

From Policy Instruments to Action Arenas: Toward Robust Fisheries and Adaptive  
Fishing Households in Southwest Nova Scotia

by

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## ABSTRACT

The coastal fishing community of Barrington, Southwest Nova Scotia (SWNS), has depended on the resilience of ocean ecosystems and resource-based economic activities for centuries. But while many coastal fisheries have developed unique ways to govern their resources, global environmental and economic change presents new challenges. In this study, I examine the multi-species fishery of Barrington. My objective was to understand what makes the fishery and its governance system robust to economic and ecological change, what makes fishing households vulnerable, and how household vulnerability and system level robustness interact. I addressed these questions by focusing on action arenas, their contexts, interactions and outcomes. I used a combination of case comparisons, ethnography, surveys, quantitative and qualitative analysis to understand what influences action arenas in Barrington, Southwest Nova Scotia (SWNS). I found that robustness of the fishery at the system level depended on the strength of feedback between the operational level, where resource users interact with the resource, and the collective-choice level, where agents develop rules to influence fishing behavior. Weak feedback in Barrington has precipitated governance mismatches. At the household level, accounts from harvesters, buyers and experts suggested that decision-making arenas lacked procedural justice. Households preferred individual strategies to acquire access to and exploit fisheries resources. But the transferability of quota and licenses has created divisions between haves and have-nots. Those who have lost their traditional access to other species, such as cod, halibut, and haddock, have become highly dependent on lobster. Based on regressions and multi-criteria decision analysis, I found that new entrants in the lobster fishery needed to maintain high effort and catches to service their debts. But harvesters who did not enter the race for higher catches were most sensitive to low demand and low prices for lobster. This study demonstrates the importance of com-

binning multiple methods and theoretical approaches to avoid tunnel vision in fisheries policy.



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## Chapter 1

### INTRODUCTION

#### 1.1 Problem Statement

Coastal communities depend on resilient ecosystems, and effective resource-based economic activities (Hilborn et al., 2003). The famous story of the collapse Atlantic codfishery illustrates the dangers of exploiting a resource beyond critical ecological thresholds. Fueled by modern technologies, subsidies, optimistic scientific assessments, and institutions that incentivized a race to fish, fishing vessels pursued cod and other groundfish species intensively throughout their range (Barrett, 1984; Hilborn et al., 2003; Rogers, 1998; Hutchings and Myers, 1994). In 1992, with clear signs that the stocks had collapsed, the Canadian government placed a moratorium on all codfishing on the Grand Banks; a moratorium that remains in place to this day. This collapse put 40,000 people out of work, cost Canadian taxpayers 1 billion in support to unemployed fishers, and has threatened the cultural foundations of Newfoundland's coastal communities (Hilborn et al., 2003; Harris, 2013; Kurlansky, 1998).

Worm et al. (2009) showed that 35% of a sample of fisheries around the world were in a state of overexploitation, and 37% in a state of recovery from previous overexploitation. Hilborn warned that “there is no shortage of evidence that fishing fleets are too large, science too imprecise, and management institutions too ineffective to prevent the Newfoundland cod story from being repeated again and again” (Hilborn et al., 2003, p. 362). But there are also stories of participants in the fishing industry working together to craft locally relevant institutions to successfully avoid overexploitation, and in some cases, to strengthen coastal communities and their cul-

tures (e.g, see Ostrom, 1990; Townsend et al., 2008; Basurto and Nenadovic, 2012; Pinkerton and Weinstein, 1995; Hilborn et al., 2005).

Steneck et al. (2013) argues that fisheries of the Atlantic must be agile to adapt to changing environmental and economic conditions. In a globalized world with increasing economic and ecological connections, it is important to understand how fisheries and their governance systems remain robust to the challenges they face (Janssen et al., 2007; Anderies et al., 2004; Young et al., 2006; Held, 1999). It is also important to understand how households who depend on the fishing industry can adapt and shape the political landscape toward positive outcomes for coastal communities and their cultures (McLaughlin and Dietz, 2008; Davis and Ruddle, 2012). But fisheries governance must also navigate the conflicts between different objectives, such as economic efficiency, maximized employment, and ecological preservation (Hilborn, 2007a) Can we know whether and how the success stories of today will remain successes in the future? What do we mean by success?

In this dissertation I will attempt to address the above objectives by analyzing the case of the multi-species fishery of Barrington, Southwest Nova Scotia (SWNS). While historically a multi-species fishery, SWNS has increasingly become a lobster fishery with few alternatives. This region had a highly active fishing economy based on groundfish species, herring, mackerel and lobster. After the cod collapsed in Newfoundland, government officials set out to reduce the fishing activities in SWNS (Peacock and Annand, 2008). This, combined with previous policies encouraging fishermen to specialize, has reduced the flexibility of fishing households (Hilborn et al., 2003; Davis, 1984b). I do not examine whether these regulations were necessary or not, or whether better alternatives existed. Instead I explore the implications of these policies for the fishing communities. By examining the interactions among members of the fishing industry, governmental organizations, resources, and the rules-in-use, I

hope to contribute to an understanding of what alternatives may be realizable in the future.

SWNS has had a notoriously contradictory and sometimes violent relationship with government (Davis and Kasdan, 1984). Their attempts to organize have often been fraught by internal conflicts, which has made it difficult for the region to speak as one voice to government (Kearney, 1989; Peacock and Annand, 2008). Ostrom (1990) discussed the case of Port Lameron in SWNS, and characterized the fishery as “fragile” because the government did not recognize their locally relevant rules. SWNS is a hotbed of resistance to fisheries policy, and the study of this region contribute to understanding what processes lead to poor relationships between government and society in the maritimes. By understanding these processes, we may better understand how to promote organization, collaboration, and more fair and adaptive decision-making processes.

## 1.2 Research Objectives and Questions

To summarize, the objective of my research is to understand what makes fishing households vulnerable, what makes the fishery and its governance system robust to economic and ecological change, and how household vulnerability and system level robustness interacts. To address these objectives I will examine the relationships between government and marine harvesters, the structural processes that have influenced their livelihood strategies, the different problem definitions in the industry, household responses to economic shocks, and the implications of household vulnerability for the ability of harvesters to organize to adapt their institutions to change. Specifically, I will address the following questions:

### 1.3 Research Strategy and Scope

To answer these questions, I used a combination of ethnographic methods, case study comparisons, surveying and quantitative data analysis. I will try to show how seemingly disparate methods can complement each other, and help us better understand the constraints a system faces, and make policy recommendations. I will also try to integrate theory from disparate fields such as political ecology, commons research, and bioeconomics. By integrating theories, I contribute to a more holistic way of thinking about fisheries, and opening up fisheries policy to alternatives.

I use the concept of the action arena as focal unit of analysis throughout the dissertation. Action arenas are the social spaces where participants in the fishing industry interact, make decisions, engage in transactions, and harvest resources. Each chapter is a discussion of different interacting components or factors that influence action arenas. The ethnographic data were derived almost entirely from the fishing industry. Members of the fishing industry have provided their perspectives on how fisheries policy has affected them, and have given various definitions of the problem. I used primary and secondary literature to better understand the reasons behind policy interventions. Governmental organizations have their own reasons for choosing a policy intervention. For example, some governmental agencies have had a legacy of favoring high-modernist projects, and have attempted to simplify and universalize complex and diverse societies to make them more manageable (Foucault, 1982; Scott, 1998). The perspectives of the fishing industry of SWNS is important for understanding the divisions that hinder effective action arenas. By understanding the perspectives of harvesters, we can understand the ecology of the fisheries, the challenges the industry face, and the processes and governance structures that lead to conflict.

## 1.4 Research Questions and Dissertation Organization

This dissertation is divided into 7 sections after this one. In the first two sections are based on reviews of primary and secondary literature. In Chapter 2, I review the literature on integrating society and the environment and on understanding the robustness of integrated social-ecological systems, and how system level processes interact with household-level vulnerabilities. I review the commons literature that has contributed theoretical insight to understanding dilemmas in fisheries. I will suggest that it is important to integrate insights from political ecology. I review fisheries relevant policy instruments and alternatives in fisheries, and the tension between seeking distributional and efficiency outcomes. I attempt to form a dialogue between different types of analysis and problem definitions. I argue that this is important for avoiding tunnel vision when analyzing problems and recommending solutions. Finally, I outline a framework for analyzing action arenas that incorporates this dialogue.

In Chapter 3, I provide a description of the study site, Barrington, SWNS, Canada. I outline the current demographic trends in the region, current lobster management policies, and the ecological and economic challenges the region faces. I then discuss the ethnographic methods I used in the field.

**What makes fisheries robust to social-ecological changes and disturbances?  
How is robustness influenced by the feedback between the operational level, where harvesters interact with the resource, and the collective-choice level, where agents develop rules to influence the behavior of harvesters?**

Chapters 4 to 7 are written as articles. In Chapter 4, I re-evaluate Ostrom's case study of the lobster and groundfishery of Port Lameron, also known as Port La Tour. Davis (1984b) wrote an ethnographic account of this case, and Ostrom analyzed

it from a commons perspective in *Governing the Commons*. I apply the concepts of feedback, governance mismatches, and the robustness of social-ecological systems to understand the pathways of institutional change in Port Lameron. I compare the changes in Port Lameron to those of Maine. I demonstrate that the feedback between the operational and collective-choice level is stronger in Maine than in Port Lameron. This has allowed harvesters in Maine to steer policies away from some of those that have produced problems in Port Lameron. I also discuss a tradeoff that has occurred. In Maine license-holders have used their influence in decision-making arenas to consolidate their power. This presents a challenge to the communitarian decision-making processes that occurred before the current co-management regime. I show that both systems would benefit from more polycentric governance.

**What social, political, and economic processes make fishing households vulnerable? Here I refer to policies, the differential agency of fishermen and buyers, and social processes that hinder collective action. How do household level responses scale up?**

In Chapter 5, I formally analyze interview data to outline the perspectives of the SWNS fishing industry. I use Elinor Ostrom's (2007) diagnostic framework to categorize the themes respondents discussed, and livelihoods and vulnerability as the outcome of interest. I apply the concept of socially constructed adaptive landscapes (McLaughlin and Dietz, 2008) to broaden Ostrom's framework to include the agency of harvesters, buyers, and investors, power relations, and the competing definitions of the problem. I show that the most salient themes to the industry include the procedural justice of decision-making processes, social capital in fishing communities, the ownership and control of access to groundfish and lobstering industries, and the interactions among fishing strategies, and economic and ecological change.



**How do households cope with the disturbances they face? What characteristics make a household sensitive to disturbances? Are there winners and losers?**

In Chapter 6, I examine some of the themes and test some of the hypotheses from Chapter 5. I describe the changing portfolio of fish species available to fishing households today compared to the past. I also describe the characteristics of the lobster fishing industry, fishing practices, and how lobster harvesters have responded to unusually low lobster prices. I use statistical regressions to determine the most important factors contributing to the income and income sensitivity of captains and crewmembers. I characterize the general negative outlook for new entrants in the industry, and other challenges and threats that concern harvesters. Finally, I triangulate a survey-based history of best and worst years in the fishery with primary and secondary data. Together the results demonstrate that captains who entered the fishery by leasing licenses, or with access to credit during the boom of the fishery have to maintain high catches to stay in business. Captains and crewmembers are more sensitive to economic shocks when they depend solely on lobsters for their livelihoods.

**How has globalization and environmental change interacted to affect Atlantic Canadian households? What assets and entitlements are lacking in most vulnerable households? Are vulnerable households less politically engaged?**

In Chapter 7, I contextualize the current economic shocks in the lobster industry and further characterize the outcomes for households. I show that the current economic shock is a product of the interacting double exposures of global environmental and economic change. I then use multicriteria decision analysis to characterize the vulner-

ability of households. While I pinpoint important factors in Chapter 6, in this chapter I show how households have a combination of these factors, and use advice from key informants to attach weights to each factor. I show that households with a low adaptive capacity are less likely to participate in association or organizational meetings, while those who are most sensitive are more likely to have a negative outlook for the future of the fishery. Thus, I show that the adaptive capacity and sensitivity of households is associated with political engagement and attitudes.

Finally, in Chapter 8, I summarize my findings, and outline the implications for fisheries policy in Atlantic Canada. I conclude the dissertation with policy recommendations, with the caveat that they be considered only in a context of fair and inclusive discussion, negotiation, and contestation.

## Chapter 2

### LITERATURE REVIEW

#### 2.1 Social-Ecological Systems, Commons Research, and the Fisheries Context

Biophysical and social systems are currently facing unprecedented social, economic and biophysical changes. Scholars have called for an integrated understanding of society and biophysical systems, and robust decision-making to maintain human well-being in the face of these changes (e.g., Anderies et al., 2004; Polasky et al., 2011; Ostrom, 2007). This need for integrated analysis is especially prevalent where food systems are faced with changes, stresses, or disturbances that have potential impacts on food security and livelihoods (Ericksen, 2008). In fisheries research, however, this integrated approach has been hindered by the specialization and separation of disciplines working within different paradigms of how the world works (Degnbol et al., 2006). Just as there are no blueprint solutions to environmental challenges (Ostrom, 2007), there is no single panacea framework or approach to understanding a system.

In this chapter, I will briefly review relevant literature to understand society-environment interactions, with particular attention to fisheries. These themes will inform the chapters that follow, but I will place greater emphasis on different elements in each chapter. In this review, I emphasize the importance of dialogue between different types of analysis and problem definitions to avoid tunnel vision. These dialogues can help us explore the assumptions and limitations of one theoretical approach, inform us of the advantages of integration, and help us develop more accurate models of how actors, institutions, political-economic structures, and biophysical systems interact.

In this review, I attempt to develop a dialogue between the vulnerability of house-

holds to the robustness of social-ecological systems; between positivistic/mechanistic and constructivist approaches; between problem definitions centered on property rights and those centered on power relations and dis-embeddedness; between considerations of efficiency and distributional and procedural justice. Different resource users, managers, and experts define the problem differently, and proposes different solutions. These different foci will lead to a different diagnosis of “the problem” and therefore a different proposed solution. Finally, I outline a framework in an attempt to integrate these ideas in the chapters that follow.

## 2.2 Conceptualizing Society and Nature

Researchers in geography, sustainability science, and ecology have increasingly emphasized the importance of studying nature and society as integrated systems (Castree and Braun, 2001; Liu et al., 2007; Turner et al., 2003; Berkes and Folke, 2000). In ecology, sustainability science, and vulnerability studies, these systems are conceptualized as coupled human-environment systems (CHES) or social-ecological systems (SEs), composed of interacting natural and social components (Liu et al., 2007; Anderies et al., 2004). These concepts reflect a shift from thinking of resources as discrete units, to a systems thinking approach that emphasizes the complex interactions and feedbacks between multiple social and natural components (Berkes and Folke, 2000).

Constructivist approaches to social-natural interactions emphasized the ways that knowledge of nature is influenced by the biases of the knower. These ways of knowing reflect social power relations, have material consequences and influence decision-making and policy. Given this view of nature as socially constructed, biophysical constraints and opportunities can only be understood in relation to their technological, economic, and cultural contexts (Douglas and Wildavsky, 1982; Oliver-Smith,

1996). Our knowledge and social, economic, and cultural relations can also “remake” nature, for example, through genetic modification or the concentration of pesticides in food chains (Castree and Braun, 2001). Vulnerability researchers have promoted a moderate constructivist approach to examine the role of perceptions, attitudes, and beliefs in shaping policy in decision-making arenas, and the causes of, and responses to, a vulnerable social context (Polsky et al., 2007; McLaughlin and Dietz, 2008).

I adopt the concept of the social-ecological system (SES) as it has been developed by Anderies et al. (2004) and Ostrom (2007, 2009). This conception is founded on mechanistic models of the interactions between humans, human-constructed “soft” and “hard” infrastructure, and biophysical components of a resource system. SESs are complex adaptive systems embedded in larger systems through cross-scale linkages. I provide a more detailed description of this concept in Chapter 4. While any model of society and nature is limited, this concept of the SES allows researchers to pay attention to socionatural interactions at the local scale, while also considering how larger-scale social, economic, and political context mediates these interactions. Additionally, the Ostrom (2007, 2009) framework was designed to encourage communication and collaboration among multiple disciplines. While I recognize the limitations of any mental model, or mechanistic interpretation of complex interactions, this framework will be highly beneficial to SES research when combined with more reflexive research approaches from fields such as political ecology and cultural anthropology.

### *2.2.1 Social-ecological systems and global change*

The process of globalization, characterized by increased flow of goods, services, and information has had profound impacts on the interrelationship between society and the environment (Held, 1999). Some of these impacts include changes in networks

of global connectivity, increased speed of interactions and innovation, expanding spatial scales of governance, and reduced diversity of institutions developed to manage natural resources (Young et al., 2006; Read et al., 2009). For many communities, global environmental and economic change have interacted to produce double exposure (Leichenko and O'Brien, 2008). In some cases, states have institutionalized and bureaucratized the management practices of resource users (Davis, 1991; Brewer, 2012b). Markets have penetrated small-scale communities, and in some cases, have transformed social relationships (McCay and Jentoft, 1998). Social-ecological researchers have emphasized the importance of understanding how SESs evolve, adapt, and react to perturbations and stresses in the context of global change (e.g., Young et al., 2006). Recent studies have increasingly emphasized the importance of the concepts of resilience, robustness, and vulnerability (Anderies et al., 2004; Janssen et al., 2007; Gunderson and Holling, 2002) to understand the characteristics of a complex SES undergoing continuous or abrupt changes (Janssen et al., 2007).

Resilience is defined as the capacity of the structure of a system to persist in the face of perturbations (Holling, 1973). Based on insights from ecology, a system that is not resilient is more likely to shift from one set of mutually reinforcing processes and structures to another. These reinforcing processes and structures, known as alternative stable states, have been identified in a range of systems including lakes (Scheffer et al., 1993; Carpenter, 2005), rangelands (Anderies et al., 2002), current (Walker et al., 2009) and past (Anderies, 2006) irrigation systems, financial markets (Scheffer et al., 2009), and the global climate system (Scheffer et al., 2009). In order to determine the resilience of a system, however, resilience scientists must identify and quantify the thresholds between stable states, and understand how close a SES is to these thresholds (Walker and Meyers, 2004). Early formations of the concept of resilience were concerned with the resilience of specific ecosystem processes to one

type of threat (Carpenter et al., 2001), but resilience has been broadened to refer to the general resilience of a system, or the resilience of all components of the system to uncertain and unpredictable threats (Resilience Alliance, 2010).

While resilience has been useful to describe or predict regime shifts in a variety of systems, Anderies et al. (2004) suggested that the concept of robustness helps scholars understand SESs with social and biophysical components that are in some way governed or controlled by human actors. A system is said to be robust when its performance is maintained despite uncertainties, or when it is subjected to external perturbations (Carlson and Doyle, 2002). The concept of robustness emphasizes the cost-benefit tradeoffs associated with management decisions. Instead of adopting generalized optimal policies for resource management, Anderies et al. (2007) suggested a robust control framework, which can be used to identify a family of policies that can maintain the performance of a SES within the boundaries of a set of uncertainties. I further outline and apply this concept to the Southwest Nova Scotia SES in Chapter 4.

Robustness and resilience have generally been used to refer to complex adaptive systems such as ecosystems, economic systems, or SESs. But the resilience of ecosystems, and decision-making for robustness of SESs have implications for the livelihoods of those that depend on a resource. Vulnerability research pays attention to the ways that political economy, governance, and environmental change affect individuals and households. The traditional definition of vulnerability encompasses three components; 1) the extent to which a group of people are exposed to social or ecological stress, 2) the sensitivity of those exposed to these stresses, and 3) resilience, or the ability of those exposed to resist or recover from the damages associated with social or ecological stresses (Clark et al., 2000). The current understanding of vulnerability has come from the integration of a development tradition that focused on

food security and entitlements; a natural hazards tradition that integrates physical science, engineering and social science; and a political and human ecology tradition that emphasizes structural causes of vulnerability (Adger, 2006).

The integration of robustness, resilience, and vulnerability approaches can improve our understanding of cross-scale interactions and the potential tradeoffs between household and system-level outcomes. This system-household vulnerability tradeoff is often found in fisheries, where fisheries management regimes must make decisions that balance the need to sustain employment and development of fishing communities, and the need to sustain or rebuild fish stock (Hilborn, 2007b). While full employment of fishing communities may benefit households within the community, it may increase the chance of fisheries collapse, with negative implications for both social and ecological components of the system. Eakin and Wehbe (2009) shows that Mexican households that employ a diversity of economic activities were less vulnerable, and that the interactions between livelihoods, social structure, and policy determine large-scale system vulnerability. This is also the case in fisheries, since fishers who specialize in the exploitation of one fish species are more vulnerable to fluctuations or collapses in availability of fish (Hilborn et al., 2003; Kasperski and Holland, 2013). Governance regimes and institutions at a larger scale mediate the processes by which resource users access resources and entitlements and carry out livelihood strategies (Scoones, 1998). These strategies, in turn, have implications for system-level dynamics at a larger scale.

Miller et al. (2010) suggested that integrating insights from resilience theory and vulnerability theory would benefit both fields of research as well as improve researchers abilities to inform policy and suggest practical solutions to social-ecological problems. In particular, Miller et al. (2010) argued that scholars can combine attention to dynamic interactions between social and ecological components from resilience, and at-



tention to actor-based approaches that emphasize power relations, equity, and social marginalization from vulnerability. McLaughlin and Dietz (2008) have argued for an integrative approach to vulnerability building on the strengths of biophysical perspectives, human ecology, political economy, social constructivism, and political ecology. They suggested that vulnerability research be built on the concept of a “socially constructed adaptive landscape” consisting of political-economic structures, environmental conditions, and human agency (McLaughlin and Dietz, 2008). I suggest that the combination of these approaches can be mutually beneficial to understanding robustness, resilience, and vulnerability. While this may be a difficult task, requiring bridging different epistemological and political traditions, it will likely lead to greater innovation in understanding and improving socio-natural relations.

All of the above bodies of literature have centered on the need for systems, households, or individuals to adapt to the pressures and disturbances they face. At the system level, many SESs have adapted their institutions to the variability commonly experienced over many generations through a process of experimentation and social learning. For example, Torbel peasants have developed a combination of both common and private property regimes as early as 1224 for the management of grazing meadows, forests, and irrigation systems (Ostrom, 1990; Netting, 1976). This process of adaptation has been characterized as the development of highly optimized tolerance to context specific variability (Janssen et al., 2007). Janssen et al. (2007) provide two examples of adaptation; spreading the rate of resource use over time or space, and investing resources to further develop infrastructure (social or physical) to manage disturbances. While these SESs have developed adaptations to deal with the temporal and spatial variability of resources they commonly experienced, these adaptations have occurred within a specific political economy with given social norms and connectivity to larger scales of governance. Changes in policy, technology, and international

economics influence, and in some cases threaten, the persistence of even long-enduring SESs by exposing them to disturbances they have not had the opportunity to adapt to. Therefore, as both the ecological and social aspects of variability and connectivity change, adaptations that were once robust may become increasingly fragile. Janssen et al. (2007) show that the adaptations of SESs to different configurations of slow persistent change and top-down interventions have different implications for robustness vulnerability tradeoffs. For example, adaptations to long-term persistent changes in resources can expose an SES to vulnerability to economic or technological variability.

While SESs can adapt by changing their governance structures and institutions, households adapt by adopting livelihood strategies. These strategies depend on the livelihood resources they have access to, and the institutions and political-economy that mediates access to resources (Scoones, 1998). Households may also engage in collective action to change the political landscape by participating in the political process (Adger, 2003). A social group can adapt to and transform a vulnerable context, depending on their political and economic power, to change the institutions that influence their access to resources (McLaughlin and Dietz, 2008).

While scholars have examined the ability of individuals or groups to adapt to hazards, risks, or climate change as early as the 1970s, recent adaptation research has paid greater attention to human agency to change institutions and create a more just society (Bassett and Fogelman, 2013). But Bassett and Fogelman (2013) distinguished between adjustments, reforms, and transformative adaptations, and argues that much of the current adaptation literature has focussed on adjustments. While adjustments may provide important short-term benefits to households or SESs, they do not address the institutions and political-economic processes that produce and reinforce these vulnerabilities (Bassett and Fogelman, 2013). While transformative adaptation addresses the political-economic and institutional structures that pro-

duce vulnerabilities, governments often prefer problem framings that do not hinder a “business as usual” strategy (Bassett and Fogelman, 2013). Leach et al. (2010) argue for an “opening up” to a wider range of alternative problem framings, and solutions (Leach et al., 2010). More open, negotiated, and democratic decision-making for adaptation will require attention to these multiple forms of adaptation based on multiple problem framings.

In the chapters that follow, I focus on the robustness of SES governance regimes, and the vulnerability of households. In Chapter 5, I focus on the social and political processes that lead to vulnerable outcomes for fishing households, and the ways they have attempted to adapt to the challenges they face. In Chapters 6 and 7, I focus on household strategies, and the composition of vulnerability at the household level. In both chapters, I relate vulnerable conditions to political participation and the prospects for harvesters to steer policy towards more empowering conditions.

### *2.2.2 Governing social-ecological systems*

To build system level robustness or reduce household level robustness, SESs respond to change through governance. Governance is the process by which a diversity of state and non-state actors attempt to steer, control, or manage society by devising institutions, and by monitoring and sanctioning those who violate them (Ostrom, 2005b; Kooiman, 1993; Adger and Jordan, 2009).

Much of SES and CPR governance strategies have been founded on the idea of the “tragedy of the commons.” Fisheries have classically been defined as common-pool resources, characterized by low excludability and high subtractability. That is, it is hard to exclude outsiders from accessing the resource, and one harvester’s exploitation patterns affects resource availability to others (Ostrom, 1990). In this often cited model, individual resource users are compelled to maximize net gains from a CPR. An

atomized individual benefits by increasing their exploitation level, but at a collective level, everybody loses due to resource overexploitation. This creates conditions where “everybody’s property is nobody’s property” (Gordon, 1954, p. 135). The tragedy of the commons narrative suggested that governments must strictly regulate or privatize CPRs to ensure sustainable resource use (Hardin, 1968; Gordon, 1954).

The tragedy of the commons narrative is simple and compelling, but belies more complex social processes. Based on a review of empirical case studies, Ostrom (1990) found that resource users self-organize to avoid tragedies by devising culturally and ecologically specific institutional and collective choice arrangements. Ostrom (1990) found that long-enduring SESs followed eight general design principles (Table 3.1, p. 90). Studies by Wade (1988) and Baland and Platteau (1996) came to similar conclusions, and suggested additional important conditions for sustainable resource-use (see Agrawal, 2001, for a synthesis). Commons research highlights the importance of maintaining the diversity of institutional arrangements that foster cooperation and collective action (Ostrom, 2005b). Furthermore, commons research also points out that well functioning institutional arrangements often consist of a complex integration of private, common, and publicly owned and managed resources, undermining earlier calls for either strong government control or private property rights.

### 2.3 Context, Diverse Rationalities, and the Dynamics of the Commons

The first wave of commons literature has argued effectively for a third way to govern CPRs. These insights have been the subject of active scholarly discussion as well as criticism. In the paragraphs that follow, I will discuss three common critiques highlighting the importance of social, political and economic context; the dynamic process of change over time; and complex and diverse rationalities. I will then discuss the potential contribution political ecology can make to strengthen CPR theory.

In a review of commons research, Agrawal (2001) argued that the CPR focus on local contexts has come at the cost of understanding the interactions among local institutions, demographic changes, markets, and state policies. In Agrawal's (2005) study of the development of forestry governance in Kumaon, India, Agrawal shows that 1) seemingly effective management institutions can lead to social asymmetries, and 2) that resource users were engaged in political negotiations and social struggles to produce their common property governance institutions. While this emphasis on the local does not accurately characterize all commons scholars (Ostrom, 2005a), discussion on larger-scale contexts has led to important theoretical advances. For example Janssen and Anderies (2007) has highlighted the importance of trade-offs inherent in governance decisions between different stakeholders objectives, performance, risks, and time scales. Ostrom (2005b) has also integrated actors and structural forces by conceptualizing governance as action arenas influenced by biophysical context, attributes of the community, and institutions at different nested scales.

The tragedy of the commons frames CPR problems as market failures caused by a lack of property rights, based on the assumption that humans are economically rational and self-interested. Mansfield (2004) argued that CPR scholars have challenged the inevitability of tragedies, but have not adequately challenged the assumption that a lack of property rights creates market failures, or the assumptions that harvesters seek only to maximize gains, a common form of economic rationality. Mansfield (2004) argued that these assumptions can be incorporated into neo-liberal discourses promoting the large-scale privatization of resources. Ostrom (2005b), however, reviewed experimental insights into the diversity of human preferences. These experimental approaches have outlined the conditions under which individuals follow norms of reciprocity, trustworthiness, and fairness, and seek or avoid positive or negative non-monetary payoffs such as pride or shame (Ostrom, 2005b). Though still

founded on rational choice theory, these theories point to the social “embeddedness” (Polanyi, 1957) of actual and experimental communities.

McCay and Jentoft (1998) have suggested the concept of embeddedness to anchor diverse rationalities of resource users within their social contexts. Embeddedness refers to the ways that economic transactions and other interactions are embedded in the social lives and cultural values (McCay and Jentoft, 1998). Disembeddedness occurs when external influences erode a community’s local control over socially mediated transactions and governance regimes (Giddens, 1994; McCay and Jentoft, 1998). One way that a community can become disembedded is when external interventions crowd out the intrinsic motivations of individuals (Frey and Jegen, 2001). McCay and Jentoft (1998, p. 23) argued that “community exists, it counts, and it shapes the nature and outcomes of commons problems.” McCay and Jentoft (1998) advocated an approach that considers the possibility of “community failure,” where the social bonds within a community are absent or eroded, and communities are unable to solve collective action dilemmas.

Ostrom (1990) developed the design principles for self-governing CPRs based on case studies. These case studies covered different time-frames before the 1990s, but essentially provided a static snapshot of the system. Boonstra and Nhung (2012) argued that the sustainability of fisheries depends on the dynamic processes by which stakeholders, governments, and the environment interact. They promoted a process-sociological approach to understanding the historical development of a fisheries management regime over time. Though using a different approach, Anderies et al. (2004) have adopted an approach that examines the changing interdependencies between resource users, governance, and biophysical systems over time, and the interactions between the collective-choice and operational levels of an SES. I will apply this approach to Nova Scotia in Chapter 4.

### 2.3.1 *The political ecology of the commons*

CPR research can be strengthened by considering insights from political ecology (Agrawal, 2005; Clement, 2013). Political ecology integrates ecological research with the study of political economy to understand the interrelations of society, natural resources, classes and social groups (Blaikie and Brookfield, 1987). In its early stages, political ecology emerged from cultural ecology and Marxist perspectives that emphasized socio-historical power relations. Recent developments have paid attention to human agency, the social production of knowledge, and positionality in relation to ethnicity, race, and gender (Biersack, 2006). Paulson and Gezon (2005) highlights four core concepts of political ecology:

1. Resource use is organized and produced through social relations
2. There are a plurality of environmental positions, perceptions, interests, and rationalities
3. Local processes shape, and are influenced by larger-scale political economic processes
4. Social marginalization and environmental degradation are mutually reinforcing processes

Political ecology of fisheries often highlight the relationship between fisheries management regimes, state policies, and ecological outcomes. For example Greenberg (2006) suggested that a tragedy of the commons in a Mexican shrimp fishery was due to federal policies that favored the rapid expansion of the shrimping fleet to increase commodity exports and pay off foreign debts. Palsson (2006) examined the relationship between power, knowledge, and environmental outcomes in Iceland. Palsson (2006) suggested that the shift to a quota management regime shifted power from

labor to capital, and marginalized the practical knowledge of harvesters. According to Palsson (2006) this shift was a product of a high-modernist project that separated society from nature, prioritized the objectivity of sciences to the practical knowledge of fishers, and subjected fisheries to a linear model of control.

While a combination of perspectives from political ecology and common property research is beneficial for understanding resource management and environmental politics, Agrawal (2005) argues that both fields have not given enough attention to the processes that create environmental subjects. Here Agrawal (2005) is calling for attention to the process by which people understand and form an identity in relation to the environment, and how this identity changes as knowledge, institutions, and politics change. Recently, Brewer (2012b) has studied subject-formation in Maine's lobster fisheries (see Chapter 4). She demonstrated the importance of subject-formation for social outcomes of fisheries management regimes.

After discussions and challenges from scholars, Ostrom (2007) developed a framework for diagnosing SESs. In this framework, an SES is composed of a resource system, governance system, resource units, and resource users. These components interact within a social, economic and political setting, and with related ecosystems. These interactions lead to locally specific outcomes. These components can be further understood by considering a second tier of variables constitute them (Ostrom, 2007, Table 1, p. 15183). An SES can then be further understood by looking deeper vertically into further tiers of analysis, and also by considering the horizontal linkages between relevant variables of an SES. Ostrom (2007) suggested this multi-tiered structure to allow scholars from diverse fields using different methodologies to contribute to greater generalized knowledge about SESs by complementing research at different conceptual levels.



While Ostrom’s diagnostic does not explicitly include some elements deemed important by political ecologists, it is possible that research agendas that focus on these elements can be incorporated into the framework. Thus, while there has not been much collaboration between political ecologists and commons researchers, the diagnostic framework may be able to foster collaboration in the future. The framework can be improved by including “dominant discourses” and “knowledge systems” in social, political, and economic settings, “power relations” in interactions, and “power and knowledge” in the outcomes (Clement, 2013, p. 3). Clement (2013) argued that the addition of these variables would allow a space in SES research for understanding the dominant framings of the problems and solutions, how knowledge is produced and contested among various social groups, and the actor-based power to influence social, ecological, and discursive outcomes. In Chapter 5, I demonstrate the effectiveness of using the diagnostic framework in combination with vulnerability research, with attention to alternative framings and actor-based power relations.

I will bring together the ideas from these perspectives under the SES framework to examine the institutions, norms, power relations, and livelihoods of fishing communities of the multi-species fishery of Southwest Nova Scotia, Canada. I will examine the changing interdependencies between resource users, governance, and biophysical systems over time, and the interactions between the collective-choice and operational levels of an SES to Nova Scotia in Chapter 4. The case descriptions in Chapters 4 and 5 clearly demonstrate the potential for political intervention and global economic and environmental change to contribute to community failure, or the disembeddedness of fishing communities.

## 2.4 Privatization, Catch Shares, and Fisheries Governance

The tragedy of the commons has similarly framed the problem definition in fisheries management. Schaefer (1957) and Gordon (1954) argued that the lack of property rights in fisheries would result in negative externalities, such as over-exploitation and “rent dissipation.” Without any restrictions, marine harvesters would enter the fishery until their average revenues were equal to average costs. When costs are low and prices high, the fishery would tend towards a bioeconomic equilibrium in which fishing effort is too high, and fish biomass is unsustainably low. As in Hardin’s framing, marine harvesters sought to maximize their profits and could not communicate to solve these problems (Ostrom, 2007).

After claiming jurisdiction over coastal resources, governments attempted to control fisheries using a variety of policy instruments, including gear restrictions, limited-entry licensing, trip limits, and season closures. But many of these measures created new externality problems. In many fisheries, governments set a Total Allowable Catch (TAC), and closed the fishing season when the TAC was reached. In the Northern Pacific Halibut fishery, where the quantity and capacity of vessels was not limited, fishing operations invested in more boats and higher fishing capacities to get a greater share of this TAC. As a result of increased overall fishing effort, the season length shortened to as low as 3-5 days (Homans and Wilen, 1997). This phenomena has been characterized “derby fishery.” This “self-reinforcing spiral toward . . . absurdity” may have been worsened as shore-based facilities increasing their processing capacity to accomodate the derby, and diverted a larger proportion of the catch into the low value frozen fish market (Homans and Wilen, 2005, p. 399).

In many fisheries, managers combined gear and input restrictions, limited-entry licensing, and TACs. Deacon et al. (2011) showed that the efficacy of this combina-

tion of regulations depends on the elasticity of substitution between regulated and unregulated inputs. Regulations that use seasonal closures and constrain inputs that cannot be substituted for can effectively avoid a derby effect. As the elasticity of input substitution increases, however, marine harvesters can adapt to regulations by investing in unconstrained inputs. Under these conditions, TACs, limited-entry licensing, and input restrictions may not be sufficient to avoid fishing derbies. These phenomena and other studies showed that government regulations can often lead to unintended consequences, such as “effort creep,” loopholes and increasingly complex and costly regulatory and enforcement regimes (Grafton et al., 2006).

With the failures of many top-down approaches, biologists and economists have increasingly promoted a property-rights approach to managing fisheries (Costello et al., 2008; Costello and Deacon, 2007; Grafton et al., 2006). This solution is based on the assumption that the economic failure of fisheries has been caused by common-property governance institutions, and that high quality property rights lead to economically efficient fishing practices (Arnason, 2012). This approach has been characterized as rights-based or incentive-based fishing management, catch shares, quotas or territorial use rights fisheries (TURFS). Quotas or catch shares are allocations of a proportion of a TAC to an individual or group, while TURFS are allocations of a coastal region to a group for self-management, sometimes also associated with TACs (Cancino et al., 2007). Costello et al. (2008) argued that defining property rights in fisheries aligns individual harvester incentives with management goals. But for effective alignment of incentives, and economic efficiency, Arnason (2012) argues that ITQs must have a high degree of exclusivity, durability, security, and tradability. This means that ITQs must exclude non-rights holders from accessing it, must be durable for a long time-span, must be secure from expropriation, and ITQ holders must have the rights to sell their quota allocations in whole or in part (Arnason, 2012). In this review,

I focus on individually allocated quotas. While catch shares may take on many institutional forms, individual quotas (IQs) and individual transferable quotas (ITQs) are dominant in Canada. For conceptual clarity, I use catch-shares to refer to the general policy of allocating a share of a TAC to an individual or group, while ITQs refer to the specific form of tradable catch shares where access rights are marketable commodities. I use IQ to refer to individually allocated quotas without transferability.

Scholars have found empirical evidence to support some of the proposed benefits of the property-rights approach. But fisheries have undergone many regulatory changes, and thus, it is often difficult to separate the effects of limited entry, TACs, ITQs or IQs, vessel monitoring, and other rules (Bromley, 2009; Costello et al., 2010). According to Costello et al. (2010), allocating a perpetual access right incentivizes rights-holders to maximize the value of their quota by adopting stewardship and conservation measures, and to harvest efficiently to maximize their profits. In many cases, ITQ or IQ fisheries have internalized the “rule of capture” externality. The rule of capture externality, associated with open access fisheries, occurs when the right of access to fish is based on who can capture the fish first, leading to the fishing derbies described above (Boyce, 1992). An IQ program in the pacific halibut fishery significantly reduced derby fishing, resulting in higher prices, and a greater percentage of fish sold to the fresh fish markets (Casey et al., 1995). Large-scale comparative studies have shown that ITQ fisheries are less likely to collapse due to over-exploitation (Costello et al., 2010), and that ITQ fisheries have a lower variability in catch rates (Essington et al., 2012). Essington et al. (2012) suggested that the lower variability in catch rates was either due to a reduction in the race to fish problem, or due to an improved alignment between fishing behavior and management objectives.

Whether ITQs and IQs can internalize externalities depends on the the complex interactions between diverse actors, incentives, and the environment. Gilmour et al.

(2011) showed that property rights may actually be a disincentive to stewardship. In the Australian abalone fishery, quota owners derived their incomes from the quantity of catch, whereas divers who did not own quota derived their incomes from both quantity, and the efficiency at which they catch abalone. Non-fishing quota owners also had an incentive to promote higher quotas when attempting to leave the industry. When quota allocations are less sustainable, divers needed to work harder and accrue more costs to catch scarce resources. Boyce (1992) makes the distinction between three common externalities in fisheries; “stock externalities,” “congestion externalities,” and externalities associated with the “rule of capture.” A stock externality occurs whenever the cost of catching fish increases with decreasing stock density. Congestion externalities are associated with the relative geographic location of fishing vessels. Congestion externalities occur when a fishing vessel chooses to catch fish in a location that reduces the returns on effort that other fishing vessels can obtain. Boyce (1992) showed that ITQ policies can efficiently deal with externalities associated with the rule of capture, but are no longer socially optimal where stock and congestion externalities exist. This is due to the fact that ITQ holders will still compete to catch fish that are easier and cheaper to catch, or to avoid the expense caused by congestion. Because ITQ policies assume that each unit harvested has the same opportunity cost, harvesters will compete when stocks have heterogeneous abundance, distribution, and economic value (Costello and Deacon, 2007). ITQ policies also do not incentive harvesters to share information, leading to inefficiencies when searching for heterogeneous fish stocks (Costello and Deacon, 2007). Costello and Deacon (2007) provide examples of fishing cooperatives that coordinate their efforts under constraints set by effort controls or quotas. These cooperatives have been able to internalize many of the externalities associated with heterogeneity.

The most controversial element of ITQs is transferability (Gibbs, 2009; Pinkerton

and Edwards, 2009; Turrís, 2010). At the same time, this transferability of quota is considered necessary for the proper functioning of quota markets, and for incentivizing stewardship (Turrís, 2010). When harvesting rights are transferable, fishers are incentivized to either sell off their quota if they are less efficient, or to buy quota if they are more efficient (Grafton et al., 2006). Transferability gives harvesters the flexibility to buy, sell or lease out portions of their quota to deal with changes quota overages or overage of non-target by-catch species (Turrís, 2010). This effectively reduces the fishing capacity of a fishery leading to higher economic efficiency and profitability of the fishery as a whole. Critics of ITQs, however, point to distributional outcomes, since unregulated transferability can often lead to consolidation of quota into fewer vessels, often large companies or industrial fleets (Yandle and Dewees, 2008). For example, fishing ownership and operations in Iceland have shifted from rural to urban regions, and have vertically integrated under processing companies. These vertically integrated fleets employ fewer harvesters using larger and more capital intensive vessels (Carothers and Chambers, 2012). In many cases, managers have adopted quotas to reduce the number of vessels in a fishery, and thus quota consolidation is an expected outcome (Yandle and Dewees, 2008). Yandle and Dewees (2008) found, however, that a greater proportion of small-scale harvesters left the fishery after the implementation of quota. Quota consolidation can also have negative consequences when wealth moves out of fishing communities, or when communities can no longer maintain their social structures and institutions (McCay and Jentoft, 1998; Pálsson, 1994).

The distributional consequences of quota leasing has also been the subject of controversy (Pinkerton and Edwards, 2009; Turrís, 2010; Davidson, 2010; Macinko, 2014). With quota transferability, some harvesters choose to stay at shore and lease their quota to those who want to fish. In other cases, processing companies or other

individuals can acquire and lease out quota. In some cases, quota owners even lease their own quota to their own boats, capturing a greater share of the rents (Macinko, 2014). These arrangements lead to questions regarding who gets the rents generated by quota systems (Macinko, 2014). Pinkerton and Edwards (2009) argued that benefits flow disproportionately to harvesters given initial allocations of quota, to processors, quota holders, brokers, and investors with greater access to capital, and to those with access to reliable information. Pinkerton and Edwards (2010) suggested that quota leasing vessels deduct the cost of leasing from revenues before determining crew shares. Thus ITQ policies may disproportionately burden new entrants and crewmembers who do not receive quota allocations. In some ITQ fisheries, it has become increasingly difficult for an aspiring crewmember to become a captain or quota owner (Carothers and Chambers, 2012). Emery et al. (2014) found that quota lessees attempted to offset the cost of leasing quota by fishing in more hazardous conditions. Thus, quota lessees were at a higher risk of fishing fatalities than fishing quota owners. The outcomes of quota policies, however, are highly dependent on specific formal and informal institutional arrangements and the sources of rent dissipation before quotas are adopted (Reimer et al., 2014).

The above problems associated with quota leasing may be avoidable, however, if remaining harvesters receive a viable initial allocation of quota. A common approach is to base each individual harvester's quota allocation on their catch history, the length or capacity of vessels, (Peacock and Annand, 2008; Sporer, 2001). But initial allocations have been highly contested in some cases by those who feel that they have been disenfranchised by a quota allocation formula (Sporer, 2001). Problems arise when the information used to allocate quotas is inaccurate, or when the allocation formula uses a time-frame that disenfranchises some harvesters more than others (Sporer, 2001; McCay et al., 1995). For example, a large percentage of quota

allocations to the Under 65' groundfishing fleet in Atlantic Canada were non-viable because landings were mis-reported in the years leading up to quota implementation. This problem was compounded by the DFO's objective of preserving the health of fish stocks by significantly decreasing the TAC (McCay et al., 1995).

Even when properly allocated, however, questions remain regarding who should benefit from the rents generated by privatizing and marketizing fishing quota. Initial allocations are often "gifts" to harvesters that can be leased or sold, and governments do not attempt to capture the rents generated from these gifts (Bromley, 2009, p. 281). In theory, government could capture a portion of the rents generated from initial allocations to deal with the inequities caused by leasing, or to promote the viability of new entrants into the fishery. In many cases, however, quota policies have not included institutions to collect rents from quota owners. This has led some to criticize ITQs as a giveaway of public resources to private agencies, with no further benefits to society (McCay et al., 1995; Bromley, 2009).

