Winter 2019

Coastal Conflicts and Cross-Sectoral Engagement: Learning from Disputes Over Science in Coastal and Ocean Systems

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COASTAL CONFLICTS AND CROSS-SECTORAL ENGAGEMENT:

LEARNING FROM DISPUTES OVER SCIENCE IN

COASTAL AND OCEAN SYSTEMS

BY

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DISSERTATION

Submitted to the University of New Hampshire

in Partial Fulfillment of

the Requirements of the Degree of

Doctor of Philosophy

in

Natural Resources and Environmental Studies

December, 2019

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DEDICATION

This dissertation is dedicated to those in my life who saw me for who I wanted to be even when I couldn't. To my siblings who shaped my negotiation and dispute resolution skills, to my parents who taught me to observe carefully both people and nature, to Izzy and Calvin who both tested and taught me, and to Eric who has always been ever so patient. And lastly to the one who I can't show this in person, you are here in these words.

ACKNOWLEDGEMENTS

This dissertation would not have been possible without the contributions of many people. First and foremost, I want to thank all the people who agreed to be interviewed for this research, without them this whole project would not have been possible. The insight and guidance from my dissertation advisor, Tom Safford, helped shape how I came to this research question, how I approached analyzing the data, and kept me going to complete the effort – thank you. I would also like to thank the rest of my dissertation committee – Cat Ashcraft, Holly Bamford, Curt Grimm, and Wil Wollheim – for each of their insights and discussions throughout this process. While challenging to blend together input from such a diverse set of expertise, I learned so much from each of them and from the process of trying to think across disciplines. Thank you to those who helped to fund portions of my doctoral studies and dissertation research as well: the New England Sustainability Consortium through the NSF funded New Hampshire Experimental (now Established) Program to Stimulate Competitive Research (NH EPSCoR) – Jan. 2015 through Aug. 2016; University of New Hampshire Natural Resources and Earth System Science (NRESS) Program (Student Support Fund and Tuition Waiver) – Fall 2017; and New Hampshire Sea Grant research development funds – May 2018 through May 2019.

I would also like to thank a few others who greatly influenced this process. First, I would like to thank Sarah Carlson and Alissa Shea for serving as research assistants on this project in 2018-2019. Your enthusiasm to learn something new helped keep me going through tough parts of the research process and helped me see how much this work can benefit future generations of scientists. I also want to thank Erik Chapman for going out on a limb and inviting me to help teach *Sustainable Fisheries* and for the Shoals leadership and staff for taking a chance on me.

Thank you to the students for asking important questions, to the guests for contributing your knowledge, and to Owen for diving blind into the adventure with me. I'd also like to thank my fellow group mates from NR 724/824 – Natalie Kashi, Allison Enck, and Lucian Pizzano –as our class project on the Great Bay water quality dispute helped form my interests and shape my early thinking on this topic. Thanks to the NRESS Student Support Network coordinators past and present, the other NRESS social science students, and members of the EPPS lab. Your comradery, support, enthusiasm, commiseration, and commitment to building community is very much appreciated. To the Academic Mamas crew, thank you for being a sounding board and sanity check to help keep me going through the rough spots and to help celebrate the wins. And while we still don't see each other enough, thank you to Team 147 for always being there.

Last and perhaps most important, I want to thank those who took this journey with me most closely. Thank you to my immediate and extended family who asked about progress without being pushy, encouraged me to keep going, and helped provide much needed time together away from this work. Thank you to the non-human crew as well – the many unnamed fish, Peter, Paul, Mary, Reggie, Charlotte, Caroline, and Kelsey - but most of all Ortiz who has seen me through a master's degree, several stressful jobs, getting married, two kids, the introduction of multiple pets and seven moves. While my decision analysis framework back in 2005 greatly underestimated how much all your vet visits and pet food would cost, you have more than earned your keep all these years. And finally, thank you to Izzy and Calvin for giving up your time with me so I could finish this journey - I know it wasn't easy. And to Eric, none of this would exist without you – thank you.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

COASTAL CONFLICTS AND CROSS-SECTORAL ENGAGEMENT: LEARNING FROM DISPUTES OVER SCIENCE IN COASTAL AND OCEAN SYSTEMS

by

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It is widely accepted that public policy decisions that account for scientific and technical advice are likely to improve outcomes for all. With more data and information available though, it is becoming increasingly difficult to even agree on the baseline facts. This research explores the question: ***How do cross-sectoral engagement opportunities influence science intensive disputes over the management of coastal and ocean resources?*** To address this question, I studied two cases in New England: 1) marine fisheries management (Northeast Multispecies Complex aka groundfish) and 2) estuarine water quality management (Great Bay, New Hampshire). Informed by participant observation and semi-structured interviews with researchers, managers, and the regulated community within each case, findings from this research are presented in three analyses: 1) examining the potential role negotiation theory can play in better understanding these dispute cases; 2) understanding how science is used within the existing processes as well as whether there is interest in and potential for more collaborative approaches; and 3) understanding the impacts of engaging across different groups of perspectives. Taken together, the findings from these analyses show that when done well, cross sectoral engagement activities help to

develop relationships, open lines of communication, and expand individual and collective understanding of the issues at hand (not driven by just one group view). These types of engagement activities also create space for creative solutions. While decisions will ultimately still need to be made and "value claimed," processes that enable a more complete picture and an expansion of the ideas at the table will ultimately be more resilient and adaptive in the face of change. These approaches can be hampered by poor process design, power imbalances, lack of resources, use of legal tools in adversarial as opposed to collaborative approaches, limited familiarity with potentially beneficial approaches from negotiation (mutual gains and/or principled), and lack of training and/or exposure to other perspectives or ways of thinking. Taken together, efforts to think differently about systems approaches, changes to research processes, new perspectives on stakeholder engagement, and multi-partner collaborative efforts might help make the jump towards progress in social-ecological systems.

CHAPTER 1

INTRODUCTION

"Science is a way of knowing about the world. At once a process, a product, and an institution, science enables people to both engage in the construction of new knowledge as well as use information to achieve desired results."
– National Academies of Sciences Engineering and Medicine, 2016

"Public understanding of science …" [implies] the condescending assumption that any difficulties in the relationship between science and society are due entirely to ignorance and misunderstanding on the part of the public; and that, with enough public-understanding activity, the public can be brought to greater knowledge, whereupon all will be well.
– British House of Lords Select Committee on Science and Technology's Third Report, 2000; as cited in Susskind, Field, & Smith, 2017

Introduction

Science plays an important role in our lives, from individual to community to global levels. Due to varying levels of familiarity and comfort with science and scientists, scientific findings are not always applied or drawn upon in settings where they could be useful. As a nation, the United States has set up many institutions to support and use science for the betterment of society.

At the same time, there has been a tendency to conflate science and policy questions, to get overly focused on ideas about static facts even though it is a dynamic world (Matsuura & Schenk, 2017a), and to move debates and disputes into traditional hard bargaining that has typified legal cases (Fisher, Ury, & Patton, 2011; Susskind & Field, 1996). To support the view of the value of science and technical advice to benefit policy decisions, it is key not only to understand the technical aspects of science, but also the human components. Given this goal, it becomes also important to study how and why science is used or discarded.

Many disputes and conflicts in coastal settings are stuck in traditional hard bargaining approaches. This limits participants' ability to move through the disputes into more productive engagements with mutually beneficial solutions across groups, but also has implications for the natural resources at play. Bruckmeier (2005) also underscores that while research (science *and* scientists) can be seen as a source for solutions, it can also become the source of new conflicts. The use and perception of science within management disputes coupled with engagement (or lack thereof) within and across sectors (i.e. management, science, industry, etc.) has played a role in the continuation of these disputes and past selection of sub-optimal solutions. In addition, the so-called "soft factors" ("values, attitudes, interests, and aspirations") are key to conflict management and their neglect is viewed as a key reason for the escalation of conflicts in coastal areas (Bruckmeier, 2005).

It is widely accepted that there is value in bringing expertise from multiple disciplines together to address complex problems. That said, scholars (Bennett et al., 2016) have identified barriers to the inclusion of social sciences in conservation research and practice. Bennett et al. (2016) identify four such barriers: "ideological, institutional, knowledge, and capacity." Acknowledging these barriers in the context of conducting multidisciplinary research provides important context to understand potential pitfalls and possible solutions. Karpouzoglou, Dewulf, and Clark (2016) describe the value of "theoretical multiplicity" (the merging of multiple theories as opposed to relying on only one) in understanding social-ecological systems.

The mark of a social-ecological system is that due to the complexities of interactions no model other than the true thing can sufficiently represent it to predict *all* the possible implications of certain actions (Bankes, 2002). That said, models are an important part of seeking to understand these complex systems. It is also important to recognize that models (including conceptual models, stock flow diagrams, causal loop, etc.) are just that – models – and are an approximation of the system presented in a simplified manner to help understand the system, convey a message, or make a decision (Miles, 2000). Jorge Luis Borges writes in "On Exactitude in Science" of a parable of the cartographers so focused on making a precise map that they eventually recreated the city and the people no longer saw the use for cartographers because they did not need an exact replica (Borges, 1998). This is an interesting fable for social and natural science researchers to keep in mind while seeking to understand these systems and communicate that understanding to managers. Research is an essential component to understanding social-ecological systems, but it is equally important to also understand the factors that influence the creation, dissemination, and use of new knowledge formed through the scientific process.

With a confluence of social and environmental processes at play, multiple feedback loops, and intensive stressors, coastal and nearshore areas are ripe for further study to better understand complex systems and what can be done to make them more sustainable into the future. In seeking to understand and influence decisions in these systems, it is valuable to explore the role of conflicts, science, and engagement. In addition, there is value in pursuing a study on humans and human social organization because the individuals, structures, and processes are key to understanding the past and charting a way ahead. This chapter outlines the overarching research question that is the focus of this work, the motivation and goals for the project, a reflexivity discussion, and ultimately provides an overview of the organization of this dissertation.

Overarching dissertation research question elaboration

At a time when there is increased access to data and information, there has also been an increase in disagreement about what constitutes facts and how they should be used in decision-making (Susskind, 2017). Disputes around the management of coastal and nearshore resources often appear to perpetuate traditional hard-bargaining approaches (mixing the people and the problems, focused on positions not interests, resistant to designing new solutions, etc. as per Fisher, Ury, and Patton (2011)). These approaches result in missed opportunities, the perpetuation of distrust across sectors, and unsustainable negative impacts on natural resources. By understanding more specifically the context of coastal disputes, and in particular those involving science, it becomes possible to understand the social forces at play, and ultimately possible opportunities to seek improved solutions for the complex social-ecological systems in play. In addition, understanding the practice of science and its connection to management and policy processes, in particular through engagement across groups, provides a lens to understand disputes in complex systems.

It is within this context of complex systems, disputes over science, and negotiation that I studied the role of cross-sectoral engagement opportunities within science intensive disputes over management of coastal resources. Specifically, my research explores the question: ***How do cross-sectoral engagement opportunities influence science intensive disputes over the management of coastal and ocean resources?*** To address this question, I researched two cases in New England - marine fisheries management (Northeast Multispecies Complex aka groundfish) and estuarine water quality management (Great Bay, New Hampshire). These cases are both framed in legal disputes specifically over the science used to make management decisions and both include a web of efforts to engage across groups. Using the case study approach, I collected data through semi-structured interviews and participant observation and analyzed this data to explore several theories of use of science and negotiation (see chapter two for a discussion of the theoretical basis for this project and chapter three for a detailed overview of each case and the research methods). Figure 1.2 and table 1.1 at the end of this introduction outline the specifics of the overall organization and approach. Figure 1.1 below outlines the conceptual frame that is the focus on this research as well – looking at the intersections of science, management, engagement and the processes, structures, and individuals by which they influence the functioning of complex social-ecological systems. While not formally tested in this research, the value of a general explanatory framework to conceptualize a system or a question is widely acknowledged (McGinnis & Ostrom, 2014)

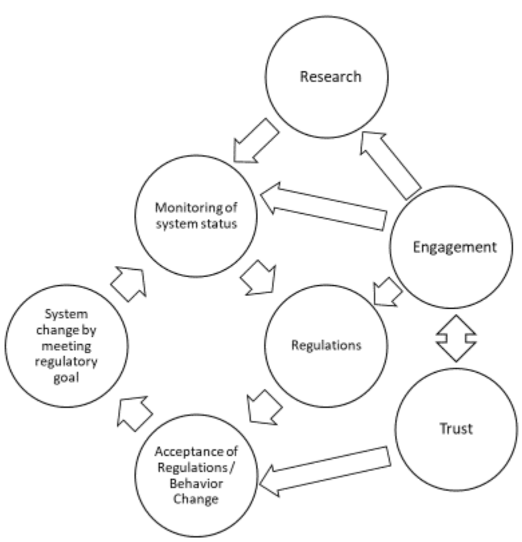

Figure 1.1. Conceptual model of the interaction of science, management, and engagement in complex social-ecological systems.

Research Motivations / Goals

This research addresses questions raised in both the scholarly literature as well as in applied settings that articulate the need for research in this area. For example, a 2014 survey of research needs in marine conservation identified 71 questions including three of particular relevance:

- 64 – "How have humankind's various worldviews shaped perceptions, relationships, and narratives related to the marine environment, and how do these influence marine conservation?"
- 68 - "What lessons derived from conflict management, resolution, and avoidance in other disciplines could be beneficially applied to marine conservation?"
- 71 – "What strategies can be used to promote long-term integrated multi-disciplinary collaborations?" (Parsons et al., 2014)

In addition, four categories of the most challenging questions in marine conservation research were noted as: "human nature, meeting our responsibilities, entrenched interests, and corporate driven policy" (Cigliano et al., 2016). Calling these the "Kraken in the Aquarium" (the marine version of the elephant in the room), the authors view these as major hurdles to advances in marine conservation. Questions identified in other applied venues like the "Ocean Research Priorities Plan" and the National Sea Grant Strategic Plans also set the stage for my dissertation research. For example, understanding human use patterns of marine resources and focus on developing resilient communities are areas I explore in my research (NOAA Sea Grant, 2014, 2018; NSTC SOST, 2013). In addition, my research addresses the call from the National Academies of Sciences Engineering and Medicine (2016) for more research on the structural elements of science (in particular the social elements) as a way to contribute to science literacy in the future across the spectrum of the scientific, management, and regulated communities. My research focuses in part on cross-sectoral engagement efforts that include scientists as contributors of knowledge, but also as participants in the knowledge generation process.

On the topic of knowledge transfer alone, there is a "recognition of the need to converge diverse but complimentary disciplinary approaches and views in response to complex problems across a wide range of sectors …" (Cvitanovic et al., 2015). My research seeks to address this by bringing in theories from several disciplines and also recognizing the potentially divergent structures of perceptions across different groups. In addition, my research will also contribute to needs identified by Levin et al. (2013) including understanding how individual behaviors (in this case the participants in cross-sectoral engagement activities) contribute to "system-level consequences" for example, the resolution of disputes. Adaptive approaches are needed, and this is where learning from experience is key. Descriptive studies help with this, but also need to be aggregated to begin to learn patterns.

