Winter 2015

Catch Share Management in the Northeast Multispecies Fishery: Implications for the Commercial Groundfish Fishery in New Hampshire

Rachel G. Feeney
University of New Hampshire, Durham

CATCH SHARE MANAGEMENT IN THE NORTHEAST MULTISPECIES FISHERY:

IMPLICATIONS FOR THE COMMERCIAL GROUNDFISH FISHERY

IN NEW HAMPSHIRE

BY

RACHEL GALLANT FEENEY
Artium Baccalaureus, Bryn Mawr College, 1997
Master of Science, University of New Hampshire, 2003

DISSERTATION

Submitted to the University of New Hampshire
in Partial Fulfillment of
the Requirements for the Degree of

Doctor of Philosophy
in
Natural Resources and Environmental Studies

December, 2015

This dissertation has been examined and approved in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Natural Resources and Environmental Studies by:

Dissertation Director, Dr. Christopher W. Glass,
Associate Director and Research Professor
Institute for the Study of Earth, Oceans and Space

Dr. Madeleine Hall-Arber, Anthropologist
Massachusetts Institute of Technology

Dr. Kenneth J. LaValley, Dean and Director
Cooperative Extension

Dr. Alberto B. Manalo, Associate Professor
Department of Natural Resources and the Environment

Dr. Julia Olson, Anthropologist
Social Sciences Branch/Northeast Fisheries Science Center
National Marine Fisheries Service

On November 3, 2015

Original approval signatures are on file with the University of New Hampshire Graduate School.

DEDICATION

To my husband, who has always known me to be a student.

A new day is dawning.

ACKNOWLEDGEMENTS

Much appreciation is extended to my advisor Dr. Christopher Glass for encouraging my professional development, first as a staff member of the University of New Hampshire (UNH) and then as a doctoral student. This research endeavor has benefited from the support of committee members Dr. Madeleine Hall-Arber, Dr. Ken La Valley, Dr. Alberto Manalo, and Dr. Julia Olson. Dr. Joshua Wiersma served as the sector manager for NEFS XI and XII from 2010 to 2014. His guidance and perspective of the New Hampshire groundfish fishery were invaluable in crafting the research questions, encouraging fisherman to participate, and interpreting results. Of course, this dissertation would not be possible without the participation of the fishermen who shared their time, stories, and frank viewpoints. Early mentorship by my undergraduate and master's research advisors, Dr. Maria Crawford and Dr. Karen Von Damm were foundational to my professional development. My husband Rob Feeney has been an unfailing support throughout. I have worked full-time while pursuing a doctoral degree, first at the Northeast Consortium (UNH), then at the New England Fishery Management Council (since March 2011). Both programs provided the flexibility necessary to accomplish this project, as well as partial financial support (tuition, travel). Primary funding for this research was provided by the Northeast Sea Grant College Consortium under the 2012-2014 Omnibus Request for Proposal.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

CATCH SHARE MANAGEMENT IN THE NORTHEAST MULTISPECIES FISHERY:

IMPLICATIONS FOR THE COMMERCIAL GROUNDFISH FISHERY

IN NEW HAMPSHIRE

by

Rachel Gallant Feeney

University of New Hampshire, December, 2015

This dissertation tests theories about catch share approaches to fishery management, examining their validity and limits relative to the Northeast groundfish sector program, and potentially modifies them in light of research outcomes. Participants of the groundfish fishery based in New Hampshire are the particular focus of research, but broader impacts are considered. Studies of this catch share program have been limited to date, and studies of catch share programs generally have focused on a particular dimension (e.g., biological, social, economic) rather than integrate across dimensions, despite increasing needs to do so for management. Here, six key aspects of fishing are investigated: fishing practices, social capital, bycatch, economic performance, safety, and well-being. Thus, this work is a novel contribution to the field of impact assessment research, both in its topic and scope.

The primary research question is: *How has the advent of catch shares impacted the Northeast commercial multispecies fishery, particularly in New Hampshire?* This is answered through a case study that involved a mix of quantitative and qualitative approaches, using semi-structured interviews of 2 informants, including members of groundfish sectors, common pool members, former fishermen, and fish dealers. Although social research often involves a process of theory

generation, in the case of the Northeast groundfish fishery, and catch share programs more generally, a number of theories have already emerged that are ripe for testing. It was hypothesized here that fishing under the control rules governing sectors has resulted in: more efficiency and flexibility for fishermen to decide where, when, and how to fish; greater social capital among fishermen; reduced bycatch; and improved economic performance, safety, and well-being.

The groundfish fishermen of New Hampshire revealed that the theorized benefits of catch share programs do not necessarily hold true. Of the six key aspects of fishing investigated here, only the benefits related to fishing practices, bycatch and safety aligned with what has occurred in this local fishery, but even some of those benefits have qualifiers. The informants who were sector members generally felt that fishing in a sector was more efficient and flexible than the former Days-At-Sea program had been, generally due to shifting catch limits from a trip basis to an annual one. This had allowed more concentration of effort during times with greater potential for profitability (e.g., fish availability, favorable markets). Reducing bycatch was an important goal of the informants, and the sector participants indicated that their level of bycatch had decreased, primarily through eliminating the trip limits and discards of legal-sized fish. Some informants went above and beyond regulations to avoid bycatch in recognition of the need to steward stocks for the future. However, some sector members identified new pressures to discard when unobserved, driven largely by the high lease costs of choke stocks. There were no major changes in safety, because the informants largely strive to be safe no matter the management program. However, removal of trip limits for sector participants created flexibility and less pressure to fish in unsafe conditions.

Theorized benefits for social capital, economic performance, and well-being did not hold true. Despite being a novel focal point for industry organization, informants felt that sectors have not been catalysts for social capital. Rather, sectors have been based on and built off of pre-existing social capital. In some cases, social capital was reduced as increased organizational responsibilities were seen as a burden and fishing became more competitive and secretive. Economic profitability and predictability had not been realized, though the concomitant decline in, and persistently low, catch limits for certain key species (e.g., cod, yellowtail flounder) vanquished any potential that catch shares had for the economic success of this fishery. The need to lease quota of constraining stocks to harvest the available fish in one's own portfolio has been a substantial and new cost, with risky debt obligations, for several informants. Business predictability declined for a majority of informants. Catch shares has, however, transformed the business climate of the groundfish industry, with more focus on maximizing one's utility. With declines in fishery participation, and dim potential for positive economic performance, the sense of well-being and future outlook for self and fishery had diminished since the advent of the catch share program. Job satisfaction decreased for most of the sector members, and a majority of all informants said that they would not advise a young person to enter fishing. The New Hampshire-based fishermen have, on the whole, not fared as well as could be assumed based on theory, exemplifying the consequences of catch shares, the potential for declining performance by those participants unable to adapt.

INTRODUCTION

The use of catch shares as a fisheries management tool is growing in frequency. The National Marine Fisheries Service (NMFS) defines a catch share fishery management program as one that allocates, "a specific percentage of the total allowable fishery catch or a specific fishing area to individuals, cooperatives, communities, or other entities" (NMFS, 2011a). The term "catch share" refers to fishery management strategies that include Limited Access Privilege Programs (LAPPs; e.g., Individual Fishing Quotas (IFQs)), Territorial Use Rights for Fishing (TURFs), and cooperatives (e.g., sectors). The first U.S. fishery to implement catch shares was the Wisconsin Great Lakes Individual Transferable Quota Program in 1971. Today, there are 16 active catch share programs in U.S. federal fisheries and more in state waters (NMFS, 2011a). The New England Fishery Management Council (NEFMC) created one of the more recent catch share program ("sectors") for the Northeast Multispecies "groundfish" fishery (initial programs in 2004 and 2006; fishery-wide program in 2010).

NMFS has been particularly supportive of catch share program development, indicating that this approach fosters sustainable fishing by ensuring harvests remain within annual catch limits, creating a greater sense of cooperation among quota holders, and promoting a culture of stewardship behavior among fishermen (NOAA, 2010). Examining the impacts of catch shares is a growing field of research. Some investigators have indeed noted more sustainable harvests and more stable fishing economies (Essington, 2010e.g., ; Levy, 2010). Branch (2009) reviewed 227 papers on catch share programs, and just 18% of those reported negative biological, economic or social impacts. Largely, there were positive effect on target species, but mixed or unknown effects on non-target species and the ecosystem. However, where quota can be leased and fishery

operations merged, fishery participation has consolidated to the determent of fishing communities (e.g., Brandt, 2005).

For the Northeast groundfish catch share program, a high level of controversy existed among fishery participants over potential negative economic and community impacts from the transition to a primarily output-controlled program. If the NEFMC is to successfully manage this catch share program or establish additional ones, it must be informed of and consider the human dimensions of its decisions. This dissertation tests theory generated about catch shares, examining their validity and limits relative to the management of the Northeast groundfish fishery, and potentially modifies them in light of research outcomes. The fishery participants based in New Hampshire are the particular focus of research, but broader impacts are considered. There have been relatively few studies of this catch share program to date, and generally, most examinations of such programs have focused on a particular dimension: biological, social, or economic. Thus, this work is a novel contribution to the field of impact assessment research, both in its topic and scope.

RESEARCH QUESTION

The primary research question is: *How has the advent of catch shares impacted the Northeast commercial multispecies fishery, particularly in New Hampshire?* Through a case study, this dissertation examines a broad range of key aspects of the fishery within a narrow group of fishery participants.

RESEARCH GOAL AND OBJECTIVES

The goal of this work is to contribute to understanding the broader question of what biological, social and economic changes have occurred within the Northeast groundfish catch share program. The effects of fishery regulatory programs are often nuanced and complex. Thus, thorough evaluation must examine a number of factors. The research objectives are to:

1. Measure quantitative and qualitative changes that have occurred relative to the Northeast Multispecies sector program that relate to six key aspects of fishing: fishing practices, social capital, bycatch, economic performance, safety, and well-being;
2. Focus on the New Hampshire fishing industry, but determine the applicability of the results to the Northeast Multispecies fishery generally; and
3. Involve a multi-stakeholder team to collect data, conduct the analysis, and then disseminate the results to end users, particularly in the management and fishing arenas.

GROUNDFISH MANAGEMENT OVERVIEW

Marine fisheries are intriguing, because while fish are owned "by the people" collectively, people have little control over the wild ocean. What can be controlled is human interaction with the marine ecosystem - setting limits on who can fish where, for what and when. Managing fisheries sustainably requires a careful balance between conservation and fishing effort, and robust information about stock abundance and potential impacts of regulatory options. Because fish are a public resource, there are many stakeholders involved (e.g., fishermen, scientists, regulators, environmentalists, consumers), and decisions can often be contentious.

The Magnuson-Stevens Fishery Conservation and Management Act is the federal law that, since its enactment in 1976 (as the “Magnuson Act;” Table 1), regulates fishing in U.S. federal waters ("MSFCMA," 2007). The Regional Fishery Council system, created through this law, includes the New England Fishery Management Council, which now manages about 25 stocks that occur throughout the Gulf of Maine, Georges Bank and Southern New England. The Councils develop fishery management plans (FMPs) that must meet the approval of NMFS, the National Oceanic and Atmospheric Administration (NOAA), and ultimately the Department of Commerce and the U.S. President. The NEFMC is comprised of 18 voting members, including the Regional Administrator of NMFS; the principal state official with marine fishery management

responsibility from each of the New England coastal states - Maine, New Hampshire, Massachusetts, Rhode Island and Connecticut; and 12 members nominated by the governors of these states (and approved by the Secretary of Commerce). There are also four non-voting members representing the U.S. Coast Guard, the U.S. Fish and Wildlife Service, the U.S. Department of State, and the Atlantic States Marine Fisheries Commission. All FMPs must comply with the MSFCMA, the National Environmental Policy Act, and other federal statutes (NEFMC, 2013b).

There are 16 stocks of nine fish species[1] managed within the Northeast Multispecies groundfish complex by the NEFMC. The groundfish fishery has full- and part-time participants from Maine to New Jersey. Most vessels are less than 90' long, fishing with a variety of gear types, primarily otter trawls and gillnets, but also hook and line, jigs, and rod and reel. In Fishing Year (FY) 2009,[2] the year prior to full catch share implementation in the groundfish fishery, total groundfish landings equaled 70.6M pounds, with revenues of $85.1M (Kitts, Bing-Sawyer, McPherson, Olson, & Walden, 2011).

The depletion of a number of groundfish stocks led the U.S. Department of Commerce to implement rebuilding plans for overfished stocks though the creation of the Northeast Multispecies Fishery Management Plan in 1986 (Table 1). The FMP has been modified many times since in an effort to promote sustainable fisheries. In 1994, a limited access program was introduced, along with allocating the number of Days-at-Sea (DAS) that a vessel could go fishing per year (and other measures). In 1996, the Sustainable Fisheries Act mandated that stocks had to be rebuilt to a biomass that would support Maximum Sustainable Yield by 2014

[1] Acadian redfish, American plaice, Atlantic cod, haddock, pollock, white hake, winter flounder, witch flounder, and yellowtail flounder.

[2] A fishing year runs May 1 to April 30.

("SFA," 1996). Although vessel buy-back programs, reductions in DAS allocations, closed areas, trip limits, and many other effort controls were implemented and revised over subsequent years to achieve that goal, several key stocks continued to be depleted.

In May 2004, Amendment 13 to the Northeast Multispecies FMP cut DAS to the point where the viability of many fishing ports was in jeopardy. Additionally, Amendment 13 allowed leasing and purchase of DAS among fishermen to help keep fishing businesses solvent, and provisions were made to allow fishermen to form harvest cooperatives (NEFMC, 2003). The Georges Bank (GB) Cod Hook Sector was the first such cooperative to form (in 2003). The second cooperative was formed in 2006, the GB Cod Fixed Gear Sector (NEFMC, 2006). Amendment 13 included a mid-point review of the stock rebuilding goals, and required subsequent adjustments if necessary (NEFMC, 2003).

AMENDMENT 16 DEVELOPMENT

Amendment 16 to the Northeast Multispecies FMP was initiated by the NEFMC in September 2006 to serve as the mid-point review of the rebuilding program for several stocks (the legal obligation to rebuild stocks by 2014). As of 2007, eight of the 16 groundfish stocks were considered overfished and/or overfishing was still occurring (Tromble, Lambert, & Benaka, 2009). Federally, the MSFCMA was reauthorized that year, which implemented a requirement to end overfishing by 2010, using Annual Catch Limits (ACLs) and Accountability Measures (AMs),[3] and to rebuild overfished stocks within ten years, unless the life history of the species necessitates a longer time frame ("MSFCMA," 2007). Amendment 16, already under development, became the vehicle to incorporate the new federal mandates (Table 2).

[3] Accountability Measures are effort controls implemented either mid-season to ensure a catch limit is not exceeded or in a following season to correct for prior overages.

Early versions of Amendment 16 included a proposal for a LAPP (IFQ) catch share program. The MSFCMA mandates that a two-thirds majority vote of fishery permit holders is required to enact a LAPP in New England (and in the Gulf of Mexico). Due to the projected time such a program would take to develop and be approved, the NEFMC eventually voted to drop this alternative, so that legal requirements for ACLs and AMs implementation deadlines could be met (through litigation, it was later affirmed that the sector program is not a LAPP (Maysonett, 2011)). Aspects of many different stakeholder proposals were pulled together to form the elements of the fishery-wide catch share program that emerged, where the ACL is allocated to groups (sectors) of fishermen. This expanded the sector concept that had been introduced to the fishery a few years earlier with the formation of the two sectors based on Cape Cod (NEFMC, 2009a).

Perhaps the most controversial component of the expanded sector program was how the ACL would be divided among sectors, i.e., the allocation formula. Several alternatives were considered. One was to use the accumulated catch histories over the previous five years associated with each permit enrolled in a sector for the first time. Thus, the new sectors would use FY 2002-2006 for their catch history (NEFMC, 2009a). This was a different time period than the two existing sectors, FY 1996–2001 (NEFMC, 2003). However, some stakeholders felt that certain components of the industry would be unfairly disadvantage, those that had not targeted groundfish in FY 2002-2006. Other alternatives proposed using a combination of landings history and the number of Category A DAS assigned to a permit or broadened the time period to FY 1996–2006 (NEFMC, 2008). After much public debate on the allocation formula, the preferred alternative was to have the allowable catch for a stock that is allocated to a sector be

calculated based solely on the FY 1996-2006 landings history that is attached to each permit that joins a sector in a given year.

In a "watershed decision," the NEFMC voted to approve Amendment 16 in June 2009 (NEFMC, 2009b). Amendment 16 was enacted in May 2010, expanding the number of allowable sectors in the fishery to 19, including the two that were already in operation (NEFMC, 2009a). Fishermen also had the option to enroll in the "common pool," to choose to not join a sector but fish under a Total Allowable Catch managed by NMFS. Amendment 16 also revised rebuilding plans for several stocks, implemented ACLs, AMs, additional mortality controls, and bycatch reduction measures (NEFMC, 2009a).

May 1, 2010, marked a dramatic change for multispecies regulations in the Northeast. Since 1994, fishermen had been catching fish using DAS with other effort control measures. However, the majority of commercial multispecies fishermen with qualifying catch history opted to join the newly formed sectors (landing 98% of the groundfish that year; NMFS, 2015b). Concurrent with the transition to catch share management, catch reductions were required to end overfishing on certain stocks. Thus, allocations to sectors and the common pool were lower than what prior landing history alone would dictate. This resulted in some uncertainty and general distrust of entering into sector agreements by the industry, but sectors were generally considered preferable to the common pool option (M. Vasquez, personal communication, 2011).

GROUNDFISH SECTORS DEFINED

A fishing sector is an organization comprised of at least three distinct entities (none of whom have an ownership interest in the other two entities) that hold limited access multispecies groundfish permits. Each sector is governed by a board of directors, and coordinated by a sector manager. A sector is assigned a common annual allocation of fish, or Annual Catch Entitlement (ACE), an upper limit of catch for each stock. Members must agree on an allocation rationing

system amongst the members as established in its annual sector operations plan, which must be approved by NMFS. Sectors have significant flexibility to form internal agreements and organizational structures, though members are jointly and severally liable for fishing within catch limits.

The amount of ACE given to a sector each year for each stock is determined approximately as follows. The catch of a given stock attributed to each permit for FY 1996-2006 is calculated as a percent of the fishery-wide catch of that stock for those years. This produces the Potential Sector Contribution (PSC) associated with each permit. For each stock, the PSC for a given permit is then multiplied by the total ACL available to groundfish sectors, resulting in the total weight of each stock for the permit. The total weight of a stock allowed for a sector (i.e., the ACE) is the sum of the total allowed for each permit enrolled in the sector (NMFS, 2010b).

Sectors must have approved operations plans approved in advance by NMFS to receive ACE. A sector has the option to hold and fish the ACE in common, or each fisherman may fish the catch history he brought to the sector. So far, all sectors have chosen to distribute allocation to members proportional to the individual fishing history of each member (NMFS, 2015a). Trading of ACE between sectors is allowed to create some flexibility, but each sector has a right of first refusal agreement (internal trades are prioritized).

Sectors are allowed exemptions from certain fishing effort restrictions that were in effect under the DAS program. This includes no daily trip limits for target species, though trip limits remain for certain non-target stocks that are in need of rebuilding (e.g., Atlantic wolffish, sturgeon). Under DAS, the Gulf of Maine cod trip limit had been 800 lb. since 2004, and excess cod needed to be discarded at sea (i.e., as “regulatory discards”). Under sectors, day gillnet vessels are no longer limited to a 50-net limit and do not need to declare out of the fishery for 120 days each

year. They can also share gillnets at sea. Sector vessels may also now access some of the areas that are closed seasonally (NEFMC, 2009a).

Full retention is required of all legal size multispecies stocks; the fish that were regulatory discards under DAS are now landed and count towards the ACE. In fact, all discards are counted against the total allocation, which gives an incentive to minimize discards. There is frequent and detailed sector- and vessel-level monitoring and reporting to track ACE usage (NEFMC, 2009a).

COMMON POOL DEFINED

Another option exists for fishermen, enrolling their permits in the "common pool." Common pool vessels fish with several of the effort controls that were required under the DAS program, though they harvest within a Total Allowable Catch (TAC) limit that applies to all enrolled in the common pool. Starting in FY 2012, the common pool has been managed with trimester (versus annual) TACs for its target stocks to help ensure that limits are not exceeded. The common pool catch accounts for about 1% of the total commercial catch in the fishery, i.e., most of the effort has been in sectors (Murphy et al., 2012). The common pool is not considered a catch share program. The Potential Sector Contribution of each enrolled permit contributes to the TAC, but specific amounts of quota for each stock are not allocated as they are to sectors. It is important, however, to understand the performance of the common pool as well as sectors, because joining the common pool is the only other option for groundfish fishermen.

PERMIT CATEGORIES

Vessels fishing in the groundfish Days-at-Sea program had Category A permits, and the majority of the catch history in the fishery used to calculate PSC is associated with these permits. Most of the active groundfish fishermen have Category A permits, however other permit categories exist. For example, Handgear A (HA) permits may be fished using handgear: rod and reel, handlines and tub trawls. The nature of fishing with handgear gave rise to many regulations that are distinct

from gillnets or trawls, the typical gears associated with Category A permits. Both of these permit types may be enrolled in a sector or the common pool and are limited access permits, meaning that they may only be issued to vessels that have previously held them or transferred to vessels under strict constraints (GARFO, 2012).

Sector formation in New Hampshire

There are two sectors, Northeast Fishery Sectors (NEFS) XI and XII, comprised primarily of permit holders based in New Hampshire. Like most sectors, NEFS XI and XII were established by an existing industry organization, in this case, the Northeast Seafood Coalition (NSC). When it became evident that sector management was the option that the NEFMC was going to recommend as the next approach for groundfish management, the NSC held a series of industry leader meetings to form a vision for sector organization. Those leaders divided the fishery into 12 sectors, and began to formulate operations plans with the assistance of NSC staff. Due to the deadlines involved, the initial operations plans for the new sectors were submitted by the NSC to NMFS for approval. Subsequently, each of these sectors became an independent organization, though the NSC still coordinates some administrative functions through the Northeast Sector Service Network (NSC, 2014). As sector management places significantly more administrative responsibilities on the fishing industry than before, the two NSC sectors comprised mainly of New Hampshire-based permit holders (NEFS XI and XII) decided that it would be more efficient to operate as essentially one sector. They are overseen by one board of directors and hired one sector manager, Dr. Joshua Wiersma, who had been working for the NSC on sector formation (J. Wiersma, personal communication, 2011). Since the two sectors act essentially as one, they are considered as a unit in this research.

CONTINUED MANAGEMENT CHANGE

The data collection for this research (interviews) occurred amid ever-evolving regulations. The catch share program began with including a dockside monitoring program, but this component was cancelled after the first year, because it was deemed to be too redundant with at-sea monitoring (NOAA, 2011). Thus, at the time of the interviews (fall 2012), the informants had participated in a brief dockside monitoring program. The NEFMC approved Amendment 17 in July, 2011 to allow state-operated permit banks to obtain ACE and transfer it to sectors (NEFMC, 2011a). As of May 2012, the State of New Hampshire had a permit bank that the fishermen could begin obtaining quota from. Throughout the period since 2010, NMFS has implemented several actions to help rebuild stocks and meet federal mandates. Amendment 18 is under review, which includes measures to prevent permit holders from acquiring or controlling an excessive share of fishing privileges via an accumulation limit (NEFMC, 2015). Annual catch limits have been volatile and/or quite low for several stocks. For example, the commercial catch of Gulf of Maine cod was 6,705 mt in FY 2009, but the commercial sub-Annual Catch Limit in FY 2010 was 4,567 mt. Catch limits for this stock have lowered almost every year since, in an effort to end overfishing and rebuild the stock. In FY2015, the sub-ACL was just 207 mt (NMFS, 2015b). The constraints that ACLs have put on this fishery cannot be overstated, the impacts of which are very difficult to tease out from those of the catch share program.

PRIOR INQUIRY

Inspiration to commence this dissertation came in large part while pursuing a Master of Public Administration degree at the University of New Hampshire. A class project during the fall of 2010 involved the creation of a case study blog about NEFS XI and XII (Feeney, 2010; Appendix A). Video interviews were created of four people associated with the New Hampshire groundfish fishery, including two fishermen, a sector Board member (who is also the wife of a

fisherman), and a representative of Yankee Fishermen's Cooperative. A presentation by the sector manger, Dr. Wiersma was video recorded and posted. Stakeholder views were noted on the six key aspects of fishing that were investigated in greater depth through this dissertation. Through creation of the blog, an opportunity was discovered for research, to complete the case study. This dissertation was also informed by a survey of the initial 24 members of NEFS XI and XII, administered by Dr. Wiersma during FY 2010 (J. Wiersma, personal communication, 2011; Appendix A). The outcomes of these prior inquiries helped form each hypothesis rationale (Chapter II) and contextualize the research outcomes (Chapters IV-X).

RESEARCH APPROACH

Given the complex and ever-shifting nature of fisheries and fisheries management, selecting the most appropriate mode of social inquiry can be daunting. The research question was answered here through a mixed methods case study. Reliance on either quantitative or qualitative approaches alone can be misleading, so to enable thoughtful consideration of diverse ways of conceptualizing impacts and testing theory, a blend of approaches was used. This can lead to deeper inference than use of a single approach alone (Greene, 2007: 13).

In choosing the project scope and approach, the need for sufficient training in research was balanced with the need to answer the research question thoroughly. As noted above, six key aspects of fishing were selected for analysis: fishing practices, social capital, bycatch, economic performance, safety and well-being. To date, most research on catch share program performance has focused on a particular aspect, such as economic performance or whether fish stocks have improved. A strength of multi-faceted research, as employed here, is that it can assist fishery managers in understanding the ever more complex array of forces driving fishery performance, and ultimately aid in future decision-making. The field of impact assessment research is moved forward by acknowledging and examining the complexity of systems.

HYPOTHESES

Although social research often involves a process of theory generation, in the case of the Northeast groundfish fishery, and catch share programs more generally, a number of theories have already emerged that are ripe for testing. A range of hypotheses are examined here that are both theoretical and specific, support the research objectives, and relate to the overall performance of the fishery. These hypotheses are based on impacts of catch shares derived from empirical research, policy statements of managers, benefits proposed through the Amendment 16 development process, and preliminary observation. The rationale for each hypothesis is explored further in Chapter III.

It is hypothesized that relative to fishing under the Days-at-Sea program, fishing under the catch share (sector) program has:

1. Fishing Practices. Improved efficiency and flexibility for fishermen to decide where, when, and how to fish.
2. Social Capital. Improved social capital (i.e., greater networking, reciprocity and trust) among fishermen in the conduct of business, in harvesting sector allocations, and reducing bycatch.
3. Bycatch. Reduced bycatch through incentives and flexibility to harvest more selectively.
4. Economic Performance. Improved economic performance (e.g., profit margins, business predictability) for fishing participants, though the fishery would consolidate to fewer permit holders and vessels actively fishing.
5. Safety. Increased operational safety for active vessels.
6. Well-Being. Improved well-being, decreasing stress and concern about the conduct of business and the future of the fishery.

The null hypothesis is that the implementation of catch shares caused no substantial changes to the multispecies fishery for these six factors, beyond what would have occurred if the DAS program had continued fishery-wide.

LIMITS IN SCOPE

There are many important social and economic facets of fisheries. Given the importance of the research question to the region, a detailed assessment of each Northeast sector may be warranted, as well as a thorough analysis of the common pool, but that is simply beyond the scope of this dissertation project. The New Hampshire sectors are not innately more suitable for the research. They were selected, because the research team has the most familiarity and connections with this geographic area and its fishery participants, and thus the greatest likelihood of project success. The impacts on each sector have likely been unique, given the diversity in membership, geography, and groundfish ACE allocations. However, some common themes likely hold true.

RESEARCH TEAM

This project was coordinated and led by Rachel Feeney who designed the interview questions and conducted all of the interviews, data coding and analysis, and writing. Dr. Joshua Wiersma, the NEFS XI and XI sector manager from 2010-2014, served as a project advisor and liaison to the fishing industry. He was particularly helpful in identifying the research population, recruiting informants, designing interview questions and groundtruthing outcomes. Audio recordings of interviews were transcribed by Natalie Waltner.

CHAPTER I. HISTORICAL CONTEXT

Although this dissertation focuses on the present day commercial fishing industry in New Hampshire, particularly the changes that have occurred relative to the implementation of groundfish catch share management in May 2010, one needs to think beyond the last few years to more fully understand why the industry is shaped as it is today and what the future may hold. This includes examining historical, ecological, logistical, social, and political aspects of fisheries, and how fishermen through the generations made decisions based on the constraints and opportunities of their time. Several questions arise. How has the coastal New Hampshire ecosystem shaped fisheries and vice versa? What have been the political, logistical, and social of the industry through time? Why are the New Hampshire ports small fishing hubs today relative to Portland and Gloucester? Although it is often assumed that Portland and Gloucester have always had more sizeable fisheries, historical records reveal that was not always the case. Precise historical reconstructions are a challenge though, as records on landings prior to about 1990 are known to under-report the size of the fisheries, by species and gear type.

FOUNDED ON A FISHERY

Europeans were first drawn to the Gulf of Maine, and particularly to the Piscataqua region, for its abundant cod stocks. The Isles of Shoals and adjacent coastal areas were used by scout fishermen in the 16th century, but it was the exploration of the Piscataqua River by Martin Pring and William Brown in 1603 that caused colonization to become serious (Saltonstall, 1941: 8). A decade later, voyagers Samuel Champlain and John Smith noted the abundance of timber and fish resources in the Piscataqua region. Though no visits to the area were recorded between 1614 and 1623 (Saltonstall, 1941: 10), the Council for New England of Plymouth, England was

issuing land grants to settle the region. Captain John Mason, governor of Newfoundland from 1615 to 1621, received one for the land surrounding the Piscataqua River (Van Deventer, 1976: 5-6). In 1623, David Thompson and William and Edward Hilton were outfitted by the Laconia Company, which Mason founded to organize merchants from the west of England. Hilton was given a land grant by the Council between 1623 and 1628 to establish fishing stations at what is now called Hilton Point in Great Bay (Van Deventer, 1976: 5). Thompson first fished on Mason's land grant out of what is now called Ordiorne Point, just south of the mouth of the Piscataqua. However, in 1624, Thompson moved south to an island in Massachusetts Bay (now called Thompson Island) to establish fisheries there. Others in his party remained in the Piscataqua area (Adams, 1825: 9-12).

What was it about the Piscataqua estuarine ecosystem that inspired settlement by these pioneers, and why would Hilton establish fishing settlements ten miles upriver? Hilton must have observed sufficient fish resources available in Great Bay to warrant settlement, though he did have an additional interest in lumber. By comparison, Great Bay is scant of wild commercial harvests today (Short, 1992). The Piscataqua region that we know, now 400 years since and populated by 418,000 people[4] (Bureau, 2010), has had significant human impact through time, including sawdust, fish waste, sewage, and industrial chemicals. Environmental concerns remain, including: effluent, shellfish closures, loss of eelgrass habitat, and shoreline development (Short, 1992: 1). These early European settlers came in the midst of the Little Ice Age (1450-1850), so the forested river ways and estuaries likely provided colder and more oxygenated habitat for anadromous fish and estuarine nurseries than today (Francis, Wolfe, Fuller, & Foster, 2002).

[4] 2010 U.S. Census data for Rockingham and Strafford Counties.

The juxtaposition of abundant fish resources, the rocky Isles of Shoals, and the Piscataqua Estuary, with its river systems that reached far inland must have been too good to pass up. The five rivers that feed the Piscataqua estuary provided over 100 miles of access to fresh water and inland timber resources (Van Deventer, 1976: 4). The Laconia Company was allured by the prospects of valuable fur, mines, and vineyard industries, but it was lumber and cod that they soon agreed with the earlier account of Capt. John Smith to be "as good as gold as the mines of Potosi and Guiana: with less hazards and charge and more certain and facility" (Barbour, 1986). The warm and sunny New Hampshire climate was more favorable than that of Newfoundland for drying and salting haddock and cod, such that fishing could be a year-round venture (Adams, 1825: 9-12).

Raw fishing stations along the New Hampshire coast transformed into settlements by 1631, and trade of fur and fish back to England became the first profitable ventures (Belknap, 1812: 150). Obtaining a sufficient supply of salt was essential to establishing fisheries, and it was manufactured through the erection of salt works (Adams, 1825: 9-12). Edward Godfrey was an early successful fisherman. By 1632, he owned a fleet based at Strawberry Banke comprised of six shallops, five smaller boats, and 13 skiffs. The towns of Dover, Hampton, and Exeter, as well as Strawberry Banke, were formally laid out by 1641. In Dover and Exeter, individuals were given exclusive rights to fish commercially with weirs (Van Deventer, 1976: 88). Although Mason's heirs did not inherit his holdings upon his death in 1635, the Laconia Company continued to support the natural resource industries (Van Deventer, 1976: 6, 88). Taking advantage of abundant timber and the natural transit system of the Great Bay rivers, shipbuilding and the mast trade became important industries in Portsmouth harbor by the mid-1600s, alongside fishing (Saltonstall, 1941: 12). At the mouth of the Piscataqua River, the fishing

settlement of "Strawberry Banke" increased in size, and by 1653 was renamed Portsmouth, since it was considered one of the finest ports in the region (Saltonstall, 1941: 11). The New Hampshire coast provided dozens of sites for small fisheries, but Belknap noted in 1812 that the Isles of Shoals, New Castle, Rye, and Hampton were "where the cod fishery was chiefly attended" (Belknap, 1812: 158).

The colonial fishing ports of New Hampshire likely resembled those developing in Massachusetts, in terms of fishing technology and techniques, but the Puritans to the south lacked a labor force that Strawberry Banke did not. The fishing life was not conducive to Puritan "landsmen" ideals, and their workers needed to be imported from England, which slowed the establishment of fisheries relative to New Hampshire (Vickers, 1994: 91-4). The people of colonial New Hampshire came to fish, not to seek haven from religious and political oppression. As one late 17th century parishioner responded to complaints from his Piscataqua minister that the flock was forsaking piety: "Sir, you entirely mistake the matter; our ancestors did not come here on account of their religion, but to fish and to trade" (Saltonstall, 1941: 12).

During the 17th century, coastal New Hampshire towns were primarily focused on establishing permanent settlements (Saltonstall, 1941: 25), though still dependent on shipments of supplies from northern Europe (Belknap, 1812: 150-70). The outbreak of the English Civil War in 1642 was a key turning point for New England fisheries, launching their independence. The extension of credit and equipment by English capitalists, such as those of the Laconia Company, had been critical to the development of markets (Jenness, 1795: 58-69). Although prices, access to credit, and traditional trade routes relative to the English market suffered, markets expanded to the Iberian Peninsula, and colonial fisheries became more self-reliant. To the Caribbean slave holding islands, low-grade cod was in demand (Vickers, 1994: 98-9). In New Hampshire,

Barbados rum and molasses were in demand, and briefly, African slaves. Fish and ship masts were key exports to both Europe and the West Indies (Saltonstall, 1941: 13). Thus, new trade routes emerged.

The cod fishery was carried out both inshore and offshore. The inshore fishery was conducted with light, swift whale-boats, rowed either with two or four oars and steered with another. In winter, the whale-boats would fish by day, but in spring and summer, they would fish until full. Schooners typically made three trips to the "Banks" per season, were 20-50 tons, and carried six or seven men and a few boys. The spring trip to the Banks caught "large, thick" cod, which when salted and boiled, turned red in color and were reserved for Saturday dinner at the finest New England tables. The cod from the summer-fall trips were divided into two types: "merchantable" and "Jamaica." The merchantable fish were white, thin, and less firm than the spring catch, but were good enough to export to Europe. The Jamaica fish was the smallest, thinnest and "most broken." These were exported to the West Indies (Belknap, 1812: 157-70). Modern studies of cod spawning indicate that the condition of cod vary seasonally with spawning, resting, and feeding (Rideout & Burton, 2000). This likely explains the varying quality of the catch. Ipswich Bay, the primary inshore grounds, is an important spring spawning ground today (Howell, Morin, Rennels, & Goethel, 2008), whereas the Georges Bank stock spawns in winter and is feeding (i.e., "thick") by spring (Kovach, Breton, Berlinsky, Maceda, & Wirgin, 2010).

Located six miles offshore, the Isles of Shoals had a generally sunnier and drier climate, which enabled high quality codfish curing. By the 1650s, the Isles fisheries were turning steady profits, such that fishermen could obtain larger estates on the mainland. Wealth was amassed, developing a mercantile class and providing a local source of capital to expand the economy. The 1660s was the high point for the Isles fisheries, with as many as 1,500 fishermen working on the

seven islands during the height of the season (Van Deventer, 1976: 88-9), exporting 12,000 quintals (1.3M lbs) of dry cod from the region per year (Table 4) (NHPP, 1667). This equates to about 4 M lbs of round cod (K. Alexander, personal communication, 2012).[5] By comparison, 1.2 M lbs of cod were landed in New Hampshire ports in FY 2010.

The period between 1680 and 1850 was marked by episodes of fisheries expansion tempered with wartime contractions as vessels, markets and manpower were redirected. But soon, conflicts with the Abnaki tribe and King Philip's War brought commerce to a relative standstill. By 1692, the population on the Isles had dropped to about 100. The colony traders were exporting just 2,200 quintals (246,000 lbs.) of cod and mackerel per year in the mid 1690s, mostly bound for Barbados (Van Deventer, 1976: 89-90). Trading patterns were generally similar between Massachusetts and New Hampshire, though by 1700, exports from Massachusetts ports, 100,000 quintals (11.2 M lbs.), far outpaced those of New Hampshire, 1,300 quintals (146, 000 lbs.; Van Deventer, 1976: 90). The close of Queen Anne's War in 1713 rebuilt English trade routes and sources of capital, but by then, colonial fisheries and merchants were well established on their own (Saltonstall, 1941: 25). Peace benefited both colonies. Portsmouth had an early rebound, with 100 vessels and 400 "seafaring men and fishermen" based in the Piscataqua River by 1720 (Van Deventer, 1976: 91) (Table 4). From 1690 to 1725, the number of Gloucester schooners headed for the Banks rose from nothing to 49, and by 1775, there were almost 150 vessels and 900 men employed. This exceeded any other port in Essex County (Vickers, 1994: 192) and likely overshadowed the effort from New Hampshire as well.

New Hampshire had many conditions that favored prosperous fisheries. Portsmouth was a fine deep water seaport. The colony was closer to North Atlantic fishing grounds than Massachusetts.

5 Conversion factors between dried cod and round cod (head and guts removed) vary, but one pound of dried cod equals roughly three pounds of round cod.

Fish was consistently one of the most profitable exports. Many Piscataqua families gained wealth through fisheries. The 1708 records of New Hampshire fish merchant George Vaughan reveal profitable fisheries in Great Bay for cod, haddock, perch, flounder, sturgeon, herring, salmon, alewife, pike, trout, bass, crabs, cockles (clams), and oysters (Vaughan, 1708). The use of fish as currency in Portsmouth during the 1720s illustrates its importance to the economy (Van Deventer, 1976: 92). However, the New Hampshire oak and white pine resources accessible from Great Bay had fostered a niche for shipbuilding and maritime trades, which diversified the New Hampshire economy. Up until the Revolution, the "infinite thick woods" produced 200 foot pines that launched Portsmouth to predominance in the mast trade (Saltonstall, 1941: 55). Unsettled political relations with Indians and distant powers made investments in fisheries uncertain. Gloucester, with its aggressive seafarers, slipped ahead in fisheries, forever parting the trajectories of the two ports (Van Deventer, 1976: 93).

FIRST SIGNS OF RESOURCE STRAIN

The New Hampshire Fisheries Gazette published a notice in March 1774 of what may be the first public act in the state to constrain fish harvests due to stock depletions. The "Act to Preserve the Fish of the Piscataqua River," prohibited fishing with seines or "setting line" anywhere in the river or its branches where "the tide ebbs and flows." The public was authorized to destroy all such gear found therein. It also established a seasonal closure from December to April for bass and bluefish. The consequence for being caught fishing was a penalty of three pounds, half to be paid to the government and half to the informant. Commerce of smelts, bass, bluefish and cod "in contrary to the Act" would also be fined. Resource concerns were expressed in the Preamble:

> *…the fishing in Piscataqua River, and in the harbor near the mouth of said river, with setting lines and seins hath already in a great measure obstructed and turned the course of the codfish and smelts in said river, and the fishing for bass and bluefish in winter, hath almost extirpated the bass and blue-fish in said river, so that*

> *these useful fisheries are in eminent danger of being lost, unless prevented by an act of the general-Assembly* ("An Act to Preserve the Fish in Piscataqua River," 1774).

The Act exemplifies what Richard Judd has argued, that the conservation movement in America began not by the upper echelons of society, but by the common people concerned with fair access to public resources (Judd, 1997: 263). The New Hampshire Division of Archives and Records Management contains over 20 petitions of concern submitted to the Governor between 1764 and 1815, some signed by over 100 people. Most complaints regarded anadromous fish passage and gear conflicts. Signatories saw diminished alewife stocks as an increasing number of mills were constructed. The petitions show struggles between fishermen with different levels of capital using different gear types: seines, scoop nets, and spears ("Petitions to the Governor, Council, and Legislature," 1764). Their concerns are not far off from what is heard at public fishery management meetings of today.

EARLY AMERICA

Trade out of Portsmouth harbor shrank rapidly during the American Revolution, as only a few vessels got permission to procure necessary provisions during wartime. Governor Wentworth was a loyalist and delayed the engagement of New Hampshire against England. It was the merchants and ship captains who took initiative, angered by restrictions on commerce (Saltonstall, 1941: 89-92). Once the United States was established, the nation was determined to grow its post-colonial economy, taking advantage of what were still largely perceived to be unlimited ocean resources (McEvoy, 1988: 213).

> *The fishing banks are an inexhaustible source of wealth; and the fishing business is a most excellent nursery for seamen. It therefore deserves every encouragement and indulgence from an enlightened legislature* (Belknap, 1812: 159).

The period between the Revolutionary War and the War of 1812 has been called the “golden age” of lumbering, shipbuilding and fishing for Portsmouth (Saltonstall, 1941: 225). As the principal port city in the New Hampshire, by population and commercial importance, Portsmouth

served as the center of the customs district, which was thriving (Wilcox, 1887: 105). By the 1790s, fifteen years into independence, the fishing industry had rebound to 27 schooners and 20 boats employing 250 fishermen. There were nearly 3 M lbs. of dried cod exports per year between 1789 and 1791, primarily to the West Indies (Table 4) (Belknap, 1812: 159). Americans had a geographic advantage on the Banks, because the spring westerlies carried their vessels to fishing grounds earlier in the season than the Europeans could. New England air was clearer for fish drying than in foggy Newfoundland and Nova Scotia (Belknap, 1812: 159). There was a steady increase in foreign trade, but the War of 1812 caused another disruption. Although shipbuilding continued, fisheries prospered, and the "coasting" trade (shipping) rose in importance, voyages to the West Indies became rare and tariffs discouraged imports from Europe. With the decline in foreign trade, more men turned to domestic cod and mackerel fisheries for employment (Saltonstall, 1941: 96). Customs records indicate that up to 81 fishing vessels operated out of the Piscataqua in 1841 (Table 4) (Saltonstall, 1941: 197).

Prominent in the 19th century fisheries revival, Captain Thomas E. Oliver of Newcastle owned or had shares in more than 89 vessels between 1809 and 1856 (Marvin, 1937). He left detailed business records between 1815-1845 that offer a picture of the fishing and coasting industries of the time. Records from 1839 for example, indicate that over 2,164 quintals (242,000 lbs.; Table 4) of "small" and "large" cod were landed from fishing grounds in the Bay of St. Lawrence, the Bay of Fundy, and Labrador (Oliver, 1815). He owned a fish yard that processed dried and salted fish products. Oil was extracted from cod, haddock, and pollock livers for medicines (Saltonstall, 1941: 197). Along with fishing, he shipped fish to cities such as Baltimore, Norfolk, and Charleston (Ware, 1930). Purchases of cod, haddock, hake, and pollock from vessels such as the *Providence*, *Nancy*, *Expedience*, and *Polly* indicate that he transported other cargo south besides

his own fish (Oliver, 1815). His vessels returned with produce, tar, and other merchandise headed for Providence, Boston, and Portsmouth (Saltonstall, 1941: 197).

The whaling industry in New England fueled much of the growing 19th century economy (Roberts, 2007: 91), and the Piscataqua River was a primary locale for shipbuilding to support whaling. Despite sightings of whales feeding on alewives in the river, it was only during the downturn of the West India trade in the 1830s that Portsmouth took to whaling. Even so, just four whaling vessels ever operated out of Portsmouth: *Plato*, *Triton*, *Ann Parry*, and *Pocahontas*. In 1835, the *Triton* was the first to return from a whaling voyage to the South Atlantic, the preferred whaling waters, with 1,350 barrels of whale oil, 120 barrels of sperm oil, and 10,000 lbs. of bone. The whaling days were short-lived though. The last vessel to be sold out of Portsmouth was the *Ann Parry* in 1848 to a company in Salem, Massachusetts who repurposed it to serve the California gold rush (Saltonstall, 1941: 197-9). Today, the local alewife runs are likely too low, and the Piscataqua River too depleted and industrial (noise, activity) to attract what whales remain in the Gulf of Maine.

The New Hampshire coast was burgeoning as a summer destination in the early 19th century, due to its fair climate and accessibility from Portland and Boston. Meteorological records show that Portsmouth had about 50% fewer rainy days and less rainfall, slightly cooler summer temperatures, and the least number of days with bleak easterly winds relative to its neighboring hubs. Summer tourism grew quickly in Rye, Hampton, Seabrook, and particularly on the Isles of Shoals (Jenness, 1795: 5-6). Though the Isles of Shoals had waned as a fishing hub after the 17th century (Jenness, 1795: 171), a few fishing families remained, apart from a brief period during the Revolutionary War when they were ordered to evacuate (Bolster, 2002: 13). In the 1840s, Star Island housed seven fishing families, and as legend goes:

> *…if a school of mackerel came into the cove at [Sabbath] meeting time, the congregation would rush out of the meeting house for their boats, with Elder Plummer not far in the rear* (Laighton, 1930: 14).