It is important to distinguish between the catch share as a potential policy instrument that can be adapted to local conditions, and neo-liberal discourses promoting the privatization and commodification of the commons. Macinko (2014) argued that many proponents of catch-share program in practice have evoked a "privatize or perish" discourse that closes off alternative management regimes or catch share configurations. Despite the claim that catch-shares can be adapted to a variety of local conditions, supported by a "benign rhetoric," catch-share programs often function as a Trojan horse for neoliberalism (Macinko, 2014, p. 40). Carothers and Chambers (2012) argued that as these discourses become dominant, those who are marginalized by the privatization of the commons are often framed as irrational, redundant, or expendable labor. Macinko (2014, p. 42) suggested an alternative to the "evangelical' approach," where "one can simply explain the basic idea of having boats on the



water pursuing fixed shares of a larger total catch,” and those who are affected can “indigenize” this concept on their own terms. Quotas have been indigenized in some cases, and as a result, there is a diversity of catch share programs. For example, Canadian government and harvesters in the SWNS groundfishery have compromised to develop what has been referred to as a “community quota” arrangement (Peacock and Annand, 2008).

The above discussion suggests that it is important to leave the framing of problems and their solutions open to alternatives (Leach et al., 2010). These alternative solutions are often rooted in the potential for members of a fishery to engage in collective action. Pinkerton (2013) showed that fishermen in the British Columbia Halibut fishery collectively agreed to stop fishing for 6 to 10 days after delivering their catch, and to take turns fishing first in the season. These “lay-up” rules were in place in the 1950s through to the late 1970s, and they spread the catch out over the season and avoided adverse distributional problems associated with quota systems. In Alaska, 65 small mostly indigenous communities were allocated Community Development Quotas (CDQs). While many of these communities do not participate in the fisheries, they can invest the money from the sale or lease of quotas into development projects, or to participate in fisheries (Mansfield, 2007). Deacon et al. (2008) provides an account in which Chignik salmon harvesters voluntarily formed cooperatives to coordinate effort, share information, and reduce costs associated with externalities not explicitly dealt with by ITQs. Some cooperatives, such as the Pacific whiting cooperative and the Yaquina Bay roe herring fishery developed their own quota systems voluntarily (Leal, 2008; Sylvia et al., 2008). Governments in Japan and Chile have allocated territorial use rights to groups of fishers. Many of these TURF fisheries have been able to achieve resource sustainability goals, while also accounting for spatial heterogeneity, the interactions between multiple species, and other ecosystem functions within their

territories (Cancino et al., 2007).

#### 2.4.1 Fisheries, vulnerability, and justice

Allison et al. (2012) argued that property-rights approaches to fisheries management do not consider issues of justice and the vulnerability of harvesters. But instead of a panacea, the idea of a catch-share is one of a set of tools that can be applied and adapted to achieve multiple objectives. Catch share and privatization discourses often center on the efficiency of markets to generate surplus rents but economic efficiency does not necessarily translate into fair or desirable outcomes (Turriss, 2010). The distributional outcomes of management approaches are thus often not included in economic analysis (but see Matulich et al., 1996; Matulich, 2008, 2009, 2010; Wilen, 2009, 2010). Gordon and Schaefer (cited in Schaefer, 1957, p. 443) acknowledged that "...the economic optimum is not necessarily the *human* optimum," and "under certain circumstances we may well prefer to have an economically 'inefficient' fishery." Hilborn (2007a) argued that fisheries governance "objectives must be clarified," before we can know whether fisheries governance regimes are successful. But clarifying objectives depends on the degree to which some groups have greater access to this process. For example, in Newfoundland, large-scale vertically integrated firms effectively packaged and disseminated information and influenced decision-making, despite protests from the small-scale fleets (Finlayson, 1994; Pinkerton and Weinstein, 1995). Thus, problem framings and analyses should also explicitly examine issues of power, vulnerability and justice to develop decision-making processes and rules that address the concerns of those who are affected.

I suggest that the issues of justice and the distribution of benefits from the fishery is an important one in considering the institutional arrangements surrounding ITQs and any other fishery management regime. While early justice theory focused

on the equity of the distribution of benefits and burdens among individuals (Rawls, 1971), recent theoretical contributions from theory and grassroots environmental justice movements have broadened the definition of justice (Schlosberg, 2009). For example, Young (1990) argues that a concept of justice is not complete if it does not consider the social relations and processes that create unequal distributions of benefits and burdens. Thus, Young (1990) concludes that justice involves two values; 1) developing your own capacities and expressing your experience, and 2) participating in determining your actions and the conditions of your actions. Similarly, Sen (1992) and Nussbaum (2001) theorize just arrangements as those that enhance or improve capabilities, or the qualities of life that enable and empower individuals to live “fully functioning lives” (Schlosberg, 2009, p. 30). According to Sen (1992) and Nussbaum (2001), injustice refers to processes and distributions that limit an individual’s ability to transform their capabilities into their own notions of the good life. Fraser (1998) and Honneth (1996) argue that injustice also involves institutions, social norms, and political processes that do not recognize social groups as accepted members of society. In a review of justice literature, Schlosberg (2009) argues that “claims of justice can, and must, be integrated into a thorough, comprehensive, and pluralist understanding of the term.”

According to the discussion above, a consideration of just fisheries governance includes an understanding of how benefits and burdens are distributed, the recognition of social groups, decision-making processes that enable participation by those affected, and processes that enable those living in fishing communities to transform primary goods into subjective experiences of the good life. These theoretical contributions can help move the discussion of ITQs towards an understanding of the process of making decisions and their outcomes at sea and at shore. The distributive outcomes of fisheries policies may lead to distrust among managers, processors, and

harvesters, especially those who have been marginalized by the decisions. But a focus on distribution alone may also prevent dialogues and practices that lead to improved policy outcomes.

In Atlantic Canada, all fish species except lobster are managed using some form of IQ. Harvesters in SWNS historically used flexible fishing strategies to respond to changing ecological and economic conditions (Davis, 1984b). The lobster fishery remains a “competitive” fishery. But the lobster industry is undergoing similar processes of concentration due to the transferability of lobster licenses. This policy may be favorable to managers hoping to increase surplus rents to fishing vessels, but unfavorable to fishing communities that prefer full employment and low costs of entry for the youth. This tension between economic and justice and vulnerability is a recurring theme in the following chapters. From a justice and vulnerability perspective, I will consider who participates in navigating this tension, and who benefits from the policy outcomes, and the agency of fishing households, fish buyers, and organizers to respond to vulnerabilities.

## 2.5 Conclusion

In the above review I discussed household vulnerability, SES robustness, mechanistic and constructivist approaches, various problem definitions and solutions in fisheries and the tension between efficiency and distributional objectives in fisheries policy. I bring these various themes together in a modified version of the Institutional Analysis and Development (IAD) framework (Figure 2.1). The IAD framework was foundational to the diagnostic framework presented in Ostrom (2007). The IAD framework, however, maintains action arenas as the focal unit of analysis. Action arenas consist of participants engaged in one or more action situations. In the following chapters the action arena in SWNS is the social space where harvesters, buyers,

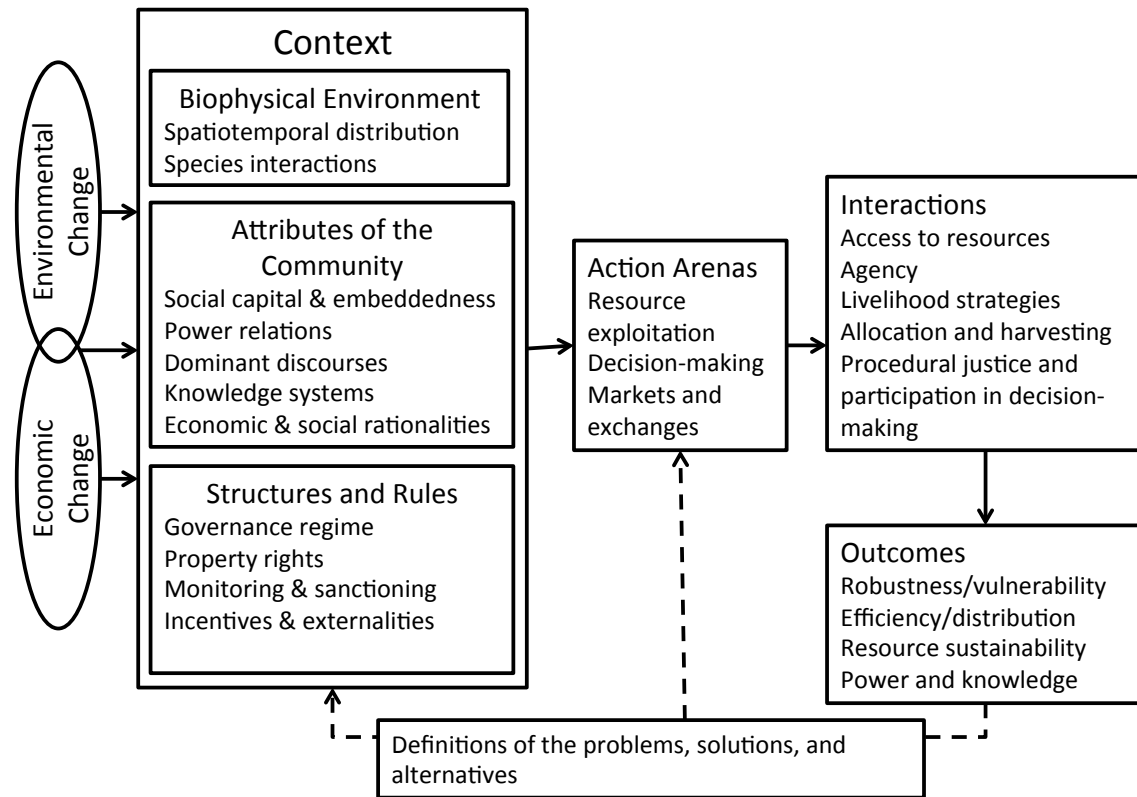


Figure 2.1: A modified Institutional Analysis and Development framework (Ostrom, 2005b; Ostrom et al., 1994)

processors, managers, academics and experts engage in collective decision-making, resource exploitation, and marketing and exchanging resources and resource-access rights. Participants interact in these action situations, with different levels of agency, access to resources, and use different livelihood strategies. Harvesters and buyers assess the fairness of procedures and choose whether to allocate their time and resources into participating in decision-making situations, or to focus on harvesting. These interactions lead to locally specific outcomes. As I have noted above, these outcomes can be examined from the perspective of system-level robustness and household vulnerability, efficiency and distribution, resource sustainability, and power and knowledge.

I agree with McCay and Jentoft (1998) that we should accompany analyses of

action arenas with “thick” contextualizations. The context box in figure 2.1 outlines three contextual components for analysis. The first is the biophysical environment, which, to a certain degree and based on our knowledge of it, constrains the possible actions participants can take. Species interact and are distributed spatially and temporally within ecosystems. I consider the interactions between cod, lobsters, and oceanographic characteristics such as depth and temperature profiles that influence migration patterns. Action arenas are also contextualized by the attributes of the community of individuals and social groups. Their interactions are influenced by social capital; the embeddedness of rules in social processes; power relations; the degree to which certain groups resist or internalize dominant discourses; conflicting knowledge systems such as those of biologists, economists, marine harvesters, and buyers; and different rationalities or values. Action arenas are also contextualized by the details of governance regimes, property rights, and the political economy in which they are embedded. Here it is important to understand how these contextual factors incentivize some actions and dis-incentivizes others, what is internalized and what is externalized, and how actors respond to the specific actions and strategies that the governance regime chooses to monitor and sanction, and those actions and strategies they choose to ignore.

As I will show in Chapter 4 and 5, action arenas are redefined over time through feedback. As action arenas experience problems and conflicts, social groups play an important role by influencing the problem definitions, solutions, and alternatives. This feedback influences community, structural, and biophysical contexts, and the action arenas themselves. Global environmental and economic change are important to this dynamic process by which action arenas change over time. Similar to Leichenko and O’Brien (2008), I include environmental and economic change as interacting disturbances or perturbations. Whether economic and environmental changes have

positive or negative influences on the context of an action arena, they fundamentally change them. The degree to which action arenas can effectively adapt to these changes over time depends on context, interactions and outcomes, and feedback.

In the following chapters, I focus in on different components and factors of the SWNS multi-species fishing action arena. In Chapter 4, I focus on decision-making processes, context, and system-level adaptation. In Chapter 5, I focus on how the decision-making processes and context have influenced the interactions between participants, and household vulnerability outcomes. In Chapters 6 and 7, I focus on the attributes of fishing households and vulnerability outcomes. Put together, these chapters constitute a holistic, but by no means complete or exhaustive description of the SWNS multi-species fishery.

## Chapter 3

### STUDY SITE AND FIELD METHODS

#### 3.1 Barrington, Nova Scotia

Barrington is a municipal district of Shelburne county, Nova Scotia, the southernmost point of Canada. Also known as the “Lobster Capital of Canada”, this municipality is subdivided into communities or villages that often surround a fishing wharf (Figure 3.1) <sup>1</sup>. Barrington Passage is the busy central hub of these communities with two grocery stores, hardware stores, locally owned and franchise restaurants, a post office, library, Department of Fisheries and Oceans (DFO) office, and a fishing supply outlet. Cape Sable Island, locally referred to as Cape Island, is separated from Barrington Passage by a narrow strait, connected to the mainland by a causeway since 1949. To the west of Barrington Passage, are the communities of Woods Harbour and Shag Harbour. Woods Harbor has a very active wharf, landing large quantities of swordfish and halibut, as well as some bluefin tuna.

Upper Port La Tour, Port La Tour and Baccaro, located to the east of Barrington Passage, were originally studied by Davis (1975, 1984a). At the time of Davis’ research, these communities had grocery stores, a post office, community halls, curling rinks, a theatre, a garage, and an army base. Today, the army base at Baccaro base has been dismantled, and the stores, garage, and halls have been closed down. Now residents of this area go to Barrington Passage for groceries and other basic needs. Port La Tour wharf and Upper Port La Tour wharf remain in use today, while the Smithsville wharf to the south has been condemned, and is no longer in use. The line

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<sup>1</sup>This map was generated in QGIS 2.20 based on spatial data from Government of Canada and U.S. Geological Survey (2006).



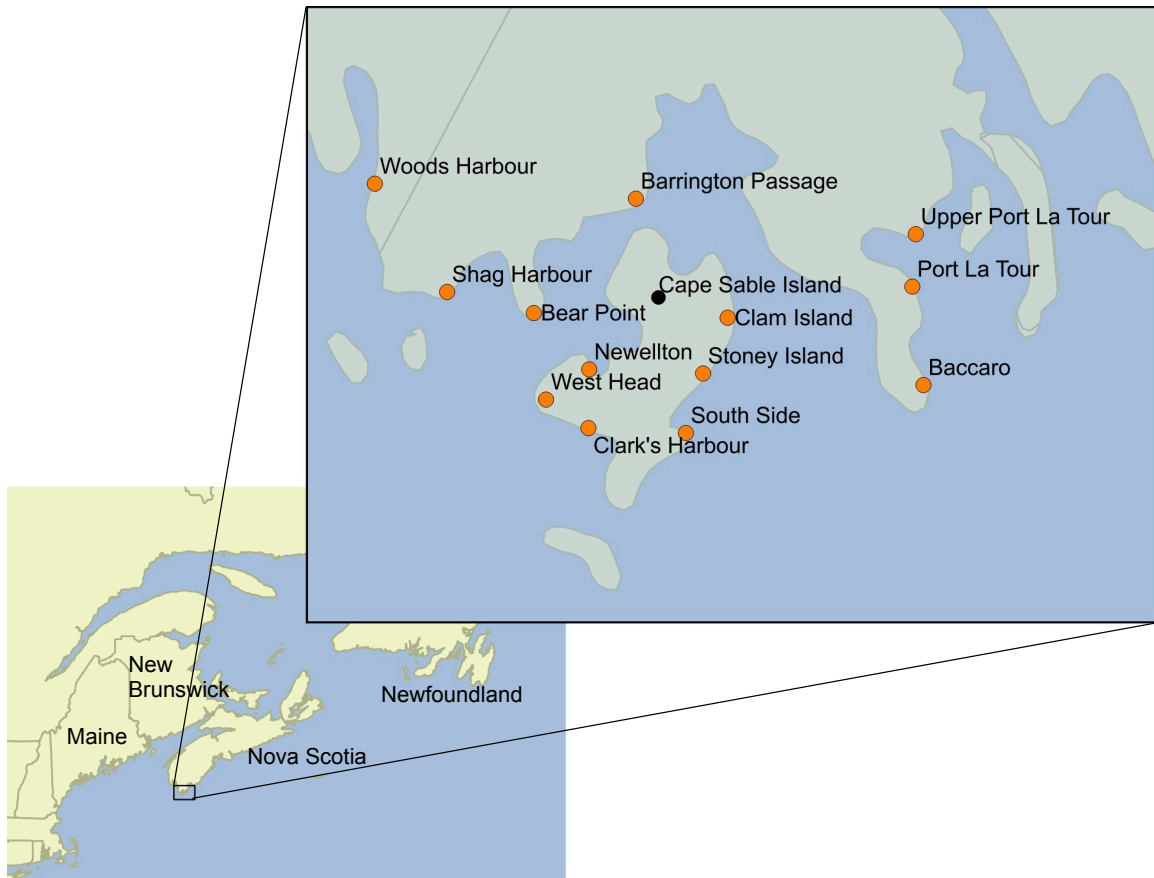


Figure 3.1: Map of Barrington Municipality and location in Atlantic Canada. Towns are indicated with orange dots, and Cape Sable Island is indicated with a black dot.

demarcating the boundary between Lobster Fishing Area (LFA) 34 to the west, and LFA 33 to the east, runs straight out from the tip of Baccaro point.

Cape Island has six main wharves, West Head, Newellton, Clark's Harbour, South Side, Clam Point, and Stoney Island. The causeway connecting Cape Island to the mainland has had significant effects on the ecology of the region. Sand has begun to accumulate to the east of the causeway. Harvesters<sup>2</sup> also claimed that herring, mackerel, and even tuna often passed through this strait, but can no longer be found since the causeway was built.

<sup>2</sup>Because harvesters in this region, male and female, self-identify as fishermen, I will use the terms fisherman and harvester to refer to harvesters of fish, crustaceans, and sea plants. I use the term industry to refer to fishermen's associations and quota groups, buyers and processors, and fishermen.

As is indicated in Figure 3.2<sup>3</sup>, Barrington communities are closely located to the most important fishing banks in Southwest Nova Scotia, including, Brown's, Baccaro, Roseway, La Havre, and Georges Bank. As will be discussed in the following chapters, fishermen have witnessed a decline in groundfish abundance on inshore banks, and thus, the majority of groundfishing that occurs today is on Georges bank, which is located within Northeast Atlantic Fisheries Organization zone 5Z. Fishermen without quota to fish in 5Z often fish in areas near the boundaries of 5Z in the inshore 4X zone, which runs from Halifax West to the American border. For example, harvesters with 4X quota often set longline gear in the channel separating Georges bank from Brown's, locally referred to as "The Gully".

There are additional communities without fishing wharves in the region, including the Hawk on Cape Island, Barrington Head to the west of Barrington Passage, and Villagedale, a cluster of beachside cottages. The majority of employment in this region is connected to the fishing industry.

These communities have a similar culture and religious background, and share a general distrust in government. Nevertheless, residents of different communities perceive outsiders as different or foreign (see Davis, 1984a; Davis and Kasdan, 1984). One harvester told a story about a resident who moved to Clark's Harbour from a neighboring village less than 5 miles away. This new resident was often referred to as an "outsider" by locals. Residents of one community often commented that residents of other communities are "odd" or "different" in some way. With the exception of a few disputes, these communities are tied together through kinship, employment in the fishing industry and friendship.

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<sup>3</sup>This map was generated using QGIS 2.20 and geospatial data from Rothworth and Signell (1998), Northwest Atlantic Fisheries Organization (nd), and Government of Canada and U.S. Geological Survey (2006)



Figure 3.2: Map of Barrington’s proximity to important fishing banks, including NAFO districts for the management of groundfish. The U.S.-Canadian boundary is indicated with a red dashed lined.

### 3.2 Demographics

I compare demographic trends occurring in Barrington to surrounding regions and national trends. Population in Barrington has declined by 4.6% to 6,994 from 2006 to 2011. This rate of decline has accelerated since 1996, which was the last census year recording an increase in population (1.4%). Halifax, the major urban center of Nova Scotia, has grown by 4.7% (Statistics Canada, 2012). Other rural fishing towns in Southwest Nova Scotia (SWNS) have experienced similar declines with different magnitudes. For example, Shelburne Municipality to the east, has declined by 8.7%, and Argyle Municipality to the west has declined by 4.6% since 2006. These population declines contrast with the Canadian national average rate of

population growth of 5.9%.

The median age of residents of Barrington has increased from 40.7 in 2006 to 44.7 in 2011. This indicates a trend towards an aging population, which is evident in provincial (41.3 to 43.7) and national (39.5 to 40.6) statistics. Barrington's faster rate of aging is likely due to low reproductive rates, high emigration and low immigration rates (Statistics Canada, 2012, October 24).

Socioeconomic data from Statistics Canada demonstrate a divide between rural and urban communities. Statistics Canada's socioeconomic data are aggregated to the health district scale, aggregating Shelburne county, and Digby and Yarmouth counties to the west. I compare these data to the national average, and to the capital district of Nova Scotia, which includes Halifax. First, education rates are lower in SWNS, while the proportion of income from government transfers is higher than both the Canadian average and the capital district. SWNS has a lower percentage of households spending more than 30% of their income on owner's major payments. This suggests that lower incomes may partially be offset by lower housing costs. This difference, however, does not hold for tenant-occupied households. Overall, these statistics indicate a higher dependence on government transfers for income, lower incomes, and lower rates of education in SWNS.

Barrington has experienced a trend of increasing foreclosures since the early 2000s. The data in Figure 3.3 were provided by a local real estate agent in Barrington. A total of 156 homes have been foreclosed on in the past 10 years. People inquiring about the status of the communities are often urged to drive around, and look at all the houses with a white sticker in front of them, indicating the home has been foreclosed on. Other informants gave accounts of fishing households that could not make payments on their home, and moved west in pursuit of employment.

Taken together, these data point to a decline in rural communities in general, and

Statistic	Canada	NS Capital District	SWNS
High school graduates (%)	87	90	74
Post-secondary graduates (%)	63	68	51
Long-term unemployment rate	3.4	3.1	5.7
Average income for males 15 and over (\$)	42,328	43,684	31,983
Average income for females 15 and over (\$)	27,653	27,650	19,288
Government transfer income as a proportion of total income (%)	18	10	22
Prevalence of low income for economic families (%)	11	10	10
Proportion of owner households spending 30% or more of household income on owner's major payments (%)	18	15	13
Proportion of tenant-occupied households spending 30% or more of household income on gross rent (%)	40	44	43

Table 3.1: Socioeconomic indicators for Southwest Nova Scotia compared to the Canadian average.

Barrington specifically. This is caused by a lack of employment opportunities and low incomes. Though costs are higher in the city, there is an income and employment premium for migrating to the nearest urban centre, Halifax, or to other regions of Canada, especially Alberta, where tar-sands oil related businesses are booming. This decline in employment and income corresponds with drastic changes in the value generated from the sea-based industries.

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. In the past 30 years, fishermen from Barrington have burnt and sunk DFO enforcement vessels, occupied national monuments and DFO offices, blockaded foreign fishing vessels, and engaged in strikes against fish buyers. More recently, fishermen from Barrington have formed a new Lobster Fishermen's Association that promises to "take back the industry."

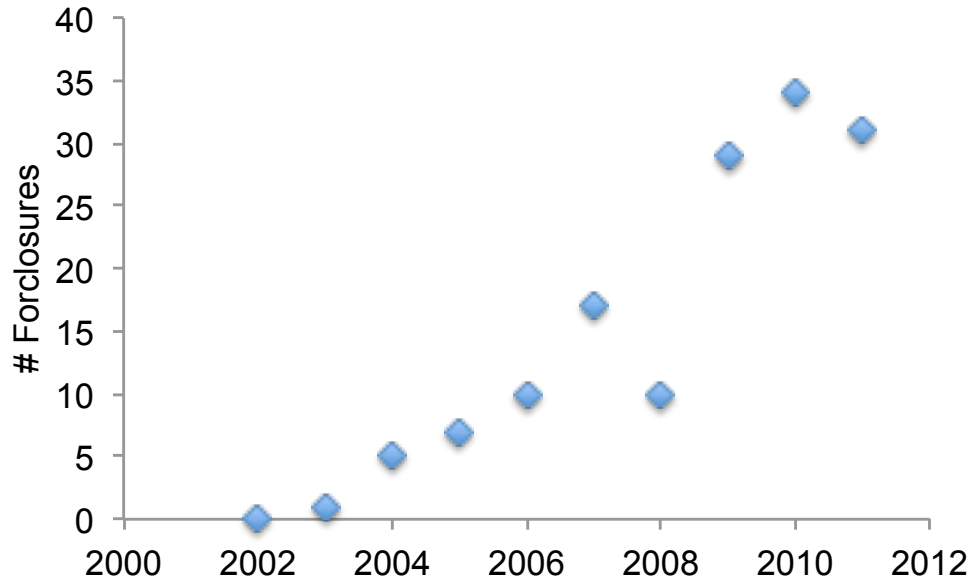


Figure 3.3: Number of household foreclosures per year from 2002 to 2012. These data were collected in 2012, and thus data for 2012 does not include the whole year.

### 3.3 Fisheries Management

At \$1 billion in annual export sales, lobster is Canada’s most valuable seafood export averaging 45,000 to 50,000 tonnes per year (Weston, 2009). The lobster fishery is currently managed by the DFO under advice from regional management boards (see Chapter 4). The regulations, summarized in Table 3.2, place emphasis on protecting juvenile and egg bearing lobsters to ensure continued larval recruitment. Additionally, restrictions on traps, boat size, and limited entry 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, such as cod and haddock, in lobster traps. This fishery consists of 41 bounded lobster fishing areas (LFA) in Atlantic Canada (Figure 3.1).

The qualitative objective of this management regime is to ensure that fishers have

Table 3.2: Regulations and their objectives in LFAs 33 and 34.

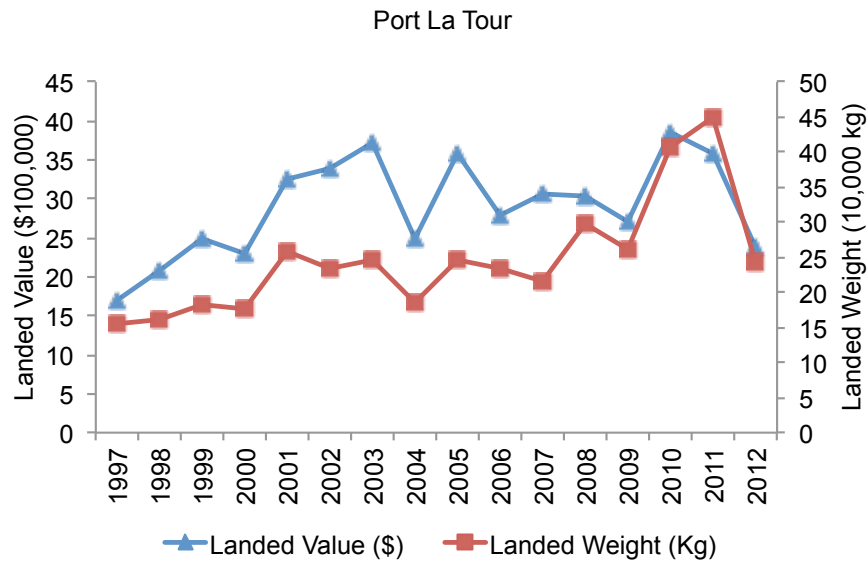
Regulation	Description	Purpose
Lobster fishing areas	41 zones throughout the Maritimes	Separate jurisdictions and management decisions for different regions
Minimum size requirement	Only lobster larger than 3.25" can be landed	Preserve breeding lobsters for larval recruitment
Season	Last Monday of November to May 31st	Reduce conflicts with other fishing and gear types, spread catches among fishing zones, and conserve species
Trap limit	375 traps permitted in LFA 34, and 250 in LFA 33	Economic rationalization and conservation of lobsters
Boat size restriction	Boats cannot be larger than 50' including a 5' extension. No restrictions on boat width	Prevent overcapitalization of the fishery
Gear restrictions	Requirements for escape hatches for undersize lobsters and other restrictions on gear used	Conserve juveniles and reduce by-catch
Female restrictions	All egg-bearing females must be returned to sea, as well as all lobsters with v-notched tails	Protect brood stock
Limited entry	985 in LFA 34 and 720 in LFA 34	Economic rationalization

a sustainable access to the harvestable stock, and that benefits from this stock in the form of employment and earnings are fairly distributed and sufficient. I discuss these regulations in greater detail in chapter 4.

### 3.4 Economic and Ecological Pressures

Despite the high economic value of Canadian lobster, Weston (2009) stated that the industry is under conditions of a “perfect storm.” This storm consists of a combination of low access to credit, increasing operating costs, and decreased lobster prices since the economic crisis (Weston, 2009). Due to uncertain economic times, banks have been more reluctant to give loans to new entrants and to buyers who require credit to meet operating costs (Weston, 2009). These findings have led the Standing

(a)



(b)

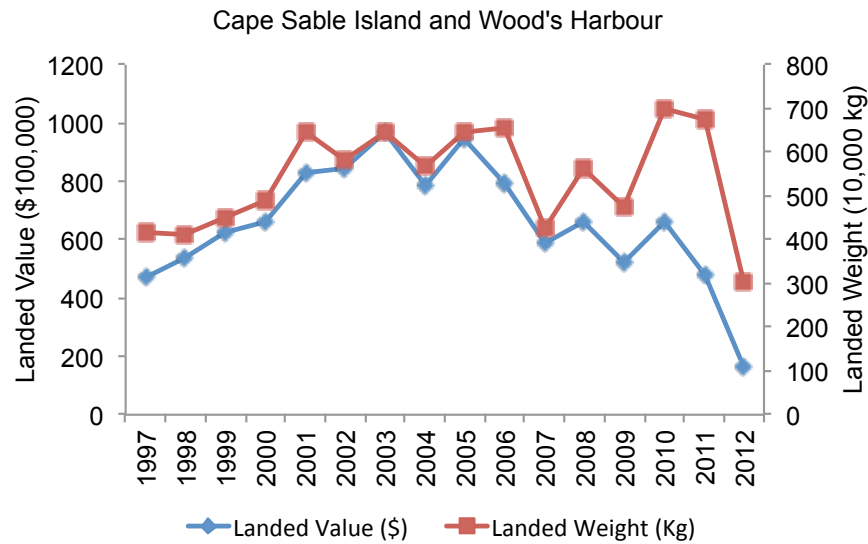


Figure 3.4: Landed value and landed weight of lobsters for a) Port La Tour and (b) Cape Sable Island and Wood's Harbour. (Source: Fisheries and Oceans Canada).



Committee on Resources (Weston, 2009) to recommend that the DFO provide income support for fishermen, increase the visibility and availability of credit for fishers and buyers, and decrease operating costs.

Figure 3.4 shows the landed value and landed weight of lobsters from 1997 to 2012 for Port La Tour and Cape Sable Island and Wood's Harbour. In both cases, landed value diverges from landed weight from 2008, indicating a depression in demand for lobsters. This divergence, is most prominent in Wood's Harbour and Cape Sable Island. Data at the LFA scale indicate a similar pattern (Figure 3.5). Prices in Figure 3.5 are based on mid-month reports from Department of Fisheries, Aquaculture and Rural Development (2013). Prices do not vary considerably within a month, but do vary within a year. Landings are provided by Tremblay et al. (2011). These data show increasing landings in LFA 34 from 2001 to 2011, and a decrease in prices especially from 2008 to 2012.

Intra-seasonal variation in prices also influences the incomes of lobster harvesters and buyers. Harvesters exploit this variation by storing lobsters in lobster cars in December and January, and selling stored lobsters in February when prices are generally higher. Prices from 2008 onwards, however, show less variation. In April of 2007, for example, prices rose up to \$12.75 per pound from a low of \$4.75 in December 2006. From 2010 onwards, the price of lobsters have not gone above \$6 per pound. Without a larger variation of prices for lobster buyers and harvesters to exploit, the benefits derived from storing lobsters have diminished.

#### *3.4.1 Landings and fishing effort*

Catch per unit effort has increased at the same time as landings have increased. Figure 3.6 shows the intra-seasonal and overall trend of CPUE for available data in LFA 33, and figure 3.7 shows the overall trend of CPUE and effort for available

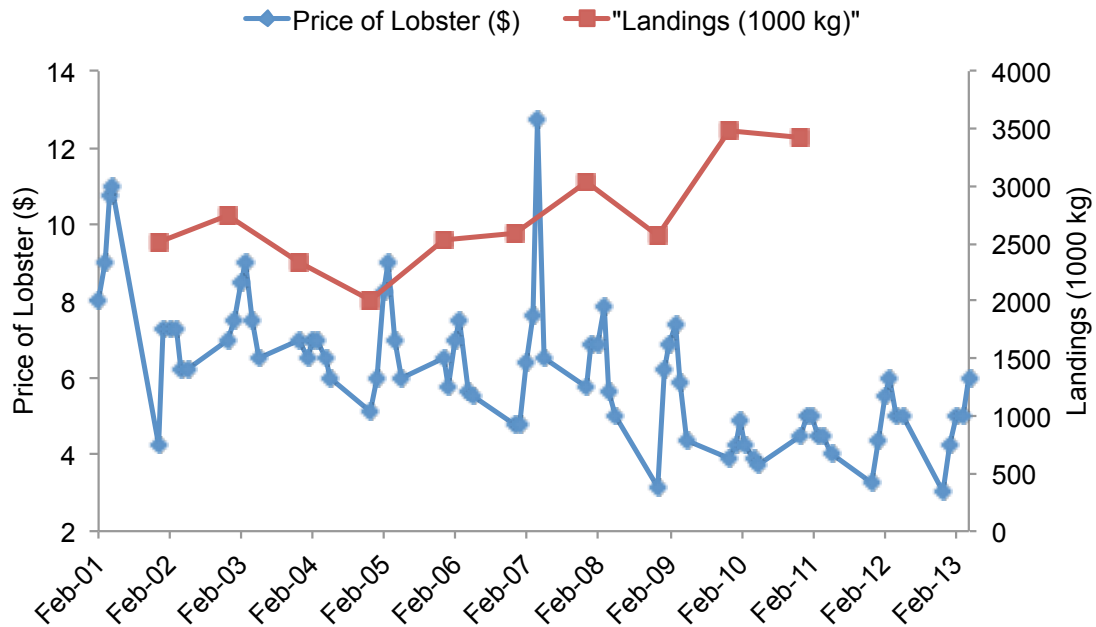


Figure 3.5: The nominal price of lobsters per pound and lobster landings (metric tonnes) from 2001 to 2012.

data in LFA 34. Catches per trap haul vary significantly over the year. Canadian LFAs generally have 6-month lobster fishing seasons. In LFA 33 and 34 in November, lobsters below the legal size limit have had six months to grow to legal size. Due to growth in the offseason, catches are highest at this time. This incentivizes harvesters to focus their effort at the beginning of the season. As the season progresses and surface temperatures decline, lobsters are less active, especially on inshore grounds. In February, harvesters that do not land their traps haul less. Both lobster and harvester activity increases as inshore water temperatures increase and lobsters migrate inshore. By the end of May, fishermen catch many sub-legal sized lobsters, which must be thrown back. At this time CPUE is low but effort is high. Despite this intra-seasonal variation, there is a slight trend for increasing CPUE from 2005 to 2009.

Based on data from Fisheries and Oceans Canada (2013), Figure 3.7 indicates a few important trends in the lobster fisheries of SWNS. First, catch per unit effort

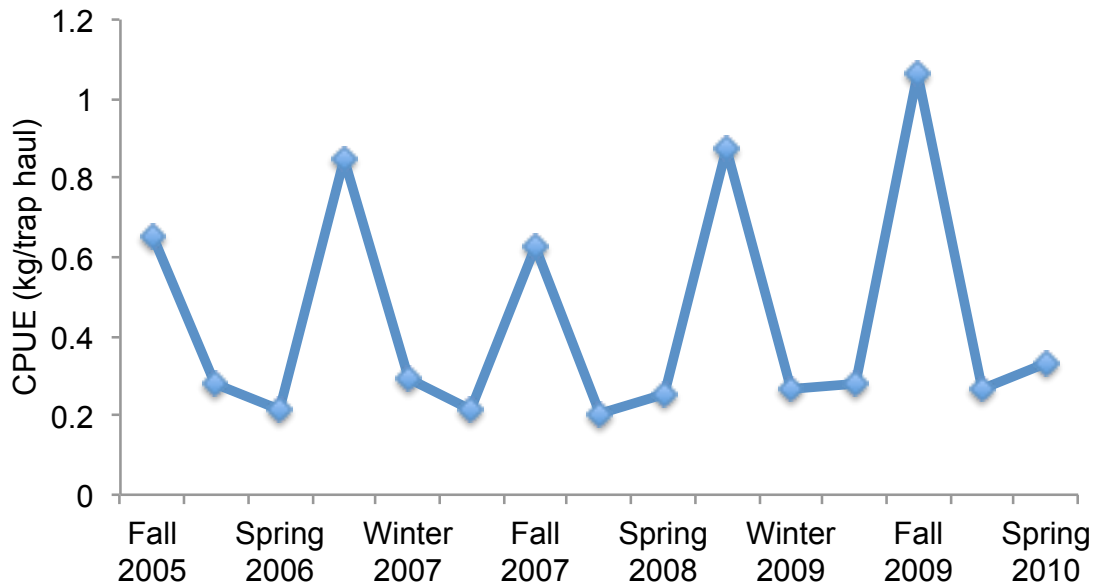


Figure 3.6: Intra- and inter-annual change in catch per unit effort (CPUE, kg/trap haul) over time in the western region of LFA 33.

has increased in nearshore, midshore, and offshore grounds by 1.6, 2.1, and 2.3 times respectively. Second, this increase in CPUE corresponded with a 21% decrease in effort nearshore, a 268% increase in midshore effort, and a 341% increase in offshore effort. Fishing technologies have remained the same throughout this period. This suggests that increasing CPUE is likely due to an increase in abundance of lobsters nearshore, and increased fishing effort offshore.

### 3.4.2 Collective action and price bargaining

In December, 2008, hundreds of lobster harvesters in Nova Scotia went on strike when lobster prices fell below \$3.25 per pound (CBC News, 2008, December 1). Based on the statements from a representative of LFA 34, fishers can break even only when prices are between \$4 and \$5 Canadian (CBC News, 2008, December 1). The strike, organized by a newly formed Lobster Fishermen’s Association, is an important event for SWNS, as it marks the beginning of new endogenous efforts for fishermen to act

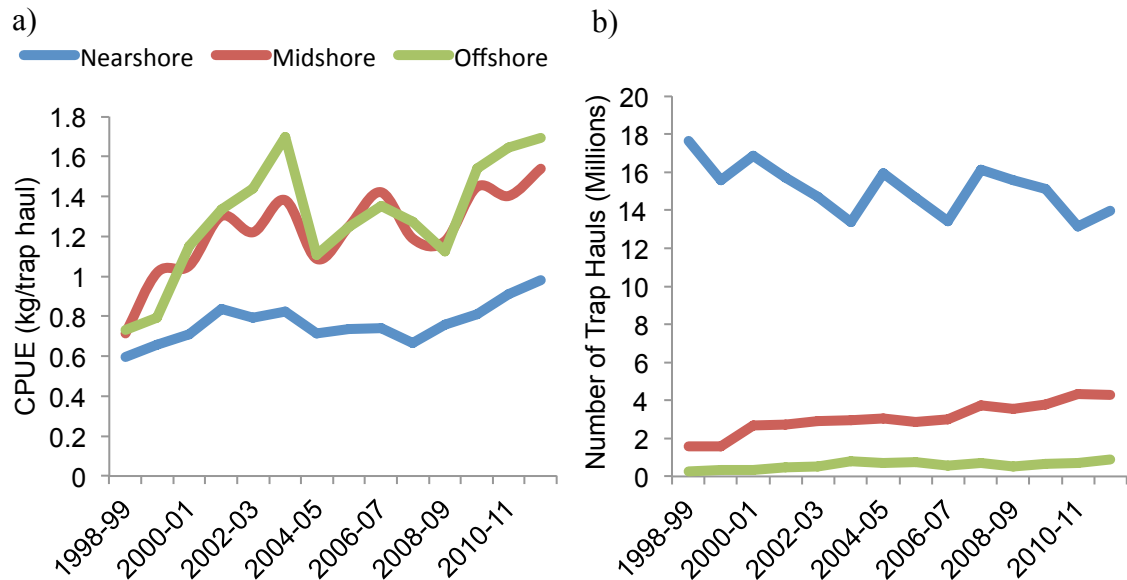


Figure 3.7: Inter-annual change in a) catch per unit effort (CPUE, kg/trap haul) and b) number of trap hauls in nearshore, midshore, and offshore waters of LFA 34.

collectively to improve their bargaining power. Other regions of Atlantic Canada and SWNS such as Argyle, NS, and the Magdalen Islands of Quebec have formed cooperatives in attempts to improve wharf prices for members. Much of SWNS, however, has been notoriously difficult to organize (see Davis and Kasdan, 1984).

Lobster prices are determined by both exogenous and endogenous factors. A statistical analysis by Fisheries and Oceans Statistical Services (2012) indicated that 92% of the variance in wharf price was explained by worldwide landings, the exchange rate of the US and Canadian dollar, and the Gross Domestic Product (GDP) of the United States. Similarly, Holland (2011) found that 84% of the variance in Maine's wharf prices were explained by a post-1994 dummy variable, monthly landings, the US-Canada exchange rate, U.S. per capita personal income, and the percentage change in U.S. GDP from the previous year. Lobsters are considered a luxury item and thus demand is higher when U.S. personal income and GDP is high. The effect of the U.S.-Canadian dollar exchange rate can be explained by the import-export rela-

tionship between the U.S. and Canada. Lobsters landed in Maine are processed in Canada, but the vast majority of landed lobsters, live or processed, are sold in the Boston market. For the Canadian lobster industry, a strong Canadian dollar results in lower ex-vessel prices because lobster buyers and dealers make less money from the Canadian US dollar difference when exporting to the Boston market. The post-1994 dummy-variable used by Holland (2011) accounts for a structural change in the Maine lobster fishery. After 1994 a larger proportion of landed lobsters has been exported to Canada for the processed frozen market rather than the live market. According to Holland (2011), this has resulted in lower prices, but more absorption of landed product with less impact on price.

The price varies significantly throughout the season, in relation to market conditions, bargaining power, and the size of landings. At the beginning of the season, effort, CPUE, and landings are high. In LFA 34 it is estimated that 50% of the lobsters are landed in the first 15 days of the season (Weston, 2009). In some years, the fishing season has opened with processors still possessing large inventories of unmarketed frozen lobsters (Weston, 2009). These gluts and unmarketed inventories contribute to a low opening price.

In general, harvesters have low bargaining power in negotiating wharf prices. Harvesters return to port with large quantities of lobsters, more than can be stored in lobster cars. Some of this product must be quickly shipped to processing plants to be cooked and frozen before it dies, and some can be stored in tank houses and shipped live to the U.S., Europe, or China. Once dead, lobsters are not suitable for human consumption, and thus, the harvester is compelled to accept a buyer's offer, try to seek out another buyer, or risk losing his catch. Hence, the strike tactic used in May 2012, and suggested for the opening of the 2012-2013 in LFA 34 and 33 is an attempt to negotiate price with buyers in a situation where bargaining power is often skewed

in favor of the buyer. Harvesters can store their lobster in lobster cars (see Figure 3.8) to hold out for a better price, but lobster cars can only store product when ambient water temperatures are sufficiently low. When surface water temperatures are high, lobsters metabolize faster, and may molt, die or degrade in quality while in storage. Thus, storage most often occurs at the beginning of the season when water temperatures are cooler and until February when prices are often improved. As a result of the storage characteristics of lobsters and technologies used, and the seasonal variation in landings, harvesters are often faced with the choice of selling their lobsters at the price offered, or throwing valuable product back to sea.

In addition to the factors discussed above, the landed price a Canadian harvester gets is the product of the informal relationship between harvester and buyers at port (Weston, 2009). Harvesters depend on buyers to market their product, and buyers depend on harvesters to land product, but other arrangements also play a role in determining the ability of harvesters to sell to buyers in a competitive market. First, as is noted in Gardner Pinfold (2006), fishermen agree to sell their lobsters to one buyer in exchange for services, such as providing supplies, credit, unloading facilities, and transportation. Second, as quotas have become more scarce, harvesters sometimes enter arrangements whereby a harvester agrees to sell all lobsters to a buyer-processor in exchange for groundfish quota leases in the summertime.

Few studies have directly examined the price system of the port market and buyer harvester relations in SWNS (see Steinberg, 1984; Apostle and Thiessen, 1992). While I will not directly address the price system in this study, I will discuss buyer-harvester relations in Chapter 5. Generally, complaints from harvesters and buyers remain quite similar to those made in Steinberg (1984).

In short, fishermen believe that processors and buyers are often “holding back,” while processors and buyers feel they are making the best



(a) Lobster cars on land at Dennis Point Wharf, Pubnico



(b) A lobster harvester placing a crate of lobsters into a lobster car.

