"We and us, not I and me": Justice, social capital, and household vulnerability in a Nova Scotia fishery

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Abstract

Marine harvesters face significant livelihood challenges due to the impacts of climate change on marine ecosystems, and due to economic fluctuations that influence their incomes. In this study, we demonstrate vulnerability as a product of the interactions among marine harvesters, government and buyers. We combined Elinor Ostrom's attention to the influence of institutions on resource exploitation, with political ecology's attention to social relations and larger-scale political economic processes. We demonstrate the benefits of this approach by examining the multi-species fishery of Barrington, Nova Scotia. We conducted 31 semi-structured interviews and 113 surveys in the summer of 2012 with buyers, harvesters, and local experts. We used Ostrom's SES framework to pinpoint system elements that were salient to respondents, with attention to household vulnerability outcomes. Based on an analysis of these themes, we outline three processes affecting vulnerability outcomes: 1) Harvesters preferred individual over collective action due to low procedural justice and social cohesion in decision-making, 2) agents with greater political and economic power gained control over fishing access-rights while others became more dependent on lobster, and 3) economic and ecological conditions, combined with increased dependence, incentivized harvesters to catch more lobsters as prices declined. The case suggests that actors sense of control over their resource base and perception of justice in the process of institutional design may be as significant in vulnerability as the exogenous drivers of change that affect livelihood outcomes. We suggest interventions

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that may improve these interactions among government, harvesters and buyers, and improve the livelihoods in coastal communities.

1. Introduction

Processes of global economic and environmental change have exposed fishing households to novel challenges, including market volatility, changing frequency and severity of extreme events, and changing patterns of species abundance and distribution (Brander, 2007; Holland, 2011; Worldfish Centre, 2007). Many vulnerability studies have focused on household attributes leading to vulnerable outcomes (Eakin and Luers, 2006). These studies consider the institutional environment as a structural constraint for households. In this study, we argue that more attention needs to be paid to the interactions through which actors influence the institutional environment. We demonstrate the importance of these interactions by examining the case of a multi-species fishery in Southwest Nova Scotia (SWNS).

In the following study, we make two theoretical and methodological contributions. First, we demonstrate vulnerability as a product of three interactions: 1) between marine harvesters[2] and government, 2) between harvesters and buyers, and 3) among harvesters. Second, we combine the social-ecological systems framework (Ostrom, 2007), which highlights the influence of institutions[3] on resource exploitation, with political ecology's emphasis on the perceptions and agency of key actors, and the contribution of justice and equity to measuring the success of institutions.

We examined fishing households in Barrington, SWNS, to understand household vulnerability. We analyzed harvester's perceptions of the institutions and social interactions occurring among households, associations, and Fisheries and Oceans Canada (DFO), a federal management organization. We analyzed social interactions to observe legitimacy and trust among actors. Institutional interactions are the mechanisms that influence the interactions between actors, and between harvesters and their fishing grounds. We then examined the influence of these interactions on household vulnerability and livelihood strategies, and how these livelihood strategies scale-up to produce outcomes for the fishing districts of SWNS.

[2]Hereafter referred to as harvesters

[3]Defined as formal or informal rules that govern the behavior of individuals or groups

2. Structure, agency, and environmental change in fisheries

In this section, we highlight the theoretical contributions of commons research and vulnerability research to the fisheries context. We argue for greater emphasis on interactions, rather than variables and attributes.

While early scholars pointed to over-exploitation in fisheries as a tragedy of the commons (Gordon, 1954; Schaefer, 1957), commons literature showed that people often engage in collective action to manage resources (e.g., Ostrom, 1990; Baland and Platteau, 1996). Ostrom (2007) expanded on this literature by incorporating important variables for natural resource governance into a social-ecological systems (SES) framework. This framework allows scholars to analyze interactions and outcomes by examining the variables that characterize the components of SESs. The SES framework is intended to be used by disciplines to locate their contribution to a body of knowledge, and to complement the knowledge generated in other disciplines. McGinnis and Ostrom (2014) have updated this framework to improve generalizability, and to outline the logical relationships between system components. Basurto et al. (2013) showed how actors can self-govern fisheries through different pathways and conditions, and recommended a grounded approach to avoid blind spots in analysis. In this study, we follow these recommendations by using the SES framework to highlight important themes, but we allow the relationships between themes to emerge based on interview responses. While we analyze the fishery SES at the community level, we use a political ecology framing to account for cross-scale interactions by situating local interactions within larger-scale political economic, and ecological processes.

The commons and SES approach has often focused on outcomes that improve ecosystems or resource use efficiency (Ostrom, 2005). These approaches have also focused on variables, institutions, and interactions that occur at the "local" scale. Vulnerability scholars, however, have demonstrated the importance of paying attention to characteristics of the political-economic setting, as well as power relations and social justice[4] (McLaughlin and Dietz, 2008; Eakin, 2005; Wisner, 2003; Downing et al., 1996; Kelly and Adger, 2000). In this study, we explore the complementarities of these two approaches.