Seasonal residents lived amid the fishermen after 1848, when the first hotel was established on Appledore Island (Bolster, 2002: 13). Although the Isles of Shoals has waned as a resort destination today, the New Hampshire coast has remained important for tourism and recreational fishing. Area fishermen throughout the centuries have benefited from the presence of fish-hungry tourists.

Industrialization brought the advent of steam-powered vessels in the 1850s, which caused a sharp downturn in the Portsmouth ship building industry, because it did not evolve with the times. By then, the Seacoast economy had diversified significantly, and the region shifted toward inland ventures (Saltonstall, 1941: 225-6). From 1867 to 1879, the fishing fleet of the Portsmouth Customs District still numbered as high as 125 vessels. During those years, Portsmouth dealers handled 154,000 cod, 494,000 mackerel, 17,000 herring, fish oil, shellfish and other fresh fish (Wilcox, 1887).

The rise of fisheries in Portland had a slower start than in New Hampshire or Gloucester. Although it was proximal to good inshore grounds and the Nova Scotian banks, the demand for fish in Portland remained small until the advent of refrigerated transport put metropolitan markets for fresh product within reach. Both Portland and Gloucester had invested in filleting plants, which New Hampshire had not (Ackerman, 1941: 223-7). In 1887, the principal fishing ports in New England, in order of value were: Gloucester, Portland, Boston, Provincetown, and New Bedford (Table 5) (Goode & Collins, 1887). New Hampshire ports remain to this day, not among the top tier.

STATE INTERVENTION IN FISHERIES

Towns were once the center of natural resource regulation, under a philosophy of common use and democratic access, but over the 18th and 19th centuries, communities that shared watersheds or marine fishing grounds began to compete for resources. With an industrializing economy, anadromous fish harvesters held little influence over more powerful mill owners that controlled river water supplies, despite their petitioning (Judd, 1997: 161). It was primarily over concern for the salmon and shad runs in the Merrimac and Connecticut rivers, where interstate waters were involved, that New Hampshire took the lead in establishing a fish commission (NHFG, 1966: 34), but other New England states soon followed. On June 30, 1865, Henry Bellows and W. A. Sanborn were appointed by the New Hampshire Legislature to inquire into the "restoration of sea-fish (i.e., anadromous species such as salmon or shad) and introduction of new varieties of fresh-water fish into the waters of the state." A stocking program for black bass, land-locked salmon and other species was started, but with an initial budget of under $100. High dams on the Connecticut and Merrimack Rivers were cited as the biggest challenge, which had excluded "sea-fish" for 20 years prior. The New Hampshire commissioners doubted that Massachusetts would agree to incur expenses related to restoring fish passage (NHFC, 1869: 643-4).

In 1922, Jackson described the ecology of the Great Bay estuary, identifying the "Cod Grounds," an area where "a considerable school of codfish," weighing six to 15 pounds each, gathered in the late fall and early spring (likely to spawn). There also could be found cunners, sculpins, flounders, and skate. He also observed "frostfish," whiting, and pollock, and shorelines of eelgrass beds "teaming with shrimp." He attributed the damming of almost all the rivers that drain into Great Bay as the limiting factor on the distribution of fish. Salmon had not been present for many years due to the dams, and the Lamprey River eel run was just a fraction of its former glory. Other species that had disappeared by then include the common sturgeon, shad,

mackerel, bluefish, and striped bass. He also noted that all of Great Bay froze over in winter (Jackson, 1922).

Although some strides were made for fish passage around dams (Judd, 1997: 161-8), commissioners by the mid-1930s had made the most progress with restocking. By then, the state Department of Fish and Game had formed, and in 1934, their "most important problem was to raise large numbers of legal fish to restock our lakes and streams." Federal funds were secured to enlarge hatcheries and create rearing stations. Annually, state efforts were introducing about 400,000 juvenile Atlantic salmon and smelts into lakes and rivers (NHFG, 1934).

State involvement in marine fishing was not formalized until 1965, when the New Hampshire General Court charged the Fish and Game Department with the "regulation and promotion" of recreational and commercial salt-water fisheries. Money from licenses and fines was designated for the Marine Fisheries Fund to promote research and regulations. The first marine biologist was hired at that time. For 100 years prior, state efforts had concentrated on restoring inland fisheries, but unfortunately, little head-way had been made. The major stumbling blocks were pollution and dams, which had both increased, and pollution was affecting marine fisheries as well. However, commissioners in the mid-1960s were encouraged. Pollution had "finally become recognized as a problem of grave national concern," and remediation funds were becoming available (NHFG, 1966: 31-5). Unfortunately, water quality in the estuaries is still a significant concern today. For the Piscataqua Estuary, 11 of 12 indicators of environmental quality had negative or cautionary trends in 2009, up from seven in 2006 (PREP, 2009). Harvest of shellfish and anadromous fish has remained quite low for several decades (NMFS, 2012).

MODERN GROUNDFISH FISHERIES

Perhaps the most impactful change in fisheries was the introduction of otter trawls and steam engines. Fishing trips to the Banks likely faded with the sunset of the schooner fishery in the late

1800s, and the 19th century New Hampshire fleet transitioned to primarily day-boats that fished near shore. Although beam trawls had been occasionally used, they were clumsy to manage and had low fishing power relative to the otter trawl, which emerged in the 1880s (Roberts, 2007: 157). This active method of harvest, later enhanced when U.S. vessels used steam engine power in the 1920s (Roberts, 2007: 156), caused much consternation among traditional fishermen who prophesied the doom of stocks. Concerned fishermen again turned to their governments for help for regulations, though within a few years, trawlers had become commonplace (Roberts, 2007: 140-58).

Today, New Hampshire fishing businesses are almost exclusively owner-operated, and likely have been since the end of the Banks schooner fishery in the 1800s. Though strong labor unions existed throughout the 20th century in New Bedford, Gloucester and Portland (White, 1954: 42-9), unionization was strongly opposed in New Hampshire. By and large, the era of mercantile capitalism in early America that had superseded colonial capitalism was giving way to independent fishermen, particularly in New Hampshire.

Although there have been federal fishing reports ever since the U.S. Commission on Fish and Fisheries was established in 1871 (NOAA, 2007), regular accounting of landings by species, gear type and state was first done annually in 1950 by what was by then renamed the U.S. Bureau of Fisheries. Over the 62 years since, federal landings data (now collected by the National Marine Fisheries Service) indicate that the New Hampshire fisheries increased and became more diversified in terms of species caught and gear type used (Table 7, Table 8) (NMFS, 2012). The data are problematic for several reasons however, and likely underreport true catch for many fisheries. First, prior to about 1990, the landings data were not very accurate. Port agents would randomly interview fishermen at the dock, and fishermen would give estimates of catch. True

weights were not measured. Second, for all vessels under five net tons, the government recorded landings before the 1990s generically, with terms such as "fish for food, other" rather than by species. For small vessels under a certain weight, landings were not specified to the state level, but lumped together regionally or nationally. Vessels used by New Hampshire fishermen were generally of this weight category. Third, many of the fishermen based in New Hampshire would land fish in Portland, Gloucester or Newburyport, and their activity was attributed to Maine and Massachusetts. Likewise, fishermen from the southern tip of Maine would use the shore-side facilities of Portsmouth (D. Goethel, personal communication, 2012). Thus, weights were not being recorded accurately, and landings did not reflect the true activity of home ports.

The landings from 1996-2006 are relatively well groundtruthed, because the formula used as the basis for setting Potential Sector Contribution (see Introduction) for the groundfish catch share program used catch history during that time (NEFMC, 2009a). When in 2008, the NEFMC set those years for the measurement of fishing history, many fishermen checked their federal landings history with their own records and worked with NMFS to resolve discrepancies. Unfortunately, many fishermen were accustomed to disposing of business records once the ten-year tax liability window had expired. For them, there was no way to verify records for the years 1996-1998 and have suffered with lower PSCs than they might have received (D. Goethel, personal communication, 2012). Even with data quality caveats, the landings do reveal a diverse industry active between 1950 and 2010, harvesting a wide variety of species (Table 7, Table 8). Gillnets and otter trawls are used to catch about 95% of groundfish today (NMFS, 2012). Although the landings data (Table 8) show that trawl gear did not migrate to New Hampshire until the 1970s, Frank Goss fished out of Seabrook from just after World War II into the 1960s

entirely with trawl gear, and there were at least two eastern rigs[6] based in Portsmouth in the 1960s. Once monofilament line became available in the 1960s, gillnets became prevalent (D. Goethel, personal communication, 2012), as seen in the time series of landings by gear type (Table 8). By 1978, there were just one or two larger groundfish vessels based in Portsmouth (J. M. Acheson, Acheson, Bort, & Lello, 1980).

Today, there are about 130 federal fishing permit holders that have a homeport or landing port in New Hampshire and about 55 of those hold limited-access commercial groundfish permits (NMFS, 2013). The current commercial groundfish fishery in New Hampshire is comprised of vessels that are all less than 56 feet in length and fish primarily within about 30 miles of shore, focused between the Isles of Shoals and Cape Ann. Only a few fishermen use handlines to catch groundfish today, as it is generally considered an unprofitable venture (D. Goethel, personal communication, 2012). They primarily use gillnet and otter trawl gear and land fish in Portsmouth, Hampton, and Seabrook, as well as out of state in Portland, Newburyport, and Gloucester. An offshore lobster fleet emerged in the 1980s, and there are now more lobstermen than groundfish fishermen in the state (NMFS, 2013).

The advent of fishermen's cooperatives in the late 20th century greatly increased the within-state landings (Table 7, Table 5). Prior, what fish were not peddled locally got trucked to Boston or landed in Gloucester (J. M. Acheson, et al., 1980: 235). Fishermen based in all the New Hampshire ports would regularly bring their catch to shore in skiffs. Several fishermen pitched their catch into trucks, drove to Newburyport, and sold it to individual dealers. After the mid-1970s, the Tri-Coastal Cooperative in Newburyport became a common destination for New

[6] An eastern rig is the fishing vessel that replaced schooners. It was powered by a diesel engine and dragged a conical otter trawl net. These vessels were common into the 1970s, when they were replaced with steel hulled vessels Seaport, M. (2012). Roann - Eastern-Rig Dragger. from http://www.mysticseaport.org/.

Hampshire fish. The Portsmouth Fishermen's Cooperative formed in 1980 as a means to support a local industry (J. M. Acheson, et al., 1980: 235), and the Yankee Fisherman's Co-operative in Seabrook was founded in 1990 (YFC, 2012).

Activity at the Tri-Coastal Cooperative declined after Amendment 7 to the groundfish FMP was adopted in 1996 and decreased local fishing activity, but by then, many of the Hampton and Seabrook fishermen were using Yankee. Fishermen turned to cooperatives, in part, because some dealers were less than straightforward in their business practices. A sense of rugged individualism persists today, which is why many of the New Hampshire fishermen were wary of joining a groundfish sector (D. Goethel, personal communication, 2012).

The New England fishing communities are more stable and diverse than northern neighbors such as Newfoundland, whose fishing economy was reliant on one product, cod. Without diversification, the Canadian communities were highly vulnerable to supply and demand and turned to the state for aid (Sider, 2003: 306). The inshore cod fishery was abandoned by the 1950s, and the state, in turn, encouraged the abandonment of small communities for a centralized industrial fleet. The "professionalization" of the fishery into open ocean trawlers barely lasted 20 years, ending with the dramatic cod collapse of the 1990s. Cod stocks remained low for some time (Sider, 2003: 3-5), though scientists have noted a recent upticks in the population (Rose & Rowe, 2015). Similarly, the New Hampshire groundfish fishery may soon become non-existent, unless it can outlast the current decline in Gulf of Maine cod.

SUMMARY

However overfished the cod stocks may be today, the cod of Ipswich Bay have been important to New Hampshire fishermen since the 1500s, and fishing activity has been constant since the early 1600s. The Piscataqua and Hampton-Seabrook estuaries have been invaluable resources, both for the species they have contained and for the inland access their rivers have provided. Although

fishing communities in New Hampshire and Massachusetts were established simultaneously, Gloucester invested heavily in fisheries, while Portsmouth diversified into shipping, ship building, the mast trade, and land-based ventures. By the mid-1700s, many of the rivers had been dammed inland, and initial concerns about resource decline came from the affected fishermen. The first state intervention in fisheries was to mitigate freshwater user conflicts, but despite over 150 years of concerted efforts, many of the anadromous and shellfish fisheries remain depleted. Marine fisheries have expanded and contracted throughout the centuries. Fisheries began by catching cod both inshore and on the Banks with sail power, but transitioned to steam in the late 1800s and then to diesel in the early 1900s. Hooks were overshadowed by trawls and then by gillnets in the mid-20th century. Today, the New Hampshire groundfish fishery is small and the effort inshore; the offshore fishery migrated out of state several generations ago.

CHAPTER II. THEORY

NATURAL RESOURCES SOCIAL THEORY

Theoretical constructs are commonly built and refined over time through scientific observation of cases. Within the study of how humans use the natural resources of their environment, it has been observed that, in the absence of external constraints, individuals tend to act rationally. They desire what is considered good. The assumption is that individuals use resources for their own best interest. Depletion occurs when the sum of the impacts by individual users is greater than what the resource can sustain. External constraints (e.g., regulations) then become necessary to ensure resource sustainability.

To understand individual and group behavior in the face of scarcity, social scientists observing these phenomena over the past half-century have developed theories with descriptors such as "rational choice," "collective action," "common property," and "participatory governance" (e.g., Abel, 1991; R. Hardin, 1982). Generally, they explain how societies use properties held in common, such as fish resources, and what conditions best promote (or hinder) sustainability - how people use their norms and institutions to interact with the natural environment.

RATIONAL CHOICE

According to rational choice theory, also called "choice theory," individuals are purposive and intentional actors with a hierarchy of preferences. They seek specified outcomes that are consistent with their preferences. Yet, due to the scarcity of resources, individual action is constrained by opportunity cost, what needs to be given up to achieve preferred outcomes. Actions are also constrained by social institutions external to the individual, such as norms or laws, and by the sufficiency of information an actor possesses for decision-making. Thus,

individual outcomes vary by preferences, opportunity costs, institutional constraints and information. In theory, self-interested individuals without group norms or rules will act to exploit the common good to their own benefit. Even though individuals behave rationally, the group can become worse off collectively. Self-interested behavior in the acquisition of finite resources can lead to conflict among individuals, and an erosion of community social capital and benefits. Where constraints are unavoidable, actors will make cost-benefit calculations to rationally choose actions that advance their preferences (Friedman & Hechter, 1988; Malena, 2009).

COLLECTIVE ACTION

Just because a common interest exists, individuals will not necessarily take action voluntarily for the collective good. The possibility of achieving a group benefit may be an insufficient reason to generate collective action. There must be either incentives or rules (Friedman & Hechter, 1988). Mancur Olson (1971) described the "logic of collective action" as the tendency, based on the cost-benefit decision process of self-interested rational individuals, to "free ride" on the collective good, rather than agree to restrain their actions. This tendency is especially prevalent in larger groups where, Olson argues, it is less likely that any individual will obtain the supply of benefits they consider optimal, unless they free-ride. Thus, collective action (e.g., regulation) is typically required to provide common good for all. With collective action, there may be fewer conflicts among individuals, but the share of the good each individual can access is likely considered sub-optimal (M. Olson, 1971: 33-6).

At what point does a group agree to take collective action? First, the benefits that result from the free-riding practices of an individual must be observed by others and cause them to free-ride as well. There becomes a point, with more free-riding, when the benefits to the free-riders become less than the benefits they would receive by taking collective action. When this is realized by enough (or sufficiently powerful) individuals, collective action occurs (R. Hardin, 1982: 8-9).

COMMON PROPERTY

Biologist Garrett Hardin, regarded as a pioneer of common property theories, argued in the 1960s that the ultimate solutions to resource scarcity problems are not technical but moral (G. Hardin, 1968). Building off the work of earlier scientists, he described a "tragedy of the commons," where in a world of finite resources, it is not possible to maximize both the human population and the acquisition of individual human good simultaneously. People acting rationally seek to maximize their individual good by consuming a resource, which decreases the amount of said resource available to the rest of society. Freedom to maximize individual use of resources will ultimately cause the detriment, or "tragedy," to society when the resource fails to sustain individual benefits. To avoid the tragedy, society may take collective action for mutual benefit. The "tragedy of the commons" has become the ubiquitous descriptor of the natural resource dilemma in the decades since the publication of Hardin's seminal article.

PARTICIPATORY GOVERNANCE

There is growing recognition that good governance requires the active participation of the governed, the public and their organizations. Participation can result in greater transparency, responsiveness and effectiveness of government and the empowerment of the citizenry. Benefits to political actors (e.g., managers) include greater stability, legitimacy and public support. In other words, rules to minimize selfish behavior have greater public acceptance and buy-in when the public is included in decision-making processes (Malena, 2009: 3-6).

MOVING BEYOND RATIONAL CHOICE

The traditional solution to the tragedy of the commons is government ownership of resources, the view that top-down organizations would best promote sustainability and enforcement of regulations (Ophuls, 1977: 226-7). Nobel laureate and economist Elinor Ostrom showed how governments can be subject to powerful lobbying by factions, have imperfect knowledge, and be

unable to enforce rules (Pennington, 2012). The opposite solution is the complete privatization of access rights, "removing wildlife from common property resource treatment" and rejecting the belief that "wildlife should be viewed as the common heritage of all mankind" (Smith, 1981: 468). Privatization, can create concentration of rights and untenable transaction costs when limited resources are monetized (Pennington, 2012).

Ostrom forwarded a different approach. People have more complex motivations and abilities to solve social dilemmas than rational choice theorists have assumed. Communities of users can develop effective rules and enforcement mechanisms for sustainable resource use. Rather than impose its will "top-down," government can provide information and assist with enforcement of rules generated by a participatory processes. Polycentric governance of common-pool resources can foster participation at different levels by multiple entities: private, community, and state (Ostrom, 1990: 8-23). What is key is the active participation of resource users, building trust in the system, and taking the time to develop rules that are well-matched with ecological processes (Ostrom, 2010).

COLLECTIVE ACTION IN FISHERIES

Theories developed within the social sciences can be used to understand the actions of individual fishermen harvesting a stock held in common and to identify management strategies that would optimize benefits. The vast ocean, once thought timeless and eternally abundant, is in fact not immune from the tragedy of the commons. Through time, the driving force of fisheries decline has been the rational need to feed and provide for an ever-growing human population and an assumption that the world is capable of absorbing human impact. Acting in the absence of rules, and long before theories were constructed on the subject, the tragedy of the commons was realized in fisheries. Open-access fisheries, lacking defined rights and regulations such that anyone could harvest resources, were becoming untenable.

To reduce conflict among users and prevent resource depletion, various forms of rights systems have emerged globally through collective action, in an effort to reign in the common property challenges (Falque, De Alessi, & LaMotte, 2002, xxi-xxv; McCay, 2004). The U.S. National Environmental Policy Act ("NEPA," 1970) has required participatory governance of common-property resources for over four decades and the Magnuson-Stevens Act implemented the Regional Fishery Management Council system, a public forum for stakeholders and managers to make recommendations for federal fisheries management. The Councils emerged during an age when resource management had become more participatory, with a growing number of stakeholders and a recognition that natural resource dilemmas are too complex for top-down approaches alone (Berkes, 2003).

In 2010, the NEFMC and NMFS took a step towards localized management when the groundfish sector program was expanded fishery-wide, delegating some management decisions to sectors of fishermen, some defined geographically and others defined by gear type or common interest. With voluntary enrollment and government by a board of directors, sectors are participatory in nature. The decision-making process to create the sector program spanned three years and involved over 70 public meetings. As an alternate management approach, the Council considered developing a Limited Access Privilege Program (e.g., IFQs), but since the MSFCMA requires a two-thirds majority vote of fishery permit holders to enact a LAPP, the NEFMC voted to drop this alternative due to the projected time such a program would take to develop. Time requirements to bring the stock rebuilding aspects of groundfish management into compliance with federal law trumped (see Introduction; NEFMC, 2007a). Though the Councils strive to practice participatory management, NMFS still has ultimate authority.

CATCH SHARE PROGRAMS

Catch share fisheries semi-privatize a common property resource by allocating a specific portion of the total available catch to shareholders for their exclusive benefit, though participants lack ownership of the fish and the ability to decide the total catch limit (NRC, 1999). These shares of public wealth are usually gifted to individuals or to groups of fishermen (e.g., cooperative, sector) at the outset who can prove recent participation. Shareholders can benefit economically by participating in the fishery, actively fishing and/or leasing quota. They can also reap a one-time gain by selling their shares. Those with ready access to sufficient capital can accumulate wealth by leasing in or permanently buying additional quota. In theory, where shares are tradable, they will go to the most efficient producers, and the excess capital and labor in the fishing industry will be redistributed to other parts of the economy (Wingard, 2000).

In the midst of fiery debate about their benefits and costs to fishermen and society, catch share programs have been instituted since 1971 in 16 U.S. federal fisheries (NMFS, 2011a), often through years of public deliberation. The public, deliberative process of the U.S. Regional Fishery Council system has been critical to approaching a balance among diverse stakeholder interests. Lessons emerge from observing the impacts of catch share programs in specific fisheries. In many cases, programs have been designed and adjusted to address concerns specific to the particular fishery as managers learn from unanticipated consequences (Fina, 2011).

Key administrators under President Obama have been particularly supportive of catch shares, and have exerted considerable pressure on the Councils to improve upon and create additional catch share programs to managing fisheries. To support the consistency and effectiveness of catch share programs around the country, NOAA convened a Catch Shares Task Force, which sought stakeholder input on a national catch shares policy, which went into effect November 4, 2010. NOAA explicitly states that catch share programs:

- Are “powerful tools” to manage fisheries sustainably, by harvesting within annual catch limits and eliminating overfishing;
- Create “greater cooperative and stewardship behavior by fishing participants;”
- Maintain or rebuild fisheries; and
- Sustain fishermen and vibrant working waterfronts (NMFS, 2011a; NOAA, 2010).

Assessing the impacts of catch share programs is a developing field of research, and the multi-faceted approach used in this dissertation is particularly novel. Thébaud et al. (2012) found, in reviewing 51 peer-reviewed studies world-wide between 2000-2011, great heterogeneity between studies in the indicators analyzed, making theory generation challenging. Studies tend to focus on a particular aspect (e.g., ecological, economic) rather than integrate across dimensions (as this dissertation strives to accomplish), despite increasing requirements to do so for management purposes. The literature is relatively rich in analysis of some programs, such as the North Pacific halibut/sablefish IFQ program, now almost 20 years old. In contrast, lessons are just emerging from the nascent sector program of the Northeast groundfish fishery. In many cases, programs have been designed and adjusted to address concerns specific to the particular fishery as managers learn from unanticipated consequences. The public, deliberative process of the fishery Council system has been critical to approaching a balance among diverse stakeholder interests (Fina, 2011).

Research suggests that, under catch shares, annual catch limits can be realized and the “race to fish” reduced relative to the prior management approach. In 15 North American fisheries, the discard rate of unwanted bycatch was significantly reduced, and fishing activity (e.g., landings, discard rates, and the ratio of catch to catch quotas) has been more stable over time since catch shares were implemented (Essington, 2010). In a study of 11,135 fisheries world-wide from 1950

to 2003, about 27% were identified as collapsed in 2003, but of the 121 that were managed with catch shares, just 9% were collapsed (Costello, Gaines, & Lynham, 2008). Catch share programs can, in theory, provide a mechanism to manage fisheries sustainably and with improved economic performance (Sanchirico & Hanna, 2004).

Not all studies have concluded positive economic, social, and/or ecological results. The dissenting critics question aspects such as the economic promise of rights-based fisheries and the social consequences of consolidation (e.g., Copes, 1986; McCay, 2004). The transition to a catch share program is often posed as the market solution to excess capacity in a fishery, or "too many boats chasing too few fish." However, the initial allocation is not market based. Wealth that is owned by the citizenry is transferred as a "right" to a limited few (Bromley, 2005). Matters of social equity have also been raised by critics. The economics of catch share programs raise fundamental questions about what is equitable in the distribution and redistribution of wealth gained from a common property resource. The income of fishing laborers (e.g., crew) may be reduced to account for the new costs of redistributed quota (Pinkerton & Edwards, 2009).

Fishing is a cherished way of life for many coastal communities, and with the redistribution of quota shares, small communities are said to suffer consequences from quota migrating to larger ports with more access to capital investments in the fishery. When fishing leaves ports, cascading impacts are felt by families and shoreside support businesses (NRC, 1999).

Factors external to a catch share program may preclude achievement of management goals, while resulting in significant social impact (Wingard, 2000). Several such factors are relevant to the Northeast groundfish catch share program. One is the level of scientific uncertainty that persists with the Northeast groundfish stocks (Palmer, 2014). Thus, efforts to harvest within the quota may be in vain if managers set ACLs higher than realistically sustainable levels. Although catch

shares may promote advance planning, uncertainty about future catch limits make this difficult for fishing businesses. Catch share programs create an economic externality in that they require substantial public resources to administer, costs that are borne by the taxpayer rather than by those benefiting from the program.

RATIONALE FOR HYPOTHESES

This dissertation tests several theories about catch chares. The rationale for each hypothesis under investigation is explained through a discussion of the theory, literature, and evidence from preliminary work. It was reasonable to expect to see evidence of if and how each factor of fishing had been impacted by the catch share program, given that the interviews occurred over two years after the implementation of the program.

FISHING PRACTICES

> *Relative to fishing under the Days-at-Sea system, fishing under the catch share (sector) program has improved efficiency and flexibility for fishermen to decide where, when, and how to fish.*

Catch share programs are theorized by economists to allow more flexibility for choice in individual fishing practices, which leads to more efficiency within the industry (Copes, 1986). By timing fishing when prices are high, rather than be constrained by trip limits or time/area closures, the economic potential of allocations can be maximized. The transition to the fishery-wide catch share program in the Northeast Multispecies fishery was concomitant with the exemption of sector vessels from daily trip limits and some closures. Amendment 16 describes that the motivations to form or join a sector include "freedom from restrictive regulations not needed to meet conservation objectives" (NEFMC, 2009a: 99). Trip limits had varied over the years prior to FY 2010, but in FY 2009, there was a Gulf of Maine cod trip limit of 800 pounds per day. By transitioning to an annual catch limit, it was theorized that fishermen would have more flexibility in how they would fish the available catch, leading to more efficient operations.

Preliminary work in 2010 for this dissertation revealed that the ability to lease quota may add some flexibility by allowing continued fishing once the ACE associated with one's own permits is caught (Feeney, 2010; Appendix A). A majority of NEFS XI and XII members interviewed by J. Wiersma had improved catch per unit effort. For the gillnetters, this stemmed in part, from fishing more gillnets per day than under DAS (J. Wiersma, personal communication, 2011; Appendix A).

SOCIAL CAPITAL

> *Relative to fishing under the Days-at-Sea system, fishing under the catch share (sector) program has improved social capital (i.e., greater networking, reciprocity and trust) among fishermen in the conduct of business, in harvesting sector allocations, and reducing bycatch.*

The concept of "social capital" is becoming increasingly popular within the social and political science arenas. Social capital is a broad term that has many definitions depending on the perspective that is particularly relevant to the case in question. A central premise is that by making and sustaining connections with one another, people are able to achieve things together that they would not be able to do individually, or could only do with difficulty (Field, 2003). The term calls attention to the importance of social ties in increasing productivity. Robert Putnam, a prominent political scientist on the subject defined social capital as:

> *…connections among individuals – social networks and the norms of reciprocity and trustworthiness that arise from them* (Putnam, 2000).

Trust within a community arises when there is mutual expectation of cooperative behavior based on shared norms and values, and when individuals can subordinate their own interests to those of the community. The ability for a group to cooperate depends on the degree of trust that exists. It is much easier to create cooperative agreements within communities where a large amount of social capital exists (Paldam & Tinggaard Svendsen, 1999). Because fishing within a sector requires some degree of cooperation among fishermen to not exceed their joint catch limits,

examination of social capital within the New Hampshire fishing community is particularly important to the research reported here.

It has been observed that the participatory aspect of catch shares can lead to an increase in social capital and cooperation among fishing participants, but the initial catch allocation formula can be a source of contention among participants (Grafton et al., 2006). The Northeast groundfish sector program was designed to devolve some of the administrative responsibilities to sectors, such as ensuring that a sector does not exceed its annual allocation and enforcing rules adopted through its sector operations plan (NEFMC, 2009a: 98-121). The first sector that formed in 2004 was comprised of fishermen on Cape Cod who were already members of the same industry association, building on social capital already established through shared interests and places (McCay, 2004). The region-wide sector program was built off a similar model of voluntary membership, with fishermen aligning largely via pre-existing networks.

Holland and colleagues have explored social capital within the Northeast groundfish fishery through a survey administered just prior to sector implementation, which can serve as a baseline measure (D.S. Holland, Kitts, Pinto da Silva, & Wiersma, 2013; D. S. Holland, Pinto da Silva, & Wiersma, 2010). At that time, a high degree of trust and information sharing was demonstrated within the industry, and it was hypothesized that the longevity of a sector may depend on the degree of social capital within it. Olson and Pinto da Silva (2014) found sector managers to be important in linking members within a sector, in linking between sectors, and with fishery managers. Preliminary research for this dissertation revealed that fishermen may be showing a degree of cooperation and willingness to make sectors be successful to a greater degree than expected, as they have traditionally been independent competitors. The new organizational construct may also be allowing new industry leaders to emerge (Feeney, 2010; Appendix A).

BYCATCH

> *Relative to fishing under the Days-at-Sea system, fishing under the catch share (sector) program has reduced bycatch through incentives and flexibility to harvest more selectively.*

Marine life that is caught accidentally in fishing gear is bycatch. "Bycatch" is an umbrella term, encompassing both regulatory and economic discards. These terms are defined legally by the Magnuson-Stevens Fishery Conservation and Management Act:

> *The term "bycatch" means fish which are harvested in a fishery, but which are not sold or kept for personal use, and includes economic discards and regulatory discards.*
>
> *The term "economic discards" means fish which are the target of a fishery, but which are not retained because they are of an undesirable size, sex, or quality, or for other economic reasons.*
>
> *The term "regulatory discards" means fish harvested in a fishery which fishermen are required by regulation to discard whenever caught, or are required by regulation to retain but not sell ("MSFCMA," 2007).*

All federally-managed fisheries must take steps to minimize bycatch "to the extent practicable," meaning that non-target fish must be avoided. If that is impossible, management measures must minimize bycatch mortality (NMFS, 2009).

Catch shares programs can be designed to reduce regulatory discards relative to a trip limit approach, if all legal sized fish must be landed. In addition, discards of under sized fish or of non-target species can be counted against total quotas. These measures help ensure that catch is sustainable. However, where there is insufficient enforcement and/or monitoring, inaccuracies in the catch data have detrimental effects on stock assessment and future management decisions. To maximize benefits from a quota, harvesters have an incentive to "high-grade" when unobserved (Copes, 1986). Discarding lesser valued fish in search of the best fish can undermine long-term fishery yields. Thus, measures designed to ensure long-term fishery benefits, can create unintended externalities borne by future generations of fishermen and consumers.

Multispecies fishery catch share programs are particularly prone to bycatch problems, because catch rarely conforms to the proportion of stocks in an allocation portfolio (Copes, 1986). The harvest limit can be reached for stock A, while stock B that is caught simultaneously remains unharvested. Without selective devices, continued fishing results in overharvest of stock A. Ideally, the quota available for both A and B would match what is caught. In practice, natural variability in the ecosystem can lead to variation in the mix of concomitant stocks when fishing activity takes place (Leal, 2002).

The Northwest Atlantic has long been a source of bounty for groundfish species, but many of these stocks are now considered overfished and remain at persistently low levels of abundance, despite several decades of restrictions on fishing gear, closed areas, number of fishing days, and other effort controls, including trip limits for depleted species. In practice, there was significant waste, since those stocks were often unavoidable. In 2010, the catch share program took a new approach with Annual Catch Limits for the multispecies fishery. Managers hoped that by introducing output controls, rebuilding targets would be met for more species (NEFMC, 2009a). However, efforts to rebuild stocks may be in vain if a significant amount of bycatch remains, particularly if leasing quota comes at a high cost.

The sector program aimed to increase efficiency for sector vessels and reduce regulatory discards. There is scant peer-reviewed literature on changes to discards, apart from stock assessment reports (see Chapter VII). There is some evidence that bycatch may be reduced for species previously subject to trip limits, but not on non-target species like windowpane flounder (T. Nies, personal communication, 2011).

The preliminary work for this dissertation indicated that discards on observed trips may be reduced, but discarding may occur when vessels do not carry federal observers (Feeney, 2010;

Appendix A). Additionally, informants interviewed by J. Wiersma indicated that avoiding bycatch was challenging, but they were adjusting fishing areas to avoid unwanted fish (J. Wiersma, personal communication, 2011; Appendix A).

ECONOMIC PERFORMANCE

> *Relative to fishing under the Days-at-Sea system, fishing under the catch share (sector) program has improved economic performance (e.g., profit margins, business predictability) for fishing participants, though the fishery would consolidate to fewer permit holders and vessels actively fishing.*

In theory, catch shares improve the economic efficiency of fishing by allowing market forces to balance capacity with resource availability. The flexibility gained by an approach focused less on input controls can lead to maximizing the economic gains from allocations, timing fishing when prices are high (Sanchirico & Hanna, 2004). Where shares are tradable, as in the Northeast Multispecies fishery, fishery participants lease or permanently transfer quota to adjust the size of their fishing businesses to remain solvent. Those wishing to leave the fishery, temporarily or permanently, may lease or sell their quota to others who wish to enter or gain more harvest rights. Excess capital (e.g., vessels) is removed from the industry, and the remaining participants realize higher profits, by reducing operating expenses and increasing revenue through developing and improving product quality for consumers (Leal, 2002).

Consolidation was a stated goal of the groundfish catch share program, as outlined through Amendment 16 (NEFMC, 2009a). By letting the market redistribute the allocation, rather than managers, consolidation has occurred in several catch share fisheries as the "winners" buy a viable quantity of quota from the "losers" (e.g., Eythorsson, 2000; McCay, 2004). An influx of quota coming to the market at the beginning of a program depresses quota prices, setting up a "buyer's market" - the buyers stand to gain significantly more than the sellers. Despite low prices, acquiring quota poses a substantial financial burden as shareholders must enter capital

markets and be strapped with debt obligations. Creditors view investment in fisheries as highly risky, given the unpredictability of Annual Catch Limits, so credit for quota purchases can come with high interest rates. Under debt obligations, quota shareholders are exposed to risk when fishery regulators reduce ACLs to rebuild fish stocks; they lose income and cannot repay their debts. Debt-laden industry members, if organized, may create enough political pressure on managers to prevent near-term reductions in harvest levels that may be necessary for long-term fishery viability, a biological consequence (Bromley, 2005).

Just prior to FY 2010, a telephone survey of groundfish permit holders across the Northeast revealed dissatisfaction with the Days-at-Sea program and declining profits, though there was little optimism for the future under sector management. Of 542 respondents, 300 were active in the fishery at the time, representing over 50% of all active permit holders. When asked about their prospects under catch shares, 78% of respondents felt that their income from groundfish would continue to decline, while just 4% predicted an increase. A majority of respondents (75%) indicated that crew incomes were declining, and it was getting harder to find and retain skilled labor. Given their economic condition, 62% of the respondents felt that they could only remain in business another two years, and 78-81% was either dissatisfied or very dissatisfied with their actual earnings or the predictability of their earnings. Most felt that the current regulatory program had increased business costs, with 74% of respondents forecasting that the imminent management changes would increase costs further (D. S. Holland, et al., 2010).

For many years before the catch share program in the Northeast, the groundfish fishery had been a limited access fishery, and restrictive stock rebuilding measures resulted in progressively decreased effort in the fishery (Kitts, et al., 2011). In addition to expanding the catch share program fishery-wide, Amendment 16 instituted restrictive catch limits. Given the short time

horizon since the sector program started, the impacts of catch shares may not be discernible by just examining econometric data. It may be difficult to discriminate between the impacts of catch shares and the concomitant reductions in harvest levels to meet rebuilding targets. Direct query of fishery participants can help to understand nuance and determine causality.

The preliminary work for this dissertation indicated that fish prices in 2010 were higher than normal, due to lower volume on the market. However, the quota was very expensive to lease and fishermen have been going out of business due to lack of quota. The Yankee Fishermen's Cooperative was experiencing 50% less revenue as of November 2010 relative to the year prior, and may have trouble remaining solvent (Feeney, 2010; Appendix A). Additionally, informants interviewed by J. Wiersma indicated that profits were down for 42% of informants, in part, due to new costs for monitoring and administration. Some fishermen had already adapted by diversifying into other fisheries to remain viable (J. Wiersma, personal communication, 2011; Appendix B).

SAFETY

> *Relative to fishing under the Days-at-Sea system, fishing under the catch share (sector) program has increased operational safety for active vessels.*

NOAA has cited improved safety as a benefit of catch shares (NMFS, 2011a). It has been theorized that by reducing the "race to fish," fishermen have less incentive to fish in dangerous weather and sea conditions and without rest (Woodley, 2002). However, Windle et al. (2008) observed through a literature review that some catch share programs have not decreased accident and fatality rates, and that where operators rely on leasing quota, or are working under contract in vertically-integrated businesses (e.g., processors controlling fishing activity), there may be increased pressure to fish in unsafe conditions. In the Northeast Multispecies fishery, removing some time constraints on effort (e.g., DAS counting, daily trip limits) may be increasing safety.

However, preliminary research for this dissertation revealed that fishing may be occurring further offshore, and the bureaucracy involved in sectors (e.g., increased observer coverage and reporting) has been creating more distractions at sea than before (Feeney, 2010; Appendix A). These are issues that may disprove the hypothesized safety benefits of catch shares in the New Hampshire case.

WELL-BEING

> *Relative to fishing under the Days-at-Sea system, fishing under the catch share (sector) program has improved well-being, decreasing stress and concern about the conduct of business and the future of the fishery.*

In the context of this dissertation, measurements of well-being focus on the personal stress of the informants, their job satisfaction, and the degree of concern about the current and future state of the fishery. Well-being has also been defined more broadly by the NMFS Northeast Fisheries Science Center to include individual, family and community physical, mental, and psychological condition (Clay, Kitts, & Pinto da Silva, 2014). If the sector program improved economic performance and safety, made fishing practices more efficient, increased social capital, and reduced bycatch, a likely product would be an improved sense of well-being for participants. There is a paucity of empirical studies of well-being relative to catch share programs, though impacts on well-being are often implied in the economic literature. Adverse consequences of catch shares can include consolidation of permits and quota, job loss, and displacement of smaller-scale harvesters, all decreasing well-being for those exiting the fishery (McCay, 2004). Studies of the Pacific halibut/sablefish IFQ fishery have shown that despite efforts to retain the historic nature of the fleet, there was a disproportionate transfer of quota out of fishing communities with populations under 1,500. These communities are remote, particularly dependent on fishing, and have little alternate economic opportunities without access to sufficient quota. Fishermen in the smaller communities tend to have less capital to purchase

sufficient quantities of quota to stay economically viable (Carothers, Lew, & Sepez, 2010; Fina, 2011). A survey of shareholders revealed that quota sellers tended to be older, have lower incomes, and be of native Alaskan decent. With the exit of quota, remote communities can suffer the consequences of unemployment and economic loss in shore-side support businesses. In that case, solving one dilemma, too many participants, created another, disproportionate impacts to small or indigenous communities (Carothers, 2013).

Pollnac and colleagues have proposed that fishing satisfies a basic human need, self-actualization, which includes a sense of challenge, adventure and independence, and that these aspects keep commercial fishermen fishing despite times of decreased economic performance (e.g., Pollnac & Poggie, 2008). A 2012 survey of over 400 commercial fishermen throughout the Northeast (New England and Mid-Atlantic) revealed that self-actualization was the only component of job satisfaction unaffected by the increase in regulations imposed on fisheries since the 1970s (Pollnac, Seara, & Colburn, 2014).

The preliminary work for this dissertation, in the fall of 2010 (less than six months after program implementation), revealed feelings of frustration, in part, because fishermen had little choice but to enroll in the sector program. At the time, there was great uncertainty regarding future catch limits, hampering informed business decisions (Feeney, 2010; Appendix A). Additionally, 33% of informants interviewed by J. Wiersma, indicated that sector management has reduced the enjoyment of fishing (J. Wiersma, personal communication; Appendix A). These observations are not surprising, given that the program was implemented with a great deal of uncertainty among fishermen for how the first year would play out. The theorized improvements to well-being may not hold true in the New Hampshire case.

CHAPTER III. METHODS

PROJECT APPROACH

Social research includes a number of theoretical approaches to meaning making. This dissertation examined a broad question through in-depth analysis of a fairly discrete population, a case study of the New Hampshire groundfish fishery. Case studies are particularly well suited for working with a small number of people and usually include detailed descriptive data from several sources including interviews of primary and secondary informants and researcher observations. Drawbacks of case studies include the potential that a case may not reflect a wider phenomena and the potential to introduce researcher bias (McQueen & Knussen, 2002: 12-13), both of which were carefully acknowledged and accounted for, as noted in this chapter.

An early step in this case study was to determine whether theory would be generated through engaging with the research subject and the empirical data to be discovered therein (e.g., a grounded theory approach) or whether testable hypotheses based on previously generated theory would be applied to determine their relevance and limits. Because a number of theories about the performance of catch share programs have already emerged, and are in some cases being used to promote additional catch share programs (Chapter II), it was appropriate to test and potentially modify current theory. However, some methods of the grounded theory approach were used, such as theoretical coding (Corbin & Strauss, 2008), as described later in this chapter.

Quantitative and qualitative research methods were used in conjunction to investigate the hypotheses. There are many legitimate approaches to social science research, and each comes with its particular strengths and limits. Quantitative methods can be carefully controlled and standardized, with random samples from a population that can confidently yield conclusions that

can be generalized. However, reliance on purely statistical descriptions of social phenomena can be misleading, and quantitative relationships between variables do not necessarily imply causality, which is where qualitative analysis can help. Qualitative research has been defined as an "interpretive study" in which "the researcher is central to the sense that is made" (Parker, 1994). Thus, qualitative approaches can require elevated levels of involvement with the subject and extra time. Qualitative methods can capture complexity and nuance and adapt to what is learned during the research process, but do not alone capture the statistical significance of a result. Mixing methods is becoming more common in the social sciences to employ the strengths of various approaches, yielding well-rounded analyses (Greene, 2007: 31-48). However, by mixing methods, some purely qualitative or quantitative analyses cannot be pursued due to time limitations. In the case of this dissertation, qualitative methods were expected to produce insights not obtainable through numerical analysis alone, so a balance was struck between approaches. Journaling was an important aspect to this project, first in a paper journal and later as memos using *QSR NVivo 10* software. A journal was used in the project design phase, to brainstorm and identify the questions, variables, population, sample, interview structure and approaches to data analysis. During project execution, this journal documented how the project methods were carried out and served as the decision record for adjusting the project as issues arose. After each interview, memos were written describing the informants, their responses, and any questions that that might need further investigation. Memos also captured themes emerging from data analysis. Journaling occurred almost every time this dissertation was worked on, up through the data analysis stage. With the transition to writing, the degree of journaling tapered as reflections on the data were recorded and developed in the dissertation itself. The utility of journaling to this project is further described later in the chapter.

DATA COLLECTION

Appropriate permissions were obtained to conduct the research from the University of New Hampshire Institutional Review Board (IRB; Appendix D). Data collection methods conformed to IRB standards and were tailored to address the research questions and hypotheses with the least bias. In selecting the population, sample, query method, and interview questions, and in conducting sampling, sources of potential bias with various approaches were weighed. Bias could exist within the study design or implementation. The research team eliminated what was avoidable and minimized what was not. Some biases were unavoidable such that results need to be qualified.

QUERY METHOD

It was determined that the best method of understanding the dynamics of the New Hampshire groundfish fishery relative to the research question was through direct query of fishery participants. The New Hampshire groundfish fishermen and fish dealers comprised the target population, ensuring that the population contains people that are directly impacted by fishery regulations. It was also determined that this population would be best queried through face-to-face contact rather than group interviews or a survey. In group interviews, response bias can be introduced when respondents defer to the dominant speaker or respond according to what is socially desirable to the group. Surveys can also have response bias if questions are misinterpreted or are inappropriate for the respondent (Weisberg, Krosnick, & Bowen, 1989). Thus, the query method selected to reduce several biases was one-on-one in-person, semi-structured interviews with primary informants asking open-and closed-ended questions.

VARIABLES

This study examined six key aspects of fishing: fishing practices, social capital, bycatch, economic performance, safety, and well-being are here considered the dependent variables.

Factors responsible for the dependent variables changing were the independent variables, such as demographics. There is a trade-off in research, between concentrating on one single factor that is likely to be the key causal variable and including all possible variables in a study, examining the combined effects on the dependent variables. The focused approach risks ignoring important causal factors, but a study can get unwieldy with too many variables. This research seeks to examine a suite of independent variables sufficient to accurately assess the hypotheses.

POPULATION IDENTIFICATION

The next decisions involved bounding the population. How should New Hampshire groundfish fishery participants be defined? An objective of the research is to measure change in the fishery across time, before and after the catch share program began in Fishing Year 2010. Thus, it is important that the population include people who are currently active in the fishery and those who were active before FY 2010. This avoids undercoverage bias. People were included in the population if, during FY 2009, FY 2010, or FY 2011, they held a limited access Northeast Multispecies permit and their homeport, primary landing port, or residence was in New Hampshire.

There were 81 permit holders (i.e., fishermen) who met the criteria for inclusion in the population (Table 9), determined using publically available lists of federal fishery permit holders obtained from the NMFS Greater Atlantic Regional Fisheries Office. Some permit holders are listed by business name, and J. Wiersma and Yankee Co-op staff helped identify an individual associated with those businesses. Internet searches also helped find people associated with business names. To capture shore-side impacts, fish dealers were also identified. Dealers were defined as those holding federal dealer permits that were based in New Hampshire and actively purchased groundfish at some point since FY 2009. There were four fish dealers who met these

criteria, two of whom were also in the permit holder population. Including this overlap (counting these individuals once), the total population was 83.