Figure 3.8: Lobster cars and storing practices.

possible offers, given market conditions and the services they provide. In general, no one is satisfied. Despite the existence of some satisfactory arrangements, mistrust seems a chronic part of the relationship (p. 33).

In the 1980s, groundfish was a large part of the Maritime port-market. Large subsidized super-firms such as Nickerson/National Sea Products acted as leaders in price-setting in port markets (Steinberg, 1984). While Nickerson/National has since disappeared as quotas and subsidies shrunk in the 1980s and 1990s, a small number of companies that remained competitive bought up much of their remaining quota. Thus, the buyer/seller relations summarized by Steinberg (1984) leading to low market-share benefits at the port seems to remain relevant to the lobster industry. Steinberg listed five main conditions that lead to low market-share benefits at the port market. These are listed below with comments based on the current situation in SWNS (see Steinberg, 1984, p. 37).

1. “Fishermen are for the most part relatively immobile, and alternative facilities are few.” Today some harvesters have been described as more “business-oriented”. For example, a few harvesters have been known to use a hoist on the vessel to load lobster crates onto their truck to be able to sell to more distant buyers that may offer a better price. Additionally, with other improvements in technology, and increasing boat size, the lobster fishing fleet is more mobile than it was in the 1980s. The extent to which a harvester will attempt to seek out distant buyers depends on depth of their ties with local buyers.
2. “Fishermen’s economic ties to buyers often are, of necessity, too close to allow much market bargaining or switching of allegiance. The extent of buyer’s equity in boats—or outright ownership—makes the point.” With the adoption of quota systems in groundfish, swordfish, crab, and other fisheries in the region, it is likely that these equity relationships remain relevant, if not more important than before. Additionally, the practice of trust agreements, whereby a third party can circumvent owner-operator policies and gain effective ownership of



a lobster license has become an issue of increasing importance in SWNS. The nature of these relationships will be discussed in Chapter 5.

3. “The size and distribution of processing firms by volume of throughput is so top-heavy as to ensure domination by major processors.” To my knowledge, data are lacking on the size and distribution of lobster dealers. It is clear that this distribution does exhibit a degree of skewness. A large portion of the Atlantic lobster industry depends on a small number of processing plants in New Brunswick. The importance of these processors is well understood by harvesters as well as shore-based buyers. In August 2012, Canadian harvesters blockaded a truck carrying lobsters from Maine to processors in New Brunswick. Canadian harvesters were upset that a glut of Maine soft-shelled lobsters was being processed in New Brunswick, which was driving down prices at the beginning of their season (Murphy, 2012, August 4).
4. “The buyer network regularly and effectively channels secondary market signals through the major processors to the landing sites under a system of strong price leadership in all but a limited set of circumstances.” This is corroborated in Chapter 5 by some but not all of buyers.
5. “The horizontal port market structure is well established by custom and tradition, and while this picture is greatly oversimplified, it is realistic.” Some harvesters, particularly offshore fishermen that recently entered the lobster fishery on credit, are often described as business-minded. These harvesters may not follow the traditions as closely.

The combination of these conditions leads to a port market system that is “tilted toward major processors” (Steinberg, 1984, p. 37) in which “[local] processors and

buyers are no more the villains than are the fishermen” (p.43). Steinberg (1984) recommends a system of collective bargaining to rebalance this pricing system. While the May 2012 lobster strike has been viewed by many in SWNS as poorly organized and divisive, it was also an attempt to tilt the pricing system back towards harvesters. If issues of organization and threats of violence are dealt with in future collective bargaining situations, it may lead to more effective price negotiations at the port market level.

The Standing Committee on Resources also recommended that the economic efficiency and value of the lobster fishery would be improved by a more coordinated market, and marketing the Atlantic Canadian Lobster fishery as “sustainable.” The coordination of the market would reduce the occurrence of gluts due to high initial landings at the beginning of the fishing season, while certifying lobster as sustainable would increase the overall value of lobster.

The 2009 Standing Committee did not discuss the practice of trust agreements, a practice that many fishermen were concerned about in a prior Standing Committee meeting (2005, March 8). According to Miller and Breen (2010), regulations have not prevented fishers from consolidating licenses, and this has reduced the returns on investments, and stability of employment and earnings for fishers.

### *3.4.3 Lobster licenses and the stealth market*

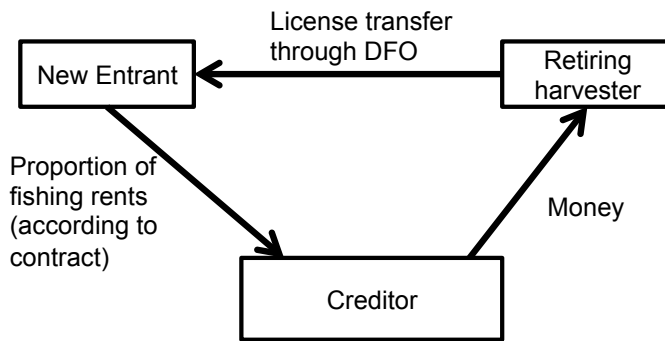
Though government has defined a fishing license as a privilege to fish, harvesters, banks, buyers, and processors have developed loopholes to create an unofficial market for licenses (Henley, 2005). While a license is a privilege to fish, the DFO permits harvesters to transfer licenses to other eligible harvesters. Because harvesters can transfer licenses to an eligible person of their choice, they routinely exchange their licenses for money. Since licenses cost more than most new entrants can pay upfront,

and banks have been reluctant to finance these transfers, many harvesters effectively lease their licenses from a company or individual through a trust agreement. In the Nova Scotia House of Assembly Committee on Resources (NSHACR, 2005, March 8), lobster fishermen expressed their concerns over the effects of trust agreements on the independence of the small-scale fishing fleets.

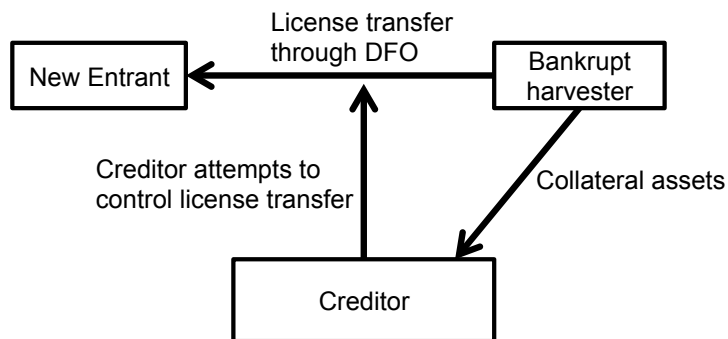
Trust agreements, also known as controlling agreements vary considerably. Figure 3.9 characterizes two common forms of trust agreement. In figure 3.9a, a retiring harvester agrees to transfer a license to a new entrant. The new entrant agrees to pay the retiring harvester for the transfer. A company or individual with sufficient capital agrees to finance the transfer. The company and the new entrant enter into contract, in which the creditor takes a proportion of the rents generated from that license. In Figure 3.9b, a harvester has gone bankrupt and must forfeit collateral assets to the creditor. In many cases, however, creditors have argued that the fishing license constitutes an asset that the harvester must also forfeit. The creditor then controls the license by assigning a new entrant. The bankrupt harvester agrees to transfer the license to the new entrant during the annual time when harvesters can renew or transfer licenses. While both forms are common, the latter form has been disputed in court cases, and the courts of Nova Scotia have often had divergent views on the property-rights status of licenses (Henley, 2005).

Trust agreements allow harvesters to enter the fishery without sufficient access to credit. Ownership of the license, however, remains in the hands of a private agency and not the harvester (NSHACR, 2005, March 8):

In this situation here, the trust agreement is being used so that the person who has loaned you the money or did the purchase is circumventing DFO policy and the person who is operating it really doesn't own the licence and is not ever going to own the licence . . .



(a) Retiring harvester to new entrant license transfer through a trust agreement



(b) A creditor attempts to hold a license in trust after a harvester goes bankrupt

Figure 3.9: Two common forms of trust or controlling agreements

This allows companies and individuals to own multiple licenses as is evident from the testimony of Wayne Spinney, member of the Resources Committee from LFA 34 (NSHACR, 2005, March 8):

We have stockpiling of lobster licences through trust agreements that contravene DFO policy. These agreements transfer the beneficial use of the licence to the landlocked person/company, who may or may not live in the area, or in our country. Processors/fish buyers and others are now

owning many lobster licences and owning licences in more than one LFA.

Spinney suggests that this practice has important implications for employment, as well as the decision-making processes of fishers:

The vertical integration of the inshore lobster fishing fleet is following the same route as groundfish, scallop, herring and the tuna fisheries - to the demise of the inshore fishing industry in our communities. The crew on most of these non-owner/operator enterprises earn less and have less job stability. There is less money to be spent in the local communities and all three levels of government have their tax revenue greatly reduced, and non-owner/operator enterprises cause increased effort on the lobster stock.

Spinney suggested that non-owner-operator fleets drive increased effort because the captain and crew of the boats retain smaller shares of the landed value and the vessels have higher capacity and higher operating costs. Thus, in order to make a decent living in lobstering, hired captain and crew must catch more fish to make the same living as an owner-operator. Another important effect is the inflation of license prices according to an informal market (NSHACR, 2005, March 8).

It is all artificially inflated and it's not the small corporations, it's not the small businesses that is buying them up around here. It's artificially inflated to \$1 million now, because it's a money game ... it is to make money on the licence with the licence. Even some of the fishermen are doing it, they own three, four, five licences, they are accumulating three, four, five of those licences for \$3-, \$4-, \$5 million ... (Therriault, Resources Committee)

Trust agreements represent an interesting and problematic relationship between creditors and fishermen. The DFO has two important policies regulating license ownership and the structure of the inshore fleet. The first is “owner-operator,” that is, a license is attached to an eligible fisherman and that fisherman’s vessel. The second is “fleet separation,” which states that the fishing fleet and fish processors must be separate entities, and licenses cannot be owned by corporations (after 1979). The aim of these policies is to maintain independence of the fishing fleet from monopolies and exploitative relationships between buyer and fishers (NSHACR, 2005, March 8). Trust agreements, however, are contractual agreements that do not fall under the legal jurisdiction of the DFO:

...it’s an agreement between two parties and they do not have the power to access the agreement between two parties. If you and I do up a trust agreement, they have no authority to go in there. If we walked into the DFO office and I say... “listen, I’m transferring my licence over to this gentleman here and he meets the criteria, he’s been fishing for two years,” they can’t stop it, that’s simply it. As far as they know, you own it but in all actuality, I’m the one who owns it, you’re going to be the hired man and...if you don’t function satisfactorily for me, I’ll replace you with somebody else ... (NSHACR 2005, March 8)

This loophole stems from the distinction between the rights to *legal title* and *beneficial interest* accruing from a license. Canadian fisheries policies are only concerned with the legal title, and not beneficial interest. A supreme court decision (British Columbia Packers vs. Sparrow) has held that the Canadian Fisheries Act does not legally prohibit the transfer of beneficial interest of a license, but only the legal title (Fisheries and Oceans Canada, 2010, February 8).

At the time of this report, it has been estimated that between 150-200 of the 968 licenses in LFA 34 were subject to trust agreements (NSHACR, 2005, March 8). The DFO has responded to the concerns of fishers by updating policies ensuring in-shore fisheries are owner-operated (Fisheries and Oceans Canada, 2010, February 8). This policy, put into effect as of April 12, 2007, requires fishers to file a declaration stating whether their license is subject to a trust agreement (also called controlling agreement). Those who declare that they are subject to controlling agreements are required to amend these agreements to satisfy new regulations as of April 12, 2014. Any license-holders who falsely declare that they are not subject to controlling agreements will lose eligibility to have their licenses reissued or transferred. Any license-holders who have successfully freed themselves or have remained free from trust agreements are categorized as “independent core” license-holders with all associated privileges including reissues and transfers (Fisheries and Oceans Canada, 2010, February 8). Since there has been little discussion in literature or in parliament, it is difficult to determine how well these new policies have been able to regulate this process. Additionally, the effects of this policy on those fishers who have entered into trust agreements, and their ability to maintain eligibility as Independent Core license holders is unknown. Importantly, the policies of the DFO only address the problem of trust agreements, but do not deal with the underlying causes of trust agreements: the inability of new entrants to access credit to purchase licenses and the high cost of licenses. Given these two problems together, the new policy may actually provide further burdens on new entrants.

Similar to the problems of the ITQ systems discussed by Clark (1976), the market for lobster fishing permits has allowed fishers to gain access to multiple licenses. In this case, however, as Clark (1976) warns, Canadian regulations have prohibited this process from occurring, but the lure of a profitable fishery has lead to a form of “sub-

terfuge.” Clark (1976) also mentions the possibility that such economic incentives can lead to increased illegal fishing. Interestingly, Nova Scotia fishers have also expressed their concerns over the illegal lobster fishing industry, and the lack of monitoring and enforcement (Nova Scotia House of Assembly Committee on Resources, 2005). According to Ashton Spinney from LFA 34 (NSHACR, 2005, March 8):

The justice system must impose stronger penalties. If a dealer or illegal fish harvester is fined, let’s say, \$2,000 to \$4,000 when caught, this low-level fine is considered the cost of doing business. If operations are pulling in \$20,000 a week for 10 weeks, these types of fines are not a deterrent.

Since the analysis of Davis (1984a) and Ostrom (1990), the village of Port La Tour has not been revisited. At the time of Davis’ study, harvesters had access to fishing grounds where cod, haddock, halibut, herring, and mackerel were plentiful, lobstering was often referred to as “christmas money”, traps were made of wood, and both industrial and small-scale fisheries were not limited by quotas. Given the massive changes that have occurred in the fishery since the 1980s, and the new economic pressures and incentives placed on fishers, a local-scale study of the current lobster fishing practices and social relations among fishers of Port La Tour would be beneficial to understand how resource users in a local scale adapt to larger regional and global processes of social and environmental change.

## 3.5 Field Methods

### 3.5.1 *Participant observation*

The benefits of participant observation were clear throughout the four months I spent in Barrington in the summer of 2012. Building relationships and identifying contacts was an important step in this research because there was not an available



list of respondents to select from. While all license-holders are listed in Fisheries and Oceans data, these data are kept confidential. Key informants knew many fishermen, exhibited exemplary knowledge and experience in the fishery, or had positions in organizations and could provide a unique perspective. In addition, reputation played an important role in these areas. It became clear early on that associating with “the wrong kind of people” would be detrimental to the research. On the other hand mentioning the name of a key informant with a good reputation can ensure the success of an interview. Early intuitive understanding of social relations, norms and boundaries was also important. Harvesters in SWNS are often highly skeptical of academic research, and do not trust the intentions of researchers. Some fishermen stated that when a researcher comes around and asks questions, a report will turn up on a government officials desk, and then a new round of regulations will be proposed. This fear was clear after initial conversations with harvesters.

In this research, time constraints did not allow me to take up employment, but I was often invited to participate in fishing practices, such as baiting longline trawl in the baiting shed, participating in lobstering and fishing trips, and a variety of social events and gatherings. In fishing trips, I started out playing the role as observer, but as I began to understand the practices better, I was able to play the role of “greenhorn” participant. As word got out among other harvesters that I had helped out over aft on a few boats, and did not spend the whole time seasick, many harvesters were pleased to encounter a researcher who wanted to understand not only what and how many fish get caught, but what it is like to fish. Some fishermen stated that scientists cannot truly understand fishing because they rarely observe and participate in the activity. I freely discussed information about the study and my own intentions with respondents. To a certain degree, I could take the role as an insider to Canada, but there was always a degree to which I would be regarded by many as an outsider

with a different educational background, heritage, manner of speech, and without familial relations in the area.

I focused my inquiries and observation more on buyer-harvester relations, livelihood strategies, rules, and aspects of social cohesiveness among fishermen, and placed less emphasis on other features such as cultural practices or gender relations. For more detailed accounts with these emphases, see Nickerson (2012) for an actor network theory approach to cultural practices and social change; Thiessen et al. (1992) and Apostle and Thiessen (1992) for an analysis of gender relations; and Apostle and Thiessen (1992) and Davis (1975, 1984b) for cultural practices and political economy.

The effectiveness of participant observation and fieldwork depends on the support from gatekeepers and key informants and the community. Gatekeepers are influential people in a study site, with the ability to impede or enhance a researchers access to the community, resources and important information (Bernard, 2006). Key informants are insiders who can help researchers gain acceptance in the community, key information, and help make sense of information that is difficult to understand as an outsider (Bernard, 2006). The negotiation of access to resources and information in a study site requires a careful description of research and goals, as well as following ethical guidelines by getting permissions (i.e. IRB), ensuring anonymity and confidentiality for participants, obtaining informed and uncoerced consent from participants, and not misleading study subjects (Bernard, 2006). With the help of Anthony Davis, I developed a detailed information letter (see Appendix A), which outlined the goals of my research, the nature of my questions, the rights of respondents, and the obligations of the researcher. These were initially given to key informants and gatekeepers, but were also shared with every respondent.

Overall, participant observation in the context of a fishing town can include any and all activities in the region, including walking on a beach, grocery shopping, getting

an oil change, or getting gas. There were, however, certain social gatherings or regular activities that facilitated further interaction with harvesters and buyers. These were also often periods when harvesters were nearly impossible to reach. For example, a researcher would be more likely to encounter a harvester at a locally organized boat race than at home or at the wharf, especially if they do not have quotas to fish in the summer. Other social gatherings and events included the annual Barrington lobster festival, the Barrington exhibition, Canada day, local dances, high school student graduation ceremonies, and weddings. In almost any setting, it would not take any coaxing to begin in-depth conversations about the fishery, the government, and the livelihoods of harvesters.

### *3.5.2 Interviewing and surveys*

I developed an interview guide, and conducted semi-structured interviews (Spradley, 1979) to understand the motivations, influences and interactions (Fontana and Frey, 1994) between agents within an SES management context. Shensul et al. (1999) argue that semistructured interviewing is most suitable for identifying the most important variables to study, operationalizing variables, refining hypotheses, and for developing qualitative data to supplement a survey. I conducted interviews with government officials, harvesters, leaders and members of fishermens associations, as well as fish buyers. Because questions for a retired harvester would be of a different nature than those directed at a new entrant or government official, there was some difference in questions among participants. In general, however, all questions focused on what challenges harvesters and buyers face, what is being done to respond to these challenges, and what hinders their ability to respond to these challenges (see Appendix C).

Since surveys are generally shorter in length, they can be administered to a larger

sample size of respondents that represent a given population Bernard (2006). The efficacy of a surveying technique, however, rests on the ability of the researcher to word questions in a clear, understandable, and culturally appropriate way. Dillman's total design method (Dillman, 1978; Salant and Dillman, 1994; Dillman, 1983; Bernard, 2006) is highly useful for ensuring higher response rates, and pretesting a survey on a small sample of respondents can help ensure questions are being interpreted appropriately (Bernard, 2006). I developed a face-to-face survey protocol based on advice from committee members, Anthony Davis, key informants, and survey pre-testing with harvesters. Survey pre-testing proved highly useful for appropriate wording and phrasing of questions. Additionally, discussion with key informants was useful to understand the boundaries of harvesters, and how to avoid questions that were too personal. All survey questions were asked in face-to-face structured interviews with respondents. In the case where a question was not understood, I provided a pre-planned rewording of the same question. After pre-testing, questions were understood well with some exceptions.

### *3.5.3 Secondary and archival data*

Supplementing data collection with archival and secondary data can allow an investigator to get access to previously inaccessible information which can provide further insight towards development and testing hypotheses (Shensul et al., 1999). Additionally, these forms of data are essential to triangulation, or using multiple sources of evidence to increase the internal validity of a case study (Gerring, 2007). The degree to which different sources of data agree or conflict with one another can provide insight into potential social and political divisions within the study area (McCann, 1998). In this study, I use archival documents, news sources, grey literature, and unpublished datasets to triangulate my findings where possible.

### 3.5.4 *Analyzing ethnographic data*

I analyzed textual data using a combination of grounded theory and more classical forms of content analysis focusing on themes. The contextual specifics of language in interviews made themes the preferred unit of analysis. For example, quotas are always referred to as “bought”, but in the majority of cases a harvester mentions “buying quota”, they are actually referring to leasing quota for the season, and not permanent purchases of quota. Contextual distinctions such as this would have been missed by analysis of words or keywords-in-context. The combination of theory generation and testing suggested here is due to the fact that significant and well tested theories have been generated for some of the questions in this research design. For example, Ostrom (1990) has developed well tested design principles for diagnosing the sustainability of SESs, and a larger set of variables for diagnosing SESs have been developed by Ostrom (2007, 2009). Thus, the variables suggested by previous work acted as themes for coding data within the study site. Theory generation and building were most important for developing subthemes (or third-tier variables), and determining how these variables interact to create contextually specific outcomes. This form of data analysis has been inspired by the grounded assessment approach suggested by researchers working in vulnerability research (Polsky et al., 2007), whereby theory and conceptual frameworks are developed through both inductive and deductive research. While similar to grounded theory (Strauss and Corbin, 1990), grounded assessment builds its concepts and theories using both empirical qualitative and quantitative data. This approach has recently been suggested as an effective way to examine the vulnerability of human-environment systems (Polsky et al., 2007), and thus, I posit that this approach is equally suitable to examining the robustness and vulnerability of SESs.

I analyzed data obtained from surveys with logistic regression in Chapter 6. In Chapter 7, I use the insights from Chapter 6 to inform an analysis of vulnerability using multicriteria decision analysis (MCDA). Eakin and Bojórquez-Tapia (2008) demonstrate the effectiveness of this analytical technique in their analysis of rural households in Tamaulipas, Mexico. MCDA is an effective analytical technique to capture a diversity of vulnerability indicators, and their interrelationships and importance to households (Eakin and Bojórquez-Tapia, 2008).

## Chapter 4

### WEAK FEEDBACKS, GOVERNANCE MISMATCHES, AND ROBUSTNESS

#### 4.1 Introduction

The insights in *Governing the Commons* (Ostrom, 1990) have provided foundational ideas for commons research for over 20 years. Ostrom (1990) showed that resource users can act collectively to manage common pool resources (CPRs), and proposed eight 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. But what has happened to the cases discussed in *Governing the Commons*? Do Ostrom's design principles confer robustness to social and ecological change?

I re-evaluated 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. I examined the consequences of these two sources of fragility over time. I re-evaluated the case using a framework to analyze the robustness of social-ecological systems (SESs) developed by (Anderies et al., 2004). The framework facilitates examination of the dynamic feedbacks between the components of a SES.

While researchers contribute to case-study knowledge of CPRs, few have revisited cases to analyze their dynamics over time. But Brewer (2012b) revisited Acheson's (1988) *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 SESs. She showed that tradeoffs are often unavoidable in policies designed to support the livelihoods and self-governance of communities harvesting a CPR. Ostrom called for “strong interdisciplinary science of complex multilevel systems” to diagnose social-ecological systems (Ostrom, 2007, 15182); studies such as Brewer (2012b) and the one I present respond to this call.

Because Maine has often been described as successful in self-governing the lobster commons, I compare its institutional development pathway to that of Port Lameron. I will show that some of the successes of the Maine system have been due, 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) characterized the Port Lameron fishery as institutionally fragile. She predicted that the federal government's approach would continue to provoke “counterproductive reactions” from fishermen, fail to “gain control over open-access deep-sea fisheries,” and “lose control of some inshore fisheries previously subject to entry control” (p. 177). I expand on the work of Ostrom and Davis, using fishermen's accounts collected from participant observation, informal interviews, and surveys. I supplement this data with primary and secondary sources. I 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 (Fisheries and Oceans Canada and local lobster communities, in Port Lameron) would each take on roles that leveraged the different types of information available to each group. Fisheries and Oceans Canada (DFO) and local communities would be loosely linked and work collaboratively. But in Port Lameron, weak feedbacks in the SES have



created a less than optimal scenario; Maine’s SES more closely approximates the best-case scenario. I 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 polycentric governance might improve fisheries governance in the future. I do not find polycentric institutions that lead to improvements in either case, but I do find instances where a lack of these institutions lead to problems. Polycentric systems have “many centers of decision-making” acting at different scales (Ostrom et al., 1961, p. 831). Each governing unit has the autonomy to develop their own institutions based on their specific knowledge of the system to be governed. 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, overlapping, and come from public, private and voluntary sectors (McGinnis and Ostrom, 2012). I highlight some of the feedbacks and interactions that could be strengthened by polycentricity in both Maine and Port Lameron.

## 4.2 Qualitative Case-Study Analysis Through a SES Lens

Early SES research originated from the ecological sciences, and did not focus on 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 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. But 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., Miller et al., 2010; Folke et al., 2003; Berkes and Seixas, 2005). It has also called attention to the importance of matching the scales of social and governance systems to the economic and ecological problems they face (Young et al., 2006; Cash et al., 2006). In this study, I look at the feedbacks between different levels of a SES, and the potential for resources users in a SES 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 4.1. 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 non-human 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). A SES is composed of two human units: resource users

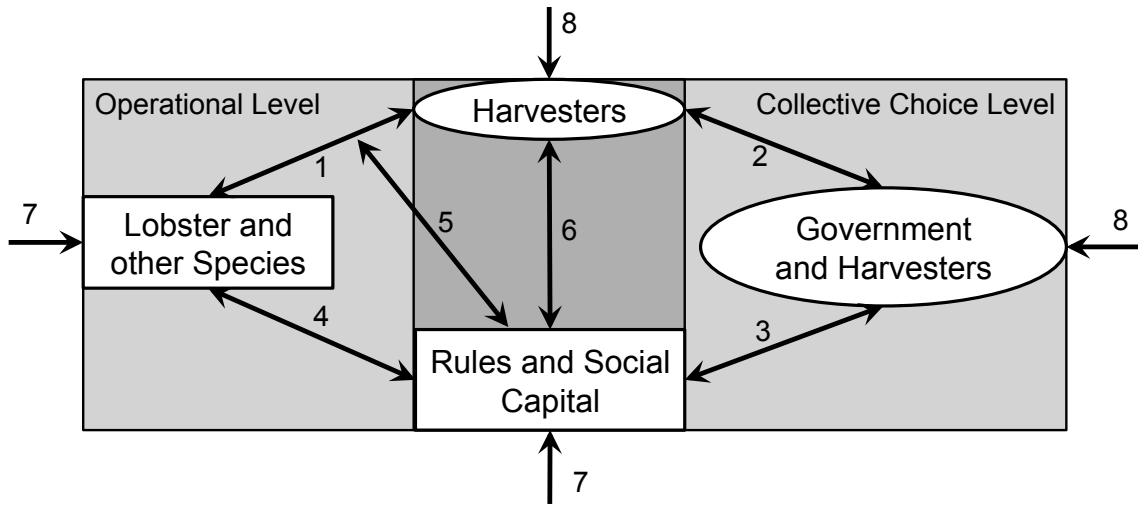


Figure 4.1: The social-ecological system, as conceptualized by Anderies et al. (2004).

and public-infrastructure providers. Public infrastructure includes elements of social capital and rules-in-use, and physical capital, such as artificial reefs or other human-built environments that affect resource dynamics. In Port Lameron and Maine, public infrastructure is largely composed of rules and social capital.

SEEs often exhibit nonlinear dynamics as the rules of local interactions change over time (Levin, 1998). Humans act upon 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” SEEs to maintain life-supporting functions, is referred to as robustness (Anderies et al., 2004). A SEE is considered robust if, when exposed to disturbances (links 7 and 8 in Figure 4.1), 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 SEE 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 co-evolve when rapid feedbacks allow them to alter the patterns of their interactions over time (Levin, 1998, 1983; Walker et al., 2004). In Figure 4.1, 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, I examined the endogenous links at the collective-choice level consisting of links 2,3, and 6. Link 2 is between harvesters and government and groups of harvesters engaged in public infrastructure provision. Harvesters recommend policies, vote for representatives, and participate in decision-making arenas through link 2. Link 2 is between government and harvester groups and the rules and social capital. Through this link, public infrastructure providers modify rules and monitor and enforce them, and attempt to invest in dialogues to promote the bonds and bridges of social capital. Harvesters who directly interact with the resource participate in monitoring, and also co-produce rules and social capital bonds through link 6.

I also examine the ability of the collective-choice level to respond to changes at the operational level (links 1 and 5). Harvesters are in a privileged position to understand fishing dynamics at an operational level. They directly observe rule violations, informal social practices, and they respond and adapt to rules by changing their fishing practices. Rules and social capital influence link 1, the dynamics of harvesting resources, through link 5. Harvesters process these changing dynamics, and respond to price signals (link 8). The feedback is completed as harvesters iteratively make recommendations in collective-choice arenas through link 2.

I 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 (1984a,b, 1975) conducted his research in Port Lameron, Brazil, and Pagesville, pseudonyms for Port La Tour, Baccaro, and Smithville. I use Port Lameron to refer to these three communities, and SWNS to refer to the whole region. Our data for this study came from field notes, informal and semi-structured interviews with association leaders, buyers, and fishermen (N=31), and from general survey information (N=113) about the relationships among fishermen, associations, and government. I supplemented our field data with a literature review of fisheries policy. Below I analyze data that emphasize changes at the collective-choice level that have occurred in Port Lameron and SWNS since Davis studied it more than two decades ago.

### 4.3 Background Information

Table 4.1: Characteristics of the Port Lameron fishery in the 1970s, and today.

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

\* Values are counts and averages, and ranges are shown in parenthesis

Basic characteristics of the Port Lameron fishery in the 1970s and 2012 are summarized in Table 4.1. I 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). I added crew-members to captains to estimate the total number of

resource users. While 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 fishermen made their living from many species including cod, halibut, herring, mackerel, and lobster. Following the cod 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 (ITQ) programs (Peacock and Annand, 2008; Crowley and Palsson, 1992). 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 Fisheries and Oceans Canada (2009) stock assessment found a high rate of unexplained cod mortality, perhaps due to increased predation from seals, or to discarded or unreported landings. While 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.

Today, fishing vessels are generally larger but less varied than in the 1970s. Davis (1975) distinguished between offshore and inshore fleets. Offshore fishing 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 15.2m in length, but they 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 offshore (Fisheries and Oceans Canada, 2013). To accommodate this shift, vessels have become larger, wider, and more capital intensive.

#### 4.3.1 *Governing the lobster commons*

In the 1970s and 80s, Port Lameron fishermen were similar to the “lobster gangs” of Maine. Fishermen 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 fishermen 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). They also reduced conflicts among fishermen 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 of violence. They sanctioned rule-breakers in proportion to the seriousness and frequency of their infractions.

These boundaries were flexible and informal. In both Maine and Port Lameron, boundaries were negotiated among fishermen within and between ports. Thus, the boundaries changed as fishermen responded to changing social, ecological, and economic conditions (Brewer, 2012a), and fishermen defended 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; Brewer, 2010; Acheson, 1988). Ostrom (1990) suggested that this informal system kept the costs of monitoring fishing behavior low

because fishermen could interact frequently, and it was easier to see when and where a fisherman used a certain technology than it was to see the type of fish caught.

The current rules in Maine and Port Lameron (see Table 4.2) are similar but have different emphases. Both fisheries have prohibited the landing of egg-bearing females and set minimum size requirements for over a century, but the details of these rules have changed over time (Parsons, 1993; Wilson et al., 2007). When fishermen catch an egg-bearing female they sometimes cut a v-notch in her tail for protection. In Maine, rules emphasize recruitment of future lobster generations by preserving egg-bearing and v-notched lobsters. 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.

I found that Maine and SWNS differed most in their relationship to government agencies, Maine's Department of Marine Resources (DMR) and Fisheries and Oceans, Canada (DFO).

#### 4.3.2 *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 of the coast under the "Law of the Sea Convention" (Ostrom, 1990; Matthews, 1988). Rapid post-war expansion of industrial foreign



Table 4.2: Comparison of rules governing the Maine and Port Lameron lobster commons

Rule	Both	Maine	SWNS
Minimum size restriction	82.5mm		
Maximum size restriction		127mm	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	15.2m maximum length

\* "NP" indicates that a rule is not present in that SES

trawlers had brought Atlantic groundfish stocks to the brink of collapse (Rogers, 1998). By declaring the 200-mile limit, the federal government assumed control of both offshore fishing grounds (which were exploited by trawlers) and inshore fisheries. This shifted the balance of authority from the provinces to the federal government. Provincial governments recognized, and in the case of Newfoundland, codified customary rules (Martin, 1979). But the federal government believed that the seas were open-access and free to all and set up their own set of institutions without recognizing customary rules. To the federal government, the only option to protect the seas was top-down regulation.

The United States passed its Fisheries Conservation Act (FCMA) in 1977, claiming federal jurisdiction over seas within their own 200-mile limit. The newly created National Oceanic and Atmospheric Administration (NOAA) set management goals for the Maine lobster fishery. But the FCMA also created Regional Fisheries

Management Councils and mandated that the 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 fishermen 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 co-management zones in 1995 (Acheson and Knight, 2000; Acheson, 2003; Brewer, 2012a). 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 lobstermen 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 fishermen 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 Section 4.4, I describe how the informal rule system in Port Lameron and the DFO’s failure to recognize it have produced conflicts and governance mismatches.

#### 4.4 Missing Feedbacks and Governance Mismatches

I wanted to understand the feedbacks flowing through the Port Lameron system, as diagrammed in Figure 4.1. All SESs are feedback systems. 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, fishermen, 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.

#### *4.4.1 Poor state-resource user relations*

I found that the DFO’s failure to recognize fishermen’s rights to organize rules and fishermen’s weak collective-choice arrangements have reinforced each other. Since the 1970s, Port Lameron’s local feedback loop has eroded (Links 1, 5, and 6 in Figure 4.1). The weak relationship between the federal government and Port Lameron’s fishermen has reduced fishermen’s capacity to act on their knowledge, and thus 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, for example, in money or time (Coase, 1960).

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 with traps that lacked government-issued tags until the 1980s

(Kearney, 1989). The crack-down led to a series of protests and disputes between the state and fishermen, culminating in May of 1983, when about 100 fishermen burned and sank two 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 fishermen; the groups first met in June 1983 (Kearney, 1989). This signalled a shift in the DFO's approach, from top-down to co-management. The Working Groups established organizations to represent fishermen's interests; these later evolved into the LFA management boards and advisory committees that operate today. Licenseholders 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 an elected chairmen.

However, all of these positions can be daunting and thankless, because fishermen 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 fishermen 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 fishermen see the LFA boards and committees and their decisions as having low legitimacy (Field Survey 2012). The majority of the fishermen I surveyed wanted the DFO to directly incorporate fishermen's knowledge and ideas into decisions; some called for a democratic process in which fishermen could make decisions themselves. While a large majority of fishermen (71.1%) paid dues to fisheries organizations, well over half (61.1%) seldom or never attended meetings. Those who did attend 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 fishermen, and a lack of positive change. Many said that there was no sense in going to meetings because they didnt change anything. Others stated that their presence at government meetings merely legitimized the decisions the “bureaucrats” were going to make anyway (Field Interviews 2012).

Table 4.3: Fishermen’s 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 fishermen	54.5
	No change at all	23.2
	Fishermen 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
	No say in decision-making process	20.6
What discourages you from attending association or organization meetings?	Arguing among fishermen	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

When Davis studied the Port Lameron fishery in the 1970s, fishermen 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 socio-economic conditions (Davis and Kasdan, 1984). In an unpublished survey conducted by Davis in 1988, 97.6% of Nova Scotia fishermen believed that the DFO should consult with them, and

66.1% believed that fishermen's views should have legal status in the decision-making process. Today, fishermen can consult with government, but the Federal Minister of Fisheries retains decision-making authority. In the past, fishermen 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, fishermen have united to represent their interests (e.g., the Newfoundland Fishermen, Food, and Allied Workers Union (Kearney, 1989)). But in SWNS, the unions and associations that formed in the 1980s could not settle differences and provide a unified voice for fishermen (Kearney, 1989). Today, the associations have changed, but intra-group divisions remain within different fishing groups. SWNS fishermen hold diverse attitudes because of their geographic isolation and a diversity of operations and strategies (Apostle and Barrett, 1992). Fishermen's attempts to organize have frequently been thwarted by problems of leadership, accountability, transparency, and reputation. Fishermen and other community members often told us stories about leaders who were corrupt or engaged in socially unacceptable behavior. Some harvesters were accused of having personally benefited in the groundfishery by engaging in corrupt practices, and the stories aroused suspicion about the intentions of would-be leaders.

The conservative Protestant culture in much of SWNS also impedes fishermen's 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 towards 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 fishermen whom I 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 co-management 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. While customary decision-making had struck a balance between “communitarian and individual interests” (Brewer, 2012a, 398), the co-management process effectively tipped the balance towards license-holding boat captains. Thus, while fishermen 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.

While the time costs of participation in co-management may be high for fishermen in both Maine and SWNS, the benefits are higher in Maine, at least from the perspective of license-holders. In SWNS, fishermen think it unlikely that their participation will lead to rule modifications. I 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 understanding of the resource system, 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. It is important to be cautious, however, of the threat that a generalized principle such as polycentricity is specified in the form of a silver-bullet solution to all social-ecological problems. Polycentricity is a general principle of supporting multiple centers of decision-making with cooperative and competitive interactions between these centers (Ostrom et al., 1961). Thus polycentricity “requires a delicate balancing act between strategic entrepreneurship and emergent dynamics and weaves an ever-changing web of cooperation and competition among its many component parts” (McGinnis and Ostrom, 2012, p. 15).

### **The mis-recognition 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. I found clear signs that the customary rule system described by Davis (1984b) had weakened over time. I also found that fishermen 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, fish-



ermen 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 fishermen I surveyed expressed frustration with those who did not respect the gentlemen’s agreement. They attributed failure to honor it to the fact that fishermen often encounter vessels from different ports, especially on offshore grounds, and to increasingly “cut-throat” attitudes. For instance, if one fisherman is pulling up traps with high catches, a cut-throat fisherman would shift his traps close to, or even on top of, the first fisherman’s traps.

In Maine, customary local rules and property relations have been recognized by the state, but in SWNS, state rules were based on the assumption that customary rules were effectively absent. This has undermined 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, fishermen stated almost unanimously that they either wanted a real seat at the decision-making table, or that they should make the rules themselves. Some fishermen were afraid of the latter because they believed that fishermen are greedy, or too diverse to agree on a decision. DFO officials also questioned the ability of fishermen 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.

The clash between local customary and federal formalized rules has created a predictable pattern in the maritimes as described by Davis and Kasdan (1984): fishermen’s frustrations eventually reaches a point of boiling over, at which point harvesters will engage in violent or non-violent forms of direct action. Instances of direct action or conflict between the DFO, harvesters, and buyers are listed in Table 4.4. With the 2012 strike recent in the minds of many harvesters, it is important to note

that these events are often traumatic, causing hard feelings among communities, kin, and friends, buyers and harvesters, fist fights, damage to trucks and other personal property, and threatening phone calls to families.

#### 4.4.2 *Governance mismatches and institutional change*

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 fit with current social, economic, and ecological conditions (see links 3 and 5 in Figure 4.1). 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 fishermen 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. Next, I discuss governance mismatches in SWNS, using examples of user boundaries, resource boundaries, trap limits, and monitoring and sanctioning.

#### **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 the benefits of user efforts to maintain a resource will not be reaped by outsiders. But well-defined boundaries that

Table 4.4: Instances of direct action originating from SWNS.

Date	Location	Action	Source of Dispute
1977	Shelburne	Mass demonstration with threats of property damage	Opening of offshore fishery (beyond 50-mile limit)
1981	Yarmouth	Otter trawler license-holders go on strike	Reduction in mesh sizes on trawlers
1983	Pubnico	Two DFO patrol vessels are burned and sunk	Enforcement of trap limits, and DFO confiscation of illegal traps
1990	Yarmouth	Protests and break-ins at DFO offices	Introduction of quotas to the <65' mobile gear fleet
1993	Shelburne	Harvesters blockade an industrial foreign fishing vessel at port	Quota cuts combined with foreign fleets fishing within the 200 mile territory
1996	Barrington	Harvesters occupy a DFO office, occupations spread across provinces	Low quotas in the groundfishery
1996	Barrington	Harvesters dump a sack of cheques and money orders on the lobby floor in parliament hill in protest	Increases to license fees
1999	Yarmouth	Harvesters protest and clash with Mikmac aboriginals, mounted police intervene	Granting of unrestricted fishing rights to aboriginal fishers
2000	Shelburne	Harvester chains himself to the mast of the Bluenose II schooner	Low ground fish quotas
2008	SWNS	Lobster harvesters go on strike and block seafood trucks	Low lobster prices
2010	SWNS	Herring harvesters go on strike	Low herring quotas
2012	SWNS	Lobster harvesters go on strike	Low lobster prices

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 fishermen and organizations seeking restrictions on “moonlighters” (i.e., part-time fishermen 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). But 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, fishermen 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 fishermen 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 license value. Answers to these questions are clear in writing, but unclear in practice. While the DFO considers access to fisheries as a privilege bestowed by government, fishermen 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 fishermen (with clear dependence on fishing), and to deny access to processing companies and moonlighters. But while licenses are not formally

transferable, a provision allowing transfers has opened the door to a stealth market in licenses. Legal decisions and extra-legal 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 twenty-five cents; shortly after limited entry in 1970, a license cost \$250. Since 1999, the value of a license in LFA 34 has gone up to more than \$500,000 (Bodiguel, 2002).

In Maine, user boundaries have been defined by the state and captains (Brewer, 2012b). Only one lobster-fishing zone has no state-defined limitations on entry (Brewer, 2012a). The creation of limited-entry programs in the US was influenced by workshop discussions in which Canadian fishermen 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 fishermen on a waiting list (Bodiguel, 2002). Brewer (2012b) provides evidence suggesting that some fishermen in Maine have pushed for transferable licenses, but that the inflated license values experienced in SWNS would be “abhorrent to virtually all Maine fishermen” (p. 396).

### **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 fit 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 co-management began in the 1990s.

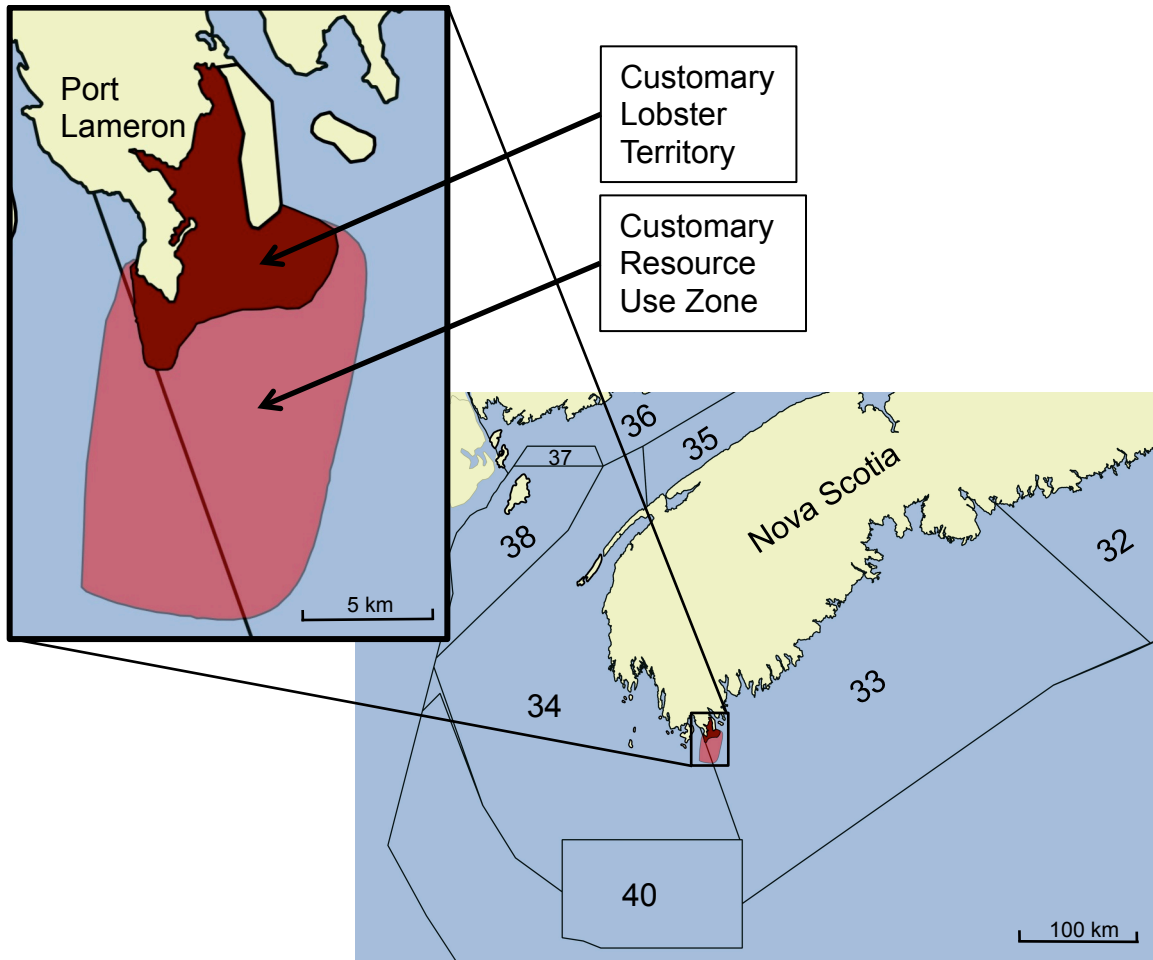


Figure 4.2: Comparison of customary lobster and general resource territory for Port Lameron described in Davis (1984a) and current state-defined resource boundaries. Numbers correspond to Lobster Fishing Areas (LFAs) or districts. Data Source: Oceans and Coastal Management Division, Fisheries and Oceans Canada (Maritimes Region), and Coffen-Smout et al. (2013)

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. The line separates fishermen from a portion of their ancestral fishing grounds. As the

efforts of fishermen to the southwest of the line expanded outwards, neighboring fishermen began to enforce the boundary more rigorously by reporting line violations to enforcement. As officers increasingly charged Port Lameron fishermen for fishing illegally over the line, the fishermen formed a group that lobbied government to move the line to the southwest. This was a highly contested process, and the line remained unchanged (Field Interviews 2012).

