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The complex challenges that Oregon's commercial fishing community faces are mainly driven by four sources of change: climate change, change in management regulations, societal shifts, and market trends. Challenges include increasing competition for ocean use, management decisions that prioritize economic efficiency over community values, and an increasingly uncertain environment. The aim of this research is to understand and identify how Oregon's fishing community is resilient and adaptive in the face of these compounding changes. In order to understand the impacts of change within Oregon's fishing community, this research dives into the multiple scales and varied lenses of the social-ecological system. With the goal of informing fisheries management, this project specifically identifies the connections between climate change and graying of the fleet (e.g., the increase in the average age of commercial fishermen). Breaking down these connections into steps helps managers more accurately conceptualize future scenarios and specific impacts of policy and management decisions, simultaneously enabling managers or policy-makers to locate specific target areas for intervention or opportunity. Data consisted of oral history semi-structured interviews with members of Oregon's fishing community and recent climate change projections from the literature. Findings reveal that climate change will likely intensify the drivers and impacts of the graying of the fleet phenomenon in Oregon. Analysis of the cumulative impacts from

these stressors demonstrate that Oregon's fishing community will likely be closer to thresholds of transformation than analysis of stressors individually indicates. Therefore, the most important direct implication that emerged from this research is the need to consider and identify the cumulative component of impacts within a system when assessing change. Additionally, analysis of the data revealed the prevalence and importance of optimism within Oregon's fishing community. The role of optimism was then further explored in order to understand the possible implications for its use as an indicator of resilience. Although optimism may support resilient communities, it may also inhibit activation of adaptive capacity. Therefore, optimism's role within Oregon's fishing community could both enable and inhibit positive decisions and action in anticipation and response to future climate change.

Perceptions of a Changing Ocean: Resilience and Oregon's Commercial Fishing Community

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Brianna I. Haugen, Author

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CHAPTER 1: INTRODUCTION, BACKGROUND, METHODS

"We inter-breath with the rain forests, we drink from the oceans. They are part of our own body." – Thich Nhat Hanh

Introduction

Environmental, management, and social changes are not new to Oregon's commercial fishing community due to the dynamic nature of the system that they live and work in. However, the rate and magnitude of change today is far greater than in the past (Pomeroy et al., 2015; Flathers, 2017; Lam et al., 2016; Hanna & Hall-Arber, 2000). Climate change is projected to challenge the world's social and ecological systems in ways never before experienced (IPCC SR15; Marshall, 2010). Although fishermen are skilled at coping with seasonal variations in ocean conditions and the longer climatic cycles in which seasonal variations occur, large scale climate change will intensify this smaller scale environmental variability (IPCC SR15). The ocean is also being considered for an expanding number of uses and services, and those that operate within and live next to its mighty waters must navigate this uncertainty (Calhoun, 2015). Additionally, fisheries management has undergone transformative shifts through changes in regulations in the past two decades, and these trends are likely to continue (Conway & Shaw, 2008; Pomeroy et al., 2015; Cramer et al., 2018). The changes in management were largely due to depletion of fish stocks and unsustainable practices, and current surveys show that many fish stocks are indeed rebounding (PFMC & NMFS, 2017). The numbers may show that some of the commercial fisheries are doing better, but any conversation with a fisherman will reveal a more complex story. Management decisions focused on and designed for ecologically sustainable practices are necessary but have unforeseen rippling socio-ecological consequences (Olson, 2011). The changes and challenges that the commercial fishing community faces require a dive into the multiple scales and varied lenses that bring into focus this complexity. The fishing community – a community of interest – is made up of the individuals whom operate based on their own values and perceptions while being part of the larger fishing industry and community of place (Conway et al., 2002). Fishing communities are influenced from

local, state, and federal institutions as well. These institutions have a profound impact on the ecological, social, and political dynamics of fishing communities.

Background

U.S. Fisheries Management and Policy

The Magnuson Stevens Fishery and Conservation Act (MSA), passed in 1976, has been the main tool for managing fisheries within the United States. Unregulated fishing just 12 miles offshore by foreign fleets became a concern and contributed greatly to the creation of the MSA (Weber, 2002). Additionally, the 1970's demonstrated a shift in the previous paradigm, which had centered on the belief in the limitless bounty of the ocean (Weber, 2002). U.S. jurisdiction was extended to 200 nautical miles and eight regional fishery management councils were created. Oregon, along with California and Washington, became part of the Pacific Fisheries Management Council (NOAA Fisheries, 2019). Two main revisions have taken place since the initial implementation of the MSA. The first is the passage of the Sustainable Fisheries Act in 1996 and the second is the MSA Fishery Conservation and Management Reauthorization Act of 2006 (NOAA Fisheries, 2019).

A fundamental goal of the MSA, and of subsequent management and policy decisions, is to maintain sustainable and healthy fisheries, preventing collapse and supporting the rebuilding of depleted stocks (16 U.S.C. 1801 – 1891(d)). The creation of a limited entry portion of the West Coast groundfish fishery was initiated in 1994 by Amendment 6, however a collapse of the fishery ensued. Within the jurisdictional boundaries of the PFMC, nine groundfish species were declared overfished in 2002, and consequently the entire continental shelf was closed to bottom trawling (Warlick et al., 2018; Conway & Shaw, 2008). Attempts to decrease human fishing pressure and resultant occupational insecurity resulted in a slew of program decisions over the next decade. A buyback program occurred in 2003, reducing the amount of boats on the water. In January 2011, the Pacific West Coast groundfish trawl fishery transitioned to a catch share program (PFMC & NMFS, 2017).

Catch Shares

Catch shares allocate a secure and exclusive share of fish to individuals or groups of fishermen, communities, or other entities such as fishing cooperatives (NOAA Fisheries, 2019; Russell et al., 2014; Brinson & Thunberg, 2016). Catch shares emphasize market-based policy instruments in order to achieve ecological goals (Essington et al., 2012). Emerging out of the prominent argument regarding the "open access" nature of fisheries, catch shares operate as neoliberal, free market solutions (Mansfield, 2004). Globally, catch share systems have been prominently utilized in New Zealand and Iceland; both of the programs began in the 1970's and 80's, therefore providing some insight into the possible effects of using this type of system (Lynham, 2013). The first catch share program in the U.S. was implemented in 1990 in the Mid-Atlantic region (NOAA Fisheries, 2019).

Individual Transferable Quotas (ITQs) are a form of catch shares and as such, are appealing as solutions to overcapitalization and overfishing. The U.S West Coast Trawl Fishery is managed specifically under an ITQ system. ITQs are the allocation of quota to individuals or enterprises, but the highlight of this specific form is that shares are transferable to others (McCay, 1995). They give the right to capture a share of the resource, but unlike private property, the overall quota is determined by the government (McCay, 1995). The individual allocation can be determined by any number of standards, such as historical catch performance, gear capacity, numbers of crew, or equal shares (Copes, 1986). New Zealand, Iceland, and the U.S. West Coast Trawl Fishery all typically operate under the standard of historical catch performance (Lynham, 2013)

Creating a successful fisheries management system requires careful thought to trade-offs, as social and economic dimensions are highly impacted alongside the ecological dimension (Warlick et al., 2018). Catch shares are designed to reduce overcapacity, increase economic efficiency, promote safety, and allow for flexible fishing schedules. Specific to fish stocks, they are designed to reduce bycatch, rebuild the strength of overfished species, and sustain healthy fisheries (Brinson & Thunberg, 2016; Warlick et al., 2018; Russell et al., 2014). Benefits from this type of program have been documented in various locations. A positive outcome noted is the

disincentivizing of the "race to fish". By ensuring the rights to a quota, they are guaranteed a set amount of fish, thereby removing the pressure to be the first to catch as much as possible (Acheson et al., 2015). The race-to-fish can lead to higher rates of discarded and incidental catch, as well as habitat destruction (Essington et al., 2012). Importantly, catch chares allows the crew the flexibility to stay home if the weather is unsafe, since their personal quota will not be affected (Pfeiffer & Gratz, 2016). It is generally accepted that catch share systems like the ITQ for the West Coast groundfish trawl fishery result in higher economic efficiency (Leonard & Steiner, 2017). Systems that use catch shares have also been noted as less likely to experience a collapse in fish landings (Costello et al., 2008; Essington et al., 2012).

Although positives such as a decreased likelihood of fishery collapse have resulted from catch share systems, the value of such a system remains a highly debated topic. Research has revealed many negative consequences from this system as well, such as consolidation of the fleet into the hands of fewer and often larger quota holders (McCay, 2001; Ringer et al., 2018; Carothers & Chambers, 2012; Carothers et al., 2010; Russell et al., 2014; Yandle & Dewes, 2008). Oftentimes an increase in unemployment accompanies the decrease in number of boats in the fleet and costs typically fall upon those who lack access to capital markets (Acheson et al., 2015; Olson, 2011). An analysis in 2015 of all U.S. catch share programs put in place found that active vessels decreased by an average of 24% in the first year of implementation (Brinson & Thunberg, 2016). In cases where preventative measures have not been put in place, infrastructure also oftentimes disappears from small communities and concentrates in large communities (Russell et al., 2014). Ultimately, catch shares can lead to a redistribution of the have's and have not's, oftentimes further dividing social classes and exacerbating inequalities (Acheson et al., 2015; Lowe, 2008; Carothers, 2013; Olson 2011; Clay et al., 2010; Himes-Cornell & Hoelting, 2015). Additionally, catch shares can prevent or reduce diversification. Diversification by participating in multiple fisheries is often necessary as a means of survival in order to supplement income when seasons change (Holland et al., 2017). Increasing costs to enter the fishing industry have also been noted, resulting in barriers for youth to enter the industry (Russell et al., 2014; Donkersloot & Carothers,

2016; Chambers & Carothers, 2017; Carothers, 2015; Carothers, 2010; Himes-Cornell & Hoelting, 2015). Limited ability and motivation to enter the industry greatly contributes to "graying of the fleet" and constitutes a central concern of this research study.

"Graying of the Fleet"

The term "graying of the fleet" (referred to here as graying) was initially coined in reference to shifting aging and succession trends identified in many Alaskan fishing communities. One of the first acknowledgements of aging within the fleet and resultant barriers to youth entry was acknowledged in 1982 in Bristol Bay, Alaska (Koslow, 1982). There has since been a push to grow our understanding of this trend. In 2014, the average age of a fishing permit holder in Alaska was 50 years. This is significantly higher than the average age recorded in 1980, which was only 40 years old (Donkersloot & Carothers, 2016). The overall percent of permit holders in Alaska under 40 has decreased since 1980. In the Bristol Bay salmon fishery there has been a 50% decrease between 1975 and 2014 of local permit ownership (Donkersloot & Carothers, 2016). In essence, the population that is expected to retire within the next 10 to 15 years does not have the equivalent replacement generation entering into the fleet.

There are many implications for this problem that necessitate planning and possible adaptation. A large concern is that as fishermen retire and leave the industry, the majority of these rights once held in the community will leave, signaling a loss of individual and community income, identity, and sustainability (Donkersloot & Carothers, 2016). Commercial fishing itself was identified as central to promoting and facilitating social relationships and cultural values (Donkersloot & Carothers, 2016; Gilden et al., 1999). The decline of a sustainable commercial fishing industry would alter the many aspects that in fact support and fuel the heart and soul of these resource-dependent communities.

A need to better understand the concept of graying has been growing in relevance and importance in recent years (Russell et al., 2014; Ringer et al., 2018; White, 2015; Carothers, 2015; Donkersloot & Carothers, 2016; Coleman et al., 2018;

Lowe, 2012; Johnson & Mazur, 2018). Although Alaska has been at the forefront of studies that are focused on graying, the trend has been seen in other places as well. Hall-Arber et al. (2001) found that Maine was experiencing an aging of fishermen that remained in the communities. Globally, Iceland has identified barriers to entry and an increase in the average age of fishermen to 60 years old (Nielsen et al., 2017). On the West Coast, research on graying has spread outside of Alaska and into the Pacific Northwest. Russell et al. (2014) published The Pacific Groundfish Fishery Social Study which interviewed participants in the fishing industry from Seattle, WA down to Monterey, CA. One of the many important conclusions in the study was that graying of the fleet was occurring within the fishery, as seen in Figure 1.1. Ongoing research from Oregon State University as part of a four-year program also explored the graying of the fleet. Research from the program identified that graying was perceived as a threat in Newport and Port Orford by members of the community of interest, such as fishermen, but not identified as a problem by members of community of place, such as local community leaders. (Cramer et al., 2018; Caracciolo, 2017; Flathers, 2017). Additionally, graying was perceived as a significantly more serious threat to the fishing industry by older-generation (over 50 yrs.) fishermen than the younger-generation (under 50 yrs.) fishermen (Caracciolo, 2017).

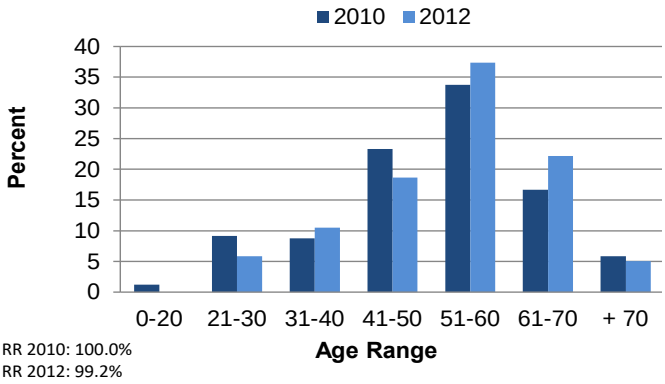

Figure 1.1 Aging trends in West Coast fishery (Russell et al 2014).

Impetus and Response

The study by Russell and colleagues began when the Pacific Fisheries Management Council and the National Marine Fisheries Service announced the plan to implement a catch shares system, specifically an ITQ program, in January 2011 for

the Pacific Trawl Groundfish and Whiting Fisheries (Russell et al., 2014). There is extensive literature on the impacts of ITQ programs on fishing communities and the 2014 study wanted to capture the social impacts of this management change. A documented consequence of ITQ programs that would affect aging is the increase in financial barriers and therefore reduction in entry opportunities (Carothers, 2010). Also noted is the disproportionate losses of fishing rights from small vessels and communities (Carothers, 2010). Equity and distribution are a central concern in an ITQ program implementation, as this redistribution of rights can have major implications such as a loss of access, exposure, and opportunity for younger generations (McCay, 1995).

Although management can have profound impacts on fleet composition and age, other factors are at play as well. Research has noted a pattern of rural-to-urban migration of youth, which could be a contributing factor to the graying of the fleet (Bjarnason & Thorlindsson, 2006). In Alaska, the concern over drugs and rough family situations were identified as barriers to establishing high-level fishing careers and increasing the challenges already facing youth well-being (Donkersloot & Carothers, 2016).