Research in an academic setting should also acknowledge that learning and adaptation occurs within agencies and communities even when it is not published into the scholarly literature. It is often shared through internal processes and through other formal mechanisms. This presents a challenge in understanding the full scope of efforts underway but is also an opportunity for additional research to document agency practices. My research begins to address this gap in accounting for the applied experiences of researchers and practitioners in disputes over coastal resources.

Why study science?

A recent National Academies of Science report specifically included in its definition of science literacy the understanding of science as a social process referring for example to "the criteria for the assignment of expertise, the role of peer review, the accumulation of accepted findings, the existence of venues for discussion and critique, and the nature of funding and conflicts of interest" (National Academies of Sciences Engineering and Medicine, 2016). Understanding science as a social construct is not at odds with viewing science as a valuable contributor to societal challenges (Susskind, 2017). By looking at both the practice of science and the existence of scientists as social actors, we can consider factors that influence the practice of science and its use in public policy, including the focus on science that is "credible, legitimate, and salient" along with other factors that have an impact.

There are also different literatures on knowledge production and knowledge use as well as different venues for discussion from an academic/theoretical versus a practical lens (Matsuura, 2017). One of the goals of this research is to try to bring this thinking together. In addition, there is a potential tension between a view that science should be driven by curiosities of individuals ("science for science sake") versus a focus on "science for solving [societal] problems" (Matsuura, 2017). Both approaches are needed, but there needs to be a wider discussion on how decisions are made about levels of investment and the balance between the two. This is further underscored by the concept that the world doesn't stand still for science to catch up as decisions have to be made with what information is available in that moment (Matsuura, 2017). My interest in studying these issues stems from questions about how to better incorporate science into the decision process when neither the science nor the decision processes are ever going to be "perfect" and both are continually evolving.

Theoretical Background

This research draws from the thinking of several disciplines, including sociology, public policy, anthropology, negotiation and dispute resolution, and ecology. It is also highly informed by efforts to bridge thinking across disciplines and merge that with applied understanding. This research is informed by ideas about social-ecological systems, feedback loops and processes, science in public policy, science for sustainability, and conflict and negotiation (see chapter two for detailed discussion of these concepts).

Reflexivity / Positionality Statement

The impact of our own training, experiences, and positionality is widely discussed in certain research circles given the role it all plays in shaping what we each chose to research, how we interpret what is shared with us or what we observe in the course of our studies, and how we then present that information (Burawoy, 1998; Emerson, Fretz, & Shaw, 2011; Hancock, 2009; Holmes, 2014; Lacy, 2017; Strauss & Corbin, 1998). Throughout the process of research and writing, one must continually reflect on the experiences that shaped our arrival at the research questions and how the process of conducting research is building and shaping our understanding of the systems we study and the people we interact with. As scientists learn more about how social-ecological systems operate, they can influence the systems through application of their findings. They also may be individually influenced by what they learn which may also change how they approach their research. This creates interesting and important feedback loops that can have positive or negative consequences for future system states.

Trained in biology and ecology as an undergraduate, I expected to spend my career in the field studying marine resources and teaching students. This vision was primarily based on the role models that I was exposed to that gave me a picture of what one does with an interest in marine science. After unsuccessfully searching for field research positions following completion of my bachelor's degree, I was hired in a contract position at the National Oceanic and Atmospheric Administration (NOAA) which was my first exposure to the inner workings of a government agency that both funds science and uses that science to develop management advice. Serving in a coordination and program support role, I interacted with scientists and managers from many disciplinary backgrounds from across the agency who were working on coral reef conservation. Intrigued by this line of work and the role of people within coastal systems, I continued my education by pursuing a master's degree focused on marine policy. I returned to work at NOAA for another eight years focused primarily on policy, budget, and communications in the NOAA National Ocean Service (covering a range of topics from navigation to coastal management to travel and tourism to protected areas to coastal research and more). The positions I held at NOAA left me constantly thinking about the science – policy interface and the tension between coordination and action, between basic and applied science, between single disciplinary and multi- or inter-disciplinary approaches, and the challenges of supporting science and management in a funding limited world. I eventually left NOAA to return to New England to pursue a PhD at the University of New Hampshire so that I could explore these questions. Specifically choosing an interdisciplinary program for my doctoral studies, I sought to pursue research that would help me begin to better understand some of these tensions and also learn to apply lessons from research to current science and management challenges. The research question that is the focus of this dissertation comes out of reading scholarly literature, but also out of challenges I saw repeated day in and day out in my work at NOAA and through many informal discussions with a variety of scientists and managers. While there are certainly overlaps in concepts and some networks of individuals between this research and my past work at NOAA, I specifically chose two case studies (fisheries and estuarine water quality) that were *not* tied to my work at NOAA to reduce the role that past experiences might play in influencing my understanding of the cases. That said, there are parallels between the cases in this research and my personal reflections on past work and research experiences that have undoubtedly shaped my thinking.

In addition to my earlier education and work experiences at NOAA, several other experiences have also shaped my views. Shortly after reaching candidacy in early 2017, I was invited to co-teach an undergraduate course titled "Sustainable Fisheries" at the Shoals Marine Laboratory. Focused on fisheries in the Gulf of Maine, the course brings a slate of guests from the fishing industry, fisheries science research community, and management agencies to engage with students to help expose them to both the complexities of and the opportunities around fisheries science and management in the future. While not formally part of my participant observation for this research, teaching the course in 2017, 2018, and 2019 had an impact on my understanding of the range of perspectives around groundfish management and science in New England.

In the fall of 2017, I ran for and won a seat on the non-partisan Dover City Council as an At-large member, beginning service on the Council in January 2018. This experience increased my direct knowledge of the operations of municipalities and elected bodies. As Dover is a municipality in the Great Bay watershed, there were several discussions that I was present for that pertained to Great Bay and water quality issues. I did not include fieldnotes from City Council activities in the analysis for this research and recused myself from two discussions and votes that allocated funding for monitoring work and legal work related to Great Bay during my data collection. As with teaching, while City Council participation was not a formal part of this research it has certainly impacted my understanding of certain aspects of the case.

Lastly, in early 2018 I accepted a research scientist position with the Massachusetts Institute of Technology Sea Grant College Program Marine Advisory Services Group. I continued to conduct this dissertation research separately from my work duties but began interacting with additional groups in Massachusetts that are connected with the groundfish case, others that shared similar characteristics to the water quality case, and some that conceptually aligned with the struggles of engaging across the scientific, management, and regulated communities.

Taken together, these experiences served both to shape my views and may have impacted access to potential interviewees. In both cases, for those I reached out to interview, my past work at NOAA may have closed some doors to interviews and opened others. In the estuarine water quality case, at the recommendation of the UNH Institutional Review Board I disclosed my role on Dover City Council to interviewees when I first contacted them and again in the interviews as part of the consent discussion. I underscored the distinction between my role on City Council and my dissertation research with all participants. This disclosure may have served to increase the willingness of certain respondents to participate and decrease willingness for others. My status as a student at UNH may have also impacted (both positively and negatively) access to respondents in the Great Bay water quality case given the close ties between the University and the issues at play.   Even with these factors, I was still able to interview a wide range of respondents in both cases gathering enough data to complete the analyses presented here.

These experiences also shaped how I think about communicating the research findings and how to infuse them into research and management processes. In addition, they have shaped my views about possibilities as part of the process of training the next generation of scientists, managers, and regulated communities to work together where possible.

Emerson et al. aptly sum it up when they state that "reflexivity is central both to how we understand the worlds of others as well as to how we understand the research enterprise" (Emerson et al., 2011, p. 248). Regular self-reflection as researchers and as decision makers can serve to increase personal awareness of potential biases and opportunities to acknowledge and/or address them. This concept also ties to the context of understanding the role of individuals, process, and structures that have shaped my own understanding and ultimately my views of what is possible in the future. While rarely acknowledged in natural science studies or quantitative social science research, reflexivity could be key to researchers exploring and reflecting on their own personal biases and work to continue to either minimize the influence of these factors on their work or acknowledge them and seek to improve trust in findings through transparency.

Organization of this document

Following this introduction, the remaining sections of this dissertation are set up to introduce the theoretical underpinnings, methods, and cases that served as the focus of this research, followed by three chapters focused on the analysis, findings, and conclusions to address the question: ***How do cross-sectoral engagement opportunities influence science intensive disputes over the management of coastal and ocean resources?*** Figure 1.2 provides a visual of how the chapters come together to address the research question and Table 1.1 summarizes the content of each part of this dissertation along with the description of the journals in which I will seek to publish each chapter. The concluding chapter revisits the overall research question and findings to underscore the overall contributions of this work.

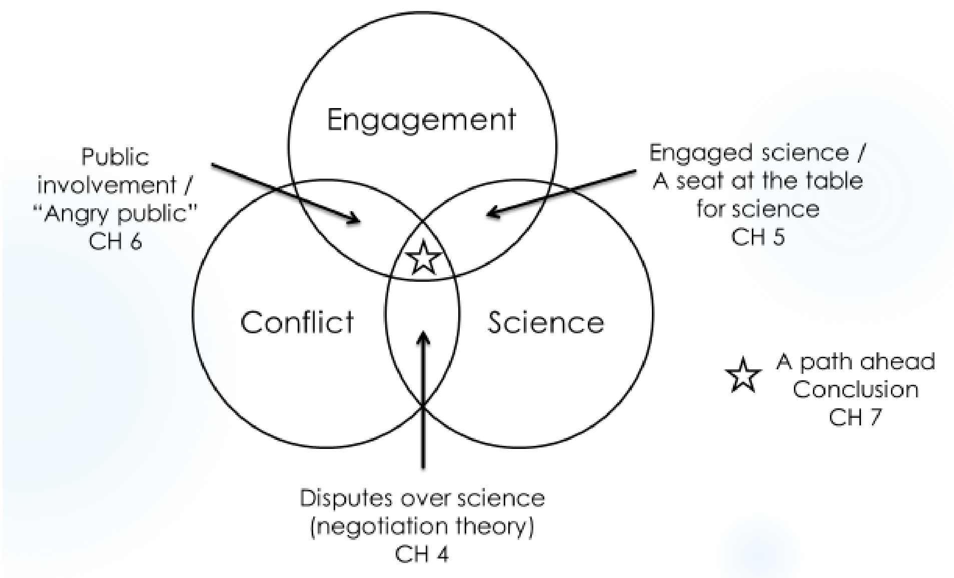

Figure 1.2. Conceptual framework of the intersection of concepts and themes in this research.

Table 1.1. Dissertation chapters and publication planning.

Dissertation Section	**Target Journal(s)**	**Notes**
Chapter 1: Introduction	n/a	
Chapter 2: Theoretical background	*Ecology and Society* or *Society and Natural Resources*	Plan to extract the collaborative approaches and negotiation synthesis
Chapter 3: Methods and case overviews	*Case Studies in the Environment*	Likely revised into two papers (one on each case)
Chapter 4: Can you live with it? Using negotiation theory to better understand disputes in coastal and marine social-ecological systems	*Ocean and Coastal Management* or *Marine Policy*	
Chapter 5: A seat at the table for science: Collaborative approaches to bridge the science-policy divide	*Ecology and Society* or *Society and Natural Resources*	Insight or synthesis (E&S) or review / practice-based knowledge (SNR)
Chapter 6: An "Angry Public" no more? Engagement across groups as a tool to address disputes over science in coastal and marine social-ecological systems	*Ocean and Coastal Management* or *Environmental Management*	
Chapter 7: Conclusion	Carsey Brief (Great Bay) and *Fisheries* (Groundfish)	Likely revised into two papers (one on each case)

CHAPTER 2
THEORETICAL BACKGROUND

Introduction

This research draws on concepts from several disciplines and is designed to contribute new understandings to several theoretical frameworks. Each is briefly summarized here in this chapter: social-ecological systems, feedback loops, science for public policy, science for sustainability, and conflict and negotiation.

Social – Ecological Systems

Throughout history, humans have relied upon the natural world for our continued existence. That relationship has changed over time from one where humans existed at the whim of non-human natural processes, to one where there is nearly no place on the planet that has not been influenced by human activities (Chen, 2015). While our relationship with nature has changed, we have always and will continue to rely upon the services provided by the natural world (Chen, 2015; Dunlap, 1980; Lubchenco, Cerny-Chipman, Reimer, & Levin, 2016; Millennium Ecosystem Assessment, 2005). As such, to sustain these services into the future and maintain our species, it is important to further understand this complex relationship between humans and the social and natural systems within which we exist (Chen, 2015).

Scholars in many disciplines and practitioners in a range of settings use systems thinking to approach complex issues. We can explore this complexity by looking at the "human" system and "natural" system independently but even more so when we look at them together. In the fields of natural resource and environmental management, the concepts of coupled human and natural systems (e.g. Chen, 2015; Liu et al., 2007), human ecology (e.g. Burns & Rudel, 2015; Dyball & Newell, 2015), complex adaptive (Levin, 2010; Lubchenco et al., 2016), socio-environmental (e.g. Palmer, 2012; Palmer, Kramer, Boyd, & Hawthorne, 2016b; B. L. Turner et al., 2016), socioecological (e.g. Zurlini, Petrosillo, & Cataldi, 2008), and social-ecological (Bruckmeier, 2016; Cox, 2014; Levin et al., 2013; McGinnis & Ostrom, 2014; Ostrom, 2007), among others, have all been used to describe the complex interrelationships between various components of natural (biophysical, etc.) and human (social, etc.) systems. This summarizes a range of different ways of explaining the study of humans and nature, but they are all approximations of the same reality. While some argue that even these distinctions between natural and human are artificial, they provide a useful frame to consider the complexities of the interactions and associated feedback loops. Social-ecological systems are often described as having characteristics that influence their processes and outcomes, including: multiple stable or steady states (Levin, 2010; Zurlini et al., 2008), non-linearity (Levin et al., 2013; Zurlini et al., 2008), competition for limited resources (Levin et al., 2013), "possibilities of non-marginal changes" (Levin et al., 2013), slow variables (change only noticeable over large timescales) (Levin, 2010), and catastrophic and chaotic behavior (Zurlini et al., 2008).

There are a range of theoretical and applied concepts to draw from when seeking to understand systems involving human and natural components of systems. Each has its own nuance but draws from the similar basic premise that humans' impact and are impacted by the natural environment and vice versa. I use the phrasing "social-ecological" throughout this work not to discount the concepts contributed from other theories, but to nest my analysis and findings within related works (i.e. McGinnis & Ostrom, 2014; Ostrom, 2007). It seems there is an over focus on debating which scholars have the best theory instead of working to truly understand the system. These theories are all approximations of the same human-nature interactions, and each theory or conceptual framework can contribute understanding, but they don't dictate how humans *should* interact or make decisions about these systems. These frameworks can serve as helpful conceptual tools, but they can't make the decisions for individuals and organizations.