The term vulnerability refers to the risk that social, economic, or environ-

[4]Defined as an equitable distribution of benefits and burdens, as well as the social processes, institutions, and the abilities of humans to develop their own capacities (see Nussbaum, 2001; Schlosberg, 2009; Honneth, 1996; Adger et al., 2006)

mental stressors will lead to adverse outcomes for individuals, households, or social groups (Clark et al., 2000). Humans, however, are not just recipients of the effects of these stressors, they are agents capable of coping with change, or altering their biophysical or political-economic landscape (Adger, 1996). The ability of social groups to shape the landscape to meet their needs or interests depends on their political and economic power. McLaughlin and Dietz (2008) have described these interactions among structure, agency, and the environment as a "socially constructed adaptive landscape" that actors adapt to and shape by legitimizing or delegitimizing specific social structures and boundaries.

Vulnerability is often contrasted with resilience, which refers to the capacity of an SES to persist and adapt to avoid radical system state changes when exposed to disturbances (Adger, 2006; Carpenter et al., 2001). These two bodies of literature share an emphasis on enhancing the ability of an SES to adapt to perturbations (Adger, 2006). In the study of SESs, vulnerability contributes understanding of social dynamics and human agency, while resilience contributes insights into social-ecological feedbacks, critical thresholds, and social-ecological transformation (Miller et al., 2010). While recognizing the complementarity of resilience to understanding SES dynamics, vulnerability is the central theme of our study.

Individuals and households are linked to political-economic structures through their agency, social capital, and decision-making procedures. The local-level bonds and extra-local networks that constitute social capital (Adger, 2003) "may be a community's best resource in maintaining a capacity to change collective direction" (Pelling and High, 2005, p. 317). When communities have strong local-level bonds but weak extra-local networks, and when the state is largely coercive with low legitimacy, the state clashes with civil society, exacerbating the vulnerability of communities (Adger, 2003). The legitimacy of the state depends on procedural justice, or the degree to which households and individuals perceive decision-making processes and structures to be fair (Folger et al., 1983; Adger et al., 2006). Daigle et al. (1996) outlined the criteria for procedural justice in fisheries decisions, and argued that these criteria are necessary to prevent conflicts, and to wisely manage resources. In this study, we focused on perceived *injustice*, and, to the extent possible, triangulated those perceptions with additional evidence. Nevertheless, both subjective and objective forms of procedural injustice limit human agency by reinforcing a belief that individuals cannot play a role in shaping their governance regimes.

Structure, agency, and the environment interact at different scales, and actors at different levels negotiate access to resources. Strategies that are adaptive at the household level may scale-up to create larger-scale system-level fragilities. For example, in response to market liberalization and environmental change, Eakin and Wehbe (2009) found that farmers adaptations in Mexico and Argentina, such as changing crop choice, diversification, and land tenure had important implications for the resilience of the regional economy, for the risk of landslides and soil erosion, and for forest biodiversity. Conversely, policies such as fishing effort controls designed to ensurer resource sustainability at the regional level can create vulnerable conditions for households who depend on those resources by reducing their access to economic opportunities (Cheung and Sumaila, 2008). The management of an SES is effective according to the degree to which it applies rules that are scaled to match problems (Cash et al., 2006), and uses incentive structures that promote stewardship (Eakin and Wehbe, 2009). Chen et al. (2014) demonstrate that vulnerability analysis could play a role as a policy tool for matching rules to problems, and for mitigating current and future impacts of economic and ecological change on vulnerable harvesters.

Cases of fisheries governance illustrate the interactions among structure, agency and the environment across scales. Neoliberal reforms at multiple levels have exposed fishing communities to new constraints, opportunities, and disturbances (Young, 2001). For example, Young (2001) found that Mexican policies aiming to promote foreign investment in the fishing sector exacerbated destructive fishing practices, due to the incursion of outside fish harvesters backed by private capital, and due to downsized state resources devoted to monitoring and enforcement. Fisheries governance debates center on property-rights and access regimes. Localized harvesters are often willing to support regulations to encourage stewardship, but inappropriate forms of access rights effectively remove these groups from the decision-making process, as local and extra-local actors with greater market power gain control of these rights (Cinti et al., 2010; Gilmour et al., 2012). Basurto and Nenadovic (2012) compare two such property-regimes in Mexican communities, and found evidence to suggest that while individual permits empowered non-fishing groups with economic power, a marine tenure grant incentivized Seri harvesters to self-organize and develop effective access rules and limit overfishing. Seri harvesters only acted collectively, however, when they perceived a common threat to their fishing grounds. Below, we will contribute further insights on the influence of governance, decision-making processes, and

access rights on social cohesion, fishing practices, and collective outcomes.

3. Study Site: Barrington, Nova Scotia

Barrington municipality includes many small communities situated around fishing ports. The total population of this municipality is 6,994. Barrington has been in a state of economic decline since the mid 1990s, when the DFO began to set strict regulations on the groundfisheries (i.e. cod, haddock, pollock) after the collapse of codfish stocks in Atlantic Canada. Despite similar economic conditions to many maritime fishing towns, Barrington has been a hotbed for civil disobedience, and sometimes violent responses to DFO regulations and enforcement. More recently, harvesters from Barrington have formed a new Lobster Fishermen's Association that promises to "take back the industry." Barrington is an important source of resistance to fisheries policy, and the study of this region is important for understanding the processes that lead to poor relationships between government and civil society in the maritimes.