As aging trends and their impacts on communities are increasingly documented, some attention has shifted to identifying solutions to the problem. A recent report published in Alaska in 2017 aimed to review the programs and policies necessary to address access challenges in the fisheries. It outlines various recommendations and represents a significant step forward in promoting actionable steps towards solutions (Cullenberg et al., 2017). However, much work still remains in order to understand and address this phenomenon.

Climate Change Impacts on the Marine Environment

Increased atmospheric levels of carbon dioxide are impacting our global environment in significant ways. The three main factors of change in the marine environment are: increasing water temperature, acidification, and deoxygenation (Hoegh-Guldberg et al., 2014). Between 1900 and 2016, surface waters have risen by a global average of 1.3° ± 0.1°F (0.7° ± 0.08°C) per century (Lindsey & Dahlman,

2018). Due to the interconnectedness of our ecosystems, impacts from these changes have cascading effects such as changes in productivity, ocean circulation and stratification, and sea level. Due to their dependence on ocean conditions, marine fish stocks are highly influenced by these changes (Hoegh-Guldberg et al., 2014). Distribution shifts and altered reproduction rates are just two of the many impacts on marine species. Figure 1.2 shows projected distribution shifts for many west coast fish species.

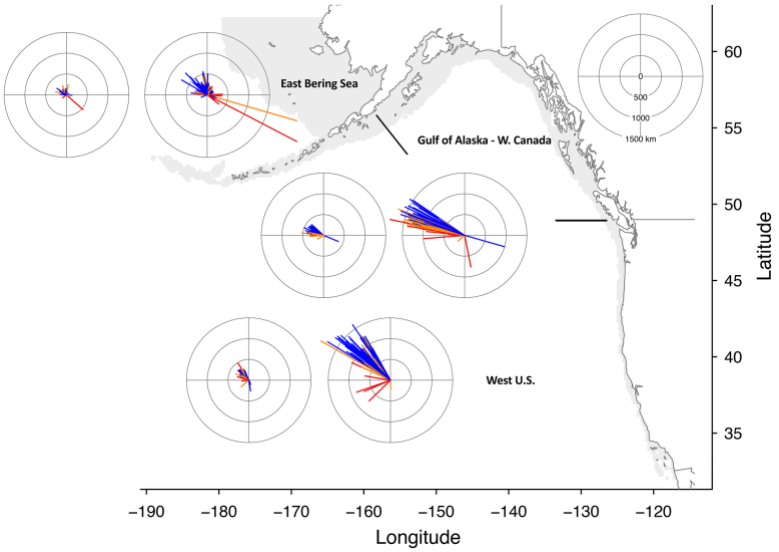

Figure 1.2 Projected species shift on the West Coast (Morley et al 2018).

Although a global understanding of climate change impacts are essential, regional variations require that this "wicked problem" is understood through multiple spatial scales (Sun & Yang, 2016). Oregon's coast is part of the California Current System (CCS), which runs equatorward from the North Pacific Current down to Baja California, Mexico (Checkley & Barth, 2009). Seasonal shifts in upwelling (summer) and downwelling (winter) regimes identify this system (Huyer, 1983). Sea surface temperatures in the Northwest Pacific have increased by about 1.4°F since 1900 and continue to accelerate (Doney et al., 2014; Mote et al., 2019). Sea level rise (highly place-dependent), acidification, and changes in climate patterns are also occurring off the coast of Oregon. The Oregon Climate Change Research Institute (OCCRI) recently released the Fourth Oregon Climate Assessment Report (Mote et al., 2019), which outlines these changes, as well as the impacts on marine fisheries, in further detail.

Resilience and Adaptation

Although there have been significant strides in the conceptualization of resilience, there is currently no single universal definition of resilience. The Resilience Alliance, established in 1999, has attempted to bring together advances in theory, understanding, and practical application of resilience in order to further clarify the concept (Resilience Alliance, 2019; Folke et al., 2016). One of the original and most prevalent definitions was put forth in the seminal paper by Holling (1973), which focused on the ecological nature of resilience and defined it as a "measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables" (p. 14). As theory developed, resilience was further defined as "the capacity of a system to experience shocks while retaining essentially the same function, structure, feedbacks, and therefore identity" (Walker et al., 2006, p. 2). There are multiple variations that each look through a specific lens, such as social resilience, community resilience, and social-ecological resilience. A general social-ecological resilience theory partly emerged from these conceptualizations and is widely accepted as defined through three key foundations: (1) the amount of disturbance a system can absorb and still retain the same structure and function, (2) the degree to which the system is capable of self-organization, and (3) the degree to which the system can build and increase the capacity for learning and adaptation (Holling, 1973; Carpenter et al., 2001; Folke, 2006).

Panarchy is a component relating to resilience and situates the community of interest within larger and smaller scales (Gunderson & Holling, 2002). Panarchy refers to nested systems and multi-level feedbacks. It extends the adaptive cycle and it's four phases (growth, conservation, collapse or release, and reorganization), to situate within nested systems of varying spatial and temporal scales (Berkes & Ross, 2016). Adaptation can be defined as the decisions and actions taken to maintain the capacity to deal with changes in the social-ecological system while maintaining basic structure and function (Nelson et al., 2007; Walker & Salt, 2006; Berkes & Ross, 2013). An important aspect to both of these systems is types of capital, specifically social capital. Social capital refers to the relationships and connections that tie people

and organizations together (Flora & Flora, 2008) Social capital is "essential for the capacity of social-ecological systems to adapt to and shape change" (Folke, 2006, p. 261), and plays an especially important role in the ability of systems to self-organize, the stated second piece of social-ecological resilience (Carpenter et al., 2001; Adger, 2003). Recently a shift towards "resilience thinking" has been emphasized (Walker & Salt, 2006). Resilience thinking incorporates the various components and definitions of resilience and adaptation. Resilience thinking therefore guides this research project, however specific components are outlined for analysis purposes.

The Necessity and Role of Social Science

The need for this research stems from the commitment for scientists to provide, and management to use, the best available science (BAS). BAS is legally required for decisions involved with the Endangered Species Act of 1973 (ESA), the Magnuson-Stevens Fishery Conservation and Management Act of 1976 (MSA), and the Marine Mammal Protection Act of 1972 (MMPA). However, decisions based on BAS have traditionally incorporated mainly the natural sciences and lacked non-economic social science, especially qualitative social science (Charnley et al., 2017). Therefore, in order to truly provide and use BAS, a full range of social sciences needs to be considered (Charnley et al., 2017); this research project contributes to this body of social science.

Additionally, The MSA renewal and revisions in 1996 outlined National Standard 8, which calls for the consideration of the effects of actions and interactions on fishing communities (16 U.S.C. §1851(2)(8)). Standard 8 also emphasizes the need for social data to be considered and incorporated into the creation of Fishery Management Plans (FMPs). The social data based upon the best available scientific information would: (1) Provide for the sustained participation of such communities; and (2) To the extent practicable, minimize adverse economic impacts on such communities. Therefore, this research project helps fulfill the federally and academically outlined need for the incorporation of the human dimension through social science data, as determined by Standard 8. (Charnley et al., 2017).

State objectives, in addition to national standards and goals, provide context for the necessity of this research. The Oregon Sea Grant Strategic Plan 2018-2021 contains multiple thematic areas that outline future objectives for work and research. The third thematic area details the necessity of integrating both human and natural dimensions of marine fisheries in order to increase the resiliency of resource-dependent communities. More specifically, it calls for an identification of possible solutions to challenges that Oregon's fishing community faces (Oregon Sea Grant, 2017). The research outlined in this thesis aims to fill these needs, simultaneously supporting the shift towards ecosystem-based management.

Ecosystem-Based Management

Ecosystem-Based Management (EBM) is a holistically focused framework that acknowledges the complexities of coupled social-ecological systems. No single definition of EBM exists, however four foundational components commonly outline the framework: connections, explicit trade-offs, focus on place, and adaptive management (McLeod & Leslie, 2012; Clay & Olson, 2008; Long et al., 2015). Furthermore, local knowledge has also emerged as an important component of EBM (McLeod & Leslie, 2012). Specifically including resource user' voices in decision-making facilitates a better comprehension of their needs, values, and perspectives (Levine, 2015). Specific to fisheries, Ecosystem-Based Fisheries Management (EBFM) is now the prioritized management framework used by The National Oceanic and Atmospheric Administration (NOAA) in order to fulfil their primary fisheries relevant mandates. Research, such as this study, that supports this management strategy is therefore useful at many levels (NMFS, 2019).

Research Aims

The aim of this research project is to contribute to the understanding of how change, through various environmental, institutional, and social factors, impacts Oregon's commercial fishing community. The objective is to understand, through the physical and psychological lenses, how individual and community resilience and adaptation might be affected by these various factors. Specifically, the objective is to

understand how resilience and adaptation might be affected by climate change, graying of the fleet, and optimism. To accomplish this objective and to provide relevant information, this research project aims to understand the complex linkages within the social-ecological system, to identify cumulative impacts and feedbacks, and to assess implications of research for fisheries management and policy decisions.

Methods Overview

The research project used a grounded-theory approach (Auerbach & Silverstein, 2003). Grounded-theory is a qualitative research method that is inductive, allowing the researcher to begin a study without first formulating a hypothesis to test. Rather, a theory or understanding of a process or phenomenon is generated from exploration of open questions (Auerbach & Silverstein, 2003). Grounded-theory is best suited when a theory is not available or useful to explain a process (Creswell & Poth, 2018). Therefore, grounded-theory was most suitable for this research project because there was no relevant pre-existing understanding to explain the research objectives. A blend of oral histories and semi-structured interviews constituted the method of data collection. Additionally, observation and notes from a "Climate and Communities Initiative" management workshop provided context and direction for the research design. Interview participants consisted of members of the fishing industry from port communities along the coast of Oregon. Participants were determined through local key informants and a snowball sampling method was used to determine additional participants (Auerbach & Silverstein, 2003; Creswell & Poth, 2018). Oral histories were audio or video recorded in order to contribute to the "Voices from the West Coast/Voices from the Fisheries" (VFWC) website and database (Calhoun, 2015). The software MAXQDA was used for data analysis in order to determine emergent themes.

Validity

Efforts were made to ensure validity of the research by referencing a validity checklist laid out in Maxwell (2013) throughout the data gathering and analyzation process (Strawn, 2018). Data was collected over a four-year period, thus representing

changes in the industry over time. Furthermore, triangulation was achieved by collecting a diverse set of perspectives from a range of locations. Cross coding of transcriptions occurred which reduced the possibility of "fitting" data within preconceived ideas. Finally, results that emerged from this research were compared to findings from past projects in order to reduce validity threats (Strawn, 2019; Maxwell, 2013).

Ethical Considerations and Potential Research Bias

Acceptance and endorsement from the Institutional Review Board (IRB) was granted for this research project. Approval was necessary due to the involvement and interaction with human subjects, thereby requiring the minimization of risks to participants and to the university. Ethical protocol was explained and practiced prior to participant interviews in order to ensure proper consent and confidentiality standards, as well as secure storage of information. No vulnerable populations were interviewed for this study. Verbal and written consent was obtained with the use of a pre-approved IRB form. All participants were informed and acknowledged that the oral histories obtained through interviews could be published on the VFWC website. All participants were also informed that the study is completely voluntary, and that oral histories and transcripts can be removed from the website upon request. Participants were given the opportunity to ask questions and contact information was made available for any follow up questions that might occur. Interviews were done in a place of their choosing as long as it was relatively quiet, in order to facilitate their comfort.

Today it is understood that "the writing of a qualitative text cannot be separated from the author, how it is received by readers, and how it impacts the participants and sites under study" (Creswell & Poth, 2018, p. 228). Both writing and qualitative research is positioned within cultural, gender, and various other norms and identities. In order to remain transparent and adhere to best practices, the following is a first-person reflection of possible personal biases:

I grew up in Minneapolis, Minnesota. I was raised in an urban environment and therefore have a limited understanding of smaller rural areas. Although my

graduate research is marine focused, I spent most of my life far from the ocean and therefore have had limited interaction with fishing dependent communities. However, I have had exposure to other resource dependent communities such as farming, and some similarities created a sense of comfort in working within and understanding these communities. A difficulty that I experienced was trying to remain neutral in discussions regarding environmental change. I grew up ideologically liberal and believe strongly in the pressing manner of climate change. Although I did my best to stay neutral, understand, empathize, and find commonalities, it is necessary to bring awareness to how this might have affected the study.

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CHAPTER 2: JOURNAL ARTICLE [Ocean and Coastal Management]

Resilience and adaptive capacity of Oregon's fishing community: Cumulative impacts of climate change and the graying of the fleet

ABSTRACT

Although there has been an increase in the acknowledgement and research of social-ecological systems, there is still much to be explored to understand the effects of change from various drivers within coastal communities and ecosystems. These drivers include climate change, management regulations, societal shifts, and market trends. The aim of this research is to understand and identify how fishing communities are resilient and adaptive in the face of these compounding changes. In order to support successful fisheries management, this study specifically identifies the connections between climate change and graying of the fleet (e.g., the increase in the average age of commercial fishermen). Breaking down the connections into steps helps managers more accurately conceptualize future scenarios and specific impacts of policy and management decisions, simultaneously enabling managers or policy makers to locate specific target areas for intervention or opportunity. Data consisted of oral history semi-structured interviews with members of Oregon's fishing community and recent climate change projections from the literature. Findings reveal that climate change will likely intensify drivers and impacts of the graying of the fleet phenomenon in Oregon. Analysis of the cumulative impacts from these stressors demonstrate that Oregon's fishing community will likely be closer to thresholds of transformation than analysis of stressors individually indicates. Therefore, the most important direct implication that emerged from this research is the need to consider and identify the cumulative component of impacts within a system when assessing change. Ultimately, it is possible that if policies continue as they are, Oregon's fishing community will take leaps, rather than steps, towards reaching their limits of resilience. Relying on the responsive adaptability of fishing community members alone may not be sufficient, as their capacity to do so could be limited in the future.