The population was stratified into five cohorts: members of NEFS XI and XII, members of other sectors, members of the common pool, former fishermen, and fish dealers. To attribute causality of variable change to the sector program versus allocation reduction or other factors, the study needed to include each cohort for comparison (Figure 1). Sector rosters (publically available) were examined to identify population members who had permits enrolled in particular sectors during the time period. Members of NEFS XI and XII were grouped into a cohort (n=27; 32%). They are the two sectors based in New Hampshire and share a board of directors and sector manager. Members of sectors not based in New Hampshire were grouped into the "other sectors" cohort (n=11; 13%). Those permit holders not enrolled with a sector were determined to be in the common pool (n=22; 26%). Former fishermen were defined as individuals who held multispecies permits in FY 2009-2011, but not in FY 2012 (n=21; 25%). A few in the population had permits enrolled in more than one category. For simplicity, a determination was made that if an individual had at least one permit enrolled in NEFS XI and XII, they were placed into that cohort. If an individual had at least one permit in another sector and rest in the common pool, they were placed in the "other sector" cohort. Identifying which cohort the individuals belong in was not easy, and the assignment of people to cohorts changed throughout the data collection process as the research team became more familiar with the population.

DEVELOPING INTERVIEW QUESTIONS

Selecting the number, content, and wording of interview questions involved minimizing voluntary and response biases. Interview length needed to be less than one hour, so that informants would be willing to complete an entire interview. A mixture of close-ended and open-ended questions were developed to garner quantitative and qualitative responses. The closed-

ended questions limit the range of response into dichotomous, multiple category, rating, and Likert (level of agreement) scales. Open-ended questions invite the interviewee to express feelings, values and opinions in an unstructured format (McQueen & Knussen, 2002). Questions were revised several times prior to the interviews to avoid confusing informants and to ensure acquisition of the intended data. Some questions were determined to be too formal. Additional open-ended questions were added to better understand the closed-ended responses. Some of the phrasing was reworded to avoid leading answers. For sensitive subjects, response categories were bracketed (e.g., age) or became open-ended (e.g., bycatch). Questions for dealers were also created. Some ideas for questions came from the dissertation committee.

Interview design and questions were tested on a small subset of the sample (four informants representing different cohorts) prior to conducting the full set of interviews. The question phrasing and order was revised after each, as limitations and mistakes were discovered. For example, the interviews included a series of the same questions about fishing activity in FY 2009, 2010, and 2011. In the first iteration, questions started with FY 2011 and worked back in time, because it was assumed that the least response bias would result from starting with topics that would be easiest to recall, from the most recent past. After the first few interviews, it was clear that informants were having difficulty tracking change back through time, so the questions were subsequently asked in chronological order.

Bias due to social desirability was a concern in designing questions. For example, to meet project objectives, it was important to ask about how business profits changed over the past few years. Rather than specific dollar amounts, the questions asked for trends, such as "Since May 2010, have the profit margins of your fishing business decreased, remained the same, or increased?" Trends are also easier to recall than specific numbers.

FISHING PRACTICES. Informants were queried about conditions that impact fishing efficiency and the level of flexibility. Fishermen were asked how their fishing practices impact Catch per Unit Effort (CPUE), i.e., the landings derived from the time spent at sea. Flexibility was measured as the ability to adjust fishing practices to local conditions and freedom to make individual decisions. Fishermen were asked to identify the area and time of year that they fish, trip length, and if there have been changes in terms of gear or fishing area conflicts or lost gear. Sector members were asked what exemptions from DAS they are using and if they are able to fish the quota they have access to.

SOCIAL CAPITAL. There is no consensus on how to measure social capital of a community, and quantitative assessments are complicated. The networks, reciprocity and trust that exist are intrinsically tied to local circumstances (Field, 2003). Thus, different proxies for social capital have been used as indicators depending on the particular purpose. Here, the focus is on understanding three key aspects of social capital as defined by Putnam (2000):

- *Networks.* Communication channels and topics.
- *Reciprocity.* Willingness to support fellow fishermen and keep quota within the community; willingness to lend and borrow resources.
- *Trust.* Cooperation in 'prisoner's dilemma' scenarios; perceptions of honesty.

Since there is no single independent variable that captures social capital in its entirety, it is important to triangulate among many sources of evidence. Thus, over ten questions on social capital were asked during the interviews (Appendix B). For example, to determine the degree of networking, data were collected on the topics that informants communicate about (e.g., business, management), where the communication location (e.g., on land, at sea), and who is included in their network (i.e., number of fishermen, where from).

BYCATCH. Public access to data and inconsistencies in data recording between the DAS and sector fisheries, both pre- and post May 2010 make quantitative measures difficult. Under DAS, bycatch includes the non-target catch (N_D), sub-legal target catch (S_D), and regulatory discards (R_D) (Table 1).[7] Under sectors, bycatch includes non-target catch (N_S) and sub-legal target catch (S_S).[8] Theoretically, total bycatch could be calculated by adding components ($N_D + S_D + R_D$ or $N_S + S_S$) or each component could be compared to determine, for example, the difference in sub-legal target catch between DAS and sectors (S_D vs. S_S). Bycatch could be compared between sector and non-sector vessels (both pre- and post May 2010) by backing out the regulatory discards of DAS management, determining difference in non-target and sub-legal catch. These calculations are difficult for a number of reasons. For sector trips, landings and discards are reported by the sector manager on a species, strata,[9] and season basis. These data are also recorded on observed trips. Prior to May 2010, the only discard data was from observed trips, and the percent of observed trips was lower at that time.

Due to the aforementioned challenges, the focus for this dissertation was not a quantitative analysis of fishery data. Rather, this dissertation attempts to show whether the incentives and flexibility inherent in sector management are acting to change fishermen's behavior to be more selective of catch. Informants were asked how bycatch has changed between the DAS and catch share program, and if and why reducing bycatch is important. Where possible, comparisons are made with publically available bycatch data.

ECONOMIC PERFORMANCE. Examining economic impacts of this catch share program must encompass many factors. Caution should be used in drawing conclusions based on any single

[7] Under the DAS system, regulatory discards are legal-sized fish caught in excess of the daily trip limit, which must be discarded at sea.
[8] Under the sector system, there are no regulatory discards, because there is no daily trip limit.
[9] Strata are defined by NMFS based on gear type and area fished.

measure. The NEFSC Social Sciences Branch conducts periodic evaluations of fishery economic performance (e.g., Murphy, et al., 2012), thus a full economic analysis was not conducted in this research. Rather, the focus was on characterizing informant views on the economic differences between fishing under the DAS and sector programs, to determine if the sector program increases overall profits and business predictability. A qualitative determination was made of overall profit margins and the strategies fishermen and dealers are employing to mitigate costs. The results for the New Hampshire case can be contextualized using the socioeconomic performance reports.

SAFETY. Perceptions of safety were compared between the DAS and catch share programs to determine if the control rules governing sectors are indeed creating safer operations at sea. Qualitative data identified differences in operational logistics that might impact safety (e.g., attention diverted to use of computers at sea, weather window flexibility).

WELL-BEING. Comparisons of overall well-being were made to determine if catch shares have led to improvements as theorized. Informants were asked closed-ended questions that relate equity, ethics, stress, fatigue, job satisfaction, and future outlook. With each question, informants were asked to elaborate on their rationale.

ADDITIONAL JOB SATISFACTION QUESTIONS. In May 2012, job satisfaction questions were added as developed by R. Pollnac (pers. comm., 2012; Pollnac, et al., 2014). These tested degrees of satisfaction with income, fatigue, stress, safety, time spent away from home, sense of adventure and challenge of the job, and the opportunity to be one's own boss. These questions were asked about one's satisfaction as a groundfish fisherman, as well as in their present occupation, if they were not groundfish fishing at the time of the interview. Since the questions in this set pertain to

several hypotheses, results are detailed in the relevant chapters, rather than just in the well-being chapter.

DATA COLLECTION

Because the total population is small and the potential variation in responses was unknown, a high rate of sampling was desired. Thus, an aggressive goal was proposed of conducting 50 individual interviews, or 60% of the population. Personal connections with the New Hampshire commercial fishing industry were used to build support for the project. R. Feeney discussed the project with several industry members individually, and at a meeting of NEFSC XI and XII in November 2011 with 15 sector members attending, ten months prior to sampling. All agreed by unanimous consent to participate (though not all actually participated). J. Wiersma, as sector manager, had worked daily with fishermen and Board members of NEFS XI and XII since May 2010, and gained the support of the Board for this research. Given the small size of the sectors, the close geographical range of home ports (within the New Hampshire coast), and the level of past and current interactions of the research team members with the fishery, there was a high likelihood of success in reaching this goal.

Sampling, or the process of conducting the interviews, was conducted between September 6 and December 17, 2012. To avoid undercoverage, a random-stratified sampling method was first pursued. An *Access 2007* database was created for the population with contact information, cohort category, and a randomly assigned identification number.

Sampling has many potential sources of bias. Undercoverage and nonresponse bias were minimized by efforts to maximize response rate of all population cohorts. Potential informants were contacted first by letter, and then with follow-up phone calls or emails. During sampling, contact information was corrected with the help of industry informants. Due to confidentiality concerns, no one in the population was asked to contact others, but several volunteered to

encourage others. One respondent agreed to an interview only after talking with another fisherman who had declined being interviewed due to "interview fatigue," but was encouraging others to participate. As a liaison to the industry, Dr. Wiersma helped encourage his sector members to participate.

After a month, it was clear that the random-stratified sampling was not yielding a sufficient response rate for all categories. To meet project objectives, the method was adjusted at that point. The entire population became included in the sample; all were invited to participate. The revised method may have introduced voluntary response bias, but this was deemed more manageable than the potential for nonresponse bias.

Before each informant was interviewed, the consent was obtained of each informant to participate in the study and to use the data. To help them prepare, interviewees were told in advance the general topics to be covered, and the approximate interview time length. The consent forms detailed expectations of participants, interview topics to be covered, that interviews can be terminated at any point, who will have access to the interview record, methods to ensure confidentiality and anonymity, etc. Participation was voluntary and subjects were allowed to withdraw at any time with no repercussions, though none actually chose to withdraw part way through.

Availability is a particular challenge with interviewing fishermen, since they frequently work very long hours for many days in a row. For some, it was difficult to commit to a time. On November 17, 2012, the researcher attended another sector meeting and recruited a few informants. One would only agree to an interview if it could be completed right then. Being flexible to meet informants on short notice was essential to securing some interviews. One Portsmouth fisherman called and said, "I can talk to you if you can get to my boat in half an

hour." Fortunately, it took just five minutes to prepare for the interview, because Portsmouth was a 25-minute drive away.

Being able to offer a financial stipend ($50) for participation helped reduce nonresponse and voluntary response bias, because it increased the response rate. Although just 50% of informants accepted the stipend, it was appreciated as evidence that the researcher valued their time and contributions to the project. One respondent said that he would not have agreed to an interview unless there was a stipend. The specific amount did not matter; it was "the principle of the thing."

Interviews were conducted as consistently as possible to create data reliability and avoid any procedural variations. Interviews took about one hour and were conducted at a location convenient to the informant (e.g., library, coffee shop, home). The interviews began with demographic questions. Then, after describing fishing practices since at least FY 2009, questions progressed through each of the six factors of fishing selected for analysis.

When necessary, the interview procedure was adapted to avoid response bias. Categorical responses to closed-ended questions were added, so informants could answer truthfully. One series of questions was consistently misunderstood, so the researcher had to develop an explanation. Informants felt comfortable to speak freely only as they trusted the researcher's objectivity. In a few cases, the respondent became uncomfortable with the questions, thinking that the research had foreordained conclusions. These interviews had to pause mid-course to discuss the project objectives, reassure the informants, and rephrase questions. These conversations also occurred at the beginning of every interview to allay any concerns. To reassure informants that the interviews were unbiased, there were times that the researcher carefully phrased a question. Asking, "What are the pros and cons of sector management,

starting with the pros?" This assured the respondent that they would later be asked to express negative views. Interviewees were queried for before-after differences, but care must be taken to avoid recall bias.

Careful recording of data was important. Each population member was coded with an identification number. Interviews were audio recorded, and later transcribed by a research assistant. The identification number was recorded on transcripts and audio files, rather than the individual's name. Closed-ended responses were recorded manually as well. Each informant granted permission to make an audio recording. As soon as possible after an interview, the researcher's own reflections were recorded as a memo in NVivo, as well as anything that the informant said off the recording. All data were securely stored.

In total, 22 interviews were conducted. While additional effort to secure interviews could have been expended into 2013, a decision was made to stop the interviews in December to not allow too much time to pass between the first and last interviews in the series. Of this total, one person was interviewed twice, once representing himself as a fisherman and once representing a dealer entity.

Population demographic data that are available publically are limited to home and landing port affiliations, how many of what type of multispecies permits were held in a given year, and how those permits were enrolled in the fishery. These data are in federal permit rosters (NMFS, 2013). The specific sector(s) that an individual had enrolled their permits in is available in the public annual operations plan for each sector (NMFS, 2014). All of this data are available online. More specific demographic data for the informants were obtained via direct query.

DATA ANALYSIS

QUALITATIVE ANALYSIS

Interview transcriptions were imported into a *QSR NVivo 10* project for qualitative coding. Transcripts were checked for spelling errors and accuracy by reading each while listening to the audio recording. Nodes were made for each person (using the identifying numbers) and each interview question. Transcripts were then coded to each question and informant, as well as any population members referred to during an interview. Transcripts from preliminary interviews in 2010 were also coded. Procedures for thematic coding and theory testing were based on Flick (2002: 186) and Auerbach and Silverstein (2003: 54-61):

A. Re-read the transcript, create a memo for the informant, and write a short definition, to be modified during further interpretation. Describe each informant and their perspectives, focusing less on the demographics and closed-ended responses and more on the open-ended responses. Record what is meaningful to each informant.
B. Conduct open coding; focus on responses to the open-ended questions (entire responses were already coded with variable nodes). Classify expressions by their units of meaning to attach concepts to them. Create Theme Nodes for these concepts. *In vivo* codes are preferred over constructed codes. Each code should have a description of its properties.
C. Categorize nodes around phenomena relevant to the research question and create nodes for categories (tree nodes).
D. Revise the informant memo to ensure key themes are expressed.
E. Repeat steps A - D for each informant. Use the codes and categories already developed and create new codes and categories if different/contradictory ideas emerge. Note which codes are repeating ideas. This helps reveal thematic structure.

F. Refine list of codes (i.e., repeating ideas). Identify how many nodes were created, including identifying parent and child nodes. Read carefully back through the list of codes to check for unnecessary repetition/overlap, logical organization, and that each node had text coded to it. Count the final number of nodes.

G. Identify themes. Create a memo for each hypothesis. Identify repeating ideas within the thematic coding that may address each hypothesis.

Through the thematic coding process, 1,112 thematic nodes were created, including 72 parent nodes and 1,040 child nodes.

QUANTITATIVE ANALYSIS

The quantitative data were coded into integer, ordinal, or categorical[10] scales (Appendix B) and entered into an Excel spreadsheet, including known demographics for the population. A row was created for each population member and columns housed the variable data. Data were then imported into a *Stata IC* database. Each variable was given a unique name and definition. Data scales for each variable were also defined.

Quantitative data were summarized and simplified into tables and illustrative graphs. Analysis included frequencies, cross-tabulations and descriptive statistics (mean, median, range, standard deviation), and was broken down by informant type (e.g., NEFS XI and XII member, former fisherman). Because of the low sample size, statistical analyses were used with caution to make inferences and evaluate the hypotheses. Using *NVivo*, memos were created for each hypothesis to store the results of related quantitative analyses, as well as focus on indentifying what data could be used to describe the population and compare that with the informants. Errors in quantitative data entries were discovered and corrected.

10 Integer data includes numeric quantities (e.g., number of permits held). Ordinal data include rank orders (e.g., level of importance). Categorical data are non-numeric (e.g., gear type).

The quantitative results were not weighted. In this case, it was not appropriate to calculate a probability weight and apply it to the data to adjust for survey design and sampling biases. Weighting is most commonly used in surveys where independent evidence (e.g., vote outcomes, other research) can validate how well the adjustment performed (Hamilton, 1992: 395-397), but such validation is not possible here. In addition, the true population percentages of key demographic variables were unknown, since the dataset had some missing values (e.g., gender).

Qualitative and quantitative marriage

Memos were created for each hypothesis that merged the separate quantitative and qualitative memos. In cases where the qualitative and quantitative analyses did not match well, the analyses were reviewed for accuracy and refined. A benefit of the mixed methods approach is the ability to cross check for quality. The statistics, however, were fairly simple due to the low sample size. The research focused on understanding the rationale for each response, provided through qualitative analysis.

"Baseline" determination

Perhaps the largest challenge in undertaking the research is determining an accurate baseline for the New Hampshire multispecies fishery from which to compare changes that have occurred since the implementation of sector management. Social data on Northeast fisheries have been collected by the NEFSC and external scientists (e.g., D.S. Holland, et al., 2013; J. Olson & Clay, 2001), and some analyses are contained in fishery management plans. However, there is no prior study of the New Hampshire region as proposed here for direct comparison. We can compare actual to projected impacts to New Hampshire vessels as were outlined in the Environmental Impact Statement of Amendment 16 to the Northeast Fishery Management Plan. Data include Annual Catch Entitlement allocations and value, costs for monitoring programs, total and per-trip average revenue, impact by boat length and gear type, and average fixed costs by boat length and

gear type (NEFMC, 2009a). Bycatch data are compiled in the U.S. National Bycatch Report (NMFS, 2011b) and by the ACCSP. Some information may be gleaned from a UNH survey of fishermen about use of DAS and the Western Gulf of Maine Closure Area (J. Cournane, personal communication via R. Robertson, 2011). Some aspects of the current research are novel and may constitute the baseline for future work.

CHANGES MID-COURSE

Due to insurmountable sources of bias that became evident mid-course, two substantial project changes are noteworthy. First, the research proposal included a network analysis of the New Hampshire fishing community that entailed recording how frequently each respondent communicates with each individual in the population and about what topics. This component was added to the project during the fall of 2011, before the dissertation proposal was finalized (January 2012). By May 2012, it was decided to drop this component. The interviews were already lengthy, and informants would unlikely take additional time to fill out an 82-row, 8-10 column spreadsheet. The informants would likely question why the researcher needs to know who specifically they talk with, how frequently, and about what subjects. Thus, significant efforts would be expended to overcome biases due to social desirability and voluntary response. It was determined that the costs outweighed the benefits of this project component.

Second, to place the results from New Hampshire within the broader fishery context, it was originally proposed to interview small groups of members of other groundfish sectors in the summer of 2013. Several catch share impact assessment projects are now underway in the Northeast, and there was concern about research fatigue among potential informants. Through conducting the interviews, it was difficult to schedule meeting individuals locally, so accessibility would be an issue for group meetings several hours away. Given the controversy over catch shares, one-on-one interviews are most appropriate. There is great potential for

research subjects to defer to the dominant group member or provide socially desirable answers. An unexpected turn of events occurred in March 2012, six months prior to the start of sampling. R. Feeney began working for the New England Fishery Management Council, and was assigned in March 2013 to coordinate the next amendment to the Multispecies Fishery Management Plan, considering quite controversial measures. While this assignment requires neutrality, the researcher became significantly more visible to stakeholders region-wide, and it would be difficult for the potential research subjects to differentiate the purpose of the interviews with other work. For these reasons, the regional group interviews were not conducted.

OTHER STEPS TO MINIMIZE BIAS

PREVENTATIVE MEASURES

Catch share management is very controversial among the stakeholders of Northeast fisheries. Despite a personal commitment to avoid researcher bias, additional steps can reassure the research population and the wider public that this project is objective (Table 6). Some organizations that promote catch share management also funded research on its impacts. The researcher sought and received funding for this project from a politically neutral organization for two reasons. First, it ensures that the funding organization would not attempt to bias the study or the communication of its outcome. Second, it would help the public feel confident that the research is unbiased. Individuals in the study population are particularly sensitive about the motives of funding organizations, so seeking opinion-neutral funding helped reduce nonresponse, voluntary and response bias. The researcher spoke directly to potential informants about the funding source to assuage fears.

The researcher considered how to best conduct oneself as an interviewer to garner respondent trust. The invitation letter and consent form required by the University of New Hampshire Institutional Review Board (UNH IRB) helped build credibility across the population, but its

formal tone may have increased nonresponse bias. Each interview began with an explanation of the background and goals of the project as well as of the researcher, explaining that the aim is to measure what has happened to the New Hampshire fishery, not to promote a certain future course of action. Most informants spoke freely, but there were a few that became concerned that a certain answer was being needled out. The researcher was able to reassure them and find alternate language for the questions. Knowing some members of the population for nine years prior to the start of the project helped to build credibility within the community and willingness to participate.

By working for the Council, the researcher has become a central, though neutral figure in the fisheries management arena. A few in the population were aware of this employment change, but the exact number was unknown. There was some potential for informants to react by declining an interview or being untruthful. The researcher decided to not tell the informants about the employment unless asked directly.

Actual bias

Despite attempts to eliminate it, bias exists within this research and has been mitigated as much as possible. The sample is not representative of the population as stratified. The total response rate is 28%, but the response rate for each category within the population varies between 9.5% and 75% (Table 9). The two categories that fall below average are the common pool members (23%) and the former fishermen (9.5%).

Attempts to increase the response rate were not entirely successful. Accessibility was an issue. It was particularly difficult to obtain correct contact information for former fishermen. A correct phone number was not available for one common pool member and one former fisherman. A correct postal address was not available for another former fisherman. One former fisherman now lives in Virginia; another lives in Florida. Thus, it is unfeasible to conduct in-person

interviews with them. Interviews were specifically declined by four individuals (one common pool, one other sector member, one NEFS XI and XII sector member, and one former fisherman). Some potential informants were willing to be interviewed, but after repeated attempts to contact them, an interview could not be set up. The former fishermen were a particularly problematic group to obtain contact info for and to sample. While some have retained permits and are active in other fisheries, others have left fishing entirely. Some may feel bitter and may not want to participate in anything to do with groundfish. One indicated schedule conflicts with his new job.

It is difficult to know how responses of the self-selected informants would differ from the nonrespondents. The sector manager and the staff of the Yankee Fishermen's Co-op know most of the people in the population, and shared what they know about some of these people. The sector manager conducted an informal survey of the NEFS XI and XII sector members in 2010, and results can be compared. A UNH student has a blog with interviews of a few fishermen. A person who declined an interview agreed that data from an earlier interview (in 2010) could be used, which had some duplicative questions. Using these other data sources may be helpful in minimizing nonresponse bias, but due to the need to ensure the consent of human subjects in research, this information was only minimally used.

The interviews were conducted in a conversational format, such that the exact wording differed between interviews. There may be cases where the questions were misinterpreted, though the researcher tried to be alert to this. There may be some potential for social desirability bias with the questions about bycatch and gear conflicts. Several informants had no problem with providing socially undesirable answers, sharing that they discarded thousands of large cod daily while fishing under the Days-at-Sea trip limits, caused fishing gear conflicts, fished illegally, or

knew of illegal drug activity. The researcher never felt that the informants were being purposefully dishonest, but it is difficult to confirm this by relying on the data alone. Through comparing responses between informants, no inconsistencies were discovered.

Hypotheses were being tested through quantitative and qualitative analyses of informant interviews. In designing and performing this project, there is a multitude of potential biases that need to be considered and corrected to the extent possible. During data analysis, tactics for testing and confirming findings help identify actual bias in the data. Where removing bias is impossible, results are communicated with appropriate qualifiers. It is important to specifically report how bias has been addressed in the project to accurately convey the limits of the results.

CHAPTER IV. OUTCOMES – FISHERY DEMOGRAPHICS

This chapter identifies key demographics necessary to understand the research population and informants, and provides context for the subsequent chapters that outline the outcomes relative to each hypothesis investigated. It should not be assumed, however, that a measured demographic change was necessarily caused by the advent of catch shares. Causality is explored in depth in subsequent chapters.

POPULATION AND INFORMANTS IN COMPARISON

PORT COMMUNITIES

There were 83 individuals in the research population, including 81 commercial permit holders and four groundfish dealers, who met the definition criteria (two dealers were also permit holders, see p.54). Individuals hailed from 18 different communities within five states (Table 13). Homeports (n=17) and landing ports (n=14) ranged geographically from Jonesport, Maine to Bath, North Carolina. Portsmouth was the most common homeport (27%) and landing port (31%), followed closely by Rye, Hampton, and Seabrook, all in New Hampshire.

The informants identified a smaller number and range of homeports and landingports, just six homeports in New Hampshire and Massachusetts and six landing ports in those states as well as in Kittery, Maine. That New Hampshire ports were primary homeports and landing ports to 90% and 81% of the informants, respectively, indicates the degree to which the local ports were important to the informants. However, this is partially a research artifact. Though the entire population was invited to participate in an interview, willing research participants were local to New Hampshire, with the exception of one informant based in New Bedford, MA.

The vast majority of the population (91%) was male, with just 2.5% female (Table 14). There were five cases where just a business name was listed in the permit tables, and the research team could not identify an individual with the business name (sex unknown for 6.2%). All of the informants were male.

PERMIT HOLDINGS

As of FY 2012, the majority (54%) of individuals in the population held one groundfish permit, but the most an individual held was five (Table 15). The average number of permits held was 1.2±0.1 permits. The informants held slightly more permits on average 1.9±0.1 within the same range (0-5). Removing those individuals who did not hold a permit in FY 2012 ($N_{population}$ = 20; $N_{informants}$ = 2), most individuals held Category A permits (population = 77%; informants = 74%), followed by Handgear A (HA) permits (population = 15%; informants = 16%).

Through the time series, the number of permit holders in the population declined. Figure 2 and Figure 3 identify how the population and informant stratification by cohort (i.e., members of NEFS XI and XII, members of other sectors, members of the common pool, former fishermen, and fish dealers) varied longitudinally. In FY 2009, 96% (n=78) of the population and 100% of the informants held a permit. However, the number of permit holders declined over time; by FY 2012, 75% (n=61) of the population and 91.5% of the informants held a permit. For the population in FY 2010, 46% opted to enroll in NEFS XI or XII, 12% enrolled in other sectors, 37% enrolled in the common pool, and 5% held a permit. By FY 2012, there were 37% in NEFS XI or XII, 14% in other sectors, and 25% in the common pool. For the informants in FY 2010, 57% opted to enroll in NEFS XI or XII, 14% enrolled in other sectors, 29% enrolled in the common pool, and 0% did not hold a permit (Figure 3, Table 16). By FY 2012, there were 52% in NEFS XI or XII, 14% in other sectors, and 24% in the common pool.

There are two possible explanations for the 22% decline in permit holders within the population between FY 2009 and FY 2012. Individuals could have moved, such that they no longer meet the population definition criteria. Alternatively, and more likely, they could have sold or not renewed their permit. Resolving this question definitively for the population was beyond the scope of this dissertation. However, as described later in this chapter and in the chapter on economic performance (Chapter VII), the number of active fishermen has declined region-wide and in New Hampshire. Thus, it is likely that the 22% decline in permit holders within the research population is primarily due to permits being sold or not renewed. For the informants, none had moved out of state during the time period, but two had become former groundfish fisherman during the time period; a sector member sold his last groundfish permit during FY 2010 due to low catch limits, and one common pool member sold his during FY 2011 due to not having enough quota associated with his permits (see Chapter VIII for more discussion on attributing causality for fishery declines).

SECTORS ENROLLED IN

In FY 2010, the 58% of the population that had permits enrolled in a sector elected to enroll in NEFS XI, NEFS XII, the Sustainable Harvest Sector, NEFS II, and NEFS III, with 43% enrolling in NEFS XI or XII (Table 16). Two individuals opted to enroll their permits in multiple sectors. For the informants, there were a higher number of individuals with permits enrolled in a sector (71% vs. 58%), with 57% enrolling in NEFS XI or XII. Through FY 2012, the distribution across the various sectors is fairly consistent, with the largest changes being that the number of people not enrolling permits in a sector increased and the number enrolled in NEFS XI or XII decreased. The distribution is even more consistent longitudinally for the informants. Environmental Assessment (EA) for NEFS XI and XII and other reports reveal a slightly different picture than the above data, derived from NMFS permit databases and sector operations

plans. In February 2010, the EAs stated that 36 permit owners would be enrolled in the sectors, who hold 56 multispecies permits and planned to fish using 42 vessels (NEFS-XI, 2010a; NEFS-XII, 2010). The sector manager reported that by the time the fishing year started in May 2010, the sector membership dropped to 24 active permit holders, holding 41 permits and using 24 active vessels. In addition, eight permit holders were members of the sectors for lease-only purposes, to lease all their allocations to other fishermen (J. Wiersma, personal communication, 2011). The fishery performance report indicated that there were just six New Hampshire vessels that entered the common pool that year (Kitts, et al., 2011). Thus, five vessels dropped out of the fishery in FY 2010 (38 total vs. 43 in FY 2009). For FY 2011, two more vessels dropped out, but there were 56 multispecies permits enrolled in NEFS XI or XII, owned by 36 individual permit owners. Despite variation in the specific numbers, there seemed to be a decline in participation in the fishery across the time series.

OTHER INFORMANT DEMOGRAPHICS

Informants were asked several demographic questions during the interviews. The age of most informants fell into either the 40-49 (38%) or 50-59 (33%) brackets (Table 17). On average, the year that informants first obtained a groundfish permit ranged from 1984 to 2008, averaging 1993 (Figure 4). The age of informants does not trend well with the year that they first obtained a groundfish permit, though the one informant in the 30-39 age range was the second most recent to obtain a permit, in 2004 (Figure 5). Half of the informants obtained their first permit before the 1994 moratorium on groundfish permits (Table 1). Thus, it is likely that half of the informants were "gifted" a permit from NMFS and the other half purchased all of their permits from other permit holders. Just one informant (4.8%) did not work as a commercial fisherman (as a crew member) prior to holding a groundfish permit (Table 18). Informants have had the same homeport and landingport on average since 1987 and 1991, respectively, though the range

for both was 1964-2010. The mean number of vessels owned by informants was 1.1±0.06, and 33% noted that they recently bought or sold a vessel. The vessels that informants fished groundfish with were on average 41±8 ft in length (range = 24-61 ft) and had 315±55 hp engines (range = 220-402 hp).

REGIONAL CONTEXT

The New Hampshire fishing industry is small relative to its neighboring states, and it, along with the entire fishery, had declines in landings and the number of active fishermen since FY 2010 with the advent of the catch share program and ACLs. New Hampshire is home to ~5% of the permit holders in the fishery (~1,400 total). Fishery-wide, the number of active groundfish vessels has declined. In FY 2009, there were 570 vessels fishery-wide with a valid limited access multispecies permit and revenue from at least one trip, and 40 (~7%) based in New Hampshire (Table 11) (Murphy, et al., 2012). In FY 2013, the number of active vessels lowered to 400, with 25 based in New Hampshire (Murphy, Kitts, Demarest, & Walden, 2015). Revenue from New Hampshire vessels constitutes 5-6% of the fishery and revenues have declined since FY 2009 (Table 12). Vessels in the fishery range up to 90', so the New Hampshire-based vessels were generally smaller than average (61' maximum). The declines in active vessels were largest for vessels under 50', such as common in the New Hampshire fishery. The largest ports in the fishery are Gloucester, New Bedford and Boston, Massachusetts and Portland, Maine, though vessels hail from as far south as New Jersey.

As dramatic as these declines are, fishery effort has been contracting since the mid-1990s, when there were over 1,000 active vessels in the fishery. Thunberg and Correia (2015) found that concomitant with this decline, fleet diversity (number of ports, vessel sizes, gear types) has also declined. However, since 2008, the fishery has not redistributed to favor a particular niche, with

two exceptions: there has been a disproportionate drop in Maine-based fishermen, and a slight increase in the proportion of larger vessels that have remained active.

KEY OUTCOMES

1. Ports in New Hampshire were highly important to the informants.
2. The 22% decline in the number of permit holders within the research population over three years is more likely due to people selling or not renewing permits, rather than moving out of state.
3. Across the time series, there were very few shifts in whether informants enrolled permits in sectors or the common pool, and few shifts in sector membership.
4. New Hampshire constitutes about 5% of the total fishery, both of which have had declines in revenue and participation before and since the advent of catch shares.

CHAPTER V. OUTCOMES - FISHING PRACTICES

RESULTS AND DISCUSSION

EFFICIENCY

Data collection focused on understanding how the informants perceived the efficiency of their fishing operations. The degree of efficiency is generally defined as the amount of marketable fish caught for the amount of effort spent in harvesting the fish. This dissertation does not consider quantitative data for either component of this measure of efficiency (e.g., NMFS trip declaration data and landings), so formal estimates of Catch per Unit Effort (CPUE) were not made.

When asked which program, Days-At-Sea or sectors, allows greater efficiency of fishing operations, the informants, on the whole, did not have strong agreement. Some informants (n=6; 29%) felt that fishing under DAS was more efficient, while others (n=8; 38%) felt that efficiency had improved under sectors (Table 21). A few informants (n=3, 15%) answered that the two programs were about equal in efficiency, while others (n=4, 19%) were either unsure or did not provide a clear answer to the question. Examining the question by informant type, informants who were currently sector members leaned towards saying that sectors have been more efficient (n=7; 50%), rather than DAS (n=4; 29%). Three sector members (21%) thought the two programs have been about equal in efficiency or were unsure. Among the informants who were members of the common pool or former fishermen, there was no strong trend in the answers.

The informants who indicated that DAS used to be more efficient for their fishing practices spoke of having focused effort on catching cod and that it had been fairly easy to catch the daily trip limit:

> *…we were going and getting our 800 pounds [of cod] out of like five or six [gill]nets. So, we were done at like eight or nine o'clock in the morning, and then we'd go lobstering the rest of the day.*

These informants did not feel constrained by trip limits. One informant indicated that he has been working harder under sectors for less money. For him, economic aspects of efficiency were important considerations.

The informants who indicated that the sector program led to more efficient fishing practices indicated that the removal of the daily trip limit was a key factor in increasing efficiency. These informants said that they could catch their annual allocation of groundfish ACE within a shorter period of time than the DAS that they had, in a matter of days to a few months depending on their amount of ACE, environmental conditions, and the timing of other fisheries that they participate in:

> *Because there's no daily limit, so you go, I mean, if the cod fish were there, the prices were decent, you could just go ... scoop up your quota, make your year's pay and be done.*

They spoke of finding a concentration of fish and then fishing on that concentration as long as possible. Being able to target fish concentrations was seen as an efficiency benefit of the sector program. Informants also indicated that they have had fewer discards under sectors, so they were wasting less time at sea handling catch that would not be sold (See Chapter VII).

The informants who felt that the DAS program was more efficient tended to own smaller vessels (mean 37±10, n=6, range 24-50') than those who felt that sectors were more efficient (mean 45±, n=8, range 39-61'), though the means were within the error. Of the nine informants with 75-100% of their income derived from groundfish in FY 2011, 44% indicated that sectors were more efficient and 33% said that DAS were. Thus, there was not a strong majority by reliance on groundfish, though perhaps the larger vessels were more able to take advantage of the lack of trip limits under sectors.

Since FY 2010, sectors have received exemptions from the rolling closures, including an exemption from the June closure of the inshore Gulf of Maine off the New Hampshire coast. Several sector members cited the ability to fish in June as a key benefit of enrolling in sectors. In that area, fish tend to concentrate in the spring (e.g., Howell, et al., 2008), so fishermen want to take advantage of fishing on that concentration of fish.

FLEXIBILITY

When asked which program provides greater flexibility for fishermen to decide where, when, and how to fish, a majority of the informants (n=11; 52%) felt that sectors do (Table 23). Some informants (n=4; 19%) felt that DAS were more flexible, while others (n=6; 29%) felt that the programs were about equal in flexibility, or the informant was unsure or did not provide a clear response. Among sector members, a majority thought sectors were more flexible (n=10; 71%), while a few (n=3; 21%) indicated that DAS were more flexible or that the informant was unsure (n=1; 7%). There was no strong trend in the answers among non-sector member informants. Removal of the daily trip limit contributes to a sense of increased flexibility under sectors, without which there was less pressure to maximize daily catch. Under DAS, fishermen felt that if they did not catch the cod limit, their trip was a waste of effort. Under sectors, there is an annual goal rather than a daily one. Removing the incentive to achieve a daily goal opens options for how to fish. A few informants indicated that fishing in a sector allows for a bit more planning, which could improve efficiency at sea and the flexibility of one's overall business strategy. Since the sector allocation is known at the beginning of the year, the members could try to time their fishing with market fluctuations. One informant indicated that fishing in the sector program had allowed him more time to have other income sources besides groundfish. He could catch his allocation and then move on to other fisheries. Another reason that informants felt sectors have

more efficiency and flexibility is the ability to trade one's allocation. This allows better matching of fishing effort with fish availability (in the ocean and through the lease market).

The researchers predicted that sector members who fish with gillnets would be taking advantage of the exemption that allows use of 150 gillnets per permit rather than 50 nets. This exemption was first allowed in FY 2011 (NEFS-XI, 2010b). This allowance was designed to promote flexibility and efficiency. The sector member informants were asked which exemptions were important to them, and just two of five who listed important exemptions included removal of the gillnet limit as important.

Another exemption that NEFS XI had received since FY 2010 is that gillnets can be shared among sector participants who join a Community Fixed Gear Group, allowing multiple vessels to coordinate to share a set of nets that remain out in the ocean. This measure was intended to increase the efficiency and flexibility of the gillnet fleet by reducing the number of individual trips necessary to set and check gear, thereby reducing the number of nets in the water as well as the costs to repair and replace gear (NEFS-XI, 2010a: 22). However, the informants did not take advantage of this opportunity. Two informants indicated that there was no need to share, because they could keep all the fish that they catch, up to their annual limits (See Chapter VIII for more discussion).

The informants who indicated that DAS had been more flexible (n=4; 19%) tended to be those who did not feel constrained by the trip limits. In addition, they cited the increased observer coverage under sectors:

> *Well, one thing that drives me crazy is, you know, the 48-hour notice we have to give to go out under the sectors and that's more for the observer coverage. You know, that drives me crazy because, you know, as a day boat we're completely dependent on the weather and, you know, to try to predict 48 hours in advance, although it doesn't sound like a long time, it's an eternity sometimes. So that, you know, flexibility with that is very constrictive for me.*

The observer program increased the pre-trip notification time, requiring commitments to make a trip further in advance.

A DIFFICULT COMPARISON

A few informants (n=2; 10%) said that it was difficult to compare the two management programs, because fishing efficiency and deciding where, when, and how to fish depend primarily on the presence of fish on the fishing grounds (i.e., fish availability), rather than the regulatory program one is harvesting under. These fishermen spoke of striving to adjust their fishing practices to be as efficient as possible no matter which program is in place. As one informant put it:

> *That's tough. I had really geared my whole business towards those days at sea, but it's pretty efficient now, I have to say. I really try to plan it. I mean, with the quota that I have, it's pretty efficient, I mean, if you can go get big sets of cod, I mean, you can make a lot of money in a short time. So, you have time now to do other fisheries...Pretty efficient both ways.*

ASPECTS OF FISHING

The informants were asked several questions about their fishing practices in FY 2009, FY 2010, and FY 2011, to characterize their fishing practices and determine any temporal changes. Results are described here.

LABOR. Informants were asked how many individuals, in a given year, worked on their vessel(s) at a given time. In FY 2009, an average of 2.4±1.2 people worked on their vessels at a given time, ranging from 1 to 6 (Table 24). Most informants operated one vessel at a time, but one informant had two vessels in operation throughout the time series. That number varied depending, in part, on what they were fishing for at the time. Of the 19 informants who had some groundfish income in FY 2009, 16 employed at least one crew member while groundfish fishing (2.4±1.3 on board on average). Two informants said that they would fish alone for groundfish, and another would fish alone for groundfish about half of the time. Through FY 2011, the

average of all the informants did not vary outside the error, though the range dropped to a maximum of four or five. Of the 17 informants that had some groundfish income in FY 2011, they had an average of 2.3±1.0 people on board. Thus, the number of crew members employed while groundfish fishing did not vary substantially during the time series.

Informants were also asked how many crew members they employed over a given year. Informants employed an average of 2.3±1.7 crew members (not including themselves) throughout FY 2009, ranging from 1 to 6. The average did not vary outside the error through FY 2011, though the range increased to a maximum of 10.

GEAR. Informants used either trawls, gillnets, hand gear, or a combination of these gear types (Table 25). There was some variation since FY 2009, but an approximately equal share of informants used trawls or gillnets (19-33%) and a smaller number used hand gear (10-19%). In FY 2011, the hand gear fishermen fished in the common pool, as did one gillnet vessel. All of the trawl vessels fished in a sector. Between FY 2009 and FY 2011, a majority of informants (52-67%) made no changes to their groundfish gear. Those who made changes to gear cited several reasons. Trawl nets were swapped out depending on the specific fish that was being targeted. Some reduced the number of gillnets, while others increased them. One tried to use a larger gillnet mesh in FY 2010 to target larger fish, but then switched back, because the net was inefficient. Two informants indicated that they no longer share gillnets at sea. One informant said that he changed nets based on whether he was carrying an observer or not (who would be measuring his discards). A majority of informants indicated that that the rate of gear loss did not particularly change through the time period, though the percentage increased who indicated that their gear loss increased from FY 2009 (5%) to FY 2011 (19%). These fishermen mentioned that

they observed larger vessels in their fishing area that were disturbing the seabed or interacting with fixed gear.

> *We're starting to lose more twine now because these boats are moving around big rocks and stuff. They're changing the bottom. I mean, there're places now I'm having a tough time towing that I didn't used to have a tough time towing. The bottom's getting changed and, you know, again, it's not the local boats that are doing it, because they haven't got that kind of power.*

TRIP. Informants indicated that they most often fish in the inshore area of the Gulf of Maine on single-day trips, which is to be expected considering the size of their vessels (≤ 61'). The average trip length cited by informants was 12-15 hours, which did not change through the time series, outside the standard error (Table 26). However, the range in trip length narrowed, from 5-42 hours in FY 2009 to 8-16 hours in FY 2011. There were fewer of the longer trips through time. Prior to FY 2010, nine informants indicated that they fished within 20 miles of the New Hampshire and northern Massachusetts coast, while 5 indicated that they fished deeper water further offshore for part of the year (e.g., Platts Bank), typically catching monkfish while catching groundfish in transit. Of the informants participating in sectors, nine said that they were fishing in similar areas, while four said that they moved to better match their allocation with what they catch. One informant's rationale follows:

> *(Informant) … changed the fishing area. I went from eight or nine months in Gloucester to, only 33 days. Half the days were out of Portsmouth and half the days out of Gloucester.*
>
> *(Interviewer) Now, why did you make that decision?*
>
> *(Informant) Because of my allocation. I only had so much fish to catch – and one of the benefits, the only benefit [laugh] to going to sectors is that you can keep more fish [no trip limit]. So I just fished when the prices were high and timed it right. And I mean, the fish were there to catch, so I just used my allocation, you know, to maximize my profits.*

EFFORT. The informant above found that the lack of trip limits had allowed for more efficient use of time at sea. Informants were asked think qualitatively about their fishing effort and how it may have changed since fishing under sectors. In cases where effort decreased, fishermen

referred to fishing a fewer number of days or taking shorter trips. Where effort increased, a few indicated that they increased trip length or the number of days. Three informants said that they had to increase their trip length, because there had been fewer fish around.

AREA CONFLICTS. The majority of informants said that relative to year prior, fishing area conflicts were either unchanged or had increased through time. Just 5% of informants (n=1) said that area conflicts were decreasing each year (Table 26), but when asked to think about overall changes to the groundfish fishery, 14% said that there were fewer conflicts under sectors because there were fewer vessels fishing. Of the larger portion of informants who had seen increased gear conflicts, 38% spoke of there being new, larger vessels fishing in their traditional fishing area. There was a good deal of concern about the impact these vessels were having on the resource.

> *I don't see anything really good going on with the sector fishing right now. I have some friends that, actually, day-fish out of Gloucester still, and there's no fish coming in anymore in Gloucester. I'm sure you heard the story, a month ago a bunch of the big offshore boats that were in the sector program came right inside and, just pounded, and that was all the fish the guys were going to try to catch up over the course of the winter.*

Described further in Chapter VI, the local vessels were communicating less with each other over the radio, in part to detract interest in their fishing areas:

> *We'll talk to each other about... where the fish are. We used to do it on the radio. We're back to not doing it on the radio anymore, because we know that these big boats are listening, because the minute you say something, one of them [a large vessel] appears, and if one of them finds something, they're like a pack of wolves. Once one of them finds something, then a bunch of them appear, and they don't go away till there's absolutely nothing. I mean they exterminate every last fish.*

Another cause for area conflict was between gillnet and trawl vessels, or with other stationary gear. Several informants cited the overall decline in groundfish effort, particularly by trawl vessels, had opened areas for lobster gear and gillnets to expand into:

> *They had the ability, and they knew the ability that we had. They kept pressing their luck and keep, they kept settin' their gear wherever they wanted. And that's what it's come to now, is that there's just lobster gear as far as you can see.*

This informant was describing how lobstermen were setting gear in voids left by the declining groundfish fishery.

REGIONAL CONTEXT

Comparisons with regional data must be made with caution due to differences in the data used. However, comparisons of general trends can be made. The annual groundfish fishery performance reports produced by the NOAA Northeast Fisheries Science Center (NEFSC) are very informative for fishery wide trends and are referred to here.

The New Hampshire informants did not, on average, have a change in the number of people employed while groundfish fishing or the number employed over a given year, outside the error of the data. Fishery-wide, crew employment data suggest that the number of crew positions and crew trips (number of crew members on a trip) had declined between FY 2009 and FY 2013, by 16% and 30%, respectively (Murphy, et al., 2015; Murphy et al., 2014). With a greater decline in crew trips than positions, if could be that opportunities for income have declined for those who remained in the fishery.

