeholders engage in a broad discussion of policy reform. Following are four aspects of the Magnuson-Stevens Act's legacy and structure that merit urgent attention.

Adjustment to Emerging International Norms

The continuing debate about basic U.S. fishery law will proceed in an environment of changing international, legal, and scientific norms.

This is especially true as the emphasis in law and management shifts away from concern with individual species and toward the ideal of ecosystem management. International law respecting fisheries and the ocean environment has been evolving rapidly in response to the global fisheries crisis, as every other fishing nation is experiencing the same sort of issues as the U.S. At the core of the legal evolution is the recognition that traditional prerogatives of national sovereignty on the high seas must be abridged and redefined if fish stocks and the larger ocean environment are to be protected.

The 1995 U.N. Fish Stocks Agreement, which provides for regional agencies to manage fisheries on the high seas, is at the forefront of this development. At the same time, however, the Biodiversity Convention requires signatory states to accept important new obligations relevant to marine ecosystems and fisheries. More generally, the precautionary approach to fishery management, with its strong implications for preservationist policies, is gaining new support in a broad range of new international agreements. Ineluctably, the shift in accepted norms in international law must be reflected in the premises and goals of a reformed national fisheries policy for the U.S. (Van Dyke, 2000; Scheiber, 2001).

Regulation and "Rights"

A second key aspect of the Magnuson-Stevens Act's legacy is the cluster of uncertainties regarding the adequacy of a traditional "command and control" regime that has emerged in its implementation. Before the 1970s, the ideal of Maximum Sustainable Yield (MSY) was the controlling paradigm for biologists and fishery managers however much industry interests may have been successful in resisting it (Scheiber and Carr, 1998). Long enshrined as the Holy Grail of scientific management, MSY produced repeated failures in a wide range of national, institutional, and environmental settings, ultimately proving to be only "a leaky cup," according to Sylvia Earle, former chief scientist at the National Oceanic and Atmospheric Administration. The concepts of Optimal Sustainable Yield or Optimal Yield (as explicitly written into the original 1976 act), based on the substitution of economic efficiency norms for the simplistic concept of sustainability, displaced MSY as the prevailing principle for management. This move has gone further in recent years, culminating in the movement to establish property rights and thus privatize fisheries (FAO, 2000).

Some scholars denounce the use of the word "rights" in regard to privatization, which is to say with respect to quota schemes (individual fishing quotas, IFQs, or their variants). Excluding the word "rights" from debates seems pointless because IFQs and related approaches are designed to create enforceable claims to fish in designated areas or for designated species. Legally enforceable claims are rights, as conventionally defined in the law, and IFQs are indistinguishable from licenses or other forms of "rights of use" in other contexts.

"Ineluctably, the shift in accepted norms in international law must be reflected in the premises and goals of a reformed national fisheries policy for the U.S."

Whatever the merits of the dispute over language, the present posture of U.S. law and policy with respect to IFQs is simply disastrous. The SFA essentially perpetuated the "fishing Olympics" approach for a moratorium period in which rival potential claimants were left free to engage in a struggle to outdo their competitors and position themselves to qualify for a future distribution of rights. A rational approach to marine resource and habitat management requires an early resolution of the question of whether privatization is to be permitted and, if so, under what circumstances. The question of circumstances is key. Similar fisheries, with similar problems, need to be treated alike in allocating access to the resource. If fishery managers use privatization, or any other management approach, selectively rather than generally, as most analysts would advise, then the principles of selectivity must be explicit and the process of allocation transparent and fair.

"Like other reforms under consideration, co-management has a strong potential downside with regard to the national public interest."

The same must be said of alternatives to the Magnuson-Stevens Act and the privatization approaches currently under debate. In particular, fairness and consistency ought to be prime considerations in any strategy to advance co-management—enlisting fishing communities' traditional wisdom and customs, and harnessing their self-interest in conservationist management—as an element of a revised national policy (McCay and Jentoft, 1996; FAO, 2000). Like other reforms under consideration, co-management has a strong potential downside with regard to the national public interest. Its proponents give little attention to accountability to the national community. Here, as elsewhere, it is essential to bring the community back into the management process if the debate is to bear anything but bitter fruit.

Community and the Public Interest

A third issue requiring urgent attention is, how the regional fishery management councils, the structures that administer the national fishery law, relate to the national interest. From 1976 on, industry members of the councils, through their numbers and influence, effectively obtained control of management policy. Even the appointees representing state governments in each of the regions usually expressed the same orientation and biases as the industry representatives. The modest restructuring of the councils under terms of the SFA was intended to give consumer interests a larger voice. On a small number of councils, indigenous peoples' interests were given some attention or were directly represented. Nonetheless, the fishing industry interests remain in a strong position to determine policy. The councils' record with regard to the ability of scientific advisers to influence the management plans when cutbacks and stringent controls of fishing are needed has been dismal. Moreover, some of the most tragic elements in the history of modern fisheries under the councils—most notably the disastrous collapse and closing of the New England cod fishery—is attributable in part to the inability or unwillingness of the scientists to stand up to industry pressures, in part due to the timidity

of the federal executive branch in exercising its default powers to impose conservationist plans or veto bad council plans (Tulane Symposium, 1996; Orbach, 1996).

The SFA reforms to the composition of council memberships do not go far enough. Even with these reforms in effect, each of the councils continues to define "community" solely in terms of its own jurisdictional boundaries. The relevant industry interest is that of its own fishing industry. The nation will benefit if reform can achieve a decisive break with the concept of the fishing industry managing itself in a decentralized policymaking process, often operating in blatant disregard of scientifically based information and guidance. The management process and structures need to be re-designed so as to be more responsive to a nationally defined "public interest" and a national community. It is offensive to the national citizenry that the councils give seats around the table only to the coastal states in each area, with the heartland areas (those without coastlines) left out of the process from the start. It is sadly mistaken to see the councils as "little groups of neighbors" (as the local draft boards that administered the military draft were often termed). Rather, they are better compared to the old system of local grazing district boards that were controlled by the industry users and made a record of little concern for the national community and its interests (McConnell, 1966).

Current policies are deficient in still another dimension of the council operations. When depletion of a fish stock creates economic hardship and social dislocation, as has happened in the New England fishing towns, Congress has been successfully pressured to respond with buyouts, grants for skills retraining, and other ameliorative programs designed to extend economic relief to distressed groups. But there has been no attention to developing national standards for such programs. Instead, the coastal communities with the most effective congressional backing can hope for help; equally distressed fishing areas or operators that lack a similar political advantage are not assured of comparable treatment. The nation needs a just and equitable federal policy for such crises, so that all coastal regions and communities similarly affected will be deemed eligible for similar benefits.

Many commentators are inclined to dismiss the notion of national community and the public interest transcending regional economic power arrangements as hopelessly idealistic and doomed to frustration. If one surrenders to that kind of dismissive criticism, one almost certainly risks excluding from the debate a vital set of issues relating to survival of the nation's fish stocks, the quality of the marine environment, and the welfare of the citizenry. The political rhetoric is heated and sometimes alarming and divisive—as exemplified by a recent condemnation of the SFA's concern for sustainable habitat as a form of "cultural genocide" against fishermen and their communities. With such bitterness evident in the debate now, it is all the more compelling that new instruments be devised for achieving fairness and with it (one must hope) mutual respect.

"The management process and structures need to be re-designed so as to be more responsive to a nationally defined "public interest" and a national community."

Legal, Social-Scientific, and Policy Research Needs

It is instructive to recall that one of the earliest National Marine Fisheries Service documents to propose a protocol for ecosystem research had 80-plus categories of data needs. Of those, only six pertained specifically to human activities and organization; and five of the six were narrowly focused on the fishing sector and allied industries. The sole remaining category read simply: "society values; estetics [sic]; employment, cultural, preservation, etc." (NMFS, 1987). Fortunately, ecosystem research has moved well beyond this point. Socioeconomic and legal studies are now being given enhanced support by NMFS, the councils, a few of the Sea Grant programs, and some universities, most notably those with marine affairs and ocean law faculty in place.

"…'bringing the community back in' will require mobilizing a broader range of perspectives and disciplines than customarily has been brought to bear on fishery problems."

"Ultimately," Professor Carol Rose wrote, "we need to figure out ways to manage ourselves, to manage the demands we place on these larger interactive systems" that constitute the ecosystem habitats of our fishery resources (Rose, 1997). The contributions of legal, social-scientific, and policy research, augmented by humanities-based studies, ideally will help achieve a better informed and more reasoned approach to the problem of more effectively building community interests into the design of management institutions, the definition of conservation and development goals, and the implementation process.

In sum, "bringing the community back in" will require mobilizing a broader range of perspectives and disciplines than customarily has been brought to bear on fishery problems. It will require a renewed commitment to transparency, fairness, and a determination to define community interests in national terms. It will also mean proceeding toward reform on a basis that defines public interest both in terms that transcend localism or regionalism and in terms that take account of emerging international scientific principles and resource-management norms.

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Rights-Based Fishing: The Wrong Concept and the Wrong Solution for the Wrong Problem

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Summary

Support for so-called rights-based fishing stems from the mistaken belief that such mechanisms will lead to sustainable fishing practices because individual private owners will want to protect resources they own. Such schemes ignore the fact that with the creation of the Exclusive Economic Zone (EEZ), all U.S. citizens became the owners of fishery resources. Under current U.S. fishery policy and management, the agencies charged with protecting the public's wealth of ocean fisheries have not fulfilled that mission and the economic incentives are defective. In order to correct these flaws, fishers should be required to pay for the opportunity to extract fish from this publicly owned resource, and to pay royalties on fish caught. Doing so would correct the economic incentives, reaffirm the reality of public ownership of the oceans and their bounty, and most assuredly lead to more sustainable use of fisheries.