Introduction

The dynamic nature of the marine and coastal environment presents complex and multi-faceted challenges. Change is the ultimate constant, requiring those who interact and live in these systems to succeed in oftentimes difficult and uncertain conditions (Young et al., 2019). The fishing industry and community embody the ability to live and work in such a system (Conway, 2001; Kuonen et al., 2019). Change is not new for these fishermen and families, they have always had to navigate challenges such as variable weather and seasonal shifts in target populations. However, the pressures that they experience are increasing due to environmental, management, and social changes (Pomeroy et al., 2015; Flathers, 2017; Lam et al. 2016; Hanna & Hall-Arber 2000; Gilden et al., 1999). Climate change poses an alarming threat to the future of resource-dependent communities (McIlgorm et al., 2010; Brander, 2007). Management decisions focused on and designed for ecologically sustainable practices are necessary but have unforeseen rippling socio-ecological consequences (Olson, 2011). The aim of this research is to understand and identify how fishing communities are resilient and adaptive in the face of these compounding changes. By focusing on this subject, this research provides an important opportunity to explore the dynamics of a "ground zero" system; a system where environmental impacts on vital economic, cultural, and ecological services are experienced first, and consequently the need to find solutions to these challenges are of utmost importance (Marshall, 2010; IPCC AR4; Young et al., 2019). The fishing community, due to this intimate relationship with their marine environment, also provides an ideal lens with which to understand coupled social-ecological systems. As environmental changes occur, whether that be through warmer water, species migration, or fishery decline, our human systems also respond and, in turn, re-shape the natural systems.

The interface between human and natural systems has come into focus in the United States in recent years, especially in marine and coastal environments (Shackeroff et al., 2009; Folke et al., 2016; Benson & Stephenson, 2018). Research has typically been narrowly funneled into thinking that divides and isolates the components of the greater system (Berkes et al., 2000). As the larger sociological

paradigms shift, and humans are seen as part of the environment rather than separate from it, information that incorporates this inherent and inseparable connection is needed (Levin et al., 2016; Miller et al., 2010). Fisheries science has typically focused heavily on the ecological dimension, leaving a gap in the equivalent social science (Hall-Arber et al., 2009; Marshall et al., 2018). Some progress towards incorporation of the social dimension has been made. Standard 8 of the amended Magnuson-Stevens Fishery Management Act (MSA) requires that the importance of fishery resources to fishing communities must be considered. The standard calls for the utilization of economic and social data to provide for sustained participation of fishing communities and to minimize adverse economic impacts (16 U.S.C. §1851(2)(8)). Social Impact Assessments (SIA) as part of Fishery Impact Statements (FIS), which look at ways in which communities are affected by policy decisions, are required through The National Environmental Policy Act (Calhoun, 2015; NEPA; 42 U.S.C. § 4321; Colburn & Clay, 2012). Shifting towards Ecosystem-Based Management (EBM) is now widely prioritized due to its holistic approach, requiring the consideration of the human dimension and enabling adaptive management (McLeod & Leslie, 2009; Long et al., 2015). Although qualitative social science that is practical and applicable to managers is a top priority, it is oftentimes difficult to accomplish (Charnley et al., 2017). This research uses a coupled systems approach that considers social-ecological connections in order to incorporate the social dimension of fisheries and to support effective management decisions, positioning the oceans to be treated as peopled seascapes (Shackeroff et al., 2009).

Social-Ecological Resilience and Adaptation

The concept of resilience first emerged from the study of ecology in the 1960's and 1970's (Holling, 1961; Holling, 1973; Folke, 2006). The inclusion of humans as agents of change within, and not apart from, an ecosystem led to the conceptualization of social-ecological resilience. Social-ecological resilience is widely accepted as defined through three key foundations: (1) the amount of disturbance a system can absorb and still retain the same structure and function, (2) the degree to which the system is capable of self-organization, and (3) the degree to

which the system can build and increase the capacity for learning and adaptation (Carpenter et al., 2001; Folke, 2006). However, further research on resilience has revealed the complexity of measuring and defining the concept. Carpenter et al. (2001) emphasized the need to define specific resilience, the "resilience *of* what *to* what?" Specific resilience is the explicit identification of the system state that is being considered, and what change or stressor is of focus (Carpenter, 2001; Walker & Salt, 2006). Specific resilience can come at a cost to general resilience. For example, increasing resilience specifically to drought may decrease resilience to floods. Therefore, both general and specific resilience are important to consider, prompting an examination of the two in this study (Walker & Salt, 2006). Additionally, a community level lens was used to assess resilience (Berkes & Ross, 2013; 2016).

Adaptation and adaptive capacity are also crucial components to consider in the discussion of resilience. Adaptation can be defined as the decisions and actions taken to maintain the capacity to deal with changes in the social-ecological system, while maintaining basic structure and function (Nelson et al., 2007; Walker & Salt 2006; Berkes et al., 2003). Equally if not more important to this study is the concept of adaptive capacity. Adaptive capacity "refers to the preconditions that are necessary to enable adaptation" (Nelson et al., 2007, p. 397). Preconditions often include assets or types of capital such as social, financial, and physical (Nelson et al., 2007; Whitney et al., 2017).

Resilience, adaptation, and adaptive capacity are seen as three distinct but interrelated concepts. All three concepts are vital to a system's ability to embrace change and continue sustainably, therefore they provide the backdrop for assessing the case study. Due to the complexity and multi-dimensionality of the environment in which this study takes place, all three concepts are considered in order to provide a more complete understanding of change and its impacts.

Case Study: Oregon's Commercial Fishing Community

This research explores resilience and adaptation specifically through a case study of Oregon's commercial fishing community. Oregon has 13 ports stretching along the entire coastline of the state. The three largest are the port of Astoria,

Newport, and Charleston (Kuonen, 2018). Multiple vessel types exist within the industry. Trawlers and some of the larger trap vessels are typically 50-90 ft in length. Smaller vessels, <50ft in length, are usually trollers, longliners, gillnetters, and trap and dive boats (Pomeroy et al., 2015).

The commercial fishing industry in Oregon, which acts as the backbone of the fishing community, is an important part of the state's economy. In 2016, commercial fisheries contributed $544 million in household income (ODFW, 2017, p. 4). Aside from distant water fisheries, the biggest household economic contributions are generated specifically by the Dungeness Crab and Groundfish fisheries. Pink Shrimp and Pacific Whiting follow closely behind in value but make up the largest catch volume of all the fisheries. The industry generates additional income unaccounted for in the state summaries through tourism and other maritime activities such as boat building, research, and education (ODFW, 2017, p. 5). Extensive economic contributions are not the only reason why Oregon's commercial fishing industry is vital to the coastal community. The industry is truly the "soul and image of Oregon's coastal communities" (Conway & Cramer, 2018, p. 219), and fuels a deeply valued collective identity and culture (Gilden J, 1999). Therefore, the sustainability and strength of Oregon's commercial fishing industry is the basis for a resilient coastal community (Conway & Cramer, 2018).

The Stressors

Although the fishing community faces many pressures, this research focuses on the two most salient to the future of the community: climate change and "graying of the fleet" (referred throughout as graying). The following is a brief background of the two stressors.

Graying of the Fleet

Shifting demographic and succession trends have been identified in many Alaskan fishing communities – termed "graying of the fleet" (Carothers, 2008, 2010; Donkersloot & Carothers, 2016; Ringer 2018; Lowe, 2012). In 2014, the average age of a fishing permit holder in Alaska was 50 years. This was significantly higher than

the average age recorded in 1980, which was only 40 years old (Donkersloot & Carothers, 2016). A strong connection has been made between drivers of the graying phenomenon and fisheries privatization policies (Koslow, 1982; Carothers & Chambers, 2012; Carothers, 2015). Today the term is widely recognized in the U.S. and in many European countries as a reference to the increase in average age of commercial fishermen, largely due to a lack of youth entry (Chambers & Carothers, 2016; White, 2015; Johnson & Mazur, 2018).

Data from the Pacific Northwest trawl groundfish and whiting fisheries also show evidence of an aging workforce in Oregon's fishing community (Russell et al., 2014). From 2010 to 2012, the number of individuals 61 years old or older increased from 22.5% to 27.2%, and the number of individuals 30 years old or younger decreased from 10.4% to 5.8% (Russell et al., 2014). The 2014 study by Russell et al. was a catalyst for further research on graying of the fleet in Oregon's fishing communities. In a pilot study as part of a larger research program, Cramer et al. (2018) identified that graying was perceived as a threat in Newport and Port Orford by members of the fishing community (a community of interest) but was not identified as a problem by local community leaders (members of the related coastal community of place). Additionally, graying was perceived as a significantly more serious threat to the fishing industry by older-generation (over 50 yrs) than younger-generation (under 50 yrs) fishermen (Caracciolo, 2017). A related research project in the program reported that perceptions of graying were also identified as differing between fisheries prosecuted (Strawn, 2019).

The main drivers of graying include financial barriers to entry and loss of fishing rights tied to fisheries rationalization, rural to urban migration, and lack of occupational knowledge (Cramer et al., 2018; Himes-Cornell, 2015). Motivations of youth to enter are affected by the perception that the fishery is not lucrative (Russell et al., 2014). Impacts of graying include loss of local and traditional ecological knowledge, loss of individual and community income, and erosion of community sustainability (Donkersloot & Carothers, 2016; Russell et al., 2014).

Climate Change Impacts

Global climate change impacts on the marine and coastal environment are numerous and include marine species variability, sea level rise, temperature increase, acidification, and deoxygenation (Hoegh-Guldberg et al., 2018; Cheung, 2009). The current ecosystems that we operate within are expected to change in unpredictable and uncertain ways. Focusing locally on Oregon's marine environment reveals some of the similar impacts.

The Oregon coast is part of the greater California Current Larger Marine Ecosystem (CCLME) which runs from Baja California, Mexico up to British Columbia, Canada. Variability in water temperatures are common due to seasonal upwelling and interannual climatic shifts (Dalton et al., 2017). However, an increase in water temperature has been experienced and is highly likely to continue to occur at an accelerated rate (Dalton et al., 2017; Mote et al., 2019). An increase in ocean acidification is also projected due to the ocean's absorption of CO_2 (Feely et al., 2016). Organisms with shells or skeletons of aragonite or calcite will encounter decreased saturation states, making formation more energetically expensive (Waldbusser et al., 2015). Although much remains unknown about the impacts of acidification on fisheries, it is likely that acidification will alter larval growth and change availability of food sources (Marshall et al., 2017). Another possible impact on Oregon's waters stem from harmful algal blooms (HABs). Domoic acid events due to HABs are connected to warmer ocean waters, leading to the possibility of increased domoic acid events due to future climate change (McCabe, 2016; McKibben et al., 2017).

Indirect climatic impacts on fisheries result in distribution and location shifts of prosecuted species, as well as the possible arrival of new species as stocks move poleward (Cheung et al., 2015; Pinsky et al., 2012). It is also likely that fish will move farther off the coast and deeper into cooler water (Cheung et al., 2015; 2018; Morley et al., 2018). Not all species will respond to change in the same way and current research is working towards further understanding the effects of climate change on fish productivity and distribution (Mote et al., 2019). It is certain that whole ecosystems will be affected, likely resulting in a system reorganization and

increased variability of fish stocks (Woodworth-Jefcoats et al., 2016). Salmon, a once highly productive fishery on the West Coast, has declined and is projected to continue facing challenges due to changes both on land and in the ocean (Crozier, 2016). Salmon species in the Pacific Northwest will likely experience thermal stress and a reduced food supply (Mote et al., 2019; Wainwright & Weitkamp, 2013). Although salmon specific projections remain uncertain, an increase in vulnerability is a likely response (Crozier, 2014; 2016).

At the interface between ocean and atmosphere lies the occurrence of storms and eventful weather (Kuonen et al., 2019). Winter precipitation amounts are projected to increase moderately (Mote et al., 2019). Seasonal climatic events such as El Niño - Southern Oscilation (ENSO) may become more extreme, amplifying wave energy and resultant coastal erosion (Barnard et al., 2015). Coastal erosion is projected to increase due to the combined sea level rise and increased wave energy (Barnard et al., 2015 Ruggiero, 2001; 2014). In the Pacific Northwest, weather conditions greatly impact a fishermen's ability to remain safe. Entering or leaving port, or "crossing the bar" presents a dangerous challenge as incoming wave heights are amplified in response to sediment accumulation on the bottom. Amplified wave energy and coastal erosion could have a large impact on the hazardous condition of the bar (Kuonen et al., 2018). As research is done to understand the ecological impacts of climate change, research on the impacts of and on humans is also needed.

Methods

The aim of this study is to explore and understand, through the perspectives of fishing community research participants, the cumulative impacts and feedbacks of a changing social-ecological system on the fishing community. The following questions guided the research: (1) With regard to the commercial fishing community in Oregon, what are the connections between climate change and graying of the fleet, and (2) How do these connections ultimately relate to the resilience and adaptive capacity of the community of interest?

Participant Recruitment and Data Collection

Combined oral history semi-structured interviews were conducted in ports along the Oregon coast from 2014 to 2018. Participants consisted of members of the fishing community (Caracciolo, 2017; Strawn, 2019; Calhoun, 2015). The initial group of interview participants was determined through local key informants, and additional participants were then identified through a modified snowball sampling technique (Auerbach & Silverstein, 2003; Berg, 2001; Bernard, 2011). Snowball sampling is a technique in which other research participants are recruited by current research participants, useful when potential subjects are hard to locate (Creswell & Poth, 2018). Interviews took place in the communities where the participants lived and worked. A diverse range of age, vessel size (i.e. small boat or big boat), gear type (i.e. trawl, long-line, pots), and position (i.e. crew, owner, skipper) were represented (Caracciolo, 2017; Strawn, 2019; Calhoun, 2015). Interview questions were open-ended and asked about perceptions of the past and future of the industry, family dynamics, and changes in management and the environment. Interviews did not directly ask about climate change or use related terms (i.e. global warming, acidification) and this accomplished two goals: 1) The interviewers avoided the possibility of charged responses and incongruent communication, and 2) Interviewees were free to bring up the environmental terms or topics that were salient to them (Nisbett, 2010; Moser, 2010). Interviews ranged from 30-90 minutes long. A total of 35 interviews were analyzed.

Data Analysis

Interviews were fully transcribed, and analysis was carried out through the use of the software MAXQDA 12. Auerbach and Silverstein's (2003) approach for grounded-theory guided analysis methods. Grounded-theory is a qualitative research method that is inductive, allowing the researcher to begin a study without first formulating a hypothesis to test. Rather, a theory or understanding of a process or phenomenon is generated from exploration of open questions (Auerbach & Silverstein, 2003).

