MARINE AREA GOVERNANCE AND MANAGEMENT IN THE GULF OF MAINE:

A CASE STUDY*

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by

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I. Introduction

A. Background and Focus of the Case Study

This case study provides a description and evaluation of marine area governance and management in the Gulf of Maine. On the advice of the Oversight Committee,[1] we began the study at a broad level by identifying marine resources, uses of the resources, existing management regimes, and conflicts among users of the resources. The results of these initial reviews are collected in the tables in Appendix A.[2] The Oversight Committee also suggested that we develop a chronology of important events relating to marine area governance and management in the Gulf of Maine, which is included as Appendix B.

As is clear from even a quick scan of the material in Appendix A, almost every conceivable use of the marine environment occurs in the Gulf of Maine at some scale. However, some of these uses are more problematic than others in terms of the governance and management problems they engender. Rather than take a broadbrush approach that might not have done justice to any of the region's many ocean resources and uses, we decided to focus the case study on one or more of its most difficult and consequential governance and management issues. The initial survey enabled us to focus in on a subset of resources, use conflicts, and governance issues, namely those associated mainly with marine fisheries governance and management.

Several considerations support the argument for a focus on fisheries governance and management. The marine fisheries are a regional-scale resource and industry, due to the mobility of the fish stocks, the geographic distribution of the users of the resource, and the fact that governance institutions have been designed to have regionwide authority. Thus fisheries mismanagement has the potential to inflict widespread social detriment and significant economic losses. Indeed, the net cost of depleted groundfish stocks under the current management structure, relative to the condition of stocks in an optimally managed fishery, has been estimated at about $139 million annually, or just under one-fifth the landed value of the entire Gulf of Maine commercial catch.[3]

Other ocean resources with potentially regional impacts, such as offshore energy, are not being pursued in the Gulf of Maine region at levels that pose significant concerns. Consequently, non-fishery resource management problems in the Gulf of Maine are, for the most part, local in scale, of comparatively minor economic significance, and not unique to the region. There is no evidence, for example, of "system-wide degradation of marine environmental quality in the Gulf of Maine. . . . The Gulf as a whole remains relatively clean, although the deep central

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[1] The members of the Gulf of Maine Oversight Committee are Ted Ames, Bob Bendick, Bill Eichbaum, Bob Howard, Bob Repetto, Trina Wellman, and George Woodwell.

[2] Some descriptive economic statistics developed as part of this survey are provided in Section III of this report.

[3] See Edwards and Murawski (1993) and sections II.B and IV.C.1 of this report.

basins appear to be accumulating several pollutants, including PAHs and PCBs" (GOMCME 1994; see also Dow and Braasch 1996 and Gould, Clark, and Thurberg 1994). Given that most pollutants of concern are concentrated in inshore waters near urban areas and in the mouths of industrialized rivers, it is not at all clear that they could be dealt with more effectively or efficiently at the regional level.

In sum, our focus on fisheries reflects our judgment that the greatest net benefits might be obtained from improvements in the governance and management of these marine resources within the Gulf of Maine region.

B. Governance: A Definition

It is important to differentiate between the terms "governance" and "management." In our study, we employ an heuristic device developed by Ciriacy-Wantrup (1971), an early natural resource and institutional economist, who was interested in evaluating policies affecting the allocation of fresh water resources in the western United States. Ciriacy-Wantrup identified three general, but overlapping, levels of decisionmaking: (1) the policy level, (2) the institutional level, and (3) the operating level.

To Ciriacy-Wantrup, the policy level is the most general. It consists of decisionmaking with respect to the design of institutions, such as the three branches of the U.S. government; the best example of rules for making decisions at this level is a constitution. The institutional level is intermediate in generality between the policy and operating levels. It comprises laws governments, markets, and hybrid institutions. At the institutional level, the purpose of decisionmaking is to "maintain and increase welfare by continuously influencing decisionmaking on the lower level under constantly changing conditions." The most specific level is the operating level, where public agencies implement specific management instruments and firms attempt to optimize their activities.

We believe that Ciriacy-Wantrup's levels of decisionmaking are consistent with the definition of marine area governance developed by the MAGAM Committee:

> The process of marine area governance has two dimensions: a political dimension where ultimate authority and accountability for action resides, both within and among formal and informal mechanisms—**governance**; and an analytical and action dimension where problem analysis leads to action and implementation—**management** (emphasis in original).

In this study, we refer to Ciriacy-Wantrup's institutional level when we consider issues of marine area "governance." Likewise, we will refer to his operating level when we consider issues of marine area "management." According to Ciriacy-Wantrup, decisionmaking at the policy and institutional levels involves political processes almost entirely, whereas the operating level involves the application of mainstream economic theory and operations research techniques

to "optimize" resource allocations.

Ciriacy-Wantrup believed that it may be possible to evaluate the effectiveness of decisionmaking at the institutional level only over time and as it responds to variable economic conditions. Using "conceptually and operationally meaningful proxies" for measuring changes in national income, institutions that lead to the greatest increase in net national income are to be preferred over others. The MAGAM Committee has adopted a different approach involving the application of a set of "decision criteria" (Eichbaum 1996) to evaluate the performance of governance institutions. Using the decision criteria, we attempt such an evaluation in Section V below. Notably, such an application requires the consideration of effects of management in an evaluation of the performance of governance institutions.

C. Organization of the Study

The case study is organized as follows. In Section II, we present a survey of the resources and uses of the Gulf of Maine. Included in this survey is a description of the Gulf of Maine and its watershed, a general description of resource uses and use linkages, and comparative estimates of the size of marine sectors, in terms of gross revenues or government expenditures.

An overview of marine governance and management in the Gulf of Maine is presented in Section III. This section reviews governance and management regimes for fisheries in the United States and Canada, international fisheries, marine mammals and endangered species, ecosystem management, and other issues, including dredging, coastal water pollution, and ocean discharges. A chronology of salient marine governance and management "events," which can be found in Appendix B, supplements the discussion in this section.

In section IV, we summarize the recent history of the harvest and management of groundfish in the Gulf of Maine. Because this case is one that has been examined in considerable detail over the years by a number of authors, instead of presenting a chronological account, we analyze some of the basic factors that have led to and shaped the current situation of near stock collapse and recruitment overfishing (see also the chronology i Appendix B). We discuss the role of interest groups in the process, the significance of management systems that oscillate from input to output controls, the importance of technological innovations, assistance programs, closures, noncompliance, determining "overfishing," and habitat protection.

In Section V, we evaluate the success of the existing system of governance in the Gulf of Maine, primarily in terms of the individual institutions and programs discussed in Section III. The charter and performance of each institution is assessed according to eleven decision criteria that have been identified and defined by the MAGAM Committee, as well as our own criterion of overall "impact," or the ability of the institution to make a significant difference to social or economic well-being throughout the region.

In Section VI, we summarize our major conclusions about marine area governance and management in the Gulf of Maine, placing particular emphasis on the fact that fisheries management stands out as a clear failure. Also highlighted in the conclusions are the increasingly important policy void concerning ocean mariculture; the fundamental adequacy of existing federal and state mechanisms to deal with regional pollution problems; and the need, in our judgment, for the scale and scope of governance and management institutions to match the scale and scope of the problems they are intended to address. Section VI closes with some suggestions for potential solutions to the Gulf of Maine fisheries crisis, including possibilities for adapting the best features of other, more successful management approaches and for correcting some of the most problematic features of the Magnuson Act, the most important of the governance institutions affecting the Gulf of Maine.

D. Approach

Specific research activities for this case study were guided by discussions with the Gulf of Maine Oversight group within the Marine Board Committee on Marine Area Governance and Management (MAGAM). We used a combination of literature review and personal and telephone interviews[4] to gather information about GoM resources, their uses, governance and management structures, and perceptions of their performance. A partial list of the literature reviewed is found in the reference section of this case study.

II. Survey of Resources and Uses

A. The Gulf of Maine and Its Watershed

Location and other unique physical attributes account for the Gulf of Maine's rich fishery resources, broad diversity of habitats and species, and uncommon scenic beauty. Extending from

[4] Interviews were conducted with the following individuals, among others: Brad Barr, Stellwagen Bank National Marine Sanctuary Manager; Patricia Clay, Woods Hole Laboratory, NEFSC, NMFS; Russ diConti, Center for Coastal Studies; Eleanor Dorsey, Conservation Law Foundation; Steve Edwards, Woods Hole Laboratory, NEFSC, NMFS; Pat Fiorelli, Staffmember, NEFMC: Mike Fogarty, Woods Hole Laboratory, NEFSC, NMFS; Christine Gault, Waquoit Bay NERR; Cliff Goudey, Westport Scallop Project; Diane Gould, Massachusetts Bays NEP; Janeen Hanson, Massport; Phil Haring, Staffmember, NEFMC; Larry Hildebrand, Environment Canada; Kathy Holmstead, Holmstead Marine Enterprises; Pete Jackson, U.S. Army Corps of Engineers, Waltham; Dave Keeley, Maine State Planning Office; Chris Kellogg, Staffmember, NEFMC; Scott Kraus, New England Aquarium; Phil Logan, Woods Hole Laboratory, NEFSC, NMFS; Art Longart, Nova Scotia Department of Fisheries; Steve Murawski, Woods Hole Laboratory, NEFSC, NMFS; Peter Partington, Canada Department of Fisheries and Oceans; Jack Pearce, Woods Hole Laboratory, NEFSC, NMFS; Judy Pederson, MIT Sea Grant College Program; Andy Rosenberg, NE Regional Administrator, NMFS; Peter Shelley, Conservation Law Foundation; Barbara Stevenson, Council Member, NEFMC; Tara Tracey, EPA Region I (Boston); Bruce Tripp, Coastal Research Center, WHOI; Bob Wall, Director, Gulf of Maine Regional Marine Research Program; David VanderZwaag, Dalhousie University; Peter Wellenberger, Great Bay NERR; John Williamson, New Hampshire Commercial Fisherman's Association; Jim Wilson, Department of Economics, University of Maine.

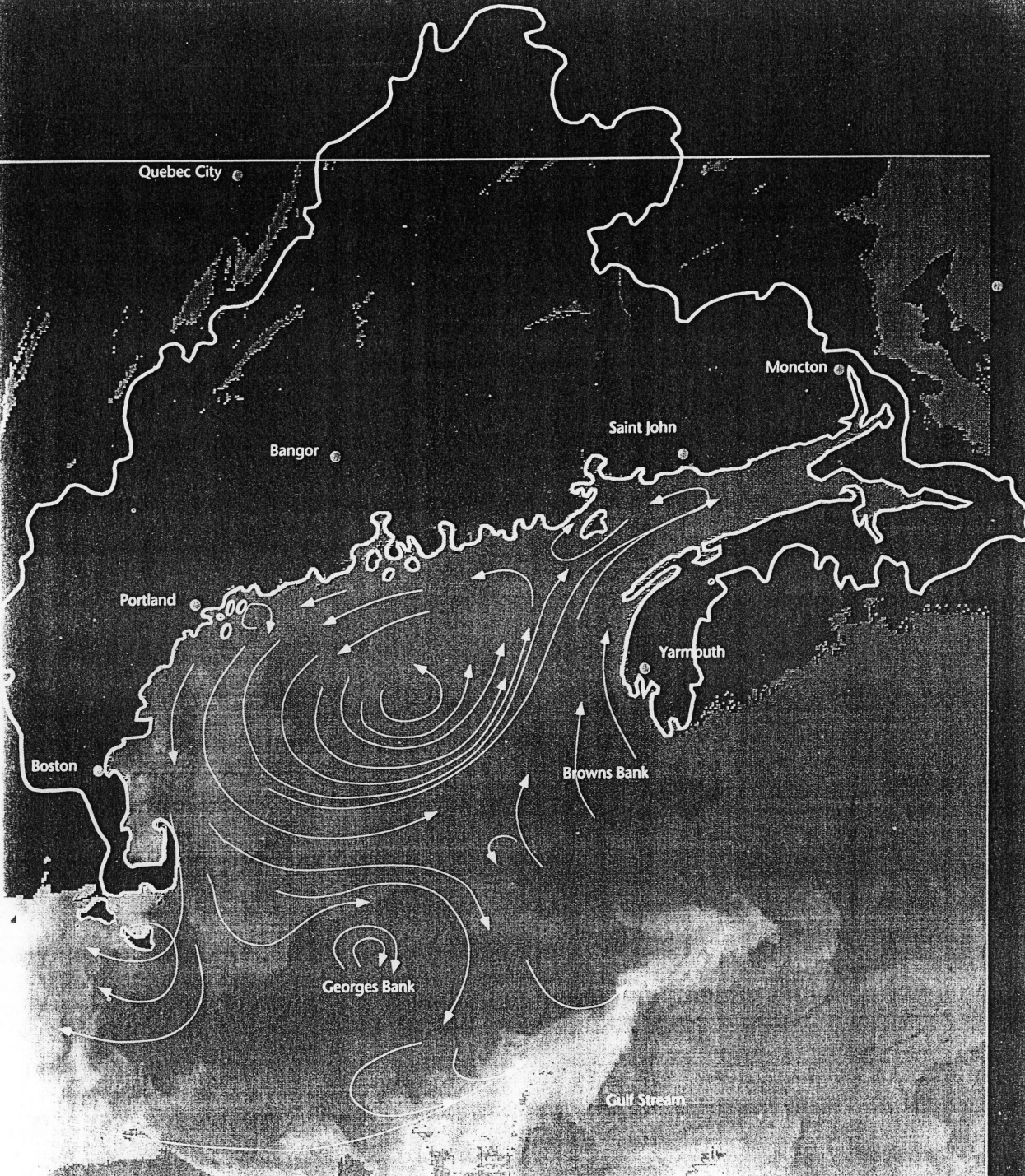
the eastern end of Cape Cod and Georges Bank to western Nova Scotia and the Bay of Fundy, the Gulf of Maine spans two distinct oceanographic regimes—the Gulf Stream to the south and the Labrador Current to the north. The Gulf intertidal zone is a complex transitional zone spanning four "biogeographic provinces" and associated categories of species: the Virginian, cool temperate, Acadian boreal, and subarctic (Sinclair, Wilson, and Rao 1992). In totality, the Gulf of Maine region supports hundreds of species of fish, shellfish, and seabirds and nearly two dozen species of mammals (Maine Critical Areas Program 1989). A study by Parks Canada (cited in Waterman 1995) illustrates the point by noting that a single location (Deer Isle, New Brunswick) is home for at least some part of the year to "836 invertebrate species, 96 fish species, 70 resident bird species, 20 mammalian species, and 223 species of terrestrial and aquatic plants."

With a surface area of 36,000 mi^2 and an average depth of 150 m (490 ft), the Gulf of Maine is the largest semi-enclosed shelf sea bordering the continental United States (Christensen, Smith, and Mayer 1992), a complex glacial basin that is delineated from the Atlantic Ocean by the Nantucket Shoals and Georges and Browns Banks. These topographic features allow for inflow and circulation patterns that counteract the warming effect of the Gulf Stream, producing anomalously cold waters (Conkling 1995; Brooks 1992). The predominant circulation patterns are the counterclockwise Gulf of Maine gyre centered over Jordan and Georges Basins and an adjacent clockwise gyre over Georges Bank (see Figure II.1). The four major drivers of these patterns are the Nova Scotia current, an offshoot of the Labrador Current that enters the Gulf around southwest Nova Scotia; an inflow of dense deep water through the Northeast Channel between Georges and Browns Banks; runoff from local rivers; and daily tides.

Annual freshwater input from the region's 60-odd rivers is estimated at 250 billion gallons (Conkling 1995). Together with direct net precipitation, this amounts to a freshwater input that accounts for only about 1 percent of the volume of all water entering the Gulf each year. The fact that "along-shelf flows into the gulf are greater than the in situ water inputs . . . is the sense in which the Gulf is an open hydrodynamic system" (Lynch 1996).

Tidal patterns, bottom topography, and the temperature, salinity, and density of water all vary tremendously across the Gulf. These variations give rise to the Gulf's great variety of marine species, beginning with the phytoplankton, which may be a mix of temperate and boreal species (Waterman 1995). Primary productivity is high throughout the Gulf, but in certain offshore locations—notably on Georges Bank, over the western Nova Scotia shelf, and in the Bay of Fundy—tides, currents, and bottom topography combine to produce strong vertical mixing of bottom and surface waters and extremely high levels of productivity (Maine Critical Areas Program 1989). Primary production on Georges Bank is estimated to be among the highest anywhere in the global ocean (Waterman 1995; Sinclair et al. 1992). A great number of migratory species, including many types of seabirds and several species of endangered whales, are attracted to the Gulf of Maine by its high primary productivity.

Other distinctive natural features of the region include a very high concentration of


Quebec City
Moncton
Saint John
Bangor
Portland
Yarmouth
Boston
Browns Bank
Georges Bank
Gulf Stream

islands and an unusually large endowment of estuarine habitat, both of which contribute to productivity and species diversity. An archipelago of some 5,000 islands rings the outer Gulf of Maine (Conkling 1995); the inner shoreline ranges from extensive beaches and salt marshes in the south to rugged cliffs and deeply indented, rocky bays and inlets in the north. The extent and complexity of the Gulf of Maine shoreline is well illustrated by some simple comparisons with the Gulf of Mexico: although the Gulf of Maine has only about one-seventeenth the surface area of the Gulf of Mexico (35,000 mi^2 vs. 618,000 mi^2), its coastline is nearly 75% longer (> 7,000 mi vs. 4,100 mi) (Conkling 1995; Broadus and Vartanov 1994).

In comparison to a global coastline that is approximately 1% estuarine, nearly one-third of the Gulf's 69,000 mi^2 watershed consists of estuarine habitat. Gulf of Maine estuaries, where the region's many freshwater rivers deposit sediments and mix with salty seawater, feature some of the highest rates of coastal productivity in the world. In the tidal mudflats and salt marshes that are characteristic of the bays and estuaries in the region, plants provide food and shelter for marine and terrestrial organisms, trap sediments, anchor substrate, and add nutrients through decomposition. Throughout the region, production of seasonal phytoplankton blooms make estuaries important as nursery grounds for juvenile fish of several species and for benthic invertebrates such as worms, mollusks, and crustaceans. Estuaries are believed to be vital at some life cycle stage to about 70% of the fish species of commercial interest along the Gulf coast (Maine Critical Areas Program 1989).[5]

Overall, the Gulf of Maine watershed is less densely populated than most coastal regions of the world (Waterman 1995); roughly 8 million people inhabit the watershed, which includes parts of the U.S. coastal states of Maine, Massachusetts, and New Hampshire; the Canadian maritime provinces of New Brunswick and Nova Scotia; and the inland province of Quebec. A comparatively favorable population density (116 persons per square mile) is often cited as an important contributor to the fact that the marine waters of the Gulf do not yet show serious signs of environmental degradation (e.g., Waterman 1995). There is disagreement, however, as to whether and for how long such a favorable assessment will remain valid. Some experts emphasize the proportionally very small contribution of river runoff to Gulf waters and the importance of "avoid[ing] the trap of 'Location-Based Thinking' about Gulf ecosystem function," seeing that "the Gulf and its sub-structures are an open system at time scales of ecological importance" (Lynch 1996). Others are far more concerned about the "considerable potential for anthropogenic impact on the gulf through the release of toxic compounds, eutrophication, or hydrodynamic changes," noting that "the [average] residence time of waters within the gulf appears to be on the order of one year, comparable to that of many other large estuaries and coastal seas which have already felt anthropogenic change" (Christensen, Smith and Mayer 1992).

[5] This fact may be misleading, because, of the approximately 52 commercial species (Conkling 1995), the largest and most valuable commercial harvests are made, for the most part, from stocks well beyond the influence of estuarine inputs in the Gulf of Maine proper.

By contrast, there is little disagreement about the seriousness of anthropogenic stresses on the region's living marine resources and estuarine habitats (Waterman 1995). The most longstanding and so far the most evidently damaging form of such stress has been the commercial harvesting of groundfish stocks, notably cod, haddock, and yellowtail flounder[6] (see Section IV). Although individual stocks of groundfish have been overharvested, in general, this should not be considered an ecological catastrophe (Steele 1996), as other stocks of less commercial importance now predominate.[7] The more recent and more localized anthropogenic stresses on estuarine habitats arise primarily from the fact that more than 60 percent of the watershed population (approximately 5 million people) is concentrated in the 26 coastal counties that are home to the region's bays and estuaries (Colgan and Plumstead 1995).

B. Resource Uses and Use Linkages

As noted earlier, nearly all conceivable uses of the marine and coastal environment occur at some scale in the Gulf of Maine region. Table II.1 displays 12 possible categories of marine and coastal resource uses and depicts the hypothetical relationship between any one of these uses and each of the others.[8] The relationships are characterized in terms of the tendency for any given use to have a beneficial (+), a negligible (0), or an adverse (-) effect on another use and vice versa.

The general message of Table II.1 is that marine and coastal resource uses vary markedly in terms of the number of alternative uses with which they are likely to conflict. For example, scientific research stands apart as being the only resource use not to have obvious conflicts with

[6]Particularly among commercial fishermen, there are those who challenge the idea that "overfishing" has been the cause of the phenomenal decline in groundfish stocks. Among other evidence of such a link, however, is the fact that the composition of fish species on Georges Bank has changed markedly over the past 45 years even though the level of total biomass has not (Waterman 1995).

[7] Steele (1995) explains that "regime shifts" of the type seen in the Gulf of Maine (characterized by a decline in the abundance of commercially important groundfish stocks and an increase in the abundance of dogfish, skates, and rays) are a natural ecological phenomenon. Commercial overexploitation might accelerate the phenomenon.

[8]We note the potential for definitional overlap and double-counting across the use categories of recreation, recreational fishing, and tourism. To the extent possible, we use economic data that reflect the following definitions. (1) Recreation includes "non-consumptive wildlife recreation" activities (as measured by, e.g., admissions to whalewatching tours and trip expenditures for birdwatching, wildlife photography, etc.; see USFWS 1991). (2) Recreational fishing includes fishing activities in marine and coastal waters for non-commercial purposes (as measured by trip expenditures, including hotels, meals, and fees for individual and charter boat rentals; see NMFS 1996; Colgan and Plumstead 1995). (3) Tourism includes visits to the Gulf of Maine region by non-residents (as reported by state/provincial departments of tourism and as typically measured by direct expenditures for, e.g., hotels; meals; auto, bicycle, and boat rentals; beach and entertainment admissions; see, for example, van Dusen and Hayden 1989). We note that tourism estimates are the most ambiguous of the three, since the relevant data are to a considerable extent "buried in other statistics on employment and industries, that cannot easily be extracted, particularly at the county level necessary to examine a region like the Gulf of Maine" (Colgan and Plumstead 1995).

