



Research

## Weak feedbacks, governance mismatches, and the robustness of social-ecological systems: an analysis of the Southwest Nova Scotia lobster fishery with comparison to Maine

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**ABSTRACT.** The insights in *Governing the Commons* have provided foundational ideas for commons research in the past 23 years. However, the cases that Elinor Ostrom analyzed have been exposed to new social, economic, and ecological disturbances. What has happened to these cases since the 1980s? We reevaluated one of Ostrom's case studies, the lobster and groundfishery of Port Lameron, Southwest Nova Scotia (SWNS). Ostrom suggested that the self-governance of this fishery was fragile because the government did not recognize the rights of resource users to organize their own rules. In the Maine lobster fishery, however, the government formalized customary rules and decentralized power to fishing ports. We applied the concepts of feedback, governance mismatches, and the robustness of social-ecological systems to understand the pathway of institutional change in Port Lameron. We revisited the case of Port Lameron using marine harvesters' accounts collected from participant observation, informal interviews and surveys, and literature on fisheries policy and ecology in SWNS and Maine. We found that the government's failure to recognize the customary rights of harvesters to organize has weakened feedback between the operational level, where resource users interact with the resource, and the collective-choice level, where agents develop rules to influence the behavior of resource users. This has precipitated governance mismatches, which have led harvesters to believe that the decision-making process is detrimental to their livelihoods. Thus, harvesters rarely participate in decision making and resist regulatory change. In Maine, harvesters can influence decisions through participation, but there is a trade-off. With higher influence in decisions, captains have co-opted the decision-making process. Nevertheless, we suggest that the fisheries of SWNS are more vulnerable to social-ecological change because of weaker feedbacks than in Maine. Finally, we have discussed the potential benefits of polycentricity to both fisheries.

**Key Words:** *Atlantic Canada; collective choice; institutional analysis; lobster; Maine; polycentricity; robustness*

### INTRODUCTION

The insights in *Governing the Commons* (Ostrom 1990) have provided foundational ideas for commons research for more than 20 years. Ostrom (1990) showed that resource users can act collectively to manage common pool resources (CPRs) and proposed 8 design principles that foster collective action and self-governance. These insights were based on an analysis of 86 case studies of fisheries, forests, and irrigation systems. However, what has happened to the cases discussed in *Governing the Commons*? Do Ostrom's design principles confer robustness to social and ecological change?

We reevaluated one case study from Ostrom (1990), the lobster and groundfishery of Port Lameron, Nova Scotia, to answer these questions. Ostrom (1990) suggested that the self-governance of this fishery was fragile because (1) the resource users did not have strong collective-choice arrangements, and (2) the government did not recognize the rights of resource users to organize. We examined the consequences of these two sources of fragility over time. We reevaluated the case using a framework to analyze the robustness of social-ecological systems (SEs) developed by Anderies et al. (2004). Although we confirm that these lacking design principles lead to fragility, we uncover subtleties that strengthen Ostrom's argument. By examining the deep interactions between institutions and people in a specific biophysical context, we find underlying feedbacks that explain the absence of these missing design principles. We show that the SES framework allows researchers to move beyond examining

institutions toward more holistic analyses of dynamic interactions among components of complex systems.

Although researchers contribute to case study knowledge of CPRs, few have revisited cases to analyze their dynamics over time. However, Brewer (2012b) revisited Acheson's (1988) *The Lobster Gangs of Maine* and demonstrated the utility of this type of analysis. She applied ideas from political ecology and poststructuralism to Acheson's work to show how the politics of scale, heterogeneity among resource users, and subjectivities that emerge from political decisions influence SEs. Ostrom (2007:15182) called for "strong interdisciplinary science of complex multilevel systems" to diagnose SEs; studies such as that by Brewer (2012b) and the one we present respond to this call.

Because Maine has often been described as successful in self-governing the lobster commons, we compare its institutional pathway to that of Port Lameron. We will show that some of the successes of the Maine system have been attributable, in part, to the presence of stronger internal feedbacks than Port Lameron's system exhibits. Davis (1975) first discussed the case of Port Lameron. Davis described a significant change in the federal government's approach to governing Atlantic Canadian fisheries. Based on Davis's work, Ostrom (1990:177) characterized the Port Lameron fishery as institutionally fragile. She predicted that the federal government's approach would continue to provoke "counterproductive reactions" from marine harvesters, fail to "gain control over open-access deep-sea fisheries," and "lose

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control of some inshore fisheries previously subject to entry control.” We expand on the work of Ostrom and Davis, using harvesters’ accounts collected from participant observation, informal interviews, and surveys. We supplement this data with primary and secondary sources. We apply the robustness framework in our analysis of this data to understand how key features of SESs contribute to or detract from good governance.

In a theoretical best-case scenario, SES governance institutions, i.e., Fisheries and Oceans Canada (DFO) and local lobstering communities, would each take on roles that leveraged the different types of information available to each group. DFO and local communities would be loosely linked and work collaboratively. However, in Port Lameron, weak feedbacks in the SES have created a less optimal scenario; Maine’s SES more closely approximates the best-case scenario. We compare the institutional changes of the two fisheries to identify what went wrong in Port Lameron with what went right in Maine, while still maintaining a critical perspective on the institutional evolution of the Maine fishery, as has been suggested by Brewer (2012b).

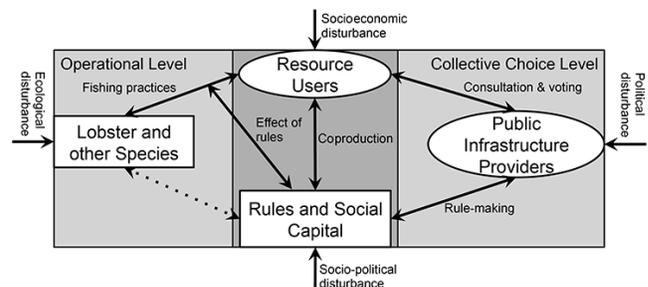
Our comparison suggests how polycentrism might improve fisheries governance in the future. Polycentric systems have “many centers of decision-making” acting at different scales (Ostrom et al. 1961:831). Each governing unit has the autonomy to develop its own institutions based on its specific knowledge of the system. Units can interact horizontally to learn from neighboring units and vertically at the appropriate scale to deal with conflicts or to solve problems like “non-contributors, local tyrants, and inappropriate discrimination” (Ostrom 2010:552). In hierarchical governance, governing bodies are neatly nested within higher level bodies. In polycentric governance, jurisdictions are messy, are overlapping, and come from public, private, and voluntary sectors (McGinnis and Ostrom 2012). We highlight some of the feedbacks and interactions that could be strengthened by polycentricity in both Maine and Port Lameron.

#### METHODS: QUALITATIVE CASE STUDY ANALYSIS THROUGH AN SES LENS

Early SES research originated from the ecological sciences and did not consider political or economic processes. Ostrom (1990) initially focused on the ability of CPR users to develop effective and long-enduring institutions but did not focus on the external influence of political economy or the biophysical dynamics of resource systems (Agrawal 2001, Mansfield 2004). Resource users adapt their institutions to the spatial and temporal variability of a resource over a long period of time. However, the rapid changes associated with globalization have exposed resources and their users to new disturbances (Young et al. 2006, Anderies and Janssen 2011). Ostrom (2007) expanded on previous CPR work and developed a framework to understand social and ecological dynamics and processes that occur at local to global scales. SES research has developed to pay more attention to how institutional, ecological, and livelihood diversity affect the capacity of SESs to respond to economic and ecological change (e.g., Folke et al. 2003, Berkes and Seixas 2005, Miller et al. 2010). It has also called attention to the importance of matching the scales of governance systems to the economic and ecological problems they face (Cash et al. 2006, Young et al. 2006). We look at the feedbacks between different levels of an SES and the potential for resource users to act collectively to adapt to new economic disturbances.