Gould and Lewis (2015) state that "environmental problems are the result of human social organization, and as such, their solutions are not simply technical but require changing human social organization," so it is essential to explore how understanding human social organization and human behavior can contribute to finding paths ahead. It is critical to seek to explore the complex nature of humans as components of the natural world, not as something apart from it. When considered together, feedback loops and complexities become evident that may be glossed over when studied on their own (Liu et al., 2007). Looking at human-nature interactions through a systems perspective provides one important approach to helping us better understand how these interactions have impacted the functioning of this important relationship but also how we might improve these interactions and where possible lessen the negative impacts on human and natural components. By studying not just the physical components of these interacting systems but also the process and perceptions, it becomes possible to increase the understanding and also develop insights for the future.

Systems perspectives applied to environmental decision making

Systems perspectives have valuable contributions to understanding the world we live in and the decisions that are made to manage our interactions with that world. Systems perspectives are particularly beneficial in environmental decision making by aiding in the consideration of the appropriate scale of research and management action (both spatial and temporal), in recognizing complexities, and in understanding feedback and interactions within and across these systems. In the context of environmental decision-making, systems perspectives can enable all actors in a system to look at their piece of the system within its larger context. Looking at human and natural components but also natural and social science to better understand individuals, structures, and processes to increase use of science in ways that are beneficial to the overall system. System perspectives also "ask" us to revisit assumptions about goals and visions for the system. Understanding diverse perspectives becomes key to seeking a shared vision and supporting science to help meet that shared vision.

Levin et al. (2013) also underscore that the previous history of a system (and in particular any management decisions associated with that system) has significant implications for where the system lands in current and future steady-states (noting also that one of the characteristics of social-ecological systems is multiple possible steady-states). Interventions can lead to regime shifts (social and ecological) that then take other options off the table for future consideration and even proposed solutions shift the social system regarding trust, collaboration, and other factors (Dyball & Newell, 2015). In both research and management, nested approaches that consider context and scale are key to creating appropriate units for study and management while not ignoring other influencing factors. While everyone can't focus on all elements, considering one scale up and one scale below a study system or proposed intervention can help provide important context and insight to ground the work.

Using systems thinking is not without challenges. From a research perspective, one must define boundaries on the system within which the research is focused, which inevitably leaves out some influential components. From a management perspective the same must be done. From a user perspective, it can be hard to see beyond the immediate challenges and opportunities you see in front of you. Even with these challenges, systems perspectives can enable the science/research, resource management, and resource user components of the system to understand that they exist in a larger context.

Complexity of social ecological systems

What moves social-ecological systems to what Levin (2010) calls “that special class of complex systems known as complex adaptive systems” are the issues of scale and interaction. He describes the microscopic to macroscopic scales and how phenomena within and across scales integrate and feed back on each other to create these complex adaptive systems (Levin, 2010). Levin (2010) goes on to describe the patterns that emerge in the ecological component of the system including species-abundance relationships, trophic web structures, and biogeochemical cycles, noting that the consistency of the patterns across different types of systems even when the individual components vary is an important consideration in understanding complexity in these systems. The same can be said for the social components. And while similar patterns can emerge, we also must recognize that by their very nature as complex adaptive systems, simply understanding these patterns is important, but not sufficient to develop a path ahead. Levin also points out criticism of the Gaia hypothesis and the “invisible hand,” arguing that when looked at more closely, neither biological systems, nor economic ones, if left to their own devices, come to some optimal state, there are too many confounding factors and influences underway and differing views of what is “optimal” (Levin, 2010; Levin et al., 2013). Digging further into the interactions, feedback loops, thresholds and tipping points (both ecological and social) becomes critical to setting a path towards long-term sustainability. Studying system components (individuals, structures, and processes) helps elucidate factors that can contribute to making decisions about the desired goals for these systems.

Systems approaches are essential to understanding, for example: “(i) how individual-level behaviors create collective system-level consequences, which feedback to influence individual actions; (ii) how well social-ecological systems perform with regard to system-level properties like social welfare or productivity; and (iii) what to do about failures” (Levin et al., 2013). Individual relationships within the system have consequences for the system level dynamics as well (Levin, 2010) but it is a challenge to understand the component elements as parts of a unified whole (Dyball & Newell 2015, p9). This provides important context for my research which is based on using systems approaches to learn from what some perceive as system “failures” (disputes). Past efforts have often focused on reductionist analysis that over simplifies these complex social-ecological systems glossing over what in some cases turn out to be important nuances in how these systems operate (Liu et al., 2007; Zurlini et al., 2008). In many cases what gets brushed over is the human and social elements (individuals, structures, and processes). Because systems operate on multiple time scales, it is equally important to look at variables that we might only notice in longer timescales. These “slow variables,” which may include the human components, may have just as much potential to destabilize the system (Levin, 2010). These long timescales are particularly relevant in social-ecological systems given that the challenges facing these systems are neither "temporary or of recent origin" and are better viewed as a predicament than a crisis (Hannigan, 2014). Certain research disciplines and management structures privilege fast variables due to decision cycles and funding structures. By better understanding the characteristics of certain human components of these systems, including conflicts, engagement, and the use of science in natural resource management decision making, it becomes possible to see opportunities to address challenges within a system over different timescales.

As society struggles to balance competing demands in creating a sustainable future, using a systems perspective can help to gain insight to why these issues become seemingly intractable and what might be done about it. Systems perspectives are especially valuable for managing in these complex systems. Cvitanovic et al. (2015) underscore that adaptive governance requires intensive knowledge structures to support "an understanding of social-ecological systems at their full complexity so as to respond to feedback from the system across both spatial and temporal scales." As noted by Lubchenco et al. (2016) the complex adaptive system framework approach has led to the insight that management goals should focus not on "trying to control the system state itself" but rather on the goal of enhancing the "robustness and resilience of the system." In effect, the authors are arguing that the reductionist approaches typically used are likely losing the nuance of complexity of the world within which we live and that an over reliance on reductionist approaches risks missing what is actually going on in the system. This thinking highlights the value of looking at the importance of science, within and across disciplines, but also the role of public engagement within science and management processes. This type of knowledge is critical as challenges in social-ecological systems are "not so much 'solved' as rendered manageable" (Dyball & Newell, 2015).

Feedbacks in social-ecological systems

Within social-ecological systems, it is important to look specifically at feedback loops and interactions in order to understand the social-ecological components and manage the human element where possible. Approaches that skip consideration of human processes, structures, and individuals ultimately ignore a significant component of feedback loops that can help shed light on the functioning of these systems. By exploring feedbacks in complex social-ecological systems, it is possible to learn more about what research is needed, but also what opportunities present themselves for improvements to management and use. The importance of understanding social-ecological systems *as systems* and not just their individual components can be seen in how their constituent elements interact. For example, when policies to buffer from fish stock fluctuations do not account for fluctuations in fish prices or where building levees to protect against flooding only considers past storms, the short-term risk is addressed but may encourage long-term change that puts the system at greater future risk of passing irreversible thresholds or tipping points (Kelly et al., 2015; Levin et al., 2013). In discussing the need for adaptive capacity, Levin et al. (2013) note that heterogeneity (diversity at all levels from genetic, to community, to system) is essential in both the "natural" components as well as the human/social systems. This allows the elements of the system to compensate for losses, ranging from the decline of a certain trait in pollinators, to the removal of an institutional leader, to a shift in food consumption patterns (Levin et al., 2013). Understanding these levels of diversity and how they interact is an important component to both research and management of these complex systems. These examples underscore the value of multiple disciplines and perspectives contributing to the understanding of the structures, processes, and individuals at work in social-ecological systems.

There is a tendency to attempt to fit simple linear models or use reductionist approaches that can lead to a "misleading representation" of how these systems work which can create challenges in developing models that truly represent a system (Levin et al., 2013). The trick then is not to include every last component in a model, but rather in what Levin et al. (2013) call the "art of modeling" which is "to incorporate the essential details, and no more." This focus on recognizing the limitations of models while still acknowledging their role is key to understanding and managing complex social-ecological systems. Looking at them as systems helps see that we need to be prepared for unintended consequences since our models can never fully approximate the complexity of interactions in these complex systems. The complexity of these systems is drawn precisely from the interaction across multiple components leading to "new, emergent, and unexpected outcomes" (Zurlini et al., 2008). Adaptive management embraces this thinking as an approach to, among other things, "… understand and respond to environmental and social feedback in the context of change and uncertainty …" (Cvitanovic et al., 2015). These approaches also enable the ability to be prepared for unintended consequences instead of being shocked when they happen, building in space to develop contingencies, consider a range of alternatives, or revisit assumptions about how components of the system interact.

Exploring feedback loops becomes especially valuable when considering the potential long-term impacts of policy decisions. Certain negotiation approaches also call for the inclusion of contingencies in agreements, understanding feedback loops in both the social and ecological components can help create the space to think about what these contingencies might be. As Levin (2010) notes "[s]pecific solutions to today's problems may confer reduced capacity to deal with tomorrow's… ." Considering feedback loops provides a valuable way to conceptualize how elements of a system interact, likewise causal loop diagrams like those presented in the following chapter provide a way to further visualize that feedback.

By looking at interactions and feedbacks within the system, it is possible to learn how a system currently operates, but also consider past system functionality and how the system might behave in the future under different pressures and stressors (Dyball & Newell, 2015; Ford, 2009). Part of why understanding feedback is so essential in social-ecological systems is because the interactions or feedbacks often cause social-ecological systems to behave in "counterintuitive" ways (Dyball and Newell 2015, p57). Considering scale (spatial and temporal) as well as the interactions and feedbacks across the systems is also important. If approaches look too widely it becomes difficult to see details, but if they look too narrowly it becomes easy to miss important the components. This is where collaboration, data synthesis, and cross/multi/inter/trans-disciplinary work can benefit efforts to better understand these systems and the interactions within. Causal loop diagrams provide one tool to do this, and they can be used to gain novel insights that benefit management. There is a tendency however to see sustainability as the desire to keep things as they are – to sustain them as is. Levin (2010) describes it as an "inclination to suppress fluctuation" without recognizing (or accepting) that "fluctuations are how systems learn, and their suppression comes with a cost." Systems perspectives enable us to see that holding a system "constant" has its own unintended consequences. Scientific focus has swung from generalists and systems thinkers like Darwin and Humboldt to specialization in disciplines at times excruciatingly narrow (Carson, 1962; Kuhn & Hacking, 2012). As the scope widens back to understanding the interlinkages across systems and disciplines, it is essential to build capacity to think and work in new ways. Systems perspectives also enable the consideration of solutions that are environmentally sound, but also socially just (Dyball & Newell, 2015).

Science for Public Policy

Those who are trained in scientific disciplines are often motivated by a desire to understand how the world works. Many are drawn to these disciplines for the structure, perceived rigor, and the idea of the search for the truth. That said, throughout history there has always been an air of controversy around scientific advancements. From Galileo to Darwin to Currie to Carson, we have seen scientists vilified and vindicated for their findings and the implications of their work. New findings can challenge existing worldviews, and their implications can also require changes in human behavior (Hoffman, 2012). This confluence of the expectation by many scientists that scientific truths alone will improve our lives, while at times ignoring that change is not always easy, serves as the backdrop for debates of over the role of science in public policy.

There is overlap between science and politics in nearly every question involving social-ecological systems (Ozawa, 2009). Public policy has been defined broadly as the action (or inaction) of government to address the public good (Theodoulou, 2013) and is viewed as the way to address the gap between the outcomes favored by the markets and the "socially optimal outcome" (Levin et al., 2013). Science is called upon to both support and facilitate the policy making process. Scientific findings and predictions can easily be turned to in an effort to ease the decision making process, i.e. the model or findings give a result that decision makers argue makes the decision clear (Miles, 2000). For decision-makers in a public policy setting, science is viewed by some as just another point of view that must be considered alongside social, political, economic, and other factors (Cvitanovic et al., 2015).

Many natural scientists prescribe to the concept of "logical positive empiricism" – that data are objective, there is one universal truth, and through rigorous application of logic we can reach towards that truth (Ozawa, 2009). Differing views on what "science" is can also play out in the consideration of how science informs policy. While some scientists view themselves as value neutral and purely objective, others point to ideas along the lines of Hoffman (2012) who stated "[s]cience is never socially or politically inert." Policy makers and other decision makers need to recognize that while science gives them tools to make a decision, those decisions must seek to balance a whole host of issues including cost, justice, equity, social acceptability, and more.

Ultimately, policy decisions are opinions of the best course of action at a moment in time. They are informed by experience and observation (including science), but they are ultimately choices between different societal values. Creighton (2005) also specifically notes that there is a difference between technical or scientific information used to inform or back a policy decision versus a technical decision. This challenge of parsing out scientific and technical questions from resources allocation questions is underscored by many (Matsuura & Schenk, 2017a; Susskind, 2014, 2017). Once the issue is one of choosing between values and different views of the world, it is no longer a technical decision and should not be presented as such, nor should scientists engage in the same way between technical decisions and broader decisions informed by science. Differing views on the importance of science can lead to "friction and frustration" between scientists and public policy decision makers, which ultimately serves to undermine knowledge exchange and collaborative efforts (Cvitanovic et al., 2015).

Other scholars discuss the idea of an irresistible urge for scientists to provide prescriptive advice and of policy makers apparent desire for it (Ozawa & Susskind, 1985). Scientists and policy makers alike would be well served to remember the limits of science and explore the balance between the two. As an educated citizen, a scientist is welcome to provide their opinion, but their science is unlikely to take into account other factors that a policy maker needs to consider. As noted by Adler (2017) "expert preferences are not 'science.'" Ultimately, a policy decision is still a policy/value judgement, not a scientific one. It is hopefully based on science and supported by facts, but it is not dictated by it. Even the National Research Council (2008b) has noted that science alone is not adequate to determine how to balance the risks, costs, and benefits of different policy decisions.[1]

Some scholars discuss the importance of pragmatism in the role of science in public policy. For example, in a discussion of the idea of "what makes a model good?" Miles (2000) notes that "[f]rom the perspective of model goodness, good environmental models should facilitate communication, convey – not bury or "eliminate" – uncertainties, and, thus, afford the active building of consensus decisions instead of promoting passive or self-righteous decisions." Unfortunately, there is a tendency to put a heavy weight on science when it can be used to bolster a view or decision held for other reasons, and likewise common to discount science that

[1] "Scientific analysis on its own is an inadequate guide to determining how the risks, costs, and benefits of environmental decisions ought to be balanced or how they should be distributed across the public. Such decisions depend not only on factual information, but also on values and preferences and on interpretations of factual information (e.g., National Research Council, 1983, 1994, 1996)." (National Research Council, 2008b).

challenges that view or decision (Hoffman, 2012; Ozawa & Susskind, 1985). This is especially risky when accompanied by the view that it is possible to find science to support any view and therefore can ignore science altogether (Susskind, 2014, 2017).