Although much of the findings described here are likely to be persistent, it is important to acknowledge the special conditions under which this fieldwork was conducted. The abundance, distribution, quantity and quality of lobsters in Atlantic Canada and the Gulf of Maine were affected by a "sea surface temperature anomaly" (Mills et al., 2013). These conditions may have caused a heightened sense of vulnerability among harvesters. This sense of vulnerability may explain the strikes and price wars in 2012, which were unprecedented in scale.[5]

3.1. Multi-Species Fishing and Regulations

The lobster fishery is currently managed by the DFO under advice from regional management boards. The regulations, summarized in Table 1, place emphasis on protecting juvenile and egg bearing lobsters to ensure reproductive success. Additionally, restrictions on traps, boat size, and limited entry

[5] A small harvester's strike also occurred in Barrington in 2008 (Comeau, 2008, December 1), and again in Cape Breton and Prince Edward Island in 2013 (Pottie, 2013, May 13; Sharratt) . But price wars were most prevalent in Canada and Maine in 2012, with strikes in Maine and Southwest Nova Scotia, and a blockade of imported Maine lobsters at a processing plant in New Brunswick (CBC News, 2012, August 2).

licensing are intended to ensure profitable livelihoods to fishermen, and prevent overcapitalization of the fishing fleet. Gear restrictions are in place to prevent habitat damage, protect marine mammals, and reduce the catch of incidental species.

While there are no limits on the amount of effort a harvester can put into lobstering, groundfishing is primarily limited by quotas. This system was put in place in the 1990s to reduce rampant overfishing and overcapitalization. Groundfishing vessels are divided by size and gear-type, and harvesters within these divisions became members of various quota management groups. The largest and most active quota groups maintain an individual transferable quota system, where quota can be bought, sold, and leased out. In the 2000s, the DFO also adopted quota management systems for halibut and swordfish. While historically, multi-species fishing was the norm in the region, today 52% of harvesters in Barrington fished only for lobster (Barnett, 2014). All harvesters surveyed fished for lobsters, and the most important secondary fisheries included groundfish (30%), halibut (18%), and swordfish (16%). The percentage of a harvester's income that came from lobster has increased from an average of 40% in the 1970s (Davis, 1984) to 82% today.

While lobster landings have more than tripled in Maine and Canada since the 1990s, the groundfishery has continued to decline. From 2000 to 2011, the DFO reduced the total allowable catch for cod in the fixed-gear fishery from 3309 to 938 metric tons on Georges Bank, and 858 to 421 inshore. A DFO (2009) report found that stocks failed to recover due to a high rate of unexplained cod mortality. This mortality may be due to high predation rates from seals, discards and unreported landings, or environmental change. Thus, while the DFO has successfully achieved their goal of reducing effort in the fishery, groundfish sustainability goals have been more elusive.

4. Methods

Fieldwork in the summer of 2012 consisted of participant observation, semi-structured interviews and surveys. Upon arriving in Barrington we established connections with key informants based on contacts suggested by outside experts and during participant observation. Key informants helped to develop a list of potential respondents. We selected respondents randomly from this list and added potential respondents based on further recommendations. We administered 113 face-to-face surveys of active captains and crew, interviewed 16 active harvesters considered to be knowledgeable, 5 buyers,

Management Measures	Lobster	Groundfish
Organization	Management and advisory boards	Advisory boards and community quota groups
Effort Controls	None	Quota allocated based on historical catch
Gear restrictions	Trap limits	Limits on fixed-gear use and type
Seasons	November-May	June to February (Georges Bank); April to March (Scotian Shelf)
Entry	Limited-entry licenses	Limited-entry licenses
Vessel Size Requirements	15.2m maximum length	Inshore fixed-gear vessel class (<13.9m)
Monitoring	DFO enforcement officers	Some at-sea monitoring and 100% dockside monitoring
Size limits	Minimum size requirements	None

Table 1: A summary of lobstering and groundfishing regulations

and 2 each of government officials and representatives, lobster association leaders, and groundfish association leaders.[6] Questions varied for each type of respondent, but all respondents were asked four similar questions: 1) what are the biggest challenges to livelihoods in the industry today? 2) What changes have brought about these challenge? 3) What are (fishermen, buyers) doing to respond to these challenges? 4) What enables or limits their ability to respond?

We transcribed and coded interviews, as well as qualitative responses from surveys. Our aim was to understand the drivers of social-ecological change, and the response strategies of resource users from the resource user's perspective. In doing so, we aimed to make visible the nature of the social and institutional relations that governed the SES. We accomplished this by constructing the dimensions and dynamics of the SES using the generic variables proposed by Ostrom (2007, 5183) from the perspective of each interviewee (see Table 2). Using the SES approach, we coded themes that corresponded to one of the 51 variables listed by Ostrom (2007) and coded sub-themes when themes were too general. We include the 13 most frequently occurring themes discussed by respondents to characterize attributes of the system. From political ecology, we elicited the interviewee's individual interpretations of the specific decision-making constraints and opportunities they faced as they responded to exogenous stressors. These interpretations and attitudes form a critical part of our analysis of the meanings the interviewees themselves associated with the elements of SES functioning, as coded using Ostrom's framework.

We examined the relationships between themes by analyzing the degree to which themes or sub-themes co-occurred in a given response. This allows us to understand how the interviewees associated social and institutional processes and livelihood outcomes in their daily lives. The link between broader scale institutions and livelihood outcomes is central to political ecology. We analyzed the matrix of co-occurrence of themes using multidimensional scaling (MDS, UCInet). The resulting plot revealed clusters of co-occurring themes[7].

