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POLYCENTRISM AND FLUX IN SPATIALIZED MANAGEMENT: EVIDENCE FROM MAINE'S LOBSTER (*HOMARUS AMERICANUS*) FISHERY

Jennifer F. Brewer

ABSTRACT

Spatial approaches to fisheries management hold great promise but require continued conceptual and policy development. Polycentrism and flux emerge as useful concepts, drawing lessons from more customary, informal resource-use patterns to produce more innovative “spatialized” policies within existing governance architectures. Empirical evidence from Maine shows that pioneering efforts have been limited by the single-species focus of conventional management hierarchies. As entry limits have consolidated the fishing fleet and eliminated flexible, diversified, and adaptive business strategies, cross-species and habitat externalities have become problematic. State lobster (*Homarus americanus* Milne-Edwards, 1837) comanagement zones have achieved some successes, including trap limits and improved industry-management communications, but incur significant transaction costs and raise equity and stewardship concerns. Kindred proposals for spatial refinement of groundfish management and locally based area-management councils lack support from the state Department of Marine Resources, Atlantic States Marine Fisheries Commission, New England Fishery Management Council, and National Marine Fisheries Service. Broader and more transparent deliberation of explicitly spatial and ecosystem approaches might be advanced by citizen panels convened to foster polycentric decision structures and accommodate more integrative management strategies.

Interest in explicitly spatial approaches to marine policy has increased in recent years (Crowder et al., 2006; Ehler and Douvere, 2007; Young et al., 2007; Douvere and Ehler, 2008). “Spatialized” frameworks have been initiated in European and Australian ocean policy contexts, and states such as California, Oregon, Massachusetts, and Rhode Island are following suit. Nonetheless, practical implementation proves more difficult in many cases. As linked policy and scientific discussions continue in this direction, fisheries present acute socioecological challenges. The fluidity and physical extent of marine environments, and related limitations to human observation of behaviors and distributions of marine organisms and harvesters, make difficult the establishment of fixed and discrete boundaries that might withstand the multiple resource-access claims and decision horizons of a diverse public. Competing pressures on marine space increase with new demands for sustainable energy, transportation, biotic and abiotic resources, leisure activities, and environmental conservation. Bio-oceanographic changes will probably accelerate because of entropy in the planetary climate system, despite the most valiant efforts to mitigate anthropogenous climate drivers. Correspondingly, fishing practices manifest strategic and adaptive choices across space, species, gear, markets, and capital and labor investments. Only significant policy innovation can cope with flux, movement, and shifting public priorities in closely coupled human-marine systems. Spatial approaches offer real benefits, but their ultimate effectiveness will require more thought, nuance and refinement than they have received thus far. In particular, existing governmental structures may not have sufficient adaptive capacity to monitor or regulate more localized attributes

of biophysical and social boundaries in marine environments. Here, I offer, among many possible avenues for the conceptual development of more spatialized fisheries management, polycentric governance and contingent boundaries as useful design concepts.

As many sciences continue to sift through the achievements and disappointments of mid-20th century quantitative revolutions, inconvenient empirical observations confound our most abstract reductions of spatial and temporal phenomena. Among other legacies, Cartesian confidence that spatial statistics can thoroughly explain human-environment relationships make way for poststructuralist reminders that everything is “place-based.” Less loudly announced but nonetheless implicit in this geographic turn, attributes of specific places are necessarily understood as being specific in time. Obvious though these insights may seem, they have yet to pervade the practice of fisheries management and policy. Congressional reauthorization of the Fisheries Conservation and Management Act (FCMA) in 2006 did little to dislodge the legal primacy of large-scale single-species yield models, despite widespread scientific recognition that tools better honed for spatial and temporal precision are needed (NRC, 1998; Wilson et al., 1999; Hilborn et al., 2005; Young et al., 2007).

Compelling arguments have been made that more spatialized marine resource management can provide increased protection to marine habitat and species, reduce conflicts among groups, improve coordination among agencies, and increase stewardship incentives among users (Wilson et al., 1999; Crowder et al., 2006; Young et al., 2007; Douvere and Ehler, 2008). Some of these authors also point to the need for cross-scalar institutional mechanisms, but none explicitly suggests that cross-scalar governance ought to accommodate not only the hierarchically nested jurisdictions typical of modern nation states but also polycentric governance modes—and the latter are difficult to envision and implement without ceding greater intellectual ground to stochastic models of socioecological systems. Similarly, few authors grapple with the virtual inevitability of social and ecological flux across even the most carefully assigned boundaries, perhaps because doing so immediately deflates our collective confidence in solving a multitude of marine policy challenges with tidy mapping exercises. As discussed below, these concepts of polycentrism and flux may prove useful in the struggle to overcome excessive transaction costs and governance dysfunction in fisheries management, spatialized or otherwise. Insightful theoretical precedent and concrete examples are found in political theory, geography, ecology, and interdisciplinary literatures. Evidence from Maine’s lobster (*Homarus americanus* Milne-Edwards, 1837) fishery encourages us to consider more specific benefits and challenges of practical implementation. Although this and other fisheries could benefit from more thoughtful management attention to spatially specific phenomena, meaningful regulatory progress in this direction also requires new mechanisms for analysis and deliberation across socioecological variables that are thus far overlooked in formal management.