Due to the nature of the systems they are designed to represent, environmental models can never portray entirely closed systems like mathematics or computer coding so they can never be fully verified (Miles, 2000). This is not a critique of models, but an acknowledgement of their limitations and a call to present them as such. The use of models across the spectrum (mental models up through to complex mathematical) and diagrams (causal loop, stock and flow, etc.) can benefit interdisciplinary thinking and public participation, but it can also cause challenges when participants are not coming with a priori shared knowledge (Dyball & Newell, 2015). That said, Ford describes the benefit of stock and flow diagraming and of causal loop diagramming to improving the development of testable mathematical models because it is more likely to provide insight that increases the understanding of dynamic behavior within the system (Ford, 2009). Models can also serve as "boundary objects" across the knowledge to action interface when parties on both "sides" jointly develop them to move ahead (Cash et al., 2003).

One challenge in application of science to policy and of science communication is the differing perceptions of risk. Hannigan (2014) discusses the concept of "proofs" of risk and describes them as legal, scientific, and moral. He goes on to note that scientific proof of risk is "notoriously fickle, its authority intact only until the next disconfirming study appears" (Hannigan 2014, p146). This has important implications for how science is viewed in a policy setting and also lends weight to the ideas of collaborative approaches, where "opposing" sides seek shared understanding not just to find or fund the “next disconfirming study” “The choice between different risks is also the choice between different visions of the world” (Beck & Kropp, 2007) which has implications for what science is pursued, funded, and how it is communicated, which ultimately influences the practice of science.

There are also differing views on the “requirements” of scientists in society. Some continue to subscribe the knowledge-deficit model of education or information sharing (simply making your research available is sufficient, others will pick it up and use it) whereas others argue for an “ethical responsibility” to engage across producers and users of scientific knowledge (Cvitanovic et al., 2015). Others note that scientists are not directly accountable to the public and therefore should not be afforded special deference to decide policy matters solely on the basis of the scientific merits (Ozawa & Susskind, 1985). Their input, however, is critical and should be considered deliberately within the policy process through mechanisms like joint fact finding, mediation, and other efforts towards co-production of knowledge. Joint fact finding is highlighted by its champions as a much needed “interface between the culture of science and that of policy makers and the general public that preserves the impartiality of the scientist and the best practices of scientific inquiry while still honoring the values and preferences of stakeholders.” (Karl, Susskind, & Wallace, 2007). Recognizing the elements of the scientific enterprise that make it unique and a community in and of itself, a wider application of co-production of knowledge approaches could serve to lessen the feeling among some in the sciences that their principles are under attack from and undervalued by policy makers and the wider public.

In addition, there is no such thing as “settled science,” the very concept is antithetical to the practice of science (Miles, 2000). But efforts to communicate science to the public often use language noting that science is settled while at the same time scientists (rightfully) continue to pursue the same lines of scientific inquiry. This logical inconsistency is not evident to scientists who are comfortable with the iterative nature of science, but to those used to the idea that you stop investigating a crime when you solve it, announcing science as settled while still studying it doesn’t sit well. In place of “settled science” there is scientific consensus, but consensus can be overturned. Ozawa (2007) cites Thomas Kuhn in describing “the progression of scientific inquiry as a temporally bound consensus of scientists.” The iterative nature of science though is what buffers us from staying too long on any disproven claims. Discussion within the scientific community is healthy but presents a challenge when that can be exploited.

The importance of translation across disciplines, with decision-makers and with the public should also be underscored: “[m]utual understanding between experts and decision makers is often hindered by jargon, language, experiences, and presumptions about what constitutes persuasive argument” (Cash et al., 2003). As an example, fishermen distrust stock assessment models that show low fish biomass because they observe relatively abundant stocks, and farmers might ask for definitive evidence of a predicted drought. These represent failures on both sides to understand the context, experiences, and sources of knowledge of the others (Cash et al., 2003).

The impact of credibility, legitimacy, and salience on the practice of science

Scholars have recently been focused more on how science is used in public policy decisions in social-ecological systems, in particular in the context of "sustainability science." As they have done so, patterns and recommendations have evolved, in particular around the ideas related to the credibility, legitimacy, and salience of the research that is conducted (Cash et al., 2003). Cash et al focus on three areas regarding the role of science in policy: 1) definitions of effectiveness involve more than just the solution, 2) effectiveness focused in on credibility, legitimacy, and salience, and 3) the role of "boundary work" (Cash et al., 2003). Credibility refers to the scientific adequacy and scholarly rigor; legitimacy acknowledges that the production of the information has been "respectful of stakeholders' divergent values and beliefs, unbiased in its conduct and fair in its treatment of opposing views and interests;" and salience accounts for the "relevance" of the science or information to the issue at hand (Cash et al., 2003; Posner, McKenzie, & Ricketts, 2016). Some other scholars argue that this thinking is too inwardly focused on what scientists think is needed and not what policy makers actually want (Dunn & Laing, 2017). Alternative approaches like a focus on "applicability, comprehensiveness, timing and accessibility" or (ACTA) have also been proposed and critiqued (Tangney, 2017). Still others have expanded on this frame for example by adding useable and understandable (Lubchenco, 2011) or iterativity (Sarkki et al., 2015) to the framework.

The 2008 NRC study report *Public Participation in Environmental Assessment and Decision Making* uses largely the same definition for legitimacy, but in that case in the context of public participation (National Research Council, 2008a) showing the diffusion of these concepts across the scientific community and into the policy realm. Still other scholars use different terminology to describe similar phenomena, for example Bruckmeier (2005) describes what he calls "the process of knowledge integration" in the context of coastal systems as requiring "i) building trust between researchers and resource users (e.g. through focus group discussions or joint working groups); ii) identifying the elbow room for informal and local solutions to conflicts; iii) looking for approaches to involve resource users and stake- holders with their knowledge in decision-making; iv) monitoring continuously the success and failure of participatory management systems, with consecutive adaptation."

The increasing attention to science that is "credible, legitimate, and salient" is also helping to shift the focus away from pitting science against science through exploitation of scientific uncertainty or incomplete understanding (Karl et al., 2007). The work by Cash et al. builds on earlier work that focused specifically on the role of science advising and the importance of legitimacy, credibility, and salience in that context and expanded it out to larger programs and systems. What remains is further scaling it up not just to place-based programs, but how entire agencies and organizations operate (Cash et al., 2003).

Other scholars and practitioners have adopted this language and use it widely to describe their efforts. For example Ferguson et al., (2016) discuss their findings that models/decision support tools need to be seen as "credible, accurate, easy to understand, and appropriate to answer the question at hand." In addition, this focus has inspired other researchers to explore in more depth the relationship between these three factors and the use of "science" in a policy or management setting. For example, a 2016 paper reported on a study that found that legitimacy of the knowledge rose above credibility and salience as the most important factor when exploring the impact of ecosystem services knowledge on policy actions (Posner et al., 2016). In another example, researchers explored the role of legitimacy, credibility, and salience in the development of a climate change action plan for the Northwest Hawaiian Islands finding that the three factors were influenced by different elements of the case they explored (Schuttenberg & Guth, 2015).

Role of Boundary Spanners

A focus on how decision makers interact with and use the "products and process of science" enables researchers to better understand how to shape their work to be usable by decision-makers. This is especially relevant in social-ecological systems where the stakes are high. These approaches also create incentive for scholars to think more broadly about their connection to managers, decision-makers, and the wider communities around the issues that they study. While some may find this an uncomfortable role, there are a large number of organizations specifically designed to serve the function of supporting the interaction (Cash et al., 2003; Ferguson et al., 2016). Scholars would be well served to use those organizations as this focus continues across the literature as well as in funding agency guidance and the increasing focus on the importance of "broader impacts" (to use the National Science Foundation terminology). These functions ("boundary work") are critical to the use of science in policy settings (Cash et al., 2003; McGreavy, Hutchins, Smith, Lindenfeld, & Silka, 2013). The role of boundary work (organization and individuals) is also key to translating between communities (in this case, science and policy/decision-makers). A key element of this is the ability for a boundary organization (or individual) to understand the norms, expectations and values of the other groups and to be trusted by the parties. While one can work to become a boundary spanner, one cannot be self-appointed as such – the parties in either group ultimately decide whether or not you function in that role (Cash et al., 2003; van Kerkhoff, 2017).

Community influences on the practice of science

From a sociological perspective, communities are defined generally as groups of people organized around commonly held interests that contribute to personal identity (Brown & Schafft, 2011; Sampson, 2012). This can include communities of place (e.g. a neighborhood), of practice (e.g. medical doctors), or of interest (e.g. sailing), among others. An individual can be a member of multiple communities simultaneously. Communities also serve as a form of social control and exclusion (Sampson, 2012). Membership in certain communities (of place, practice, etc.) also define boundaries around how individuals think and act. This applies to the scientific community writ large as well as the disciplinary (and interdisciplinary) communities within the larger practice of science (Khagram et al., 2010; Sampson, 2012). People take "cues" from their different communities (of practice, of place, of interest) and these impact how people behave. Ultimately the role of communities of practice (i.e. where a scientist is employed) may have as much if not more impact than disciplinary training on how scientists conduct their own work. For example, scientists in some government agencies are quite accustomed to conducting research on applied questions asked by other portions of the same agency (e.g. Caldow et al. (2015)) whereas conducting an interdisciplinary project might be more foreign to a scientist who has only been exposed to academic training and employment in a single discipline.

Another way the scientific community impacts the practice of science is in how new ideas and controversy are handled. In the scientific community "new ideas are often dismissed as being incorrect or unimportant" and scholars reaching outside their field of training are often critiqued for doing so (Davis, 2003). Davis goes on to note that "the necessary conservatism and rigorous skepticism of science are sometimes hard to distinguish from obstructionism" which certainly impacts both the practice and perception of science in the public eye (Davis, 2003). In addition, Davis notes that "science does not reward those who take on controversy." This becomes particularly challenging in the context of social-ecological systems where many issues involve difficult policy choices. In addition, given the need for more engaged scholarship, scientists may knowingly or unknowingly walk into highly contentious issues. This has bearing not only on the reputation of science and scientists, but also for the fact that science and scientists can also become the source of or exacerbate conflict in social-ecological systems (Bruckmeier, 2005).

Assumptions, inferences, and researcher judgement also influence the practice of science (Ozawa, 2009). Scientific work reflects the latest consensus among scientists, not an unchanging body of facts (Ozawa, 2009). Simplifying assumptions are made based on researcher judgement and the "prevailing logic" in their discipline (Ozawa & Susskind, 1985). The prevailing logic changes over time across disciplines. This does not make the assumptions made under a previous prevailing logic fraudulent, but rather a product of their time (Kuhn & Hacking, 2012; Matsuura & Schenk, 2017c; Wootton, 2015). Understanding the context of assumptions within a discipline or a field is key, and where appropriate disclosure of assumptions is essential (Ozawa & Susskind, 1985) but challenging in many science communication venues.

Impacts of Scientific training

Elements of the practices and experiences that create the "scientific community" are also driven by one's education and training in the process of "becoming" a scientist and strongly influence the practice of science (Soule & Press, 1998). That training also extends to how scientists are taught to interact with each other and communicate with others. For example, the nature of how scientists are taught to write proposals and journal articles, and to communicate in general, is to point out the gaps in previous work and how their work helps fill that gap. This approach is easily exploitable by those who know the process, but have different end goals (see Brennan (2015) for an interesting case of a neurologist called in as science advisor to challenge coastal ecology findings). These norms of communication are accepted within the scientific community but can be foreign to others which can impact perceptions of the credibility of science.

In addition, the norms of determining what is valuable to study dictate what “scientists-in-training” are taught are legitimate sources of research ideas. This is where there is a divergence between the traditional academic scientific community and the applied scientific community (including some academics and those working in more applied settings). In academic circles, “the literature” is held up as the source for determining research gaps and pointing to future research needs, whereas many management agencies report their research needs through other venues (strategic plans, etc.). The prevailing norms in the broader scientific community would dictate that those agency sources are not as valid as the published literature, but it in fact reflects different norms between the two parts of the larger scientific community. Looking only at the literature doesn’t draw on needs identified by managers and those working in the systems, just the other researchers who work in these areas. While questions identified by other scientists are important, so too are those identified by managers and decision-makers. These needs are often captured in different forms of communication that can feel foreign to academic scientists (needs assessments, strategic plans, etc.). Likewise, looking only at the needs identified by managers also misses the larger research trends captured in the scholarly literature. Setting research priorities more broadly and being open to questions from non-traditional groups can lead to important insights and advancements (Ferguson et al., 2016).

The scientific method also includes room for subjectivity – what specific method, what variables, what measurements, what timeframe, what sites, etc. – all play into what the results will be (Ozawa, 2009). While this is accepted as part of the practice of "doing science" in the scientific community, it can be the source of skepticism outside.

Communication is important for another reason too which ties directly back to the characteristics of science for public policy, in this case it is centering around inclusion in the scientific process. For example, Cash et al found that "[e]xcluded parties often questioned the legitimacy of the information that emerged from the ensuing conversations, regardless of the information's salience or credibility" (Cash et al., 2003). This same theme is echoed by others as well "when people have a say in the design, analysis, and application of scientific inquiry—a collaborative problem- solving process—they are more likely to value and use it" (Karl et al., 2007). In addition, several scholars have highlighted the role of acknowledging the importance of "lay knowledge" in operating within the social or policy confines of a system as well as the increase in perceived legitimacy of science through stakeholder engagement (Ferguson et al., 2016). That said, the knowledge exchange literature in the context of natural resources is not well developed and has limited connection to the robust writings in other disciplines (Cvitanovic et al., 2015). This makes it challenging to draw complete conclusions, but also points to needed research.

In addition, changes to the social practice of science, expectations of funding agencies and society are at times at a disconnect with academic incentives. Scholars are not rewarded for being a good collaborative citizen and the very behaviors that might make someone a good collaborator may be considered a liability in some circles. On the other hand, academic researchers are rewarded for active dissemination and use of their work, something that increases in transdisciplinary or “comprehensive” efforts (Ferguson et al., 2016). These dueling views continue to influence the practice of science by current scholars, as well as how the next generation of scientists is trained to operate within the social structures of the science enterprise.

Community and training come together with many other factors to influence the values, norms, and perceptions, in the practice of science and ultimately how science is (or is not) translated into policy or management decisions.

Frameworks for science in resolving public policy disputes

Scholars and practitioners alike have argued that science and politics need to be kept separate (Karl et al., 2007; Ozawa & Susskind, 1985), and while direct political interference in scientific practice is cause for concern, we cannot ignore that through funding, organizational structures, and application of science to societal challenges, they are fundamentally connected. In public policy disputes involving science, there is a legitimate role for both science and politics in the sense that “politics” are the mechanism by which the interests of the public are communicated in democratic societies (Karl et al., 2007; Ozawa & Susskind, 1985; Susskind & Field, 1996).

