Managing Resilience in a Changing World: A Multiscale Analysis of Fisheries Governance Challenges

Marina Cucuzza
University of Maine, marina.cucuzza@maine.edu

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MANAGING RESILIENCE IN A CHANGING WORLD: A MULTISCALE ANALYSIS OF FISHERIES GOVERNANCE CHALLENGES

By

Marina Cucuzza

B.A. College of the Atlantic, 2016

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Advisory Committee:
Heather Leslie, Associate Professor of Marine Sciences, Co-Advisor
Joshua Stoll, Assistant Professor of Marine Policy, Co-Advisor
Gayle Zydlewski, Professor of Marine Sciences
Carl Wilson, Director, Bureau of Marine Science, Maine Dept. of Marine Resources
Fisheries are complex social-ecological systems comprised of fish, humans, the institutions they create, and the broader ecological and social systems within which they are embedded. Changing ocean conditions, declines and shifts in key species, and loss of working waterfront infrastructure are among the many threats to the longevity of fisheries and fishing communities worldwide. A resilience approach to fisheries governance is increasingly recognized as key to sustaining coastal systems and the human communities that depend on them in the face of mounting socioeconomic and environmental challenges. Here I define resilience as the capacity of a system to withstand disturbances without altering its essential functions, structures, feedbacks, or identity (after Walker et al., 2004). Resilient species, individuals, communities, and systems are desirable, however, the factors related to resilience at multiple scales is understudied.

Building resilient social-ecological systems and climate-ready fisheries management requires governance approaches that are adaptive and robust to uncertainty. By identifying the factors that enable resilience, we are better able to understand the capacity of fisheries systems to be maintained long-term. Resilience theory provides a holistic paradigm to understand complex system dynamics and governance of social-ecological systems. This thesis explores associations
between key attributes of governance in managing resilience in fisheries systems at three nested scales. At the national scale, I evaluate the integration of two prominent fisheries management approaches in order to provide enriched fisheries management and conservation outcomes. At the community scale, I explore the role that municipal comprehensive plans play as tools to build adaptive capacity in coastal communities in Maine. Finally, I explore latency in Maine’s commercial fisheries to understand individual fisher’s risk management behavior in response to changing socioeconomic and environmental conditions. Although each of the cases are distinct in scale and scope, key elements of participation, adaptation, and innovation in governance stand out; all are integral in enabling overall system resilience. By critically evaluating factors that contribute to adaptation in social-ecological systems, this work aims to inform governance approaches that strengthen the capacity of fisheries systems to manage for resilience in a changing world.
DEDICATION

I dedicate this thesis to the marine harvesters in Georgetown, Maine, who welcomed me into their community and inspired my research.
ACKNOWLEDGEMENTS

I am incredibly grateful for the many people who have supported me during my time at the University of Maine. First, I would like to thank my advisors, Dr. Heather Leslie and Dr. Josh Stoll for their guidance and mentorship throughout my Master’s process and for providing the opportunity and support for me to conduct interdisciplinary, solutions-oriented research. I would also like to thank my committee members, Dr. Gayle Zydlewski and Carl Wilson for their guidance and academic support on the development of this research.

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LIST OF ACRONYMS

EBFM- Ecosystem-based Fisheries Management
NOAA- National Oceanic and Atmospheric Administration
POC- Pew Oceans Commission
USCOP- US Commission on Ocean Policy
JOCl- Joint Ocean Commission Initiative
ORAP- Ocean Research Advisory Panel
AORA- Atlantic Ocean Research Alliance
FEPs- Fisheries Ecosystem Plans
CM- Co-management
Maine DMR- Maine Department of Marine Resources
C-FAR- Community Fisheries Action Roundtables
MMPA- Marine Mammal Protection Act
NMFS- National Marine Fisheries Service
SPO- Maine State Planning Office
FEMA- Federal Emergency Management Agency
CHAPTER 1

THESIS INTRODUCTION

1.1 Background

Fisheries are complex social-ecological systems comprised of fish, humans, the institutions they create, and the broader ecological and social systems within which they are embedded (Wilson, 2006; Mahon et al., 2008; Miller et al., 2010). Changing ocean conditions, declines and shifts in key species, and the loss of working waterfront infrastructure are among the many compounding stressors that threaten the resilience of coastal systems. The ecological, social, and economic impacts of climate change on fisheries is expected to increase in frequency and magnitude, further adding to the complexity of governing fisheries systems in the face of uncertainty (Myers and Worm, 2003; Hutchings & Reynolds, 2006; Tuler et al., 2008; Ojea et al., 2016).

Governance involves policy-making, decision-making, and formal management, but also those who are making decisions and the processes and information used in decision-making (Charles, 2012). Building resilient social-ecological systems and climate-resilient fisheries management necessitates dynamic governance approaches that are robust to uncertainty and regime shifts (Thrush et al., 2016). Resilience is increasingly recognized as the key to sustaining fisheries systems, as well as the human communities that depend on them (Mahon et al., 2008; Miller et al., 2010). In its broadest sense, resilience recognizes social systems and ecological systems as “coupled, interdependent, and co-evolving” (Berkes, 2015 pg. 51). In the context of social-ecological systems science, resilience encompasses the amount of change the system can...
undergo while still retaining key elements of identity, structure, and functioning (after Berkes and Folke, 1998; Berkes et al., 2003; Folke, 2006; Leslie and Kinzig, 2009).

Resilience can be cultivated at the individual scale and at the collective level, spanning spatial and geographic scales (Ross and Berkes, 2014; Beatley, 2012). Humans are intricately imbedded in social-ecological systems and adaptability can be thought of as the capacity of humans to influence the resilience in a system (Walker et al., 2004). Understanding and fostering resilience in individuals and broader social-ecological systems that provide benefits to humans are both desirable, however, the association between individual-level and system-level resilience remains largely unstudied (Kimhi, 2016). By identifying the factors that enable individual and system-level resilience, we are better able to understand the capacity of fisheries systems to be maintained long-term (Label et al., 2006).

1.2 Purpose of Research & Thesis Organization

The goal of this research is to investigate the attributes of governance that enhance the capacity to manage resilience in fisheries systems at three nested scales. In this thesis, I draw on insights learned from fisheries cases at the national, community, and individual scale to evaluate characteristics of governance that enhance resilience in the face of socioeconomic and environmental change. The scale and scope of each chapter is summarized in Table 1.
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Table 1. Scale and scope of thesis chapters.

As marine systems across the globe face unprecedented environmental and socioeconomic change, attention in forwarding alternative fisheries management approaches is mounting. My research begins at the national scale, with a content analysis-based literature review that explores the relationship between ecosystem-based fisheries management (EBFM) and fisheries co-management (Chapter 2). While EBFM and fisheries co-management are not new ideas in fisheries management, growing interest in both warrants reflection on the theoretical and practical interplay of these key concepts in marine conservation and management that have traditionally been viewed as disparate approaches.

The aim of this chapter is to understand the extent to which these two alternative fisheries management approaches are linked both in theory and in practice. The review highlights the similarities and tensions between how these management approaches are defined and described in the literature and identifies drivers, attributes, and outcomes that are used to define and characterize them. To contextualize these relationships, I describe three case studies in marine
resource management in the U.S. to illustrate how EBFM and co-management are being integrated on the ground in order to provide enriched management outcomes in practice.

At the community scale, planning for resilience is critical to ensuring the longevity of coastal communities. Many state and national governments in the U.S. and other nations have foregrounded resilience planning at this scale. While such policy frameworks highlight the importance of planning for resilient coastal communities, they are not necessarily linked with community-scale concerns or strategies. Similarly, adaptation plans are often developed at geographically extensive scales, yet drivers of change in coastal systems, such as declining fish stocks, flooding, and economic disruption, are experienced at the local scale—in the social and ecological interactions that people have with one another and the coastal and marine ecosystems of which they are part (Sievanen et al., 2011).

Communities are unique and have their own needs, experiences, resources, and ideas about preventing and responding to stressors that threaten coastal ecosystems and local economies. In Maine, the comprehensive planning process provides a platform for communities to envision the future and articulate objectives and policies that address social, economic, and environmental issues. Chapter 3 explores the role that municipal comprehensive plans play as tools to mobilize communities to develop local policies that enhance their adaptive capacity in the face of socioeconomic and environmental change. I evaluate comprehensive plans from coastal Maine communities by employing a framework of theoretically grounded indicators across social, ecological, and economic domains of resilience. I operationalize this framework by evaluating the degree to which Maine’s coastal community comprehensive plans actively incorporate key principles of social-ecological resilience in their planning policies. Information gained from this systematic review of comprehensive plans is vital to determine strengths and
weaknesses in Maine’s local planning approaches and provides insight into the challenges of advancing the vision of resilient communities in coastal Maine.

At the individual scale, the ability for fishers to remain resilient in the face of change is determined by their capacity to adapt and respond. Understanding fishers decision-making processes and their adaptive responses, is essential both for anticipating fishery outcomes and predicting the capacity of fishers to adapt to future change (Sethi, 2010; Mori et al., 2013). Chapter 4 is focused on the role that fishing license latency plays in individual fishers’ resilience planning. In this chapter, I provide insight into the role that latent effort plays in individual fishers’ resilience planning. Latency refers to the act of temporarily disengaging from a fishery and is exhibited by those who hold fishing licenses but do not fish. Latency represents a management and conservation challenge because latent license holders can activate a license without notice and therefore place increased pressure on a fishery system. Though latency eliminates mechanisms of control for managers, it can mitigate uncertainty for fishers who are able to strategically participate in the fishery through the deployment of a license they have acquired. Latent effort is currently unregulated by the state of Maine and is a significant concern for both fishers and managers throughout the state.

After analyzing license and landings data from state and federal commercial fisheries in the state of Maine, I develop a typology of latent effort to characterize patterns of license deployment in Maine’s commercial fisheries. I also employ the qualitative approach of phenomenology to interview fishers about perceptions of latency, motivations for holding licenses while not actively landing, and perspectives related to the effects of latency in Maine’s commercial fisheries. The goal of this research is to better understand the license deployment
strategies that individual fishers employ and to capture the perspectives of the impacts of latency in Maine’s commercial fisheries.

Though each of the three fisheries cases examined is distinct in scope and scale, elements of participation, adaptation, and innovation in governance are critical in enabling resilience at each scale. The impacts of global fisheries challenges and the potential solutions to these challenges manifest at smaller scales, thus studying governance transformations at the individual and community scale can provide insight into understanding larger-scale fisheries challenges (Charles, 2012). Attributes that enable resilience at smaller scales can be scaled up and applied to fisheries governance arrangements more broadly, and insights from large-scale arrangements can be applied more locally (Charles, 2012). Overall, this research adds to the body of literature on governance approaches that strengthen the capacity of fisheries systems to manage resilience in a changing world.

1.3 Situating My Research

My thesis research has largely been informed by my continued engagement with the town of Georgetown, Maine. Throughout my Master’s program, I have been working with members of the community to develop the Marine Resources section of their municipal comprehensive plan. Georgetown is a small island community in midcoast Maine that lies between the confluence of the Sheepscot and Kennebec Rivers. Like many coastal communities in the state, Georgetown faces several significant marine resource related challenges such as declining fish populations, restricted access to the waterfront for commercial fishing, water quality issues, and declining participation of youth engaged in fishing. Growing concerns about the compounding threats to marine resources and the implications of these threats on the local marine economy spurred the community to update their 1993 comprehensive plan. My role as technical staff on the Marine
Resources Committee involved collaborating with municipal officials, facilitating town meetings, analyzing and mapping fisheries landings, and surveying harvesters to identify data necessary for effective decision-making (Appendix B-F). This work informed the development of policies that address local marine resource concerns and climate adaptation efforts and catalyzed a state-wide assessment of Maine’s coastal comprehensive plans that I led, using key indicators of social, ecological, and economic resilience (Chapter 3).

My engagement in Georgetown provided me with the opportunity to experience fisheries at the community scale, where I observed resource users mobilize to prepare and address global challenges at the local level. I saw how intricately connected the culture and economy of the town is tied to marine resources and learned how policy manifests itself in fishers’ everyday lives. Embedding myself in the community planning process and working alongside fishermen and other community members offered a first-hand perspective of the role that local planning plays in preparing coastal communities to adapt and respond to the complex marine resource challenges they face (Appendix A). My experiences in Georgetown catalyzed my interest in understanding individual-and system-level resilience in the face of socioeconomic and environmental change.
CHAPTER 2
INTEGRATING ECOSYSTEM-BASED FISHERIES MANAGEMENT AND FISHERIES CO-MANAGEMENT

2.1 Introduction

A central objective of fisheries management is to maintain sustainable marine resources long-term. Ecosystem-based fisheries management (EBFM) has been highly regarded as the future of fisheries conservation and stewardship, appearing prominently in an array of high-level policy documents both in the United States and internationally (e.g., POC, 2003; USCOP, 2004; JOCI, 2006; ORAP, 2013; AORA, 2017). EBFM deviates from traditional single-species approaches to management by considering multiple species, habitat issues, bycatch, and overall system resilience (Berkes, 2012). Around the world, including in the United States, there are many ongoing efforts to incorporate ecosystem-based approaches to fisheries management. For example, in 2016, the U.S. Department of Commerce’s NOAA Fisheries released an EBFM Policy and subsequent roadmap that outlined a series of guiding principles to maintain resilient marine ecosystems through holistic management and concurrently directed the Regional Fisheries Management Councils to develop Fisheries Ecosystem Plans (FEPs) (NOAA EBFM Policy, 2016; NOAA EBFM Roadmap, 2016). This shift towards an ecosystem-based approach to fisheries management parallels the rise in coastal and marine spatial planning as well as a growing recognition that single-species based approaches often fail to account for the complexity of marine systems that is necessary to maintain resilient marine ecosystems long-term (POC 2003; USCOP, 2004).
Despite continued interest in moving EBFM from theory to practice, limited attention has been devoted to assessing the theoretical and practical linkages to other management approaches beyond single species management. The focus of this paper is on the relationship between EBFM and fisheries co-management. EBFM and fisheries co-management are not new ideas and are often thought of as independent management approaches, though some scholars have noted parallels between these concepts in the literature (e.g., see Symes, 2006; Christie et al., 2007; Chuenpagdee and Jentoft, 2007; Pollack et al., 2008; Jiang and Xue, 2015; Linke and Bruckmeier, 2015). Continued interest in both EBFM and fisheries co-management however, warrants reflection on if, how, and to what degree they are interconnected.

We report on the results of a content analysis-based literature review that identifies the synergies and tensions between these two management concepts. First, we provide a review of the stated drivers, attributes, and outcomes of EBFM and fisheries co-management based on a detailed review of the literature. Next, we quantitatively assess the degree of overlap that exists between these management approaches based on themes derived from the literature review. Finally, we review three marine resource management initiatives in the U.S. that illustrate the varying degrees that EBFM and fisheries co-management are integrated in practice to provide enhanced management outcomes. We conclude with an overview of the relationship between EBFM and fisheries co-management and suggest how a deeper understanding of the interplay between these key approaches in ocean management and conservation may help bring clarity to their use and application.

2.1.1 Ecosystem-Based Fisheries Management

Efforts to define EBFM based on descriptions from the peer reviewed literature provide useful insights about its interplay with co-management. EBFM is a holistic approach to fisheries
management that aims to protect ecosystem health while managing marine resources to meet human needs (Pikitch et al., 2004; McLeod and Leslie, 2009). EBFM differs from traditional single-species fisheries management approaches in that it encompasses a more holistic approach to fisheries management that considers the sustainability of marine resources and the dynamic nature of marine systems (Pikitch et al., 2004; Field & Francis, 2006; McLeod and Leslie, 2009; Bellchambers et al., 2010). EBFM accounts for the complexity of biological, physical, economic, and social factors associated with managing living marine resources and addresses the diverse goals of fisheries management to allow for a greater understanding of how ecosystems and their components respond to multiple stressors (Gibbs, 2009; Dunn et al., 2015; Long et al., 2017).

Traditional fisheries management has focused primarily on specific species in isolation to control harvest limits and has not considered broader ecosystem characteristics (Marasco et al., 2007). Consequently, this approach has been criticized for not effectively sustaining stocks, as the focus is on maximizing the catch of a single target species and often ignores the broader biological, social, and economic components of fishing (Pikitch et al., 2004). An EBFM approach considers the interconnections among species, their physical and living environments, and human influences in order to sustain the composition, structure, and function of a distinct place (Gibbs, 2009; Dunn, 2015; Long et al., 2017).

NOAA Fisheries defines EBFM as “a systematic approach to fisheries management in a geographically specified area that contributes to the resilience and sustainability of the ecosystem; recognizes the physical, biological, economic, and social interactions among the affected fishery-related components of the ecosystem, including humans; and seeks to optimize benefits among a diverse set of societal goals” (NOAA EBFM Policy 2016; pg. 2). The Food and Agriculture Organization describes an ecosystem approach to fisheries management as one
that strives to balance diverse societal objectives, by taking account of the knowledge and uncertainties of biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach within ecologically meaningful boundaries (Garcia, 2003). Long and colleagues note that EBFM balances ecological, social, and governance principles at appropriate temporal and spatial scales in a distinct geographical area to achieve sustainable resource use with stakeholders involved in integrated, adaptive management process where decisions reflect societal choice (Long et al., 2017).

Pikkitch et al. (2004) summarize the main elements of EBFM, including (i) avoiding the degradation of ecosystems; (ii) minimizing the risk of irreversible change; (iii) obtaining long-term socio-economic benefits from fishing; and (iv) adopting a precautionary approach to uncertainty (Pikitch et al., 2004; Smith et al., 2007). The definitions of EBFM in the scientific literature share common themes. Many recognize the importance of food web dynamics, habitat, non-target species, ecosystem connections, and acknowledge humans as an integral part of the overall system in which fishing takes place (Pikitch et al., 2004). EBFM encompasses coupled social-ecological systems and engages stakeholders in an integrated and adaptive management process (Long et al., 2017; Freitg et al., 2018, Trochta et al., 2018). EBFM seeks to broaden the scope of traditional fisheries management so that it considers a wider range of ecological, social, and environmental factors in the exploitation of natural resources (Marasco et al., 2007). A key aspect of EBM involves evaluating trade-offs among ecosystem services and management goals (Levin et al., 2009). The purpose of an EBFM approach is to manage fisheries in a manner that addresses the multiple different uses of an ecosystem while sustaining healthy marine ecosystems and the fisheries they support (Pikitch et al., 2004).
The implementation of EBFM in marine ecosystems is a significant hurdle, and there is no single approach or pathway for successful operation. In their analysis of the implementation of EBM, Arkema et al. (2006) found that there is a large disconnect between how scientists defined EBM and how it was implemented in management plans. Their results indicate that managers are beginning to incorporate EBM principles into practice, however this implementation needs to be much greater, as key ecological and human elements that are emphasized in the literature are not being effectively translated to management (Arkema et al., 2006). The interest in moving towards EBFM is a common theme in fisheries management discussions worldwide (Marasco et al., 2007). In many places, adaptive planning and fisheries management processes have developed to enable scientists, managers, and stakeholders to move beyond single species management to adopt a more comprehensive and holistic approach to resource allocation and management (Tallis et al., 2010).

2.1.2 Fisheries Co-Management

Co-management is a type of cooperative management of a resource where stakeholders at multiple scales share the authority for governing a set of common pool resources in a particular place (Carlsson and Berkes, 2005). Co-management is often defined as a partnership between the government and local resource users who share responsibility in managing natural resources in a specific area (Pomeroy and Williams, 1994). In reality, there often are multiple local interests and government agencies at play, and co-management is sometimes connected with agents such as NGOs and research institutions, in addition to other resource stakeholders (Carlsson and Berkes, 2005). Central to the principles of co-management is the arrangement of power sharing between public and private sectors, such as resource user groups and government agencies. This power sharing leads to the distributed responsibilities and rights for governing common pool
resources (Armitage et al., 2008; Pinkerton et al., 2014). This leads groups of fishers, communities, or organizations to establish and enforce rules and norms for utilizing the resource with support from the government (Carlsson and Berkes, 2005). Pomeroy and Berkes (1997) note that co-management arrangements can be analyzed by the degree to which groups hold property rights over a resource (Pomeroy and Berkes, 1997). There are no standardized approaches to co-management, but rather a variety of arrangements, levels of sharing of responsibility and power, and ways of integrating local management mechanisms with more formalized government systems (Garcia, 2003).

Carlsson and Berkes define co-management as governance systems that combine state control with local, decentralized decision making and accountability and which combine the strengths and mitigate the weaknesses of each (Carlsson and Berkes, 1998). They note three similarities among definitions of co-management in the literature: (i) they explicitly associate the concept of co-management with natural resources management; (ii) they regard co-management as some kind of partnership between public and private actors; and (iii) they stress that co-management is not a fixed state but a process that takes place along a continuum from the simple exchange of information to formal partnership (Carlsson and Berkes, 2005).

The fisheries co-management approach has been noted to offer particular advantages in comparison to traditional, top-down management regimes (Grafton, 2005; Jentoft, 2005; Gruber, 2010). Co-management incorporates different types of knowledge, such as local ecological knowledge of fishers, in addition to scientific knowledge and traditional ecological knowledge (Plummer and Armitage, 2007). Additionally, co-management can enhance adaptive capacity of a community through the process of building networks that are critical for coping with disturbances and by retaining the resilience that underpins the social and ecological components
of the system (Tompkins and Adger, 2004; Olsson et al., 2004). Central to co-management efforts is cooperative leadership at the community level. This joint commitment to action provides a process for adaptive learning and decision-making and can reduce enforcement costs due to increased rule-following from self-governance (Plummer and Armitage, 2007). Other advantages of co-management include improved data reliability as well as a high degree of compliance and buy-in of management measures from stakeholders who are actively engaged in the management process (Plummer and Armitage, 2007). Additionally, co-management efforts have resulted in greater participation of fishers in management as well as improved social cohesion and community development (Pomeroy and Williams, 1994).

2.2. Research methodology

2.2.1 Content Analysis

Content analysis is a research method for interpreting text through the classification process of coding and identifying themes or patterns in the text data (Hsieh and Shannon, 2005). The purpose of content analysis as a research methodology is to attain a broad description of a phenomenon (Downe-Wamboldt, 1992; Bryman, 2008). Content analysis allows for replicable and valid inferences to be made from text data through a systematic, rule-guided process of analysis in order to provide knowledge and novel insights (Krippendorff, 1980; Knafl, 1984; Krippendorff, 2013). In order to assess how EBFM and fisheries co-management are described in the literature, we employed a mixed-methods approach to content analysis, incorporating both qualitative and quantitative strategies so as to create a more complete picture of the research topic and systematically explore the relationship between the two management approaches (Johnson and Onwuegbuzie, 2004).
2.2.2 Literature Review: Data Collection, Preparation, and Database Management

A literature search was conducted via Web of Science, an indexing service that provides a comprehensive search of the scientific literature. To ensure a wide breadth of results, searches performed in Web of Science were ‘topic searches’, which search for keywords, titles, and titles of cited articles (after Johnson et al., 2013). Search terms included in the topic search were ‘ecosystem-based fisheries management,’ and ‘fisheries co-management.’ The search terms did not include ecosystem management, ecosystem-based management, or co-management more broadly, as we were specifically interested in the fisheries management context.