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 further from port in search of bigger catches. Some Port Lameron fishermen expressed frustration about fishermen 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 co-management zones are divided into districts with district councils; license-holders in each district elect council-members to represent them (Brewer, 2012a). Still, Maine's co-management zones are larger than the territories of traditional harbor gangs. The re-scaling 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 fishermen 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**

While 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 foreign

to fishermen. In Maine, fishermen developed trap limits voluntarily, in some cases, and in others they have been able to influence trap limits through the co-management structure. When developed voluntarily, trap limits reflect fishermen's definition of the social or ecological dilemma, and their preferred solution to that dilemma. Fishermen have been able to tailor the trap limit to their own social preferences when the limit has been developed within a co-management 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 fishermen's local ecological knowledge and experience 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; Brewer, 2012a; Acheson, 2003, 1998). While 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 average when created, but they lacked the spatial distinctions fishermen have customarily been able to make. Kearney (1984) found that 80.4% of fishermen favored trap limits to control fishing effort, but they suggested limits that varied from 308 to 546 among different communities and captains with vessels of different sizes. In LFA 34, the trap limit was set to 375, while LFA 33 has 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 fishermen, and if they had better approximated the



heterogeneity of the fishing grounds and fishing practices.

The DFO's rationale for introducing trap limits was based on bioeconomic assumptions of maximizing economic yield (MEY) from one resource (DeWolf, 1974). Assuming that customary management practices are absent and that fishermen act individually to maximize their profits, lobster fishermen would use more traps than the economically optimal number. But these assumptions did not account for the customary rules in the majority of SWNS ports (Davis and Kasdan, 1984). And the assumption that fishermen seek to maximize profits did not account for the fact that fishermen preferred to maintain consistent economic benefits rather than maximized profits (Davis and Kasdan, 1984; Davis, 1984b). Fishermen in Port Lameron and the majority of ports in Nova Scotia had developed their own management practices based on their operational-level experience of the appropriate amount of effort localized lobstering grounds can accommodate to provide stable economic returns (Davis and Kasdan, 1984). The MEY rationality for trap limits was foreign to the practices and objectives of SWNS fishermen.

The mismatch between MEY theory and SWNS reality may partly explain increased trap use after the enforcement of trap limits in 1983 (Kearney, 1989). Before the implementation trap limits, some harvesters used more than the limit, while some used less. Between 1968 and 1972 when trap limits were implemented, trap limit use increased by 5.6 percent. Davis and Kasdan (1984) pointed out that fishermen perceived the limits to be a *target*. Fishermen also attempted to maximize flexibility within the constraints of a new rule (discussed above). Just as fishermen retained flexibility by using licenses they didn't need at the time, they 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 fishermen on Monhegan and Swan's Island persuaded

others to adopt trap limits within their territories, and petitioned the State of Maine to formalize the limits (Acheson, 1998). In these cases, trap limits were implemented to solve distributional battles. Fishermen using many traps created gear congestion at sea. These fishermen also controlled a large portion of the lobstering grounds, limiting the ability of others to get their fair share (Acheson, 1998). Monhegan and Swan's Island developed trap limits at a smaller spatial scale than fishermen in SWNS, to solve problems that they perceived at the local-level.

In the 1990s, the NOAA and the Atlantic States Marine Fisheries Commission pressured fishermen to implement trap limits to limit fishing effort and conserve the resource (Brewer, 2012a). But federal and state governments delegated these decisions to co-management zones. In each zone, fishermen decided whether they wanted trap limits, and what the limits should be. All zones adopted trap limits that ranged from 600-800 traps (Brewer, 2012a). Fishermen 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, fishermen 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. But 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 fishermen had customarily used. In contrast, Maine fishermen 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, I can conclude from the outcomes discussed above 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. But most fishermen now perceive it to be beneficial. In our 2012 survey of 113 respondents in SWNS, 102 wanted to see trap limits stay the same; one wanted them increased. At an LFA 34 management board meeting in June 2012, the DFO informed fishermen 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 fishermen 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 on lobstering grounds would return, with some fishermen hogging the grounds and placing up to 1500 traps. Fishermen have adapted to the DFO-set trap limits, and see them as vital to protect the fishery. But despite their acceptance of current trap limits, the conflicts created by the initial policy implementation remain a source of distrust.

### **Monitoring and technological change**

The DFO has commissioned faster enforcement vessels with sophisticated technologies to increase their capabilities. But fishermen also have access to technologies that allow more sophisticated forms of subterfuge. While the Cape Islander vessels of SWNS are slower and less agile than enforcement vessels, fishermen no longer need to mark traps with buoys to retrieve them later. Now a harvester can set a string of 10-20 unmarked lobster traps on a line, mark their location on a GPS, and then later send a dragging device to the seafloor, and drag a perpendicular line to the location of the traps. This enables a harvester to retrieve their traps, but keeps their location unknown to officers. Fishermen often encounter unmarked traps because it is more

likely that another harvester will set their traps on top of a set of unmarked traps unknowingly. Fishermen reportedly responded to the discovery of unmarked traps in two ways. The first is a practice locally referred to as “field dressing”, whereby a vessel will cut out the mesh netting of a lobster trap rendering it useless for capturing lobsters. The second response is to inform enforcement officers of the location of unmarked traps.

Another lesser mentioned complication to monitoring is the increasing scale of lobstering operations. While Davis (1984a) reported that lobster fishing occurred predominately within 25 miles from shore, harvesters now fish all the way to the 50-mile boundaries of their LFA. This expansion is also occurring in the Maine lobster fisheries (Brewer, 2012b). As fishermen expand to deeper more open seas, enforcement vessels must patrol a larger area. Monitoring is more effective inshore because inshore grounds are more intensely exploited, and trap buoys are more closely spaced. While it is often stated by inshore lobster fishermen, many believe that illegal activity is most prominent on offshore grounds.

The ability to monitor resource users in open-sea fisheries rests on the cooperation of the resource users themselves. Under geographical conditions where it is virtually impossible for enforcers to observe all but a small percentage of the infractions occurring, enforcement officers must depend on tips from harvesters. During the cod boom in the 1980s, harvesters worked together to evade fisheries officers. Fishermen in some communities shared information on the location of enforcement officers, ensuring that illegal catches and quota or trip limit overages would slip by unnoticed. Groundfish processors were also in cooperation with these operations, and marked large amounts of cod as “shack” or cusk to avoid quota overages and fishery closures (Field Interviews 2012). At the height of this illegal activity, one DFO official reported that they had gotten “the system down to a science.” More recently, fishermen from some

ports are less likely to cooperate to evade officers where it is likely that the infracting harvester will be the sole benefactor of the infraction. According to field interviews, many harvesters have increasingly cooperated with enforcement to report infractions.

The sense of dissatisfaction with the rules, rule-making process, and monitoring has led to frequent disputes with monitors. In a study by McMullan et al. (1993), enforcement officers describe the effects of this governance regime on their personal lives. Officers reported to be the subject of gossip (45%), to have received abusive or threatening phone calls (41.5%), to have received threats on their property (18.9%) and on their family (7.9%), and to have had their children harassed (5.1%).

#### 4.4.3 *Summary*

Weak feedback makes it difficult to change rules as conditions change. The difficulty is exemplified by fishermen's resistance to change. Many SWNS fishermen see no benefit to being involved in the rule-making process. Many resist rule changes. Of the fishermen I 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 voting fishermen. There are four often-stated reasons for fishermen's 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 fishermen believe that despite historical drawbacks, current rules are working for now. Third, many believe that any rule change will inevitably benefit one group of fishermen more than others. Finally, some fishermen believe that any rules coming from the DFO will only

damage their livelihoods (Field Interviews 2012). Fishermen perceive the benefits of participating in the decision-making process to be low and the costs to be high. These findings suggest that harvesters have low trust in the efficacy of DFO governance.

To summarize, the weak link between resource users and the DFO has produced rules that reflect DFO rationalities with little influence from fishermen (link 3). These rules have affected the behavior and dynamics of the harvesting process (link 5) in ways that resource users deem detrimental. This negative perception of the effects of DFO rules have reduced fishermen's participation in the co-production of rules at the local level (link 6). Polycentric governance would allow fishermen 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. In the following section, I discuss some of the adaptation failures caused by the weak feedback loops currently in place.

#### 4.4.4 *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 USA since 1975 (Steneck et al., 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 USA have been successful.

Recent studies of Atlantic ecosystems, however, have suggested that governance may only partially explain the rising abundance of lobsters. Steneck et al. (2013) suggested that the current success of lobster fisheries is an unintended consequence of failure to manage the groundfisheries of Atlantic Canada. While Atlantic cod have historically dominated the Atlantic Ocean as a top-predator, the fishing boom of the 1960s-80s effectively removed cod as a trophic level. The “ecological extinction” (Estes et al., 1989) of cod has pushed the Atlantic ecosystem into a 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 non-human 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 multi-species fishing communities to concentrate on lobstering. Once fishing communities set out on this path, it becomes increasingly difficult to change direction. The gilded trap has tightened since the economic crisis of 2008, which decreased both demand for lobster and access to credit, and increased the cost of bait and fuel (Weston, 2009). In Canada, the potential value of landed lobsters has not been realized due to increased gluts, in which 50% of lobsters are estimated to be caught within the first 15 days of the season (Weston, 2009). Fishermen’s main strategy for responding to low prices has been to fish harder and catch more. This strategy initiates a vicious circle, exerting higher pressures on lobster stocks and receiving lower prices for landed lobsters (Theriault et al., 2013).

Harvester responses to low prices were individual. When asked what they do to respond to low prices, 41.6% of fishermen 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 the LFA 34 and some of the LFA 33 fleets stayed at the wharf until buyers guaranteed a \$5 price per pound of lobster. While fishermen 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 \$3.

Individual strategies may have kept many fishing households in business, but new challenges to this lobster-dominated fishery may lie ahead. In the late 1990's, 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 et al., 2013). Lobstering communities and their governance regimes will likely need to adapt to a "brave new ocean" (Steneck et al., 2013).

Steneck et al. (2013) argued that I will need to be more "agile" in dealing with new challenges. Here, I argue that agility depends on the efficacy of the feedbacks between the collective-choice and operational levels of ocean SESs. While 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 fishermen 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. But 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. This dilemma exemplifies our main argument, that while achieving conservation goals is crucial to the robustness of fisheries, the rule-making process must not compromise the potential for collective action on the part of fishermen. Maintaining strong feedback between the operational and collective-choice levels ensures that future social-ecological goals can be met through collective action. A polycentric approach could promote localized initiatives and social experiments. DFO officials, facilitators and management boards have favored LFA-wide trap limit reductions to reduce gluts at the beginning of the season. Some harvesters have suggested a spatialized approach based on the productivity of lobstering grounds, and the costs of fishing more distant lobstering grounds. Support for these spatialized initiatives could bring together a subset of ports within the LFAs that exploit a sub-region of the LFA. Ports can share the results of these initiatives and experiments at LFA management board meetings. In this way, groups of harvesters can spread the rules that work to other relevant regions, and modify or abandon those that do not work for their regions.

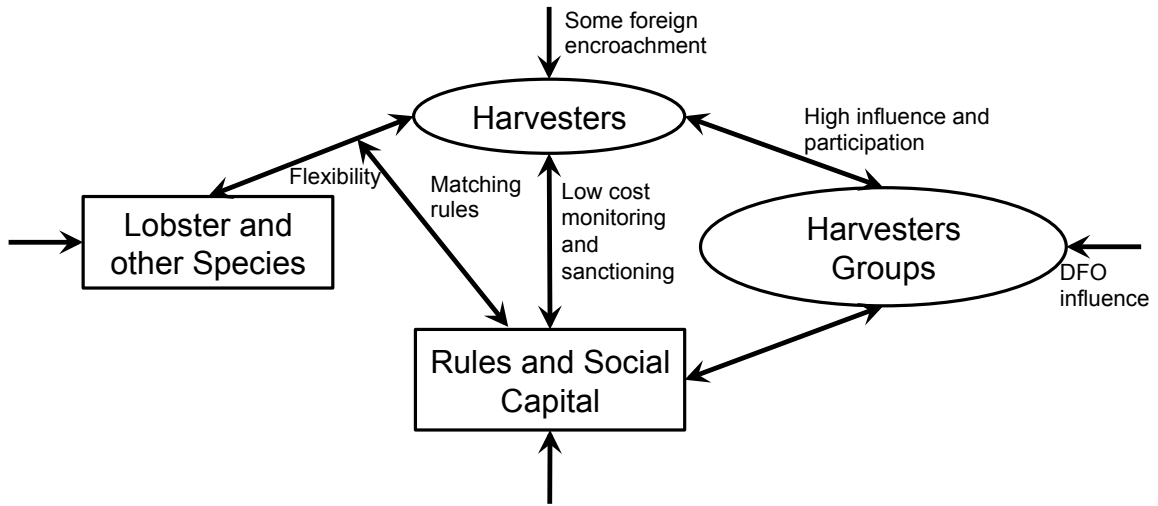
#### 4.5 Discussion

Figure 4.3 summarizes important interactions in the Port Lameron SES as a before and after snapshot, according to the framework developed by Anderies et al. (2004). 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

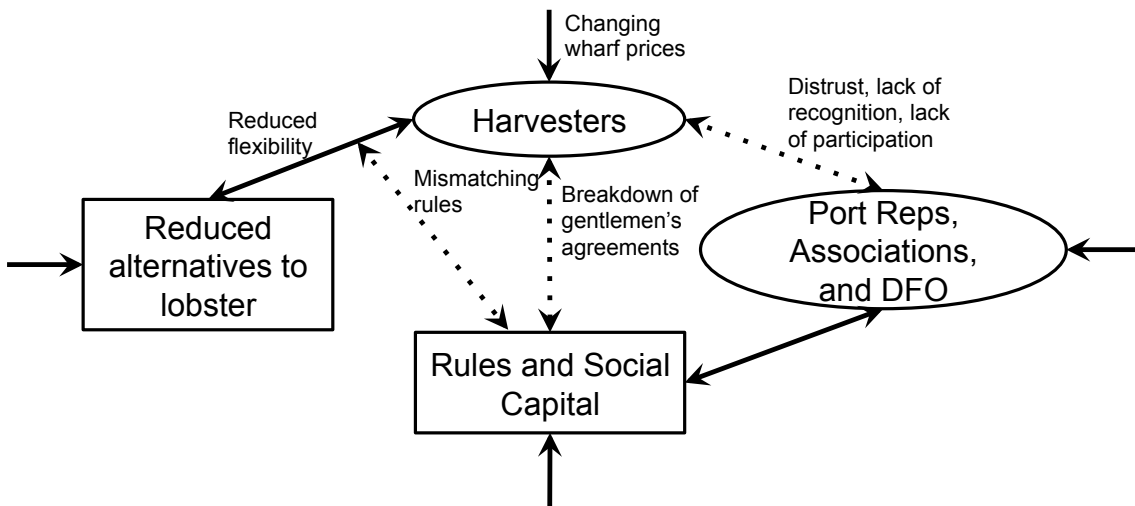
social preferences, spatial mismatches, trap limits that do not fit local social and economic conditions, and conflicts between enforcers and fishermen. The mismatches have reinforced the weak feedback between the SES's operational and collective-choice levels. Fishermen have little influence on decision-making in SWNS and perceive the benefits of contributing to the co-management structure to be small. The combination of governance mismatches and fishermen's perceptions of participation has resulted in deterioration of critical feedback between resource users and the resource, and deterioration of users' capacity to generate livelihoods from the resource. Based on this finding, I hypothesize that similar governance mismatches are strongly related to a lack of recognition of rights to organize, and weak collective-choice arrangements.

The co-management structure of SWNS has mostly disempowered fishermen 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 tradeoff in co-management processes—the tradeoff between empowering resource users to influence decision-making and regulating from the top-down. While co-management 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. This tradeoff may be avoidable in Maine by refining collective-choice rules to reflect the interests of a broader spectrum of lobstering stakeholders than just captains.

The SWNS fishermen I interviewed took a very negative view of the Canadian fisheries management regime, but it is important to consider 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



(a) The Port Lameron SES as originally described by Ostrom (1990) and Davis (1984a)



(b) The present-day Port Lameron SES as described above

Figure 4.3: Snapshots of the Port Lameron SES according to Anderies et al. (2004) in two points in time

economic dynamics. But change has created disturbances beyond the local-level. The state has played an important role in restricting user boundaries to bona fide fishermen 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 benefits of polycentricity relative to those of top-down rule making.

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, the trend toward consolidation of power can be checked by overlapping governance regimes, vertically or horizontally. In SWNS, ports could make decisions at a local level, 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) 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” (p. 289). 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. But I argue that there is greater potential for fishermen in Maine to engage in collective action to solve the economic and ecological problems they currently face, and those that may arise in the future. With greater dependence on lobster and increasing lobster abundance, fishermen in

Maine and SWNS have experienced lower returns due to seasonal gluts in supply (Holland, 2011; Weston, 2009). In SWNS, the potential for locally congruent harvester-influenced rules to solve this dilemma is low, because collective-choice arrangements are rigid. This regulatory rigidity, caused by harvester's resistance to change, makes the SES fragile. But potential for adaptive change still exists, thanks to the solidarity that remains among fishermen in ports and municipalities. Rather than influence the public-infrastructure providers (state government), fishermen can fill institutional lacunae by becoming infrastructure providers themselves, and developing locally relevant rules to smooth out supply and improve livelihoods.

The case of the collapse of the Atlantic codfishery highlights the threat of institutional failure in the region. Acheson (2006) argues that this case exemplifies Scott's 1998 criteria for *Seeing Like a State*. These criteria are 1) the attempt to make complex social-ecological processes legible and controllable, 2) "high modernism", or an uncritical belief in science and technological progress and a disdain for uncertainty and complexity, 3) a centralized state power that pushes legibility and high modernism, and 4) a civil society that lacks the capacity to resist government intervention. While the government's promotion of high modernist trawlers and large-scale processing plants have dwindled, DFO management continues without sufficient input and cooperation from harvesters.

Some progress has been made, however, as some science for lobster stocks is based on a partnership between scientists and harvesters. Also, the government has moved increasingly towards decentralizing power to smaller scales through consultation processes mentioned above. But the Canadian government has adopted a policy of austerity since the 2008 economic crisis. It announced \$79.3 million in funding cuts to the DFO from 2012-2015 (Bissett, 2012, May 29). MacDonald, (2013, April 8) estimated that these cuts will eliminate 1,164 DFO jobs, a 10% decrease. This loss will likely

constrain the knowledge-generating capabilities of the DFO (Hume, 2012, October 26). To maintain operations, the DFO closed three 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 fishermen (Comeau, 2012, November 23). Despite these changes, the top-down consultative decision-making process remains.

To respond to these challenges, fishermen in SWNS formed the LFA 33 and 34 Tags and Licensing Association to manage trap-tags, and to assist fishermen who are now required to renew their licenses online (Comeau, 2013, April 24). While efforts to change rules through management boards and the DFO have largely been ineffective, associations have organized fishermen's strikes and pushed for the opening of a cooperatively managed lobster processing plant on Cape Sable Island, 25 km from Port Lameron (Bennett, 2013, September 24). The DFO has been influenced by, and granted greater decision-making authority to organizations that have effectively represented fishermen in some regions of Atlantic Canada (Kearney, 1989). Current events in SWNS indicate renewed efforts by fishermen to organize. But to do this successfully, fishermen in SWNS will have to unite a diversity of opinions into one voice.

## Chapter 5

### JUSTICE, SOCIAL COHESION, AND HOUSEHOLD VULNERABILITY

#### 5.1 Introduction

The UN Food and Agricultural Organization (2008) estimated that 43.5 million people directly depend on capture fisheries for their livelihoods, with millions more employed indirectly along the commodity chain. But many fisheries face significant challenges. Demand for fish protein continues to increase (Food and Agricultural Organization, 2008), but the majority of fisheries studied to date are either over-exploited, being rebuilt, or at their maximum level of exploitation that they can support (Worm et al., 2009). Further, climate change is projected to have significant impacts on marine systems, altering nutrient cycling, water temperatures, ocean pH and chemistry, and the frequency and severity of extreme events (Brander, 2007; Worldfish Centre, 2007). These changes will affect the abundance and distribution of fish species, requiring fishing households to adapt. Fishing households also face the challenge of adapting to global economic changes, such as decreased demand for some fish species since the financial crisis of 2008 (Holland, 2011). In this paper, I examine the combination of processes and factors that make an Atlantic Canadian multi-species fishery vulnerable to economic and ecological change.

The Atlantic Canadian lobster fishery produces Canada's most valuable seafood with an annual export value ranging from \$800 million to \$1 billion, and recent catches averaging between 110 and 120 million pounds. This fishery is also an important source of employment, supporting 10,000 license-holders as well as additional crew, buyers, processors, boat builders and retailers. Since the Canadian government

declared a moratorium on the codfishery in Atlantic Canada, and imposed strict regulations on various fish species, fishing communities have considered lobster to be the “backbone” of coastal livelihoods. Yet despite increasing and seemingly sustainable catches, many fishing communities have declined in population, and fishermen, facing threats to their livelihoods, have frequently engaged in strikes for better prices.

I examined fishing households in Barrington Municipality, Southwest Nova Scotia (SWNS) to understand what makes fishing livelihoods vulnerable. I analyzed the interactions occurring among households, associations, and Fisheries and Oceans Canada (DFO), a federal government fisheries management organization. I then examined the impacts 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. My analysis was limited to the perceptions of fishing households, association leaders, and local experts involved in capture fisheries for multiple species, including lobster, haddock, cod, pollock, hake, swordfish, and tuna. I did not include regulators because the effectiveness of fisheries management depends at least as much on the social capital of fishing households, their perceptions of procedural justice in decision-making, and their definition of the problems and challenges the industry faces as it does on the rules set by regulators.

In the next section, I outline how together, the social-ecological systems (SES) framework (Ostrom, 2007) and vulnerability research contribute to understanding the sustainability of social-ecological systems and the vulnerability of households. I highlight the important contributions of vulnerability research to analyzing political-economic contexts, power relations, procedural justice, and social capital. I use the theory of a socially constructed adaptive landscape (McLaughlin and Dietz, 2008) to expand on the SES framework.



## 5.2 Theoretical Framework

Scholars have pointed to over-exploitation in fisheries as a tragedy of the commons (Gordon, 1954; Schaefer, 1957). Commons literature (e.g., Ostrom, 1990; Baland and Platteau, 1996; Wade, 1988) showed that these tragedies could be avoided, and suggested variables that characterized cases of effective governance of common-pool resources (CPRs). Others (e.g., Agrawal, 2001) challenged this literature for ignoring important variables, and highlighted the challenge of doing cumulative research on social-ecological systems with many relevant variables. As a response to these challenges, Ostrom (2007) suggested a framework to analyze the sustainability of SESs. In this framework, a SES is composed of interactions between the resource system, resource units, governance system, and users. These interactions lead to social, economic, and ecological outcomes, which then feed back into the components of the system. The interactions within an SES occur within a social, economic, and political setting, and the SES is linked to other related ecosystems. Ostrom (2007, 2009) also lists 51 variables that scholars have suggested to be important to characterize the components, interactions, and outcomes of a SES.

Ostrom (2007) does not attempt to suggest how we can determine if a SES is sustainable, rather the SES framework is meant to be used by one discipline to locate their contribution to a body of knowledge, and to complement the knowledge generated in other disciplines. CPR research often focuses on the attributes of the community, the biophysical environment, and rules-in-use that lead to a given outcome (Ostrom, 2005b). 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 (McLaughlin and Dietz, 2008; Eakin, 2005; Wisner, 2003; Downing et al., 1996; Kelly and Adger, 2000). I contend that the

SES framework can be used to explore the complementarity between commons and vulnerability research agendas.

The term vulnerability refers to the risk that social, economic, or environmental stressors will lead to adverse outcomes for individuals, households, or social groups (Clark et al., 2000). The vulnerability of a household or group depends on the degree to which they are exposed to a stressor, are sensitive to its effects, and are able to respond to or adapt to it (Clark et al., 2000). Vulnerability theory brings together the study of the interactions among socio-political structures, human agents, and environmental processes, leading to different outcomes for different social groups (McLaughlin and Dietz, 2008). The degree to which social groups are exposed to a stressor depends on its magnitude and distribution, both in space and time. For example, coastal communities are disproportionately exposed to the effects of sea-level rise, and an increasing frequency and intensity of storms (Intergovernmental Panel on Climate Change, 2007). Humans, however, are not just recipients of the effects of these stressors, they are agents capable of coping to change, or of altering their biophysical or political-economic landscape (Corbett, 1988; Adger, 1996). The ability of social groups to shape the landscape to meet their needs or interests depends on their political and economic power. One way a group can do this is to frame a problem in such a way that the solution will likely favor a certain gender, class or race (Tierney, 1999; Enarson, 2002). Thus, the variability of vulnerability among different social groups also depends on the level of inequality of power relations among them (Pelling, 2001; Wisner, 2003). 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. For example, British colonialists invoked a discourse of “forestry as progress” to legitimize teak production for imperial expan-

sion, and marginalized Burmese discourses on local forest control and subsistence use (Bryant, 1996, p. 169).

Vulnerability scholars have emphasized the importance of social capital for the adaptive capacity of households or social groups (e.g., Adger, 2003; Eakin and Lemos, 2006; Eriksen and Lind, 2008; Mustafa, 2005; Pelling, 1998; Pelling and High, 2005). Adger (2003) distinguishes between two elements that constitute social capital; local-level bonds of kinship and friendship, and extra-local social networks of trust and reciprocity. These local-level bonds and extra-local networks “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 will clash with local civil society, and this interaction exacerbates the vulnerability of communities (Adger, 2003). Pelling (1998) found that households used individual mitigation strategies to respond to urban flooding because of a weak civil society and a centralized decision-making process that alienated communities. He argued that a centralized political culture “caused local social capital to deteriorate and stifled civil society.”

Because of its emphasis on the differential vulnerability among households or social groups, vulnerability research is intertwined with with issues of social justice (Dow et al., 2006; Kasperson and Kasperson, 2001; Cutter, 2012). Rawls (1971) defined social justice as the fair distribution of goods in a society. Other scholars have expanded this definition to include justice in social relations and processes. In a review of justice literature (e.g., Young, 1990; Nussbaum, 2001; Sen, 1992; Fraser, 1998; Honneth, 1996), Schlosberg (2009) argues for a definition of justice that include access to resources, participation in decision-making, fair and democratic procedures, and the capabilities of individuals and social groups. This expanded definition incor-

porates distribution, procedures, and agency. Young (1990) and Adger et al. (2006) argue that procedural justice is an important precondition of social justice. Additionally, Adger et al. (2006) suggests that adaptation to climate change depends on the legitimacy of decisions made by local and national governments, and legitimacy in turn, rests on procedural justice.

Concepts of justice, social capital, and vulnerability imply interactions among different scales and levels (Adger et al., 2008). I use levels to refer to hierarchically arranged jurisdictions or territories, such as state, province, region, or fishing port (Poteete, 2012). I use scale to refer to the area or time-frame within which a phenomenon is studied (Cash et al., 2006). 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 fragilities at the level of a fishery or fishing region. Conversely, policies designed to ensure sustainability of resources at the regional level or scale can create vulnerable conditions for households who depend on those resources, at least in the short-term. The management of a social-ecological system is effective according to the degree to which it applies rules that are scaled to match the scale of the problem (Cash et al., 2006), and uses incentive structures that promote stewardship (Eakin and Wehbe, 2009).

### *5.2.1 Vulnerability in fisheries*

Cinner et al. (2012) found numerous drivers of vulnerability in fishing communities, including the diversity of income sources, the terms and information of market relationships, inflexible non-adaptive policies, and weak social capital among households. Daigle et al. (1996) analyzed the causes of opposition to fisheries regulations using the criteria for procedural justice. These criteria include consistency, suppression of bias, the belief that information used for decisions is accurate, the potential

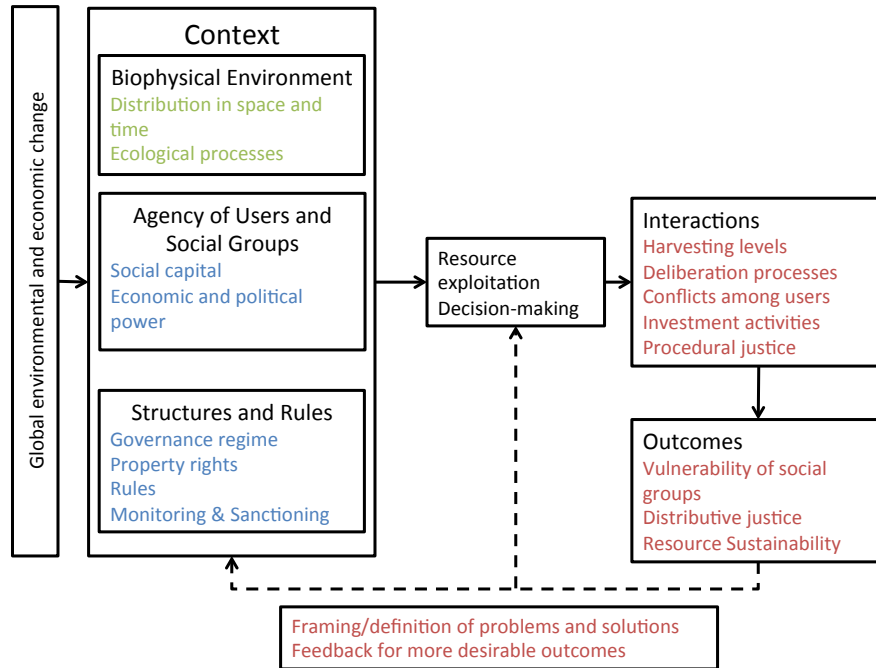


Figure 5.1: A summary of the contextual interactions of environment, agency, and structures that have influenced the action situations and interactions of the SWNS multi-species fishery.

for rule modification, the opportunity for all affected to voice their opinions, and the degree to which rules and regulations coincide with the values and morals of groups involved (Leventhal, 1980). Daigle et al. (1996) argues that these criteria are necessary to prevent conflicts among regulators and fishermen, while also allocating resources wisely. For vulnerability research, this implies that adaptive and flexible decision-making in the face of social-ecological change requires procedural justice to maintain the legitimacy of governance systems. Procedural justice is fundamental to decision-making, whether it is top-down or some other form of participatory co-management. Both approaches to governance may or may not adhere to principles of procedural justice. For example, shortsightedness in participatory approaches is

caused by procedures that do not effectively deal with stakeholder bias, and effective top-down management depends on how well a benevolent dictator can make rules that reflect the concerns and moral values of those who are affected. Where the social groups affected by decision-making perceive procedural justice to be low, it is more likely that they will engage in “everyday forms of resistance” (Scott, 1986, p. 6), or that government agencies will create rules that cause distributional problems (Adger et al., 2006; Pinkerton and Weinstein, 1995).

Figure 5.1 provides a summary of the above discussion including the interactions between the biophysical environment, the agency of social groups, structural forces and rules. I apply these concepts to the decision-making and resource exploitation process in Barrington, the interactions between fishermen and DFO managers, the livelihood strategies of fishermen, the vulnerability outcomes for households, and the differences in problem definition among fish buyers and harvesters. In the following discussion, I provide case-study research to understand three questions. First, what makes fishermen vulnerable to economic and ecological change? Second, how do household livelihood strategies scale-up to the area of the fishing district? Finally, how do different agents in the fishing industry characterize the problem? I used the Ostrom (2007) SES framework as a template to determine important themes in the system. I define these themes, their interrelationships, and the difference of theme usage among buyers and fishermen using an inductive approach and text analysis. Using this approach, the importance of procedural justice and social capital to the vulnerability of fishing households and sustainability of fisheries became clear. This study can be used by broad-scale studies of fisheries vulnerability, and by those who focus on the potential and actual consequences of policy instruments and decision-making processes.

### 5.3 Study Area: Barrington, Nova Scotia

Barrington municipality includes a large number of communities situated around fishing wharves, including Woods Harbor, Cape Sable Island, Port La Tour, Smithville, and Baccaro. The total population of this municipality is 6,994. Similar to many towns in the region with economies based on the fishing industry, Barrington has been in a state of decline since the mid 1990s, when the DFO began to set strict regulations on the groundfisheries (i.e. cod, haddock, pollock, hake) 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. In the past 30 years, fishermen from Barrington have burnt and sunk DFO enforcement vessels, occupied national monuments and DFO offices, blockaded foreign fishing vessels, and engaged in strikes against fish buyers. More recently, fishermen 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.

#### 5.3.1 *Description of management system*

The lobster fishery is currently managed by the DFO under advice from regional management boards (see Chapter 4). The regulations, summarized in Table 3.2, place emphasis on protecting juvenile and egg bearing lobsters to ensure continued larval recruitment. Additionally, restrictions on traps, boat size, and limited entry 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, such as cod and haddock, in lobster traps.

#### 5.4 Methods

I conducted fieldwork in the summer of 2012 (May-September). I conducted participant observation to establish rapport in the community throughout the fieldwork. This including participation in fishing at sea, in baiting longline trawls at shore based facilities, and participation in events within the community (e.g., weddings, boat races). This allowed me to expand my list of potential contacts and interviewees, and to gain insider knowledge of customs and norms in the communities to ensure that interview and survey questions were culturally appropriate and understood.

I used a combination of snowball and random sampling for surveys and semi-structured interviews. Upon arriving in Barrington I established connections with key informants based on contacts suggested by outside experts and during participant observation. Key informants helped me develop a list of potential respondents. I selected respondents randomly from this list and added potential respondents based on the recommendations of respondents.

I administered 113 face-to-face surveys of active fishermen, and interviewed 16 active fishermen considered to be knowledgeable, five lobster buyers, and two each of government officials or representatives, lobster association leaders, and groundfish association leaders. For the purpose of anonymity, I refer to association leaders, officials and representatives as “local experts”, and use pseudonyms for all individuals. Interviews lasted between thirty minutes and two hours. While questions were varied for each type of respondent, all respondents received four similar types of questions: 1) what are the biggest challenges to livelihoods in the industry today? 2) What changes have brought about this challenge? 3) What are (fishermen, buyers) doing



to respond to these challenges? 4) What enables or limits their ability to respond? (See Appendix C).

I coded transcriptions from interviews, as well as comments and responses to surveys. I used transcriptions of surveys and interviews for analyzing the relationships between themes, but only used interview responses to compare theme usage between buyers and fishermen. I used the variables suggested by Ostrom (2007) as themes, and coded sub-themes inductively as needed (Ostrom, 2007, Table 1, p. 15183). For example, property rights, an attribute of the governance system, was further subdivided into quotas and licenses, to distinguish between quotas for fish, and licenses for lobster. I include the 13 most frequently occurring themes discussed by respondent to characterize attributes of the governance system, resource unit, resource system, resource users, interactions, outcomes, and political-economic setting.

I coded themes by responses to questions. In cases where respondents brought up multiple subjects in response to one question, I used transitioning statements (e.g., “another problem is ...”) to break up the transcript into separately coded paragraphs.

In the next step of the analysis, I examined how the themes were related to each other in the text. For example, the co-occurrence of themes of dependency on lobster and livelihood outcomes suggests a correlation and potential causal relationship. Using MaxQDA, I generated a matrix of theme co-occurrence and corrected it for the frequency of occurrence. This corrects for the probability that frequently mentioned themes will have more co-occurrences with all themes. I analyzed the matrix of co-occurrence using multi-dimensional scaling (MDS, UCInet), which groups similar themes and visualizes their euclidean distances in two-dimensional space. The resulting plot revealed clusters of themes. 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 chance (Sturrock and Rocha, 2000). Thus, MDS plots with 13 objects that approach this value can be considered to be statistically significant. MDS distinguished four main clusters of themes illustrated in Figure 5.2 in a two dimensional plot with a stress of 0.206. These clusters were decision-making and social cohesion; quota cuts, buy-ups and quota leasing, referred to below as ownership and control; price bargaining, market conditions, storage, lobster quality, lobster fishing strategy, and temperature change, referred to below as economy and ecology, and the price of lobsters; and dependency and livelihoods, referred to below as livelihood outcomes.

After I identified clusters of themes. I used Wilcoxon rank comparison test, often used to test for differences in the counts of themes. I compare the themes discussed by buyers and fishermen during interviews only (local experts were not included in this test due to low N). In all cases, P-values are provided for the difference between buyers and fishermen in the number of times a given theme is mentioned, including a False Discovery Rate correction for multiple comparisons. This test was used to determine whether the main drivers of vulnerability differ among social groups.

## 5.5 Results and Discussion

In the following sections, I discuss the clusters of themes determined in figure 5.2. The occurrences of these themes and their correspondence to variables in Ostrom (2007) are listed in table 5.1.

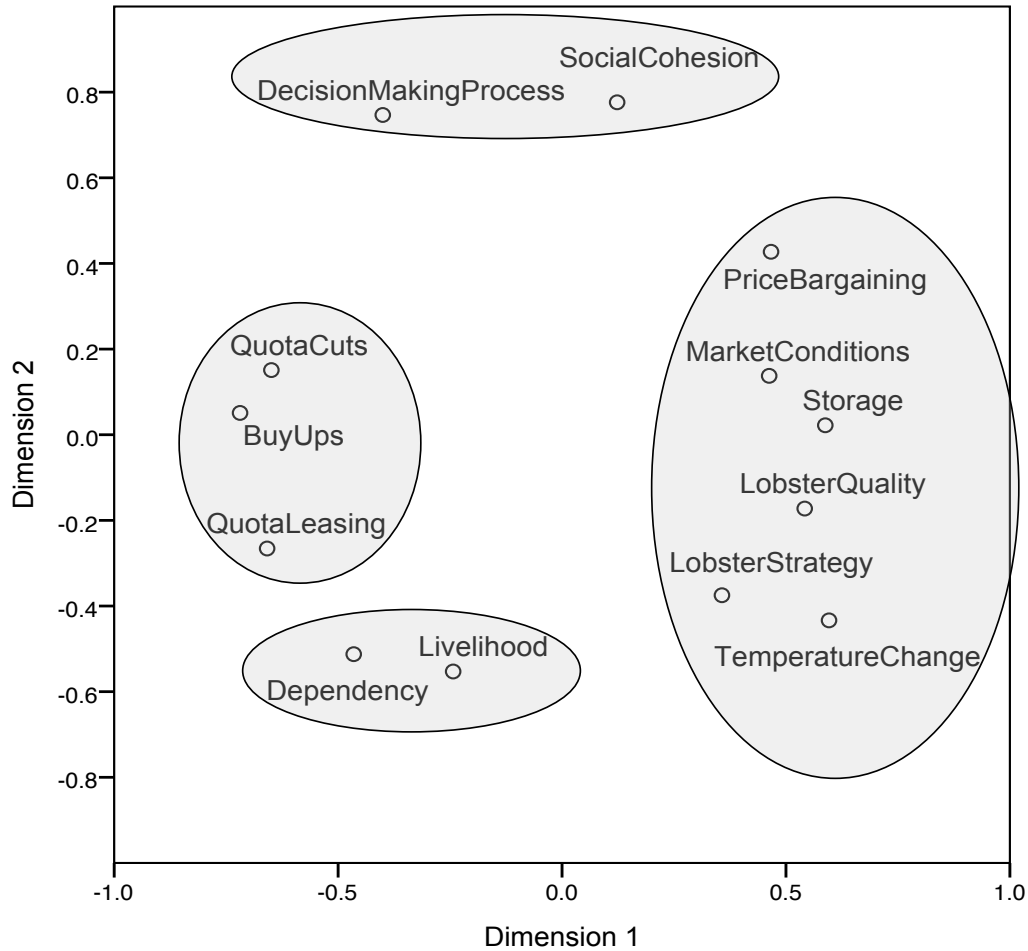


Figure 5.2: Multidimensional Scaling of themes from semi-structured interviews, surveys, and field notes.

### 5.5.1 Decision-making and social cohesion

#### Low Procedural Justice in Decision-Making Processes

The decision-making process included meetings with lobster fishing area management boards, consultations over policy with the DFO, and advisory meetings where fishermen can comment on the findings of DFO scientists. Fishermen and association leaders had little trust in Fisheries and Oceans, Canada (DFO), and regarded the decision-making procedure as unfair. Of the six criteria for procedural justice listed in Daigle et al. (1996) and Leventhal (1980), industry's responses suggested that

Table 5.1: Themes discussed by fishermen, buyers and local experts, represented according to the SES framework (Ostrom, 2007, 2009)

## Social, Economic and Political Settings

Market conditions (64)

### Resource System

Tankhouses, lobster cars, and lobster pounds (76)

### Governance System

Fish quotas/leasing (77)

### Resource Units

Quality of lobsters (82)

### Users

Social capital (sticking together) (126)

Dependence on resource (82)

### Interactions → Outcomes

Lobstering strategy (119)

Livelihood outcomes (92)

Price bargaining/conflict (77)

Deliberation processes/decision-making (99)

Quota cuts (85)

Buy-ups (76)

### Related Ecosystems

Climate-change/water temperature change (28)

decision-making procedures did not give fishermen the opportunity to adequately voice their concerns, were inconsistent, based on inaccurate information, and inflexible or irreversible. I will discuss these four criteria in the following paragraphs.

Meetings between DFO and industry generally have a period for industry to voice their opinions and concerns, but respondents complained that their concerns were not recognized and accounted for in these meetings.

These management boards are only in an advisory capacity. So they can make recommendations to Ottawa, and Ottawa will basically dictate what the policies are. To me, there has to be a more direct involvement with these sets of policies, almost on a regional basis ... (Logan, local expert)

Industry makes recommendations at meetings, but the final decisions do not represent these recommendations. These unrepresentative decisions frustrate and dissatisfy industry, and demotivates participation in the process. Fishermen believe that participation does not only lead to frustration, it can also serve to legitimize the DFO decisions they oppose.

One of our friends was on [a lobster management board] for years, and DFO said “Well you fellas passed this.” And he said, “No, 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.” (Aaron, local expert)

Fishermen and local experts also suggested that decisions were inconsistent among officials and over time. For example:

... we used to have to comply to owner-operator, it was one boat one license, one license holder, then this lady came in Yarmouth and she said, “No, now you are allowed to stack a license ...”, and so, behind closed doors, this was negotiated with companies ... and then ... she was transferred, so who do you complain with? (Jake, fisherman)

Jake refers to a change in the conditions limiting who can own a lobster license, and how many licenses one harvester can own (see Ownership and Control below). Inconsistency creates uncertain conditions that make it difficult for fishermen and new entrants to plan, invest in fishing and gear, and retire.

Many in the industry believe that the scientific information used to determine quota allocations is inaccurate, especially regarding groundfish. Fishermen and quota groups have criticized the techniques the DFO uses to estimate 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. Fishermen argue that sampling strategies should not remain the same, but should change according to temperature and current changes. Finally, fixed-gear longliners often argue that baited hooks can demonstrate better productivity than the bottom trawlers used by the DFO to estimate biomass. While it is likely that DFO scientists provide credible scientific information for decisions, they have been unable to present this 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 Wyatt, a local expert, “If the fishermen makes a decision and a regulation is put in place, 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, to a lot of detriment to your industry.” Industry believes that it is difficult to modify rules, and the DFO is often obstinate even when the conditions in fisheries threaten livelihoods. This may explain the failure of the LFA 34 lobster management board’s attempt to introduce a temporary rule, which would have reduced the number of traps each fisherman could use in the fishery from 375 to 300. While the management board believed that this measure would have improved profits for lobster fishermen, 60.6% of license-holders voted against it.

In addition to the procedural problems suggested by Daigle et al. (1996) and Leventhal (1980), fishermen pointed out that the decision-making process is complicated by difficulties in communication between the industry and scientists and managers. While fishermen have extensive knowledge of their fishery, some have trouble under-

standing the potential consequences of regulatory changes:

You know what fishermen are like . . . [T]hey know what they are doing out in the boat, but 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. (Brody, fisherman)

It is likely that the procedures of decision-making would be more representative, consistent, legitimate, flexible, and understandable if industry members were more directly represented at the scale of the wharf where they land their catch to more regional scales. Fishermen frequently talked about the need to “stick together,” or to “get together and talk about the good of the fishery as a whole, not with personal interest, and take those ideas to the DFO, and tell them this is what we're going to do, not, ‘will you let us do this?’” (Aaron, local expert). Marcus, a local expert, suggested, “if fishermen do not get organized, the government will step in and do something.” I will now turn to the challenges the industry faces when attempting to stick together.