POLYCENTRISM AND FLUX

Polycentric governance as a theoretical construct differs somewhat from prevailing understandings of hierarchy theory (Ostrom et al., 1961; Simon, 1962; Gunderson and Holling, 2002; Hooghe and Marks, 2003; Rocheleau and Roth, 2007; Pahl-Wostl et al., 2008). As in dynamic hierarchical systems, polycentric interunit relationship

may be independent or interdependent, informal interactions can be as important as formal ones, and cooperative and competitive feedback loops intersect. Rather than a neatly nested and discrete array of organizational units, however, polycentrism envisions less orderly networks of governing bodies with partly overlapping jurisdictions. Formal and informal attributes such as group membership or spatiotemporal extent may be incongruent. Polycentric governance institutions are less permanent; they may arise, reform, or dissolve in response to functional needs and do not offer the same breadth of goods or services provided by conventionally hierarchical jurisdictions such as municipalities, states, provinces, or nations. Polycentrism's particular relevance to the present discussion is that it permits more flexible and opportunistic institutional design, more mutable boundaries, and less fixed and exclusive loyalties among members. It may even encourage policy entrepreneurship through the prospect of competing providers of ecosystem goods and services (Hooghe and Marks, 2003). In the present era, polycentric governance is unlikely to maintain complete independence from hierarchical arrangements, because nation states provide essential legal, monetary, and physical resources. Nonetheless, some scholars point to more autonomous examples in alliances of corporations and nongovernmental organizations, Swiss cantons, the European Union, and the high seas (Ruggie, 1993; Rosenau, 1997; Frey and Eichenberger, 1999; Steinberg, 2001; Hooghe and Marks, 2003).

Concepts of flux are prominent in hierarchy theory, often referring to information passed up and down scalar levels of organization (Simon, 1962; Gunderson and Holling, 2002; Walker et al., 2006). My discussion here considers flux as movement and influence across socioecological boundaries, such that the boundaries must be recognized as contingent, flexible, or fuzzy. Boundaries may be contingent in both spatial and temporal terms in that they move over time, become more or less permeable over time, are more porous in some physical locations than in others, and are more easily transgressed by some people or things than others. This phenomenon is well documented in geographic studies of international borders and territories, where borderland residents may play one governmental authority against another, selectively mobilize territorial identities and governmental processes to leverage local natural resource access, or continually revise cultural conceptions of "us" and "them" (Sahlins, 1989; Newman and Paasi, 1998). International-relations scholar John Ruggie asserts further that the norm of discrete and exclusive territories is an evolutionary anomaly, specific to the episteme, or rationality, of modernity, and therefore vulnerable to fundamental transformation in the postmodern era (Ruggie, 1993). Indeed, urban mixed-use neighborhoods and medieval, kin-focused, peasant, indigenous, and nomadic societies provide numerous examples where livelihoods, social relationships, migration patterns, and historical precedent often trump territorial claims (Jacobs, 1961; Bruce et al, 1993; Ruggie, 1993; Scott, 1998; Steinberg, 2001; Mol and Law, 2005).

Although some observers might assume that polycentrism and flexible boundaries are less able to internalize externalities, accounting for externalities often depends on the temporal and spatial units of analysis and rarely takes into account costs across formal and informal organizational units such as business firms, government offices, and broader social structures (Commons, 1934; Granovetter, 1985; Acheson, 1994). In particular, fluctuating transaction costs of monitoring, enforcement, and institutional reform are often overlooked in comparison to static costs of initial establishment and routine adjustments.