From an initial search of these terms, a total of 361 articles were identified for EBFM and 115 articles were identified for fisheries co-management. Only peer-reviewed articles were included in the review and duplicate articles were subsequently removed. The remaining papers were analyzed in detail to ensure that they include an explicit definition of either EBFM or co-management. Articles containing the search term without a definition or description of the management type were excluded from further analysis. Following this process, the analysis was conducted on 146 peer-reviewed journal articles: 93 focused on EBFM and 53 focused on fisheries co-management. Journal articles that were selected for the content analysis literature review were published between 1993 and 2018 and spanned over 50 peer-reviewed journals (Appendix H; Figure 1).
Figure 1. Publication years of literature analyzed in the literature review of ecosystem-based fisheries management (n=93) and fisheries co-management (n=53) peer-reviewed publications.
2.2.3 Coding Schema

The data preparation phase is a critical step in the content analysis process prior to the data analysis phase (Elo et al., 2014). The preparation phase starts with the selection of the unit of analysis (Guthrie et al., 2004). Since the purpose of the research was to understand the relationship between EBFM and fisheries co-management, the unit of analysis for this study were the two different management types of interest. After articles were downloaded from Web of Science and met the selection criteria for analysis, they were stored using the NVivo (version 11.4.2) qualitative data analysis software. Descriptors such as title, author, year and journal published were recorded for each article in addition to the scale and scope of the research and if the article was written from a developed or developing country context (Appendix H).

Content analysis as a methodology is a systematic, replicable technique for compressing many words of text into fewer content categories based on explicit rules of coding (Schreier, 2012; Mayring, 2014; Bengtsson, 2016). Two approaches to content analysis can be distinguished: inductive and deductive analysis (Moretti et al., 2011). An inductive approach to content analysis involves themes emerging from the raw data through repeated examination of the text (Fereday and Muir-Cochrane, 2006). A deductive approach involves predetermined coding schemes that are applied to the text (Elo et al., 2014). The choice of approach is determined by the main purpose of the study. Deductive content analysis is recommended when the purpose of the study is to test theory (Schreier, 2012). Inductive analysis is used when there are no previous studies that deal with the phenomenon or when former knowledge is fragmented (Bryman, 2008). In this study, both an inductive and deductive approaches were employed simultaneously. This combined approach allowed predetermined coding categories to be
collected for each article while also providing an opportunity for themes and new insights to emerge from the coding process (Morgan, 2007).

Four coding categories were predetermined before analysis and collected for each article (Figure 2., A). These include definition (how EBFM and co-management are being defined in the article) drivers (why the management approaches are being championed) attributes (characteristics of the management approach) and outcomes (what they seek to accomplish) (Table 2). Transparency and replicability of the research design are key component of content analysis and were ensured by careful documentation of the entire research process (Guba, 1994; Schreier, 2012).

<table>
<thead>
<tr>
<th>Coding Categories</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definition</td>
<td>Descriptions of EBFM and co-management in the article</td>
</tr>
<tr>
<td>Driver</td>
<td>Motivations for initiating the management approach</td>
</tr>
<tr>
<td>Attribute</td>
<td>Characteristics of the management approach</td>
</tr>
<tr>
<td>Outcome</td>
<td>Goals that the management approach seek to accomplish</td>
</tr>
</tbody>
</table>

Table 2. Predetermined coding categories and descriptions from deductive approach to content analysis.

To make valid inferences from the text, it is critical that the coding classification procedure be reliable and consistent (Elo et al., 2014). A model of the coding process for the literature review is illustrated in Figure 2. Following the preparation/organization phase and the deductive coding generation (Figure 2., B), the first cycle of open coding was conducted to organize data into meaningful categories through thematic analysis. Thematic analysis is a search for themes that emerge as being important to the description of the phenomenon (Saldaña,
The process involves the identification of themes through careful reading and re-reading of the data (Rice & Ezzy, 1999). It is a form of pattern recognition within the data, where emerging themes become the categories for analysis (Miles et al., 2013). Codes that emerged inductively from the dataset are listed in Table 3. These codes were identified as prominent themes throughout the process of reviewing the literature (Miles et al., 2013) (Figure 2., C). A comprehensive list of inductive and deductive coding categories identified in the coding cycles as well as example text for each management type are listed in Table 4.

<table>
<thead>
<tr>
<th>Coding Categories</th>
<th>Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Inhibiting factors</em></td>
<td>Factors that prevent EBFM and co-management efforts from occurring or advancing</td>
</tr>
<tr>
<td><em>Critiques</em></td>
<td>Doubts and concerns related to the legitimacy of the management type</td>
</tr>
</tbody>
</table>

*Table 3.* Inductive coding categories and descriptions that emerged from the coding process.
<table>
<thead>
<tr>
<th>Coding Category</th>
<th>EBFM</th>
<th>Fisheries Co-Management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition</strong></td>
<td>“Ecosystem-based management is an integrated approach to management that considers the entire ecosystem, including humans” (Eisma-Osorio et al., 2009, pg. 293)</td>
<td>“In its broad context, co-management is joint management through a cooperative organization of government and resources users” (Trisak, 2005, pg. 165)</td>
</tr>
<tr>
<td><strong>Driver</strong></td>
<td>“EBM is driven by a recognition of the failure of conventional management to protect marine ecosystems from over-exploitation” (Long et al., 2017, pg. 245)</td>
<td>“Co-management of marine resources is advocated by many as a solution to the failures of top-down management strategies or open access situations in fisheries management” (Levine, 2015, pg. 1279)</td>
</tr>
<tr>
<td><strong>Attribute</strong></td>
<td>“Ecosystem-based fisheries management (EBFM) requires the expansion of fisheries research programs to include the relationship between target species and their habitats such that trophic and other ecological interactions can be assessed” (Bellchambers et al., 2010, pg. 279)</td>
<td>“Co-management arrangements generally have at least one vertical linkage between the government and a user group and may rely on the collaboration of diverse stakeholders across multiple scales, including research institutes, nongovernmental organizations (NGOs), and civil society” (Levine, 2016, pg. 1279)</td>
</tr>
<tr>
<td><strong>Outcome</strong></td>
<td>“The aim of EBFM is to sustain healthy ecosystems and the fisheries that they support” (Eddy et al., 2015, pg. 1381)</td>
<td>“Taken together, co-management has the potential to increase both community and ecosystem resilience through the sharing of knowledge and creation of management plans tailored to specific places and situations” (Whitehouse &amp; Fowler, 2018, pg. 128)</td>
</tr>
<tr>
<td><strong>Inhibiting Factors</strong></td>
<td>“The complexity of ecosystems, variety of stakeholders, lack of data, limited funding and capacity, conflicting management goals, and rapid shifts in political support are still serious impediments to implementing EBM, even in California where EBM approaches are required in law” (Hazen et al., 2016, pg. 154)</td>
<td>“Lack of funding and political will to support co-management was also considered a major factor inhibiting co-management implementation in Brazil” (Chuenpagdee &amp; Jentoft, 2007, pg. 666)</td>
</tr>
<tr>
<td><strong>Critiques</strong></td>
<td>“EBFM is ‘holistic’ and considers ‘all factors,’ but it is impossible for management to incorporate all factors into EBFM” (Biedron and Knuth, 2016, pg. 40)</td>
<td>“While co-management has been put forth as the only realistic solution for the majority of the world’s fisheries, establishing real co-management arrangements, with strong community participation in resource management, is not a simple or even a feasible option in all ecological and governance contexts” (Levine, 2016, pg. 1289)</td>
</tr>
</tbody>
</table>

Table 4. A list of inductive and deductive coding categories as well as example text for each management type derived from the literature.
Once the literature was initially analyzed and inductive and deductive coding categories were generated, a second cycle of coding was conducted (Miles et al., 2013). The second cycle of coding involved creating sub-categories of themes generated from the initial coding categories (Saldaña, 2015). The second-cycle codes were generated through the process of sub coding, where meta-codes are developed that identify similarly coded data by grouping them into themes (Miles et al., 2013). Once both cycles of coding were complete, NVivo was used to generate queries, matrices, and models to display major themes that emerged from the coding process (Miles et al., 2013).

After qualitative coding was complete and major themes were identified, the quantitative analysis phase consisted of summarizing the total number of papers that identified each major characteristic derived from the qualitative coding. Major themes were identified from the content analysis review of drivers, attributes, and outcomes of EBFM and co-management literature are depicted in Figure 4.
2.3. Results

2.3.1 Drivers, Attributes and Outcomes

We identified a variety of overlaps and areas of disagreement through our analysis of descriptions of EBFM and fisheries co-management in the scientific literature. These overlaps coalesce around a series of drivers, attributes, and outcomes. Both EBFM and co-management are driven by a common recognition that marine systems are dynamic and necessitate a holistic approach to manage for such complexity (Christie et al., 2007; Brown et al., 2015; Aalto and Baskett, 2017; Gruss et al., 2018). As alternative approaches to conventional management, both EBFM and co-management literature cite that traditional approaches to management do not account for this complexity and often are critical of their ability to maintain resilient fish stocks.
and marine ecosystems long-term (Link, 2002; Jin et al., 2012; Nunan et al., 2015; Levin et al., 2008). Bottom-up efforts were exclusively cited as drivers in co-management papers in addition to a need for equitable management. The need for management change and policy directives calling for an ecosystem approach were the two most prominent drivers of EBFM efforts identified in the literature. The preservation of ecosystem health was the most commonly cited driver shared by both management approaches.

The content analysis review revealed numerous shared attributes between EBFM and co-management. Both EBFM and co-management are characterized as adaptive and flexible forms of management (Pomeroy and Berkes, 1997; Long et al., 2017; Makino et al., 2017; Freitag et al., 2018; Gullestad et al., 2018). Both have long-term, continual goals for system health and sustainability of ecosystems (Froese et al., 2008; Barratt et al., 2015; Dunn et al., 2017). EBFM and co-management are described as being place-based, however the scale of this implementation typically differs. Co-management efforts often occur at the local level, while EBFM is envisioned at a larger spatial scale and spans multiple jurisdictions (Carlsson and Berkes, 2005; Levin et al. 2009). EBFM efforts typically focus on multiple species and species interactions, whereas fisheries co-management tends to focus on single species resource management (Pikitch et al., 2004; Plummer and Armitage, 2007). The fisheries co-management literature heavily emphasizes community outcomes such as social learning, power-sharing, trust, and focuses more specifically on stakeholder engagement. The EBFM literature also incorporates social outcomes, but more explicitly focused on broader ecological outcomes such as conservation of fish stocks, preserving fish habitat, and the development of ecological metrics and indicators of ecosystem health to inform decision-making (Link, 2002; Ma et al., 2010;
Similarities among attributes are also prevalent in descriptions of EBFM and fisheries co-management. For example, feedback loops of information are often described as key attributes of co-management whereas a focus on holistic human-natural connections is described as an important characteristic of EBFM (Pikitch et al., 2004; Carlsson and Berkes, 2005; McLeod and Leslie, 2009). These characteristics are potentially related in that tight feedback loops of information created through co-management efforts can provide detailed, fine-scale knowledge to inform holistic human-natural connections at larger scales (Tompkins and Adger, 2004; Olsson et al., 2004).

Outcomes stated for both EBFM and co-management include enhanced decision support, productive and sustainable fisheries, and socioeconomic benefits. The co-management literature additionally cited unintentional and negative outcomes of management arrangements, such as conflict or corruption, and focused more on societal and community outcomes overall. The EBFM literature emphasized meeting multiple objectives, whereas co-management papers heavily referenced specific outcomes of fishing area closures and moratoriums on fishing. Both management arrangements cited outcomes related to greater collaboration and interaction between management organizations, as well as fostering resilient social-ecological systems. Major themes of drivers, attributes, and outcomes derived from the EBFM and co-management literature are quantified in Figure 3 with key overlaps summarized in Table 5.
Ecosystem considerations

Analytical tools

Place-based

Informs management action

Stakeholder engagement

Attentive to interactions

Holistic

Power sharing

Multi-species approach

Knowledge pluralism

Indicator based

Empowerment

Precautionary management

Conflicts or crisis

Need for management changes

Policy directions and initiatives

Preserve ecosystem health

Percent of EBFM and co-management papers analyzed

Spectrum of management

Addresses trade-offs

Trust

Acknowledge uncertainty

Precautionary management

Indicator based

Empowerment

Knowledge pluralism

Multi-species approach

Power sharing

Holistic

Attentive to interactions

Stakeholder engagement

Informs management action

Place-based

Analytical tools

Ecosystem considerations

Percent of EBFM and co-management papers analyzed
**Figure 3.** Major themes identified from a content analysis of drivers, attributes, and outcomes of the literature on EBFM and co-management. Colored bars depict the percent of papers within the management type that were coded for a specific theme.
<table>
<thead>
<tr>
<th></th>
<th>EBFM</th>
<th>Co-Management</th>
<th>Key overlaps and interplay</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Driver</strong></td>
<td>• Management failure</td>
<td>• Management failure</td>
<td>○ Shared Driver</td>
</tr>
<tr>
<td></td>
<td>• Recognition of complexity</td>
<td>• Recognition of complexity</td>
<td>○ Shared Driver</td>
</tr>
<tr>
<td></td>
<td>• Changing environmental conditions</td>
<td>• Marginalization</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Trend towards ocean and coastal planning</td>
<td>• Constrained budget environment</td>
<td></td>
</tr>
<tr>
<td><strong>Attribute</strong></td>
<td>○ Adaptive</td>
<td>○ Adaptive/flexible</td>
<td>○ Shared Attribute</td>
</tr>
<tr>
<td></td>
<td>○ Systematic</td>
<td>○ Collaborative</td>
<td>○ Shared attribute, however the scale of implementation differs</td>
</tr>
<tr>
<td></td>
<td>○ Geographically based (large-scale, spans multiple disciplines, ecosystem boundaries)</td>
<td>○ Geographically based (smaller scale, local level)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>○ Multi-scaled</td>
<td>○ Involves power sharing and decentralization</td>
<td></td>
</tr>
<tr>
<td></td>
<td>○ Fisheries-focused</td>
<td>○ Enables shared learning (experimental/experiential</td>
<td></td>
</tr>
<tr>
<td></td>
<td>○ Attentive to system interactions</td>
<td>○ Inclusive of multiple sources of knowledge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>○ Holistic (human/natural connections)</td>
<td>○ Facilitates feedback of information</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Long-term</td>
<td>• Long-term/ continual</td>
<td>○ Potential synergy</td>
</tr>
<tr>
<td></td>
<td>• Tends towards multi-species focus</td>
<td>• Tends towards single species focus</td>
<td>(feedback in a complex adaptive system can enable attentiveness to system interactions at a fine scale )</td>
</tr>
<tr>
<td><strong>Outcome</strong></td>
<td>• Sustained ecosystem services</td>
<td>• Sustained ecosystem services</td>
<td>○ Shared outcome</td>
</tr>
<tr>
<td></td>
<td>• Increased system-level resilience</td>
<td>• Increased and balanced accountability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Sustained system function</td>
<td>• Empowered communities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Optimized benefits/tradeoffs</td>
<td>• Produces collective goods</td>
<td></td>
</tr>
</tbody>
</table>

Table 5. A summary of key drivers, attributes, and outcomes commonly described in defining ecosystem-based fisheries management and co-management as described in the literature.

Examples of overlap and interplay as described in the literature are noted.
2.3.2 Inhibiting Factors

Inhibiting factors that prevent the progression of EBFM and co-management efforts were identified. A reoccurring theme cited as an impediment to successful management efforts included unrealistic outcomes and objectives (Lopes et al., 2011; Forrest et al., 2015; Long et al., 2017). Similarly, ambiguous or conflating management objectives were identified as a cause of confusion in both EBFM and co-management efforts (Arkema et al., 2006; Long et al., 2017). This uncertainty in outcomes makes it difficult for managers and stakeholders to measure and evaluate how progress is being made and how goals are being achieved (Arkema 2006; Long et al., 2017).

The need to understand the effectiveness of the management arrangement was cited as crucial for identifying needs and barriers to successful management for both EBFM and co-management efforts (Arkema, 2006; Dunn et al., 2017). A lack of indicators to serve as reference points for key thresholds in the management arrangements was also referenced as a barrier to implementation for both EBFM and co-management efforts (Methratta and Link, 2006). These indicators can help to identify key targets that are vital to effective management and can identify if the management approach is achieving results, what threats are impacting the goals, and what strategies are necessary to meet those goals.

Limited data and scientific knowledge to understand critical pieces of the fisheries ecosystems were two additional factor identified as inhibiting factors that threaten the success of EBFM and fisheries co-management arrangements (Freitag et al., 2018; Ma et al., 2010). Funding challenges to acquire this information or to support management implementation was identified as a major barrier to the progression of EBFM and fisheries co-management efforts as
well (Pomeroy and Berkes, 1997; Gibbs and Thebaud, 2012; Kuriyama et al., 2015). Inhibiting factors and exemplary text are identified in Table 6.
<table>
<thead>
<tr>
<th>Inhibiting Factor</th>
<th>Management Type</th>
<th>Supporting Text</th>
<th>Year Published</th>
<th>Journal Published</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conflicting objectives</td>
<td>EBFM</td>
<td>“Furthermore, simultaneously stated objectives such as “maximize economic benefits” and “no species overfished” may be in direct conflict” (Forrest et al., 2015, pg. 293)</td>
<td>2015</td>
<td>Fisheries Research</td>
</tr>
<tr>
<td>Ignoring linkages</td>
<td>EBFM</td>
<td>“A system is made up of its components (e.g., targeted fish stock, interacting species, habitats, people employed by fishing), and the links among them (e.g., predator-prey interactions, fishermen who shift from one fishery to another). These links can span regulatory units and jurisdictions. Management actions that do not account for these links can produce unintended indirect effects” (Levin et al., 2008, pg. 49)</td>
<td>2018</td>
<td>Marine Policy</td>
</tr>
<tr>
<td>Lack of political will</td>
<td>Fisheries co-management</td>
<td>“Many fisheries co-management schemes that were unsuccessful or faced difficulty in implementation lacked government involvement in the process or suffered from the governments’ inability to delegate authority to the community” (Whitehouse and Fowler, 2018, pg. 137)</td>
<td>2018</td>
<td>Marine Ecology Progress Series</td>
</tr>
<tr>
<td>Lack of clear definitions</td>
<td>Fisheries co-management</td>
<td>“However, the lack of guidelines and a clear definition of the co-management arrangements have recently been causing internal conflicts at the household and community levels” (Lopes et al., 2011, pg. 429)</td>
<td>2011</td>
<td>Journal of environmental planning and management</td>
</tr>
<tr>
<td>Lack of data</td>
<td>EBFM</td>
<td>“Ecosystem-based fisheries management requires data on all parts of the ecosystem, and this can be a barrier in data-poor systems” (Ainsworth, 2011, pg. 190)</td>
<td>2011</td>
<td>Marine and Coastal Fisheries</td>
</tr>
<tr>
<td>Lack of funding</td>
<td>EBFM</td>
<td>“Lack of funding and capacity to implement even the strongest legal mandates makes it challenging for managers to be transparent in their decision-making and to adequately track their management effectiveness” (Hazen et al., 2016, pg. 149)</td>
<td>2016</td>
<td>Fisheries Research</td>
</tr>
</tbody>
</table>

Table 6. Selected examples of overlapping inhibiting factors of EBFM and fisheries co-management as exhibited in the literature.
2.3.3 Critiques

Numerous critiques of EBFM and fisheries co-management emerged from the literature review. These critiques were distinct for EBFM or co-management, with little overlap. Fisheries co-management was critiqued for often being based on a definition of “local resource user” that was too narrow. For example, Barratt notes that co-management has relied on the assumption that communities are homogenous, which can exclude important stakeholders from engaging in decision-making processes (Barratt et al., 2015). Additionally, fisheries co-management was critiqued for being viewed as a panacea to all fisheries management problems. As noted by Levine et al., fisheries co-management may not be the most practical or feasible option in all fisheries governance contexts (Levine et al., 2016). Kuperan et al. emphasize that fisheries co-management should be viewed as an adaptive process that evolves over time, adjusting to incorporate aspects of power sharing and social empowerment (Kuperan et al., 2018). Lopes et al. add that unless co-management is followed by adaptive management and increased participation from resource users and diversification of economic sources, it does little to enhance the resilience of communities (Lopes et al., 2010). Finally, fisheries co-management was cited as being prone to the ‘free-rider’ or ‘fox in the henhouse’ problem, where user organizations with a formal position in the management system will be tempted to abuse the trust they have been permitted as guardians of the resource (Jentoft, 1998).

EBFM is criticized for emphasizing language that supports unrealistic management goals. As noted by Gilman et al., terms like “integrity” and “health” of the ecosystem imply that there is a target state of an ecosystem that management should strive to ultimately achieve. They argue that this state is unrealistic in the face of expanding anthropogenic impact on natural systems (Christie et al., 2007; Gilman et al., 2017). Numerous papers noted that the theory of EBFM is
well developed, while the practical application of this management approach on the ground lags behind (Christie et al., 2007; Froese et al., 2008). This gap between theory and practice that is emphasized in the literature parallels a disconnect between science and management. Arkema reports that scientists characterize EBFM differently than managers who implement it, noting that the concept of EBFM needs to be more effectively translated in practice. Debate on how EBFM should be effectively implemented is a major factor that is contributing to the skepticisms of EBFM as an approach to sustainable fisheries management (Forrest et al., 2015, Jin et al., 2012, Trochta et al., 2018).

2.4. Discussion

2.4.1 Concepts on a Continuum

A significant catalyst for this work was the observation that many individuals hold different views about the relationship between EBFM and co-management. Perceptions of these management concepts appear to be deeply subjective despite the existence of formal definitions. One potential explanation relates to the definitional flexibility that exists in how EBFM and co-management are defined. In practice, drastically dissimilar efforts can be labeled as either EBFM or co-management. Thus, it can be argued that very traditional approaches to management have elements of EBFM and co-management, while seemingly strong cases of EBFM or co-management can be seen as poor examples of the concepts (Biedron and Knuth, 2016). This definitional ambiguity impedes the progress to rigorously evaluate the theoretical and applied connections between these management approaches.

In reality, fisheries management approaches do not exist in isolation, but along a gradient of approaches with elements of co-management regularly appearing in conventional management
regimes and vice versa (Link, 2002). Both EBFM and co-management have been described as flexible management approaches that exist along a spectrum (e.g., Christie et al., 2007; Link, 2002; Link, 2002; Wilson, 2006; Evans et al., 2011; Link and Browman, 2014). A simplified depiction of the relationship between EBFM and co-management is represented in the conceptual continuum in Figure 4. On one side of the continuum, EBFM and fisheries co-management are separate and weak or no overlap exists between these management approaches. Towards the middle of the continuum, elements of EBFM and co-management are integrated. Towards the opposite side of the continuum, EBFM and co-management are highly integrated, with EBFM as a critical part of fisheries co-management and fisheries co-management as a critical part of EBFM.