Because SESs are complex, system elements can be defined in various ways. Anderies et al. (2004) suggested the elements and relationships as shown in Figure 1. This framework, based on Ostrom’s design principles, highlights key interactions between the operational level, where resource users interact with the resource on a daily basis, and the collective-choice level, where agents develop rules to influence the behavior of resource users. In this conceptualization, SES refers to complex adaptive systems composed of human and nonhuman subsystems and embedded in larger systems. Complex adaptive systems have diverse interacting biophysical and social components and an autonomous selection process by which some components are reproduced (Arthur et al. 1997, Levin 1998). Complex systems adapt to change through these interactions and selection processes, and hierarchical organization emerges in the absence of a global controller (Levin 1998). An SES is composed of two human units: resource users and public-infrastructure providers. Resource users can be broadly defined to include environmental groups, municipalities, and other stakeholders. Public infrastructure includes elements of social capital and rules in use, as well as physical capital, such as artificial reefs or other human-built environments that affect resource dynamics. In Port Lameron and Maine, public infrastructure is primarily composed of rules and social capital.

**Fig. 1.** The social-ecological system, as conceptualized by Anderies et al. (2004).



SESs often exhibit nonlinear dynamics as the rules of local interactions change over time (Levin 1998). Humans act on components of the system, attempting to adapt to change or to transform the system when existing interactions can no longer be supported by its components (Walker et al. 2004). This element of human activity, in which humans attempt to “design” SESs to maintain life-supporting functions, is referred to as robustness (Anderies et al. 2004). An SES is considered robust if, when exposed to disturbances, institutions and human interactions are able to prevent regime shifts that would make people unable to harvest a resource or likely to experience “long-term human suffering.” To maintain SES robustness, decision makers must navigate trade-offs, but enhancing robustness to one type of disturbance can increase the fragility of a system to others. For example, Anderies et al. (2007) showed that policies robust to uncertainty about the biological stock of fisheries were vulnerable to uncertainties in harvesting and revenues.

System components interact through flows of information, nutrients, energy, and materials (Levin 1998). These flows are

iterative, and components coevolve when rapid feedbacks allow them to alter the patterns of their interactions over time (Levin 1983, 1998, Walker et al. 2004). In Figure 1, the arrows between system components represent iterative interactions and feedbacks over time. As social-ecological dynamics change, SESs may need to adapt by changing operational rules (Anderies et al. 2004). In the Maine and Port Lameron fisheries, we examined the endogenous links at the collective-choice level between resource users and public infrastructure providers, between public infrastructure providers and rules and social capital, and between the resource users and rules and social capital. The processes at the collective-choice level interact with operational-level processes, consisting of interactions between rules and social capital and fishing practices, and between harvesters and the resource.

We did fieldwork in Barrington, Southwest Nova Scotia (SWNS), Canada, to collect data with which to animate the framework. Barrington, known as the “lobster capital of Canada,” consists of a large number of interlinked communities and ports. Davis (1975, 1984a, b) conducted his research in Port Lameron, Brazil, and Pagesville, pseudonyms for Port La Tour, Baccaro, and Smithsville. We use Port Lameron to refer to these three communities and SWNS to refer to the whole region. Our data came from field notes; informal and semistructured interviews with association leaders, buyers, and harvesters (N = 31); and general survey information (N = 113) about the relationships among harvesters, associations, and government. We supplemented our field data with a literature review of fisheries policy. Subsequently, we analyze data that emphasize changes that have occurred in Port Lameron and SWNS since Davis (1975).

### The setting

The basic characteristics of the Port Lameron fishery in the 1970s and 2012 are summarized in Table 1. We estimated the number of crew members by multiplying the number of vessels by the average number of crew members per vessel (1.28, from survey data). We added crew members to captains to estimate the total number of resource users. Although the number of vessels and resource users in Port Lameron has remained relatively constant, the structure of the fishery has changed.

In the 1970s, Port Lameron harvesters made their living from many species including cod (*Gadus morhua*), halibut (*Hippoglossus hippoglossus*), herring (*Clupea harengus*), mackerel (*Scomber scombrus*), and lobster (*Homarus americanus*). Following the groundfish collapse and subsequent fishing moratoria in Atlantic Canada, the DFO tightened restrictions on inshore groundfishing vessels. By 1997, all types of vessels were regulated through individual transferable quota programs (Crowley and Palsson 1992, Peacock and Annand 2008). In Shelburne County, which includes Port Lameron, the number of groundfishing vessels decreased from 633 in 1996 to 156 in 2005 (Peacock and Annand 2008). The DFO also reduced the quota for inshore vessels from 3309 in 2000 to 938 in 2011 metric tons. Despite these efforts, the DFO (2009) stock assessment found a high rate of unexplained cod mortality, perhaps attributable to increased predation from grey seals (*Halichoerus grypus*) or to discarded or unreported landings. Although historically groundfishing was the most important livelihood activity, lobstering has become the “backbone” of the maritime coastal economy. Compared to the 1970s, a larger percentage of a fishing

household’s income is derived from the lobster industry. Dependence on lobster has influenced the economics of fishing in the region and the structure of the fleet.

**Table 1.** Characteristics of the Port Lameron fishery in the 1970s and today. Values are counts and averages, and ranges are shown in parentheses.

Characteristic	1970s	2012
Number of vessels (inshore)	42	40
Number of vessels (offshore)	10	
Number of resource users	99	91
Inshore vessel length	(< 11.9 m)	11.9 m (9.1 m-14.9 m)
Offshore vessel length	(11.9 m-18.3 m)	
Inshore vessel width	(< 3 m)	4.6 m (2.7 m-5.8 m)
Offshore vessel width	(3 m-4.9 m)	
Percentage of income from lobster	40	82 (13-100)

Today, fishing vessels are generally larger but less varied than in the 1970s. Davis (1975) distinguished between offshore and inshore fleets. Offshore vessels were more capital intensive, with larger crews, more fishing gear, and more sophisticated technologies. These boats were often specialized for groundfishing. Smaller inshore vessels were less specialized, fished closer to shore, and used simple handline techniques. Today, the distinction between offshore and inshore vessels is unclear, and all vessels are sized to meet lobster-fishing eligibility requirements. DFO regulations state that lobster vessels cannot exceed 15.2 m in length, but the regulations do not limit width. License holders fish for lobster more intensively than they did in the 1970s and have put more pressure on grounds as far as 50 miles (80.5 km) offshore (DFO 2013). To accommodate this shift, vessels have become larger, wider, and more capital intensive.