The NEFSC tracks fishing effort each year in terms of three indicators: the number of "active" vessels making groundfish trips (defined as landing at least one pound of groundfish in a year, the number of trips, and the number of days that vessels are at sea (i.e., "absent from port"). Chapter IV details how, fishery-wide, the number of active groundfish vessels had declined since FY 2009. The total number of groundfish trips, had also declined, by 61% between FY 2009 and FY 2013. The total number of days spent fishing (i.e., days absent) on a groundfish trip had declined by 31%. However, average trip length increased from 1.35 days per trip in FY 2010 to 1.68 in FY 2013(25% increase; Murphy, et al., 2015; Murphy, et al., 2014). So, in general, fishermen were taking fewer, but slightly longer trips. Several of the informants, said that they were making fewer trips as well, but the trips were getting shorter in length, not longer. If effort

is considered in terms of revenue, total groundfish revenue divided by the number of days absent on groundfish trips decreased from $3,353 per day in FY 2009 to $3,245 in FY 2013, just a 3% reduction. Perhaps those who remained in the fishery are, in general, the more efficient vessels. In the Norwegian cod fishery, regulations changed in the 1990s under the assumption that fishing effort had been proportional to technological capacity (e.g., vessel length), whereas Maurstad (2000) found that effort had been influenced more by socioeconomic factors (e.g., debt, lifestyle choice). When fishing rights were set in the 1990s based on technical capacity (e.g., vessel size), effort increased as an unintended consequence, as the participants with below average effort were then incentivized to maximize their catch. In the Northeast U.S. groundfish fishery, the opposite effect may be happening. Under DAS trip limits, smaller vessels were incentivize to maximize catch, and larger vessels were constrained. Under catch shares, it appears that effort is decreasing with the removal of trip limits and low annual catch limits.

Pollnac et al. (2011) asked 138 Rhode Island-based fishermen in 2010 to describe the advantages and disadvantages of fishing in a sector, and the most frequent responses were "not familiar" or "no opinion." The study suggested that the new program was not well understood at the time. However, it should be noted that just 17 (12%) of the informants indicated that groundfish was their primary fishery. This dissertation focused entirely on groundfish fishermen and two years into the program, all informants expressed options about the advantages or disadvantages of the sector program. Most commonly cited advantages were: more choice in how to fish, less pressure to fish hard or maximize daily catch, and less wasted fish. Key disadvantages were: biological impacts to local schools of fish, the costs and obligations associated with working with a sector manager, and that consolidation is eliminating the local fishery.

SUMMARY

The informants expressed a variety of opinions about which program, DAS or sectors were more efficient and flexible for their fishing operations, and there was not strong agreement in the data. Those who felt that sectors were more efficient generally felt that the removal of trip limits and having an annual allocation to fish, allowed for more concentrated effort, harvesting their annual limits in fewer trips. Those who were more dependent on groundfish for their income did not necessarily feel that one program was an improvement over another, though the data suggest that the informants with larger vessels tended to feel that sectors was the more efficient for them, that they could take advantage of the lack of trip limits better than before. The smaller-scale operations were less impacted by removing trip limits. There were no substantial changes in crew employment overall. Most of the informants did not make any particular changes in their gear since FY 2009, though some had increased gear loss. While some vessels used to make two-day trips, informants indicated that they were generally all taking one-day trips under sectors. Most informants saw either no change in area conflicts or increases as new groundfish vessels move into their fishing area or stationary gear takes up more fishing areas with declines in mobile gear. Regionally, employment and effort has dropped in the fishery through time and there was some evidence that those who have remained in the fishery are perhaps the more efficient operators.

KEY OUTCOMES

1. There was no strong agreement among informants about whether sectors were more efficient and flexible for fishing operations than Days-At-Sea, though sector members with larger vessels seem to have greater efficiency in the absence of trip limits.

2. Some informants saw increased gear conflict as new groundfish vessels moved into their fishing area or stationary gear expanded to fill voids left by the decline in groundfish gear.

CHAPTER VI. OUTCOMES - SOCIAL CAPITAL

RESULTS AND DISCUSSION

DEGREE OF ORGANIZATION WITHIN THE INDUSTRY

The informants were asked to identify which, if any, trade associations they were members of. There was not a close correlation between membership in a sector and voluntary membership in another trade association. Apart from sectors, 90% (n=19) of the informants indicated membership in at least one trade associations (Table 27). There were ten different industry organizations (besides sectors) that the informants belong to, most common is the Northeast Seafood Coalition (62%). However, members of NEFS XI and XII are automatically members of the Northeast Seafood Coalition (NSC), so this rate of affiliation is expected.

The second most common organization informants were members of was the New Hampshire Commercial Fishermen's Association (NHCFA; 33%, n=7). This association is open to all commercial fishermen (including lobstermen) with an interest in supporting the New Hampshire fisheries. The reasons cited for NHCFA membership include that it was a means to solve problems within the state, particularly between the groundfish and lobster industries. New Hampshire is a small state relative to its neighbors and members felt that it was important to have a united voice in regional management arenas. Also, there are vessel and health insurance discount benefits.

Of the sector member informants, fewer (29%) were members of the NHCFA than the common pool informants (57%), and apart from the required membership in the NSC, 45% (n=5) of the members of NEFS XI or XII were not a member of any other trade association. Thus, there was not a particular leaning to be involved with both organizations. Rationale for why an informant

was not a NHCFA member included disagreements with individuals who were members as well as with positions that the NHCFA has taken, including decisions of how federal disaster relief funding was distributed within the New Hampshire groundfish fishery and opposition to the NHCFA's support of a lawsuit filed against NMFS that focused on the distributional implications of the allocation formula used in Amendment 16 (Lovgren, 2010). Informants who were members of other sectors were all affiliated with another trade association (e.g., Associated Fisheries of Maine). Just two informants did not belong to any industry trade organizations, one former fisherman and one common pool member. Forty-three percent of the informants had served in a leadership in a trade association. Of the sector members, 50% had served in a leadership position and 29% of the others had. Though most of the informants indicated that they were a member of an industry association, there was no evidence from the interviews that the advent of sectors impacted the involvement of informants in trade associations, apart from the NEFS XI and XII joining the NSC if they had not already.

One theory could be that the institutional framework of sectors has encouraged civil involvement more than involvement in other industry organizations. While this theory was not explored in depth, the general sense was that the informants were already involved in industry organizations prior to joining sectors, in part, for joint political power in management arenas. Sectors may build on existing will for political involvement, more than serve as a catalyst. One informant did speak of their manager as a political advocate, and another as a liaison with NMFS, saying:"who would want that job [sector manager] is beyond me. [laugh] That's like whoa, buffer zone between NMFS and the fishermen." A few informants indicated that belonging to a sector resulted in better advocacy in the management arena, citing a case where their sector manager

helped negotiate a resolution to potential gillnet time and area closures associated with protection of marine mammals.

One informant, a member of the NEFS XI and XII Board, expressed that he had too many obligations, to his sector as a Board member, to the NSC, and to individuals as an industry leader. He became more civilly involved, but was doing so begrudgingly, because others in his community were not willing to, and it was increasing his fatigue levels:

> *(Wife) He signed up for another obligation, committee meetings nonstop. They want him to do, there's so much work. He doesn't go to bed at night till 8:30, nine o'clock. Every night, paperwork, paperwork, paperwork.*
>
> *(Informant) It's gotten pretty bad.*
>
> *(Wife) Phone rings off the hook. It's insane. It's insane.*
>
> *(Informant) It wasn't like it with Days at Sea.*
>
> *(Interviewer) Because you were working more on your own?*
>
> *(Informant) Yeah, kind of, yeah…. Just involved with so many groups.*
>
> *(Interviewer) Do you find that it's worth it in the end or are you kind of frustrated with it?*
>
> *(Wife) No.*
>
> *(Informant) No. You know what really bothers me is the way that I feel as though it's my responsibility now to help other fishermen when they just do nothing. And they don't care. And they just say, "We won't fail because [I] won't fail. We can just be like [me]. That burns my ass a little bit. What are you going to do? I can't not do it, because they're not going to do it.*
>
> *(Interviewer) Could there be term limits on the Board to rotate the responsibilities?*
>
> *(Informant) Yeah, but nobody's going to do it. No one would, no. No one would.*

Degree of business collaborations

Whether the advent of catch shares has changed the way that fishermen did business with each other was investigated.

Lending equipment. A possible expression of social capital is a willingness to lend equipment to fellow fishermen. Of those who answered the question or to whom it was relevant, 47% indicated that they tended to share equipment with fellow fishermen, and 53% did not (Table

28). More of the sector members indicated a tendency to share (54%) than the other informants (33%). A few informants indicated that it was more difficult to share trawl gear than other gear types (e.g., gillnets). However, a cross tabulation of the question of if they were willing to lend and their principal groundfish gear type in FY 2011 revealed that there was no difference between the answers given by those who fished for trawls and those who fish with gillnets; 50% of both groups said they were willing to share, and 50% said they were unwilling to.

TALKING ABOUT CATCH AND FISHING AREAS. The majority (76%) of informants indicated that they did share information about fishing areas with other fishermen (Table 28). Slightly more of the sector members (79%) than the others (71%) were willing to share information. Just two informants, sector members, indicated that they share information with the entire community. Of those who share with just part of the community, the average number of fishermen that they share with was 7±6, ranging from two to 20. Sector members shared with six and others shared with nine, though with high standard deviations, the averages were the same within the error. One sector informant indicated that he was sharing information on catch and area more freely, because everyone was working off of a set quota, so there was less competition. Two sector informants indicated that they became more secretive about their fishing areas, that they talked less freely on the radio, because vessels from outside their community that do not usually fish in the area come in once they hear word of a fish aggregation. As one put it:

> *We're back to not doing it [talking] on the radio anymore, because we know that these big boats are listening, because the minute you say something, one of them appears, and if one of them finds something they're like a pack of wolves. Once one of them finds something, then a bunch of them appear, and they don't go away till there's absolutely nothing. I mean they exterminate every last fish. No, most of it's done with cell phones and scramblers now.*

This also indicates desire to increase well-being within one's community, as opposed to outsiders, positive but bounded social capital. Another sector member fishing with fixed gear had always been secretive, because strategic positioning of one's nets was critical:

> *I only need to tell one person and then everybody knows, but it takes a little time and see, that time delay is exactly what I'm looking for. Position is everything in the gillnetting business. By the time so-and-so figures it out it's too late. I'm a young guy. You have to respect your elders. There's some kind of chain; you have to earn your respect…it's been the same ocean for so long and the fishermen have been there. …Most of the time they're going; they're not coming, but sometimes there's one or two that's coming, and then we have to deal with the guys from Gloucester on occasion when they want to come up and fish in our area. You're going to have to either work with them or box them out...That's how fishing is, so who you share information with... you better trust…But you don't really need to share information, because there's people watching you. That's what fishing is. If you're not watching what's going on around you, you're not going to be a very good fisherman.*

SHARING ALLOCATION. A sector is allocated ACE according to the PSC of the permits enrolled in it, held by individual fishermen. Technically, the allocation is shared by the sector, so there may be opportunities for members to collaborate more so than outside the sector framework. In practice, NEFS XI and XII have distributed the ACE within the sector to individuals in proportion to the PSC that they each bring to the sector, and there is a right of first refusal, where ACE must be offered within the sector prior to making it available outside the sector. When informants were asked whether they would accept a lower price for leased ACE to keep it in the community, 50% indicated that they were not willing to do so, and 50% were willing to take less than fair market value. While the responses were split evenly, 50% shows a fairly strong willingness to support others in the community. The majority (71%) of informants felt that it was important to keep allocation within the New Hampshire fishing community and 10% felt that it was unimportant (Table 29). Sixty-four percent of sector members felt that it was important and 86% of common pool members do. For the members of NEFS XII and XII, 73% felt that it was important and the remainder (27%) felt neutral.

For the common pool, the PSC of enrolled permits is pooled into an annual Total Allowable Catch that is implemented by trimesters. There was no common agreement across the common pool about how the ACE will be fished, thus creating the potential for a derby fishery each trimester. Among the informants enrolled in the common pool members, the data did not reveal any substantial efforts to work together to catch allocation. In fact, there was some degree of competition among the common pool members.

There was little evidence that the informants were using social capital to coordinate fishing areas to reduce gear conflicts or bycatch. Three fishermen felt that gear conflicts were generally on the decline, because there were fewer vessels fishing in their fishing area in recent years (see Chapter V). However, 11 informants felt that gear conflicts were increasing: seven observed that there were new vessels coming into the area, and several noted that there was more stationary gear, particularly lobster gear. The interviews did not reveal that the informants work together any more under sectors to reduce bycatch. Although sector members are all responsible (subject to accountability measures) should the sector exceed its ACE for a stock, the sector informants did not indicate a tendency for members to work together to avoid bycatch.

MARKETING. The catch share program had some impact on how the fishermen work together to market their fish. NEFS XI and XII members and its manager initiated New Hampshire Community Seafood, a community-supported fishery as a way to foster local markets and increase revenue. In the opposite direction, the certainty of one's catch allocation helped one informant have the confidence to try opening his own fish market rather than continuing to land fish at a fishing cooperative, though with persistently low ACLs, this market did not remain viable.

MERGERS. Perhaps the highest degree of social capital is for individual fisherman to decide to go into business together. One informant indicated that he elected to partner with another fisherman by jointly owning a vessel, sharing use of it. However, this merger was done begrudgingly. He was determined to survive as a fisherman and felt that it was a necessary measure to cut costs and remain viable.

REGARD FOR THE NEW HAMPSHIRE FISHERY AS A COMMUNITY

Many informants expressed the importance of keeping opportunities to catch fish within the New Hampshire community and helping local fishermen. The research investigated if the informants who already felt connected to the New Hampshire community opted to join NEFS XI and XII and if having sectors based in New Hampshire fostered a new or increased sense of community. The majority of informants (67%) indicated that it was more important to help fishermen from inside his community than from outside (Table 29). A higher majority of the sector members (71%) felt this way rather than other informants (57%). One sector member indicated that a reason why he joined a sector based in New Hampshire was due to concern about the future viability of the local fleet and he felt that forming a sector and working together would help secure its future. Many were very supportive of the idea, but for some, their sense of community was not necessarily tied to the state. It does not seem like the advent of NEFS XI and XII particularly changed things. One informant indicated that the sector had not brought the community any closer together than it already was. Two informants indicated that keeping ACE in the community was not particularly important. One sector member had become a fish dealer to help the fisherman in his port remain viable, and with that, the shore side infrastructure necessary for his own operations.

One informant indicated that he had lost his connection to the New Hampshire fishing community, in part due to differences of opinion about the catch share program. He opted to join

a different sector, because he felt that the fishermen in his home community were focused on what they do not have, rather than what they do, in the decision of the New Hampshire Commercial Fishermen's Association to join the lawsuit against NMFS regarding the catch history formula used. The informant was committed to making his business work within the program, whatever program is in place, as best he could, and felt that the sector he joined was more forward thinking.

DEGREE OF CONFLICT

The majority of informants (67%) indicated that there were fishermen who they avoid talking with in their community (Table 29). There was no differentiation between the sector members and others in this response. For some informants, these personal conflicts were significant enough to dissuade the informant from joining a sector with the other individual. Others just avoid the individual if possible, though they could be in the same sector. One informant spoke of the sector as a forum to work out conflicts. However, two informants expressed that the creation of the ACE leasing market within and between sectors had created greed within the industry, which they abhorred. They felt that fishermen were charging lease prices above fair market price to maximize personal benefit, and that it was unfair that some permit holders can gain income from just leasing their allocation without going through the effort and expense to fish.

DEGREE OF TRUST OF FELLOW FISHERMEN

The majority of informants (67%) indicated that they "sometimes" trust other fishermen in their community in business dealings, with 19% indicating that they never trust others and 14% indicating that they always trust others (Table 29). Results were similar for sector members, but none of the other informants indicated that they always trust others and 86% indicated that they sometimes trust. For the sector members, 79% indicated that they trust members of their sector about the same as other fishermen. Thus, though there were some opportunities to work together

within a sector, the sector members were not overwhelmingly more trusting of each other than others in the fisher. Tendencies towards individualism persist. One informant indicated that that there can be "bad eggs" in every sector.

VIEWPOINTS OF MANAGEMENT AND REGULATORY ENTITIES

The majority of informants (52%) indicated that they “sometimes” trust NMFS to have the best interest of the industry in mind (Table 30). The sector members had a more negative view of NMFS than the other informants, with 50% of the sector members and 14% of the others feeling that NMFS “never” had the interest of the industry in mind, whereas 0% of the sector members and 29% of the others indicated that NMFS “always” had the interest of the industry in mind. When pressed for specifics on the rationale for their viewpoints, most of the informants expressed both positive and negative examples. Twenty informants cited 32 different reasons why negative viewpoints were held about NMFS. Most common among those include that the agency was too sided towards environmentalists and was not focused on helping the industry, that it doesn’t take impacts on human communities into account and had made too many mistakes. Informants also felt that NMFS was too confrontational, not willing to negotiate with industry. Nine informants with mixed responses most commonly said that fishermen’s complaints were misguided, that NMFS was just implementing ideas generated by managers or was forced to implement a law (the MSFCMA) that was not flexible enough. Eleven informants gave seven different positive comments, most commonly that the current Regional Administrator seems willing to work with industry, that the staff tries to do well, and the informants were glad that NMFS was willing to listen to industry and shift the times that the fishery would be closed due to harbor porpoise protection.

Several informants felt disgruntled by the uncertainty in scientific stock assessments used to set catch targets. Due to the mobile nature of the species involved, the groundfish stock assessments

have been very difficult, with significant sources of uncertainty and dramatically varying outcomes through time. The 2008 assessment for Gulf of Maine cod indicated that the stock was rebuilding and would meet recovery targets. Catch rates were allowed to increase by 18% between FY 2010 and FY 2011 (NEFMC, 2011b). Fishermen made business investments accordingly. However, the 2011 assessment indicated that the stock was actually much smaller than what the earlier assessment revealed, including the years leading up to 2008. Sufficient rebuilding to meet legal mandates was, in fact, not occurring (NEFSC, 2011). The 2011 assessment was determined to better minimize uncertainty and incorporate recent data on fishery discards that were unavailable in 2008 (NEFSC, 2013). Allowable Biological Catch was subsequently cut by 77% between FY 2011 and FY 2012 (NEFMC, 2013b). Even though the fishermen have harvested under the levels that managers felt would end overfishing and rebuild stocks, many stocks remain in a state of decline. This implies that there had been too much uncertainty in the science undergirding groundfish management. A 2010 industry survey indicated that just 7% of respondents felt that the science undergirding management was accurate (D. S. Holland, et al., 2010). The industry had little faith that the management process can be successful.

DEGREE OF SOCIAL CAPITAL WITHIN SECTORS

Sector members tended to feel that their sector works fairly well together, and some were rather surprised at how well people were working together, because they had traditionally been so competitive. All of the sector member informants felt that they trust members of their sector about the same as or more than other fishermen (Table 31). Of the sector members, 36% had served on the Board to date and virtually all (93%) indicated that sector members respect the rules of the sector. The one informant excepted did not want to answer that question, saying, "I

can only speak for myself." All of the sector members said that having a sector manager had been helpful. A former sector member said that the manager was not particularly helpful.

Three informants indicated that a benefit to sectors was that they became part of a group working towards common goals. However, one informant indicated that a disadvantage of sectors was the need to join with a group of fishermen; he would prefer to remain individualistic.

A few fishermen indicated that his own network of fishermen was defined by the sector that he belongs to, but more people indicated that their network was defined by other attributes, such as geographic proximity, type, home or landing port, and a longstanding working relationships or trust. One informant indicated that, because fishermen have tended to group into sectors with similar fishermen (gear type or port), it had helped strengthen the divisions within the industry in a negative way. One informant indicated that he would prefer to lease to people within his own personal network, rather than work with some of his sectors. Thus, the sector members were generally working well together, but social capital certainly existed within the industry prior to sectors, which sectors could build on.

PERSONAL SOCIAL CAPITAL

This research was not able to tease out trends in what would make an individual fishermen inclined to promote social capital within his community. There were no discernible traits based on age, fishing practices or other demographic characteristic of a particularly high- or low-social capital informant. In addition, each informant expressed some degree of social capital, though in varying ways. One informant was very secretive about his fishing practices, yet was integral to the formation of his sector and committed to his success. Another informant joined a sector that was based in his landing port and that had a large allocation, motivated by his personal convenience and opportunities for profit, but had not sought out collaborative opportunities with the membership. He had retained memberships in a fishing organization based in his early-career

homeport. He does not like fishing within a sector, constrained by a set of rules, yet appreciates having a sector manager as a neutral broker between fishermen. A third informant with relatively little PSC joined a sector, but had found that it had not promoted a sense of community. He was not a member of the New Hampshire Fishermen's Association, due to personal conflicts, though he was very open with other fishermen and finds them trustworthy. Helping New Hampshire-based fishermen was important to him, yet he felt offended that he was excluded from legal settlement funds.

FISHERIES COMPARED

This dissertation was not designed to compare the social capital of the groundfish fishery with other fisheries in the region, yet several informants offered comparisons with the lobster fishery, comparisons that differ from those in the literature, and thus are worth noting here.

James Acheson (2006) constructed a comparative analysis of the lobster and groundfish fisheries of the Northeast, asserting that lobster management "effectiveness," defined as stock abundance and catch rates at all-time highs, is largely due to the conservation measures promulgated by a homogeneous industry that operates within a management program that had been responsive to industry lobbying. Indeed, lobster is a fairly sedentary species, with most individuals moving within a range generally smaller than the management zones lobstermen are confined to operate within. This incentivizes local conservation for future access. In contrast, the "top-down" nature of federal groundfish management and the diversity of that industry, he asserts, has provided little incentive to promote conservation from within the industry and hindered implementation of industry input into management, resulting in continued stock depletion. The fishery is prosecuted with several different gears and vessel sizes, and fishermen who operate in an area tend to come from disparate ports. These are factors that Acheson argues create less social capital and consensus on management approaches than exist within the lobster fishery, impediments to collective action.

From the lens of rational choice theory, he argues that the characteristics of the lobster industry and its management arena have enabled more effective participatory governance and collective action.

There was evidence, however, that the social capital within the groundfish fishery was stronger than within the lobster fishery, at least in New Hampshire. For example, the following is an excerpt from an informant who exclusively harvested groundfish until the fall of 2010, when he switched to full-time lobster. Here, he was responding to questions about gear conflicts and trust within the New Hampshire fishery:

> *[Groundfish] fishermen, it always seemed like you could, they could get along with all of them. Now, since I've become a lobsterman, I'm pretty sure they hate their own mother. They just don't like each other. Lobstermen, they don't talk on the radio. They don't talk with each other. They just, it's, it's a cut-throat business when it comes to lobster fishing. That's, that's the only difference I can see. Fishermen they get along, I mean, it's not like you're stealing their fish and this and that. But lobstermen, you, you catch a lobster, you're taking one of their lobsters. And that's what it comes down to. …You can see it in Maine; you can see it in Jersey. People in Jersey used to shoot each other over lobster fishing. …Fishermen, the ocean's nobody's. It's everybody's, so that's the way it is.*

Other informants also view the groundfish fishermen as more collaborative and less possessive about the resource. However, conflicts between mobile and fixed gear groundfish fishermen are a constant source of tension, but the more migrant nature of the groundfish resource likely results in less conflict than within the lobster fishery. In practice, the localized nature of the lobster resource and its management has resulted in a sense of territorial ownership within the industry. This has led to instances of property destruction and, in rare instances, gun violence (AP, 2009). Although enforcement is swift (Dicolo & Friedman, 2012), the troubles lead to questioning the social cost of territorialism.

As Ostrom (2010) describes, there are "no panacea" approaches to natural resource management. Acheson concludes his analysis by postulating that the lobster and groundfish "cases seem to

argue for bottoms-up management" (J.M. Acheson, 2006), implying that groundfish would be better managed at the local level. There have been a few industry-initiated proposals discussed by the NEFMC over the years that would split current groundfish management segments into smaller zones to be co-managed by communities of users (NEFMC, 2007b). The proposals have failed to gain much traction, largely because the zones were too small to manage stocks appropriately, and there was insufficient industry-wide support and participation in their development. The industry-wide sector approach adopted in FY 2010 does delegate some decisions to communities of fishermen. Those communities were left to the fishermen to define, who they align with socially rather than geographically.

In the case of groundfish, the geographic range and the diversity of the stocks and the fishermen who harvest them, make the current management structure the most appropriate. There is sufficient participation of the industry in the management process and social capital to garner collective action. What is still necessary is improved science undergirding decisions and a better alignment of regulations with ecological processes.

REGIONAL CONTEXT

Results from region-wide analysis by Holland et al. (2010) of social capital indicated that a high degree of trust existed within the groundfish fishery in 2010, just prior to catch share implementation. Of the groundfish permit holders surveyed at that time, 71% indicated that they trust most of the other fishermen in their fishing community. This agrees with the results of this dissertation, that 67% of informants "sometimes" trust fellow groundfish fishermen, and 14% always do. In the larger study, 83% agreed that fishermen in their community "trust one another in matters of lending." In terms of networking, 93% indicated that they share information with a group of fishermen. On average, these networks comprise 12 fishermen, within the range that informants for this dissertation indicated as the number of people they share information with

about fishing areas and catch. For the survey participants who had joined a sector, 67% were expecting the sector to work well together.

Holland et al. (2013) further analyzed the survey data, creating statistical scoring of social capital indices: bonding, bridging, linking, information sharing and trust, and at individual and sector levels. Results suggest that groundfish fishermen self-define their communities and place substantial value on social capital, expressed in various ways. This contrasts to the reputation of rugged individualism within the groundfish fishery. In that dataset, the sectors with relatively small vessels from a smaller geographic region tend to have stronger ties with fellows sector member, and example of bonding social capital, than sectors with larger more geographically dispersed, in which relationships and information sharing outside the sector were more important. The social capital data were compared with economic performance for the first two years of sectors. While there were some significant correlations, causality was unclear.

Olson and Pinto da Silva (J. Olson & Pinto da Silva, 2014) found through interviews of sector managers in 2011 that, region-wide, those sectors with more financial resources and social capital have tended to fare better. However, many factors were influencing success. Sectors have benefitted from varying degrees of external organizational and financial support and catch allocation. Sectors began as a community-based effort through Amendment 13, but were formalized fishery-wide in Amendment 16 through a top-down process. Indeed, 46% of respondents to the Holland et al. (2010) survey in 2010 felt that sectors were forced on them. Each sector is governed by a board of directors, and has a professional sector manager, to distribute quota and ensure compliance with sector rules. The potential for collaborative, decentralized governance exists, though all sectors have returned quota to fishermen in proportion that each contributes PSC to the sector. Some sectors view the role of their manager

as an agent for tracking ACE used by the sector. Others, such as NEFS XI and XII, use the manager as an advocate in the management arena, as facilitator of improved business practices and liaison with the National Marine Fisheries Service, fostering social capital within their sector. Overall, sectors were behaving more as a facilitator of individual allocations more than a forum for localized collaborative management as perhaps envisioned (J. Olson & Pinto da Silva, 2014).

SUMMARY

There was some evidence that sectors increased social capital, but it was not a strong conclusion, as there was also evidence that social capital was not dependent on sectors, and that in some ways, sectors reduced social capital due, for instance, to increased organizational responsibilities. Sector informants do not appear to be more inclined to voluntarily join trade organizations than other informants. Sector informants tended to lend equipment and share information on fishing areas and catch more than others. There was little evidence that the informants were using social capital to coordinate fishing areas to reduce gear conflicts or bycatch. Though many felt that supporting the New Hampshire community was important, it was not uniform. It appears that the selection of the specific sector that an informant joined was determined in part by the level of social capital that already existed with fellow industry members. Sectors can build on whatever social capital may already exist within the industry. There was no particular set of traits that distinguish high-from low-social capital informants. Perhaps this could be investigated in future research that examines social capital across the industry as a whole, a larger and more diverse population than the fishermen of New Hampshire. These conclusions align with regional evidence that there was a high degree of social capital already within the groundfish industry.

KEY OUTCOMES

1. Contrary to the hypothesis, the sector program did not increase networking, reciprocity, and trust among informants uniformly.
2. In some cases, social capital was reduced as increased organizational responsibilities were seen as a burden and fishing became more competitive and secretive.
3. Sector members tended to be more willing to lend equipment to fellow fishermen and share information about fishing areas. However, some became more secretive to gain a competitive edge in finding fish aggregations.
4. Informants showed that the social capital of a fishing community could be augmented by fishing within a sector, but that the sector is not necessarily a source of social capital.
5. There was no particular set of traits that distinguish high-from low-social capital informants, though traits may emerge in a larger data set.
6. Networks were defined less by their sector, but more by geographic proximity, gear type, home or landing port, trust, or longstanding relationships.
7. Sector members were not collaborating to reduce bycatch, despite being collectively responsible should the sector exceed its quota.

CHAPTER VII. OUTCOMES - BYCATCH

RESULTS AND DISCUSSION

DEGREE OF IMPORTANCE OF BYCATCH REDUCTION

Most all of the informants (90%, n=19) indicated that reducing bycatch was important to them (Table 32). Two informants indicated that they felt neutral about bycatch reduction. These were both sector members, though groundfish was not their primary source of fishing revenue. One was a lease-only member, not actively fishing for groundfish himself (was active in the lobster fishery). The other actively fishes using both gillnet and trawl gear. No one said that bycatch reduction was unimportant.

The dominant reason why reducing bycatch was important, cited by ten informants, was that it was important to keep fish in the ocean for the health of future stocks. Another common response (n=8) was that reducing bycatch improves efficiency, in reduced deck sorting time. It was also important to not waste fish from an economic perspective, that because discarded fish have a low likelihood of survival, discarding was viewed as wasting money.

FISHING UNDER DAS

Many informants spoke about their time of fishing under DAS trip limits, with seven indicating that there were more discards than under sectors, and that the trip limits forced the discards. The informants were constrained by trip limits in diverse ways. One fisherman described his decision in 2006 to cease groundfish fishing, because he had an enforcement violation for being over his landing limit:

> *…the $5,000 fine was a big hit, but it wasn't going to end my career or anything. I was just ashamed…I am like beyond goody-two-shoes, and it hurt my feelings so bad that I was just like, 'I can't do this' because if I get caught again, I'll just be, I'll be done, everything. I'll just sell my boat and be done… I've always had a reputation of*

> *being pretty honest …It just blew my mind that I did something dishonest, not even trying to.*

The overage was unintentional, and although he was planning to fish for many more years, the embarrassment and potential for damage to his reputation caused him to switch to full-time lobster harvesting. At the time of the interview, he was just leasing his groundfish quota within a sector.

Other fishermen felt disdain towards management and demoralized by being forced to discard, but kept on fishing while many pounds of large cod went over their rails each trip. When asked about the advantages of the sector program, one such respondent said:

> *The primary advantage is biological, is that we're not throwing any fish over. I mean, in my small dragger in 2007, we probably wasted a million pounds of cod, you know, we got our 800 or 1,600 [trip limit] and we had days that we caught 20,000 three times a day. It was stupid.*

One respondent identified that the volume of unreported discards prior to catch shares had negatively impacted the cod stock assessments:

> *When they call it "retrospective pattern," that's us throwing fish over, but nobody will admit it…It's true, yeah. When there's a retrospective pattern in the population of cod, it's the fish that were thrown over that weren't reported, you know.*

A retrospective pattern occurs when the estimates of fish population and mortality rates back in time differ between two different stock assessments. These patterns create uncertainty in the stock abundance levels, which then creates uncertainty in the acceptable catch levels for the fishery (Mohn, 1999).

BYCATCH UNDER CATCH SHARES

When asked how their level of bycatch had changed since May 2010, removing the four informants to whom the question was not relevant (e.g., former fishermen and a lease-only member of a sector), 47% of informants indicated that their bycatch had decreased, 35% said that it was unchanged, and 18% said that it had increased (Table 32). Comparing sector members to

other informants, 50% of the sector members and 40% of the other informants indicated that their level of bycatch had decreased. So, both groups saw a distinct decrease in bycatch. Under DAS, seven informants recalled that there were more discards than under sectors, and that the trip limits forced the discards. Six informants indicated that their discards had reduced since May 2010, because there are no legal discards under sectors, but five informants felt that their bycatch had not changed much. Eight informants felt like they did not have much bycatch prior to FY 2010, so comparisons are difficult when totals under both DAS and sectors were low.

By gear type, more informants who fish with trawls (66%) noted reductions in bycatch relative to gillnetters (33%). Two fishermen who used handgear, a commercial fisherman and a charter fisherman both in the common pool, indicated that their gear type had very little bycatch in general. Four gillnetters also felt that they have little bycatch, catching few undersized fish. Though six sector member informants felt that their bycatch had decreased under sectors, and just one said that it had increased (Table 32), there were a few lines of evidence that bycatch may still be an issue. Under catch shares, gillnet vessels fishing sectors may share gear, which was enacted to reduce bycatch (e.g., harbor porpoise). However, the interviews revealed that was not occurring in the fishery. Those fishermen who were secretly sharing gillnets under DAS were no longer. By allowing fishermen to keep what they catch under sectors, the advantages to using one's own gear outweigh the advantages of sharing. Generally, the informants did not make significant gear configurations with the advent of catch shares. There was evidence that bycatch may be occurring related to the multispecies nature of this catch share fishery, discarding of allocated legal-sized stocks. One respondent described it this way:

> *Let's say you get 50,000 pounds of cod to catch, and you have say, 1,500 pounds of black backs [winter flounder] you're allowed to keep, and all the sudden you're up against all these black backs. You still have 8,000 pounds of cod to catch. What are*

> *you going to do with the black backs? You're going to throw them over. You know, because you can't, I mean the lease quota on these fish is outrageous.*

The ACE for stocks of low abundance was in high demand, so it was very expensive to lease. When unobserved, this gives fishermen an incentive to discard. That respondent was a leader in his sector, and as such, felt that he should not discard as a moral example. However, he was aware of it occurring in the fishery.

ACTIONS TAKEN TO AVOID BYCATCH

The majority (67%) of informants indicated that they go above and beyond the regulations to avoid bycatch, with a stronger majority (79%) among sector members (Table 32), though 57% of the common pool members indicated that they do. One informant referred to there being two types of fishermen. One type were the people who fished in a way that avoided bycatch, like fishing on the edge of an aggregation of fish or who would stop fishing when they got close to the DAS trip limit. Other fishermen "had no qualms" about discarding a lot of fish under DAS, "dumping 15, 17,000 pounds of dead fish over the side."

Gillnetters spoke of strategies they had taken under DAS program to reduce bycatch. Three informants shared how under DAS trip limits, gillnet fishermen were willing to violate regulations so that discarding could be avoided. Specifically, it was against the DAS regulations to share gillnets at sea among vessels. However, informants described how a fisherman with a large catch in his nets would get on the radio and invite others to harvest some of his nets rather than set their own, minimizing waste. This occurred on trips that were not monitored by observers and where enforcement was out of sight. Here was how one gillnet fisherman described the practice:

> *I'd haul till I get my limit and then bring those nets home, and then finish the string up the next day. I got really good at that. I mean you got to the point where we wouldn't throw anything away, or if it got that bad we'd have other people come and haul.*

To them, collaboratively reducing bycatch was more important than obeying regulations. Alternatively, one fisherman spoke of how reduce bycatch without violating regulations. He would haul nets until he got his trip limit, take those nets out, leave the rest, and then come back the next day. One fishermen spoke of these measures as a way of taking steps to "police ourselves" in bycatch reduction.

Under sectors, one member said that he takes steps to reduce bycatch only if it improves his deck sorting time. Another spoke of a gear modification experiment that he was doing that was successfully avoiding undersized cod, but he felt that he was not catching much cod to begin with anyway. People spoke of making some adjustment to mesh size to reduce undersized fish, because of the quota limitations, trying to catch just legal-sized fish. Four informants spoke of using a larger mesh than required to avoid bycatch, and eight spoke of moving their gear to avoid aggregations of fish that they want to avoid. One informant indicated that he would fish more selectively with an observer on board.

REGIONAL CONTEXT

ESTIMATING BYCATCH

Determining the level of bycatch in the Northeast groundfish fishery was challenging due to the diversity of vessels, gear configurations, fishing trip durations, the unique reaction of species to different gears, natural environmental variability, and limited human resources to collect data and make calculations. For over a century, the government has collected data from commercial fishing trips, but during the past few decades, bycatch estimations have dramatically improved. During the 1990s, the Northeast Fisheries Observer Program (NEFOP) of the National Marine Fisheries Service (NMFS) focused their limited resources on monitoring the interactions between fixed-gear fisheries and protected species (e.g., harbor porpoise takes in the gillnet fishery). Monitoring discards of all Northeast fisheries increased substantially in 2001, and an observer

program is now required for all Fishery Management Plans (FMPs), though rates of observer coverage vary. NEFOP records weights of kept and discarded species and biological data (e.g., age, sex), and has vessel selection protocols to minimize systematic bias. In addition to the federal observers, there has been mandatory self-reporting for the landing and sale of all Northeast species since 1994. Vessel Trip Reports (VTRs) and dealer reports are submitted to NMFS and now contribute to catch calculations (NMFS, 2011b).

A substantial amount of data imputation is required in creating bycatch estimates. For the Northeast groundfish fishery, the observer program has been in operation since 1990. Prior to that, there were no direct, systematic measures of bycatch in the fishery (NEFSC, 2013). At-sea observer coverage levels from 2005 to 2009 ranged between 2% and 10% of the fishery trips, and rates before 2005 were even smaller (NMFS, 2011b). The coverage level increased to about 30% with the advent of the catch share program in May 2010. Inaccuracies in catch data can be a significant source of uncertainty in stock assessments (Hilborn, 2003), and how much bias exists within the observer data is a topic of ongoing debate.

An "apples-to-apples" comparison of the bycatch caught by the vessels participating in the catch share program with their prior performance was not possible with the data that have been reported publicly. The post catch shares data are reported by fishing year (May 1 – April 30) and the earlier data report by calendar year. Prior to FY 2010, the commercial discards reported for each stock combines all effort, direct and indirect. From FY 2010 forward, the data are broken down by all fishery components with sub-ACLs (e.g., sector, common pool, herring fishery). However, since 99% of the effort targeting groundfish is through the sector, qualified comparisons can be reasonable.

BYCATCH PRIOR TO CATCH SHARE MANAGEMENT

A FISHERY-WIDE SNAPSHOT. The first U.S. National Bycatch Report was produced by NMFS in 2011 and contains a snapshot from 2005 of landings and bycatch data across 274 federal, state, international and tribal commercial fisheries (NMFS, 2011b). The Northeast Multispecies fishery is prosecuted with several different gear types, and the bycatch data for each are summarized in Table 1, broken down by each species in the multispecies complex. The data include all fishing trips with these gear types, not just those targeting groundfish under the federal Multispecies FMP (e.g., monkfish trips).

Due to the aforementioned caveats, the data presented here cannot be attributed to just the Northeast Multispecies fishery operating in federal waters. That said, there was 28,824.9 mt of bycatch from gear types that can target the groundfish fishery in 2005, and 10.3% of that was of groundfish species. More than half of the bycatch was skates. The total bycatch ratio (bycatch:catch) was 0.35. Trawl gear had the highest bycatch ratios, 0.32-0.44, followed by gillnets, 0.17-0.32. Longlines and handlines had the smallest bycatch ratios, 0.08-0.22. The largest bycatch of a single species in the multispecies complex was Atlantic cod, at 819.0 mt, 27.5% of the total multispecies bycatch, followed by windowpane flounder and haddock (NMFS, 2011b).

By 2005, the groundfish fishery had been managed for 11 years under a Days-at-Sea effort control system, since 1994 (NEFMC, 1993). Measures in place included minimum mesh and fish sizes, and rolling and year-round area closures to avoid certain stock aggregations. Although trip limits were imposed for haddock (1994-1997) and cod (1997-2009) to reduce mortality, discarding was known to be an issue. Cod and haddock caught in excess of the trip limits or of sublegal length had to be released at sea, i.e., as "regulatory discards" (NEFMC, 2009a). Thus, the high bycatch of cod in 2005 (Table 33) was likely due to the trip limits in place.

TIME SERIES. A time-series of catch data (landings and discards) back to 1960 is available from NEFSC stock-assessment reports. Data from before 1990 are back calculations, due to the absence of observer data. From 1990 forward, numbers are estimated by compiling observer, VTR, and dealer datasets. The data are of all commercial catch, not just from vessels targeting the groundfish stocks under the Northeast Multispecies FMP. Generally, discards of multispecies stocks have decreased dramatically since 1990, and for most stocks, this is largely due to gear changes. Tables 2-5 provide catch calculations for Gulf of Maine and Georges Bank haddock and cod since 1986, the first year of the FMP (NEFSC, 2012a, 2012b).

Some correlation of discards with trip limits is evident for Gulf of Maine and Georges Bank haddock (Table 34 and Table 35). Trip limits of 500-1,000 lbs/day were in place between 1994 and 1997, the years with the highest percent discards, 30.2-43.8% for Gulf of Maine haddock. Other than those years, discards constitute a minor fraction of total Gulf of Maine haddock catch, ≤13.3%. For Georges Bank haddock, 1994-1997 had some of the highest discard rates in the time series, particularly 1994 (91.0%). The catch in 1994 (2,302 mt) was similar to years prior, but the catch in 1995-1997 was substantially lower (309-1,151 mt). It is possible that the trip limits incentivized the offshore vessels to fish inshore, in the Gulf of Maine stock area during that time. After 1998, Georges Bank haddock discards remained under 4.5% until 2004, when the stock had another pulse of high discards on western Georges Bank that has lasted through 2010. This may be due to the large 2003 year class that was progressing through the fishery (NEFSC, 2012b).

For Gulf of Maine cod, the years of low trip limits also correspond fairly well to the years with higher total discards (Table 36). Commercial trip limits were first imposed in 1997 at 1,000 lbs/day to reduce effort on this species that was considered overfished. The cod trip limits were

reduced several times over the next few years, getting as low as 30 lbs/day in 1999. The highest discards were recorded in that year, 49.5% of the catch. The subsequent trip limit years also had higher discard rates (6.5% - 32.8%) than the period prior to 1999 (2.8% - 12.3%). The low trip limits caused a substantial amount of discarding, such that in 2004, the limit was raised to 800 lbs/day and remained as such until the advent of the catch share program in May 2010, when trip limits were removed entirely (NEFMC, 2009a). The catch in FY 2010 included just 4.3% discards.

Trends in Georges Bank cod discards do not correlate with the trip limits that were in place from 1997-2009 (Table 37). Discards were ≤8.0% of the catch from 1986-2004, but in 2005, the discards jumped to 27.4% and have been between 17.3-31.0% ever since (NEFSC, 2012b). While landings have generally declined since the 1980's, discards have remained fairly stable, pushing the discard rates higher recently. The discards may be comprised of sublegal-cod or cod caught as bycatch in other fisheries (e.g., scallops).

IMPLEMENTATION OF CATCH SHARES

The implementation of a catch share program (i.e., sectors) for the Northeast Multispecies FMP brought many changes. New ACLs for each stock constrain all vessels, eliminating the need for many of the former effort controls (NEFMC, 2009a). Sectors were expanded fishery-wide and 99% of the directed effort is now subject to this catch share program. Non-sector vessels, 1% of the effort, continue to fish under many of the prior control rules (Kitts, et al., 2011). For sector vessels, trip limits were removed and full retention is required of all legal size groundfish. These fish were regulatory discards, but are now landed and count against the Annual Catch Entitlement (ACE) of the sector to which a fisherman belongs. Fishermen now need sufficient quota of a stock, held or leased, to land the stock. Possession limits do remain for certain non-target stocks in need of rebuilding (e.g., Atlantic wolffish). At-sea observer coverage

dramatically increased, to about 30% (NEFMC, 2009a). For the first year, the fisheries also had dockside monitoring, but that was eliminated starting in FY 2011, largely because the cost to obtain this data outweighed the marginal benefit (NEFMC, 2011b).

DISCARD RATE CALCULATIONS. Methods to calculate bycatch in the fishery have become more sophisticated. The vessels in each sector are divided into strata by similar gear type, species fished and fishing area. A set of unique assumed discard rates for each stock are calculated for each stratum. These assumed discard rates are used to calculate the level of discards for each unobserved trip and count against the ACE. Discard rates set at the beginning of FY 2010 were calculated based on observed sub-legal discards during FY 2009. As the fishery proceeds, the assumed discard rates are updated weekly, incorporating new observer data. Vessels fishing in the same stratum are subject to the same discard rates, so the observed discards of one vessel in a stratum affect the assumed discard rates for all other vessels (NMFS, 2010a). In addition to mitigating the ethical dilemma of wasting the resource, fishermen have new incentives to minimize discards: to reduce their own ACE deduction, to reduce the ACE deduction across their sector, and to mitigate the ethical dilemma of throwing over healthy groundfish.

BYCATCH UNDER CATCH SHARE MANAGEMENT. The Northeast Regional Office tracks sector ACE usage (landings and discards), and reports this data on their website (NMFS, 2015b). For the first two years of the program (FY 2010 and FY 2011), the sector discards for all stocks in the multispecies fishery were 1,215 and 1,575 mt and the discard rates were 4.0% and 4.9%, respectively (Table 38 and Table 39). This data do not include other species (e.g., skates). The multispecies stocks that are unallocated to the sectors are those with the highest discard rates: Southern New England winter flounder, windowpane flounder, ocean pout, halibut, and wolfish. Of the allocated stocks, the highest discard rates are of Cape Cod/Gulf of Maine yellowtail

flounder (10.7%, 10.5%) and plaice (11.4%, 12.0%). Discards of haddock and cod were ≤2.1% and ≤4.5%, respectively. Bycatch of Gulf of Maine cod has not been this low since 1998, since before the lowest trip limits were in place (Table 36). This suggests that removing the trip limits and eliminating the discard of legal-sized fish has lessened bycatch for this stock. Gulf of Maine haddock discards have been very low for many years (Table 34) and have remained low under catch shares. For Georges Bank cod and haddock, sector discards have been ≤4.5%. Thus, the catch share program has resulted in low bycatch rate estimates, at least for the allocated stocks.

WHAT CHALLENGES REMAIN

The core of a catch share program is to implement a fishery-wide catch limit and distribute it among fishery participants. Will catch share management alone decrease bycatch in the Northeast groundfish fishery? Not likely. Attempts to restrict landings on a daily or an annual basis both incentivize discarding of "choke" stocks, the species that need to be rebuilt. Fisheries with catch shares and 100% observer coverage, like the British Columbia groundfish fishery (Branch, Rutherford, & Hilborn, 2006), tend to have the lowest bycatch levels. It may not be feasible at present to increase the observer rate for the Northeast Multispecies fishery from 30%. To date, observers have been federally funded, and any attempt to shift the burden onto the industry has been met with strong political opposition. Profit margins are too slim for many fishermen to be able to afford observers. Such a measure may result in rapid consolidation, a socially undesirable outcome. In today's federal budget climate, prospects are dim of increasing the line item for this expense.