We propose the continuum approach as an alternative to defining singular definitions of EBFM and fisheries co-management. Approaching fisheries management options as existing along a continuum eliminates ambiguity by presenting a range of options for the relationship between the concepts EBFM and fisheries co-management (Link, 2002). The array of management strategies present in the continuum reflects the complexity of fisheries management designs in reality and eliminates imposing static definitions for these concepts. This approach may additionally eliminate the need for creating new definitions for these concepts in the future.

![Figure 4. A simplified model of the conceptual overlap between ecosystem-based fisheries management (EBFM) and fisheries co-management (CM).](image-url)
2.5. Integration of EBFM and Co-Management in Practice

To illustrate the gradient of EBFM and co-management approaches in practice, we describe three initiatives in marine resource management: rebuilding Maine’s inshore scallop fishery, NOAA’s EBFM implementation, and cetacean mortality reduction efforts in the North Atlantic. These efforts are reviewed based on the degree to which EBFM and co-management are integrated in the decision-making process. Each example is situated on the conceptual continuum in figure 4 based on the incorporation of EBFM and co-management elements that are exhibited. Key components of these initiatives are highlighted in Table 7.

2.5.1 Rebuilding Maine’s Inshore Scallop Fishery

The restoration of Maine’s inshore winter scallop fishery exemplifies a strong fisheries co-management effort to integrate fishermen’s knowledge into management. Inshore landings of Atlantic sea scallops in Maine have steadily declined since the 1990s, reaching their lowest level in 35 years in 2005 (Maine DMR, 2018). In 2009, the Maine Department of Marine Resources issued a moratorium on new licenses entering in the fishery and 20% of state waters were subsequently closed to scallop fishing for a three-year period in an attempt to rebuild the scallop stocks (Schick and Feindel, 2005).

In 2010, the Maine Department of Marine Resources asked the Maine Center for Coastal Fisheries, a regional non-profit community development organization, to convene scallop fishermen to propose potential management suggestions for reopening and managing the previously closed near-shore scallop fishery. To achieve this, the Maine Center for Coastal Fisheries engaged in the process of community fisheries action roundtables (CFAR). They held
over 100 meetings statewide and heard from roughly half of Maine’s scallop fishermen over the course of nearly two years. The goal of the CFAR process was to mobilize the fishing sector and engage resource harvesters in deep conversations about their vision for the future of the fishery and provide a platform to share their values and knowledge about the resource (Brewer, 2013). Meetings were organized around specific and timely concerns identified by fishermen and the process involved facilitated sessions where harvesters collaborated with scientists and regulators to share their knowledge and express concerns (Maine Center for Coastal Fisheries, 2017).

Through the CFAR process, fishermen identified ecologically and socio-economically distinct scalloping areas along the Maine coast. In 2012, they submitted a proposal to the Maine Department of Marine Resources that suggested separate management approaches for the three distinct areas they identified. Following the proposal, the State agreed to manage the regions as three separate management areas as suggested by fishers. In the years that followed the new management regime, a significant rebounding of the scallop fishery was observed and in 2017, the fishery exceeded expectations for abundance and profitability (Maine DMR, 2017). In-season information sharing, timely closures, and ongoing collaborations between fishers and scientists to further improve monitoring of the resource additionally have contributed to the rebound of the scallop fishery. The communication and trust built between industry, scientists, and managers filled a critical knowledge gap and fostered a collaborative decision-making process that led to zone-based management of the resource (Maine Center for Coastal Fisheries, 2017).

This initiative represents a cooperative management effort between fishermen, scientists, and managers to develop a place-based resource management approach catalyzed by the local ecological knowledge of fishers (Maine Center for Coastal Fisheries, 2017). The rebuilding of Maine’s inshore scallop fishery illustrates the importance of stakeholder engagement and the
benefits of flexible management approaches. In assessing how management decisions were made, this initiative would fall towards one end of the theoretical co-management and EBFM continuum where EBFM and co-management are not integrated, as illustrated in Figure 5. This case study exemplifies traditional co-management efforts where decisions were made at a scale that is hyper-localized and disassociated from the larger ecosystem as it pertains to the management of a single resource. For the inshore scallop fishery efforts to integrate concepts of EBFM, a broader recognition of the ecosystem as well as increased management consideration beyond the local scale would be necessary.

2.5.2 NOAA Fisheries’ Approach to Ecosystem-based Fisheries Management

In 2016, NOAA Fisheries released an EBFM policy to direct continued progress towards the national implementation of an EBFM approach. The EBFM policy directed the Regional Fisheries Management Councils to develop fisheries ecosystem plans as a mechanism for incorporating ecosystem principles, goals, and policies into the current fishery management structure. Fisheries ecosystem plans provide council members with direction on how the fundamental physical, biological, and human/institutional context of ecosystems within which fisheries are managed guides the development and implementation of fisheries management options. The agency’s adoption of EBFM policies is intended to more efficiently and effectively fulfill its mandates to sustainably manage the nation’s living marine resources. The subsequent EBFM road map, released in 2016, builds upon the Policy and identifies actions to address each of the Policy’s six Guiding Principles to maintain resilient marine ecosystems through EBFM (NOAA EBFM Policy, 2016).
NOAA’s EBFM road map advances the broader implementation of a big-picture approach that considers habitat, predator-prey interactions, and the impacts of changing ocean conditions in fisheries management. The systematic approach is intended to enable the facilitation of tradeoffs between priorities and establishes a framework to enhance and accelerate the implementation of EBFM within the National Marine Fisheries Service. The road map describes operational EBFM from a national perspective while allowing for flexibility in the regional application. In this way, the road map is meant to provide a menu of options to Regional Fishery Management Councils and is not a prescriptive process or list of mandatory requirements. The road map calls for the development of regional implementation plans which will leverage ongoing work through existing resources, encourages active partnership with Councils, engagement with external stakeholders, and internal coordination between science and management in addition to focusing on regionally specific priorities (NOAA EBFM Roadmap, 2017).

A central objective of the NOAA EBFM road map is to identify complementary agency efforts that would benefit from additional coordination. The road map states that NOAA Fisheries will ensure that its various efforts are well coordinated among NOAA Fisheries Science Centers, Regions, Headquarters Offices, Regional Fishery Management Councils, states, and key stakeholders. As outlined in NOAA’s EBFM Policy Statement, the agency strongly supports implementation of EBFM to better enable decisions regarding trade-offs among and between fisheries. In NOAA’s EBFM implementation, the Regional Fisheries Management Councils are accountable for developing fisheries ecosystem plans to describe and integrate ecosystem goals, objectives, and priorities across multiple fisheries and the effects of various pressures on fisheries within an ecosystem (NOAA EBFM Roadmap, 2017).
The Regional Fisheries Management Councils system can arguably be viewed as a form of co-management, as management councils include a diverse group of key stakeholders in fisheries. Established by the Magnuson Stevens Fisheries Management and Conservation Act, each of the nine councils are comprised such as state and federal officials along with industry representatives and environmental interest groups (da Silva and Kitts, 2006). Although the agency calls for increased coordination with councils and other partners through the EBM policy and road map, implementation and decision-making is ultimately a top-down approach with some input from councils. In addition, the ecosystem information that will be generated to support the Fishery Ecosystem Plans is decoupled from the council decision-making processes. Elements of both EBFM and co-management are present in NOAA’s EBFM implementation and this case study would thus fall in the middle of the conceptual continuum in Figure 5.

2.5.3 Cetacean Mortality Reduction in the Atlantic

The Marine Mammal Protection Act (MMPA) of 1972 mandates NOAA's National Marine Fisheries Service (NMFS) to develop and implement Take Reduction Plans to prevent the depletion and assess the recovery of certain marine mammal stocks that are seriously injured or killed incidentally in commercial fisheries (Marine Mammal Protection Act of 1972). In 1996, the Atlantic Large Whale Take Reduction Team was established to develop a take reduction plan for reducing the incidental take of right whales, humpback whales, fin whales, and minke whales in commercial trap/pot and gillnet gear in U.S. waters from Maine to Florida. The Take Reduction Team is composed of a variety of stakeholders including fishermen, scientists, conservationists, as well as state and federal officials. The plan is dynamic in nature and evolves as NOAA Fisheries Service learns more about why whales become entangled and how fishing
practices might be modified to reduce the risk of entanglement to cetaceans (NOAA Take Reduction Plan, 2015).

Numerous challenges in decision-making exist in the case of marine mammal mortality reduction. These challenges include data paucity, a variety of conflicting stakeholder perspectives, and the complex life history of cetaceans. To account for these challenges in the management process, NMFS implements working groups by area, fishery, or topic to promote focused discussions that relay information back to the larger team. Discussions with the smaller sub-groups have allowed NMFS to identify where key improvements can be made to the larger take reduction process. The Plan has several components including gear restrictions and modifications, outreach, and a disentanglement program (Borggaard et al., 2017).

Research relating to whale populations, behavior, prey distribution, as well as fishing gear interactions and modifications works towards filling critical knowledge gaps to inform management. In the northeast sub-group, the fishing community is heavily engaged in field testing modifications to fishing gear that is critical in advancing mortality reduction strategies for the protection of the critically endangered North Atlantic right whales. This includes testing alternative color, strength, and shape of fishing rope to reduce bycatch while also meeting the needs of the fishing industry. Alternative forms of fishing, such as rope-less fishing methods, are additionally being explored and field tested for effectiveness and practicality on the water (Baumgartner et al., 2018).

The Take Reduction Team approaches the complexity of whale entanglement as a coupled social-ecological systems problem as the Plan incorporates both the social and ecological elements of this complex cetacean conservation issue. Management of marine mammals through the Take Reduction Plan exhibits components of both co-management and
ecosystem-based management (Borggaard et al., 2017). Although the Plan is federally mandated, bottom-up support was built within the top-down mandate. Regional working groups work closely with industry to fill critical knowledge gaps and engage industry and other stakeholders in solutions that inform larger management practices for cetacean mortality reduction in the region. The integration of co-management and EBFM exhibited in the Take Reduction Team would situate this effort closer to one side of the theoretical continuum where EBFM and co-management are strongly integrated, as depicted in Figure 5.

Figure 5. A depiction of where each management initiative falls on the conceptual continuum model that illustrates the overlap between EBFM and co-management.
<table>
<thead>
<tr>
<th>Marine Resource Management Initiative</th>
<th>Scale</th>
<th>Goal of initiative</th>
<th>Attributes of EBFM</th>
<th>Attributes of co-management</th>
</tr>
</thead>
</table>
| Maine’s inshore scallop fishery       | Inshore Gulf of Maine | Incorporate scallop fishermen’s local knowledge in rotational closure management plan | • Place-based  
• Focus on optimizing benefits and tradeoffs | • Engagement with fishermen in decision-making  
• Incorporation of local knowledge in management |
| NOAA’s EBFM implementation             | Nationally (USA) | Maintain ecosystems in a healthy, productive, and resilient condition so they can provide the services humans want and need. | • Facilitates trade-offs between different stakeholder priorities  
• Balancing diverse social and ecological needs | • Some decision-making power given to regional councils with a variety of stakeholder representation |
| Right whale mortality reduction in North Atlantic | Eastern North Atlantic | Prevent mortality of the critically endangered North Atlantic Right Whale with gear entanglement and ship strikes | • Considers a broad range of social and ecological needs in decision-making process | • Power-sharing in decision-making process  
• Directly engages with fishermen in solution-oriented science |

Table 7. Key factors of EBFM and fisheries co-management incorporated in marine resource management initiatives.

2.6. Conclusions

Fisheries are highly complex social-ecological systems. The growing recognition that traditional single-species based fisheries management approaches do not account for this complexity has prompted an interest in forwarding alternative management practices. EBFM and fisheries co-management have gained recognition as alternatives to traditional fisheries.
management and have been highly promoted as the future of fisheries conservation (Wilson et al., 2013). These management approaches have largely been viewed as distinct modes of operation though, some scholars have acknowledged similarities in the literature through time. In this paper, we employed a content analysis-based review of the literature to evaluate the extent to which these concepts are related and describe the similarities that exist between drivers, attributes, and outcomes of EBFM and co-management efforts.

In practice, EBFM and fisheries co-management are not isolated approaches. Similar drivers, attributes, and outcomes of both management types characterize EBFM and fisheries co-management in the literature and are exhibited in marine resource management efforts on the ground. The scallop co-management case study demonstrates that enriched management outcomes can be achieved with enhanced participation from resource harvesters. Local fishers embedded in the management process resulted in increased participation, communication, labor, trust, and shared information between the fishing community and decision-makers. At the federal level, NOAA’s EBFM implementation represents a top-down approach to EBFM that includes some key elements of co-management. The EBFM integration process encourages coordination with the Regional Councils and presents a range of options for Councils to operationalize EBFM on a regional scale. The NOAA Take Reduction planning effort revealed that stakeholder engagement early in the decision-making process greatly contributes to improved management outcomes. At-sea testing in sub-groups of the Take Reduction Team fills critical knowledge gaps that informs regional management to protect cetaceans. It is important to note that although these case studies highlight state efforts that exemplify co-management and federal efforts that are top-down, we do not suggest that state and federal efforts characteristically fall on opposite sides of the continuum.
Fisheries management has seen a broadening in the view of fisheries as simply fish and fleet, to fish in the broader context of a complex biophysical environment, and fishers as part of coastal communities with dynamic social, economic, and political environments (Wiber et al., 2004). Each of the marine resource initiatives presented highlight that fishers can directly contribute to an ecosystem approach to fisheries. The engagement of fishers in the management process resulted in enriched outcomes, such as increased participation, communication, labor, trust, and resources. Similarly, an ecosystem-based approach helps inform fisheries co-management arrangements. Bringing EBFM and co-management together in a coherent way will require a deeper engagement in the role that stakeholders play in these management efforts.

Disparities in perceptions of the relationship between these concepts can largely be attributed to the definitional ambiguity surrounding these terms. We propose that engagement in the idea that EBFM and co-management exist on a conceptual continuum rather than as distinct management approaches. The continuum approach captures the diversity of management practices associated with EBFM and co-management. Considering this continuum provides an alternative to defining strict definitions for these concepts and potentially prevents the need for developing alternative concepts in the future. We review three case studies in marine resource management to illustrate the diversity in the interplay between EBFM and co-management of marine resource management initiatives in the water.

Managers who focus on understanding the interactions of marine systems demand both the fine-scale and localized knowledge that is produced through co-management in addition to holistic knowledge of the system that is essential for an EBFM approach. Co-management generates high-resolution, continuous, and place-based information that is necessary to understand the physical, biological, economic, and social interactions of fisheries systems (Link,
2002). These management requirements bring these two concepts closer together, to a situation where EBFM and co-management are highly integrated.

The varied scales and goals of EBFM and co-management remain key challenges to implementation and attention must be paid to the information and institutional structures that are needed to effectively manage a system in an integrated, ecosystem based manner as well as what is required to collect, maintain, interpret, and use this information in decision-making. As marine systems across the globe face unprecedented environmental and socioeconomic change, attention in forwarding alternative fisheries approaches is mounting. A deeper understanding of the interplay between these two approaches to ocean management and conservation may help bring clarity to their use and application.
CHAPTER 3
COMPREHENSIVE PLANS AS TOOLS FOR ENHANCING COASTAL COMMUNITY RESILIENCE

3.1. Introduction

Coastal communities around the world are increasingly recognized as vulnerable places, particularly in the context of climate change (Beatley, 2009; Barbier, 2014; Horton et al., 2014; de Coninck et al., 2018; Wuebbles et al., 2017). Planning for both social and ecological resilience is key to ensuring the longevity of coastal communities (Berke and Conroy, 2000). In this context, resilience can be understood as the ability of coastal communities to withstand disturbances without fundamentally altering their essential identity, structure, and functions (after Berkes and Folke, 1998; Leslie and Kinzig, 2009). Examples of disturbances include environmental stressors, i.e., flooding, storm surge, sea level rise (Horton et al., 2014; de Coninck et al., 2018; Fu et al., 2017; Wuebbles et al., 2017), as well as socioeconomic stressors, i.e. recession, shifts in market demand (Kashem et al., 2016; Stoll et al., 2016). Resilience planning emphasizes building capacity to anticipate and prepare for crises under uncertainty (Walker and Salt, 2012); and reducing both individuals and communities’ vulnerability to potential disturbances, thereby increasing adaptive capacity (Beatley, 2009).

Many scholars argue that polycentric governance arrangements are effective at addressing complex natural resource challenges (Ostrom, 2009; McGinnis and Walker, 2010; Sovacool, 2011). Decisions and policies about how to adapt and remain resilient in the face of change need to be implemented at multiple governance levels (Tribbia and Moser, 2008). State and national governments in the US and many other nations have foregrounded resilience...
planning at the community scale. For example, the US National Oceanic and Atmospheric Administration’s Ecosystem-Based Fisheries Management Policy identifies maintaining community resilience and evaluating community well-being as essential parts of the resilient ecosystem guiding principles of the Policy Implementation Roadmap (NMFSI 01-120-01 2016). Additionally, the 2010 US National Ocean Policy incorporated actions aimed to specifically benefit coastal communities, such as enhanced research and communication about the direct and indirect impacts of climate change, ocean acidification, infrastructure, economies, habitats and key species (E.O. 13547).

While these policy frameworks highlight the importance of planning for resilience, they are not necessarily linked with community-scale concerns or strategies (Sievanen et al., 2011). Similarly, adaptation plans are often developed at geographically extensive scales. Yet, drivers of change in coastal systems, such as declining fish stocks, flooding, population decline, and economic disruption are experienced at the local scale – in the social and ecological interactions that people have with one another and the coastal and marine ecosystems of which they are part (Leslie et al., 2015; Sievanen et al., 2011). Communities are unique and have their own specific needs, experiences, resources, and ideas about preventing and responding to stressors that threaten coastal ecosystems and local economies (Brody, 2003). Comprehensive plans are intended to guide the future actions and direction of a community (Conroy and Berke, 2004). The comprehensive planning process serves as a platform for communities to envision the future and outline objectives and policies that address social, economic, and environmental issues to guide the future direction of the community (Berke and Conroy, 2000).

Critically assessing resilience in comprehensive plans is one key way to understanding the aspects of resilience that are prioritized by communities. Complementing research on
resilience planning at broader scales, our paper focuses on local scale planning efforts and how they align with resilience principles. The State of Maine provides a useful case study, as changing ocean conditions, declines in marine fisheries, and the loss of working waterfront infrastructure threaten the resilience of coastal communities throughout the state (Springuel et al., 2007). With over 3,000 miles of coastline and a culture and economy deeply tied to marine resources, citizens and municipalities in Maine have important questions and concerns about the capacity of their coastal communities to respond and adapt in the face of mounting social, economic, and environmental pressures.

The goal of our study was to investigate how local planning is addressing resilience principles. To explore this, we investigate the degree to which Maine’s coastal communities are incorporating resilience principles into their comprehensive plans. To answer this, first we provide an overview of the history of comprehensive planning in Maine, including the state requirements that guide plan development. Next, we explore the concept of social-ecological resilience in the context of coastal communities. We apply a framework for evaluating the incorporation of resilience principles to analyze 30 comprehensive plans from coastal communities in Maine. We draw on a framework that employs three types of resilience indicators – ecological, social, and economic – which together reflect elements of social ecological resilience. Finally, we explore the factors that may be influencing the degree to which comprehensive plans incorporate resilience principles and offer recommendations for the use of comprehensive plans as tools to enhance coastal community resilience.

3.1.1. Exploring Social-Ecological Resilience in a Community Context

In its broadest sense, resilience recognizes social systems and ecosystems as “coupled, interdependent, and co-evolving” (Berkes, 2015, p.51). The focus on social-ecological systems
emphasizes the complexity that arises from interactions among the biophysical and institutional domains and across spatial and temporal scales (Ensor and Berger, 2009, Berkes and Folke, 1998; Adger and Barnett, 2009).

In a resilient social–ecological system, social and ecological changes create opportunity for innovation and development (Folke, 2006). Folke and colleagues (2010) differentiate between “specific” and “general” resilience. Specific resilience refers to the capacity of the system to withstand one kind of disturbance, whereas general resilience relates to the capacity of a system to withstand all kinds of disturbances (Folke et al., 2010). This is a significant distinction, as general resilience encompasses coping with stressors in all ways, whereas specific resilience only buffers the system against one kind of shock, or protects particular components of the system from disturbance (Folke et al., 2010). Efforts to foster specific resilience may not be beneficial long term, as the concentration on individual parts of the system and specific shocks may inadvertently cause the system as a whole to lose resilience in other critical ways (Folke et al., 2010).

Resilience can be cultivated at both the individual and collective level and can occur at multiple spatial and geographic scales (Ross and Berkes, 2014; Beatley, 2009). There are numerous definitions of resilience from fields such as ecology, engineering, and geography. The concept of ‘community resilience’ similarly has varied definitions. In general, it is viewed as a positive attribute, associated with decreased risk and increased local capacity at the community scale (Patel et al., 2017). A community’s resilience is often described as a function of the community members’ capacity to mobilize, learn, and work towards a common goal (Steiner and Atterton, 2015). For example, after a systematic assessment of definitions of community
resilience from the peer reviewed and grey literature, Patel et al., (2017) found that the concept is
associated with decreasing risk and increasing social support and resources in a community.
Additionally, local knowledge, community networks, effective communication, and leadership,
among other attributes, emerged as critical elements that can build resilience within a community
before a disaster and can mitigate long-term damage and retain the essential structure and
function of a community after a disaster (Patel et al., 2017).

In assessing coastal community resilience, themes of flexibility, adaptability, opportunity,
and durability are prominent in the literature (Beatley, 2009). Paton (2006) advocates for a
bottom-up, community-based approach to effectively plan for resilience. Walker and Salt (2012)
identify a number of characteristics of a ‘resilient world,’ including ecological variability,
diversity, innovation, modularity, and overlaps in governance. Buckle (2006) additionally
identifies several elements that support resilience at the community scale, such as robust social
networks, connected information channels, and community knowledge of hazards. Communities
are also influenced by both internal and external economic forces such as economic growth
opportunities, stability and diversity of livelihoods, and equitable distribution of income (Norris
et al., 2008).