Table II.1 Hypothetical Relationships Between Marine Uses in the Gulf of Maine

	cFISH	rFISH	AQUAC	HABIT	TRANS	DREDG*	WASTE*	TOUR	SCI	REC	DEF	MIN
cFISH	+/+											
rFISH	-/-	+/+										
AQUAC	-/-	-/-	+/+									
HABIT	+/-	+/-	+/-	+/+								
TRANS	-/-	-/-	-/-	0/0	+/+							
DREDG*	-/-	-/-	-/-	-/-	+/+	+/+						
WASTE*	-/-	-/-	-/-	-/-	0/0	+/+	+/+					
TOUR	0/+	0/0	0/0	0/+	+/+	0/0	+/-	+/+				
SCI	+/+	+/+	+/+	+/+	+/+	+/+	+/+	0/0	+/+			
REC	0/0	0/0	-/-	+/+	-/-	0/+	0/-	+/+	0/+	+/+		
DEF	0/0	0/0	0/-	-/-	-/+	+/+	0/0	-/0	+/+	-/-	+/+	
MIN	-/-	-/-	-/-	-/-	+/+	+/+	+/0	-/-	+/+	-/-	+/-	+/+

Key:

One use has a beneficial (+), negligible (0), or adverse (-) effect on another use. The table entries are read as follows: the symbol to the left of the slash refers to the effect of the entry in the leftmost column on the corresponding entry in the top row; the symbol to the right of the slash refers to the effect of the entry in the top row on the corresponding entry in the leftmost column. For many of the entries, but especially for the ones identified by an asterisk (*), it will be important to consider both the particular use and its result to fully understand the nature of the effect on the corresponding use.

The abbreviations in the left column and top row stand for the following categories of resource use: commercial fishing, recreational fishing, aquaculture, habitat conservation, transportation, dredging, waste disposal, tourism, scientific research, non-consumptive wildlife recreation (e.g., whalewatching, wildlife photography), defense activities, and mineral production.

any others and, in fact, to have a mutually beneficial relationship with nearly all other uses. The resource use that most closely rivals scientific research in this regard is tourism, which, hypothetically, creates adverse effects (or opportunity costs) only for mineral production and is adversely affected only by waste disposal, mineral production, and defense activities. At the other end of the spectrum is aquaculture, which has adverse effects on all but two other uses (scientific research and tourism) and is adversely affected by all but four others (scientific research, tourism, habitat protection, and defense activities).

As noted in the key to Table II.1, a clear understanding of the actual relationships between uses in any particular setting requires information about the specific forms they take and their results. Figure II.2 depicts the 12 resource uses from Table II.1 in terms of one of the broadest and most basic measures of resource use "results," namely relative "economic size." Economic size is not a rigorous term, and we include this figure only to demonstrate roughly the scale of each activity.[9] The overwhelming predominance of tourism, coupled with the fact that an unusually large share of prime tourist real estate in the Gulf of Maine region is estuarine habitat, suggests that the effects of tourism on habitat conservation may well be more adverse—or at least more complicated—than any general characterization of hypothetical use relationships can capture.

The tables in Appendix A provide considerably more detail about the specific forms of resource use in the Gulf of Maine, including prominent instances of abuses and use conflicts, the extent to which such problems have transboundary consequences, and the primary governance structures and management mechanisms that have been developed to avoid or minimize undesirable resource use outcomes. Tables A.1–A.5 group "primary uses" into five categories, according to whether the resource of interest is the marine/coastal environment as a whole, one or more protected biological species, or hydrocarbon and hard mineral deposits. In Tables A.1–A.3, the first of these resource groupings is further subdivided into resource orientations that treat the marine/coastal environment as fisheries habitat, as assimilative capacity, and as unobstructed estuary or ocean space.

Table A.1 is of special relevance to the focus of this case study. In addition to use conflicts between mariculture ventures and "wild harvest" fishing, the table provides data on the management and current stock status of more than 30 species of fish and shellfish targeted by commercial (and in some cases recreational) fishers. The information in Table A.1 clearly highlights the comparatively complicated and unsuccessful management histories of Gulf of Maine groundfish stocks as compared to those of most other fish and shellfish species.

[9] Economic size is a measure of economic activity, broadly defined. As such it represents neither economic value (the sum of consumer and producer surpluses) nor economic impacts (the effect of the activity on different parts of the economy). The data in Figure II.2 are estimates of individual expenditures (tourism, wildlife recreation, recreational fishing), government expenditures (defense, waste disposal, scientific research, dredging, habitat), or gross revenues (commercial fishing, transportation, aquaculture).

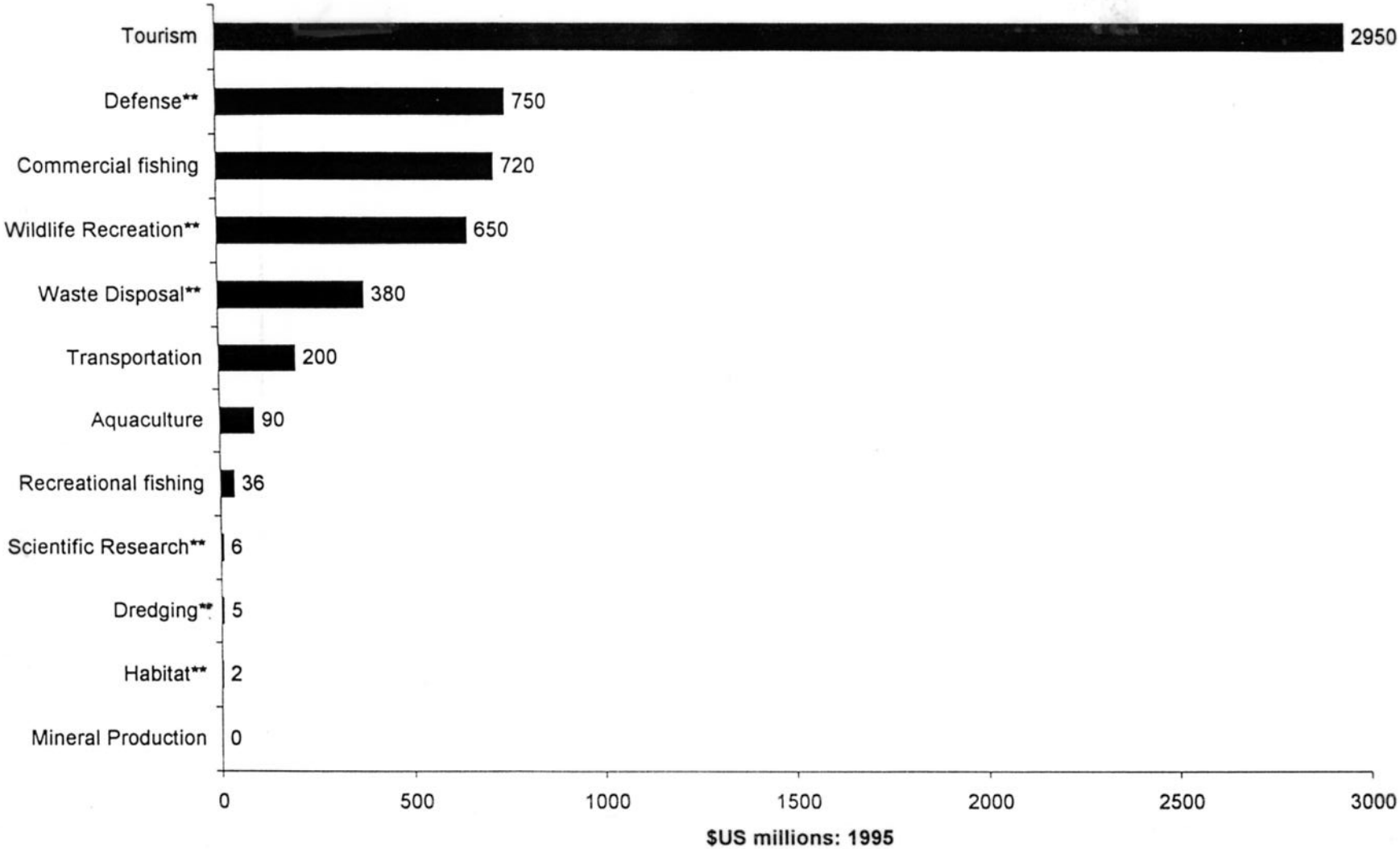


Figure II.2 Estimated Size of Gulf of Maine Sectors

**U.S. only.

Data on the 1993 landed values of commercial fish caught in U.S. and Canadian waters are provided in Table A.6.

C. Scale and Scope

With the exception of migrating fish stocks and certain pollutants, most resource management problems in the Gulf of Maine are local in scale. Other uses with potentially regional implications, such as offshore energy, are not being pursued at levels that pose significant concerns in the region at present. In addition to being mostly local in scale, non-fishery resource management problems encountered in the Gulf are of relatively minor economic consequence, and are not unique to the region. Many Gulf of Maine fish stocks, by contrast, are in poor condition, due (largely) to failures in governance and management, to the region's economic and social detriment. This combination of circumstances led us to focus on fisheries management in our case study. There is a clear case for managing regional fish stocks at a regional scale.

The scope of governance and management regimes across distinct resources (i.e., the need for joint management) is related to intersectoral linkages among these resources, as suggested in Table II.1. For example, fish stocks are affected by certain environmental pollutants as well as by human fishing activity. Linkages such as the effect of environmental pollution on fish stocks are real and must be taken into account in the design of governance and management regimes. In the Gulf of Maine, however, they are of secondary importance compared to the effects of commercial harvesting; and this is reflected in the relative emphasis we give to fisheries harvest management in our case study. We address related management problems, such as waste disposal and water pollution, in correspondingly less detail.

III. Governance and Management Review

A. Overview

Governance institutions concerned with the fish species and environmental quality of Gulf of Maine waters date back to the first decade of this century, with the establishment of the International Council for the Exploration of the Sea (ICES, in 1902) and the U.S.-Canada Boundary Waters Treaty of 1909. By the 1930s, intensive research was under way in the United States to investigate the reasons for changing levels of haddock landings and abundance on Georges Bank, and in 1949 the first international body was created that had authority to regulate and manage high seas fisheries in the Northwest Atlantic, including the Gulf of Maine.

Commercial fishing and fisheries management in the Gulf grew steadily more international in character until 1976, when the United States unilaterally extended its jurisdiction over fisheries resources from 3 to 200 nm offshore. Canada soon followed suit, and since 1978

Gulf of Maine fisheries have been governed and managed under the separate laws and very distinct policies of these two states. Only recently have the two management approaches begun to converge and measures been discussed to promote consistent management of certain stocks.

The 1970s also produced a great deal of landmark environmental legislation in the United States, which established a number of federal and state environmental programs with a substantial presence in the Gulf of Maine. Here we concentrate on programs concerned with the conservation and protection of marine mammals, endangered species, and marine and coastal ecosystems—the last of these an area of very active U.S.-Canada cooperation in the 1990s despite the absence of any treaties or formal ties at the federal level.

Information about the major laws and management mechanisms governing some of the other resource uses discussed in Section II (especially energy production, transportation, and scientific research) is provided as a chronology of events in Appendix B. The chronology also includes considerable detail to supplement our discussion in this section of the major institutions and processes by which Gulf of Maine fisheries and marine and coastal ecosystems are managed.

B. U.S. and Canadian Governance of Fisheries

1. Magnuson Act. The most important governance institution affecting the Gulf of Maine is the Magnuson Fishery Conservation and Management Act of 1976 (Magnuson Act).[10] The Magnuson Act was enacted in 1976 to establish a 197 nautical mile "fisheries conservation zone," (FCZ), now known as the exclusive economic zone (EEZ),[11] extending from the limit of the territorial sea,[12] within which fishing by foreign fleets would be restricted and fishing by U.S. fishermen on stocks requiring conservation and management would be regulated. The Magnuson Act applies to all marine life except seabirds, marine mammals, and highly migratory species of tuna. It applies to anadromous species, even when they straddle out of the EEZ (Kalo et al. 1994).

The main impetus behind the enactment of the Magnuson Act was the concern that foreign fishing fleets were causing widespread depletion of fish stocks located near the United States. To make their case for the exclusion of foreign fishing from U.S. waters, New England fishermen sailed up the Potomac River to Washington in 1974 to protest the adverse effects of foreign fishing on coastal U.S. stocks of groundfish and pelagics (CLF 1994). Of particular concern were the adverse effects of foreign fishing on the Georges Bank haddock stock, which had been an important fishery in the post-World War II period (Murawski 1996).

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[10] 16 U.S.C. 1801 et seq. (1995). General legal interpretations of the MFCMA are found in Kalo et al. (1994) and Jacobsen et al. (1985). Wallace et al. (1994) provide a layman's overview of the MFCMA.

[11] The fishery conservation zone was replaced by a coextensive "exclusive economic zone" in 1983.

[12] The U.S. territorial sea was extended from 3 to 12 nm in 1988, but state fisheries jurisdiction remains within 3 nm.

The establishment of a fishery conservation zone and the determination of "total allowable levels of foreign fishing," "domestic annual harvests," and, subsequently, "domestic annual processing" capacity became central features of the Act. The policy incorporated into the Act mirrored international discussions at the third United Nations Conference on the Law of the Sea (UNCLOS III) with respect to national fishing zones. The basic idea was that an "optimum yield" would be established for certain stocks, and foreign fishing would be permitted to the extent that domestic harvesting and processing capacities were incapable of harvesting the entire optimum yield. In the long run, the general effect of these provisions was to exclude foreign fishing entirely from the U.S. zone.

The Magnuson Act established eight regional fishery management councils (FMCs) with authority to develop fishery management plans (FMPs) for certain stocks. The New England FMC (New England Council) is the relevant council for the Gulf of Maine. The councils include representation from the National Marine Fisheries Service (NMFS), regional coastal states, and knowledgeable individuals from the general public, usually fishermen, who, when voting en bloc, constitute a voting majority.[13] Nonvoting members include regional officials from the U.S. Coast Guard, the coastal Marine Fisheries Commission, the Fish and Wildlife Service, and the State Department.

There is apparently no model or precedent upon which the concept for the regional councils was based. Rogalski (1980) notes that there are practical, biological, and political reasons for the distribution of representation on a council. Prior to the Magnuson Act, marine fisheries management expertise resided primarily at the state level, and the council system was designed to take advantage of this fact. Furthermore, it was recognized that there should be a requirement for coordinated management among the states of a region in an area in which fishermen from each of the states were directing fishing effort at single or biologically linked stocks. Fishermen and state government officials expressed serious concerns with the idea of centralized federal management of the resource (Branson 1987). It was believed that the council system might productively strengthen a resource management relationship between the states and the federal government. Finally, the councils were envisioned as a public "sounding board" for advice and information (Branson 1987).

The councils are an unusual institutional form, and the federal laws governing their activities raise questions of accountability. In their survey of professionals in the field of marine fisheries, Miller et al. (1990:285) note that "[i]t is feared that the will of narrow interest groups overrides sound conservation principles and thereby is a threat to the biological health of the nation's fish stocks." Council activities are explicitly exempt from the Federal Advisory

[13] The 17 voting members on the New England council (NEFMC) include the NMFS Regional Director, five state Fisheries Directors, and individuals nominated by each of the five state governors and appointed by NMFS. The five states are Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut.

Committee Act,[14] and are therefore not required to conform to its provisions (Kalo et al. 1994). As long as council members file and keep financial disclosure forms up to date, actions they may take, such as council votes, that arguably advance their own financial interests are not prosecutable under the federal criminal code (McManus 1995). McManus (1995:16) notes that regulations promulgated under the Magnuson Act are "essentially impervious to review" and that "the case law construing the Magnuson Act grants what is probably the maximum deference to the Secretary [of Commerce], while the statute itself requires the Secretary, in turn, to grant maximum deference to the industry-dominated councils." A council cannot be sued directly for its failure to take action to conserve or manage stocks (Dorsey, p.c., 1996). The primary method by which the councils are held accountable for their planning activities is federal review of proposed FMPs or FMP amendments (Rogalski 1980).

The councils are responsible for the preparation of fishery management plans for each fishery within their respective jurisdictions that requires conservation and management.[15] The Secretary of Commerce approves, disapproves, or partially disapproves FMPs or FMP amendments developed by the councils and promulgates implementing regulations. Much of the approval authority has been delegated to the NMFS Regional Administrator, although a central Department of Commerce review has been retained (Finch 1985). The development and implementation of an FMP is a lengthy process, requiring several rounds of public hearings and review. This process is summarized in Figure III.1, from Wallace et al. (1994). In order to enhance management flexibility, NMFS allows FMPs to include "framework adjustments." Framework adjustments allow the NMFS Regional Administrator to implement management changes without having to go through the lengthy FMP amendment process (Finch 1985).

If a council fails to develop a plan where it is needed, the Secretary of Commerce may issue his own FMP, but this is rare and difficult to accomplish from a political standpoint (Rosenberg 1996). The Secretary may also issue "emergency" regulations that amend an FMP for a short period of time.

The Magnuson Act includes a list of statutory principles (Table III.1), called the "National Standards," that must be followed in the construction and implementation of an FMP.[16]

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[14] The Federal Advisory Committee Act (FACA), 5 U.S.C. app. 1-15 (1995), was enacted to limit industry influence in regulation, to open the federal policymaking process to public scrutiny, and to eliminate unnecessary committees. However, because of onerous requirements relating to the establishment and maintenance of advisory committees, due to ambiguous terms in the Act's language, and due to the threat of litigation, federal agencies have been reluctant to establish advisory committees. Thus, the results of the Act have been counter to its purposes (Norris-York 1996).

[15] Most, but not all, commercially important fisheries are now covered by FMPs. Existing FMPs can be amended or revoked and reissued.

[16] 16 U.S.C. 1851 (1995). The Secretary of Commerce determines the "consistency" of any FMP with the National Standards. The "Section 602" guidelines for interpreting and applying the National Standards are found in the Code of Federal Regulations, 50 C.F.R. 602.

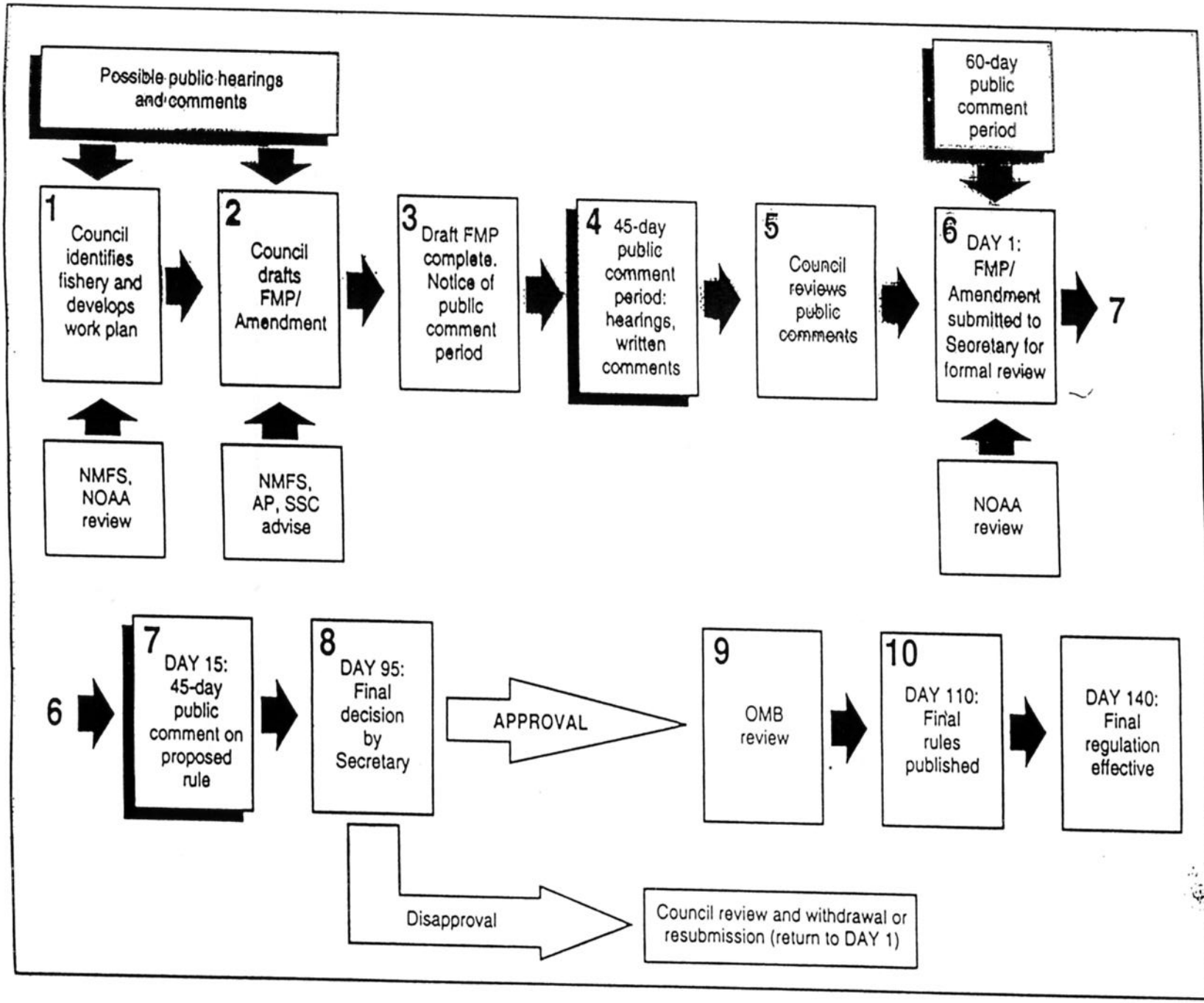

Figure III.1. FMP Development and Implementation Process

Table III.1. Magnuson Act: National Standards

(statutory principles that must be followed in any FMP)

1. Optimum yield: Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery for the United States fishing industry.

2. Scientific information: Conservation and management measures shall be based upon the best scientific information available.