“Science” has been used in many instances in an effort to resolve science intensive public policy disputes. Three approaches described by Ozawa & Susskind (1985) for the role of science in public conflicts are science courts, science panels, and “consensus-finding conferences.” These three fall generally in line with adversarial science and the idea of science courts described below. Here I focus on three approaches that have been used to consider the role of science in resolving these science intensive public policy disputes: 1) adversarial science, 2) science court, and 3) collaborative approaches, including joint fact finding.

Adversarial Science

Scientific findings, and the uncertainty associated with them are regularly used to support “contradictory policy positions” and it is not uncommon for parties to cherry-pick or narrowly interpret scientific input to uphold a preferred position or action (Ozawa, 2009; Ozawa & Susskind, 1985). Adversarial science can be viewed as pitting scientific findings and scientists against other findings and scientists in an effort to “win” to resolve a dispute. Adversarial approaches risk science ultimately being ignored as decision-makers struggle with competing interpretations (Susskind, 2014).

Specifically, in the case of legal proceedings in disputes over science, the court case resolves the immediate dispute by a judge issuing a ruling, but often leaves the larger conflict unresolved and is not without consequences for the parties involved and the perception of science. These approaches often boil down to whether the process of science met the standard set in the law (best available, or using processes laid out by law, etc.), in some cases that means it’s less about the content than about the process.

In adversarial science, differing factions are pitted against each other in ways that can lead to the exploitation of the scientific process to undermine other actors in the scientific community. One example of adversarial science, the dispute over the fate of the Drakes Bay Oyster Company, in California provides a valuable case in point. In the dispute over the science surrounding the impact of the oyster farm on the larger ecology of the area, the owner of the company called in the services of a neurologist who was ultimately adept at challenging and raising questions about the science used to determine the level of impact of the oyster farm. Although couched as legitimate questions about the quality of the science, the adversarial approach in this case left losers all around (Brennan, 2015). See the following chapters for further discussion of these concepts as it pertains to the research question at hand.

Adversarial approaches to science in disputes can undermine the role of science in that specific case, but also in the longer term and may also lead to just ignoring the science since it is too hard to figure out who is right. Decision-makers are left to be the "arbitrators" between conflicting science and also risk ending up in court where a judge ends up making the call. It is often not that decision-makers need more education or don't understand, it's that they are presented with conflicting research that leaves no easy path to determine how to consider the science (Matsuura & Schenk, 2017a).

Science Court

The idea of the science court is modeled off the legal system in the United States. Instead of hearing legal cases, the idea is that the science court would hear scientific ones. Judges (or panels of judges) would be selected for their specific expertise and hear arguments from "opposing" scientists before making a determination (Jasanoff, 1997; Ozawa & Susskind, 1985). Originally proposed in a 1967 article in the journal *Science* titled "Proposal for an Institution for Scientific Judgment" (Kantrowitz, 1967), the idea has been largely abandoned after briefly gaining traction in the mid 1970's (Jasanoff, 1997). Critiqued at once for perpetuating the adversarial nature of our courts (Ozawa & Susskind, 1985) and also for being unable to actually serve the function originally proposed (Jasanoff, 1997), it remains still just a proposal.

Collaborative approaches to science in conflict and dispute settings

Ozawa & Susskind (1985) describe the pitfalls with adversarial and court focused approaches and proposed instead mediation and the process of joint fact finding. Although formal mediation and the process of joint fact finding are a bit different, they do share characteristics and mediation can certainly be designed to accommodate joint fact finding. Similarly, other consensus building and collaborative approaches share similarities (described further below). For example, the role of a trusted neutral (facilitator or mediator), information sharing or co-creation, and their voluntary nature are just a few of the similarities (Karl et al., 2007; Ozawa & Susskind, 1985; Susskind, 2014; Susskind & Field, 1996).

Within the context of environmental disputes, Ozawa (2007) lays out four perceived roles for science based on the "logical positive empiricism" view of science: discoverer, mechanism of acountability, shield, and tool of persuasion. Science can be more than these four categories though and one key opportunity is science as a tool for facilitation (Ozawa, 2009). Science can come into a dispute mediation process early on as participants take time to explore the science needs, the data sources, the assumptions, etc. before they dig into the meat of the mediation (Ozawa, 2009; Ozawa & Susskind, 1985). This approach allows for the upfront acknowlegement of competing interests and the inclusion of stakeholders in decisions about how to address these competing interests in the context of the science used within the dipute resolution process (Ozawa, 2009). Instead of a focus on maintainig positions (Fisher et al., 2011), the focus is turned to "collectively accumulating and making sense of relevant data and analyses" (Ozawa, 2009).

Collaborative science approaches can be used to resolve a dispute and/or to ward off future disputes. There is a wide range of names for related approaches that share some characteristics, but stem from different disciplinary and practical traditions. Examples include:

- action research (Adler, 2017),
- action science (Adler, 2017),
- blue-ribbon panels (McCreary, Gamman, & Brooks, 2001; McCreary, Gamman, Brooks, et al., 2001),
- co-innovation (Macdonald, 2012; Percy, Turner, & Boyce, 2019),
- community based research (Macdonald, 2012),
- cooperative inquiry (Adler, 2017),
- co-production of actionable science (Beier, Hansen, Helbrecht, & Behar, 2016),
- collaborative model development (Ferguson et al., 2016; Miles, 2000; Ozawa & Susskind, 1985),
- collaborative research (Macdonald, 2012),
- collaborative stakeholder engagement (Ferguson et al., 2016),
- comprehensive approach (Dyball & Newell, 2015),
- developmental action inquiry (Adler, 2017),
- ecosystem based management (McLeod & Leslie, 2009; Patrick & Link, 2015),
- epistemological pluralism (Miller et al., 2008),
- Gibbons "Mode 2" science (Matsuura, 2017),
- joint fact finding (see further discussion below),
- knowledge co-production (Schuttenberg & Guth, 2015; van der Molen, 2018; van der Molen, Puente-Rodríguez, Swart, & van der Windt, 2015),
- knowledge exchange (Cvitanovic et al., 2015),
- living theory (Adler, 2017),
- management strategy evaluation (Ono et al., 2018),

- participatory action research (Macdonald, 2012),
- participatory research (Adler, 2017),
- Pasteur's Quadrant - basic, applied, and use-inspired research (Matsuura, 2017),
- sustainability science (Macdonald, 2012; McGreavy et al., 2013; McGreavy, Silka, & Lindenfeld, 2014), and
- transdisciplinary approaches (Eigenbrode et al., 2007; Khagram et al., 2010; Lang et al., 2012; Miller et al., 2008).

Regardless of what name it is given, these ideas all point to the power in working together to solve the challenges ahead. While critics have argued that they are insufficient and don't lead to improved outcomes (Layzer, 2002, 2008), the evidence suggests that they do have a positive impact. The point of all these approaches is also to move people towards more common ground and "civil discourse" in an effort to make decisions.

These approaches also have shared characteristics in the links and nexus with applied or management relevant science questions, incorporation of multiple parties and perspectives, and reliance on boundary spanners and/or trusted neutrals. While these approaches can all provide valuable contributions, I focus further here on joint fact finding given its ties to negotiation and consensus building.

Joint Fact Finding

Over the past two decades, joint fact finding or JFF has evolved as "a procedure or set of best practices … for ensuring that science and politics are appropriately balanced..." (Karl et al., 2007). These processes can be initiated by parties in a conflict that has turned to the courts already or the parties can use the JFF process to avoid escalation to court proceedings. Joint fact finding is held up as an approach that allows the consideration of knowledge from multiple sources, including but not limited to technical knowledge, local ecological knowledge, expert practitioner knowledge, and other culturally or socially relevant sources (Karl et al., 2007). An additional benefit of the joint fact finding approach is that the participants overall understanding of the context, technical aspects, and policy matters at issue are all likely to increase (Ozawa & Susskind, 1985). Posner et al. (2016) also discuss joint fact finding and what they refer to as the importance of "iterative" engagements across sectors. Wondolleck and Yaffee (2000) also briefly discuss what they call "joint research and fact-finding" as approaches to involve the public through both formal processes associated with disputes and negotiated agreements as well as more generally to advance collaborative efforts. Joint fact finding is also compared to other approaches like blue-ribbon panels and "adversarial" science (i.e. in court proceedings or public hearings) and described as beneficial (McCreary, Gamman, & Brooks, 2001; McCreary, Gamman, Brooks, et al., 2001; Ozawa & Susskind, 1985). Some scholars and practitioners discuss joint fact finding specifically as a part of a formal alternative dispute resolution (ADR) process (McCreary, Gamman, & Brooks, 2001; McCreary, Gamman, Brooks, et al., 2001) while others call it out as something apart from ADR (Ozawa & Susskind, 1985). Self-titled "pracademic" Lawrence Susskind further elaborates on the joint fact finding approach in his 2014 book *Good for You, Great for Me* calling it "a multi-step, collaborative process for bringing together negotiating partners with different interests, values, and disciplinary perspectives" (Susskind 2014, p24).

Table 2.1 presents a synthesis of the components of joint fact finding to include the following stages: scope, define, conduct, review, use. In addition to those summarized here, other scholars and practitioners discuss the process of JFF but without giving it as prescriptive a set of steps (Andrews, 2002; McCreary, Gamman, & Brooks, 2001). Each of these scholars (and others) elaborate on the components of these steps, including Adler (2017) who describes what I call the "use" phase in more depth than those noted in the table – he adds on several detailed steps binned under "problem solving and consensus building" as the final stage (Adler, 2017).

Table 2.1. Synthesis of approaches to Joint Fact Finding (text within body of the table is drawn directly from the noted sources).

	Ozawa & Susskind (1985)	**Ehrmann & Stinson (1999)**	**Karl et al. (2007)**	**Adler (2014)**	**Susskind (2014)**	**Matsuura & Schenk (2017a)**	**Susskind, Field, & Smith (2017)**
Scope/ Assess	Frame the research questions	Define issues of concern	Prepare for JFF Scope the JFF process	Start Scope	Scope the dialog	Assess the need for JFF Convene multi-stakeholder process	Assess the need for JFF Convene the stakeholder process
Define	Select the researchers Specify the method of inquiry	Define questions to be asked and methods of analysis	Define the most appropriate methods of analysis Define process for getting information	Plan Convene	Jointly chose experts Define the appropriate method of analysis Clarify roles/ responsibilities	Scope the research agenda	Define the scope of the study
Condu ct	Monitor the work		Conduct the study	Research and deliberate Align Produce		Conduct the research	Conduct the study
Revie w		Define limitations of analysis and methods	Evaluate the results of JFF	Deliver	Assess tentative findings together	Evaluate the results	Evaluate the results of the study
Use		Define the best way to proceed	Communicate the results of the JFF process		Communicate results.	Communicate the results	Communicate the results of the JFF process

Although viewed as too time consuming or expensive by some, proponents of joint fact finding argue that parties can save resources by conducting and/or financing shared research and analysis

(Susskind, 2014). For example, in a two party dispute where each group hired their own science expert, they would spend double the cost of hiring one group of experts jointly and sharing the costs (Susskind, 2014). Given the type of disputes that lend themselves to joint fact finding (i.e. those in social-ecological systems), there is a strong likelihood that the experts needed for such an endeavor would need to be adept at working in inter- and transdisciplinary teams and have experience with undertaking collaborative approaches.

One of the benefits of JFF is argued to be the ability to bring science into a process where it might otherwise be ignored. This approach also becomes a valuable antidote to the temptation to completely ignore scientific facts as might happen in an alternate approach where two sides bring their own conflicting science to the negotiating table (Susskind 2014, p24). Instead, through the use of the joint fact finding process, parties in a dispute can seek to create value for all and increase the overall chance that all parties will end up better off (Susskind 2014, p25). Even with joint fact finding, the same data can be interpreted differently and those seeking a solution will have many different characteristics (level of risk tolerance, etc.). Parties need to be prepared for this reality (Susskind, 2014). Karl et al. (2007) describe joint fact finding as an approach that can be used at all levels (federal, state, and local), but there may be different types of challenges to consider at the larger scales. In describing the joint fact finding process, Karl et al. (2007) make explicit reference to local and community scales. It seems the JFF process is most well suited for cases where it is easier to put bounds on who the affected and who the interested parties are. At larger scales in some states, in inter-state regional issues, and at the national level, these approaches might become harder to implement. In addition, practitioners and scholars caution against the use of joint fact finding when there is a significant power imbalance

(Ehrmann & Stinson, 1999; Matsuura & Schenk, 2017a). As such, the approach may be less relevant to some disputes. That said, there are lessons from JFF and similar approaches that might apply and given their success in de-escalating other cases, it is worth considering their application on a large-scale dispute. Some critics of joint fact finding have expressed concern over "science by committee" or the devolution to "lowest common denominator" thinking, but proponents argue that a well-run joint fact finding process can avoid these pitfalls (Karl et al., 2007). Another challenge could be that of tight budgets and timelines given the assumption that an agency will be the convener of these types of joint fact finding processes (Karl et al., 2007).

Susskind (2014) underscores that technical advisors must remain objective and not recommend an approach even after delivering their results in these collaborative processes. The selection of the final approach is informed by the information developed in joint fact finding, but it is up to the parties to the dispute to decide on the final action. Interestingly Beier, Hansen, Helbrecht, & Behar (2016) include in their review of steps towards actionable science a recommendation to scientists to be up front about their policy preferences. This can be interpreted not as advocating for a particular decision, but rather being honest about their values. While in practice this may come down to individual scientist comfort levels, those that chose to discuss a preferred policy outcome need to be clear when it is a recommendation based on their own scientific expertise and when it is a personal policy preference. Given that scientists' words (in some settings) are afforded great deference, it is incumbent upon the scientists to be clear about the extent of their expertise versus their opinion.

For these joint efforts to be successful, the following conditions must be met:

> “First, access to scientific expertise and analysis must be available to all stake holding parties. Second, the agenda for negotiations must clearly set aside a period for addressing explicitly political concerns in order to discourage participants from stubbornly posturing behind technical positions that they believe will afford them political gains. Finally, experts invited to participate in the decision-making process must commit to share scientific information in order to educate, not intimidate the [other][2] stakeholders” (Ozawa, 2009).

Joint fact finding is also framed by some scholars and practitioners (Karl et al., 2007) as a piece of the mutual gains approach to resolving disputes that also sets out a framework that is directly applicable to science-intensive disputes. Considering the steps of the mutual gains approach from Susskind & Field (1996) as a larger context for joint fact finding is also beneficial. In particular, the mutual gains approach emphasizes “talking with, not at each other” which is important for joint fact finding, but also for the broader context of collaborative approaches.