[6]For the purpose of anonymity, we refer to association leaders, officials and representatives as "local experts", and use pseudonyms for all individuals.

[7]The stress value of an MDS plot indicates the amount of stress required to accurately represent the interrelationships of themes in two-dimensional space. A two dimensional plot with 13 objects has a 1% probability of exhibiting a stress level of 0.199 by random

Table 2: Themes discussed by fishermen, buyers and local experts, represented according to the SES framework (Ostrom, 2007, 2009; McGinnis and Ostrom, 2014)

Social, Economic and Political Settings (S)

Market incentives

▷ Market conditions (64)

Resource System (RS)

Human-constructed facilities

▷ Tank-houses, lobster cars, and lobster pounds (76)

Governance System (GS)

Property-rights systems

▷ Fish quotas/leasing (77)

Resource Units (RU)

Economic value

▷ Quality of lobsters (82)

Actors (A)

Norms/social capital

▷ Sticking together (126)

Dependence on resource (82)

Action Situations

Interactions ⟶ Outcomes

Harvesting

▷ Lobstering strategy (119)

Conflicts among users

▷ Price bargaining/conflict (77)

Deliberation processes

▷ Decision-making (99)

▷ Quota cuts (85)

Investment activities

▷ Buy-ups (76)

Social performance measures

▷ Livelihood outcomes (92)

Related Ecosystems (ECO)

Climate patterns

▷ Climate-change/water temperature change (28)

5. Results and Discussion

MDS distinguished four main clusters of themes illustrated in Figure 1 with a stress of 0.206. These clusters of themes and sub-themes form the basis for the structure of the discussion and quotes that follow.

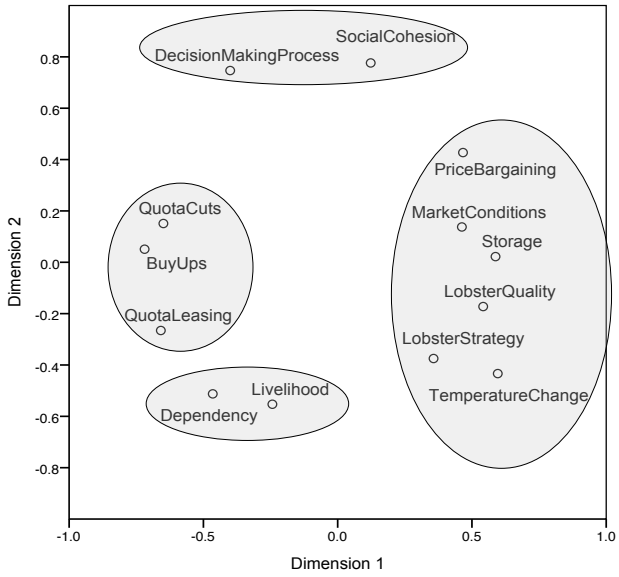

Figure 1: Multidimensional Scaling of themes from semi-structured interviews, surveys, and field notes. Similar to a biplot generated using Principle Components Analysis (PCA), the x and y-axes delineate the coordinates of each theme or sub-theme in 2-dimensional space. This analysis provides a visualization of the level of similarity of themes, based on their co-occurrences in individual responses.

5.1. Procedural Justice and Social Cohesion

The decision-making processes that harvesters discussed included meetings with lobster fishing area (LFA) management boards, consultations over policy with the DFO, and science advisory meetings. Harvesters and association leaders regarded the decision-making procedures as unfair. Of the six criteria for procedural justice identified by Daigle et al. (1996), harvesters and buyers suggested that decision-making procedures were inconsistent, based

chance (Sturrock and Rocha, 2000). Thus, MDS plots with 13 objects that approach this value can be considered to be statistically significant.

on inaccurate information, inflexible or irreversible, and did not give fishermen the opportunity to adequately voice their concerns.

Meetings between DFO and industry generally allow industry to voice their opinions and concerns, but respondents complained that their concerns were not represented. For example, one local expert stated:

> These management boards are only in an advisory capacity... [DFO] will basically dictate what the policies are... There has to be a more direct involvement with these sets of policies ...

These decisions frustrated and dissatisfied industry and demotivated their participation in the process. Harvesters believed that participation does not only lead to frustration, it can also serve to legitimize the DFO decisions they oppose.

> ... DFO said "Well you fellas passed this." And he said, "No, we didn't pass it. This is what you told us and we had to pick one or the other. It ain't what we wanted at all." (local expert)

Harvesters and local experts also suggested that decisions were inconsistent among officials and over time.

> ... we used to have to comply to owner-operator [policy] ... then this lady came in Yarmouth and she said, "No, now you are allowed to stack a license" ... then she was transferred, so who do you complain with? (harvester)

Inconsistency creates uncertain conditions that make it difficult for fishermen and new entrants to plan, invest, and retire.

Many in the industry believed that the scientific information used to determine quota allocations was inaccurate. Harvesters and quota groups have criticized the techniques the DFO used to estimate groundfish biomass, which determine quota allocations. The scientific method of random sampling should estimate overall abundance for a fishing zone, provided that the sampling protocol accounts for the spatial and temporal heterogeneity of the resource. To fishermen, this practice underestimates groundfish abundance. Some random samples are located in areas that fishermen know have low productivity. Further, as water temperatures and currents have changed, fishermen have noticed that productive fishing areas have changed. Harvesters argued that sampling strategies should reflect these environmental

changes. DFO scientists have been unable to present scientific information in a manner that is salient and legitimate to industry (see Cash et al., 2003).