Three rounds of analysis were completed in order to accomplish the goal of this research: to identify the connections between climate change and graying of the fleet. Figure 2.1 conceptually represents the three rounds of analysis completed. The first round of analysis involved selecting relevant text from the entirety of all the transcripts. For the purpose of this research, text was selected that referenced any type of environmental change. This ranged from direct references of climate change, to discussions of changes in fish stock and characteristics, water temperature and other ocean conditions, or weather. Relevant text regarding environmental changes were not separated to differentiate between natural cycles, climate change, responses from human pressure or management decisions. Rather, any mention from a participant of an environmental change regardless of the source of that change was included as relevant text. Additionally, in the first round of analysis, relevant text was analyzed in order to understand sets of important or repeating themes. The primary round of coding resulted in general idea groups such as: barriers and challenges, emotions/feelings, perceptions of the future, and types/results of changes. The second and subsequent rounds of coding further refined repeating ideas and clustered them into concise themes (Auerbach & Silverstein, 2003). The process of memoing was crucial to the process and further helped organize and identify themes and categories (Creswell & Poth, 2018). Memoing is the act of writing down ideas and thoughts as data are collected and analyzed (Creswell & Poth, 2018). From this inductive approach, five themes emerged as salient which were termed: Collective Knowledge; Rewiring

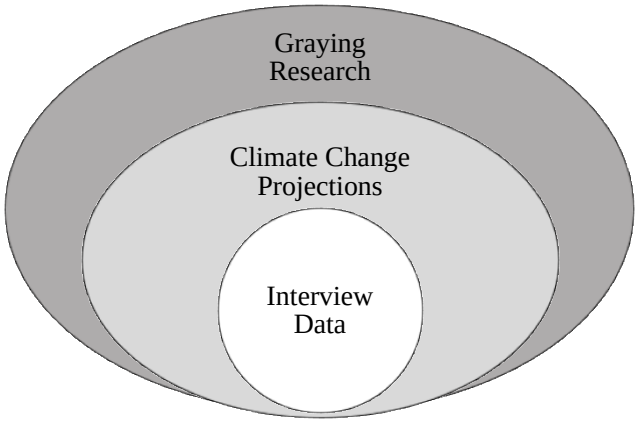

Figure 2.1 Conceptual diagram of analysis framework

Connections; Limitations; Flexibility; and Optimism. The scope of this article covers all themes except "optimism"[1].

The codes in each of these remaining four themes were then reorganized into "type of environmental change" and "response" in order to enable further analysis. Perceived environmental changes and participant responses obtained from the interview data were situated within the context of climate change in order to complete the second round of analysis. Climate change projections were determined from the literature and ranged in time scales and scenarios. The projections used in this study were based on a range of emission scenarios, such as those established by the Intergovernmental Panel on Climate Change (IPCC), and ocean condition models, such as the Earth System Model (ESM2.1) developed under NOAA (Cheung, 2018). The literature used in this study also included projections based on the expectations of the continuation of past trends.

In the third and final round of analysis, results from the second round of analysis were integrated with the results from previous research program analyses which looked at drivers and impacts of graying through youth barriers and motivations to entry. The results from this research were not meant to be predictive, but rather projective. Furthermore, this framework projects future scenarios under four assumptions: 1) Current management systems continue under current conditions, 2) Social trends continue, 3) Graying trends continue, and 4) Climate change impacts are as projected from the latest research.

Results

The combined results reveal six prominent connections that link climate change with the graying of the fleet phenomenon. A natural division emerged from the data that separate the six connections into two conceptually distinct categories. The first category consists of the material dynamics of specific climate change impacts (see Figure 2.2) and refers to results regarding physical resources such as money and infrastructure. The second category consists of the relational dynamics of

[1] The theme "optimism" is not included in this manuscript because it is covered in a partner manuscript to be published.

systemic climate change (see Figure 2.3) and refers to results regarding relationships and social networks.

Material Dynamics of Specific Climate Change Impacts

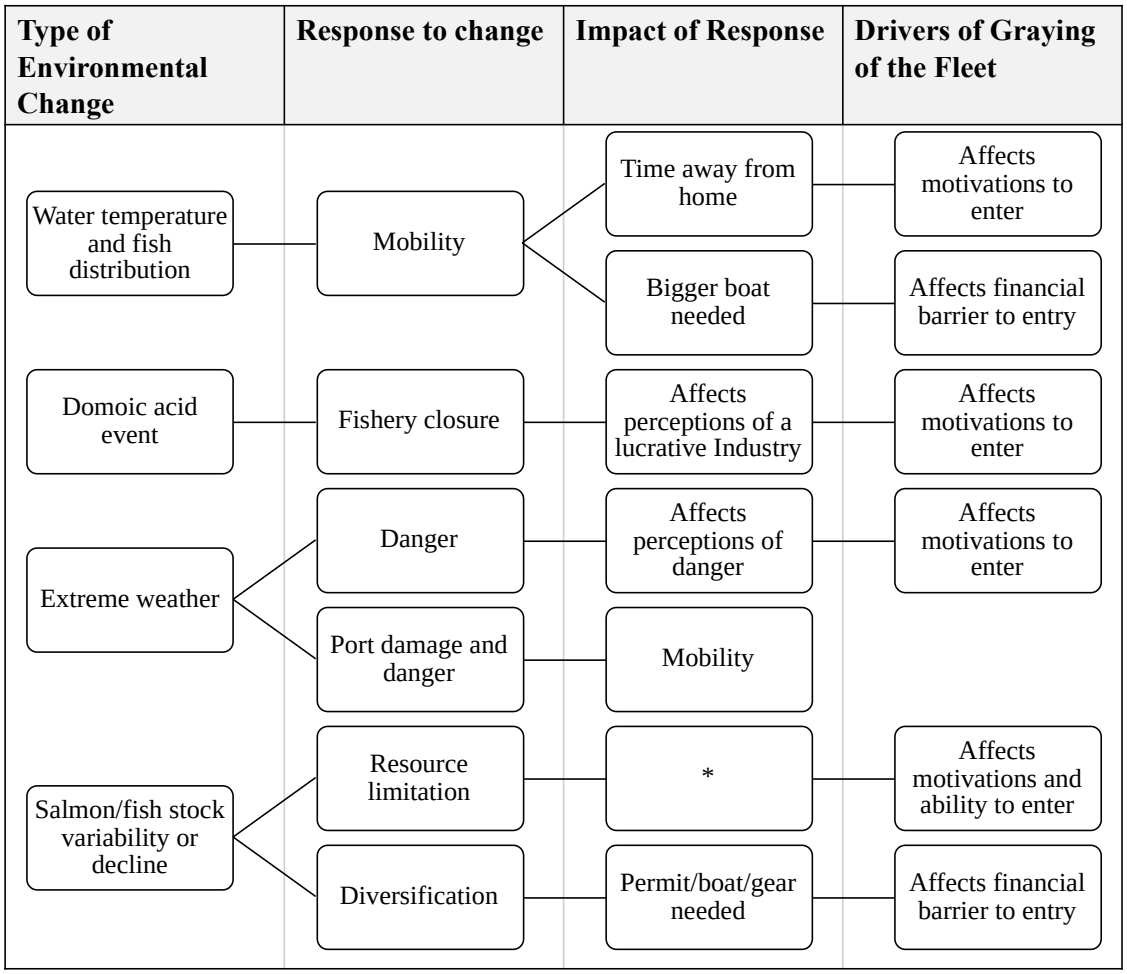

Figure 2.2 Material dynamics of specific climate change impacts

Water Temperature and Fish Distribution

Fishermen research participants described changes in fish distribution and location, oftentimes correlated with changes in water temperature. The following quote exemplifies these discussions: *(The) fish were scattered literally over three states, two countries; there were just not very many places where the fish were*

grouped up. Fishermen discussed responses to these changes and described the need to be flexible and mobile enough to prosecute the desired species that have moved. Under climate change scenarios reported in the research, water temperature will increase off the coast of Oregon, resulting in further fish distribution and location changes (Cheung et al., 2015; Morley et al., 2018). It is projected that the majority of fish targeted by the commercial fishing industry will move north and/or move deeper into the water column and farther off the coast (Morley et al., 2018). Therefore, mobility is enhanced by owning or operating a bigger vessel that is fit for this type of travel. However, bigger vessels typically require a larger financial investment, increasing the financial barrier for youth wanting to enter the industry. Financial barriers are one of the main drivers of graying of the fleet in Oregon, therefore a strong connection could be made, as outlined in the first row of Figure 2.2, between fish distribution shift due to climate change and a resultant exacerbation of drivers of graying of the fleet.

Additionally, the need to pursue fish that are farther away from port leads to longer times traveling on the water and away from home. Time away from home is one of the factors that negatively affect motivation to enter the industry, therefore likely intensifying graying of the fleet.

Domoic Acid

Fishing community research participants discussed domoic acid events and described the loss of income opportunity due to resultant closures or delays. The following represents the sentiments of many participants:

> *It was a 'go' a week before the season was supposed to open. Then, all of a sudden, they're like, "Oh sorry, you guys ain't going (because) you've got domoic acid." That's when we had a nice volume of crab down here. Then between the time we were supposed to go and we were actually allowed to go, they shifted up towards Newport, and we're down here like 'where did all our crab go?'*

Elevated levels of domoic acid stemming from harmful algal blooms (HABs) are connected to warmer water temperatures, and the number of events is likely to

increase in the future due to climate change (McCabe, 2016; McKibben et al., 2017). The Dungeness crab fishery is one of the most lucrative fisheries in Oregon and responds to elevated domoic acid levels with season delays or closures. Youth are unmotivated to enter the industry if they perceive that the job will not be lucrative. Therefore, a decrease in income due to domoic acid events will likely discourage youth from wanting to fish, contributing to graying of the fleet. This connection is demonstrated in the second row of Figure 2.2. In the case of Oregon's crab fishery, previous research indicated that the fishery is not perceived as graying, however if domoic acid events increase, it is possible that scales will tip and graying could occur (Strawn, 2019).

Extreme Weather

Bad weather and storms are an integral part of any fishermen's occupational challenges. They are often reluctant to fish when the weather is extremely bad due to dangerous conditions. Leaving port regardless during bad weather is not a desirable situation (Kuonen, 2018, Kuonen et al., 2019) and research participants reflected this in the following statement:

> *The winter is sometimes still and perfect. But it also comes with storms, some unpredictability, and often judgement calls. The most dangerous part of this job is crossing the bar when the swell is high, and the swells are only a factor during winter months. I don't like dealing with that at all.*

A change in weather patterns is projected to occur off the coast of Oregon as the climate changes. Larger wintertime waves are expected, and some studies have projected an increase in storm intensity (McCabe, 2001; Ruggiero, 2010). This change could result in a possible increased danger risk for fishermen. Danger is a factor that discourages youth from wanting to fish (Kuonen, 2018). Therefore, a change in weather and resultant danger could lead to a decrease in motivation to enter the industry, likely a contributing driver of graying of the fleet (Figure 2.2).

Damage to port infrastructure is also a result of an increase in wave energy and erosion, and this concern is reflected in statements such as:

> *[W]e've had some erosion lately around the harbor, around the periphery where it's starting to sluff into the harbor…there's kinda this thought that our infrastructure's gonna go away. I just read that they only expect our infrastructure to last another ten years, the Port Managers apparently came up with that.*

Each port along the Oregon coast is unique and has the capability for certain fisheries. Additionally, some are more dangerous in bad weather than others. The consequence of the combination between bad weather and port infrastructure is that mobility is needed in order to cope. The following response demonstrates this situation:

> *…that port (name of port) is very difficult to get out in, especially in the winter times. I think most of the fisheries there were summer based, which would be salmon and rockfish and urchin. Folks that are going out crabbing in different ports, you just can't get out in (name of port). So even if they were crabbers, they would go out of a different port during the winter.*

Going out of another port is a means of flexibility but results in increased time away from home and therefore decreased youth motivations to enter, as time away from home has been identified (Caracciolo, 2017) as negatively affecting desire to enter the industry. Movement in order to temporarily launch from a different port, or longer-term coping mechanisms such as moving to a new town, could affect social capital through altered social relations and changing social fabric of that coastal community.

Lastly, fishermen research participants oftentimes referred to vessel size as a limiting factor in the face of stormy weather, noting that:

> *It was probably 6 months that I had my boat out here before people would see that I am going out to fish when the weather lets me, and chewing me out for going out during the times that I shouldn't have, because the weather was a little big for that small of a boat.*

A larger vessel will be needed to stay safe and continue getting out to fish in the face of variable and uncertain weather. Again, bigger vessels generally require a larger financial investment, increasing the financial barrier youth are already experiencing.

Salmon Stock Vulnerability and/or Fish Stock Variability

The topic of salmon stocks was often brought up when fishing community research participants were asked to reflect on changes they experienced. They discussed the decline of the fishery and noted the complexity of factors that thus contributed, demonstrated in the following statement:

> *[A] lot of the boats down there were into salmon fishing, and, like we're experiencing right now, there's no salmon fishing on the South Coast in the ocean. So, part of it was there's less resources….*

The availability and yearly instability of the resource diminished desire and limited ability to enter the fishery.

Under climate change scenarios, there is a high probability that the vulnerability of salmon stocks will increase as temperatures rise and coupled land-ocean stressors are magnified (Crozier, 2014; 2016). Although it is difficult to say with certainty exactly how salmon and other fish stocks will change, it is likely that variability in stocks will increase due to shifts in ecosystem dynamics (Woodworth-Jefcoats et al., 2016). Therefore, based on the responses of community members to past fluctuations in salmon stocks due to environmental change, it is highly likely that limitations to enter (both physical and psychological) will increase, and graying will intensify. The fourth row in Figure 2.2 outlines this connection.

Another response to changes in salmon stocks that fishing community research participants discussed was the need to diversify and participate in multiple fisheries as explained in the following quote:

> *[Y]ou have to be diversified, you can't just buy a boat thinking "Well I'm just going to go salmon fishing" or "I'm just going to black cod." You have to be in there with as many options as possible to survive…*

However, the flexibility that diversification enables requires resources such as permits, quota, or different gear, all of which are costly. Increasing costs to enter the industry have been identified as a driver of graying, therefore diversification (and flexibility) is limited by the resources and coincident costs needed to participate in that fishery.