The Setting

U.S. fishery policy suffers from a flawed diagnosis of the fishery "problem," which in turn leads to flawed solutions. A prime example of such a flawed solution is the misnamed concept of "rights-based" fishing associated with the introduction of individual fishing quotas (IFQs). The Magnuson-Stevens Fishery Conservation and Management Act is abundantly clear that such transferable fishing permits fail to bestow an ownership interest in the oceans or the fish. Fisheries with IFQs are nothing but quota fisheries, and that is what they should be called. The second flawed solution is the fiction that IFQs will rectify other problems in the fishery—paramount among them being the critical issues of stewardship and good management. Quota fisheries provide no incentives for fishing firms to resist the temptation to press fishery management councils to adopt total allowable catch (TAC) levels that threaten sustainable stocks over time. Moreover, having the exclusive opportunity to pursue a share of a specific allowable catch does not provide a fishing firm the opportunity to influence or control the fishing behavior of others. Indeed, with each fisher under a limit of what can be landed (the quota share), there are incentives for fishers to discard, at sea, certain fish that may not bring the highest prices. Finally, IFQs, as currently administered, do nothing to produce income for U.S. citizens, who are the owners of the wealth of ocean fisheries. Indeed, the few IFQ programs now in operation have simply handed over many millions of dollars of income drawn from publicly owned ocean fisheries. Given the untold millions of dollars in government subsidies to expand fishing capacity over the past

several decades, the industry now benefits in three ways: (1) by subsidies that have expanded fishing capacity; (2) by the opportunity to gain income from a public asset without the inconvenience of paying for that opportunity; and (3) by paying nothing for the fish removed from the oceans. Small wonder U.S. fishery policy is so flawed.

"Unfortunately, much of the fisheries literature continues to invoke the language of property rights with little attention to the essential concepts of rights, property, and property rights."

Unfortunately, much of the fisheries literature continues to invoke the language of property rights with little attention to the essential concepts of rights, property, and property rights. The literature does so without benefit of other literature on property rights in general, and natural resource property regimes in particular (Becker, 1977; Bromley, 1991; Christman, 1994; Hohfeld, 1913; Hohfeld, 1917). This conceptual incoherence is the primary source of defective policy advice that prevents clear thought and action regarding innovative fishery management policies.

On Institutional Structure

There are two structural issues in fishery policy. The first pertains to behavioral incentives emanating from the working rules (institutions) that define and mediate the actions of individual fishing firms. The second concerns the property regimes within which firms seek to harvest fish. Contrary to the received wisdom, there is no causal relationship between the two.

Behavioral Incentives

The literature in fishery economics began with a story that linked property regimes and incentives. Starting in 1954 with H. Scott Gordon's incorrect reference to the open-access fishery as a regime of "common property," and with additional writings in the late 1960s by Harold Demsetz (1967) and Garrett Hardin (1968), most fishery economists had acquired the necessary terminology to craft bogus stories about what came to be called the "fishery problem." The recent preoccupation with IFQs is the predictable result of Gordon's flawed structural diagnosis.

Gordon and those who followed wrote that flawed incentives caused the fishery problem because no one owned the fish until they were harvested. Because no one owned the fish (or rights to the fishery), these writers alleged that no one had an incentive to take care of the fishery. With this magical association between private ownership and proper incentives for stewardship, it became *de rigueur* to insist that a fisher who owned the right to the entire fishery would take good care of it. This is the "sole owner" of early fishery economics. This link between ownership and good stewardship is grounded on one part of economic theory that suggests individuals will always act in their own best interest and would thus be good to nature if only they could become the owner of it.

Interestingly, another part of economic theory points out that a single owner will not necessarily exercise wise and sustainable stewardship of a natural resource. This result follows from the possibility that the owner's desire for income might outstrip the rate at

which the natural resource is regenerated—the natural rate of growth of a forest or of a fish stock. If this occurs, then it is optimal for the individual owner to catch as many fish as possible as quickly as possible and invest those proceeds where they will grow faster than the underlying resource stock. This behavior arises from what is called the "iron law of the discount rate" (Clark, 1973; Page, 1977). Simply put, private ownership of nature provides no assurance that degradation and destruction will not occur. From this realization, the fervent claims for IFQs as private property, and therefore as the sufficient management tool to ensure safe harvests of the fish stock, are twice flawed. IFQs are not private property, and even if they were, that would not be sufficient to assure sustainable management.

Whose Resource Is It, Anyway?

It is curious to observe that when writers advocate privatizing the fishery under IFQs they overlook the obvious fact that all U.S. citizens already own the fishery resource and other economic assets in the EEZ. The advent of the EEZ brought fisheries out to the 200-mile limit under the ownership and jurisdiction of the U.S. The EEZ is a clear example of a state property regime (Bromley, 1991). In addition, the federal government has made unprecedented subsidies to the fishing industry to expand fishing capacity over the past 25 years.

The fishing industry harvests what U.S. citizens already own and sells it back in a different form. This is no different from the harvesting of timber on public lands. However, for some reason, fishery policy is talked about in quite different terms. Specifically, the reality of public ownership is curiously missing from discussions of the fishery—a remnant of the original diagnosis that fisheries were common property and therefore "un-owned."* Thus, it should not be a surprise that fishery policy is a far cry from policy toward petroleum leases on the Outer Continental Shelf or the sale of timber from public land. Only in fisheries are private firms allowed to capture and profit from publicly owned assets without paying anything beyond a nominal license fee. Nor does the industry pay a royalty for every unit of valuable resource taken from the ocean.

"Only in fisheries are private firms allowed to capture and profit from publicly owned assets without paying anything beyond a nominal license fee."

Ironically, constant talk of the quota fishery as an example of rights-based fishing has compounded the flaws in this wealth transfer. This artful use of language is evidently motivated by the desire to bolster political support for the idea that if only the U.S. would get on with privatizing its fisheries, the magnificent stewardship tendencies of the industry will burst forth to trump the iron law of the discount rate.

It is essential to understand that property is not an object but is, instead, an income (or benefit) stream that can be associated with a particular setting or circumstance (Bromley, 1991; Macpherson, 1973). It is also necessary to understand that a right is the capacity to compel the state to validate and protect a particular setting or circumstance. A property right, therefore, is the legal ability to com-

* This association is itself flawed. Common property is not a regime of the absence of ownership; it is merely the absence of *individual* ownership (Bromley, 1991).

mand the state to protect one's interest in a particular stream of benefits arising from specific settings and circumstances (Becker, 1977; Bromley, 1991; Hohfeld, 1913; Hohfeld, 1917). The state stands ready to be enlisted in the cause of those to whom it has granted rights. Rights expand the capacities of the individual by indicating what one can do with the aid of the collective power (Bromley, 1989; Macpherson, 1978; Commons, 1968). Sloppy reference to all manner of objects—driver's licenses, grazing, or fishing permits—as "rights" is responsible for much of the incoherence in fisheries policy. This is an example of what legal scholar Mary Ann Glendon calls "rights talk" (Glendon, 1991).

"Fishery policy would be much enhanced if those who wished to profit from fishing had to offer bids for the opportunity to fish...."

In practical terms, the empirical content of property rights is determined when conflicting rights claims are brought before the courts—especially the U.S. Supreme Court. As a result, property rights are the result of a process that must determine which of the conflicting rights claims before the court seems better, at the moment, to sanctify. Those settings and circumstances that gain protection from this process acquire, by virtue of that protection, property rights (Bromley, 1993; Bromley, 1997).

Whither Fishery Policy?

Clarity in the realm of property relations helps gain clarity in the realm of behavioral incentives. Specifically, language and concepts must become logical, honest, and consistent. Without talk of rights-based fishing or privatizing the fishery, it would be easier to make the case that the wealth of ocean fisheries belongs not to the fishing industry but to all U.S. citizens. Once this is recognized, it becomes more difficult to justify massive giveaways of income and wealth to the industry as part of establishing IFQ systems. Indeed, with the idea firmly established that the ocean fishes belong to the citizens, it is easier to sustain the case that firms wishing to earn revenue from a fishery in the U.S. EEZ must pay.

Fishery policy would be much enhanced if those who wished to profit from fishing had to offer bids for the opportunity to fish—the same method used to apportion public timber and fossil fuels. The bidding could be structured so that each firm agreed to pay a fixed permit fee scaled to the size of the vessel, and then offered to pay a royalty for each fish landed. Fishing opportunities could be awarded for multiyear periods to the highest bidders within each partition of vessels—small, medium, and large.

The royalty on each fish would reduce the firm's net price of a fish landed at the dock and this lower net price would induce each vessel to reduce fishing effort sooner than they would in the absence of the royalty. This auction scheme would reduce the artificial inducement for excessive capital and labor now in fishing (artificial because it is free, while land-based producers must own land and pay property taxes). It would also award fishing opportunities to those firms that were the most efficient and could therefore offer the highest royalty bids. Most profoundly, the scheme would finally produce income for the

owners of the ocean and its commercial wealth. In the early years of such an auction, most of the proceeds might be devoted to assisting in the exit of much redundant fishing capacity—both capital and labor—from the fishery, and to economic transition programs for fishing communities. Over the longer run, the proceeds must go to the owners of the wealth of ocean fisheries. That is, the proceeds must go to the public treasury.

"Over the longer run, the proceeds must go to the owners of the wealth of ocean fisheries."

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The Economics of Fishery Management: Behavioral Incentives and Management Costs

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Summary

Economics teaches the behavioral lesson that people respond to the incentives they face and are, for the most part, rational in what they do. In this way, the economics of fisheries and their management are interrelated. The relationship stems from the signals management provides, the incentives those signals create, and the behavioral responses caused by those incentives. The incentives created by fishery management encourage managers and fishermen to take short-term perspectives and act against long-term ecological and economic interests. Their actions create costs for management that affect its performance. A precondition for improving fishery management is to contain these costs.

Management Structure

The present costs of fishery management have their origins in the management structures and incentives established 25 years ago. The 1976 Fishery Conservation and Management Act (the act) was the first legislation to provide comprehensive federal authority to manage fisheries within the United States Exclusive Economic Zone (EEZ). It removed most foreign fishing from U.S. waters and established a new domestic fishery governance structure that distributed authority among the federal government and the regions through a system of eight regional fishery management councils.

The councils are democratic decision-making bodies comprised of representatives of recreational and commercial user groups, states, tribes, the federal government, and the public. Council advisers include scientists, user groups, and environmental organizations. All contribute to the development of Fishery Management Plans (FMPs) and regulations.

The idea behind the councils is to develop regional approaches to fishery management. The regional approach is based on the premises that people with working knowledge of regional fisheries can make the most informed decisions about those fisheries and that management of fisheries within state waters (out to three miles from shore, in most cases) should be coordinated with management of fisheries in federal waters.

The councils recommend management plans and regulations to the U.S. secretary of commerce, who has final authority for their approval and responsibility for their consistency with federal law. In most cases, the secretary delegates approval authority to the National Marine Fisheries Service (NMFS). The eight councils take different approaches to decision-making and management, as anticipated and intended by the act.