Although they generally use different terminology, geographers and anthropologists in the shared subfield of political ecology point out the unpredictability of interactions between polycentric and hierarchical structures in natural-resource management (Rocheleau and Roth, 2007). They particularly emphasize the prevalence of polycentric structures within informal resource-management regimes, where subgroups differentiated by class, age, gender, ethnicity, or other factors perpetuate different patterns and norms of resource use and resource user group bounding. They frequently stress the movement of material, financial, and human resources; ideologies; practices; and policies across scales and boundaries of human-environment systems, whether these bounds be analytical, physical, or social, and despite the inherent methodological challenges of such studies. This evidence underscores the need to assess resource management regimes not only from the perspective of administrative functionaries but with close attention to material manifestations visible at the local level. For example, a founding treatise in political ecology articulated causal chains through which political and economic marginalization can worsen environmental degradation by shortening decision horizons and eroding norms of resource stewardship (Blaikie and Brookfield, 1987). By way of contrast, analyses bounded by conventionally ecological or economic parameters are unlikely to reveal such socioecological feedbacks. Another study observed that fences surrounding formally declared parklands can make poachers of local residents who breach them to pursue longstanding subsistence and religious practices (Bruce et al., 1993). Such a mismatch between more static legal tenure categories and more fluid preexisting customary systems can escalate social tensions, raise transaction costs, and reduce conservation incentives. A somewhat later paper reported that petty corruption can significantly reroute the localized impacts of government policies for natural resource management (Robbins, 2000), reminding us that not only resource users but also government officials have multiple and conflicting loyalties. Yet another noted that, as resource-dependent peasant communities ally with environmental groups to oppose industrial enclosures of local resources, multinational industry groups coalesce to rebut with global public-relations campaigns (Stonich, 2000). Clearly, these informal networks built across sub- and supragovernmental scales can challenge formal governmental efforts.

In all these examples, different groups claim legitimacy through different moral authorities and sources of political power. Resource-use conflicts arise or intensify and the transaction costs of conservation efforts escalate when governance fails to accommodate diverse livelihood strategies, patterns of resource access, and conceptions of appropriate decision processes. Whether rigid or flexible, social and biophysical boundaries require maintenance and monitoring, raising questions about who will be responsible for these activities and to whom they will be accountable. In more metatheoretical terms, when hierarchical institutions neglect polycentrism and flux across material, social, and discursive domains, policy outcomes become less certain. In this vein, management of Maine's lobster fishery provides an instructive example of differences between polycentric and hierarchical architectures in marine governance and of the significance of flux across contingent socioecological boundaries.

LEARNING FROM THE MAINE LOBSTER

The set of data informing the present analysis includes more than 200 interviews and informal conversations with more than 150 fishing-industry members and more than 70 fisheries professionals and scientists; more than 80 randomized surveys completed by Maine fishermen; participant observation in fishing households, on working waterfronts, at professional and scientific meetings, aboard fishing boats, and at more than 35 public meetings; and review of relevant textual sources in printed and electronic formats. These activities took place over the last decade, mostly in Maine but also in Massachusetts, Washington, D.C., Alaska, and other locations in the United States and other countries.

INFORMAL PRACTICES

As Jim Acheson (1988) documented two decades ago, entry to Maine's lobster fishery has long been governed informally by harbor- and kin-based groups. Also noted but more rapidly forgotten was that, until late in the last century, many if not most lobstermen also participated in other coastal fisheries, such as those for groundfish—which often include cod (*Gadus morhua* Linnaeus, 1758), haddock [*Melanogrammus aeglefinus* (Linnaeus, 1758)], winter flounder [*Pseudopleuronectes americanus* (Walbaum, 1792)], American plaice [dab, *Hippoglossoides platessoides* (Fabricius, 1780)], witch flounder [grey sole, *Glyptocephalus cynoglossus* (Linnaeus, 1758)], saithe [Atlantic pollock, *Pollachius virens* (Linnaeus, 1758)], silver hake [whiting, *Merluccius bilinearis* (Mitchill, 1814)], red hake [*Urophycis chuss* (Walbaum, 1792)], and Acadian redfish (*Sebastes fasciatus* Storer, 1854)—or for northern bluefin tuna [*Thunnus thynnus* (Linnaeus, 1758)], shrimp (*Pandalus borealis* Krøyer, 1838), scallops [*Placopecten magellanicus* (Gmelin, 1791)], herring (*Clupea harengus harengus* Linnaeus, 1758), Atlantic medhaden [pogy, *Brevoortia tyrannus* (Latrobe, 1802)], Jonah and rock crabs (*Cancer borealis* Stimpson, 1859, and *Cancer irroratus* Say, 1817), or, eventually, urchins [*Strongylocentrotus droebachiensis* (Müller, 1776)] (Wilson, 1982; Acheson, 1988). As detailed in field interviews, the decision of which species to fish was determined by species availability, market prices, labor and capital resources, and the willingness of other fishermen to share local ecological knowledge. Whereas close family members were virtually guaranteed entry, the decision to support or tolerate fishing entry by neighbors or more distant kin was made entirely outside the legal system, permitting fishing-reliant communities to adapt to changing social and ecological conditions. When fishing effort was deemed excessive, fewer new entrants were permitted. When new entrants might be useful to maintain markets, fishing areas, labor pools, local economies, or needy households, entry could be granted more generously. Certainly the system was not without flaws, such as the ability of some families or groups to consolidate decision influence through violence, but broad deliberations and protracted negotiations involving a number of local residents were often possible. Such conversations could take place on the water, at the shore, around town, and in households where the perspectives of other family members might be considered. Local youth generally built up their business and expertise by hand hauling a few cast-off lobster traps from a small rowed skiff. Some new adult entrants could work their way in by settling in town, crewing, and biding their time while generally ingratiating themselves. In this way,