Relational Dynamics of Systemic Climate Change

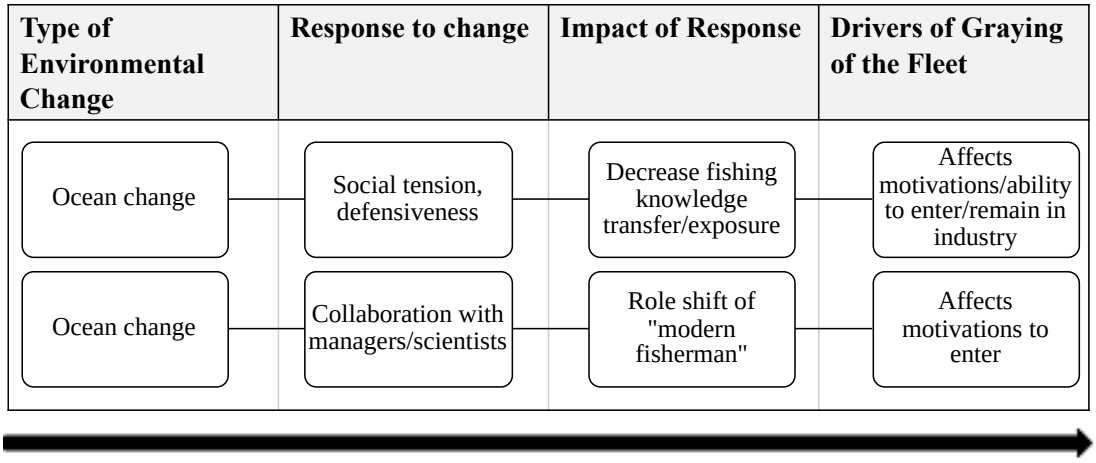

Figure 2.3 Relational dynamics of systemic climate change

Tension

Interviews with the fishing community research participants revealed social tension and defensiveness within the fishing community in response to myriad environmental factors such as domoic acid events, stock fluctuation, and fish movement or collapse. The most discussed areas of community tension were found between individual fishermen, and between fishermen and buyers. An example of this defensiveness is described in the following quote:

> *Tuna fishing right now is not limited. So, if shrimping gets horrible, all the shrimp boats will have to go tuna fishing. So, the tuna fleet feels like, "Jeez, if tuna goes bad, I don't get to come into your fishery because I don't have a permit for your fishery." So, you can see where people feel like they are boxed into a corner and they don't want their corner to get crowded.*

Overall, interview data indicated that the participants were extremely aware and vocal about the inequalities between community members. Some of the respondents directly explained that fishermen often turned on each other in response to environmental change stating: *And what is the first thing we do? We turn on each other. I think it's a real problem.* The erosion of relationships and increased tension as a result of environmental change will likely increase with future climate change.

Fishing knowledge, such as how to tie a knot or fix a vessel engine, is vital to enter and remaining in the fishing industry. Oftentimes youth learn theses skills through conversations and asking other fishermen questions, described in the following two, separate responses:

> *[J]ust keep your head down and work. And don't be afraid to ask questions. And if guys who you're working with don't want to answer your questions, you don't want to work with them because there's a lot going on and you need to learn. And in order to learn (you have to) ask questions.*

> *There's no safety net and that's just the way the timing worked. It's just the way things go. So, for these younger guys, you know, I try to tell them "You've gotta live within your means. If you can't pay cash, you don't need it."*

An erosion of relationships therefore limits the ability of youth to enter or remain in the industry as a result of a disconnect between the transfer of vital fishing knowledge, thus intensifying graying (Figure 2.3).

Collaboration

Although relations within the community appear to be eroding in response to environmental change, positive relations with scientists and managers appear to be strengthening. Many of the fishing community research participants mentioned the necessity of working with management and scientists in order to enable a successful fishing industry. Collaboration between these groups was either noted as a goal or noted as currently happening. Research participants talked about the positive results they experienced from collaboration. Interview responses also indicated that this type of collaboration was not always the case. The following quote demonstrates a common sentiment in which environmental changes further motivated the need for science and industry to work together:

> *[O]ne fisherman says, "I don't like the fact that the bottom of the ocean, the lower water, is getting warmer." So, they're looking to the science community to help them understand what the ocean is doing. I've noticed that.*

Collaboration was most often talked about in response to acidification, warming water, general climate change or global warming, and species stock variability. As climate change continues to drive an increase in oceanic variability and contribute to these environmental changes, although trust remains a barrier, increased collaboration is likely to continue.

Results from this research indicate that as fishermen become more involved with science, politics, and management, they tend to describe the need to be able to fulfill multiple roles. The ability to successfully fish in modern times often means being involved in management decisions, politics, science and business. As roles shift and the skills necessary to fish successfully change, the type of education needed also shifts. For example, research participants shared that young family members were discouraged from entering the industry in order to obtain a higher education degree. Oftentimes the need for a higher degree was emphasized so that they could return to fishing with the necessary skills required of the modern fishermen, such as being business and politically savvy and science literate. It is possible, then, that an increase in collaboration and continual shift towards these types of science and management roles, could exacerbate graying due to the need for youth to obtain a higher education degree before or instead of going into fishing.

Discussion

Results from this research reveal that climate change may exacerbate or contribute to graying of the fleet in Oregon. While cumulative impacts from these stressors will challenge Oregon's fishing community, they will most likely remain resilient to collapse or disappearance. This research indicates that even in the face of a shrinking window of opportunity, fishermen find a way to catch the fish. Although the community will most likely continue to exist, results reveal a more nuanced picture of resilience. For the individuals, families, and households who make up the fishing community and whose values thus define it, it is and will continue to change and transition. Therefore, in order to discuss implications for resilience and adaptation, the "domain of attraction" must be designated for this system (Holling,

1973; Walker & Salt, 2006). For the purposes of this study, the domain of Oregon's fishing community is not solely measured by the ability to catch and sell fish, but rather through the ability to retain community-valued systemic functions and components. Three examples of vital systemic functions and components are: support of small intergenerational fishing businesses; thriving community waterfronts; and shared culture and tradition (Conway & Cramer, 2018; Doyle et al., 2018). Defining the fishing community through these terms, rather than solely through their ability to catch and sell fish, reveals that a transition into another domain of attraction is of greater probability. Therefore, Oregon's fishing community will likely become less resilient to a transition into an undesirable state.

Results reveal that a shift in the location of fish lead to an increase in the financial capital needed to enter the industry, with no indication of support provided to youth to combat this elevated financial requirement. Accumulation of financial capital is foundational to a resilient community (Flora & Flora, 2008; Bennett et al., 2014). Without the necessary resources available, communities could experience a harder time coping with and responding to changes (Scoones, 1998). Financial capital is also affected by domoic acid events, destabilizing income and therefore the resources needed to be resilient and adaptive. Previous research has shown that fishing dependent communities have suffered due to a further destabilization of income (Ritzman, 2018). Infrastructure capital is also a component of adaptive capacity and resilience (Flora & Flora 2008; Bennet et al., 2014). For fishing communities, an extremely important piece of infrastructure is the port itself. An increase in storm intensity and wave energy leads to port infrastructure damage, thus likely decreasing the stability of infrastructure capital and subsequently the capacity to adapt or be resilient. Furthermore, movement out of or into another town in response to port infrastructure damage or a shifting target species could erode place attachment. Place attachment has been shown to be an important factor contributing to community resiliency (Faulkner et al., 2018; Amundson, 2015).

There is a high probability that variability or possible degradation of salmon and general fish stocks leads to a decrease in resilience due to the decline in natural capital (i.e. fish) (Flora & Flora, 2008). If there are less fish to catch, there will most

likely be less fishermen fishing. Additionally, an actual or perceived failure or decline in one fishery can result in diversification into another fishery (Johnson et al., 2014). Diversification has been shown to increase resilience due to this reason, if one fishery fails than a fisherman still has income from another fishery (Cline et al., 2017). However, barriers to entry associated with permit and quota costs limit this flexible coping mechanism, effectively inhibiting adaptation and resilience.

An increase in social tension due to environmental change is consistent with previous research, and likely leads to an erosion of social capital (Dutra, 2015; Ford et al., 2006). Social capital and the relationships and networks that define it, are crucial to maintaining a resilient and adaptive system (Adger, 2003; Folke, 2006; Gutierrez et al., 2011; Dutra, 2015; Norris et al., 2008; Faulkner et al., 2018). Results show that an increase in collaboration and resultant role shift could lead to a decrease in youth participation, negatively impacting resilience in many ways (Cramer et al., 2018). However, an increase in collaboration could also lead to innovation and learning facilitated by these strengthened social networks and relationships (Gilden & Conway, 2002; Yochum et al., 2012).

The previously-outlined impacts on resilience and adaptive capacity largely stem from climate change impacts. However, erosion of resilience and subsequent probability of transition into an undesirable state is of further concern when combined with impacts from an intensification of graying of the fleet. Previous studies have described the impacts of graying related changes in the fishing industry on coastal community resilience (Cramer et al., 2018; Johnson & Mazur, 2018). Although nuanced, a general decrease in resilience occurs due to shifting social networks, capital, and cultures. Specifically, relevant to this study, an intensification of graying results in the decreased transfer of adaptive knowledge. As older fishermen retire with all the skills and information they have learned over the years, and youth are not present to receive that knowledge, it can be lost (Johnson & Mazur, 2018). Therefore, as climate change necessitates an increase in adaptability and resilience, fishermen's ability to meet this need would likely decrease. Graying of the fleet and climate change both separately impact resilience and adaptive capacity, however an

understanding of the combined impacts provides further insight into future scenarios and possible erosion of resilience.

Although the disappearance or collapse of the fishing community is unlikely, it is difficult to say with certainty where the threshold line rests due to the complexity of nonlinear feedbacks (Nelson et al., 2007). There may come a time where costs to enter and remain in the industry do not outweigh the benefits for the majority of people. For some people, this situation already holds true, revealed through data that supports the presence of graying (Russell et al., 2014). This study does not specifically measure threshold proximity; however, results show that climate change will most likely continue to tip the cost benefit scale in unequal ways. This is consistent with previous literature (Webster et al., 2017; Fulton, 2011; Adger et al., 2009).

Results show that, in terms of material dynamics, four specific climate change impacts emerge as connectors to graying: species shift; domoic acid events; increases in extreme weather; and fish stock variability or decline. In reference to relational dynamics, however, myriad of climate change impacts act as connectors. It is possible then that those four specific climate change impacts will be the most significant for the succession of and entry of youth into the industry in terms of resource capital, but all climate change impacts could be significant in relation to social capital.

Conclusion

The findings of this research can inform EBM through the identification of connections that illuminate explicit trade-offs, the incorporation of local knowledge to understand community resilience, and providing information that supports adaptive management. Understanding the steps that connect climate change to graying can help managers more accurately conceptualize future scenarios and specific impacts of policy and management decisions. Breaking down the connections into specific steps allow managers or policy makers to locate specific target areas for intervention or opportunity. For example, the connector between domoic acid events and graying is the perception of a lucrative industry. Therefore, managers can plan to counteract the possible real and perceived financial instability in response to domoic acid closures,

addressing both climate change and the possibility of graying of the fleet. The connector between fish distribution shift and graying is the flexible response of mobility, therefore management can mitigate climate change impacts and enable flexibility through decisions that support mobility. However, results also reveal negative feedbacks of a seemingly desirable response, namely that mobility could decrease motivations to enter. Therefore, this research allows managers to explicitly consider tradeoffs of enabling or inhibiting this flexible option. Furthermore, findings reveal how management might prioritize preparation and action to maintain future resiliency. Although many climate change impacts are projected, preparation specifically for stock distribution change and variability, domoic acid events, and increases in extreme weather might provide the best support to crucial vulnerabilities.

The nature of this study was largely exploratory and future research should expand on findings by assessing connections between climate change and graying of the fleet for specific ports and specific fisheries. Analysis at this scale would reveal highly localized scenarios that rest within larger state scenarios in order to assist with successful adaptation planning. Ultimately, combining perceptions of graying of the fleet and empirical climate change projections add an important dimension to the existing body of literature surrounding drivers and impacts of social change in resource-dependent communities. Emphasis on interactions between the social and ecological systems provide a necessary lens to make decisions based on best available science. This research provides further evidence of the need to change current management systems and policies. It is possible that if policies continue as they are, Oregon's fishing community will take leaps, rather than steps, towards reaching their limits of resilience. Relying on the responsive adaptability of fishing community members alone may not be sufficient, as their capacity to do so could be limited in the future. Collaborative planning and preparation are needed immediately.

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CHAPTER 3: JOURNAL ARTICLE [Ecology & Society]

Exploration of the suitability of optimism as a qualitative indicator of community resilience

ABSTRACT

The complexity and speed of environmental change occurring within the earth's social-ecological systems fuels a need to understand tools that address present and coming challenges. Although the "wicked problem" of climate change is daunting, resilience thinking has emerged as a tool to cope with this change. Research that aims to further understand the concept of resilience would then be useful. Therefore, the objective of this study is to explore the suitability of optimism as an indicator of community resilience through a case study of Oregon's fishing community. Data consisted of oral history semi-structured interviews with members of the fishing community. Findings reveal that multiple components of optimism identified in the fishing community do indeed contribute to the resilience of the individual and the community. However, findings from this research show that various components contributing to optimism could also lead to complacency and a lack of anticipatory adaptive action. Ultimately, this research reveals that optimism may not always be suitable as an indicator of resilience: the level and type of optimism are important to understand. Awareness of the role of optimism within resource dependent communities could enable researchers, managers, and communities to identify how the concept might be used as a tool to enable adaptation activation. Or conversely, to understand how it might be a "social limit" to adaptation activation, therefore affecting individual and community resilience in response to change.

Introduction

The intensity and rate of climate change felt by the world's social-ecological systems is of great concern to many citizens and scientists (IPCC AR5; Ripple et al., 2017). Climate change projections reveal that impacts are likely far beyond what current systems have experienced (IPCC SR15). Local scales illuminate other challenges as well, largely stemming from management and social change (Cramer et al., 2018; Russell et al., 2014). The literature emphasizes resilience thinking as a tool to cope with this change (Berkes & Ross, 2013; Zautra et al., 2008). Management agencies, such as the National Oceanic and Atmospheric Administration (NOAA), have also emphasized the importance of the concept of resilience through implementation of Ecosystem-Based Management (EBM) (NMFS, 2009a). EBM is a holistically focused framework that outlines resilience as one of its key components (McLeod & Leslie, 2012). A deeper and dynamic understanding of the resilience of social-ecological systems could then support decision-makers in efforts to successfully navigate the challenging path that climate change presents. Furthermore, it could prove useful for researchers, local community members, and managers to be able to identify attributes or indicators that enhance, erode, or signal a system's resilience. Therefore, the objective of this study is to explore a possible indicator of community resilience, specifically the concept of optimism, through a case study of Oregon's fishing community.

Individual and Community Resilience

No universal definition of resilience exists largely due to its role in various disciplines and situations. Walker et al. (2006) defines resilience as "the capacity of a system to experience shocks while retaining essentially the same function, structure, feedbacks, and therefore identity" (p.2) and focuses on the entire social-ecological system. Literature on resilience also stems from psychology and largely focuses on the individual (Windle, 2010; Ross & Berkes 2014). Attention on resilience at the community level has therefore been lacking (Ross & Berkes 2014). Community resilience literature is not yet well developed, and multiple concepts of resilience from varying disciplines and subjects stand disjointed (Berkes & Ross, 2013).