### Governing the lobster commons

In the 1970s and 1980s, Port Lameron harvesters were similar to the “lobster gangs” of Maine. Harvesters in Maine and Port Lameron collectively asserted a right of first access to nearby fishing grounds based on their historical use, membership in the community, and economic dependence on the grounds (Davis 1984b, Acheson 1988). Within these zones, they allocated subzones to harvesters using different technologies for different species. These subzones reflected localized “knowledge of relations between species, as well as the composition/complexity of the resource zone” (Davis 1984a:145). The subzones also reduced conflicts among harvesters using different technologies (Ostrom 1990). Fishing groups defended their boundaries from outsiders and newcomers through social sanctions, such as shunning or slander, or physical sanctions, such as destroying fishing gear or threatening violence. They sanctioned rule breakers in proportion to the seriousness and frequency of infractions.

These boundaries were flexible and informal. In both Maine and Port Lameron, boundaries were negotiated among harvesters within and between ports. Thus, the boundaries changed as harvesters responded to changing social, ecological, and economic conditions (Brewer 2012a), and harvesters defended

**Table 2.** Comparison of rules governing the Maine and Port Lameron lobster commons. NP indicates that a rule is not present in that social-ecological system.

Rule	Both	Maine	Southwest Nova Scotia
Minimum size restriction	82.5 mm		
Maximum size restriction		127 mm	NP
Trap limit		600-800	250-375
Seasons		NP	November-May
Prohibitions	Egg-bearing females V-notched lobsters		
Trap Requirements	Trap-tags Biodegradable panels Juvenile escape vents Maximum trap dimensions		
Limited entry		License waiting lists	Transferable licenses
Vessel Requirements		NP	15.2 m maximum length

their territories more vigorously when fish were scarce (Davis 1984b). Fishing community members maintained their system of rules through local customs and reinforced it through frequent interactions at sea and on land (Davis 1984a, Acheson 1988, Brewer 2010). Ostrom (1990) suggested that this informal system kept the costs of monitoring low because harvesters could interact frequently, and it was easier to see when and where a harvester used a certain technology than it was to see the type of fish caught.

The current rules in Maine and Port Lameron (see Table 2) are similar but have different emphases. Both fisheries have prohibited the landing of egg-bearing females and set minimum size requirements for more than a century, but the details of these rules have changed over time (Parsons 1993, Wilson et al. 2007). In Maine, rules emphasize recruitment of future lobster generations by preserving egg-bearing lobsters and lobsters with v-notches cut in their tails by harvesters. This and minimum size requirements allow a sufficient percentage of lobsters to mature and reproduce before they can be harvested. Maine's "maximum" size requirement also protects larger, more fecund lobsters. Rules in SWNS emphasize limiting fishing inputs and effort. "Inputs" refers to the technological capacity of a vessel to catch lobsters. Trap limits and vessel-size limits aim to protect the fishery from overcapitalization. Fishing seasons limit effort to November through May, allowing lobster stocks to recover in the off-season. The seasons in Canada's 40 lobster-fishing areas (LFAs) are also staggered throughout the year to reduce market gluts. We found that Maine and SWNS differed most in their relationship to government agencies, Maine's Department of Marine Resources (DMR) and DFO.

#### Relationship to government agencies

Ostrom (1990) suggested that Port Lameron's rule system was fragile mainly because it was not recognized by the DFO. In 1977, Canada claimed jurisdiction over fishing grounds within 200 miles (322 km) of the coast under the "Law of the Sea Convention" (Matthews 1988). Rapid postwar expansion of industrial foreign trawlers had brought Atlantic groundfish stocks to the brink of collapse (Rogers 1998). By declaring the 200-mile (322-km) limit, the federal government assumed control over both offshore, exploited by trawlers, and inshore fisheries. This shifted the balance of authority from the provinces to the federal government. Although the provinces recognized customary rules (Martin 1979), the federal government thought that these rules

left the seas open access and free to all. To the federal government, the only option to protect the seas was top-down regulation.

The United States passed its Fisheries Conservation and Management Act (FCMA) in 1977, claiming federal jurisdiction over seas within its own 200-mile (322-km) limit. The newly created National Oceanic and Atmospheric Administration (NOAA) set management goals for the Maine lobster fishery. However, the FCMA also created Regional Fisheries Management Councils and mandated that NOAA appoint fishing-industry representatives to negotiate federal management goals (Brewer 2012a). This initiated an "unfriendly dance" between federal agencies and the lobster-fishing industry, with harvesters rejecting federal proposals for regulatory change (Acheson and Knight 2000:16). Leaders in the lobster industry and the DMR organized and lobbied for decentralized management authority. These lobbying efforts led to passage of the Atlantic Coastal Fisheries Cooperative Management Act in 1993 and a DMR bill establishing comanagement zones in 1995 (Acheson and Knight 2000, Acheson 2003). Under these laws, federal agencies ceded much of their authority to the Atlantic states and to elected industry representatives. The federal government has formally recognized the right of Maine's lobster industry to organize and develop rules, something that has not happened in SWNS. Maine lobster harvesters have also been able to organize effectively to lobby for recognition of their rights.

Ostrom (1990) argued that lack of recognition of local rights to organize creates conflicts between customary and federal rules, and within the community as harvesters attempt to circumvent local traditions by appealing to federal rules. Because these conflicts would ultimately erode the customary rule system, she saw collective-choice arrangements in Port Lameron as "weak." In *Missing feedbacks and governance mismatches*, we describe how the informal rule system in Port Lameron and the DFO's failure to recognize it has produced conflicts and governance mismatches.

#### MISSING FEEDBACKS AND GOVERNANCE MISMATCHES

We wanted to understand the feedbacks flowing through the Port Lameron system, as diagrammed in Figure 1. Governance is essentially a feedback mechanism through which collective decision-making arenas process information and translate it into

actions that feed back into the system and maintain or alter its state (Anderies et al. 2013). Good governance builds appropriate feedbacks to guide systems toward outcomes desired by managers, harvesters, and other agents. Our analysis of the SWNS system revealed that missing and inappropriate feedbacks have led to poor governance and introduced new fragilities into the SES.

#### **Missing feedbacks: poor state-resource user relations**

We found that the DFO's failure to recognize harvesters' rights to organize rules and harvesters' weak collective-choice arrangements have reinforced each other. Since the 1970s, Port Lameron's local feedback loop, where harvesters develop infrastructure to alter their fishing practices, has eroded (Fig. 1). The weak relationship between the federal government and Port Lameron's harvesters has reduced harvesters' capacity to act on their knowledge and thus has removed a feedback critical to the system.

#### *Weak collective-choice arrangements*

Rules that are congruent with local social and ecological conditions are often the product of collective-choice arrangements, in which "most individuals affected by the operational rules can participate in modifying [them]" (Ostrom 1990:93). Collective-choice arrangements are more likely to be made when the benefits of collective decision making are higher than the costs, e.g., in money or time.

In SWNS, customary rules competed with DFO rules, which "have different origins, reflect different principles, and are motivated by different objectives" (Davis 1984a:140). The first major conflict between the DFO's top-down approach and the customary rule system was the Pubnico Affair in 1983, which centered on a dispute over trap limits. Though trap limits were passed in 1968, officials did not begin to crack down on fishing over the limit until the 1980s (Kearney 1989). The crackdown led to a series of protests and disputes between the state and harvesters, culminating in May 1983, when about 100 harvesters burned and sank 2 DFO patrol vessels (see Davis and Kasdan 1984, Kearney 1989, for a more detailed account).

