Subdivide and capture:

The genesis of a fishery zoning policy

in the Northeast Continental Shelf Large Marine Ecosystem (USA)

Steve Edwards

NOAA\National Marine Fisheries Service

28 Tarzwell Drive

Narragansett, RI 02882

Tel: 401-782-3313

e-mail: steve.edwards@noaa.gov

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Abstract

Geo-spatial regulations changed the course of renewable resource management in the Northeast Region of the United States beginning in 1994 when ten areas were closed to fishing vessels capable of catching harbor porpoise or groundfish targeted by the large-mesh fishery. By 2004, the entire region was covered by a patchwork of over 100 overlapping areas that addressed the legal mandates of conservation laws. Many of these areas, however, also protected the resource claims of groundfish fleets and environmental groups with de facto zoning regulations that minimized the damaging effects of competitors' spillovers. Although effective at minimizing regulatory bycatch, takings, and alteration of the seafloor, experience with terrestrial zoning practices suggests that ocean zoning will be costly to society due to rent-seeking, suppression of the total aggregate value of market and environmental goods and services, and boundaries that are inflexible to new information. A more productive spatial management policy could be founded on harvest rights and contracting.

Keywords: Ocean zoning, Contracting, Property rights, Northeast Continental Shelf Large Marine Ecosystem (USA)

"… as a rule, regulation is acquired by the industry and is designed and operated primarily for its benefit." [1, p. 3]

Prof. George J. Stigler, 1982 Nobel Prize in Economics

1. Introduction

In the first comprehensive assessment of the oceans since the 1969 Stratton Commission study, the U.S. Commission on Ocean Policy (Ocean Commission) in 2004 reported widespread and persistent externalities, or spillovers, between competing uses of the ocean that are negatively affecting economic welfare in American society [2]. Established sectors (such as commercial fishing, sport fishing, oil and natural gas production, mining, shipping, tourism, telecommunications, and ocean dumping) are interfering with each others' production and enjoyment in many areas of the territorial sea and EEZ (Extended Economic Zone), and they oppose making room for innovations, including renewable energy, offshore aquaculture, and marine protected areas (MPAs).

Zoning has emerged practically unquestioned as the leading policy to resolve use-conflicts in the ocean. It has been embraced by some environmental organizations[1] and coastal states [3] in the region, and it is endorsed by ecologists and social scientists inside academia and the federal government [4, 5, 6] as an integral part of an ecosystem approach to resource

management in the ocean. Although widely reported by the media as supportive of zoning, the Ocean Commission avoided the term, but the 2003 Pew Oceans Commission was straight forward in its report on living marine resources in asking Congress to prepare zonal plans for all uses of the ecosystem.[2] Such broad support for ocean zoning was recently underscored when a group of over 200 scientists and marine policy experts from academia urged governments to "… [i]nitiate zoning of regions of the ocean … by designating areas for particular allowable uses in both space and time".[3]

Perhaps zoning's familiarity on land in the United States explains its popularity as a "technical fix" [7] of user conflicts. Zoning has become a ubiquitous public policy instrument used by states and, especially, cities and towns to minimize spillovers between seemingly incompatible uses of private land since the early 1900s [8]. Initially land was sub-divided into exclusive districts with uniform uses that were regulated to protect public health, safety, and general welfare. As zoning methods matured, regulations that accommodated some mixed uses and environmental protection became more common, but the U.S. Constitution still prevents a government from completely attenuating private property rights [9]. In contrast, the Property Clause of the U.S. Constitution gives Congress the supreme power "to dispose of and make all needful rules and regulations respecting the territory or other property belonging to the United States".[4] Federal agencies exercise this power when using zoning strategies to manage the federal government's extensive holdings

of land resources for commerce, recreation, and preservation. This authority has been affirmed by the Supreme Court without limitations [10].

Not counting the somewhat related experiences of developing management plans for the land-sea interface under the authority of the 1972 Coastal Zone Management Act,[5] zoning offshore areas of the ocean is a relatively new phenomenon, but current events suggest that this could change. Several federal MPAs around the country already have formal zoning plans that exclude oil and natural gas production, among other things [11]. In addition to being integral to the federal government's notion of an ecosystem approach to management (mentioned above), it is included in the Bush Administration's U.S. Ocean Action Plan of 2004 for coral protection, offshore aquaculture parks, and energy development.[6]

Given the growing acceptance of ocean zoning, it is worthwhile to examine the current situation and to assess lessons that might be learned from the classical use of exclusive zoning on land. This paper focuses specifically on the Northeast Region of the United States (Maine to North Carolina) where 102 areas were used in 2004 to manage fish stocks, "essential" fish habitat, and marine mammals. The Ocean Commission charted shipping lanes, hazardous areas, telecommunication cables, national marine sanctuaries, and a proposed wind farm in a small part of this area adjacent to Massachusetts and Rhode Island to illustrate crowding, but areas used to manage living marine resources were not included.[7]

Section 2 describes the management areas and regulations. Section 3 identifies their zoning characteristics and discusses the connections between zoning, spillovers, and property rights. The paper concludes in Section 4 with the suggestion that an economically superior spatial resource management policy could develop from a comprehensive system of harvest rights and contractual negotiations among the resource claimants and the government. Compared to exclusive zoning, which is more costly than assumed by its supporters, contracting should (a) internalize the opportunity costs of spillovers in a timely fashion unless the transaction costs are too great; (b) generate greater total aggregate value among interacting uses through the exchange of property rights instead of ignoring the value of excluded or restricted activities when minimizing spillovers; and (c) be flexible to changing uses and boundaries in response to new scientific information, beneficial technological change, and sustained changes in people's preferences.

2. Management areas and regulations

2.1. The 2004 Regulatory Chart

Figure 1 depicts a conventional view of the geography of living marine resource management in the Northeast Region. Shown are (a) the regional boundary lines for state and federal waters, (b) the four sub-systems of the

Northeast Continental Shelf Large Marine Ecosystem (LME; Gulf of Maine, GOM; Georges Bank, GB; Southern New England, SNE; and Mid-Atlantic, M-A), (c) the four regulatory mesh areas which stipulate general guidelines for fishing gear restrictions, (d) the average number of Atlantic cod and Atlantic sea scallop collected at biological sampling stations (1987-1992), and (e) the three original year-round groundfish closed areas implemented in December, 1994 (i.e., Closed Areas I and II on GB and the Nantucket Lightship Closed Area in SNE) are mapped because of their historical significance and influence on policy in the region. The cod and scallop data are merely representative of the populations of many species targeted by commercial and recreational harvesters. Not shown are spatial distributions of fisheries [see 14*].

By 2004, conventional views of resource management had been sub-divided by a complex patchwork of 102 overlapping management areas, many with unique sets of geo-spatial regulations (Table 1). The areas mapped in Figure 2 are GIS coverages that were converted to a 1-km^2 raster grid. (See Appendix 1 for the GIS methods. Overall, the entire region was overlapped by at least three management layers owing to comprehensive spatial policies for harbor porpoise protection, Atlantic herring management, and management of gillnet fisheries for goosefish, spiny dogfish, and skates. Overlaps averaged seven management layers, but 80 percent of the region was covered by up to 15 layers, especially in New England and relatively close to shore in the GOM, SNE, and, to an extent where all three areas meet (see Figure 1). GOM waters

between Cape Cod, Massachusetts and southern Maine were overlapped with up to 19 management layers.

The physical scale of the 102 management areas is daunting – i.e., nearly 3.5 million km^2 when combined, or over seven times the size of federal and state waters in the region, and almost a third of the size of the entire U.S. EEZ. Likewise, the perimeters of the areas - which amount to about 110 thousand kilometers in aggregate, or nearly 10 times the circumference of the region's shoreline and EEZ, and over five times the size of the U.S. shoreline – are extensive and require considerable monitoring and enforcement to be fully effective.

This complicated picture resulted, in part, from decisions to manage the spatial heterogeneity of resources under the existing single-species framework which treats species (stocks) in isolation from each other. Typically, managers have concentrated on optimizing biomass and (where possible) age-structure throughout the range of a stock. Factoring in spatial attributes can, in theory, improve yield; but, the inevitable interactions among fisheries (such as regulatory bycatch, takes of protected species, and alteration of the seafloor) are regarded as spillovers, that detract from single-species management objectives. We will return to the economics of spillovers in Section 3 after describing the management area in more detail.

2.2. Characteristics of the management areas

The management areas were assigned to six categories based on their primary objective. The 1977 Fishery Conservation and Management Act and subsequent amendments (now referred to as the Magnuson-Stevens Act) focus primarily on managing fish stocks at optimum yield by preventing biological overfishing, minimizing bycatch, and minimizing the adverse impacts of fishing gear to “essential” fish habitat (i.e., EFH, or those habitats that are necessary to managed species for spawning, breeding, feeding, or growth to maturity species). The fourth category is preservation of marine mammals and other protected species as required of NMFS by the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973. In many cases, ocean space or fishery resources were allocated by area in order to resolve gear conflicts or multiple claims to the same species. Finally, there was one MPA in the region’s federal waters. These areas are described in Table 1 along with another 15 areas that expired or were subsumed by new areas during 1994-2004.