In response to changing fishery conditions, Congress has made many amendments to the act. The most recent amendments in 1996 charges the councils with stricter stewardship responsibilities.

Management Incentives

Congress passed the original version of the act in a climate of foreign exclusion and domestic expansion. The act gave domestic fleets priority and incentives to expand, prohibiting foreign fishing in U.S. waters except in cases where domestic fishing capacity did not exist. However, the councils were given little direction and few tools to accomplish their most difficult task—the allocation of fish between competing and expanding domestic interests.

The council system has operated under mixed incentives. The act eliminated the problem of open access fishing by foreign fleets but did little to resolve the problem of open access fishing by domestic fleets. The law required councils to keep exploitation within conservation limits at the same time they were operating in an expansionary mode. Determined to provide fishing opportunities to all, some councils put the needs of development before conservation. In addition, federal programs designed to assist in fishing industry renovation and expansion—low-interest loans and tax-deferred vessel construction programs—remained in place.

American fishery management under the original act and its subsequent amendments has followed a predictable path. Open access created a race for fish that led to an overinvestment in fishing capital. The race for fish had common-sense origins and destructive results. Because access to most fisheries remained open, ownership of fish could be achieved only by capture. Fishermen competed by investing in bigger and better fishing vessels. Seafood processors expanded their plants. Investments in fishing and processing capacity far exceeded levels that could be supported by the fishery resource over time (Hanna, 2002).

"The race for fish had common-sense origins and destructive results."

Concurrent with this overinvestment in fishing and processing capital was an underinvestment in the management capital needed to keep pace with changing conditions. Management capital includes decision-making skills, knowledge of management tools, and understanding of monitoring and evaluation systems (The Heinz Center, 2000).

The race for fish, fishing overcapacity, and management undercapacity combined to shorten the time frames of fishery managers and user groups. Short-term actions crowded out long-term strategies. Reactions to crisis overwhelmed planned management. Assurance about the future declined, and conflict among competing interests increased. From the perspective of rehabilitation and expansion of U.S. fisheries, the path led to limited short-term success. From the perspective of building an institutional structure for long-term ecosystem sustainability, the path led to a fishery management system plagued by dysfunction and high costs (Hanna, 1998).

By the 1990s, U.S. fishery management was under pressure to change. The 1996 SFA added several important strictures to federal fishery law. It required that management actions be taken to eliminate overfishing, rebuild overfished stocks, minimize bycatch, protect essential fish habitat, and account for the effects of fishery regulations on fishing communities.

Also during the 1990s, the U.S. signed several international ocean agreements to protect marine ecosystems by reducing overfishing, reducing bycatch and discards, reducing fishing capacity, and strengthening governance and the scientific basis for ecosystem management (FAO, 1997).

Despite these changes at national and international levels, the problem of incompatible incentives remains in U.S. fishery management. Additionally, expansionary pressures from overcapacity, lingering expectations for growth, and inadequate attention to the long-term economic productivity of fisheries create costs for management as it attempts to adapt to stricter conservation requirements.

"In responding to the incentives provided by the management system, fishery managers and user groups have contributed to the inflation of management costs."

Management Costs

Productivity losses have required more complicated regulations, expanded requirements for information, and created more conflicts among user groups. In turn, these factors have increased management costs while undermining management's legitimacy and decreasing its effectiveness.

Fishery management is conducted with reference to a set of objectives specified in a FMP. Ideally, management will cost the minimum necessary to achieve its objectives, and will generate more benefits than costs. Though reality never reaches the ideal, management can contain costs through the structure of regulations and the process of making decisions.

The costs of fishery management are transactions costs (Matthews, 1986; Eggertsson, 1990). For the councils and NMFS, transactions costs result from coordinating requirements to collect and analyze data, assess the status of fish stocks, design and implement regulations, and communicate and resolve conflicts. For fishery user groups, transactions costs are related to participation in management, including the cost of lost work time and time spent in acquiring information, as well as direct monetary expenditures for information, travel, and communication. Some transactions costs remain fixed; others vary with structure and process (Hanna, 1995).

In responding to the incentives provided by the management system, fishery managers and user groups have contributed to the inflation of management costs. Management has focused on the short-term exploitation of individual species, functioning with poorly articulated objectives, shortened time horizons, and high levels of scientific uncertainty. Broadscale monitoring and the evaluation of performance are absent. The increasing intensity of fishery use creates a large regulatory burden that strains the personnel resources of management and requires management to focus on short-term regulatory needs. The

short-term focus prevents the development of design experiments that would increase management's adaptability.

Attempts to improve the performance of fishery management through additional requirements such as those added by the SFA have further added to transactions costs. New regulatory requirements are increasingly proscriptive and limit the flexibility with which management can meet its objectives.

One example of the increasing transactions costs burden of fishery management is the large number (greater than 100) of lawsuits pending against the secretary of commerce and challenging specific aspects of fishery management. These suits represent both dissatisfaction with the present costs of fishery management and new transactions costs generated by the information requirements of litigation.

Some transactions costs are attributable to the lack of property rights to guide and control the use of fishery resources. Property rights define legitimate owners and the rules and responsibilities so that expectations are consistent and enforcement possible (Bromley, 1991). The failure to adequately specify property rights to fisheries is a large barrier to the cost-effective conduct of basic management tasks.

Cost Containment

The present management environment includes significant barriers to containing transactions costs, but also suggests the conditions necessary for cost containment. There are several barriers to cost containment:

- *Fishing overcapacity:* the scarcity created by excess fishing capacity leads to crisis-driven fishery management that tends to be reactive rather than strategic.
- *Adversarial strategies:* overcapacity means that management decisions create winners and losers who are pitted against each other instead of working toward a common objective.
- *The search for no-impact options:* the desire to find management actions without distributional effects causes the expenditure of large amounts of time on analysis.
- *Vague management objectives:* fishery management plans contain long lists of competing and qualitative objectives that make it difficult to assess management performance.
- *Strained human capital:* increasingly complicated management is generating sophisticated information needs and increasing demands on human capital.
- *Micromanagement:* detailed national management requirements ignore regional contextual differences, focus on process, and divert attention from desired outcomes.
- *Inadequate understanding of incentives:* underinvestment in research on incentives and behavior precludes the development of incentive-compatible management approaches.
- *The shadow of history:* the path created by past actions limits the consideration of present alternatives.

"The failure to adequately specify property rights to fisheries is a large barrier to the cost-effective conduct of basic management tasks."

There are a number of conditions that could facilitate cost containment:

- *Increase the economic productivity of fisheries:* motives to conserve and to participate effectively in management depend on economic well-being.
- *Decrease fishing pressure:* reduce capacity to a level that is profitable at much lower yields.
- *Specify measurable objectives:* provide long-term performance targets that leave management less vulnerable to short-term pressures.
- *Specify property rights:* provide consistent expectations about rights and responsibilities of fishery participants.
- *Realign incentives:* define responsibilities associated with rights, introduce accountability, and reward desired behavior.
- *Monitor and evaluate management performance:* develop performance indicators that promote adaptation and improvements in management.
- *Experiment with alternate management approaches:* identify management alternatives that are flexible, less vulnerable to short-term interests, and more cost-effective.

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Utilization of Social Science in Federal Management of U.S. Marine Fisheries: Strong Commitment to Research Will Improve Management Outcomes

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Summary

Fishery managers should expand the scope of fishery-related social science research, which has generally focused on characteristics of fishing constituencies and regulatory options, to cover the ecological knowledge of fishermen. Managers could also improve fishery social science by prioritizing research needs explicitly tied to management objectives and increasing resources devoted to studies that (1) examine problems of enforcement and sustainability of indigenous fisheries and (2) evaluate the success or failure of management policies. Although there is momentum to make these changes in research priorities, the number one problem inhibiting the legally mandated contribution of social science to the federal management of marine fisheries is the small number of social scientists on the staff of the National Marine Fisheries Service (NMFS).

The Nature of Fishery Problems

In a recent collaboration involving the National Oceanic and Atmospheric Administration (NOAA), participants identified key marine fishery problems, including "overfishing, overcapitalization, bycatch, habitat degradation, aquaculture and its impacts on the marine environment, and management of inter-jurisdictional fisheries" (The Heinz Center, 1998). Of course, each of the eight regional fishery management councils could expand on these lists of concerns.

Fishery management "problems" are problems because some members of the constituency of fishermen, environmentalists, and scientists are dissatisfied with some condition of the fishery system. Because they involve human judgments, fishery problems are social (or social science) problems. Fishery problems and solutions are inherently controversial:

"In the last analysis, social [fishery] problems arise and are sustained because people do not share the same common values and objectives" (Fuller and Myers, 1941).

Fortunately, the social, cultural, and economic processes that underlie fishery management problems can be described, modeled, and predicted with social science.

Goals of Fishery Management

Under the Magnuson-Stevens Fishery Conservation and Management Act, the controlling goal of fishery management is framed as Optimum Yield (OY), which is defined in the act:

> The term "optimum," with respect to the yield from a fishery, means the amount of fish that
>
> (A) will provide the greatest overall benefit to the nation, particularly with respect

to food production and recreational opportunities, and taking into account the protection of marine ecosystems;

(B) is prescribed on the basis of the maximum sustainable yield (MSY) from the fishery, as reduced by any relevant social, economic, or ecological factor; and

(C) in the case of an overfished fishery, provides for rebuilding to a level consistent with producing the maximum sustainable yield (MSY) in such fishery [16 U.S.C. § 1802 (28)].

"OY challenges managers to pursue opportunities for humans to improve their lot while recognizing responsibilities to implement an environmental ethic."

Some challenge the concept of OY for its vagueness. While some argue that OY leads to policies that favor fish and the environment over society, others insist just the opposite. OY is appropriate as a basic fishery management concept because it poses a better, if more difficult to answer, question than does the concept of MSY, which it displaced.

OY challenges managers to pursue opportunities for humans to improve their lot while recognizing responsibilities to implement an environmental ethic. To this end, an appreciation of developments in environmental philosophy and the history of sustainable development and ecosystem management could inform the development of a pragmatic OY philosophy. For example, see J. B. Callicott's essays on environmental philosophy (Callicott, 1999).