3. Management units: To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.

4. Allocations: Conservation and management measures shall not discriminate between residents of different states. If it becomes necessary to allocate or assign fishing priveleges among various United States fishermen, such allocation shall be: (1) fair and equitable to all such fishermen; (2) reasonably calculated to promote conservation; and (3) carried out in such a manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

5. Efficiency: Conservation and management measures shall, where practicable, promote efficiency in the utilization of fishery resources: except that no such measure shall have economic allocation as its sole purpose.

6. Variations and contingencies: Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.

7. Costs and benefits: conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

In making a determination of the extent to which an FMP is consistent with the Magnuson Act, the Regional Administrator refers to the National Standards. The National Standards can be interpreted as policy objectives, but it should be recognized that these objectives are not necessarily mutually compatible in all circumstances. For example, the implementation of a management measure designed to promote efficiency (standard 5), such as an individually transferable quota (ITQ), could result in one firm holding an excessive share of fishing privileges, thus violating standard 4.[17]

The Section 602 guidelines to the development of FMPs appear to recognize the potential for incompatibility among the National Standards. Each council is responsible for setting clear, comprehensive, and practically attainable management "objectives" in its construction of an FMP. Section 602.10(b) of the guidelines states that:

> [e]ach FMP, whether prepared by a Council or by the Secretary, should identify what the FMP is designed to accomplish, i.e., the management objectives to be attained in regulating the fishery under consideration. In establishing objectives, Councils balance biological constraints with human needs, reconcile present and future costs and benefits, and integrate the diversity of public and private interests. If objectives are in conflict, priorities should be established among them. . . . The objectives of each FMP provide the context within which the Secretary will judge the consistency of an FMP's conservation and management measures with the national standards (emphasis added).

We argue below that the problems that arise in fisheries management in the Gulf of Maine, as well as in other parts of the EEZ, are due largely to incompatibilities among national standards, as reflected in the management objectives of the relevant fishery. More specifically, when FMP objectives are designed to meet the "fair and equitable allocation" provision of National Standard 4, the potential for depletion of the resource may be heightened. This argument will become more clear in the context of the specific case of the New England groundfish fishery, discussed in Section IV.

The most important National Standard is the first one, which refers to "overfishing." Under the guidelines, after 1990, an objective and measurable definition of overfishing[18] must be developed for any fish stock subject to a management plan. The overfishing definition must be based on the best scientific information available.[19] If the relevant fish stock is determined to be

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[17] The guidelines to the National Standards clearly recognize this source of conflict. Section 602.15(b) states that ". . .[t]he goal of promoting efficient utilization of fishery resources may conflict with other legitimate social or biological objectives of fishery management . . . given a set of objectives for the fishery, an FMP should contain management measures that result in as efficient a fishery as is practicable or desirable."

[18] "Overfishing" is defined as a "level or rate of fishing mortality that jeopardizes the long-term capacity of a stock or stock complex to produce [maximum sustainable yield] on a continuing basis." 50 C.F.R. 602.11(c).

[19] Fox (1990) has argued that, in practice, this provision and others place the burden of proof on fishery scientists,

overfished, then a program must be established for rebuilding the stock.

Even in cases where it is clear that conservation objectives must override other objectives, it is difficult to lay the blame for a feckless management plan completely at the feet of an "unaccountable" council.[20] In fact, it may be best to conceptualize the councils as having "responsibilities" but no "authority" under the Magnuson Act (Rosenberg 1996). A "needs assessment" conducted by the National Fish and Wildlife Foundation in 1990 found that NMFS was subject to "political pressure from the fishing industry working directly or through members of Congress" (NFWF 1990:3). Finch (1985) notes that [t]hose who believe council decisions have not been in their favour will frequently muster Congressional and other pressures on all levels of management in Washington, D.C., during the approval process to make further attempts to achieve their objectives. This appears to be the marine fisheries version of the "end-run" to Congress phenomenon (cf. Fordham 1996; Dewar 1983).

At a general level, the Magnuson Act was designed (1) to exclude foreign fishing, thereby creating opportunities for the U.S. fishing industry, and (2) to conserve commercially important fish species. The Act has been almost completely successful at achieving the first goal, but, on a national basis, it has a mixed record with respect to the second (Miller et al. 1990; Finch 1985). As a result, opportunities for economic development of the U.S. fishing industry are not as great as they might have been if stocks had been conserved. Although the Magnuson Act, as a governance institution, has clearly failed in this respect, other policies may have contributed synergistically to the failure. Among these are policies to subsidize the development of the U.S. fishing industry. These policies, their purposes, and their likely effects are listed in Table III.2. With regard to the Gulf of Maine, there has been little research to establish the relative contribution of each of these subsidy programs to the problem of overcapacity in the groundfish fishery, although it is believed that the accelerated depreciation provisions of the Tax Reform Act of 1980 may have had the greatest effect (Logan, p.c., 1996).

2. U.S. Atlantic Coastal Fisheries. The Atlantic States Marine Fisheries Commission was established in 1942 by an interstate compact, which was approved by Congress in 1942 and again in 1950. The Commission is composed of the 15 states along the Atlantic Seaboard and the District of Columbia.

In 1993, the federal Atlantic Coastal Fisheries Cooperative Management Act (ACFCMA) (P.L. 103-206) redefined the authority of the Commission.[21] The ACFCMA requires the Commission to prepare and adopt fishery management plans for "coastal fishery resources."

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not the fishermen, to demonstrate the adverse effects of fishing on commercial stocks.

[20] The concentration of "special interests," namely fishermen, on the Councils has recently become something of a cause célèbre for environmental public interest groups who have sought to have Council seats reserved for the conservation community. See Fordham (1996) and WWF (1995).

[21] 16 U.S.C. 5101 et seq. (1996).

Table III.2. Policies to Subsidize Fishing Industry Development

Policy	Citation	Purpose
Fisheries Loan Fund*	16 U.S.C. 742c; 50 C.F.R. 250	loans to commercial fishermen for financing or refinancing costs of purchasing, constructing, equipping, maintaining, repairing, or operating new or used commercial fishing vessels or gear
Fisheries Obligation Guarantee Program**	46 U.S.C. 1271 et seq.	guarantees obligations that aid in financing or refinancing construction, reconstruction, or reconditioning of vessels
Capital Construction Fund**	50 C.F.R. 259	owners or lessors of vessels can make tax deductible contributions to a capital construction fund to replace, reconstruct or build new vessels
Saltonstall/ Kennedy	15 U.S.C. 713c-3	federal funding for market and product development
Tax exemptions	19 U.S.C. 1309 26 U.S.C. 4221	exemptions from customs duties and excise taxes for fishing vessel supplies
Tax Reform Act		accelerated depreciations schedules for capital
Training grants	16 U.S.C. 760d	grants to universities and colleges to promote the education and training of scientists, technicians, and teachers in the field of commercial fishing
Fishermen's Protective Act	22 U.S.C. 1973 and 1977	reimbursement to fishermen for financial charges and losses sustained as the result of seizure by a foreign country outside that country's territorial waters

*The Fisheries Loan Fund ceased to exist in 1986

** Part of the Merchant Marine Act

Coastal fishery stocks are defined as those that move between or are distributed across two or more of the Atlantic seaboard states or between one state and the EEZ. If there is no federal plan regulating the harvest of the relevant coastal fish stocks under the Magnuson Act, then federal regulations can be promulgated to complement the coastal fisheries plan.[22] The Act provides for financial and other support for the development, implementation, and enforcement of coastal fishery management plans.

An important aspect of coastal fishery management plans is that each state can implement its own measures, as long as these are deemed to be in compliance with the plan. This is called "conservation equivalency." If coastal states fail to implement and enforce their own measures, the Secretary of Commerce can declare a moratorium on fishing the relevant stock within the waters of the noncomplying state.

The recovery of the striped bass fishery is widely judged to be a successful intervention into the management of a coastal fishery by the ASMFC, although it should be recognized that there was a separate piece of legislation governing the recovery effort. The ACFCMA is thought to have been modeled on this legislation.

NMFS has just removed the Magnuson FMPs for lobster and bluefish, in preparation for these species to be managed under the ACFCMA (Plante 1996).

3. U.S. State Governance: The Maine Lobster Innovation. The American lobster fishery is one of a few commercial fisheries that are very heavily concentrated in state waters.[23] Lobster is a basically territorial species exhibiting marked subregional differences in life history parameters, such as rates of growth, maturation, and fecundity. Each state has historically managed its lobster fishery independently, and attempts by federal and state officials over the years to coordinate their lobster management policies through informal cooperative arrangements have met with only limited success. As a whole, the industry is heavily regulated, but the specifics vary considerably from one state to another. The major state regulations include a licensing requirement, prohibitions against the taking of berried (egg-bearing) females, a minimum size requirement of 3 and 1/4 inches, and gear regulations and catch/effort reporting requirements of various types (NEFMC 1994).

To some extent, the variation in state regulatory regimes reflects a pattern of territoriality that may be unique to lobstering and that is particularly pronounced in Maine, which has the predominant lobster fishery on the Atlantic coast. There lobster fishing is a livelihood and way of life that is very deeply rooted in family and local traditions. Amendment 5 to the NEFMC's American lobster fishery management plan devotes considerable discussion to the existence of a

[22] The complementary federal regulations must be consistent with the National Standards found in the Magnuson Act.

[23] For the 10 Atlantic coastal states from Maine to Virginia combined, 73 percent of 1992 lobster landings occurred in state territorial waters (NEFMC 1994).

"sub-local lobster culture within coastal communities" that has developed a "highly organized, albeit informal, self-governance of the resource by individual lobstermen" (NEFMC 1994). Territoriality over fishing waters and acceptance into harbor-specific social units (widely referred to as "harbor gangs" among non-lobstermen) are the key norms around which the self-governance system has coalesced. When they are not out fishing, lobstermen from any given harbor spend a great deal of their time talking and socializing together on the docks.

In this milieu, compliance with regulations and informal customs tends to be high, for two main reasons. First, violations are readily detected, and the social costs of detection are likely to be high.[24] Second, the closeness of the community fosters consensus about what is good for the industry and the resource, and consensus has traditionally produced regulations favored by lobstermen and has derailed regulatory proposals they oppose. The growth in the number of lobster regulations in Maine in the 1980s has been linked, for example, to changes in the lobstermen's attitudes toward favoring limitations on entry and on numbers of traps in order to loosen "a severe cost/price squeeze" (Acheson 1975, as described in NEFMC 1994). Similarly, Maine's unique maximum size requirement (5 inches) and v-notching program[25] have been retained at the insistence of Maine lobstermen (who perceive them to be valuable conservation measures) despite efforts within the state legislature to remove them in the interest of greater conformity with federal and other states' regulations.

There is little scientific evidence that Maine's v-notching program, maximum size limit, and other conservation measures contribute significantly to stock resilience in the face of intensive fishing effort. Noting that similar effort and population trends tend to hold elsewhere throughout the species' range, fisheries scientists instead credit fundamental population dynamics and certain life history characteristics of the species (Fogarty, pers. comm., 1996).[26]

In general, a significant proportion of lobsters are landed before reaching sexual maturity, and in Maine waters the catch is in fact dominated by recruits (Fogarty 1988). Larval drift from

[24]As noted by the NEFMC (1994), this generalization, while essentially valid, obscures many nuances as to the different kinds of violations that may be tolerated at a low level in any given locale, depending primarily on the degree to which the violator is perceived to be a longstanding and otherwise reliable member of the "gang."

[25]Lobstermen voluntarily cut a notch in the tails of berried female lobsters before returning them to the water, and the state purchases berried females from pounds and returns them to the sea after notching them. It is unlawful in Maine to possess a v-notched lobster. All other states and NEFMC prohibit the landing of berried lobsters, but outside of Maine the notching of berried lobsters is generally considered not worth the risk of infection it may pose. Studies into the degree of such a risk have been inconclusive. (NEFMC 1994).

[26]Fogarty (1995) notes that several hypotheses have been advanced to explain recently documented increases in lobster abundance, including: (1) reduced predation levels due to the depletion of such predators as Atlantic cod and other groundfish, which has resulted in increased survival and recruitment; (2) reduced inter-species competition with flatfish; (3) reduced exploitation rates in Canada as a result of enhanced enforcement of existing regulations; (4) the comparatively recent and widespread use of escape vents, which has reduced within-trap and discard mortality for sublegal-sized lobsters; and (5) recent increases in minimum legal size within the United States. Fogarty also speculates that "[r]ecent improvements in water quality in coastal regions may be a factor in increased production."

offshore waters is believed to act as a compensating mechanism, in that it provides a substantial buffer or "subsidy" of progeny to inshore stocks (Fogarty 1995; Fogarty, pers. comm., 1996).[27] Both the rate of larval survival and the rate at which lobster molt to legal size are strongly affected by temperature, however (Fogarty 1988, 1995; Campbell, Noakes, and Elner 1991; NEFMC 1994); and "[v]ery small changes in the survival rate during the early life history stages can result in marked increases [or decreases] in recruitment levels (Fogarty 1995)." Thus, an unusually cold year could well be followed by a "precipitous" decline in landings (Fogarty, pers. comm., 1996). As one fisheries biologist has summed it up, "The factors controlling the production rates of lobster populations are highly dynamic, presenting important challenges for the development of effective management strategies" (Fogarty 1995).

In June 1995, the Maine state legislature passed a bill which reflects the widespread belief among Maine lobstermen that their system of self-governance has been a key factor in maintaining the health of the Maine lobster fishery while the "over-all resource" has been designated overfished and in need of stock rebuilding (NEFMC 1994). The legislation required the state Commissioner of Marine Resources to establish zones along the coast as the basis for achieving more effective management of the lobster fishery, in terms of both the ecological characteristics of the resource and the sociocultural delineations among its harvesters. The impetus for this action was the threat of a rush of new entrants from the declining groundfish fishery (Watson 1996). The legislation specifies that each zone will have a managing council composed of harvesters elected by other harvesters within the zone, and that councils will have the authority to establish rules concerning the number of traps fished, the number of traps on a trawl, and the days or times of day when lobster fishing may take place within their zones.

A draft plan was developed by a working group appointed by the state commissioner and was discussed at public meetings held in January-February 1996 at nine locations along the length of Maine's 4,500-mile coast. The plan calls for the establishment of five zones, which are thought to approximate ecological differences in the lobsters and are each sufficiently small to ensure good representation of the harvesters (approximately 1 council representative per 100 harvesters) and a council of manageable size. The zone boundaries will be subject to renegotiation by the five councils after the first six months of operation.

Other important features of the draft plan include a federalist approach in which a larger Council of Councils is established to deal with interzone issues and conflicts. Provision is also made for the creation of subzones to accommodate smaller-scale ecological or community distinctions. (Thus, the entire system can be thought of as telescoping down to the state level the national system of federal-state-local jurisdictions.) Voting rights are limited to holders of Maine State Class I, II, and III lobster fishing licenses, who represent those with the greatest stake in the fishery. To guard against the capture of a zone council by a special interest group, a 2/3 majority is required to effect changes in rules. Harvesters who fish in more than one zone will be required

[27]According to the NEFMC (1994), the scientific evidence that large areas of the lobster's range are connected by a common larval supply has been "equivocal."

to declare a single zone in which they will vote and will have to comply with the most restrictive rules of all the zones in which they fish.

Concerns voiced about the draft plan at public meetings included the potential in some zones for part-timers (those who harvest lobster 3 months or less out of the year) to predominate among those entitled to vote, which gave rise to a proposal that the votes of full-time lobstermen be weighted more heavily to reflect their income dependence on the lobster fishery.[28] Another issue of broader concern was the question of whether potentially conservative zone rules are really a good idea for the 6,500 holders of Maine lobster licenses (who must comply with Maine regulations out to the 200-mile limit of the EEZ), seeing that others can fish right on the 3-mile state limit under less restrictive rules. In this connection, many Maine lobster fishers believe that the state limit for lobster fishing should be extended to 12 miles or more.[29]

Concerns such as these make the recent withdrawal of the federal lobster management plan especially welcome in Maine, where lobster populations extend well beyond the 3-mile limit but only about 900 lobster fishermen from the state have been issued federal licenses. According to the Maine Commissioner of Marine Resources, the Atlantic Council is seen as far more receptive than the NEFMC to giving lobstermen a significant voice at the local level and trying new concepts such as "controlled entry"[30] rather than closing entry entirely for specified periods as the NEFMC had done (Plante 1996).

The Maine lobstermen's system of self-governance may indeed result in more efficient allocations of lobster stocks among harvesters. By institutionalizing this approach in zone councils composed entirely of harvesters, however, the Maine state legislature appears to assume that harvesters are the only users or owners of the resource. The state's new system of "community-based management" leaves consumers completely out of the picture.

The Maine State Commissioner's working group has been revising its draft "community-based management plan" to take account of public comment, and the emphasis on local decision making and decentralized management has reportedly been growing (*Commercial Fisheries News*, April 1996: 19A). Maine's new lobster zone councils plan is scheduled to go into effect on July 1, 1996, and there is already talk of extending the concept to other inshore fisheries, such as sea urchins. The ASFMC hopes to complete its first lobster plan by the spring of 1997 (Plante 1996).

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[28]This concern is being addressed by the creation of a sportfishing license, which is expected to absorb some portion of the part-timers. However, the greatest reliance is being placed on the 2/3 majority vote requirement for rules changes.

[29]As noted by John Williamson (1996), with a 12-mile limit the range capabilities of navigational radar commonly in use would support the effectiveness of traditional self-regulation techniques to essentially the same degree that binoculars have supported enforcement within 3 miles of home ports.

[30]Maine recently adopted a required apprenticeship program aimed at slowing entry to its lobster fishery and enhancing its professionalism.

4. Mariculture. In the U.S. exclusive economic zone (EEZ), ocean mariculture facilities have been proposed as alternatives to traditional commercial wild harvests. Ocean mariculture is unlikely to replace wild harvests completely as a supply of seafood, but significant potential exists for mariculture operations to supplement existing supplies of some seafood products (Martin 1995; OTA 1995). Moreover, mariculture presents as yet inchoate opportunities for redeployment of labor and capital displaced from depleted wild fisheries (EOEA 1995).

Unlike marine fisheries, ocean mariculture operations are designed to contain the stocks being raised within specific geographic areas using nets, pens, or other technologies. The site-specific nature of ocean mariculture operations requires "security of tenure" (limited property rights) to designated areas of ocean space, possibly including the underlying seabed and neritic and surface waters. Although the allocation of exclusive or proprietary rights to ocean space will be a contentious issue, without security of tenure, the potential exists for other uses of the ocean to impinge upon mariculture operations (cf., Posner 1986; see Table II.1). Furthermore, the availability of investment capital for ocean mariculture operations is likely to be extremely limited in the absence of security of tenure (Cahill 1993; Kornfeld 1993).

In the EEZ, the United States has sovereign rights over the exploitation of commercial living resources. Historically, the United States has exercised those rights through policies designed to manage wild, open-access fish stocks. At present, there is no coordinated policy in the United States governing the use of the EEZ for ocean mariculture operations (Brennan 1995). In particular, there are no specific policies providing security of tenure.

Government officials from the regional Fishery Management Councils, the National Marine Fisheries Service (NMFS), the U.S. Army Corps of Engineers, the Environmental Protection Agency, and the U.S. Coast Guard (USCG), among others, are now being contacted to approve applications or permits of various sorts for ocean mariculture operations. But U.S. policy is not fully developed with respect to the siting of such operations, and permitting is likely to proceed on an inefficient, ad hoc basis.

In a recent study of U.S. aquaculture policy, the U.S. National Research Council (1992) has found that "[c]urrently no formal framework exists to govern the leasing and development of private commercial aquaculture activities in public waters. A predictable and orderly process for ensuring a fair return to the operator and to the public for the use of public resources is necessary to the development of marine aquaculture." Recent efforts of the Joint Subcommittee on Aquaculture have been directed at clarifying the permitting process (Dastin 1996). The New England Fisheries Management Council has recently organized an Advisory Committee to develop an open ocean aquaculture policy (Fiorelli 1996).

Several mariculture ventures are being pursued or proposed in the Gulf of Maine and adjacent waters. These include pen-rearing of salmon off the coast of Maine and scallop and tuna mariculture proposals just south of Cape Cod. The process of obtaining exclusive rights to marine areas for scallop mariculture through the NEFMC has proved to be awkward, as capture

fishermen are reluctant to lose access to fishing grounds (and to reveal publicly where those fishing grounds are). An optimal process for allocating leases to mariculture ventures remains to be developed.

5. Canadian fisheries. Canada's Department of Fisheries and Oceans (DFO) was given the lead role for Canadian ocean policy development in 1977, and is responsible for managing fish stocks within Canada's jurisdiction. An advisory committee (Gulf of Maine Advisory Committee, GOMAC) was established by DFO in the late 1970s as a vehicle for discussion among fishing industry representatives, government officials, and fisheries scientists on the management of fish stocks in the Gulf of Maine.

Over the past two decades, the Canadian approach to fisheries governance has been more centralized than the regional governance structure established in the United States. The Canadian fisheries management system has relied on a combination of limited entry, vessel licensing, total allowable catch levels (TACs) and quotas to manage stocks, in contrast to the effort-control approach favored by NEFMC. Other contrasts arise in the relatively clean separation of science (stock assessment) and management/allocation decisions in the Canadian system (TACs are determined by DFO; quotas are allocated by industry), in the far more stringent catch reporting requirements facing Canadian fishermen, and in the greater Canadian investment in enforcement.

Unlike its deepwater Atlantic fisheries, which have been integrated into large-scale businesses by government policy, Canada's Gulf of Maine fisheries industry is small-scale and atomistic, much like that of the United States (Doeringer and Terkla 1995). Canada manages Gulf of Maine fish stocks in its territory independently from the United States; no formal agreement exists except on enforcement of the Hague Line boundary. However, informal cooperation (herring catch quotas, area closures) and scientific collaboration (regional surveys carried out by both countries) have taken place. Recently, management approaches appear to be converging with the stricter controls of Amendment 7 to the Northeast Multispecies Fishery Management Plan (see Section IV.C), and talks on consistent management of groundfish and herring stocks began in 1996 between NEFMC and GOMAC.