2.2.1. Stock rebuilding (n=12)

The biological overfishing theme contains areas enacted primarily to rebuild depleted fish stocks or to maintain harvests at optimal biological levels. To date, the areas are designated for stocks managed by either the Northeast Multispecies Fishery Management Plan (Groundfish Plan) or the Atlantic Sea Scallop Fishery Management Plan (Scallop Plan). The groundfish areas

increased in number from the three indefinite, year-round closures established by a NMFS Emergency Rule in 1994 (i.e., Closed Areas I and II and the Nantucket Lightship Closed Area) to ten in 2004, including several seasonal rotational management areas in the GOM, and three Special Access Programs (SAPs) for haddock and yellowtail flounder. A recent innovation in partitioning resource use among harvesters, an SAP is "a narrowly defined fishery for a large-mesh species that is prosecuted in such a way as to avoid or minimize impacts and bycatch on groundfish stocks of concern, as well as impacts on Essential Fish Habitat".[8]

The two Atlantic sea scallop access areas are part of a new rotational management strategy implemented under Amendment 10 to the Scallop Plan in 2004. Once areas with large numbers of small scallops are closed, sea scallop fishermen will not be allowed to access these areas for a few years, although no other fisheries are excluded or restricted unlike the groundfish closed areas (see below).

2.2.2. Regulatory bycatch (n=32)

National standard 9 of the Magnuson-Stevens Act states that managers should "to the extent practicable, (A) minimize bycatch and (B) to the extent that bycatch cannot be avoided, minimize the mortality of such bycatch." At some point, the notion of bycatch was construed to include the catch of species that another fishery perceives to belongs to them.

Controls on bycatch of Atlantic cod and other large-mesh groundfish apply either to fisheries granted exemption status to fish in the year-round groundfish closed areas, or to areas elsewhere on the shelf where restrictions on gear or season are designed to minimize groundfish bycatch. In both cases, the rule for small-mesh fisheries states that "[e]xempted fisheries allow fishing vessels to fish for specific species in certain areas using small mesh gear otherwise prohibited provided the bycatch of regulated species is minimized and certain conditions are met", such as a 5% incidental catch standard provided the large-mesh species is not overfished and the use of excluder devices.[9]

Several "exempted" fisheries were allowed unrestricted access to the groundfish closed areas because their gear has minimal contact with Atlantic cod, flounder, and other large-mesh groundfish or could be modified to minimize bycatch. The lists of exemptions differ among areas, but the following description illustrates the policy: "Closed Area II, unless further restricted under EFH Closure Areas, is closed year-round to all fishing vessels, with the following exceptions: Vessels fishing with or using pot gear designed to take lobsters or hagfish, pelagic hook and line gear, pelagic longline gear, harpoon gear, tuna purse seine outside the portion of CAII known as the Habitat Area of Particular Concern, pelagic mid-water trawl gear, and vessels fishing in the CAII Yellowtail Flounder Special Access Program."[10] In contrast, restricted fisheries (such as recreational fishing, charter boat fishing, and "small-mesh" fisheries for

Northern shrimp, scallop dredge, and whiting) have gained partial access to the groundfish closed areas, but only after demonstrating that their gear could be modified to avoid catching the large-mesh species. Restricted fisheries are further constrained by output controls, particularly trip limits for their target species and zero possession limits on large-mesh groundfish. This policy is a boon for the lobster fishery which previously contended with gear conflicts with the mobile gear.

Other, mostly seasonal areas were established to control bycatch of groundfish in fisheries that use small-mesh gear: “allow fishing vessels to fish for specific species in certain areas using small mesh gear otherwise prohibited provided the bycatch of regulated species [i.e., large-mesh species] is minimized and certain conditions are met”.[11] The conditions include use of fish excluder devices in the Northern shrimp fishery (i.e., the Nordmore grate), a maximum dredge width in the GOM scallop fishery, stowing nets in the Cultivator Shoal whiting fishery when transiting the GOM/GB Regulated Mesh Areas, and a variety of trip limits, fishing periods, and zero possession of large-mesh groundfish. Similar constraints were placed on the large-mesh trawl and gillnet fisheries for monkfish, dogfish, and skates across the EEZ.

The number of groundfish bycatch areas grew steadily during the 1990s from four in 1994 to 24 in 1999 (Figure 3), doing much to push the total number of management areas over 60. Most of the bycatch areas are in the GOM, GB, and SNE.

2.2.3. Essential fish habitat (n=7)

Section 303 of the M-S Act directs NMFS and the Regional Fishery Management Councils (Regional Councils) to "… minimize to the extent practicable adverse effects on such habitat [i.e., EFH] caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat". A successful law suit filed by the American Oceans Campaign (now Oceana) against the Secretary of Commerce (Civil No. 99-982 GK D.D.C. December 17, 2001) resulted in the implementation of seven year-round habitat closures under Amendment 13 to the Groundfish Plan in 2004 which were subsequently adopted by the Scallop Plan in Amendment 10 (until overturned in 2005 by another successful Oceana suit requires NMFS to use the scallop EFH areas in Amendment 10).[12] The regulations state "no vessel or person on a fishing vessel with bottom tending mobile fishing gear on board the vessel may enter, fish in, or be in the EFH Closure Areas" with the exception of the restricted Northern shrimp fishery in the Western GOM Habitat Closure Area. The areas, which are scattered across the GOM and GB and apply to both large-mesh and small-mesh mobile bottom gear fisheries, subsumed the juvenile cod Habitat Area of Particular Concern (HAPC, or EFH that is especially important ecologically or particularly vulnerable to degradation) established on the northern edge of Georges Bank in 1999.

2.2.4. Protected species (n=35)

NMFS used an Emergency Rule in 1994 to initiate the practice of closing areas to protect marine mammals when it enacted three harbor porpoise closures near the coast in the GOM in 1994. Take reductions plans for harbor porpoise and Atlantic large whales increased the number of protected species closures seven-fold by 1998 (Figure 3).

Watched carefully by the environmental community, NMFS monitors takes of harbor porpoise and large whales in fishing gear used to harvest groundfish, monkfish, dogfish, and skates. Large whales are also vulnerable to entanglement in the buoy and ground lines of lobster pots. Areas were, therefore, initially closed to these fisheries, but access was eventually permitted to vessels using gear with sanctioned deterrents (e.g., with pingers, sinking buoy and ground lines, weak links, etc.) that minimize the chances of interactions or entanglement.

Protected species closures are comprised of seasonal closure areas for harbor porpoise, year-round restricted areas and critical habitat for the Atlantic large whales, and two Seasonal Management Areas stretching between Cape Cod, Massachusetts, and the EEZ at GB which require gear restrictions to protect whales. The endangered Northern right whale has also been protected since 2001 by stringent restrictions on fishing in Dynamic Management Areas for 1-2 weeks after a credible siting. The large increase in the number of Dynamic Management Areas in 2004 accounts for the increase in protected

species areas. The majority of marine mammal closed areas are found in the GOM and SNE.

2.2.5. Allocation (n=15)

It is significant that the fishing industry developed three proposals during the mid-1990s that would zone the region. A Gear Conflict Advisory Committee from throughout the region (convened jointly by the New England and Mid-Atlantic Councils) proposed two resolutions in 1994 which were never adopted by either council [see 14*]. One resolution delineated the EEZ by Loran lines, season, and depth for separate uses by fixed gear, mobile gear, and drift gear, with buffers in between and some unrestricted areas. The second resolution used vessel size to define separate bands parallel to the coast except for a ban on all fishing west of -70°W reserved for hook boats. A third proposal, developed in 1996 by the Groundfish Oversight Committee (industry members of the New England Council) during the early phase of Amendment 7, would have sub-divided New England waters into nine shared areas regulated by quarterly gear closures, but it was withdrawn before Public Hearings [14*].

The other theme that showed a large increase in number of areas between 2003 and 2004 was allocation (Figure 3). The original four areas in this category resulted from gear conflicts between lobster trap and mobile trawl and dredge gear along the outer edge of the shelf in SNE. An agreement negotiated by industry on how to rotate use of this area was adopted by the New England

Council in 1997.