In the wake of the Pubnico Affair, the DFO established Working Groups of lobster harvesters; the groups first met in June 1983 (Kearney 1989). This signaled a shift in the DFO's approach from top-down management to comanagement. The Working Groups established organizations to represent harvesters' interests; these later evolved into the LFA management boards and advisory committees that operate today. License holders at each wharf elect a port representative; the representatives attend LFA management board and advisory committee meetings with DFO representatives. The management boards also have elected chairpersons.

However, all of these positions can be daunting and thankless because harvesters vent their frustrations about the lack of positive change on representatives, who must try to explain to their constituents the slow process by which policies can be modified. There has been a high rate of turnover among representatives (field interviews, 2012). Some harvesters see the management boards as "yes men" for the government rather than representation for the industry. This view has led to the formation of more radical associations that have vowed to "take back the industry."

Port Lameron harvesters see the LFA boards and committees and their decisions as having low legitimacy (field survey, 2012). The majority of the harvesters we surveyed wanted the DFO to directly incorporate harvesters' knowledge and ideas into decisions; some called for a democratic process in which harvesters could make decisions themselves. Although a large majority of harvesters (71.1%) paid dues to fisheries organizations, well over half (61.1%) seldom or never attended meetings. Those who attended did so to get information and know what was coming. The majority stated their reasons for not attending as having no say in the decision-making process, arguing and fighting among harvesters, and a lack of positive change. Many said that there was no sense in attending meetings because they did not change anything or because they merely legitimized the decisions the "bureaucrats" were going to make anyway (field interviews, 2012).

When Davis studied the Port Lameron fishery in the 1970s, harvesters criticized the DFO most for not consulting with them prior to developing rules and for making rules that did not reflect regional differences in practices and socioeconomic conditions (Davis and Kasdan 1984). In an unpublished survey conducted by Davis in 1988, 97.6% of Nova Scotia harvesters believed that the DFO should consult with them, and 66.1% believed that harvesters' views should have legal status in the decision-making process. Today, harvesters can consult with government, but the federal minister of fisheries retains decision-making authority. In the past, harvesters were cynical about the DFO rules because there was no consultation process; today, they see the existing consultation process as inadequate because it does not incorporate their views.

In other Canadian Maritime regions, harvesters have united to represent their interests, e.g., the Newfoundland Fishermen, Food, and Allied Workers Union (Kearney 1989). However, in SWNS, the unions and associations that formed in the 1980s could not settle differences and provide a unified voice for harvesters (Kearney 1989). Today, the associations have changed, but intragroup divisions remain. SWNS harvesters hold diverse attitudes because of their geographic isolation and a diversity of operations and strategies (Apostle and Barrett 1992). Harvesters' attempts to organize have frequently been thwarted by problems of leadership, accountability, transparency, and reputation. Harvesters and other community members often told us stories about leaders who were corrupt or engaged in socially unacceptable behavior. Corruption was often attributed to gains made by some in the groundfishery, and the stories aroused suspicion about the intentions of would-be leaders.

The conservative Protestant culture in much of SWNS also impedes harvesters' ability to self-organize. "The industry and much of rural Nova Scotia value individualism, believe unshakably in free enterprise, and intensely dislike big government and big companies" (Apostle and Barrett 1992:301). Much cynicism toward government stems from the real and perceived relationships between government and the corporate sector. For example, Barrett (1984) described government support for expanding the groundfish-processing capacity and trawler fleets of National Sea Products Limited. Many harvesters whom we interviewed recounted events such as this one, which reinforce the idea that government represents the "big guy's" interests, not those of fishing communities. This perception persists despite the

fact that the subsidies have ended and many large corporations such as National Sea Products have gone bankrupt since the cod collapse.

In Maine, license holders directly influence policies within their fishing zones, but problems have arisen because some license holders have attempted to co-opt collective-choice arrangements (Brewer 2012a). As state management agencies tried to rationalize the fishery through a comanagement system, license holders strategically advanced user-boundary rules and license entry-exit ratios that facilitated consolidation of their own access and power. Two factors made this possible. First, license holders were the primary stakeholders in the decision-making process, to the exclusion of crew members and other community members. Second, decisions were made through voting with anonymous mail-in ballots, so individuals were not accountable to the rest of the community. Although customary decision making had struck a balance between “communitarian and individual interests” (Brewer 2012a:398), the comanagement process effectively tipped the balance toward license-holding boat captains. Thus, although harvesters in Maine have more say in decision making than those in Port Lameron, the consolidation of power by license holders may generate distributional problems. The consolidation of license-holder power could be checked by polycentric governance, which provides for vertical and horizontal interactions among overlapping organizations.

Although the time costs of participation in comanagement may be high for harvesters in both Maine and SWNS, the benefits are higher in Maine, at least from the perspective of license holders. In SWNS, harvesters think it unlikely that their participation will lead to rule modifications. We concluded that the link between harvesters and government is the primary weakness of collective-choice arrangements in SWNS. Maine and Port Lameron face different dilemmas, but both would likely benefit from polycentric governance. In Port Lameron, greater local autonomy would allow ports to maintain their customary institutions. The management boards and advisory committees would facilitate interactions between ports, which could foster institutional learning. Management boards and ports could interact with processors, unions, and other groups that cut across jurisdictional boundaries. Federal agencies would continue to contribute scientific knowledge, set broad management goals, and help solve dilemmas that the ports or management boards could not. In Maine, horizontally and vertically interacting organizations could provide checks on the power of any one group.

#### *The misrecognition of customary rights to organize*

The DFO’s failure to recognize customary rights in SWNS has played out much the way Ostrom (1990) expected it would. We found clear signs that the customary rule system described by Davis (1984b) had weakened over time. We also found that harvesters and buyers used DFO rules and enforcement to gain an advantage in price bargains or to limit their competitors’ success (field interviews, 2012).

One rule that has weakened over time is the “gentlemen’s agreement” to set traps at enough distance to avoid “snarls” and competition for lobsters. In the past, harvesters who set their traps too close to those of others were likely to be punished with shaming or property damage (Davis 1984a, b). Many of the harvesters we surveyed expressed frustration with those who did

not respect the gentlemen’s agreement. They attributed failure to honor it to the fact that harvesters often encounter vessels from different ports, especially on offshore grounds, and to increasingly “cutthroat” attitudes. For instance, if one harvester were pulling up traps with high catches, a cutthroat harvester would shift his traps close to, or even on top of, the first harvesters’ traps.

In Maine, customary rules and property relations have been recognized by the state, but in SWNS, state rules and local customs clash. These clashes have weakened the efficacy of local-level customary institutions. A polycentric approach to governance would add new layers of institutions that would not weaken those that are working but could deal with problems that local-level institutions have been unable to solve.

In Port Lameron, harvesters stated almost unanimously that they either wanted a real seat at the decision-making table, or that they should make the rules themselves. Some harvesters were afraid of the latter because they believed that harvesters are greedy or too diverse to agree on a decision. DFO officials also questioned the ability of harvesters to be stewards of the oceans (field interviews, 2012). Thus, improved connections between resource users and public-infrastructure providers are hindered by a lack of trust among the parties involved.