Sustainable Development

Publications by the World Commission on Environment and Development and the World Conservation Union, in association with the United Nations Environment Programme and the World Wide Fund for Nature, generated perhaps the two most widely known statements on sustainable development:

1. Economic growth always brings risk of environmental damage, as it puts increased pressure on environmental resources. But policymakers guided by the concept of sustainable development will necessarily work to assure that growing economies remain firmly attached to their ecological roots and that these roots are protected and nurtured so that they may support growth over the long term (WCED, 1987).
2. [Sustainable development means] improving the capacity to convert a constant level of physical resource use to the increased satisfaction of human needs (IUCN, UNEP, and WWFN, 1990).

Ecosystem Management

In an essay discussing the historical development of ecosystem management, Grumbine reports that most authors cited in his review support a general goal of "ecological integrity," and that five specific goals were frequently endorsed:

1. Maintaining viable populations of all native species in situ.
2. Representing, within protected areas, all native ecosystem types across their natural range of variation.
3. Maintaining evolutionary and ecological processes (e.g., disturbance

regimes, hydrological processes, nutrient cycles, etc.).

4. Managing over periods of time long enough to maintain the evolutionary potential of species and ecosystems.
5. Accommodating human use and occupancy within these constraints (Grumbine, 1994).

Fortunately, resource managers are increasingly incorporating ecosystem management ideas into the practice of marine fishery management. This trend should be encouraged.

Fishery Management Under OY

In the course of the policymaking process in an OY framework, the councils address two connected fishery management decisions. The first—the conservation decision—refers to the quantity of fish that fishers can harvest on a sustainable basis. The second—the allocation decision—concerns the way in which managers should distribute access to harvestable fish across fishing constituencies.

Conservation (or Quantity) Decision

The authoritative fishery management question for the scientific study of the fish side of the fisheries equation may be phrased as: What is the value/significance/importance/meaning of fishing (a) to target species, and (b) to other species and the habitat?

Allocation (or Distribution) Decision

The authoritative fishery management question for the scientific study of the human side of the fisheries equation may be phrased similarly as: What is the value/significance/importance/meaning of fishing (a) to people who fish, and (b) to other members of society?

Social Science and Fishery Management

The vast majority of fishery social science studies that researchers provide to fishery managers are analyses pertinent to the allocation question. Almost by definition, social science entails the direct collection of data from elements of the fishing industry. In particular, economists and cultural anthropologists who have talked with fishermen have asked two kinds of questions:

1. What are your characteristics? (Who are you?)
2. What is your policy position or preference? (What do you want?)

Studies oriented to the first question generated economic and ethnic profiles of industries, measurements of fishermen's dependence on fishing, fishermen's patterns of fishing and career mobility, and specifications of the human relationships created and sustained through fishing, among other understandings. Studies oriented to the second question generated an understanding of preferred regulations and policies, and some appreciation of how fishermen might respond to changes in regulations.

Fishery social scientists usually design research to connect to the managers' allocation decision. However, sometimes it is desirable to focus instead on the conservation question.

"The vast majority of fishery social science studies that researchers provide to fishery managers are analyses pertinent to the allocation question."

With this goal, it is possible to pose a third kind of question to fishermen (and fishery scientists) with an entirely different form from the one employed in studies related to allocations:

3. What do you know? (How do you think the natural world works?)

In asking fishers what they know, researchers might investigate what social scientists refer to as local or traditional knowledge. In particular, it might be desirable to elicit the fishermen's knowledge of the ecological condition of a particular fishery and compare it with that of the fishery scientists.

"In particular, it might be desirable to elicit the fishermen's knowledge of the ecological condition of a particular fishery and compare it with that of the fishery scientists."

The Fishery Social Science Agenda

Fishery social scientists have available a wide array of concepts, theories, and methodologies suitable for the study of fisheries (Miller et al., 1987). As the field matures, those who engage in social assessments of fisheries can learn much from the lessons produced over decades of work by forestry social scientists (Gale, 1987).

Following are several challenges facing fishery management in applying social assessments of fisheries, as well as suggested remedies.

- ***Issue:*** NMFS lags far behind other executive agencies, such as the U.S. Forest Service and the National Park Service, in its use of applied social science. NMFS has only 37 social scientists (34 economists and 3 anthropologists) on staff to conduct fishery social science. In comparison, NMFS provides far greater support to biological research, with an estimated 583 employees that collect, process, and conduct research for fish stock assessments (NRC, 2000).

Comment: The low number of social scientists on staff at NMFS 25 years after the passage of the Magnuson-Stevens Act is entirely unacceptable. NMFS is developing plans to recruit 95 new social scientists (NRC, 2000), but Congress has yet to fund those new positions.

- ***Issue:*** Competing demands for scarce monies limit the social science conducted by the staffs of regional fishery management councils.

Comment: Congress should augment council budgets to support social science work by staff.

- ***Issue:*** On occasion and in part due to budget constraints, councils contract out social science research to private consultants. In response to the paucity of federally sponsored studies, special-interest constituencies, such as fishermen's associations, also hire private-sector fishery experts to study fishery problems. The councils subsequently ask scientific and statistical committees to evaluate this research, which qualifies as the "best available" scientific information.

Comment: Private-sector fishery science is not necessarily "bad science"; often it is technically correct. The main complaint of such work is the research design: Are the researchers asking the right questions? Social science (or any fishery science) research conducted or funded by

interested parties outside government raises questions about the legitimacy of its results and governance based on these results.

- ***Issue:*** What problems should fishery social science study first?

Comment: Research needs should be prioritized on a regional basis. For example, the Western Pacific Regional Fishery Management Council prioritized social science research questions for pelagic fisheries. In this effort, the council tied specific types of research (e.g., baseline/profile studies, impact analysis, modeling activities) to fishery management plan objectives (Miller, 1996). Currently, the councils underutilize the expertise of advisory panels, which can provide substantial input to help the councils determine the most important research issues in their region.

- ***Issue:*** Generally, the social science research agenda has focused on baseline, descriptive, and impact questions [16 U.S.C. §1853(a)(2) and (a)(9)]. The secretaries of commerce and interior are authorized to provide grants to sustain traditional indigenous fishing practices for selected western Pacific communities [16 U.S.C. §1855(i)]. Only rarely have they funded research to examine environmental attitudes and enforcement issues or to evaluate policy decisions pertaining to indigenous communities made by the councils after the fact.

Comment: Fishery management leadership should expand and fund the range of the social science research agenda to address these issues.

"Currently, the councils underutilize the expertise of advisory panels...."

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Comments on the Use of Scientific Information in Fishery Management and the Protection of Marine Ecosystems

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Summary

Federal laws establish that the primary role of science in fishery management is to provide managers with the information needed to protect and conserve marine ecosystems. Fishery science is moving away from an ecosystem paradigm based on a single state of stability to one based on multiple states that are highly vulnerable to natural and human influence. Because of this variability, baseline information on natural conditions is more difficult, but also more important, to collect and human impacts more difficult to assess. In view of the limited understanding that fishery managers and scientists have of these ecosystems and the limits of scientific methods for assessing them, precautionary management is essential to ensure their protection. Fishery management strategies must recognize these limits, characterize baseline conditions in a manner sufficient to measure fishery-induced changes in the ecosystem, and foster realistic expectations with regard to the time and resources necessary to investigate and resolve important uncertainties about the ecosystem and fishery effects. To ensure that management is guided by the best available information, the objectivity, integrity, and independence of the scientific process also must be protected. Although the transition to ecosystem-based management is a major challenge, fishery management can take a number of important steps to hasten that transition and improve the usefulness of science to the management process.

Intended Use of Science in Fishery Management

Society's intended use of science in fishery management is revealed in its laws.

Magnuson-Stevens Fishery Conservation and Management Act: "conservation and management" are defined as, among other things, "...all of the rules, regulations, conditions, methods, and other measures (a) which are required to *rebuild, restore, or maintain...any fishery resource and the marine environment;* and (b) which are designed *to assure that...irreversible or long-term adverse effects on fishery resources and the marine environment are avoided....(emphasis added)*"

Marine Mammal Protection Act: "...marine mammals...should be protected and encouraged to develop to the greatest extent feasible commensurate with sound policies of resource management and ... the primary objective of their management should be to maintain the *health and stability of the marine ecosystem.*"

*The views expressed in this paper are those of the author and not necessarily those of the Marine Mammal Commission.

Endangered Species Act: "...various species of fish, wildlife, and plants in the United States have been rendered extinct as a consequence of economic growth and development untempered by adequate concern and conservation; [and] other species of fish, wildlife, and plants have been so depleted in numbers that they are in danger of or threatened with extinction…." The expressed purposes of this act are "...to provide a means whereby the *ecosystems upon which endangered species and threatened species depend may be conserved,* [and] to provide a program for the conservation of such endangered species and threatened species...."

National Environmental Policy Act: requires federal agencies to "...identify and develop methods and procedures...which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decisionmaking...." This act explicitly promotes "...efforts which will prevent or eliminate *damage to the environment and biosphere....*"

The common, fundamental concern of these acts is the potential for human activities to cause irreversible damage to marine ecosystems. Based on that concern, the major purpose of science in fishery management is to provide adequate descriptions and assessments of fished marine ecosystems to ensure that fishing does not cause irreversible or long-term adverse effects.

Assessing Ecosystem Change or Degradation

The Balance of Nature and Baseline Conditions

Understanding how marine ecosystems function and change naturally over time is key to determining the impact of fishing on ecosystems. The balance-of-nature paradigm shaped much of scientists' understanding of change in nature. In this paradigm, an ecosystem consists of a relatively stable community of species whose evolution and persistence reflect the influence of the system's natural elements and ecological interactions. "Balance" implies a stable equilibrium in which each species remains at or near the environment's carrying capacity. Under this paradigm, a healthy ecosystem is one that is in or near such a state of equilibrium. Conceptually, a fishery management strategy based on this paradigm could assess the ecosystem's natural, undisturbed state and its fished state and then determine fishery effects by assessing the differences between the two states.

"...the major purpose of science in fishery management is to provide adequate descriptions and assessments of fished marine ecosystems to ensure that fishing does not cause irreversible or long-term adverse effects."

Ecosystem Dynamics

Understanding of ecosystems is shifting from the balance-of-nature paradigm toward a paradigm that accommodates multiple stable states, as well as marked variability, cycles, shifts, and trends. Observations of patterns over large areas and long periods of time show that multiple factors, both natural and human-related, are capable of altering ecosystems in ways generally beyond the current ability of fishery scientists and managers to understand or predict. Natural conditions and

interactions that structure ecosystems are more vulnerable to human influence than was recognized previously.