Community resilience is supported by a resilient local economy with diverse businesses
and employment opportunities (Steiner and Atterton, 2015). Building community resilience
requires the development of a community’s social capital (Putnam, 1995; Magis, 2010). Resilient
communities promote human well-being by creating common objectives to strive for and
encouraging citizens to work together for the greater good (Patel et al., 2017; Armitage et al.,
2012). Many definitions of community resilience focus on enhancing adaptive capacity, or the
ability of social actors to make deliberate changes that influence the resilience of the complex
social-ecological systems in which they are embedded (Ensor et al., 2014; Walker, 2014). Although communities do not control all of the conditions that affect them, they do have the ability to anticipate, plan for, and change many of the conditions that can increase their overall resilience and adaptive capacity in the face of disturbances. Adaptive capacity is defined by the ability of systems to modify their structure in response to changing socioeconomic and environmental conditions in order to adjust and cope with these changes, moderate potential damage, and take advantage of opportunities that arise from change (Adger and Vincent, 2005; Folke et al., 2002). Advancing adaptive capacity in coastal communities requires holistic planning efforts and the principles of social-ecological resilience provide critical insight to sound coastal management in the future (Wilkinson, 2012).

Through this analysis, we seek to understand the degree to which comprehensive plans in Maine are currently incorporating principles of social-ecological resilience. Answers to this question highlight the general challenges of enhancing the resilience of communities in Maine. Plan evaluation is a critical component of the comprehensive planning process as the quality of the plan affects its implementation. Information gained from a systematic review of comprehensive plans is vital to determine strengths and weaknesses in Maine’s local planning approaches and will provide valuable insight into planning for resilience in coastal communities in the future (Wilkinson, 2012).

3.1.2. A history of Comprehensive Planning in Maine

Municipalities in Maine began writing comprehensive plans as early as 1918 (Richert and Most, 2005). The development of these initial plans across the country was primarily driven by the interest in adopting zoning ordinances to direct population growth and developmental sprawl. Comprehensive plans are the legal underpinning of zoning ordinances and are intended to ensure
that zoning is conducted fairly and with careful consideration to community needs (Conroy and Berke, 2004). In keeping with planning conversations nationwide, sprawl became a major concern in Maine in the 1970s and 1980s, as rapid population growth shifted from urban centers to rural communities. Rural municipalities did not have the appropriate infrastructure, ordinances, or facilities to support the rapidly increasing populations. As a result, residents across the state were concerned that the rural character of their communities would decline as roads became increasingly congested, forests were cleared for housing development, and taxes began to rise (Richert and Most, 2005). In 1988, Maine adopted the Comprehensive Planning and Land Use Act, also known as the Growth Management Law. This law initially established local comprehensive planning and land use management in each municipality of the state (Guidelines for the Comprehensive Planning and Land Use Regulation Act 1988). The Act requires that municipalities appoint a planning committee to prepare a comprehensive plan, which must consider a broad range of public review and comment from the community. As planning for population increase was a pressing issue in the state during the 1970s and 1980s, a central goal of the Act is preventing developmental sprawl (Dolan and Walker, 2006). To achieve this, comprehensive plans were designed to direct anticipated growth to specific designated growth areas, and away from rural areas in each municipality (Richert and Most, 2005).

The Act details 11 goals that promote the ‘health, safety, and welfare of citizens of the state.’ These goals include the protection of the state’s natural resources such as agricultural, forest, and marine resources, the preservation of historic and archaeologic resources, the promotion of recreational opportunities, and the promotion of affordable housing. Additionally, it calls for a three-stage analysis as part of each plan: inventory and analysis of existing
conditions, policies to address the issues identified in the inventory section, and implementation strategies to address these issues. Towns are asked to address 13 topics as part of the inventory and analysis section: topography (soils, geology, and water resources), habitat and other significant natural resources, historical and archaeological resources, agriculture/forestry and marine resources, local and regional economy, population and demographics, land use patterns, housing, transportation, recreation and open space, public facilities and services, and fiscal capacity. In addition to inventoring these topic areas, comprehensive plans are required to include policies that address specific issues raised in the inventory section and outline strategies to achieve these goals. (Guidelines for the Comprehensive Planning and Land Use Regulation Act, 1988).

In the late 1990s and early 2000s, many Maine communities began to update their comprehensive plans. Most municipalities had plans that were over 10 years old. At the same time, the Maine State Planning Office (SPO), as part of ongoing efforts to curb sprawl and promote smart growth, began advocating for bolder comprehensive plans that were more effective at guiding growth and addressing other pressing local and regional issues. By 2003, 47% of Maine’s organized municipalities developed comprehensive plans that were compliant with the goals of the Comprehensive Planning and Land Use Act (Richert and Most, 2005). In the same year, the SPO developed a handbook of 50 recommendations to help guide towns in strategies to address sustainable growth patterns (Richert and Most, 2005). The handbook served as an opportunity for the SPO to reflect on some of the lessons learned from the collective experience of over 10 years of comprehensive planning in Maine under the Planning and Land Use Regulation Act.
In 2005, the Maine State Planning Office released this manual to guide Maine’s communities in developing comprehensive plans. The manual called for communities to tackle a broad range of community issues and encouraged them to take a critical look at their growth patterns and to develop a stronger next generation of plans. It emphasized the importance of citizen involvement as a continuous process in the development of comprehensive plans and calls for realistic, specific, and directive policies. The manual states that the State Planning Office recognizes that comprehensive plans that are consistent with state laws may not necessarily fulfil the local goals and policies of a community, and thus encouraged municipalities to go beyond state laws and develop strategies to meet local needs as well as the requirements of the state (Richert and Most, 2005).

The handbook accompanied an updated comprehensive plan grant program that the SPO launched in 2001. This new grant program provided state funding for comprehensive plan development for the first time. The grants were geared towards a new generation of comprehensive plans that incorporated stronger policies and implementation strategies to address pressing issues facing Maine’s communities. This shift was largely in response to the earlier generation of comprehensive plans that were effective at inventorying community resources, but less successful at guiding growth and meeting other planning objectives. In many cases, these early comprehensive plans were quite vague, resulting in ineffective strategies to implement policies (Richert and Most, 2005).

The Growth Management Law was amended in the early 1990s. The mandate for municipalities to develop a plan was removed when the economic boom ended and state budgetary problems resulted in cutbacks that limited funding for local growth management efforts. While state approval of municipal comprehensive plans is no longer required, there is a
process for the voluntary review of the plans by the Maine Municipal Planning Assistance Program. If a town’s plan is found to be consistent with the Growth Management Act guidelines, there can be benefits for the municipality, including preferential treatment for some state grant programs (Maine Municipal Planning Assistance Program). Over $80 million is awarded annually through 25 state grant and loan programs that include approval of a comprehensive plan as a review criterion. Examples of these programs include the Land and Water Conservation Fund and Community Development Block Grants. In addition, as provided by state law, when a comprehensive plan is adopted by the municipality, it serves as the basis for updating the town’s zoning and land use regulations. In addition to funding opportunities, in order to provide legal support for any local zoning, zoning ordinances must be pursuant to, and consistent with, a comprehensive plan adopted by the municipality (Richert and Most, 2005). Comprehensive plans detail many different aspects of a community. These include community goals and policies that address issues identified by the community, a future land use plan that anticipates growth and development, and implementation strategies that describe how the plan objectives will be implemented in the future (Berke and Conroy, 2000).

A review of the evolution of comprehensive planning in Maine highlights a complex history of local governance. Plans were initially intended to address urban sprawl, a pressing issue in Maine in the 1970s and 1980s. While this is no longer a critical issue facing many towns, municipalities are actively developing comprehensive plans throughout the state to be eligible to compete for grant opportunities and to update local zoning ordinances. Although comprehensive planning is no longer mandatory by the state, the local planning process provides a platform for communities to address challenges facing the community and assert a set of priorities and
policies to implement a collective vision for the future. Social-ecological resilience offers a flexible, holistic, and robust lens to critically address the multifaceted challenges that coastal communities face and focuses on interactions that are relevant in managing human-environment systems in the context of change (Quinlan et al., 2016).

3.2. Methods

3.2.1 Plan Selection

We analyzed comprehensive plans from coastal communities across the state of Maine to investigate how social-ecological resilience principles have been incorporated in local planning documents. Comprehensive plans were selected based on a sample from each coastal community county in Maine. Each municipality is located within Maine’s coastal zone as designated by the Maine Coastal Program. The plans selected for analysis were identified as consistent with Maine’s Growth Management Act by the Maine Municipal Planning Assistance Program. Municipalities closest to the 25th, 50th, and 75th percentile of the county population were selected in order to assure that both small and large municipalities are included in the analysis. Thirty plans out of a total of 49 state approved coastal plans were analyzed, thereby representing 61% of all possible coastal municipal plans. The goal of this sampling process was to represent the diversity of Maine’s coastal communities with active, state-approved comprehensive plans.

3.2.2 Resilience Assessment

To assess the degree to which Maine’s coastal communities are incorporating resilience principles in their local planning efforts, comprehensive plans were evaluated using an assessment framework focused on social-ecological resilience (modified from Boulware, 2013). The framework integrates key indicators of resilience from a variety of nationally recognized resilience frameworks, such as the National Oceanographic and Atmospheric Administration's
Coastal Community Resilience Indicators and Rating System (NOAA Coastal Community Indicator and Rating System) as well as the Federal Emergency Management Agency Community Resilience Indicators (FEMA Community Resilience Indicators), and is consistent with the diversity of resilience principles outlined in the peer-reviewed literature (Godshalk et al., 2000; Chaskin, 2001; Beatley, 2009; Leslie and Kinzig, 2009; Magis, 2010; Boulware, 2013). Although indicators are drawn from national frameworks, they are generalizable with the intent to be applied to any community. Downsizing national frameworks to the local scale may not capture the local needs of a community. To address this, indicators were specifically selected based on the hazards and threats facing the state of Maine. Resilience principles were divided into three categories for analysis: ecological, social, and economic. Although the resilience indicators were categorized for evaluation purposes, they are interrelated and in many ways overlap and are dependent on each other (See Appendix I for complete indicator list).

Ecological principles address the relationship between physical development and natural processes and include indicators such as conservation and restoration of natural systems, wetland migration, hazardous area acquisition, shoreline protection, and the incorporation of policies related to coastal hazards, such as sea level rise, storm surge, erosion, and flooding (Godshalk et al., 2000; Beatley, 2009; NOAA, 2010). Social aspects of increasing resilience include indicators such as identifying vulnerable populations within the community, enhancing community education of hazards, promoting emotional and physical well-being among residents, and providing opportunities to strengthen social networks (Godshalk, 2003; Magis, 2010; Beatley, 2009). Economic aspects of increasing resilience include indicators such as promoting a diverse economic base in the community, business owner education related to hazards, and fostering relationships between local businesses and the community (Beatley, 2009).
Each comprehensive plan (n=30) was coded based on the incorporation of social-ecological resilience indicators outlined in the framework using the qualitative data analysis computer software package NVivo version 11.4.2. Each plan was scored on a scale of 0-2 for the presence or absence of each individual indicator (after Berke and Conroy, 2000). A ranking of 0 indicates that an indicator is not identified in a comprehensive plan. A ranking of 1 indicates that the indicator was suggested or vaguely defined, but not well incorporated throughout the plan. A ranking of 2 indicates that the indicator was well identified in detail, contains directive language and specific guiding policies or goals addressing the indicator. This method is widely applied in the planning field as a systematic approach to operationalize qualitative planning evaluation measures (Berke and Conroy, 2000; Godshalk et al., 2000; Paton, 2006). A complete list of indicators is outlined in Appendix I.

The total score for each of the three resilience categories was calculated by the number of points (raw score) scored divided by the total possible points for that category. Total resilience scores were calculated for each of the 30 plans in addition to individual scores for social, ecological, and economic resilience. The maximum possible score that a plan could receive was 100%. Nonparametric statistical tests were conducted to test whether there are significant differences in resilience category scores. Specifically, a Kruskal-Wallis test was used to investigate whether there is a statistically significant difference between ecological, social, and economic resilience category scores for the comprehensive plans analyzed. A Wilcoxon signed-rank test was used to determine whether plans addressed resilience differently based on the year they were adopted.
3.3. Results

3.3.1. Total Social-Ecological Resilience Score

Total resilience scores for each plan were calculated and reported based on the percentage of the summed values from the ecological, social, and economic scores present in each plan (Figure 6). Portland had the highest total social-ecological resilience score calculated for a municipality, at 80%. Bangor had the lowest score, of 18%. The average total score for the 30 plans evaluated was 40% (Table 8).

![Figure 6. Total resilience score for each municipality, out of a maximum possible score of 100%.]
Table 8. Total scores for each municipality are depicted, along with the year each plan was adopted. Each total social-ecological resilience score is based on the summed values of the plan’s ecological, social, and economic scores, which was then converted into a percentage.
3.3.2. Resilience Scores by Category

We evaluated the comprehensive plans based on the presence of resilience indicators in three categories: ecological, social, and economic resilience. The scores for each municipality by category are summarized in Table 9 and depicted in Figure 7. The average score for the social resilience category was higher than ecological and economic scores for the comprehensive plans analyzed. The average ecological score for all municipalities analyzed was 40%. The average social score was 55% and the average economic score was 32%. We summarized the variation in total resilience scores, and the relative emphasis different communities place on the social, ecological, and economic elements of resilience in their plans in Figure 8.

Results from a Kruskal-Wallis test indicate a statistically significant difference between ecological, social, and economic resilience category scores (p<0.05). Paired contrasts were examined through a Wilcoxon signed-rank test. Results indicate that there is a statistically significant difference between social and economic scores (p<0.05), however there is no statistically significant difference between ecological and social or ecological and economic scores (p>0.05). Statistical analyses revealed that social attributes of resilience were emphasized over ecological and economic aspects of resilience in the comprehensive plans that were assessed.
Table 9. Scores for each municipality by ecological, social, and economic resilience categories.

Raw scores represent the total number of points for the resilience category from the comprehensive plan analysis. Total scores are percentages calculated based on the raw score divided by the total possible score for each resilience category.
One criterion that may have influenced overall plan ranking is the year the plan was adopted. This could potentially be significant given that more recent plans should reflect the availability of recent research related to coastal community resilience and hazard mitigation, in addition to the 2005 Maine State Planning office directive for comprehensive plans to address a broader range of challenges in communities. A Wilcoxon signed-rank test was conducted to determine whether plans addressed resilience differently based on the year they were adopted. Results indicate that there is an association between total resilience score and year adopted (p<0.05) such that more recent plans tend to have higher total scores. Figure 9 depicts average total comprehensive plan resilience score by year. Population, land area, and per capita income of the municipalities were not statistically associated with plan score (p>0.05).

**Figure 7.** Comprehensive plan total scores for each municipality by social, ecological, and economic resilience category.
3.3.3 Resilience Indicator Analysis

Analysis of resilience scores relating to particular indicators in the framework reveal which indicators were well incorporated in comprehensive plans, as well as the indicators that were largely not addressed. Thus, this analysis highlights what coastal municipalities prioritize in resilience planning throughout the state. The highest and lowest indicators for each resilience category are outlined in Table 10. Indicators that received an average score greater than or equal to 70% and less than or equal to 30% are reported for each resilience category.

**Figure 8.** Comprehensive plan analysis scores by resilience category and mapped by municipality.
Figure 9. Total comprehensive plan resilience score and the year each plan was adopted.
Table 10. Indicators of social-ecological resilience that scored an average of 30% or below, or 70% or above for each resilience category. These thresholds represent indicators that are minimally addressed and integrated in the comprehensive plans, as well as indicators that are well integrated into comprehensive plans on average.

3.4 Discussion

Our results reveal that social-ecological resilience principles are not well incorporated in Maine’s current comprehensive plans in coastal communities overall, but have increased through time. Of the 30 comprehensive plans analyzed, the highest score assigned to a municipality was 80%, the lowest score was 18%, and the average resilience score for municipal comprehensive plans was just 40% out of a possible 100%. Plans that received lower scores failed to address specific indicators, or did not incorporate policies, strategies, or action items that detailed how the community will address the indicators. In comparison, plans that received high scores had a
detailed vision statement, thorough inventory sections, and policies or action items derived from the inventory sections that outline major priorities and delegate specific committees or organizations within a community with oversight and implementation.

We also found heterogeneity in the degree to which municipalities are incorporating indicators of resilience. Although Maine’s coastal community comprehensive plans, overall, do not incorporate social-ecological resilience principles, there is a higher emphasis on social measures relative to ecological and economic measures. Many of the plans emphasized a strong sense of community and a desire to limit development and maintain the rural character of the town. This is exemplified in the Edgecomb town vision to “accommodate and guide Edgecomb’s growth while supporting the expressed wishes of the townspeople to retain their individual autonomy, the community spirit and rural environment” (Edgecomb Comprehensive Plan, pg. 1). Emotional and physical well-being and an increased quality of life were promoted throughout many of the plans as goals. Mention of community hazard awareness and education, as well as policies and goals focused on adaptive capacity were absent in many of the plans.

Priorities in comprehensive plans within the ecological resilience category focused around erosion and flooding and were specifically attentive to infrastructure protection. Some plans encouraged the conservation of natural systems, as well as the use of living shorelines for shoreline stabilization. The strong emphasis on erosion and shoreline stabilization in comprehensive plans is likely a reflection of Maine’s Mandatory Shoreline Zoning Act (M.R.S.A. sections 435-449), which controls land uses and placement of structures within the shoreland area for the purposes of protecting habitat, wildlife, water quality, historic and archaeological sites, in addition to conserving space and public access. In addition, the Disaster Mitigation Act of 2000 (Public Law 106-390) encourages communities to develop policies that
mitigate long-term effects of coastal hazards. The incorporation of these policies in comprehensive plans likely resulted in high scores for indicators related to flooding, erosion, and shoreline stabilization in the ecological resilience category across all the comprehensive plans that were analyzed. However, few plans incorporated policies that related to the accommodation or relocation of structures in hazardous areas, the prevention of hazardous area acquisition, and redevelopment of structures after hazardous occurrences.

Allusions to climate change impacts were absent from the majority of the plans. Few plans called out sea level rise and storm surge as potential threats. When these threats were identified, objectives and policies addressing these hazards in the community were absent. Results of the ecological resiliency category indicate that many Maine communities are not considering the potential impacts of climate change in town planning. The median adoption year of these plans is 2011, however, and plans developed after this year tend to include more explicit language about climate change impacts and adaptation planning. It is important to note that towns may be planning for and incorporating aspects of resilience in documents other than comprehensive plans. For example, the town of Georgetown has developed a climate adaptation report, which outlines potential climate-related impacts on the community and lists recommendations for the community to prepare for these impacts. Similarly, Lincoln County has prepared a sea level rise plan for the region that projects scenarios of flooding in specific areas in the associated communities. These plans provide valuable information to inform community planning and should be included as part of the comprehensive planning efforts (Baynham and Stevens, 2014).

Components of economic resilience that were highlighted in the plans include policies that encourage coordinated business planning to achieve objectives focused on protecting,
sustaining, and enhancing the economic base of the municipality. Many of the plans recognized 
the relationship between healthy natural systems and a healthy economy, as many coastal 
municipalities are heavily dependent on commercially harvested marine resources as well as 
marine tourism. Many municipalities acknowledge this economic dependence in their plans, 
however few address strategies for economic diversification. Economic recovery options in the 
face of stressors such as natural disasters or recession were absent from most of the 
comprehensive plans. Coastal communities in Maine rely on natural resource activities such as 
fishing, forestry, and agriculture. The future of these resources is threatened by coastal hazards 
and anthropogenic impacts such as climate change. Greater efforts should be put toward 
developing policies that address the natural resource dependency of economies in Maine’s 
coastal regions in local planning policies.

Investing in resilience planning can be economically beneficial to municipalities in the 
long term. For example, the Maine Coastal Program administers a competitive grant program 
that provides financial assistance for municipalities to conduct projects related to topics such as 
storm hazard resiliency, water quality improvement, and public access. In 2013, the town of 
York used these funds to develop a sea-level rise analysis and adaptation strategy chapter for 
their comprehensive plan. This work allowed the community to assess inundation areas and 
identify vulnerable infrastructure to prioritize action strategies that mitigate the costs of replacing 
infrastructure in the future.

Incorporating social-ecological resilience measures into comprehensive plans is an 
important step toward fostering resilience in coastal communities (Beatley, 2009, 2014; Berkes 
and Seixas, 2005). In addition to the focus on social aspects of resilience, many of the 
comprehensive plans in Maine focus on specific resilience by prioritizing actions and policies
that mitigate disturbances related exclusively to infrastructure. While prioritizing specific hazards can help communities prepare for particular disturbances, a social-ecological resilience approach that emphasizes general resilience by encompassing components of social, ecological, and economic resilience has a greater capacity to prepare communities to adapt to a broad range of disturbances long-term (Folke et al., 2010; Boulware, 2013). Communities face social, ecological, and economic challenges; thus a holistic prioritization of resilience that moves beyond a focus on infrastructure alone may help communities in Maine prepare for extreme, novel, or unexpected disturbances. Comprehensive plans cover a variety of topics such as housing, natural resources, transportation, and the local economy. These sections and related policies are often written in isolation; however, the multifaceted nature of the plans can facilitate a general resilience approach with a prioritization of feedback and connectivity between the different components of a community plan.

There are numerous social, political, and economic barriers to building resilience that are specific to the context of each community. Increasing resilience at the community scale requires financial investments, time, and human resources. Some of the major obstacles that have been identified in the coastal planning literature include low prioritization of hazards, limited ability or willingness to confront big issues, short decision-making time-frames, political impediments, as well as limited financial resources and staff capacity (Beatley, 2009; Goodwin, 2003; Picketts, et al., 2014). There are many tradeoffs associated with resilience planning, as building resilience at the community scale may compete with other local objectives. Thus, increasing resilience in one area may be at the expense of another. For example, development of land may increase economic productivity in a community, but may negatively impact critical habitats such as wetlands, which provide extensive ecosystem services that contribute to human well-being. Communities in
Maine are faced with addressing these tradeoffs. The town of Stonington, Maine’s leading port for commercial fishery landings, is confronted with the need to adjust infrastructure to address storm surge and sea level rise hazards while maintaining the working waterfront infrastructure that is necessary for its viability as a fishing port. The development of effective local and regional planning strategies to enhance resilience and increase adaptive capacity among coastal communities necessitates a deep and multifaceted understanding of these obstacles to inform efforts to address them (Beatley, 2009).

There is no panacea to overcome the complex barriers to building resilience in coastal communities. However, comprehensive plans can be repurposed to serve as a tool to address and plan for challenges around resilience and adaptive capacity at the community level. Climate change impacts such as sea level rise, ocean acidification, and increased storm severity are already being experienced in coastal communities in the US Northeast (Moser et al., 2008; Lyles et al., 2018; Hare et al., 2016). Policy-makers and resource managers must prepare and plan for the impacts of climate change to coastal communities and implement plans on the ground to address these stressors. We envision the next generation of comprehensive plans as iterative, adaptive planning documents that not only identify resource challenges in communities, but also articulate goals and management strategies across the ecological, social, and economic domains that can support resilient coastal communities.

3.5. Conclusion

Coastal communities worldwide face an extensive set of threats from a myriad of ecological, economic, and social stressors. Many high-level international and national policies acknowledge the importance of resilient coastal communities, however they do not touch the ground at the community level, where people are closely connected to the coast and are
vulnerable to such stressors. Coastal communities may be better able to prepare for the impacts from socioeconomic and environmental change if they began preparing for them now. Planning for resilience is integral to ensuring the longevity of coastal communities and building local adaptive capacity in the face of ecological and socio-economic change.