C. International Governance

International management regimes have had little direct effect on Gulf of Maine fish stocks since the United States and Canada extended national jurisdiction over fisheries out to 200 miles in 1976/77. However, the failure of international management regimes to prevent overfishing has contributed to present low stock levels in Canadian Atlantic waters and has influenced the development of national fisheries management systems in both Canada and the United States.

1. ICNAF and NAFO. The International Convention for the Northwest Atlantic Fisheries (ICNAF) was signed by the United States, Canada, Iceland, and Great Britain in 1949

and entered into force in 1950 (Parsons 1993). It led to the establishment in 1951 of the International Commission for the Northwest Atlantic Fisheries (ICNAF). ICNAF's authority extended to the high seas and did not cover coastal states' jurisdictions.

ICNAF began to regulate fisheries through mesh size controls in the 1950s and adopted maximum sustainable yield (MSY) as its management objective. During the 1950s, there was little concern for the stability of stocks in the northwestern Atlantic. When distant-water fleets grew dramatically and stocks began to decline in the 1960s, ICNAF's Standing Committee on Research and Statistics (STARCES) warned that mesh regulations were no longer adequate to protect the stocks and began to argue for TAC quotas. Canada and the United States attempted to convince ICNAF to adopt catch quotas in the late 1960s, but unanimity requirements and the need to amend the Convention to permit national allocation of quotas delayed the imposition of workable catch quotas for most species until 1974.

ICNAF TACs were too high to prevent further stock declines (Parsons 1993), and UNCLOS III negotiations had paved the way for extended national jurisdiction. The role of ICNAF in the management of Gulf of Maine fish stocks ended with the extension of fisheries management zones to 200 miles by the United States in 1976 and by Canada in 1977. In December 1976, a special meeting of ICNAF amended the Convention to restrict the Commission's activities to areas outside national fisheries jurisdictions.

Discussion began in 1977 on a new convention to address the management of areas beyond the 200 mile zones. In October 1978, the Convention on Future Multilateral Cooperation in the Northwest Atlantic Fisheries was signed by nine nations (including Canada but not the United States) to establish the Northwest Atlantic Fisheries Organization (NAFO). The NAFO Convention applies to Northwest Atlantic waters, including those within national fishery zones; its Regulatory Area lies beyond national fisheries jurisdictions. The Convention applies to all fish resources except salmon, tuna, marlin, cetaceans, and sedentary species on the continental shelf. NAFO began its work in 1979, concurrent with the last meeting of ICNAF (Parsons 1993).

NAFO consists of a General Council (internal affairs and relations among constituents), a Scientific Council (to provide scientific advice to the Fisheries Commission and to coastal states, as requested), and a Fisheries Commission (responsible for the management and conservation of fishery resources of the Regulatory Area). The Fisheries Commission meets annually in September to establish TACs and national allocations for stocks in the Regulatory Area. NAFO is of little direct importance to Gulf of Maine fish stock management, except by virtue of scientific information provided by NAFO's Scientific Council.

2. The Hague Line. With the passage of MFCMA in 1976, the United States established a 200-mile fishery conservation zone. Canada followed suit in 1977 with its own 200-mile jurisdictional claim. The maritime boundary between these zones was in dispute; offshore mineral resources as well as fishing grounds were at issue. U.S.-Canada agreements on

the boundary and fishing, as well as joint fisheries commissions, were negotiated and signed in the late 1970s, but opposition by New England fishermen prevented ratification by the United States. Each country banned the other from fishing in its undisputed waters in 1978, and fish stocks on Georges Bank have been managed separately and independently by each country since June 1978.

In 1981, the United States and Canada agreed to submit their boundary dispute to the International Court of Justice in the Hague. The Court decided the dispute in 1984 on the basis of principles and rules of international law, taking into account primarily geographic rather than biological resource factors (Herbert 1995). This Court-determined boundary is known as the Hague Line. The Line divides Georges Bank and bisects significant spawning grounds of cod and haddock. It also cuts off U.S. access to the most productive scallop grounds on the northeastern end of Georges Bank. Extensive violations of the boundary (mainly by U.S. scallopers) were documented until completion of the 1990 Reciprocal Enforcement Agreement between DFO and the U.S. Coast Guard.

3. Gulf of Maine Council on the Marine Environment. The Gulf of Maine Council on the Marine Environment (GOMCME) was established in 1989 by an agreement signed by the Governors of Maine, Massachusetts, and New Hampshire and the Premiers of Nova Scotia and New Brunswick to "cooperatively work to achieve sustainable development in the region, protect natural resources, and maintain the ecological balance of the Gulf. . . ." (GOMCME, n.d.). The agreement charged the new Council with development of a 10-year Action Plan for a new Gulf of Maine Program, which was completed in 1991. Among other things, the Action Plan specifies that GOMCME's goals are the promotion of research and monitoring, reduction of marine debris, protection of habitat, management of data and information, and production and dissemination of educational material.

The GOMCME Council consists of 15 Governors' and Premiers' representatives. In addition to one non-governmental individual from each state and province, Council members include: the Director of the Maine State Planning Office and the Commissioner of the Maine Department of Environmental Protection; the Secretary and Assistant Secretary of the Massachusetts Executive Office of Environmental Affairs; the Director of the New Hampshire Office of State Planning and the Commissioner of the New Hamsphire Department of Environmental Services; the Ministers of New Brunswick's Department of Environment and Department of Fisheries and Aquaculture; and the Ministers of Nova Scotia's Department of Environment and Department of Fisheries. Decisions of the Council are based on the development of a "unified consensus on policies and programs affecting their mandate" (GOMCME 1995). Although votes may be taken on specific issues, the results are non-binding on members that oppose or abstain from the decision. The Council is supported by a GOM Working Group consisting of one person appointed by each Council member and one co-chair from each committee that the Council may establish as necessary to fulfill its mandate. As of 1995, the Council had appointed formal committees on data and information management, environmental monitoring, marine debris reduction, and public education and outreach.

Among governance and management institutions in the Gulf of Maine, GOMCME is distinctive for its emphasis on maintaining an ecosystem-wide perspective on the entire Gulf of Maine region (i.e., including the entire waterhsed out to the 200-mile EEZ limits) and for its special attention to problems and activities of transboundary significance (Keeley 1996). Another noteworthy feature is that GOMCME has no regulatory authority or fixed budget, since it was created by a non-binding cooperative agreement and was designed to be administered within existing agencies and programs. The Secretariat function rotates annually from one host state or province to another and is supported by contributions of at least $5,000 from each of the five partners (GOMCME 1995). While this approach avoids the expense of establishing an entirely new organization, it has been found to undermine continuity and the accumulation of institutional memory (see Chircop, VanderZwaag, and Mushkat 1995).

Approximately half of the financial support for GOMCME's research, monitoring, and outreach activities comes from federal agencies, such as NOAA's Office of Ocean and Coastal Resources Management and the various Canadian departments that have supported a multiyear mussel monitoring program, known as GulfWatch. During the first five years of its existence, GOMCME's annual budgets have fluctuated between several hundred thousand and about one million dollars (Keeley 1996), making it difficult in some cases to plan and execute long-term projects. Consequently, an important criterion for the Council in the selection of its mission priorities has been the existence of opportunities for leveraging resources and expertise by partnering with other organizations (Keeley 1996).

In 1993, GOMCME signed a Joint Statement of intent to consult and collaborate with the Regional Association for Research on the Gulf of Maine (RARGOM) and the Gulf of Maine Regional Marine Research Program (GOM RMRP). The RMRP was created and funded as a demonstration project under the U.S. Regional Marine Research Act of 1990 (P.L. 101-593), which established nine such programs to set priorities for regional marine and coastal research in support of efforts to safeguard the water quality and ecosystem health of each region.[31] RARGOM, founded in 1991, is an association of institutions with active research interests in the Gulf of Maine and its watershed. Its basic missions are to advocate and facilitate a coherent and efficient program of regional research; to provide scientific and technical advice and planning for federal, regional, state, and local agencies; and to serve as a vehicle for communication among scientists and the public (GOMCME 1995). Both of these associations have played an active role in scientific studies and meetings co-sponsored by GOMCME, and they have spearheaded the establishment of a distributed Research and Environmental Data and Information Management System (REDIMS) for use by scientists and engineers, marine and environmental resource managers, and state and provincial planners.[32]

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[31]The legislation established such programs for nine coastal regions, but the Gulf of Maine program was the only one ever to be funded. Funding for the Gulf of Maine program expires in 1996.

[32]REDIMS is still under development, but information on its status can be found on the World Wide Web at http://nansen.unh.edu/redims/redims.html.

The Action Plan calls for a review of progress in the Gulf of Maine Program every two years and a reassessment of priorities and objectives every five. In 1995, the program counted among its important accomplishments the development and broad distribution of a watershed map intended to promote public awareness of the Gulf of Maine as an ecosystem; the funding and implementation of "stewardship mini-grants" to support action to reduce marine debris; substantial progress toward the construction of REDIMS; and the completion of an inventory of point and non-point source pollutants of coastal and marine waters. Areas where the Council saw a need for improvement included problems of continuity with the rotating Secretariat and the very low level of involvement to date of NGOs and industry representatives (Keeley 1996).

The Council also identified five coastal and marine habitat focal areas in which it will concentrate its priority actions over the next several years. Among these are restoration of shellfish beds and actions to promote the restoration of groundfish resources. Until this decision, GOMCME had steered a course away from fisheries issues, both because they have been a source of so much tension between the U.S. and Canada in recent years and because of perceptions that state and provincial fisheries managers do not welcome intrusions onto their turf (Wall, p.c., 1996). Given the Council's emphasis on cooperation in addressing transboundary and regional-scale problems, however, fishery resources may be a particularly appropriate focus for if efforts, albeit one that GOMCME approaches "with great trepidation" (Keeley 1996).

D. Marine Mammals and Endangered Species

Several species occurring in or passing through the waters of the Gulf of Maine are protected under the 1972 Marine Mammal Protection Act (MMPA) or the 1973 Endangered Species Act (ESA) (see Appendix B). In this section, we will briefly discuss measures taken to protect the right whale, humpback whale, and harbor porpoise, which are the species of greatest concern (NEFMC 1996). Further specific details can be found in MMC (1996).

1. Right whales and humpback whales. Right whales were one of the first of the great whales to be harvested by the whaling industry, and by the late nineteenth century they were commercially extinct. In the North Atlantic the 300-350 right whales believed still to exist are clearly threatened with extinction. The chief threats to the remaining population are ship collisions and entanglements in fishing gear. Under provisions of the ESA, NMFS adopted a recovery plan in 1991 and designated three areas as "critical habitat" for the right whale, including one in Cape Cod Bay and one in the Great South Channel on Georges Bank. Even with these protections, NMFS has not yet adopted recommendations from the Marine Mammal Commission (MMC) concerning additional regulation of fishing activities in these critical habitat areas to lower further the probability of entanglements and collisions.

The western North Atlantic stock of humpback whales is one of thirteen stocks worldwide, all of which are depleted. The humpback whale was designated as endangered in 1973, but its recovery is thought to be slowed by human uses of the marine environment; gear entanglements and, potentially, whalewatching activities are seen as the main impediments

(MMC 1996). An international cooperative scientific research project, entitled "Years of the North Atlantic Humpback Whale," has focused on stock assessments, physiological studies, and migration patterns since 1992.

In 1994, NMFS established a Northeast U.S. Right Whale and Humpback Whale Recovery Plan Implementation Team (RPIT). Like its counterpart in the southeast, the Northeast RPIT was established to coordinate government actions to conserve right and humpback whales during their residence in the Gulf of Maine. The team is composed of 13 members from NMFS, MMC, the New England Council, the Stellwagen Bank National Marine Sanctuary, the U.S. Coast Guard, EPA, the Massachusetts Water Resource Authority, the Massachusetts Port Authority (Massport), the Massachusetts Offices of Coastal Zone Management and Nongame and Endangered Species, the New England Aquarium, the Center for Coastal Studies, and the University of Rhode Island. The team has focused on methods for reducing ship collisions, reducing entanglements with fishing gear, setting research priorities, and seeking habitat protection (MMC 1996). To date the actions of the team have been limited to commenting on proposed ocean aquaculture projects in Cape Cod Bay.

Under an action taken pursuant to Amendment 5 to the Northeast Multispecies FMP, the New England Council closed "Area I," which overlaps about one-third of the area designated as critical habitat for the right whale in the Great South Channel. This closure is used to protect spawning aggregations and juveniles of haddock. (Earlier the Council had extended a seasonal closure in Area I to gillnets because of the proposed critical habitat designation.) The RPIT has considered making a formal recommendation to the New England Council to prohibit gillnets and offshore lobster gear in critical habitats during periods of peak whale occurrence, but the team decided to wait for the implementation of Amendment 7 to the NEFMC Multispecies Groundfish Plan (see Section IV.C). Amendment 7 provides no additional protection for right whales and humpbacks, but it does open up the possibility of creating area closures or imposing other regulations specifically to protect marine mammals through a framework adjustment.

2. Harbor porpoise. The harbor porpoise, a small cetacean, is distributed throughout the Gulf of Maine, but concentrations of animals vary seasonally as they undertake migrations from the mid-Atlantic up to Canada and back. The harbor porpoise is susceptible to entanglement in the New England groundfish sink gillnet fishery gear. Subsequent to the requirements for fishing observers in the 1988 amendments to the MMPA, estimates of the incidental take of harbor porpoise were as high as 7 percent of the standing stock, easily exceeding sustainable levels (MMC 1996). Incidental take occurs in both the U.S. and Canadian portions of the Gulf of Maine as well as off the mid-Atlantic coast.

1994 amendments to the MMPA required marine mammal stock assessments, the calculation of a sustainable "potential biological removal" (PBR) level, and a determination of whether or not a marine mammal stock should be considered to be "strategic." Stocks that are designated as strategic require the establishment of an "incidental take reduction team" to prepare a "take reduction plan." Recent stock assessments conducted for the harbor porpoise

clearly indicate that the stocks are strategic; the best estimate of abundance was 47,200 animals, and NMFS set the PBR level at 403 animals per season. In late 1995, NMFS established a Harbor Porpoise Incidental Take Reduction Team (ITRT), and this team must implement a Take Reduction Plan leading to bycatch levels below the PBR for harbor porpoise by the spring of 1997.

Studies of the location of incidental take of harbor porpoise show that take varies by location and season, following aggregations of harbor porpoises as they migrate. In order to control bycatch, the New England Council implemented, through a framework adjustment to Amendment 5, a system of time-area closures for gillnetting in the Gulf of Maine. (These closures substituted for proposals to ratchet gillnet fishing effort down on an annual basis until the PBR was reached.) It subsequently became clear that the closures were neither large enough nor long enough to permit the required reductions in incidental take.[33]
Analysis of the usefulness of the closures became problematic when NMFS switched to a new computer data management system in 1994 (MMC 1996); during that year, harbor porpoise bycatch rates apparently were occurring at levels three times higher than in previous years (NEFMC 1996).

By 1995, the New England Council had agreed to follow advice presented by the Council's own Harbor Porpoise Review Team (HPRT) to extend the closures temporally and spatially, and to require the use of acoustic bycatch reduction devices in certain areas (Jeffrey's Ledge). In addition, the significant reductions in days-at-sea for vessels of all gear types fishing on groundfish are expected to result in reduced harbor porpoise bycatch. Amendment 7 now includes as an explicit objective the reduction of incidental take of harbor porpoise to the PBR level of 403 animals by 1 April 1997.[34] Reductions in days-at-sea in combination with closures are expected to achieve this objective; further restrictions through framework adjustments can also be implemented to reach this objective (NEFMC 1996).

Beginning in 1991, an ad hoc coalition of scientists, animal rights activists, and gillnetters, known as the "Harbor Porpoise Working Group," organized several experiments to test the effectiveness of acoustic pingers that can be attached to gillnets to ward off harbor porpoises.[35] Early experiments suffered from design flaws, but, once these were ironed out, the later tests demonstrated successfully the effectiveness of the pingers. The HPWG was not mandated by Congress, but arose of its own accord, albeit with the credible threat of government

[33] Even so, Williamson (1996) notes that many Maine gillnetters were put out of business by the time-area closures under Amendment 5.

[34] In fact, this deadline was incorporated into the 1994 MMPA amendments of section 102, which anticipated that the harbor porpoise stocks in the Gulf of Maine would be found to be "strategic," thereby requiring a take reduction plan. 16 U.S.C. 1389(j)(2) (1994).

[35] A similar approach was derailed in California by recreational fishermen who supported a statewide gillnet ban (Williamson 1996).

intervention on the horizon (Williamson 1996).[36]

E. Ecosystem Management

Three major national programs concerned with marine and coastal habitat protection and ecosystem management are the National Marine Sanctuaries Program, the National Estuarine Research Reserve System, and the National Estuaries Program. Each program has at least one designated site in the Gulf of Maine. Although motivated by similar concerns to serve similar ends, the three programs are quite distinct in terms of their specific missions, governance features, and linkages to other government programs and the public.

1. National Marine Sanctuaries Program. The National Marine Sanctuaries (NMS) Program was established under the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972 for the purposes of identifying and designating areas of the marine environment of special national significance; providing for their conservation and management; supporting scientific research and monitoring of their resources; and enhancing "public awareness, understanding, appreciation, and wise use of the marine environment" (16 USC 1431 Sec. a(4)). Separate regulations are promulgated for each sanctuary as it is designated, taking into account its particular features, resources, habitat protection needs, and appropriate uses.

Stellwagen Bank, which lies approximately 10 km north of the tip of Cape Cod in Massachusetts Bay, was designated a National Marine Sanctuary (NMS) during reauthorization of the MPRSA in November 1992. In addition to Stellwagen Bank itself, the 638 nm^2 sanctuary includes Tillies Bank and Basin and the southern portion of Jeffreys Ledge. It is the only NMS in the Gulf of Maine, and its designation was the culmination of a decade-long effort by concerned citizens and environmental and research groups[37] to secure environmental protection for the area, which is critical habitat for the right whale, a major aggregation area for more than a dozen cetacean species, an important fishing area for bluefin tuna, and a feeding area for the endangered leatherback and Atlantic ridley sea turtles. Stellwagen Bank NMS is believed to be the site of several historic shipwrecks as well.

The sanctuary lies entirely within U.S. federal waters, and it is administered by the Sanctuaries and Reserves Management Division of NOAA's Office of Ocean and Coastal Resource Management (OCRM). Authorizing regulations for the Stellwagen Bank NMS provide for the protection of its cultural resources and prohibit sand and gravel mining, discharges of materials and substances, and disturbance of the seabed, marine mammals, marine seabirds, and sea turtles. Also, as a condition of its designation, fish are not to be managed by the sanctuary.

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[36] In 1991, NMFS was petitioned by the Sierra Club Legal Defense Fund to list the harbor porpoise as threatened under the ESA. This petition has received the support of the Marine Mammal Commission. To date, no decision has been made on the listing (MMC 1996).

[37] Prominent among these interests, known collectively as the Stellwagen Bank Coalition, was the Center for Coastal Studies in Provincetown, MA, which is known especially for its cetacean population research.

This circumstance has been attributed to pressure applied by the fishing industry to block the designation; it is also in keeping with OCRM's position that "[r]egulatory measures taken by fishery management agencies in the interest of maintaining a healthy commercial fishery are generally sufficient to meet the needs of the sanctuary program" (OCRM 1996).[38]

The NMS program has very limited regulatory authority under the MPRSA and is almost wholly dependent on other federal agencies to make regulatory decisions that protect sanctuary resources. The 1992 MPRSA amendments established a formal "consultation process" that gives sanctuaries standing to comment, through the Secretary of Commerce, on how other agencies exert authority over activities occurring within sanctuary boundaries or affecting their resources. There is no requirement for a collaborative solution, however, or even a direct response—only that the agency in question submit in writing to the Secretary of Commerce its reasons for not adopting whatever "reasonable and prudent" alternatives to its proposed actions he has recommended.

For the Stellwagen Bank NMS, this circumstance has been particularly troublesome with respect to fishery management plans developed by the New England Fishery Management Council and approved by NMFS. Although the sanctuary may not regulate fishing, fish are officially listed as an important sanctuary resource, and one of the sanctuary's conservation challenges concerns the possible alteration of benthic habitats by mobile fishing gear such as trawls and dredges. NMFS and the sanctuary have signed a Memorandum of Understanding that is supposed to encourage "collaboration" on such matters, but the MOU does not make reference to any formal process of "consultation." To date such consultation has been sporadic at best, and recently the NEFMC claimed that it is not required to consult with the sanctuary because this would amount to consulting with "itself," seeing that both are under the authority of NOAA and the Secretary of Commerce. NOAA lawyers are now reportedly debating whether there should be consultation "regulations" instead of just "guidelines."

Another, more immediate prospect of strengthening the consultation process lies in the recent appointment of a Stellwagen Bank Advisory Committee "to provide assistance to the Secretary" in sanctuary management (Sec. 315 of the 1992 reauthorization). Advisory Committee members are drawn from among federal and state managers with expertise in natural resources management, regional FMCs, and representatives of local user groups, conservation and other public interest organizations, scientific and educational organizations, and other parties interested in the protection and multiple use management of sanctuary resources. Advisory Committee meetings are required by law to be open and public and to include on the agenda oral and written statements by other interested parties.

The NMS program's mandate to support scientific research and monitoring of sanctuary

[38]The Sanctuary program has on occasion determined that additional regulation of certain fishing methods and gear are needed to protect sanctuary historic sites or natural resources. Such exceptions have been made at the USS MONITOR, Key Largo, Looe Key, Gray's Reef, Fagatele Bay, and Flower Garden Banks NMSs.

resources is another avenue by which Stellwagen Bank has sought to assert influence over fishery management issues with a bearing on habitat and species conservation. One science proposal developed in collaboration with NOAA's National Underwater Science Center would close a designated area of Stellwagen Bank to fishing for five years in order to determine the effects of mobile fishing gear on benthic habitat quality (see Auster et al. 1995). Another would establish an "experimental fishery" for sink gillnets with pingers to study whether such devices are indeed effective in reducing bycatch of harbor porpoise.