### **Strong Community Bonds, but Low Social Capital in Fishing**

Respondents frequently spoke of the need for cohesion among fishermen, perhaps because I interviewed them one month after they went on strike. While some were proud of the solidarity among fishermen during the strike, others stated that “people were fighting against each other instead of standing up for each other” (Jackson, fisherman). Fights occurred when some fishermen attempted to go fishing while others were on strike. While many in LFA 34 went on strike in LFA 34, fewer did in LFA 33. Much debate centered on the ability of different fishermen to miss fishing

days in the fall. According to Brody (fisherman), there is “[a] lot of difference when you got a big debt hanging over your head, and it affects the way you think too. But like I say, if we could unite as one I think we could be way better.”

Fishermen in SWNS often are attached to place, and to their identities as fishermen. For example, Landon (fisherman) stated that fishing is “in my blood and I love it”, and Riley (fisherman) said that he could make better money if he moved to Alberta but, “[t]his is my home. [Is it] that bad to ask for a job at home?” 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 what suits them” (Lucas, fisherman). Some fishermen reported that decreasing social interaction and increasing competitive “cut-throat” attitudes have further divided communities. For example, many fishermen said that people used to help each other haul their boats up for repairs and cleaning. According to Landon (fisherman), “people would come out of nowhere to help, as if they were coming from the bushes. Today, they might try to knock your boat over to smash it in two.” Mason (fisherman) suggests that “. . . there’s no helping one another out no more. There’s no sense of being a fishermen. People aren’t proud to say they are fishermen and we’re losing our culture.” To others, the cutthroat attitude has always been a part of fishermen’s culture, and will be difficult to overcome.

Fishing has always been, “I’m trying to outsmart you . . .,” and it’s almost like when this challenge comes along, we’re all against it . . . and then we start thinking about it, and the more we think, some of us will start splitting off and saying, “I can survive that challenge, but can he?”



... “Can I hang in there and survive another year and then maybe I’ll get more.” (Easton, fisherman)

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, Barrington and SWNS pooled their resources to continue the search, and helped to pay for a group of fishing vessels carrying chartered rescue divers. The fishing vessels found the hull of the 13.5 metre vessel 100 kilometres offshore, but rescue divers could not find the five men. This unfortunate news brought closure to the family and friends of the lost fishermen, and to the coastal communities of Atlantic Canada. By August 2013, a charity raised \$111,000 in local and national donations, which was given to the families of the lost men.

The above story demonstrates the capacity for 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. Fishermen have social bonds within communities, but often do not trust fishermen 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.

### *5.5.2 Ownership and control of fisheries*

The nature of a fisherman’s ownership of quotas and lobster licenses determine the costs of fishing, and the share of landed value they receive for selling their fish. According to some fishermen, those who foresaw quota allocations found ways to secure a larger share. For example, a processing company was described as having an “in-

side scoop,” making some “smart purchases” to secure quota by buying licenses and vessels before the transition to quota management. According to Jeremy (fisherman), these individuals “only used the cards . . . the government give him to play, that’s all. But the little fella, for a quick fix, was selling thinking it was the best way out, right?” The “little fella” were often hand-line fishermen who did not keep accurate records of their catches, and consequently received a low allocation based on their historical catch records. As big fella bought up little fella, quotas for swordfish, halibut, cod, haddock, and other species became concentrated. Fishermen give different estimates of how much quota processors own because they have low access to reliable information. The groundfishery, is a multi-species fishery, and thus an agent who controls key species can control access to other species. Those processors who have secured quota can benefit by getting both ends of the margin by leasing out quota, and by buying and selling the fish caught from the quota they lease out. While fishermen do not place blame on processors for buying quota up, many fishermen argue that it is contrary to local norms and cultural practices “that a man should own fish and sit at home” (Aaron, local expert).

The concentration of quota has been intensified by quota cuts. Because the DFO perceived an imminent collapse in the region, It took action to conserve the resource by cutting quotas. From 2000 to 2011, the total allowable catch (TAC) for cod in the fixed-gear fishery was reduced from 3309 to 938 metric tons on Georges Bank (4X), and 858 to 421 inshore (5Z). As quotas decreased, those with small initial allocations began to sell what little they had left to other companies or individuals. The Fisheries and Oceans Canada (2009) report on cod stocks found a high rate of unexplained cod mortality despite reducing fishing effort on all fishing grounds. The mortality rate may be due to high predation rates from seals, as well as discards and unreported landings.

In the codfishery, the quota and fish-pricing system incentivize high-grading and discarding, locally referred to as “shacking” fish. Discarding occurs when multiple species are sought on a quota, and when it is difficult to catch one species without catching others. When the quota for codfish is reached, some fishermen may continue to fish for haddock until that quota is reached and discard any cod that they catch. 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 would be reasonable. But when the DFO allocates six pounds of haddock for every one pound of cod, it becomes prohibitively difficult to catch haddock without overrunning the cod quota. Fishermen have characterized these allocations of separate single-species quotas as “fishing with a shopping list.” The higher the ratio in this allocation, the more likely a fishermen will shack fish off. But shacking is not the only strategy to avoid overruns. For example, on one fishing trip, I witnessed groundfishing vessels sharing information on cod catches in an attempt to find fishing grounds with a low ratio of cod to haddock.

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 that type exclusively. For example, the price of cod varies according to the size of fish. January 2010 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. These price differentials also exist for haddock and other groundfish species. Pat (local expert) suggests 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, Pat, sell my

fish, and I'd say, "So what do you want for it?" "Ah, doesn't matter, long as I get enough to pay you your dues and I get a little money tucked aside for deer hunting." They didn't care because they were doing so fantastic on the water for lobstering ... Now it's not the same. "What's the most you think I can get?" And that is, it's economics. One industry affects the other ...

Wyatt recounted a meeting in which it was suggested that all groundfish be bought at the wharf with one price. At the meeting, Wyatt stated that fishermen were "stomping against that," but now he sees the potential of changing the price structure to incentivize fishermen to land all fish caught.

With such drastic declines in quotas, the majority of fishermen who continue to fish in the summer lease quotas from dealers, processors, or retired fishermen. For some, "friendship and family provide a buffer against prohibitive quota prices" (Oliver, fisherman). While quota prices are driven by local demand, wharf prices are driven by overall supply and international economic conditions. As fishing revenues decline in the lobster fishery, more fishermen attempt to supplement their incomes in the quota fisheries. This drives up local demand, and increases quota prices, with a weak connection to wharf prices. One fisherman 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). As was suggested above, quota lease prices may be higher when incomes from the lobster fishery decrease, but quota lessees will also be willing to pay more for quota. According to Jeremy, "[Y]ou 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 for a fishing trip is higher.

## **Buy-Ups in the Lobster Fishery**

Many fishermen fear that the lobster industry will eventually succumb to the same process of consolidation that has occurred in the quota fisheries. Whether it will or not depends on the future of owner-operator and fleet-separation policies. Owner-operator policy states that a license owner must operate the licensed vessel, while fleet-separation policy blocks vertical integration by prohibiting shore-based facilities from owning the harvesting fleet. These policies aim to “maintain an independent and economically viable inshore fleet, . . . ensure that the benefits of fishing licenses flow to the fish harvester and the coastal community, and assist fish harvesters to retain control of their fishing enterprises” (Fisheries and Oceans Canada 2010, February 8). The policies were an attempt to stop the truck system, whereby harvesters were tied by debts and sale of daily catches to one buyer holding a local monopoly on supplies and a monopoly as fish buyer (Davis, 1975; Innis et al., 1940).

Today, many fishermen are weakly tied to a buyer through arrangements for ice, bait and other supplies, but buyers cannot exert as much control over a fisherman’s catches unless they engage in contractual agreements with fishermen for licenses. For example, in a trust agreement or controlling agreement, a company or individual may agree to pay a retiring fisherman who wishes to sell his license. The retiring fisherman will then transfer that license to an eligible fisherman in a contractual agreement with the buyer. The new entrant, then, is bound to the obligations set out in the contract with the buyer. This arrangement has become more prevalent as the market price of licenses has increased to as much as \$500,000, and banks have become increasingly hesitant to finance loans for license purchases (Bodiguel, 2002; Weston, 2009). Individuals or agencies have also used trust or 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 through trust agreements. In Barrington, 11% of survey respondents reported that they were currently in a trust agreement, and 6% reported that they were previously in trust agreements. Local experts living south of Barrington suggest that trust agreements are much more prevalent in ports such as Yarmouth, Meteghan, Digby, and Pubnico.

The details of these trust 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. Under trust agreements, fishermen are obligated to give a share of their landed value to the agent who controls the license. For example, Jacob, a fisherman tied to a lobster buyer in a trust agreement, pays 47% of his landed value to the buyer, fishing expenses are then subtracted, and the remainder is split equally among captain and crew. In this arrangement, the captain does not own boat, gear, or license. Other informants estimated that approximately 10-15% is deducted from total revenues when the captain owns the boat and gear, but not the license.

Jacob was not distressed about his arrangement. With no large stake in the fishery, he said, "I can walk away anytime I like." Another harvester reported that engaging in a trust agreement saved him from losing his boat, and added that the individual who controlled his license "...used me pretty good. Without it I would have been out West." Nevertheless, Jacob, other harvesters and local experts worry about the potential for consolidation of lobster licenses by an individual or agency. In general, 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

got the money and then they'll just get someone else. They'll never go aboard the vessel, but they want to just take over, I mean it's just. It's sad ... (Chase, local expert)

Andrew (harvester) suggests that companies have taken advantage of the current economic problems harvesters face to further consolidate their control.

I just looked into it recently. In Shelburne and Yarmouth County, there are 25 boats in arrears with the loan board that can't pay their interest. There are 30 something that are just paying interest, or having interest paid by family members or corporations. [A private agency] is buying up boats in arrears. Fifty percent of Yarmouth boats are corporate owned.

Joel and Pat, lobster buyers, argued that "landlocked businesspeople who buy and stack licenses, and lease them out through trust agreements also act to distort the costs of fishing upwards." When the trust agreement share deductions are high, it leaves tighter margins for captain and crew. Dale, a retired crewmember, provided the example of a captain engaged in a trust agreement who had "paid for his license twice." From the buyer's perspective, a trust agreement may drive wharf prices up, but it may also drive down the price for a fisherman, because "if he owned the rig, he'd have more freedom to ... sell his lobsters where he wants. He's got no choice, he's got to sell to the buyer" (Brody, fisherman).

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

Well the crews are out there for free because there's no way they can get anything from [groundfishing] ... [but] the crews have to stay on, because, say that dragger owns 7 lobster licenses. That crew does lobster

and fishing, so even if you do rotten fishing, unless you don't want to lose your lobster site, you're gonna stay on that boat.

### 5.5.3 *Economic and ecological change, and the price of lobsters*

Respondents described a complex web of effort, storage, and exchange that links a fisherman in Barrington to dinner tables predominately in the United States, China, and Europe. This process exhibits a seasonal pattern that fishermen and buyers knowingly exploit. At the beginning of the season, catches are high thus buyers often open at a lower price. At this time, fishermen store a large proportion of their catch in lobster cars, which are semi-submerged wood-and-wire cages. With cold fall and winter temperatures, lobsters enter a dormant state and can be kept alive with minimal effects on quality. Winter weather often limits fishing effort, as storms and rough seas are more prevalent, and cold temperatures limit lobster activity. Buyers store lobsters in tankhouses with refrigerated pools of circulated seawater. Demand generally increases through Christmas and continues to rise through February (especially around Valentine's Day). As a result of this seasonality, the industry 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 effectively explained the variance in wharf price for lobsters using data on the US-Canada currency exchange rate, overall lobster landings, the GDP of the United States, and the extent to which lobster landings are being processed by Canadian processing plants (Holland, 2011; Fisheries and Oceans Statistical Services, 2012). Given the poor performance of US currency in relation to the Canadian dollar, and poor economic conditions in the United States since the economic crisis of 2008, it is reasonable to expect a decline in demand for lobsters.



Additionally, increased landings in the United States and Canada have made gluts bigger at the beginning of the season, so more lobsters are sent to processing plants. Jack, a local buyer described the economic conditions that led to low prices in the spring of 2012:

The Americans start dropping their price because the lower they can get them from us, the more profit they can make from there. They more or less had us. 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. I mean [the fishermen] wanted to sell. They were in every day: “Can you sell my lobsters, can you move the lobsters?” So we sold them and give them 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, time was going, and the fishermen we’re starting to put their gear out for the spring. We were caught in a no-win situation.

With increased landings in the beginning of the season and decreased demand, buyers could not sell their product to the live market quickly enough. As time passes, lobsters stored in tankhouses and lobster cars lose quality due to “shrinkage” (loss of meat-mass), and with the threat of lobsters dying, buyers reportedly sold their lobsters to processors at a loss.

Climate change has increased the uncertainty of returns from fishing and storing lobsters. While many harvesters did not attribute water-temperature changes to climate change, 91% of the harvesters surveyed believed that water temperatures have gotten warmer since they started fishing. In the year 2012, both harvesters and scientists reported anomalous water conditions. For fishermen, changing water temper-

atures affect the abundance and the quality of lobsters, as well as lobster-harvesting strategies. Warmer water temperatures increase the metabolism of lobsters, which may partially explain increases in lobster abundance. With higher water temperatures raising metabolic and growth rates, it is expected that lobsters will molt more often and at different times. This leads to storage problems. Fishermen often recounted unanticipated events when storing their lobsters, such as lobsters molting in storage, or more frequent die-offs.

Water temperatures also influence the reproduction and migration patterns of lobsters. Male lobsters prefer habitats where water is warmer, up to 19°C, while females must balance a tradeoff between warm waters that promote growth, and colder waters (below 8°C) that promote ovarian development (Chang et al., 2010). 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). Fishermen 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 numerous studies demonstrate 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, as described by Jake, a fisherman:

It used to be an inshore fishery ... I'm talking about a guy that goes out at 6:00am; he's back from 3:00 to 6:00 pm. The offshore boats might be gone for two days, three days, and the guy that fishes inside, the bottom is better, lobster is healthier the yield is good. That 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 . . .that's why people are making bigger boats, bigger to follow the Jones or to catch more dollars . . .

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, fishermen are motivated to fish for quantity, especially when prices are low. For example, Ethan (fishermen) says, "You're really forcing it to try to sustain that income, right? I mean, we're forcing a lot harder in the wintertime, fishing harder to try to make up for the downfall in price." While some fishermen said that they fished harder or more aggressively when prices were low, others used cost-reducing strategies. For example, many harvesters reported "slack[ing] back on the gas pedal" to improve fuel efficiency. Another response to low prices was to increase 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. For example, Easton said, "I would say a lot of them managed because of the good weather, they fished all through the winters so their catch was up." Davis (1984b) observed that all fishermen in Port Lameron landed their traps in late January until the weather improved and lobsters started to "crawl." The fishermen I interviewed reported that lobsters were more active throughout the winter, due to warmer waters and more stable water temperatures offshore.

Taken together, market conditions, storage, lobster quality, and lobstering strate-

gies lowered demand, increased storage risks, made lobster catch quality less predictable, and resulted in higher catches and thus lower wharf prices. Some fishermen have resorted to collective bargaining for better prices through strikes, generally directed against the local buyers. In the May 2012 strike mentioned above, more than half of the 1688 fishermen in LFAs 33 and 34 refused to fish if prices dropped below \$5 per pound. fishermen were divided on the effectiveness of this tactic. For example, Liam (fisherman) stated, “It’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 Noah (fisherman) said, “You’re not going to miss out because you’ll catch them in the spring.”

Collective bargaining strategies have been proposed to correct imbalances in the port market system, in which harvesters have little choice but to sell a deteriorating resource to local buyers, and local buyers have, in turn, little choice but to sell to wholesalers with greater market control (Steinberg, 1984). But local buyers often suggested that the strike tactic has been disproportionately directed at them. For example, Aiden 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. All of my fishermen [that sell to me] have lobster cars. The big cookers [processors] set the price. I’ve been taking a lot of abuse.” In an interview involving two buyers, Joel and Ben, 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.

#### 5.5.4 *Livelihood outcomes for harvesters*

Harvesters linked livelihood outcomes to dependency on lobster, and to the ownership and control of lobster licenses and fishing quotas. Davis (1984b) reported that Port Lameron had a multi-species fishery, with harvesters fishing for cod, haddock, hake, pollock, herring, mackerel, and lobster. Because all fisheries except the lobster fishery have declined, dependence on lobster has increased significantly. A retailer in Barrington pointed out that this dependency creates a lot of tension as lobstering season begins. “There is a lot riding on the first haul of the year . . . Fishermen will have their new furnaces and their Christmas gifts on layaway, and they aren't ready to pay for it until their first haul.” In some households, spouses have taken on jobs to supplement household incomes. Harvesters often spend the summers repairing and building traps and lobster cars to reduce the costs of fishing. 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” (Brody, fisherman).

For some, higher lobster catches have made up for lower prices, and incomes have remained stable. Chase, a local expert, summarized diverse livelihood outcomes:

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; four, five, \$600,000 dollars, the banks want their money eventually . . . 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 crewmem-

bers. For example, Jayden (fisherman) 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 and the owner of the boat, plus expenses, there is no money left for the crews. We’re paying out all this money, but the crew that wants to go fishing can’t make any.” Alternatively, Ethan (fisherman) suggests that “a lot of captains are taking less to try to keep the crews . . . cause if not . . . they’re not going to stay there.” Another account by Ryan (fisherman) suggests that some captains use employment in the lobster fishery as leverage to secure crew in less lucrative fisheries.

It is common for a captain tell crewmembers, “if you don’t go fishing, you don’t go lobstering.” Crew will make the most money from lobstering, and sometimes will not make anything from groundfishing, but if they want to go lobstering, they will put in the hours over the summer. Everyone in Alberta can tell you that story.

Ryan links crew livelihoods to emigration, most notably to the tar sands of Alberta, where the oil business is booming. Captains must navigate the tradeoff between maintaining their boat and maintaining their crew, especially highly skilled crew. When crewmembers share of earnings from a fishing trip are too high, a captain will not have enough reserve money saved up in the event of an engine blowout or damage to the boat or traps, but when boat shares are too high, it is more likely that skilled crew will seek out another boat to work on, or emigrate.

### *5.5.5 Comparison of buyers and fishermen*

In this section, I examine the degree to which fishermen and buyers have contributed different sides or different pieces to the story based on knowledge of the conditions of their practices (see Figure 5.3). While buyers discussed market conditions

( $P = 0.01$ ), storage ( $P = 0.008$ ), and lobster quality ( $P = 0.01$ ) significantly more often, (4-6 times per interview), fishermen talked about quota leasing significantly more often ( $P = 0.03$ ). Comparisons not shown in figure 5.3 were not significant at  $\alpha = 0.05$ . It may be that more differences exist among buyers and fishermen, but the small sample size of buyers makes it difficult to observe these differences. Nevertheless, these results suggest a difference in perceptions of the problem. To fishermen, the challenges are focused on changing conditions of access rights to fisheries. To fish buyers, there is a localized challenge of improving the quality of lobsters and storing lobsters, but prices will not improve without a change in global economic conditions.

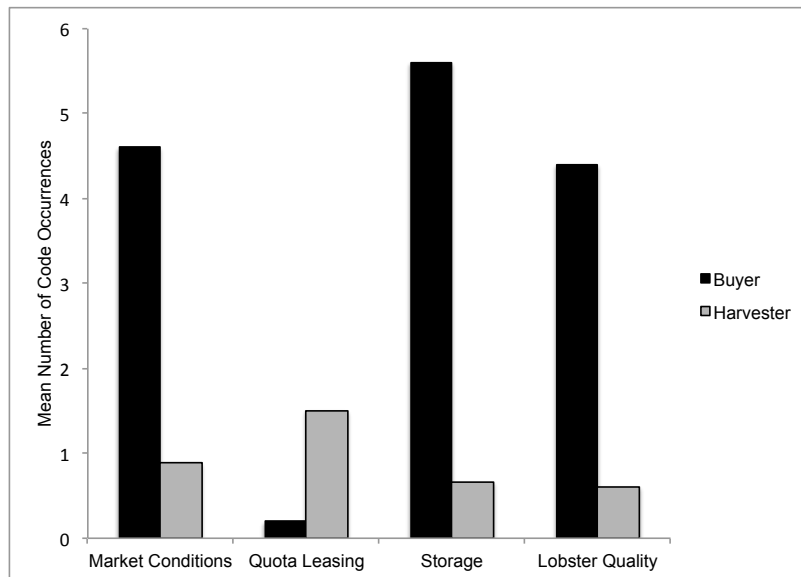


Figure 5.3: Differences in the frequency of themes discussed per conversation by fishermen and buyers. All differences between buyers and fishermen are significant at  $\alpha = 0.05$ .

## 5.6 Conclusions

I used a combination of concepts from vulnerability and institutional analysis to demonstrate how agency (harvesters, buyers, and government), regional structure (formal and informal institutions, property rights, and the structure of the decision-

making process), and the environment have combined to produce and reproduce regionally specific action situations at different levels. At the local level, high dependence on lobster, low social cohesion, and low trust in government have reinforced an individualist approach to current environmental conditions. Fishermen attempt to catch more, decrease costs, or invest in storage facilities, while refusing to participate in deliberation processes that they perceived to be illegitimate. Harvesters recognize the importance of working together to agree upon and articulate an alternative vision for regulating 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 up quota, and by circumnavigating rules that attempt to limit consolidation. In the process of buying-up access rights, fishermen are concerned that fishing communities are losing control of their local industry, and the benefits, and cultural norms and practices that come with local control. Those with less political and economic power are more sensitive and have a lower capacity to respond to challenges. These include fishermen who fish lobster exclusively, those with high fishing costs due to debt and quota leasing costs, and crewmembers. This has created regulatory rigidity, wherein fishermen resist regulatory changes on the grounds that outcomes will be negative, even if it is possible that some change can bring positive outcomes. But even productive regulatory changes in this region would likely fail without procedural justice, a strong commitment to culturally appropriate understandings of equity, and an understanding of the diversity of strategies and social relationships that characterize communities (Davis and Ruddle, 2012; Davis, 1996).

In Barrington, a top-down co-management process has replaced local-level, customary resource management (see Chapter 4), and some elements of social cohesion have weakened. While harvesters remain attached to their communities and identities



in fishing, and are capable of significant acts of solidarity, their willingness to act collectively in the context of fishing, or to form extra-local links of trust and reciprocity with associations and the government is low. The combination of a participatory process that is perceived as illegitimate with a culture of individualism in heterogeneous fishing communities stifles the potential for adaptation through collective action.

In this paper, I used the concept of the socially constructed adaptive landscape (McLaughlin and Dietz, 2008; McLaughlin, 2001, 2011), and Ostrom's (2009; 2007) diagnostic framework for SESs to frame my study. These methods were useful for highlighting the interactions between the biophysical, the social and cultural, and the institutional processes of the system I studied. However, I did not include all actors in this analysis (e.g., wholesalers, mobile and fixed-gear harvesters, government agencies, and environmental NGOs). Neither did I examine the degree to which the framing of low lobster prices reflect the buyers emphasis on external market conditions, or the harvesters emphasis on uneven bargaining power in the market chain. Policy suggestions that reflect a buyers perspective would likely propose that the practices at sea must change (e.g., quotas, trap reductions, or buyback programs). Policy suggestions that reflect fishermen's perspective would emphasize understanding and correcting the control of markets by large buyers or wholesalers, monopoly conditions at ports, and collusion among buyers. It is likely that social groups will oppose policy change that do not address their perspectives, or do not support these changes with salient and accurate information.

Agricultural studies have demonstrated how adaptations to stressors can create new biophysical and social conditions which result in sensitivities to future shocks (e.g., Adger et al., 2008; Eakin et al., 2014). Similarly, the current vulnerability of SWNS harvesters is the product of an coping response to previous vulnerabilities. As groundfish quotas and availability declined, many invested in increased capacity

for lobster fishing by purchasing more efficient traps, bigger and more mobile boats, and lobster storage facilities. Some who were too deeply embedded in the groundfish economy had to start anew, or enter into trust agreements to continue to earn their livelihood in fishing. This harvester response increased the overall fishing capacity of the lobster fleet, and made fishing communities more sensitive to gluts and low demand.

Bacon (2005) noted that the effects of low coffee prices are amplified by the increasing concentration of stocks among a few transnational companies; Steinberg (1984) noted a similar process of concentration among wholesalers in the multi-species fisheries of SWNS. Some accounts from fishermen and buyers reported here also support the claim that buyers can “exercise their power to expropriate the lion’s share of commodity value” by controlling the terms of exchange (Davis and Ruddle, 2012, p. 250). Only a few studies have examined the commodity-chain interdependency that links local communities to global markets. Harvesters do not trust recent industry reports because they have not been conducted independently of lobster buyers and wholesalers. In this study, I only interviewed buyers at the port level, and thus questions of top-down market control is beyond the scope of this study. Independent research on commodity-chain relations, and the institutions of the commodity chain would benefit the industry. If well communicated and documented, better knowledge of commodity-chain relations could put harvester’s questions to rest. Alternatively, if imbalances in the commodity-chain are found, then institutional changes would benefit both buyers and harvesters at the port level (Steinberg, 1984).

This research provides supporting evidence for similar processes occurring south of the Canada/US border. Though the institutional structures of Maine and Nova Scotia are different, Brewer (2011) found evidence of consolidated ownership of fishing access-rights, reduced accountability and transparency in quota fisheries, reduced

flexibility of multi-species harvesters, and a lack of trust in the governance regime. Like Brewer (2011), I conclude that current governance structures will only further current processes that result in a loss of diversity in harvesting strategies and economic practices, and a loss of local knowledge.

## Chapter 6

### DEPENDENCY AND STRATEGIES FOR COPING WITH CHANGE

#### 6.1 Introduction

In Chapter 5, I outlined the changing landscape of the multi-species fisheries of Barrington, Nova Scotia. From the perspective of harvesters in the region, three important processes have played together to threaten their livelihoods. The first was a lack of social capital and social cohesion. The second was a process of alienation from historical access to fish through the decline of fish stocks, consolidation of quota and lobster licenses, and quota cuts. Finally, rising costs of fishing, changing ecological conditions, and decreased demand for lobsters has constrained the efficacy of individual strategies, such as storing lobsters and fishing harder.

This qualitative examination of the fishery provides insight into household livelihoods and livelihood strategies in the region. In this chapter, I provide quantitative data to further characterize fishing livelihoods in the region. First, I consider the alternative sources of fishing income harvesters used in the past, and the sources still in use today. Additionally, I provide a timeline for the loss and the current distribution of quota ownership among harvesters. Second, I examine the fishing strategies, assets, and arrangements that affect livelihood outcomes. Finally, I provide further qualitative and quantitative data to examine the outlook harvesters have for the future of the fishery, and a timeline that characterizes the ups and downs, and degree of division among harvesters regarding this outlook over time. In this study, I test the hypotheses generated from these interviews. Based on the insights from the previous chapter, I hypothesized that younger harvesters without halibut, groundfish, or

swordfish quota, lower catches, without lobster storage, who do not own their boat, who are in trust agreements, who are making boat payments, who bought into the fishery on credit since 1999, and who are most dependent on lobster will have decreased income, ability to save, and ability to pay off debts since 2006, when ex-vessel prices of lobsters began to decrease. Additionally, I hypothesized that these harvesters will be less likely to have made preparations for retirement. These hypotheses fit the analysis from semi-structured interviews, suggesting that the characteristics of entering the fishery, and the access to other sources of income from fishing are most important to fishing household livelihoods.

## 6.2 Methods

In May 2012, I conducted a field survey in Barrington Municipality, Nova Scotia. This region is composed of numerous fishing ports including Port La Tour, Baccaro, Cape Sable Island, Shag Harbor, and Woods Harbor. Port La Tour and Baccaro consists of approximately 40 harvesters located in the LFA 33, while an additional 298 license-holders fished out other ports in a portion of LFA 34. The list of license-holders and their contact information kept by Fisheries and Oceans was confidential. For this reason, I talked with key informants to develop an initial list of potential respondents. Survey respondents were then asked to identify other potential respondents. I selected harvesters from this growing list of potential respondents at random, with attempts to meet quotas of harvesters for LFA 34 and LFA 33. I also recruited some survey respondents during participant observation on fishing vessels, at the wharf, and at shore-based facilities.

I pre-tested surveys with five respondents and made modifications based on feedback. Following modifications, I conducted all surveying face-to-face with respondents. Uniform responses were prepared for any situations in which respondents asked

for a clarification. Additional qualitative information and stories were also written down on surveys, and analyzed along with semi-structured interviews in chapter 5.

In total, I conducted 113 face-to-face surveys, including 23 harvesters from LFA 33, 90 from LFA 34, 19 crew-members, and 94 captains. The response rate for surveys was 85.6%, including attempts to recruit by phone and in person. This sample is intended to draw from the population of active lobster harvesters. But since almost all harvesters in Barrington fish for lobster, this is also a sample drawn from all active harvesters. While I encountered and interviewed some harvesters who left Barrington in seek of employment, I could not adequately sample inactive harvesters because the majority do not live in the community anymore.

## 6.3 Results and Discussion

### 6.3.1 *Access to fish species*

Overall, a total of 56% of harvesters in LFA 33 and 51% in LFA 34 harvesters fish only for lobster. Secondary fisheries included groundfish (haddock, cod, hake, pollock), halibut, swordfish, and sea plants (figure 6.1). A small number of respondents participated in fisheries in other regions, such as the snow crab fishery in Northeastern Nova Scotia, or the Digby Scallop fishery, or in test fisheries, such as the “slime-eel” (hagfish). Captains (9%) and more frequently crew-members (32%) collected irish moss in the summer in smaller vessels with outboard motors.

Whether a harvester fishes for groundfish, swordfish, or halibut largely depended on the amount of quota they own. For example, the mean quota ownership of a harvester who did not fish for groundfish was 5,800 pounds, while an active groundfish harvester owned an average of 43,000 pounds (ANOVA,  $P = 0.001$ ). Figure 6.2 demonstrates the skewness of quota ownership among harvesters. While very few

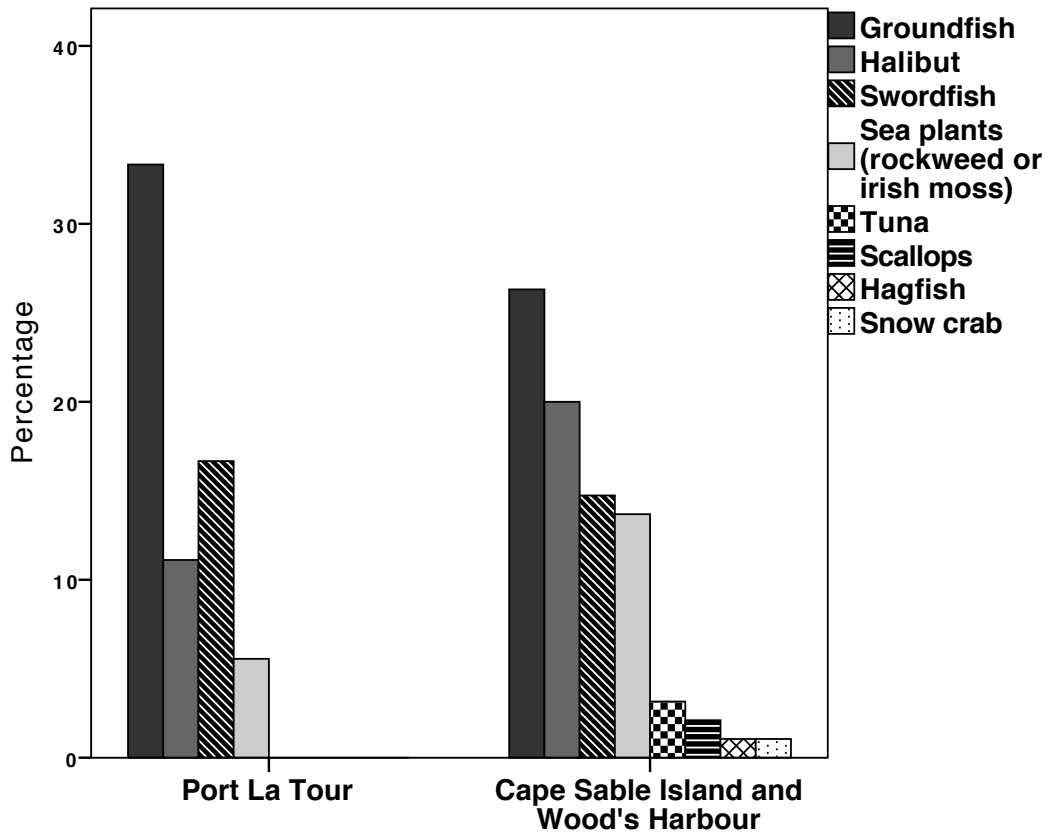


Figure 6.1: Percentage of surveyed harvesters fishing for other species in addition to lobsters.

harvesters own as much as 450,000 pounds of groundfish quota, a large percentage own zero to 2,000 pounds (see Appendix D). In general, a harvester using longline technologies must be able to make at least three or four trips to pay for the costs of upkeep of fishing gear. A vessel will often return from a longline fishing trip with 10,000-20,000 pounds of groundfish. Thus, a captain must own at least 30,000 pounds, but most likely more to remain active in the fishery. Based on informal discussions with captains and experts, captains often remain active in the groundfishery as long as they do not have to lease more than half of their quota.

After surveying began, I realized the importance of understanding when harvesters

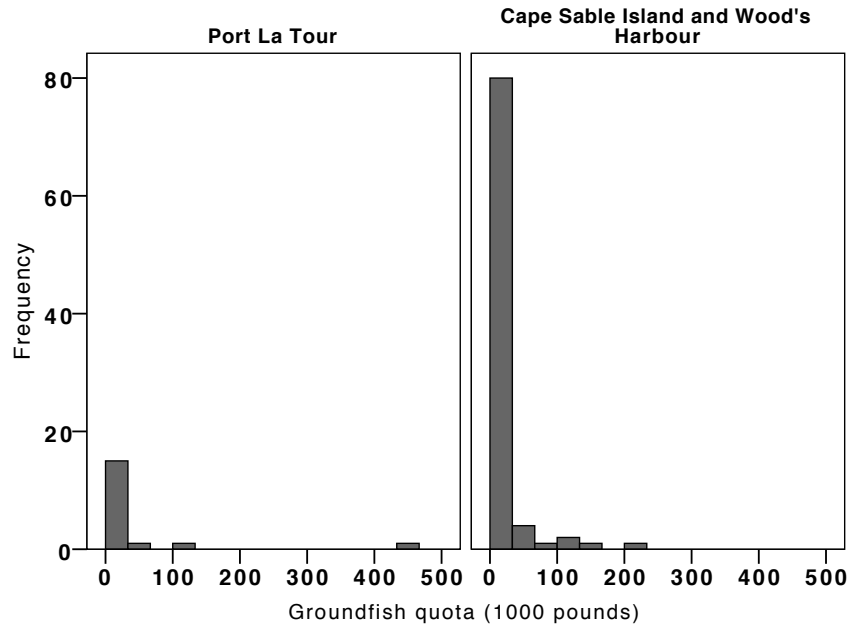


Figure 6.2: Histogram of groundfish quota ownership for Port La Tour (PLT) and Cape Sable Island/Woods Harbour (CSIWH).

lost their access to the groundfishery. As a result, I asked 73 of the total 113 harvesters surveyed when the last year they went groundfishing was. Though this may not be fully representative of all survey respondents or Barrington at large, it is relevant to point out trends among respondents. Figure 6.3 shows an increasing number of harvesters leaving the groundfishery, peaking at around year 2000. Of the harvesters who responded to this question, 32% fished for groundfish in 2012. These trends correspond to important regulatory changes in the groundfishery. Groundfish quotas were first introduced in the large-scale mobile-gear fleets ( $>65'$ ) as early as 1982 (Hache, 1989). This was followed by a quota system for the now largely extinct inshore mobile fleet ( $<65'$ ) in 1991, and community quota system for the fixed gear fleet ( $<45'$ ) in 1997 (Peacock and Annand, 2008; Crowley and Palsson, 1992). A large proportion of the inshore fixed-gear fleet were hand-liners. While the loss of quota



played a role in the decline of hand-lining, hand-liners also said that the abundance and quality of inshore groundfish species has declined. They often mentioned that inshore groundfish was increasingly infested with parasites, and implicated the growing population of grey seals as a vector for parasites. Remaining vessels that continue to fish for groundfish species use long-line fishing gear on the same vessels used for lobstering in the fall and winter.

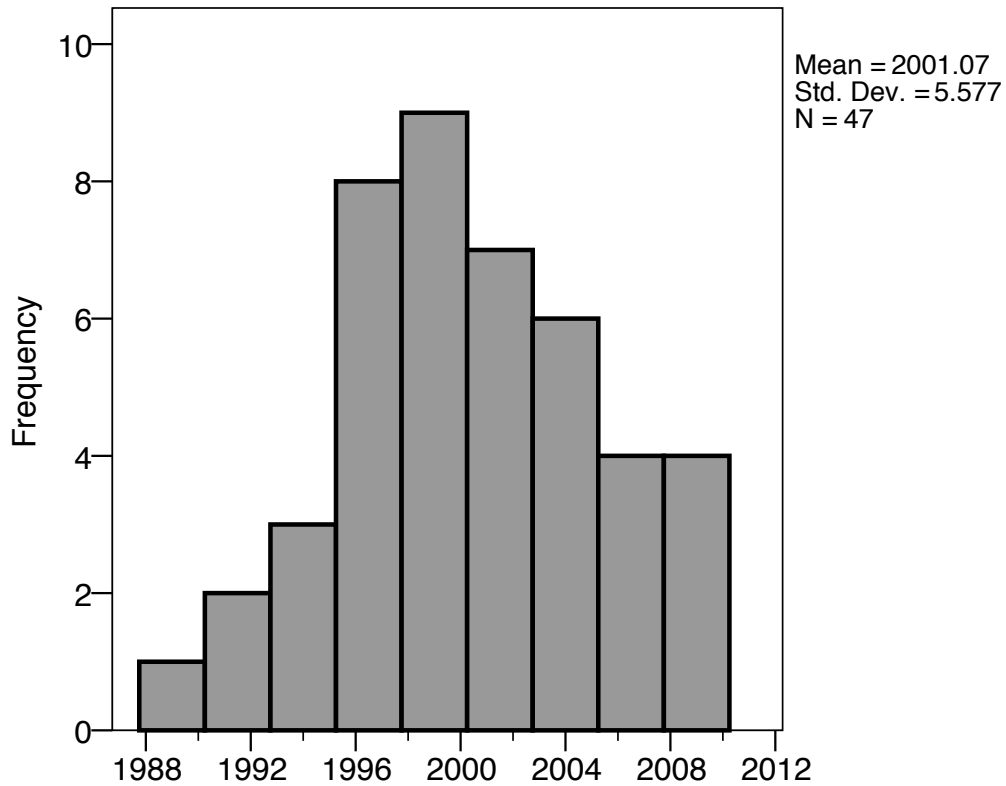


Figure 6.3: Frequency histogram of the last year a harvester fished for groundfish species.

### 6.3.2 Characteristics of lobster fishing

Table 6.1 provides a brief overview of Barrington harvesters and their vessels. The median age for a lobster harvester was 54 years, 11 years and 14 years older than the median age in Nova Scotia and in Canada respectively (Statistics Canada, 2012, July 1). Additionally, Barrington harvesters generally had a low level of education attainment, averaging ten years, though younger harvesters had more years of education. Older harvesters often told stories of how they dropped out of school as teenagers on to make a living in fishing. As teenagers, many were drawn to the sea, in many instances, learning to fish from their fathers. On average, harvesters began fishing at the age of 20 and have fished for 32 years, though these numbers can vary considerably. For example, one respondent began fishing at 11, and had fished for 70 years at the time of the survey.

Table 6.1: Characteristics of lobster harvesters.

Variable	Port La Tour	CSIWH
Mean Age		52 (11)
Education		Grade 10 (3)
Number of Years Fishing		32 (13)
Winter Catch (x1000 lbs)	17 (14)	36 (15)
Spring Catch (x1000 lbs)	10 (10)	17 (4)
Boat Length	39 (5)	45 (5)
Boat Width	15 (2.7)	19 (3.3)
Number of Crew	1.3 (0.46)	1.9 (0.42)

Note: Standard deviations in parenthesis. Two numbers are provided where averages for PLT and CSIWH are significantly different (T-Test for unequal variances,  $P < 0.05$ ).

LFA 34 boats were longer, wider, and harvesters fishing out of these ports reported a higher average seasonal catch (53,000 pounds) than LFA 33 (27,000 pounds). LFA 34 reported a higher average number of crew-members than LFA 33. Thus while LFA 34 caught more than LFA 33, they also had higher expenses for remunerating crew. Smaller boats generally have better fuel economy, and crew expenses are lower. Additionally, harvester reports suggest that the cost of licenses is highest in LFA 34. Thus, it is likely that much of the higher catches in LFA 34 are offset by higher costs, though the overall margins will likely depend on the ex-vessel price for lobsters. This is corroborated by data presented in Chapter 3.1, which suggests that the value of lobsters per pound caught and per license-holder has decreased more sharply in CSIWH than in PLT.

Harvesters in LFA 34 also exert a higher amount of effort to sustain higher catches, as is indicated in Figure 6.4. Both regions fish the most in the first month and last month of season, but LFA 34 harvesters fished more in the months of January, March, and April when weather and temperature conditions are less favorable for fishing. Both districts fished approximately 4-5 days per week in February, and 18-22 days in December and May. Taken together with data presented in Chapter 3.1, it is clear that December is the best month for fishing, with high effort and high catch per unit effort, while in May higher effort is required to catch a smaller amount of available lobsters. A much higher proportion of lobsters caught in May are smaller than the minimum size requirement, and thus, harvesters are required to return these lobsters to the sea.

Warmer winter water temperatures increase lobster activity. As a result, lobster catches do not decrease in the winter as drastically as before. Davis (1984b) reported that harvesters land their boats in the winter months, and switch to groundfishing as early as April as lobster catches decline. I found that harvesters are more often

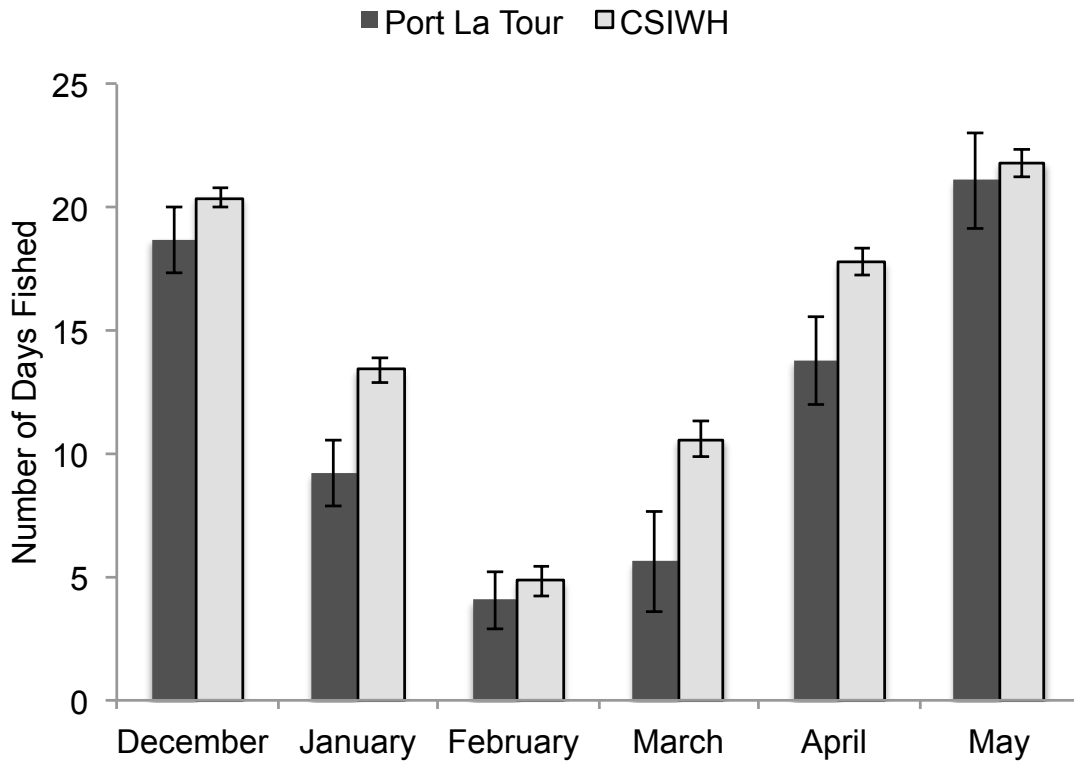


Figure 6.4: Monthly fishing effort (number of days fished) in PLT and CSIWH. Significant differences between CSIWH and PLT are indicated with a star (T-test for unequal variances,  $P < 0.05$ ).

continuing to fish through the winter months, and fishing with high effort until the end of May. This is because there are no fisheries to switch to, and harvesters can sustain high catches and potential earnings in the lobster fishery.

### 6.3.3 Harvester responses to stressors

When asked what price of lobster they needed to make a living, responses did not vary among region or position (captain or crew). The mean price suggested by harvesters was  $5.0 \pm 0.4$ , and ranged from a minimum of \$3.5 and a maximum \$6.25. This reflects the time of research. Recent strikes for a price of \$5 have likely led to widespread adoption of the idea that \$5 as a “fair” price that would allow most

harvesters to make a good living.