Comprehensive plans serve as a platform for communities to develop policies that encourage responsible use of coastal resources and acknowledging the connections of the natural and human systems in order to foster social-ecological resilience. The emphasis on social-ecological resilience focuses on interactions that are relevant in managing human-environment systems in the face of change (Quinlan et al., 2016). Several key planning dimensions are critical to advance social-ecological resilience in coastal communities: resilience of ecosystems and coastal environments, social resilience, and economic resilience (Beatley, 2009). These categories of resilience are not independent but are intricately related.

A key step in moving communities toward resilience is to monitor, assess, and evaluate the degree to which local communities are integrating resilience in local planning documents. A review of 30 active comprehensive plans from coastal communities in Maine among these three categories of resilience revealed that many coastal municipalities are not incorporating social-ecological resilience principles in their comprehensive plans. The results of the comprehensive plan analysis demonstrate a gap between the academic development of resilience indicators, frameworks, and policies and the integration of key aspects of resilience into coastal community comprehensive plans. Further, there is heterogeneity in the extent to which components of resilience are addressed in comprehensive plans, with social characteristics outweighing ecological and economic components.
Anticipating potential disturbances through the early implementation of resilience principles can be cost effective and can provide current and future benefits to communities. The comprehensive planning process provides a platform for communities to envision the future and outline objectives and policies that address social, economic, and environmental issues to guide the future direction of the community. Comprehensive plans along Maine’s coast have largely not altered from the original requirements of the Comprehensive Planning and Land Use Act. This act was written in 1988 to encourage towns to address the pressing issue of urban sprawl. Thirty years later, sprawl no longer remains the central challenge facing municipalities. Comprehensive plans are no longer a requirement of municipalities in Maine, however grant-based incentives and local zoning ordinances motivate municipalities to keep updated comprehensive plans. New, expansive directions beyond inventorying community resources and directing sprawl are required to reform how comprehensive plans are made.

Climate change is, and will continue to, impact every aspect of municipalities including infrastructure, but also public health, housing and biodiversity. Building resilience requires significant structural shifts to address the root causes of challenges in the community, as well as a paradigm shift in planning to move towards a more proactive approach and a holistic consideration of resilience. Resilience building is an ongoing process and comprehensive plans are living documents that create a foundation for coastal communities to articulate their vision for the future and implement strategies to build adaptive capacity as we face unprecedented challenges and plan for a changing world.
CHAPTER 4
LATENCY IN MAINE’S COMMERCIAL FISHERIES: IMPLICATIONS FOR ADAPTATION

4.1 Introduction

Fisheries worldwide are experiencing mounting environmental and socioeconomic changes (Worm, 2003; Pinsky, 2013; Saba et al., 2016). Declining fish stocks, warming ocean temperatures, and increasingly globalized markets shape marine systems and the livelihoods of those that depend on them (Brander, 2010; Perry et al., 2011). The ability for fishers to remain resilient in the face of these changes is determined by their capacity to adapt and respond. The capacity for resource users to influence resilience within a system is referred to as adaptability (Walker et al., 2004; Walker and Salt, 2006). Enhancing adaptive capacity encompasses taking advantage of opportunities that arise from change, coping with disturbances, and mitigating potential damages (Gallopin, 2006; Frawley et al., 2019). Understanding how individuals make decisions to fish and the options they have for responding to changing conditions is critical to enhance individual resilience and build adaptive capacity in marine social-ecological systems (Perry et al., 2011; Coulthard and Britton, 2015; Pellowe and Leslie, 2019).

Fishers employ a variety of strategies to stabilize or enhance their income in response to socioeconomic and environmental changes. These strategies may include modifications to fishing behavior such as fishing further offshore, fishing for longer hours, fishing in different locations, or waiting to fish until conditions change or improve (Perry et al., 2011; Kasperski and Holland, 2012; Sievanen, 2014). They may switch the species they catch, target more lucrative fisheries, or diversify their fishing portfolio to include a variety of species (Madin et al., 2012;
Other modifications include reducing crew size to cut expenses or changing gear types to more effectively target catch (McClanahan et al., 2005; Badjeck et al., 2009; Aguilera et al., 2015). To supplement a declining income, fishers may increase the value of their catch, engage in other occupations outside of fishing, or may leave fishing entirely for more lucrative employment opportunities (Allison and Ellis, 2001; Salmi, 2005; Stoll et al., 2019).

The capacity for fishers to employ one or more of these strategies to cope with or mitigate income variability is dependent on a variety of influences. Adaptability is constrained by individual factors (e.g., personal income, local knowledge, proximity to fisheries), as well as exogenous historical, cultural, political, and economic forces (e.g., environmental conditions, physical access to the waterfront, constricting local governance rules and limited entry systems) (Adger et al., 2009; Sethi, 2010; Stoll et al. 2016; Frawley et al., 2019).

Previous work has described the role that fishing diversification plays as an adaptation strategy to buffer individual income variability and mitigate economic risk (e.g. Mumford et al., 2009; Sethi, 2010; Schindler et al., 2010; Badjeck et al., 2010; Aguilera et al., 2015; Finkbeiner 2015; Kasperski and Holland, 2013; Stoll et al., 2017). This work highlights that individuals who hold a diverse portfolio of fishing licenses are more prepared to endure stress than those who are specialized (Stoll et al., 2017; Frawley, 2019; Silver and Stoll, 2019). While license diversification is recognized as a key adaptation strategy, limited attention has focused on the role that latent license redeployment plays as a risk management strategy for individual fishers.

Latency in the context of fishing is a term used to describe potential effort in a fishery that is not used and is exhibited by those who hold fishing licenses but do not fish. Latency can occur at multiple temporal scales, such as over the course of a season or for prolonged periods that extend multiple years. Latency represents a management and conservation challenge because
latent license holders can reactivate a license at any time, within the constraints of fisheries regulations, without notice and therefore place increased pressure on a fishery system.

Managers require accurate numbers of harvesters, effort, and catch to evaluate fishing pressure and make decisions about how to regulate fisheries. While this process differs by fishery, it generally starts with the issuance of fishing licenses or permits to a finite number of harvesters. Licenses are a management tool that gives harvesters access to a fishery and are a form of governance intended to make fishing activities more ‘legible’ (Scott, 1998; Silver and Stoll, 2019) (Figure 10). While latency is not explicitly mentioned in the literature to our knowledge, it is recognized as a deficiency in the fishing license system in that it creates uncertainty for managers. Those who hold licenses but do not use them, i.e., are latent, are legally considered active participants in the fishery, even if they are not actively landing (pers. com. T. Rouleu; C. Wilson; and others).
Figure 10. Simplified model of fisheries system. Managers create a specific number of licenses to restrict access in a given fishery in order to control harvest (A). To evaluate fishing pressure and inform decisions about when to close a fishery, managers depend on harvest information such as accurate numbers of harvesters, effort, and catch (B). Latency creates uncertainty for a managers’ and impacts the predictability they expect to manage a fisheries system (C).

Understanding fishers decision-making processes and their adaptive responses is essential for anticipating fishery outcomes and predicting the capacity of fishers to adapt to future change (Sethi 2010; Mori et al., 2013). In this paper, we explore the role that latent effort plays in individual fishers’ resilience planning. We use commercial fisheries in Maine as a case study, as latent effort is currently unregulated in the state and has increasingly gained recognition by both
fishers and managers as a significant governance challenge. For example, a previous study of lobster licenses in Maine highlighted that latent effort in the form of unused commercial licenses and unused trap tags pose a risk to the fishery if latent effort is activated (Dayton et al., 2012). Through an analysis of Maine’s commercial fisheries, we assess patterns of latent license redeployment across Maine’s fisheries through time. We employ the qualitative approach of phenomenology to interview fishers about motivations for holding latent licenses and explore perspectives surrounding the impacts of latency in Maine’s commercial fisheries. To our knowledge, this is the first study that aims to quantitatively measure latency and explore perceived and real impacts of latent effort across commercial fisheries.

4.2. Methods

4.2.1 Quantitative Approach

To determine fisher latency, individual-level commercial fisheries license and landings data were acquired from the Maine Department of Marine Resources and NOAA’s Greater Atlantic Regional Fisheries Office (GARFO). State and federal commercial licenses and landings across species were merged to provide a comprehensive license portfolio for every individual, following methods described by Stoll and colleagues (Stoll et al., 2017). License holders were classified as latent based on an analysis of annual landings from 2010 to 2017. This time period was selected due to the initiation of mandatory reporting requirements in the state that became effective in 2009. Thus, subsequent years include the most complete record of landings for Maine’s commercial fisheries (pers. com. R. Watts). Individuals were categorized as latent if they disengaged from fishing during one or more years of the eight-year time series. Disengagement from the fishery was classified as landing less than 100 pounds on a particular year across all fisheries.
To develop a history of fishing license deployment, individual landings data was aggregated by year from 2010 to 2017 for each license holder using the R statistical programming software (version 1.1.383). Next, landings data were converted to a binary matrix to allow for pattern recognition in an individual’s landings across years. A threshold of 100 pounds was applied to landings data, where landings of 100 pounds or less was converted to a 0 and landings of greater than 100 pounds were converted to a 1. Following this process, license deployments patterns for individuals were grouped into categories based on landings history through the time series.

4.2.2 Qualitative Approach

We employed the qualitative approach of phenomenology to capture perspectives on the implications of latency in Maine’s fisheries and to understand individuals’ motivations for holding a license while not actively fishing. Phenomenology seeks to understand how individuals make sense of their lived experiences (Creswell, 2013). Phenomenological studies focus on how people perceive and talk about events and involves the use of thick description to understand how meaning is created through participants’ descriptions of a phenomenon (Sokolowski, 2000).

Detailed semi-structured interviews were conducted to capture individuals’ perspectives and motivations surrounding latent fishing effort (n=6). Once latent harvesters were identified from an analysis of landings history, we used both random sampling and purposeful sampling to recruit fishers for interviews. Care was taken to interview license-holders from a range of commercial fishing sectors and from across the state of Maine who represent both state and federal fisheries. We complemented random sampling with purposeful sampling to interview license-holders in Maine to further capture the diversity of perspectives on latency.
Interviews were guided by a series of open-ended questions to encourage personal narratives of why fishers keep their licenses when they are not actively fishing. This process allowed participants to shape the direction of the interview based on their own ideas and thoughts. Interviews focused on understanding the personal, social, and environmental factors that catalyze license redeployment among fishers as well as the individual perspectives on the impacts of latency in Maine’s fisheries. We additionally collected information on individual fishing histories and observations of changes in Maine’s licensing system over time. Saturation was reached when no new concepts were identified by participants related to motivations for latency and potential implications of latency. For both of these questions, saturation was reached after 5 interviews. Interviews were conducted between October 2019 and February 2020. Interviews were between 40 and 80 minutes in length and were conducted both in person and over the phone based on the preference of the participant. All interviews were audio recorded with the permission of the participants.

Interviews were transcribed verbatim, and analyzed using the NVivo 12 qualitative data analysis software. Two cycles of qualitative coding of transcripts enabled the identification of prominent themes to be extracted from interviews. The first cycle of coding involved highlighting patterns that emerged from in vivo codes of participant’s words that were then arranged as clusters of “meaning units” (Giorgi, 1997). The second cycle condensed meaning units of participants’ words into themes that allowed for detailed descriptions of the latency phenomenon. Interviews were triangulated with local newspaper articles and articles from regional fisheries newspapers. Newspapers were acquired using Maine Newsstand, a database that archives newspapers published in Maine. Coding was enhanced through the development of
cognitive mapping to construct a detailed description of participants’ experiences and perceptions of latency (Giorgi, 1997; Priest, 2002)

4.3. Results

4.3.1 Typology of Latency

An analysis of licenses in Maine’s commercial fisheries from 2010 to 2017 revealed that a significant number of individuals that hold licenses are not actively fishing (Figure 11). The number of latent harvesters has increased since the beginning of the time series in 2010. Further investigation of landings history revealed several major patterns of disengagement from fishing (Figure 12). These patterns were broken into the categories: No fishing, (harvesters who hold a license, but did not land throughout the time period,) Run (a period of two or more years of continuous fishing preceding or followed by a period of inactivity), Single year (fishing for a single year, preceding or followed by a period of inactivity), Break (multiple periods of disengagement in the fishery), and Dropout (fishing for more than three years consistently and then disengaging in the fishery while still holding an active license). A typology of common deployment patterns for the time series is described in Table 11 and depicted in Figure 12.
Figure 11. The number of harvesters in Maine’s commercial fisheries with active or not active fishing status between 2010 and 2017.

<table>
<thead>
<tr>
<th>License Deployment Pattern</th>
<th>Description</th>
<th>N (2010-2017)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No fishing</td>
<td>Holding an active license with no landings</td>
<td>11249</td>
</tr>
<tr>
<td>A. Run</td>
<td>Fishing continuously for at least two consecutive years followed or preceded by a period of inactivity while holding an active license</td>
<td>2966</td>
</tr>
<tr>
<td>B. Single year</td>
<td>Fishing for a single year proceeded or followed by a period of inactivity</td>
<td>2174</td>
</tr>
<tr>
<td>C. Break</td>
<td>Multiple periods of disengagement from fishing within the timeframe while holding an active license</td>
<td>1823</td>
</tr>
<tr>
<td>D. Dropout</td>
<td>Fishing for more than three years consistently and then disengaging in the fishery while still holding an active license</td>
<td>362</td>
</tr>
</tbody>
</table>

Table 11. Typology of fishing license deployment among Maine’s commercial fishers between 2010-2017. Descriptions of each pattern and number of fishers that exhibit each pattern during the time period are included.
Figure 12. Examples of the (A) run, (B) single year, (C) break, and (D) dropout patterns of license deployment exhibited by harvesters throughout the time series that contain latent effort (1=landings and 0= no landings).
4.3.2 Motivations for Holding Latent Licenses

**Personal circumstances**

Interviews with latent license holders in Maine’s commercial fisheries revealed that a variety of factors may motivate an individual to hold onto an inactive license (Table 12). Some participants expressed that they only commercially fish occasionally, or part-time, and primarily depend on other sources of employment for their livelihood, which may result in low or very limited landings over the course of a year. Some expressed that they only fish when market prices are high so they can get a good price for their catch. Other personal circumstances may lead an individual to retain a license while not actively landing. Participants identified injury, military service, family issues, and economic hardship as factors that kept them from fishing for a year or multiple years. These individuals may fall into many of the license deployment categories such as dropout, break, and run. As one interviewee observed:

*I'm not going to give my license up, and that's what people generally do. Just because I was laid up, oh three, four years. I had a knee done, a couple of hip replacements. Got one more knee to go, then it's probably a shoulder.* [Fisher #4].

**Identity of being a fisherman**

Multiple participants shared that their license is a piece of their identity. Even though they no longer fish, they hold on to their license because it is a token of being a fisherman.

*When you've done something all your life it's like if you don't drive anymore, you want to give up your license? Or, how many retired teachers have given up their teaching certificate? You just go through the list. You identify with the things you have done most*
of your life. Even though you can’t do them, you have this token of your participation. [Fisher #3].

Another participant noted:

It's hard to let go. That's probably part of it for me, the idea of letting go of something you've held on to for so long that's been a big part of you. [Fisher #6].

These individuals who retain their licenses without fishing for many years would fall into the no fishing or dropout license categories.

Anticipating policy changes

Many participants identified that keeping their license was a strategic decision associated with anticipating changes in the licensing system. These individuals have been fishing for many years and have observed changes in how licenses are allocated in Maine’s fisheries. Participants identified waiting for transferable license systems that would allow them to pass on their licenses to a family member or eventually sell it to someone who wants to enter the fishery as a motivation for keeping it. One fisherman identified that impending limited entry systems that restrict participation in a fishery may make his license valuable to sell in the future.

Right now there are a whole bunch of open access fisheries that open doors and anybody can get one. That's why they are not worth anything. That's why my bluefish permit at the moment is not worth anything because anybody can get one. But if they go to limited entry, and I have my permit when they go to limited entry and they stop issuing permits,
now all of a sudden my permit has value. You don’t give anything up voluntarily that may help you in negotiation of limited entry programs in the future. [Fisher #2].

This individual viewed their latent licenses as a bargaining chip that would allow them to turn a profit in the long-term if licensing systems change. Another fisher noted:

_Some would like to see a bloodline transfer, but that could tie up licenses for endless generations until no one new can get into the fishery._ [Fisher #1].

**Anticipating species changes**

Other individuals identified keeping latent licenses in anticipation of changing fisheries assemblages. These individuals believe that changing ocean conditions may modify fish distribution, creating opportunity that they can capitalize on.

_If other species ever work their way this far north, you know, we want to be ready to catch them. We don't want to be stuck on the outside to saying ‘Jeez, we had a permit for them ten years ago, but we don't now and therefore they're not going to give us one.’_

[Fisher #2].

**Limited upkeep**

Some participants identified that particular permits are easy and inexpensive to acquire and renew. This low cost and limited upkeep incentivize them to keep the licenses even if they don’t fish them.
Don't give it up. You know, if it's free, and all you have to do is check off a box, why wouldn't you do that? [Fisher #5].

Use it or lose it

Others, particularly in the lobster fishery, acknowledged the difficulty associated with getting a license back once it is relinquished. Similarly, certain lobster zones in Maine allocate trap tags based on a history of past effort in the fishery. Individual expressed that the “use it or lose it” trap allocation system promotes latency and keeps people from giving up their permits or trap tags even if they are not being used.

There are guys who've got the ability to have 600 traps in this zone, that fish 300. But they still buy the 600 tags, because if they don't, if you don't buy them, they'll take them away. If you quit, and then you want to go back, you've got to start at 100 tags. Let's say I get sick. I did, and I just kept my license but I didn't buy tags. When I started again, I started with 100 then I could go to 200 the next year, then 300 the next year. Come on, you can't make any money doing that. [Fisher #4].
### Identified Motivations for Latency

<table>
<thead>
<tr>
<th>Identity</th>
<th>Anticipating Fisheries Changes</th>
<th>Strict Management Regulations</th>
<th>Anticipating Changes in Management</th>
<th>Personal Circumstances</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>License as a token of identity as a fisher</td>
<td>Changing fish assemblages • Changes in market prices</td>
<td>Performance requirements/use it or lose it • Licenses are difficult to get back once they are relinquished</td>
<td>Transfer or sell license • Waiting for a financial incentive to relinquish license</td>
</tr>
</tbody>
</table>

**Table 12.** Summary of motivations for holding latent licenses identified by participants.

### 4.3.3 Perceptions on the Effect of Latency

Participants identified a number of effects of latent effort in Maine’s commercial fisheries, relating to social conflict, economic impact, policy implications, sustainability of fish stocks, and individual flexibility and adaptive capacity (Table 13).

**Social and economic implications**

Both newspaper articles and fisher interviews highlighted that increased effort caused by reactivated latent licenses could lead to amplified competition and congestion on the water. Additionally, participants identified that latent licenses prolong waitlists for new participants to enter limited entry fisheries, such as the lobster fishery.

*There's a lot of latency in the urchin industry and the groundfish industry and in the lobster fishery. There's some guys who just won't give up their licenses but there's a very long wait list.* [Fisher #3].
Another fisher noted:

*That latent license thing. What seems to be the problem? Use it or lose it. There are a lot of people who would like a shot at this lobster glut before they are gone. Or is that the plan?* [Fisher #1].

The economic impacts of latency were identified as a threat both to fishermen and to the Department of Marine Resources that manages state licenses. As one newspaper noted:

*There would be a significant fiscal impact to the department that regulates the lobster fishery if all latent license holders suddenly relinquished their licenses and stopped paying their fees.*

-Mistler, S. *Kennebec Journal* (02.18.2016)

A fisher observed:

*If all latent urchin licenses were activated, all the guys fished, the ones that had licenses, I don't think the resource could stand that much pressure. Ground fishing, if all the licenses fished, it'd be interesting to see who could actually make the cut, because there's only so much allocation, there's only so many fish allowed to be caught and if everyone takes a bigger piece of the pie, the pie gets pretty small.* [Fisher #5].

One newspaper noted that recovery in a fishery, such as the scallop fishery, might motivate latent license holders to reactivate their licenses.

*As the fishery has recovered, it has become more attractive to pursue. Many fishermen got licenses just before the freeze on new licenses went into effect in 2009, but not all actually fished for scallops when catches were low. Now that catch volumes and the price have increased, more of those so-called "latent" licenses are being put to use, resulting in*
more competition on the water.


**Biological implications**

Perceptions on the biological implications of latency from fisher interviews and newspaper articles conflicted. Some fishers noted that licenses not in use are a form of conservation because there is no fishing associated with them. Multiple license holders expressed concerns that the unpredictability of reactivated latent licenses threatens the long-term sustainability of fisheries. As one license-holder noted:

*Many lobstermen are licensed to use more traps than they actually set in the water, and the potential for those latent traps to be actively used could increase the statewide fishing effort and have an adverse impact on the resource.* [Fisher #3].

Officials from the Maine Department of Marine Resources were quoted in a local newspaper:

*A lobster biologist with DMR, told fishermen at Tuesday's meeting that state officials do not believe adjusting the number of traps in the water would have a noticeable impact on the lobster resource. Reducing the number of traps in use could have meaningful social or economic benefits for fishermen, he said, but it likely would not have any meaningful biological impact on the gulf's lobster population.*

-Trotter, B. *Bangor Daily News* (04.01.2014)

**Policy implications**

Potential policy and management implications associated with latent effort were highlighted in newspapers and emerged as a prominent theme from interviews. A newspaper noted that
management decisions are made based on information such as the number of licenses in a fishery, which includes those that are latent:

*Federal officials assume all those latent traps could end up in the water at any time when they enact new regulations.*

- Trotter, B. *Bangor Daily News* (04.01.2014)

*They [managers] consider those licenses active, even though they're not. They're not figured into the calculations, but there’s potential there. [Fisher #2].*

*Flexibility*

A positive implication of latent effort identified by multiple participants is the individual flexibility that it allows them to strategically participate in the fishery. This flexibility enables license-holders to take on other jobs, to fish when they want to, when they can participate, and when it is profitable for them. One participant observed that this flexibility gives people who are passionate about fishing the opportunity to fish:

*You know, everybody is in it, but not everybody grows up in it and stays there forever. We're not serfs, we are modern people with complex lives and we're doing all kinds of things in our lifetimes. The average is what, three, four major jobs or professions in the course of a person’s life? We are no different. There are just an awful lot of people still in the business who were born in and stayed in it all their life and went off to school or through the service or came ashore for one thing or another. I was injured for a period of time and taught school for a few years. But as soon as I was well enough, I went fishing. And today with the latent licenses, if you eliminate them, you void a whole section of*
people’s lives. And people, people end up going back fishing because they love it. [Fisher #3].