Finally, industry complained that DFO decisions are difficult to alter when conditions change or if the decision proves to be counterproductive. According to a local expert, "If the fisherman makes a decision, ... in a years time, he sees it's no good, he will change it. DFO puts it in place ... you might live a lifetime trying to get it changed ...."

In addition to the procedural problems suggested by Daigle et al. (1996), harvesters pointed out that the decision-making process is complicated by communication problems. While fishermen have extensive knowledge of their fishery,

> ... when it comes to conversation with, take lawyers or government people ... you just can't comprehend what they are trying to tell you, and they can make things sound good that aren't good. (harvester)

This perception that decision-making is unfair was a constraint to the collective agency of harvesters. Participation in decision-making does not seem to make rules more reflective of harvester perspectives, so there is little incentive to participate. This reinforces an individualist approach to responding to problems. As we discuss below, while it may be possible that greater social cohesion among harvesters would improve the decision-making process, harvester groups face significant barriers to collective action.

Harvesters frequently talked about the need to "stick together," and to make decisions themselves rather than leave decision-making to the DFO. But some local experts suggested that harvesters needed to change their mindset to work together. One local expert stated,

> It's [currently] about me and I, and they got to remember, they gotta change their mindset because ... before we can get anything done ... its going to have to be about we and us.

Sticking together, however was presented as a particular challenge. While some were proud of the solidarity among harvesters during the strike in May 2012, others stated that "people were fighting against each other instead of standing up for each other." Fights occurred when some went fishing while others were on strike. Much debate centered on the capability of different harvesters to miss fishing days in the fall. According to a harvester, " ... when

you got a big debt hanging over your head, and it affects the way you think ..."

Harvesters in SWNS often are attached to their place and identity. One harvester stated that fishing is "in my blood and I love it." While similarities and shared identities and attachments can bind communities, differences in scale of fishing operation, fishing technology, and geography split people apart. These differences, combined with a strong culture of individualism (Apostle and Barrett, 1992) make it difficult for fishermen to stick together. Although they face a common problem, meetings frequently get "...into an uproar and a fight 'cause everybody's got a different opinion ..." (harvester). Some harvesters reported that decreasing social interaction and increasing competitive "cutthroat" attitudes have further divided communities. For example, many harvesters said that people used to help each other haul their boats up for repairs and cleaning. According to one harvester, "Today, they might try to knock your boat over to smash it in two." Another harvester suggested that "...there's no helping one another out...we're losing our culture."

Nevertheless, though competitive, fishermen told many stories of the community acting collectively. The most significant example occurred in February, 2013, when five men from Woods Harbour were lost while fishing for halibut in rough winter seas. Frustrated when the coast guard called off their search, the Barrington community pooled their resources to continue the search, and helped to pay for a group of fishing vessels carrying chartered rescue divers. Though rescue divers could not find the lost men, the fishing vessels recovered the hull of the vessel 100 kilometres offshore. This brought closure to the family and friends of the lost harvesters. By August 2013, a charity raised $111,000 in local and national donations, which was given to the families of the lost men.

This story demonstrates the capacity of people in Barrington to act collectively to respond to a disaster. But while the fishing industry faces many common challenges, they have been unable to respond collectively. Harvesters have social bonds within communities, but often do not trust harvesters from other communities, or government officials. Thus while harvesters have strong networks of trust within a community, inter-community bonds are too weak to support organizations that represent larger regions. These constraints together limit the ability of harvester groups to re-shape the policies they deem most important to their livelihoods; policies that determine who owns and controls the fisheries.

5.2. Ownership and Control of Fisheries

Collective action, procedural justice, and individual vulnerability is also tied to the sense of control actors have over their resources and decision options. Licenses and quotas, the primary institutions that govern access to fish, were core concerns. A harvester's ownership of quotas and lobster licenses determine fishing costs, and the share of landed value they receive for selling their fish.

Control was explained as an issue of individual agency: those who anticipated the quota system found ways to secure a larger share. One processing company had an "inside scoop," and made "smart purchases" to secure quota by buying licenses and vessels before the transition to quota management. "But the little fella, for a quick fix, was selling thinking it was the best way out" (local expert). The decision to sell quota and exit fisheries was exacerbated by successive quota cuts, which also reduced a harvester's sense of control over historically accessible resources. The "little fellas" were often hand-line fishermen who did not keep accurate records of their catches, and consequently received low allocations. As big fella bought up little fella, quota ownership became concentrated. Quota-owning processors benefited from both ends of the margin by leasing out quota, and by buying fish caught from the quota they lease out.

The quota system was implemented to improve stock abundance, and incentivize stewardship among harvesters. But price signals and single-species quotas have incentivized high-grading and discarding, locally referred to as "shacking" fish. Thus harvesters are individually incentivized to engage in short-term behavior that compromises the potential for improved quota access in the future.

Discarding occurs when it is difficult to catch one quota species without catching others. For example, when the quota for codfish is reached, some fishermen continue to fish for haddock and discard cod. In an informal discussion, a group of fishermen and fish buyers agreed that quota allocations with a ratio of haddock to cod of about 4:1 is feasible. As this ratio increases, it becomes difficult to catch haddock without overrunning the cod quota. The higher the ratio, the more likely a harvester will "shack off" cod. But shacking is not the only strategy to avoid overruns. Groundfishing vessels often shared information on cod catches in an attempt to find fishing grounds with less cod.