If increasing NEFOP observers is not feasible, there are other steps to help monitor the fishery and keep bycatch to a minimum. Industry self-monitoring of bycatch hot spots is proving successful for the scallop fishery (UMass, 2013). Although informal networks exist among groundfish fishermen, the industry could become more organized in this manner. Fishermen have

more flexibility to decide where, when and how to fish. This increases opportunity to target marketable stocks in their portfolio when there is ready access to markets. Profits can be improved by minimizing costs and improving product quality. Economic discards can be turned into landings with market innovations. Fishing gear restrictions are effective at avoiding bycatch, but gear selectivity can still improve, as can understanding what incentivizes adopting more selective gear (Campbell & Cornwell, 2008).

An important concern remaining for the gillnet fisheries is interaction with harbor porpoise, a protected species under the Marine Mammal Protection Act. Attaching acoustic pinging devices to nets has proven effective at deterring interactions and is required for the fishery, along with time and area closures (Palka, Orphanides, & Warden, 2008). However, the sensors to determine if the pingers are working are unaffordable for the industry, as are the fines for non-compliance. Keeping assumed discard rates low is essential to the future of this segment of the groundfish fishery.

SUMMARY

The groundfish fishermen informants indicated that the transition to catch shares had decreased their bycatch. The data show that for the most part, reducing bycatch was important to these fishermen and that they saw their level of bycatch decrease with the advent of the catch share program, primarily through eliminating the trip limits and discards of legal-sized fish. Some informants had gone above and beyond regulations to avoid bycatch in recognition of the need to steward stocks for the future. The quantitative NMFS data suggest that bycatch of legal-sized target fish had been eliminated and overall bycatch of groundfish is low. The qualitative data from New Hampshire reveal more nuance. Some fishermen noted no longer wasting marketable fish, but others identified new pressures to discard when unobserved, driven largely by the high lease costs of choke stocks. At the vessel level, quota available had not matched natural

abundance. A new management tool to try to reduce bycatch, sharing of fixed gear, is not occurring, at least in the New Hampshire fishery. Catch shares did not incentivized the industry to make their gear substantially more selective either. High-grading may be occurring in the fishery, but there was no evidence in the qualitative data analyzed to date that the practice was any more or less widespread than before. Although catch shares have the potential to reduce bycatch, evidence from the Northeast groundfish fishery suggests that factors such as inaccurate stock assessments and unobserved discards may be buffering gains.

It seems like the most common theme was that bycatch had either remained the same or improved for individual informants, and that collectively, bycatch had improved. Though discarding may be reduced, the overall biological benefit is questionable if fishermen have been targeting concentrations of fish more.

KEY OUTCOMES

1. Consistent with the hypothesis, reducing bycatch was important to informants, and they saw their level of bycatch decrease with the advent of the catch share program, primarily through eliminating the trip limits and discards of legal-sized fish.
2. Region-wide, the catch share program had reduced documented bycatch; though discards may be lower with reduced trip limits and retention of legal sized fish, pressures remain to discard when unobserved.

CHAPTER VIII. OUTCOMES - ECONOMIC PERFORMANCE

RESULTS AND DISCUSSION

INCOME, COSTS, AND PROFIT

Questions regarding economic performance began with seeking to understand the degree of household and personal dependence on fishing in general (e.g., including lobster), as well as on groundfish fishing specifically, and how this dependence changed longitudinally. Answers were based on recollection rather than actual earnings. Between FY 2009 and FY 2011, the percent of total household income from fishing remained fairly stable, with 52-57% of informants deriving 76-100% of their income from fishing (Table 40). All of the informants had household income from fishing in FY 2009 and FY 2010, but one informant, a former groundfish fisherman had none in 2011 (other former groundfish fishermen still had income from other fisheries). In terms of their own income, a large majority (76-81%) of the informants derived 76-100% of their own income from fishing through the time series, with a slightly higher percentage of informants in FY 2009 than in later years. Very few informants (0-5%) derived 26-75% of their income from fishing and a few informants (14-19%) derived 1-25% of their income from fishing. In terms of dependence on the groundfish fishery, less than half of the informants (43%) indicated that 76-100% of their fishing income was derived from groundfish, which included about half of the sector members. Thus, most households were highly dependent on fishing and most informants worked as fishermen for their full-time income, with a minor amount working part-time as fishermen. There was little longitudinal change in these results.

Lobster, shrimp, herring, and monkfish were the most common other fisheries that the informants participated in. Informants had several other sources of income during the time series

besides fishing, including investment or retirement income, owning another business (e.g., fuel company, property management, small contractor), or working at a company (e.g., shipyard, marine insurance). Some had gained income through service on the New England Fishery Management Council, training federal fisheries observers, or conducting collaborative research. For the sector members, the transition from fishing a set number of days to having an annual weight of fish that they could catch was daunting. They did not know how quickly they would catch different stocks in their allocation portfolio and be then forced to either lease or tie up their vessel. This caused some to proceed cautiously during the first year of catch shares. A fisherman recalled that in the second year:

> *I wasn't as passive in my fishing practices. I was confident that I could acquire quota and utilize it. But in 2010, I didn't have the level of confidence … that I was going to be okay.*

This learning curve impacted income; some sector members noted income increases in the second year as they became more comfortable with the catch share program and more savvy to fish when they could maximize price.

Informants were asked, "Since May 2010, how has the profit margin of your groundfish fishing operations changed?" For some informants (n=4), the question was not directly relevant, such as those who were not active in the groundfish fishery since May 2010 (Table 42). Otherwise, the most common response, by sector and common pool members alike, was that groundfish profits dropped since the advent of the catch share program, with 12 informants noting this from personal experience or having observed the industry. Of the active fishermen, 59% (n=10) indicated that profits had decreased, including 50% of the sector members and 80% of the common pool members. Just three informants, all sector members, had improved profits. Several reasons were given why profit margins declined. Some fishermen mentioned not finding as much fish to catch, while others spoke of the low catch limits. One informant mentioned that

fuel costs were constraining too. These may be more important factors than being within a catch share program per se, given that most of the common pool members had worsening profits in addition to sector members. The aforementioned constraints would be felt by the common pool as well. A few informants indicated that they were just breaking even, and one was actively trying to sell his vessel and permits, primarily because fishing was becoming economically unviable.

An additional constraint for sector members is the amount of PSC assigned to their permits, such that leasing ACE is required to harvest the available fish in one's own portfolio. This was a substantial new cost for several informants. One described that he had recently grossed as much money as ever, but he netted about the same, because costs increased. A few indicated that they were taking on more debt under sectors and had reservations about doing so. For them, the dollar earned may have improved, but the dollar spent is rising.

The sector and former sector members were asked how the costs associated with sectors compare to what was anticipated (e.g., membership fees, ACE leasing). Sector costs were as expected for 57% of informants, and 14% indicated that they were higher than expected. Just one informant indicated that costs were lower than expected (Table 42). Two sector members were unsure how costs matched expectations; perhaps they had entered the program without knowing what to expect.

Three sector members and a common pool member had no substantial change in profits. One of these noted that there had been some ups and downs, but overall, his income had been fairly steady. He attributes this to having three permits with the PSC he needs, suggesting that the fishermen who have PSC that does not match with what they catch were having a harder time, because they were more reliant on leased fish.

For the three informants with improved profits, all sector members, there was no particular demographic similarity. Their demographics span the range of the population. The lengths of their vessels range from 39-61', they fish out of three different ports, and they first became permit holders between 1985 and 1998. They hold one to four permits each, so the number of permits held does not correlate with profitability in this case. The profitable informants found ways to keep expenses in check:

> *The profit to expense ratio is much better now, because your expenses remain the same whether you go out under Days at Sea or under the Sector Program. It costs 'x' amount of dollars to start the boat in the morning, and nine times out of ten you're bringing in more fish per day now. You're catching your fish in a shorter period of time, so I'd say it's gone up.*

This fisherman explained his improved profits as an outcome of decisions to become more efficient.

Several informants noted unusual circumstances that drove their profit margins up or down. One informant had a boat fire that decreased his income for several months as necessary repairs were made. In FY 2011, two informants did not see much fish in their typical fishing area, so had low profits. One chose to fish less and the other fished more hours for less money, due to increased time searching for fish. In FY 2012, fish prices improved and one informant recalled improved profits as a result.

The impacts on the New Hampshire fishermen resemble observations of Bromley (2005), that buyers in catch share programs (here, lessees of ACE) were forced into capital markets and risky debt obligations. Several informants took on substantial debts to have sufficient allocation. The debt allowed revenue to increase but, the "dollars earned per dollar invested had gone down," as one respondent described. In FY 2011, the value of cod that one fisherman leased in exceeded the value of his home. He felt that he did not have much choice; "it was either fish or stay home." One wife sitting in on an interview said that it is, "scary how much we have to go into

debt to stay in business, with the changes ever looming over your head." She was referring to the uncertainty in the stock ACLs that can sometimes change mid-year as managers acquire updated assessment information.

Several informants mentioned specific steps they took to adjust their business strategy to help improve their profits. Several were trying to be active in more diverse fisheries (n=6). The timing of fishing had been adjusted to maximize fish prices at the dock (n=2). Permits have been purchased to better match PSC with catch (n=2). Costs have been cut by sharing ownership of a vessel with another fisherman (n=1). A non-fishing business was purchased (n=1).

An informant mentioned the permit bank that NEFS XI and XII formed to make ACE more readily available to its members (n=1).

One risk that sector members face is being unable to harvest the entire quota leased in by the end of the fishing year. One respondent relayed an instance when he needed to lease more cod, but could only find a 10,000 lb. block available, which was much more than he projected that he would likely use, but he felt forced to buy it, so he could go fishing. When there got to be just two months left in the fishing year:

> *I was on the verge of eating that money, and so then I leased it back out, and I lost money on that, because I had to sell them for less than I leased it for just to get some of the money back to cover what was going to be a catastrophic loss.*

Accessibility to quota was certainly constraining fishing. Near the end of a fishing year, haddock and yellowtail flounder were prevalent in the fishing area of one respondent, but he only had 900 and 500 pounds of ACE left, respectively. The only ACE he could find was in 50,000 pound blocks at 60 cents per pound. He was in a bind:

> *I don't even know where to get that kind of money, and so we just ended up tying the boat up. And I leased out the bits and pieces I had left. Some of it I literally gave away... just so other people could fish.*

A respondent suspected that it would not be possible to make enough money by relying on leasing fish in. He learned:

> *…that as a boat owner and an operator, I can't make any money leasing vast amounts of fish … more than 50% of the value of the fish is going to leased fish. And that used to be all our money to work with.*

Some fishermen were clearly having trouble adjusting. Other informants, in the face of risk, opted for the safer route of simply leasing out their allocation or leaving the fishery altogether. The catch share program had increased the complexity of fishing operations.

BUSINESS PREDICTABILITY

Informants were asked how the predictability of their fishing business had changed since May 2010. The question was not applicable to former fishermen (n=2). Two of the sector members, who were lease-only fishermen, did not feel like the question was appropriate for them and did not provide an answer (Table 42). Neither of them had substantial groundfish income for several years since before 2010. Removing those four informants, 59% of the informants felt that the predictability of their fishing business had decreased since May 2010. Broken down by sector and common pool members, results were similar, 58% and 60%, respectively. By and large, factors were cited that would be applicable to both cohorts: the economy, weather, fish distribution in one's fishing area, landing price, annual (and sometimes more frequent) changes in catch limits, and the resultant uncertainty about whether one will be in business next year. Fluctuating lease prices was also noted as a factor by three sector members. One gillnetter indicated that the mobile fleet was having a greater impact on his operations in terms of gear conflict. The few informants who indicated that sectors provide a degree of predictability said that by knowing their allocation for the year, they could plan ahead a bit more. A few informants spoke of the continual need to adapt to continue on as a fisherman, and of the difficulties sometimes in doing so.

SOCIAL IMPACTS OF ACE LEASING

Motivations and connections in the industry and their communities are complex. Some of the New Hampshire fishermen were recognizing a transformation in the business climate of the groundfish industry, with more focus on maximizing one's utility. Although a vessel may have had very efficient operations, the business might not have been viable if leasing a large amount quota was needed. Entering credit markets can expose fishermen to great risk. A risk-adverse alternative is emerging, a non-harvesting segment of participants, like it has in the mid-Atlantic surfclam and ocean quahog fishery. After nine years of its ITQ program, 60% of the firms in that fishery were non-harvesters (Brandt, 2005).

Most (79%) of the sector member informants both leased and actively fished in FY 2010 and FY 2011; there were 14% were lease-only participants, and 7% were active harvesters who did not lease. These numbers did not change between FY 2010 and FY 2011 (Table 20). By participating in a novel market (leasing), fishermen were changing the way they interact, and one fisherman felt strongly that the economic impacts were a detriment to his community:

> *It has unleashed, in my opinion, the basest of human emotions, which is greed. And this whole thing from day one has been all about greed; the allocation formulas, all of it. … Scrape away some of the rhetoric and whatnot, and it's all about, 'How can I get the most out of my neighbor? I don't care what happens to him one bit.'*

These individuals who choose to lease out their entire quota rather than actively fish are what some refer to as "armchair fishermen." Informants indicated that some fishermen chose this route, because they did not have enough allocation to make fishing viable and they would rather not take on the risk of leasing. Others may want to retire from active fishing, and see leasing as a way to continue an income stream, and perhaps cover the costs of prior capital investments. For active fishermen interviewed, some viewed lease-only participation as unfair.

Reductions in the employment of active fishermen is a common result of privatizing fisheries into catch share programs (J. Olson, 2011). For those active informants who relied on leasing in

allocation, some found that the cost to lease in quota is so high that there is not enough left to pay competitive wages. Several informants spoke about how good labor was becoming scarce. The impact of leasing quota on crew wages may be felt industry-wide, regardless of whether fishermen have to lease quota or not.

SUSTAINING A LOCAL FISHERY

Creative local marketing has recently been important to sustaining the New Hampshire industry and securing its future. Within the last few years, fishermen have worked with university extension specialists and community organizations to foster local markets. New Hampshire Sea Grant and the University of New Hampshire Cooperative Extension have fostered the "New Hampshire Fresh and Local" brand, which has caught the interest of area merchants and restaurateurs (UNHCE, 2012). Since 2009, the annual New Hampshire Fish and Seafood Festival has boosted public interest in supporting the local industry (PPAF, 2012). New Hampshire Community Seafood was founded in the spring of 2013 by sector members and the manager of NEFS XI and XII, which offers a community supported fishery for the sectors (NHCS, 2015). These creative efforts were helping keep fishing alive in New Hampshire.

The informant representing the Yankee Fishermen's Co-operative, and others who have been members, indicated that the Co-op was becoming less tenable, as the number of members landing fish has declined. Business predictability has declined, since the co-op relies on groundfish income to survive. Income from lobster, tuna, and shrimp landings was not sufficient. The Co-op was trying several strategies to remain solvent though, including local marketing at farmer's markets and opening a retail store onsite. It has offered Community Supported Fisheries, for shrimp, lobster, and groundfish (YFC, 2012). When the Portsmouth Co-op closed (in 2008), Yankee gained some fishermen who land in Rye by offering to truck their fish. A few informants noted that they were not sure how Yankee was surviving, and that losing just one

more groundfish fisherman could drive the Co-op under. An informant predicted that if Yankee closes, that would spell the end to groundfish fishing in the state, because the aging group of fishermen would not have the energy to truck their own fish to Gloucester or other ports. They would just stop fishing.

ACE USE BY NEFS XI AND XII

A large portion of the available ACE for the New Hampshire-based sectors has gone unharvested. For example, in FY 2010, the NEFS XI and XII were allocated roughly 5.8M pounds of 16 multispecies stocks, about 3% less than the 6.0M pounds of total landings in 2009 (Table 41). During that first year of sector operations, about 3.0M pounds of allocation was harvested by NEFS XI and XII (50% less than FY 09 landings), 330K pounds were leased to non-NH sectors (6% of the allocation), and the remaining 2.47M (43%) was left unharvested (J. Wiersma, personal communication, 2011).

Why were 2.47M pounds of the fish allocated to NEFS XI and XII not harvested in FY 2010? Catching the full quota (not only this first year) was inhibited by constraints on particular stocks that also have ripple effects on the ability to catch other stocks. Of the total harvest by these vessels, just three stocks accounted for 96% of 2010 landings (similar to 2009): Gulf of Maine (GOM) cod, pollock, and white hake (Table 41). Some stocks in the allocation portfolio of NEFS XI and XII were not useful to the members. For example, Georges Bank haddock distribution was too far offshore for their vessels to fish, and there was more overall allocation than can be harvested (low demand for leasing this stock). Catching commercial quantities of redfish requires using a small mesh trawl. NEFS XI and XII did not yet have such an exemption, so redfish was not targeted. These were some of the factors that caused the overall revenue for New Hampshire vessels in FY 2010 to be about 50% lower than in FY 2009 (J. Wiersma, personal communication, 2011).

Focusing on GOM cod and pollock more specifically, NEFS XI and XII started FY 2010 with low quota for both stocks, and because GOM cod and pollock are harvested together, the fishermen did not target either stock due to the risk of exceeding both quotas. In August 2010, NMFS raised the fishery-wide catch limit on pollock five-fold (5M to 25M lbs.), so it became more possible to fish. The rapid increase in pollock quota supply caused its lease price to drop from $0.50/lb to $0.05/lb. Pollock quota became easier to lease into the sector, but the opportunity to harvest pollock was hampered by the high cost of cod. As fishermen tried to target pollock, the demand for GOM cod increased, and its lease price increased from $0.75/lb to $1.50/lb. (J. Wiersma, personal communication, 2011).

PRESSURES TO CONSOLIDATE

Participation in the groundfish fishery by New Hampshire fishermen was on the decline. Within the population this study (n=81), all those individuals who held a permit and listed a New Hampshire town as their homeport, landing port or residence during at least one year from FY 2009 – FY 2012, and time scale of this study, the number of individuals, the number of individuals without a groundfish permit increased from 4% in FY 2009 to 25% in FY 2012 (Figure 2). The following snapshots are how and why some of the informants were inactive or former groundfish fishermen under sectors. Informants A and B no longer had groundfish permits, C and D were lease-only sector members, and Informant E had no allocation on his permit.

INFORMANT A. He sold his vessel and all of his permits in January 2011 and had shore-side employment at the time of the interview. He had been a fisherman for 31 years and thought that it was time to try something else, as his health was failing. Groundfish had been a minor fishery for him, and he got little allocation under the catch share program, including no cod, due to his catch history in the qualification years. The category of his permit got changed to a C permit,

which meant that no PSC was assigned to it. He would have had to lease in all fish to participate in the fishery. That would have been economically untenable.

INFORMANT B. He had been an active groundfish fisherman since the late 1980s, and had decided to enroll in a sector for FY 2010, but quickly saw his financial prospects dimming, so sold his groundfish permit in the fall of 2010 and switched over to lobstering:

> *I could see the future and what was going to happen. When my wife and I discussed it, we decided to grab the money before the permit was worth nothing. … [Otherwise,] we'd be sitting with a boat and a permit and get nothing out of it. … and by the looks of it, we did the right thing, because next year, I don't think they're going to be able to fish. The guys are going to starve to death and they're not going to get anything for their permits.*

He felt that with the declining catch limits, groundfish permits would soon be worthless, so he decided to sell while his permit still had some value.

INFORMANT C. He was an active groundfish fisherman until about 2007. He decided to sell his groundfish vessel and a permit when he felt that the regulations "got too overbearing." Another reason was that he found a willing buyer.

> *I mean, once you find a buyer, if you have anybody interested in the boat – the boat was in excellent condition – once you find a buyer, you hold onto them like Grimm Death.*

At the time of the interview, he had retained one groundfish permit, enrolled in a sector, and was leasing the ACE associated with it while continuing to be active in the lobster fishery. He felt like the sector program was much too complex and preferred to fish (lobster) in state waters.

INFORMANT D. For at least ten years prior to 2006, groundfish had constituted about 25% of his income. His plan was to retire from lobstering at age 55 and then remain a groundfish fisherman. One day, while fishing under the 800 lb./day DAS trip limit, he had an enforcement violation of exceeding the limit.

> *I came in over my limit, and I got like a $5,000 fine. … We had stacked the fish like they told us to. We had eight boxes that we could stack; we just had really heavy codfish. … I was just like, this is crap. I'm done. [laugh] So we quit. … The*

> *regulations were just too strict anyways. I mean, we were going and getting our 800pounds out of like five or six nets, so we were done at like eight or nine o'clock in the morning, and then we'd go lobstering the rest of the day. So I was just like, "I'm just going to go lobstering." It's easier, less hassle.*

He also received very little quota, because he was more active in the lobster fishery during the qualification years. He was making more money by lobstering and he recalls that managers promised that the catch share program would not be based just on catch history, so he thought he was "going to be all set." Later in the interview, he further revealed his rationale for leaving the fishery:

> *I'm not someone who goes and purposely violates laws and stuff. And that's why I quit. I was so ashamed when I got caught. The $5,000 fine was a big hit, but it wasn't going to end my career or anything. I was just ashamed. I'm like beyond goody-two-shoes, and it hurt my feelings so bad that I was just like, I can't do this because if I get caught again I'll just be, I'll be done, everything. I'll just sell my boat and be done. … I've always had a reputation of being pretty honest, and it just blew my mind that I did something dishonest, not even trying to. You know, it was just, it was, it was hard.*

Though he has had to rewrite his career path, he retained the groundfish permit, enrolled it in a sector, and leased what little fish it had to a friend.

INFORMANT E. His family has been groundfish fishing in New Hampshire since 1638, but he expected to be the last generation to do so. He last fished for groundfish in 1991, as he found lobstering to have more predictable income as the groundfish resource declined.

> *In the mid-70s, there was only one dragger in Hampton-Seabrook Harbor, and then there was a big boom of gillnetters and draggers all the way up through into the '90s. And then the fish stocks petered out. It was difficult to make a living. That's one reason I got out of the fishery is I mean, I had a mortgage to pay back then, and I couldn't do it ground fishing, but I could do it lobstering. So it's simple economics of you either pay the mortgage or you go chase the last codfish in the ocean and hope you catch it before the next guy does.*

When the DAS program began (1994), he did not have sufficient groundfish landings to be assigned any DAS, and so was issued a C permit. Thus, he had no catch history to be assigned

PSC when the catch share program began. Like Informant A, he chose to not join a sector, as leasing would be too expensive.

Though each of these informants mentioned low catch limits as constraining, their stories reveal the impact of the allocation formula used in the catch share program, reducing the number of people who could be viable by fishing on their own permits. Relying on leasing for all (or a majority) the ACE one needs was not economical for them.

REGIONAL CONTEXT

The groundfish fishery has not been flourishing under the catch share program. Revenue has generally declined since FY 2007, apart from an increase in FY 2011, particularly in FY 2012 and FY 2013 (Table 12). For some of the years, fishermen received overall increased prices for fish, but generally, the fishery has not followed normal supply and demand curves. Price increases have not kept pace with landings declines, attributable to constraining catch limits (Kitts, et al., 2011; Murphy, et al., 2015).

It was difficult to determine how profitability has changed fishery-wide, as there were new costs of sector membership and leasing allocation. Membership fee structures are unique across sectors, some charge a flat fee, others charge based on PSC or landings. There are three impediments to estimating leasing costs. Leases have occurred primarily at the individual permit or vessel affiliation levels, and the data have been only partially available to NMFS. Sectors report annually on some of the transaction costs, but there may be other hidden costs associated with broker fees, advertizing, and transaction times. Finally, there are no data available to judge the magnitude of lost leasing opportunities, where both lessee and lessor would have been better off had the transaction taken place (Kitts, et al., 2011; Murphy, et al., 2015).

The NEFSC reports that, not accounting for leasing (revenue gained by leasing out quota or the costs to lease in quota), the average share of revenue from groundfish trips per day for both

owners and crew fell to a four-year low in FY 2013. For vessels in the 30'-50' length range, including most of the New Hampshire vessels, the owner's share declined by 17.9% from the year prior. Average trip costs have remained stable since FY 2010, at least in the NEFSC calculations, such that the declines in profitability are attributed to changes in revenue (Murphy, et al., 2015).

By various measures, effort in the groundfish fishery had been declining for several years, and this has continued under catch shares. The number of "active" vessels fishery-wide, those with groundfish revenue from at least one trip, has declined since 1996 when effort controls became increasing restrictive to help rebuild stocks. At that time, there were over 1,000 active vessels. In FY 2013, there were just 323 (NEFMC, 2015). Between FY 2007 and FY 2013, the decrease was 50.3% (Table 11). So, although declines in effort occurred in New Hampshire, a 43.2% reduction in active vessels during that time span, the declines are keeping pace with the rest of the fishery (Kitts, et al., 2011; Murphy, et al., 2015). Declines in active vessels are not uncommon in catch share programs. In the Mid-Atlantic surfclam and ocean quahog fishery, after nine years of its ITQ program, 60% of the firms were non-harvesters (Brandt, 2005).

As Amendment 16 was being implemented, the public raised concerns about the potential for the catch share program to consolidate the fishery and decrease fleet diversity. There are about 1,500 individuals who have a holdings interest in the approximately 1,200 Northeast Multispecies limited access permits. With the allocation of Potential Sector Contribution based on catch history during set qualification years, a relatively small number of individuals hold most of the PSC. In FY 2010, the individual who held the most PSC fishery-wide held an average of 7.316 across the suite of stocks, with the median holding 0.128 and the average individual 0.010. By FY 2014, the top individual held and average PSC of 9.358, a 28% increase. Thus, fishery

holdings are becoming more consolidated – as hypothesized for this current study of the New Hampshire case.

With the consolidation in fishery effort and holdings, one may assume a concomitant decline in fleet diversity. The NEFSC and the Massachusetts Division of Marine Fisheries identified "species" of fishing vessels (unique combinations of gear type, vessel length, and primary landing port county) and measured species diversity trends since 1996. With the decline in active vessels, from over 1,000 in 1996 to under 400 in 2012, diversity has also declined, though a core group of vessel species has persisted. Since 2008, the decline in active vessels has outpaced the species decline. Thus, diversity has been declining, but the fishery make-up is remaining diverse (Thunberg & Correia, 2015).

A goal of Amendment 16 to the Northeast Multispecies FMP was to reduce overcapacity in the fleet, and while this has occurred, significantly more consolidation could have happened than actually has under the catch share program (NEFMC, 2015), perhaps due to the diversity of participants with complex motivations for participation.

SUMMARY

The macro-scale view that catch share programs provide economic benefits to participants is a stark oversimplification of the socioeconomic dynamics of a fishery. It reduces fishermen to rational actors, with undifferentiated economic needs and social relationships. Motivations and connections in the industry and their communities are complex. In the New Hampshire case, only three informants, or 21% of sector members, noted improved economic performance, contrary to the hypothesis explored. Profits and business predictability generally declined, though grass-root efforts are helping to sustain participation though use of permit banks and community supported fisheries. It was also hypothesized that pressures to consolidate are outweighing incentives to maintain a diverse fleet. The consolidation in New Hampshire is also occurring fishery wide.

Though some segments of the fishery were experiencing more consolidation than others (Murphy, et al., 2015), the fleet is remaining fairly diverse (Thunberg & Correia, 2015). Some of the New Hampshire fishermen were recognizing a transformation in the business climate of the groundfish industry, with more focus on maximizing one's utility. Although a vessel may have very efficient operations, the business may not be viable if leasing quota is required. Entering credit markets exposes fishermen to great risk. As has happened in other fisheries, a new cohort of non-harvesting participants (lease-only sector members) is emerging.

KEY OUTCOMES

1. Contrary to the hypothesis, participating in the catch share program improved the economic performance of just 14% of sector member informants.
2. The New Hampshire-based fishermen did, on the whole, not fare as well as could be assumed based on the theorized benefits of catch shares.
3. In New Hampshire and fishery-wide, profits and business predictability have declined and the number of active vessels and permit holders was declining.
4. It was difficult to definitively conclude that catch shares was causing this decline, because the fishery has had very low catch limits in an effort to rebuild stocks.
5. Catch shares has, however, transformed the business climate of the groundfish industry, with more focus on maximizing one's utility.

CHAPTER IX. OUTCOMES - SAFETY

RESULTS AND DISCUSSION

The informants were asked whether the rules governing each regulatory program have ever compromised vessel safety and to explain why. A majority (n=12; 57%) of informants indicated that the DAS program did not compromise safety (Table 43). The response was the same between informants who were sector members at the time of the interview and those in the common pool or former fishermen. If a large majority of sector members had said that the DAS program was unsafe, then that might have explained their decision to enroll in a sector. However, the degree to which DAS was perceived to be safe did not correlate with choosing to enroll in the sector program.

The informants who were currently or had fished actively in a sector (n=13) were then asked, if the sector regulations they operate(d) under have ever compromised vessel safety. A strong majority (77%) indicated that the sector program had not. The most common repeating idea when informants were asked to explain their responses to the closed-ended questions on safety was that there was no substantial change in safety in the transition to the catch share program. There were several fishermen (n=7) who indicated that safety was very important to them and they choose to be safe regardless of the regulations, though a few have observed other fishermen making choices that are unsafe, choices that were unrelated to the regulatory program. For example, gillnets must be tended regularly, because the fish caught in them are perishable. Thus, fishermen need to tend their nets regardless of the weather, so they may do so in unsafe conditions. One fisherman indicated that he had only had 39 DAS and a low amount of ACE under sectors, so it has been pretty easy to pick days to fish with safe weather conditions.

Regardless of the regulatory program, cuts in fishing opportunity (i.e., DAS or ACE reductions) make it more difficult to afford investment in vessel maintenance, which compromises safety.

> *"Days at sea, you could pick your days. You know, you had, oh well at the end there, you had 39 days which, you know, you try to stretch out….you could pick your days. But you can still pick your days as a sector too."*

Some informants said that fishing under the DAS had been unsafe (n=9). The full economic potential of a DAS would be lost if a vessel ended a trip early. To the subset of informants (n=5) indicating that fishing under sectors was a bit safer, the rationale included that fishing in a sector does not have the time constraints of passing the DAS demarcation line:

> *I hated having to stay out. That was the stupidest rule they ever had was if you caught two days' worth of fish you had to stay 24 hours. That was very unsafe. There was many a nights where we sat off the beach blowing forty or fifty, because we couldn't land, anchored up. It was ludicrous.*

With a bit more flexibility in choosing when to fish, there was less need to fish in bad weather. One fisherman who fishes alone indicated that without the "clock ticking," he was less rushed. He has a bit more time to fish and then lay to while he sorts and clean the fish; his deck operations have become rushed. Another fisherman indicated that he worked longer hours at sea under DAS, so would be more sleep deprived than he was under sectors.

A few informants indicated that the sector program was less safe than DAS were. One informant referred to the fishing practices of vessels that tend to fish offshore for multiple days. Under DAS, he said when there was a storm coming, fishermen would be more apt to go to shore rather than ride out the storm, using up valuable DAS. He felt that fishermen tend to stay at sea under sectors, because the "clock" was no longer running. Generally, the fishermen in the research population tend to fish for just a day or two, so they may be less likely to lay-to like he was referring to. Another informant felt that the federal observers that come on his vessel do not know how to be safe, and since the rate of observed trips has increased, safety has become more compromised. He would like the observers to stand in a certain place on his vessel that is safe,

but where they can see everything. He does not want an observer to stand where they will have collisions with the crew or be near the wenches. The observers do not have a lot of experience with being at sea and staying safe on a vessel.

Informants in the common pool indicated that they felt some pressure to fish in unsafe conditions, because fishing opportunities in the summer are more limited with the common pool ACLs split into trimesters:

> *...Where is the logic? … Is it safer for a 28-foot boat to fish during the summer, or to force them to haul nets out of the water, put them back in the water, jockey them around with the seasons and limits. It makes absolutely no sense.*

Some vessels are not made for safe winter fishing. A few informants in the common pool would prefer to fish in summer months when the water is calm.

REGIONAL CONTEXT

Assessing the safety of the groundfish catch share program region-wide relative to prior management approaches was difficult due to scant data on the safety of the Northeast Multispecies fishery. Commercial fishing, generally, is one of the least safe occupations. The National Institute of Occupational Health and Safety (NIOSH) reports that there was a national annual average of 46 deaths from commercial fishing during 2000-2010, or 124 per 100,000 workers, compared four per 100,000 workers among all U.S. industries. Dividing the nation into four regions, the highest percentage of those deaths occurred on the East Coast (33%, 2000-2009). Based on the number of fatalities, the Northeast Multispecies fishery was the fourth most deadly fishery from 2000-2009, with 26 fatalities, but measured by the number of workers, it was the most fatal fishery, with 600 deaths per 100,000 full-time equivalent employees. NIOSH has not yet reported comparative data for the years (2010 onward) since the catch share program was instituted (Lincoln & Lucas, 2010).

Jin et al. (Jin, Kite-Powell, Thunberg, Solow, & Talley, 2002) modeled accident probability in northeastern U.S. fisheries (including groundfish) using data from 1981-1993 and found that the probability declined during that time period. Greater accident probability was associated with high wind speeds, medium sized vessels, fishing in winter, fishing inshore versus offshore, and within the Gulf of Maine versus Georges Bank and Southern New England. Substantial management change occurred in 1994. Through Amendment 5, fishing was limited by Days-At-Sea, placing a premium on the time spent fishing and steaming to and from fishing grounds (Table 1). Effort shifted inshore from Georges Bank, though a number of inshore seasonal closures may have pressured smaller vessels to fish far enough offshore to be unsafe (Jin & Thunberg, 2005). This suggests that the fishery based in New Hampshire may be more susceptible to accidents than other communities in the Northeast.

Given the management changes, Jin and Thunberg (2005) updated the analysis with data through 2000 and examined potential economic and regulatory influences. Changes in fishery management since 1994 did not result in higher accident probability, though it may have contributed to higher probability of accidents in the Gulf of Maine versus other areas. Primarily, Jin and Thunberg found that safety was more dependent on physical factors such as weather, wind speed, and fishing location rather than management programs. However, programs can be designed to discourage fishing during unsafe physical conditions.

Jin and Thunberg (2005) theorized that management programs that allow more flexibility in when and where to fish would result in safer fisheries, as poor physical conditions could be avoided. The groundfish sector program was designed to provide this flexibility. With a few more years of data, the aforementioned regional studies are likely to soon be updated, for better evaluation of the influence of the catch share program on vessel safety.

SUMMARY

The informants indicated, overall, that the advent of the catch share program had resulted in no major changes in safety, because the informants largely strive to be safe no matter the management program. However, removal of trip limits for sectors had brought a degree of flexibility and less pressure to fish in unsafe conditions, while the trimester approach to managing the common pool was making the common pool members choose between fishing more in winter months versus potentially forgoing catch. Comparison of the New Hampshire case with the region was hampered by a lack of regional data. However, it was likely the case that sector fishermen were generally taking advantage of the increased flexibility of the catch share program to fish in safer conditions.

KEY OUTCOMES

1. Contrary to the hypothesis, fishing under the catch share program resulted in no major changes in fishing safety for the informants, because they strive to be safe no matter the regulations.
2. However, the flexibility inherent in catch chares provides fewer reasons to fish in unsafe conditions than Days-At-Sea or the common pool trimester approach.

CHAPTER X. OUTCOMES - WELL-BEING

RESULTS AND DISCUSSION

FAIR ALLOCATION

The informants were asked whether they consider the allocation formula used to calculate PSC holdings to be fair (i.e., catch history during the years 1996-2006). Not including one informant for which the question was not relevant (a party/charter HA permit holder), 70% of informants felt that the allocation was unfair to them (71% of sector members, 67% of other informants; Table 44). The most common rationale was that it was not a true measure of fishing history, because the informants had shifted effort away from cod during that period:

> *… between '95 and '01, I was doing what they wanted me to do and do [focus] another fishery [besides cod]. I was still a fisherman. I wasn't a lawyer, or an accountant, or I didn't go back to school. I thought I should get a 'thank you' note in the mail, and instead, the people that got the big allocations are the people that stayed in that fishery and pounded and pounded and pounded. They got rewarded.*

One informant was building a vessel during one of the years, so he had no catch, which brought down his average catch in the calculation. Informants had invested in buying permits for the number of DAS attached to them not the catch history, so with the allocation formula, they were stuck holding permits that had little value. Some felt that allocation by a combination of DAS, vessel size and catch history might have been a more balanced approach.

The New Hampshire Commercial Fishermen's Association was a plaintiff to a legal challenge in 2011 to several aspects of nascent catch share program, including the allocation formula used. In November 2012, during the time of these interviews, the court upheld the NMFS decisions ("Lovgren, J. et al. v. Locke, G. et al.," 2012). However, just one informant referenced the lawsuit, someone who withdrew membership in the Association in part due to his disagreement

with the plaintiffs. This was someone who thought that the allocation formula was fair to him and that others in the community were too backwards-looking:

> *There's no entitlement to being a fisherman. If you don't like, it's like a plumber or electrician or any of it, if it sucks, go do something else. Don't say that, 'I can't do something else.' That's a cop out. And I'm sick of having the New Hampshire guys say that. [Fisherman A]… is the biggest cry baby there ever was. If he put his head down and went fishing, but he fishes next to [Fisherman B] … who struck $700,000 a year. [Fisherman A] … hasn't even struck $300,000 right next to him. Don't blame the system; blame the fishermen.*

Another informant who considered the formula to be fair to him had very little fishing history on his permits, which drove his decision to fish in the common pool. To him, that offered greater potential to catch fish than had he joined a sector.

UNDERSTANDING REGULATIONS

The informants were asked if the level of difficulty in understanding the rules of the DAS and sector programs was about the same or if one was more difficult. Removing the two informants for whom the question was not relevant (had not participated in the DAS or sector programs), 37% said that the two programs were about equal, 37% said that sectors were more difficult, 16% said that DAS was more difficult, and 10% were unsure or did not answer the question (Table 44). Thus, there was not a strong trend in responses, though a slight lean towards indicating that the sector program rules were more difficult to understand. Of the sector members, 50% said that the two programs were about the same and 36% said that sectors were more difficult. Of the other informants, 40% said that sectors were more difficult. Others were unsure, did not answer the question, or thought DAS were more difficult.

The primary reason why informants thought the DAS was easier to understand was that the trip limit on cod was the only catch limit that they needed to keep track of. Under sectors, the catch of all stocks needs to be counted against sector ACE. There was also additional complexity with working with a sector manager and declaring a fishing trip:

> *Days at Sea were much simpler. Just this registration process nearly drives me insane. There's the whole observer thing. I have to register on the computer two days in advance and then I got to wait for this notification and then I got to send these trip end hails, catch reports and got to hand all this paperwork in to the sector manager. I mean, this is the most bureaucratic system I've ever seen, … and that's saying something.*

One informant indicated that having a sector manager had been particularly useful in helping understand the new operating rules.

FATIGUE

The informants were asked if their fatigue level at sea had decreased, remained the same, or increased since the advent of the catch share program. There were two informants for whom the question was not relevant, a former fishermen and a shore-based permit holder who does not go to sea himself. For the remainder, none of the informants answered that their fatigue had decreased, and 53% indicated that their fatigue level was unchanged while 47% indicated that it had increased (Table 45). There was differentiation between sector members and the other informants. A majority (62%) of the sector members said that their fatigue level had increased, while just 17% (n=1) of the other informants indicated such.

Many of the informants cited aging as a cause for increased fatigue, however, age did not correlate statistically with increased fatigue ($R^2 = 0.02$). A few of the sector member informants cited that they were working harder at sea under sectors, including the following informant who cited that working harder and aging was impacting fatigue:

> *I'm just older … we [used to] run 800 pounds of cod a day [under trip limits] and we didn't break a sweat. Now, you know, we had … 11,000 the other day. And we were like, "we're old." You got to be careful what you ask for.*

Two informants noted that they were more fatigued, because they had too many obligations under sectors. An interview included the fisherman's wife who corroborated the increase in fatigue due to sector obligations (see quote Chapter VI).

The informants who were not sector members largely said that their fatigue had not changed. Several of them were lobstering or had been fishing with hand gear, both of which are less physically taxing than groundfish fishing with gillnets or trawls.

STRESS

The informants were asked if fishing had become more or less stressful than it was before May 2010. Removing the one informant for which the question was not relevant (i.e., a former groundfish fisherman who had no other fishing permits), 75% of informants said that fishing had become more stressful (Table 45). For them, the most common stressful aspect of fishing was the general uncertainty of the future:

> *It's, knowing that there's always something getting ready to take everything you've got, or thinking you're going to lose everything you ever invested in … That's stress and that's enough to be dissatisfied over, sure.*

Other stressful themes include making sure one keeps in compliance with the regulations, and specific to participating in sectors, increased paperwork, computer use and fishery observers on one's vessel. Some of the former fishermen indicated that they left the groundfish fishery, because it was becoming too stressful. A member of the common pool said that the uncertainty of when the common pool would reach the trimester catch limits and shut down was particularly stressful.

Just two informants (10%) felt that fishing under sectors was less stressful, both of whom were sector members. One of these informants was leasing his ACE to other groundfish fishermen, focusing on lobstering, which was a much less stressful fishery for him. The other was an active groundfish fisherman who felt that fishing in a sector was generally less stressful, because he was less pressured to maximize catch to fulfill the cod trip limit, though the advent of increased at-sea observers had been more stressful.

Three informants (15%) felt that there had been no change in the level of stress; two of whom had focused on lobstering for several years. For the third, groundfish had been a minor component of his fishing portfolio, and he makes conscious efforts to live stress-free:

> *(Informant) I don't stress … I just don't stress … I mean, way back when I was raising my family and my children and stuff, yeah, I mean, there was stress there, I mean, yeah of course.*
>
> *(Interviewer) But nowadays you don't really consider it [fishing] a stressful thing.*
>
> *(Informant) No, fishing in bad weather and stuff, don't do it; (laughs) real simple.*

It could be that older fishermen are less stressed than younger, because they might be less concerned about ensuring years of productive income or have less business debts. Maurstad (2000) found that in the Norwegian cod fishery of the 1980s, other factors besides vessel capacity influenced the decisions to fish, particularly financial obligations (i.e., debt). Younger fishermen tended to be more debt-laden and more driven to fish harder than older fishermen who were relatively debt-free. For this dissertation, the degree of indebtedness was not investigated directly, however, a cross tabulation of age with stress reveals that age does have some correlation with stress in this case (Table 45). The two informants who indicated that they were less stressed under sectors were also in the oldest age bracket, 60-69. The youngest informant, the only one in the 30-39 age bracket, felt that fishing had become more stressful under sectors, in part, due to the need to take on more debt, by leasing in ACE to remain viable. Chapter VII describes further the financial risks fishermen face if they need to lease in ACE to remain viable. The stress associated with ACE leasing can be felt by fishermen of any age.

JOB SATISFACTION

The informants were asked if their job satisfaction had changed since the advent of the catch share program. Of the 18 informants who answered the question, 44% indicated that their satisfaction had decreased, 28% said that it had not unchanged, and 28% said that it had

increased (Table 45). Of the sector members, 54% indicated that their satisfaction had decreased, while 20% of the other informants (n=1) indicated such. Thus, the decline in job satisfaction was more pronounced among sector members than other informants.

For the majority who felt a decline in job satisfaction, the strongest themes expressed were that the informants were less happy and lost their love of fishing. For many, their recent loss in job satisfaction was part of a longer term decline:

> *Oh, I've lost my identity completely [laughing]. No, my job satisfaction is just like, it's not even a job. It's not a job anymore. I'm basically retired right now. I mean, I hit my marks and that's it. I mean, as far as having like a future in this business, it's over, it's done (pause) for me. You know what really pisses me off? They took my swagger, (laugh) by doing this $%^&. They really did. I mean you had pride and $%^&. And you don't have that $%^& going on when you're walking around. That was pretty cool. I miss that.*

Others spoke of being unsatisfied because of profit loss, difficulty with finding fish, and there were too many regulations and too much enforcement and observers.

Job satisfaction had increased for some (28%); two sector members tied the increase to the removal of the cod trip limit, one for the bycatch that was being avoided and the other for how fishing effort was less constrained:

> *(Informant A) Oh, definitely improved … There's nothing more demoralizing than kicking over 10,000 of large cod. It's just stupid … You know, and to have everybody doing it for the sake regulations.*
>
> *(Informant B) I think it's increased, yeah. It kind of sucked going out there knowing you could only catch so much no matter what you did.*

Job satisfaction was unchanged for some (28%). One sector member informant felt like a curmudgeon; he was never satisfied. A former groundfish fisherman who was solely lobsters was still satisfied, primarily because he can be on the water:

> *Well, I enjoy my job anyways, so it doesn't, I mean … you're fishing. That's, that's the main thing … If I had to go in the back of a garbage truck, I probably would be a little different, but.*

One sector member was determined to do well despite the regulatory program, and felt like the effort put in had been worthwhile:

> *(Informant) Seems like what you put in, you.*
>
> *(Interviewer) You get out?*
>
> *(Informant) Get out, yeah. And you know, it seems like the guys that always did well are still doing well, and the guys that did mediocre, some of them have gone by the wayside.*
>
> *(Interviewer) Others are struggling?*
>
> *(Informant) Yeah, yeah. But it's not the system. It's the fishermen, you know, but.*
>
> *(Interviewer) Do you feel like it's your personal determination to?*
>
> *(Informant) To succeed*
>
> *(Interviewer) Make it work?*
>
> *(Informant) To make it work, right.*

This example of a successful fisherman opens the avenue for a potential line of inquiry, how satisfaction correlates with the opportunities that differing amounts of PSC holdings provide. Within this sample of fishermen, though, there were certainly cases of full-time groundfish fishermen who were unsatisfied. Further discussion of job satisfaction is contained in the regional context section of this chapter.

RETIREMENT

The informants were asked if they expect to retire as a fisherman. Just two informants indicated that they did not. One, a former groundfish fisherman, had sold his permit and vessel and, at the time of the interview, was working in another industry. The second was a sector member who currently had his vessel and permits for sale. He was actively looking to exit fishing. All the other informants were still active in fishing, but 29% (n=6) were unsure whether they could continue as a fisherman until retirement. The majority (62%; n=62%) of informants felt that they would retire as a fisherman, whether they were still involved in the groundfish fishery or not (Table 45). The distribution of responses among sector members and other informants was

similar, 64% of the sector members and 57% of the other informants were sure they would retire as fisherman. Sector members generally felt like they have more years left fishing than the other informants. The average number of years that informants expect to be fishing was 4.6, ranging widely from 0 to 25 (Table 46). That average was higher for sector members, at 6.0±8.2 years. The average for the other informants was 1.7±0.8 years, ranging from 0-2. It may be that sector members may have more PSC assigned to their permits than others, and thus more assurance that they can participate in the fishery.