Harvester responses to economic and ecological change are summarized in Table 6.2. In most cases, responses do not add up to 100% because many respondents gave more than one response. A large proportion of harvesters responded to low prices by storing their lobsters in lobster cars. As many as 20,000 pounds of lobsters can keep in cars for a few months. Prices generally increase from December to February. Storing lobsters is an effective method for harvesters to improve their earnings, provided that the price increases enough to offset the cost of building, maintaining, and renting space for the lobster car.

Out at sea, harvesters engaged in three techniques; fish the same as they always would, double or triple set, or haul around the clock. At the beginning of the season fishermen generally return to sea daily, haul their traps, collect lobsters, rebait the traps, and return to shore to sell their catch. A double or triple setting harvester will haul their traps and collect lobsters every two or three days. The traps are able to “soak” longer, and thus the catch per trap is higher when a harvester double or triple sets. This strategy increases the number of lobsters caught per trip and reduces fuel and bait costs. Contrary to double and triple setting, some harvesters fish harder by “hauling around the clock,” or staying at sea for a two or three days, and repeatedly hauling their traps. This strategy is more commonly used by offshore harvesters, because the fuel and time cost of traveling to and from the fishing ground makes the daily haul less cost-effective.

Another strategy is for the captain to conserve on fuel and bait, or reduce his crew. Captains reduce their fuel costs by optimizing the speed of the vessel to maximize fuel efficiency. Fuel efficiency depends on the size of the vessel and the type of engine it has. In addition, harvesters can choose from a wide range of baits. Harvesters often favor herring and mackerel, but when the cost of these fish species is high, a

harvester may choose to use a cheaper bait. These strategies have their limitations. Fishing wharves do not have the capacity for all harvesters to use lobster cars, and harvesters must take the risks of incurring start-up costs of as much as \$40,000. Some harvesters stated that they shared the costs and use of lobster cars. Those who do not have access to lobster cars said they couldn't store their lobsters, while some who had lobster cars said that they did not have enough storage capacity. Any amount of lobsters in excess of the storage capacity would have to be sold at the current wharf price. As I have indicated in Chapter 5, there is also the risk that weather conditions will cause lobsters to molt or die in storage.

Fishing strategies at sea come with tradeoffs. The downside to double and triple setting is that harvesters can only fish during the season and when weather is favorable. While the costs are low, a captain that double sets too much will not haul their traps and catch enough through the season to pay the crew and maintain their boat. While hauling around the clock likely results in a lower catch per trap than double or triple setting, the overall catch per trip may be higher. But higher catches through hauling around the clock comes with higher bait and fuel costs. Thus harvesters double or triple set to reduce costs and haul around the clock to increase revenues, but they cannot do both.

The choice of bait may also affect the catch rate per trap. Harvesters prefer herring and mackerel because they believe that it is the most effective at attracting lobsters to their traps. Thus lower bait costs may sometimes be offset by lower catches.

Harvesters also stated that they could not respond to low prices because prices were determined by the economy, or by local buyers. Other harvesters stated that they could not change their fishing practices in response to low prices because they needed the revenue, or because they needed to work enough days per year to get employment insurance benefits. Harvesters who do not have summer employment

Table 6.2: Harvester survey responses regarding their response to economic and ecological change

Question	Response	Percent
What do you do when prices are low?	Store lobsters	42%
	Don't do anything differently	23%
	Double or triple set	22%
	Conserve fuel, bait, or reduce crew	17%
	Haul around the clock/fish harder	13%
What limits your ability to respond to low prices?	Lack storage or storage capacity	31%
	Cannot reduce expenses any further	15%
	Buyers control the price	10%
	The economy determines the price	10%
	Need to fish to get cash, income or employment insurance stamps	9%
Since you started fishing, have you noticed less, the same, or more soft or weak lobsters?	Fishermen are not organized enough	9%
	More	56%
	The same	44%
	Warm water temperatures	40%
In your opinion, what has caused this increase?	Captains fishing on poor bottom	32%
	Lobsters lack food	25%
	Higher abundance of lobsters	24%
What do you do to improve the quality of lobsters delivered to buyers?	Handle lobsters with care	51%
	Sort lobsters at sea or at port	27%
	There is nothing that can be done	16%
	Sell all lobsters immediately	7%
	Fish on good bottom	6%
	It's the buyers job to sort lobsters	5%
What difficulties do you face when you try to do this?	None	21%
	The volume of lobsters and handling time	16%
	Weather	13%
	Improved quality doesn't improve the price	10%
	People won't work together to improve quality	10%
In your opinion, has the water temperature gotten warmer since you started fishing?	Yes	91%
	No	6%
	Don't know	3%
How has this affected your fishing practice?	Increased catches	33%
	Problems with lobster quality	23%
	Better weather allowing more offshore fishing	20%
	No effect	15%
	Changed lobster migration pattern	10%

depend on employment insurance (EI) in the summer. Captains and crew-members must work a minimum number of days in the year to draw EI. Harvesters who do not have a source of employment in the summer must fulfill this minimum day requirement within the 6 month lobstering season. Thus, if a harvester responds to low prices by shifting or delaying their effort, they risk losing their EI benefits.

Another problem affecting the price of lobsters is the quality of lobsters. Buyers and some inshore harvesters claim that some vessels land too many “soft” lobsters that must be flipped to processors at a lower price. Of those who believed that vessels are landing more soft lobsters than in the past, many believed that this was caused by warm water temperatures, a lack of food for lobsters, or captains fishing on poor bottom. Warmer water temperatures can increase the metabolism of lobsters, and change their seasonal molting patterns. If warmer water temperatures significantly alter lobster molting patterns, then harvesters may encounter soft lobsters at unexpected times. Harvesters also associate high quality lobsters with rocky bottom. Poor bottom refers to regions of the fishing grounds where the seafloor is sedimentary or muddy. These areas are considered to be poor bottom because they lack suitable prey species for lobsters to eat. Many harvesters said that more than one of these processes were occurring at the same time. Alternatively, some simply stated that harvesters always caught a certain percentage of lobsters that were soft. To these respondents, the percentage has not changed, just the overall quantity of soft lobsters landed.

I asked harvesters what they did to improve or maintain the quality of lobsters. Many harvesters responded that they handled lobsters with care. While seemingly a simple act, lobster handling has a significant impact on lobster health and longevity along the market chain. Lobster biologist, Jean Lavallee, has stressed this importance, suggesting that when caught, lobsters are “as fragile as eggs - a brittle shell on



the outside and squishy inside” (Taber, 2012, October 26). Some harvesters sorted lobsters at sea, and returned soft lobsters to sea, or fished on good bottom. Another strategy was to sell the lobsters immediately. This reduces the amount of time lobsters spend in storage, and thus increases the chances of their survival.

Strategies to improve or maintain the quality of lobsters were limited by handling time, weather, and a lack of incentive to do so. Since catches have increased by nearly 4 times in Canada (Steneck et al., 2013), lobstering vessels are catching much larger quantities, especially in the first month of the fishing season. Captains and crew-members must work fast to clear the lobsters from a string of traps, and measure and band the lobsters before arriving at the next string of traps. When catches are high, lobsters begin to pile high in crates. While un-banded in crates, lobsters bite each other. Some crew-members may resort to throwing lobsters into crates. It is also difficult to check the softness of each lobster’s shell in these conditions. But most importantly, there seems to be no incentive for landing high quality. Buyers must account for “shrinkage” - the death of lobsters in their tank-houses, or en route to wholesalers and retailers - when determining the wharf price. Fishing for quantity rather than quality is a common-pool dilemma; harvesters that land large quantities of low quality lobsters subtract from the quality of the average landed lobster, and this decreases the average wharf price for all. Though quality-based pricing may be an important way to incentivize quality, it is also important to understand *why* harvesters favor higher landings.

The vast majority of harvesters believed that water temperatures had gotten warmer since they started fishing, but did not always attribute warmer water temperatures to climate change. Harvesters believed that warmer water temperatures have increased their catches, caused lobster quality problems, improved the weather, and changed lobster migration patterns. Better weather conditions allow harvesters

to fish more in the winter time, but also increase the activity of lobsters in the winter time. Many respondents reported that they used to bring their traps to shore in February because catches were too low. Today, however, catches did not decrease as much as they did in the past.

It is important to note some of the interesting responses that were too infrequent to include Table 6.2 on the effects of warmer waters. While less than 5% of respondents mentioned these processes, they may serve as an early indication of ecological change. Three harvesters (2.7%) said that warmer waters were causing a shift in relative abundance of species. Sharks were more abundant in the summer, and Irish Moss was less abundant. Another respondent reported to have seen more sea squirts (Tunicata) attached to the bottom of his boat. One harvester stated that warmer waters have made it more difficult to catch swordfish using harpoons. Harpooning is a highly selective and sustainable method for catching swordfish. Only 10 survey respondents reported to participate in the swordfish harpooning fishery. This practice exploits the behavior of swordfish. Swordfish “sun” themselves close to the surface to thermoregulate. Harpooners are skilled at spotting swordfish from a distance and “sticking” them. One swordfish harpooner stated that warmer water temperatures have decreased the amount of time swordfish spend at the surface, and thus made it more difficult for harpooners to catch them.

#### *6.3.4 Variables for household livelihood analysis*

In the following analysis, I consider the influence of independent variables on household livelihood outcome variables listed in Appendix D. All independent variables were suggested as important by harvesters, with the exception of education. I use 1999 as a benchmark for buying into the fishery on credit because this year demarcates a significant increase in lobster license prices in Atlantic Canada, an event

largely attributed to the Marshall decision, which granted First Nations the right to fish lobster for subsistence. Following a series of disputes between non-First Nations and aboriginal harvesters, and discussions involving all parties, the DFO began a fishing license buy-back program. These licenses were bought from non-aboriginals exiting the fisheries, and then given to aboriginal groups (see Coates, 2000). The DFO sent all license-holders applications to participate in the program. DFO officials received applications from license-holders estimating that their licenses were worth as much as \$1 million, though no buybacks were made at that price. The Marshall decision resulted in a spike in license prices in the region, but some interview respondents suggested that prices for lobster licenses would still be high due to high lobster wharf prices and catches. Given the potential difficulties associated with asking personal questions, I used the date of entry on credit as a indicator of the costs of entry. Thus, I assume that harvesters who have entered the fishery on credit after 1999 have higher loan repayment obligations, and thus, will be more vulnerable to the current downturn in prices.

Additionally, I consider the potential importance of ecological knowledge. Each harvester was asked to recommend other harvesters who were deemed knowledgeable about the lobstering grounds in their area. Thus, knowledgeable harvesters are those who were mentioned most by other harvesters.

In Chapter 5 some interview respondents reported that trust agreements influenced a harvester's income. The nature of these agreements may introduce sources of error into this measure. For example, harvesters who benefit from trust agreements may not wish to give accurate information, especially under new DFO regulations requiring harvesters to declare and end these agreements. My survey estimate of 11% of Barrington harvesters being involved in these arrangements was deemed accurate by experts inside and outside the study site. Those experts maintained that trust

agreements were more common to the west of Barrington, in ports such as Digby, Meteghan, Yarmouth, and Pubnico.

### 6.3.5 *Factors contributing to vulnerability outcomes*

I conducted ordered and binary logistic regression (ologit, and logit, STATA 12), to determine the factors contributing to household vulnerability outcomes. I conducted separate analyses for captains and crew. Crew-member analysis must be interpreted with caution due to a low statistical power. Results for captains generally had higher levels of explanatory power and significance due to a higher number of respondents. Ordered regressions were tested for violation of the parallel odds assumptions. In the following sections, I present both the full model and a minimal model where only significant ( $P < 0.05$ ) and weakly significant ( $P < 0.10$ ) variables were retained.

#### **Captains**

The first indicator of household livelihood outcomes is income. Of a total of 113 respondents, 14 respondents refused to answer questions about income. Thus regressions involving income have lower statistical power than questions about income change, and debts. An ordered logistic regression indicated that age, dependency, boat length and total catch were most important for a captain's income (Table 6.3). Harvesters who were older and more dependent on lobster were 1.1 times and 52 times more likely to report a lower income. Harvesters with longer boats and a higher 5-year average total lobster catch were 1.1 and 1.04 times more likely to report a higher income. The overall model was highly significant with a McFadden's  $R^2$  of 0.2303.

The results of a binary logistic regression for a household's income change yielded similarities and contrasts to results above ( $R^2 = 0.34, P < 0.0001$ ). Results of this regression are summarized in Table 6.4. I used binary logistic regression instead of

Table 6.3: Ordered logistic regression model for a captain's income.

Independent variable	Full model			Reduced model		
	Estimate	SE	Odds ratio	Estimate	SE	Odds ratio
age	-0.0916**	0.0333	0.9124	-0.0935**	0.0231	0.9107
boatpay	-0.0215	0.5284	0.9786			
credit1999	-0.4419	0.7952	0.6428			
dependency	-3.6784**	1.3961	0.0253	-3.9666**	1.042	0.0189
groundfish quota	0.0106	0.0227	1.0107			
halibut quota	-0.1161	0.0926	0.8904			
knowledge	0.0296	0.2078	1.030			
length	0.1359*	0.1360	1.146	0.08796*	0.0435	1.0919
LFA 34	-0.0203	0.8516	0.9800			
lobster storage	0.2671	0.2672	1.3062			
owns boat	1.2094	0.9322	3.1245			
swordfish quota	0.0194	0.0227	1.0195			
total catch	0.0537†	0.0280	1.0552	0.0390**	0.0123	1.0398
trust agreement	0.0460	0.3913	1.0471			
width	-0.1154	0.1254	0.8910			
spouse works	0.7922	0.6560	2.2084			
N		76			81	
$LR\chi^2$		69.01			62.52	
McFadden's $R^2$		0.2712			0.2303	
P-value		0.0001			< 0.0001	

Note: P-values are indicated with † <0.10, \* <0.05, \*\* <0.01.

ordered logistic regression because there were few cases where harvesters reported an increase in their incomes. This caused errors when testing for parallel odds assumptions. Results indicated that harvesters with a 10% increase in dependency on lobsters were 10 times more likely to report a decrease in their income. A 1000 pound increase in groundfish quota ownership decreased a captain's likelihood of reporting a decrease in income by 1.02 times. Together, these results demonstrate the importance of alternative sources of income for a captain's income sensitivity. Contrary to my hypothesis, however, harvesters who had boat payments were 9.8 times less likely to report a decrease in their income. I did not ask captains how high their boat payments were. It may be that most captains were able to maintain their incomes

and make boat payments in general, but some boat payments may be too high. This effect may be partially captured by the positive relationship between boat width and captain's who experienced a decrease in their income. A captain with a boat that is five feet wider was 6.6 times more likely to report a decrease in their incomes. As gas prices increased in the 2000s, captains may have been affected by the lower fuel efficiency of a wider boat. A wider boat has sufficient capacity for carrying a full load of traps for greater mobility, and may be versatile for other fishing practices. Thus, a harvester with a wider boat may be able to offset lower fuel efficiency if they have access to quotas and if they maintain high lobster catches by shifting gear and fishing efficiency.

Captains who owned their boats were 7.4 times less likely to report a decrease in their income. Captains with full boat ownership may have greater flexibility to make decisions, and lower payments. They may have also benefit from access rights that have been passed on through family relationships. Captains tied to trust agreements, however, were 3.6 times more likely to report a decrease in their incomes. These captains may have lower flexibility, or alternatively, they may have to work with a lower share of total fishing revenues to maintain their household incomes. Captains without lobster storage were more likely to report that their income decreased since 2006. This effect was weakly significant in the full model, and did not remain in the reduced model. The general trend suggests that storing lobsters is an important strategy for coping with low lobster prices.

In Chapter 5, interview respondents suggested that new entrants had to accrue a large amount of debt to enter the fishery. In Table 6.5, I present the reduced model binary logistic regression for captains who have experienced a decreased ability to pay off their debts. Captains who entered the fishery after 1999 were 16 times more likely to state they were less able to pay off their debts since 2006. Captains who

Table 6.4: Binary logistic regression for captains who entered the fishery before 2007 and have experienced a decrease in their income since 2006.

Independent variable	Full model			Reduced model		
	Estimate	SE	Odds ratio	Estimate	SE	Odds ratio
age	0.1057*	0.0473	1.1114	0.04887†	0.0297	1.0501
boatpay	-2.3384*	0.9891	0.0965	-2.2793**	0.7944	0.1024
credit1999	2.8077	3.2115	16.571			
dependency	6.8990**	2.2915	991.33	4.6451**	1.4205	104.07
groundfish quota	-0.0457†	0.0236	0.9554	-0.0238*	0.0125	0.9764
halibut quota	0.3792	0.2557	1.4612			
knowledge	0.1023	0.2972	1.1078			
length	-0.0234	0.1130	0.9768			
LFA 34	0.7607	1.4005	2.1398			
lobster storage	-1.5275†	0.8607	0.2171			
owns boat	-2.2038†	1.2746	0.1104	-1.7953†	1.0242	0.1356
swordfish quota	1.1014	1.8314	3.0085			
total catch	0.0468	0.0418	1.0479			
trust agreement	1.358	0.8247	3.8893	1.2728*	0.5938	3.5710
width	0.1534	0.2185	1.1658	0.2888*	0.1176	1.3348
spouse works	1.4559	1.0208	4.2883			
constant	-12.993*	5.4691		-7.9100	2.8550	
N		76			78	
LR $\chi^2$		53.09			35.71	
McFadden's $R^2$		0.5132			0.3360	
P-value		< 0.0001			< 0.0001	

Note: P-values are indicated with † <0.10, \* <0.05, \*\* <0.01.

were considered to be knowledgeable also reported a decreased ability to pay off debts. Captains who had a spouse who worked, however, were 2.7 times more likely to report that their ability to pay off debts has remained the same or improved. Thus new entrants have higher debt loads, but debt loads can be mediated by contributions from their spouses. Fishing debt, however, does not necessarily translate into lower incomes. This may be due to the other mediating factors influencing incomes from table 6.4.

To better understand debt, I compared the average year at which a captain got a loan from the bank to the Nova Scotia Loan Board (NSLB). An independent sample

Table 6.5: Binary logistic regression for captains who entered the fishery before 2007 who have been less able to pay off their debts since 2006

Independent variable	Coefficient	SE	Odds Ratio
knowledge	0.3223†	0.1877	1.3803
credit1999	2.7972*	1.2121	16.398
spouse works	-0.9804†	0.5463	0.3752
constant	-0.7922	0.3503	
N	85		
LR $\chi^2$	11.31		
McFadden's $R^2$	0.1037		
P-Value	0.0102		

Note: P-values are indicated with † <0.10, \* <0.05, \*\* <0.01.

t-test revealed captains received loans from banks in 1993-1994, and from the NSLB in 2001-2002 (N=31, P-value=0.057). Many informants suggested that the NSLB was more lenient than commercial banks. Captains that have repayments to make to the NSLB were more able to make payments only on the interest of their loans. Thus, captains that got credit since 1999 may be unable to pay their loans, but due to the leniency of the NSLB, they are still able to maintain their household income. Commercial banks, on the other hand, have increasingly considered it too risky to lend money to harvesters, buyers, and processors in the fish business (Weston, 2009). This is especially the case for new entrants. Commercial banks were reluctant to lend to harvesters and new entrants due to general uncertainty regarding economic conditions due to the financial crisis, and because fishing licenses have an uncertain property-rights status to banks, and cannot be used as collateral (Henley, 2005; Weston, 2009).

The hypothesis that captains who entered the fishery with higher debts would be most sensitive was partially rejected. Instead, younger captains with boat payments were more likely to report stable incomes. Captains who entered the fishery through trust agreements, however, were more likely to report a decrease in their incomes. Taken together with the importance of catches for incomes, this suggests that younger new entrants have been able to keep ahead of their credit, or at least interest payments



by catching more lobsters. Larger quantities of lobsters, however, often results in gluts and decreases in prices. Thus, harvesters are trapped in the fishing equivalent to an agricultural treadmill, whereby increasing effort and technological efficiency and inelastic demand for lobster results in decreasing prices, further incentivizing strategies to increase production efficiency (Cochrane, 1958). This trap has been recognized in a recent industry-based report (Theriault et al., 2013).

As suggested in Chapter 5, those older harvesters who do not increase their effort to stay above the wave of declining prices have experienced a decline in their income. This may be because these harvesters prefer the traditional way of fishing for lobster, or due to the “grit” of younger captains to use intensive fishing methods, such as overnight trap hauling, multi-day fishing trips further offshore, and shifting gear frequently.

Other characteristics had important implications for income sensitivity. Captains who were less dependent on lobster, and who had groundfish quota were less sensitive to economic change. Boat dimensions played a role in sensitivity as well. In the early 2000s when lobster prices and catches were high, and gas prices were relatively lower, a wider boat was economically feasible. Today, higher gas prices penalize less efficient boats the most. Many older harvesters, often fishing smaller older boats, stated that younger captains bought boats that too far beyond their means, and beyond what the prices and catches could pay for. One survey respondent stated that he was experiencing difficulties making payments and maintaining his income after entering the fishery and purchasing a new boat. He sold his boat and purchased a smaller more efficient boat, and has since been less sensitive to gas prices and lobster prices.

## Crew Employment and Remuneration

In this section, I examine the implications of the above household attributes for crew-shares and boat-shares. In Chapter 5, I discussed the tradeoffs between keeping crew and maintaining the vessel. When a captain does not pay crew enough, it is likely that the crew will seek employment either on another vessel, or outside of fishing. However, if a captain does not take a large enough boat share to maintain their vessel, it is more likely that they will not be able to pay for the upkeep of the vessel.

Table 6.6 summarizes a linear regression for winter crew-shares per crew-member. I used winter crew-shares because this is the period in which the crew and captain make the majority of their income from lobstering. The linear regression model in Table 6.6 demonstrates the importance of debt, boat length, catches, trust agreements, and whether the captain allocated crew-shares after deducting expenses ( $R^2 = 0.52$ ,  $P\text{-value} < 0.001$ ). On average, a captain who entered the fishery after 1999 on credit gave 3.4% less. A one-foot increase in boat size resulted in a 0.4% decrease in crew-share. Captains with longer boats and credit may have higher expenses, and as a result, must allocate smaller crew-shares to pay these expenses. A 10,000 pound increase in total catch was associated with a 0.6% decrease in crew-share as well. The effect of total catch on crew-share is offset by the increased earnings from catching more lobsters. For example assuming a 15% crew-share and a wharf price of 4\$, a crew-member on a vessel that caught 50,000 pounds would make \$30,000, while a crew-member on a vessel that caught 60,000 pounds would make \$35,856. Crew-members who worked with captains tied to trust agreements were allocated 1.4% lower crew-shares on average. Captains who deducted expenses before allocating shares gave 5.7% higher crew-shares on average. Deducting expenses incentivizes crew-members to use resources, such as food and drinks, or to allocate bait to traps

efficiently.

Table 6.6: Linear regression of winter crewshares.

Independent variable	Full model		Reduced model	
	Coefficient	Robust SE	Coefficient	Robust SE
after expenses	0.0573**	0.0127	0.0540**	0.0124
age	0.0010	0.0009		
boatpay	-0.0138	0.0127		
credit1999	-0.0253	0.0177	-0.0342**	0.0144
dependency	-0.0336	0.0326		
groundfish quota	-0.0000	0.0001		
halibut quota	0.0002	0.0016		
knowledge	0.0047	0.0047		
length	-0.0036*	0.0024	-0.0041**	0.0019
LFA 34	-0.0111	0.0320		
lobster storage	0.0113	0.0129		
owns boat	-0.0039	0.0182		
swordfish quota	-0.0000	0.0003		
total catch	-0.0003	0.0006	-0.0006*	0.0003
trust agreement	-0.0204†	0.0152	-0.0143†	0.0086
width	-0.0012	0.0026		
spouse works	0.0145	0.0181		
constant	0.3676**	0.0803	0.4914**	0.0736
N	79		83	
F	3.07		18.66	
R <sup>2</sup>	0.4526		0.5248	
P-value	0.0008		< 0.0001	

Note: P-values are indicated with † < 0.10, \* < 0.05, \*\* < 0.01. Robust standard error estimation used due to heteroskedasticity of residuals.

Most captains reported that they employed one or two crew-members, but three reported that they employed three. I excluded these outlying cases and conducted binary logistic regression for captains that hire two crew-members. As is indicated in Table 6.7, captains who were older, caught more lobsters, and who had longer vessels were all 1.1 times more likely to report that they employed two crew-members (McFadden's  $R^2$ , P-value < 0.0001). The importance of these variables indicate two different influences on crew-member employment. Older captains often have less

Table 6.7: Reduced binary logistic regression model for captains who hire two crew-members.

Independent variable	Coefficient	SE	Odds Ratio
age	0.0978**	0.0342	1.1028
totalcatch	0.0873**	0.0309	1.0912
length	0.1352†	0.0802	1.1447
constant	-13.722**	3.8204	
N	86		
LR $\chi^2$	48.81		
McFadden's $R^2$	0.4708		
P-Value	< 0.0001		

Note: P-values are indicated with † <0.10, \* <0.05, \*\* <0.01.

household expense, and have established their fishing business, and thus often do not need to take as much to make payments or for household expenses. Older captains also employ their children or their in-laws as apprentices in the lobster business. Captains with larger vessels that catch more lobsters, however, require a larger crew to ensure lobsters are measured and banded quickly enough, especially in the winter when catches are at their highest.

### Crew Outcomes

Due to low statistical power for crew-members I used a matrix of Kendall's  $\tau$  rank correlations to determine the factors that influenced a crew-member's income, change of income, or change in debts. I found no correlations between crew-share and income, though this may be due to a lack of statistical power. I also found no variables correlating with crew-members reporting a decrease in income. However, the weak trends in the correlation matrix in Table 6.8 corroborate the patterns I found in the analysis of the sensitivity of captains. Crew-members who worked on vessels that caught more lobsters, and who were less dependent on lobster reported higher incomes. Crew who worked on vessels that caught more lobsters, and who had a spouse that works were also more able to pay off their debts. These results corroborate the importance of

Table 6.8: Table of pairwise Kendall’s  $\tau$  rank correlation of dependent and independent variables.

	Income	Debts	Dependence	Total catch
Debts	-0.2574†			
Dependence	-0.3824*	0.0994		
Total catch	0.3000†	-0.2647†	0.0956	
Spouse works	0.2206	-0.2047†	-0.2105	0.0368

alternative household sources of income and catching lobsters to maintain incomes and pay off debts. While the livelihoods of captains and crew-members are clearly tied together, it is possible that a larger sampling of crew-members would reveal the importance of other livelihood strategies for crew-members, such as harvesting sea plants, migration, or summer employment in other local sectors.

### 6.3.6 Discussion of qualitative responses

Harvesters corroborated the narrative of the importance of dependency on lobster livelihood by responded to the the open-ended question, “Overall, what limits your ability to make a living in fishing the most?” The most common responses were quotas (60%), the price of lobster (35%), DFO regulations (12%), and the costs of fishing (10%). Harvesters believed that quotas were the most important limitation to their livelihood. Without access to quota, harvesters were unable to supplement their incomes with groundfish, swordfish, halibut, or other fish species.

Recent changes to the employment insurance have threatened to increase the sensitivity of harvesters to lobster prices. Of captains and crew, 57% expressed concern over austerity-driven cutbacks to employment insurance. These changes were recent when I arrived in Barrington, and thus it is difficult to tell what the effects of these policy changes will have on fishing communities. Harvesters were concerned that they would have to look for low paying work in the community (22%), crew would become less available because they would move away (16%), or their income streams will be

unstable (11%). Some of these concerns may have been warranted, because EI recipients have declined by 12% in Nova Scotia as of October, 2013. This drop in EI recipients has disproportionately affected Atlantic provinces (Bailey, 2013, October 25).

Overall, harvesters were not optimistic about the future of the fishery. When asked, “[d]o you think your access to the lobster fishery will be less, the same, or more than in the past?” 59% responded “less”. Additionally, when asked the same question for the quota fisheries, 67% said less and only 2.7% said more. I compared groundfish quota ownership among the respondents to this question. Harvesters who said less owned a significantly higher amount of quota (T-test assuming unequal variances,  $P < 0.05$ ). Harvesters who said their access to the quota fishery would be less owned an average of 20,864 pounds of groundfish quota, while those who said their access to the quota fishery would be the same owned an average of 3,650 pounds. Survey respondents with small quotas often stated that their access will remain the same because they don’t have any now, and they don’t think it is going to change. These results contradict the claim that quota ownership confers security of tenure. In the case of Barrington, declining stocks and quotas have decreased the security of their tenure in the fisheries. However, this sense of insecurity was not necessarily caused by the introduction of quotas per se. Insecurity of tenure may be due to the legacy of over-exploitation of groundfish, and continuing species decline due to ecological change. Grainger and Costello (2014) showed that fishing quotas do not confer security of tenure when there are ownership disputes, illegal fishing activities, or when owners believe that government will eventually revoke their fishing rights. Some or all of these sources of insecurity are at play in Atlantic Canada.

Finally, captains and crew-members were asked to report the worst and best years they experienced in fishing. I summarize harvester responses in Figure 6.5. Harvesters

explained that the worst years were those when catches were low (41%), when prices were low (41%), when gear or the boat was damaged or lost (15%), when they were no longer able to go groundfishing (15%), or when the weather was poor (9%). The best years were those when catches (67%) and prices (51%) were high, or when harvesters could fish year round (26%). Most harvesters considered the 1970s, 1983, 1993, and 2008-2010 to be bad years. The best years were 1989-1991, and 1999-2004. Harvesters were most divided about 2012. Nearly equal numbers of harvesters listed 2012 as a good and bad year.

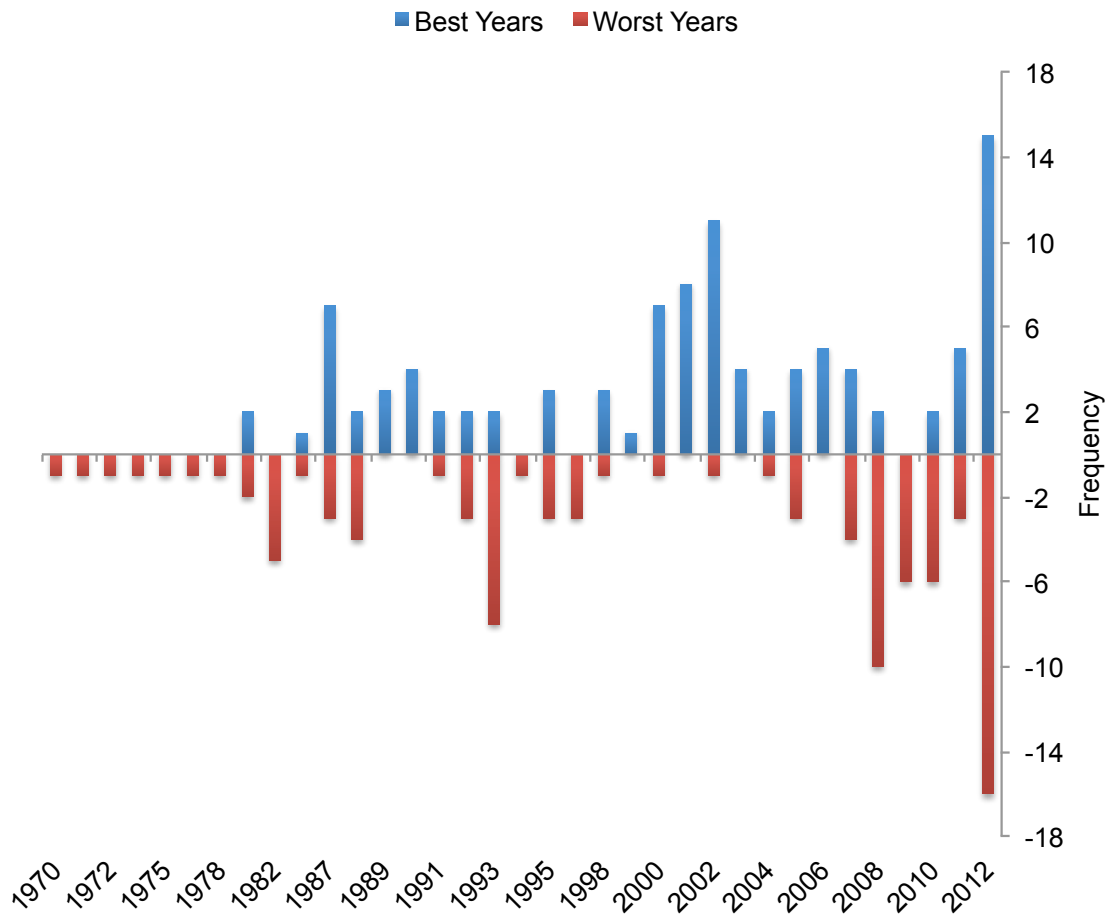


Figure 6.5: Frequency histogram of the years that harvesters reported to be their best (blue bars with positive numbers) and worst (red bars with negative numbers).

The best and worst years listed by harvesters often corresponded to well-known historical events in the region. In the 1970s, many foreign industrial trawlers were exploiting the groundfishery well beyond a sustainable level, and nearly collapsed the stocks by the end of the decade (Rogers, 1998). Those harvesters that fished at this time reported that prices and catches were low. The next bad year was 1983, the year of the dispute over trap limits between harvesters and the DFO. Also in this year, the codfishery was closed early because harvesters over-ran the total allowable catch early. Codfish catches improved in the 1980s due to a slight recovery, and some harvesters remembered the late 80s and early 90s as the best years in fishing. In 1992, the DFO declared a moratorium on codfishing in Atlantic Canada, issued strict reductions in the total allowable catches for inshore fixed gear fleets, and introduced individual transferable quotas to the <65' mobile fleet in SWNS (Peacock and Annand, 2008; Crowley and Palsson, 1992). In addition to these misfortunes in the groundfishery, 1993 was a memorable year in SWNS for quota cuts and the Shelburne blockade. In the neighboring municipality of Shelburne, 100 small-scale fishing vessels surrounded a 400 foot Russian trawler attempting to unloading 12,000 tons of groundfish at a Shelburne processing plant. This blockade was lifted after six days of protest when Ottawa agreed to order all foreign fishing boats to leave Canadian fishing waters (Demont, 1993). As is evident in Figure 6.5, groundfishing livelihoods did not improve in the 90s. The slight spike in worst years reports in 1997 was the year when the inshore fixed gear sector (hand-liners and longliners) were allocated individual quotas based on the history of their 1986-1993 catch records (Peacock and Annand, 2008). These policies were met again with civil disobedience. This time, harvesters in Barrington and other regions occupied local DFO offices demanding an end to the quota system. As was noted in Peacock and Annand (2008), the 1997 introduction of the community quota system in this region was fraught with conflicts



within and between quota groups.

By the end of the 1990s, the harvester's best and worst years reports were tied to fortunes in the lobster fishery. Many harvesters reported the early 2000s to be the best years in fishing. In these years, lobsters were becoming more abundant, and the markets for lobsters were strong as prices rose to as high as \$14 per pound. Figure 6.5 clearly indicates a downturn in this trend peaking in 2008, when the financial crisis precipitated a decline in demand for luxury items, including lobster. Interestingly, the greatest split occurs in 2012, when an equally high number of harvesters reported best and worst years. This may reflect the split between fishing strategies, and possibly, the emergence of "fishing for volume" as an adaptive/coping strategy to new market conditions. This split supports the claim made by some harvesters in Chapter 5 that prices based on quantity are rewarding fishermen who increase their effort, while punishing those who do not.

#### 6.4 Conclusion

The analysis above clearly demonstrates that having a diversity of sources of income from fishing is important to livelihoods. Captains and crew that were less dependent on lobster, that had groundfish quota, or who had a spouse that worked were less sensitive to economic change. Characteristics of new entrants were also important, but these findings were contrary to my hypothesis in most tests. Younger captains with boat payments had lower income sensitivity. New entrants since 1999 were less able to pay off their debts, though they may be able to cope by making only interest payments to the NSLB. Debt and catches also played a role in crew-shares. New entrants that entered with credit, or captains tied to trust agreements allocated lower shares to crew. These captains, however, were able to offset lower crewshares by catching more lobsters.

For many, the response to decreased prices has been to increase effort and invest in lobster storage. Lobster storage was only weakly related to income sensitivity. But Climate change projections suggest that storms will become more intense (Intergovernmental Panel on Climate Change, 2007). Increasing storm intensity in Barrington will increase the risk in both cases. First, high fishing effort strategies will become increasingly risky as intense storms can damage and in some cases, sink fishing vessels. Also, increasingly intense rains and warmer water temperatures can increase the risk to lobsters stored in lobster cars. Lobsters are highly sensitive to low salinity, and thus, high rains in a fishing wharf can result in massive die-offs of lobsters.

How many lobsters a captain caught had implications for crew-shares, and the incomes for captains and crew. Clearly, increasing lobster landings increases incomes. But dependence on stable high lobster catches come with the risk that ecological disturbances lower lobster abundance in the future. One such disturbance is lobster shell disease. This has received media attention recently because the disease has begun to move north from New England to Maine, causing concern for Canadian biologists (CBC News, 2013, August 13). This and other potential disturbances to the lobster fishery would significantly reduce the quantity of marketable lobsters landed in the region. This would have a drastic negative impact on fishing livelihoods, especially those that depend on high catches.

The above analysis does not consider the adaptive capacity and vulnerability of fishing households in multiple dimensions. Eakin and Bojórquez-Tapia (2008) used multi criteria decision analysis to examine the livelihood vulnerability of Mexican farmers to climate change. This method also uses the analytical hierarchy process to weight household attributes and sensitivity indicators based on interviews and expert opinion. In Chapter 7, I will apply multi-criteria decision analysis to examine the composition of household vulnerability in Barrington, Nova Scotia.

## Chapter 7

### ADAPTIVE CAPACITY AND SENSITIVITY TO DOUBLE EXPOSURE

#### 7.1 Introduction

In December 2008, a group of lobster fishermen in Southwest Nova Scotia went on strike. They were protesting the lowest wharf price for lobsters since 1991. Fishermen claimed they could not make a living on \$3 per pound, and that their incomes have been squeezed by increasing costs of bait and fuel. The buyers countered that they could not offer a higher price because wholesalers were not buying enough lobsters, and processing plants could not absorb the large supply of lobsters because they lacked the credit to maintain operations (Comeau, 2008, December 1). Only two days after the initiation of the strike, fishermen voted to return to sea without progress in price negotiations. Despite the low prices, many fishermen stated that they needed the income to pay their debts. This lobster price crisis has continued to challenge Atlantic fishing communities. Another strike occurred in SWNS in May, 2012, headed by a new association. In August 2012, lobster harvesters in New Brunswick blocked trucks delivering lobsters from Maine to local processing plants (CBC News, 2012, August 2).

This lobster industry crisis was a local manifestation of the global economic financial crisis of 2008. As economic growth slowed in the United States, demand for lobsters decreased. The American/Canadian dollar exchange rate also declined, decreasing the export value of Canadian lobsters. The low prices also reflect record high lobster catches throughout Atlantic Canada (Holland, 2011). But if we examine the decline in lobster prices through the lens of double exposure (Leichenko et al.,

2010), it becomes clear that the financial crisis was only one of many interacting processes leading to this event. The financial crisis of 2008 was the catalyst that exposed the vulnerabilities associated with changing underlying economic and environmental conditions in Atlantic Canadian fishing communities.

Global and regional-scale environmental and economic change interact with local actors, political processes, and households to create a unique vulnerability context. By understanding what makes some households vulnerable to this local context, we can better understand the strategies and political process that enhance livelihoods, I briefly review the interacting processes that constitute double exposure in Barrington, Southwest Nova Scotia, Canada. I then use multicriteria decision analysis (MCDA) to characterize the differential vulnerability of households in this community. Finally, I briefly examine the implications of this variation in vulnerability for the governance of the fishery.

## 7.2 Literature Review

Globalization and environmental change have altered social and ecological systems at a rapid pace and large scale (Homer-Dixon, 2006; Leichenko and O'Brien, 2008). But the outcomes of these processes are often uneven. Environmental change manifests as habitat and species loss, changing temperatures patterns, and changing water availability (Leichenko and O'Brien, 2008). Globalization has had uneven impacts on economic growth and capital mobility, income and wages, political mobilization, and the diffusion of technology at a regional or national scale (Smith, 2008). Through processes acting at multiple scales, many rural communities have been exposed to novel disturbances (Peet and Watts, 2002; Scoones et al., 2007; Adger, 2006).

Vulnerability research evaluates the processes, conditions, and characteristics of systems that lead to adverse outcomes for a unit of interest, such as an individual,

household, or community (Eakin and Luers, 2006). According to (Clark et al., 2000), a individual or group is vulnerable if 1) they are exposed to a disturbance, 2) if they are affected or sensitive to this disturbance, and 3) if they are unable to adapt to or resist the adverse outcomes caused by a disturbance. Vulnerability is a dynamically changing condition that depends on the changing political structures, access to resources and entitlements, historical legacies of marginalization, and the decisions social groups make from a set of choices available to them (Eakin and Luers, 2006; Adger, 1999; Eakin, 2005).

In this study, I measure the sensitivity and adaptive capacity of households to globalization and environmental change. It is often difficult to separate sensitivity and exposure because both concepts are related to impacts on a resource and a household's dependence on that resource (Eakin and Bojórquez-Tapia, 2008; Smit and Wandel, 2006). Households that have the capacity to adapt have a set of characteristics that enable them to mobilize resources and reorganize their livelihood strategies to diminish the threat of adverse outcomes (Eakin, 2005).

Households are vulnerable to globalization and environmental change when they have insufficient income or wealth, and when they lose access to the entitlements they depend on for their livelihoods (Adger, 2006; Sen, 1997). The sustainable livelihood approach facilitates the analysis of a household's assets and entitlements (Scoones, 1998). Entitlements are potential or realized resources available to an individual or household, based on their production, assets, reciprocal arrangements and institutions (Adger, 2006; Sen, 1997). This approach categorizes the assets and entitlements as natural, social, physical, financial, and social capital. Households mobilize these forms of capital to anticipate and respond to change, or to create their on change. Understanding assets and entitlements in this way allows a researcher to pinpoint critical resources to vulnerable households, and the nature of the livelihood strategies

they employ (Eakin and Luers, 2006).

Vulnerability researchers have demonstrated that livelihood diversification is an important source of adaptive capacity (Cinner et al., 2012; Eakin and Bojórquez-Tapia, 2008; Eakin and Wehbe, 2009). Fishing households can diversify to new fishing gears that target different species to reduce their sensitivity to ecological impacts (Cinner et al., 2012), and income volatility due to fish prices (Davis, 1984b). Cinner et al. (2012) also suggests that fishing households can reduce their sensitivity by diversifying out of fishing-based industries. But a household's ability to diversify depends on their access to capital, risk aversion, education, age, their willingness to work elsewhere, and the nature of their primary income activity (Cinner et al., 2012; Marshall, 2011). Many households continue to depend on diminishing resources due to an attachment to their community, their identity as "fisherman or farmer", and their geographic region (Marshall, 2011; Minnegal et al., 2003; Measham, 2006). These attachments to place and occupation become a source of vulnerability when environmental changes decrease a household's access to a diversity of local resources.

Adger (2003) argues that a society's capacity to adapt to climate change depends on their ability to act collectively. When faced with global environmental and economic change, local communities can act collectively to mobilize resources, enhance their decision-making power, and change the political landscape (McLaughlin and Dietz, 2008). But vulnerable households often withdraw from collective action and rely on individual mitigation strategies when political systems and participatory decision-making processes are weak or do not represent their interests (Pelling, 1998). Vulnerable households can employ individual strategies to cope or adapt to disturbances, but these responses can preclude the possibility of more efficient coordinated strategies that can improve underlying social and ecological conditions. Such individual household strategies may also affect the ability of other households to adapt, or

increase the sensitivity of a system at a larger scale (Eriksen and Lind, 2008; Eakin and Luers, 2006).

In the following section, I outline the double exposure framework, and discuss how globalization and environmental change have acted as double exposures for fishing communities of Atlantic Canada. This provides a context to understand how a legacy of decreasing entitlements and assets have influenced the variability of household sensitivity and adaptive capacity in Barrington, SWNS.

### 7.3 Double Exposure

The double exposure framework accounts for the interactions between global environmental and economic changes (Leichenko et al., 2010). Leichenko and O'Brien (2008) describe three pathways of double exposure; 1) outcome double exposure, 2) context double exposure, and 3) feedback double exposure. Outcome double exposure is the pathway in which globalization and environmental change interact to produce disturbances that affect households. This pathway produces “double winners” and “double losers” depending on household exposure, sensitivity, and adaptive capacity (Leichenko et al., 2010). Context double exposure identifies the pathway through which a process, or set of processes, can change the vulnerability context of a region. This changing context influences the capacity of households to respond to future disturbances. Feedback double exposure is the process through which actors or groups of actors respond to changing context and outcomes. These responses through feedback double exposure may reinforce the processes that produce vulnerable contexts and outcomes.

### 7.3.1 *The lobster price crisis in context*

The processes that have led to a current vulnerability context in Atlantic Canada can be historically traced to the 17th century globalization of trade under European mercantilism (Innis et al., 1940). Newfoundland became an important outpost supporting British international dominance. The abundant stocks of cod provided the British empire with a source of food, economic diversification, and a source of trade (Kurlansky, 1998; Innis et al., 1940). Vested interests in England promoted direct trade with the West Indies and opposed trading between the West Indies and the Atlantic colonies, as well as New England (Rogers, 1998; Innis et al., 1940).