Collaborative approaches, including joint fact finding, can help create a zone of possible agreement, develop creative solutions, and lower the cost of science (Susskind, 2014). In addition, these approaches can help create a “common basis for understanding” across all participants (Ozawa & Susskind, 1985), akin to the concept of a priori shared knowledge that Dyball and Newell (2015) describe as essential to collaboration.

Theories of Negotiation

Karl et al. (2007) contrast the consensus building process with that of traditional approaches to public engagement which they describe as having little to no discussion and typically time-limited opportunities for stakeholders to present their concerns on issues where the decisions

[2] I added “other” to this quote because scientists and technical experts invited to participate are in fact stakeholders as well. Treating them separately from others in the system continues to afford them status as more important to the process than other input.

have most likely already been made. Whereas Layzer (2008) refers to the typical approach of agency decision making as “decide, announce, defend,” Karl et al. (2007) and others characterize much public engagement as “inform, invite, ignore.” The frustration that brews over the feeling of a pre-determined outcome and of not being listened to fuels a lack of engagement and further conflict within the systems. Conventional bargaining is focused on the distribution of value, whereas consensus building (or the mutual gains approach) is about creating value first, then seeking to distribute (or claim) that value.

Scholars and practitioners have developed and studied a number of approaches to negotiation and dispute resolution. Two approaches have particular relevance to - and the possibility to benefit - cases of conflicts in social-ecological systems. First, the “mutual gains approach” may provide a framework for moving to more effective solutions and second, the steps of “principled negotiation” have potential to serve as a second lens to consider natural resource disputes.

Susskind and Field (1996) define six components of the mutual gains approach:

- “Acknowledge the concerns of the other side
- encourage joint fact-finding
- offer contingent commitments to minimize impacts if they do occur, promise to compensate knowable but unintended impacts
- accept responsibility, admit mistakes, and share power
- act in a trustworthy fashion at all times
- focus on building long-term relationships.”

In addition, Fisher et al. (2011) outline four elements of “principled negotiation:”

- “Separate the people from the problem
- Focus on interests not positions
- Invent options for mutual gain
- Insist on using objective criteria.”

Table 2.2. Negotiation theories (Fisher et al., 2011; Susskind & Field, 1996) and science for sustainability (Cash et al., 2003) conceptual interaction.

		Science for Sustainability (Cash et al., 2003)		
		Credibility	Legitimacy	Salience
Mutual Gains (Susskind and Field, 1996)	"acknowledge the concerns of the other side"	Tension in accounting for other scientific perspectives and generating repeatable outputs for decision makers impacts credibility of science within the scientific community.	Inability to account for differences impacts perceptions of the legitimacy of science among stakeholders.	Acknowledgement of concerns can lead to science that is more salient to the actual management issues at hand.
	"encourage joint fact finding"	Joint processes can create spaces for scientists who might otherwise poke holes in each other’s work to bring their knowledge together.	Joint processes benefit the acceptance of the results by increasing the perceived legitimacy of the process.	Joint processes have the benefit of being tied directly to management needs, but risk hyper focus on certain concerns.
	"offer contingent commitments to minimize impacts if they do occur, promise to compensate knowable but unintended impacts"	Thinking of science as a negotiation can increase the credibility by helping scientists prepare for system responses that don't match expected outcomes.	Involvement of other groups can improve the perception of science by building in contingencies based on other groups concerns.	Science that already accounts for the possibility of unexpected outcomes is more likely to maintain a seat at the table in management processes.
	"accept responsibility, admit mistakes, and share power"	Sharing power can be difficult in settings with very different structures of perceived authority (i.e. scientists, managers, regulated entities).	Sharing power in a scientific setting opens up the black box and can increase perceived legitimacy.	Sharing power is essential to designing research and monitoring that meets applied needs.
	“act in a trustworthy fashion at all times”	Acting in a trustworthy manner builds opportunities for enhanced credibility	Acting in a trustworthy manner with other scientists as well as with managers and regulated entities builds legitimacy	Acting trustworthy may increase the likelihood of people being invited into applied venues that can increase the salience of future work for scientists.
	"focus on building long-term relationships”	Processes that remind participants (inc. scientists) of the importance of building relationships can enhance credibility.	A transparent and inclusive scientific process builds relationships that can be drawn on in the long term.	Different models of funding science/research lend themselves to different relationship structures and relevance to the issue at hand.

Principled Negotiation (Fisher, Ury, and Patton, 2011)	"Separate the people from the problem"	Differentiating disagreements about science questions from those about policy solutions can open doors	While people connected with an issue may exhibit behaviors that make them difficult to involve, their inclusion is essential to the perceived legitimacy of the process and outcomes (including science).	The researchers most regularly involved may not be the ones who actually have the right expertise to provide science that is salient to the issue at hand.
	"Focus on interests not positions"	"Positions" exist in science and can decrease credibility if perceived to outlive the weight of evidence.	"Positions" in science can derail efforts and decrease views of the legitimacy of the work.	There is a tension between research to support positions and research that is "salient" to the issue at hand.
	"Invent options for mutual gain"	Science can be the source of new ideas that benefit the system if developed in ways that are viewed as credible.	Science can be the source of new ideas that benefit the system if developed in ways that are viewed as legitimate.	Science can be the source of new ideas that benefit the system if developed in ways that are viewed as salient to the issue at hand and the local context.
	"Insist on using objective criteria"	Objectivity and transparency build credibility	Objectivity and transparency build perceptions of legitimacy by helping those impacted see how science decisions were made.	Objectivity and transparency can help build connections to conduct science that is more salient to the issue at hand.

Joint Fact Finding and the Credibility, Legitimacy, and Salience of Science

Joint fact finding and other collaborative approaches can also serve to increase the credibility, legitimacy, and salience of research which are highlighted by many scholars as critical to the use of science in public policy (Cash et al., 2003; Lubchenco, 2011; Posner, McKenzie, & Ricketts, 2016, among others). In the context of dispute resolution, the use of jointly selected technical experts directly supports the credibility of the science, while the joint fact finding process itself enhances the legitimacy by drawing directly on the interests of those involved. Lastly, the work will have high salience to the issue at hand based on the design of the joint fact finding process.

When scientists step into more active roles within the dispute themselves, it can raise questions in the context of their credibility with other researchers. This is one of the challenges with approaches like joint fact finding, participatory action research, or other co-production of knowledge models for research. The issue of credibility might be raised not within the group working on the collaborative project, but those in the scientists' other "communities" – scholarly and otherwise – if they think that by working closely with decision-makers, the work is no longer scholarly credible. Perhaps in part perhaps because of this risk to career and perceptions of credibility, it appears that it is often other non-academic organizations like consultants, NGOs, citizen science groups, etc. that end up serving the science needs of broader collaborative projects that involve applied issues. Science in an advocacy organization is still science, but with a known angle. In some cases, this might actually increase the perceived credibility because people feel like they know the "angle" upfront. In the context of joint fact finding, the disconnect between traditional funding streams and expectations of home (academic) institutions may also present barriers to the more widespread use of the practice.

Stakeholder engagement efforts have also been found to build consensus, in part because the effort can provide space to clarify differences in opinion and the associated "co-learning" can serve to reduce potential for conflict in the process (Ferguson et al., 2016). Not all joint fact finding processes end up producing conclusive results or resolving the disputes, but they can still be seen as increasing the capacity within a community to engage productively and address some of the overarching challenges (Karl et al., 2007). Joint fact finding can help set the stage to build trust which is an "essential condition for people to work together successfully," but the overall process design must be keep in mind as key to the ultimate success (Karl et al., 2007).

In addition to mechanisms to use science within the dispute process, there is also a need to acknowledge the role of science and public engagement in potentially avoiding protracted conflicts. This is valuable in thinking of the design and operation of efforts as larger programs as opposed to one off approaches that address and immediate need as opposed to a long-term challenge. For example, NEPA reform efforts or use of existing mechanisms like Federal consistency trainings to bring conflicting parties together to avoid a Secretarial appeal of a consistency determination. Here the benefit is not seen in resolving disputes, but in their avoidance in the first place.

Approaches like joint fact finding and mediation also create space for parties to the dispute to "save face" in the event a previously stated view doesn't hold up. Saving face can be critically important in finding a solution (Fisher et al., 2011; Ozawa & Susskind, 1985; Susskind, 2014; Susskind & Field, 1996). This is especially critical in the current landscape where scientific data has been caught in the political cross-hairs and as such become a cultural flashpoint as well. Collaboration can lead to creative solutions in part by reframing the debate to one where "side" acknowledge the legitimacy of other views and shared interests (Karl et al., 2007).

There is the risk of falling into the trap of the "mythical fixed pie" (Bazerman & Neale, 1992) when dealing with these types of efforts though. The idea behind this is that there are barriers to creativity because we make assumptions about what is "true" based on what we experience. In the context of joint projects, multiple perspectives can serve to limit consideration of new approaches if people focus on what has not worked in the past. That said, seeking to broaden instead of narrow ideas can also open up dialog. Keeping this in mind creates space to think more creatively, and seek perhaps alternate or new approaches that might address the challenges, yet still within the confines of the law, etc. It also helps to consider the larger context when exploring the "mythical fixed pie." Stepping back to look at the larger context – and in some cases that means considering the broader social ecological system within which the dispute sits – it is possible to see that other solutions might actually get at the problem. This also ties into the benefits of inter and transdisciplinary work and the opportunity for news ideas from different ways of thinking. Engagement with the associated communities can also benefit the scientific process by identifying new questions and providing access to data that might be unknown to researchers (National Academies of Sciences Engineering and Medicine, 2016).

Public participation and engagement in social-ecological systems

At its most basic, public engagement in environmental decision-making is a mechanism for interacting with those who will be impacted by a decision. Creighton describes public participation (and by extension engagement) efforts as a way to ensure that those who make decisions that impact people's lives have a dialog with those people and notes that public participation *informs* but does not *make* decisions (Creighton, 2005). The U.S. has a long history of attempts at engagement processes through environmental laws and policies, but at the same time has an equally long history of tactics by corporations and government alike that have sought to suppress that engagement (National Research Council, 2008b; Susskind & Field, 1996). This history is part of the context in which all public engagement efforts sit.

Creighton (2005) defines public participation as "the process by which public concerns, needs, and values are incorporated into governmental and corporate decision making." In this case, I am focused solely on those decisions made by government agencies, elected officials, and the associated public engagement processes and approaches. Public participation typically includes more than just one-way information, there is some element of a two-way interaction between the decision-making body and "the public." In addition, here has to be an expectation of some level of impact on the outcome of the decision for people to consider participating (Creighton, 2005). In their 2008 report, the NRC described the goal of public engagement as seeking to "improve the quality, legitimacy, and capacity of environmental assessments and decisions" (National Research Council, 2008a).

In an effort to further define "public participation" Creighton (2005, p 9) suggests the idea of a continuum from informing the public through jointly developing "agreements" (in this case he referring to "agreements" beyond the bounds of formal negotiation). Although he describes general areas of the continuum, he underscores that there is overlap across the elements from "inform the public" to "listen to the public" to "engage in problem solving" to "develop agreements." The mechanisms for gathering input vary, but can include meetings, written and oral testimony, participatory processes, scoping, listening sessions, roundtables, "town hall" meetings, public comment, agency webinars, constituent calls, hearings, etc.

The history of thought behind public engagement in environmental decision making in the U.S., points to its origins in the policy development of the New Deal era (1930's) but also more generally to the founding ideas of direct public input on policy decisions exemplified through the original New England town meeting process (National Research Council, 2008b). These early processes (and those in use in the U.S. today) are not without fault and challenges.

The 1946 Administrative Procedures Act (APA, 5 USC § 551 et seq.) sets forth processes by which the federal government must notify the public of actions and accept comment on those actions (including requiring that the Federal Register[3] be used as the mechanism by which this notification formally occurs). The APA provides a layer of guidance for all federal agencies, many of whom are also guided by more specific programmatic laws that have their own public engagement processes outlined within them. Where program specific authorizing legislation does not specifically require public engagement, agencies are only required to meet the "notice and comment" standards of the APA.

The 1969 passage of the National Environmental Policy Act (NEPA, 42 USC § 4321 et seq.)[4] expanded upon the APA requirements and specifically in the context of environmental decisions, required notification and opportunities for input *before* a federal decision was made that would impact the environment (this includes funding and issuing a permit in addition to any direct activities of the federal government). That said, agencies are not required to use that input nor are they required to directly account for the public comment received in the process (National Research Council, 2008b). Critiques of NEPA and predecessor laws in the anti-poverty and development sphere pointed to the unrealistic expectations regarding who would have the time or

[3] Touted as "the daily journal of the United States Government," the Federal Register can be viewed at https://www.federalregister.gov/.

[4] Congress stated that the purpose of NEPA is "To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality." 42 U.S. Code § 4321, available: https://www.law.cornell.edu/uscode/text/42/4321.

capacity to participate, concerns over an end-run around the electoral process if decisions were opened up to public input, as well as outright efforts by public officials to “constrain, obstruct, and derail” public processes that they perceived as infringing on their power (National Research Council, 2008b).

Under the requirements of NEPA, agencies must have a “meaningful response” to input, but don’t have to incorporate the input in their decision and they are not required to select the least environmentally damaging alternative (Creighton, 2005). That said, NEPA is not just designed to inject public input into federal decision-making, but also to provide a venue for incorporation of science into the policy making process. The focus is on procedural compliance not on content and concerns abound about NEPA in theory versus NEPA in practice (Creighton, 2005). Recent reform efforts have attempted to address some of those concerns through implementation guidance and more streamlined structures in the White House Council on Environmental Quality and the Environmental Protection Agency which have key roles in implementing NEPA (White House Council on Environmental Quality, 2017; White House Council on Environmental Quality & State of California Governor’s Office of Planning and Research, 2014). Regardless of these efforts, NEPA is still often derided as a burdensome and overly complicated process.

Following the passage of NEPA, many states instituted similar laws and procedures and nearly every environmental law since has underscored the principles of public notice, input, and engagement in their procedures (National Research Council, 2008b). Public engagement is also a core premise behind a number of federal and state partnerships (for example Sea Grant, Coastal Zone Management, National Estuarine Research Reserves, the National Estuary Program, and others) that came out of this same era (1970's and 1980's). Other place based federal programs are designed to include local input as well (including for example the National Marine Sanctuary System, the National Park System, and the National Wildlife Refuge System, among others).

More specifically in the coastal and ocean realm, I focus here on two laws that are directly relevant to the cases that are the focus of this research: the Clean Water Act (CWA, 33 U.S. Code § 1251 et seq.), and the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA, 16 U.S. Code § 1801 et seq.). In addition to the requirements of NEPA outlining steps for review processes for all federal actions, these laws frame processes for actions and participation directly in federal activities as it pertains to coastal and ocean areas. While relevant to inland and coastal waters alike, the CWA (originally passed in 1972 as amendments to the 1948 Federal Water Pollution Control Act) also includes references to requirements for notice and comment throughout and specifically includes provisions for citizen lawsuits regarding violations, a unique mechanism for public involvement in the enforcement of the act. The MSFCMA (originally passed in 1976) includes repeated explicit requirements for final agency actions to only occur "after notice and an opportunity for public comment." This pertains generally to a number of actions, but there are also specific legally binding timelines included in some instances. For each of these laws, the accompanying federal regulations also lay out specific public notice requirements, comment processes, and timelines. Each of these laws has also been extensively litigated so case law also dictates their practices.