each fishery and each fishing group represented one of many in a flexibly bounded and overlapping pattern of polycentric decision making. The fishing industry was notorious for its disinterest in most aspects of legal regulation, except for widespread adherence to laws protecting young and broodstock lobsters, which gained popularity after a lobster population crash in the first part of the 20th century (Acheson, 1988, 2004). Until the 1990s, these laws were debated and set by the state legislature, after public hearings and informal conversations between elected representatives and any interested constituents.

Field observation reveals that, in addition to these movements of individuals across the social boundaries of fishing communities, spatial arrangements in the lobster fishery have also exhibited flux. The lobster-trap setting grounds of each harbor or group have spatial boundaries, "invisible lines," that are constantly contested and negotiated. When unfamiliar or unwelcome traps appear at the perimeter of an area, they might or might not be forcibly removed. Owners of offending traps might be warned off initially with knots or opened trap doors. Sometimes persistent intrusion will result in lost traps or more costly retaliation, but sometimes a game of lower stakes tit-for-tat ensues for a short or lengthy period. New traps might be tolerated on bottom of less immediate or general interest, or after a reciprocity agreement in which access is traded for another piece of bottom. Once new traps are in place for some time, they are considered to be more established by both area newcomers and those with longer-term spatial claims. Similarly, in the past lobster catchers and groundfish draggers would often agree to allocate some bottom for exclusive trapping or dragging, to avoid costly accidental damage to both sets of gear and the possibility of precipitating intentional gear damage in retaliation or to expand bottom claims. These customary practices allowed integrated monitoring and maintenance of social and biophysical boundaries and frequent consideration of proposed boundary adjustments.

Today, these informal norms of polycentrism and contingent boundaries still exist to some extent. Randomized surveys indicate that the majority of Maine fishermen have participated in more than one fishery in their lifetimes, some having participated in more than 10 (see Table 1). Most harbors' trap-setting areas are now expanding and less strongly defended, but most boundaries continue to shift even as some coalesce (Acheson and Brewer, 2003; Acheson, 2004). As conveyed by the literatures reviewed above, such polycentric and flexibly bounded patterns are often characteristic of informal, or extralegal, governance and resource management. As long as markets, technology, and capital were limited, informal management was relatively effective, with some assistance from the state legislature (Acheson, 2004). As described below, however, an enveloping cascade of legal and regulatory events occurred during the late 20th century, imposing a more hierarchical management architecture and drawing more rigid boundaries. This shift toward a more fixed and exclusionary policy framework was first resisted by both local harvesters and state officials. Nonetheless, a gradual transformation increased state compliance with federal administrative pressures, reduced the ecological and social adaptiveness of the fishery, and produced limited gains in resource conservation. Several antecedent drivers of this change sequence can be traced to Maine's groundfishery.

Table 1. Number of fisheries participated in by individual Maine commercial fishermen. n, number of fishermen surveyed.

Survey group	n	Mean no. fisheries	SD	Time period	Survey year
Maine commercial marine harvest license holders	12	4.0	3.2	lifetime	2003
Maine commercial lobster harvest license holders	29	2.8	1.8	lifetime	2002
Portland, Maine, commercial groundfish harvest permit holders	16	2.7	1.4	first fishery, 1983, 1993, 2003	2005