No additional areas fell into the allocation theme until Amendment 13 added seven in 2004 (Figure 3). A bi-lateral agreement between Canadian and the U.S. governments which shares the transboundary stocks of GB cod, haddock, and yellowtail flounder resulted in two management areas in U.S. waters that are accessible only to large-mesh groundfish fishermen with limited access permits. In addition, a large area around GB was designated as the place where a harvest cooperative of hook fishermen from Cape Cod could specifically harvest their allocations. This area included two SAPs for cod and haddock in Closed Area I that were initially allocated-only the harvest cooperative (the program is now extended to all hook fishermen). In addition, any hand-gear fisherman with a groundfish limited access permit can take yellowtail in two new areas subject to trip limits. Most areas grouped in the allocation theme are within GB or SNE.

2.2.6. Marine Protected Area (n=1)

Only one MPA currently exists in the region's federal waters (i.e., the Stellwagen Bank National Marine Sanctuary in Massachusetts Bay), although many of the other management areas would qualify as MPAs based on the criteria established by the U.S. federal government (e.g., an area closed for at least two consecutive years with the potential for permanence[13]).

3. Zoning practices and property rights arrangements

The economic theory of regulation begun by Stigler [1] describes a "market" for favors, entitlements, and services which are demanded by businesses and the citizenry and supplied by different sectors of the government for various forms of "payments". Applied to the management of living marine resources [13], this theory predicts that the rapid increase in the number of management areas (underscored by the 21 areas added by groundfish Amendment 13 in 2004; Figure 3), their geographic extent, and their persistence can not be explained on conservation grounds alone, particularly since there is little scientific evidence that area closures have successfully rebuilt fish stocks or protected marine mammals during the past decade. More likely, this policy of closing areas and restricting fishing practices has the acceptance, if not support, of influential parties who have staked claims to large-mesh groundfish, habitat, or protected species.

This interpretation of the preponderance of area closures has merit. It is apparent where environmental groups and their supporters demand areas for the exclusive protection of EFH, or where marine mammals are protected from unfettered use of lobster gear or sink gillnets. Forty-two of the 102 areas fell into these categories in 2004. Although less obvious, there is support for the hypothesis that large-mesh groundfish fleets also support the closure policies. The large-mesh groundfish fisheries are located in New England waters where

most closed areas are found and where representatives of the groundfish fleets are council members. Most of the 44 areas that benefit the large-mesh fleets preferentially (including the 32 areas enacted to minimize bycatch of Atlantic cod, haddock, and flounder by other fisheries, five SAPs, five indefinite year-round closures, and the two US/Canada Cod Sharing Areas) were developed by the Council. Further, part of the New England Council membership's interest in zoning was mentioned above in the section on allocation.

The emphasis on using geo-spatial regulations to minimize spillovers either by excluding offending parties from an area (e.g., the exclusive EFH habitat closed areas) or by requiring changes in fishing technologies or behaviors (e.g., via gear modifications and regulatory bycatch rules) suggests a nascent zoning policy that is evolving incrementally. This section considers the likely economic merits of exclusive zoning.

3.1. Zoning as a property rights arrangement

Fischel, Nelson, and others identified zoning as a property rights arrangement in their studies of land use in the late 1970s [8, 14, 15, 16, 17, 18]. As a property right, zoning requires a government to sanction certain uses (industrial, commercial, recreation, preservation) within an area and either restrict (attenuate) or exclude other, interfering uses that cause spillovers. That is, zoning is a geo-spatial property rights regime which specifies entitlements

and responsibilities of people in a society to spatially-defined resources. Further, it is a social contract that stipulates legitimate uses and users of a resource, how entitlements may be attenuated, and how users and others in society may be benefited or harmed [19, 20, 21].

Ocean zoning will face different circumstances than on land. One important difference, which has already been addressed by the Ocean Commission, is the degree that an ecosystem is subdivided by geo-political boundaries and agency purviews. On land, an ecosystem is subdivided by the zoning plans of numerous towns and cities and even the federal and state governments where public lands are concerned. The Northeast Shelf LME is segmented by many fewer political boundaries – the states, the federal government, and the international Hague Line shared with Canada. The largest share of the LME belonging to the federal government (78 percent) could facilitate an ocean zoning plan that is consonant with ecosystem function, but the segmentation of resource authorities among different agencies will undermine economic returns for the nation (as discussed below in detail).

A second difference that does concern us here involves ownership natural resources. In Northeast states, most land, mineral, and other non-fugitive resources (e.g., timber) are privately-owned. Potable water supplies are less easy to classify with private and public ownership arrangements, but other fugitive resources, particularly wildlife and the atmosphere are publicly owned and managed. In contrast, the cost of information about ocean resources

(quantities, quality, dynamics, interactions) has been high compared to land, making it difficult to establish private or group ownership and self-governance. As a result, practically all resources retain common pool characteristics with a relatively high percentage of attributes exposed in the public domain where they are subject to excessive use and damage from spillovers. For example, despite the considerable resources, talent, and effort expended on fisheries management, resource dynamics (such as recruitment) are too difficult to predict accurately. Also, predator-prey relationships among juvenile and adult fish probably generate spillovers in all fisheries in the Northeast Region ("my" fish eats "your" fish, so don't catch "your" fish).

Dean Lueck's [22] analysis of the history of development of property rights in the United States indicates that common pool circumstances have favored the "rule of capture" of benefits from flows (such as harvests) because of the prohibitive expense in taking possession of an asset. Exclusive zoning, however, offers a way for stakeholders and user groups to secure a claim to ocean resources through "first possession". That is, geo-spatial regulations can function like fences and exclude competitors from the same ocean space or significantly restrict their access to the stakeholders' claims, supplying de facto if not real ownership of an asset's benefits in a particular area. Lueck's comment about the establishment of property rights to common pool resources on land in the United States could be equally telling for the ocean: "Overwhelmingly, first possession has been the chosen method by which rights

are established both in custom and law."

3.2. The interaction of location and spillovers

The property rights notion of zoning causes us to ask how well exclusivity or restrictions internalize spillovers and evaluate tradeoffs between competing activities. Two issues involving the location attribute of ocean resources need to be recognized: (1) location is a potentially valuable attribute of a resource; and (2) the indivisibility characteristic of the location attribute predisposes uses of mingled resources to spillovers.

An important teaching of property rights theory states that the economic value of a manufactured or environmental good or service is partly a function of the specific attributes covered by the property rights [23, 24]. Gross value increases with the number of attributes and the thoroughness of property rights assignments (i.e., the degree of exclusivity, enforceability, transferability). For example, aquaculture farms on land or adjacent to the shoreline exercise more control over fish attributes, such as color, texture, size, growth rate, diet, gene pool, and habitat (e.g., water quality, predators), than harvesters or managers of wild fish stocks ever can.

An old real estate saw stresses that the three most valuable attributes of a property are "location, location, and location" (particularly if the other attributes have a significant spatial co-variance with location). Gordon illustrated

this condition in his seminal paper on property rights to fishery resources using differences in growth rates of fishes on different fishing grounds [25]. As he explained, when individual fishermen have “no legal title to a section of the ocean bottom” (p. 131), each is drawn to the location with the highest average catch rate until productivity is equalized and the value of the growth rate attribute is dissipated.

Spillovers in the ocean can be traced back to the indivisibility characteristic of the location attribute (this could be 3-dimensional involving the water column). Indivisibility means that even though property rights to uses of co-mingled resources can be divided (the same attribute or different attributes among different people), the location attribute cannot because it is a physically shared, inseparable input to production (except in time or perhaps the vertical dimension). The co-evolution of species in an ecosystem is a major cause of spillovers because catches in one fishery are likely to influence catches by other fisheries through processes such as predation and competition. Production technology is another major cause of spillovers,, including physical incompatibilities (e.g., fixed vs mobile fishing technologies), unspecialized inputs (e.g., bycatch), and incidental byproducts (e.g., habitat damage, oil spills, collisions between ships and endangered species).[14]

3.3. Property rights regimes and zoning

Property rights to the location attribute of resources affects economic growth and well-being. The Ocean Commission addressed governance problems that occur when different agencies have competing or conflicting authorities over uses of ocean resources [2]. For example, both seafood and energy are important to U.S. society, yet NMFS (U.S. Department of Commerce) and the Minerals Management Service (U.S. Department of Interior) have separate and non-transferable authorities and, therefore, no incentive to manage for total aggregate value. To correct this kind of problem, the Ocean Commission recommended that all ocean resource responsibilities be centralized in one agency.

Equally important, though, are the incentives created by governance arrangements that distribute property rights between the government and resource claimants. Fischel identified this issue at the local level of government where “zoning represents an incomplete assignment of property rights”, with the zoning board having the right to exclude activities from an area [14, p. 979]. In federal fisheries, the U.S. government is sovereign owner of all rights to ocean resources within the EEZ (and Federal Submerged Lands), but fishermen have been entitled to keep the resource component of harvest income (i.e., the resource rent). Further, the collective rights to manage fishery resources and to exclude parties reside with NMFS and Regional Fishery Management Councils who serve as agents for the Executive Branch.[15] Finally, while commercial fishermen and anglers have developed claimant status based on historical use

and investment in fishing capital, conservation organizations are attempting to do so through the courts.