Separate and apart from the associated notice and comment provisions, some laws related to social-ecological systems have another layer where "public engagement" is brought to bear. For example, under the MSFCMA the public can provide input through regularly held Fishery Management Council (FMC) meetings across eight regions of the U.S. and that input is then also shared with the NOAA National Marine Fisheries Service through attendees at meetings and during the rule-making processes. In addition, the FMCs are made up of seats that are intended to represent interests related to fisheries and oceans in each region, so the management recommendations themselves are informed in part by this "public" perspective brought by FMC members. As another example, coastal and ocean programs designed as federal-state partnerships that go beyond just the transfer of funds also have a large informal component where federal and state staff are in regular communication. For example, the national coastal zone management program (under the CZMA), the national sea grant program (under the National Sea Grant College Act), and the national estuary program (under the CWA) are all run with regular interaction between state and federal staff. This also serves as a mechanism to bring a "public" perspective into federal agency management decisions regarding social-ecological systems. These and other entities serve as conduits to express to the federal agencies the concerns and input they are hearing from the states and from the local public at large. In addition, members of Congress serve as a conduit for public input and feedback to the agencies through hearings, questions for the record, and general inquiries and meetings with agency officials. As elected representatives for the public and as legislators, this is an appropriate role for them to serve.

Lastly, there is a burgeoning set of informal public engagement processes that are designed more about knowledge transfer and partnership development than tied to a specific agency decision. These approaches are designed to address the more general problem of lack of participation, awareness, and knowledge across sectors. That said, these approaches do not follow Creighton's definition of public participation because they are not always lead by a convening agency that is set to make a decision. While they are in some cases funded by agencies that do make decisions, there is not a direct link between the informal engagement activity and a specific decision. Examples include large scale efforts like the Landscape Conservation Cooperatives, and Regional Ocean Planning, but also smaller scale efforts like the Coastal Training Program (CTP) for municipal decision makers as part of the National Estuarine Research Reserve System, various engagement activities that are part of the National Estuary Programs or National Sea Grant College Programs, or the Marine Resources Education Program (MREP) which was set up to help participants in fisheries management across sectors engage more directly in the process.

Public engagement does not necessarily equate to a change in the process or the outcome, but robust engagement processes where people feel listened to can support the legitimacy of processes and acceptance of the solutions (Cash et al., 2003; Fisher et al., 2011). Although some critiques of public involvement in environmental decisions making are based on the complexities of the scientific issues at hand, most are more focused on what NRC calls the "practical" aspects (National Research Council, 2008b). More specifically, they point to three general areas of critiques: "that the costs are not justified by the benefits, that the public is ill-equipped to deal with the complex nature of analyses that are needed for good environmental assessments and decisions, and that participation processes seldom achieve equity in process and outcome." (National Research Council, 2008b). Others critique public consensus and decisions reached through public processes as "fleeting" and based only on who happens to participate at the time (National Research Council, 2008b).

One of the challenges with broad public engagement is that all parties might not know the legal and institutional constraints on the system and might be frustrated that proposed solutions and creative ideas are not viable. This is one of the goals that some programs like MREP and CTP aim to help address – by helping participants better understand the legal and organizational framework. This can help but might also lead to a limiting of the creative solutions if everyone who participates is bounded by the solutions that fall within the existing system. Sometimes the solution might be that the system needs to change.

Layzer (2002) cautions against the risk of fiscal constraints and power imbalances within the system as major reasons to avoid the widespread application of "civic environmentalism" and other names for collaborative approaches to environmental decision making. In addition, she notes that "[t]here is a limit to the endurance of even the most public-spirited citizens." Citing the Belmont Open Space case where "[b]y the end of the controversy, [Open Space Alliance] members were exhausted and dispirited, and many had withdrawn from the political process altogether" (Layzer, 2002) she highlights these risks. While this statement is in line with other scholars on the risks associated with public processes (Susskind & Field, 1996), it should not however be read as an indictment of "civic environmentalism," public engagement in environmental decision making, or collaborative processes in general. Rather it calls for acknowledgment that the existing structures are not conducive to public engagement to the right side of Creighton's spectrum (joint development of agreements) because most systems were designed with only the left side (information sharing) in mind. Layzer (2002) points out that she is not alone in underscoring that conflicts arise precisely because of fundamental differences in values across participants in our political systems, but unlike her conclusion that this means there is no chance for collaborative processes to be successful, other scholars see this as space to seek out not shared values, but rather shared interests as the basis for working together (Susskind, 2014; Susskind & Field, 1996).

In public hearings or comment periods required under certain laws, individual citizens and groups have an opportunity to present additional information or contradicting evidence. The process does not require a response and typically a version close to what the agency has already proposed is ultimately approved (Ozawa & Susskind, 1985). Avenues for parties that disagree are then limited to the courts. This raises the question of "what is the right timing and level of participation? Creighton (2005) notes that it depends. If an agency is already pre-committed to an outcome, efforts on the "inform" side of the spectrum are far better, otherwise you create a veneer that the public is providing input when the decision has really already been made. This sets the precedent for distrust in other venues.

Traditional public engagement comment processes are also typically undertaken at a point when much of the work has already been done. There are limited opportunities for additional research or for course changes. This can leave the public feeling like the path has already been decided if they are not presented carefully. Karl et al 2007 discuss the importance of meaningful participation for these participatory processes to work. When groups feel ignored and then don't participate it becomes a vicious cycle of exclusion, not showing up, and then perceived indifference to the process by those running it. Figure 2.1 provides a conceptual framework for how public engagement typically plays out in formal and informal ways through government decision processes.

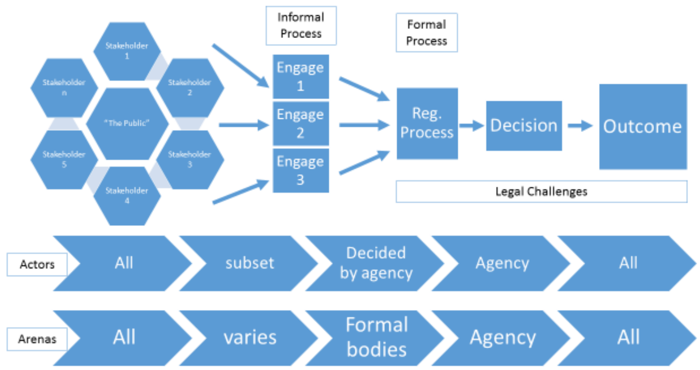

Figure 2.1. Conceptual framework for informal and formal engagement processes.

The typical picture of public input process is either sending a written comment into the ether or attending a large public meeting held in a hotel meeting room, where agency officials come and present a proposed rule, decision, etc. and then sit and listen to input from interested parties. There is no opportunity for discussion and no opportunity for either side to ask clarifying questions or to interact with each other. Some processes are structured specifically to have only limited opportunity for the "public" to engage, excluding those who will most directly feel the negative impacts of the decision. Often set up as two to five-minute windows for individual public comment that must be requested in advance, the standard "public comment" period at a meeting is often the sole outlet to engage directly with another person other than calling agency staff or reaching out to elected officials to engage with the agency on their behalf. Alternatively, a typical process that includes committees of experts (i.e. advisory panels or related councils) affords those members of the public increased access to the decision-makers by virtue of their technical expertise and the design of the process. This set up is ripe for resentment by those who feel they want to participate but cannot get selected for a seat on a committee or board. This approach also breeds disengagement because some feel the deck is stacked against them. This is a recipe for adversarial outcomes and the warnings of creating an “angry public” as described by Susskind and Field (1996).

Another complicating factor is the question of how public engagement fits in with the employment situation for participating members (Straus, 1999). There is an ease to participation for those who have jobs that are salaried and directly connected to the topics at hand, versus others who may work for themselves or organizations that can’t or won’t support their time to attend public meetings. Those that represent or work for a government agency, academic institution, non-profit organization, or large business are likely to be paid by their employer for the time they spend in meetings or preparing public testimony, etc. Those who are self-employed or employed in a sector outside of the one directly involved are likely to have to participate on their own time. For example, work like fishing or hourly wage jobs don’t lend themselves to taking a day off to listen and speak at a public meeting. This further limits engagement, because in some cases it means that even if the “public” does attend, they will likely only attend the brief public comment period and not stay to hear the rest of the discussion creating a missed opportunity to understand the process and the content, but for understandable reasons (like avoiding lost wages). In addition, they may only come when encouraged to by others in an attempt to halt a proposed action. This aspect of the alignment (or lack thereof) between who can participate based on the nature of their employment has implications for the perceptions of legitimacy and quality of the public engagement processes.

The logistical approaches to setting up an opportunity to provide public input or engage with the public can also impact their perceived legitimacy and authenticity (Straus, 1999). These aspects can be used to purposefully or inadvertently limit participation such as choosing locations that are not easily accessible or dates/times that conflict with activities that are culturally or socially important to the target audience. In addition, the mechanism for announcement also create challenges. For example, unless someone is already engaged with a group that will tell them about an event, very few people read the Federal Register daily see a meeting announcement comes up. This has also become an issue with advances in technology and announcements in printed newspapers versus electronically accepted means in a community. This is also why industry groups and NGOs have proliferated as a way to help their constituents track what is going on.

This aspect also helps explain the role of industry groups as different from actual businesses that engage in the processes. For example, fishermen, aquaculturists, farmers, etc. have to work in specific locations (i.e. on the water or on their farms) in order to bring in their pay. Taking a day or three to go to a meeting means losing wages whereas for those paid by academic or government organizations get paid for their time participating. Therefore, there is a strong and valid role for industry group and environmental NGO representatives to attend. That said, there is also power in the direct participation of such actors when possible which goes to the perceived legitimacy of the input. The challenge then becomes whether participants understand the processes at play and how to provide effective input. Those who are professionals at these processes are accustomed to engaging and know how to approach them to get their input heard.

The 2008 NRC report concluded that "when done well, public participation improves the quality and legitimacy of a decision and builds the capacity of all involved to engage in the public process." In particular, recommendation three regarding design of the process has relevance and parallels to approaches to consider science in dispute resolution processes where they note four principles: "1) Inclusiveness of participation, 2) collaborative problem formulation and process design, 3) transparency of the process, and 4) good-faith communication" (National Research Council, 2008a). The NRC report underscores that there is no one set of best practices because the context and content of each issue has its own nuances. In addition, participants (leading and participating) need to be willing to adapt as the process unfolds in the context of new information, or other adjustments that are needed to increase the effectiveness and applicably of the process.

Cross Sectoral Engagement

For the purposes of this research, I define cross-sectoral engagement as opportunities for individuals working in or representing different stakeholders or groups within a social-ecological system to interact in a meaningful way. This could include (but is not limited to) training workshops, public councils/forums, cooperative research, etc. Driven by questions about the benefits and costs of public participation, the 2008 NRC Report specifically explored "whether and under what conditions, public participation achieves the outcomes desired" in environmental decision-making (National Research Council, 2008a). Considering the role of cross-sectoral engagement activities as a type of public participation in social-ecological systems provides a lens through which it is possible to explore the impact of social activities on the ecological functioning of these systems through various feedbacks.

The NRC points out the decisions about environmental issue are intrinsically public as they are made primarily in the context of public environmental laws and therefore are intended specifically to include a balancing of public and private interests (National Research Council, 2008b). In their book *Getting to Yes: Negotiating Agreement Without Giving In*, Fisher et al. (2011) state the following: "[g]ive them a stake in the outcome by making sure they participate in the process" (Fisher, Ury, and Patton 2011, p29). They also note that you should always expect that the others will hear something different from what you actually said (Fisher et al. 2011, p35), which is why regular two way communication and interaction becomes so important so that there is an increase overlap in the areas of shared a priori context (Dyball & Newell, 2015).

Other negotiation scholars also underscore the role of listening. For example, Shell (2006) lists "[having] the patience to listen" as a key element of bargaining in negotiation. In addition, listening is key so that participants can acknowledge that they heard the input and demonstrate that they understand it (Fisher et al., 2011). This does not mean that the input has to be accepted or the request granted, but the power of listening and acknowledging paves the way for future interactions. In addition, these elements may also support increased compliance, even if all actors don't directly agree with the outcome.

See chapter six for an in-depth analysis and discussion of these topics.

Conclusion

Given the complex nature of the research question at hand, drawing from thinking across several disciplines is valuable to seek to shed new light on old challenges. Exploring the concepts of social-ecological systems, feedback loops, science for public policy, science for sustainability, and conflict and negotiation helps bring these new insights to light.

CHAPTER 3

METHODS AND CASE OVERVIEWS

"Social-ecological problems are not so much 'solved' as rendered manageable."

- Dyball & Newell, 2015 p10.

Introduction

To set the context for the findings reported here, this chapter outlines the research methods used to address the question "How do cross-sectoral engagement[5] opportunities influence science intensive disputes[6] over the management of coastal and ocean resources[7]?" Overviews of the two cases – marine fisheries management (Northeast Multispecies Complex aka groundfish) and estuarine water quality management (Great Bay, New Hampshire) are also provided, presenting the social-ecological context for the discussion and findings throughout this dissertation.

Coastal and Nearshore Areas as Complex Social-Ecological Systems

In considering the complexity of social-ecological systems, coastal and nearshore systems are viewed as additionally complex due to several factors. In many coastal areas, the confluence of

[5] Definition of "cross-sectoral engagement": Opportunities for individuals working in or representing different stakeholders or groups within a social-ecological system to interact in a meaningful way. This could include (but is not limited to) training workshops, public councils/forums, cooperative research, etc. This phrase is not a reference specifically to fishing "sectors" as defined in the context of fisheries management in New England.

[6] Definition of "science intensive disputes": Conflicts that are defined in part by a specific challenge to the science used in the situation. This includes cases where a lawsuit has been threatened and/or filed that challenges the validity of the science involved.