<table>
<thead>
<tr>
<th>Identified Effects of Latency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Social</strong></td>
</tr>
<tr>
<td>• Potential congestion on water</td>
</tr>
<tr>
<td>• Fiscal impact to department from latent licenses</td>
</tr>
</tbody>
</table>

Table 13. Summary of real and perceived effects of latent effort in Maine’s commercial fisheries noted by participants.

4.4 Discussion

The ability of fishers to adapt in specific ways in response to change is influenced by social, economic, and institutional forces operating at scales ranging from individual fishers to global economies (Daw et al., 2012). Understanding fishers decision-making processes, their interactions with governance structures, and their adaptive responses is essential for anticipating broader fisheries outcomes and for predicting the capacity that fishers have to adapt to future changes. We sought to understand why individuals hold on to fishing licenses when they are not actively fishing and explored potential and real effects of this latent effort on individual adaptive capacity. Those who hold latent licenses can activate them at any time without restrictions, a
phenomenon that has caused concern for both fishers and managers in Maine. By evaluating the current level of latency in Maine, identifying patterns and types of latency, and interviewing fishers about perceptions of the implications of latency, we reveal the tension it creates between managers need for predictability and fishers’ preparations for uncertainty.

An analysis of state and federal landings and licenses in Maine’s commercial fisheries from 2010 to 2017 highlighted that a significant proportion of individuals that hold licenses are not actively participating in any fishery (36% to 49%). When we examine harvesting history by year, individuals exhibit unique patterns of license redeployment that can be grouped into categories, or types of latency. These categories reflect patterns of engaging and disengaging from fishing while retaining a license. To explore the underlying motivations and implications of latency, we interviewed fishers across a range of fishing sectors who hold latent licenses. Interviews highlighted that an individual may choose to keep a license when they are not fishing for variety of reasons. Participants noted changing personal circumstances (e.g., injury, economic hardship), predicting changes in other fisheries (e.g., changing fish assemblages with warming oceans), and anticipating changing management (e.g., the move towards transferability of licenses, the implementation of buyback programs) as motivations for keeping licenses. Interviews highlighted that fishers are holding on to licenses to buffer against regulatory, market, and environmental uncertainty. In this way, latency allows for individual flexibility, as fishers can choose to strategically participate in a fishery when they want to, within the operating rules of the fishery.

Fishers interviewed in this study emphasized that while latency creates this individual flexibility, latent license holders can reactivate their license at any time, potentially posing complex and uncertain impacts to fisheries systems. Impacts of latency spanned social,
economic, and ecological concerns and included implications for overfishing and long-term sustainability of resources, overcrowding on fishing grounds, diluted profits, and misinformed management decisions. In addition to concerns regarding reactivated latent effort, participants repeatedly emphasized that latent license holders are preventing new participants from entering fisheries in Maine, many of which are characterized by long waitlists and strict limited-entry systems.

Our results indicate that latency creates tension between fishers’ and managers needs to cope with uncertainty. Managers depend on information about a fisheries system, such as accurate numbers of harvesters, effort, and catch, in order to determine when to open and close a fishery and to inform how many licenses are issued. Licenses are allocated to a finite number of individuals who are considered active participants when given access to a fishery. In this way, licenses are an act of governing that is intended to make fisheries activities more legible (Scott, 1998). When fishers retain licenses that they are not actively using and redeploy them at will, they create uncertainty for managers that complicates their ability to predict and control the system. However, fishers exhibit latency as a strategy to buffer against regulatory, environmental, and market uncertainty. Their mobilization of latent licenses is a strategy employed to mitigate and respond to variability in income and anticipate the need to adapt to changes in governance that may impact their access to a fishery. There is some irony in the fact that fishers and managers are both trying to grapple with uncertainty and control but appear to be caught in a loop that actually perpetuates it.

4.5 Conclusion

A variety of adaptive responses and behaviors that fishers employ to respond and buffer against uncertainty in natural resource economies that are prone to changes have been
documented (e.g. Mumford et al., 2009; Sethi, 2010; Schindler et al., 2010; Badjeck et al., 2010). Based on our analysis of latent effort in Maine and phenomenological interviews, this work highlights that latent license redeployment should be considered as an additional strategy used by fishers. We evaluated latency on an annual basis; it would be beneficial in the future to investigate longer and shorter temporal scales. Understanding how latent effort differs by fishery is another area ripe for future studies. Our study qualitatively explored the individual motivations for latent license deployment. Future studies that assess the social and ecological triggers of license redeployment should consider how latent effort changes in the face of broader-scale ecological and economic disturbances, e.g., recessions, national emergencies and, rapid ecological changes that impact global economic stability such as recessions, national emergencies and, rapid ecological changes.

This work demonstrates how adaptive responses to change at the individual scale are influenced and in turn influence adaptation and governance at multiple scales. We highlight that latent effort has the potential to cause social, ecological, and economic impacts in fisheries systems. Latent licenses can also create flexibility in fisheries systems that can enhance individual fishers’ adaptive capacity to buffer against socioeconomic and environmental change. The complexity, tradeoffs, and feedbacks associated with latent effort should considered by management agencies and other institutions, when policies are considered that to address and potentially remove latent licenses entirely from fisheries.

Calls to reduce and eliminate latent effort have been historically proposed for the lobster fishery in Maine and in other coastal fisheries such as New York’s commercial fisheries (Lapointe, 2019). It is critical that efforts to address latent effort in fisheries consider the individual flexibility and adaptive capacity it provides fishers as well as the underlying social
and economic motivations for retaining licenses. This can inform potential solutions such as distributing certificates of recognition that celebrate retired fishers, which could possibly prevent individuals from retaining licenses as a token of fishing identity, freeing up licenses for others to enter the fishery. The implementation of tiered licensing systems has been proposed for the lobster fishery in Maine, where license holders are placed at a certain tier based on effort history and latent license holders can keep their licenses and have a systematic path to enter the fishery based on effort (Dayton, 2012). These tiered systems could be considered for other fisheries as a mechanism to control latent effort.

To address latency in management, it is first necessary for fishing institutions to monitor and gather information about how latent effort in a fishery changes through time. Evaluating landings history at the individual fisher scale, as demonstrated in this study, can inform social, economic, and ecological goals related to sustainable marine fisheries. Monitoring adaptive responses and considering how system-level adaptive capacity is impacted as individuals respond to change may allow for a deeper understanding of feedbacks and potential improvements to governance approaches for building adaptive capacity.
CHAPTER 5

THESIS CONCLUSION

Social and ecological changes in fisheries systems interact across spatial and temporal scales, creating challenges that are difficult to manage in the face of uncertainty. In order to build and maintain resilience in complex social-ecological systems, there is a need to understand the factors that enable resilience and adaptation. This thesis explores several key elements for managing resilience in fisheries systems, based on an integrative social-ecological systems perspective (Ostrom, 2009). While many researchers have focused on managing resilience in global, large-scale fisheries systems, here I highlight the importance of smaller scales with examples of social-ecological systems relevant to national fisheries management, coastal communities, and individual fishers (Charles, 2012). By examining fisheries governance challenges at the national, community, and individual fisher scale, themes of participation, adaptation, and innovation in governance emerge; each plays a critical role in managing for resilient fisheries systems.

Chapter 2 examined the theoretical and practical linkages between ecosystem-based fisheries management and fisheries co-management, two concepts in fisheries management that have been highly regarded as the future of fisheries conservation but have traditionally been viewed as disparate approaches. Through an extensive review of the peer-reviewed literature aimed at assessing the drivers, attributes, and outcomes of EBFM and fisheries co-management, I highlight the overlap that exists between these two concepts. I review three marine resource initiatives in the United States that exemplify how EBFM and fisheries co-management are being integrated in practice. I propose that that the relationship between these management concepts exists along a continuum, with elements of co-management regularly appearing in conventional
management regimes and elements of EBFM appearing in co-management approaches. Managers who focus on understanding the interactions and interconnectivity of marine systems demand both the fine scale and local knowledge that is foundational to co-management. This requirement brings the concepts of EBFM and co-management closer together. A deeper engagement in the idea that these management approaches exist along a continuum and further consideration of the role that stakeholders play in ecosystem-based fisheries management is necessary in order to bring these ideas together and integrate them in practice.

Chapter 3 explores the role that municipal comprehensive plans play as tools for communities to implement strategies that build local adaptive capacity in the face of socioeconomic and environmental change. At the community scale, planning for change is critical to ensuring resilient coastal communities. In Maine, the comprehensive planning process provides a platform for communities to articulate policies that address social, economic, and environmental issues. While comprehensive plans were initially required of municipalities to address issues related to urban sprawl over thirty years ago, a broad range of challenges face coastal communities today. Through an analysis of 30 comprehensive plans from coastal communities across the state, I investigate the degree to which plans incorporate key principles of social-ecological resilience. The results reveal significant variability across comprehensive plans, with some communities addressing key indicators of resilience and others engaging with them in a limited way. This work underscores that resilience planning requires significant structural shifts to address the root causes of challenges in the community, as well as a paradigm shift in planning to move towards a more proactive, holistic consideration of resilience. By more explicitly incorporating principles of social-ecological resilience, the next generation of comprehensive plans can be repurposed to serve as tools for communities to implement
strategies that build adaptive capacity as they face unprecedented challenges and plan for a changing world.

Chapter 4 is focused on the role that latent effort plays in individual fishers’ resilience planning. The ability for individual fishers to make particular adaptations in response to change is influenced by social, economic, and institutional factors operating at scales ranging from individual fishers to global economies (Daw et al., 2012). Understanding fishers decision-making processes, their adaptive responses, and their interactions with governance structures is essential for anticipating broader fisheries outcomes and predicting the capacity of fishers to adapt to future change. The purpose of this chapter is to understand why fishers hold on to fishing licenses that they are not using. Through a quantitative analysis of Maine’s commercial fisheries landings and license data, I assessed patterns of latent license deployment across Maine’s fisheries through time. I employed the qualitative approach of phenomenology to interview fishers about their motivations for holding latent licenses and captured varied perspectives surrounding the impacts of latency in Maine’s commercial fisheries. This work highlighted that fishers are holding on to licenses to buffer against regulatory, market, and environmental uncertainty. When fishers hold on to licenses that they are not using, it creates tension between managers’ need for predictability and fishers flexibility in managing uncertainty. These results demonstrate how adaptive responses to change at the individual scale are influenced, and in turn influence factors at multiple scales. This work highlights that latency creates flexibility in fishing licensing systems that can enhance individual fishers’ adaptive capacity.

In each of the cases analyzed, adaptation may be viewed through a governance lens, to focus on policy measures and mechanisms that enable system resilience in the face of change.
Although each chapter is distinct in scale and scope, this work as a whole highlights the importance of understanding how attributes that enable resilience in fisheries systems at the individual fisher and local community scale can be scaled up and applied to fisheries governance arrangements more broadly, and that insights from large-scale arrangements can be applied more locally.
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APPENDIX A: Comprehensive Plan Project Summary

Comprehensive Plans as Tools for Coastal Community Resilience

Background
Coastal communities in Maine face threats from compounding ecological, economic, and social stressors. While national and state policies acknowledge the importance of resilient coastal communities, many decisions about how to adapt to threats and remain resilient in the face of environmental and economic change will need to be made at the community level. Coastal communities may be better able to prepare for the impacts from socioeconomic and environmental change if they begin preparing now. Planning for resilience is integral to ensuring the longevity of coastal communities and building local adaptive capacity in the face of ecological and socioeconomic change.

Comprehensive Plans
Comprehensive plans are documents written by communities that are designed to guide the future actions and direction of those communities. Plans serve as a platform for communities to develop policies that encourage responsible use of coastal resources in order to foster social-ecological resilience. Several key planning dimensions are critical to advance social-ecological resilience in coastal communities: resilience of ecosystems and natural coastal environments, social resilience, and economic resilience.

Comprehensive Plan Analysis
A review of 30 active comprehensive plans from coastal communities in Maine among three categories of resilience revealed that municipalities overall are not incorporating social-ecological resilience principles in their comprehensive plans (Figure 1). Further, there is variability in the extent to which components of resilience are addressed in comprehensive plans, with social characteristics outweighing ecological and economic components (Figure 2).

Figure 1. Total resilience score for each municipality. Total scores calculated for each municipality out of a maximum score of 100%.
Figure 2. Comprehensive plan analysis scores by resilience category and mapped by municipality.

**Conclusion**

- Anticipating potential changes through the early implementation of resilience principles can be cost effective and can provide current and future benefits to communities. The comprehensive planning process provides a platform for communities to envision the future and outline objectives and policies that address social, economic, and environmental issues.

- Comprehensive plans along Maine’s coast have largely not altered from the original requirements of the Comprehensive Planning and Land Use Act. This act was written in the 1988 to encourage towns to address the impacts of rapid population growth. New, expansive directions beyond inventorying community resources are required to reform how comprehensive plans are made.

- Climate change is currently and will continue to impact every aspect of municipalities including infrastructure, but also public health, housing, and biodiversity. Building resilience requires significant structural shifts to address the root causes of challenges in the community as well as a paradigm shift in planning to move towards a more proactive and holistic approach to resilience.

- Resilience-building is an ongoing process and comprehensive plans are living documents that foster a platform for coastal communities to implement strategies to build adaptive capacity as we face unprecedented challenges and plan for a changing world.

For more details about this work, contact:
Marina Cucuzza\(^1\),\(^2\), Joshua Stoll\(^1\),\(^3\), & Heather M. Leslie\(^1\),\(^2\)

School of Marine Sciences, University of Maine\(^1\), Darling Marine Center\(^2\), Maine Center for Coastal Fisheries\(^3\)

marina.cucuzza@maine.edu, joshua.stoll@maine.edu, heather.leslie@maine.edu,

Saltonstall-Kennedy Grant Program NA17NMF4270198
APPENDIX B: Georgetown Comprehensive Plan Survey

Georgetown Comprehensive Plan-Marine Resources Survey

A survey of Georgetown residents with fishing licenses

Dear Georgetown resident,

The Town of Georgetown is in the process of updating the Georgetown Comprehensive Plan. To help inform its development, you are encouraged to participate in a Marine Resources Survey of commercial fisheries license holders. The goal of this survey is to learn more about marine resource uses and better understand your perspectives on the challenges and opportunities related to fisheries in the area.

This survey is being administered by the University of Maine on behalf of the Town of Georgetown. As an active commercial fisher, your name and contact information were obtained from the Maine Department of Marine Resources and Greater Atlantic Marine Fisheries Office. All responses you provide in this survey will be anonymous.

Following the survey, we will be conducting in-person interviews and will mail out a survey follow-up postcard with more information. If you would be open to participating in an in-person interview in the future, please fill out your contact information and return the post card to schedule an interview.

*Please return* the enclosed *questionnaire* using the *pre-addressed* postage paid *envelope*.

Thank you for your time,

Marina Cucuzza
Dual M.Sc. Student, Marine Biology & Marine Policy
School of Marine Sciences, University of Maine
Marina.cucuzza@maine.edu
781-888-6450
Informed Consent Form for Participation in a Research Study

Purpose: You are invited to participate in a research project being conducted by Marina Cucuzza, a Marine Sciences graduate student at the University of Maine, Joshua Stoll and Heather Leslie, faculty at the School of Marine Sciences at the University of Maine. This survey is being administered by the University of Maine on behalf of the Town of Georgetown. The purpose of this research is to assess marine resource use in Georgetown to inform the marine resources section of the Georgetown Comprehensive Plan. As an active commercial fisher, your name and contact information were obtained from the Maine Department of Marine Resources and Greater Atlantic Regional Fisheries Office. All responses you provide in the survey will be kept confidential.

What will you be asked to do? If you decide to participate, please complete the attached survey about your fishing activities, the species you fish, the areas you fish, and your observations about fisheries in Georgetown. It may take approximately 30 minutes to complete the survey.

Risks: Except for your time and inconvenience, there are no risks to you from participating in this study.

Benefits: Although there are no direct benefits to you from participating in this study, the information gained from the survey will help to inform the marine resources section of the Georgetown Comprehensive Plan. The Comprehensive Plan process provides a platform for the town to identify issues related to marine resources in Georgetown and establish policies to address these issues. As such, the information you provide will directly inform the communities goals related to the future of marine resources in Georgetown.

Confidentiality: All of your responses will be anonymous. Only the researchers involved in this study and those responsible for research oversight will have access to the information you provide. Your name will not be on any of the data. Data will be kept on a password-protected computer and deleted in January 2023. Hard copies of the surveys will be destroyed in 2020.

Voluntary: Participation in this research study is voluntary. If you choose to take part in the study by completing the survey, you may stop at any time. You may skip questions you do not wish to answer.

Contact information: If you have any questions about this study, please contact Marina Cucuzza at marina.cucuzza@maine.edu, or at 781-888-6450, Joshua Stoll at joshua.stoll@maine.edu or 207-581-4307, or Heather Leslie at heather.leslie@maine.edu or 207-563-3146. If you have any questions about your rights as a research participant, please contact the Office of Research Compliance, at 207-581-1498 or 207-581-2657 (or email umric@maine.edu).

UMaine IRB #2018-05-13 Approved 2018-06-19
Georgetown Comprehensive Plan-Marine Resources Survey

1. Is your household involved in growing, catching, or harvesting seafood?  ○ Yes  ○ No

2. How many individuals in your household receive income from fishing?
   ○ 1  ○ 2  ○ 3  ○ 4  ○ 5  ○ More than 5

3. Is your household involved in commercial or recreational fishing?
   ○ Commercial  ○ Recreational  ○ Both commercial & recreational

4. What do you currently fish for (including in the capacity of crew or assistant)?
   ○ Lobster  ○ Eel/elver
   ○ Bloodworms/sandworms  ○ Sea urchin
   ○ Softshell clams  ○ Shrimp
   ○ Scallop  ○ Bluefin tuna
   ○ Oyster  ○ Crab
   ○ Quahog
   ○ Groundfish (specify) ________________________________
   ○ Other (specify) ________________________________

5. What time of year do you fish? (Select all that apply)
6. What commercial fishing licenses or permits do you currently hold?

- Lobster
- Bloodworms/sandworms
- Softshell clams
- Scallop
- Oyster
- Halibut (endorsement)
- Groundfish (specify)

________________________________________________

7. Have you held other fishing licenses in the past?

- No
- Yes (please specify) ________________________________
8. What gear types do you use? (Check all that apply)

- Dredge
- Gillnet
- Raft/Cage
- Hook and line
- Traps
- Trawl
- Other (please specify)

9. Of the species you target, please indicate the relative trends in their availability in the last 5 years.

<table>
<thead>
<tr>
<th>Species</th>
<th>Large Increase</th>
<th>Increase</th>
<th>Remained the Same</th>
<th>Decrease</th>
<th>Large Decrease</th>
<th>Unsure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lobster</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bloodworms/sandworms</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Softshell clams</td>
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<tr>
<td>Oyster</td>
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<tr>
<td>Quahog</td>
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<td>Groundfish</td>
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<tr>
<td>Crab</td>
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<td>Eel/elver</td>
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<td>Sea urchin</td>
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<tr>
<td>Bluefin tuna</td>
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<tr>
<td>Other</td>
<td></td>
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</tbody>
</table>
10. For the numbered areas on the map below, please specify your level of fishing activity from VERY LOW to VERY HIGH and the species you target for each area. Please write more than one species per area if appropriate.

<table>
<thead>
<tr>
<th>Area</th>
<th>Very Low</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
<th>Very High</th>
<th>Specify target species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lobster</td>
</tr>
<tr>
<td>(1) Sheepscot River</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>(2) Robinhood Cove</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>(3) Harmon’s Harbor</td>
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<td>(4)</td>
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<td>(5)</td>
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<tr>
<td>(6) Sagadahoc Bay</td>
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<tr>
<td>(7) Heal Eddy</td>
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<tr>
<td>(8) Todd Bay</td>
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<td></td>
<td></td>
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<tr>
<td>(9) Hockomock Bay</td>
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<td></td>
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<tr>
<td>(10) Kennebec River</td>
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</tbody>
</table>
11. If there are areas not depicted on the map where you fish, please specify below:

<table>
<thead>
<tr>
<th>General fishing Area</th>
<th>Very Low</th>
<th>Moderate</th>
<th>High</th>
<th>Very High</th>
<th>Specify Target Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example: Cashes Ledge</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>Groundfish</td>
</tr>
</tbody>
</table>

12. Do you have any other sources of income other than commercial fishing?

- [ ] Yes
- [ ] No

13. If YES, what percent of your livelihood comes from non-fishing activities?

- [ ] Less than 25%
- [ ] 25-50%
- [ ] 51-75%
- [ ] More than 75%

14. How do you access the water and what type of water craft (ex. kayak, lobster boat) do you launch there? (check all that apply)

- [ ] Todd’s Landing: vessel type______________________________
- [ ] Five Islands: vessel type______________________________
- [ ] Private Property: vessel type______________________________
- [ ] Other (please specify location and vessel type)______________________________

_____________________________________________________________________________

_____________________________________________________________________________
15. Do fishers from other zones or towns come to Georgetown to commercially harvest marine resources?

- Yes
- No
- Unsure

16. If YES, what species do they harvest and where?

____________________________________________________________________________________

____________________________________________________________________________________

17. If YES, what areas do they come from?

____________________________________________________________________________________

____________________________________________________________________________________

18. Does your household engage in fishing or aquaculture activities in any areas outside of Georgetown?

- No

If YES, please list all the areas that you go to and what you harvest there:

____________________________________________________________________________________

____________________________________________________________________________________

19. What are the three most economically important marine species from the region?

1. __________________________________________

2. __________________________________________

3. __________________________________________
20. Do you participate in any local fisheries meetings (ex: shellfish committee)?

- [ ] No
- [ ] Yes (please specify) ________________________________________________

21. Do you participate in any regional fisheries meetings (ex: lobster zone, scallop zone meetings, New England Fisheries Management Council)?

- [ ] No
- [ ] Yes (please specify) ________________________________________________

22. Do you participate in any fisheries cooperatives?

- [ ] No
- [ ] Yes (please specify) ________________________________________________

23. How strong is local leadership in the fishing industry?

- [ ] High
- [ ] Moderate
- [ ] Low

24. Who are the local fishing leaders in Georgetown?

____________________________________________________________________________

____________________________________________________________________________

____________________________________________________________________________
25. Who buys the seafood you catch or produce? (Check all that apply)

- Dealer
- Cooperative
- Market/grocery store
- Restaurant
- Private individual
- Other (please specify) ___________________________________________

26. What is the average time it takes you by car to reach a dealer to sell your product?
______________________________________________________________

27. To what extent are fisheries regulations enforced where you fish?

- Unknown
- Very poorly
- Poorly
- Sufficiently
- Well
- Very well

28. Do you have concerns regarding fisheries other than your own (ex. gear conflict)?

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

127
29. What is your vision for the future of marine resources in Georgetown?