However, community resilience has been gaining attention in recent years and is defined as "the existence, development, and engagement of community resources by community members to thrive in an environment characterized by change, uncertainty, unpredictability, and surprise." (Magis, 2010). There is a need then to further explore and contextualize the concept of community resilience. Panarchy situates the community of interest within larger and smaller scales (Gunderson & Holling, 2002), referring to nested systems and multi-level feedbacks (Berkes & Ross, 2016). Therefore, along those lines of thought, individual and household resilience are linked to that of the community (Berkes & Ross, 2014). Nested systems give justification for this study's analysis of resilience through multiple scales.

Indicators

Although the concept of resilience has gained in popularity, it is still difficult to operationalize (Davidson et al., 2013). Efforts have been made to create frameworks and indicators that attempt to address this lack of measurability and consistency (Bahadur et al., 2015). In recent years, a majority of government and research attention has focused on resilience indicators to disasters in order to mitigate impacts on communities (Cutter, 2010). Social indicators for vulnerability and resilience assessments have been the main tool used by NOAA in understanding how coastal fishing communities will cope with change (Jepson & Colburn, 2013; NMFS, 2019b). Similarly, indicators and targets of adaptive capacity and vulnerability to climate change have been a recent focus of research (Cinner et al., 2018; Colburn et al., 2016). Adaptive capacity refers to the conditions that allow people and communities to anticipate and respond to change (Grothmann & Patt, 2005). Recently, activation of adaptive capacity has also been acknowledged. Therefore, adaptive capacity not only includes resources and assets, but also the intent and ability to activate those resources (Cinner et al., 2018). Because adaptive capacity is a component of and contributes to resilience, further exploration of this capacity would likely also be useful in promoting resilience thinking. Although progress has been made in identifying indicators that contribute to resilience, there is still a need for research that explores, clarifies and integrates ideas (Berkes & Ross, 2013).

Furthermore, the majority of research on indicators of resilience at the community or system level focuses on objective measurements (Jones, 2019; Schipper & Langston, 2015). Objective approaches and indicators are independent of the subject's judgement, often meaning that characterizations of resilience are defined by the evaluator instead of by the subject themselves (Jones, 2019). Subjective methods and indicators have recently been advocated for (Bene et al., 2016; Claire et al., 2017; Jones, 2019) and stems from subjective resilience, which centers on people's perception of their own resilience and what it means to them (Jones & Tanner, 2017). The focus of subjective resilience has largely been at the individual and household level (Jones & Tanner, 2017). Assessments and indicators that consider and represent both objective and subjective components do exist, though they are still largely objective focused (Jones, 2019). More research is needed then to understand social and subjective dimensions of resilience, because as "behavioral psychology and social sciences have long demonstrated, decisions are often (if not always) based on the perception that people have about reality, not on that reality *per se*" (Bene et al., 2016, p. 166). This study contributes to an understanding of the social and subjective dimensions of resilience.

Case Study: Oregon's Fishing Community

The term "community" is used in this article in reference to a community of interest, rather than a geographic place (Conway et al., 2002). The community of interest is made up of members of the fishing industry and related businesses, and their families (Conway et al., 2002). However, the community of interest in this study area is intimately tied with the community of place, and both are resource dependent (Gilden et al., 1999). The community has experienced, and continually cope with, tremendous amounts of change that stem from environmental, regulatory, and social factors (Gilden et al., 1999; Conway et al., 2002; Cramer et al., 2018).

Fishery collapse of the West Coast groundfish fishery occurred in 2002, and consequently the entire continental shelf was closed to bottom trawling (Warlick, 2018; Shaw & Conway, 2007). Attempts to decrease human fishing pressure and resultant occupational insecurity resulted in a slew of program decisions over the next

decade. A buyback program occurred in 2003, reducing the amount of boats on the water. In January 2011, the West Coast groundfish trawl fishery transitioned to a catch share program (PFMC & NMFS, 2017).

Despite having benefits such as the reduced likelihood of fishery collapse and the ability for fishermen to stay home in dangerous weather (Costello et al., 2008; Essington et al., 2012; Pfeiffer & Gratz, 2016), catch shares often result in consolidation of the fleet into the hands of fewer and often larger quota holders (McCay, 2001; Russell et al., 2014; Yandle & Dewes, 2008; Carothers, 2010; 2015; Chambers & Carothers, 2017; Carothers & Chambers, 2012). Oftentimes an increase in unemployment accompanies this system and costs typically fall upon those who lack access to capital markets (Acheson et al, 2015; Olson, 2011).

Another significant change for Oregon's fishing community is that salmon populations have greatly declined largely due to environmental changes and overfishing (Ohlberger et al., 2018; Strawn, 2019; Busby et al., 1996; Myers et al., 1998). Income from the fishery declined from $55.5 million in the 1980's to only $5.2 million between 1994 and 1998 (PFMC, 2000).

These recent changes, along with likely future challenges, contribute to the evidence that the fishing community is currently undergoing change at a rate and magnitude far greater than in the past (Pomeroy et al., 2015; Flathers, 2017; Lam et al., 2016; Hanna & Hall-Arber, 2000). Climate change is projected to challenge the world's social and ecological systems in ways never before experienced (IPCC SR15; Marshall, 2010), threatening the ability for the community to survive and flourish (McIlgorm et al., 2010; Brander, 2007). Although fishermen are skilled at coping with seasonal variations in ocean conditions and the longer climatic cycles in which seasonal variations occur, large scale climate change will intensify this smaller scale environmental variability (IPCC SR15).

Even in the face of past and future change, members of the fishing community find ways to continue coping. Optimism was one of several significant factors that emerged from this research. "Optimism" and a "positive outlook" are terms generally defined as the tendency to expect positive outcomes (Chang, 2001). It is the belief that future conditions will work out for the best (Chang, 2001). In psychology, both

are often interchangeably cited as factors that positively influence individual resilience (Riolli, 2006; Mak et al., 2011).

More recently, research that focuses on social-ecological systems has acknowledged the role of optimism in promoting social resilience (Berkes & Ross, 2013; Buikstra et al., 2010; Johnson, 2014). Buikstra et al., (2010) studied a rural farming community in Australia in order to identify components of resilience. Eleven major resilience concepts were revealed, with "positive outlook" emerging as the second most frequent concept. In particular, respondents discussed determination and perseverance as components of optimism and essential to resilience. Berkes and Ross (2013) explored the integration of resilience concepts from health, psychology, disaster, and social-ecology literature in order to better understand community resilience. A positive outlook was noted as a resilient component in multiple sources referenced in the study, oftentimes in regard to rural communities. Berkes and Ross concluded that little exploration still remains of dimensions such as "agency, self-efficacy, empowerment, optimism, and self-esteem in determining how people deal with shocks and stresses" (p. 17). A gap in the research then exists of the exploration of the concept of optimism as it relates to community resilience. Furthermore, existing research that has connected optimism and resilience has largely focused on rural farming communities, leaving research on fishing communities lacking. Johnson (2014) began to fill this gap by identifying optimism as a component of resilience in Maine's fishing community. However, more research that explores the linkage between resilience in fishing communities and optimism is needed.

The prevalence of optimism in the fishing community and its connection to resilience motivated the research questions specific for this study: (1) Might optimism be an indicator of resilience in Oregon's fishing community?, and (2) What are the wider implications of this as a possible indicator for other communities?

Methods

Participant Recruitment and Data Collection

Combined oral history semi-structured interviews were conducted along the entire Oregon coast from 2014 to 2018. Participants consisted of members of the

fishing community: fishermen, their families, and local suppliers (Calhoun, 2015; Caracciolo, 2017; Strawn, 2019). The initial group of interview participants were determined through local key informants. Additional participants were then identified through a modified snowball sampling technique (Auerbach & Silverstein, 2003; Berg, 2001; Bernard, 2011). Snowball sampling is a technique in which other research participants are recruited by current research participants, useful when potential subjects are hard to locate (Creswell & Poth, 2018). Interviews took place in the communities where the participants lived and worked. A diverse range of age, vessel size (i.e. small boat or big boat), gear type (i.e. trawl, long-line, pots), and position (i.e. crew, owner, skipper) were represented (Caracciolo, 2017; Strawn, 2019). This study was not designed to assess optimism as an indicator of resilience. Rather, this theme emerged from interview data originally designed to understand how the fishing community experienced change over time. Therefore, interview questions were open-ended and asked about perceptions of the past and future of the industry, family dynamics, and changes in management and the environment. Additionally, interviews did not directly ask about climate change or closely related terms (i.e. global warming, acidification). This accomplished two goals: 1) The interviewers avoided the possibility of charged responses and incongruent communication, and 2) Interviewees were free to bring up the environmental terms or topics that were salient to them (Nisbett, 2010; Moser, 2009). Interviews ranged from 30-90 minutes long. A total of 35 interviews were analyzed.

Data Analysis

Interviews were fully transcribed, and analysis was carried out through the use of the software MAXQDA 12. Auerbach and Silverstein's (2003) approach for grounded-theory guided analysis methods. Grounded-theory is a qualitative research method that is inductive, allowing the researcher to begin a study without first formulating a hypothesis to test. Rather, a theory or understanding of a process or phenomenon is generated from exploration of open questions (Auerbach & Silverstein, 2003). The first step involved selecting relevant text from the entirety of all the transcripts. For the purpose of this research, text was selected that referenced

any type of environmental change. This ranged from direct references of climate change to discussions of changes in fish stock and characteristics, water temperature, or weather. Relevant text regarding environmental changes were not separated to differentiate between natural cycles, climate change, responses from human pressure or management decisions. Rather, any mention from a participant of an environmental change regardless of the source of that change was included as relevant text. Relevant text was then analyzed in order to understand sets of important or repeating themes. The first round of coding resulted in general idea groups such as; barriers and challenges, emotions/feelings, perceptions of the future, and types/results of changes. The second and subsequent rounds of coding further refined repeating ideas and clustered them into more concise themes (Auerbach & Silverstein, 2003). Memoing was crucial to the process and further helped organize and identify themes and categories (Creswell & Poth, 2018). Memoing is the act of writing down ideas and thoughts as data are collected and analyzed (Creswell & Poth, 2018). From this inductive approach, five themes emerged as salient, of which "optimism" was one of them. Further rounds of coding were then performed in order to explore this specific theme in depth.

Results

Optimistic sentiments were present in nearly every interview conducted. Furthermore, a large majority of the participants exhibited an overall optimistic outlook. This research examines participant responses specifically to environmental change. Therefore, the optimistic sentiments are situated within the context of environmental change. The following themes emerged organically from the data and represent the various ways that optimism takes shape for the fishermen and other community members who participated in this research.

Successful Management and a Healthy Ecosystem

Fishing community research participants discussed mixed feelings over management decisions and systems. Oftentimes they acknowledged the need for some type of management, but they also saw the negatives that resulted from the

regulations. Although some participants talked about getting "regulated out of the industry", more often than not, members of the fishing community referred to management as a reason for their optimism. The following quote demonstrates these sentiments:

> *Overall, I think the fishery is going in the right direction. As slow and frustrating as it is, what they're doing now will keep it around.*
> Another participant reasoned, *Management takes a lot of hits, but I kinda have faith now that they are managing the fisheries well enough that I don't think we will overfish things.*

Specifically, they talked about learning from past mistakes and looking forward with a better understanding of how to be good stewards and manage the fisheries effectively. Learning was central to a positive outlook, and collaboration with management and scientists was seen as key to learning. The following quote is representative of many participants' statements:

> *Overall the West Coast has learned from past mistakes and now the change is directed ahead at sustainable fisheries. How do we do it? Bycatch reduction. A lot of different things like that.*

It was also common for participants to talk about management within the context of a healthy fishery and ecosystem as demonstrated in the following quote:

> *The most highly regulated industry, or fishing country in the world is the United States, and it shows. Because, at least on the West Coast, we still have an abundance of fish, and it's just getting healthier. The last several years we've just seen enormous amounts of feed…and to see lots of that, gives us hope. When you have lots of that, then you have more predators, you have more tuna, more cod.*

This sentiment demonstrates that the perception of a healthy ecosystem was directly related to an optimistic mentality about the future, which was expressed often in this research. Research participants specifically referred to stocks rebounding and the diversity of fish in the ocean. Participants also referred to the huge amount of resources in the ocean and the health of the ecosystem in general, as demonstrated in the following quote:

> *The amount of fish, crab, and shrimp that comes out of the ocean every year is really amazing. I mean you're talking about thousands and thousands of tons, maybe millions of tons, of product coming out of that ocean every year. And it's just a super healthy ecosystem. The way it's being managed right now is very conservative, at least compared to 20 years ago…I see it getting nothing but better compared to how it was even 25 years ago when I first started in it. I don't think it's going anywhere.*

It is important to keep in mind that optimism about management and science was in response to changes in the environment, and only provide a piece of the whole picture.

Some fishing community participants did not share the positive mentality towards management and scientific actions. Specifically, these research participants spoke of extreme frustration with the timeliness and responsiveness of decisions, noting that: (*the) Council is always 2 years behind where they should be with regulations*.

Perception of Ability to Adapt

Research participants described a sense of optimistic confidence in their ability to cope and adapt to change. Their ability to adapt was both directly and indirectly referenced. Perseverance and persistence were traits that they often described, which contributed to their confidence in their ability to cope with anything. The following quote is representative of this sentiment:

> *Fishermen are like cockroaches. We're the only thing that can survive a nuclear blast because we're just resourceful. We just aren't gonna go anywhere. We're always going to persevere regardless of what happens. We're gonna find a way to make it through.*

Other members of the fishing community also talked about how capable those involved in the industry as a whole were at dealing with challenges and change. One participant's response represents these sentiments, explaining that:

> *(my) greatest hope for fishing is just that it always finds a way to adapt and change, if that's what the people in the industry so desire. I think*

> *they are very, very capable of dealing with change, they always have been.*

Interview data often highlighted the complexity of the industry and how management and environmental factors have required the ability to adapt and anticipate. Several research participants talked about adapting, anticipating, planning and this connected to optimism. For example, they discussed how the future will be okay because they try to anticipate instead of waiting to see what happens.

The data also reflected an ability to, and the importance of, learning from the past. Overall, confidence stemmed from successfully living and fishing through past changes. Natural cycles were often referred to as a source of variability in their occupation but successfully weathering past challenges meant that future challenges could be handled as well.

Perception of Risk

Fishing comes with many risks and fishing community research participants were very aware of, and talked about, these risks. Interview questions revolved around a discussion of the future of the fishing industry and the possibility of a non-specified "tipping point". Research participants guided the interview responses towards concerns and hopes that were relevant for them. Responses reinforced the idea that not all community members experience or perceive risk in the same way. Optimistic responses diverged into two main subthemes regarding perceptions of risk.