High grading can occur in a single species fishery when different size-classes of a species have a higher wharf price, and when it is difficult to catch

one size exclusively. In January 2010, cod prices ranged from $0.75/LB for large to $0.35/LB for small codfish. Assuming a vessel has a quota for 10,000 pounds of codfish, a vessel landing 100% large cod would make $4000 more than a vessel landing 100% small cod. A local expert suggested that the incentive to discard is even more pronounced when the incomes from lobster fishing are low.

> My theory would be high grading would be worse when you have a bad season in the lobster industry ... When the lobster industry was booming ... the guys would come in the office ... and they would say, "sell my fish," and I'd say, "So what do you want for it?" "Doesn't matter, long as I get enough to pay you your dues and I get a little money tucked aside for deer hunting." ... Now it's not the same. "What's the most you think I can get?"

Many fishermen fear that the lobster industry will eventually succumb to the same process of consolidation that has occurred in the quota fisheries. New legal arrangements between buyers and harvesters–controlling agreements–have emerged, which allow harvesters to maintain access to the competitive fishery, but at a cost to independence. In a controlling agreement, a company or individual agrees to pay a retiring harvester to transfer their license. The retiring harvester will then transfer that license to an eligible harvester in a contractual agreement with the company. The new entrant, then, is bound to the obligations set out in the contract with the company. This arrangement has become more prevalent as the market price of licenses increased to as much as $500,000, and banks became hesitant to lend money for license purchases (Bodiguel, 2002; Weston, 2009). Individuals or agencies have also used controlling agreements to circumnavigate rules that limit quota concentration. While the DFO sets limits on how much quota one individual can own, some individuals own well over this limit by controlling multiple licenses. In Barrington, 11% of survey respondents reported that they were currently in a controlling agreement, and 6% reported that they were previously in controlling agreements. Local experts living south of Barrington suggested that controlling agreements were much more prevalent in neighboring ports.

The details of these controlling agreements vary. An owner-operator typically splits the revenue from a fishing trip into a share for the boat, a share for the captain, and the remaining share is divided among crew. Harvesters

give a share of their landed value to the owner of the controlling agreement. One harvester tied to a lobster buyer paid 47% of his landed value to the buyer, fishing expenses were then subtracted, and the remainder was split equally among captain and crew. In this arrangement, the captain does not own the boat, gear, or license. Other informants estimated that 10-15% is deducted from total revenues when the captain owns the boat and gear, but not the license.

With no large stake in the fishery, a harvester in a controlling agreement "can walk away anytime [they] like." Another harvester reported that a controlling agreement saved him from losing his boat. Nevertheless, fishing communities are concerned about losing control and maintaining their local norms and practices.

> The bigger companies, the ones that own all these groundfish quotas will buy up the lobster licenses also because they got the overhead . . . They'll never go aboard the vessel, but they want to just take over. . . (local expert)

Another harvester suggested that companies have taken advantage of the current economic decline to further consolidate their control. "There are 25 boats in arrears with the loan board that can't pay their interest. . . [A private agency] is buying up boats in arrears."

Some lobster buyers argued that agencies that own licenses through controlling agreements distorted the costs of fishing upwards. When the shares to controlling agreements are high, it leaves tighter margins for captain and crew. A retired crewmember provided the example of a captain engaged in a trust agreement who had "paid for his license twice" in shares. But controlling agreements may also drive down the price for a harvester, because, in a controlling agreement "he's got no choice, he's got to sell to the buyer" (harvester).

A local expert suggested that control of lobster licenses allows captains and processors to have greater control over labor.

> If they didn't catch any fish, well they can't pay, and the crews have to stay on, because, say that dragger owns 7 lobster licenses . . . unless you don't want to lose your lobster site, you're gonna stay on that boat.

In the above sections, we have shown how harvesters perceive their interactions with government, and with the institutions that influence their

fishing practices. In the following section, we discuss how these perceptions play out at sea, as harvesters fish for lobsters, and respond to economic and ecological signals.

5.3. Economic Change, Ecological Change, and Lobster Prices

The institutional context of harvesters' and buyers' decisions extends far beyond the local dynamics of quotas, contracts and licenses. Respondents described a complex web of effort, storage, and exchange that links a fisherman in Barrington to dinner tables internationally. This process exhibits a seasonal pattern that fishermen and buyers knowingly exploit. At the beginning of the season, catches are high and buyers often open at a lower price. At this time, harvesters store a large proportion of their catch in lobster cars, semi-submerged wood-and-wire cages. With cold fall and winter temperatures, lobsters can be stored alive with minimal effects on quality. Storms and rough seas in the winter months limit fishing effort, and cold temperatures limit lobster activity. Buyers store lobsters in tankhouses with refrigerated pools of circulated seawater. Demand generally increases through December and continues to rise through February. Harvesters can often expect to get double the wharf price that they receive during the opening of the season. Economic, social, and ecological changes increase the uncertainty of the benefits to engaging in the above practices.