________________________________________________________________________________

________________________________________________________________________________

________________________________________________________________________________

30. Do you have suggestions on how to improve marine resources in Georgetown in the future?

________________________________________________________________________________

________________________________________________________________________________

________________________________________________________________________________

Demographic Information:

1. What is the nature of your residency in Georgetown?
   
   ○ Primary residence
   ○ Rent property and reside for more than 6 months per year
   ○ Own property and reside for more than 6 months per year

2. Age: __________

3. Gender:
   
   ○ Female
   ○ Prefer to self-describe__________________________
   ○ Male
   ○ Prefer not to say
   ○ Non-binary/third gender
4. Race:
   - White
   - Black or African American
   - American Indian or Alaska Native
   - Asian
   - Native Hawaiian or other Pacific Islander

5. What is the highest level of school you have completed or the highest degree you have received?
   - Less than high school degree
   - High school degree of equivalent (e.g., GED)
   - Some college but no degree
   - Associate degree
   - Bachelor degree
   - Graduate Degree

6. How many other people live in your household, including yourself?
   - 1
   - 2
   - 3
   - 4
   - 5
   - More than 5

7. What is your household income?
   - $0-$9,999
   - $10,000-$19,999
   - $20,000-$29,999
   - $30,000-$39,999
   - $40,000-$49,999
   - Over $100,000
   - Prefer not to answer

8. How much money did you personally earn in 2017?

- [ ] $0-$9,999
- [ ] $10,000-$19,999
- [ ] $20,000-$29,999
- [ ] $30,000-$39,999
- [ ] $40,000-$49,999
- [ ] Over $100,000
- [ ] $50,000-$59,999
- [ ] $60,000-$69,999
- [ ] $70,000-$79,999
- [ ] $80,000-$89,999
- [ ] $90,000-$99,999
- [ ] Prefer not to answer

Thank you for taking the time to complete this survey. Your input is valuable to the development of the marine resources section of the Georgetown Comprehensive Plan.

If you have any further questions regarding this survey, please contact Marina Cucuzza at marina.cucuzza@maine.edu or 781-888-6450.

Please return this survey using the pre-addressed postage paid envelope.
APPENDIX C. Georgetown Household Survey of Harvesters: Results

Introduction:

A household survey of recreational and commercial fisheries license holders was distributed in August of 2018 by the University of Maine on behalf of the Town of Georgetown. The purpose of the survey was to assess the different types of marine resource uses in Georgetown and to better understand perspectives on the challenges, concerns, and opportunities related to marine resources from those directly engaged in fishing. Responses to the survey helped to inform the marine resources section of the Georgetown Comprehensive Plan. Additionally, Georgetown was selected as a focal community for the University of Maine Coastal Community Resilience Project. Survey responses and engagement with the Georgetown marine resources committee provided insight into the challenges that coastal communities in Maine face and how Maine communities are planning for the future. The sections below provide an overview of the UMaine Coastal Community Resilience Project as well as a summary of the responses to the Georgetown Marine Resources survey.

Georgetown Engagement in the University of Maine Coastal Community Resilience Project:

The Maine Coastal Community Resilience project is a collaborative research project between the School of Marine Sciences, the Maine Department of Marine Resources, Maine Sea Grant, and the Maine Center for Coastal Fisheries. The overall goal of the project is to assess the capacity for sustainability of fishing-dependent communities in coastal Maine in the face of environmental and socioeconomic change. The project aims to increase the capacity among fishermen and other community members, local decision makers, researchers, and resource managers to work together on solutions-oriented science and community development projects. The Georgetown Marine Resources Committee signed a Memorandum of Understanding with the University of Maine for the purposes of researching and preparing the Marine Resources section of the revised comprehensive plan. Members of the University of Maine team assisted in analyzing town level commercial fishing license and landings trends, mapping marine resource use, as well as conducting the marine resources comprehensive plan survey as detailed below.
Georgetown Marine Resources Survey of Recreational and Commercial Fisheries License Holders

A total of 17 fishers in Georgetown participated in the marine resource survey. All respondents are full-time Georgetown residents ranging in age from 23-72.

1.) How many individuals in your household receive income from fishing?

![Bar chart showing income from fishing](chart1)

2.) Is your household involved in commercial or recreational fishing?

![Bar chart showing fishing type](chart2)
3.) What do you currently fish for?

4.) What time of year do you fish?
5.) What commercial fishing licenses or permits do you currently hold?

6.) Have you held other fishing licenses in the past?
7.) What gear types do you use?

8.) Of the species you fish, please indicate the relative trends in availability of that species in the last 5 years.

<table>
<thead>
<tr>
<th>Species</th>
<th>Observed Trends in Availability</th>
<th>Number of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft-shell clam</td>
<td>Decrease</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Remained the same</td>
<td>3</td>
</tr>
<tr>
<td>Lobster</td>
<td>Remained the same</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Increase</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Significant increase</td>
<td>2</td>
</tr>
<tr>
<td>Bloodworm/Sandworm</td>
<td>Decrease</td>
<td>1</td>
</tr>
<tr>
<td>Crab</td>
<td>Decrease</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Remained the same</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Increase</td>
<td>2</td>
</tr>
<tr>
<td>Tuna</td>
<td>Remained the same</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Increase</td>
<td>2</td>
</tr>
<tr>
<td>Groundfish</td>
<td>Remained the same</td>
<td>1</td>
</tr>
<tr>
<td>Striper</td>
<td>Significant decrease</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Increase</td>
<td>1</td>
</tr>
<tr>
<td>Urchin</td>
<td>Significant decrease</td>
<td>1</td>
</tr>
<tr>
<td>Oyster</td>
<td>Increase</td>
<td>2</td>
</tr>
</tbody>
</table>
9.) For the numbered areas on the map below, please specify your level of fishing activity from VERY LOW to VERY HIGH and the species you target for each area.
<table>
<thead>
<tr>
<th>Area</th>
<th>Very Low</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
<th>Very High</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Sheepscot River</td>
<td>Lobster(2)</td>
<td></td>
<td>Lobster (2)</td>
<td>Lobster (2)</td>
<td>Lobster(3)</td>
</tr>
<tr>
<td>(2) Robinhood Cove</td>
<td>Lobster (3)</td>
<td>Clams (1)</td>
<td>Lobster(1)</td>
<td>Lobster(1)</td>
<td>Lobster(2)</td>
</tr>
<tr>
<td></td>
<td>Stripe (1)</td>
<td>Lobster(1)</td>
<td></td>
<td>Pelagic(1)</td>
<td>Oysters(2)</td>
</tr>
<tr>
<td></td>
<td>Lobster (2)</td>
<td>Clams (1)</td>
<td>Lobster(2)</td>
<td></td>
<td>Quahog (1)</td>
</tr>
<tr>
<td>(3) Harmon’s Harbor</td>
<td>Striper(1)</td>
<td>Clams (1)</td>
<td>Lobster(1)</td>
<td>Lobster (1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lobster(2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4)</td>
<td></td>
<td>Lobster(1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5)</td>
<td></td>
<td>Lobster(1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) Sagadahoc Bay</td>
<td>Lobster (1)</td>
<td></td>
<td>Soft shell clams(2)</td>
<td>Lobster(1)</td>
<td>Lobster(1)</td>
</tr>
<tr>
<td></td>
<td>Stripe (1)</td>
<td></td>
<td>Surf clams(1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(7) Heal Eddy</td>
<td>Lobster (1)</td>
<td>Clams (1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stripe (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(8) Todd Bay</td>
<td>Lobster (1)</td>
<td>Clams (1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stripe (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(9) Hockomock Bay</td>
<td>Lobster (1)</td>
<td></td>
<td>Lobster(1)</td>
<td>Clams (1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stripe (1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(10) Kennebec River</td>
<td>Lobster (1)</td>
<td>Clams (1)</td>
<td></td>
<td>Striper (1)</td>
<td>Lobster(1)</td>
</tr>
<tr>
<td></td>
<td>Mackerel (1)</td>
<td></td>
<td></td>
<td>Stripe (1)</td>
<td></td>
</tr>
</tbody>
</table>
10.) Do you have any other sources of income other than commercial fishing?

11.) What percent of your livelihood comes from non-fishing activities?
12.) How do you access the water and what type of water craft do you launch there?

<table>
<thead>
<tr>
<th>Access Point</th>
<th>Water Craft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Todds Landing</td>
<td>Skiff (4) Lobster boat (2)</td>
</tr>
<tr>
<td>Private property</td>
<td>Skiff (2) Kayak (2) Center console (2) Lobster boat (5) Sail boat (1)</td>
</tr>
<tr>
<td>Mooring</td>
<td>Skiff(1)</td>
</tr>
<tr>
<td>Five Islands</td>
<td>Lobster boat (4) skiff(4)</td>
</tr>
</tbody>
</table>

13.) Do fishers from other zones or towns come to Georgetown to commercially harvest marine resources?

![Bar Chart: Yes: 12, Unsure: 2]
14.) What are the three most economically important marine species from the region?

15.) Do you participate in any local fisheries meetings (ex. Shellfish committee)?
16.) Do you participate in any regional fisheries meetings (ex: lobster zone, scallop zone meetings)?

17.) Do you participate in any fisheries cooperatives?
18.) How strong is the local leadership in the fishing industry?

19.) To what extent are fisheries regulations enforced where you fish?
20.) Do you have concerns regarding fisheries other than your own?

<table>
<thead>
<tr>
<th>Concerns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worming</td>
</tr>
<tr>
<td>Commercial lobster license holders that don't put any traps overboard. They don't fish at all.</td>
</tr>
<tr>
<td>Access to the water, closures, costs of fishing and farming going up (trap wire due to tariffs)</td>
</tr>
<tr>
<td>People who have commercial licenses that don't even own a boat or lobster trap</td>
</tr>
<tr>
<td>People who have commercial fishing licenses, but don't fish</td>
</tr>
<tr>
<td>Gear conflict, etiquette</td>
</tr>
</tbody>
</table>

21.) What is your vision for the future of marine resources in Georgetown?

<table>
<thead>
<tr>
<th>Vision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquaculture</td>
</tr>
<tr>
<td>Good if not overfished, i.e. too many new licenses</td>
</tr>
<tr>
<td>Sustain a good lobster fishery</td>
</tr>
<tr>
<td>Management stability and economic diversity</td>
</tr>
<tr>
<td>We need to support our local fishermen. The vocation is a large part of the Georgetown Island identity</td>
</tr>
<tr>
<td>Boat ramp other than Todd's Landing</td>
</tr>
<tr>
<td>Good, but it's overfished</td>
</tr>
<tr>
<td>Strong fisheries and aquaculture</td>
</tr>
<tr>
<td>Strong fisheries and aquaculture</td>
</tr>
</tbody>
</table>
22.) Do you have suggestions on how to improve marine resources in Georgetown in the future?

<table>
<thead>
<tr>
<th>For everyone working together</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grandfather licenses</td>
</tr>
<tr>
<td>Limits-no overfishing</td>
</tr>
<tr>
<td>Improve waterfront access. Not sure how to do that</td>
</tr>
<tr>
<td>Trap limits again</td>
</tr>
<tr>
<td>Waterfront access for oyster</td>
</tr>
<tr>
<td>Maintain restrictions on groundfish until they are restored to historic abundance and distribution</td>
</tr>
<tr>
<td>Invest in and protect them</td>
</tr>
</tbody>
</table>
Coastal communities in Maine face pressure from compounding ecological and economic threats. Changing ocean conditions, declines in key fisheries, the loss of working waterfront infrastructure, and shrinking access to the shore are among the many stressors that threaten the resilience of coastal fishing communities and the livelihoods of thousands of fishermen throughout the state. Like those of many coastal communities in Maine, Georgetown’s marine resources face an uncertain future. Planning plays a critical role in addressing local marine resource challenges that prepare the community to respond to these stressors.

Lobster is the most economically important species in Georgetown and while the recent lobster catch in our area has been stable, predicted declines leave our commercial fishermen facing an uncertain future. In the U.S. North Atlantic, fisheries data show that at least 85 percent of nearly 70 federally tracked species have shifted north or to deeper waters offshore, or both, in recent years when compared to the norm over the past half-century. The most dramatic of species shifts have occurred in the last 10 or 15 years. The lobster population has shifted north from Long Island, Rhode Island, Massachusetts and New Hampshire, migrating at a reported rate of 4.5 miles per year. Casco Bay has already begun to experience a decline. While Georgetown has benefitted from this northern shift of lobsters, our area may soon experience declines such as those that have devastated the southern New England lobster grounds. Local fishermen report catching southern species never before seen in our northern waters. In addition to species shifts, our commercial lobster fishermen face additional challenges including overfishing, decreased herring quotas recently imposed by the New England Fishery Management Council, bait shortages, and the prospect of more expensive trap wire as a result of federal government sanctions against steel producing countries. In addition to the above, in the 2018 Survey of Georgetown Commercial Fishermen conducted by the University of Maine (see appendices p. 149), fishermen voiced support for new trap limits and a call for the State to address commercial license holders who no longer fish.

The clam harvest in Maine reflects a similar pattern of decline that is felt locally. Wild harvest shell-fishermen in Maine have become increasingly vulnerable in recent years as their primary resource, the soft-shell clam, has experienced dramatic declines due to increased predation from the invasive European green crab and milky ribbon worms. This is a major concern in areas like Georgetown, where soft-shell clams are one of only two species that comprise 99% of the Town’s commercial landings.

Recent and Ongoing Initiatives

Oysters have become a viable economic aquafarming success in Robinhood Cove. Georgetown Aquaculture has received a 20-year, 14.2-acre lease in Robinhood Cove (see appendices map p. 170) to provide present and future cooperative space for resident independent farmers. In the coming years, it is foreseeable that local aquafarming could include quahogs, scallops and kelp.
A project in the Heal Eddy clam flat was unsuccessful in seeding and protecting juvenile clams to create a commercially viable recovery at current market prices. The site continues to be monitored to better understand the biological and financial implications of clam farming and, as a hands-on classroom for Georgetown Central School students to learn about clams, clam harvesting and intertidal ecology.

The Shellfish Conservation Committee, in cooperation with Manomet and the University of Maine, has received funds from the Maine Shellfish Restoration and Resilience Project to reintroduce the northern quahog, a hard-shell clam that can outgrow crab predators and may be less susceptible to predation by milky ribbon worms.

Efforts are being made locally and statewide to determine whether the invasive European green crab can be an economically viable resource.

Because Georgetown is ideally suited for fishing, digging, aquafarming and other marine-based activities, history suggests that the economic future of our marine industries will adapt and diversify to take advantage of new opportunities. As a respondent to the University of Maine Marine Survey stated, “it’s always something.”

**Marine Resources State Goal:**
To protect the State’s marine resources industry, ports and harbors from incompatible development and to promote access to the shore for commercial fishermen and the public.

**Georgetown Goal 1:**
While improving the ecological integrity and diversity of marine habitats, expand the marine economy to include sustainable harvest of multiple species.

**Action Items:**
- Encourage property owners who have overboard discharge systems to replace them where possible and educate other shoreland property owners on the importance of properly maintaining their in-ground systems. (4.1.1)
  - Timeline: 1 – 5 years
  - Primary Responsibility: Conservation Commission
- Educate and engage the community and School in marine resource issues and emerging sectors. (4.1.2)
  - Timeline: 1 – 5 years
  - Primary Responsibility: Shellfish Conservation Committee

**Georgetown Goal 2:**
Protect our marine resource industry, ports, and harbors from incompatible development, including the cumulative effect on coastal resources. Promote existing access to the shore for commercial fishermen and property taxpayers of Georgetown.

**Action Items:**
• Develop a recommendation for the succession of the Shellfish warden to ensure continuity in municipal shellfish enforcement. (4.2.1)
  ➢ Timeline: Ongoing
  ➢ Primary Responsibility: Shellfish Conservation Committee

• Proactively search for and recommend a landing that promotes use by commercial fisherman and recreational access for residents and their guests. (4.2.2)
  ➢ Timeline: 1 – 5 years
  ➢ Primary Responsibility: Town-Owned Property Management Board (TOPMB)
  ➢ Timeline: ongoing

• Benchmark user fees, facilities and services of neighboring town harbors and landings as a basis for planning and recommending future policy and ordinances. (4.2.3)
  ➢ Timeline: Ongoing
  ➢ Lead: Primary Responsibility: TOPMB

**Georgetown Goal 3:**
Promote the maintenance, development and revitalization of Georgetown landings and harbors for fishing, transportation, and recreation.

**Action Items:**
• Authorize and support the necessary levels of enforcement for waterfront facility use. (4.3.1)
  ➢ Timeline: Ongoing
  ➢ Primary Responsibility: Board of Selectmen

• Improve support facilities for marine resource use, such as parking, storage, etc. (4.3.2)
  ➢ Timeline: Ongoing
  ➢ Primary Responsibility: TOPMB

• Investigate and promote dialog with shorefront owners and conservation groups to create public and/or commercial water access. (4.3.3)
  ➢ Timeline: Ongoing
  ➢ Primary Responsibility: TOPMB and Conservation Commission

**Georgetown Goal 4 :**
Encourage and support the development of marine related programs with State, municipal, non-profit and research institutions.

**Action Items:**
• Explore and support youth mentorship programs. (4.4.1)
  ➢ Timeline: 1-5 years
  ➢ Primary Responsibility: Shellfish Conservation Committee
APPENDIX E: Georgetown Marine Resources Inventory Section

The Aquaculture Farms, Conserved Area, and Shellfish Closure Areas map, the Oyster Suitability map, and the Mudflat and Salt Marsh map appear in the Map Appendix. The Marine Survey of fisheries license holders appears in Appendix 1.

Purpose
The purpose of this section is to identify the Town’s key marine resources and assets that are integral to the identity and economy of the community. This inventory will guide the outline of strategies that will protect and improve coastal habitats, maintain and preserve the Town harbor and facilities, and assess access for commercial fishing, marine related activities, and recreation. Water quality is critical to marine resources and focused discussion is found in the Natural Resources section.

Marine Economy
Georgetown Island comprises 18.5 square miles of land and has 82.77 miles of ocean shoreline fronting deep water, tidal water, and salt marsh. Of this extensive shoreline, only a fraction is accessible to the public. Activities based on the salt water provide economic support for over one hundred commercial harvesters, and marine activities including fishing, boat building and maintenance and seafood sales.

The figure below depicts the total commercial fisheries licenses held by Georgetown residents from 2010-2016 (Maine DMR, 2018). This includes all state commercial fishing licenses and all classes of lobster licenses. The decrease in licenses after 2012 is largely due to the moratorium of the commercial shrimp fishery. Decreases in 2015 are due to declining commercial fishing licenses. An increase in licenses in 2016 is due to student licenses and increased commercial shellfish licenses. As the commercial aquaculture sector grows in Georgetown, we predict an increase in the number of commercial licenses held by Georgetown residents in the coming decade.
Over the past twenty-five years, overharvesting and climate variability has dwindled commercial fish stocks in the Gulf of Maine. For example, the urchin fishery peaked in 1996 with 33MM pounds caught and a value of $35MM statewide. In 2016, the urchin fishery was valued at $5MM with just 2MM pounds caught. Once the third most valuable commercial species to Georgetown, the shrimp fishery closed after the 2012 season and has not yet been reopened by the State.

The figures below depict trends in the total value and total pounds of Georgetown’s commercial fisheries landings from 2006-2016 (DMR Landings, 2017). Increases in landings and value in 2015 and 2016 have largely been due to increased lobster landings. As ocean temperatures in the Gulf of Maine rise, lobster populations migrate north. Georgetown may temporarily benefit from this northern migration of lobster, however, the impact of this warming trend on commercial species in the Gulf of Maine is largely uncertain (NOAA Climate Watch). Landings information only contains state license and landings. It should be of note that a small portion of fishermen in Georgetown have federal fishing permits. Landings values represent all commercially harvested species landed in Georgetown, including those of fishermen who are not Georgetown residents. With the opening of the Five I fuel dock in 2018 and stable lobster prices, it is likely that more fishermen will fuel up and land their catch in Georgetown, thus landings may likely increase in the next decade.
Maine’s marine economy has become disproportionately dependent on the lobster harvest and Georgetown landings reflect this statewide trend. In 2016, lobster made up 76% of Georgetown’s total landings as depicted below. Aquaculture is the fastest growing sector of Maine’s marine economy and in 2010 the first oyster farm in Robinhood Cove was established. In 2017 and 2018, ten new farms received Limited Purchase Aquaculture leases (LPAs) from the State and those farms began selling market sized oysters in the Fall of 2018. It is projected that 300,000 oysters will be harvested from aquaculture farms in Georgetown in 2019. At $0.80 per oyster sold wholesale, it is projected that Georgetown’s total landings may increase by $260,000 in 2019. While oysters are the only species currently being commercially grown in Georgetown, it is possible that additional species such as scallops and quahogs, and sea crops like kelp may further diversify the marine economy, broaden fishermen’s opportunities beyond lobster, and increase Georgetown’s total landings.

Despite projections of increases in total landings, Georgetown’s marine economy faces numerous challenges in the coming years. Consistent with our community demographic, the age of our commercial fishermen is also increasing. For example, of the twenty current commercial shellfish license holders, only four are full-time and most are over 40 years old. Additionally, for every five commercial lobster licenses given up, the State will issue only one new license. In October of 2018, the New England Fishery Management Council approved quota cuts and vessel restrictions in the herring fishery escalating the prospect of a shortage of herring bait for Maine's lobster fishing fleet, price increases for bait fish and concern about the long-term availability of
bait. As ocean waters warm and species migrate, Georgetown fishermen may experience increased expenses to harvest and may have to target locally available, underutilized, or undervalued species to minimize their cost to harvest, or travel further offshore to fish.

People have long been attracted to Maine for its beauty and the bounty available in the Kennebec Estuary and Casco Bay. Up and down the coast, Mainers are reliant on our marine resources to provide a marine economy and Georgetown is no different. As was identified in the 1993 Comprehensive Plan and in the 2018 Community Survey, the protection of marine resources and preservation of a marine economy are of great interest to the Town and should remain a priority in all present and future planning.

**Five Islands Harbor and Town Wharf**

The Georgetown Waterfront and Open Space Association was organized in May 1972. Its purpose was to raise $30,000 by public fundraising toward the $60,000 purchase of the Howard property, composed of woodlands, a shorefront field, wharf and wharf buildings. The Association raised $32,000. Matching funds came from the U.S. Department of the Interior and the Maine Department of Parks and Recreation. Despite perception that the Five Islands Wharf was donated to the Town, the establishment of the Wharf is exemplary of how our community raised and secured matching funds to establish the working waterfront as we know it today. Looking forward, the community should investigate additional opportunities to preserve the marine economy and secure recreational and commercial access to the water.
Picturesque Five Islands Harbor, located on the east side of the island facing the Sheepscot River, has an area of about 100 x 500 yards usable for moorings protected by offshore islands from easterly storms and free of ice throughout the winter. The main entrance to the harbor is northward of Malden Island. Boats can also enter from the northwest following the west shore and passing inside of all islands and shoals. Crow Island Ledge, west from Crow Island and at the north entrance, is marked by a day beacon. There is also a clear channel from the east, south of Malden Island.