By the middle of the nineteenth century, the British mercantilist system had been dismantled, but the colonies of New Brunswick, Nova Scotia, and Prince Edward Island remained largely independent from Canada. These colonies showed signs of successful economic growth leading up to their confederation into Canada in 1867 (Clow, 1984). Political economists have linked the decline, stagnation, and underdevelopment of maritime provinces since confederation to a few processes. These processes include: the concentration of capital and productive industries into Canadian centres, such as Toronto and Montreal (Clow, 1984); federal banking and transport policies that favored manufacturing and financial capital in Canadian centres (Baker, 1977, cited in Clow, 1984); heavy dependence on the export of primary sector products such as fish, coal, lumber, and pulp to Central Canada and the United States (Innis et al., 1940; Veltmeyer, 1978); heavy dependence on imports from Central Canada (Veltmeyer, 1978); and monopoly control of primary production (Sacouman, 1980). In the early twentieth century, production and employment in maritime economies declined drastically, and more than 300,000 maritimers migrated to central provinces seeking employment. Many who remained sought employment in local primary sec-



tor economies. This process has produced long-term dependence on staples and has exposed maritime industries to the volatility of international markets (Veltmeyer, 1978).

After the Second World War, the Canadian government attempted to modernize their Atlantic fleets to compete with the rapid expansion of European vessels exploiting offshore grounds in the North Atlantic (Barrett and Davis, 1984; Rogers, 1998). International agreements stated that underutilized species within domestic territories must be granted to the other nations that use them (Pinkerton and Weinstein, 1995, p. 167). From 1954 to 1974, the number of bottom trawling vessels (draggers) fishing in the North Atlantic increased from 620 to 1537, and Canadian vessels larger than 50 tons increased by 320% in terms of catching capacity in the 1960s. The Canadian government fueled this expansion through subsidies to modernized industrial fleets (Barrett and Davis, 1984; Barrett, 1984). Yet this increase in capacity coincided with a mere 18% increase in catch (Rogers, 1998). These industrial fleets quickly ran into crisis as fishing capacity exceeded the productivity of the fishing grounds (Barrett, 1984).

The rapid post-war expansion of highly industrialized trawlers brought the Atlantic groundfish stocks to the brink of collapse in the 1970's, leading to Canada's 1977 declaration of the 200-mile economic zone (Rogers, 1998). Rogers (1998) demonstrates the contradictory Canadian policies of economic development of Atlantic provinces through the expansion and subsidization of modern industrial domestic fishing fleets, and of the simultaneous regulation, control, and restriction of fishing effort to avoid a tragedy of the commons. While the Department of Fisheries and Oceans (DFO) was "slowly tightening up the licensing regime with one hand (and preaching constraint), it was passing out subsidies for fishing vessel construction with the other, as were provincial loan boards" (Kirby, 1982, p. 20).

By 1989, the Groundfish Task Force estimated that the capacity of the fishing fleet exceeded economically efficient levels by five times (Hache, 1989). The DFO introduced Individual transferable quotas (ITQs) as “Enterprise Allocations” to a portion of the offshore groundfishing fleets (65’-100’ and >100’) as early as 1982, and Hache (1989) recommended the expansion of this regime to the the smaller mobile and fixed-gear sectors. Following the collapse of the cod fishery on the Grand Banks of Newfoundland in 1991, the government introduced individual quotas to the inshore mobile fleet (<65’) and the inshore fixed gear fleet (longliners and hand-liners <45’), and introduced a community quota system with an informal ITQ group in 1997 (Peacock and Annand, 2008; Crowley and Palsson, 1992). Fishing capacity since the introduction of ITQs has decreased significantly among the fixed and <65’ mobile gear fisheries. For example, in Shelburne county, including Shelburne, Pubnico, and Barrington, the number of vessels decreased from 633 in 1996 to 156 in 2005 (Peacock and Annand, 2008).

Coastal fishermen in SWNS responded to privatization with protests, occupying DFO offices, and demonstrations. The declining access and abundance of groundfish affected all sectors of the fishing industry including processors, industrial fleets, and the fixed gear sector. As quotas declined, some fishing enterprises with sufficient capital maintained their operations by buying up quotas from fishermen with small and declining quota allocations (see Chapter 5). But small-scale hand-line fishermen have declined disproportionately more than all others.

Hand-lining is a simple fishing strategy that dates back to the beginning of the commercial Atlantic fishery. The technology consists of a single line with several size and species-specific baited hooks, and a lead weight (see Davis, 1984b, p. 104). While the technology does not allow a harvester to catch as much as longline or trawler technologies, hand-liners have low fishing costs, and can often bring in high-

quality live fish. Hand-lining was especially cost effective when groundfish stocks were abundant close to shore.

Hand-line fishermen played a large role in the 1996 occupation of DFO offices (Cox 1996, March 8). At that time there were still 500 hand-liners in SWNS (Cox 1996, March 8). During my fieldwork in Barrington, I only encountered three handliners who continued this practice, and all of them reported that they could not continue fishing because of low quotas and a scarcity of fish inshore.

These processes have increased fishermen's dependence on lobster as a source of income. In the 1970s, Davis (1984b) estimated that 40% of a fisherman's income was derived from lobster. Fishermen made a living from a variety of fish species, including cod, haddock, hake, cusk, halibut, pollock, herring, mackerel, and lobster (Davis, 1984a). Today, based on the survey results below, that number is 82% on average.

As fortunes in groundfishing faded, however, the lobster industry began to boom due to increasing catches and high prices. Generalized fishing households began to specialize in lobstering. The market for lobster licenses grew, and the cost of a license rose to as high as \$500,000 (Bodiguel, 2002). According to Weston (2009) fishermen have historically had low access to credit because licenses cannot be used as collateral. Those who could not obtain their licenses through traditional credit sought extra-legal leasing arrangements with companies, processors, or fish buyers. Fishermen also increased the scale of their lobstering operations, expanding to further offshore waters, and investing in higher capacity boats.

But Steneck et al. (2011) has characterized the economic success of the lobster fishery as a "gilded trap." The seeming success of the lobster fishery is partially due to the collapse of groundfish predators, such as cod (Steneck et al., 2013). Though fishermen throughout the Atlantic made large financial gains by expanding their lobster

fishing operations, the economic and ecological diversity of fishing communities have declined (Steneck et al., 2011). With greater dependence on few species, fishermen have become vulnerable to economic and ecological shocks.

The global financial crisis has revealed underlying or hidden conditions that make households and regions vulnerable to double exposure (Leichenko et al., 2010; Yohe and Leichenko, 2010). The lobster boom of the early 2000s also helped to conceal the vulnerability of the lobster fisheries of SWNS. Weston (2009) characterized this condition as a “perfect storm,” caused by the combination of increased costs, decreased demand, and decreased access to credit. This crisis, however, differs from previous crisis in Atlantic Canada because fishing households no longer have ability to switch their livelihood strategies to target different species.

### *7.3.2 Double exposure in Atlantic Canada*

Double exposure to globalization and economic change have acted at different temporal and spatial scales to produce a context double exposure characterized by high dependence on lobster. The combination of British imperial policies, Canadian economic development policies, and capital flows have limited the economic diversification of the region. This shaped post-war maritime development policy. In a context of high dependence on natural resources, the Canadian government saw the Atlantic groundfishery as a way to modernize and grow the maritime economy, as well as compete with international fishing fleets. But the collapse and subsequent privatization of groundfish species in the 1980s and 1990s constrained the diversity of livelihood strategies available to coastal fishing communities. Global economic relations combined with environmental changes caused by overexploitation to shape the current context of dependency.

Warmer water temperatures caused by climate change has also influenced lobster

and groundfish stocks. Both warmer sea surface temperatures and fishing have favored an alternative ecological state in the North Atlantic dominated by crustaceans (Kirby et al., 2009; Steneck et al., 2013). Beaugrand and Kirby (2010) demonstrated that warmer surface temperatures are changing the abundance and distribution of plankton species that play an important role as a diet to larval cod. Kirby et al. (2009) suggest that fisheries managers will be unable to rebuild cod stocks due to the synergistic effects of fishing and climate change. Climate has also affected the geographical distribution of lobsters. Lobsters are migrating to cooler waters to the North and further offshore at a rate of 6 km per year (CBC News, 2013, September 21; Pinsky et al., 2013). At the southern extreme of their geographic range, lobster stocks are increasingly threatened by the outbreak of disease, promoted by warmer water temperatures (Steneck et al., 2013).

The collapse of the groundfishing industry in Atlantic Canada is a long-term and potentially permanent disturbance to the Atlantic ecosystem. Climate change and overfishing have combined to favor an ecosystem dominated by crustaceans, such as lobsters. Outcome double exposure manifested itself 17 years after fisheries managers recognized the cod collapse when a crustacean dominated ecosystem and lobster dependent fishing context combined with the economic crisis of 2008.

In the following sections, I explore the current vulnerability context in the fishery. What responses are available to fishing households today? What sets of assets and entitlements have enabled them to adapt or cope with double exposure. What is the potential for households mobilizing through associations to act as a political feedback, and to reshape their regional political economic context.

## 7.4 Methods

### 7.4.1 Survey

I surveyed 94 fishing captains and 19 crew members in Barrington Nova Scotia in the summer of 2012 (May-September). Due to low statistical power for analyzing crew members, I focus my analysis on captains. Survey questions were designed to collect indicators of household assets and capital (Scoones, 1998) that are relevant to assessing the vulnerability of fishing households to ecological and economic change.

I apply the characterization method used in Eakin and Bojórquez-Tapia (2008) to develop indices of adaptive capacity and sensitivity that constitute vulnerability. Adaptive capacity was composed of human/social capital (age, education, help from others in the community, and knowledge of the fishing grounds); financial assets and debts (boat payments, license leasing arrangements, loan repayments for licenses, preparing for retirement, medical insurance, and a spouse with employment); access to natural assets (lobster catches, groundfish quota, halibut quota, swordfish quota, and licenses to harvest sea plants); and physical assets (boat capacity, boat ownership, and lobster storage facilities). All of these variables constitute adaptive capacity because they determine a captain's ability to adapt to change through alternative employment, social relationships, fishing for different species, depending more on other household income contributions, selling or trading physical assets, or storing lobsters when prices are low. Debts, leasing arrangements, and lacking boat ownership constrain the adaptive capacity of a captain because they can lower the finances available to adapt, and limit the decision-making power of a boat captain.

Eakin and Bojórquez-Tapia (2008) measured sensitivity and exposure together, and divided sensitivity/exposure into two categories; crop sensitivity, and livelihood sensitivity. That different fish species will respond differently to climate change sug-

gests that a household sensitivity will depend on the species fished for. But the effects of climate change on various interacting species are uncertain. Thus, I only include livelihood sensitivity in this analysis. Livelihood sensitivity included the change in a fisherman's income, ability to save, and household migration. A decrease in income or ability to save following an economic or ecological shock suggests higher sensitivity. The population of maritime provinces is shrinking fast, with 7 of the 10 fastest shrinking cities in Newfoundland and Nova Scotia (Statistics Canada, 2011). Many fishing households expressed concerns over the loss of local youth due to unemployment or underemployment in Barrington. Thus, the number of household members who have migrated may indicate the household's sensitivity to change.

#### *7.4.2 Determining vulnerability indices using MCDA*

Similar to Eakin and Bojórquez-Tapia (2008), I used Multicriteria Decision Analysis (MCDA) to characterize the vulnerability of fishing households in multiple dimensions. This method is detailed in Eakin and Bojórquez-Tapia (2008). Here I highlight my application of this method. Eakin and Bojórquez-Tapia (2008) developed indices using the analytic hierarchy process (AHP) and compromise programming (CP), and classified households using fuzzy classification. In this analysis I also used the AHP and CP. Instead of using fuzzy classification, however, I analyzed the distribution of adaptive capacity and sensitivity scores among households. I present this classification scheme in the results.

#### **Weighting indicators**

The first step in the AHP is to arrange indicators hierarchically (Saaty, 1980). I organized adaptive capacity and sensitivity indicators hierarchically. Adaptive capacity was composed of a secondary level, including social/human, financial, natural,

and physical assets, and a tertiary level including the indicators collected in surveys. Sensitivity was composed of a secondary level only, livelihood sensitivity and its indicators.

The AHP uses pairwise comparisons to determine the relative weights of each variable. A higher weight indicates a greater importance in the composition of adaptive capacity and sensitivity. In the AHP, the relative importance of all indicators within a hierarchical level are assessed. The hierarchical structuring of comparisons greatly reduces the number of comparisons required to determine weights. I performed pairwise comparisons using Super Decisions (2.2.1), developed by Thomas Saaty.

Eakin and Bojórquez-Tapia (2008) emphasized the role of the AHP in articulating hypotheses about the relationship between indicators and vulnerability. The weighting process is subjective and contingent on the experience and knowledge of the individual making the comparisons. I used a combination of survey and interview data, and consultation with key informants to develop indicator weights. I returned to the field site in February 2013 to conduct pairwise comparisons with key informants. The time of my arrival, however, coincided with the loss of five fishermen at sea. Thus, I avoided sampling where it may be deemed intrusive, and completed only one set of pairwise comparisons. I also conducted a ranking using pile-sorting with a second key informant. I used these inputs to inform my own set of pairwise comparisons considering information from all sources. By comparing the weightings generated by comparisons made by key informants, we can better understand the subjective process involved in assessing vulnerability.

### **Transforming survey data using value functions**

In the next step, I transformed all survey data into a uniform scale (0-1) using value functions. All variables are transformed to reflect their hypothesized relationship



to vulnerability. Fishing households are most vulnerable when adaptive capacity is low and sensitivity is high. I transformed each variable to reflect their hypothesized relationship to adaptive capacity or sensitivity. For example, I hypothesized that there is an age at which adaptive capacity is highest. I reasoned that fishermen younger than 50 need to “prove themselves” as captains, and locate suitable fishing grounds to make a living. But as fishermen age past 50, their capacity for physical labor and working long hours will diminish. Thus, age at which fishermen have the highest adaptive capacity is likely when they have established themselves, but still have sufficient capacities for intense physical labour. Therefore, from age 25-50, a captain’s vulnerability decreases linearly from 0.8 to 0. After the age of 50, a captain’s vulnerability begins to increase from 0 to 0.5. I reasoned that since captains can enlist the labor of young crew members, an older captain with experience is likely to be less vulnerable than a 25 year old captain.

Value functions are in linear, exponential, and binary forms, depending on the variables used. Some survey questions resulted in ordinal data. For example, fishing households reported whether their income increased, stayed the same, or decreased since 2007. This translated into a sensitivity score of 0, 0.17, or 1. This reflects the fact that households with a decrease in income are most vulnerable, but households with stable incomes are not in a middle position between vulnerable and the ideal state. A stable income under changing economic or ecological conditions suggests closer proximity to the ideal state, than to a vulnerable one. All value functions along with their hypothesized relationship to vulnerability are listed in Appendix F.

### **Compromise programming (CP)**

I used CP to aggregate weighted indicators for each household. This yields a score from 0 to 1 for adaptive capacity and sensitivity based on the sum of all indicators.

This score is a measure of the distance from an ideal state, where vulnerability is lowest. Eakin and Bojórquez-Tapia (2008) use the equation from Szidarovszky et al. (1986).

$$d_i = \left[ \sum_j^J w_j^p (1 - x_{ij})^p \right]^{1/p} \quad (7.1)$$

The distance ( $d_i$ ) to the anti-ideal state (i.e., vulnerability) is a function of  $w_j$ , the weight of the indicator determined using AHP,  $x_{ij}$ , the standardized score of that indicator,  $(1 - x_{ij})$  the difference between  $x_{ij}$  and the ideal point, and  $p$ , a constant distance metric parameter. While the sensitivity index represents the distance from the ideal state, I subtracted the adaptive capacity index from 1 to reflect the inverse relationship to vulnerability. Following Eakin and Bojórquez-Tapia (2008), I use the “city block” or “compensatory mode” where  $p = 1$ , and a small distance from anti-ideal state can be compensated by an large distance in another indicator. Under ideal conditions, a household’s adaptive capacity score and sensitivity is 0.

Due to difficulties I encountered while determining a final vulnerability score, I will discuss the methods I used to calculate the vulnerability score in the results section.

### 7.4.3 *Indicators for political engagement*

Due to the exploratory nature of the survey, the majority of questions regarding fishermen’s perspectives were open-ended. I used two closed-ended questions to serve as indicators of fishermen’s perspectives on the future of the fishery, and participation in organizations. First, I asked fishermen whether they would 1) definitely , 2) probably, 3) probably not, or 4) definitely not, “advise a child of [theirs] to go into fishing if they had to start from scratch.” Responses to this question indicate a fisherman’s uncertainty for the future of the fishery for younger entrants. In the second question,

I ask, “how frequently do you attend fisheries association or organization meetings.” Responses to this question ranged from 1 (always), to 4 (never). Responses to this question indicated a fisherman’s level of participation in the politics of the fishery. Finally, I included the question, “what association or organizations do you pay dues to?” as an indicator of engagement in lobster fishing associations. Fishermen belonged to many associations or organizations, but only two have voluntary dues. All quota fisheries have dues taken out as a mandatory fee. Thus, the two lobster associations in LFA 33-34 are the only associations or organizations for which due payments reflect political engagement. I tested for nonparametric correlations (Kendall’s  $\tau$ ) between these survey responses and vulnerability scores as calculated above.

## 7.5 Results

### 7.5.1 Weights

The weights of indicators differed widely among the two key informants. This may be due to their differing positions in the fishery; one was retired and the other was an active captain. Their estimates of the relative importance of indicators were based on their own experience. For example, one informant had a spouse who is employed part time, and depended on swordfishing as an alternative source of income. He ranked the spouses’ contribution to the household lower, and swordfish higher. The retired key informant, however, ranked contributions from a spouse higher. This informant’s spouse works full time, and provides a larger contribution to the household. He argued that swordfishing is only a small industry in the area, not enough to support the fishing community. In my final set of pairwise comparisons, I ranked the fisheries with a stronger foundation in the fishing community as more important natural capital relating to adaptive capacity. For example, groundfish was more important than

swordfishing and harvesting sea plants. Groundfishing, which includes haddock, cod, hake, and other species, was also ranked as more important than halibut. Though groundfishing vessels also catch halibut, halibut is generally a small contribution to earnings on a groundfishing trip. I ranked lobster catches above all other fishing activities, because fishermen have a high dependency on lobster, and lobster is considered the “backbone” of maritime fishing communities. I used a similar strategy for all other pairwise comparisons. I weighed the interview and survey data against the accounts of key informants, and decided on the relative importance of each set of indicators relative to human/social, financial, natural, and physical capital variables. These variables constitute adaptive capacity. The weights obtained through these different methods, and final weights are listed in Appendix C.2. The five most highly weighted variables constituted adaptive capacity were lobster catch (0.21), boat ownership (0.13), license leasing (0.09), groundfish quota (0.08), and ecological knowledge (0.07). These five accounted for 57% of adaptive capacity.

### 7.5.2 *Household classifications*

The distribution of household adaptive capacity and sensitivity scores in Figure 7.1 suggest different methods for each score. Adaptive capacity scores are normally distributed among households. Sensitivity scores, however, are bimodal. Thus, I classified households within one standard deviation of the mean score as having moderate adaptive capacity. Households with scores above or below these bounds were classified as low or high adaptive capacity households. Households with a sensitivity scores above or below 0.5 were classified as having high or low sensitivity.

I classified vulnerability based on the combination of adaptive capacity and sensitivity classifications. A combination of high or moderate adaptive capacity and low sensitivity yielded a classification of low vulnerability; low adaptive capacity and low

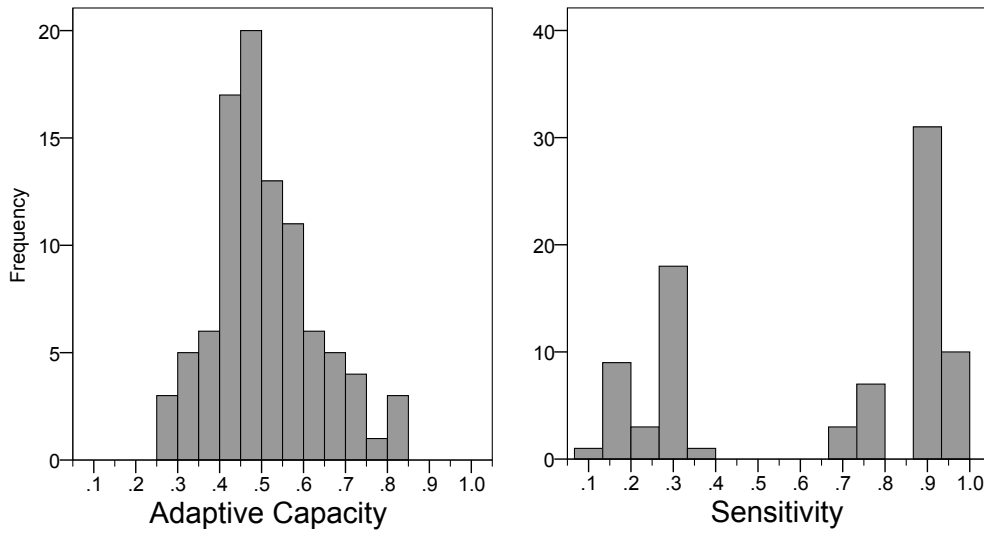


Figure 7.1: Distribution of adaptive capacity and sensitivity scores among fishing households

Table 7.1: Vulnerability classes of fishing households.

	% of households	Sensitivity Score	Adaptive Capacity Score
High	42.6	0.89	0.54
Moderate	20.2	0.62	0.50
Low	37.2	0.19	0.47
One Way Anova <i>P</i> -Value		<0.001	0.06

sensitivity or vice versa yielded a classification of moderate vulnerability; and low or moderate adaptive capacity and high sensitivity yielded a classification of a household as highly vulnerable. The resulting household classifications are listed in Table 7.1.

Table 7.1 indicates that vulnerability scores were driven primary by sensitivity scores. A Tukey’s post-hoc test revealed that all sensitivity scores were significantly different at  $\alpha = 0.001$ . Adaptive capacity scores were only weakly statistically significant, and the differences between adaptive capacity scores were small.

Due to the difficulty of combining sensitivity and adaptive capacity scores into a vulnerability score, I developed a measure to characterize households with the highest vulnerability scores. I reversed the capacity index so that a high score in sensitivity

and adaptive capacity combine to produce a high vulnerability score. I defined high vulnerability as those households with both a high adaptive capacity score and a high sensitivity score. I tested for differences in adaptive capacity and sensitivity scores between households classified as highly vulnerable and other households. Overall, there were only 7 households in this category. I tested for differences using a Mann Whitney test, and applied the False Discovery Rate correction for multiple comparisons (graphically sharpened method) (Benjamini and Hochberg, 2000). Similar but less conservative than the Bonferroni correction, the False Discovery Rate correction accounts for the increased probability that a significant difference will be discovered between groups due to chance when conducting multiple comparisons.

Adaptive capacity scores of highly vulnerable households are summarized in Figure 7.2. Highly vulnerable households had higher license leasing scores and boat ownership scores. These households also had higher indicator scores for knowledge and lobster catch, and entering the fishery on credit though these differences were only weakly significant. Highly vulnerable households had lower but weakly significant indicator scores for sea plants. Among sensitivity indicators, highly vulnerable households had a higher income change indicator score. ( $p = 0.016$ ). All highly vulnerable households had an income change indicator score of 1.

I disaggregated the vulnerability scores into adaptive capacity and sensitivity scores to evaluate the combinations of indicators that constituted low adaptive capacity and high sensitivity. The components of adaptive capacity are shown in figure 7.4. I tested for differences between classes for each indicator using a Kruskal Wallis one way analysis of variance (SPSS 22) applying the False Discovery Rate correction for multiple comparisons.

Comparison of indicator scores of low, moderate, and high adaptive capacity households are summarized in figure 7.3. Household classes differed significantly in

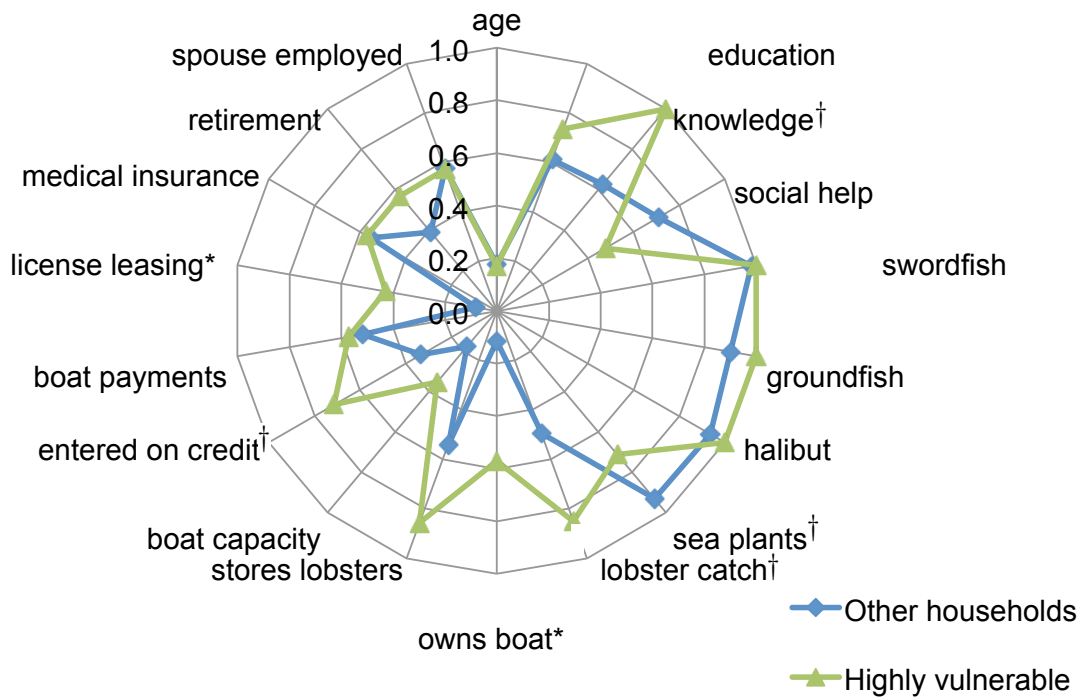


Figure 7.2: Composition of adaptive capacity indicators among highly vulnerable households. Significant differences are marked with a ‘†’ ( $p < 0.1$ ), ‘\*’ ( $p < 0.05$ ), and ‘\*\*’ ( $p < 0.01$ ).

knowledge, lobster catch, boat ownership, and license payments. Additionally, there was a weakly significant difference ( $\alpha = 0.1$ ) between household classes in lobster storage, boat capacity, and license leasing arrangements. Households with a high adaptive capacity were considered more knowledgeable, caught more lobsters, owned their boats, and did not have debt in the form of license payments, used lobster storage facilities, had sufficiently sized boats, and did not lease their licenses. These conditions were opposite for households with low adaptive capacity. For all indicators except license payments, lowest indicator scores were found in high adaptive capacity, and highest indicator scores were found in low adaptive capacity households. High adaptive capacity households had higher license payment scores on average than moderate adaptive capacity score households, but this difference was not significant.

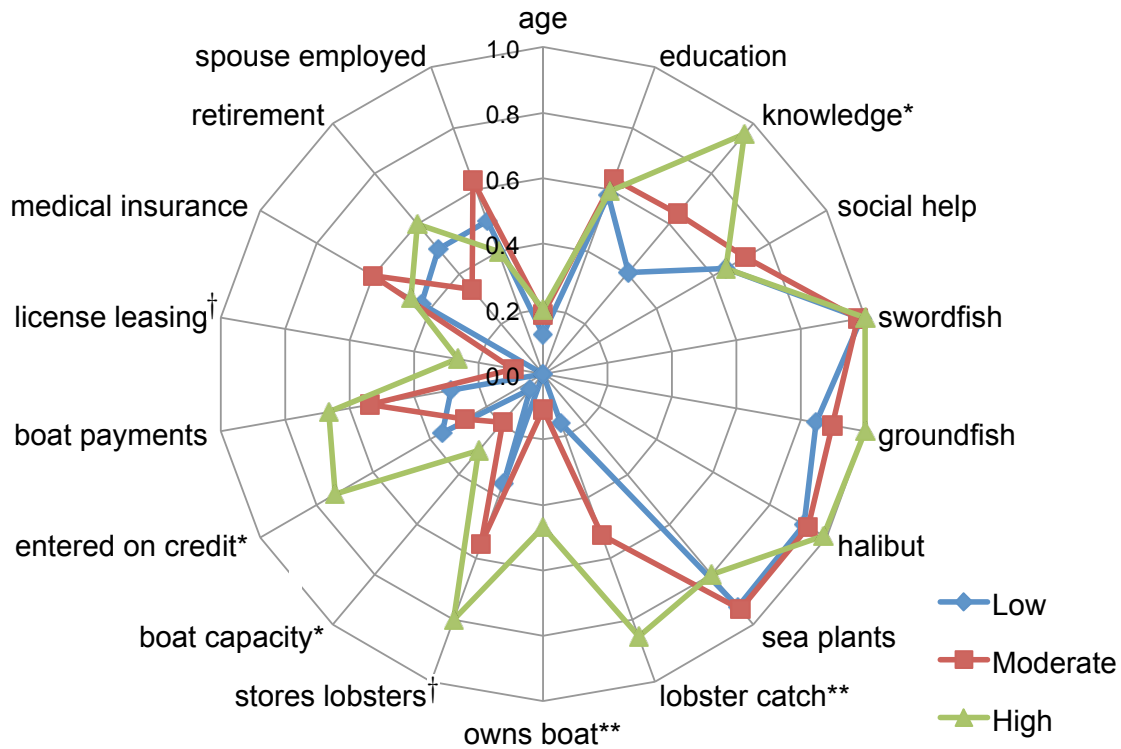


Figure 7.3: Composition of adaptive capacity indicators among low, moderate, and high adaptive capacity households. Significant differences are marked with a ‘†’ ( $p < 0.1$ ), ‘\*’ ( $p < 0.05$ ), and ‘\*\*’ ( $p < 0.01$ ).

Moderate adaptive capacity score households had a lower average license payment score than low adaptive capacity households. In other cases, indicator scores differed between low and high adaptive capacity score households, but not moderate classes. But total lobster catches differed among all household classes.

I compared sensitivity indicators among high and low sensitivity households using a Mann Whitney U test for nonparametric data (SPSS 22). High sensitivity households were more likely to report a decrease in income, and a decrease in their ability to save, but did not differ in reported family migration.



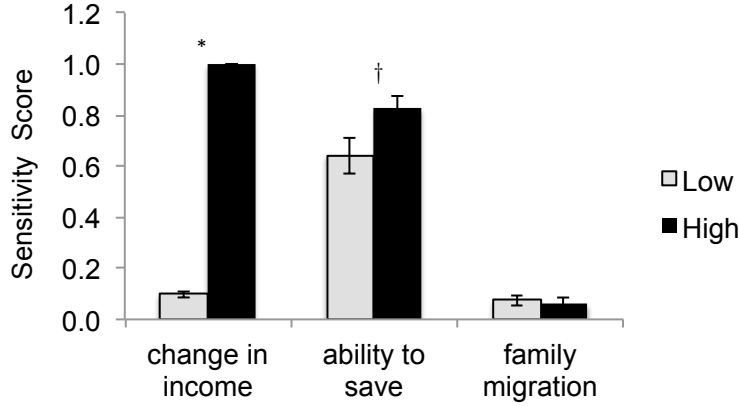


Figure 7.4: Composition of sensitivity indicators among low, and high sensitivity households. Significant differences are marked with a ‘†’ ( $p < 0.1$ ), ‘\*’ ( $p < 0.05$ ).

Table 7.2: Kendall’s  $\tau$  correlation table between adaptive capacity, sensitivity, and participation in association or organizational meetings, and perceptions of the future.

	Sensitivity	Discounting	Attendance	Association 1	Association 2
Capacity	-0.094	0.015	<b>0.25**</b>	-0.054	-0.15
Sensitivity		<b>0.21*</b>	-0.022	-0.034	0.016
Uncertainty			-0.011	-0.011	-0.066
Attendance				<b>-0.23*</b>	<b>-0.16†</b>
Association 1					<b>-0.26*</b>

Significant differences are marked with a ‘†’ ( $p < 0.1$ ), ‘\*\*’ ( $p < 0.05$ ), and ‘\*\*\*’ ( $p < 0.01$ ).

### 7.5.3 Vulnerability and political engagement

Adaptive capacity was positively correlated with attendance in fisheries association or organization meetings, and sensitivity was positively correlated with uncertainty. This means that fishing households with low adaptive capacity were more likely to “never” attend meetings than households with high adaptive capacity. Households with high sensitivity were more likely to respond that they would “definitely not” recommend a child to enter the fishery from scratch. Fishermen who paid dues to either lobster fishing association were more likely to attend organization meetings “always”. But fishermen who paid dues to one association did not pay dues to another.

## 7.6 Discussion

Globalization and environmental change have acted synergistically to produce a double exposure outcome of high sensitivity and low adaptive capacity. A long history of global economic relations combined with Canadian fisheries policy and climate change to produce a context double exposure characterized by high dependence on lobster as a source of income in Atlantic Canada. This vulnerable context and the global economic crisis of 2008 created a economic crisis among lobster-fishing households.

In Barrington, SWNS, the results of MCDA indicate that diversifying fishing strategies have not been a source of adaptive capacity for households. In this respect, low, moderate, and high adaptive capacity households are in the same boat in terms of high dependence on lobster. The majority of fishing households lack enough quota to adequately supplement their incomes with groundfish, halibut, or swordfish. Though weakly significant, highly vulnerable households were more likely to exploit sea plants (Irish Moss and Rockweed). This livelihood strategy is labor intensive, but can be a source of summer employment and a supplement to incomes from lobster fishing. Harvesting sea plants may also be an indicator of coping rather than adaptive capacity, particularly if this practice does not reduce long-run sensitivity, exposure, or build capacity to respond to future shocks.

The most important fishing livelihood strategy to respond to low prices was catching more lobsters. This is effective as long as increasing revenue from high catches outpace increasing bait and fuel costs. This depends on a fisherman's knowledge of the fishing grounds, their ability to work longer hours and more days in the season, and the capacity of their vessel to exploit offshore grounds where lobster catches are high. But if a fishing captain cannot sufficiently increase their catches to outpace de-

creasing prices, high boat capacity becomes a burden. This strategy is a short-term adjustment to an immediate threat, and thus can be considered more as a coping strategy than adaptive (Adger, 2006). Eakin (2005) argued that improving adaptive capacity requires the ability of households to engage in livelihood activities that do not enhance their vulnerability to future disturbances. Fishing for quantity, while an effective coping strategy, can further depress prices (Theriault et al., 2013) and lead to increased vulnerabilities over the long term.

Households with high adaptive capacity were more likely to own their boats, be free from license leasing arrangements and license payments. These households may have obtained their licenses before the rapid rise in fishery entry costs, or they may have inherited these assets from a family member. License leases and payments increase annual fixed costs of fishing. Households who entered the fishery at high cost with credit have the highest payments, and must meet these payments with high catches when prices are low. Boat owners who are not engaged in leasing arrangements have greater decision-making power. They may lack the ties to a specific buyer or vessel-owner and thus be better able to exploit competition between buyers at the port level.

The final source of adaptive capacity for households is lobster storage. Many households have invested in “lobster cars”, floating wooden structures used to store as many as 20,000 pounds of lobsters at the wharf. Lobster cars allow a household to hold lobsters until prices increase. In a year when prices increase from \$3 in December to \$6 in February, a fishing household can gain as much as \$ 60,000.

MCDA revealed that low adaptive capacity households had lacked all of the above assets, entitlements, human capital, and catches. Thus, low adaptive capacity households were vulnerable to increased costs due to debt, decreased decision-making power due to a lack of sole ownership, and low earnings due to low catches. Households with

low adaptive capacity were not necessarily more sensitive. Households classified as highly vulnerable, however, had similar characteristics of low adaptive capacity households, including entering the fishery on credit, not owning their boat, lower catches, being engaged in license leasing arrangements, and having less knowledge of the fishing grounds compared to other households. It is likely that I would have been able to resolve more differences among households with a larger set of indicators and higher statistical power.

Household sensitivity and adaptive capacity may have implications for political engagement of the fishery. Highly sensitive households were more likely suggest that new entrants should “definitely not” attempt to pursue a living in fishing without access to entitlements such as licenses, a vessel, and quotas. This response may indicate that highly sensitive households are more likely to discount the future of the fishery for new entrants. In some cases, discount rates influence the willingness of individuals to cooperate or act collectively (Axelrod and Hamilton, 1981; Acheson and Gardner, 2011). Clark (1973) also showed that profit maximizing individuals or firms with higher discount rates would overexploit a resource in both common-property and private-property situations.

Rather than coping, fishing households can adapt through collective action. I found that low adaptive capacity correlated significantly with low attendance at fisheries association and organization meetings. Households with low adaptive capacity may be less likely to attend due to time constraints. For example, A fishing captain attempting to meet costs by catching a high volume of lobster would likely have less time to devote to meetings during the lobster fishing season. Another potential explanation is that associations and organizations do not represent their interests. For example, fishing captains further to the north in LFA 33 have a smaller time window to catch lobsters in the beginning of the season because lobsters begin to migrate

offshore sooner than in the south. To these households, the vast majority of their income is derived from the first two weeks of the fishing season. These fishermen were more likely to oppose a strike at the beginning of the season. Fishermen that paid dues to either of SWNS' two lobster fishing associations were more likely to attend association and organization meetings. These associations may have had some success at mobilizing captains and crew-members to act collectively. Households that paid dues to one association, were less likely to pay dues to another, suggesting a split between fishing households over which association best represents their interests. One association has taken a more confrontational stance against the DFO and fish buyers, a strategy that may appeal to some households more than others.

The perception of what makes a household vulnerable differs among regions, cultural contexts, and political environments (Eakin and Luers, 2006; Brooks et al., 2005). I found a large difference in indicator weights between two key informants. The fishing strategies and experiences of each informant played a large role in their rankings of different indicators. While I am in one sense an “expert” with my own bias I also have access to a wider frame of knowledge and data to obtain a sector-wide understanding of vulnerability. An insightful avenue of future research would be to see if my findings—the determinants of capacity and sensitivity and the distribution of vulnerability—make intuitive sense to the respondents. While individual experience will differ among harvesters, they may provide insights into the overall panorama of vulnerability.

Due to the limitations of this study, some sources of vulnerability remain unexamined. For example, Cinner et al. (2012) found that African fishers could improve their adaptive capacity with strengthened information and bargaining power in the market. Similarly, fishermen and some buyers have suggested that there is a large amount of top-down control of lobster prices. Some fishing ports in Nova Scotia market their

lobsters through cooperatives, and thus may be less sensitive to decreasing demand for lobsters. This would also depend on whether cooperative can achieve favorable market terms with the wholesalers higher on the market chain. Weale (r 20) argued that the price of lobsters is strongly influenced by a brokerage monopoly. Weale (r 20) stated that Orion Seafoods International markets 70% of Atlantic lobsters, and provides credit to maintain processing operations. These claims, however, are beyond the scope of the research presented here. Future surveys of fishing households in this region could incorporate survey variables, such as the market destination of the product, the number of buyers the harvester sells to. Additionally, an analysis of the network of lobster buying and selling relations may reveal agents with powerful positions along the market-chain. Understanding the competitiveness and top-down control of the lobster market chain would require an in-depth analysis at a larger geographical scale. Fisheries researchers, however, have often placed emphasize on the actions of fishermen at sea. Though many collective action dilemmas occur at sea, it is likely that an analysis of the formal and informal arrangements and interactions that occur at shore will reveal dilemmas that place pressure upon fishermen.

Adger (2006) argues that policy interventions that seek to reduce vulnerability must identify and address processes that cause inequity and exclusion, as well as the structural processes that produce vulnerability. In the above discussion, I have highlighted the long history of structural causes of vulnerability in SWNS and Atlantic Canada. Policy interventions to address the current vulnerability context in SWNS would need to address the factors that make fishing households less able to adapt to changes. Addressing licensing policies which drive up the costs of entry, for example, could reduce the annual costs of fishing. With this type of change, households would be able to operate and maintain their livelihoods with lower catches. This, in turn, would lessen time constraints that could hinder participation in association and

organizations. Research into the potential for opening new underexploited fisheries may also be a source of livelihood diversification. One example of this is the current experimental hagfish fishery operating on Cape Sable Island. Policy interventions can also address more long-term structural causes of vulnerability in the region by promoting economic diversification in the region.

## Chapter 8

### CONCLUSION

#### 8.1 Objectives

The objective of my research was to understand what makes the fishery and its governance system robust to economic and ecological change, what makes fishing households vulnerable, and how household vulnerability and system level robustness interacts. I addressed these questions by focusing on action arenas, their contexts, interactions and outcomes. I used a combination of ethnography, surveys, quantitative and qualitative analysis to understand what influences action arenas in Barrington, SWNS.

I met these objectives by responding to five research questions, corresponding to chapters.

##### *8.1.1 What makes fisheries and its governance system robust to social-ecological change?*

In Chapter 4, I re-evaluated the case of Port Lameron, SWNS, and applied the concepts of feedback, governance mismatches, and robustness to the case of Port Lameron. I compared the pathway of institutional change of Port Lameron, where the government historically has not recognized the rights of resource users to organize their own rules, to Maine, where the government formalized customary rules and decentralized power. I found that the Canadian government's lack of recognition of rights of resource users to organize has eroded the feedback between the operational level, where resource users interact with the resource, and the collective-choice level,



where agents develop rules to influence fishing behavior. This weak feedback has precipitated governance mismatches, or rules and monitoring that do not fit with social preferences, economic and ecological conditions, and do not match customary spatial scales of governance. These mismatches have fueled harvester dissatisfaction and discouraged their further participation in the decision-making process. In Maine, license-holders have been able to influence decisions and avoid some, but not all, of these mismatches. But Brewer (2012b) showed that there can be negative consequences of stronger feedback when decision-making arenas do not include some social groups. I concluded that both cases could benefit from more polycentric governance.

### *8.1.2 What social, political, and economic processes make fishing households vulnerable?*

In Chapter 5, I examined the interactions among the differential agency of harvester and buyers, social processes, and economic and ecological change. I found that harvesters were not satisfied with the consultative co-management system. Harvesters described a decision-making process that lacked procedural justice. Some experts who work closely with the DFO have countered that the fishermen are not organized enough to provide a voice that could be represented in decision-making processes. This is also a valid point. Fishing communities have very strong community bonds, but many communities in SWNS do not trust outsiders, whether they are harvesters, buyers, government officials, or businessmen. Davis (1984b) showed that harvesters made effective rules at the port level, but the LFA divisions today tie together the decisions of many ports. These ports are divided geographically, culturally, and in terms of scale of fishing operations and fishing strategies. While it is more feasible for Port Lameron or Cape Sable Island to come to an agreement in a fisheries-related decision, it is less feasible for all of the communities of SWNS to

make unified decisions.

Fishermen also expressed their concerns over the consolidation of control of both the lobster fishery and the other quota-based fisheries. The consolidation of quota into processing companies and fish buyers is mirrored by a similar, though more limited, process of trust agreements. Companies that have consolidated ownership of licenses and quotas give harvesters the opportunity to enter the lobster fisheries and quota fisheries. But this often comes at the cost of tighter margins between costs and revenues.

Economic and ecological changes have worked together to reduce the returns fishing households receive in the lobster fishery. Warmer waters make storing lobsters risky, but have made fishing for quantity a more viable strategy for harvesters seeking to maintain their profits. But lobsters have become less predictable as they used to be in this “brave new ocean” (Steneck et al., 2013). Buyers have had to deal with larger gluts, larger volumes of soft or weak lobsters, and low demand from buyers higher up in the market chain.

Harvesters are attached to their place and occupation, but are increasingly dependent on lobster to maintain their livelihoods. Some will “grasp at straws” and lease quota at tight margins, and some are buffered from high lease prices through networks of kith and kin. For many, it comes down to the beginning of the lobster season, when the catch per unit effort is high. As low demand and low prices decrease the margins for captains, they must choose between cutting back on boat maintenance, or employing less crew with lower crew shares.

Harvesters have responded to these challenges individually, but some have tried to organize the industry. Associations have organized strikes, crewmembers have held meetings to discuss refusing to leave the wharf without a guaranteed price from buyers. But many harvesters place great importance on their first haul to pay off

debts, and make the majority of their annual income.

Buyers and harvesters contributed different pieces of this narrative. Buyers emphasized market conditions, lobster quality, and lobster storage. Harvesters emphasized their lack of access to fisheries for their livelihoods. Taken together, this narrative highlights the importance of powerful groups to “play the cards they’re dealt with,” the embeddedness of property-rights in social relations, social capital, and procedural justice.

### *8.1.3 How do households cope with the disturbances they face? What characteristics make a household sensitive to disturbances?*

In Chapter 6, I tested some of the qualitative insights and hypotheses generated from the thick contextualization in Chapter 5. I analyzed survey data regarding quota ownership, fishing strategies, and the factors that relate to low incomes and income sensitivity for captains and crews. I also tested to see whether the current economic crisis has created winners and losers.

I found that quota ownership was extremely skewed. In the 2000s, many harvesters left the groundfishery, the most important fishery to SWNS, and specialized on lobster. While in the 1970s, harvesters would have responded to low prices by switching to a different species, today harvesters coped with low prices by changing their lobster fishing strategies. They used lobster cars to store lobsters, and modified their rate of hauling traps to either increase revenue, or minimize costs. These strategies are constrained by a harvester’s need for revenue, a minimum of days at sea for unemployment, the price of fuel and bait, and the risk associated with storing lobsters.