#### **Pathways of institutional change and governance mismatches**

The poor relationship between the DFO and resource users in SWNS has weakened system feedback at the collective-choice level, where rules that influence fishing behavior are modified to promote fishing activities that fit with current social, economic, and ecological conditions. An analysis by Finlayson (1994) provides a good example of how weak links produced fragilities that led to the collapse of the Atlantic cod fishery. Although inshore harvesters were concerned that cod stocks could not sustain the rate of exploitation in the late 1980s, the DFO did not address these concerns until it was too late.

Because of SWNS’s weak feedbacks, ineffective rules are more likely to be made there than in Maine, where links are stronger. “Effective” rules are congruent with local biophysical and socio-cultural conditions and ensure that the benefits of participating in management exceed the costs (Ostrom 1990). Ostrom (1990) suggested that Port Lameron’s customary rules were effective, but governance mismatches were set in motion before *Governing the Commons* was published. Subsequently, we discuss governance mismatches in SWNS, using examples of user boundaries, resource boundaries, and trap limits.

#### *User boundaries and social preferences*

Self-governing SESs set boundaries on who can access, and participate in management of, the resource. These user boundaries ensure that “outsiders” will not reap the benefits of user efforts to maintain a resource. However, well-defined boundaries that do not fit local norms can create a sense of uncertainty that these benefits will be realized.

In Port Lameron and SWNS, user boundaries are enforced by the DFO through a limited-entry licensing system. The minister of fisheries implemented limited-entry licensing in response to letters from harvesters and organizations seeking restrictions on “moonlighters,” i.e., part-time harvesters with alternative employment (Bodiguel 2002). The majority of these letters came from regions with high dependence on unemployment insurance

benefits and areas limited by winter ice, including Cape Breton and the Gulf coast of SWNS, but not from Port Lameron (Bodiguel 2002). However, the DFO's implementation of the limited-entry system was unsatisfactory because it reduced flexibility to use technologies and catch species according to economic and ecological variation (Davis 1984a, Ostrom 1990). Thus, harvesters obtained licenses for all species and technologies to maintain this flexibility. As the DFO began to see its errors, it attempted to reduce the number of license holders by adding requirements that harvesters demonstrate license use. So harvesters increased their efforts considerably by using new technologies and vessels to demonstrate use (Davis 1984a), undermining DFO objectives.

Since the inception of limited-entry licensing, the DFO and fishing communities have struggled with the institutions surrounding licensing. Questions center on whether access to a fishery is a privilege or a right, to whom these rights or privileges should be extended, and on the value of a license. Answers to these questions are clear in writing, but unclear in practice. Although the DFO considers access to fisheries as a privilege bestowed by government, harvesters consider it their right based on a history of use (Davis 1984a). Over time, the DFO added licensing criteria to provide access only to bona fide harvesters, with clear dependence on fishing, and to deny access to processing companies and moonlighters. However, although licenses are not formally transferable, a provision allowing transfers has opened the door to a gray market in licenses. Legal decisions and extralegal contractual arrangements have opened the door further, so that processors, buyers, and other companies can own and lease out licenses (Bodiguel 2002). Some individuals have begun to speculate on license prices, buying, and selling according to market fluctuations (field interviews, 2012). The market in, and speculation on, lobster licenses has increased the economic value of a license significantly. Before limited entry, a license was worth Can\$0.25; shortly after limited entry in 1970, a license cost Can\$250. After 1999, the value of a license in LFA 34 has gone up to more than Can\$500,000 (Bodiguel 2002).

In Maine, the state and captains have defined user boundaries (Brewer 2012b). Only one lobster-fishing zone has no limitations on entry (Brewer 2012a). The creation of limited-entry programs in the United States was influenced by workshop discussions in which Canadian harvesters gave an "impassioned warning to American fishermen, telling them not to follow the Canadian example" (Bodiguel 2002:279). Because of these warnings and deliberations among state and industry representatives, Maine pools licenses and distributes them to harvesters on a waiting list (Bodiguel 2002). Brewer (2012b:396) provides evidence suggesting that some harvesters in Maine have pushed for transferable licenses, but that the inflated license values experienced in SWNS would be "abhorrent to virtually all Maine fishermen."

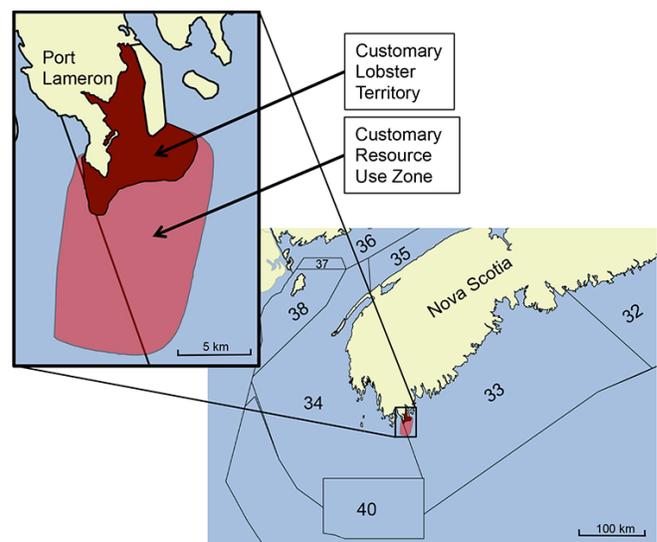
#### *Spatial scales of resource boundaries*

Resource users often define a resource boundary or territory to which their rules apply. The degree to which boundaries can effectively manage a resource depends on the fits between the spatial scales of social, political, and economic systems (Cash et al. 2006). Clear, impermeable boundaries in SWNS predate those in Maine. In 1968, the DFO created LFAs, splitting coastal regions

into resource zones (Miller and Breen 2010). The spatial governance mismatch created by these zones has precipitated conflicts within and between LFAs. The conflicts mirror those that have occurred in Maine since comanagement began in the 1990s.

The clash between customary and state-defined boundaries is pronounced in Port Lameron because it is located next to the line that separates LFAs 33 and 34 (see Fig. 2). This line also separates harvesters from a portion of their ancestral fishing grounds. As the effort of harvesters to the southwest of the line expanded outward, neighboring harvesters began to enforce the boundary more rigorously by reporting line violations to enforcement. As officers increasingly charged Port Lameron harvesters for fishing illegally over the line, the harvesters formed a group that lobbied government to move the line to the southwest. This was a highly contested process, and the line remains unchanged (field interviews, 2012).

**Fig. 2.** Comparison of customary lobster and general resource territory for Port Lameron described in Davis (1984a) and current state-defined resource boundaries. Numbers correspond to lobster fishing areas or districts. Data source: Coffen-Smout et al. (2013).



DFO boundary lines give a license holder the right to fish in any fishing ground within their district. With increasing mobility and storage capacity, many vessels venture farther from port in search of bigger catches. Some Port Lameron harvesters expressed frustration about harvesters coming from the northeast to fish the southern grounds of LFA 33 and about their own inability to claim access rights within customary territories.

Maine's comanagement zones are divided into districts with council members elected by license holders (Brewer 2012a). Still, Maine's comanagement zones are larger than the territories of traditional harbor gangs. The rescaling of resource boundaries has had similar effects on customary territoriality as those in Port Lameron. Brewer (2012a) recounted conflicts between adjacent harbor groups that historically shared fishing grounds before they were divided into separate zones. Some harvesters have

interpreted license ownership as a right to fish anywhere within state-defined boundaries, which has weakened the customary territoriality of harbor gangs.