The wedge between interests of different claimants and other parties and the regulatory authority of NMFS and the Regional Councils to exchange or attenuate harvest opportunities frequently creates uneconomic incentives which dissipate potential gains from spillover controls. Although fishermen have occasionally negotiated sharing rules under the present governance arrangement which imposes high transaction costs[16], their agreements are not legal unless adopted by the Regional Councils and NMFS. Liabilities for spillovers are ill-defined for common pool resources, so parties petition the government for favorable allocations and laws (such as protective bycatch rules, area closures, and gear restrictions). Although individually rational, in aggregate the expenditure of resources on political action and law suits (including defensive actions) can negate whatever value is recovered from reduced spillovers. This behavior – known as rent-seeking [26] - was emphasized by economists who criticized the economic performance of exclusive zoning of local private land [15, 27].

In addition to the collective costs of rent-seeking, excluding or significantly restricting activities that infringe on the favored use generates additional opportunity costs from lost production which are borne by other sectors of the economy. These costs are usually inconsequential to parties whose use of an area is sanctioned, but can be costly for society if there exists

a middle ground where tradeoffs result in greater aggregate returns. Two hypothetical zoning scenarios are illustrated in Figure 4 where Use 1 of one of the resources generates negative spillovers that affect the value of Use 2 of the second resource. Assume that the Use 2 value curves associated already reflect spillovers (i.e., are lower than they would be without Use 1), and that both curves are net of estimates of rent-seeking costs and enforcement costs. In Figure 4a, the scenario supports a single-use area (depending on uncertainty in the estimates and degree of risk aversion) because aggregate value drops rapidly with the onset of Use 2. The high-value Use 2 might be preservation of a scarce resource with few examples and no substitutes (i.e., a unique asset or environment), a highly-valued but fragile environment, or an environment with a high quasi-option value owing to the value of future information to reduce uncertainty on an irreversible investment or action. These situations might describe an endangered species, existence of isolated areas of deep-water corals and other emergent growth valued by the public, or seamounts in the New England chain with unknown species composition and bio-prospecting (medicinal) potential, respectively. In contrast, Figure 4b shows a more clear tradeoff across a wide range of activity levels of both uses. If not addressed, the spillovers from Use 1 would overwhelm Use 2. However, aggregate value is greatest with both uses operating at moderate levels in the area. Figure 4b is most likely the more common situation in which some spillover is part of the cost of optimizing uses of ocean resources (just as some emissions from cars,

homes, and businesses is part of the cost of living comfortably and working). Internalizing the spillover creates an incentive (i.e., increase returns) to find ways to reduce its output or impact.

There are many contemporary examples of competition for ocean resources that illustrate the economics of regulation and rent-seeking in the presence of diseconomies, such as spillovers and common pool situations [28]. Alaska fishermen lead the country in harvest rights innovations such as harvest cooperatives [29], but their lobby against offshore aquaculture resulted in a bill before the Senate (S. 2859) which called for a moratorium on any planning or approvals for fish farming for the foreseeable future.[17] Opposition from the fishing industry and environmental community led to congressional and executive moratoria against oil and natural gas development in many coastal areas through the year 2012, including the entire North Atlantic Planning Area from Maine to New Jersey [9]. Finally, some in the environmental organizations advocate bans on trawling and dredging[18] and favor networks of wilderness MPAs that preserve 10-40% or more of the world's oceans [11].

Exclusivity is an essential element of the property rights "bundle of sticks" because it lends security to investments, including in natural resource stewardship. However, when the right to exclude is applied preferentially to the indivisible location attribute of mingled resources the aggregate value of production from an area can decline unless the right to exchange also exists. That is, if parties cannot resolve spillovers (including crowding effects) when

their ownership of resource rights is divided [23], then property rights might be exchanged and bundled to allow individuals to internalize tradeoffs in joint production decisions. This solution to “the problem of social cost” was identified by Coase who methodically explored the role of transaction costs in property rights and the structure of economic production [30]. Once a spillover is internalized, the owner(s) can evaluate the tradeoffs at different production levels and select the optimum mix, including the possibility of zero production for one or more sectors in an area. In other cases when the technology is too specialized, the rights to production can be sold or leased under contracts with stipulations that reflect the opportunity costs of spillovers.

Many real-world examples exist of spillovers being internalized in contracts, including with environmental organizations and governments. A well-known example concerns production of oil and gas from 37 wells on the 80-year-old Rainey Wildlife Sanctuary in Louisiana which netted the Audubon Society $25 million over the years [31]. The Nature Conservancy has a new marine initiative to acquire property rights to submerged lands through ownership, leases, or easements and then negotiate with industry and local governments for ways to preserve the natural environment and allow for both fisheries and public access.[19] In a different program, the Nature Conservancy joined the Environmental Defense Fund in negotiations with the Pacific Fishery Management Council to buy out a percentage of the groundfish trawlers in exchange for a network of marine reserves[20]. Oil and gas production and

recreational activities taking place inside the boundaries of the Flower Garden National Marine Sanctuary in the Gulf of Mexico reportedly have not resulted in any measurable harm to the coral reef ecosystem[21], and the rig workers provide free monitoring of boaters' activity on the reefs. On land, there are many examples of wildlife production and environmental protection being supplied by farms, ranches, and households [28]. It is not difficult to imagine, therefore, similar contracts between fisheries involved in gear conflicts or bycatch disputes (provided they own the rights to contract), or contracts between fisheries and other ocean sectors, including environmental protection, oil and gas production, and aquaculture.

4. Contracting - An Alternative to Exclusive Zoning

The groundfish and harbor porpoise closures in 1994 charted a new course in the management of renewable resources in the Northeast Region of the United States and created a new avenue for the fishing industry and environmental groups to secure resource claims which were facilitated by the conservation mandates of environmental laws. Within a decade, federal waters were blanketed with 3-19 layers of management areas designed to rebuild depleted fish stocks (mostly groundfish), minimize bycatch of groundfish in other fisheries, minimize adverse impacts to groundfish EFH, preserve marine mammals, and allocate harvest opportunities and areas among competing

fleets. At the same time, most of the areas also protected the interests of the large-mesh fleets and the environmental community preferentially.

Using area-specific regulations to minimize spillovers is the classic argument for zoning and could be an avenue towards first possession of resource claims. The fishing industry's attempts during the 1990s to propose zoning plans to resolve gear conflicts and to share fishery resources (including the Groundfish Oversight Committee's work), membership from the groundfish fleets on the New England Council, lobbying and law suits by environmental organizations, and the persistence and increase in the number of management areas with rules that favor groundfish fleets and NGOs are consistent with this viewpoint. The New England Council's on-going work on EFH Omnibus Amendment 2 would make zoning a reality by closing new areas for environmental protection and scientific research, and stipulating locations where different types of fishing gear can be used depending on habitat characteristics. At the moment, though, the work heavily favors environmental protection, and is therefore controversial with the fishing industry.

The popular belief that exclusive zoning is economically beneficial has been contradicted by economic research of its use on land, however. Rent-seeking costs and foregone production by the excluded or restricted parties typically outweigh any gains from reduced spillovers. Further, from a dynamic standpoint, exclusive zoning preserves inefficient resource allocations because it is costly to influence decision-makers to change boundaries [14].

Generally speaking, the costs of exclusive zoning are likely to be even greater in the ocean than on land for several, related reasons. As mentioned above, information on ocean resources is inherently more costly to gather information than on land and, therefore, ocean resources are known with less certainty. Further, ocean resources are predominantly common pool resources which have attributes exposed to the public domain where their value can be dissipated. Thirdly, government ownership of ocean resources induces marine industries, non-governmental organizations, and the general public to rent-seek for “permits and licenses” [28]. Under the current governance arrangements in fisheries, rent-seeking is a necessary part of obtaining (or protecting) resource privileges, whereas on land the degree of rent-seeking is mollified by private or communal rights that are recognized in law or custom. Finally, the segmentation of resource authority among different agencies of the government (as stressed by the Ocean Commission) practically precludes evaluation of tradeoffs as depicted in Figure 4b because there is no mechanism to exchange authority (or incentive for heads of agencies to voluntarily reduce the amount of their authority or to ignore their constituencies). For example, the EFH regulations require NMFS to consult with other agencies who are reviewing marine projects for adverse impacts on EFH. In the Northeast Region (as elsewhere), renewable and pollution-free energy projects that require physical capital in the water (e.g., windmills), sand and gravel dredging projects to replenish beaches and supply the construction industry, waste disposal, pipelines, oil and gas

exploration, and so on are resisted and recommended to use inefficient alternatives, if at all.