REGULATORY CONTEXT

Passage of the FCMA in 1976 not only expelled foreign fishing vessels from the newly declared Exclusive Economic Zone but created loans for larger boats and gear. Previously, most Mainers caught groundfish with tub trawls and a few gillnets, neither of which require large boats or heavily damage benthic habitat. As reported by many experienced fishermen, new investments in heavy otter trawls and roller gear exposed previously unfished bottom to intensive fishing effort and habitat degradation. As groundfish populations declined, a landmark lawsuit by the Conservation Law Foundation and Massachusetts Audubon Society in 1991, amendments to the FCMA in 1996, and subsequent challenges from environmental groups increased the intensity of National Oceanic and Atmospheric Administration (NOAA) oversight in groundfish and other fisheries through the National Marine Fisheries Service (NMFS). The New England Fishery Management Council (NEFMC), originally created by the FCMA as one of eight regional councils to help expand the domestic fleet, responded by limiting new groundfish permits and limiting each permit's annual fishing days, often favoring permit holders with the most dedicated groundfish histories and pushing many fishermen with more flexible strategies into dedicated lobstering, which was still open to new entrants. Other fisheries managed by the NEFMC or Maine Department of Marine Resources (DMR) became subject to similar entry limits, gradually boxing each fisherman into fewer and fewer species and creating political and social identities more focused on single fisheries and less interested in cross-species dynamics or the overall balance of the ecosystem.

Although many entry-limit decisions were certainly triggered by stock depletions, some were disproportionately influenced by a small number of fishing firms, especially a handful of more specialized and capitalized boat owners who could afford the shore time to protect their fishery access through NEFMC lobbying and participation. For example, field interviews and archival data confirm that when an environmental lawsuit forced the NEFMC to make dramatic cuts to aggregate groundfishing days at sea in 2002, three of the six landings years selected retroactively as days at sea qualification criteria were years with long and/or profitable winter shrimping seasons (1996–1998), during which many diversified boats had abbreviated or skipped their usual spring groundfish rotation. Many of those boat owners were then granted fewer groundfishing days than owners who had continued to concentrate on depleted groundfish species. The regulatory decision ignored common understanding that shrimp populations and prices fluctuate dramatically with oceanographic and economic drivers mostly unrelated to local fishing effort; can only sustain a seasonal

and diversified fishery; and can be helpful in diverting fishing effort away from over-fished species (Clark et al., 2000). Many small diversified boats had also suspended their groundfish rotation during qualification years because of temporary inshore gillnet bans designed to protect harbor porpoises (*Phocoena phocoena* Linnaeus, 1758). Trawlers had been allowed to continue fishing those waters, however, thereby limiting incidental gains for groundfish stock conservation. Although the NEFMC has also implemented some coarsely defined groundfish spawning-area closures inshore, industry members and community-based nongovernmental organizations requesting stronger and more empirically supportable protection of inshore spawning habitats have been repeatedly rebuffed by NEFMC members and staff, often on the grounds that any resulting conservation gains would not be recognized by federal stock-assessment models. Notably, those models are constructed to assess species populations on the spatial scale of the Gulf of Maine. They assume that the existing time series of species population data incorporates sufficient spatiotemporal variation in factors such as benthic habitat structure, fishing technologies, fish migration and spawning behaviors, water temperature and other oceanographic phenomena, and other possible impacts on target species populations that are difficult to quantify (Wilson et al, 1999; Ames, 2004). Adding insult to injury, continued fleet reductions have not sufficiently restored groundfish populations. Now-excluded fishermen increasingly call for more spatialized and ecosystem-based approaches, as evidenced by letters submitted to the NEFMC in 2006.

Although most groundfishermen started their careers on small lobster boats, those who found themselves regulated out of groundfishing and refocused primarily on lobstering had acquired larger boats, more willingness or ability to take on debt, and more ambitious business plans. This trend accelerated a general increase in lobster-boat sizes, trap numbers, trap setting areas, and profit expectations. Effort especially increased offshore on larger broodstock lobsters, which play a disproportionate role in replenishing heavily fished inshore populations. Former groundfishermen, more prepared for deep water and less prepared to defend claims to inshore customary trap-setting areas, were among those who pioneered the offshore effort increase.

Most Maine fishermen opposed legal entry limits in the past. At least through 1978, more than two thirds of groundfish and herring-boat captains opposed them, and even supporters were very concerned with the possibility of excluding young people or restricting interspecies livelihood strategies (Acheson, 1980). On one large and cooperatively run lobster wharf in 1989, a well established fishing family member alerted friends and neighbors to a proposal to limit lobster fishery entry but received blank stares and dismissive comments from fishermen who apparently found the proposal incomprehensible or unworthy of discussion. As late as 2004 in a highly fishing-dependent eastern Maine town, interview data documented that the vast majority of residents vigorously opposed entry limits for any fishery. Crew, often hoping to have their own boats and licenses in the future, generally express stronger opposition, even in harbors with more entry-limit supporters.