*Trap limits and social, economic, and ecological conditions*

Although a trap limit is a useful input control, the DFO trap limit in SWNS was a governance mismatch because it did not account for the heterogeneity of fishing communities and livelihood strategies, and because it was based on a rationality that was foreign to harvesters. In Maine, harvesters developed trap limits voluntarily in some cases, and in others, they have been able to influence trap limits through the comanagement structure. When developed voluntarily, trap limits reflect harvesters' definition of the social or ecological dilemma and their preferred solution to that dilemma. Harvesters have been able to tailor the trap limit to their own social preferences when the limit has been developed within a comanagement structure.

The Canadian government established trap limits in 1968 (Miller 1990) but did not enforce them until the 1980s. Before trap limits, the number of traps used was a function of harvesters' ecological knowledge of heterogeneous lobstering grounds (Davis and Kasdan 1984). The suitability of a given trap number depends on many biophysical, economic, and social conditions, including trap design; bait quantity and quality; soak time; lobster behavioral patterns; water temperature; lobster wharf price; characteristics and heterogeneity of local lobstering grounds; costs of labor, fuel, and bait; and the captain's personal preferences (Miller 1990, Acheson 1998, 2003, Brewer 2012a). Although trap-usage decisions were previously congruent with local conditions at a fine spatial scale, and varied within and among ports, new regulations have homogenized decision making at the larger LFA scale. Trap limits may have approximated LFA-wide averages when created, but they lacked the spatial distinctions harvesters have customarily been able to make. Kearney (1984) found that 80.4% of harvesters favored trap limits to control fishing effort, but the suggested limit varied from 308 to 546 among different communities and vessel sizes. In LFA 34, the trap limit was set to 375, while LFA 33 had a trap limit of 250. The higher limit in LFA 34 reflects the struggle over trap limits and also the fact that fishing grounds there are, on average, more productive than those in LFA 33. Trap limits would perhaps have created less conflict if the rules had reflected greater influence from harvesters and had better approximated the heterogeneity of the fishing grounds and fishing practices.

The DFO's rationale for introducing trap limits was based on the bioeconomic objective of maximizing economic yield (MEY; DeWolf 1974). Assuming that customary management practices are absent and that harvesters act individually to maximize their profits, lobster harvesters would use more traps than the economically optimal number. However, these assumptions did not account for the customary rules in the majority of SWNS ports (Davis and Kasdan 1984) and the fact that harvesters preferred to maintain income stability through flexible practices and multispecies fishing (Davis 1984b, Davis and Kasdan 1984). The MEY rationality for trap limits was foreign to the practices and objectives of SWNS harvesters.

The mismatch between MEY theory and SWNS reality may partly explain increased trap use after trap limits enforcement in 1983 (Kearney 1989). Davis and Kasdan (1984) pointed out that

harvesters perceived the limits to be a target. Additionally, just as harvesters retained flexibility by using licenses they did not need at the time, lobster harvesters may have increased trap usage to maintain the option to use the maximum number in the future.

In Maine, some harbor gangs developed trap limits, but not to achieve MEY. In the 1970s and 1980s, influential harvesters on Monhegan and Swan's Islands persuaded others to adopt trap limits within their territories and petitioned the state of Maine to formalize them (Acheson 1998). In these cases, trap limits were implemented to solve distributional battles. Harvesters using many traps created gear congestion at sea and controlled a large portion of the lobstering grounds, limiting the ability of others to get their fair share (Acheson 1998). Monhegan and Swan's Islands developed trap limits to solve problems that they perceived at the local level.

In the 1990s, NOAA and the Atlantic States Marine Fisheries Commission pressured harvesters to implement trap limits to limit fishing effort and conserve the resource (Brewer 2012a). However, federal and state governments delegated these decisions to comanagement zones. In each zone, harvesters decided whether they wanted trap limits and what the limits should be. All zones adopted trap limits that ranged from 600 to 800 traps (Brewer 2012a). Harvesters voted for these limits to solve dilemmas they perceived at their ports, mainly distributional issues caused by individuals who "hogged" the resource and congested the lobstering grounds (Brewer 2012a). Even with official limits set, harvesters within a zone may still be able to develop individualized strategies. As in SWNS, however, the number of traps used in Maine increased after trap limits were set. However, the trap limits did stop the trend of increasing trap usage throughout the fishery (Brewer 2012b).

In SWNS, trap limits did not fit local conditions; instead, they homogenized the fine-scale management strategies harvesters had customarily used. In contrast, Maine harvesters have been able to implement trap limits that reflect the dilemmas they perceive. Nevertheless, and excepting Monhegan and Swan's Islands, Maine trap limits have had a homogenizing effect similar to that in SWNS. Still, we can conclude from the outcomes discussed previously that SESs with stronger feedbacks, like Maine's, develop rules that fit better with social-ecological conditions than do those of SESs with weaker feedbacks, like SWNS.

When implemented in the 1980s, the SWNS trap limit program was a governance mismatch. However, most harvesters now perceive it to be beneficial. In our 2012 survey of 113 respondents in SWNS, 102 wanted to see trap limits stay the same; 1 wanted them increased. At an LFA 34 management board meeting in June 2012, the DFO informed harvesters that it will no longer be responsible for the trap-tag program. Trap tags allow enforcement officers to determine if a trap has been placed legally and thus are essential to enforcing trap limits. Many harvesters were concerned that the LFA management boards would not be able to assume responsibility for the program in the time frame set by the DFO. They were concerned that previous problems would return with some harvesters hogging the grounds and placing up to 1500 traps. Harvesters have adapted to the DFO-set trap limits and see them as vital to protect the fishery. However, despite their acceptance of current trap limits, the conflicts created by the initial policy implementation remain a source of distrust.

**Table 3.** Harvesters' responses to questions about decision making and participation.

Question	Response	Percent
What changes would you like to see to the decision-making process?	A consultation process/incorporating input and knowledge of harvesters	54.5
	No change at all	23.2
	Harvesters should make the decisions democratically themselves	12.2
Do you pay dues to an association or organization?	Yes	71.7
	No	26.5
How often do you attend association or organization meetings?	Always	6.2
	Frequently	32.7
	Seldom	37.2
	Never	23.9
What motivates you to attend organization or association meetings?	Getting information/knowing what's coming	55.7
	Working for the future of the fishery	13.6
	Having a say in decisions that affect me	10.2
	Making a living in fishing	8
What discourages you from attending association or organization meetings?	No say in decision-making process	20.6
	Arguing among harvesters	19.6
	A lack of positive change	16.8
	Poor leadership or organization	8.4
	No time to attend	8.4
	Always hearing bad news	7.5

*Mismatches and feedbacks between operational and collective-choice levels*

Weak feedback makes it difficult to change rules as conditions change. Harvesters' resistance to change exemplifies this difficulty (see Table 3). Many SWNS harvesters see no benefit to being involved in the rule-making process. Many resist rule changes. Of the harvesters we surveyed, 52.4% wanted no changes to lobster-fishing regulations, and 12.4% suggested some method of limiting fishing effort. In the fall of 2012, as the November fishing season approached, the LFA 34 management board had license holders vote on temporary effort reductions to lessen the fall glut and improve wharf prices. This measure, which would reduce trap limits from 375 to 300 in the fall, was voted down by 60.6% of harvesters. There are 4 often-stated reasons for harvesters' reluctance to modify current rules. First, if a rule does not have the anticipated or desirable effects, the bureaucratic process of government will respond too slowly to calls for removing or modifying it. Second, some harvesters believe that despite historical drawbacks, current rules are working for now. Third, many believe that any rule change will inevitably benefit one group of harvesters more than others. Finally, some harvesters believe that any rules coming from the DFO will only damage their livelihoods (field interviews, 2012). Harvesters perceive the benefits of participating in the decision-making process to be low and the costs to be high.