This criticism of exclusive zoning does not rule it out in all circumstances, even on economic grounds. Holland [*] points out that zoning might be more economical than contracting when savings from spillover reductions are greater than the costs of enforcing boundaries. These are important considerations, but we must also account for the opportunity costs of foregone production and environmental services and the net difference in rent-seeking costs. Scenarios that favor exclusive zoning are most likely to occur when (a) resources have the characteristics discussed with Figure 4a in Section 3 (i.e., scarce, no substitutes, high or uncertain value, action is irreversible); (b) spillovers are continuous but costly to quantify; and/or (c) the technologies involved are highly specialized which discourage bundling. The latter two conditions would undermine negotiation by affected parties due to high transaction costs (condition (b)) and preclude internalizing the spillover by a single entity (condition (c)) [32]. In other cases (such as depicted in Figure 4b), an alternative to exclusive zoning is needed to allocate resource spatially at low cost, to grow the ocean economy (including the non-market, or environmental benefits), and to be adaptive to new long term changes brought about by gains in scientific information, beneficial technological change, and sustained changes in society's preferences.

An alternative is found in Cheung's [24] seminal work on property rights:

“[t]he alleged “externalities” [i.e., spillovers] in fisheries are thus attributable to the absence of the right to contract”. As used here, contracting is the act of private negotiation with the intention to find a mutually beneficial set of terms (not just price) for the exchange of property rights. Parties to the process could be any person or any entity (i.e., self-organized group, business, government) who is the legal owner of the property rights of interest in the exchange. Contracting is a substitute for rent-seeking and government regulations to allocate resources. Support for contracting comes from a variety of sources. Contracting also comports with centuries of experience with “formal” (private) [33] and “informal” (commons) [34] agreements. In their review of the Ocean Commission and Pew reports, Sanchirico and Hanna call on the government to soon develop harvest rights for all fishery uses [35]. Finally, contracting takes advantage of Coase’s [30] keen insight that governments can induce positive economic growth by transferring property rights to the affected parties and thereby reduce the transaction costs of and exchange because the parties who own the right to contract are bounded and known. For example, in Alaska harvest cooperatives have negotiated harvest or profit shares of a total sector allocation in a couple hours or days, compared to several years of rent-seeking for “dedicated harvest privileges” in the traditional fishery management council system [29]. Further, many ITQ systems have evolved self-governance arrangements after the transaction costs were reduced by property rights assignments [Townsend *].

Contracting is seldom mentioned as a policy for living marine resource management, but it was highlighted by Townsend and Pooley [36] in their taxonomy of distributed governance arrangements. While industry and non-governmental groups concentrate on production and where to conserve representative examples of ocean environments, the government can focus on its comparative advantages in areas of police power, international relations, and public goods, including necessary attenuations of spatial property rights for national security, public health, stewardship of protected species and special environments, monopoly pricing as a result of consolidations, basic scientific research, and measurement of asset values and flows for national income and production accounts.

For contracting to work best, property rights should be (a) transferable or else contracting is precluded; (b) legal (versus a privilege) for security of ownership and long-term investments and planning; and, if possible, (c) spatially-defined on a relatively small grid. Spatially-defined property rights will facilitate the initial allocation of harvest rights by the government in auctions (as for OCS oil and gas leases) or other means because claimants can closely match preferences for fishery, community, and areas valued for environmental protection. Spatial rights will also minimize transaction costs in subsequent exchanges as private parties, groups, and businesses design a geography of uses based on relative values.

Without a field experiment, economic returns of contracting and

exclusive zoning can only be compared in theory and related experience. In general, the transaction costs of resource allocation should be significantly less under contracting because the set of legitimate property rights owners is bounded and managers do not constrain production decisions with scores of inefficient regulations. In contrast, under exclusive zoning rent-seekers (and rent-defenders) have an incentive to expend transaction costs up to the expected value of their individual objective.

The aggregate benefits of spatial management should be greater with contracting because the incentive to account for the opportunity costs of excluded or restricted uses is much stronger compared to the current regulatory regime. Levels of production by different activities will be decided by comparisons at the margin in tradeoffs instead of spillover minimization rules that look at only one side, and decision-makers who neither bear the costs of costly choices nor receive the benefits of comprehensive consideration of what is at stake. For example, in Figure 4a the presumed high value of Use 1 (most likely a special area of the environment or species) would justify a single-use area (on economic grounds), while Figure 4b would be a multiple-use area that experiences some spillover that diminishes the value of Use 1. In the latter case, owners have the incentive to voluntarily reduce spillovers to enhance the aggregate value from production and environmental services in an area. Coase [30] outlined the organizational options as to whether to bundle or divide property rights to the mingled resources, and how to use contracts, new

technology, or new production processes to reduce the opportunity costs of spillovers. If resource ownership remains divided, Use 1 could negotiate with Use 2 for a reduction in the damaging effects of the spillover. Or, if Use 1 was protected by law, Use 2 would evaluate whether it was less costly to compensate Use 1 or to adopt practices to reduce the spillover (or both). In contrast, one use might purchase the other, internalize the spillover, and find ways to reduce its damage. Or, if the technologies are too specialized, one of the uses could be leased to someone else under contract with stipulations that protect the other use [30]. The latter approach was adopted by the Audubon Society when it received millions of dollars in royalties for leasing the right to produce oil and gas on its Rainey wildlife sanctuary.

Boundaries will be well-defined in either the zoning or contract cases, but contracting boundaries will be more adaptive to new information about the ecosystem, changes in technology, or durable changes in society's preferences. Outcomes gained from rent-seeking are rigid because any change creates uncompensated losers who lobby to prevent it. In contrast, the contracting approach involves voluntary exchange of legal property rights which requires compensation.

In ending, contracting is not a type of "technical fix" that was recently criticized in this journal [7]. The transition from the current regulatory arrangement to a comprehensive allocation of spatially-defined harvest rights is an enormous challenge that would need to overcome (a) obstacles imposed by

heterogeneous fisheries to property rights [Libecap *]; (b) resolution of the first-allocation mechanism and whether industry will pay a fee or bid at auctions or continue to receive free distributions; (c) apprehension about making fishing a harvest right instead of a “dedicated harvest privilege”; and (d) data deficiencies when defining fishing rights spatially on small grids. Once overcome, negotiations would sometimes break down whenever transaction costs (including information costs) are too high at the time, especially initially as experience is gained and there are no pieces of the puzzle on the board. It is important to note, though, that the presence of exclusive zoning does not signal success where contracting fails because, unlike contracting, zoning ignores the opportunity costs of excluded or restricted activities. Also, every piece of the puzzle that is laid down makes the next negotiation or round of negotiations easier.

The apparent excess demand for uses of ocean resources in the Northeast Region and its complement of spillovers is largely an artifact of the common pool characteristics of the resources, the single-species framework which attempts to optimize interrelated resources and uses individually, the divided governance arrangements, and a regulatory ownership regime with misaligned incentives. There is broad support in government, academia, and non-governmental organizations to use exclusive zoning as a quick-fix to eliminate the spillover symptoms instead of the causes. Unfortunately, while spillovers might physically be minimized, exclusive zoning will grossly

underachieve the economic benefits that the Ocean Commission and government anticipate from a geography that excludes or restricts many uses inside each area. We should look at exclusive zoning more critically and carefully consider alternatives such as contracting before diving in over our heads.

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Appendix 1: Database Methodology

Regulations that govern fisheries in federal waters (including takings of marine mammals and protected species) can be found on the websites of the Northeast Regional Office of NMFS (http://www.nero.noaa.gov) and the New England and Mid-Atlantic Fishery Management Councils (http://www.nefmc.org and http:///www.mafmc.org). This information was used to search the U.S. government's Federal Register for the coordinates of the 98 management areas in effect during 2004 (http://www.gpoaccess.gov/fr/index.html). Appendix 2 describes the management actions and provides the source documents.

The geographic coordinates of each area were generated into coverages using ESRI's ArcGIS software (v. 8.3). In many cases, arc segments from boundary coverages of the shoreline (http://www.edc.uri.edu/lme) and state waters (3-nautical miles) and the 200-nautical mile Exclusive Economic Zone (http://www.noaa.gov/mbwg/htm/boundary_summary2.htm) were added to complete a polygon.

All coverages were projected to a Mercator coordinate system (meters, -70ºW central meridian, 39ºN true scale latitude, 0ºE false easting, 0ºE false northing). In addition, coverages were converted to raster grids (1-km cell size) using the ESRI Spatial Analyst Extension. Grids were added using the raster calculator to show the number of management areas that covered a cell. "No Data" values were reclassified as zeros to keep from erasing cells in the map extent.