It was difficult to identify correlations between the age of an informant, whether they expect to retire as a fisherman and how many more years they expect to be fishing. The informants had a great deal of uncertainty about the future. Many expressed that they would try to keep fishing as long as possible, some out of determination and pride, and others because they felt financially stuck or that they would not be able to transition into another career:

> *[I'll be fishing] Till the boat sinks. … What else, like I say, what else is there? There's nothing. What do you do with a boat? Who is that boat valuable to? There's virtually no, nobody needs a boat. Everybody's got a boat. They need a permit.*

The uncertainty of future fishery regulations was also a concern that constrained retirement plans. In the following exchange, the fishermen's wife seems more determined than the fisherman that he would keep going until retirement:

> *(Interviewer) Do you expect to keep at this until you retire?*
>
> *(Wife) Yes.*
>
> *(Informant) Um...It depends on how old you think I'm going to be when I retire. I don't know. (laugh)*
>
> *(Wife) It's in the blood. His father is, his uncle, his other uncle.*
>
> *(Informant) Yeah I mean, I don't know. If I...*
>
> *(Wife) You don't know how not to work.*
>
> *(Informant) ... I might, I might miss it. I might miss it at some point if I was to stop, but I don't know. It depends on how difficult they made it, you know. I could be bought; there ain't no doubt.*

ADVICE TO YOUNG PERSON

The informants were asked if they would advise a young person to enter fishing. The majority (71%, n=15) said that they would not. This response was consistent among both the sector members and other informants (Table 46). The most common rationale provided was economic, that it is too costly to buy into the fishery and that there were better ways to make a living:

> *For the amount of capital that it would take to get underway for even a small operation like mine, if they spent that on anything else, they'd be further ahead. Almost anything else. Lots of other things.*

Some felt that it is a hard life with little reward. Others indicated that, with the uncertainty of regulations, it would be hard for a young person to build a business plan. One informant indicated that the physical safety risk is not worth the reward. A minority of informants (29%, n=6) indicated that they would advise a young person to enter the fishery, but with caution and careful thought about the finances.

OUTLOOK

Informants were asked if their outlook on the future of the New Hampshire groundfish fishery was negative, neutral or positive. The majority (71%, n=15) had a negative outlook and the remainder were neutral (29%, n=6). No one had a positive outlook. This response was consistent among both the sector members and other informants (Table 46). The strongest reasons for the negativity included that the New Hampshire fishermen cannot withstand continued cuts in quota, and a sense of disappointment that sacrifices in fishing effort had not paid off:

> *...I guess that's entirely up to the Service. I don't know where they're headed with this, and that's our, everybody's biggest concern is we keep doing all they ask us to do, and they keep telling us it's not enough. So that kind of gives you a negative outlook. This system itself is working, because we're still here. But if they keep every year taking away half, you run out of halves after a while.*

The perceived lack of opportunity for young people to enter the fishery, that it is an aging group of fishermen, was also a negative.

Under the current scenario of catch shares and low catch limits, some felt that only a few fishermen would survive, particularly the fishermen who currently hold large amounts of quota. There was a sense that fishing would become more corporate as the smaller-scale fishing operations go out of business. In terms of their own future, a few informants indicated that they did not want to make investments in the fishery or that they may go out of business soon. A few felt badly that they would not be able to pass their business onto their children. One likened fishing to gambling. Three informants were concerned about overfishing and the lack of fish.

LIVING LIFE OVER

Informants were asked if they could live their live over, whether they would still choose to be a groundfish fisherman. The majority of informants (67%, n=14) said that they would. However, fewer of the sector members than other informants (57% vs. 86%) indicated that they would be a fisherman again (Table 46). Those who would be a fisherman indicated that they would do so, because they enjoy the work despite the challenges and uncertainties. A few spoke of loving to work on the ocean:

> *I like the outdoors. I'd go nuts inside every day ... this last summer tuna fishing, I seen more sunrises and sunsets than a person probably sees their whole lifetime, really, because a lot of people are up after … sunrise, and sunset they're usually home like with the TV on. But then again, you know, an 8-5 job, weekends off, you know, not have to stress. I don't know, I'd probably still say I'd like to be a fisherman. (laugh) Glutton for punishment...ugh.*

Several of those who would not choose to be a fisherman again, reflected positively on many years of good fishing, but felt that the downturn of recent years made their career choices not worthwhile:

> *Just after what I've gone through, I mean, you know. I'm 45 years old. I have, you know, been in the industry almost thirty years, working on the docks and stuff and, you know, what do I got to show for it? You know, now I've got to change careers basically. So no, I wish I hadn't. It was fun for quite a few years but, you know, that was my hope I could retire a fisherman, but just in the last five years it's gone downhill fast.*

REGIONAL CONTEXT

Several researchers have noted the non-economic satisfactions that come from fishing, likely drivers for fishermen to continue fishing despite negative economic performance (e.g., Pollnac & Poggie, 2008). Assessing the well-being of participants in the groundfish catch share program region-wide relative to prior management approaches was difficult due to scant comparative data. Notably though, Pollnac and colleagues have conducted several studies of job satisfaction among fishermen, identifying components that consistently comprise this variable (e.g., Pollnac & Poggie, 2008). Pollnac et al. (2014) surveyed 478 fishermen (owner/captains, captains and crew) from Maine through North Carolina in 2012. Informants were asked to rank their satisfaction level with several aspects of fishing, fulfilling: basic needs (actual earnings, predictability of earnings, safety), social-psychological needs (time away from home, fatigue, healthfulness of job), and self-actualization (adventure and challenge of the job, opportunity to be your own boss). Informants who participated in the groundfish fishery had the lowest levels of satisfaction and were least likely to advise a young person to enter the fishery or choose to be a fisherman if they could live their life again. However, the self-actualization aspects of job satisfaction were high across all informants. An earlier study focusing on Rhode Island fishermen found similar results, that there was little change in self-actualization among fishermen between 1977 and 2010 (Pollnac, et al., 2011). This component of job satisfaction may be what keeps fishermen fishing despite decreasing economic performance (Pollnac & Poggie, 2008).

For this dissertation, job satisfaction questions were used as developed by Pollnac et al. (2014). Informants were asked a set of questions about their satisfaction as a groundfish fisherman, and if they were no longer groundfish fishing, their satisfaction with their new profession (Table 47). Consistent with other studies noted above, the New Hampshire fishermen were highly satisfied

with the self-actualization aspects of job satisfaction, with at least 76% of informants indicating that they were satisfied or very satisfied with the sense of adventure, sense of challenge and the opportunity to be self-employed. The basic needs and social-psychological aspects rated lower. Informants were the least satisfied with their earnings predictability and the healthfulness of the job.

Informants who had a current profession other than groundfish fishing were also asked the same series of job satisfaction questions related to their current profession. Overall, these informants were more satisfied with their current profession than all of the informants were as groundfish fishermen. There were only three responses of very dissatisfied or dissatisfied. Those who were lobstering indicated that they were not making as much money, but the income was more predictable.

The aforementioned Rhode Island-based study was conducted in 2010 and included examining several aspects of the transition to catch shares in the groundfish fishery (Pollnac, et al., 2011). It found that the sector members felt that the rules and regulations were less clear than nonsector members, which is consistent with this dissertation, which revealed that more New Hampshire fishermen in 2012 felt that the sector program was more difficult to understand than DAS. The Rhode-Island study surveyed 137 fishermen, with 17 identified as groundfish fishermen, and compared results to 1977 data. Longitudinally, there was a statistically significant drop in the percentage of informants who would encourage a young person to enter fishing, with 62% indicating “no” or “maybe” in 2010. Their 2010 results are consistent with this dissertation (71% of informants would not advise a young person to enter fishing), and suggests that this sentiment may not be unique to the groundfish fishery. In both studies, a majority of informants indicated that they would choose to be a fisherman again if they could live their life over (groundfish

fisherman specifically in the New Hampshire case), which points to the self-actualization aspects of the job that informants in both cases are satisfied with.

SUMMARY

The informants indicated, overall, that they had a decline in well-being since the advent of the catch share program. The majority felt that the allocation received though Amendment 16 was unfair, not a true reflection of their fishing history. Informants leaned towards feeling that the rules governing sector fishing were more difficult to understand than DAS. Informants were as fatigued, or more, than prior to FY 2010, and while aging was a factor, sector members in particular said that they were working harder and had more obligations. A vast majority of informants had become more stressed, including both sector and common-pool members; keeping in compliance with the regulations, increased paper and computer use and the increase in fishery observers (for sector members) were common themes. A decline in job satisfaction was particularly more pronounced amongst sector members, though the self-actualization facets of job satisfaction were high. A majority of informants felt that they would retire as fisherman, whether or not they were still active in the groundfish fishery. Sector members generally anticipated that they would be fisherman for a longer period of time than the other informants. A majority of informants would not advise young people to enter fishing and had a negative outlook for their community and the future of the groundfish fishery, though most would choose to be groundfish fishermen if they could live their life over due to the satisfactions derived from aspects such as working on the water. Overall, many of the declines in well-being were outcomes of the shift to catch share management, in contrast to the hypothesized benefits.

KEY OUTCOMES

1. Contrary to the hypothesis, the well-being of informants had generally declined, particularly sector members as they are constrained by the allocation given to them through Amendment 16 and fish under a program they felt was more complicated and fatiguing.
2. Informants would not advise a young person to enter fishing and had a negative outlook for the future of the New Hampshire groundfish fishing community.
3. Regional data was scant, but consistent with the current study, that fishing in a sector had increased stress among fishermen, though the self-actualization aspects of the profession (e.g., sense of adventure, being self-employed) remain high.

CHAPTER XI. CONCLUSIONS

A great deal of controversy has attended the introduction of catch shares in fisheries, particularly with the Northeast Multispecies program. In addressing the more general question: *How has the advent of catch shares impacted the Northeast commercial multispecies fishery, particularly in New Hampshire?,* answers to commonly asked questions about catch shares were sought through understanding how 21 commercial fishermen have been impacted by the program first-hand. Theories regarding six specific aspects of fishing have been examined to determine their validity and limits in this case and, where possible, more broadly across the fishery.

FISHING PRACTICES. It has been theorized that participating in a catch share program would increase the efficiency and flexibility for fishermen to decide when, where and how to fish. This theory was confirmed by sector member informants, who generally felt that fishing in a sector was more efficient and flexible than the Days-At-Sea program had been, generally due to shifting catch limits from a trip basis to an annual one. This had allowed more concentration of effort during times with greater potential for profitability (e.g., fish availability, favorable markets). However, those who were more dependent on groundfish for their income did not necessarily feel that one program was an improvement over another, though sectors were an improvement for vessels that were previously constrained by the trip limits (e.g., cod-dependent, larger vessels). For the wider fishery, there was evidence that removing trip limits had increased the mobility of larger vessels. The influx of vessels into local waters was a concern for several of the informants with smaller vessels. In general though, reduced groundfish fishing effort due to low catch limits had opened up more grounds for the local lobster fleet. Thus, the local groundfish fleet had increased gear conflicts from two sources.

SOCIAL CAPITAL. It has been theorized that participating in a catch share program would result in greater social capital (i.e., networking, reciprocity, trust) among fishermen in the conduct of business, in harvesting sector allocations, and in reducing bycatch. Despite being a novel focal point for industry organization, the sector member informants indicated that the sectors, as organizations, have been based on and built off of pre-existing social capital, rather than being a catalyst for social capital. The advent of sectors did not increase the voluntary involvement of informants in trade associations, and those who took new leadership roles in sector operations did so begrudgingly. The potential for collaborative, decentralized governance exists, though NEFS XI and XII had behaved more as a facilitator of individual allocations, though the professional manager had been an advocate in management and facilitator of improved business practices. There was little evidence that the informants were using social capital to coordinate fishing areas to reduce gear conflicts or bycatch. Though many felt that supporting the New Hampshire fishing community was important, it was not uniform.

BYCATCH. It has been theorized that catch share programs provide incentives and flexibility to harvest more selectively, thereby reducing bycatch. This theory was confirmed, at least by the quantitative NMFS data that suggest that bycatch of legal-sized target fish had been eliminated and overall bycatch of groundfish was low. The qualitative data from the research informants reveal more nuance. Reducing bycatch was an important goal of the informants, and the sector participants indicated that their level of bycatch had decreased, primarily through eliminating the trip limits and discards of legal-sized fish. Some informants went above and beyond regulations to avoid bycatch in recognition of the need to steward stocks for the future. Some sector members identified new pressures to discard when unobserved, driven largely by the high lease costs of choke stocks. At the vessel level, quota available had not matched natural abundance. A

new management tool to try to reduce bycatch, sharing of fixed gear, was not occurring, at least in the New Hampshire fishery. Although catch shares have the potential to reduce bycatch, evidence from this investigation suggests that externalities may be buffering gains. Though discarding may be reduced, the overall biological benefit is questionable if fishermen were targeting concentrations of fish more.

ECONOMIC PERFORMANCE. It has been theorized that the economic performance (e.g., profit margins and business predictability) of fishing businesses would improve under catch shares, though the fishery would consolidate (e.g., fewer permit holders and vessels actively fishing). Theory regarding profitability and predictability had not been realized, though the concomitant decline in, and persistently low, catch limits for certain key species (cod, yellowtail flounder) vanquished any potential that catch shares had for the economic success of this fishery. The groundfish fishery has not been flourishing under the catch share program, particularly in New Hampshire, though grass-root efforts were helping sustain participation (e.g., permit banks, community supported fisheries). Profits and business predictability generally declined. Only three of the informants noted improved economic performance; those who were able to cut operational expenses and not rely on leasing in fish fared better. Entering credit markets exposes fishermen to great risk. As in other fisheries, a new cohort of non-harvesting participants (lease-only sector members) emerged and fishery participants have had to navigate the nascent quota market. Fishery-wide, economic performance has generally been poor. Regarding consolidation, the number of people holding permits and the number of active vessels has declined as theorized (and as stated in the Amendment 16 goals). The fleet was remaining fairly diverse despite consolidation. The sense of self-actualization realized from working on the water, as well as the

logistical constraints with exiting the fishery, may be maintaining participation at levels above what economic theory might suggest.

SAFETY. It has been theorized that vessels participating in catch share programs would have greater operational safety. This theory was confirmed. The informants indicated, overall, that the advent of the catch share program had resulted in no major changes in safety, because the informants largely strive to be safe no matter the management program. However, removal of trip limits for sectors had brought a degree of flexibility and less pressure to fish in unsafe conditions, while the trimester approach to managing the common pool, was making the common pool members choose between fishing more in winter months versus potentially forgoing catch. Comparison of impacts in the New Hampshire relative to the region was hampered by a lack of regional data. However, it is likely that sector fishermen are generally taking advantage of the increased flexibility of the catch share program to fish in safer conditions.

WELL-BEING. It has been theorized that catch share programs improve the well-being of participants, decreasing stress and concern about the conduct of business and the future of the fishery. With declines in fishery participation and dim potential for positive economic performance, the sense of well-being and future outlook for self and fishery had diminished since the advent of the catch share program. Factors include a sense that the allocation formula had been unfair, the rules governing sector fishing were more difficult to understand than DAS, increased fatigue due to working harder and increased obligations. A decline in job satisfaction was particularly more pronounced amongst sector members, though the self-actualization facets of job satisfaction were high across all informant categories. Most informants would not advise young people to enter fishing and had a negative outlook for their community and the future of

the groundfish fishery, though most would choose to be groundfish fishermen if they could live their life over due to the satisfactions derived from aspects such as working on the water. A few informants remained optimistic and were determined to remain active in the fishery, no matter the specific management program in place.

This case study of the groundfish fishermen of New Hampshire revealed that the theorized benefits of catch share programs do not necessarily hold true. Of the six key aspects of fishing investigated here, only the benefits related to fishing practices, bycatch and safety support what has occurred in this local fishery (Table 48). The New Hampshire-based fishermen had, on the whole, not fared as well as could be assumed, based on theory.

The conclusions of this research must be kept in context of the biological status of the groundfish stocks and the severe reductions in catch limits implemented concurrently. These constraints have likely masked much of the positive potential for catch shares. Success under a catch share program is perhaps more likely attained in fisheries not constrained by stock rebuilding plans and by those participants able to adapt (e.g., tools, skills, financial resources, business savvy). Catch shares create markets for fishery quota that drive a fishery towards greater economic efficiency. If this is desired, catch shares may be a justified means, though managers should also expect and approve of the social consequences of enabling the privatization of public resources. If the aim is to share the beneficiaries of public resources, catch shares may not be justifiable.

CHAPTER XII. EPILOGUE

The New Hampshire commercial fishery has continued to evolve since the field work for this dissertation concluded in 2012. Despite successful efforts to locally market fish through New Hampshire Community Seafood, the persistently low catch limits has forced a number of tough changes. One informant, a sector member who at the time of the interview had his vessel and permits for sale, did find a buyer, but he found subsequent employment in shoreside support services. In FY 2015, NEFS XI and XII only have six or seven active fishermen, no longer landing enough fish to employ a full-time sector manager. The individual serving that role was able to move on to other employment in the field of fisheries policy advocacy. The new part-time sector manager used to be a full-time manager for another sector based in Southern New England. With declining participation, both sectors were forced to cut costs by making the manager a part-time position, but it works well to share one, because the respective memberships tend to be active at different times of year.

A key factor to the viability of the sector program has been the federal funding of the required fishery observers, though each year, the continued availability of this subsidy has been in question. Unfortunately, in the spring of 2015, NMFS announced that during the summer of 2015, federal funding for observers would no longer be available, and the sectors would need to cover this cost. On a per trip basis, this added cost would make fishing unviable for many participants. Federal funds have been extended for a few more months, and sectors and the Council are currently developing solutions. Catch share programs tend to require a high degree of monitoring to ensure compliance, but there needs to be sufficient value in the fishery to make it viable. This added cost alone may drive even the most efficient participants out of the fishery.

TABLES

Table 1 - Timeline of federal actions associated with Northeast Multispecies management

1976	*Magnuson Act enacted* This federal law established the regional fishing council management system and the Exclusive Economic Zone, creating federal jurisdiction of waters from 3-200 miles off the U.S. coast. The domestic landings of fish increased dramatically with the exclusion of foreign boats.
1986	*The Northeast Multispecies fishery management plan (FMP) adopted* Overfishing was occurring on 28% of the stocks (nationally). In the Northeast, NMFS and the NEFMC developed plans to end overfishing on cod, yellowtail flounder and haddock.
1994	*Multispecies FMP Amendment 5 adopted* To further protect stocks and promote rebuilding of fisheries, the following measures were established: permanent fishing closures, minimum net mesh sizes, the Days-at-Sea program, and reductions of fishing pressure on cod, haddock and yellowtail flounder. Fishermen were required to report landings, and there was a moratorium on new multispecies permits issued.
1996	*Magnuson-Stevens Act reauthorized (a.k.a. the "Sustainable Fisheries Act")* It established new mandates to reduce bycatch, protect essential fish habitats, and create specific stock rebuilding time-frames. National standards were included that emphasized minimizing the impact of management decisions on fishing communities and improving safety at sea. *Multispecies FMP Amendment 7 adopted* Area closures to protect juvenile and spawning fish were broadened and fishermen's Days-at-Sea were reduced.
1999	*Multispecies FMP Amendment 9 adopted* Overfishing definitions and optimum yield standards were established for 12 multispecies species, bringing the plan into compliance with the Sustainable Fisheries Act.
2001	*Multispecies FMP Amendment 11 adopted* Adopted essential fish habitat designations.
2004	*Multispecies FMP Amendment 13 adopted* Fishing pressure was further reduced and the first two fishing sectors were created (both of Cape Cod fishermen). There were measures to address overcapacity in the fleet, minimize bycatch, protect habitats, and improve reporting and record keeping requirements.
2007	*Magnuson-Stevens Act reauthorized* Amendments included a requirement to end overfishing in the U.S. by 2011 through the implementation of annual catch limits and accountability measures. The law also was changed to formally allow fishermen to organize into sectors.
2010	*Multispecies FMP Amendment 16 adopted* Implemented on May 1, the amendment included the authorization of 17 fishing sectors region-wide.
Reference: NEFMC (1993, 2009a).	

Table 2 - Development of Amendment 16 to the Northeast Multispecies FMP

2006	
Sept. 26-28	NEFMC votes to prepare an EIS and open a public scoping period.
Nov. 6	Committee holds a workshop with the AP and RAP to develop standards to guide development of management proposals for the Amendment.
Nov. 14-16	NEFMC reviews workshop outcomes and considers adopting recommendations.
Dec. 29	Scoping period closes with eight hearings held.
2007	
Jan. 18	Committee discusses scoping comments and forwards proposals to NEFMC.
Feb. 6-8	NEFMC agrees to stakeholder proposals for further consideration.
Summer-Fall	The sector concept gains traction.
2008	
Jan. – Dec.	Development of alternatives, including allocation formulas.
2009	
Feb. 9-11	NEFMC approves Amendment 16 DEIS.
Apr. 15	NEFMC-approved DEIS submitted to NMFS.
Apr. 24-Jun. 8	Public comment period on DEIS.
Jun. 24-25	NEFMC approves Amendment 16 FEIS.
Oct. 16	NEFMC-approved FEIS submitted to NMFS.
Oct. 23	NMFS publishes Notice of Availability of FEIS.
Oct. 23 – Dec.	Public comment period.
2010	
Jan. 21	NMFS sends letter to NEFMC indicating partial approval of Amendment 16 as voted on by the NEFMC.
Apr. 9	NMFS publishes Final Rule on Amendment 16.
May 1	Amendment 16 implemented.
Jun. 22-24	NEFMC begins work on what would become Amendment 18.

Table 3 – Control rules for common pool and sector vessels

Rule	**Common pool**	**Sectors**
Trip limits	Yes (daily)	No
Discard of legal-sized fish	Required if over the trip limit	Full-retention
Discard of sub-legal fish	Required	Required
Economic discards	Not allowed	Not allowed
Hard TAC	Since 5/2012	Since 5/2010
Reference: NEFMC (2013a)		

Table 4 - New Hampshire fishery data, 1720-1841

Year	Data	Reference
1669-74	*Port of Piscataqua:* Dry fish exported per year = 1.3 M lbs [a]	Van Deventer (1976: 90)
1694-1695	*Port of Piscataqua:* Dry fish exported per year = 246, 000 lbs [a]	Van Deventer (1976: 90)
1700	*Port of Piscataqua:* Dry fish exported per year = 146,000 lbs. [a]	Van Deventer (1976: 90)
1720	Vessels based in the Piscataqua River = 100 Fishermen and seafaring men = 400	Van Deventer (1976: 90)
1789-1791	*Port of Piscataqua:* Dry fish exported to Europe = 28,000 lbs. [a] Dry fish exported to West Indies = 2.94 M lbs.	Belknap (1812: 162)
1791	*Piscataqua and its neighborhood:* [b] Number employed in the cod and scale fishery Schooners 27 Boats 20 Tonnage 630 Seamen 250	Belknap (1812: 162)
1839	*Landing record of Capt. Oliver:* Small and large cod = 242,000 lbs.	Oliver (1815)
1841	Vessels based in the Piscataqua River = 81	Saltonstall (1941: 197)

Notes:

[a] Weight was measured in quintals. One quintal equaled 112 lbs. of dried fish (Rosenberg et al., 2005). The conversion factor between dried and round cod is roughly 1:3 (K. Alexander, personal communication, 2012).

[b] Excludes the Isles of Shoals.

Table 5 - New England fishery data, 1880: employment, vessels, and boats

			Employment		Vessels [a]		Boats [b]	
	Capital Invested	Value of Product	Fishermen	Shoresmen	Vessel number	Tonnage	Number	Value
Maine	$3,375,994	$3,614,178	8,110	2,961	806	17,632.65	5,920	$245,624
New Hampshire	$209,465	$176,684	376	38	23	1,619.95	211	$7,780
Massachusetts	$14,334,450	$8,141,750	17,105	2,952	1,054	83,232.17	6,749	$351,736

Notes:
[a] "Vessels" were large enough to venture offshore to the Grand and Western Banks (Wilcox, 1887).
[b] "Boats" were small and would be used to fish inshore (Wilcox, 1887).
Reference:
Goode and Collins (1887).

Table 6 – New England fishery data, 1880: value of products by fisheries

	General [a]	Whale	Seal	Menhaden	Oyster	Sponge	Marine salt
Maine	$3,578,678				$37,500		
New Hampshire	$6,581,204	$2,089,337		$61,769	$405,550		$3,800
Massachusetts	$170,634				$6,050		

Notes:
[a] Includes all food species except oysters.
Reference:
Goode and Collins (1887).

Table 7 - Landings in New Hampshire by species, 1950 to 2010 (lbs.)

	Species	2010	2005	2000	1995	1990	1985
Anadromous	Alewife	7,469					61,300
	American Shad		25	5,942	30,561	38,206	7,300
	Eel	81			65	502	2,230
	Rainbow Smelt	4					2,800
	Sturgeons					140	
Groundfish	Atlantic Cod	1,226,518	1,293,047	1,756,330	2,761,019	3,774,455	1,656,700
	Flounder	58,012	264,364	516,813	523,366	649,878	1,290,900
	Haddock	18,427	98,680	134,301	34,234	36,057	104,900
	Pollock	1,041,589	1,996,786	1,337,440	842,404	1,699,460	1,646,500
	Redfish	17,981	32,461	47,992	19,287	31,784	46,600
	White Hake	106,264	270,334	705,446	480,739	1,521	358,000
Invertebrates	Lobster	3,658,884	2,556,232	1,709,746	1,834,794	1,658,200	1,193,881
	Sand Lance						
	Bloodworms						
	Clam					9,010	
	Conch			274	4,544		
	Crab	169,729		693,152	120,912	206,616	
	Sandworms						
	Sea Urchins			792	4,074	59,800	
	Sea Scallops	360	76,414		256		400
Pelagics	Atlantic Herring	2,829,980	12,562,021	5,581,880	320,394	368,000	5,100
	Atlantic Mackerel	343	1,306	7,620	45,812	49,645	14,600
	Swordfish						
	Tuna	99,028	28,143	8,171	105,110	62,194	39,700
Other	Atlantic Halibut	339	515	9,552	802	848	700
	Atlantic Wolffish			21,674	39,915	25,409	39,700
	Bluefish			23,927	186,979	197,075	22,600
	Butterfish			7,335	283	1,207	500
	Cusk	2,348	8,157	81,181	102,031	127,928	46,500
	Goosefish	172,441	1,225,813	1,872,520	932,505	265,089	127,600
	Hake, Other	215,716	101,453	388,841	218,603	582,208	396,600
	Menhaden	390				264,500	
	Northern Shrimp	963,294	566,900	467,956	1,658,588	986,194	457,300
	Skates		20,705	84,709	54,281	23,140	5,100
	Spiny Dogfish	1,213,903	152,969	2,334,497	2,106,255	185,175	
	Squids				881	810	1,300
	All other	16,721	24,569	87,494	256,165	163,607	90,800
	Total:	**11,819,821**	**21,280,894**	**17,885,585**	**12,684,859**	**11,468,658**	**7,619,611**

Reference: NMFS (2012).

Table 7 – cont.

	Species	1980	1975	1970	1965	1960	1955	1950
Anadromous	Alewife			31,000	125,000	95,000		
	American Shad	6,900	500					
	Eel	6,000	5,600	5,500	5,000	6,000	6,000	
	Rainbow Smelt	18,300	25,000	58,000	110,500	37,000	70,000	300
	Sturgeons	1,100	500	200				
Groundfish	Atlantic Cod	2,376,300	670,900	189,000	85,000	20,000		4,400
	Flounder	2,418,400	131,100	65,500				
	Haddock	1,961,900	59,500	7,000	60,000	20,000		800
	Pollock	2,395,100	1,079,400	2,900	10,000	5,000		1,600
	Redfish	583,900	9,100	8,000				
	White Hake	819,800	283,400	900	1,500			16,000
Invertebrates	Lobster	723,900	480,000	688,000	765,000	935,000	850,000	612,700
	Sand Lance		8,700	18,000	25,000			
	Bloodworms	4,800			1,000	6,000	2,500	100
	Clam							7,500
	Conch							
	Crab	42,000	50,600	60,500	37,000	50,000	20,000	
	Sandworms	22,200	28,700	15,000	16,000	3,000		
	Sea Urchins							
	Sea Scallops	49,300						
Pelagics	Atlantic Herring	6,635,800						
	Atlantic Mackerel	13,500	300		1,200	8,500		
	Swordfish	93,200						
	Tuna	800	11,200	15,000	10,000			
Other	Atlantic Halibut	3,200	2,100	500	2,800			100
	Atlantic Wolffish	23,500	12,000	300				200
	Bluefish	1,500						
	Butterfish							
	Cusk	314,800	153,500	1,000	10,000	3,000		1,200
	Goosefish	51,000	17,600					
	Hake, Other	89,600	23,200	18,000				
	Menhaden							
	Northern Shrimp	13,800	64,800	120,000				
	Skates	39,500						
	Spiny Dogfish	14,800						
	Squids							
	All other	25,700	24,200	14,500				200
	Total:	**18,750,600**	**3,141,900**	**1,318,800**	**1,265,000**	**1,188,500**	**948,500**	**645,100**

Reference: NMFS (2012).

Table 8 - Landings in New Hampshire by fishing gear, 1950 - 2010.

	Gear	2010	2005	2000	1995	1990	1985
Dredge	Dredge Urchin, Sea				2,943		
	Dredge Scallop, Sea	107		438,556			
	Dredge Clam					9,010	
	Dredge Other	117,624	21,675				
Gillnets	Gillnets, Other		10				2,804,700
	Gillnets, Drift, Other						
	Gillnets, Sink/Anchor, other	3,273,983	4,327,692	7,098,024	7,124,792	5,661,818	
Lines	Lines Hand, Other	117,241	160,136	65,107	107,999	65,085	38,200
	Lines Jigging Machine				815		
	Lines Troll, Other				304		
	Lines Long set with Hooks				431	480	
Nets	Bag Nets						
	Cast Nets	6,163					
	Dip Nets, Common	8					21,100
	Haul Seines, Beach	29					
	Purse Seins	91,819	835,080			632,500	3,500
	Weirs/Pound nets	954					45,230
Traps	Pots/Traps, Lobster Inshore	832,750	392,273	434,876	572,205	1,011,150	
	Pots/Traps, Lobster Offshore		1,595,601	2,067,396	1,395,979	925,641	5,800
	Pots/Traps, Other	2,995,512	733,703		575		
Trawls	Otter Trawl Bottom, Fish	3,953,856	12,441,695	1,817,422	1,812,583	1,902,631	2,843,600
	Otter Trawl Bottom, Shrimp	204,710		692,944	1,665,342	1,200,580	670,500
	Otter Trawl Midwater	98,250	111,800	888,061			
	Midwater Trawl, Paired		422,102	4,350,828			
Other	Harpoons, Other	1,138	3,227	1,419	201		1,500
	Spears						
	Hoes						
	Diving outfits, Other		3,883	792	690	59,800	
	All Other	125,677	232,017	30,160			1,185,481
	Total:	**11,819,821**	**21,280,894**	**17,885,585**	**12,684,859**	**11,468,695**	**7,619,611**

Reference: Federal landings database. NMFS (2012).

Table 8 – Cont.

	Gear	1980	1975	1970	1965	1960	1955	1950
Dredge	Dredge Urchin, Sea							
	Dredge Scallop, Sea	49,300						
	Dredge Clam							
	Dredge Other							
Gillnets	Gillnets, Other	5,409,700	1,803,700	125,700				
	Gillnets, Drift, Other				1,200	8,500		
	Gillnets, Sink/Anchor, other							
Lines	Lines Hand, Other	142,200	71,900	69,400	156,300	30,000	55,000	5,400
	Lines Jigging Machine							
	Lines Troll, Other				2,500			
	Lines Long set with Hooks	424,500	201,100	19,800	105,500	48,000		19,400
Nets	Bag Nets	6,300	3,100	2,500	3,500			
	Cast Nets							
	Dip Nets, Common	4,800	4,500	11,000				
	Haul Seines, Beach		8,700	18,000	25,000			
	Purse Seins	6,635,800						
	Weirs/Pound nets	9,400	9,200	35,500	152,000	108,000	21,000	
Traps	Pots and Traps, Lobster Inshore	551,000	492,000	708,000	780,000	985,000		612,700
	Pots and Traps, Lobster Offshore	181,400						
	Pots and Traps, Other	33,500	38,600	40,500	22,000		870,000	
Trawls	Otter Trawl Bottom, Fish	5,274,900	392,200	120,600				
	Otter Trawl Bottom, Shrimp		79,000	149,300				
	Otter Trawl Midwater							
	Midwater Trawl, Paired							
Other	Harpoons, Other	800	11,200	15,000	7,500			
	Spears		1,800	2,500				
	Hoes	27,000	28,700	15,000	17,000	9,000	2,500	7,600
	Diving outfits, Other							
	All Other							
	Total:	**18,750,600**	**3,145,700**	**1,332,800**	**1,272,500**	**1,188,500**	**948,500**	**645,100**

Reference: Federal landings database. NMFS (2012).

Table 9 – Population and informant stratification

Category	Population	Informants	Response Rate
NEFS XI & XII	27 (32%)	11	41%
Other sector	11 (13%)	3	27%
Common pool	22 (26%)	5	23%
Former fisherman	21 (25%)	2	9.5%
Dealers	4 (4.7%)	3	75%
Total	**85** (100%)	**24***	**28%**

Notes:
*Twenty-two interviews were conducted. Two were of dealers who also fit into another category, "NEFS XI & XII" and "former fisherman." One person was interviewed twice, once representing himself and once representing a dealer entity.

Table 10 - Calculation of DAS and sector bycatch

Days-At-Sea	Sector Management
Non-target catch = N_D	Non-target catch = N_S
Sub-legal target catch = S_D	Sub-legal target catch = S_S
Regulatory discards [a] = R_D	Regulatory discards [b] = 0
Total bycatch = $N_D + S_D + R_D$	Total bycatch = $N_S + S_S$

Notes:
[a] Under DAS, regulatory discards are legal-sized fish caught in excess of the daily trip limit, which must be discarded at sea.
[b] Under sectors, there are no regulatory discards, because there is no daily trip limit.

Table 11 – Number of active groundfish vessels, New Hampshire vs. total

Fishing Year	New Hampshire	All states (ME to NJ)	%NH
2007	44	658	6.7%
2008	42	611	6.9%
2009	43	566	7.6%
2010	32	446	7.2%
2011	28	418	6.7%
2012	25	400	6.3%
2013	25	327	7.6%

Notes: FY 2007-2009 data from Kitts et al. (2011); FY 2010-2013 data from Murphy et al. (2015). "Active" means vessels with revenue from at least one groundfish trip.

Table 12- Fishery revenue and vessel length, New Hampshire vs. total

Fishing Year	New Hampshire	All states (ME to NJ)	%NH
2007	$3.6M	$94M	3.8%
2008	$4.2M	$91M	4.6%
2009	$4.5M	$87M	5.2%
2010	$3.3M	$83M	3.9%
2011	$4.2M	$89M	4.7%
2012	$3.3M	$68M	4.8%
2013	$1.9M	$55M	3.5%
	<45’	<~90’	

Notes: FY 2007-2009 data from Kitts et al. (2011); FY 2010-2013 data from Murphy et al. (2015). Revenue in 2010 dollars. “Active” means vessels with revenue from at least one groundfish trip.

Table 13 - Homeports and landing ports of the permit holder population and informants

		Homeport/Hometown		**Landingport**	
State	**Port**	**Population**	**Informants**	**Population**	**Informants**
ME	Jonesport	1.2%		1.2%	
	York	1.2%		1.2%	
	Eliot	1.2%			
	Kittery	2.5%		1.2%	4.8%
NH	Newington	1.2%		1.2%	
	Portsmouth	27.%	43%	31%	38%
	New Castle	1.2%			
	Rye	17%	19%	19%	19%
	Hampton	22%	14%	17%	
	Seabrook	8.6%	14%	11%	24%
	Hampton Falls	2.5%		1.2%	
MA	Newburyport	3.7%		3.7%	
	Gloucester	4.9%	4.8%	8.6%	9.5%
	Boston	1.2%			
	New Bedford	1.2%	4.8%	1.2%	4.8%
NJ	Tom's River	1.2%		1.2%	
VA	Greenbackville			1.2%	
NC	Bath	1.2%			
Total		100%	100%	100%	100%

Reference: Interviews for informants. NMFS (2013) for all others in population.
Note: For non-informants, NMFS data for FY 2012 were used, or the last year that the individual was listed as a permit holder. $N_{population} = 81$; $N_{informants} = 21$.

Table 14 – Sex of population and informants

	Population	**Informants**
Male	91%	100%
Female	2.5%	0%
Unknown	6.2%	0%
n	81	21

Table 15 - Permits held by the population and informants in FY 2012

Number of commercial groundfish permits

	Population (n=81)		**Informants (n=21)**	
# held	Frequency	%	Frequency	%
0	20	24.69%	2	9.52%
1	44	54.32%	10	47.62%
2	7	8.64%	2	9.52%
3	6	7.41%	4	19.05%
4	2	2.47%	2	9.52%
5	2	2.47%	1	4.76%
Mean	1.2±0.1		1.9±0.3	

Category of commercial groundfish permits held

	Population (n=61)		**Informants (n=21)**	
Category	Frequency	%	Frequency	%
A	47	77.05%	14	73.68%
HA	9	14.75%	3	15.79%
C	1	1.64%	1	5.26%
D	1	1.64%	0	0.00%
F	1	1.64%	0	0.00%
multiple	2	3.28%	1	5.26%

Table 16 - Specific sectors individuals enrolled in

	FY 10				FY 11				FY 12			
	pop		informants		pop		informants		pop		informants	
	n	%	n	%	n	%	n	%	n	%	n	%
NEFS XI	30	37%	8	38%	30	37%	8	38%	25	31%	8	38%
NEFS XII	5	6%	4	19%	6	7%	3	14%	5	6%	3	14%
SHS	3	4%	2	10%	2	2%	2	10%	3	4%	2	10%
NEFS II	6	7%	1	5%	7	9%	1	5%	7	9%	1	5%
NEFS III	1	1%	0	0%	1	1%	0	0%	1	1%	0	0%
multiple	2	2%	0	0%	0	0%	0	0%	0	0%	0	0%
n/a	34	42%	6	29%	35	43%	7	33%	40	49%	7	33%
Total	81	100%	21	100%	81	100%	21	100%	81	100%	21	100%

n/a = Individual did not enroll in a sector.

Table 17 - Age of informants

	Enrollment status as of FY 2012					
	NEFS XI or XII	Other sector	Common pool	Former fisherman	Total	
Age 30-39	1	0	0	0	1	5%
Age 40-49	4	2	2	0	8	38%
Age 50-59	3	0	2	2	7	33%
Age 60-69	3	1	1	0	5	24%
Total	11	3	5	2	21	100%

Table 18 - Other informant demographics

Did you work as a commercial fisherman prior to holding a permit? (n=21)

No	1 (4.8%)
Yes	20 (95%)

How long has your homeport been your homeport? (n=21)

Mean	Since 1987±13 years
Range	1964 – 2010

*How long has your landingport been your landingport? (n=20)**

Mean	Since 1991±14 years
Range	1964 – 2010

*How many vessels do you currently own? (n=20)**

Mean	1.1±0.6
Range	0-3

Did you recently buy or sell any vessels? (n=21)

No	14 (67%)
Yes	7 (33%)

*What is the length of vessel that you fish(ed) groundfish with? (n=20)***

Mean	41±8 ft.
Range	24 – 61 ft.

*What is the horsepower of vessel that you fish(ed) groundfish with? (n=20)***

Mean	315±55
Range	220 - 402

* One former fisherman doesn't have a landingport, since he doesn't fish at all anymore.
** No data for one former fisherman.

Table 19 - Performance of the New Hampshire multispecies industry

	FY 2009 [a]	FY 2010 projected [b, e]	FY 2010 actual	FY 2011 actual
Permit owners	tbd	36	24 (6) [f]	24 (tbd)
Permits	tbd	56	41 [f]	56
Active vessels	43 [d]	42	24 (6) [f]	28 (tbd)
Lease-only vessels	n/a	n/a	8 [f]	8 [f]
ACE total	n/a	n/a	5.8M lbs. [d]	tbd
ACE harvested	6.0M lbs. [c]	n/a	3.0M lbs. [d]	tbd
ACE leased out	n/a	n/a	330K lbs. [d]	tbd
Fishing trips	3,332	n/a	1,442 [d]	tbd
Home port revenue	$6.1M	n/a	$3.3M [d]	tbd

Notes:
[a] Fishing Year 2009 was prior to sector implementation.
[b] The figures for FY 2010 compare what was stated in the Environmental Impact Assessment with what actually occurred.
[c] In 2009, there was no TAC. This figure is total landings.
() denotes vessels fishing in the "common pool."
References:
[d] Kitts et al. (2011).
[e] Northeast Fisheries Sectors XI (2010a) and XII (2010).
[f] J. Wiersma, personal communication, 2011.

Table 20 - ACE use by informant sector members

Were you a sector member for lease-only purposes or did you actively fish?

	FY 10	FY 11
Lease-only	13%	14%
Active	7%	7%
Both	80%	79%
n	15	14

Were you able to harvest all your allocation?

	FY 10	FY 11
no	33%	21%
yes	66%	79%
n	15	14

Table 21 - Efficiency

Which program provides greater efficiency for fishing operations?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
DAS	6	29%	4	29%	2	29%
sectors	8	38%	7	50%	1	14%
equally efficient	2	10%	2	14%		
equally inefficient	1	5%			1	14%
unsure	2	10%	1	7%	1	14%
unknown	1	5%			1	14%
n/a	1	5%			1	14%
	21	100%	15	100%	7	100%

Table 22 - Informant rationale for perspectives on fishing efficiency and flexibility

Why sectors are more efficient and flexible:

- No daily trip limits
- Knowing one's allocation at the beginning of the year
- Ability to trade allocation
- No limit on the number of gillnets that a fishermen can use at once
- Better catch per effort for some

Why DAS were more efficient and flexible:

- When targeting cod, it was fairly easy to catch the trip limit
- Better catch per effort for some

Table 23 - Flexibility

Which program provides greater flexibility for fishermen to decide where, when, and how to fish?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
DAS	4	19%	3	21%	1	14%
sectors	11	52%	10	71%	1	14%
equally inflexible	1	5%			1	14%
unsure	3	14%	1	7%	2	29%
unknown	1	5%			1	14%
n/a	1	5%			1	14%
n	21	100%	15	100%	7	100%

Table 24 - Labor

How many individuals worked on your boat(s) at a given time?

	n	Mean	Range
FY 09	21	2.4±1.2	1 - 6
FY 10	21	2.3±0.9	1 - 4
FY 11	19	2.3±1.0	1 - 5

How many total people did you employ as crew throughout the year?

	n	Mean	Range
FY 09	21	2.3±1.7	1 - 6
FY 10	21	2.2±1.6	1 - 7
FY 11	19	2.3±2.1	1 - 10

Table 25 - Gear

What was your principal groundfish gear type? (n=21)

	FY 09	FY 10	FY 11
trawl	29%	19%	29%
gillnet	33%	33%	29%
handgear	14%	19%	10%
combination	5%	10%	5%
n/a	19%	19%	29%

In FY 2011, what was your principal groundfish gear type? (n=21)

	NEFS XI & XII	Other sector	Common pool	Former fisherman	Total
trawl	4	2	0	0	6
gillnet	5	0	1	0	6
handgear	0	0	2	0	2
combination	0	1	0	0	1
n/a	2	0	2	2	6
total	11	3	5	2	21

Did you make any changes to your groundfish gear? (n=21)

	FY 09	FY 10	FY 11
no change	67%	52%	52%
change	10%	24%	14%
unknown	5%	0%	0%
n/a	19%	24%	33%

Compared to the year prior, did your gear loss rate decrease, remain the same, or increase?

	FY 09	FY 10	FY 11
no change	76%	76%	52%
increase	5%	10%	19%
unknown	5%	5%	0%
n/a	14%	10%	29%

Table 26 - Fishing trips

How long was a typical groundfish fishing trip (hours)?

	n	Mean	Range
FY 09	17	15±11	5-42
FY 10	16	12±6	6-33
FY 11	15	12±2	8-16

How were area conflicts relative to the year prior?

	FY 09	FY 10	FY 11
Decreased	4.76%	4.76%	4.76%
No change	61.90%	52.38%	38.10%
Increased	19.05%	33.33%	33.33%
Unknown	4.76%	4.76%	0.00%
n/a	9.52%	4.76%	23.81%

Table 27 - Affiliation with industry organizations

Do you belong to any industry organizations, not including your sector?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
no	2	10%	0	0%	2	29%
yes	19	90%	14	100%	5	71%
n	21	100%	14	100%	7	100%

Which industry organizations to you belong to? (n=21)

Northeast Seafood Coalition	62%
NH Commercial Fishermen's Assoc.	33%
National Assoc. of Charter Boat Operators	5%
Maine Professional Guides Association	5%
Granite State Fish	10%
Yankee Fishermen's Co-op	14%
Associated Fisheries of Maine	10%
Northeast Tuna Club	5%
Northeast Hook Fishermen's Assoc.	5%
Salt Water Party Boat Assoc.	5%

Have you served as a leader in any of these organizations?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
no	12	57%	7	50%	5	71%
yes	9	43%	7	50%	2	29%
n	21	100%	14	100%	7	100%

Table 28 - Sharing within the fishing community

Do you share any equipment with other fishermen?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
No	10	53%	6	46%	4	67%
Yes	9	47%	7	54%	2	33%
n	19	100%	13	100%	6	100%

Do you share any equipment with other fishermen?	*What was your principal groundfish gear type in FY 11?*					
	Trawl	Gillnet	Handgear	Combo.	n/a	Total
No	3	3	1	0	3	10
Yes	3	3	1	1	1	9
Unknown	0	0	0	0	2	2
total	6	6	2	1	6	21

Do you share information about fishing areas with other fishermen?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
No	5	24%	3	21%	2	29%
Yes	16	76%	11	79%	5	71%
n	21	100%	14	100%	7	100%

How many fishermen do you share information with about what you're catching?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
Whole community	2	10%	2	14%	0	0%
part of community	19	90%	12	86%	7	100%
	21	100%	15	100%	7	100%

If part of the community, how many?