Moorings in the harbor are used for both recreational and commercial boats. The harbor is, and has been for many years, at capacity. Mooring availability is infrequent, and the wait list’s oldest request dates to back to 1995.

The town-owned 700 square foot timber wharf is the hub of activity and attraction in Five Islands and is a working dock for loading and unloading of shellfish and finfish for bait and human consumption. Buildings on the wharf are leased by the Town for cold and wet storage and commercial wholesale and retail seafood sales. Five Islands Lobster Company is the current leaser and its take-out restaurant and ice cream shack have often been featured in the local and national media, drawing many tourists during the summer season.

On the north side of the wharf is the town-owned float which is utilized by commercial fisherman. The access provided by the wharf is estimated to be used by 90% of Georgetown’s fishermen and sternmen. Recreational boaters use a float on the south side of the wharf and Malden Island residents own and maintain a private float south of the recreational float. There is no facility in Five Islands for berthing of commercial or recreational boats.

The Town-Owned Property Management Board (TOPMB) is responsible for the maintenance, repair, and oversight of the Five Islands Wharf and other properties including First Church, Old Stone Schoolhouse, and Todd’s Landing. The largest part of the TOPMB’s annual budget is for the maintenance and repair of the Wharf.
The Select Board and Town have maintained multiple reserve funds exclusively for preservation of the marine economy, recreation and the working waterfront. Depicted below are the reserve fund balances from the 2016 – 2017 Town Report:

<table>
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<th>Fund</th>
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<tr>
<td>Harbor Emergency Reserve Fund</td>
<td>$26,549.94</td>
</tr>
<tr>
<td>Wharf Reserve Fund</td>
<td>$109,824.00</td>
</tr>
<tr>
<td>Float &amp; Water Access Reserve Fund</td>
<td>$5,000.00</td>
</tr>
<tr>
<td>Parking Lot Reserve Fund</td>
<td>$4,634.00</td>
</tr>
<tr>
<td>Todd’s Landing Reserve Fund</td>
<td>$3,150.00</td>
</tr>
<tr>
<td>Water Access Reserve Fund</td>
<td>$15,000.00</td>
</tr>
<tr>
<td>Shellfish Conservation Reserve Fund</td>
<td>$0.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$164,157.94</strong></td>
</tr>
</tbody>
</table>

In July of 2018, Five Islands Fuel/Harborside General Store opened; it supplies fuel, diesel, mooring rentals, snacks, drinks, ice, and locally harvested clams and oysters.
During the summer months Five Islands is a busy mixed-use location of commercial fishermen, tourists, island residents, and guests. Both parking lots are often full and a stream of cars is often parked along Five Islands Road. Road congestion is cause for concern for pedestrian and vehicle safety.

Gott’s Cove

In 1997 the Georgetown Fisherman’s Coop relocated from the Five Islands Wharf to Gott’s Cove and continues to lease buildings and a wharf to operate their commercial wholesale business. Membership has remained consistent through the years and resides at twenty as of 2018. The leased site affords parking, refrigerated storage, and commercial truck access, but not moorings or gear storage. Remaining on the leased site is a building that between 1998 and 2005 operated as take-out eating facility and a temporary float that attracted locals and visitors. It is uncertain if the lease holders intend to re-lease the building.

Robinhood Cove

Derecktor Robinhood, formerly Robinhood Marine Center, offers extensive facilities at the north end of Robinhood Cove, including seasonal and transient slips and moorings, yacht maintenance and repairs, fuel sales, a pump-out station, winter storage, houseboat rentals, a yacht brokerage, and a restaurant. Winter storage includes inside ( uninsulated), outside on land, and in-the-water as dockside water doesn’t freeze due to depth and current. The marina equipment includes a 50-ton Travelift, a hydraulic boat moving trailer, a forklift and additional equipment to support the 150-yacht summertime fleet. Favorable rates have been extended to local commercial fishermen to launch and haul out. The Anchor Bar and Grill is seasonal.

Parking at the marina is limited. A fee is charged after two hours for visitors or noncustomers.

Todd’s Landing

Located along Route 127 between the West and East branches of Robinhood Cove, Todd’s Landing is Georgetown’s only self-launch facility. Managed and maintained by the TOPMB, the landing, known to the Todd family as The Shipyard, is generously leased to the Town by the Todd heirs on a month-to month basis. For generations, Todd’s Landing has been crucial to the Town’s marine economy and today, it is utilized for launching and hauling commercial vessels and recreational boats, the loading and unloading of building materials for island communities, access for mooring service vessels, commercial and recreational mooring access, parking and mudflat access for commercial diggers, and access to aquaculture farms located within the Cove. The Landing location is on a busy Route 127 curve directly across Route127 from the Josephine Newman Sanctuary and Richard’s Library entrances. Nevertheless, the Landing’s central location, gradual grade, and access to deep water is a lifeline for commercial and recreational users. There is limited parking, especially for trailers, and traffic and pedestrian safety is a concern. The TOPMB sign posted at the launch identifies use for Town residents only; however, the reality is that Todd’s Landing is used by a considerable number of non-residents. Unauthorized access at Todd’s Landing is a problem. Historically there has been no Town enforcement for unauthorized use.
**Back River**
Back River Boat Yard is situated on a fifty-acre peninsula just south of the Route 127 bridge to Arrowsic and has provided a gamut of marine services since 1975. This family owned business has shifted through the years. Today, it stores approximately seventy 16’ – 28’ boats, performs engine repairs, and offers 12 slips and four moorings. The surrounding property has been developed with seasonal housing, including treehouses, and year-round rentals. The yard’s unique Back River location also provides limited parking and access to the Back River by canoe or kayak with permission.

**Recreation**
Based on the 2018 Community Survey, over 75% of respondents listed access to recreational fishing and boating as “extremely” important. Unless private access is available, resident access is limited to Todd’s Landing, off the wharf at Five Islands, off the beach at Reid State Park and from tidal flats, as well as from nearby islands. Swimming is permitted off the wharf, at Reid State Park, and Ledgewood Preserve. Vehicle and trailer parking at each of the above locations is limited and a vehicular and pedestrian safety concern.

Hunting for sea ducks, geese, and bay ducks is most often from small boats, rights of way, or by receiving land access with permission of the landowner. Coastal populations of sea birds suitable for hunting appear to have declined over the years and many blinds around the island have fallen into disuse (U.S. Fish and Wildlife).

**Access to the Water**
Public access to the water may simply be defined as people’s ability or right to reach the shoreline. It means different things to different people: a ramp to launch and haul a boat, a pathway to the mud flats, a place to park a vehicle for canoeing or kayaking, a parking lot to capture views or take pictures, or a simple walk on the beach. Maine has only a fraction of its coastal area in public ownership, yet the coast is crucial for marine resources industries, recreation and tourism.

The changing pattern of shoreland ownership and use has closed off many traditional accessways in Georgetown and other coastal communities. Efforts by the State and conservation groups to purchase and develop local access have not kept pace with demand nor enhanced public access, especially direct access for water-dependent industries and individuals. The controversy over public access boils down to the basic issue of private property rights vs. public access rights. The current state in Georgetown and along the coast of Maine puts greater pressure on existing accessways. In recent history, the Town has explored increasing water access at Todd’s Landing and/or creating access in Harmon’s Harbor; however, neither option has been successful. The clear majority of clam diggers and wormers in Georgetown either cross private shorelands, use town-owned property, park along State and town roads or use paths and old tote roads to access the tidal flats. For clammers, multiple access points are vital to continue to work when specific flats are closed by the State.

The Josephine Newman Sanctuary, Reid State Park, Ledgewood Preserve, Loring Conant Preserve and Schoener Preserve, as well as a few nearby islands provide pedestrian access to the
shore. Only the Ledgewood Preserve provides easy access for the loading and unloading of a canoe or kayak, however parking is very limited.

Five Islands Harbor provides access for many recreational boaters and is the primary access for the majority of local commercial fishermen. Fishermen pay a user fee to utilize the Town-owned wharf to get to and from their boats and either unload their catch at the wharf or at the Coop in Gotts Cove. Space in the Harbor is limited and at capacity. Some commercial fishermen moor and provide dock space from their own property.

Many residents and property owners are also able to moor from their own property; some, who do not use moorings or dock space themselves, rent or allow others to use the access with permission. A few residents and property owners have a road or have constructed a means which allows them to launch a boat, although many of these launches are tidal. For those who do not own or have access to such a property, public launches on the Kennebec in Bath or Phippsburg, Todd’s Landing or paying a fee at a commercial boatyard are their only local means to launch a boat.

Recreational activities attract thousands to our beaches and to Five Islands, dramatically increasing the population of the Town when summer residents and visitors arrive. Businesses such as stores, shops, inns, restaurants, art galleries and campgrounds are dependent upon summertime guests, many of whom come to take advantage of the marine environment. For example, recreational clamming has increased in Georgetown over the last decade, as depicted below. There are no non-resident commercial clam licenses in the time series.

![Georgetown Clam Licenses](chart.png)
Marine Resources Concerns Identified by Marine Resources Committee & Georgetown Community

- Access to waterfront and moorings
- Access to clam-flats (clams, quahogs, worms)
- Water Access (for residents, guests, visitors, commercial fishermen)
- Resource Threats including northern migration of lobster, invasive green crabs, adjacent zone trap limits
- Lack of diversification of marine economy
- Water quality is impacted by outhouses, overboard discharge, surface runoff, faulty septic and upriver discharge.
This map depicts Georgetown’s Limited Purpose Aquaculture Sites (LPA) and aquaculture leases as well as Maine’s conserved land sites and the Maine Department of Marine Resources (DMR) National Shellfish Sanitation Program (NSSP) area closures. The DMR Shellfish Growing Area Classification Program classifies shellfish areas based on the results of a shoreline survey and fecal coliform testing. During a shoreline survey, DMR staff look for the presence of pollution sources. Once the information is compiled, each area is classified as Approved, Conditionally Approved, Restricted, Conditionally Restricted or Prohibited using standards set by the National Shellfish Sanitation Program (NSSP), a federal/state cooperative program that sets the requirements for all states involved in interstate shellfish harvest and sale. Created: May 01, 2019. Source: Maine DMR, Maine Office of GIS. Cartographer: Marina Cucuzza, UMaine
This map depicts key habitat in Georgetown, Maine. The extent of the mudflat and marsh habitat is apparent on the southern and western side of the island. The island is bordered by ocean to the east and freshwater to the west. Sandy beaches border the southern edge of the island, particularly on the southeast at Reid State Park. Mudflats are extensive at low tide, largely bordering the southern end of the island. Marshes are found primarily on the southeast end of the island and on the northwest side bordering the freshwater. The largest feature of interest by area is the forest, which heavily covers the majority of the island (6923 hectares). Georgetown has an extensive area of wetland (1785 hectares).

This map is the result of a supervised digital image classification of habitat types. Classification was conducted on a USDA National Agriculture Image Program (NAIP) aerial image. Created: 11/03/2018
Cartographer: Marina Cucuzza, UMaine
Earliest (A & C) and latest (B & D) Landsat imagery of Georgetown and Bath. The historical and recent image comparison highlights the dense development that occurred between 1982 and 2003 in Bath. The coastal islands like Georgetown have remained largely undeveloped. Panels A and C are Landsat 4 Thematic Mapper images from 12/08/1982. Panels B and D are Landsat 8 aerial images acquired 06/14/2017. Cartographer: Marina Cucuzza, UMaine
Principal component analysis (PCA) on a National Agriculture Inventory Program (NAIP) aerial image of Georgetown, Maine, USA acquired on July 5th, 2015. The first three components of the transform are displayed as a color composite image displayed as red, green, and blue, respectively. This transformation depicts the mudflat habitat around Georgetown in great detail and also shows the extent of marsh on the southern end of the island. Mudflats are critically important to the local marine economy as they provide habitat for softshell clams, a species that is commercially harvested in Georgetown.

Cartographer: Marina Cucuzza, UMaine
APPENDIX G: Semi-structured Interview Questions for EBFM Experts

General:
- Will you describe the general purpose of this initiative?
- What role did you play? When? How long?

Initiation:
- What was the motivation for implementing the initiative in the region?
- Who pushed the project forward?
- How did the projects take initial steps forward?
- Is the term “ecosystem based management” explicitly being used to describe the efforts in the region?

Issues:
- What are the environmental issues associated with the area?
- What are the major human uses in this area?

Governance:
- How is the initiative organized/governed?

Strategies:
- How are targets for recovery set?
- What management tools and strategies are being used to reach these recovery targets?
  - Are these tools working?
- How are scientific and decision support tools used to facilitate planning and implementation?
- What does local engagement look like for this project?
- How is this initiative linked to broader management efforts in the state, regional, and national levels?
  - How were these links established?
  - What made these links possible?

Conflicts
- What conflicts and challenges have there been in implementing the initiative in the region?
- How are conflicts managed?

Accomplishments:
- What are the major accomplishments of the initiative?
  - What tools/people enabled this success?

Lessons Learned:
- What are the biggest lessons learned through the development of this initiative?

Looking forward:
- What advice do you have for groups interested in implementing a similar initiative in other parts of the world?
### EBFM Literature List

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<tr>
<th>Title</th>
<th>Authors</th>
<th>Year Published</th>
<th>Journal</th>
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<td>Reconciling complex system models and fisheries advice: Practical examples and leads</td>
<td>Sigrid Lehuta, Raphaël Girardin, Stéphanie Mah’evas, Morgane Travers-Trolet, and YouenVermard</td>
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<td>Improving essential fish habitat designation to support sustainable ecosystem-based fisheries management</td>
<td>Cordelia Moore, Jeffrey C. Drazen, Ben T. Radford, Christopher Kelley, Stephen J. Newman</td>
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<td>Evaluating the effect of a selective piscivore fishery on rockfish recovery within marine protected areas</td>
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<td>End-to-end modeling as part of an integrated research program in the Bering Sea</td>
<td>André E. Punt, Ivonne Ortiz, Kerim Y. Aydin, George L. Hunt Jra, Francis K. Wiese</td>
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<td>Interactive effects of predator and prey harvest on ecological resilience of rocky reefs</td>
<td>Dunn, R. P., Baskett, M. L., &amp; Hovel, K. A.</td>
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<td>Effectiveness of lobster fisheries management in New Zealand and Nova Scotia from multi-species and ecosystem perspective</td>
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<td>Ecological data from observer programmes underpin ecosystem-based fisheries management</td>
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<td>Oceanographic determinants of ocean sunfish (Mola mola) and bluefin tuna (Thunnus orientalis) bycatch patterns in the California large mesh drift gillnet fishery</td>
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<td>Key principles of ecosystem-based management: the fishermen’s perspective</td>
<td>Rachel D Long, Anthony Charles I &amp; Robert L Stephenson</td>
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<td>Feeding dynamics, consumption rates and daily ration of wahoo Acanthocybium solandri in Indo-Pacific waters</td>
<td>J. N. Perelman, K. N. Schmidt, I. Haro</td>
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<td>The incorporation of traditional knowledge into Alaska federal fisheries management</td>
<td>Julie Raymond-Yakoubiana, Brenden Raymond-Yakoubianb, Catherine Moncrieffe</td>
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<td>Inclusion of ecological, economic, social, and institutional considerations when setting targets and limits for multispecies fisheries</td>
<td>Rindorf, A., Dichmont, C.M., Thorson, J., Charles, A., Clausen, L.W., Degnbol, P., Garcia, D., Hintzen, N.T., Kempf, A., Levin, P. and Mace, P.</td>
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<td>Ecosystem-Based Fisheries Management in the Chesapeake: Developing Functional Indicators</td>
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<td>Assisting Ecosystem-Based Fisheries Management Efforts Using a Comprehensive Survey Database, a Large Environmental Database, and Generalized Additive Models</td>
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<td>Meta-analysis reveals that fisheries co-management alters socio-economic outcomes and resource well-being</td>
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### APPENDIX I: Indicators for Comprehensive Plan Analysis

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<td>Does the plan discourage hazardous area acquisition?</td>
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<td>Does the plan encourage coastal setbacks as buffers to protect coastal communities?</td>
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<td>Is infrastructure protection and relocation emphasized as a component of the plan?</td>
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<td>Is the relocation of critical facilities out of hazardous areas a component of the plan?</td>
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<td>Does the plan promote land use regulations that allow coastal wetlands to migrate? (Hazardous area zoning)</td>
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<td>Does the plan limit redevelopment and rebuilding of a structure after it has been compromised or lost due to a hazardous occurrence?</td>
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<td>- Infrastructure relocation and protection?</td>
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<td>- Hazardous area zoning?</td>
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<td>- Land acquisition?</td>
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<td>Does the plan encourage the conservation of natural systems?</td>
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<td>Does the plan encourage the restoration of natural systems?</td>
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<td>Does the plan encourage shoreline protection using living shorelines?</td>
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<td>Are the following hazards addressed:</td>
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<td>- Erosion?</td>
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<td>- Sea level rise?</td>
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<td>- Salt water intrusion?</td>
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<td>- Storm surge?</td>
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<td>NOAA, Godschalk et al., Godschalk</td>
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<td>- Flooding?</td>
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<td>Does the plan map and identify areas vulnerable to:</td>
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<td>- Erosion?</td>
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<td>- Sea level rise?</td>
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<td>Is community hazard awareness and education addressed in the plan?</td>
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<td>Do the goals of the plan promote emotional and physical wellbeing/increased quality of life among residents?</td>
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<td>Beatley, Magis, Goodman</td>
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<td>Are particularly vulnerable populations/areas identified?</td>
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<td>Does the plan seek to establish a sense of community in the municipality?</td>
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<td>Beatley</td>
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<td>Does the plan establish stewardship of the environment/natural resources?</td>
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<td>Beatley, Godschalk, Berkes &amp; Seixas</td>
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<td>Does the plan discuss/address the adaptive capacity of the community?</td>
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<td>Does the plan acknowledge social networks?</td>
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<td>Does the plan have a community recovery component?</td>
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<td>Beatley, Magis, Berkes &amp; Seixas</td>
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<td>Do economic development or redevelopment strategies include provisions for mitigating natural hazards?</td>
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<td>Does the plan guide business development away from hazards?</td>
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<td>FEMA</td>
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<td>Does the plan encourage more coordinated planning with surrounding municipalities to achieve objectives focused on protecting, sustaining, and enhancing the local economic base?</td>
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<td>FEMA</td>
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<tr>
<td>Does the plan promote a diverse economic base?</td>
<td></td>
<td></td>
<td>FEMA, Magis</td>
</tr>
<tr>
<td>Does the plan encourage businesses to connect with the local community?</td>
<td></td>
<td></td>
<td>Beatley, Chaskin</td>
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<tr>
<td>Does the plan address economic recovery options?</td>
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<td>Beatley, Godschalk</td>
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<tr>
<td>Does the plan acknowledge the relationship between healthy natural systems and a healthy local economy?</td>
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<td>eBrkes &amp; Seixas</td>
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<tr>
<td>Does the plan have a business owner education component for the following hazards:</td>
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<tr>
<td>-Erosion?</td>
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<td>NOAA, Godschalk et al., Godschalk, FEMA</td>
</tr>
<tr>
<td>-Sea level rise?</td>
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<td>NOAA, Godschalk et al., Godschalk, FEMA</td>
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<tr>
<td>-Salt water intrusion?</td>
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<td>NOAA, Godschalk et al., Godschalk, FEMA</td>
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<td>-Storm surge?</td>
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<td>NOAA, Godschalk et al., Godschalk, FEMA</td>
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<tr>
<td>Flooding?</td>
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<td>NOAA, Godschalk <em>et al.</em>, Godschalk, FEMA</td>
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<tr>
<td>Total</td>
<td>/24</td>
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</tbody>
</table>
APPENDIX J. Semi-structured Interview Questions: Latent License Study

Background Information
1.) Where are you from originally?
2.) Are you from a fishing family?
3.) How did you get involved in fishing?
4.) What age were you when you began fishing?

Port-shed information
5.) What town do you currently live in?
6.) Which harbor or town do/did you fish out of?
   *If current location and fishing location are different*
7.a) Did you ever live in [name of town they fish]?  
   *if yes*
7.b) Why did you move away?
7.c) What led you to the decision to move away?
7.d) What was it like to live in a different place than where you fished?
7.e) Has living away from where you fish impacted your ability to fish? Why/how?
7. f) How much of a connection do you have to that place?

Licensing information
8.) Are you engaged in other employment outside of fishing? If so, what percent of your livelihood comes from fishing?
9.) What licenses do you currently hold? What gear types do you use?
10.) Where do you fish and for what?
11.) How often/what time of year do you fish?
12.) When do you stop fishing?
13.) Why do you stop fishing?
14.) When and why do you start fishing again?
15.) Do you start and stop fishing consistently throughout each year? What factors influence your decisions about when to fish?

   *For those that have not fished for a longer period of time*
Have you considered participating in fishing again?
What circumstances would make you want to fish again/more frequently?
Do you think this will happen?
Why do you keep your license if you don’t actively fish?
Would you drop your license? Why?

Latency perceptions
15.) Have you heard of the term “latent” before used to describe licenses?
16.) What contexts have you heard this term used?
17.) What does latency mean to you?
18.) Do you consider your license to be latent? Why?
19.) Do you think latent effort poses a threat to fisheries in Maine? Why?
20.) Have you noticed changes in Maine’s fishing licensing systems in your time fishing?
b.) What changes have you noticed?
c.) What are the implications of these changes on Maine’s fisheries?

Demographics
21.) Sex: M/F
22.) What is your age?
APPENDIX K: Newspaper Articles & Pubcast Pertaining to Research

- **DMC Summer Research**: https://umaine.edu/news/blog/2017/10/06/marina-cucuzza-dmc-assistantshipgreat-prep-research-resilience-fishing-communities/


- **Comprehensive Plan Work**: https://dmc.umaine.edu/2020/01/18/coastal-communities-differ-in-their-resilience-to-environmental-change/

- **Comprehensive Plan Work**: https://umaine.edu/news/blog/2020/01/13/media-share-cucuzzas-research-on-climate-change-coastal-communities/

- **Pubcast for Coastal Routes Lab**: https://soundcloud.com/user 76762384/comprehensiveplans
BIOGRAPHY OF THE AUTHOR

Marina Cucuzza was born in Stoneham Massachusetts on October 1st, 1994. She was raised in Malden, Massachusetts and graduated in 2012 from Essex Agricultural and Technical High School in Danvers, Massachusetts, where she studied Environmental Sciences. She moved to Maine in 2012 to attended College of the Atlantic and graduated in 2016 with a Bachelor’s degree in Human Ecology with a concentration in Marine Sciences. After completing a Batten Research Fellowship in marine mammal and sea turtle conservation with the Virginia Aquarium, she returned to Maine and entered the dual degree Marine Biology and Marine Policy graduate program in the School of Marine Sciences at the University of Maine in the summer of 2017. Marina is a candidate for the Master of Science degrees in Marine Biology and Marine Policy from the University of Maine in May 2020.