As harvesters have specialized on lobstering, the industry as a whole has shifted from a focus on quality to quantity. Captains and crewmembers with high depen-

dence on lobster had lower incomes and were more likely to report that their incomes decreased since 2006. Some harvesters have been able to pay their debts and maintain their incomes by catching more lobsters. But the race to catch more lobsters has created a split in the industry between those who have had the best years of their career since 2007, and those who have had the worst. Younger captains with boat payments reported lower income sensitivity to economic change than older captains without boat payments. At first, this result seems counter-intuitive. But in the context of a race for quantity, these younger captains have been able to keep ahead of their debts by catching more lobsters and possibly deferring their loan repayments. Those who have not increased their fishing effort reported higher income sensitivity.

Crewshare and crew employment also varied among captains with different characteristics. Captains with debts and trust agreements gave lower crewshares. Captains with higher catches also gave lower crewshares, but the lower crewshares were offset by the revenue from higher catches. Additionally, captains with larger boats and higher catches generated more income and employed more people. Captains who were older were also more likely to hire two crewmembers, suggesting that older crewmembers employ more as their living expenses and debts are paid off.

*8.1.4 How has globalization and environmental change interacted to affect Atlantic Canadian households? What assets and entitlements are lacking in most vulnerable households? Are vulnerable households less politically engaged?*

In Chapter 7, I put current conditions into context, showing how historical political-economic processes have reduced the economic diversification of the region as a whole. The cod collapse was the product of a long history of dependency on resource-based economic activity in the region. Since the Maritimes joined Canada at confederation, Canadian policy has favored the uneven development that has reduced the

economic diversity of Maritime provinces. In the fisheries boom of the 1960s-1980s, Canadian government attempted to develop the region by subsidizing fleet modernization and expansion. When this development project overreached the natural limits of the fishing grounds, the double-exposure vulnerability context had changed. The environment had shifted to a new state, in which cod was ecologically extinct. Climate change and overfishing have combined to favor an ecosystem dominated by crustaceans. This new context was characterized by a high dependence on lobster. The hidden fragilities of this context became clear when high dependence on lobster combined with the economic crisis of 2008.

Using MCDA, I demonstrated that dependency was important, but that there were very few in Barrington that did not have a high degree of dependence on lobster. Households with a low adaptive capacity leased licenses, did not store lobsters, were considered less knowledgeable, entered the lobster fishery on credit after 1999, did not own their boat and caught less lobsters.

The results of Chapter 6 and 7 suggest that captains have been able to cope with double-exposure, but not adapt. While the most effective form of adaptation is likely collective action, I found that captains with low adaptive capacity were less politically engaged than those who had a high adaptive capacity. Captains who had experienced a decrease in their incomes and abilities to save were more negative about the future of the industry for the youth seeking to make a living in fishing. Captains who pay voluntary dues to an association were also more politically engaged, but it seems that fishermen are divided among two associations that take a different approach to negotiating with government and buyers.

## 8.2 Theoretical Contributions

In Chapter 4, I have contributed to a dynamic understanding of SESs. Recent high-profile papers have used meta-analysis to point to a small set of factors that relate to the success of common pool resources or fisheries. For example, Gutierrez et al. (2011) suggests that fisheries with leadership, social capital, and incentives are successful. Studies using meta-analysis have found variables that correlate with success in fisheries or CPRs. The authors included the case of Shelburne (which encompasses Barrington and two surrounding communities) in their analysis, and cited Peacock and Annand (2008). Peacock and Annand (2008) described the case as a success due to wide industry acceptance, a new bottom-up approach to governance, decreased fishing effort, and reduced conflict. The case was framed as an agreeable solution to the conflicts in the fishery. This account seems to gloss over the widespread protest to quotas throughout the 1990s, and the overwhelming dissatisfaction with the quota system I have reported here.

I contend that meta-analyses do not provide sufficient explanation without an analysis of action arenas and the dynamic shifts of context over time. When a success is related to the presence or absence of a broadly defined factor, the details of how rules are tailored to local conditions, and how leaders and social capital emerge over time, are left out. In short, policy based solely on meta-analysis studies may lack the nuance to move beyond panaceas. But meta-analysis studies can be used in iterative dialogue with in-depth case study research (see below). This would lead to a more nuanced approach to address deeper questions, and to greater institutional diversity and innovation.

I assessed the robustness of the SWNS by examining the interactions between the operational and collective-choice levels. This is the first study, to my knowledge,

that has applied the SES framework in this way. This method of analysis illuminated the dynamics of the Port Lameron fishery over time, and helps scholars locate vital system feedbacks for robust decision-making. While robustness was developed in the field of engineering, and applied to SESs, it could be useful for social and ecological science research that seeks to understand the interdependencies between humans, biophysical systems, and physical and social infrastructure. When properly framed within political economic context, it can facilitate understanding the social processes that produce effective rules, and successful outcomes. Alternatively, it can facilitate understanding how biophysical processes set constraints on which rules and social processes will succeed at producing which outcomes.

In Chapter 5, I demonstrated the complementarity of Ostrom's diagnostic framework, institutional analysis, and vulnerability research. Institutional analysis has focused on how rules, biophysical and social context influence the behavior of individuals, often under the presumption that individuals have some form of economic rationality (e.g. bounded rationality). Vulnerability research has called attention to power relations, the ability of powerful groups to shape political landscapes, and procedural and distributional justice. I show that while Ostrom did not explicitly include these variables in her framework, the framework is a useful tool for scholars to use to organize variables to understand the variables that relate to specific outcomes, such as vulnerability. This analysis also facilitated a connection between household level vulnerability and SES system level fragility. The fishing industry highlighted salient themes that influence vulnerability and livelihood strategies, and these strategies had implications for system level dynamics. This is a novel approach to understanding how system components interact leading to locally specific outcomes.

The majority of bioeconomic models that examine quota management regimes suggest that harvesters will leave the fishery when their monetary rewards from fish-

ing are less than those realizable from alternative employment opportunities. This assumes that harvesters will attempt to maximize their monetary gains. In SWNS, this was not the case. The case of SWNS paints a more complex picture of how property-rights regimes are socially embedded. Harvesters placed high value on their occupations in fishing and their attachment to place. The efficacy, efficiency, or distributional outcomes of a policy instrument will depend on the harvester's preferences and rationalities. This finding points to the importance of better understanding and characterizing the types and heterogeneity of utility functions of harvesters in bio-economic models. Additionally, those who did leave the quota fisheries often sought employment in the tar sands of Alberta. It was beyond the scope of my study to examine the social costs of dislocation for those effected.

Grafton et al. (2006) suggested that traditional fisheries regulations such as effort controls are subject to loopholes and effort creep. I found that limited-entry licensing and quotas do not eliminate the generation of loopholes. Instead, they may shift the production of loopholes to the creation of complex arrangements for access rights. These loopholes, such as trust and controlling agreements, have important implications for the distribution of rents flowing from a fishery. If a company can acquire licenses through trust agreements, then they are no longer tied to rules limiting quota ownership. While each license is limited to a certain percentage of a TAC, a company or individual can obtain multiple licenses to gain control over a much larger share. Hanna and Munasinghe (1995) recognized the importance of three mechanisms; monitoring and enforcing limits and restrictions, democratic decision-making to develop institutions that ensure outcomes are desirable, and market incentives that achieve efficient allocation and use of resources within the boundaries defined by institutional constraints. In this case, the DFO has attempted to develop institutions with an objective of avoiding undesirable outcomes, but individuals and agencies have found



loopholes around them. This might be thought of also as a sub-optimal response to the DFO's failure to delineate these rules and rights formally. Maine, however, has been able to avoid these negative consequences by allocating licenses from retirees to a pool of eligible new entrants (Brewer, 2012b). While it is important to develop institutions to set up desirable outcomes when designing any form of property-rights system, it is also important to understand the behaviors that result from the set of rules and property-rights developed, and the unintended consequences when theory meets reality.

By exploring double exposure in Atlantic Canada, I showed that double exposure need not be a single event in time. Global economic and environmental change act on a locality through a combination of processes that act at different time scales. The uneven development of Canada has influenced the economies of Atlantic Canada since British-dominated mercantilism in the 17th century. Thus, Atlantic Canada has been globalized for a long time. Underdevelopment, decreased economic diversity, fleet expansion, climate change, ecological change, and the booms and busts of the global economy have all acted at different times, scales, and speeds. These findings demonstrate the benefits of exploring the interactions that produce double exposure.

I took the action arena as the focal unit of analysis. Each chapter contributed to describing the context, interactions, problem definitions, and outcomes of action arenas in SWNS. The above chapters show the efficacy of understanding action arenas through a variety of theoretical and methodological lenses. I contend that we can avoid tunnel vision in fisheries policy by forming a dialogue between disciplines, methods, and sectors of the industry.

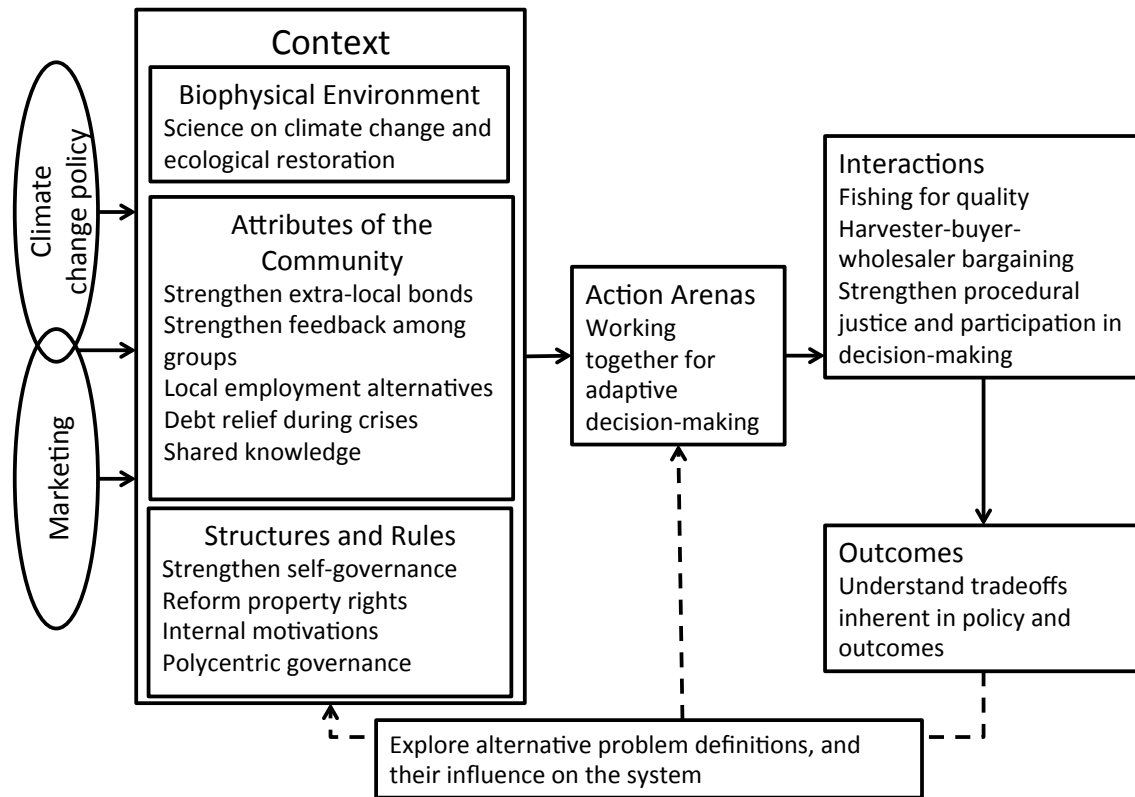


Figure 8.1: Recommendations for navigating robustness and vulnerability outcomes in SWNS

### 8.3 Practical Implications

To make practical recommendations based on the findings above, I return to the modified IAD framework I presented in the introduction. In figure 8.1 I outline recommendations to produce action arenas that involve collective action and adaptive decision-making. In the following sections I will present my suggestions in greater detail.

#### 8.3.1 *Climate change and the biophysical environment*

Steneck et al. (2013) suggested that the Atlantic fisheries are confronting a brave new ocean. The ability to respond to future environmental change will depend, in

part, on our scientific understanding of how climate change and ocean acidification will affect Atlantic ocean ecosystems. This requires investments into understanding how species interactions will change with warmer water temperatures. Which species will be dominant in this brave new ocean? What strategies can fisheries and fisheries governance regimes use to steer this brave new ocean towards ecosystems that are diverse and resilient. As the abundance and distribution of species change, how can coastal communities adapt their fishing strategies? Under what conditions will it be possible to rebuild the groundfish stocks? It may be that the scale of climate shocks and the ecological legacy of overexploitation will limit the potential adaptive capacity of fishing communities at a local or regional scale. If the coastal communities of SWNS cannot adapt to these shocks, then what larger-scale processes can facilitate a transition to alternative locations and employment? What are the social costs of these transitions, and how can they be reduced?

### 8.3.2 *Attributes of the community*

Based on the above discussions, it is clear that strengthening extra-local bonds, or bridging social capital is vital to improving the governance of the fishery. Many communities distrust outsiders and value individualism, and thus this is not an easy task. Kearney (1989) suggested that we need to build upon already existing solidarities. This means starting at the port level where strong community bonds remain. But the conditions for government officials are difficult. It is well known that repeated interactions with positive outcomes build trust (Ostrom, 2005b). I would suggest that government and communities must build trust through a large number of small victories over time, rather than one large restructuring of the system.

Another way to build trust is to strengthen the feedback among groups. In Chapter 4, I demonstrated that policy-making needs to be more cognizant of the processes

harvesters and buyers experience at the operational level. This requires venues for incorporating local knowledge of operational-level dilemmas, and greater incentives to share knowledge. In some cases sharing knowledge is actually dis-incentivized. Currently harvesters are concerned about the effects of rising grey seal populations on groundfish species. Inshore harvesters have reported increasing quantities of groundfish infected with seal worm, a parasite from seals that infect fish. Additionally, harvesters report that seals damage fishing gear and eat lobsters, cod, haddock, and halibut off of their longlines. Harvesters and scientists need to collaborate to better understand and quantify the effects of seals on the fishery. But harvesters state that they are disincentivized to share information because any fish losses from seals would likely be subtracted from their quotas.

ITQs are designed to reduce overcapacity in fisheries. To harvesters and buyers, this means putting people out of work. Alternative employment opportunities are scarce in the region, and unemployment is significantly higher than urban centers. But many who grew up in the fishing industry hold attachments to their occupations and place. Improving alternative employment in fishing would require opening new test fisheries such as the hagfish fishery, whelk, or green crabs (an invasive species). To open more test fisheries, government organizations would have to invest in understanding the ecology of these species. But diversification of fishing strategies alone may not be sufficient to reduce household sensitivity to market volatility. To improve the economic diversity of SWNS, policy in Canada would have to address and reverse the decades of uneven economic development that have produced a predominately primary-sector economy in Atlantic Canada. There is potential for tourism in various fisheries, especially those that target charismatic species such as tuna, swordfish, and lobster. Tourist opportunities would be stronger if provincial governments committed to restoring ferry services running from Maine to Yarmouth, Nova Scotia. Federal

and provincial governments could deepen their investments in education, both primary and vocational, and provide loans and grants for experimental fisheries or for the development of recreational tourism businesses. By restructuring the Atlantic quota fisheries (a point discussed below), the federal government could recapture a proportion of quota-based rents to help pay for these community development projects.

Based on my results, debt is an important influence on fishing strategy. Harvesters that paid more for their license must catch enough lobsters to service their debts. When prices are lower, catches must be even higher. Debt relief during times of crisis may decrease the drive for higher catches, encourage harvesters to try different fishing strategies, and encourage participation in decision-making. As noted in Chapter 6, this may already be occurring for captains who obtained loans from the NSLB.

### 8.3.3 *Structures and rules*

Self-governance can improve feedback, and facilitate institutional innovation. Rules are often better monitored and sanctioned when they are developed by the people who are affected by them (Ostrom, 2005b). But polycentric governance can facilitate greater communication between management objectives at multiple layers. In some instances, the objectives of NGOs and government do not align with those of fishing communities. Polycentric governance may facilitate processes that allow fishing communities to indigenize externally motivated rules. Brewer (2010) suggested polycentric governance and spatialized management. Spatialized management would mimic the rules harvesters historically created in both Maine and Canada (Davis, 1984b; Brewer, 2010; Acheson, 1988). These rules limited where a harvester could use certain types of gear and catch certain types of species. These spatialized rules could also apply within a single-species fishery. For example, the most efficient trap limit will depend on the productivity of a fishing ground and its distance from shore.

Under spatialized management, it may be more efficient for offshore grounds to allow a higher trap limit than inshore grounds, where congestion externalities are stronger.

As an epilogue to the above point, in March 2014, a DFO-commissioned facilitator has been holding meetings in LFA's 33 and 34 to discuss modifying the rules of the lobster fishery for the 2014-2015 season. The DFO officials have stated that their objective is to put "all options on the table, because he doesn't want to be accused later of having left anything out of the discussion" (Comeau, 2014). Some harvesters have suggested developing separate rules for offshore and inshore fisheries at these meetings. This is one potential way to make management more spatially explicit. Informants have stated that proposals such as this have been dismissed. Instead, the DFO has favored LFA-wide trap reductions, despite the heterogeneity of fishing strategies and conditions in SWNS.

Another way to improve livelihood diversity in SWNS is to reform the property-rights regime to restore some access to groundfishing and other species. For example, property-rights could be reformed with the objective of supporting the recovery of handline fishing. In a critique of ITQs, Bromley (2009) suggested that fishing access rights be auctioned off every year. Auctions could be stratified based on gear-type and boat size-classes. Soliman (2014) recommended that government should attempt to buy back "armchair quotas," owned by individuals who do not fish, and auction quotas off annually. The effectiveness of auctions, however, would depend on the degree to which harvesters do not overbid for groundfish rights when their returns from the lobster fishery are low.

#### 8.3.4 *Interactions and outcomes*

Currently it pays to fish for quantity. Many in the industry have said that "we have to fish smarter, not harder." One way to fish smarter is to fish for quality and

not quantity. Buyers have suggested returning “culls” to sea. One example of a cull is a one-clawed lobster. These lobsters are less economically valuable. One-clawed lobsters can provide a source of larval recruitment for future generations, and will eventually re-grow their claws. Similarly, soft lobsters could be returned to sea and caught again when their shells harden. Fishing for quality, however may require a change in lobster pricing. Buyers would offer a different price to premium hard-shelled lobsters, than to culls, one-clawed, or soft lobsters. With separate prices, both fishing for quantity and fishing for quality can potentially co-exist. These strategies could be strengthened by industry-wide marketing strategies. One example is “thisfish” ([www.thisfish.info](http://www.thisfish.info)), a program designed to allow consumers to trace fish at grocery stores to the harvester who caught it. This appeals to urban desires to know where their food comes from. Others in the industry have suggested marketing a selection of landed lobsters as high-grade, or premium hard-shelled lobsters with a “made in Canada” branding strategy. The efficacy of these strategies would depend on the extent to which there is a premium for quality downstream in the market. This would also depend on the ability of harvesters and others along the supply chain to innovate to produce different products to meet different markets.

While buyers, government officials, and scholars have focused their attention on the interactions occurring at sea, harvesters have repeatedly demanded better information on the lobster market chain. To date, studies of the lobster market chain have been conducted with funding and support from processors, buyers, and wholesalers. Thus, these studies lacked the legitimacy and saliency harvesters have demanded. Yet one unverified source suggested that one wholesaler controls 70% of lobster sales (Weale, 2013, November 20). Thus, it is clear that there is a need for an independent study of the lobster market chain that can provide legitimacy and saliency to harvesters.

Daigle et al. (1996) has provided a basic outline for procedural justice in decision-making. I recommend greater effort to improve the representation of ports and harvesters, to ensure their input influences policy, and that policy is responsive to the needs of the industry. This may encourage greater participation in decision-making processes. With greater representation and participation, it is likely that harvesters could better navigate the tradeoffs inherent in policy design to ensure outcomes that are desirable to coastal communities.

Finally, I have stated above that the problem has been traced to the actions of harvesters at sea. When evaluating the efficacy of new and current policies, Leach et al. (2010) has suggested that is important to explore alternative definitions and framings. Here I have attempted to make recommendations that reflect conditions at sea and on land. Just as tunnel vision hinders progress in academia, I suggest that the industry could benefit by considering fisheries management from a holistic perspective.

#### 8.4 Future Work

These discussions lead to a few future research directions listed below.

1. I have demonstrated that weak feedback leads to governance mismatches and dissatisfaction, but how can harvesters and governments strengthen feedback after it has been weakened? It seems that low participation and low recognition of the rights of resource users to organize are mutually reinforcing processes. Thus it may take significant effort to strengthen the feedback in an SES. Cash et al. (2002) suggests that boundary work helps to build salient, legitimate, and credible information for decision-making. The Fishermen and Scientist Research Society has made in-roads in generating discussion and collaboration among scientists and society. I hypothesize that boundary organizations such



as this are essential to strengthening trust and feedback between harvesters and government.

2. This above contradiction raises the question of who defines success? (Steins and Edwards, 1999, p. 541) showed that success and failure is “constructed differently by different stakeholders.” But success and failure is also constructed differently by different modes of analysis and methodologies. What are the dimensions of success? Does one dimension of success limit the potential for another? Does success necessarily require navigating tradeoffs, or are can improvements in each dimension be achieved through better policy design? I propose that future meta-analyses could pinpoint abstract variables related to success and then explain the mechanisms by combining statistical methods and case study analysis. Regressions or quantitative comparative analysis could be used to pinpoint important variables, but case study comparisons could be used to explain the processes that make those variables important. By comparing regressions to case comparisons, scholars could also find explanations for those cases that do not fit the narrative generated by regressions. Another option is to abandon the coding protocol altogether, and instead, analyze case studies as discourses using text analysis. What problems do the case studies define, and what solutions do they propose? What metrics of success to scholars use and what outcomes lead from different metrics? This approach would help to understand the degree to which our meta-analyses are reproducing the potential biases that case studies exhibit.
  
3. I found that households exhibited different utility functions than simple profit maximization strategies. Davis (1991) differentiated between livelihood fishing and accumulation fishing strategies and argued that Canadian fisheries man-

agement favored accumulation fishing strategies. How do bioeconomic models that incorporate these livelihood strategies differ from those that assume simple profit maximization functions? Do optimal policies differ if we assume different rationalities?

4. In SWNS, harvesters and buyers are almost unanimously dissatisfied with the groundfish quota management system. Many were confrontational and refused to participate in meetings with the DFO. But other studies have showed that the region has a long history of individualism and distrust in government. Have ITQs or the DFO's method of implementing ITQs damaged the potential for future collective action in the fishery? This question could be addressed in an experimental setting. What are the conditions under which property-rights regimes hinder investment into public or collective goods? What are the conditions under which property-rights regimes promote stewardship? Based on the results of this study, I hypothesize that externally induced property-rights to manage common-pool resources would hinder collective action when they are perceived as unfair. Experimental studies could also compare an ITQ policy design to cooperative or TURFs. Could cooperatives or TURFs with bottom-up development be more effective in this context? To what degree do these different policy designs build social capital, trust, or serve as a platform for negotiating between different groups, such as harvesters and buyers.
5. Experimental studies could also explore the dimensions of management that create or hinder security of tenure. Here, it is helpful to characterize the full bundle of rights different quota systems delineate. Quotas do not just delineate a harvester's access to the fishery and a quantity of fish. Quota owners also have a share in a fishery managed by a quota governance regime. The security of tenure

of this property-right is thus dependent on a quota owner's trust or confidence in the fish governance regime. This suggests that security of tenure may differ among quota governance regimes with different procedural characteristics.

6. I characterized the vulnerability of captains and crewmembers. But how does vulnerability spread horizontally and vertically in fishing communities and along market-chains? How do larger-scale vulnerabilities transfer down and up fisheries marketing chains? What strategies do actors along the market chain adopt to cope or adapt to the challenges they face? How do these strategies affect other parts of the market chain?

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## APPENDIX A

### RESEARCH PROTOCOL: LIVELIHOODS IN THE SOUTHWEST NOVA SCOTIA LOBSTER FISHING INDUSTRY

I am a graduate student working from the School of Human Evolution and Social Change at Arizona State University. I am conducting a study to understand how lobster fishermen, and crew maintain their livelihoods in the face of economic and ecological change.

#### The Study

Fishing communities have been faced with many challenges in the past two decades, including the Marshall decision, the moratorium on groundfish, rising fuel prices, and decreasing lobster prices. This study seeks to learn from the experience and knowledge of fishermen and crewmembers to understand how the small boat fishing industry is responding to these challenges, what limits their ability to respond, and what can be done to ensure prosperous and sustainable small boat coastal fisheries. It is important that the experiences, concerns and opinions of fishermen, their families and communities be documented, understood, and incorporated.

#### Methods

The methods I plan to use include active participation and observation in Fishermen's Association meetings, fishing trips, and other important events. I would also like to interview fishermen and crewmembers to learn their opinions and experiences. If it is deemed feasible and beneficial by fishermen and crewmembers, I will also administer a survey. The majority of this research will be conducted in the summer of 2012 from May 20 to September 10, but I will continue to consult with, and provide information to inshore fishing communities and people well beyond this date. During this summer research period, I am living in Barrington Passage and focusing on the fishing industries of Cape Sable Island, Port La Tour, and Wood's Harbour.

#### Confidentiality and Anonymity

All information obtained through this study will be considered and treated as strictly confidential. The results of this research study may be used in academic reports, presentations, and publications, but **I am obligated to ensure the anonymity of participants**. In order to maintain anonymity of your records, I will disguise the names, identities, and location of events and occupations of participants in reports and academic papers. I am the only person who will have access to confidential information stored in password-protected files on a secure computer. Information will be destroyed upon request, or three years after reports have been disseminated.

#### Participation and Information Sharing

Throughout this study I will be encouraging the participation of the Fishermen's Associations, fishermen, and crewmembers. If my methods are considered inappro-

priate or incomplete I will make every effort to address concerns and to incorporate feedback. I am concerned that the research outcomes be as useful as possible for the participants. For example, participants will be provided with a summary of research outcomes, and with complete copies of research outcomes such as presentations, reports, and publications. Participants will also be provided with opportunities to review research outcomes before they are presented or distributed as a way to insure full disclosure, to verify the accuracy of content, and to enable feedback.

#### Conditions of Termination of Research Partnership

This research study depends on the voluntary participation of fishermen and crewmembers. **All potential participants in this study have the right to refuse to participate either before or during the research process.** If my research is deemed too intrusive, then fishermen and crewmembers are encouraged to request that I change my methodology. I commit to fully address these concerns and will suspend my research methods until concerns are satisfactorily addressed.

#### Funding

The U.S. National Science Foundation and Dr. John M. Anderies from Arizona State University are providing funding in support of this research.

If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Office of Research Integrity and Assurance, at 480-965-6788.

APPENDIX B

CAPTAIN SURVEY: LIVELIHOODS IN THE SOUTHWEST NOVA SCOTIA FISHING INDUSTRY

**Section I: Fisheries Participation**

1. To start off, about how many years have you been fishing for a living? .....
2. What wharf do you fish from?.....
3. Currently would you describe yourself as a full-time or part-time fisherman?
  - (a) i. Full-time
  - ii. Part-time
- (a) Would you prefer to fish full-time or part-time?
  - i. Full-time
  - ii. Part-time

4. What species do you fish for?
  - (a) Do you own a lobster license? Do you own more than one lobster license?
  - (b) Do you own any other licenses or quotas? How many?
  - (c) For which species do you own quota? Do you have to buy additional quota? For which species?
  - (d) Of the fisheries you participate in, which is the most important to you?

Species	How many li- censes or quotas	Buy Additional Quota?	Most important

- (e) What makes this fishery the most important to you?

**Section II: Sensitivity to Change**

5. In the 2011 season, approximately how many days did you haul traps in each month of the season?

How many days in December	
... January	
... February	
... March	
... April	
... May	

6. What is an average winter catch for you (from December to the end of February)?\_\_\_\_\_

(a) What is an average spring catch for you (from March to the end of May)?\_\_\_\_\_

(b) What price of lobster (or other) do you need to make a living? \_\_\_\_\_

(c) On an average day, how much does it cost you for fuel? \_\_\_\_\_

(d) On an average day, how much does it cost you for bait? \_\_\_\_\_

(e) What do you do when prices are low?

(f) What limits your ability to respond to low prices (change your fishing practice)?

7. Since you started fishing, have you noticed less, the same, or more soft or weak lobsters?

(a) i. Less

ii. The same

iii. More

(b) (IF MORE) In your opinion, what has caused this increase?

(c) What do you do to improve the quality of lobster delivered to buyers?

i. Sort at sea

ii. Handle with care

iii. Sell weak lobsters immediately

iv. Sell all lobsters immediately

v. Other\_\_\_\_\_

(d) What difficulties do you face when you try to do this?

8. In your opinion, has the water temperature gotten warmer since you started fishing?

(a) i. No

ii. Yes

iii. Don't know

(b) How has this affected your fishing practice?

9. Have you participated in a fishery that was put on moratorium or collapsed?

(a) Name of fishery\_\_\_\_\_

(b) What did you do when this fishery collapsed?

10. Overall, what limits your ability to make a living in fishing the most?

11. Would you like to see changes to the lobster fishery regulations?

(a) i. No

- ii. Yes
  - (b) What would you like to see changed?
- 12. Would you like to see changes to the way rules and regulations are made?
  - (a)
    - i. No
    - ii. Yes
  - (b) What would you like to see changed?
- 13. Will the proposed changes to employment insurance affect you?
  - (a)
    - i. No
    - ii. Yes
  - (b) How will these changes affect you?
- 14. Thinking about the future, do you think that your access to the lobster fishery will be less, the same, or more than in the past?
  - (a)
    - i. Less
    - ii. The same
    - iii. More
- 15. Thinking about the future, do you think that your access to the other fisheries will be less, the same, or more than in the past?
  - (a)
    - i. Less
    - ii. The same
    - iii. More
- 16. What was the worst year you experienced as a fisherman?.....
  - (a) What made this year difficult?
- 17. What was the best year you experienced as a fisherman? .....
  - (a) What made this year good?

**Section III: Participation in Associations or Organizations**

- 18. Are you currently paying dues to any fisheries organization or association?
  - (a)
    - i. No
    - ii. Yes
  - (b) Name of fisheries association(s):
    - i. \_\_\_\_\_
    - ii. \_\_\_\_\_

iii. -----

iv. -----

- (c) How frequently do you attend fisheries association or organization meetings? Do you attend always, frequently, seldom, or never?
- i. Always
  - ii. Frequently
  - iii. Seldom
  - iv. Never
- (d) (IF SELDOM, FREQUENTLY, OR ALWAYS) What motivates you to attend?
- (e) What discourages you?

#### **Section IV: Attachment to Fishing**

19. Thinking for a moment about your working life in fishing. . . IF you had your life to live over, how likely do you think it is that you would go into fishing again? Do you think you would definitely, probably, probably not, or definitely not?
- (a)
    - i. Definitely
    - ii. Probably
    - iii. Probably not
    - iv. Definitely not
20. Now, turning our thoughts for a moment to young people and the present day fisheries. . .
- (a) Would you definitely, probably, probably not, or definitely not advise a child of yours to go into fishing if they had to start from scratch?
    - i. Definitely
    - ii. Probably
    - iii. Probably not
    - iv. Definitely not
  - (b) Would you advise a child of yours to go into fishing if they could start with a boat and only a lobster license?
    - i. Definitely
    - ii. Probably
    - iii. Probably not
    - iv. Definitely not
  - (c) . . . if they could start with a boat and all of the important fishing licenses or quotas?
    - i. Definitely



- ii. Probably
- iii. Probably not
- iv. Definitely not

21. Including children, parents, and siblings, how many family members have moved out of the province?
- (a) Children.....
  - (b) Parents .....
  - (c) Siblings .....

**Section V: Trust and Cooperation**

22. Now, thinking of the past, do you think that people from this place help each other out less, the same, or more today than they did in the past? Do people help each other out?
- (a) i. ...less than in the past?
  - ii. ...the same as in the past?
  - iii. ...more than in the past?

**Section VI: Assets and Debts**

23. Do you own your current fishing boat?
- (a) i. No
  - ii. Yes
  - (b) What are the length, width, and horsepower of the fishing vessel you own?
    - i. Length.....
    - ii. Width .....
    - iii. Horsepower.....
24. (IF THEY OWN LOBSTER LICENSE) Did you get credit or financing to get a lobster license?
- (a) i. No
  - ii. Yes
  - (b) (IF YES) In which year did you get financing? .....
  - (c) Where did you get financing? .....
25. (IF YES TO 26) Are you currently making payments on your boat?
- (a) i. No
  - ii. Yes
26. Are you, or were you previously in a trust agreement/controlling agreement?

- (a) i. No, never
  - ii. Yes, before but not now
  - iii. Yes, I am currently in a controlling/trust agreement
27. Do you have any medical insurance?
- (a) i. No
  - ii. Yes
28. Are you doing anything to prepare for retirement?
- (a) i. No
  - ii. Yes
  - (b) What are you doing to prepare?
29. Currently, would you say that your ability to pay off household debts is less, the same, or more than in the past?
- (a) i. ...less than in the past?
  - ii. ...the same as in the past?
  - iii. ...more than in the past?
30. Currently, would you say that your ability to save for the future is less, the same, or more than in the past?
- (a) i. ...less than in the past?
  - ii. ...the same as in the past?
  - iii. ...more than in the past?

31. How does your crew get paid?	Are crew paid after expenses?	Yes No
	Crew share	
	How many crew are there on the boat?	
	Other comments:	

**Section VII: Personal Information**

32. In what year were you born? \_\_\_\_\_
33. Would you tell me what was the highest grade or year you completed in school, college, or university?

Primary School 1 2 3 4 5 6
Junior High School 7 8 9
High School 10 11 12
Public or vocational school 1 2 3 4
College 1 2 3 4
University 1 2 3 4 5 6 7 8
Fisheries courses or private college (number of years)

34. Who does the book keeping for your fishing business?
- (a) i. Spouse/Wife
  - ii. Other family member
  - iii. I do
  - iv. Hired Bookkeeper
  - v. Other\_\_\_\_\_
35. Approximately what percentage of your income comes from lobster fishing?  
\_\_\_\_\_
36. Including income from your spouse and children that reside in your household, approximately what percentage of the household's income comes from lobster fishing?\_\_\_\_\_
37. Including your spouse and children, what other jobs do members of this household have?
- (a) i. Daughter\_\_\_\_\_
  - ii. Daughter 2\_\_\_\_\_
  - iii. Son\_\_\_\_\_
  - iv. Son 2\_\_\_\_\_
  - v. Wife\_\_\_\_\_
  - vi. Do you have any other jobs? \_\_\_\_\_
38. Would you say that your income including all the people in your household is less, the same, or more than it was in 2006?
- (a) i. Less
  - ii. The same
  - iii. More
39. Some household income categories are listed below. Please choose a category that represents the total combined income before taxes for ALL THE PEOPLE IN YOUR HOUSEHOLD in 2011.
- (a) i. 20,000 and under
  - ii. Between 20,001 and 40,000
  - iii. Between 40,001 and 60,000
  - iv. Between 60,001 and 80,000
  - v. Between 80,001 and 100,00
  - vi. Between 100,001 and 120,000
  - vii. Between 120,001 and 140,000
  - viii. Between 140,001 and 160,000
  - ix. Between 160,001 and 180,000
  - x. Between 180,001 and 200,000

- xi. More than 200,001
- xii. Refused to answer

40. As an important part of this study I will be interviewing people, either currently fishing or retired, who are knowledgeable about their local fishing area. Other than yourself, who would you say knows the most about your local inshore fishing area?

- (a) i. \_\_\_\_\_
- ii. \_\_\_\_\_
- iii. \_\_\_\_\_

Thank very much for taking the time to respond to this survey. Do you have any further comments regarding this survey?

Is there anyone else you would recommend that I speak to?

## APPENDIX C

### SEMI-STRUCTURED INTERVIEW PROTOCOL

- C.1 Local Expert Interviews (Government Officials, Quota Group Managers, and Lobster Association Leaders)
1. What are the biggest challenges to the ability fishermen to maintain their livelihoods today?
    - (a) What changes have brought about these challenges?
    - (b) Is there anything fishermen are doing to respond to these challenges?
    - (c) What can they do to respond?
    - (d) What enables fishermen to respond in the way they do?
    - (e) What limits their ability to respond?
  2. Based on your experience dealing with fish quotas, how have fish quotas changed the fishing industry?
    - (a) What percentage of fishing quota do active fishermen now own?
    - (b) How has this percentage changed since quotas were introduced?
    - (c) What has caused this change?
    - (d) Which types of fishermen and crewmembers have been most affected?
      - i. Which boat size classes?
      - ii. Which type of gear, longline, handline, dragger etc...?
    - (e) What effects have these changes had on the fishing communities?
    - (f) How have fishing practices changed due to quotas?
  3. Would you want to see any changes to the lobster fishing regulations?
    - (a) IF YES, what changes?
    - (b) What about the other quota fisheries?
  4. Would you want to see any changes to the way regulations are made?
    - (a) Why would you want to see this changed?
    - (b) What about the other quota fisheries?
    - (c) Why would you want to see this changed?

## C.2 Retired Fishermen's Interview

1. When did your first start fishing for a living?
  - (a) When did you decide to retire?
  - (b) What motivated you to retire?
2. What species did you fish for (besides lobster)?
3. When you started fishing, what was the biggest challenge to your ability to make a living in fishing?
  - (a) What is the biggest challenge fishermen face today to make a living in fishing?
4. Since you started fishing, what changes have you seen in the lobster fishery?
  - (a) Do lobster fishermen fish differently today?
  - (b) How have the lobstering grounds changed?
5. What changes have you seen in the other fisheries you participated in?
  - (a) Are fish found in the same places?
  - (b) Are they as abundant as they used to be?
  - (c) What happened to you when these fisheries went to quota?
  - (d) Were you given a historical allocation that allowed you to fish the same?
6. When you retired, what did you do with your license and boat?
  - (a) Was it passed on to a relative?
  - (b) If your children or grandchildren could not inherit a license, would you say that they could still make a go at it?
7. What changes have you seen in your community?
  - (a) Do you think that people help each other out as much as they did in the past?
  - (b) In your opinion, why (do/dont) people help each other out as much?

APPENDIX D

VARIABLES FOR ANALYZING HARVESTER'S SENSITIVITY TO CHANGE

Table D.1: Description of variables used in statistical analysis of survey responses.

Variable	Measurement	Type	Range	N	Mean	Standard Deviation
Independent Variables						
knowledge	Number of times the survey respondent was named by other respondents as knowledgeable	Ordinal	0-6	113	0.76	1.2
age	Age of survey respondent	Continuous	28-81	113	52	11.2
LFA	LFA harvester fishes in. 1 for LFA 33 and 2 for LFA 34	Binary	1-2	113	1.8	0.37
groundfishquota	Total groundfish quota ownership including haddock, pollock, cod, and excluding halibut (1000 pounds)	Continuous	0-450	107	16	52
swordfishquota	Swordfish quota ownership (1000 pounds)	Continuous	0-85	112	1.7	8.9
halibutquota	Total halibut quota ownership (1000 pounds)	Continuous	0-40	110	49	20
totalcatch	Average total lobster catch for the last 5 years in a season (1000 pounds)	Continuous	9-145	111	49	20
lobsterstorage	Whether a harvester indicated that they store lobster when prices are low	Binary	0-1	113	0.42	0.5
ownboat	Whether a respondent claims to own their current fishing vessel	Binary	0-1	105	0.76	0.43
credit1999	Whether the respondent entered the fishery on credit after 1999 (when there was a significant increase in license prices)	Binary	0-1	113	0.15	0.36
trustagreement	Whether the respondent is currently in leasing arrangement for a lobster license	Binary	0-1	113	0.10	0.30
boatpay	Respondent is currently making boat payments	Binary	0-1	113	0.49	0.50

dependency	Percentage of fishing household's income that comes from lobster fishing	Continuous	13-100	113	72	24
education	Number of years of education (grade school + college + university and vocational training)	Continuous	6-18	112	10.3	2.5
length	Length of the captain's vessel (feet)	Continuous	21-50	90	44	5.7
width	Width of captain's vessel (feet)	Continuous	9-26	90	18	3.5
spouseworks	The spouse is also employed	Binary	0-1	113	0.43	0.50
afterexpenses	Whether a captain allocates crewshares after expenses	Binary	0-1	105	0.68	0.47
Dependent Variables						
income	Income category of respondent (total of 11 categories)	Ordinal	1-9	100	3.6	1.5
incomechange	Respondent's income has decreased, stayed the same, or increased since 2007	Ordinal	1-3	113	1.6	0.78
debtchange	Respondent's ability to payoff household debts is less, the same or more than in the past	Ordinal	1-3	113	2	0.82
crewshares	The share of total revenues allocated to each crew-member	Continuous	0.12-0.5	106	0.20	0.062
numcrew	Number of crew employed on a vessel	Continuous	1-3	1.77	0.477	



APPENDIX E

WEIGHTING OF VULNERABILITY INDICATORS

Table E.1: Weighting of indicators based on pairwise comparisons and rankings with a key informant, and using regression results for ranking.

Indicator	Pairwise Comparison	Ranking	Regression Results	Final Weight
Human/Social	0.55	0.14	0.12	0.14
age	0.035	0.041	0.034	0.042
education	0.022	0.0064	0.030	0.0060
ecological knowledge	0.24	0.073	0.030	<b>0.066</b>
help from others	0.24	0.025	0.030	0.027
Financial	0.30	0.062	0.33	0.28
boat payments	0.10	0.014	0.039	0.062
leasing a license	0.025	0.022	0.10	<b>0.090</b>
license payments	0.10	0.014	0.068	0.062
planning for retirement	0.0083	0.0016	0.030	0.0084
medical insurance	0.015	0.0036	0.030	0.010
spouse is employed	0.051	0.0063	0.061	0.045
Natural	0.053	0.27	0.40	0.39
lobster catch	0.020	0.12	0.14	<b>0.21</b>
groundfish quota	0.020	0.024	0.061	<b>0.078</b>
halibut quota	0.0075	0.079	0.061	0.062
swordfish quota	0.0031	0.042	0.076	0.021
harvests sea plants	0.0019	0.01	0.061	0.011
Physical	0.10	0.52	0.15	0.20
boat capacity	0.0077	0.058	0.030	0.014
boat ownership	0.071	0.32	0.030	<b>0.13</b>
lobster storage	0.023	0.14	0.087	0.056
Sensitivity				
change in ability to save	0.048	0.29	NA	0.19
change in income	0.77	0.56	NA	0.73
family migrations	0.16	0.16	NA	0.081

Note: The five largest contributors to adaptive capacity are indicated in bold font.

APPENDIX F

VALUE FUNCTIONS FOR MULTICRITERIA DECISION ANALYSIS

Table F.1: Value functions determining the relationship between each variable and vulnerability

Variable	Type	Value Function	Relation to Vulnerability
Human and Social			
age	integer	if $25 < x < 50$ , then $-0.035x + 1.75$ , if $x > 50$ , then $0.01x - 0.5$	Fishermen gain experience but begin to lose ability to fish as intensely after 50
education	integer	$1 - \frac{1}{1+e^{-0.9x+10}}$	Greatest benefit to finishing high school
ecological knowledge	integer	$e^{-x}$	Exponential decrease in vulnerability with increasing knowledge
help from others	ordinal	Less=1, Same=0.17, More=0	Help from others decreases vulnerability
Financial			
boat payments	binary	Yes=1, No=0	Debt increases vulnerability
trust agreements	binary	Yes=1, No=0	Trust agreements increase vulnerability
entered fishery on credit	binary	Yes=1, No=0	Credit increases debt and vulnerability
planning for retirement	binary	Yes=0, No=1	Planning for retirement reduces vulnerability
medical insurance	binary	Yes=0, No=1	Medical insurance reduces vulnerability
spouse is employed	binary	Yes=0, No=1	Decreased income vulnerability if spouse is employed
Natural			
lobster catch	continuous	$1 - \frac{1}{1+e^{-0.18x+9}}$	Increasing vulnerability when catch is below average (50,000 pounds)
groundfish quota	continuous	$1 - \frac{1}{1+e^{-0.16x+8}}$	Sufficient quota for a few fishing trips required
halibut quota	continuous	$e^{-0.00015x}$	
swordfish quota	continuous	$1 - \frac{1}{1+e^{-0.0003x+8.5}}$	Alternative source of income
harvests sea plants	binary	Yes=0, No=1	

Physical			
boat capacity	continuous	if $\leq 240$ then 1, else $0.000003(x - 817)^2$	Higher vulnerability when boat capacity is greater or less than average
boat ownership	binary	Yes=0, No=1	Less vulnerable as boat owner
lobster storage	binary	Yes=0, No=1	Can store lobsters to reduce vulnerability
Sensitivity			
change in ability to save	ordinal	Less=1, Same=0.17, More=0	Most sensitive if ability to save decreases.
change in income	ordinal	Less=1, Same=0.17, More=0	Most sensitive if income declines
family migrations	integer	0.25x	Family migration suggests increased sensitivity