The first subtheme revolved around discussions of cycles and the normalization of change. The variability in seasons and the cyclic nature of the job was brought up often. Research participants discussed the normality of these variations and resultant lack of concern for the future. A representative statement is captured in the following quote: *I think it's just going to plug along like it has. I think it's boom and bust like it always has been. We have been here 40 years and I think we have seen 4 boom or busts.* These kinds of references to the commonality of cycles were used as a means to support an optimistic outlook for the industry, as demonstrated in the following:

> *In the 80's we had a really bad El Niño. That's why I went up to Alaska in the 80's, early 90's. We had a 5 year El Niño, which was the worst one ever. In '97 we saw 3-4 years of bad production and then things got better. It's a natural up and down thing…things are going to rebound.*

The second theme referenced concerns in response to changes in the ocean associated with climate change, such as acidification or fish movement[2]. However, these statements took the form of "but" statements, always ending on a positive note:

> *As aquaculture becomes more developed, the sea chemistry changes, and the ocean is used for a greater variety of purposes, it is hard to say what they future of the commercial fishing industry will be.* ***But*** *right now, it is so diverse and full of amazing sources of healthy protein, I can't see that changing overnight.*

Less than one third of the research participants responded with statements like these, which revealed that "climate change" (directly referenced) or it's attributed impacts (indirectly referenced) were of great initial concern. Individual participant responses almost always aligned exclusively with one subtheme or the other, but not both. The participants that referenced concerns to climate change or its impacts, were separate from those that thought the future would continue under usual cycles and whom emphasized the normalization of change.

Survival

The last theme that emerged related to optimism was how it was used as a means of survival. In other words, research participants expressed hope or positivity when faced with negative past or perceived future experiences. It appears that keeping an optimistic mindset allows fishermen to stay motivated to fish. The following quote reflects this sentiment: *Got to be [optimistic], if you're a fisherman. You got to believe the next time you're out there you're going to get 'em*'. Having an optimistic outlook and holding onto hope enables fishermen and other community member s to persevere. The ability to persevere was crucial to being successful as a

[2] The movement of fish northwards and farther off the coast into deeper water is expected in the future as a response to climate change (Cheung, 2018).

commercial fisherman. Interview data related to hope emerged in tandem with optimism as a coping mechanism, as represented by the following:

> *I just don't see a tipping point where there are no fisheries. I can't even imagine that…perhaps…but that's kind of the end…I think. If there's no fisheries and no fish to catch, we are in serious trouble. Way beyond anything I hope to ever see. I'm hoping we are a little smarter than that, you know. We deal with all kinds of problems. Like ocean acidification, it's daunting because it is coming from all over the world, it's not just here. But…I don't see fisheries going away from (place) anytime soon. I hope not. I'm kinda invested in it.*

In this context, hope is connected to survival. Hope provided an answer to a fearful situation and optimism ensued. At the end of the statement, the research participant demonstrated that an optimistic outlook is a coping and survival mechanism; if one is invested in the fisheries, they are going to hope and stay optimistic because the alternative would mean defeat.

Discussion and Conclusion

The prevalence of optimism in Oregon's fishing community is similar to other research on resource-dependent or resource-focused communities that discuss optimism or a positive outlook (Johnson et al., 2014; Buikstra et al., 2010). Both Johnson and Buikstra et al. identified optimism or a positive outlook as one of the most frequent themes that emerged from the data. Results from this research, however, specifically reveal that members of the fishing community are largely optimistic when discussing changes in the environment. Findings from this research have three significant implications.

Contributes to Resilience

Optimistic characteristics identified contribute to individual and community resilience. Optimism was demonstrated in response to a perceived improvement in the health and management of the fisheries. Although not uniform, the majority of research participants expressed this in reference to the management of groundfish stocks. Data from the West Coast Groundfish Trawl Catch Share Program Five-year

Review has shown that the groundfish stocks have indeed stabilized since collapse and many are rebounding faster than expected (PFMC & NMFS, 2017; Strawn, 2019). Fish stocks are a form of natural capital, and as such, are foundational to a resilient community (Flora & Flora, 2008; Adger et al., 2005). Therefore, optimism in this situation is in response to and an indicator of an increase in natural capital and can also be tied to community resilience attributes. Learning (i.e. from past mistakes) was a common thread in the research data about recovery and conservation of fish stocks and contributed to a positive outlook for the future and "getting through it." This is directly related to learning being a key component of resilience and adaptation. Specifically, the third component of a general social-ecological resilience theory states that resilience is defined by; the degree to which the system can build and increase the capacity for learning and adaptation (Holling, 1973; Carpenter & Gunderson, 2001). The perception of one's ability to adapt and the perception of risk have also been identified as two components of social resilience by Marshall and Marshall (2007). An increased perception of fishing community research participants regarding their ability to successfully cope with changes and challenges in the future was partially attributed to their ability to have successfully dealt with past difficulties (Marshall & Marshall, 2007). The knowledge gained from coping with past changes contributes to adaptive capacity, as it constitutes a resource of information that community members can draw upon in order to adapt to future challenges (Grothmann & Patt, 2005). Similarly, survival was another characteristic of optimism found through this study. The fishermen research participants had a positive outlook because it enabled them to continue fishing. This is an indicator of resilience, as a lack of that survival mechanism would signal an erosion of the individual and the system to continue.

These relationships demonstrate that multiple components of optimism identified in Oregon's fishing community do indeed contribute to the resilience of the individual and the community. This is consistent with previous results from the literature (Johnson et al., 2014; Buikstra et al., 2010). However, both the components and the general concept of optimism may not always indicate resilience. Evidence for this is discussed in the following research implication.

Inhibits Activation of Adaptive Capacity

Optimistic characteristics also may, in fact, inhibit activation of adaptive capacity. Confidence in the ability to adapt, a component of optimism identified in this research, may mask the need for pre-emptive adaptation (Gifford, 2011; Marshall, 2010; Kuruppu & Liverman, 2011). Fishermen and other community members are largely confident due to successfully dealing with past environmental variability. However, impacts from climate change will likely exceed scenarios that fishing community members have dealt with in the past (IPCC AR5). Therefore, community members past adaptive responses may not be sufficient to adapt in the future, and confidence could pose a barrier to anticipatory adaptation (West & Hovelsrud, 2010).

Additionally, confidence is a factor that contributes to an overall perception of risk. Of the participants that discussed future environmental change or climate change as a major concern, overall risk and vulnerability were perceived as low largely due to the individual's and community's perceived ability to adapt. Of the participants that conveyed a lack of concern about future environmental change, overall risk was perceived as low. This was due to the acknowledgement of the normalcy of natural cycles and the expectation that variability would continue as it always had. Dannevig and Hoveslrud (2015) found similar results with fishermen in Norwegian fishing communities. However, they attribute a lack of concern for climate change to the lack of climate change salience and demonstrated disinterest in adaptation. Bercht (2017) points out that salience may not be lacking, but rather, psychological and mental barriers exist which mask the true concern and fear of the fishermen. Similarly, this research does not discuss results under the assumption that risk of climate change is not necessarily a salient threat to Oregon's fishing community. Rather, it asserts that a lack of acceptance and acknowledgement of that threat might inhibit anticipatory activation of adaptive capacity. Previous research supports this statement, concluding that anticipatory action is unlikely where acknowledgement of the specified threat is lacking (Adger et al., 2009; Wolf et al., 2009; O'Brien et al., 2006). One possible explanation for the lack of acceptance or acknowledgement among fishing community research participants is cognitive dissonance. *Cognitive dissonance* comes

from the psychology discipline and states that "contradicting cognitions serve as a driving force that compels the mind to acquire or invent new thoughts or beliefs, or to modify existing beliefs". This is done in order to reduce or get rid of the uncomfortable internal mental conflict resulting from the opposing cognitions (Festinger, 1957; Adams, 1973; van Putten et al., 2015). The livelihoods of members of the fishing community depend on a healthy ecosystem and manageable risks. Therefore, information that could threaten ecosystem health or increase risks (such as climate change) could threaten the very core of their identity as a part of the fishing community.

Ultimately, results from this research show that various components contributing to optimism in Oregon's fishing community could also lead to complacency and a lack of anticipatory adaptive action (O'Brien et al., 2006; Shepperd et al., 2013).

Level and Type are Necessary to Consider

The level and type of optimism are necessary to consider in determining impacts on resilience. The complex nature of optimism signals a need to further explore its role within Oregon's fishing community. Although this research study is a start, it would be beneficial to explore the subject further in order to identify what types and levels of optimism promote or inhibit adaptive action and planning. Findings ultimately demonstrate that it would be unwise to assume that an optimistic or positive outlook would prove robust as a positive indicator of resilience. The individual components contain both positive and negative indicators of resilience and adaptive capacity. For example, one's confidence in their ability to adapt can both enhance intention and motivation for action, but also create a sense of complacency (O'Brien et al., 2006, Adger et al., 2009; Grothmann & Patt, 2005). Adaptive capacity is intertwined with resilience, therefore an inhibitor of adaptive capacity may, although not always, decrease resilience. The multi-dimensionality of resilience thinking, which incorporates these many components, likely signal that straightforward or universal indicators may not capture the system accurately.

The research presented in this article contributes to the discussion around integrated subjective-objective indicators of community resilience. If the world's social-ecological systems are to prepare, plan, and successfully thrive in the face of change, a better understanding of system complexity must ensue. Ultimately, awareness of the role of optimism within resource-dependent communities could enable researchers, managers, and communities to identify how optimism might actually be used as a tool to enable adaptation activation. Or conversely, to understand how it might be a "social limit" to adaptation activation, therefore affecting individual and community resilience in response to change (Adger et al., 2009). At the end of the day, external changes may be outside of human control, but individual and collective actions and responses do not have to be.

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CHAPTER 4: CONCLUSION

The rate and magnitude of change in Oregon's fishing industry and community are greater today than in the past (Pomeroy et al., 2015; Flathers, 2017; Lam et al. 2016; Hanna & Hall-Arber, 2000; Gilden et al., 1999). The combination and culmination of external and internal factors have contributed to the concern over the resilient and adaptive abilities of the community (Conway & Cramer, 2018). In response to this concern and to the call for social considerations mandated by the MSA, the aim of this research project was to understand how Oregon's fishing industry and community have been and will be impacted by various drivers of change. The research largely focused on impacts to resilience but specific components such as adaptation and adaptive capacity were considered. Findings show that the fishing community will be challenged through environmental, management, and social stressors and their feedbacks, connections, and cumulative impacts. Specifically, this research reveals that climate change will likely exacerbate and intensify graying of the fleet through an increase in financial instability, an erosion of vital community relationships, and through the limitation or variability of resources. Essentially, the cumulative impacts of system stressors that interact and feedback into each other could magnify the threats to the future of fishing in Oregon.

Although this study used a grounded theory approach, which is inductive and not driven by outcome expectation, results are fairly intuitive and consistent with trends in published research. The intensity and amount of threatening climate change projections conducted by the IPCC and others have seemed to exponentially increase in a short time period. In fact, the IPCC wasn't even created until 1988, one year after the Montreal Protocol. In about thirty short years, one human's lifetime, projections for the earth have gone from an official recognition of the warming of the planet to the probability of rapid and unprecedented changes (IPCC SR15). This is partly due to an increase in understanding of feedback loops and compounding changes. Similarly, this research gives a glimpse into scenarios where cumulative impacts and feedbacks bring communities and populations leaps and bounds closer to thresholds; thresholds where resilience and adaptation are no longer possible, and system

transformation is likely. However, the intimate connections and feedbacks between these stressors also provide an opportunity for targeted and efficient decisions and actions that address these cumulative impacts. Therefore, the most important direct implication that emerged from this research is the need to consider and identify the cumulative component of impacts within a system when assessing change.

Limitations

As with all research, limitations are unavoidable, and are outlined here for transparency and contextualization. The connections that emerged from the analysis in this research were only a small portion of the possible connections that exist. In order to have avoided making unsupported or assumptive theoretical connections, the graying of the fleet portion of analyses was limited to individual research projects conducted by members of the larger graying of the fleet research program. Connecting to the larger body of graying literature could have provided even more feedbacks or insight, but due to the variability in study populations and scenarios, would likely have increased uncertainty and decreased validity.

The questions asked during the interviews were crafted and approved previous to this study. Additionally, many of the interviews were collected by previous program teammates. Although this allowed for consistency across the span of projects within the program, it limited the ability to ask additional questions that were of specific interest to this study. For example, a previous program teammate focused on women's roles in the fishing community, and therefore asked more follow-up questions regarding that topic (Calhoun, 2015). Overall, however, this limitation did not erode the quality of data specific to my study. Additionally, enough interviews were collected to ensure that responses regarding environmental changes were exhibiting saturation (Auerbach & Silverstein, 2003). Regardless, it is possible that results would have been different if all the interviews were collected with the intention of this specific study guiding them.

The questions that guided this research were relatively broad in focus and allowed space and flexibility for exploration. However, the broad scope also limited the ability to dive in depth into certain topic areas. Optimism was the one area of many that was investigated further; others might have been to identify specific

community values in order to inform desirable decision making, or to focus solely on the role of flexibility within the community. Additionally, the large net cast resulted in a large amount of data to analyze and an endless number of possible codes or lenses with which to look through. Although certainly qualitative social science, especially grounded theory, is naturally complex and filled with cyclic twists and turns (Creswell & Poth, 2018). Although complex, the rewards of this type of research are great and generate findings for future research to expand upon.

Future Research

The complexity of the subject and area of research make it important to consider the scale at which the research is conducted. It would be useful to conduct additional highly localized studies that aim to continue to understand the connections between climate change and graying of the fleet. Climate change impacts will vary depending on location of the coast. Specific fish populations and species distribution may not change uniformly. For example, species currently available on the South Coast of Oregon may shift northward and therefore only be available off of the North Coast under future conditions (Morley et al., 2018). Additionally, ports have different infrastructure, such as Port Orford, Oregon which is completely exposed to the open ocean and has a hoist system versus a dock system. Changes in weather or sea level may then have a different impact in Port Orford than in other ports. Furthermore, it could be useful to consider the connections between climate change and graying of the fleet for each fishery because not all fisheries are perceived as graying, and different fisheries fall under different management systems (Strawn, 2018).