To summarize, the weak link between resource users and the DFO has produced rules that reflect DFO rationalities with little influence from harvesters. These rules have affected the behavior and dynamics of the harvesting process in ways that resource users deem detrimental. These negative perceptions of the effects of DFO rules have reduced harvesters' participation in the coproduction of rules at the local level. Polycentric governance would allow harvesters more autonomy in determining trap limits, as has occurred in Maine. Ports using different trap limits could

learn from the successes and failures of their neighbors. The DFO would still play an important role in enforcing user and resource boundaries, but these boundaries would incorporate local-level boundaries. This would strengthen the feedbacks at the operational and collective-choice levels and facilitate adaptation as conditions change. Subsequently, we discuss some of the adaptation failures caused by the weak feedback loops currently in place.

**Missing feedbacks, governance mismatches, and outcomes**

Maine and Canada have taken different fisheries conservation measures, but the ecological outcomes have been similar. Lobster landings have increased by 3.6 and 4.8 times in Canada and the United States, respectively, since 1975 (Steneck and Wahle 2013). There has been a significant increase in recruitment of larval lobsters to both fisheries (Fisheries Resource Conservation Council 2007). Catch per unit of effort has also increased since 1982 and remained stable in the past decade (Fisheries Resource Conservation Council 2007). These trends suggest that the conservation measures adopted in Canada and the United States have been successful.

Recent studies of Atlantic ecosystems, however, have suggested that governance may only partially explain the rising abundance of lobsters. Steneck and Wahle (2013) suggested that the current success of lobster fisheries is an unintended consequence of failure to manage the groundfisheries of Atlantic Canada. Although Atlantic cod have historically dominated the Atlantic Ocean as a top predator, the fishing boom of the 1960s to 1980s effectively removed cod as a trophic level. The "ecological extinction" (Estes et al. 1989) of cod has pushed the Atlantic ecosystem into an alternative stable state dominated by crustaceans and crabs (Zhang and Chen 2007). In the cod-dominated state, even large lobsters were prey (Steneck 1997). Today, mature lobsters are virtually free from nonhuman predation even in offshore waters (Wahle and Steneck 1992).

Steneck et al. (2011) argued that the apparent success of conservation measures has created a “gilded trap” for Atlantic fishing communities. The combination of rising profits in the lobster fishery and declining profits in other fisheries has encouraged traditionally multispecies fishing communities to concentrate on lobstering. Once fishing communities set out on this path, it becomes increasingly difficult to change direction. In Maine, harvesters have been able to maintain or improve their incomes (Steneck et al. 2011). In Canada, the potential value of landed lobsters has not been realized because of increased gluts, in which 50% of lobsters were estimated to be caught within the first 15 days of the season (Weston 2009). The gilded trap has tightened since the economic crisis of 2008, which decreased both demand for lobster and access to credit, as well as increased the cost of bait and fuel (Weston 2009). Harvesters’ main strategy for responding to low prices has been to try to catch more. This strategy initiates a vicious circle, exerting higher pressures on lobster stocks and further lowering wharf price (Theriault et al. 2013). In Barrington, 54% and 71% of harvesters reported a decrease in income and ability to save, respectively, since 2006, and Barnett (2014) found an increasing rate of household foreclosures since 2000. The population of SWNS has declined by 2.8% from 2008 to 2012, with an 8.1% decline in the population of 15- to 34-year-olds (Statistics Canada 2013). These economic problems are because of gluts and low prices, low economic diversity, harvesters’ dependence on lobster for incomes, and the high costs of entry associated with Canadian licensing and quota policies (Barnett 2014).

Harvester responses to low prices were individual. When asked what they do to respond to low prices, 41.6% of harvesters replied that they stored their lobsters, 30% reduced costs by conserving fuel and bait, 23% did not change anything, and 13% tried to catch more. The exception to these individual responses was the May 2012 strike, during which a large proportion of LFA 34 and some of LFA 33 stayed at the wharf until buyers guaranteed a Can\$5 wharf price. However, the strike revealed divisions among and within fleets caused by geographic and economic differences (Barnett 2014). Although harvesters gave mixed reviews of the tactic’s success, all agreed on the importance of organizing. There were calls for a similar tactic as the November 2012 lobster fishing season approached, but it became clear that many captains would not participate. As a result, status quo fishing led to gluts and a low wharf price of Can\$3.

Individual strategies have kept some fishing households in business, but new challenges to this lobster-dominated fishery may lie ahead. In the late 1990s, warm water temperatures and high lobster abundances led to an outbreak of lethal shell disease, causing a crash in the Rhode Island lobster population (Castro et al. 2006). As the seas warm, more southern species have begun to invade northern waters (Steneck and Wahle 2013). Lobstering communities and their governance regimes will likely need to adapt to a “brave new ocean” (Steneck and Wahle 2013).

Steneck and Wahle (2013) argued that we will need to be more “agile” in dealing with new challenges. We argue that agility depends on the efficacy of the feedbacks between the collective-choice and operational levels of ocean SESs. Although Port Lameron’s economic problems do not stem from feedbacks within the SES, the potential for collective action to solve externally

caused problems has not been realized because the feedbacks between the operational and collective-choice levels are weak. Holland (2011) demonstrated that harvesters could improve their profits in the Maine lobster fishery by reducing their harvesting efforts or changing their harvesting schedule. These strategies would reduce the gluts in both Maine and SWNS and shift effort to times when the demand for lobster is higher. Harvesters can effect change at their ports by negotiating schedules with buyers or, at the regional scale, by lobbying for rules that better fit social and ecological conditions. However, license holders and crew members must participate in the development and implementation of these strategies if coastal livelihoods are to improve.

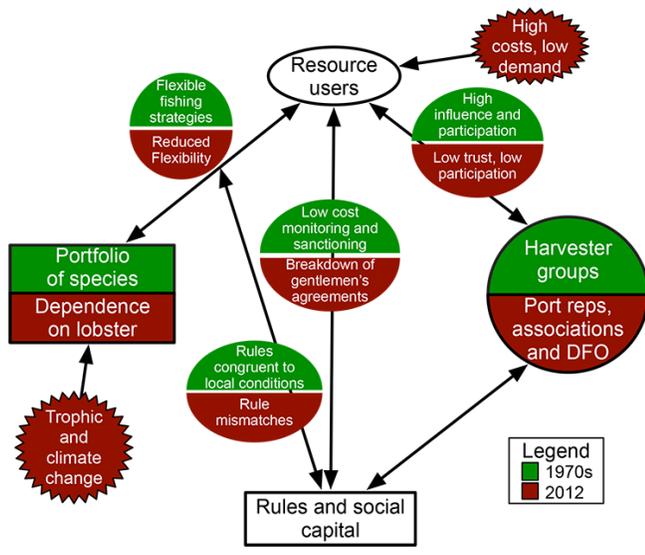
Despite the trend of lower wharf prices each season, license holders have resisted changing the way they fish. Their lack of trust in the effectiveness of decision making by the DFO, associations, and leaders has played a big role in their resistance. Although the conservation rules in both Maine and SWNS have been effective in conserving the stocks, harvesters in SWNS have not taken a proactive role in adapting the rules to solve social and economic problems, and this has negatively impacted fishing livelihoods.