These manifestations of ecosystem change complicate the tasks of evaluating the natural or expected ecosystem state and attributing observed changes to a particular cause or set of causes. More sophisticated conceptual frameworks are needed to characterize the effects of fishing in more variable ecosystems. Baseline information is more important but more difficult and time-consuming to collect and understand. Because ecosystems may change unpredictably even under natural conditions, control areas are essential for comparison with fished areas to determine fishery effects.

"Scientists must convey to managers the importance of establishing essential baseline information to reliably assess the effects of fisheries on marine ecosystems."

The current approach to fishery management fails to require sufficient scientific description of baseline ecosystem conditions, including natural variability and trends, as well as sources of such variability. Without this reference information, the natural or healthy state of an ecosystem cannot be described, and the degree, nature, and significance of any observed changes cannot be assessed. Scientists must convey to managers the importance of establishing essential baseline information to reliably assess the effects of fisheries on marine ecosystems.

The Single-Species Approach

The current single-species, fishery management approach is founded on the major assumption that target species in an ecosystem can be safely fished to their maximum sustainable yield levels without significant consequences to other species related through ecological interactions such as competition or predation (for a contrary view, see Larkin, 1977). Yet, this approach results in a reduction of spawning biomass of the target species by 60 to 65 percent or more, and it is hard to imagine that such a reduction does not have potentially profound ecological consequences, particularly for predators in the ecosystem that depend on the same species targeted by the fishery.* Such reductions in prey availability may affect not only the foraging success of predators, but also their reproduction, survival, and population status. Therefore, the assumption that the current single-species management approach is ecologically safe is highly questionable and must be challenged.

Values and Standards

Type I and II Errors, Burden of Proof, and Statistical Power

The challenge to fishery management is largely one of avoiding risk. Perceived risks depend on society's values and the values of participants in the management process. In statistical terms, the risks result from Type I and Type II errors. Type I errors occur when managers assume that a fishery has significant effects when, in fact, it does not. Type II errors occur when managers assume that a fishery does not have significant effects when, in fact, it does. A Type I error may result in unnecessary constraints on a fishery, whereas a Type II error may allow unintended and undetected adverse impacts on target species, ecologically related

* This approach has been applied, for example, to a suite of groundfish stocks (e.g., pollock, cod, Atka mackerel, various flatfishes, and various rockfishes) in the Bering Sea and Gulf of Alaska, under the assumption that such fishing will not have significant ecosystem effects on marine mammals (e.g., Steller sea lions), seabirds, or other fishes.

species, and the ecosystem at large.

In a fishery controversy, society expresses its level of concern about possible Type I and II errors by imposing the burden of proof on one party to the controversy. The placement of the burden of proof is crucial because science often has relatively little ability to resolve important issues with an acceptable level of certainty. The laws described earlier require managers to use the best available scientific information as a basis for their decisions. However, the term "best available" can lead to management approaches that are not precautionary if the available data is treated as the only basis for a decision, without sufficient allowance for reasoned interpretations to inject a necessary measure of caution. Until science can provide detailed descriptions of fishery effects, interpretation is required to develop an appropriately broad view of potential problems and a correspondingly precautionary management approach. Sole reliance on data can lead to the faulty "absence of evidence" argument, in which the absence of data supporting a particular point of view is mistaken as a form of disproof of that view. The absence of evidence argument is particularly problematic with respect to ecosystem conservation because the scientific or statistical power to detect significant fishery effects is generally low.

Independence and Integrity

Fishery management blends science and social values. The utility of science depends on its objectivity, independence, and integrity: science should provide objective, reliable information pertinent to fisheries issues but independent of potentially value-laden fishery management. Management can misuse science to impose its own values irrespective of scientific input, control the nature and amount of scientific research conducted, and select the scientific information used in the decision-making process. Management also can manipulate science and scientists through the funding process, bureaucratic chain of command, control of careers, and even the scientific review process. Those with political influence over the management process can use these same mechanisms to manipulate fishery management. Abuses of science through the above mechanisms may result simply from the structure and function of the management bureaucracy. As a consequence, the independence and integrity of science is easily violated and its utility is correspondingly diminished.

"The placement of the burden of proof is crucial because science often has relatively little ability to resolve important issues with an acceptable level of certainty."

Expectations and Time

Unrealistic expectations and time constraints encumber the science-based management of fisheries. Although controversial issues in fishery management can be resolved immediately by political means, decades or more of research may be required to resolve them on the basis of sound science. The fishery management process, however, is often driven by a sense of economic urgency that generally overwhelms any tendency for a cautious ecosys-

tem-based approach. Fishery management operates on an annual cycle driven by the nature of the fisheries and the annual federal funding cycle. The demands of a short-term cycle impede efforts to develop and carry out long-term research programs essential to resolving major conservation problems.

"The demands of a short-term cycle impede efforts to develop and carry out long-term research programs essential to resolving major conservation problems."

Recommendations

The following recommendations stem from the comments in this paper.

- Assess natural baseline conditions in marine ecosystems before fishing (or additional fishing) is initiated. Require comprehensive information on the target species, related species, and relevant sources of ecosystem change. Information should include assessment of natural long-term trends and variability in population parameters and ecological interactions.
- Eliminate the single-species approach and investigate the potential yield that can be safely removed from natural ecosystems without significant disruption of nontarget species and their ecological relations.
- Establish marine protected areas to serve as controls for assessing ecosystem change and as reserves to replenish damaged or degraded ecosystems.
- Establish realistic long-term research and management plans with explicit goals and objectives that ensure conservation as and after uncertainties are resolved.
- Require explicit description and consideration of Type I and Type II errors in the fishery management process.
- Assign the burden of proof for controversial issues to those whose actions may potentially change or degrade natural ecosystems.
- Require explicit statistical power analyses for research designed to detect fisheries effects; that is, scientists should be required to describe quantitatively the likelihood that their research would detect a significant effect if one occurred.
- Assure the integrity of science by establishing scientific agencies that are protected from political interference.
- Assure the integrity of management agencies responsible for resource conservation by protecting them from undue political pressure or micromanagement.

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Improving Science in Marine Fishery Management: Looking at Other Disciplines for Strategies to Develop New Models

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Summary

The fundamental basis of many models used in fishery management was conceived when fisheries were under the paradigm of exploitation and expansion. In order to protect marine ecosystems, fishery managers need new models based on scientific information that successfully integrates ecosystem considerations and environmental variability. Experiences in atmospheric and oceanic science offer possible examples for strategies to develop new operational models that integrate up-to-date research. The development and effective use of such models, however, will require significant financial and intellectual resources. Creation of an oversight body to coordinate all federal programs that affect the marine environment may speed this process.

Does the Environment Matter in Fishery Management?

Moving from single-species management to ecosystem-based management, which considers complex information on predators, prey, competitors, habitat, and the physical environment, is a recurring theme in improving fishery management (NRC, 1999; NMFS, 1999). Variability in the physical environment, however, is also known to affect single species, so it is useful to evaluate its current application in fishery management.

The impact of environmental variability on marine populations and ecosystems depends upon the scale of the variation. Small-scale variability can affect survival of young stages of fish while larger-scale environmental variability exerts a wider impact over the broad geographic distributions of marine fishes. As a result, larger-scale variability may have greater potential for use in fishery management. El Niños, for example, can affect the distribution of mobile species living in open oceans while also affecting the productivity of more sedentary species. On time scales of decades to centuries, changes have been documented in fish stock productivity, ecosystem carrying capacity, and other fluctuations independent of fishery activities (Steele, 1996). Given the relatively short length of time series of fisheries data, however, it is still difficult to separate effects of fishing from the effects of environment on many species.

A great deal of environmental information is available for use in fishery management (Boehlert and Schumacher, 1997). Large-scale research programs in fishery oceanography (e.g., the International Oceanographic Commission's Ocean Sciences in Relation to Living Resources; National Oceanic and Atmospheric Administration's Fisheries

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Oceanography Coordinated Investigations; and the Global Ecosystem Dynamics Program) have established linkages—proposed since the early 1900s (Hjort, 1914)—between variability in the environment and variability in fish populations. Unfortunately, aside from input to recruitment forecasts (Megrey et al., 1996) or experimental approaches, these data have not been used for fishery management.

"A concerted, priority effort to develop the next generation of models is overdue."

Many fishery management models still in use are based on theory dating back several decades when the typical fishery paradigm was one of exploitation and expansion, as opposed to conservation and sustainability. While dependent upon large numbers of input parameters, these models generally do not take environmental variations into account (Gulland, 1983). Many of the models do a good job estimating stock size but are not designed with forecasts in mind. Alternative, ecosystem-based models (Pauly et al., 2000) are generally used as comparative research tools but may be inadequate for practical, *operational* fishery management. A concerted, priority effort to develop the next generation of models is overdue.

Research and Operational Models: Adequacy of the Tools

The lack of significant advances and improvements in fishery management models is in marked contrast with the advances in atmospheric or oceanographic science (Parsons, 1996). The mechanisms of model development and implementation in these disciplines may provide prototypes for similar applications in fishery management. The national defense and weather communities provide good examples.

In the United States Navy, the model development process proceeds through four phases: exploratory/advanced technology development, demonstration and validation, operational implementation, and operations. The Naval Research Laboratory serves as the "corporate laboratory," developing the models and participating in the first three phases, finally turning the models over to the Naval Meteorology and Oceanography Command, which uses the models to provide operational products in support of the Department of Defense missions.

An analogous process exists in the civilian sector in the National Weather Service and the National Centers for Environmental Prediction at the National Oceanic and Atmospheric Administration. The process is highly rigorous, with review panels, committees, and well-documented steps. Shortcomings in operational models are dealt with through aggressive programs to fund and develop new generation models as part of the process.

High stakes are involved in the accuracy of these models—defense models deal with national security issues and weather forecasts with safety and economic impacts. The results affect human or political conditions. Consequently, society provides the resources and intellectual talent to improve them. It is time for society to decide whether the stakes are now equally high in the health of fish

stocks and marine ecosystems.

It is tempting to examine approaches that separate the research and management functions in a regulatory agency, removing the research from short-term demands and the vagaries of politics. The danger, however, is that the research may become less relevant or responsive to the needs of management. The Navy's approach to research and operational model development has potential applicability. Short-term research dictated by operational needs exists side-by-side with long-range research meant to improve how the work is done.