A specific area that would be of interest for future research emerged from the data in relation to mobility. In particular, the connection between species distribution changes, fishermen's need to flexibly follow the fish, and the benefits of a larger, sturdier vessel. A larger vessel might allow flexibility and safety in the face of climate change. Research by Young et al. (2019) indeed indicated that vessel size (categorized as either >65ft or <65ft) was a significant predictor in determining whether East Coast trawl fishermen changed fishing location in response to fish movement. A larger commercial or factory vessel could therefore be favored, which

could ultimately make smaller family fishing vessels and businesses irrelevant. This connection would be important to explore because if that scenario is likely, fishing families should know preemptively in order to prepare or plan.

Another area of future research resulted from the exploration of optimism within the community. Although the results of this research indicated that optimism may not always be suitable as an indicator of resilience, it did reveal that social barriers to adaptation are likely present within the community. Future research aimed at understanding social barriers to anticipatory activation of adaptation would be most useful. Research of this manner would be useful because although fishing community members are highly adaptive, action may not be enough unless pre-emptive, and geared towards climate change rather than just normal variability.

It is a common sentiment to "wish we knew then what we know now." Although I am no exception, I am also motivated by the possibility that future research will pick up where this study left off. Ultimately, the most important topic of future research found through this research is that of adaptive capacity. In a world of transition and change, it may not be possible to stay resilient in the same manner. However, if we are to truly be flexible enough to deal with whatever may come, we need to have the capacity to deal with those changes. Therefore, I urge future research to aim for further exploration of adaptive capacity. Furthermore, I emphasize the need to incorporate methods that understand both subjective and objective adaptive capacities. Both must be understood because they are intertwined and the mismatch between objective and subjective levels can lead to undesirable outcomes (Grothmann & Patt, 2005; Kuruppu & Liverman, 2011). Progress then lies within the incorporation of multiple dimensions of the concept: individual and community adaptive capacity, anticipatory activation and reactionary adaptive capacity, and subjective and objective adaptive capacity.

Management Considerations

Informing EBM

The research from this study contributes to Ecosystem-Based Management in many ways. Connections is a core concept of EBM (McLeod & Leslie, 2012).

Therefore, the approach used for this research supports this concept by focusing on understanding the connections and feedbacks of the socio-ecological system. Looking at the community in this way also facilitates the acknowledgement of cumulative impacts, which is a basic principle of the EBM framework (McLeod & Leslie, 2012). Another aspect of the approach taken in this study that is in line with EBM is the emphasis on local knowledge. Specifically including resource users' voices in decision-making facilitates a better comprehension of their needs, values, and perspectives (Levine, 2015). The research approach utilizes semi-structured, oral history interviews with members of the fishing industry, allowing valuable information to be shared and a connection established with community members. The larger purpose of this research is to understand how the resilience and adaptive capacity of the fishing community will be affected by environmental change, again supporting a core EBM component. Lastly, this research helps to make trade-offs explicit through the combined examination of the graying of the fleet and climate change.

Recommendations

In order to make efficient and effective decisions that address the likely reduction in adaptive capacity and resilience, both graying of the fleet and climate change need to be considered together. Due to the multiplicative effect of their relationship, management and policy decisions that target overlapping impacts would be most useful. Recommendations that outline the areas of overlap and consequently areas of prioritization are summarized and then expanded upon below.

- Strengthen community relationships (social capital) in order to facilitate transfer of adaptive and vital fishing knowledge.
- Support financial stability through encouragement of a diversified economy and diversified income for those within the fishing community. Support the smart and responsible management of income for fishing families to address financial instability.

- Work to narrow the responsive time gap between management and oceanic systems.
- Further incorporation of disciplines across traditional boundaries of science.

Research from this study reveals that relationships within the fishing community are currently and will likely continue to erode. Therefore, it would be beneficial for both the community and management to make decisions that strengthen community relationships (social capital) in order to facilitate transfer of knowledge. This could be done through an increase in formal or informal community organizations, networks or events. Organizations such as Newport Fishermen's Wives and Port Orford Ocean Resources Team (POORT) are existing successful examples. Additionally, creating avenues of formal education specific to the occupation would relieve the pressure for vital knowledge to be gained informally from others in the industry or community.

Financial insecurity is another area to target efforts. As costs to continue fishing increase, and seasons may become more unpredictable, security needs to be provided. Financial security would ensure that the members of the fishing community do not go bankrupt from an inability to pay their debts due to domoic acid closures or costs associated with buying a bigger vessel. To be clear, this research does not indicate that a complete subsidization or absorption of financial costs associated with the fishing industry would be beneficial. It indicates that some type of monetary stability under future unstable conditions could mitigate the decline of adaptive capacity and resilience. One way to accomplish this would be to make decisions that directly or indirectly encourage a diversified economy and diversified income for those within the fishing industry (Young et al., 2019; Cline et al., 2017). Alternatively, programs that support the smart and responsible management of income for fishing families would be useful in addressing financial instability.

Another recommendation for management emerged from the first round of transcript coding rather than through connective analyses. However, the importance of this topic to fishing community research participants motivated the need to include it here. The research participants talked about limitations to flexibility due to the

disconnect between management and industry time scales. They were frustrated with the fact that management decisions were behind and not responsive to what they saw changing in the ocean. The nature of the two systems, natural and regulatory, inherently operate on different spatial and time scales. Therefore, in order to enable flexibility in the industry, closing the responsive time gap could be beneficial.

Finally, management and policy-makers could benefit from further and continued incorporation of varying disciplines. While it's been traditionally ecologically- and economically-focused, fisheries management has already made steps to incorporate a more wholistic view; continued effort in this direction would be useful. Research, such as this study, has shown the benefits of incorporating other approaches such as social science, anthropology, and psychology. Therefore, continued support and incorporation of disciplines across traditional boundaries of science could be emphasized.

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APPENDICES

Appendix A.
Conway & Cramer: Using Oral Histories to Track Changes

Purpose. We want to understand the intergenerational fishing family business, the presence or absence of the "graying of the fishing industry," and any impact on community resilience. You've been identified as a research subject based on your participation in VFWC.

Activities. We want to listen to your oral history, as shaped through answering six broad questions, and compare your experience with the literature on this topic.

Time. The length of the oral history is up to you; they generally last anywhere from 30-90 minutes.

Risks. There are no possible risks and/or discomforts associated with being in this study.

Benefits. There are no direct benefits for participation; the benefit is that you get to share your stories and life histories on the VFWC website for the public to view.

Payment. You will not be paid for participation.

Confidentiality. The VFWC oral history recordings and transcripts will be made public upon unloading to the Voices from the Fisheries website. Participants have the right to choose anonymity or remove their associated oral history from the record at any time, but this rarely happens; most tend to take great pride in their stories and their participation. If a participant refuses to save their oral history interview placed on the website, their confidentiality will be maintained by de-identifying data gathered (although there is a small chance that we could disclose information that might identify the participant).

Voluntariness. Your participation and consent are voluntary. There is no penalty for choosing not to participate or for leaving the study at any time. You are free to remain silent on any topic. You may choose to take part in the VFWC oral history project and not this research project.

Contact Information: Flaxen Conway is the leader (541-737-1339); fconway@coas.oregonstate.edu) and Astrea Strawn and Bri Haugen are the student researchers (720-365-0442; strawnas@oregonstate.edu; 612-2106533, haugenbri@oregonstate.edu) on this project. The IRB at OSU oversees all research (531-737-8008)

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Appendix B.
NOAA VFWC Consent Form

TO BE COMPLETED BY THE PERSON BEING INTERVIEWED

I, _____, am a participant in the Voices from the West Coast Project (herein "VFWC") of the National Oceanic and Atmospheric Administration's National Marine Fisheries Service, Northwest Fisheries Science Center (NOAA/NMFS/NWFSC), and inclusive of collaborators at the NMFS West Coast Regional Office (WRO), Oregon State University (OSU), Warrington High Fisheries Inc. (WarHF), and the Newport Fishermen's Wives (NFW). I understand that the purpose of the VFWC is to collect audio-and video-recorded oral histories of the United States of America and its territories' commercial, recreational, and subsistence fishermen and women, and those who support them, other community members engaged and with knowledge of environmental issues in their communities such as climate change, wave energy and other issues, scientists, and environmental manager, as well as selected documentary materials such as photographs for inclusion in the Voices from the Fisheries Database (hereafter "VFF DB"). The VFF DB is housed on NOAA/NMFS servers and will be accessible to the public through a website. These oral histories and related materials serve as a record of the Nation's commercial, recreational, and subsistence fisheries and as a scholarly and educational resource for NOAA and the general public.

I understand that NOAA/NMFS/NWFSC/WRO/OSU/WarHF/NFW plans to retain the product of my participation in the VFWC in digital form, including but not limited in my interview, presentation, video, photographs, statements, name, images or likeness, voice, and written materials ("My Collection") as part of its permanent collections in the VFF Database.

I also understand the VFWC and its partners plan to retain the product of my participation for potential use in a public display(s) on website(s), community festival(s), possible museum(s), and for other outreach and educational materials.

I hereby grant to NOAA/NMFS/NWFSC/WRO/OSU/WarHF/NFW of the physical property compromising My Collection. Additionally, I hereby grant to NOAA/NMFS/NWFSC/WRO/OSU/WarHF/NFW, at no cost, the perpetual, nonexclusive, transferable, worldwide right to use, reproduce, transmit, display, perform, prepare derivative works from, distribute, and authorize the redistribution of the materials in My Collection in any medium. By giving this permission, I understand that I retain any copyright and related rights that I may hold.

I hereby release NOAA/NMFS/NWFSC/WRO/OSU/WarHF/NFW and their assignees and designees, from any and all claims and remands arising out of or in connection with the use of My Collection, including but not limited to any claims for copyright infringement, defamation, invasion of privacy; or right of publicity.

Should any of my part of My Collection be found to include materials that NOAA/NMFS/NWFSC/WRO/OSU/WarHF/NFW deems inappropriate for retention with the collection of for transfer to other collections, NOAA/NMFS/NWFSC/WRO/OSU/WarHF/NFW may dispose of such materials in accordance with its procedures for disposition of materials not needed for NOAA's collections.

I hereby state that I am of legal age and competent to sign this release. I agree that this release shall be binding on me, my legal representatives, heirs, and assigns. I have read this release form and I am fully aware of its contents.

ACCEPTED AND AGREED

Signature_____ DATE_____

Printed Name_____

Name of Interviewer (if applicable)_____

Appendix C.
VFWC Semi-Structured Questions for Oral History Interviews

1. What was your first job in fishing/fish processing/service?
    a. What made you get into it? (family business, choice, necessity…)

    b. How many years have you been in the industry and how have your jobs changed over the years?

2. Which fisheries have you worked in?
    a. Best ones for you?

    b. Worse ones for you?

3. What changes have you seen in the ocean, coast and/or fishing over time?

4. What role has your wife/husband played in your fishing-related business and how has this changed over time?

5. **What role has your kid(s) played in your fishing-related business and how has this changed over time? (2000, 2010, and present)**

6. What does fishing mean to you?
    a. What was the high and low of your career?

    b. What brings you the most joy and the most grief in this industry?

    c. What are your greatest hopes for fishing?

Probing Questions for Fishermen / Wives (from Q5 above)

What role has your kid(s) played in your fishing-related business and how has this changed over time? (2000, 2010, and present)

5a. Have you found yourself encouraging or discouraging your kid(s) to stay in the fishing-related business? Why? What are the benefits or costs of them staying in the industry?

5b. Thinking about young adults in general,

- What attracts these folks to the industry and how has this changed over the years? What are the 3 biggest motivators?
- Are there obstacles or barriers for young people to get into the industry?
    - If yes, what are the 3 biggest barriers?
    - Has this changed over the years?

5c. There are data that indicate that the average age of commercial fishermen is in the 50s. In your opinion, has this always been the case, or is the fleet "graying?"

- What do you see here in (PLACE) that agrees or disagrees with this?
- If graying is happening, what is or might be the impact of this in (PLACE)? How about in other coastal towns?
- What is or might be the impact on the fishing community over time?

5d. What would it be like for you if your family fishing business (OR THE ONE YOU WORK FOR) were sold?

- Would this have any impacts on the fishing community?
- Would this have an impact on (PLACE) or other coastal communities?
- What is the "tipping point"? In other words, what would happen in (PLACE) if most (or all) of the fishing family businesses were sold?

Probing Questions for Fishing Adult Kids or Young Adults that Fish

So, first we'd ask them the six questions above IF that is relevant, but then we'd go on to ask:

5a. What was it like to grow up in a fishing-related family business?

- What role(s) have you played and why?
- Has this changed over time? (2000, 2010, and present)
- In what ways was growing up in a fishing family similar or different to other family businesses in town?

AND/OR

5a. As a young adult currently involved in the fishing industry, can you please share your perspective on what attracts young people to the industry?

- What are the 3 biggest motivators?
- What obstacles, if any, are there for young people to get into the industry? What are the 3 biggest barriers? Has this changed over the years, and if so, how?

5b. Are most fishing family kids **or** young adult fishermen satisfied with their work in the commercial fishing industry? Why or why not?

5c. What are your key skills and abilities that help you do your tasks in the fishing related business?

- Are these skills transferable to other industries? If so, which ones?

5d. Please talk with me a little bit about the kinds of places you want to live and work?

- Do you want to stay here or move somewhere else?
- Where do you see yourself in 5-10 years?

5e. What would it be like for you if your family fishing business (OR THE ONE YOU WORK FOR) were sold?

- Would this have any impacts on the fishing community?
- Would this have an impact on (PLACE) or other coastal communities?
- Is there a "tipping point"? In other words, what would happen in (PLACE) if most (or all) of the fishing family businesses were sold?

Questions for Non-fishing-related people (fisheries-related managers and/or community leaders)

We wouldn't ask the typical OH questions, but rather just get into this:

1. Tell me about your community (Demographics, size of business, level of specialization, length of time in industry, economic aspects of this place, technological aspects of this place, and environmental aspects of this place)

2. How economically and culturally important is the fishing industry to (PLACE)?

3. Have you seen a lot of intergenerational fishing-related businesses in (PLACE)?

4. There are data that indicate that the average age of commercial fishermen is in the 50s. In your opinion, has this always been the case, or is the fleet "graying"? What do you see here in (PLACE) that agrees or disagrees with this?
   - Why do young adults want to/not want to get into fishing-related businesses?
   - What is or might be the impact on the fishing community over time?
   - Please share your thoughts about how this will ripple out to supporting industries over time?

5. What is or might be the impact of this in (PLACE) or other coastal towns?
   - What are some potential (social, cultural, economic, environmental) impacts of this graying?
   - What are other options for careers for young adults in (PLACE)?

- Is there a “tipping point” for the impact of an aging fleet? In other words, what would happen in (PLACE) if most (or all) of the fishing family businesses were sold?