2. National Estuarine Research Reserve System. Scientific research and monitoring constitute the core mission of the National Estuarine Research Reserve System (NERRS, or Reserve System), which was established as part of the Coastal Zone Management Act (CZMA) of 1972. The NERR research mission is supported by the complementary objectives of long-term protection (or "stewardship") of estuarine reserve resources and the enhancement of public awareness and understanding of the estuarine environment (education/outreach). As of 1996, the Reserve System included 22 sites in 18 states and Puerto Rico, each representative of a distinct biogeographic region. Together these sites (and those still to be designated) constitute a national coastal monitoring system, which is linked by a distributed data management and exchange system.

All three of the Gulf of Maine coastal states has a designated NERR. The Waquoit Bay site on Cape Cod[39] is representative of the Virginian biogeographic region, and the NERRs in Great Bay, New Hampshire, and Wells, Maine, are representative of the Acadian boreal region.

Like the National Marine Sanctuaries Program, the NERR System as a whole is administered by the Sanctuaries and Reserves Division of NOAA's Office of Ocean and Coastal Resources Management. Whereas the sanctuaries are entirely federally owned and administered, however, the design of the Reserve System reflects the CZMA's emphasis on federal-state partnerships to achieve comprehensive environmental protection and land-use planning and management in the U.S. coastal zone. Each site is nominated by its state and, upon acceptance, becomes the property of the state and an administrative unit of an appropriate state agency.[40]

These requirements, and the overall mission and design of the Reserve System, are seen as establishing a built-in opportunity for collaboration among federal, state, and local participants that itself reinforces a "holistic perspective" on estuarine habitat and resource use.

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[39]There is no clear consensus as to whether the Waquoit Bay site, located on Nantucket Sound on the southern coast of Cape Cod, is properly included in a definition of the Gulf of Maine.

[40]The NERR at Wells, Maine, is an exception. When the state proved unwilling to fund the purchase and administration of the reserve, a grassroots organization prevailed upon the legislature to designate the private, non-profit Laudholm Trust as the Reserve Management Authority. (Wellenberger, p.c. 1996). For Waquoit Bay, the relevant state agency is the Massachusetts Department of Environmental Management. For Great Bay, management is the responsibility of the New Hampshire Fish and Game Department, and acquisition and development have been carried out by the Office of State Planning.

Both the federal and state governments acquire an active presence and a more familiar, cooperative image within local communities; and state governments are compelled to learn and adopt federal priorities and to apply the results of locally generated research in cooperation with local governments and citizens (Gault, p.c. 1996). Among the NERR sites in the Gulf of Maine region, examples of state involvement in the application of locally generated research results include the revision of state septic system regulations on the basis of nitrogen loading studies conducted at Waquoit Bay; the reopening of shellfish beds based on monitoring data collected at Wells; and the revision of set-back regulations based on wetlands research at Great Bay. Other NERR research and stewardship activities of significance to fisheries resources in the Gulf of Maine region include the protection of wetlands and other important nursery and spawning areas; salt marsh restoration; fish habitat assessments; and reopening of fishways for trout, alewives, and eels.

On balance, the strengths of the federal-state partnership approach appear substantially to outweigh its chief weakness, which is the increased likelihood that certain responsibilities and opportunities will "fall through the management cracks" (Gault, p.c. 1996). On this score, system design may be less of a culprit than chronic underfunding at the federal level. Throughout the 1980s and early 1990s, the annual appropriation for the entire system has been in the range of $3–4 million—a far cry from the estimated $10 million required by the Reserve System to fulfill its mission of nationally coordinated research, resource stewardship, and local education and outreach (Review Panel on the NERRS 1993).

3. National Estuary Program. Established in 1987 under authority of the Clean Water Act (CWA), the National Estuary Program (NEP) shares the Reserve System's focus on estuarine resources and its partnership approach to their protection and improvement. In contrast to the Reserve System, however, the emphasis in the NEP program is on community-based decision making and action to protect and improve the quality of the community's own estuarine resources. In addition to representatives from relevant government agencies (e.g., EPA and state CZM), each NEP involves local citizens, business leaders, educators, and researchers in a collaborative decision-making process known as "management conferences."

Management conferences are convened over a five-year period to produce a Comprehensive Conservation and Management Plan (CCMP) that incorporates an assessment of the estuary's environmental condition and develops approaches that make use of existing management and regulatory systems for the coordinated implementation of priority mitigation actions. (Consequently, mitigation efforts often differ from region to region and even from state to state.) Management conferences have no regulatory authority; their role is to develop and disseminate information, determine issues of concern, and concentrate the focus of participating communities on appropriate remedial actions. Once a plan and funding for action by communities are in place, the management conferences have no further role to play.

Estuaries are selected into the program, which is administered by EPA's Office of Wetlands, Oceans, and Watersheds, on the basis of the sponsoring state's potential to address

issues of significant national concern and its demonstrated commitment to taking protective action. Annual federal funding in recent years for the entire NEP has been in the range of $15 million. On average, new programs receive approximately $150,000 in federal funds for their first year of operation, with total federal planning grants to individual estuary programs ranging between $200,000 and $300,000 annually (Imperial and Hennessey 1996). States typically provide matching funds (e.g., 75 federal/25 state), although municipalities are sometimes required to provide the state match for local demonstration projects (Tracey, p.c. 1996). The cost of implementing a CCMP, for which no single, stable source of funding exists, can range as high as $1.6 billion (Imperial and Hennessey 1996).

NEPs in the Gulf of Maine region include the Massachusetts Bays (Mass Bays) Program, the Casco Bay NEP in Maine, and the recently designated New Hamsphire Estuaries NEP. The Mass Bays program, designated an NEP in 1990, was launched in 1988 with initial funding of $1.6 million from the Massachusetts Environmental Trust, which was established as the result of settlement fines from a suit filed by the EPA and the City of Quincy against the Commonwealth of Massachusetts for violations of the Clean Water Act in Boston Harbor (Mass Bays Program 1995).[41] As an NEP, Mass Bays is funded by EPA and the Massachusetts Executive Office of Environmental Affairs (EOEA) and is administered by the state CZM Office, an agency of EOEA. One of the largest NEPs in the nation, it involves coordinated planning and action by 49 communities in five coastal subregions. The Mass Bays CCMP consists of 15 action plans for joint implementation by the 49 municipalities and state and federal agencies in such areas as protecting and enhancing coastal habitat and shellfish resources; reducing and preventing oil and toxic pollution; managing municipal wastewater, boat wastes, marina pollution, and local land use; and protecting nitrogen-sensitive embayments.

These priorities reflect the NEP program's emphasis on such traditional coastal/nearshore concerns as lowering the levels of pathogens, toxics, and nutrients and improving habitat quality in coastal and nearshore waters. Thus, other than an interagency shellfish bed restoration program, the attention of the Mass Bays Program to fishery resources per se has been limited to funding of a study to evaluate the relative contributions of environmental degradation vs. over-fishing to the problems besetting the region's fishing industry.[42] Similar priorities dominate the agenda of the Casco Bay NEP, which is administered by the Maine Department of Environmental Management.

Given the NEPs' lack of ownership rights and regulatory authority, their successes to date in securing local cooperation and achieving measurable improvements in water quality have been attributed to the availability of significant levels of federal and state matching funds for local planning and demonstration projects. The results are perhaps particularly impressive in Massachusetts, where a strong "home rule" tradition is always a potential obstacle to the kind of

[41]The court decision mandated a new $3.5 billion sewage treatment project, which is described in Section III.G.3.

[42]The report is expected to be completed in the spring or summer of 1996.

integrated, regional approach that the Mass Bays program has adopted and that the NEP essentially dictates (Tracey, p.c., 1996).

G. Other Governance Issues

Environmental quality—the presence of pollutants in water and sediments—is a concern to fisheries management and to other uses of Gulf of Maine resources, including recreational use. Disposal of dredge spoils, coastal water pollution, and ocean dumping play major roles in determining environmental quality.

1. Dredging. Dredging of channels and berths for maritime commerce in U.S. ports has become a contentious issue because of concerns over the environmental impact of dredge spoil disposal and re-suspension of pollutants during dredging. The major dredging project at present in the Gulf of Maine is a proposed Navigation Improvement Project and Berth Dredging Project for Boston Harbor (BHNIP). Minor maintenance dredging is underway in other Gulf of Maine ports, but the Boston Harbor project is the only one involving contaminated sediments (Jackson 1996).

The U.S. Army Corps of Engineers (ACoE) is the federal agency responsible for planning, designing, constructing, and maintaining federal navigation channels. BHNIP improvements were first proposed in 1988 and authorized by Congress in the Water Resources Development Act of 1990 (P.L. 101-640). Under the guidance of the New England Division of ACoE and the Massachusetts Port Authority, work on an environmental impact statement for BHNIP began in 1992. Apart from channel maintenance dredging, BHNIP includes the deepening of various channel segments from 35 to 38 or 40 feet and maintenance and improvement dredging of several berths in the Port of Boston. BHNIP involves an estimated 1.1 million cubic yards of sediments and a total project cost of $72 million. The project is not expected to start before spring of 1998, and will take 1.5 years to complete (Jackson 1996).

The draft environmental impact report published in 1994 drew extensive comment from more than 60 towns near proposed disposal sites in Massachusetts Bay and from environmental and fisheries groups (ACoE and Massport 1995). Most of these comments concerned possible adverse impacts from disposal of contaminated sediments at five sites within Massachusetts Bay. (In this case, spoils from maintenance dredging tend to be contaminated, while clay and gravel from improvement dredging tend to be clean.) The final disposal plan responded to these concerns by providing for disposal of all contaminated spoils in cells dug beneath the channel, capped with 3 feet of clean material. Uncontaminated spoils will be disposed of at the Massachusetts Bay Disposal Site near Stellwagen Bank. This site is also being used for disposal of clean sediments from other Gulf of Maine maintenance dredging projects.

Most of the contentious issues were resolved in discussions by a Massport advisory committee that included representatives of ACoE, EPA, NMFS, the Fish and Wildlife Service, the U.S. Coast Guard, the Massachusetts Executive Office of Environmental Affairs, and private

environmental and fisheries groups. Remaining minor issues now focus on re-suspension of contaminants during dredging operations and the design of a monitoring program (Jackson 1996).

An interesting footnote to the Boston Harbor dredging plans is the diversity of opinion about its effect on future vessel traffic in the port. Environmental groups (and representatives of ACoE) see the channel improvement as a means of reducing the number of commercial transits (and associated damages) through Boston Harbor and Massachusetts Bay: a deeper channel will permit fewer, larger vessels to carry Boston's cargo and reduce the need for lightering operations and the use of barges (Jackson 1996). On the other hand, the Port of Boston Economic Development Plan of the Boston Redevelopment Authority/ Economic Development and Industrial Corporation and Massport (1996) sees the dredging project and other infrastructure improvements as a means of more than doubling the port's present container traffic of 90,000 containers per year.

2. Coastal water pollution. Some parts of the Gulf of Maine are contaminated, primarily nearshore areas at urban centers (Boston, Salem, Portsmouth, Saint John) and the mouths of industrialized rivers (Kennebec, Merrimack, Saint John). However, there is no evidence of "system-wide degradation of marine environmental quality in the Gulf of Maine...[t]he Gulf as a whole remains relatively clean, although the deep central basins appear to be accumulating several pollutants, including PAHs and PCBs" (GOMCME 1994).

GOMCME (1994) lists several pollutants as sources of concern in the Gulf of Maine. Heavy metals (chromium, copper, lead) from tanneries and other early industrial activity near the coast and rivers, as well as from contemporary sources (runoff from cars on coastal roads), settle into sediments soon after discharge from rivers and have bioaccumulated in nearshore fish and shellfish. DDT and DDE remain in the coastal environment from forest spraying in New Brunswick during the 1950s and 60s; they have affected local seabird populations and some nearshore fish (flounder), but their levels are declining. Polychlorinated biphenyls (PCBs) persist at high levels in harbor sediments and have been found in trace amounts elsewhere in the Gulf of Maine; they have affected some local fish populations. Dioxin, likely originating from chlorine bleaching processes at pulp and paper plants, has been found in fish and in lobster, leading to fish advisories for several rivers and warnings against eating certain parts of lobsters (tomalley). Polycyclic aromatic hydrocarbons (PAHs), byproducts of incomplete combustion of fossil fuels, are found in sediments throughout the Gulf of Maine. Concerns have also been raised over growing inputs of nutrients due to human sewage loads near some coastal communities (Maine), and lead and oil runoff from car traffic on coastal roads (Waterman 1990). In recent years, contaminant levels have been found to be declining in many nearshore areas of the Gulf of Maine (GOMCME 1994).

Most of the significant pollution problems in the Gulf of Maine, therefore, are local in scale. Regional dispersion of pollutants results primarily from the coastal current, which carries algal blooms, for example, south along the coast from their origins northeast of the Kennebec

and Androscoggin Rivers. The coastal current is part of the Gulf's general counterclockwise circulation, which is driven by an influx of fresh water from rivers, primarily along the coast of Maine. Under certain environmental circumstances, this current can carry red tide organisms well into Massachusetts Bay. Most regional-scale pollution of the Gulf of Maine, however, is insignificant (GOMCME 1994).

Coastal pollution problems are the purview of the EPA and state environmental protection agencies in the United States; in Canada, at least 15 federal agencies and at least as many provincial counterparts share responsibility (Hildebrand, p.c., 1996). Legislation such as the 1972 Clean Water Act and its amendments[43] and federal and state water quality regulations address the input of pollutants to coastal waters. While some problems clearly remain, primarily in urban harbors, water pollution in the Gulf of Maine is fairly well understood and, to the extent it is necessary, is successfully controlled.

3. Ocean discharges. Boston Harbor has been identified as one of the most polluted harbors on the east coast of the United States. Much of this pollution derives from sewage discharge. To comply with a federal court order to meet standards of the Clean Water Act, the Massachusetts Water Resources Authority (MWRA) is improving the sewage treatment system serving the greater Boston area. A new primary treatment facility started operating in January 1995. By 1999, secondary treatment, and an outfall tunnel that will discharge treated sewage 9.5 miles into Massachusetts Bay, will be operational (the present outfalls are located around the entrance to Boston Harbor). Other MWRA initiatives include projects to reduce combined sewage overflows and decrease the amount of toxic metals and contaminants entering the sewage system (MWRA 1995).

Early indications (based on monitoring of mussels) suggest that initial improvements to Boston's sewage systems have already reduced the input of organic compounds into Boston Harbor waters (GOMCME 1994). Additional improvements, and a gradual restoration of Boston Harbor water quality generally, are expected as system upgrades continue (MWRA 1995). While there is some concern over possible adverse effects of discharge from the new outfall tunnel, particularly from groups on Cape Cod (APCC 1995), the scientific consensus seems to be that the outfall and improved treatment plants represent a safe means of disposing of Boston area sewage (Pederson 1996).

IV. Groundfish Fisheries: Story and Evaluation of Governance

A. Introduction

This section summarizes the recent history of the harvest and management of groundfish in the Gulf of Maine. Several recent studies and accounts present this history in extraordinary

[43](40 CFR 25 Sec 101(3) and 33 USC 125(e)).

detail (Fordham 1996; Murawski 1996b; Healey and Hennessey 1996; NEFMC 1996; Doeringer and Terkla 1995; Edwards 1995; Collins 1994; CLF 1994; Holmes 1994; Anthony 1993; NEFMC 1993; Serchuk and Wigley 1992; Mayo et al. 1992; Anthony 1990; MOGTF 1990; Hennemuth and Rockwell 1987; Dewar 1983).[44] Although some repetition of the basic elements of the "story" will be necessary, we will not present a detailed chronological account. Instead we will discuss the basic factors that have led to and shaped the current situation. (See Appendix B for additional details.)

B. Interest Groups

As a preliminary matter, it is important both to identify the different interests and to characterize their points of view.

Under section 101(a) of the Magnuson Act, "the United States claims, and will exercise in the manner provided for in this Act, sovereign rights and exclusive management authority over all fish, and all Continental Shelf fishery resources, within the exclusive economic zone." By this section, the Act makes the EEZ fish stocks public resources to be managed by the government in the U.S. public's interest.

One might expect, therefore, that the general public is an important interest group. However, it is difficult for the great majority of the members of the U.S. public to maintain more than a fleeting interest in the management of EEZ fish stocks. This fact is explained succinctly by Anderson (1986:196) with respect to fisheries regulation:

> Although the whole economy will benefit from proper management, the gain to the average noninvolved citizen is neither evident enough nor large enough to induce his active support in the political arena.

Thus it is difficult for the general public to behave as if it has an interest, and impossible, therefore, for it to be described as an "interest group" (Landy, p.c., 1996).

Given this general indifference, opportunities arise for special interests to influence management in such a way that it produces results that are beneficial to their own interests. We focus on two important, clearly defined interest groups here.[45] The nature and scope of their opportunities to influence fisheries management may depend upon the ways in which the governance system permits special interests to participate in management decisions. In the following sections, we discuss in greater depth the nature of the governance and management

[44] Earlier histories of the fishery are found in German (1987), Hennemuth and Rockwell (1987), Merriman (1982), and Graham (1970).

[45] Other important interest groups may include recreational fishermen, fisheries scientists, the New England Council staff, federal agencies, and Congress. See NEFMC (1996, 1993), Hall-Arber (1993), and Dewar (1983) for further detail.

systems.

Under the current rules for constituting a Fishery Management Council, representatives from the fishing industry have been given extraordinary opportunities for influencing management decisions. According to section 104(b), "public" appointees to a council:

> must be individuals who, by reason of their occupational or other experience, scientific expertise, or training, are knowledgeable regarding the conservation and management, or the commercial or recreational harvest, of the fishery resources of the area concerned.

This requirement, coupled with the potential political benefits to a state governor from nominating individuals from the fishing industry, have tended to favor industry appointments. The predominance of industry appointments to the New England Council has come under sharp criticism recently from the conservation community (Fordham 1996; WWF 1994).

Although industry representatives clearly have a majority, it is inaccurate to characterize the fishing industry as having homogeneous interests. Instead of the "fox guarding the henhouse," industry participation on the councils may be more like a case of "foxes" (McCay 1992). Branson (1987:301) observes that the basis for most problems in fisheries management is allocation disputes among "fiercely independent groups of entrepreneurs." McManus (1995) characterizes fishermen on the councils as advocating their own interests strategically in order to gain a competitive advantage in relevant markets.[46] Hall-Arber has shown that it is possible to differentiate fishermen by gear type, home port, vessel size, ethnic group, fishing skill, and marketing practices (NEFMC 1996).[47] Fishermen who identify with one group often blame fishermen from other groups for overfishing and stock depletion (Hall-Arber 1993). One reason put forward for the preference that fishermen have for gear-based management is that the distributional impacts may not be as clear as they are under quota-based management (Stevenson, p.c., 1996).

Another important interest group is the conservation community. Until fairly recently, the conservation community paid little attention to fisheries management. In 1989, the Conservation Law Foundation (CLF) began attending meetings of the New England Council (Dorsey, p.c., 1996). The conservation community is more likely than the fishing industry to speak with one voice, although there has never been a voting member of an environmental organization on the New England Council to express that voice directly (Shelley 1996). The

[46] Further, some fishermen may be at a disadvantage vis-a-vis other fishermen because they are not able to gain a seat on the New England Council (Ames, p.c., 1996).

[47] The "Human Environment" section to the Northeast Multispecies FMP has four full pages of the commercial fishing industry association yellow pages (NEFMC 1996). The industry may also be differentiated into upstream-downstream sectors. In New England both tend to be atomistic, with little vertical integration (Doeringer and Terkla 1995).

motivations of environmental organizations in fisheries issues may be complex in some cases, as these groups tend to be in favor of: quota-based management (but not necessarily individual transferrable quotas, or ITQs); area closures to protect spawning stocks, marine mammals, and fish habitat; precautionary management practices; and the maintenance of small-scale, local fishing capacity. For example, CLF has pushed both to reduce overcapacity in the New England groundfish fishery and to protect the fishing port infrastructure in Gloucester against the incursions of condominium developers (Shelley 1996).

C. The Simple Story

1. Background. Many reasons have been put forward for the historical decline and depleted status of groundfish resources in the Gulf of Maine. Among these are destruction of fisheries habitat, the adverse effects of pollution, temperature shifts associated with global warming, and others.[48] Notwithstanding these hypotheses, the scientific community has concluded that the depletion of Gulf of Maine groundfish is unquestionably a case of biologically and economically excessive harvesting, also known as "overfishing" (Dow and Braasch 1996; Murawski 1996b; Anthony 1993, 1990; MOGTF 1990). Murawski (1996b), a fisheries scientist at the New England Fisheries Science Center's Woods Hole Laboratory, makes the clearest case in a recent paper:

> Groundfish . . . have not fared well under domestic management. Most stocks of groundfish are at or near record low levels of abundance and are considered recruitment overfished. The rapid increase in fishing effort during the late 1970s and early 1980s resulted in increased fishing mortality rates. Improved juvenile survival in the 1970s and 1980s, and the expanding fishing effort temporarily increased landings, but these levels could not be sustained. Fishing practices during much of this period reduced the inherent resilience of the populations by removing many of the older (breeding) fish and resulted in the fisheries depending almost completely on the strength of the incoming fisheries ("recruitment fisheries"). . . . In recent years, fishing mortality rates have exceeded recruitment overfishing levels by a factor of 2 or more. . . . The recent declines in these offshore resources is attributable to persistent, gross recruitment overfishing. Although environmental variability has had a role in fluctuating survival rates for groundfish, declines in stock sizes and landings could have been averted or at least mitigated if the stocks had not been significantly recruitment overfished.

Figure IV.1 (from Murawski 1996b) displays the pattern of landings for important groundfish stocks in the Gulf of Maine during the post World War II period, depicting the major outlines of

[48] Some fishing interests still maintain that groundfish stocks are not even depleted and that concerns about overdepletion are based upon imprecise scientific evidence. However, these claims are themselves based upon nonscientific methods (Stevenson, p.c., 1996).