With marine fisheries in crisis, marine ecosystems need to be protected while multiple uses are preserved, requiring significant new resources. NOAA proposed a budget initiative called the Stock Assessment Improvement Plan (SAIP), which has strong support and includes several steps known as Tiers of Assessment Excellence. Tier one will improve assessments using existing methodologies; tier two will elevate all assessments to a nationally acceptable level; and tier three will develop next-generation assessment models to incorporate ecosystem considerations and environmental variability.

The content and intent of SAIP are appropriate, and there is no shortage of ideas within the agency and elsewhere for improvements appropriate to tier three (Mace, 2000). The difficulty arises, however, in achieving tier three under budget constraints and in the face of compelling needs under tier one and tier two. The tiers represent, whether intentionally or not, a sequential time line or set of priorities. In the federal budget process, the lower priority items, such as tier three, are relegated to "out-year" budget initiatives. This leads to problems in developing and implementing new advances, particularly in a political environment.

The Problem of Implementation

Ecosystem-based management is not a new idea at the National Marine Fisheries Service (NMFS). From 1987 to 1989, NMFS launched an internal initiative called Ecosystem Monitoring and Fisheries Management. It included a formal "program development plan" complete with seven "large marine ecosystems." NMFS generated detailed plans for each ecosystem and presented the program to a combined meeting of representatives of the regional fishery management councils. The approach was not well received by this group, and all traces of this program disappeared, except for a few gray literature reports (Fougner and Boehlert, 1989), and individual efforts to keep the concept alive within the agency.

"Ecosystem-based management is not a new idea at the National Marine Fisheries Service (NMFS)."

Congress generated the next attempt at ecosystem-based management. The Magnuson-Stevens Fishery Conservation and Management Act required NMFS to establish an advisory panel to "develop recommendations to expand the application of ecosystem principles in fishery conservation and management activities." NMFS convened the panel and it produced a report, which the secretary of commerce delivered to Congress (NMFS, 1999). A clear plan to fund and implement the recommendations in the report remains to be developed through the

budget initiative process.

As a principal agency regulating marine fisheries, NMFS is a management agency with constituencies whose political agendas lead to fundamental conflicts. Frequent changes in NMFS leadership, new mandates, and changes in long-range plans also hinder progress in implementing programs.

"A Marine Ecosystem Commission, modeled on the pattern of the independent Marine Mammal Commission, could develop the requisite oversight of programs—including fisheries—that affect the marine environment."

Concluding Comments

The problems of fishery management defy simple solutions. Increased public awareness of the failings of fishery management is in part responsible for the rapid movement toward marine protected areas. Although increasing the number of protected areas is certainly recommended as a component of ecosystem management (NMFS, 1999), marine fisheries represent only part of man's use of the marine ecosystem. Numerous agencies impact the marine ecosystem, either through direct action, promulgation of regulations, or permitting authorities. A Marine Ecosystem Commission, modeled on the pattern of the independent Marine Mammal Commission, could develop the requisite oversight of programs—including fisheries—that affect the marine environment. Such an entity could become the driving force behind developing a comprehensive approach to marine ecosystem management.

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The Scientific Case for Precautionary Management: Current Fishery Problems Traced to Improper Use of Science

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Summary

Because of the imprecise nature of fishery science, scientific uncertainty must be accepted as a fundamental ingredient of the fishery decision-making process and not used as an excuse for inaction. Many recent fish population declines and collapses can be traced to the improper use of scientific information in fishery management decision-making. Based on a review of the recent history of U.S. fishery management, as well as some recent advances in the understanding of the behavior of exploited fish populations, the case for a precautionary approach to fishery management is stronger than ever.

MSY is Too High

A quarter century ago, the Transactions of the American Fisheries Society published a paper by the late Peter Larkin entitled "An Epitaph for the Concept of Maximum Sustained Yield" (Larkin, 1977). Dr. Larkin made a comprehensive, compelling case for replacing MSY with a more conservative objective. His seminal paper included a poem, excerpted below:

Here lies the concept MSY
It advocated yields too high
And didn't spell out how to slice the pie.
We bury it with the best of wishes
Especially on behalf of fishes
We don't know yet what will take its place.
But we hope it's as good for the human race.

Despite Larkin's epitaph, MSY lives on. Optimum Yield (OY), the goal of U.S. fishery management, is defined as a modification of MSY, but the lack of specificity in defining OY has often led to its being defined, de facto, as MSY itself.

In fact, prior to 1996, U.S. fishery legislation explicitly allowed for yields to exceed MSY if there was an economic, social, and/or ecological rationale to do so. Often, short-term social and economic considerations were used to justify fishing at levels above MSY. Such catches, by definition, were not sustainable in the long run, and over a period of time frequently led to severely depleted fish populations. This legislative loophole effectively allowed overfishing to occur routinely at the discretion of the regional fishery management councils.

The Loophole Closes but Overfishing Continues

The Sustainable Fisheries Act of 1996 redefined OY as a yield not greater than MSY. This action reduced the flexibility of the councils to set yields exceeding MSY on the basis of short-

term social and economic grounds and closed a loophole that contributed to past overfishing. Overfishing, however, continues in many fisheries, with arguments over scientific uncertainty used as a rationale for inaction, which leads to continued overfishing.

"...the uncertainty of the science is not the primary culprit. Rather, the problem is that fishery managers used scientific uncertainty to justify hazardous decisions."

Southeast Atlantic Coast Shark Fishery

The large coastal shark fishery off the southeast Atlantic coast is a prime example. A 1998 assessment indicated that large, sustained cuts in quotas were needed to avert a population collapse. Even if fishing were to cease immediately, the assessment predicted that recovery would take at least two decades. However, the fishery continued to operate at pre-1998 quota levels while the industry contested the assessment, resulting in a court-ordered peer review that was completed more than three years later. In the interim, as the shark population continued to decline, the assessment methodology was published in a peer-reviewed scientific journal (McAllister et al., 2001; Babcock and Pikitch, 2001).

While the scientific scrutiny afforded by additional peer review ultimately may prove useful, a more precautionary stance would have been to reduce fishing mortality to the levels indicated by the 1998 assessment until legal conflicts were resolved and management advice based on a new assessment could be promulgated. The precautionary approach requires that scientific uncertainty—in this case, uncertainty about the assessment—not be used as a pretext for inaction. Rather, the more conservative, risk-averse management strategy should be implemented until the scientific uncertainties are resolved. In this case, fishery managers' hazardous response to uncertain science was to allow high levels of fishing to continue, placing the shark populations at greater jeopardy.

Spiny Dogfish Fishery

The spiny dogfish fishery off the mid-Atlantic and New England coasts provides another example where scientific uncertainty resulted in continued overfishing rather than rebuilding. Although spiny dogfish were recognized as an overfished population for several years, it was not until April 2000 that fishery managers finally implemented a rebuilding plan. Even at that, the quota exceeded the scientifically advised level by a wide margin—4.0 million pounds versus 2.9 million pounds—and in the first year of the plan, fishers exceeded that quota by 67 percent (Fordham, personal communication).

In both of these examples, the uncertainty of the science is not the primary culprit. Rather, the problem is that fishery managers used scientific uncertainty to justify hazardous decisions. A requirement to respond to uncertainty with precaution could go a long way toward solving this problem.

New Evidence of Greater Scientific Uncertainty: Retrospective Analysis

One of the most important indicators of population trends in a fish species is the number

of new members of the species entering the fishery. This is known as recruitment. Increasing recruitment may signal recovery for depleted fish populations and could allow for increased future catches. The size of the incoming year-class, often termed "recruitment strength," is of particular importance in heavily fished populations in which new recruits may represent a sizeable portion of the fishable population.

Despite the importance of recruitment estimates, generally they are poorly estimated, especially when they first appear in fishery data. Over time, scientists can better quantify the size of a year-class, enabling them to gauge, in retrospect, how far off the initial estimates may have been. As more retrospective analyses are completed, further evidence of past large errors in abundance estimates accumulates. While the data show both positive and negative deviations, the consequences of abundance overestimates, which may in fact be more common, are much more serious than the impacts of underestimates.

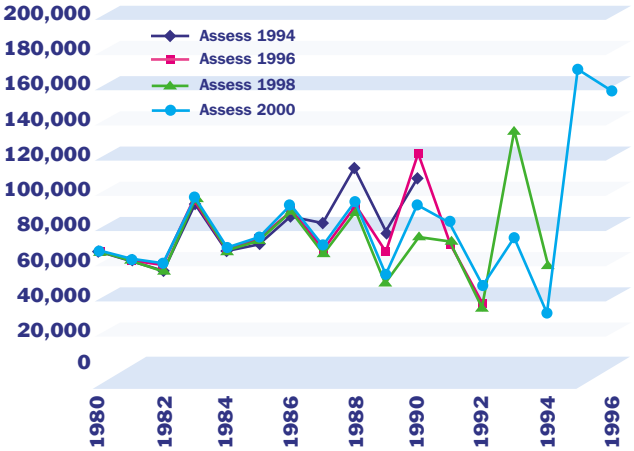
Western Atlantic Bluefin Tuna

Figure One is a retrospective analysis of recruitment for Western Atlantic bluefin tuna. Year-class abundance estimates of a given year-class differ markedly—up to a factor of two—in assessments conducted only two years apart. For example, the abundance of the 1993 year-class, as estimated in 2000, is one-half of that estimated in 1998 for the same year-class. Overall, there is a tendency for large year-classes estimated in one assessment to be unsubstantiated in the next.

Figure One

Analysis of Recruitment for Western Atlantic Bluefin Tuna

Estimates of year-class size from the base case assessments conducted in the years 1994, 1996, 1998, and 2000, showing the tendency for large year-classes estimated in one assessment to not be substantiated in the next. The reverse also sometimes occurs.



Source: ICCAT, 2001.

The 2000 assessment provided the first and only estimates of the 1995 and 1996 year-class sizes. These estimates suggest incoming year-classes more than double the size of those seen on average for this population since 1980. This optimistic interpretation is tempting, but one must ask if it should be acted upon as if it were true. Adopting the optimistic interpretation would be irresponsible given the pattern seen in recruitment estimates over time. Moreover, in light of the fact that the adult Western Atlantic bluefin tuna population is severely depleted and on a 20-year rebuilding schedule, adopting the optimistic interpretation could have disastrous consequences if these estimates prove to be too large. A precautionary strategy based on the assumption that population abundance is

overestimated, as it has been in the past, appears to be warranted.

Fish Populations Are Less Resilient Than Once Thought

"Recent scientific advances indicate that the precision of fisheries assessments is lower than previously thought, that fish populations are less resilient than once imagined, and that the recovery of populations once depleted is much slower than expected."