Mean	Mean	Mean
7.11±6.04	5.83±4.28	9.29±8.20

Table 29 - Community ties

How often do you trust fishermen in your community (NH) in business?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
Never	4	19%	3	21%	1	14%
Sometimes	14	67%	8	57%	6	86%
Always	3	14%	3	21%	0	0%
n	21	100%	14	100%	7	100%

Are there some fishermen you avoid talking with?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
No	7	33%	5	33%	2	33%
Yes	14	67%	10	67%	4	67%
n	21	100%	15	100%	6	100%

Is helping a fisherman inside your community more important than helping a fisherman from outside?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
No	7	33%	4	29%	3	43%
Yes	14	67%	10	71%	4	57%
n	21	100%	14	100%	7	100%

How important to you is keeping allocation within the New Hampshire fishing community?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
Not important	2	10%	2	14%	0	0%
Neutral	3	14%	3	21%	0	0%
Important	15	71%	9	64%	6	86%
n/a	1	5%	0	0%	1	14%
n	21	100%	14	100%	6	100%

When selling/leasing allocation, are you willing to accept a lower price to keep it in the community?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
No	8	38%	7	50%	1	14%
Yes	8	38%	7	50%	1	14%
n/a	5	24%	0	0%	5	71%
n	21	100%	14	100%	7	100%

Table 30 - Views of NMFS

In general, how often to you trust NMFS to have the best interests of the industry in mind?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
Never	8	38%	7	50%	1	14%
Sometimes	11	52%	7	50%	4	57%
Always	2	10%	0	0%	2	29%
n	21	100%	14	100%	7	100%

Table 31 - Degree of social capital within sectors

Have you served on the Board of your sector?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
No	10	48%	9	64%	1	14%
Yes	5	24%	5	36%		
n/a	6	29%	0	0%	6	86%
n	21	100%	15	100%	7	100%

Do sector members respect sector rules?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
Yes	14	67%	13	93%	1	17%
Can't say	1	5%	1	7%	0	0%
n/a	6	29%	0	0%	6	86%
n	21	100%	14	100%	7	100%

Do you trust members of your sector more, the same, or less than other fishermen?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
The same	12	57%	11	79%	1	14%
More	3	14%	3	21%	0	0%
n/a	6	29%	0	0%	6	86%
n	21	100%	14	100%	7	100%

Has working with a sector manager been helpful?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
No	1	5%	0	0%	1	17%
Yes	14	67%	14	100%	0	0%
n/a	6	29%	0	0%	6	86%
n	21	100%	14	100%	7	100%

Table 32 - Bycatch

How important is reducing bycatch to you (e.g., decreased deck sorting time)?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
Neutral	2	10%	2	14%	0	0%
Important	19	90%	12	86%	7	100%
n	21	100%	14	100%	7	100%

How has your level of bycatch changed since May 2010?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
Decreased	8	38%	6	43%	2	29%
Unchanged	6	29%	5	36%	1	14%
Increased	3	14%	1	7%	2	29%
n/a	4	19%	2	14%	2	29%
n	21	100%	14	100%	7	100%

		Decreased	Unchanged	Increased	n/a	Total
By principal gear type in FY 11?	Trawl	4	2	0	0	6
	Gillnet	2	3	1	0	6
	Handgear	1	1	0	0	2
	Combination	0	0	1	0	1
	n/a	1	0	1	4	6
	total	8	6	3	4	21

Do you go above and beyond the regulations to avoid bycatch (e.g., modify/test gear)?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
No	6	29%	2	14%	4	57%
Yes	14	67%	11	79%	3	43%
n/a	1	5%	1	7%	0	0%
n	21	100%	14	100%	7	100%

Table 33 - Northeast Multispecies Commercial Bycatch Estimates (2005, mt)

Common Name	Large-Mesh Otter Trawl	B-Reg DAS Large-Mesh Otter Trawl	US/Canada Area Large-Mesh Otter Trawl	Extra-Large-Mesh Gillnet	Large-Mesh Gillnet	Bottom Longline	Haddock Sector Longline	Hand Line	Total
American Plaice	191.8	8.1	37.2	1.0	1.2	0.0	0.0	0.0	239.4
Atlantic cod	304.4	54.0	264.5	33.6	91.8	45.9	1.5	23.2	819.0
Atlantic halibut	4.6	1.0	2.8	3.3	0.8	0.1	0.3	0.0	13.0
Haddock	20.3	45.4	240.3	1.9	3.1	36.6	30.7	0.0	378.4
Ocean Pout	65.7	11.1	43.2	1.4	0.6	3.0	0.0	0.0	125.0
Pollock	6.6	2.6	8.2	13.7	33.8	0.2	0.0	0.0	65.1
Redfish	34.4	13.5	23.2	2.2	2.1	0.4	0.1	0.0	75.9
White Hake	6.9	2.1	5.8	10.8	11.0	1.1	1.0	0.0	38.7
Windowpane Flounder	158.4	64.9	299.7	0.0	0.0	0.0	0.0	0.0	523.1
Winter Flounder	118.9	2.5	13.4	2.0	4.2	0.0	0.0	0.0	141.0
Witch Flounder	99.7	10.4	35.6	0.2	1.3	0.0	0.0	0.0	147.3
Yellowtail Flounder	249.6	43.1	110.4	2.4	11.8	0.0	0.0	0.0	417.3
Totals:									
Multispecies Bycatch	1,261.5	258.7	1,084.5	72.4	161.9	87.3	33.7	23.2	2,983.2
Other Bycatch	8,199	4,130	9,758	1,476	1,979	258	42	0	25,841.7
Fishery Landings	19,757	5,584	14,826	7,478	4,573	1,246	609	275	54,348.6
Total Catch	29,218	9,973	25,669	9,026	6,714	1,591	685	298	83,173.4
Fishery Bycatch Ratio	**0.32**	**0.44**	**0.42**	**0.17**	**0.32**	**0.22**	**0.11**	**0.08**	**0.35**

Notes: Some of these fisheries have trips targeting non-Northeast Multispecies stocks or operating in state waters. Values in live weight. Large-mesh otter trawl is > 5.5 inch mesh. For gillnets, extra-large mesh is > 8.0 in; large-mesh is 5.5-7.99 in. "Other Bycatch" does not include marine mammals.

Table 34 - Commercial catch (mt, live) of Gulf of Maine haddock

Year	Catch	Landings	Discards	%Discards	Trip Limit (mt/day)	Trip Limit (lbs/day)
1986	1,598.4	1,590.4	8.0	0.5%		
1987	830.4	829.2	1.2	0.1%		
1988	417.7	416.2	1.5	0.4%		
1989	272.5	263.8	8.7	3.2%		
1990	435.7	433.3	2.4	0.6%		
1991	435.0	430.9	4.1	0.9%		
1992	330.9	311.8	19.1	5.8%		
1993	222.7	193.0	29.7	13.3%		
1994	213.6	120.1	93.5	43.8%	0.23	500
1995	300.6	173.0	127.6	42.4%	0.23	500
1996	353.1	246.6	106.5	30.2%	0.45	1,000
1997	956.8	588.6	368.2	38.5%	0.45	1,000
1998	909.3	885.2	24.1	2.7%		
1999	545.4	542.5	2.9	0.5%		
2000	775.8	737.9	37.9	4.9%		
2001	956.2	929.1	27.1	2.8%		
2002	1,000.5	976.9	23.6	2.4%		
2003	1,045.6	1,023.0	22.6	2.2%		
2004	973.1	946.5	26.6	2.7%		
2005	998.9	961.5	37.4	3.7%		
2006	667.6	618.2	49.4	7.4%		
2007	723.9	673.7	50.2	6.9%		
2008	520.9	508.5	12.4	2.4%		
2009	499.8	486.0	13.8	2.8%		
2010	565.7	561.1	4.6	0.8%		

Notes: Data updated through 2012. Values in live weight. Discards estimated using NEFSC observer data. Values from NEFSC. Groundfish Assessment Updates 2012, Tables C1.
Reference: NEFSC (2012b).

Table 35 - Commercial catch (mt, live) of Georges Bank haddock

Year	Catch	Landings	Discards	%Discards	Trip Limit (mt/day)	Trip Limit (lbs/day)
1986	3,339	n.d.	n.d.	n.d.		
1987	2,156	n.d.	n.d.	n.d.		
1988	2,492	n.d.	n.d.	n.d.		
1989	1,718	1,430	288	16.8%		
1990	2,106	2,005	101	4.8%		
1991	1,434	1,395	39	2.7%		
1992	2,053	2,005	48	2.3%		
1993	827	687	140	16.9%		
1994	2,302	207	2,095	91.0%	0.23	500
1995	309	231	78	25.2%	0.23	500
1996	436	320	116	26.6%	0.45	1,000
1997	1,151	880	271	23.5%	0.45	1,000
1998	2,192	1,915	277	12.6%		
1999	2,628	2,574	54	2.1%		
2000	3,280	3,203	77	2.3%		
2001	5,037	4,820	217	4.3%		
2002	6,741	6,532	209	3.1%		
2003	5,954	5,760	194	3.3%		
2004	8,415	7,375	1,040	12.4%		
2005	7,278	6,604	674	9.3%		
2006	3,938	2,643	1,295	32.9%		
2007	4,855	2,930	1,925	39.6%		
2008	6,207	2,695	3,512	56.6%		
2009	5,477	5,397	80	1.5%		
2010	9,310	4,879	4,431	47.6%		

Notes:

Data updated through 2012.

Values in live weight.

Discards estimated using NEFSC observer data.

Values from NEFSC. Groundfish Assessment Updates 2012, Tables B1 and B2.

Reference: NEFSC (2012b).

Table 36 - Commercial catch (mt, live) of Gulf of Maine cod

Year	Catch	Landings	Discards	%Discards	Trip Limit (mt/day)	Trip Limit (lbs/day)
1986	11,029.1	9,669.6	1,359.5	12.3%		
1987	8,771.2	7,526.2	1,245.0	14.2%		
1988	8,905.4	7,948.2	957.2	10.7%		
1989	11,651.8	10,550.7	1,101.1	9.5%		
1990	17,637.9	15,439.7	2,198.2	12.5%		
1991	18,892.5	17,959.0	933.5	4.9%		
1992	11,963.2	11,019.4	943.8	7.9%		
1993	9,179.1	8,366.7	812.4	8.9%		
1994	8,311.0	8,030.2	280.8	3.4%		
1995	6,921.7	6,606.8	314.9	4.5%		
1996	7,220.2	7,019.8	200.4	2.8%		
1997	5,547.1	5,432.1	115.0	2.1%	0.45, 0.68	1,000, 1,500
1998	4,173.8	4,074.3	99.5	2.4%	0.18, 0.32	400, 700
1999	2,789.5	1,407.4	1,382.1	49.5%	0.01, 0.05, 0.09	30, 100, 200
2000	5,053.1	3,771.8	1,281.3	25.4%	0.18	400
2001	6,355.3	4,314.4	2,040.9	32.1%	0.18	400
2002	5,410.3	3,638.3	1,772.0	32.8%	0.23	500
2003	4,903.2	3,865.6	1,037.6	21.2%	0.23	500
2004	4,642.9	3,782.3	860.6	18.5%	0.36	800
2005	3,988.6	3,557.6	431.0	10.8%	0.36	800
2006	3,527.8	3,029.4	498.4	14.1%	0.36	800
2007	4,265.5	3,989.8	275.7	6.5%	0.36	800
2008	5,958.0	5,443.5	514.5	8.6%	0.36	800
2009	6,994.7	5,952.9	1,041.8	14.9%	0.36	800
2010	5,597.5	5,356.4	241.1	4.3%		

Notes:

Data updated through 2012.

Values in live weight.

Discards estimated using NEFSC observer data.

Values from NEFSC. 53rd SAW Assessment Summary Report.

Prior to 1989, there are no direct estimates of commercial discards.

Reference: NEFSC (2012a).

Table 37 - Commercial catch (mt, live) of Georges Bank cod

Year	Catch	Landings	Discards	%Discards	Trip Limit (mt/day)	Trip Limit (lbs/day)
1986	17,947	17,490	457	2.5%		
1987	19,301	19,035	266	1.4%		
1988	26,633	26,310	323	1.2%		
1989	25,994	25,056	938	3.6%		
1990	28,818	28,110	708	2.5%		
1991	25,024	24,219	805	3.2%		
1992	18,366	16,899	1,467	8.0%		
1993	15,079	14,590	489	3.2%		
1994	9,973	9,737	236	2.4%		
1995	7,135	7,026	109	1.5%		
1996	7,396	7,261	135	1.8%		
1997	7,687	7,548	139	1.8%	0.45, 0.68	1,000, 1,500
1998	7,178	7,041	137	1.9%	0.18, 0.32	400, 700
1999	8,455	8,313	142	1.7%	0.01, 0.05, 0.09	30, 100, 200
2000	7,820	7,600	220	2.8%	0.18	400
2001	11,533	10,749	784	6.8%	0.18	400
2002	9,777	9,472	305	3.1%	0.23	500
2003	7,333	6,852	481	6.6%	0.23	500
2004	3,813	3,509	304	8.0%	0.36	800
2005	3,794	2,754	1,040	27.4%	0.36	800
2006	3,265	2,700	565	17.3%	0.36	800
2007	5,359	3,699	1,660	31.0%	0.36	800
2008	3,720	3,255	465	12.5%	0.36	800
2009	3,872	2,999	873	22.5%	0.36	800
2010	3,251	2,688	563	17.3%		

Notes: Data updated through 2012. Values in live weight. Discards estimated using NEFSC observer data. Values from NEFSC. Groundfish Assessment Updates 2012, Table A1.

Reference: NEFSC (2012b).

Table 38 – FY 2010 End of Year Accounting of Northeast Multispecies Commercial Catch

Stock	Sector Sub-ACL	Sector Catch	Sector Landings	Sector Discards	% Discarded	Total Groundfish Catch	Total Groundfish Discards	% Discarded
GB cod	3,302	2,745.8	2,627.7	118.1	4.3%	3,028.9	147.3	4.9%
GOM cod	4,327	3,617.1	3,537.1	80.0	2.2%	4,091.2	119.6	2.9%
GB haddock	40,186	8,248.0	8,207.4	40.6	0.5%	8,542.0	111.2	1.3%
GOM haddock	799	370.5	367.8	2.7	0.7%	388.3	3.4	0.9%
GB Yellowtail Flounder	803	739.0	672.3	66.7	9.0%	809.7	128.1	15.8%
SNE Yellowtail Flounder	235	152.5	147.8	4.7	3.1%	314.7	140.0	44.5%
CC/GOM Ylt. Flounder	729	559.8	500.1	59.7	10.7%	671.4	118.5	17.6%
Plaice	2,748	1,503.7	1,331.9	171.8	11.4%	1,607.7	224.3	14.0%
Witch Flounder	827	695.4	638.2	57.2	8.2%	832.5	143.2	17.2%
GB Winter Flounder	1,823	1,382.4	1,364.6	17.8	1.3%	1,531.3	160.2	10.5%
GOM Winter Flounder	133	80.7	79.1	1.6	2.0%	193.5	29.9	15.5%
SNE Winter Flounder	n/a	42.3	7.9	34.4	81.3%	370.1	208.3	56.3%
Redfish	6,756	2,143.3	1,991.6	151.7	7.1%	2,166.9	157.6	7.3%
White Hake	2,505	2,215.6	2,184.1	31.5	1.4%	2,344.7	48.3	2.1%
Pollock	16,178	5,449.8	5,371.5	78.3	1.4%	7,532.0	88.4	1.2%
Northern Windowpane	n/a	151.7	0.3	151.4	99.8%	162.6	162.3	99.8%
Southern Windowpane	n/a	52.7	0.1	52.6	99.8%	534.9	488.3	91.3%
Ocean Pout	n/a	56.5	0.1	56.4	99.8%	102.4	101.3	98.9%
Halibut	n/a	25.6	6.1	19.5	76.2%	36.2	21.3	58.8%
Wolfish	n/a	18.9	0.2	18.7	98.9%	22.5	22.2	98.7%
Total	**81,351**	**30,251**	**29,036**	**1,215**	**4.0%**	**37,333.8**	**2,623.7**	**7.4%**

Notes:

Data updated through November 10, 2011.
Values in live weight.
Reference: NMFS (2015b).

Table 39 – FY 2011 end of year accounting of Northeast Multispecies commercial catch

Stock	Sector Sub-ACL	Sector Catch	Sector Landings	Sector Discards	% Discarded	Total Groundfish Catch	Total Groundfish Discards	% Discarded
GB cod	4,208	3,215.3	3,071.0	144.3	4.5%	3,405.9	155.3	4.6%
GOM cod	4,721	4,368.0	4,222.6	145.4	3.3%	4706.8	188.9	4.0%
GB haddock	30,393	3,828.8	3,746.8	82.0	2.1%	4,252.0	368.9	8.7%
GOM haddock	770	483.7	476.2	7.5	1.6%	499.1	15.7	3.1%
GB Yellowtail Flounder	1,122	988.0	939.1	48.9	4.9%	1,117.0	166.0	14.9%
SNE yellowtail Flounder	404	364.0	345.3	18.7	5.1%	514.9	149.3	29.0%
CC/GOM Yellowtail	913	795.1	711.5	83.6	10.5%	853.1	91.9	10.8%
Plaice	3,038	1,631.6	1,435.9	195.7	12.0%	1,660.7	206.9	12.5%
Witch Flounder	1,211	992.9	930.9	62.0	6.2%	1,186.0	227.1	19.1%
GB Winter Flounder	1,993	1,924.2	1,911.0	13.2	0.7%	1,984.8	71.6	3.6%
GOM Winter Flounder	313	158.2	153.1	5.1	3.2%	287.3	45.9	16.0%
SNE Winter Flounder	n/a	86.9	3.3	83.6	96.2%	298.7	237.5	79.5%
Redfish	7,505	2,703.2	2,518.8	184.4	6.8%	2,720.6	194.6	7.2%
White Hake	2,946	3,014.4	2,981.8	32.6	1.1%	3,035.5	36.5	1.2%
Pollock	13,848	7,543.1	7,433.7	109.4	1.5%	9,064.0	116.5	1.3%
Northern Windowpane	n/a	156.2	0.0	156.2	100.0%	191.3	190.9	99.8%
Southern Windowpane	n/a	83.0	0.2	82.8	99.8%	504.1	462.3	91.7%
Ocean Pout	n/a	56.3	0.0	56.3	100.0%	90.2	90.2	100.0%
Halibut	n/a	41.4	10.3	31.1	75.1%	52.1	33.1	63.5%
Wolfish	n/a	32.2	0.0	32.2	100.0%	33.0	32.9	99.7%
Total	**73,385**	**32,467**	**30,892**	**1,575**	**4.9%**	**38,335.9**	**3,082.0**	**8.5%**

Notes:

Data updated through June 28, 2012.
Values in live weight.
Reference: NMFS (2015b).

Table 40 - Economic performance of informants (n=21), FY 2009 - FY 2011

What % of total household income was derived from fishing?			
	FY 09	FY 10	FY 11
0%	0%	0%	5%
1-25%	14%	14%	14%
26-50%	14%	14%	14%
51-75%	14%	14%	14%
76-100%	57%	57%	52%
What % of your own income was derived from fishing?			
	FY 09	FY 10	FY 11
0%	0%	0%	5%
1-25%	19%	14%	14%
26-50%	0%	5%	0%
51-75%	0%	5%	5%
76-100%	81%	76%	76%
What % of your fishing income was derived from groundfish fishing?			
	FY 09	FY 10	FY 11
0%	10%	10%	19%
1-25%	10%	24%	14%
26-50%	19%	14%	14%
51-75%	19%	10%	10%
76-100%	43%	43%	43%

Table 41 - Multispecies stocks ACE allocated and percent caught for FY 2010.

Stock	Fishery-wide ACE (lbs.)	% caught	NEFS XI initial ACE (lbs.) [a]	NEFS XI final ACE (lbs.) [b]	% caught [c]	NEFS XII initial ACE (lbs.)	NEFS XII final ACE (lbs.)	% caught
GB cod, East	717,441	77.9%	2,952	822	0.00%	60	200	0.00%
GB cod, West	6,563,099	83.7%	27,003	2,625	0.00%	546	189	0.00%
GOM cod	9,540,389	83.6%	1,375,164	1,213,417	87.59%	126,954	113,323	85.04%
GB haddock, East	26,262,695	15.3%	9,778	9,778	0.00%	43	1,354	0.00%
GB haddock, West	62,331,182	22.7%	23,206	23,206	0.00%	102	3,175	0.00%
GOM haddock	1,761,206	46.4%	58,418	30,900	59.64%	2,384	4,285	8.14%
GB yellowtail flounder	1,770,451	92.0%	29	29	0.00%	8	3	0.00%
SNE yellowtail flounder	517,372	65.0%	94	94	0.00%	6	4	0.00%
CC/GOM yellowtail flounder	1,608,084	76.7%	37,927	18,308	58.26%	8,311	20,862	87.22%
Plaice	6,058,149	54.7%	117,224	70,250	25.08%	22,789	29,037	38.47%
Witch flounder	1,824,125	84.0%	34,871	13,464	67.51%	5,171	6,614	65.78%
GB winter flounder	4,018,496	75.8%	144	144	0.00%	4	2	0.00%
GOM winter flounder	293,736	60.6%	7,391	4,828	56.65%	1,132	5,128	50.47%
Redfish	14,894,618	31.7%	283,102	282,718	12.71%	10,127	3,761	1.09%
White hake	5,522,677	88.4%	271,643	200,772	85.36%	1,948	1,162	4.99%
Pollock	35,666,741	33.7%	3,379,854	3,399,411	48.49%	19,167	9,597	3.07%
Total	179,350,461	35.69%	5,628,800	5,270,766	56.48%	198,752	198,696	67.14%

Notes:
Run Date: June 29, 2011.
[a] Allocation at the beginning of the fishing year.
[b] Accounts for trades into/out of sector.
[c] Percent of final ACE caught.
Reference:
NMFS (2015b).

Table 42 - Other economic performance responses

Since May 2010, has the profit margin of your groundfish fishing operations changed?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
Decreased	10	48%	6	43%	4	57%
Unchanged	4	19%	3	21%	1	14%
Increased	3	14%	3	21%	0	0%
n/a	4	19%	2	14%	2	29%
N	21	100%	14	100%	7	100%

How do the costs associated with sectors compare to what was expected?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
Lower than expected	1	5%	1	7%	0	0%
As expected	9	43%	8	57%	1	14%
Higher than expected	2	10%	2	14%	0	0%
Unsure	2	10%	2	14%	0	0%
Unknown	1	5%	1	7%	0	0%
n/a	6	29%	0	0%	6	86%
N	21	100%	14	100%	6	100%

Since May 2010, has the predictability of your fishing business changed?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
Decreased	10	48%	7	50%	3	43%
Unchanged	4	19%	4	29%	0	0%
Increased	3	14%	1	7%	2	29%
n/a	4	19%	2	14%	2	29%
N	21	100%	14	100%	7	100%

Table 43 - Safety

A. Did the DAS regulations you operate(d) in ever compromise safety?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
No	12	57%	8	57%	4	57%
Yes	9	43%	6	43%	3	43%
n	21	100%	14	100%	7	100%

B. Do (did) the sector regulations you operate(d) under ever compromise vessel safety?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
No	10	77%	9	75%	1	100%
Yes	3	33%	3	25%	0	0%
n	13	100%	12	100%	7	100%

Note: Question B was not relevant for eight informants (common pool members, former fishermen and lease-only sector members).

Table 44 - Well-being A

A. Do you consider the allocation of PSC to your permits under A16 to be fair or unfair?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
Unfair	14	70%	10	71%	4	67%
Fair	5	25%	4	29%	1	17%
Unsure	1	5%	0	0%	1	17%
n	20	100%	14	100%	6	100%

B. For which program are the rules more difficult to understand, DAS or sectors?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
DAS more difficult	3	16%	2	14%	1	20%
Sectors more difficult	7	37%	5	36%	2	40%
Equally easy	3	16%	3	21%		
Equally difficult	4	21%	4	29%		
Unsure	1	5%			1	20%
No answer	1	5%			1	20%
n	19	100%	14	100%	5	100%

Note: Question A was not relevant for one informant (HA permit holder fishing as party/charter). Question B was not relevant for two informants who did not participate in the DAS or sector programs.

Table 45 - Well-being B

A. Since May 2010, has your fatigue level at sea decreased, unchanged, or increased?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
Unchanged	10	53%	5	38%	5	83%
Increased	9	47%	8	62%	1	17%
n	19	100%	13	100%	6	100%

B. Is fishing today more or less stressful than before May 2010?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
Less stressful today	2	10%	2	14%	0	0%
No change	3	15%	2	14%	1	17%
More stressful today	15	75%	10	71%	5	83%
n	20	100%	14	100%	7	100%

C. Correlation of age with stress

Age	*Is fishing today more or less stressful than before May 2010?*			
	Less stress	No change	More stress	Total
30-39	0	0	1	1
40-49	0	0	8	8
50-59	0	1	5	6
60-69	2	2	1	5
Total	2	*3*	15	20

D. Since May 2010, has your job satisfaction changed?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
Decreased	8	44%	7	54%	1	20%
Unchanged	5	28%	3	23%	2	40%
Increased	5	28%	3	23%	2	40%
n	18	100%	13	100%	5	100%

E. Do you expect to retire as a fisherman?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
No	2	10%	1	7%	1	14%
Yes	13	62%	9	64%	4	57%
Unsure	6	29%	4	29%	2	29%
n	21	100%	14	100%	7	100%

Note: Question A was not relevant for two informants that do not go to sea today. Question B was not relevant for one former groundfish fishermen who doesn't fish today. Question C was not relevant for one informant. Three informants did not answer Question D.

Table 46 - Well-being C

A. How many more years do you expect to be fishing?

	range	mean	std. dev	n
All informants	0-25	4.6	6.9	21
Sector members	1-25	6.0	8.2	14
Others	0-2	1.7	0.8	7

B. Would you advise a young person to enter fishing?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
No	15	71%	10	71%	5	71%
Yes	6	29%	4	29%	2	29%
n	21	100%	14	100%	7	100%

C. Is your future outlook of the New Hampshire groundfish fishery neutral, negative or positive?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
Negative	15	71%	10	71%	5	71%
Neutral	6	29%	4	29%	2	29%
n	21	100%	4	100%	7	100%

D. If you had your life to live over again, would you still fish?

	All informants		Sector members		Others	
	Freq.	%	Freq.	%	Freq.	%
No	6	29%	5	36%	1	14%
Yes	14	67%	8	57%	6	86%
Unsure	1	5%	1	7%	0	0%
n	21	100%	14	100%	7	100%

Table 47 – Job satisfaction, questions after Pollnac et al. (2014)

How satisfied are/were you with the following related to groundfish fishing (n=21)?

		very dissatisfied	dissatisfied	neutral	satisfied	very satisfied	n/a
Basic needs	Earnings	10%	10%	29%	**43%**	10%	
	Earnings predictability	10%	29%	**33%**	19%	10%	
	Job safety	19%	0%	24%	**38%**	19%	
Social-psychological	Time spent away from home	0%	24%	29%	**38%**	5%	
	Physical fatigue of the job	14%	10%	33%	**38%**	0%	5%
	Healthfulness of the job	24%	**29%**	19%	19%	10%	
Self-actualization	Sense of adventure	10%	0%	10%	**52%**	29%	
	Sense of challenge	10%	5%	10%	**38%**	**38%**	
	Opportunity to be your own boss	5%	0%	14%	33%	**48%**	

How satisfied are you with the following related to your current occupation (if other than groundfish) (n=5)?

		very dissatisfied	dissatisfied	neutral	satisfied	very satisfied	n/a
Basic needs	Earnings	0%	20%	20%	20%	**40%**	
	Earnings predictability	20%	20%	0%	20%	**40%**	
	Job safety	0%	0%	20%	20%	**60%**	
Social-psychological	Time spent away from home	0%	0%	20%	**40%**	**40%**	
	Physical fatigue of the job	0%	0%	20%	**40%**	**40%**	
	Healthfulness of the job	0%	0%	**60%**	40%	0%	
Self-actualization	Sense of adventure	0%	0%	**40%**	20%	**40%**	
	Sense of challenge	0%	0%	20%	**40%**	**40%**	
	Opportunity to be your own boss	0%	0%	0%	0%	**100%**	

Notes: The most frequent response is in bold.

Table 48 - Case Study Conclusions

Factor	Hypothetical Impact	Case Study Conclusions
Fishing Practices	Increased efficiency and flexibility	No strong agreement, though vessels constrained by trip limits have increased efficiency and flexibility.
Social Capital	Improved networking, reciprocity and trust	Sectors have built off of pre-existing social capital more than been a source for it.
Bycatch	Reduced bycatch and increased stewardship	Documented bycatch that has been reduced, though pressures exist to discard when unobserved. Actual improvement in bycatch and stewardship unclear.
Economic Performance	Improved business profits and predictability	Business profits and predictability declined primarily due to reduced catch limits, particularly for fishermen who rely on leasing in ACE. Improvements for fishermen who have reduced costs or diversified fishing portfolio.
Safety	Improved safety at sea	No substantial changes, though fewer incentives exist to fish in unsafe conditions.
Well-Being	Improved well-being and outlook for self and fishery	Overall decline in well-being and outlook for self and fishery.

FIGURES

Figure 1- Determining causality
Determining causality between the sector management program or other factors, such as the reduction in catch limits.

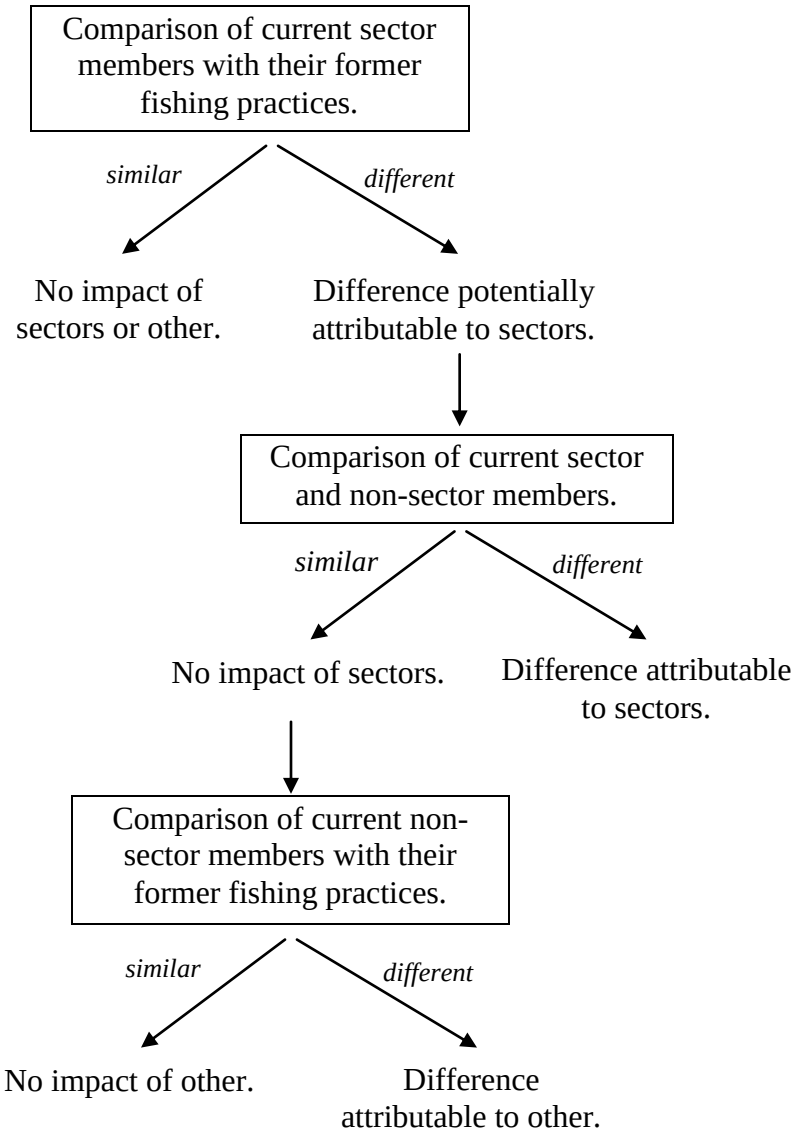


Figure 2 - Stratification of the population (n=81)

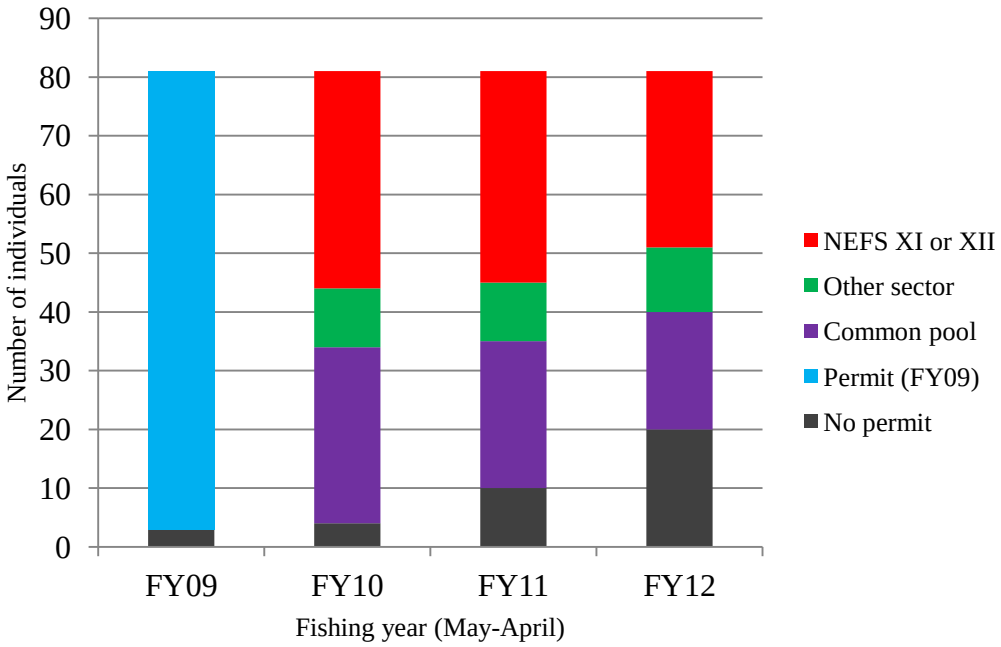


Figure 3 - Stratification of the informants (n=21)

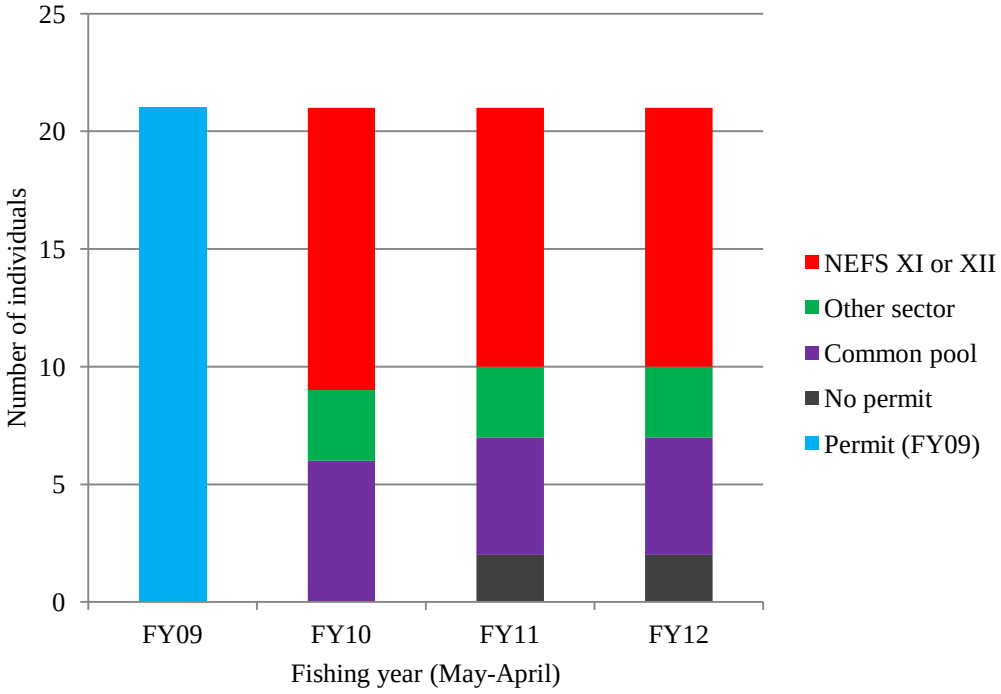
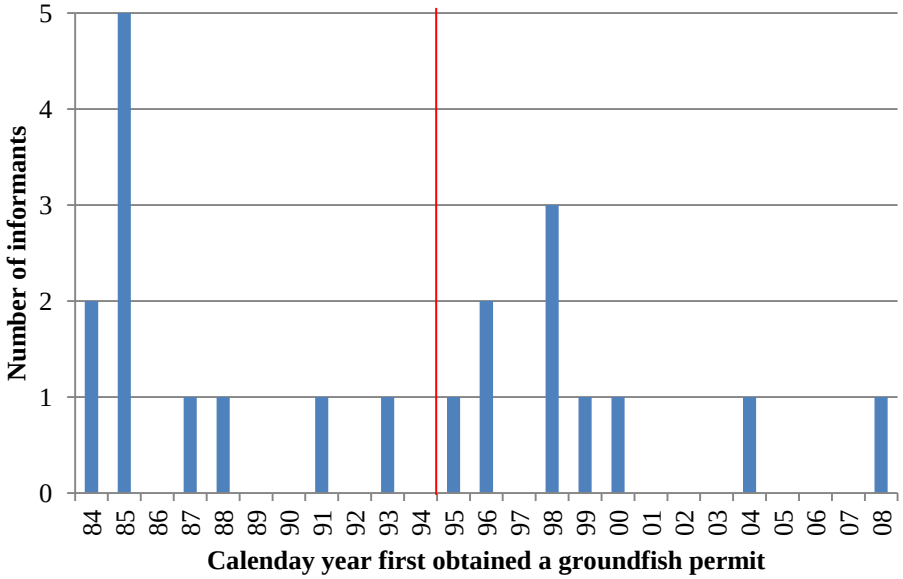
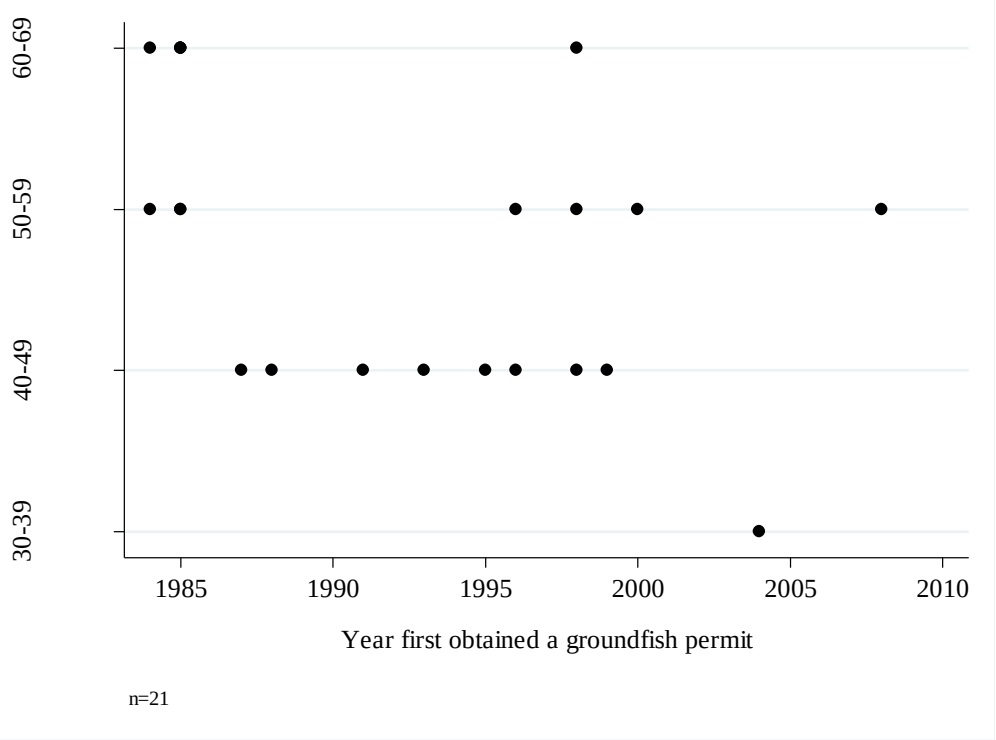


Figure 4 - Calendar year informants first obtained a groundfish permit



Note: Red line indicates the federal permit moratorium. Permits obtained since that time were likely bought from other permit holders.

Figure 5 - Scatter plot of age of informants vs. year they first obtained a groundfish permit



LIST OF REFERENCES

Abel, P. (1991). *Rational Choice Theory*. Aldershot, UK: Edward Elgar Publishing Ltd.

Acheson, J. M. (2006). Lobster and groundfish management in the Gulf of Maine: A rational choice perspective. *Human Organization, 65*(3), 240-252.

Acheson, J. M., Acheson, A. W., Bort, J. R., & Lello, J. (1980). *The Fishing Ports of Maine and New Hampshire: 1978*. Orono, ME: Maine Sea Grant.

Ackerman, E. A. (1941). *New England's Fishing Industry*. Chicago, IL: University of Chicago Press.

Adams, N. (1825). *Annals of Portsmouth, Comprising a Period of Two Hundred Years from the First Settlement of the Town, with Biographical Sketches of a few of the most respectable Inhabitants*. Exeter: Nathaniel Adams.

An Act to Preserve the Fish in Piscataqua River. (1774). *The New Hampshire Gazette, 18*(906).

AP. (2009, July 21, 2009). Police: Maine lobster turf war led to shooting. *Associated Press*.

Auerbach, C. F., & Silverstein, L. B. (2003). *Qualitative Data: An Introduction to Coding and Analysis*. New York: New York University Press.

Barbour, P. L. e. (1986). *The Complete Works of Captain John Smith (1580-1631) in Three Volumes* (Vol. 2). Chapel Hill, NC: University of North Carolina Press.

Belknap, J. (1812). *The History of New Hampshire* (Vol. 3). Dover, NH: J. Mann and J. K. Remick.

Berkes, F. (2003). Rethinking community-based conservation. *Conservation Biology, 18*(3), 621-630.

Bolster, W. J. (2002). *Cross-Grained and Willy Waters: A Guide to the Piscataqua Maritime Region*. Portsmouth, NH: Peter E. Randall.

Branch, T. A. (2009). How do individual transferable quotas affect marine ecosystems? *Fish and Fisheries, 10*, 39-57.

Branch, T. A., Rutherford, K., & Hilborn, R. (2006). Replacing trip limits with individual transferable quotas: Implications for discarding. *Marine Policy, 30*(3), 281-292.

Brandt, S. (2005). The equity debate: Distributional impacts of individual transferable quotas. *Ocean and Coastal Management, 48*, 15-30.

Bromley, D. W. (2005). Purging the frontier from our mind: Crafting a new fisheries policy. *Reviews in Fish Biology and Fisheries, 15*(3), 217-229.

Bureau, U. S. C. (2010). 2010 Census. from http://2010.census.gov/2010census/#

Campbell, L. M., & Cornwell, M. L. (2008). Human dimensions of bycatch reduction technology: Current assumptions and directions for future research. *Endangered Species Research, 5*, 325-334.

Carothers, C. (2013). A survey of U.S. halibut IFQ holders: Market participation, attitudes, and impacts. *Marine Policy, 38*, 515-522.

Carothers, C., Lew, D. K., & Sepez, J. (2010). Fishing rights and small communities: Alaska halibut IFQ transfer patterns. *Ocean & Coastal Management, 53*(9), 518-523.

Clay, P. M., Kitts, A., & Pinto da Silva, P. (2014). Measuring the social and economic performance of catch share programs: Definition of metrics and application to the U.S. Northeast Region groundfish fishery. *Marine Policy, 44*, 27-36.

Copes, P. (1986). A critical review of the individual quota as a device in fisheries management. *Land Economics, 62*(3), 278-291.

Corbin, J., & Strauss, A. (2008). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory* (3rd ed.). Los Angeles, CA: Sage Publications, Inc.

Costello, C., Gaines, S. D., & Lynham, J. (2008). Can catch shares prevent fisheries collapse? *Science, 321*, 1678-1681.

Dicolo, J. A., & Friedman, N. (2012, July 16, 2012). Lobster glut slams prices. *The Wall Street Journal*.

Essington, T. E. (2010). Ecological indicators display reduced variation in North American catch share fisheries. *Proceedings of the National Academy of Sciences of the United States of America, 107*(2), 754-759.

Eythorsson, E. (2000). A decade of ITQ-management in Islandic fisheries: Consolidation without consensus. *Marine Policy, 24*(6), 483-492.

Falque, M., De Alessi, M., & LaMotte, H. (Eds.). (2002). *Marine Resources: Property Rights, Economics and Environment*. Oxford: Elsevier Science, Ltd.

Feeney, R. G. (2010). The New Hampshire Fishing Sectors. from http://www.nhfishingsectors.blogspot.com/

Field, J. (2003). *Social Capital*. London and New York: Routledge.

Fina, M. (2011). Evolution of catch share management: Lessons from catch share management in the North Pacific. *Fisheries, 36*(4), 164-177.

Flick, U. (2002). *An Introduction to Qualitative Research* (2nd ed.). London: Sage Publications.

Francis, D., Wolfe, B. B., Fuller, J., & Foster, D. (2002). *Is there a Little Ice Age signal in New England sediments?* Paper presented at the Geological Society of America, Denver, CO.

Friedman, D., & Hechter, M. (1988). The contribution of rational choice theory to macrosociological research. *Sociological Theory, 6*, 201-218.

GARFO. (2012). *Greater Atlantic Regional Fisheries Office - Northeast Federal Fisheries Permit Application*. Retrieved from http://www.greateratlantic.fisheries.noaa.gov/permits/forms/initlins.pdf.