Partly for these reasons, the state of Maine and its fishing industry have frequently opposed NEFMC and NMFS policies, including fleet consolidation, and assumptions in many federal impact assessments that fished stocks, habitats, and fishing communities are homogeneous across large areas. Some of these conflicts between state and federal policies were partially resolved by reduction of NOAA's direct management oversight of lobster and other species. In 1995 the Atlantic States Marine Fisheries

Commission (ASMFC) was given a more central role as an interstate compact, leaving some regulatory discretion to individual states through provisions for conservation equivalencies. Nonetheless, NOAA began pressuring ASMFC to implement lobster-trap limits in the Gulf of Maine and perhaps entry limits or other fleet-consolidation mechanisms.

ZONE COMANAGEMENT

Because lobstermen in different parts of the Maine coast had developed different fishing-effort levels and trap-limit preferences to accommodate local socioecological conditions, and because DMR leadership wished the industry to assume greater responsibility for comanagement, in 1995 DMR convinced the state legislature to create seven lobster zones along the state coastline, incorporating input from a few lobstermen, and dividing each zone into several district subunits. DMR then developed administrative procedures for zone referenda and elected representation, granting voting rights to lobster license holders (Acheson, 2004). Different trap limits could now be established in different parts of the state, placating NOAA and ASMFC while allowing the industry to adjust the rules to local needs and norms. Another, less-publicized intent, occasionally noted in more private conversations with comanagement advocates in academia and DMR, was to use the lobster zones as a foundation from which to build a more participatory and ecosystem-based management regime, permitting greater cross-species flexibility and greater consideration of habitat and social variables. Nonetheless, the immediate intent of DMR leadership was for the zone lines merely to delineate voting groups, not to restrict the spatial extent of individual trap-setting areas.

After the zones passed trap limits, however, regulatory enforcement where adjacent zone trap limits differed required monitoring of zone lines and trap locations by state marine patrol officers. Interviews reveal that some license holders cited the new zone boundaries to assert fishing rights in waters beyond those fished by their traditional harbor group but within their home zone. Others interpreted the zone boundaries to mean that they were now authorized to exclude traps intruding from adjoining zones, even if they belonged to lobstermen who had fished those same waters in the past. The increasing availability of cheap electronics for geographic positioning made it easier for fishermen to learn unknown bottom without assistance from older peers. Violent and legal disputes arose around several boundaries, requiring DMR to invest in professional mediation, legal representation, and the creation of buffer areas at some zone boundaries (Acheson and Brewer, 2003; Acheson, 2004). Whereas informal fishing areas were constantly negotiated, the zones lines are fixed in law. DMR also increased penalties for trap cutting, decreasing the industry's ability to impose extralegal sanctions on unwanted individuals and actions. Whereas a few lobstermen had to reduce their trap numbers to comply with trap limits, others increased their traps because they could now compete more easily with the most ambitious fishermen.

Newly empowered by zone voting rights and fixed spatial claims, and now excluded from most other fisheries, some lobstermen successfully lobbied the legislature for additional legal power to restrict entry by voting on ratios of exit to entry. Despite initial refusals by DMR to approve very restrictive exit-to-entry ratios, in five zones a series of increasingly exclusionary votes established ratios issuing only one new license

for each five licenses not renewed. In one zone one license is issued for each three licenses not renewed, and one zone still remains open to new entrants. Waiting lists have become years long, and a 2008 DMR survey found half of lobster license holders to be supportive of a statewide license freeze. Although all zones still allow 18-year-olds with 3 yrs of lobstering experience to circumvent waiting lists and obtain full licenses, most have seriously debated repealing that provision. As one member of a multigenerational fishing family and staunch entry-limit opponent said, "There were always a few people who wanted [entry limits]. But until there was a receptive government, it didn't go anywhere. It was like looking at a girlie magazine. These things can be incremental. Then one day you go in and everyone has a girlie magazine on their desk and you say 'okay'" (anonymous source, 1999). Although many observers and current lobster-license holders uphold entry limits as necessary for fishery conservation and economic profits, many members of would-be fishing households believe their permanent exclusion to be profoundly unjust, observing before the global economic recession that some lobstermen fishing the most productive areas were raking in annual profits exceeding \$200,000. Although the specter of overfishing is frequently cited by industry, management, and academic observers as the necessitating driver for entry limits, the particular choice of a stringent entry limit mechanism instead of more spatioecologically nuanced options such as gear restrictions or area protections has been made likely by the relative ease with which fleet reduction and specialization mechanisms satisfy federal effort-reduction mandates. Conservation arguments for entry limits have been quietly undermined as state and academic fisheries scientists and lobster harvesters have repeatedly contested longstanding federal declarations that the lobster populations is overfished (Steneck, 2006).