Previous statistical analyses have explained the variance in wharf price for lobsters using data on the US-Canada currency exchange rate, overall lobster landings, United States GDP, and the extent to which lobster landings are being sent to processing plants (Holland, 2011; Fisheries and Oceans Statistical Services, 2012). Poor economic conditions in the United States since the economic crisis of 2008 have resulted in a decline in demand for lobsters. Additionally, increased lobster landings have increased gluts at the beginning of the season, so more lobsters are sent to processing plants. A local buyer described the economic conditions that led to low prices in the spring of 2012:

> The Americans start dropping their price . . . The weather was starting to get better in March, we still had product, our boats still had their product the first week of March, and it was getting scary. . . So we sold them and give [the harvesters] the same as what we got for them, and ours was still in storage. . . That's why we had to start selling them to the processors because the quality

> was starting to go down... and the fishermen we're starting to put their gear out for the spring.

With increased landings in the beginning of the season and decreased demand, buyers could not sell their product to the live market quickly enough. Lobsters stored in tankhouses and lobster cars lost quality, and with the threat of lobsters dying, buyers reportedly sold their lobsters to processors at a loss.

The volatility in the market is exacerbated by changing environmental conditions. Changing water temperatures affect the abundance and the quality of lobsters. Higher water temperatures raise metabolic rates, and lobsters may molt more often and at different times. This leads to storage problems. Harvesters often recounted unanticipated events when storing lobsters, such as lobsters molting in storage, or more frequent die-offs.

Water temperatures also influence the reproduction and migration patterns of lobsters. In the spring, lobsters migrate to shallower and warmer inshore waters for molting and mating, and then migrate back to deeper and more stable offshore waters in the fall as surface temperatures decrease (Chen et al., 2006). Harvesters have shifted their fishing effort to different grounds as previously productive grounds have become less so. The ecological interactions that have led to these changing spatiotemporal patterns have not been well studied, but studies have demonstrated the importance of water temperatures in lobster spatiotemporal distribution (e.g., Pinsky et al., 2013; Waddy and Aiken, 2005; Pezzack and Duggan, 1986; Chen et al., 2005).

The abundance and quality of lobsters is also a product of harvesting strategies:

> It used to be an inshore fishery ... That [inshore] guy's catch, let's say he catches 30,000 pounds at $5 a pound is $150,000. The guy that's put the effort in it that goes deeper ... everybody knows the deeper you go the less the quality is, if he catches 70,000 pounds at the same price... who's making the bucks? So we're forcing the industry to go [fish harder] ... that's why people are making bigger boats ... (harvester)

In the lobster industry, quality-based pricing would not increase lobster mortality because the majority of lobsters caught in traps can be returned to sea and live, while most groundfish species cannot. Without quality-based pricing, harvesters are motivated to fish for quantity, especially when prices

are low. One harvester stated that "... we're forcing a lot harder in the wintertime, fishing harder to try to make up for the downfall in price." Some harvesters used cost-reducing strategies, such as "slack[ing] back on the gas pedal" to improve fuel efficiency and increasing the time between hauling traps, or soaking time. Soaking traps for longer increases the catch per trap, and decreases the fuel costs associated with hauling traps, but results in smaller catches than do aggressive fishing strategies.

Warmer water temperatures have incentivized catching for volume. According to one harvester,"I would say a lot of them managed because of the good weather, they fished all through the winters so their catch was up." In the 1980s, harvesters landed their traps in late January until the weather improved and lobsters started to "crawl" Davis (1984) But harvesters reported that lobsters were more active throughout the winter, due to warmer waters and more stable water temperatures offshore.

In sum, market conditions, storage, lobster quality, and lobstering strategies lowered demand, increased storage risks, made lobster catch quality less predictable and resulted in lower wharf prices. In the May 2012 strike, more than half of the 1688 harvesters in LFAs 33 and 34 refused to fish if prices dropped below $5 CDN per pound. Harvesters were divided on the effectiveness of this tactic. A harvester stated that "[i]t's not like ... we won't catch our lobsters this week because the price is down, when the lobsters are crawling and the water's warm, you gotta catch 'em." But another harvester argued that "[y]ou're not going to miss out because you'll catch them in the spring."

Steinberg (1984) recommended collective bargaining to correct imbalances in the port market system, in which harvesters have little choice but to sell to local buyers, and local buyers have, in turn, little choice but to sell to wholesalers with greater market control. But local buyers often suggested that the strike tactic has been disproportionately directed at them. One buyer said that "these fishermen think that the dealers get together and say 'let's rip off the fishermen'. It's not that way. I was losing money..... The big cookers [processors] set the price. I've been taking a lot of abuse." In an interview involving two buyers, both noted the upward pressure on prices in some regions. For example, "Cape [Sable] Island is a hornets nest. Buyers are fighting over boats, and this spills over off the island." The majority of this competition, however, was reported to be at the local or port-market level.

The lobster strike was a demonstration of agency in collective action

among harvesters in response to economic and ecological change. But given current incentives, perceptions of decision-making that involve government, and the changing ownership and control of fisheries, harvesters have favored individual responses to these problems. In the next section we show that these strategies result in vulnerable outcomes for some, but not others.