In part, because many fish species have enormous reproductive potential (as measured by numbers of eggs) compared with others in the animal kingdom, one myth about marine fish populations is that they are especially productive and resilient. For years many believed the notion that the seas were inexhaustible and fish populations could not be seriously depleted, but scientific circles largely have discarded this notion as the number of collapsed and severely depleted populations has increased.

As recently as two years ago, however, many in the fishery community still believed that marine fish populations would rebound rapidly if given a chance (NRC, 1999). Now, even this popular myth is crumbling in the face of empirical evidence showing very slow recovery of many depleted fish populations (Hutchings, 2000; Hutchings, 2001). As Hutchings points out, careful reexamination of the basis of this myth should make these findings less surprising. It is not the number of eggs that counts. What affects the resilience and recovery potential of fish populations is how many fish survive to become parents.

As it turns out, high reproductive output is not strongly associated with high resilience. In addition, Hutchings explains that an increased risk of extinction logically must be associated with the length of time a population spends at low levels of abundance. Thus, the observation that fish populations recover more slowly than had been thought leads to the conclusion that risk of extinction consequently is higher than previously believed.

The Strengthened Case for a Precautionary Approach

Recent scientific advances indicate that the precision of fisheries assessments is lower than previously thought, that fish populations are less resilient than once imagined, and that the recovery of populations once depleted is much slower than expected. In short, the likelihood of making a mistake is greater, while the costs of making a mistake are much higher, than previously believed.

This brief discourse on the history of U.S. fishery management shows that the lack of scientific certainty has been used by managers to justify continued overfishing of already seriously depleted fish populations. At worst, this places some marine populations at serious risk of extinction, while at best it greatly delays the day when recovery may occur. Taken together, these observations point to a more critical need for a practical and timely implementation of the precautionary approach to fisheries management. While the need for a precautionary approach has been voiced before, the strength of the arguments has increased. It is time that fishery management progresses beyond talking about the notion of precautionary management to actually practicing it.

Concrete Steps Toward Precautionary Management

The following recommendations begin to incorporate precautionary approaches to fishery management:

- Develop a national standard that requires a precautionary response to scientific uncertainty. A key element would need to be a formal decision analysis that elaborates and compares the risks and rewards of various possible management actions.
- Establish management targets incorporating a margin of error to account for scientific uncertainty. Targeted yields should be less than MSY and/or fishing mortality targets smaller than FMSY (a fishing mortality rate which, applied year after year, would result in an average annual yield of MSY). Such targets must be defined specifically and clearly, and either numerically or methodologically. The percentage adopted could be derived from an empirical review of retrospective case studies or, more simply, consensus of expert opinion.
- Develop fishing mortality restrictions that cause permissible maximum fishery mortality rates to drop automatically as population levels decline (Applegate et al., 1998). A small decrease in allowable catch at an early stage can avert the need for later drastic sustained cuts in catches.
- In cases where there is controversy about which of several scientific interpretations is correct, proceed with the more precautionary interpretation. If experience proves the interpretation incorrect, then rebuilding would occur faster than anticipated. In contrast, the consequences of adopting the less precautionary stance, if in fact it proves incorrect, could mean the elimination of a fishery in the short or long term.

"In cases where there is controversy about which of several scientific interpretations is correct, proceed with the more precautionary interpretation."

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U.S. Marine Fisheries Policy: A Proposal for Structural Reform

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Summary

Existing fishery policy in the United States divides responsibility between the federal government and the states, which have a variety of mechanisms for setting policy and managing their resources. Congress should update federal fishery law or pass a new law to require comprehensive coverage and greater coordination between state and federal authorities and provide a better mechanism for state/federal compatibility and compliance.

Objectives for Policy Reform

The objectives of policy reform are to:

- establish an integrated and consistent environmental and political/administrative national marine fisheries policy structure;
- maintain sensitivity to regional differences in fisheries;
- encourage broad participation in the development and implementation of marine fisheries and marine fisheries habitat policy.

Current Policy Structure

The current policy structure for marine fishery management in the U.S. is outlined below.

1. Individual states have primary authority and responsibility in areas of state jurisdiction, which generally includes internal waters and ocean waters out to three miles. Individual states develop fishery policies through a variety of bodies, including legislatures, administrative agencies, and independent commissions. They use various management instruments, including statutes, regulations, and management plans.
2. The Magnuson-Stevens Fishery Conservation and Management Act established federal authority in the U.S. Exclusive Economic Zone (EEZ), generally from 3 to 200 miles out. As set forth in the Magnuson-Stevens Act, the federal government exercises its authority and responsibility through the regional fishery management councils, which develop Fishery Management Plans (FMPs), and the Department of Commerce, which, as the federal public trust agency, reviews, approves, and implements those plans.
3. Three Interstate Marine Fisheries Commissions (interstate compacts funded primarily by the federal government) have only coordination responsibilities, except for the Atlantic States Marine Fisheries Commission (ASMFC), which, under the 1993 Atlantic Coastal Fisheries Cooperative Management Act (ACA), has certain unique responsibilities. The ACA gives the ASMFC responsibility for developing FMPs, exclud-

ing those developed under the Magnuson-Stevens Act, for interjurisdictional fisheries from the headwaters of the states' internal waters to the 200-mile EEZ boundary. The individual states are then responsible for implementing the provisions of the ASMFC plans through state-promulgated regulations consistent with the ASMFC plan. If a state does not comply with the ASMFC plan, the ASMFC may apply to the Department of Commerce for a moratorium on the fishery in the offending state until it is in compliance. Congress modeled the ACA after the successful Striped Bass Act of 1986, which is commonly credited with the restoration of the Atlantic Striped Bass fishery.

Proposal for Structural Reform

Implementation of the following recommendations would help fill some of the existing gaps, overlaps, and inconsistencies in current U.S. fishery laws.

Congress should pass a new federal law combining the features of the Magnuson-Stevens Act and the ACA. The new law could be accomplished as an amendment to the Magnuson-Stevens Act or the ACA, or passed as a new law, which might be termed the Comprehensive State-Federal Fisheries Management Act (CSFFMA). The law should include several key provisions:

1. Unified federal authority from the headwaters of U.S. coastal watersheds to the extent of the EEZ in all U.S. states, territories, and commonwealths (as with the ACA).
2. Regional councils, as mandated in the current Magnuson-Stevens Act, would be retained with appropriate appointment mechanisms.
3. The Department of Commerce, or possibly the Department of Interior—if the National Oceanic and Atmospheric Administration (NOAA) were moved to that department—would be the principal public trust authority, with fishery management plans submitted by the regional councils to the department for review.
4. FMPs would have two forms of implementation. Outside of a state's jurisdiction, the federal public trust agency would have the primary authority and responsibility for implementation of the plans. Inside state jurisdiction, the individual states would have primary responsibility and authority for implementation of the plans (as in the current ACA). The federal government, however, would have preemption authority (as opposed to the current moratorium authority under the ACA) up to the headwaters of the states, if the states were found to be out of compliance with the plan. Enforcement mechanisms could stay essentially the same as currently exist.
5. In order to implement the intent of the Sustainable Fisheries Act of 1996 with respect to fisheries habitat, the Departments of Commerce and Interior, the Environmental Protection Agency (EPA), and relevant states would be

"Congress should pass a new federal law combining the features of the Magnuson-Stevens Act and the Atlantic Coastal Fisheries Cooperative Management Act."

required to jointly develop Comprehensive Fishery Habitat Plans (CFHPs) covering fishery habitat from the headwaters to the outside edge of EEZ. The CFHPs would be separate from, but companions to, the FMPs. Similar to the current consistency provisions of the Coastal Zone Management Act, the CFCMA would require all state and federal regulations to be consistent with the CFHPs.

"Bold, revolutionary action should be considered at this point in the history of U.S. coastal and ocean policy despite potential political challenges."

Effects of a Comprehensive State-Federal Fisheries Management Act

The enactment of a new state-federal fisheries law as outlined above would have a number of benefits:

1. An ecosystem-based, state-federal fishery policy framework, in both its biophysical and its sociopolitical characteristics.
2. Representation of individual state, regional, and national interests.
3. A system of checks and balances between and among the states and the federal government.
4. The integration of comprehensive habitat and individual fishery policy.

The aforementioned framework probably would be most effective if accompanied by some federal administrative restructuring, such as moving NOAA from the Department of Commerce and the Office of Wetland, Oceans, and Watersheds (OWOW) from EPA and combining them into a new Coastal and Ocean Unit of the Department of Interior. The Weather Service could be split off from NOAA and given to National Aeronautics and Space Administration or the U.S. Geological Survey, if necessary.

Conclusion

Bold, revolutionary action should be considered at this point in the history of U.S. coastal and ocean policy despite potential political challenges. This paper provides a proposal for discussion and debate in the fisheries arena. Similar proposals could be developed for other areas of coastal and ocean policy.

A Selection of State and Federal Laws and International Agreements Referenced

Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA)
16 U.S.C. 5101–5109; Title VIII of Pub. L. 103–206, as amended.
Enacted in 1993
The Atlantic Coastal Fisheries Cooperative Management Act authorizes the Atlantic States Marine Fisheries Commission to prepare and adopt coastal fishery management plans for interjurisdictional fisheries in state waters. Composed of 15 states from Maine to Florida, the Commission adopts plans, specifies the states required to implement and enforce a plan, and specifies criteria necessary for state compliance with a plan. Each individual state is then responsible for writing regulations to implement and enforce a plan in waters under its jurisdiction.

ACFCMA also authorizes the Commission to determine when states do not comply with approved fishery management plans. Upon such a determination, the Commission must report the finding to the secretaries of commerce and interior. Under these circumstances, and only under these circumstances, the secretary of commerce may impose a moratorium on all fishing for the species in question within the offending state's waters until that state comes into compliance with the Commission plan.

Congress modeled the ACFCMA after the successful Striped Bass Act of 1986, which is commonly credited with the restoration of the Atlantic Striped Bass fishery.

California's Marine Life Management Act (MLMA)
Enacted in 1998
Based on lessons learned from years of experience in management of marine fisheries and other living marine resources, the MLMA seeks to begin a new era in the conservation and management of living marine resources. The principal goal of the MLMA is to ensure the conservation, sustainable use, and restoration of California's marine living resources. The law applies to all marine wildlife rather than only commercially and recreationally valuable fish and shellfish. It encourages an ecosystem-based approach to management that is further reinforced in explicit policies. Key management policies protect living marine resources by conserving the health and diversity of marine ecosystems, allowing only sustainable uses of marine living resources and recognizing the importance of nonconsumptive values and uses of marine living resources, as well as the importance of sustainable sport and commercial fisheries to the economy and culture of California. Policy authority is delegated to the California Fish and Game Commission; implementation responsibility to the California Department of Fish and Game.

Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR)
CCAMLR was established mainly in response to concerns that an increase in krill catches in the Southern Ocean could have a serious effect on populations of krill and other marine life, particularly birds, seals, and fish, which mainly depend on krill for food. It takes an ecosystem approach to managing living marine resources in the Southern Ocean and utilizes a precautionary approach to fisheries management. The objective of the convention is the conservation of Antarctic living marine resources, allowing for rational use of those resources. CCAMLR came into force in 1982, as part of the Antarctic Treaty System. Many observers feel this pioneering work on the precautionary and ecosystem approaches set standards for fisheries agencies worldwide.

Endangered Species Act (ESA)
ESA; 16 U.S.C. 1531–1543; Pub. L. 93–205, as amended.
Enacted in 1978
The ESA protects species that are in danger of extinction or endangerment throughout all or a significant portion of their range and the conservation of the ecosystems on which they depend. The ESA requires federal agencies to ensure that any action authorized, funded, or carried out by them is not likely to jeopardize the continued existence of listed species or modify their critical habitat.

The National Marine Fisheries Service (NMFS) must develop recovery plans for species listed as endangered under the Endangered Species Act. It must also ensure that fishery management actions do not compromise the conservation and survival of threatened and endangered species, and their habitats. ESA-listed species under NMFS jurisdiction include marine mammals such as the Steller sea lion and Hawaiian monk seal, anadromous fish (Pacific salmon), sea turtles, and several species of whales. The U.S. Fish and Wildlife Service manages seabirds.

Magnuson-Stevens Fishery Conservation and Management Act
16 U.S.C. 1801–1883; Pub. L. 94–265, as amended.
Enacted in 1976
The Magnuson-Stevens Act regulates fisheries within the United States Exclusive Economic Zone (EEZ). The law vests authority over the nation's fisheries with the secretary of commerce. The secretary has delegated that authority to the National Marine Fisheries Service (NMFS), which is responsible for the conservation and management of the nation's living marine resources. The law also established a unique regionally based management system by creating eight regional fishery management councils.

The council system is designed to adapt the management of individual fisheries to suit local needs and to increase the meaningful involvement of regional fishers. The councils are initially responsible for developing fishery management plans that fulfill the objectives of the law. Councils submit these plans to NMFS, which either approves or disapproves them based on a set of guiding principles articulated as "national standards" in the Magnuson-Stevens Act. If approved, plans are implemented through federal regulations written by NMFS. Amendments to fishery management plans are adopted in the same manner.

Congress originally enacted the legislation in 1976 as the Fishery Management and Conservation Act and changed the name to the Magnuson Fishery Conservation and Management Act in 1980. After the Sustainable Fisheries Act of 1996 amended the law, Congress changed the name to the Magnuson-Stevens Fishery Conservation and Management Act to honor the role of Senator Ted Stevens (R-AK).

Marine Mammal Protection Act (MMPA)
16 U.S.C. 1361–1421; Pub. L. 92–522, as amended.
Enacted in 1972
Congress passed the MMPA to protect and manage marine mammals and their products (e.g., the use of hides and meat). The MMPA also established the Marine Mammal Commission whose duties include reviewing laws and international conventions relating to marine mammals, studying the condition of the mammals, and recommending steps that federal officials should take to protect marine mammals.

Under the Marine Mammal Protection Act, NMFS is required to prepare stock assessments for all marine mammals in waters under U.S. jurisdiction, and to develop and implement "take" reduction plans for populations that may be reduced or are being maintained below their optimum sustainable population levels due to interactions with commercial fisheries. The term "take" is defined to mean, "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." NMFS manages the "taking" of marine mammals incidental to commercial fishing (i.e., bycatch).

National Environmental Policy Act (NEPA)
42 U.S.C. 4321–4347; Pub. L. 91–190, as amended.
Enacted in 1969
The basic policy of the act is to assure that all branches of government consider the environment before undertaking any major federal action that significantly affects the environment.

NEPA requires NMFS to prepare an environmental assessment or environmental impact statement before adopting fishery management plans or amendments. By evaluating potential effects of the proposed fishery management action, disclosing potential adverse environmental impacts that may result, and considering alternatives to the proposed action, these analyses are intended to improve the fishery management decision-making process and to help managers mitigate adverse effects on the marine environment.

Sustainable Fisheries Act (SFA)
Pub. L. 104–297.
Enacted in 1996
The Sustainable Fisheries Act amended the Magnuson-Stevens Act. Significant conservation requirements were added to address overfishing, bycatch (the incidental capture of marine life while fishing), and fish habitat protection. To further future conservation, the act established an Ecosystem Principles Advisory Panel. This panel was charged with providing recommendations to Congress about how to expand the application of ecosystem principles in fishery conservation and management activities. The SFA also placed a moratorium on the development and implementation of new Individual Fishing Quota (IFQ) programs and required a comprehensive assessment of IFQ programs by the National Academy of Sciences.

United Nations Agreement for the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (the U.N. Fish Stocks Agreement)
Signed in 1995 (ratified by the U.S. Senate on August 21, 1996)
Technically limited to fisheries involving straddling or highly migratory stocks, the U.N. Fish Stocks Agreement was negotiated to implement the U.N. Convention on the Law of the Sea (UNCLOS) and contains several obligations new to international fisheries, including mandating a precautionary approach to fishery management that protects biodiversity and minimizes bycatch. The **U.N. Food and Agriculture Organization (FAO) Code of Conduct for Responsible Fisheries** (the FAO Code), which is nonbinding, is intended to apply fishery conservation requirements consistent with the UNCLOS and the U.N. Fish Stocks Agreement to fisheries for all stocks in all areas of the oceans. In 1997, the U.S. created an implementation plan for the FAO Code, proposing that existing laws and programs would fulfill the objectives of the code.

United Nations Convention on Biodiversity
Signed in 1992 (not yet ratified by the U.S)
Signed at the United Nations Conference on Environment and Development in Rio de Janeiro, Brazil, the Convention on Biological Diversity is the first global agreement on the conservation and sustainable use of biological diversity. The convention has three main goals: (1) conservation of biodiversity, (2) sustainable use of components of biodiversity, and (3) sharing the benefits arising from the commercial and other use of genetic resources in a fair and equitable way. The convention also guides decision-making based on the precautionary principle; where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat. Pending ratification of the convention, the 1969 Vienna Convention on the Law of Treaties obligates the U.S. not to undercut the biological diversity convention.

United Nations Food and Agriculture Organization (FAO) International Plan of Action for the Management of Fishing Capacity
This voluntary plan calls on countries to develop national plans to manage fishing capacity in an efficient, equitable, and transparent manner by 2005. The issues of excess fishing capacity in world fisheries is an increasing concern to the FAO, given the overall objective of sustainable fisheries established in the Code of Conduct for Responsible Fisheries. The International Plan of Action for the Management of Fishing Capacity states:

1. Excessive fishing capacity is a problem that, among others, contributes substantially to overfishing, the degradation of marine fisheries resources, the decline of food production potential, and significant economic waste.
2. The Code of Conduct provides that states should take measures to prevent or eliminate excess fishing capacity and should ensure that levels of fishing effort are commensurate with sustainable use of fishery resources.

Glossary

Anadromous
Species that spend their adult lives in marine waters but migrate to fresh waters to spawn.

Biodiversity
The variation in living systems at all organizational levels, from the large-scale diversity of ecosystems to the minutiae of genetic diversity within a particular population. Biodiversity is often evaluated through measurement of species diversity in a given area or over a specific period of time.

Biomass
The quantity of a living marine resource as measured by weight.

Bycatch
Marine life caught incidental to the catch of the primary target species. Bycatch may be retained or discarded. Discards may occur for regulatory or economic reasons.

Community Quotas (CQs)
Assignments of quota shares to individual communities, or groups of communities, rather than to individual firms.

Derby fishery
A short frenetic fishery resulting from a race for fish in which each boat tries to catch as many fish as possible as quickly as possible. It often occurs in fisheries featuring a total allowable catch limit but no limits on individual catches.

Individual Fishing Quotas (IFQs)
Fishery management tool that allocates a certain portion of the total allowable catch to individual vessels, fishermen, or other eligible recipients, based on initial qualifying criteria.

Maximum Sustainable Yield (MSY)
The largest average catch that can be taken continuously (sustained) from a stock under average environmental conditions.

Observer coverage
Placement of a person on a boat to observe fishing practices, including catch amount and bycatch.

Optimum Yield (OY)
Term defined in the Magnuson-Stevens Fishery Conservation and Management Act as the amount of fish providing the greatest overall benefit to the nation based on the MSY from the fishery as reduced by any relevant economic, social, or ecological factors

Quota share
Amount of quota, translated into pounds or number of fish, that a particular individual or corporation is allowed to harvest or process.

Recruitment

Number, or percentage, of fish that survive from birth to a specific age or size. The specific age or size at which recruitment is measured may correspond to when the fish first become vulnerable to capture in a fishery or when the number of fish in a cohort can be estimated reliably by stock assessment techniques.

Spawning biomass

Total amount of all sexually mature fish in a stock as measured by weight.

Territorial Use Rights in Fishing (TURF)

The assignment of exclusive rights to a fishery area to an individual or to a group.

Total Allowable Catch (TAC)

Total catch permitted to be caught from a stock in a given period, typically a year. In the United States, the responsible agency at the state, regional (commissions or councils), or federal (National Marine Fisheries Service) level determines the limit.

U.S. Exclusive Economic Zone (EEZ)

All waters from the seaward boundary of coastal states (generally 3 miles offshore) out to 200 nautical miles.

Year-class

Fish of a given species spawned or hatched in a given year. For example, a three-year-old fish caught in 1998 would be a member of the 1995 year-class. Year-class is a “generation” of fish.

Pew Oceans Commission

Connecting People and Science to Sustain Marine Life

The Pew Oceans Commission is an independent group of American leaders conducting a national dialogue on the policies needed to restore and protect living marine resources in U.S. waters. After reviewing the best scientific information available, the Commission will make its formal recommendations in a report to Congress and the nation in early 2003.

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