Archival and interview sources confirm that legal entry limits also overtook a slower-moving DMR plan to establish a formal lobster-fishery apprenticeship, which was to mimic the flexibility and social breadth of traditional entry practices by requiring new license holders to invest two years as crew and acquire management-relevant knowledge and skills through an organized education program. The education program was never implemented, and the few individuals completing apprenticeships now find they must wait some years longer for a license. Whereas apprenticeship was intended to establish more socially mediated and contingent barriers to entry, zone-entry ratios grant current license holders legal exclusion rights and foster a sense of entitlement and enclosure. In areas where the few remaining groundfishermen still operate, trap-versus-drag gear conflicts have escalated, because so few fishermen can now participate in both fisheries, and most view one another as competitors instead of allies. Knowing that cod prey on lobster, most lobstermen finding cod in their traps now spear them for bait, although a few who still hope to groundfish some day release them alive to reproduce. In contrast, those most interested in the future of groundfishing, even low-volume hook fishing, are often inspired to note and discuss the spatial and habitat patterns of accidentally trapped cod, just as they routinely track lobster migrations and habits to maximize yields per trap haul. Although lobstermen routinely observe and memorize the movements and behavior of lobsters across local bottom, adjusting trap setting strategies to maximize per trap hauls over time, no zones have seriously discussed the possibility of area closures, even as catches and populations have declined from all time highs in 2006 and 2002 (Correia et al., 2005). Even longstanding arguments for seasonal closures during molting season, when recently molted lobsters are difficult to market, have gained little traction.

Whereas zone districts were originally envisioned as a site of local comanagement participation and engagement, they now operate primarily to elect zone representatives. Because voting on exit-to-entry ratios, trap limits, and other key issues occurs through mail-in referenda, collective discussion is often limited and is unlikely to include non-license holders such as crew, family members, or other fishing-related businesses. Without the repeated kitchen-table and pickup-truck conversations that were required to mobilize informal agreements to include or exclude fishing activities by kin and neighbors, active consideration of ethical responsibilities and public welfare at the community level is diminished. Voting requires significant oversight and administration by DMR staff, who also provide secretarial and advisory support at each zone meeting and ensure that zone procedures are codified to withstand legal scrutiny from both industry members and environmental groups. The zones have also been fortunate enough to inherit relatively healthy lobster populations (Steneck, 2006). Their response during a period of dramatic resource decline remains to be seen. The possibility of widespread disease or mortality caused by rising water temperatures like those in Long Island Sound and southern New England remains a lurking worry.

Expansion of more spatialized comanagement to other Gulf of Maine fisheries has been slow. The time required of industry members who become actively involved in comanagement rule making for a single fishery is significant. Active comanagement participation in more than one fishery is virtually impossible without reduction of fishing time. Although DMR recognizes the importance of the lobster zones in improving communications between the industry and the agency, most other state-managed fisheries bring lower prices, fish depleted populations, attract less public attention as statewide icons, and are less politically powerful. Repeated grassroots requests to permit some decentralization of groundfish management, or at least some refinement of the spatial scale at which management occurs, have not gained DMR support, partly because of a change in its leadership shortly after the zones were created.

SCALING UP?

As noted above, previous DMR leadership once hoped to expand comanagement and apprenticeship to other fisheries. Some fishing-industry members and nonprofit organizations working with coastal communities have come to share that hope. A few express support for the idea of multiple-fishery licensing as a vehicle for ecosystem-based stewardship. Little progress has been made in this direction, however; federal policies are a primary impediment. As long as environmental lawsuits and NOAA legal defenses focus on the prognoses of relatively aspatial, single-species statistical models, the advance of substantively spatial and ecosystem-based approaches will be difficult. This incongruence between aspatial single-species policies and interest in more place- and ecosystem-based alternatives among some environmental and industry groups suggests that structural problems are slowing the transfer of information and innovation up and down these scales of human-environment decision making and are increasing transaction costs to a point at which the NEFMC process is scarcely functional. Foundational social-science research tells us that government often incurs high transaction costs as a result of bounded rationality, imperfect knowledge, opportunism, and other institutional foibles (Acheson, 1994).

Regulatory capture by private firms is not uncommon. Less frequently discussed is the likelihood that environmental organizations exhibit related limitations and have strategic reasons to prefer legal or public-relations battles to less confrontational solutions. Because both NEFMC and judicial routes to fisheries-management reform have been mostly unsuccessful in the Gulf of Maine, another option might be to create a set of parallel management institutions, reverting to a more hybrid governance architecture that incorporates polycentric and hierarchical modes and more flexible boundaries to accommodate socioecological and analytical flux such as across fished species, fishing group memberships, and species-habitat variables.