5.4. Livelihood Outcomes

Harvesters believed that livelihood outcomes varied according to a harvester's access to quota (see Figure 1). Many harvesters who continue to fish groundfish lease quotas from dealers, processors, or retired harvesters. While quota prices are driven by local demand, wharf prices are influenced by international economic conditions. As lobster-fishing revenues decline, more harvesters attempt to supplement their incomes in quota fisheries. This drives up local demand, and increases quota prices, irrespective of wharf prices. One harvester estimated lease prices that amounted to as much as 80% of wharf prices in the halibut fishery, a number that closely approximates those reported in Pinkerton and Edwards (2009). But quota lessees will also be willing to pay more for quota when incomes from lobster are low. According to a harvester, "You want to know why they go? 'Cause they're grasping at straws, trying to hang on, a little is better than nothing right?" When margins between lease price and wharf price are small, the risk of returning to port with a negative balance is higher.

Tight margins in the quota fisheries have increased harvester's dependence on the lobster fishery. Davis (1984) reported that harvesters fished a portfolio of species. In a multi-species context, harvesters would "spread things out all over the year, [now] they got to depend on that one season to make their living and there's so much pressure being put on it" (harvester). This dependency creates a lot of tension as lobstering season begins because, "there is a lot riding on the first haul of the year." In some households, spouses have taken jobs to supplement household incomes. Harvesters often spend the summers repairing and building traps and lobster cars to reduce the costs of fishing.

A local expert summarized the potential livelihood outcomes in the lobster fishery:

> Every family has a different challenge ... it's hard because the people that have been in the fishery for years ... basically owns everything they have. People that are ... getting into the

> fishery are borrowing large amounts of money . . . and if the prices of lobsters are down and your catches are basically holding the same . . . cost of everything is higher, you got less money, and you are not going to make it.

Some respondents suggest that diminished incomes are more pronounced for crewmembers. For example, one captain describes the effects of quota and license leasing on crew shares: "They've got such a high price-tag on fish [quota], for us to pay them . . . plus expenses, there is no money left for the crews." Another captain suggested that "a lot of captains are taking less to try to keep the crews . . . cause if not . . . they're not going to stay there." Captains must navigate the tradeoff between maintaining their boat and keeping their crew. When the crewmembers' share of earnings from a fishing trip are too high, a captain will not have enough money to keep up with boat maintenance, but when boat shares are too high, it is more likely that skilled crew will seek out another boat to work on, or emigrate.

6. Conclusions

Vulnerability in this case is clearly a product of individuals constructing livelihood strategies in a context of significant institutional and environmental change. The interviewees reveal how their choices are not only constrained by the institutions that govern their resource base, but also by the sense of trust and agency that exists among actors in the system. Thus, fishing household choices are not only a feature of institutional arrangements, but of how those arrangements differently affect actors within a system, and how those actors perceive fairness in rule implementation. While the SES approach allows for a systematic analysis of the role and function of system elements, we examined these elements from a political ecology understanding, demonstrating the importance of an actor-oriented perspective on the meaning of institutions for their livelihoods.

The decision-making process involving the state and fishing households lacked procedural justice, and harvesters often refused to participate in processes they perceived to be illegitimate. Harvesters recognized the importance of working together to articulate an alternative vision for governing their fisheries, but lacked the inter-community social ties and trust to do so. Meanwhile, buyers or large fishing companies with sufficient economic and political capital have maintained their businesses by buying quota, and by

circumnavigating rules that attempt to limit consolidation. Fishing households were concerned that fishing communities are losing control of their local industry, and the benefits, cultural norms, and practices that come with local control. Those with less political and economic power were more sensitive and have a lower capacity to respond to challenges. These include harvesters who fished lobster exclusively, those with high fishing costs due to debt and quota leasing costs, and crewmembers. With low capacity to respond collectively, harvesters have favored individual strategies such as attempting to catch more, decreasing costs, or investing in storage facilities. These findings indicate that vulnerability is being produced not only through the implementation of institutions that structure choice, but also the procedures of decision-making and individual agency that construct the institutional context.

These results underscore the need for integrating Ostrom's institutional approach and political-ecological approaches that consider the interactions between structure and agency. Ostrom's (2007) framework provides a useful starting point for examining the institutions, interactions and outcomes in natural resource use. Brewer (2012), however, has demonstrated that political-ecological approaches can broaden the narrative regarding the successes and failures of common pool governance regimes. Broadening this narrative will likely lead to constructive policy and institutional change (Leach et al., 2010).

To improve policy, collective action, and livelihood outcomes in SWNS, we suggest initiatives that encourage co-production of knowledge, information sharing, and inclusive action arenas involving harvesters and the state. Organizations such as the Fishermen and Scientist Research Society (FSRS) have built trust between scientists and harvesters. But decision-making arenas must facilitate discussions between many communities to determine the sources of consensus and difference, and to better fit the scale of policy to geographic scales of the dilemmas harvesters face. Harvester groups cannot change global economic conditions, but the FSRS has collaborated with US scientists to develop the American Lobster Settlement Index to monitor variation in lobster settlement related to climate variability (Wahle et al., 2010). Additionally, LFA management board leadership and the Maine Lobstermen's Association have established collaborative ties, with an Annual US/Canadian Lobster Town Meeting, and binational marketing task forces and collaborations since 2012. Finally, we found vulnerability was linked to harvester relationships to markets for fish and fishing access rights. Improv-

ing trust and equalizing bargaining power in buyer-harvester interactions would likely ensure that harvesters and buyers equitably benefit from fishing resources. Current property rights regimes could be reformed to ensure the viability of captains entering the fishery, and improve access to affordable fishing quotas and leases.

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