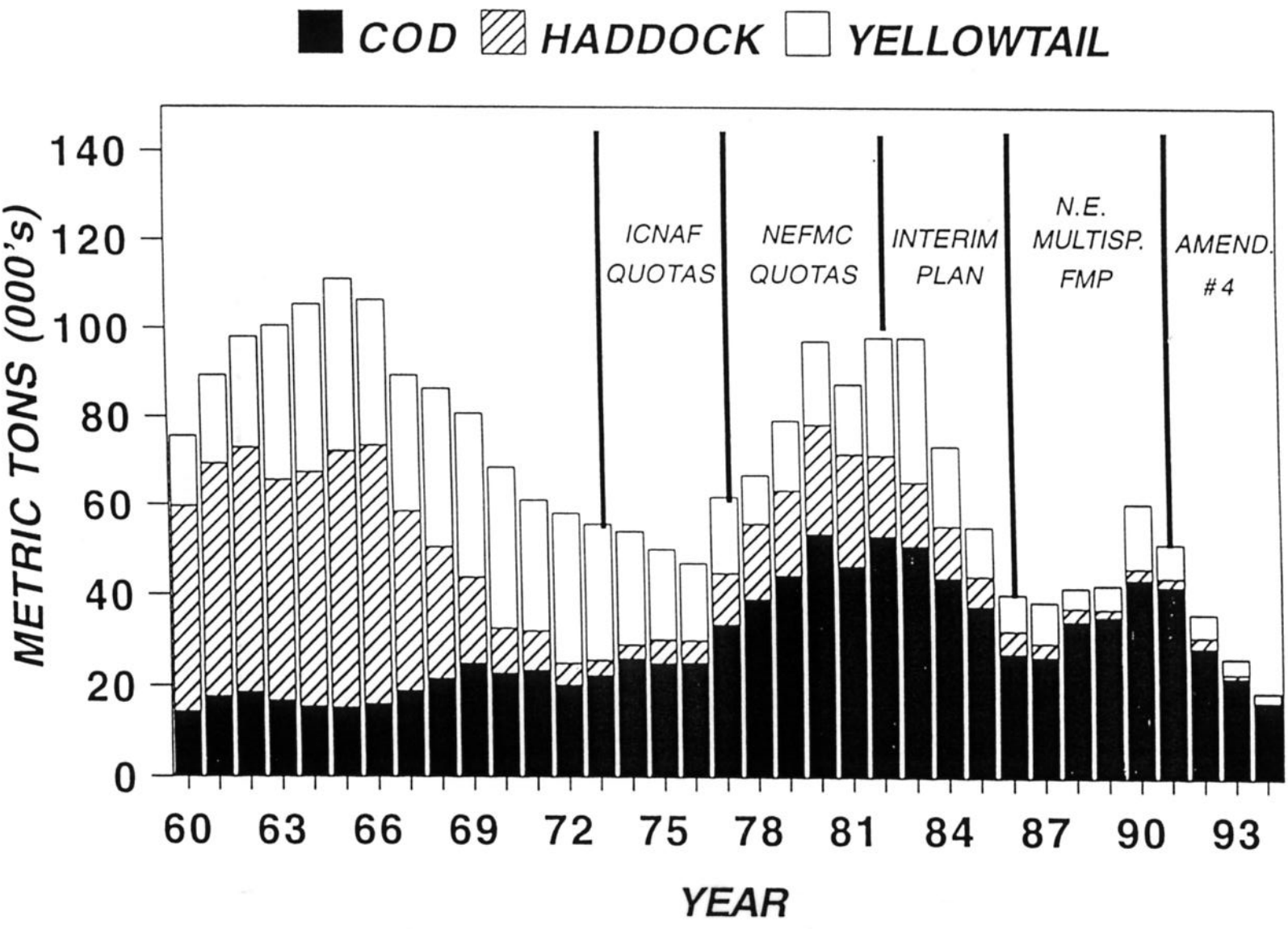

Figure IV.1. US landings of cod, haddock, and yellowtail flounder, 1960-1993 (Source: Murawski 1996)

the "story" behind the depletion of commercially important groundfish stocks in New England.

It is possible to identify two recent periods during which the resource has been overfished.[49] The first period occurred during the early 1960s when U.S. and foreign fishing, particularly factory trawlers from the Soviet Union, depleted the major stocks of haddock, cod, yellowtail flounder, and other groundfish and pelagic stocks. After a partial resurgence during a period of quota-based management in the 1970s, a second bout of overfishing caused by a fleet[50] of U.S. boats occurred during the 1980s. The cause of overfishing during both periods was very clearly a case of the overexploitation of an open access resource, abetted by an inability of the relevant resource "owners," namely the U.S. public, to integrate policies, and exacerbated by major advances in fish harvesting technologies.

The stocks that make up the New England groundfish fishery are now in a state of "collapse." Most of the commercially important stocks have fallen below or are near falling below the lowest estimated levels of abundance on record (NEFSC 1994a). Two localized stocks, Gulf of Maine haddock and Georges Bank yellowtail flounder, have been declared to be commercially extinct. The groundfish stocks are "recruitment" overfished (Murawski 1996b), meaning that they are being harvested at levels that will not permit enough new recruits—fish old enough to reproduce—to reach an age at which their reproduction will enable the stocks to grow larger. A useful aggregate measure of the status of the fish stocks, spawning stock biomass (Figure IV.2), has shown steep declines since 1982 for cod, haddock, and yellowtail flounder (from Murawski 1996b).

In 1990, the Massachusetts Offshore Groundfish Task Force (MOGTF), a specially convened expert panel, identified the following types of "losses" from the depletion of the New England groundfish fishery: (1) reduced landings of groundfish; (2) reduced incomes and employment for fishermen, processors, distributors, restaurants, and retail markets; (3) higher prices and lower quality of fish for consumers; (4) increased reliance on imported fish; and (5) reduced opportunities for recreational fishermen.[51] The MOGTF estimated the average

[49] Serchuk and Wigley (1992) divide the era since 1890 into five distinct periods (1893-1914; 1915-1940; 1940-1960; 1960-1976; and 1977-present) based upon significant technological or policy shifts. We focus here on the latter two periods. Several important stocks were overfished during earlier periods, including halibut (1840s), haddock (1930s), and redfish (1950s). While these cases are of historical interest, there was no serious attempt at governance of marine fisheries prior to World War II.

[50] It is probably inaccurate to describe the whole of the U.S. commercial groundfishing industry as a "fleet," which would imply coordinated behavior. The industrial organization of the harvesting sector is atomistic and highly competitive. Until the imposition of a moratorium on new entrants in 1994, entry into the fishery was unimpeded and, in fact, facilitated by government support. It is precisely these characteristics that enhanced overexploitation and resulted in stock depletion. See Doeringer and Terkla (1995) for further details on market structure.

[51] Note that increased reliance on imported fish is not necessarily a "loss" unless it involves either lower- quality or higher-priced fish, or both. Further, the potential for losses in the downstream sectors may be limited. Doeringer and Terkla (1995) explain that, in the short run, the processing sector easily switched from New England groundfish

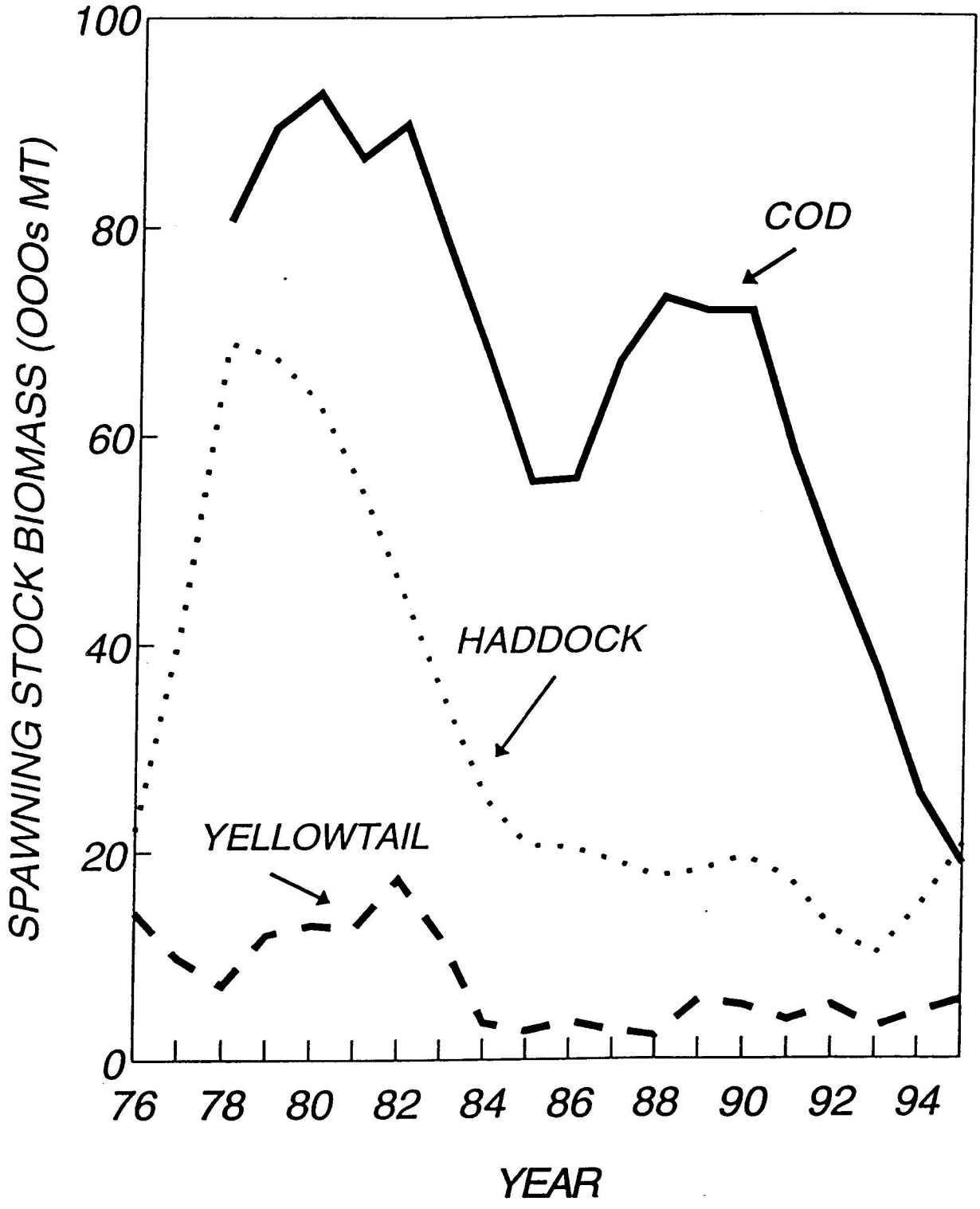

Figure IV.2. Spawning biomasses for Georges Bank stocks (Source: Murawski 1996)

consumer benefits, gross income, and employment that would have resulted from the exploitation of six groundfish stocks at their "longterm potential level" (MOGTF 1990).[52] The results of these estimates are presented in Figure IV.3. The estimates for "lost" gross income ($349 million) are the direct economic impacts in harvesting, processing, distribution, food service, and retail market sectors. The estimates for lost consumer benefits ($41 million) are based upon demand models for each stock; these estimates may be biased upwards because they do not account for the potential displacement of imported fish in the relevant markets.

Edwards and Murawski (1993) estimate that the opportunity costs associated with the current management of the New England groundfish are about $139 million annually.[53] These estimates are not directly comparable to the MOGTF estimates because they focus on net economic benefits (not gross economic impacts), on the upstream harvesting sector only, and only on the three main groundfish stocks (cod, haddock, and yellowtail flounder). Further, Edwards and Murawski consider the dynamic maximum "economic" yield (not the "biological" maximum sustainable yield). These authors calculate that, after a presumed ten-year recovery period for groundfish stocks, the discounted net economic value over a thirty-year horizon for an optimally managed fishery would be approximately $2 billion. Roughly 50 percent of that potential value would be attributed to cod, haddock, and yellowtail. Decades of overfishing have resulted in the loss of billions of dollars to the New England economy.

2. Oscillating management systems. Since World War II, the Gulf of Maine fishery has been "governed" by two distinct institutions: the International Commission for North Atlantic Fisheries (ICNAF) from 1951 to 1976 and the Magnuson Act from 1976 to present. Until recently (1994), the fishery has been "open access," meaning that, subject to certain requirements, vessels could enter (and exit) the fishery at will. Prior to the Magnuson Act, the fishery was open to vessels of any nation. Upon passage of the Magnuson Act, the fishery was still open access, albeit restricted to U.S. boats.

Since 1951, the management system has oscillated between input and output controls.[54]

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to imports. In the long run, processors specializing in fresh product may be affected adversely.

[52] The "longterm potential level" was based upon estimated maximum sustainable yield (MSY) for cod, haddock, yellowtail, and redfish, using a correction term for bycatch. The levels for two other species, American plaice and witch flounder, were based on estimated long-term average landings (MOGTF 1990, Appendix).

[53] Using an aggregate dynamic bioeconomic stock production framework, Edwards and Murawski (1993) estimate that the annual net economic benefits from the socially optimal level of groundfish harvest would be approximately $149 million each year. Current net economic benefits are on the order of $10 million per year. The authors consider that their estimate of potential net economic value may be conservative because of uncertainty about the amount of discards, difficulties in modelling changing biological community structure, the potential differentiation of markets by fish size, likely savings from the removal of inefficient regulation, and the existence of highliner rents that were not modeled.

[54] This discussion simplifies the description of the management system, which in its detail is extraordinarily complex. Temporal and spatial closures, similar in effect to quotas in many respects, limits on days at sea, minimum fish sizes, and haddock bycatch quotas (possession limits) are also utilized. See NEFMC (1996) for the

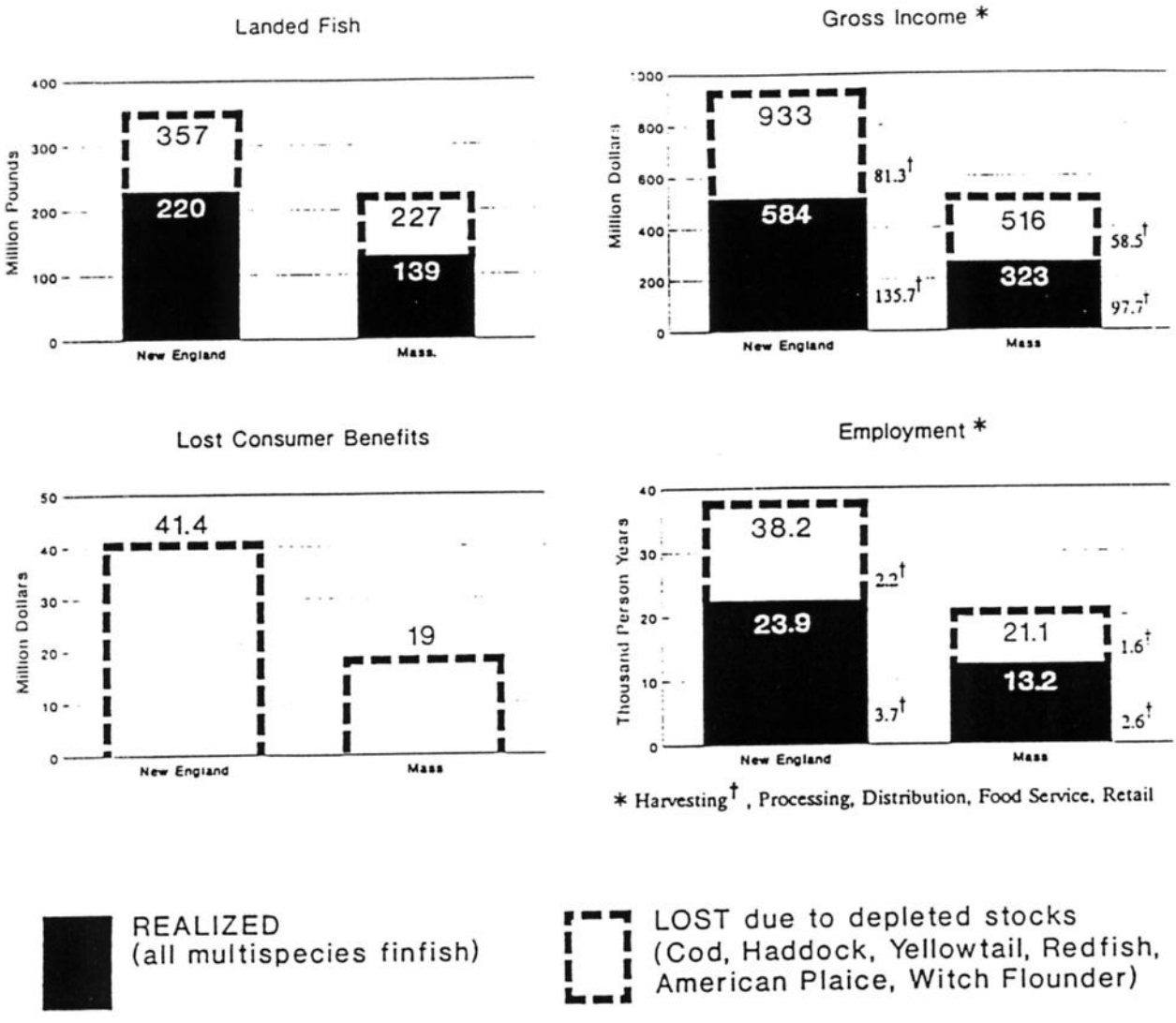

Figure IV. 3. Annual impact of depleted New England groundfish stocks. The solid bars are for actual annual landings, income and employment from 1986-89 for all multispecies finfish. The open bars are for additional landings, income, employment and consumer benefits that would have been realized if the catch of six groundfish species were at their long term potential level, instead of being reduced due to overfishing. The lost income and employment figures are conservative because they assume that, except in the case of redfish, increased landings would not replace imported fish, so prices would decrease considerably because of increased supply. For income and employment, the figures attributed to the harvesting sector are indicated with a dagger. The lost consumer benefits are benefits that would have accrued to consumers from having more fish at a lower price.

(Source: MOGTF 1990)

Table IV.1 summarizes some important aspects of the northeast multispecies fishery management plans under the Magnuson Act since 1977. Input controls include gear restrictions, such as minimum mesh size in trawl nets, or the prohibition of certain technologies, such as "pair trawling." Output controls, such as a total allowable catch (TAC), limit the amount of fish that can be harvested. During the early years of ICNAF, minimum mesh size was the preferred management method. Beginning in 1971, a TAC was set on the primary groundfish species, and, by 1974, ICNAF member nations had agreed to divvy up the quota for each stock among themselves (Hennemuth and Rockwell 1987). The method of individual stock quotas was incorporated into the first groundfish fishery management plan under the Magnuson Act in 1977. By 1982, the quota-based management system had been eliminated and replaced by a system of input controls: minimum mesh sizes and minimum fish sizes. In 1994, the fishery was closed to new entrants through the imposition of a moratorium, and fishing effort was further restricted by limiting the number of "days at sea." An amendment to the New England Multispecies FMP, approved in May 1996, incorporates both input and output controls. Minimum mesh and fish sizes and limits on "days at sea" have been retained, and target TACs have been set. If a TAC is exceeded in any season, further restrictions on fishing effort may need to be implemented through a framework adjustment process for the next season (NEFMC 1996).

Explanations for the oscillation between gear- and quota-based management systems are fairly clear in the Gulf of Maine. ICNAF's initial 4.5" minimum mesh size for haddock, implemented in 1951, corresponded to the "cull curve" used by fishermen to discard nonmarketable juvenile haddock (Hennemuth and Rockwell 1987). As a result, the restriction was readily adopted by the industry because it lowered the cost of discarding. Later, individual nation quotas were adopted only after the haddock stock had collapsed when pulse-fished by the Soviet trawler fleet in the 1960s using small (40mm) mesh nets. The quota-based system adopted initially under the Magnuson Act led initially to "derby" behavior in the fishery, causing the fishery to be closed down earlier and earlier as vessels entered the open access fishery (Kellogg 1989). When the system was modified to limit the catch on individual fishing trips, it became difficult to monitor landings; and many landings were mislabelled (Sutinen et al. 1987). Many fishermen perceived the individual vessel allocations as unfair because they were not based on individual vessel characteristics. At the same time, stocks began to recover in the late 1970s, arguably due to the quotas (Anthony 1990). As a result, there was considerable industry support for a return to the gear-based system of regulation, which was adopted in the Interim Groundfish Plan in 1982.[55] As in the case of the haddock stocks in the 1960s, a decade of open access resulted in severe depletion of several stocks. Amendment 7, just adopted in May 1996, now includes target TACs, representing the beginning of the next cycle.

3. Technological innovation. The fishing industry is technologically progressive,

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latest version of the management plan.

[55] Anderson (1986) notes that fishermen tend to favor regulations, such as gear restrictions, that do not restrict effort, but arguably may protect fish stocks. Quotas restrict effort because, once the quota is reached, the fishery must shut down.

Table IV.1. Northeast Multispecies Fishery Management Plans, 1976-1996

Year	Plan	Regime	Comment
1977	First groundfish FMP (developed by NMFS)	individual species quotas	substantial entry; derby behavior
		individual vessel trip limits	mislabelling and misreporting; minimal monitoring; data unreliable as a result; frequent closures, reopenings
1982	Interim groundfish plan	minimum fish sizes; mesh size restrictions; closed haddock spawning areas	"open fishing"; small-mesh fishing for certain spp. allowed; numerical measure of OY abandoned; operational OY = amount harvested
1986	Northeast multispecies FMP	20% maximum spawning potential as a goal; minimum fish sizes; mesh size restrictions; closed haddock spawning areas	NMFS conditional approval; concerns re: overfishing; disconnect between MSP and management measures
1987	Amendment 1	decreased area for small mesh silver hake; tightened mesh restrictions for yellowtail	good cod, YTF year classes; fished out by 1992
1989	Amendment 2	more stringent minimum fish sizes; mesh size restrictions; closed haddock spawning areas	
	Amendment 3	"flexible area action system"	not seen as effective
1991	Amendment 4	more stringent minimum fish sizes; mesh size restrictions; closed haddock spawning areas	
1994	Amendment 5	moratorium on new entrants; days at sea (DAS) program; minimum fish sizes; mesh size restrictions; closed haddock spawning areas	response to CLF consent decree
	Amendment 6	NMFS initiated; 500lb haddock possession limit	NMFS added protection for haddock
1996	Amendment 7	target quotas; more stringent DAS; minimum fish sizes; mesh size restrictions; closed haddock spawning areas	new SAW results forced this amendment; NMFS instituted major closures in late 94-95

in part due to the open access nature of the resource. Under certain forms of regulation, however, the diffusion of new fishing technologies can occur at an inefficiently fast rate because of open access (Anderson 1977). In such circumstances, old but still marginally productive equipment is abandoned too rapidly, with potentially adverse effects on the fish stocks. Although technological invention and diffusion is beneficial, in terms of reducing the costs of fishing effort, problems can arise through the expansion of capacity even if the number of vessels is held constant. A summary measure of technological change in a fishery is a parameter known as "catchability." Catchability is a measure of the efficiency of a particular fishing technology in turning inputs (fishing effort and stocks) into an output (harvest of fish). Roy and Gates (1991) have estimated catchability to increase at a rate of 1.5% per year in the New England otter trawl fleet. Edwards and Murawski (1993) approximate technological change at a slightly higher rate of 2% per year in the same fleet.