Table 1

Inventory of living marine resource management areas in the Northeast Region, USA. GOM is Gulf of Maine; GB is Georges Bank; SNE is Southern New England; M-A is Mid-Atlantic.

a. In effect during 2004

Name	Year	Season	Comment
Biological overfishing (n=12)			
Closed Area I Closed Area II	1994	Annual	
Nantucket Lightship Closed Area Cashes Ledge Closed Area Western GOM Closed Area	1998	Annual	
Closed Area II Yellowtail Flounder Special Access Area		6/1-12/31	
Closed Area II Haddock Special Access Area		5/1-2/28	
GOM Cod Trip Limit Area GB Cod Trip Limit Area	2004	Annual	Quota could trigger early closure
Eastern US/Canada Haddock Special Access Pilot Program		5/1-12/31	
Hudson Canyon Sea Scallop Access Area	1998	Annual	Will open to controlled fishing on 3/1/06
Elephant Trunk Scallop Rotational Closed Area	2004	Annual	Will open to controlled fishing on 3/1/07
Groundfish bycatch (n=32)			
Cultivator Shoal Whiting Fishery Exemption Area	1994	6/15-10/31	

GOM Raised Footrope Trawl Exempted Whiting Fishing Area 1		9/1-11/19
GOM Raised Footrope Trawl Exempted Whiting Fishing Area 2		11/21-12/31
Small Mesh Northern Shrimp Fishery Exemption Area		local decision
Mid-Water Trawl & Purse Seine Exemption	1995	
GOM/GB Dogfish & Monkfish Gillnet Fishery Exempted Area		7/1-9/14
GOM/GB Dogfish Gillnet Fishery Exempted Area		7/1-8/31
SNE Monkfish and Skate Gillnet Exempted Area		Annual
SNE Dogfish Gillnet Exempted Area	1996	5/1-10/31
Nantucket Shoals Dogfish Fishery Exemption Area		6/1-10/15
Small Mesh Area 1		7/15-11/15
Small Mesh Area 2		1/1-6/30
SNE Monkfish and Skate Trawl Exemption Area SNE Mussel and Sea Urchin Dredge Exemption Area GOM/GB Inshore Restricted Roller Gear Area GOM Scallop Dredge Exemption Area Nantucket Shoals Mussel and Sea Urchin Dredge Exemption Area	1997	Annual
GOM Rolling Closure I	1998	3/1-3/31
GOM Rolling Closure II		4/1-4/30

GOM Rolling Closure III		5/1-5/31	
GOM Rolling Closure IV		6/1-6/31	
GOM Rolling Closure V		10/1-11/30	
SNE Little Tunny Gillnet Exemption Area		9/1-10/31	
GB Seasonal Closure Area	1999	5/1-5/31	
GOM Grate Raised Footrope Trawl Whiting Fishery Exemption Area	2003	7/1-11/30	
SNE/M-A Winter Flounder Special Access Area	2004	Annual	
SNE Scallop Dredge Exemption Area			
Scallop Dredge Closed Area I			
Scallop Dredge Closed Area II	2004	6/15-1/31 through 2006	
Scallop Dredge Nantucket Lightship Closed Area			
Scup Northern Gear Restricted Area	2000	11/1 to12/31	
Scup Southern Gear Restricted Area	2001	1/1-3/15	
EFH closures (n=7)			
Closed Area I North Habitat Closure Area	2004	Annual	
Closed Area I South Habitat Closure Area			
Closed Area II Habitat Closure Area			new configuration of 1999 cod HAPC
Nantucket Lightship Habitat Closure Area			
Western GOM Habitat Closure Area			

Cashes Ledge Habitat Closure Area			
Jeffry's Bank Habitat Closure Area			
Protected species (n=35)			
Northeast Closure Area	1994	8/15-9/13	
Mid-Coast Closure Area		9/15-5/31	
Massachusetts Bay Closure Area		12/1-5/31	
Cape Cod South Closure Area	1996	12/1-5/31	
Offshore Closure Area	1998	11/1-5/31	
Cashes Ledge Closure Area		2/1-2/28; 6/1-6/30	
New Jersey Waters		1/1-4/30	
Southern M-A Waters		2/1-4/30	
New Jersey Mud Hole		2/15-3/15	
Cape Cod Bay Restricted Area	1997	Annual	Additional winter closure (1/1-5/15)
Stellwagen Bank/Jeffreys Ledge Restricted Area			
Great South Channel Restricted Lobster Area			Additional spring closure (4/1-6/30)
Northern Inshore State Restricted Lobster Area			
Northern Nearshore Restricted Lobster Area			
Southern Nearshore Restricted Lobster Area			
Offshore Restricted Lobster Area			
Great South Channel Restricted Gillnet Area			Additional spring closure (4/1-6/30)

Great South Channel Restricted Gillnet Sliver Area			
M-A Coastal Restricted Gillnet Area			
Other Northeast Restricted Gillnet Area			
Right Whale Seasonal Management Area East	2002	5/1-7/31	
Right Whale Seasonal Management Area West		3/1-4/30	
Right Whale Dynamic Management Area	2004		Short-term closures (1-2 weeks) based on credible sitings with different coordinates each year: 2/27-3/12; 3/1-3/12; 3/14-3/28; 3/25-3/31; 4/1-4/8; 4/1`-4/8; 4/22-4/30; 5/2-5/16; 7/24-7/31; 8/1-8/7; 8/25-9/8; 9/2-9/16; 12/22-1/5/05
Allocation (n=15)			
Mobile Gear and Lobster Trap/Pot Restricted Gear Areas I, II, III, and IV	1997		Mobile gear closures: I: 10/1-6/15; II: 11/27-6/15; III:6/16-11/26; IV: 6/16-9/30 Lobster gear closures: I: 6/16-9/30; II: 6/16-11/26; III: 1/1-4/30; IV: not restricted
GB Cod Hook Sector Area	2004		
Closed Area I Hook Gear Special Access Area			
Western U.S./Canada Resource Sharing Area			
Eastern U.S./Canada Resource Sharing Area			
Cape Cod/GOM Yellowtail Flounder Trip Limit Area		Annual	Quota could trigger early closure

SNE/M-A Yellowtail Flounder Trip Limit Area			
CA1 Hook Sector Haddock SAP	2004	10/1-12/31	
Inshore GOM Area 1A			
Offshore GOM Area 1B	2000		
South Coastal Area 2			
GB Area 3			
MPA (n=1)			
Stellwagen Bank National Marine Sanctuary	1992		
b. No longer in effect			
Name	Year	Season	Comment
Offshore juvenile cod closure	1999	2/1-2/28	expired
Offshore juvenile cod closure		4/1-4/30	
Virginia Beach Sea Scallop Access Area	1999 to 2003	Annual closure until 2001	expired
Rolling Closure VI	*-2001	*	Combined with Rolling Closure III in 2002
Juvenile cod HAPC	1999 to 2003	Annual	Combined with Closed Area II Habitat Closure in 2004
Dynamic Management Areas	2001 to 2003	1-2 weeks	2 complete closures in 2001; 4 complete closures in 2002; 3 closures with access restrictions in 2003
Westport Scallop Enhancement and Aquaculture Project	1997 to 1999	Annual	Exclusion of wild fisheries. Ended after first phase due to numerous difficulties.

Captions

1. A conventional geographic view of fisheries management in the Northeast Region (USA) showing boundaries of state and federal waters, the four sub-systems of the Northeast Continental Shelf Large Marine Ecosystem, the four general regulated mesh areas, and populations of Atlantic cod and Atlantic sea scallops at biological survey stations (1987-1992). The three original groundfish closed areas are also shown for reference (Closed Areas I and II and the Nantucket Lightship Closed Area).
2. Raster layers of the 102 management coverages in the Northeast Region (USA) during 2004 on a 1-km^2 grid.
3. Time-series of the number of management areas in the Federal waters of the Northeast Region (USA) beginning with the Stellwagen Bank National Marine Sanctuary in 1992 and ending with 102 areas in 2004. See Appendix 2 for the list of areas.
4. Illustration of aggregate economic benefits from a hypothetical area of the ocean where two resources co-exist but Use 2 generates a negative spillover affecting Use 1: (a) value is maximized by a single use of the area; and (b) value is maximized by multiple uses of the area and damages from spillovers is part of total costs.

Figure 1.