Goode, G. B., & Collins, J. W. (1887). The fishermen of the United States. In G. B. Goode (Ed.), *The Fisheries and Fishery Industries of the United States* (Vol. IV, pp. 168). Washington, DC: U.S. Government Printing Office.

Grafton, R. Q., Arnason, R., Bjorndal, T., Campbell, D., Campbell, H. F., Clark, C. W., et al. (2006). Incentive-based approaches to sustainable fisheries. *Canadian Journal of Fisheries and Aquatic Sciences, 63*, 699-710.

Greene, J. (2007). *Mixed Methods in Social Inquiry*. San Francisco: Jossey-Bass.

Hamilton, L. C. (1992). *Regression with Graphics: A Second Course in Applied Statistics*. Belmont, CA: Wadsworth, Inc.

Hardin, G. (1968). The tragedy of the commons. *Science, 162*, 1243-1248.

Hardin, R. (1982). *Collective Action*. Baltimore, MD: John Hopkins University Press.

Hilborn, R. (2003). The state of the art in stock assessment: Where we are and where we are going. *Scientia Marina, 67*, 15-20.

Holland, D. S., Kitts, A. W., Pinto da Silva, P., & Wiersma, J. (2013). Social capital and the success of harvest cooperatives in the New England groundfish fishery. *Marine Resource Economics, 28*, 133-153.

Holland, D. S., Pinto da Silva, P., & Wiersma, J. (2010). *A Survey of Social Capital and Attitudes toward Management in the New England Groundfish Fishery* (No. NEFSC Reference Document 10-12). Woods Hole, MA: Northeast Fisheries Science Center.

Howell, W. H., Morin, M., Rennels, N., & Goethel, D. (2008). Residency of adult Atlantic cod (Gadus morhua) in the western Gulf of Maine. *Fisheries Research, 91*, 123-132.

Jackson, C. F. (1922). Ecological features of Great Bay, New Hampshire, and a preliminary checklist of its fish. *Ecology, 3*(1), 48-54.

Jenness, J. S. (1795). *The Isle of Shoals, an Historic Sketch* (Vol. 2). Hanover, NH: Peter E. Randall.

Jin, D., Kite-Powell, H. L., Thunberg, E., Solow, A., & Talley, W. K. (2002). A model of fishing vessel accident probability. *Journal of Safety Research, 33*(4), 497-510.

Jin, D., & Thunberg, E. (2005). An analysis of fishing vessel accidents in fishing areas off the northeastern United States. *Safety Science, 43*, 523-540.

Judd, R. J. (1997). *Common Lands, Common People: The Origins of Conservation in Northern New England*. Cambridge: Harvard University Press.

Kitts, A., Bing-Sawyer, E., McPherson, M., Olson, J., & Walden, J. (2011). *Report for Fishing Year 2010 on the Performance of the Northeast Multispecies (Groundfish) Fishery (May 2010 - April 2011)* (No. NEFSC Reference Document 11-19). Woods Hole, MA: Northeast Fisheries Science Center.

Kovach, A. I., Breton, T. S., Berlinsky, D. L., Maceda, L., & Wirgin, I. (2010). Fine-scale spatial and temporal genetic structure of Atlantic cod off the Atlantic coast of the USA. *Marine Ecology Progress Series, 410*, 177-195.

Laighton, O. (1930). *Ninety Years at the Isles of Shoals*. Boston, MA: The Beacon Press, Inc.

Leal, D. R. (2002). *Fencing in the Fishery: A Primer on Ending the Race to Fish*. Bozeman, MT: Political Economy Research Center.

Levy, S. (2010). Catch shares management. *Bioscience, 60*(10), 780-785.

Lincoln, J., & Lucas, D. (2010). Commercial fishing deaths - United States, 2000-2009. *Journal of the American Medical Association, 304*(13), 1437-1439.

Lovgren, J. (2010). *Memorandum of the Cities of New Bedford and Gloucester and others in Support of their Motion for Summary Judgment* (No. 1:10-CV-10789-RWZ). U.S. District Court for the District of Massachusetts.

Lovgren, J. et al. v. Locke, G. et al., 11-1952 68 (U.S. Court of Appeals for the First Circuit 2012).

Magnuson-Stevens Fishery Conservation and Management Reauthorization Act, 16 U.S.C. 1801-1884(2007).

Malena, C. (2009). *From Political Won't to Political Will: Building Support for Participatory Governance*. Sterling, VA: Kumarian Press.

Marvin, E. S. (1937). December 27, 1937 letter of E. S. Marvin, Marblehead, MA. Harvard Business School Baker Library.

Maurstad, A. (2000). To fish or not to fish: Small-scale fishing and changing regulations of the cod fishery in northern Norway. *Human Organization, 59*(1), 37-47.

Maysonett, J. A. (2011). *Federal Defendants' Consolidated Judgment and in Response to Oppositions by Plaintiffs New Bedford and Lovgren, Docket Nos. 83 and 84*. Gloucester, MA: United States District Court of Massachusetts.

McCay, B. J. (2004). ITQs and community: An essay on environmental governance. *Agricultural Resource Economics Review, 33*(2), 162-170.

McEvoy, A. F. (1988). Toward an interactive theory of nature and culture: Ecology, production, and cognition in the California fishing industry. In D. Worster (Ed.), *The Ends of the Earth: Perspectives on Modern Environmental History* (pp. 211-227). Cambridge, UK: Cambridge University Press.

McQueen, R. A., & Knussen, C. (2002). *Research Methods for Social Science: An Introduction* (Vol. 1). Harlow, England: Prentice Hall.

Mohn, R. (1999). The retrospective problem in sequential population analysis: An investigation using cod fishery and simulated data. *ICES Journal of Marine Science, 56*(4), 473-488.

Murphy, T., Kitts, A., Demarest, C., & Walden, J. (2015). *2013 Final Report on the Performance of the Northeast Multispecies (Groundfish) Fishery (May 2013-April 2014)* (No. NEFSC Reference Document 15-02). Woods Hole, MA: Northeast Fisheries Science Center.

Murphy, T., Kitts, A., Records, D., Demarest, C., Caless, D., Walden, J., et al. (2014). *2012 Final Report on the Performance of the Northeast Multispecies (Groundfish) Fishery (May 2012-April 2013)* (No. NEFSC Reference Document 14-01). Woods Hole, MA: Northeast Fisheries Science Center.

Murphy, T., Kitts, A., Records, D., Demarest, C., McPherson, M., Walden, J., et al. (2012). *2011 Final Report on the Performance of the Northeast Multispecies (Groundfish) Fishery (May 2011-April 2012)* (No. NEFSC Reference Document 12-30). Woods Hole, MA: Northeast Fisheries Science Center.

National Environmental Policy Act, 42 U.S.C. 4321-4347(1970).

NEFMC. (1993). *Amendment 5 to the Multispecies Fishery Management Plan*. Newburyport, MA: New England Fishery Management Council.

NEFMC. (2003). *Amendment 13 to the Northeast Multispecies Fishery Management Plan including a Final Supplemanetal Environmental Impact Statement and an Initial Regulatory Flexibility Analysis*. Newburyport, MA: National Marine Fisheries Service in collaboration with the New England Fishery Management Council.

NEFMC. (2006). *Framework 42 to the Northeast Multispecies Fishery Management Plan*. Newburyport, MA: New England Fishery Management Council.

NEFMC. (2007a). *Council Report, February 6-8 meeting*. Newburyport, MA: New England Fishery Management Council.

NEFMC. (2007b). *Groundfish Committee Meeting Summary, April 20*. Newburyport, MA: New England Fishery Management Council.

NEFMC. (2008). *Council Report, February 12-14 meeting*. Newburyport, MA: New England Fishery Management Council.

NEFMC. (2009a). *Amendment 16 to the Northeast Multispecies Fishery Management Plan including a Environmental Impact Statement and Initial Regulatory Flexibility Analysis*. Newburyport, MA: New England Fishery Management Council in cooperation with the National Marine Fisheries Service.

NEFMC. (2009b). *Council Report, June 22-25 meeting*. Newburyport, MA: New England Fishery Management Council.

NEFMC. (2011a). *Amendment 17 to the Northeast Multispecies Fishery Management Plan to address NOAA-Sponsored, State-Operated Permit Banks including a Regulatory Impact Review*. Newburyport, MA: New England Fishery Management Council and National Marine Fisheries Service.

NEFMC. (2011b). *Framework Adjustment 45 to the Northeast Multispecies Fishery Management Plan*. Newburyport, MA: New England Fishery Management Council.

NEFMC. (2013a). *Framework 50 to the Northeast Multispecies Fishery Management Plan*. Newburyport (MA).

NEFMC. (2013b). New England Fishery Management Council. from www.nefmc.org

NEFMC. (2015). *Amendment 18 to the Northeast Multispecies Fishery Management Plan including an Environmental Impact Statement and Initial Regulatory Flexibility Analysis*. Newburyport, MA: New England Fishery Management Council in cooperation with the National Marine Fisheries Service.

NEFS-XI. (2010a). *A Final Environmental Assessment*. Portsmouth, NH: Northeast Fishery Sector XI.

NEFS-XI. (2010b). *Sector Operations Plan and Agreement for FY 2011*. Portsmouth, NH: Northeast Fishery Sector XI.

NEFS-XII. (2010). *A Final Environmental Assessment*. Portsmouth (NH): Northeast Fishery Sector XII.

NEFSC. (2011). *52nd Northeast Regional Stock Assessment Workshop (52nd SAW) Assessment Summary Report* (No. NEFSC Reference Document 11-11). Woods Hole, MA: Northeast Fisheries Science Center.

NEFSC. (2012a). *53rd Northeast Regional Stock Assessment Workshop (53rd SAW) Assessment Report* (No. Northeast Fisheries Science Center Ref. Doc. 12-05).

NEFSC. (2012b). *Assessment or Data Updates of 13 Northeast Groundfish Stocks through 2010* (No. NEFSC Reference Document 12-06). Woods Hole, MA: Northeast Fisheries Science Center.

NEFSC. (2013). *55th Northeast Regional Stock Assessment Workshop (55th SAW) Assessment Summary Report* (No. NEFSC Reference Document 13-01). Woods Hole, MA: Northeast Fisheries Science Center.

NHCS. (2015). New Hampshire Community Seafood. from http://www.nhcommunityseafood.com

NHFC. (1869). *Report of the Fish Commissioners to the Legislature, June Session*. Concord, NH.

NHFG. (1934). *Report of the Department of Fish and Game for the Biennial Period ending June 30*. Lebanon, NH: Cory-Hewitt Press, Inc.

NHFG. (1966). *Report of the Department of Fish and Game for the Biennial Period ending June 30*. Lebanon, NH: Cory-Hewitt Press, Inc.

NHPP. (1667). Providential papers: Documents and records relating to the Province of New Hampshire. *Calendar of State Papers, Colonial Series: America and West Indies, 1574-1736, 17*(687), 520-521.

NMFS. (2009). *National Standards Guidelines*. Washington, DC: National Oceanic and Atmospheric Administration.

NMFS. (2010a). *How Discards are Calculated for Groundfish Sectors and the Common Pool*. Gloucester, MA: NOAA Fisheries Northeast Regional Office.

NMFS. (2010b). *How is the Potential Sector Contribution Calculated?* Gloucester, MA: NOAA Fisheries Northeast Regional Office.

NMFS. (2011a). Catch Shares. from http://www.nmfs.noaa.gov/sfa/management/catch_shares/index.html

NMFS. (2011b). *U.S. National Bycatch Report* (No. NOAA Technical Memorandum NMFS-F/SPO-117C). Washington, DC: U.S. Department of Commerce.

NMFS. (2012). NMFS Commercial Fisheries Landings Data. from http://www.st.nmfs.noaa.gov/commercial-fisheries/

NMFS. (2013). NOAA Fisheries Northeast Region Permit Data. from http://www.nero.noaa.gov/permits/permit.html

NMFS. (2014). Greater Atlantic Region Northeast Multispecies Webpage. from https://www.nero.noaa.gov/sustainable/species/multispecies/index.html

NMFS. (2015a). *Fishing Years 2015-2020 Northeast Multispecies Sector Operations Plans and Contracts: A Programatic Environmental Assessment*. Gloucester, MA: National Marine Fisheries Service.

NMFS. (2015b). NOAA Fisheries Northeast Multispecies (Groundfish) Monitoring Reports. from https://www.greateratlantic.fisheries.noaa.gov/aps/monitoring/nemultispecies.html

NOAA. (2007). NOAA Celebrates 200 years of Science, Service, and Stewardship. from http://celebrating200years.noaa.gov/

NOAA. (2010). *NOAA Catch Share Policy*. Washington, DC: National Oceanic and Atmospheric Administration.

NOAA. (2011). Magnuson-Stevens Fishery Conservation and Management Act Provisions; Fisheries of the Northeastern United States; Northeast (NE) Multispecies Fishery; Framework Adjustment 45; Final Rule and Interim Final Rule. *Federal Register, 50 CFR Part 648*, 23042-23076.

NRC. (1999). *Sharing the Fish: Towards a National Policy on Individual Fishing Quotas*. Washington, DC: National Research Council.

NSC. (2014). Sectors/NESSN. from http://northeastseafoodcoalition.org/fishery-101/sectors/

Oliver, T. E. (1815). Business records. Cambridge, MA: Harvard Business School Baker Library.

Olson, J. (2011). Understanding and contextualizing social impacts from the privitization of fisheries: An overview. *Ocean and Coastal Management, 54*, 353-363.

Olson, J., & Clay, P. M. (2001). *An Overview of the Social and Economic Survey Administered during Round II of the Northeast Multispecies Fishery Disaster Assistance Program* (No. NOAA Technical Memorandum NMFS-NE-164). Woods Hole, MA: Northeast Fisheries Science Center.

Olson, J., & Pinto da Silva, P. (2014). Changing boundaries and institutions in environmental governance: Perspectives on sector management of the Northeast U.S. groundfish fishery. *Maritime Studies, 13*(3).

Olson, M. (1971). *The Logic of Collective Action*. Cambridge, MA: Harvard University Press.

Ophuls, W. (1977). *Ecology and the Politics of Scarcity*. San Francisco, CA: W.H. Freeman and Co.

Ostrom, E. (1990). *Governing the Commons*. Cambridge, UK: Cambridge University Press.

Ostrom, E. (2010). Beyond markets and states: Polycentric governance of complex economic systems. *American Economic Review, 100*(1-33).

Paldam, M., & Tinggaard Svendsen, G. (1999). *Is social capital an effective smoke condenser? An essay on a concept linking the social sciences*. Washington, DC: The World Bank.

Palka, D., Orphanides, C. D., & Warden, M. L. (2008). *Summary of Harbor Porpoise (Phocoena phocoena) Bycatch and Levels of Compliance in the Northeast and Mid–Atlantic Gillnet Fisheries after the Implementation of the Take Reduction Plan: 1 January 1999 – 31 May 2007* (No. NOAA Technical Memorandum NMFS-NE-212). Woods Hole, MA: Northeast Fisheries Science Center.

Palmer, M. (2014). *2014 Assessment Update Report of the Gulf of Maine Atlantic Cod Stock* (No. NEFSC Reference Document 14-14). Woods Hole, MA: Northeast Fisheries Science Center.

Parker, I. (1994). Qualitative Research. In P. Banister, E. Burman, I. Parker, M. Taylor & C. Tindall (Eds.), *Qualitative Methods in Psychology: A Research Guide*. Buckingham, UK: Open University Press.

Pennington, M. (2012). Elinor Ostrom, common-pool resources and the classical liberal tradition. In E. Ostrom (Ed.), *The Future of the Commons: Beyond Market Failure and Government Regulation* (pp. 21-47). London, UK: The Institute of Economic Affairs.

Petitions to the Governor, Council, and Legislature. (1764). Concord, NH: New Hampshire Division of Archives and Records.

Pinkerton, E., & Edwards, D. N. (2009). The elephant in the room: The hidden costs of leasing individual transferable fishing quotas. *Marine Policy, 33*, 707-713.

Pollnac, R. B., Colburn, L., Seara, T., Weng, C., & Yentes, K. (2011). *Job Satisfaction, Well-being and Change in Southern New England Fishing Communities*. Narragansset, RI: University of Rhode Island.

Pollnac, R. B., & Poggie, J. J. (2008). Happiness, well-being and psychocultural adaptation to the stresses associated with marine fishing. *Human Ecology Review, 15*(2), 194-200.

Pollnac, R. B., Seara, T., & Colburn, L. L. (2014). Aspects of fishery management, job satisfaction, and well-being among commercial fishermen in the Northeast region of the United States. *Society and Natural Resources, 0*, 1-18.

PPAF. (2012). Fourth Annual New Hampshire Fish and Lobster Festival. from www.fishtival.org

PREP. (2009). *Piscataqua Region Estuaries Partnership Environmental Indicators Report*. Durham, NH: University of New Hampshire.

Putnam, R. D. (2000). *Bowling Alone: The Collapse and Revival of American Community*. New York: Simon and Schuster.

Rideout, R. M., & Burton, M. P. (2000). The reproductive cycle of male Atlantic cod (Gadus morhua L.) from Placentia Bay, Newfoundland. *Canadian Journal of Zoology, 78*(6), 1017-1025.

Roberts, C. (2007). *The Unatural History of the Sea*. Washington, DC: Island Press.

Rose, G. A., & Rowe, S. (2015). Northern cod comeback. *Canadian Journal of Fisheries and Aquatic Sciences, 72*(12), 1789-1798.

Rosenberg, A. A., Bolster, W. J., Alexander, K. E., Leavenworth, W. B., Cooper, A. B., & McKenzie, M. G. (2005). The history of ocean resources: Modeling cod biomass using historical records. *Frontiers in Ecology, 3*(2), 84-90.

Saltonstall, W. G. (1941). *Ports of Piscataqua*. Cambridge, MA: Harvard University Press.

Sanchirico, J. N., & Hanna, S. S. (2004). Sink or swim time for U.S. fishery policy. *Fishery Management, Fall*, 45-52.

Seaport, M. (2012). Roann - Eastern-Rig Dragger. from http://www.mysticseaport.org/

Short, F. T. (1992). *The Ecology of the Great Bay Estuary, New Hampshire and Maine: An Estuarine Profile and Bibliography*. Durham, NH: University of New Hampshire.

Sider, G. M. (2003). *Between History and Tomorrow: Making and Breaking Everyday Life in Rural Newfoundland* (2nd ed.). Peterborough, Ontario, Canada: Broadview Press.

Smith, R. (1981). Resolving the tragedy of the commons by creating private property rights in wildlife. *CATO Journal, 1*(2), 439-468.

Sustainable Fisheries Act, 16 U.S.C. 1801(1996).

Thebaud, O., Innes, J., & Ellis, N. (2012). From anecdotes to scientific evidence? A review of recent literature on catch share systems in marine fisheries. *Frontiers in Ecology, 10*(8), 433-437.

Thunberg, E. M., & Correia, S. J. (2015). Measures of fishing fleet diversity in the New England groundfish fishery. *Marine Policy, 58*, 6-14.

Tromble, G. R., Lambert, D. M., & Benaka, L. R. (2009). Prelude to sustainability: Ending overfishing in U.S. fisheries *Our Living Oceans: Report on the Status of U.S. Living Marine Resources* (6th ed., pp. 57-66): U.S. Department of Commerce,.

UMass. (2013). Bycatch Avoidance Programs. from www.umassd.edu/smast/smastnewsyoucanuse/bycatchavoidanceprograms/

UNHCE. (2012). NH Seafood. from NHseafood.com

Van Deventer, D. E. (1976). *The Emergence of Provincial New Hampshire, 1623-1741*. Baltimore, MD: Johns Hopkins University Press.

Vaughan, G. (1708). George Vaughan to the Board of Trade, July 6, 1708. *Calendar of State Papers, Colonial Series: America and West Indies, 1574-1736, 19.*

Vickers, D. (1994). *Farmers and Fishermen: Two Centuries of Work in Essex County, Massachusetts, 1630-1850*. Chapel Hill, NC: University of North Carolina Press.

Ware, R. D. (1930). *Summary of the Capt. Thomas E. Oliver Papers*. Cambridge, MA: Harvard Business School Baker Library.

Weisberg, H. F., Krosnick, J. A., & Bowen, B. D. (1989). *An Introduction to Survey Research and Data Analysis* (2nd ed.). Glenview, IL: Scott, Foresman and Co.

White, D. J. (1954). *The New England Fishing Industry: A Study in Price and Wage Setting*. Cambridge, MA: Harvard University Press.

Wilcox, W. A. (1887). The Fisheries of New Hampshire. In G. B. Goode (Ed.), *The Fisheries and the Fishery Industries of the United States* (Vol. 2, pp. 103-112). Washington, DC: U.S. Government Printing Office.

Windle, M. J. S., Neis, B., Bornstein, S., Binkley, M., & Navarro. (2008). Fishing occupational health and safety: A comparison of regulatory regimes and safety outcomes in six countries. *Marine Policy, 32*, 701-710.

Wingard, J. D. (2000). Community transferable quotas: Internalizing externalities and minimizing social impacts of fisheries management. *Human Organization, 59*(1), 48-57.

Woodley, C. (2002). *Quota-based fishery management regimes.* Paper presented at the International Fishing Industry Safety and Health Conference, Cincinnati, OH.

YFC. (2012). Yankee Fisherman's Cooperative. from www.yankeefish.com

APPENDICES

APPENDIX A. PRELIMINARY RESEARCH

STAKEHOLDER OBSERVATIONS FROM FALL 2010 PRELIMINARY INTERVIEWS

Interviews were conducted by R. Feeney (2010).

FISHING PRACTICES.

- The ability to lease unused quota adds some flexibility to continue fishing.
- People are fishing when the prices are best and when the quota is available.
- Now the fishermen try to not catch fish, which goes against the grain.
- Boats do not fish full days, because fishermen are worried about their allocations.
- The dockside monitoring events take significantly more time, and costs in payroll time.

SOCIAL CAPITAL.

- NMFS and environmentalists want sectors, but 92% of the fishermen do not want sectors, because 8% of the boats (politically-connected) own 52% of the quota.
- Many fishermen and municipalities have joined a law suit against NMFS over the allocation formula.
- The fishermen have showed a degree of cooperation and willingness to make a "bad system" work that is far greater than expected.
- Fishermen have traditionally been competitors; now they are forced to collaborate.
- Some new industry leaders have emerged.

BYCATCH.

- There are fewer discards, but it is the high observer coverage that is reducing discards, not a greater sense of ecosystem stewardship.
- The assumed discard rate pressures the fishermen to discard fish at certain times.

ECONOMIC PERFORMANCE.

- The quota is very expensive to lease.
- In 2010, fish prices have been the highest ever, because there is less on the market.
- As of November, 2010, the Yankee Fishermen's Co-op had 50% less multispecies income.
- Fishermen are opposed to Amendment 16, because the allocation formula changed the currency from Days-at-Sea to catch history in a limited number of qualifying years.
- The Yankee Fishermen's Co-op is the only remaining dealer of multispecies in New Hampshire. The fishermen work hard to make the Co-op succeed, but many members are no longer fishing.
- A lot of fishermen are going out of business. People do not have enough quota.
- If fishermen have to pay for observers in 2012 as proposed (~$900 per day), it will make the small boats operations unviable.

SAFETY.

- Fishing is occurring further offshore.
- The bureaucracy involved in sectors creates more distractions at sea.

WELL-BEING.

- There has been added confusion; the data from dockside monitoring is not being used by NMFS, which adds to fishermen's frustration.
- The uncertainty of future catch limits prevents fishermen from making informed business decisions.
- Fishermen had no other option but to join a sector that they wished did not exist.

PRELIMINARY RESEARCH OF DR. J. WIERSMA

Dr. J. Wiersma, manager of NEFS XI and XII, conducted a survey during FY 2010 of the 24 participants of his sectors. Of the 16 informants (67%), the average vessel size was 41' with 340 hp engines, and 84% said that their 2010 initial allocation was about 28% less than what they landed in 2009 under DAS. Vessels with larger horsepower had 2010 allocations closer to their 2009 catch. He asked whether it was difficult to fish balancing the portfolio of stock allocations, and 42% agreed. Profits were down for 42% of respondents in 2010 relative to 2009. The additional monitoring required is considered burdensome and costly to 75% of respondents. Sector members are now required to submit weekly vessel trip reports (VTRs) to NMFS and daily VTRs to the sector manager, and to double the data inputted into their Vessel Monitoring System Skymate unit (doubling transmission costs). He asked whether they would be more likely to sell their multispecies permit or purchase another; 33% said they would sell. Sector management has reduced the enjoyment of fishing for 33%, but 66% said that their catch per unit effort has increased (J. Wiersma, personal communication, 2011).

Although multispecies catch and revenue was down by 50% in 2010 vs. 2009 for NEFS XI and XII, total fishing revenue declined only by 7.5% for the survey respondents, due shifts in effort to monkfish, herring, lobster, and other fisheries. Of the respondents, 75% fish alone, without crew members. They reported that the biggest challenges were the monitoring and reporting requirements, as well as avoiding bycatch of "choke stocks" - low-allocation stocks that are caught concurrently with higher-allocation stocks. They adapted to these challenges by fishing in different areas to avoid bycatch, learned how to use a computer, fished more nets (gillnets) to land more fish per day, and they did not feel rushed while fishing. Respondents reported that the biggest benefit of sectors is the elimination of regulatory discards, which provides more accountability. When asked what management regime they would prefer, 65% said sectors, 10%

said DAS, and 25% said neither. A six-fold increase in the price of permits was also observed, attributed to the new state-run permit bank in Maine. There are several hidden costs associated with sectors, which may be diminishing the flexibility gained (J. Wiersma, personal communication, 2011).

APPENDIX B. INTERVIEW QUESTIONS, VARIABLES, AND CODING SCHEME

Variable	**Question**	**Coding**
Informant	Was this person interviewed?	0 = no; 1 = yes

Background Demographic Variables		
Sex	Record sex	0 = male; 1 = female; 98 = unknown
Age	What is your current age bracket (years)?	0 = 0-29; 1 = 30-39; 2 = 40-49; 3 = 50-59, 4 = 60-69; 5 = 70-79 98 = unknown
Permit1	How many commercial groundfish permits do you own currently?	record actual number
Permit 5	What is the permit category?	1 = A; 2 = HA; 3 = C; 4 = D; 5 = F; 6 = multiple; 99 = n/a
Permit2	If answered "0" on *Permit1:* When did you sell your last commercial groundfish permit?	record actual year; 98 = unknown; 99 = n/a
Permit3	In the last few years, did you buy or sell any groundfish permits?	0 = no; 1 = yes; 98 = unknown; 99 = n/a
Permit4	Please explain:	
Years1	What year did you buy/obtain your first permit?	record actual year; 98 = unknown; 99 = n/a
Years2	Did you work as a fisherman prior to owning a permit?	0 = no; 1 = yes; 98 = unknown; 99 = n/a
HomePort1	What is your home port?	0 = Portsmouth; 1 = Rye; 2 = Hampton; 3 = Seabrook; 4 = Portland; 5 = Gloucester; 6 = New Bedford; 7 = Kittery; 8 = Jonesport; 9 = York 10 = Eliot; 11 = Newburyport 12 = Newington; 13 = Boston; 14 = Bath, NC; 15 = Greenbackville, NC 16 = Tom's River, NJ 17 = New Castle, NH 18 = Hampton Falls, NH
HomePort2	How long has it been your homeport?	record actual year; 98 = unknown; 99 = n/a
LandPort1	What is your primary landing port (75%+)?	(same as *HomePort1*)
LandPort2	How long has it been your homeport?	record actual year; 98 = unknown; 99 = n/a
Vessel1	How many vessels do you own currently?	record actual number; 98 = unknown
Vessel2	In the last few years, did you buy or sell any vessels?	0 = no; 1 = yes; 98 = unknown; 99 = n/a
Vessel3	Please explain.	
Vessel4	What is the length of the vessel(s) you fish groundfish with?	record actual length; 98 = unknown; 99 = n/a

Vessel5	What is the horsepower of the vessel(s) you fish groundfish with?	record actual horsepower; 98 = unknown; 99 = n/a
FY 2009 Fishing Activity		
09Own	Did you own a groundfish permit in FY 09?	0 = no; 1 = yes
09Income1	What percent of total household income was derived from fishing in FY 09?	0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%
09Income2	What percent of your own income was derived from fishing in FY 09?	0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%
09Employ	If less than 100, what other employment did you have in FY 09?	
09Income3	What percent of your fishing income in FY 09 was derived from groundfish?	0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%
09Income4	If less than 100, what other fisheries contributed to your income?	
09Labor1	How many individuals worked on your boat at a given time on average in FY 09?	record actual number
09Labor2	How many total people did you employ as crew in FY 09?	record actual number
For all fishermen with FY 09 groundfish income		
09Gear1	What was your principal groundfish gear type in FY 09?	0 = trawl; 1 = gillnet; 2 = handgear; 3 = combination; 99 = n/a
09Gear2	Describe any changes in groundfish fishing gear you made in FY 09?	0 = no change; 1 = change; 98=unknown; 99 = n/a
09Trip	How long was a typical groundfish fishing trip in FY 09?	record actual hours; 99 = n/a
09Area1	What was your general groundfish fishing area in FY 09?	
09Conflict	Compared to FY 08, did area conflicts with other fishermen decrease, remain unchanged, or increase?	0 = decreased; 1 = unchanged; 2 = increased; 99 = n/a
09Gear3	Compared to FY 08, did your rate of lost groundfish gear decrease, remain unchanged, or increase?	0 = decreased; 1 = unchanged; 2 = increased; 99 = n/a
09DAS1	How many groundfish DAS were you allocated for FY 09 or did you lease?	record actual DAS; 99 = n/a
09DAS2	Did you fish or lease all your DAS in 2009?	0 = no; 1 = yes; 99 = n/a

FY 2010 Fishing Activity		
10Own	Did you own a groundfish permit in FY 10?	0 = no; 1 = yes; 99 = n/a
10Income1	What percent of total household income was derived from fishing in FY 10?	0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%
10Income2	What percent of your own income was derived from fishing in FY 10?	0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%
10Employ	If less than 100, what other employment did you have in FY 10?	
10Income3	What percent of your fishing income for FY 10 was derived from groundfish?	0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%
10Income4	If less than 100, what other fisheries contributed to your income in FY 10?	
10Labor1	How many individuals worked on your boat at a given time on average in FY 10?	record actual number
10Labor2	How many total people did you employ as crew in FY 10?	record actual number

For all fishermen with FY 10 groundfish income		
10Gear1	What was your principal groundfish gear type in FY 10?	0 = trawl; 1 = gillnet; 2 = handgear; 3 = combination; 99 = n/a
10Gear2	Describe any changes in groundfish fishing gear you made in FY 10?	0 = no change; 1 = change; 99 = n/a
10Trip	How long was a typical groundfish fishing trip in FY 10?	record actual hours; 99 = n/a
10Area1	What was your general groundfish fishing area in FY 10?	
10Conflict	Compared to FY 09, did area conflicts with other fishermen decrease, remain unchanged, or increase?	0 = decreased; 1 = unchanged; 2 = increased; 99 = n/a
10Gear3	Compared to FY 09, did your rate of lost groundfish gear decrease, remain unchanged, or increase?	0 = decreased; 1 = unchanged; 2 = increased; 99 = n/a
10Sector1	Were you a member of a sector in FY 10?	0 = no; 1 = yes; 2 = both 98 = unknown; 99 = n/a
For sector members		
10Sector2	Which sector(s) were you a member of?	0 = NEFS XI; 1 = NEFS XII; 2 = SHS; 3 = NEFS II; 4 = NEFS 3; 5 = multiple 98 = unknown; 99 = n/a
10Sector3	Were you a sector member for lease-only purposes or did you actively fish in FY 10?	0 = lease-only; 1 = active; 2 = both; 99 = n/a
10Exempt	What exemptions from DAS did you utilize in FY 10? Which were most important?	
10Harvest1	Were you able to harvest all your allocation in FY 10?	0 = no; 1 = yes; 99 = n/a
10Harvest2	Please explain.	
10Pool1	Were you a member of the common pool in FY 10?	0 = no; 1 = yes
For common pool members		
10DAS1	How many DAS did you go fishing in FY 10?	record actual DAS; 99 = n/a
10DAS2	How often did you meet your trip limit in FY 10?	0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51=75%; 4 = 76-100%; 99 = n/a

FY 2011 Groundfish Fishing Activity		
11Own	Did you own a groundfish permit in FY 11?	0 = no; 1 = yes
11Income1	What percent of total household income was derived from fishing in FY 11?	0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%
11Income2	What percent of your own income was derived from fishing in FY 11?	0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%
11Employ	If less than 100, what other employment did you have in FY 11?	
11Income3	What percent of your fishing income in FY 11 was derived from groundfish?	0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51-75%; 4 = 76-100%
11Income4	If less than 100, what other fisheries contributed the most to your income in 2011?	
11Labor1	How many individuals worked on your boat at a given time on average in FY 11?	record actual number
11Labor2	How many total people did you employ as crew in FY 11?	record actual number

For all fishermen with FY 11 groundfish income		
11Gear1	What was your principal groundfish gear type in FY 11?	0 = trawl; 1 = gillnet; 2 = handgear; 3 = combination; 99 = n/a
11Gear2	Describe any changes in groundfish fishing gear you made in FY 11?	0 = no change; 1 = change; 99 = n/a
11Trip	How long was a typical groundfish fishing trip in FY 11?	record actual hours; 99 = n/a
11Area1	What was your general groundfish fishing area in FY 11?	
11Conflict	Compared to FY 10, did area conflicts with other fishermen decrease, remain unchanged, or increase?	0 = decreased; 1 = unchanged; 2 = increased; 99 = n/a
11Gear3	Compared to FY 10, did your rate of lost groundfish gear decrease, remain unchanged, or increase?	0 = decreased; 1 = unchanged; 2 = increased; 99 = n/a
11Sector1	Were you a member of a sector in FY 11?	0 = no; 1 = yes; 2 = both 98 = unknown; 99 = n/a
For sector members		
11Sector2	Which sector(s) were you a member of?	0 = NEFS XI; 1 = NEFS XII; 2 = SHS; 3 = NEFS II; 4 = NEFS 3; 5 = multiple 98 = unknown; 99 = n/a
11Sector3	Were you a sector member for lease-only purposes or did you actively fish in FY 11?	0 = lease-only; 1 = actively fished; 2 = both; 99 = n/a
11Exempt	What exemptions from DAS did you utilize in FY 11? Which were most important?	
11Harvest1	Were you able to harvest or lease all your allocation in FY 11?	0 = no; 1 = yes; 99 = n/a
11Harvest2	Please explain.	
11Pool1	Were you a member of the common pool in FY 11?	0 = no; 1 = yes
For common pool members		
11DAS1	How many DAS did you go fishing in FY 11?	record actual DAS; 99 = n/a
11DAS2	How often did you meet your trip limit in FY 11?	0 = 0%; 1 = 1-25%; 2 = 26-50%; 3 = 51=75%; 4 = 76-100%; 99 = n/a

FY 2012 Fishing Activity		
12Own	Did you own a groundfish permit in FY 12?	0 = no; 1 = yes;
12Sector1	Were you a member of a sector in FY 12?	0 = no; 1 = yes; 2 = both 98 = unknown; 99 = n/a
12Sector2	Which sector(s) were you a member of?	0 = NEFS XI; 1 = NEFS XII; 2 = SHS; 3 = NEFS II; 4 = NEFS 3; 5 = multiple 98 = unknown; 99 = n/a
Fishing Practices Generally		
Flexibility1	Which program would you say provides greater flexibility for fishermen to decide when, where, and how to fish: DAS or sectors?	0 = DAS; 1 = sectors; 2 = equally flexible; 3 = equally inflexible; 4 = unsure; 99 = n/a
Flexibility2	Please explain.	

Efficiency1	Which program would you say allows greater efficiency for fishing operations: DAS or sectors?	0 = DAS; 1 = sectors; 2 = equally efficient; 3 = equally inefficient; 4 = unsure; 99 = n/a
Efficiency2	Please explain (e.g., fuel, sorting efficiency, better operational management and planning).	
Understand1	Are the rules more difficult to understand for Days-at-Sea or sectors?	0 = DAS; 1 = sectors; 2 = equally easy; 3 = equally difficult; 4 = unsure; 99 = n/a
Understand2	Please explain.	
Advantages	What are the advantages of belonging to a sector?	
Disadvantages	What are the disadvantages of belonging to a sector?	
Chose	What are the main reasons why you chose to join a sector/remain in the common pool?	

Social Capital		
Organize1	Do you belong to any fishermen's organizations (besides sectors)?	0 = no; 1 = yes
Organize2A	Which? Northeast Seafood Coalition?	0 = no; 1 = yes
Organize2B	Which? New Hampshire Commercial Fishermen's Association?	0 = no; 1 = yes
Organize2C	Which? National Association of Charter Boat Operators?	0 = no; 1 = yes
Organize2D	Which? Maine Professional Guides Association?	0 = no; 1 = yes
Organize2E	Which? Granite State Fish?	0 = no; 1 = yes
Organize2F	Which? Yankee Fishermen's Co-operative?	0 = no; 1 = yes
Organize2G	Which? Associated Fisheries of Maine?	0 = no; 1 = yes
Organize2H	Which? Northeast Tuna Club?	0 = no; 1 = yes
Organize2I	Which? Northeast Hook Fishermen's Association?	0 = no; 1 = yes
Organize2J	Which? Salt Water Party Boat Association?	0 = no; 1 = yes
Leader1	Have you served in a leadership position in any of these organizations?	0 = no; 1 = yes; 99 = n/a
Lend1	Do you to share any equipment with other fishermen?	0 = no; 1 = yes
Lend2	Please explain.	
Communicate1	Do you tend to share information about fishing areas with other fishermen?	0 = no; 1 = yes
Communicate2	Please explain.	
Trust1	In general, how often do you trust fishermen in your community (NH) in business dealings?	0 = never; 1 = sometimes; 2 = always
Trust2	Please explain.	
Network1	Describe the network of fishermen you communicate with, without naming individuals (on land and/or at sea; talk about fishing and/or management; from New Hampshire or beyond; sector members or not?).	
Network2	Are there some fishermen you avoid talking with?	0 = no; 1 = yes
Network3	How many fishermen do you share information with about what you're catching?	Record actual number; 98 = whole community; 99 = n/a

Network4	Is helping a fisherman inside your community more important to you than helping a fisherman outside your community?	0 = no; 1 = yes
Allocation1	How important to you is keeping allocation within the NH fishing community?	0 = not important; 1 = neutral; 2 = important
Allocation2	When selling/leasing allocation, are you willing to accept a lower price to keep the quota within your sector?	0 = no; 1 = yes; 99 = n/a
Trust3	In general, how often do you trust NMFS to have the best interest of the industry in mind?	0 = never; 1 = sometimes; 2 = always
Trust4	Please explain.	
For sector members		
Leader2	Have you served on the Board of your sector?	0 = no; 1 = yes; 99 = n/a
Compliance3	Do sector members respect sector rules?	0 = no; 1 = yes; 98 = can't say; 99 = n/a
Trust5	Do you trust the members of your sector more, the same, or less than other fishermen?	0 = less; 1 = the same; 2 = more; 99 = n/a
Manager1	Has working with a sector manager been helpful?	0 = no; 1 = yes; 99 = n/a
Manager2	Please explain.	
Bycatch		
Important1	How important is reducing bycatch to you (e.g., decreased deck sorting time, higher quality catch, stock rebuilding purposes)?	0 = not important; 1 = neutral; 2 = important
Important2	Please explain.	
For all active fishermen		
Change1	Do you feel that your level of bycatch since May 2010 has decreased, is unchanged, or has increased?	0 = decreased; 1 = unchanged; 2 = increased; 99 = n/a
Avoid1	Do you go above and beyond the regulations to avoid bycatch (e.g., modify/test gear, adjust fishing area)?	0 = no; 1 = yes; 99 = n/a
Avoid2	Please explain.	

Economic Performance		
Predict1	Since May 2010, has the predictability of your fishing business decreased, remained the same, or increased?	0 = decreased; 1 = unchanged; 2 = increased; 99 = n/a
Predict2	What conditions most affect business predictability?	
Profit	Since May 2010, have the profit margins of your fishing business decreased, remained the same, or increased?	0 = decreased; 1 = unchanged; 2 = increased; 99 = n/a
Sell	Describe where you sell your fish and if that has changed in recent years.	
For sector members only		
Cost	How do the costs associated with the sectors compare with what was expected?	0 = lower than expected; 1 = as expected; 2 = higher than expected; 3 = unsure; 99 = n/a

Safety		
Safety1	Do (did) the DAS regulations you operate(d) under in the groundfish fishery ever compromise vessel safety?	0 = no; 1 = yes
Safety2	Please explain.	
Safety3	Do (did) the sectors regulations you operate(d) under in the groundfish fishery ever compromise vessel safety?	0 = no; 1 = yes; 99 = n/a
Safety4	Please explain.	
Well-Being		
Fairness	Do you consider your initial allocation under Amendment 16 to be fair, unfair, or are you unsure?	0 = unfair; 1 = fair; 2 = unsure; 99 = n/a
Stress1	Is fishing today more or less stressful than before May 2010?	0 = less stressful today; 1 = no change; 2 = more stressful today 99 = n/a
Stress2	What aspects of fishing do you consider stressful?	
Fatigue1	Since May 2010, has your fatigue level at sea decreased, remained the same, or increased?	0 = decreased; 1 = unchanged; 2 = increased; 99 = n/a
Job1	Since May 2010, has your job satisfaction decreased, remained the same, or increased?	0 = decreased; 1 = unchanged; 2 = increased; 99 = n/a
Retirement	Do you expect to retire as a fisherman?	0 = no; 1 = yes; 2 = unsure
Job2	How many more years do you expect to be fishing?	record number of years; 98 = unsure
Young1	Would you advise a young person to enter fishing?	0 = no; 1 = yes
Young2	Please explain.	
Outlook1	Is your outlook for the future of the New Hampshire groundfish fishery negative, neutral, or positive?	0 = negative; 1 = neutral; 2 = positive
Outlook2	Please explain.	
Life1	If you had your life to live over, would you still fish?	0 = no; 1 = yes; 2 = unsure
Life2	Please explain.	

From Richard Pollnac:		
How satisfied are you with the following items related to the occupation of groundfish fishing? (For former fishermen, ask "how satisfied were you…")		
Earnings1	Your actual earnings?	1 = very dissatisfied; 2 = dissatisfied; 3 = neutral; 4 = satisfied; 5 = very satisfied; 6 = unsure
Predict3	Predictability of your earnings?	1 = very dissatisfied; 2 = dissatisfied; 3 = neutral; 4 = satisfied; 5 = very satisfied; 6 = unsure
Safety5	Job safety?	1 = very dissatisfied; 2 = dissatisfied; 3 = neutral; 4 = satisfied; 5 = very satisfied; 6 = unsure

Time1	Time spent away from home?	1 = very dissatisfied; 2 = dissatisfied; 3 = neutral; 4 = satisfied; 5 = very satisfied; 6 = unsure
Fatigue2	Physical fatigue of the job?	1 = very dissatisfied; 2 = dissatisfied; 3 = neutral; 4 = satisfied; 5 = very satisfied; 6 = unsure
Health1	Healthfulness of the job?	1 = very dissatisfied; 2 = dissatisfied; 3 = neutral; 4 = satisfied; 5 = very satisfied; 6 = unsure
Adventure1	Adventure of the job?	1 = very dissatisfied; 2 = dissatisfied; 3 = neutral; 4 = satisfied; 5 = very satisfied; 6 = unsure
Challenge1	Challenge of the job?	1 = very dissatisfied; 2 = dissatisfied; 3 = neutral; 4 = satisfied; 5 = very satisfied; 6 = unsure
Boss1	Opportunity to be your own boss?	1 = very dissatisfied; 2 = dissatisfied; 3 = neutral; 4 = satisfied; 5 = very satisfied; 6 = unsure

APPENDIX C. DEFINITION OF ACRONYMS

ACCSP	Atlantic Coastal Cooperative Statistics Program
ACE	Annual Catch Entitlement
ACL	Annual Catch Limit
AM	Accountability Measure
CC	Cape Cod
DAS	Days-at-Sea
EA	Environmental Assessment
FMP	Fishery Management Plan
FY	Fishing Year
GB	Georges Bank
GOM	Gulf of Maine
IFQ	Individual Fishing Quota
IPA	Interpretive Phenomenological Discourse Analysis
IRB	Institutional Review Board
LAPP	Limited Access Privilege Program
MIT	Massachusetts Institute of Technology
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
NEFMC	New England Fishery Management Council
NEFS	Northeast Fishery Sector
NEFSC	Northeast Fisheries Science Center
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NSC	Northeast Seafood Coalition
PSC	Potential Sector Contribution
SNE	Southern New England
TAC	Total Allowable Catch
TURF	Territorial Use Right for Fishing
UNH	University of New Hampshire
VTR	Vessel Trip Report

APPENDIX D. INSTITUTIONAL REVIEW BOARD APPROVAL

University *of* New Hampshire

Research Integrity Services, Service Building
51 College Road, Durham, NH 03824-3585
Fax: 603-862-3564

22-Jun-2012

Feeney, Rachel G.
EOS/OPAL, 142 Morse Hall
Durham, NH 03824

IRB #: 5500
Study: Catch Share Management in the Northeast Multispecies Fishery: Implications for Fishing Practices, Social Capital, and Bycatch in New Hampshire
Approval Date: 22-Jun-2012

The Institutional Review Board for the Protection of Human Subjects in Research (IRB) has reviewed and approved the protocol for your study as Expedited as described in Title 45, Code of Federal Regulations (CFR), Part 46, Subsection 110.

Approval is granted to conduct your study as described in your protocol for one year from the approval date above. At the end of the approval period, you will be asked to submit a report with regard to the involvement of human subjects in this study. If your study is still active, you may request an extension of IRB approval.

Researchers who conduct studies involving human subjects have responsibilities as outlined in the attached document, *Responsibilities of Directors of Research Studies Involving Human Subjects.* (This document is also available at http://unh.edu/research/irb-application-resources.) Please read this document carefully before commencing your work involving human subjects.

If you have questions or concerns about your study or this approval, please feel free to contact me at 603-862-2003 or Julie.simpson@unh.edu. Please refer to the IRB # above in all correspondence related to this study. The IRB wishes you success with your research.

For the IRB,

Julie F. Simpson
Director

cc: File
Glass, Christopher
Wiersma, Joshua