In the Gulf of Maine, some of the most striking stock collapses since the turn of the century have been attributed to technological innovations (Serchuk and Wigley 1992).[56] The combination of the otter trawl (in wide use by the 1930s), the diesel engine (1930s), and the development of refrigeration, filleting, and canning (1920s) led to the great haddock stock collapse in the early 1930s. Likewise the development of factory ships (1960s) led to the haddock collapse of that period. Other important technological advances include the steam engine (1906), stern trawling, propeller designs, fish sticks and portion meals (1950s), synthetic nets, fishfinders (1970s), and electronic navigation (1980s).

4. Assistance programs. Most experts believe that the several fishery subsidy programs offered by the federal government (Table III.2) contributed to overcapacity in the Gulf of Maine groundfish fishery, but there has been no research to estimate either the total contribution of all subsidy programs or the relative contribution of each program to the development of overcapacity. Dewar (1983) surveys some of the post-war subsidy programs, providing an intriguing account of the industry's political influence in the U.S. Congress.

Some of the more important subsidy and assistance programs include the public improvement of port and harbor facilities at the local level and the federal fishing vessel obligation guarantees (FVOGs), capital construction funds (CCFs), gear damage compensation funds, and fuel subsidies. Doeringer and Terkla (1995) report that FVOGs may have been important during the 1970s, but their use is now limited to boats or processing plants focusing on underdeveloped fisheries. The use of CCFs, which involve interest-free loans for the construction, reconstruction, or acquisition of boats, has dwindled to only 84 boats in 1994. A recent internal NMFS study reportedly shows that the impact of CCFs and FVOGs within the

[56] Edwards (1995) and Smith (1997) discuss the qualitative effects of technological advances in the fishing industries of the Gulf of Maine. A detailed history of technological advances and their impacts is chronicled in the fishing industry trade press but has not been adequately surveyed to date (Murawski, p.c., 1996; Edwards, p.c., 1996). We have found no other studies that have examined the specific contribution of advancing technology to the development of overcapacity in the Gulf of Maine groundfish fishery.

last five years has been minimal (Rosenberg, p.c., 1996).

Over the years, the industry has been somewhat successful in obtaining capital assistance and other forms of protection, such as the Nicholson Act, which prohibits foreign fishermen from landing fish in U.S. ports (Doeringer and Terkla 1995). However, many industry observers feel that the accelerated depreciation provisions of the Tax Reform Act of 1980, which were not directed specifically at the fishing industry, may have had the greatest effect (Rosenberg, p.c., 1996). These provisions were modified in 1986. In 1992, the Fisheries Reinvestment Act made available small amounts of money for the development of underutilized fisheries.

More recently, government assistance programs have been more along the lines of social welfare programs. In March 1994, the Commerce Department announced a package of "emergency assistance" funds from several federal agencies, including the Departments of Labor and of Housing and Urban Development and the Small Business Administration, totalling about $30 million (Hamilton et al. 1995; Smullen 1994). This assistance took the form of loan restructuring, community planning grants, job counseling and retraining, and grants to individual fishermen. An additional $25 million in "disaster assistance" was announced by the Commerce Department in 1995 to extend an experimental Fishing Capacity Reduction Demonstration Program to retire permits and boats permanently from the New England groundfish fishery (Hamilton et al. 1995).

5. Closures. Upon enactment of the Magnuson Act, the U.S. fishery conservation zone off New England represented a vast area for a U.S. fishing fleet that was composed predominantly of small, aged vessels that focused mainly on nearshore fishing. Under open access conditions, the FCZ provided a huge incentive for boats to enter a fishery that had been the province of foreign fleets. However, as the fleet began to expand, encouraged by federal assistance programs and the promise of rents, the area to be exploited began to shrink.

The Hague Line, established in 1984 in settlement of a U.S.-Canada boundary dispute, has drawn an extensive commentary (Springer 1995), but it is unusual only in the limited sense that it was the first decision to draw a boundary between exclusive economic zones as well as continental shelves. The boundary allocates the tip of the highly productive Georges Bank to Canada. It cuts across single stocks of scallops, haddock, cod, and pollock (Figure IV.4), raising the potential for transboundary management problems.[57] An important effect of the boundary was to concentrate trawlers from the U.S fleet into a reduced U.S. fishery region, thereby placing increased pressure on groundfish stocks located in the smaller area (Fordham 1996; Stevenson, p.c., 1996). Also, closure of the redfish fishery in the deep basins of the Gulf of Maine in the 1980s resulted in redfish vessels redirecting effort on groundfish (Stevenson, p.c., 1996).

Under the Interim Plan and in subsequent plans, area closures for important spawning

[57] Interestingly, the World Court disregarded arguments in favor of drawing the boundary so as to maintain the continuity of stocks on the tip of Georges Bank.

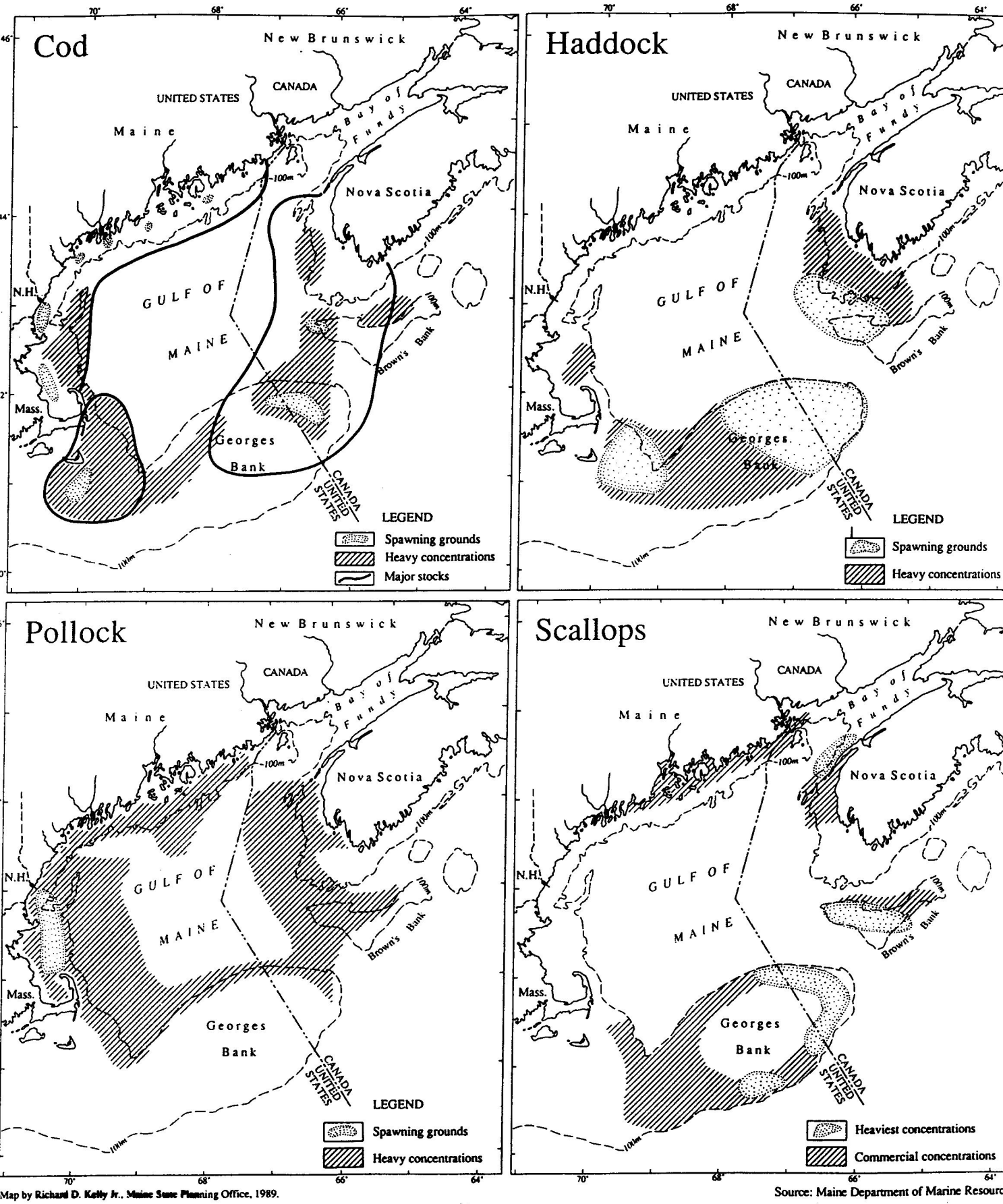

Figure IV.4. **Distribution of cod, haddock, pollock, and scallop stocks relative to the Hague Line. (Source: Maine State Planning Office 1989)**

grounds and juvenile habitats, especially for haddock, have been closed. Although these closures serve to further reduce areas available for groundfishing, concentrating effort in open areas, limited evidence suggests that these closures contribute to the rebuilding of stocks. A "flexible area action system" was adopted under Amendment 3 in 1989 to protect spawning and juvenile aggregations through expedited area closures. However, possibly due to the New England Council's inability to act quickly to implement management measures, the system has never been used.

6. Noncompliance. Another factor contributing to overexploitation is noncompliance with fisheries management regulations. Because compliance with regulations is costly, and because monitoring and enforcement of fishing vessels is incomplete, noncompliance can be a significant problem. Hennemuth and Rockwell (1987) note that enforcement was difficult under the ICNAF regime, particularly with respect to the gear-based restrictions. Foreign fishing vessels were permitted to carry nets with small meshes on-board for specialized fisheries. It was difficult to determine whether or not the small mesh nets were used in the large mesh fisheries.

One of the primary reasons for the switch from a quota-based system to a gear-based system under the Magnuson Act regime was the widespread abuse of the individual vessel quotas. At that time, it was impossible for NMFS to monitor daily landings from all vessels. It was often the case that catches were mislabelled, landed illegally, and fishing locations were misreported (NEFMC 1994). Those fishermen who were compliant were put at a competitive disadvantage; those who were noncompliant earned rents and expanded their fishing capacity (NEFMC 1996). Further, NMFS and the U.S. Coast Guard lacked the budgetary resources to effectively monitor and enforce catches and landings.

Studies by Sutinen et al. (1990, 1989) examined compliance and enforcement during the period when the switch to a gear-based management system was discussed and implemented (1981-1988). They found noncompliance to be both extensive and increasing over time (Figure IV.5).[58] In particular, Georges Bank, perhaps because of its remoteness, had the highest noncompliance rates. The specific reasons for noncompliance included (1) price effects (as stocks fell, prices increased, providing financial incentives for noncompliance); (2) imitation of successful noncompliers; (3) weak penalties (often penalties were treated as a normal business cost); and (4) enforcement difficulties (the Coast Guard reported that mesh size violations were virtually unenforceable).

7. Determining "overfishing." As required by National Standard 1 in the Magnuson Act, conservation and management measures shall prevent overfishing. Regrettably,

[58] Interpretation of this result is qualified by the fact that investigative effort increased during later periods, which tended to bias the trend upward, and the probability of detection declined, which tended to bias the trend downward. Although these two factors pull the series in opposite directions, it is not clear that the effects are equal in magnitude.

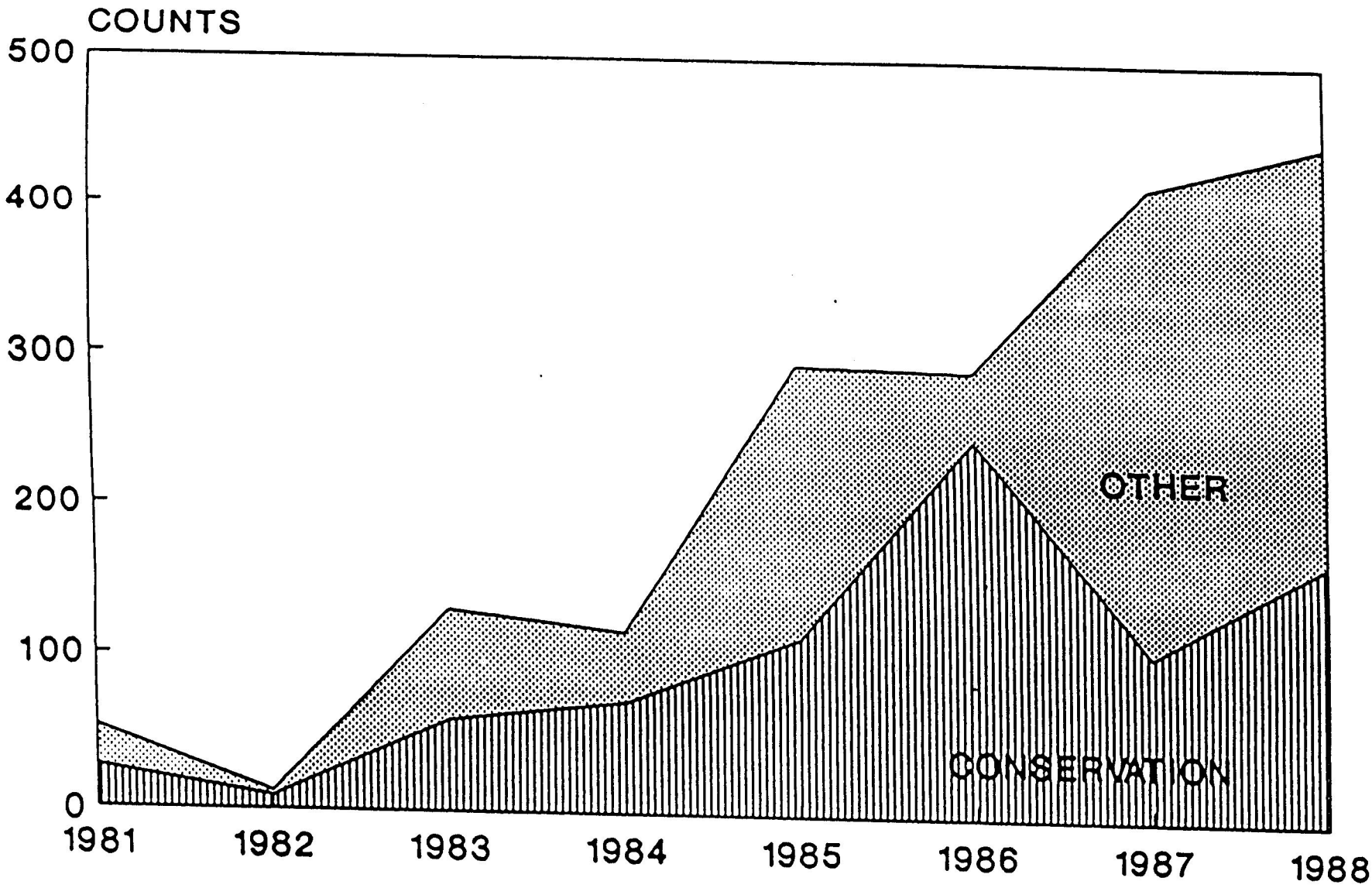

Figure IV.5. Groundfish violations (Sources: Sutinen et al. 1990, 1989)

the Act does not define the term overfishing (McManus 1995). An early version of the Northeast Multispecies FMP, which was implemented in 1986, identified percentages of "maximum spawning potential" (MSP) as targets to ensure that enough of the recruits to each stock remained unharvested to allow stocks to regenerate themselves.[59]
However, fishing effort under the gear-based management system was incapable of achieving these targets (Dorsey 1994).

Due to a NOAA fishery management study in 1986 (the "Calio Report"), the 602 guidelines were revised in 1989 to mandate the councils to specify in each FMP overfishing definitions for the relevant stocks and to develop programs for rebuilding the stocks.[60] In 1989, the New England Council adopted the percentage MSP targets as their definition of overfishing and began discussions on a new plan amendment to reduce effort so that the stocks could be rebuilt. As explained by Dorsey (1994), the New England Council was slow to develop a rebuilding program. Most important, industry council members could not agree that stocks needed to be rebuilt because of good year classes of cod and yellowtail in the late 1980s, mistrust of the results of fisheries science, and a general aversion to additional regulations. An important issue was the absence of any deadline in either the 602 guidelines or in the Northeast Multispecies FMP that would force the Council to act.

In 1984 the Conservation Law Foundation, a regional environmental public interest group, filed a lawsuit to force the New England Council to adopt an Amendment 5 to the FMP incorporating a fishing mortality reduction of 50 percent over five years to rebuild the groundfish stocks. Notably, the Council could not be sued directly, so CLF sued NMFS, arguing that the Magnuson Act imposed a duty on the Secretary of Commerce to ensure that FMPs meet the national standards.[61] The suit resulted in a "consent decree" with deadlines as the central feature. In the event that the Council failed to act, NMFS would be forced through the provisions of the consent decree to promulgate a Secretarial Amendment to force fishing mortality reductions. Although the Council missed the deadline once, by 1994 Amendment 5 had been implemented.

The current Amendment 7 incorporates its own deadlines in the framework adjustment process to ensure that target TACs will be met eventually (NEFMC 1996). Even with these FMP deadlines, both the conservation community and NMFS have argued for incorporating deadlines into the 602 guidelines to force the New England Council to become more accountable (Rosenberg 1996; Dorsey 1994).

8. Scientific inputs. Scientific information on the status of U.S. fish stocks in the Gulf of

[59] An unfished stock has a MSP of 100%; targets of 20% MSP for cod and 30% MPS for haddock were set to define overfishing.

[60] Although the 602 guidelines use the term "must," suggesting that the definition and rebuilding program guidelines are mandatory, the Magnuson Act itself specifies that the 602 guidelines are merely "advisory."

[61] Most experts agree that this was a "friendly" suit, agreed to by both parties in order to force an otherwise unaccountable Council to take action (Stevenson, p.c., 1996).

Maine is provided primarily by fisheries scientists based at the Woods Hole Laboratory of the Northeast Fisheries Science Center. The history of this laboratory goes back 125 years, to when Spencer F. Baird, Assistant Secretary of the Smithsonian, was appointed the first U.S. Fish Commissioner. Baird personally interviewed members of the fishing industry to investigate declines in southern New England fisheries (Hobart 1995). The current stock assessment process has its roots in the scientific investigations initiated under ICNAF; in general, the northwest Atlantic fisheries, including the Gulf of Maine, are thought to have the best data and the best scientific capabilities for assessing the data of any in the world.

Data on the status of fish stocks is collected from research surveys, from landings data collected by port agents, and through a limited on-board observer program. Fisheries scientists employ methods developed to estimate the number of fish in each stock and their age structure. Estimates of fishing mortality are developed and compared to "optimal" fishing mortality rates. The methods and results are peer reviewed in annual stock assessment workshops (SAWs) by stock assessment review committees (SARCs). The peer-reviewed results are available to the public and are provided to the New England Council for use in its management deliberations.

Some members of the commercial fishing industry have been critical of the pace at which the stock assessment process proceeds. As a rule, due to budgetary constraints, stock assessments are not conducted on an annual basis for each stock (NRC 1994). For example, the stock assessment for the Georges Bank cod stock was last performed in 1994, using data from 1993 (NEFSC 1994b). This analysis was used to set the target TAC for the Georges Bank cod stock under Amendment 7, implemented in May 1996.

Fishermen have claimed, on the basis of first-hand observations, that there is evidence that groundfish stocks have rebounded (Stevenson, p.c., 1996; Hall-Arber 1993). However, the NEFSC has been reporting evidence of stock depletion in the New England groundfish fishery since the early 1980s (Murawski, p.c., 1996a). Because there has been no evidence of stock recovery in the last decade, using the best scientific methods and employing data from multiple sources, it seems unlikely that the industry argument has much merit.

The Magnuson Act authorized each of the Fishery Management Councils to establish a Scientific and Statistical Committee (S&S Committee). Although an S&S Committee was established by the New England Council early in its history, it soon became clear that the NEFSC peer-reviewed stock assessment process provided the necessary objective scientific inputs. Except for an ad hoc convening of the panel to investigate studies of the effects of fishing on the relatively good year classes of cod in the late 1980s, the S&S Committee has not been utilized (Haring, p.c., 1996).

One must wonder at the effectiveness of a process that has permitted continued overfishing even in light of virtually incontrovertible scientific evidence of its adverse effects on fish stocks. A criticism, nationwide, of the process is that fisheries scientists are forced to bear

the burden of proof of demonstrating depletion effects (Fox 1990).[62] In the face of uncertainties limiting precise predictions of the effects of fishing on stock sizes, this may be a difficult burden to bear. A further complicating factor may be the difficulty that many fishermen have in understanding the stock assessment methodology (Hall-Arber 1993).

9. Habitat protection. Research has begun to demonstrate the adverse effects on habitat of fishing with certain technologies, especially otter trawls (Watling et al. 1996; Dow and Braasch 1996; Langton 1994). In particular, trawl and dredge gear can modify seafloor habitat in ways that slow the potential recovery of depleted groundfish stocks. Some scientists have begun to argue that habitat modification may have a greater adverse effect than overfishing on the ability of groundfish stocks to rebuild (Langton et al. 1996). However, without question, the cause of the current groundfish collapse can be attributed to "persistent, gross recruitment overfishing" (Murawski 1996b). Regardless of any debate about causation, the only remedy available to allow stocks to rebuild is the reduction of fishing effort (Holmes 1994). Restrictions on the nature of the gear in use (e.g., limitations on dragging) or the location of fishing may also be important.