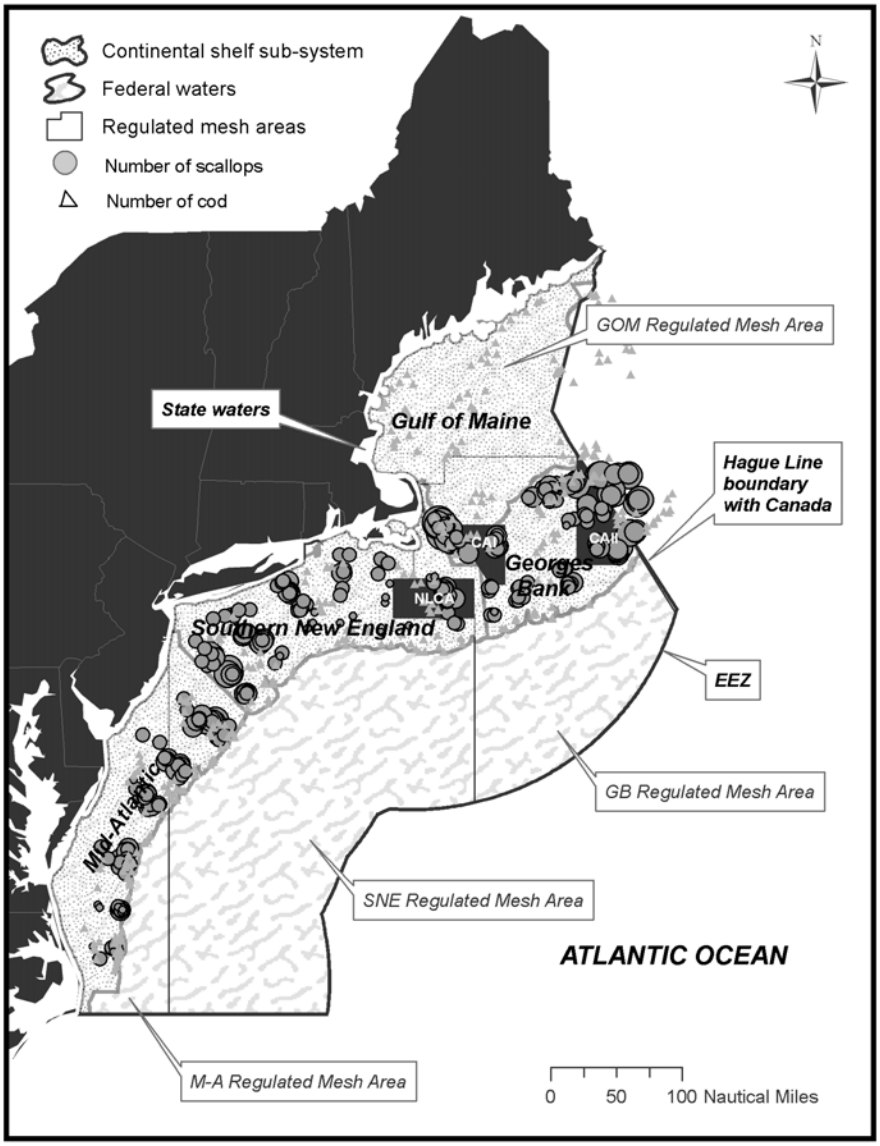
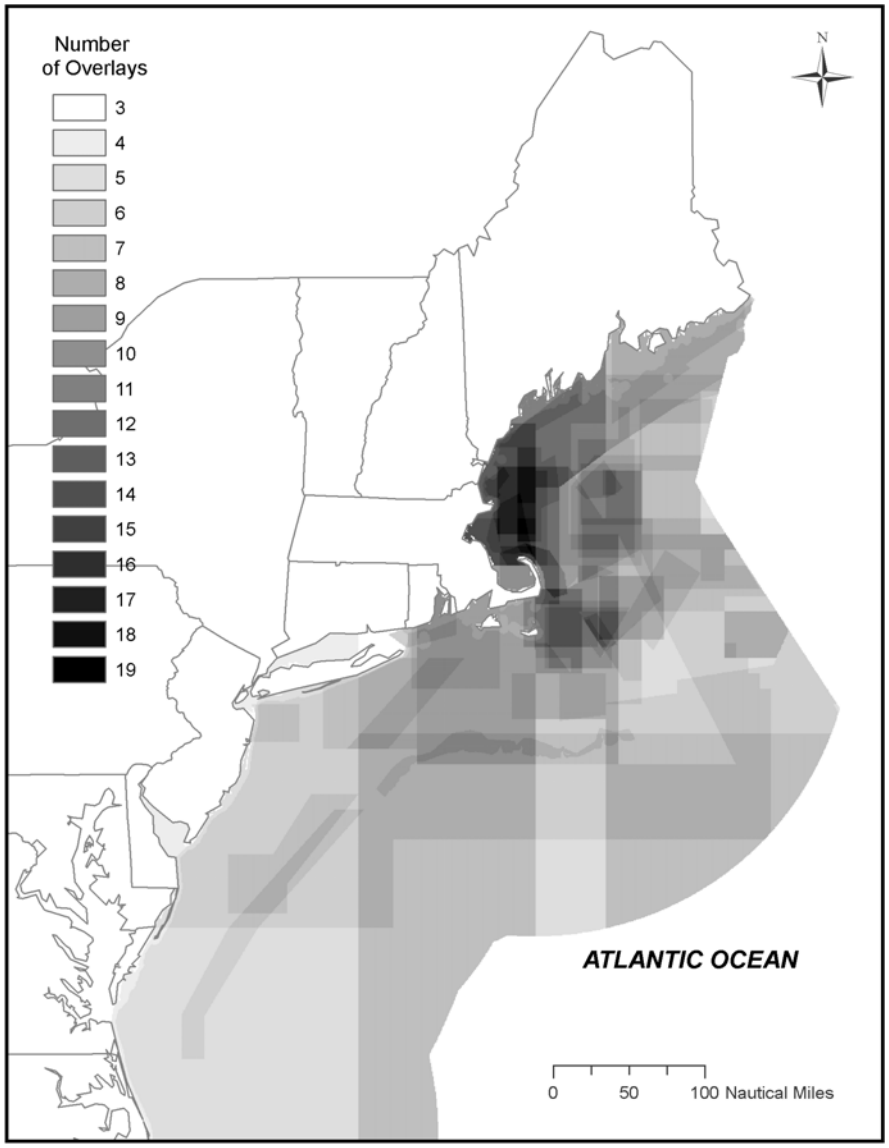

Continental shelf sub-system
Federal waters
Regulated mesh areas
Number of scallops
Number of cod
N
GOM Regulated Mesh Area
State waters
Gulf of Maine
Hague Line boundary with Canada
CA I
CA II
Georges Bank
NL
Southern New England
EEZ
GB Regulated Mesh Area
Mid-Atlantic
SNE Regulated Mesh Area
ATLANTIC OCEAN
M-A Regulated Mesh Area
0 50 100 Nautical Miles

Figure 2.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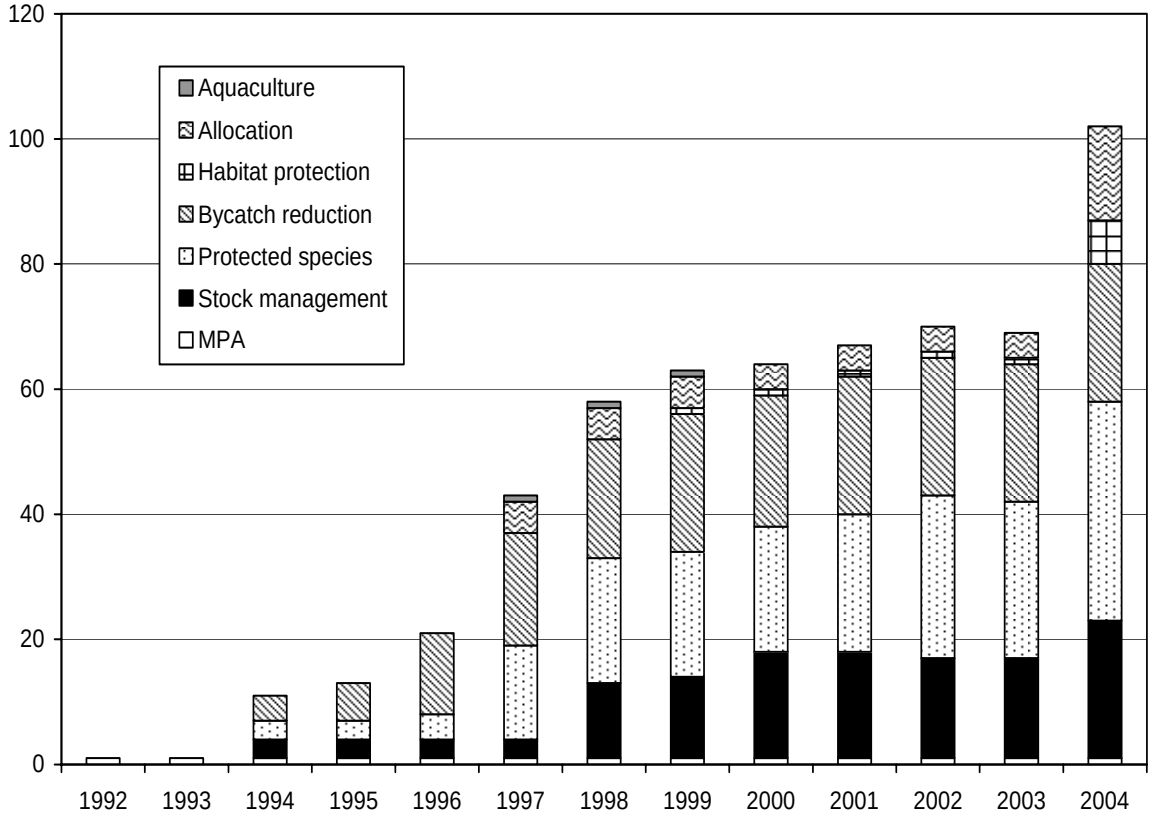
100 Nautical Miles

Figure 3.