This dilemma exemplifies our main argument, that although achieving conservation goals is crucial to the robustness of fisheries, the rule-making process must not compromise the potential for collective action. Maintaining strong feedback between the operational and collective-choice levels ensures that future social-ecological goals can be met through collective action.

## DISCUSSION

Figure 3 summarizes important changes in Port Lameron according to the SES framework. Our longitudinal analysis of the SES and comparison with the Maine SES demonstrate how the lack of two of Ostrom’s design principles, i.e., strong collective-choice arrangements and government recognition of customary institutions, precipitated governance mismatches. There are mismatches between boundary rules and social preferences, spatial mismatches, and trap limits that do not fit local social and economic conditions. The mismatches have reinforced the weak feedback between the SES’s operational and collective-choice levels. Harvesters have little influence on decision making in SWNS and perceive the benefits of contributing to the comanagement structure to be small. The combination of governance mismatches and harvesters’ perceptions of participation has resulted in deterioration of critical feedback between resource users and the resource, as well as deterioration of users’ capacity to generate livelihoods from the resource. Based on this finding, we hypothesize that similar governance mismatches are strongly related to a lack of recognition of rights to organize and weak collective-choice arrangements. We add to Ostrom’s (1990) argument by uncovering feedbacks that explain the absence of these missing design principles and governance mismatches. This analysis provides insights into the interactions between people, institutions, and biophysical systems that generate fragilities. By better understanding these interactions, we may be able to promote interactions and feedbacks that promote robust SESs.

**Fig. 3.** Comparison of the Port Lameron social-ecological system in the 1970s (Davis 1984a, Ostrom 1990) and in 2012.



The comanagement structure of SWNS has mostly disempowered harvesters and motivated them to seek alternatives to the official rule-making process. Alternatives have included direct action, protest, property damage, and the formation of more radical associations. Comparison of the pathways in Maine and SWNS reveals an important trade-off in comanagement processes, the trade-off between empowering resource users to influence decision making and regulating from the top down. Although comanagement comes with a threat that powerful groups will co-opt the decision-making process, strong top-down regulation often results in rules that do not fit local conditions. However, top-down governance regimes are not immune to co-optation. Some have argued that political and economic agents have attempted to steer Atlantic Canadian fishing policies in a new direction and have attempted to do so by limiting the possibility for feedback from coastal communities (see CURRA 2012). Dilemmas such as these may be avoidable by refining collective-choice rules to reflect the interests of a broader spectrum of stakeholders and by strengthening feedback.

The SWNS harvesters we interviewed took a very negative view of the Canadian fisheries management regime, but what might have happened if the DFO had not intervened? In a perfect world, perhaps the traditional management regime would have been sustainable, as long as its rules were not destabilized by globalization and its associated transformation of social, ecological, and economic dynamics. However, change has created disturbances beyond the local level. The state has played an important role in restricting user boundaries to bona fide harvesters in some regions and limiting the encroachment of foreign trawlers on fish stocks exploited by coastal communities. This story is not about whether the state should have intervened, but about the relative benefits of polycentric feedback mechanisms.

To avoid weak feedbacks and governance mismatches, future institutional innovations would need to recognize the importance

of multiple levels of governance. The case for polycentricity applies to both Maine and Port Lameron. In Maine, overlapping governance regimes, vertically or horizontally, can check the trend toward consolidation of power. In SWNS, ports could make decisions at a local scale, while organizations at the LFA level could facilitate learning among ports and mediate conflicts. The DFO could provide support for local institutions and help solve dilemmas that spill over local and regional boundaries. At each level, these organizations would be able to contribute knowledge and institutions that match with different scales. Brewer (2010:289) suggested polycentric governance institutions for the Maine fisheries to facilitate policy entrepreneurship, “more flexible and opportunistic institutional design, more mutable boundaries, and less fixed and exclusive loyalties among members.” American and Canadian lobster fisheries can learn from each other’s successes and failures, and polycentric governance that crosses national borders can facilitate further learning.

Despite the different pathways of the institutions and governance regimes of Maine and SWNS, the ecological outcomes are similar. However, we argue that there is greater potential for harvesters in Maine to engage in collective action to solve the economic and ecological problems they currently face, as well as those that may arise in the future. In SWNS, the potential for locally congruent harvester-influenced rules to solve this dilemma is low because collective-choice arrangements are rigid. This rigidity makes the SES fragile. However, the potential for adaptive change still exists, thanks to the solidarity that remains among harvesters in ports and municipalities. Rather than influence the public-infrastructure providers, i.e., state government, harvesters can fill institutional lacunae by becoming infrastructure providers themselves and developing locally relevant rules to smooth out supply and improve livelihoods.

The Canadian government has adopted a policy of austerity since the 2008 economic crisis. It announced Can\$79.3 million in funding cuts to the DFO from 2012 to 2015 (Bissett 2012). Macdonald (2013) estimated that these cuts would eliminate 1164 DFO jobs, a 10% decrease. This loss will likely constrain the knowledge-generating capabilities of the DFO (Hume 2012). To maintain operations, the DFO closed 3 offices in Nova Scotia, moved from face-to-face to online licensing services, transferred the costs and responsibilities of the trap-tag system to lobster management boards, and shifted the costs of the at-sea observer program for quota fisheries to the harvesters (Comeau 2012). Despite these changes, the top-down consultative decision-making process remains.

To respond to these challenges, harvesters in SWNS formed the LFA 33 and 34 Tags and Licensing Association to manage trap tags and to assist harvesters who are now required to renew their licenses online (Comeau 2013). Although efforts to change rules through management boards and the DFO have largely been ineffective, associations have organized harvesters’ strikes and pushed for the opening of a cooperatively managed lobster-processing plant on Cape Sable Island, 25 km from Port Lameron (Bennett 2013). The DFO has been influenced by, and granted greater decision-making authority to, organizations that have effectively represented harvesters in some regions of Atlantic Canada (Kearney 1989). Current events in SWNS indicate renewed efforts by harvesters to organize. However, to do this

successfully, harvesters in SWNS will have to unite a diversity of opinions into one voice.

Low opportunity in the groundfishing industry contributed to harvesters's tendency to shift and expand to lobster. In SWNS, the decline of groundfishing was partially because of declining groundfish populations, but also because of the high costs of entry and quota leasing costs (Barnett 2014). However, when incomes from lobster decline, Barnett (2014) observed that harvesters suggested that they attempted to supplement their incomes in the groundfishery despite high lease costs and tight margins. This underscores the importance of understanding the interactions between fisheries, as well as the implications that these interactions have for ecological stewardship, collective action, and livelihood outcomes.

Responses to this article can be read online at:  
<http://www.ecologyandsociety.org/issues/responses.php/6714>

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