For example, one study led by the former DMR commissioner, a pivotal lobster comanagement zones advocate, proposed the creation of local multi-interest committees as area-based governance units, balanced by statewide species committees. These would base decisions on multiple ecological parameters, in addition to single-species stock assessment indicators (Alden and Hayden, 2003). Keeping the history of existing regional fishery management councils firmly in mind, however, we might consider that government advisory groups, fisheries related or not, are often convened through some process of stakeholder group representation, overlooking the reality that most individuals bring a number of internally inconsistent interests to the table, that a small group can rarely represent the full breadth of interested groups and subgroups, and that such representative designation can sometimes polarize and entrench narrow conflicts rather than fostering consensus or policy innovation. In this case, the relevant interests run far beyond fishing-license holders to include crew, households, shoreside businesses, environmental groups, and many other users of marine resources. Because the proposed area advisory groups could become dominated by narrow fishing interests, and vulnerable to the rigid bounding of fishery-access rights promoted by federal managers DMR and some environmental groups, we might further speculate that a parallel institutional mechanism could be given some oversight or monitoring role, representing an even broader slate of interests.

Among possible parallel institutions, consensus conferences, citizen panels, and citizen juries provide attractive options. These closely related vehicles for public input on policy and regulatory issues were pioneered in the United States by the National Institutes of Health but are more widely adopted in northern Europe to address technological hazards (Andersen and Jæger, 1999; Gustin, 1999). They gather small stratified groups of neutral, disinterested citizens to produce collective policy opinions. Professional staff normally facilitate each group's acquaintance with relevant information and arguments, including scientific opinion. Each group deliberates in a nonadversarial and transparent venue with the goal of reaching consensus, or at least a well-considered majority vote. In some instances participants are selected from a larger prospective pool, as in a courtroom jury. A steering committee is sometimes convened to oversee the process.

The scale and terms of such diversified citizen involvement would certainly require significant discussion and analysis before implementation, including the articulation of relationships across new and existing management structures. It could, however, help to complement single-species fish population assessments, which, in our overarching system of governmental checks and balances, are often the principal criterion by which individual courtroom judges evaluate agency efforts to juggle disparate social interests and comply with federal law. For those skeptics who might argue that average citizens are incapable of integrating scientific information into complex

rule making, the National Research Council recently released a report concluding that public participation, when thoughtfully implemented, can increase the quality, legitimacy, and capacity of environmental policy (NRC, 2008). As any scientist who interacts frequently with the general public will attest, questions from nonexperts may not reflect theoretical sophistication but are often quite incisive in their ability to seek out weaknesses in our underlying assumptions and extrapolations to public policy. Permanent mechanisms for more broadly public oversight could also strengthen monitoring and evaluation of the governance process, something often advocated but rarely practiced in natural-resource management.

CONCLUSION

As described above, inflexible hierarchies and boundaries can limit the ecosystem potential of spatial fisheries-management decision making. Maine's lobster fishery retains remnants of flexible, polycentric, and adaptive governance, rooted in local, customary practices that can accommodate socioecological flux. Fishing firms were once diversified across target species and habitats, and informal entry controls and fishing area claims were subject to extensive negotiations; in this way, social and biophysical boundaries could be carefully monitored and maintained. The federal intensification of formalized management imposed new constraints on more localized and integrative resource use strategies, as single-species policies have failed to internalize cross-species and habitat externalities. The creation of area-based lobster comanagement zones has achieved some success but has fallen short in other respects. NOAA and NEFMC pursuit of legal entry limits and fleet consolidation have been replicated at the zone and state levels, ostensibly by channeling of industry preferences through the legislature and DMR, but also by a process of elimination, as more holistic and ecosystem-cognizant alternatives are now difficult to advance. Industry priorities have been realigned from collective to individual concerns, entrained within overarching policies of a relatively rigid regulatory hierarchy. More spatial, ecosystem-based, and adaptive management innovations have been stalled. Broader public participation in area management—including citizen panels or related mechanisms of enhancing public accountability, informed deliberation, and transparent decision processes—might be helpful in loosening this deadlock. With thoughtful implementation, these could bring more rigorous and evaluative scrutiny to the goals, processes, and knowledge foundations of fisheries decision making and might provide avenues for more formal integration of human, cross-species, and habitat variables.

As proposals for more spatialized mechanisms for marine resource management move forward, whether under the umbrella of marine planning, zoning, protected areas, fishing-area closures, or ecosystem-based management, the mixed outcomes from the Maine case may be instructive. As in terrestrial resource systems, many marine harvester groups exhibit adaptive informal rule making with polycentric governance and flexible boundaries that accommodate socioecological flux. These can be eroded by rigidly hierarchical policies that encourage discrete bounding of species access rights while failing to consider more complex causal relationships among social and biophysical variables.

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