120
100
80
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Aquaculture
Allocation
Habitat protection
Bycatch reduction
Protected species
Stock management
MPA
1992
1993
1994
1995
1996
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1998
1999
2000
2001
2002
2003
2004

Figure 4a.

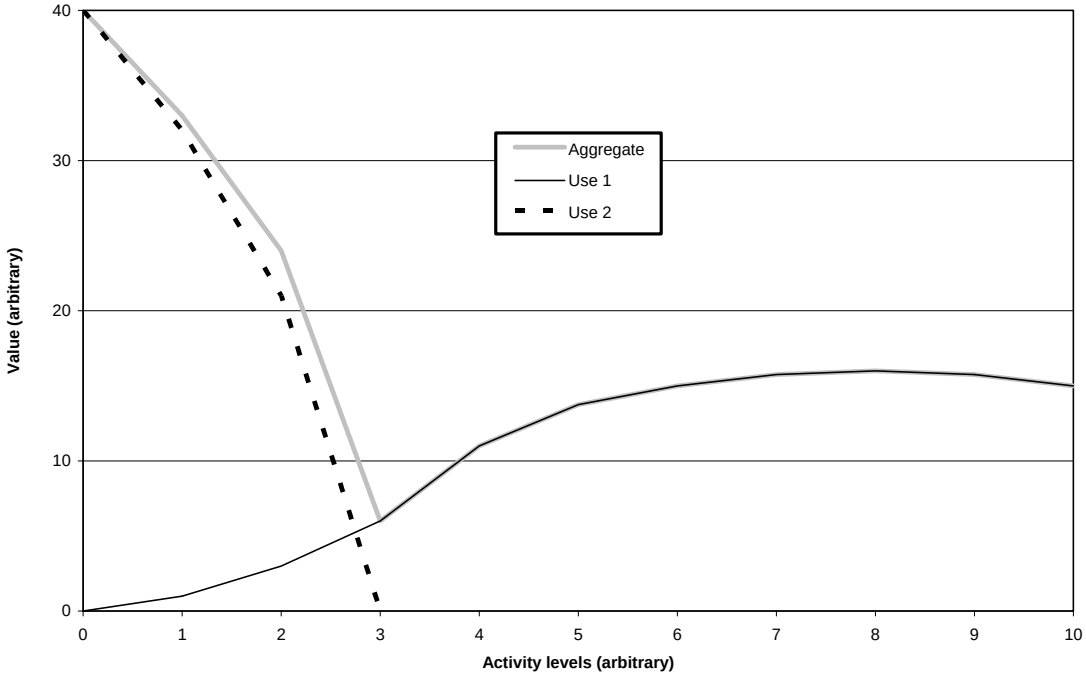
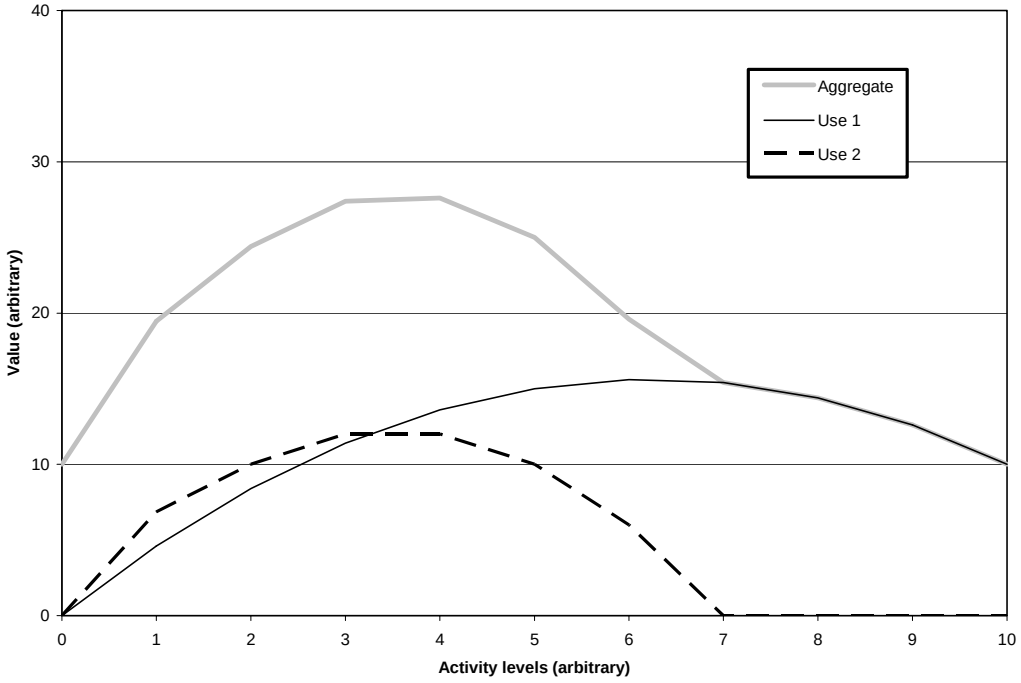

40
30
20
10
0
Value (arbitrary)
0
1
2
3
4
5
6
7
8
9
10
Activity levels (arbitrary)
Aggregate
Use 1
Use 2

Figure 4b.


40
30
20
10
0
Value (arbitrary)
0
1
2
3
4
5
6
7
8
9
10
Activity levels (arbitrary)
Aggregate
Use 1
Use 2

Notes and References

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1 "Taking charge of Maine's future: establishing a marine planning and management program" (http://www.clf.org)

2 http://www.pewoceans.org

3 http://www.compassonline.org See consensus statement on p..5.

4 U.S. Constitution, Article IV, Section 3, Clause 2 (Property Clause).

5 The Coastal Zone Management Act of 1972 encourages states to develop federally-approved coastal zone management plans (including "special area management plan") to regulate land and water uses that compete. See http://www.ocrm.nos.noaa.gov/czm.

6 See http://www.ocean.ceq.gov/actionplan.pdf

7 See p. xxxviii of the Executive Summary [2].

8 See 50 CFR 648.4

9 See 50 CFR 648.4

10 50 CFR Part 648

11 NOAA Fisheries Northeast region Information Sheet No. 2 (08/02/04) – Page 1. Northeast Regional Office, NMFS (http://www.nmfs.nero.gov)

12 Federal Register, vol. 69, No. 19, January 29, 2004, p. 4412.

13 http://www.mpa.gov

14 Spillovers are not always negative. For example, Texaco staff working on natural gas platforms in the Gulf of Mexico reportedly alert the Flower Garden

National Marine Sanctuary-illegal uses of the coral reefs. See http://www.sanctuaries.noaa.gov/oms/omsflower/omsflowermanag.html

15 Members of Management Councils are from the commercial and recreational fishing industries, environmental organizations, and the fishing agencies in federal and state governments. They develop management plans which stipulate access and harvest rules. NMFS also develops fishery management plans for some species (the highly migratory species of sharks, tunas, swordfish, and billfish), approves Management Council actions, undertakes Emergency and Interim Actions in response-pressing fisheries management problems, and enforces regulations (with the U.S. Coast Guard). In addition, NMFS develops recovery plans for endangered or threatened species and take reduction plans for marine mammals.

16 The lobster pot fishery and the trawl and dredge fisheries for groundfish and sea scallops devised the four rotational closed areas along the shelf edge in Southern New England. Likewise, the Atlantic Offshore Lobsterman's Association and a groundfish group, Associated Fisheries of Maine, are negotiating a share-plan for the Eastern U.S./Canada SAP. Recall that lobster fisheries were automatically exempt from the groundfish closure exclusions.

17 See http://thomas.loc.gov.

18 For example, see Oceana's (http://northamerica.oceana.org) and the Ocean Conservancy's (http://www.oceanconservancy.org) campaigns against

bottom trawling and dredging.

19 http://nature.org/files/tnc_leasing_booklet.pdf

20 Stephen Freese, NMFS, personal communication

21 See “Long-term monitoring of the East and West Flower Garden Banks National Marine Sanctuary, 1998-2001: Final Report”, OCS Study MMMS 2003-031 at http://www.gomr.mms.gov/homepg/whatsnew/techann/2003-031.htm.