V. Evaluation

A. Decision Criteria for Successful Governance

In this section, we examine the success of the existing system of governance in the Gulf of Maine. We evaluate some of the more important governance institutions using "decision criteria" developed by the MAGAM Committee (Eichbaum 1996).[63] Where feasible, our focus is on decisionmaking institutions, including the New England Council, the Gulf of Maine Council on the Marine Environment, and other councils, committees, or teams. We discuss briefly the extent to which the most significant criteria are achieved by these institutions in the Gulf of Maine, and conclude with a summary evaluation of marine resource governance in the Gulf.

For our evaluation, we have generalized the decision criteria into two overarching criteria, as follows:

- Economic and scientific soundness. This criterion includes the following MAGAM decision criteria: improved economic efficiency; fair procedures and results; technologically achievable outcomes; scientific validity; timeliness; adaptive; sustainable development; and long-term commitment. This criterion incorporates notions of the separation of efficiency (science) from fair allocation (politics), the adoption of timely, adaptable decision mechanisms, and appropriate enforcement.

[62] It is clear that improvements are needed in stock assessment models to incorporate fully biological interactions among species, other environmental effects, and the size and effects of bycatch and discards of target species (NRC 1994).

[63] Definitions for each of the MAGAM decision criteria are contained in the full Committee report.

•Appropriate scale and scope. Appropriate scale and scope and linkages to related governance institutions include the following MAGAM decision criteria: regional ecosystems concepts; terrestrial connectivity; integrated.

While the criterion of "economic and scientific soundness" is straightforward, "appropriate scale and scope" warrants a brief discussion here. In general, ecosystem boundaries do not coincide with political boundaries. If a governance system is constrained by political boundaries that lie partially or wholly within an ecosystem, the possibility exists that management actions dealing with a subset of the ecosystem's resources may impose external costs on those who use or value resources beyond the pale. Advocates of "regional" (rather than local) "ecosystem" (rather than individual resource) management argue for integrated management on a large geographic scale and across a wide range of resources (see, among others, Cicin-Sain 1993 and Knecht 1994). Optimal management requires identification of the appropriate scale and scope—which is not always the entire region (i.e., the Gulf of Maine) and not always all ecosystem resources jointly.

Both scale and scope must be appropriate to the circumstances if management is to be effective/efficient. For example, managing one half of a regional fish stock separately from the other half because of a geographic boundary could lead to ineffective outcomes (scale too small). Managing scallops on southwestern Georges Bank jointly with scallops on Browns Bank, on the other hand, is unnecessarily complex (inefficient) because the two stocks are, for practical purposes, not connected (and not fished by the same vessels). Similar considerations apply in determining the appropriate scope. If two fish stocks are linked biologically (predator/prey), managing each separately can lead to ineffective outcomes. On the other hand, it is not necessary (inefficient) to manage estuarine water quality jointly with haddock spawning grounds, because haddock spawning takes place offshore. Application of this decision criterion requires a careful delineation of political and ecosystem boundaries.

B. Comparative Evaluation of Governance Institutions

We preface the following comparative evaluation with the caveat that any such comparison is made problematic by the diversity of institutional characteristics (scale, scope, impact, duration). We indicate some of these distinctions below.

In particular, our evaluation includes a brief assessment of each institution's "impact" as a summary measure of the institution's ability to make a significant difference to the management of marine resources and its economic, social, and/or ecological consequences for the Gulf of Maine region as a whole. Impact also takes into account the extent to which a governance mechanism has in fact been implemented. Given this definition, an institution can, in principle, score high on most or all of the 11 decision criteria and still not have much regional impact because of inadequate funding or more deliberate (and possibly appropriate) limitations on the scale or scope of its charter.

1. New England Fisheries Management Council (NEFMC). Governance and management activities by the New England Council have had a significant impact on fisheries resources in the Gulf of Maine for the past twenty years, and a notable impact on the region's fishery-based economic sector. The NEFMC record of governance is poor on economic and scientific soundness and better on appropriate scale and scope (though some concern exists over disjoint management of transboundary stocks between the United States and Canada). In particular, NEFMC governance has failed to improve economic efficiency, to base decisions on scientifically valid information, to make timely and integrated management decisions, and to achieve sustainable development of fisheries resources. Regrettably, the New England Council's long-term commitment to address the fisheries resource and its ability to target technologically achievable outcomes have been its only strong suits among the MAGAM decision criteria.

2. Atlantic States Marine Fisheries Commission (ASMFC). The ASMFC has had a moderate impact on the management of coastal fisheries and their economic effects in (and beyond) the Gulf of Maine for 54 years. Its economic and scientific soundness has been mixed; the restoration of the striped bass fishery is its most well-known success. Management of individual stocks at the state level allows for appropriate scale and scope within a framework of consistency with the Commission's regional management plan. Although it has not done much to improve economic efficiency or use an integrated approach, the ASMFC's record is good on most other MAGAM decision criteria.

3. Harbor Porpoise Working Group/Incidental Take Reduction Team (HPWG/ITRT). The HPWG/ITRT has had significant impact on incidental take of harbor porpoise in the Gulf of Maine over the past five years, though its impact on the region's economy has been limited. Both scale and scope and the soundness of economic and scientific decisions have been appropriate. The chief success of HPWG/ITRT has been achieving consensus for the use of acoustic pingers that keep harbor porpoise away from gillnets. HPWG/ITRT earns high marks for technologically achievable outcomes, scientific validity, and sustainable development; but it falls short on timeliness, integration, and adaptiveness.

4. Northeast U.S. Right Whale and Humpback Whale Recovery Plan Implementation Team (RPIT). The Whale Recovery Plan Team has been active for only two years; it has had a modest impact on right and humpback whale stock protection in the Gulf of Maine, and a negligible impact on the region's economy. Scale and scope appear to be appropriate; soundness of economic and scientific bases for decisions remains to be seen, as RPIT has done little of substance to date. RPIT has strongly embraced regional ecosystem and sustainable development concepts, but has not always targeted technologically achievable outcomes or used an integrated approach.

5. State Lobster Governance Mechanism, Maine. The new Maine lobster governance scheme is expected to have a moderate impact on Maine lobster resources. The scale and scope of this governance mechanism seem appropriate to the resource, but questions

remain about scientific and economic soundness. In particular, the mechanism does not explicitly take into account scientific understanding of lobster population dynamics. Further, the lobstermen's self-governance can be expected to promote the economic well-being of Maine lobstermen more readily than that of U.S. citizens and consumers, who ultimately "own" the resource and in whose interest it ought to be managed. While it is unlikely, therefore, that the scheme will improve economic efficiency, and while its ability to eliminate over-exploitation remains in question, the Maine state lobster governance mechanism seems to meet most other MAGAM criteria fairly well.

6. Gulf of Maine Council on the Marine Environment (GOMCME). The Gulf of Maine Council has been active in non-fisheries policy coordination in the Gulf of Maine for eight years; it has had little direct impact on the management of marine resources or on the region's economy. Economic and scientific soundness are difficult to judge, since GOMCME does not manage directly. Scale and scope are broad, which is appropriate for policy coordination but excessive, for example, for pollution remediation efforts. GOMCME meets most of the MAGAM decision criteria, though its continuity and long-term commitment are in doubt, inasmuch as has no regulatory authority or fixed budget. It is the clearest example of a regional ecosystem-based governance organization in the Gulf of Maine, and the only institution comparable in geographic coverage to NEFMC. The Council's achievements in improving economic efficiency, and timeliness and integration of management, are at best moderate.

7. International Convention for the Northwest Atlantic Fisheries (ICNAF). ICNAF was active for 28 years in the management of northwestern Atlantic fish stocks and had but little impact on Gulf of Maine fish stock management. Its scale and scope were reasonable, but sound economic and scientific management proved elusive. Despite producing valuable stock assessment data, ICNAF did not reduce TAC quotas adequately to prevent stock collapses. It failed to improve economic efficiency, make timely decisions, or use integrated and sustainable approaches to management. On the other hand, ICNAF incorporated regional ecosystem concepts and contributed to the advancement of fisheries science.

8. Northwest Atlantic Fisheries Organization (NAFO). NAFO has replaced ICNAF for the past 18 years, with somewhat greater impact on fisheries resources in the northwestern Atlantic but little impact in the Gulf of Maine. Its contribution to Gulf of Maine marine resource management lies in the scientific information it provides about fish stocks in adjacent Atlantic waters. While NAFO, too, receives low marks for integration and sustainable development, it has done somewhat better than ICNAF in improving economic efficiency and making timely decisions.

9. Stellwagen Bank National Marine Sanctuary (SBNMS). The Stellwagen Bank Sanctuary has been in existence for four years as an "area protection" mechanism, and has had little impact. While the limited regulatory authority vested in the National Marine Sanctuaries program makes it difficult to judge the economic and scientific soundness of SBNMS, a clear problem exists in scale and scope. SBNMS is charged with protecting, among other resources,

the fish stocks in the sanctuary; but NMFS and NEFMC are not required to incorporate SBNMS fish stock and habitat protection measures in their management plans, or even to consult with SBNMS managers on the topic. SBNMS ranks high on most of the MAGAM criteria, with the notable exception of terrestrial connectivity and integration.

10. National Estuarine Research Reserve System (NERRS). The three NERRs around the Gulf of Maine (Wells, Maine, Great Bay, New Hampshire, and Waquoit Bay, Massachusetts) have provided estuarine research sites for the past 24 years, with moderate regional impact. Through scientific research, resource stewardship, and local education and outreach at a small scale, Research Reserves are intended to contribute indirectly to improved management at the regional (and even national) scale. NERRS meets all MAGAM decision criteria and do particularly well in the areas of sub-regional ecosystems concepts, technologically achievable outcomes, scientific validity, terrestrial connectivity, and sustainable development.

11. National Estuary Program (NEP). The three NEP sites around the Gulf of Maine (Casco Bay, Great Bay, and Mass Bays) have provided estuary planning services for the past eight years, with moderate impact. Despite a lack of ownership rights and regulatory authority, the NEP sites around the Gulf of Maine have contributed to economically and scientifically valid management of estuarine resources by assisting existing agencies in planning and through small-scale demonstration projects. NEP meets all MAGAM decision criteria fairly well.

In summary, the majority of Gulf of Maine governance institutions has performed well in meeting the decision criteria. A notable exception is the New England Council. Among those scoring particularly well in this assessment are NERRS, NEP, GOMCME, and the Maine Lobster governance scheme. Gulf of Maine governance institutions are in greatest deficit on the criteria of integration and improving economic effectiveness. Most other criteria are addressed fairly well by these institutions. The regional ecosystem concept, technologically achievable outcomes, and scientific validity fare particularly well.

This mostly positive assessment stands in contrast to the bleak picture painted previously of the history of fisheries management in the Gulf of Maine. We explain this in part by the wide range in level of impact achieved by these governance institutions. Indeed, none of the institutions judged to perform well across all decision criteria has a high impact at the regional scale on the kinds of resources and uses they address. If we remove low-impact institutions from consideration, the overall assessment of institutional performance becomes more negative. Perhaps more significantly, if we look only at the institutions achieving high levels of impact (such as the New England Fisheries Management Council and harbor porpoise activities), their achievement of decision criteria is moderate at best.

One way to explain the failure of fisheries management in the Gulf of Maine is as a failure to separate scientific and political issues. Stock assessment and scientific management of

the fish stocks to assure maximum economic yield over time have not been allowed to operate separately from the processes by which allocation and distribution of benefits are determined. The result of this failure to deal correctly with the twin (but separate) issues of efficiency and allocation has been a dramatically inefficient outcome on the major criterion of economic and scientific soundness.

VI. Conclusions and Potential Solutions

A. Conclusions

The overriding shortfall of marine area governance in the Gulf of Maine has been the failure to manage properly the commercial capture fisheries, as evidenced by overfishing and stock collapse in groundfish stocks. Management decisions flowing from the governance institutions responsible for this resource have been inadequate to the task of managing fisheries in an economically and socially sound manner. Nonetheless, we believe that fisheries management problems in the Gulf of Maine can, in all likelihood, be resolved with minor adjustments to relevant governance mechanisms, along the lines suggested in Section VI.B.

Our general conclusions about fisheries management and governance rest on a number of more specific observations and findings, the most important of which are the following:

- Many commercial Gulf of Maine fish stocks are in poor condition, or "overfished," due largely to failures in governance and management. The poor condition of commercial stocks is not necessarily an indication of poor ecological health, however (Steele 1996). The effects of habitat degradation and pollution on fish stocks are important, but they are not the main cause of depletion of the resource. Nonetheless, the extent of habitat degradation and pollution may have an impact on the rate of recovery of commercial stocks.

- The reason for the decline and depleted status of groundfish resources in the Gulf of Maine is unquestionably a case of overfishing. Overfishing has resulted, by best estimates, in losses of several billion dollars to the New England economy over the last four decades. Overfishing occurred both prior and subsequent to the establishment of the current governance system.

- Certain management and governance factors have contributed to the building of overcapacity, which, in addition to being inefficient in and of itself, has enhanced the potential for stock collapse. These factors include the open-access nature of management; technological innovations to improve fishing power; assistance programs in the early decades; the Hague line, which concentrated effort in a more restricted area; noncompliance with regulations; an FMP development process that faced no deadlines; a governance system that placed the burden of proof on fisheries scientists to demonstrate

stock effects; and little interest, until recently, in the benefits of habitat protection.

- The problems that arise in commercial fisheries, such as stock collapse, are due largely to incompatibilities among the Magnuson Act's National Standards, as interpreted, prioritized, and reflected in the management objectives of the relevant fishery.

- Another significant problem is political pressure put on NMFS by interest groups operating "outside" of the governance structure: the "end run" phenomenon.

- Devolution of management responsibility to a single user group, with minimal government oversight, has been advocated for some fisheries, such as Maine lobster. Governance of this type is likely to be beneficial to the specific user group, especially in the short run. Questions remain, however, about (1) the applicability of such a system to a blue-water fishery, such as groundfish; (2) the potential for inefficient levels of fishing capacity to develop; and (3) the potential for adverse effects on seafood prices and consumers.

- The concept of "conservation equivalency" has had some success in managing the recovery of stocks of fish, such as striped bass, that migrate along the Atlantic coast. It is worth noting, however, that the political power of a dominant user community, recreational fishermen, was an important determinant in the recovery of striped bass.

Apart from fisheries, no gross failure of governance or management is evident in the Gulf of Maine at present. Emerging as a potentially serious governance shortcoming, however, is the absence of a federal policy applicable to ocean mariculture, which is coming to be recognized as a constraint on the development of the industry. Other uses are seen as having precedence over aquaculture in the absence of specific governance or management guidance to the contrary.

As alluded to above, pollution problems exist, but they are primarily local in nature and confined to coastal areas around urban harbors and the mouths of rivers used by industrial facilities. Although some local estuarine environments are seriously degraded, this is not a regionwide phenomenon. The degradation of the marine environment and the accumulation of contaminants in local fish populations are undesirable but are being managed adequately by national and state mechanisms. Other contentious issues, such as dredge spoil and sewage disposal, are also being handled adequately by the responsible governance mechanisms. Overall, the environmental quality of the Gulf of Maine is good; many problem areas appear to be improving, and there is no evidence of serious intra-regional or inter-resource effects going unaddressed by existing governance mechanisms.

This last point suggests that the less-than-regionwide scale of most Gulf of Maine governance institutions is generally suitable to the kinds of issues they address. Other than the New England Fisheries Management Council, the Gulf of Maine has only one regional-scale governance institution: the Gulf of Maine Council on the Marine Environment, which focuses on coordination, not management, of the marine-related activities of state and provincial

governments in the region. The Gulf of Maine Council has contributed significantly to some regionwide scientific research efforts and has taken initial steps to evaluate the regional "state of the environment." Like other non-fisheries governance institutions, however, the Council's scope of concern has not included specific attention to fisheries issues in the past.

This is consistent with a pattern in which, for the most part, fisheries governance in the Gulf of Maine has been kept distinct from governance of other uses. The National Estuary Program, the National Estuarine Research Reserves, and Stellwagen Bank National Marine Sanctuary likewise have had little or no influence over fisheries management decisions. One recent exception to this pattern is protection for certain species of marine mammals, which is now being incorporated into federal fisheries management to a more significant extent than before. The best example in the Gulf of Maine is the harbor porpoise, for which management "integration" was aided significantly by the credible threat of a "threatened" species listing under the ESA, the collaborative private-public sector development of a technological solution to incidental take, and the need for effort reduction in commercial fisheries interacting with harbor porpoise.

Most ecosystems management programs, including National Marine Sanctuaries, National Estuaries, and National Estuarine Research Reserves, tend to be subregional or local in scale, and their impacts are limited by financial constraints. Nevertheless, these programs provide an important potential governance "infrastructure," even if not fully realized to date, for the protection of areas of important economic and ecological significance. Temporal and spatial fishery management closures serve a related purpose and may be looked to increasingly as a means to control the effects of fishing on habitat and to protect "strategic" marine mammal stocks.

In sum, our evaluation of governance institutions in the Gulf of Maine region concludes that the majority of institutions—with the notable exception of the New England Fisheries Management Council—perform well according to the 11 decision criteria proposed by Eichbaum (1996). On the whole, Gulf of Maine governance institutions perform well under most of the decision criteria, especially technological achievability, scientific validity, and sustainable development. They score low on measures of integration and improving economic efficiency.

We believe that the low scores on integration, in particular, should not necessarily be taken as indicators of poor performance by governance institutions, inasmuch as they may reflect institutional scale and scope that are appropriate to resource-use patterns in the Gulf of Maine region. In economic terms, tourism is by far the most important marine or coastal activity in the region; and, other than marine fisheries, ocean resources with potential regional impacts, such as offshore energy, are not being pursued at levels that pose significant concerns.

B. Potential Solutions

Institutions exist to address the problems faced by all resources and most uses identified

in the Gulf of Maine. At present, governance of marine resources is split between the New England Council for capture fisheries and all other institutions for other aspects of marine and coastal resource management. However, this split is neither the reason why many of the commercially important species are overfished nor why some of the groundfish stocks have collapsed. Thus, it is not clear that "integrating" management by erasing this governance split necessarily will improve fisheries governance. As a result, it may be the case that, in the Gulf of Maine, the most appropriate solution to the fishery governance problems may be to take small steps to repair existing institutions, rather than establishing an additional layer of bureaucracy or expanding the authority of existing regional institutions.

We begin with two possible models of fisheries governance, and then turn to specific proposals for improving economic and scientific soundness of management and interagency consultation.

1. Models of fisheries governance and management. The ASFCMA appears to be a viable approach to the management of coastal fisheries, placing management responsibility in the hands of the coastal states. It has been successful in restoring and managing several coastal fish stocks, including striped bass, and will soon be applied to others, including lobster. However, it is unlikely that such a governance system is viable for blue-water EEZ stocks, where a single jurisdiction would seem to require a single set of rules.

The Canadian record of managing fish stocks in the Gulf of Maine and surrounding waters is characterized by stock depletion, as is that of the United States. However, according to Doeringer and Terkla (1995), ". . . the causes of the stock collapse are somewhat different in New England than they are in Atlantic Canada. The declines in New England stocks are almost solely attributable to domestic overfishing, while faulty stock analyses, changes in the oceanic environment, and overfishing of transboundary stocks by foreign trawlers join overfishing by the domestic fleet as significant causes of the stock collapse in Canada."

The Canadian fisheries management system, currently under revision, provides some valuable indications of how certain problems can be avoided:

Enforcement: Any system relying on TACs and quotas must be backed up with a substantial investment in enforcement. Lack of enforcement, and noncompliance, arguably doomed to failure the brief U.S. experiment with TACs in the early years of the Magnuson Act. While far from perfect, Canadian enforcement is stricter than that in the United States. Canadian-type enforcement is also likely to be much more costly, requiring the allocation of additional resources to enforcement efforts to reduce noncompliance.

Management Measures: The Canadian system's greater reliance on limited entry, vessel licensing, TACs, and quotas has had some success; and the most recent decisions of the New England Council suggest that it is moving in these directions as well. Canada also imposes significantly stricter reporting requirements on fishermen to inform fisheries management

authorities of their landings, thereby improving the quality of information available to managers.

Separating Science from Politics: Canada also avoids problems by rigorously separating science (stock assessment) from management/allocation decisions (assignment of quotas to fishers). This helps remove the untenable burden of proving depletion and the need to convince recalcitrant fishers of the validity of scientific techniques they are not trained (or inclined) to understand.

2. Economic and scientific soundness of management. The Magnuson Act's National Standards stress fair allocations along with conservation and efficient use of fish stocks. These standards are, at times, in conflict; and this arguably has contributed to depletion of fishery resources. A possible solution is to prioritize the Magnuson standards such that government managers, acting in the interest of the general public, determine the efficient level of harvest first, and address concerns about fair allocation second (or, indeed, leave this distribution issue to industry altogether).

Special interests sometimes circumvent established governance processes if a decision is not going their way by going straight to Congress in an "end run." This has occurred with New England Council deliberations and with oil and gas moratoria for Georges Bank. There is some evidence that end runs have contributed to the mismanagement of fisheries in the Gulf of Maine (Fordham 1996; Rosenberg 1996). The problem may be endemic to the U.S. system of government, and difficult to resolve. A possible solution may be stronger laws and governance mechanisms that are less susceptible to manipulation by Congressional pressure, also implying better separation of science/management from politics.

Some observers have suggested that the New England Council planning process is not sufficiently constrained to produce timely and relevant management decisions (Rosenberg 1996). Possible solutions include the imposition of deadlines, end-run prohibitions, and other constraints on the council process.

The Fishery Management Councils have been described by some analysts as unaccountable for their actions. Possible solutions to increase accountability include modifying the governance structure to allow the Councils to be sued, forcing them to follow FACA procedures, and imposing requirements to avoid conflicts of interest in Council membership. All of these solutions may involve costs of delays, public hearings, etc. A partial solution may be to broaden the range of interests represented on the Council to include ecologists and perhaps environmentalists and other members of the public. A significant problem is finding a way for the public, as the resource "owner," to secure and sustain an interest in the management process.

3. Interagency consultation. Increased interagency consultation, as exemplified by the Stellwagen Bank sanctuary process, is seen as one way to achieve better management across resources in a system of fragmented management institutions. However, agency consultations may be merely procedural and may not really represent "integrated" management.

It is not clear how to strengthen the integration without giving non-lead agencies some sort of veto authority.