[7] Definition of "management of coastal and ocean resources": Living and non-living resources found across the spectrum of land-side coastal areas (the inland boundary of the U.S. coastal zone as defined by each state) out through waters under the jurisdiction of coastal nations (200 mile exclusive economic zone) as codified in the U.N. Law of the Sea are considered coastal for the purposes of this research. Their management includes the range of policies, law, regulations, and associated practices that govern associated human uses.

higher population densities, the meeting of freshwater and marine systems, and the proliferation of water dependent industries, among other things, creates a unique and complicated web of interactions. In the U.S., over 50% of the population lives in coastal watershed counties (NOAA National Ocean Service, 2013) that accounted for over $10 trillion (56%) of the U.S. Gross Domestic Product (GDP) in 2015 alone (NOEP, 2016a). Not only are coastal areas an engine of the U.S. economy, but this nexus of land and sea provides essential ecosystem services ranging from buffering of storm damage, to nursery grounds for commercially and recreationally important species, to cultural and spiritual values, to waste-water filtration, a platform for marine transportation, and more (Millennium Ecosystem Assessment, 2005). Coastal areas also provide a direct connection between what happens on land and what happens in the ocean primarily through linkages in the water cycle but also through extraction of resources. Coastal nearshore areas serve as important nursery grounds for many marine species, while other species are uniquely adapted to spend their whole lives in this interface area.

Coastal and nearshore areas also have a complex overlay of management structures given our different legal frameworks and management agencies in terrestrial, estuarine, and marine systems. Layering in municipal, state, regional, federal, tribal governance entities and legal mandates along with social and cultural expectations that can vary greatly makes these areas additionally complicated to study and manage. Given this complex social-natural matrix, coastal and nearshore areas have a mix of possible research and scientific disciplines that could considered as the basis for management decisions, but many cases only draw on a limited set of scientific input.

Methods

Case Study Approach

I used the case study method (Burawoy, 1998; Yin, 2013) to address the research question through a comparative study of two dispute cases. This approach is appropriate for this research question for several reasons. First, case study research allows the researcher to focus on the specifics of the case while also allowing them to retain a "holistic and real-world perspective." Case study research in the social sciences is best suited for research focused on "how" and "why" questions in a largely contemporary setting, where the researcher doesn't have direct control over the research target, all of which apply in the context of the research question addressed here: "How do cross-sectoral engagement opportunities influence science intensive disputes over the management of coastal and ocean resources?" The approach is also considered valuable in situations where "the boundaries between phenomenon and context may not be clearly evident" (Yin, 2013). These characteristics directly apply to the research question and cases at hand. Case study research also serves as an area of opportunity in framing a way ahead with interdisciplinary work in the use of case studies as a "boundary object" across disciplines and practitioner settings (Cash et al., 2003; Cvitanovic et al., 2015; McGreavy et al., 2014). In the context of evaluation research, case studies are also critical because we want to know more than just whether or not a program works, we want to know *how* it works (Yin, 2013). While not specifically an evaluation research project, the research question addressed here shares this characteristic of seeking to understand the "how." In order to understand what elements are key to the contributions of "cross-sectoral engagement activities", it is necessary to know *how* it works as well. These characteristics, among others, make case study research particularly relevant to social-ecological systems and more specifically to address the research question in this project. Drawing on the work of Miller et al. (2008), my research embraces the concept of epistemological pluralism which “recognizes that, in any given research context, there may be several valuable ways of knowing, and that accommodating this plurality can lead to more successful integrated study.” Miller et al. specifically call out the value of this way of thinking in “study and management of social–ecological systems.” This thinking is also important to help understand and interpret the structures, processes, and individuals within these cases.

What stands out in the need for rigor of research is not that all disciplines use the same methods, but that they use the selected methods in a rigorous way (Yin, 2013). All research methods have strengths and limitations, so it becomes important not to discount one method for another, but rather to understand the contexts within which different approaches are most relevant and also to acknowledge their shortcomings (Andersen, 2016; Yin, 2013). In this case, the use of case studies with a focus on qualitative research fits both the context and the research question. Some quantitative questions are used where appropriate to help create scales and ratings that further elaborate on the cases and context. “The purpose of qualitative methodology is to describe and understand, rather than to predict and control” as in quantitative approaches (Macdonald, 2012). What we can see from this, is that there is value to both approaches, and additional value when they are brought together to highlight different elements within a study.

Study Area – Site Selection and Rationale

The New England region of the United States provides a valuable setting for my case selection due to the long history of interactions between humans and associated natural systems, and in particular with coastal systems. Bruckmeier (2005) notes the importance of looking at conflicts within their larger context, as the "social, economic and ecological" context is critical to understanding the issue and the possible solutions. Whether looking at the native peoples who have long inhabited the region, Vikings and Basques who traveled nearby for the cod stocks (Kurlansky, 1998), early European settlers who made the region home, or the present day economy, the region has always been tied to the sea. With ports going back nearly 400 years and a 2013 ocean economy of over $16 billion (NOEP, 2016b), this region exemplifies a complex coupled history between humans and nature. More specifically connected to the concept of disputes over science, the history of the region also lends itself to this research question given the high number of science and management institutions and embedded nature of regional characteristics as they pertain to expectations of individual and collective action.

The two cases selected for this research – U.S. marine fisheries management (northeast multi-species complex, aka groundfish) and U.S. estuarine water quality management (Great Bay, New Hampshire) – represent examples of two different overarching legal authorities, management structures, and regulated communities, but share the characteristics of legal disputes over science, high degree of contention, and a range of multi-stakeholder /cross-sectoral engagement approaches. They also share the characteristic of being issues with both a federal and a state role in research and management, overlap in social and political spheres, and both formal and informal engagement processes. These two cases also share specific legal disputes over the science being used for management (stock assessments in groundfish and the impairment determination in estuarine water quality). Each case also has the shared framework of key actors across the scientific, management, and regulated communities. Lastly, access to participant observation events and ability to interview a range of actors within each case contributed to the selection of these two cases. These cases can also serve as illustrative cases to consider the science – policy interface and disputes over science in coastal and ocean systems across the United States. For example, there are estuaries that share many of the same characteristics all around the country including 28 other sites designated as National Estuarine Research Reserves through NOAA and 27 others designated as part of the National Estuary Program through EPA. In addition, groundfish is one of nine fisheries management plans covering 29 federally managed species in New England (New England Fishery Management Council, 2019a) and a total of 46 federal fishery management plans in seven other regional fishery management councils nation-wide (NOAA Fisheries, 2018). Taken together, these characteristics make them useful cases to address the overarching research question and provide possible insight for other cases. Detail on each case is provided in Table 3.1, with future elaboration provided later in this section.

Table 3.1. Overview of case selection characteristics

	U.S. Marine Fisheries Management (Northeast Multispecies Complex)	**Estuarine Water Quality Management (Great Bay, NH)**
Ecological context	coastal/offshore; population dynamics; habitat; species interactions; climate	estuarine/nearshore; hydrodynamics; biogeochemistry; multiple watersheds
Social/ cultural/ economic context	historic, cultural, economic, food systems, etc.	cultural, recreational, economic, multiple jurisdictions, etc.
Actors/ Stakeholders (orgs/types)	NOAA (reg., science, partnerships), fishermen, industry groups, ENGOs, academic researchers, etc.	EPA (reg., science, partnerships), municipalities, ENGOs, state agencies, academic researchers, etc.
Legal/ policy context	Magnuson Stevens Act primary, others	Clean Water Act primary, Coastal Zone Management Act, others
Scientific context of dispute	Stock assessment science used to set catch limits	Scientific report used to determine impairment status
Legal Challenge to Science	Massachusetts v. Pritzker (2013)	Dover v. NHDES and Dover v. EPA
Required public engagement	Under MSFCMA and NEPA	Under CWA and NEPA + DES/NH requirements
Cross sectoral engagement examples	Marine Resource Education Program (MREP); NH SeaGrant gear workshops; cooperative research	Piscataqua Region Estuaries Partnership workshops; Great Bay NERR Coastal Training Program

Data Collection

I used two data collection methods to enable broad coverage and where possible triangulate and ground my evolving understanding of the system based on new data and the literature. Using both interviews and participant observation, I was able to gain insights on individual perspectives, influencing structures, and overarching social processes. Conducting semi-structured interview enabled me to have a consistent data collection tool to facilitate cross-case comparisons for analysis and theory building. In addition, the confidential nature of the interviews enabled respondents to share frank perspectives and in other approaches is considered a key component of mapping elements of a conflict (Susskind, 2014; Susskind et al., 2017). Participant observation enabled me to build understanding of the social world of the actors I studied through my direct participation in the same events and activities they were experiencing (Emerson et al., 2011). I served as a note-taker at some events, participated in field trips, and at others served as an audience member like others in attendance. Through this mix of semi-structured interviews and participant observation, I collected data between October 2016 and July 2019. This research also draws upon initial exploratory document analysis conducted in 2015 and interviews conducted in 2016 for a related project on perceptions of science, water quality, and seafood in Great Bay (Williams, Safford, & Whitmore, n.d.).

After approval by the University of New Hampshire Institutional Review Board (#6754), I conducted a total of 33 interviews with 34 people interviewed across the two cases (see Appendix A for IRB documentation and Appendix B for the interview guide). The interview guide included three major sections covering perspectives on the dispute, cross-sectoral engagement, and policy recommendations. I categorized respondents into those in the regulated community (municipal government for Great Bay and fishing industry for groundfish), managers/regulators (those managing/regulating a place or a resource use), and members of the scientific community based on a mix of their responses to interview questions and my knowledge of the cases (see Table 3.2 for a summary of respondents). An additional 19 people were contacted but either declined to be interviewed or did not respond. As I am seeking to generalize to a process and not a population, this sample is sufficiently large for the purposes of addressing this research question. In addition, as I progressed through the interviews and observations, I began to see and hear the same themes and patterns indicating that I had reached saturation of concepts. Respondents ranged from 36 to 80 years old with a median age range of 51-55 (followed closely by 41-45 and 46-50). They had an average of 26 years of experience (range of six to 51). The majority (50%) were employed by local, state, or federal government, followed by academia (20%) and then non-profit and private sector (15% each). All respondents were from Maine, New Hampshire, and Massachusetts and were a higher percentage female (38% overall, 47% for groundfish) than their respective fields are thought to be. Several respondents had experience working in more than one category, but they were grouped based on their current role. Location, gender make-up, and roles are factors that could impact the generalizability of the results.

Table 3.2. Summary of interview respondents by case and grouping.

	Scientific Community	**Managers/ Regulators**	**Regulated Community**	**Total**
New England Groundfish Mgmt.	7	7	5	**19**
Great Bay Water Quality Mgmt.	7	4	4*	**15**
TOTAL	**14**	**11**	**9**	**34**

* Two additional interviews from a separate 2016 project were included in the analysis but not listed here.

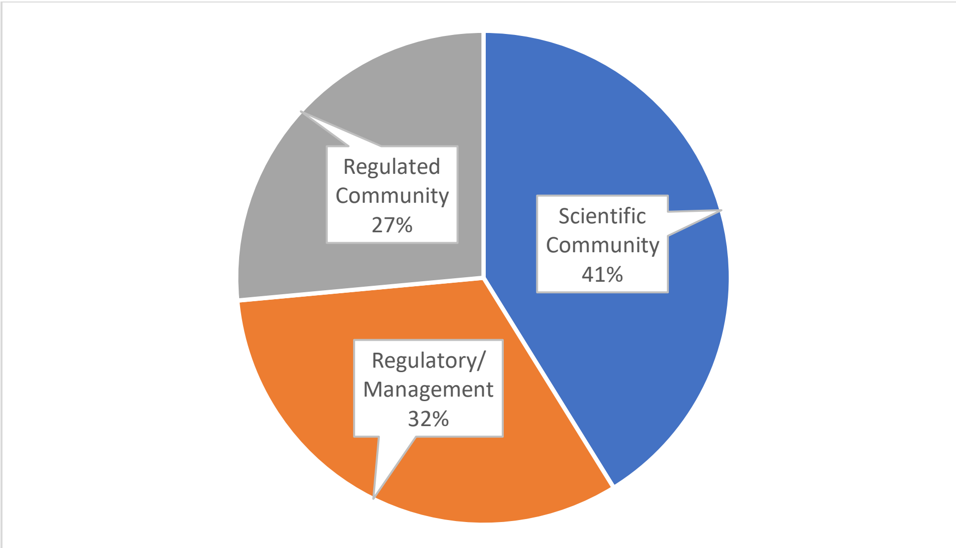

Figure 3.1. Overall distribution of interview respondents across both cases: 27% (9) from regulated communities, 32% (11) from regulatory/management community, and 41% (14) from the scientific community. An additional two interviews from Great Bay regulated communities are not shown in the breakdown but were included in some portions of the qualitative analysis.

I attended 29 public events between October 2016 and July 2019 (20 related to groundfish and nine related to Great Bay). These events ranged from decision making bodies to technical advisory groups to film screenings and community dinner events. While not formally an ethnographic study, several additional immersive components of the study contributed to my understanding on the cases. For example, while conducting interviews and attending public events as part of participant observation, I spent a significant portion of time driving through various communities connected to both cases which further increased my understanding of the geographic, social, and community context for these cases. Two additional activities also provided significant exposure to individuals and issues in both cases. First, in 2017, 2018, and 2019 I served as co-instructor of a two-week Sustainable Fisheries course that included guest speakers from across the same suite of groups interviewed and observed in my research. Secondly, in the fall of 2017 I was elected as an at large member of the Dover City Council (a municipality within the Great Bay watershed) and served from January 2018 to present. While not formal components of interviews or participation, these activities contributed to my understanding of the issues at hand.

All interviews were audio recorded and transcribed for detailed analysis. Field notes from the interviews as well as participant observation notes were kept throughout the project and also used in the analysis. Data collection resulted in 42.5 hours of audio and 859 pages of transcripts from the interviews and 309 pages of participant observation notes. NVivo12 qualitative data analysis software was used to support analysis of transcripts and participant observation notes (Adu, 2016; Bazeley & Jackson, 2013; Emerson et al., 2011; Saldana, 2016; University of Aukland, 2017). Portions of the analysis were completed using the Framework method in Microsoft Excel to share across researchers (Gale, Heath, Cameron, Rashid, & Redwood, 2013; King, 2000).

I used a combination of a priori codes developed early in the research process based on the literature and existing theories of negotiation and use of science, augmented by emergent codes developed throughout the interview, observation, and analysis phases (Bazeley & Jackson, 2013; Duneier, 2011; Saldana, 2016; Seidman, 2013; Strauss & Corbin, 1998). I used grounded theory (Strauss & Corbin, 1998) as part of this mixed methods approach (Small, 2011) to ensure that I explored both research derived theoretical meaning but also emergent themes and the exploration of "inconvenient facts" that might point to other underlying causes of the disputes, perceptions of science, and the role of cross-sectoral engagement activities. Through review of fieldnotes and jottings, I further refined the coding structure for use in NVivo.

Case Overviews

As noted earlier, the two case study locations/topics provide illustrative cases to explore social-ecological systems with complex components. Here I will provide more detailed overviews building on Table 3.1 presented earlier in this chapter. For each case I will provide general context, information on the governance structure and stakeholders, causal loop diagrams representing the system, an overview dispute system design to characterize the framing dispute structure, and highlights of the science, conflict, and engagement components in each case. As a frame to explore each case, I use the revised social-ecological system framework (SESF) per McGinnis & Ostrom (2014) to describe relevant factors.

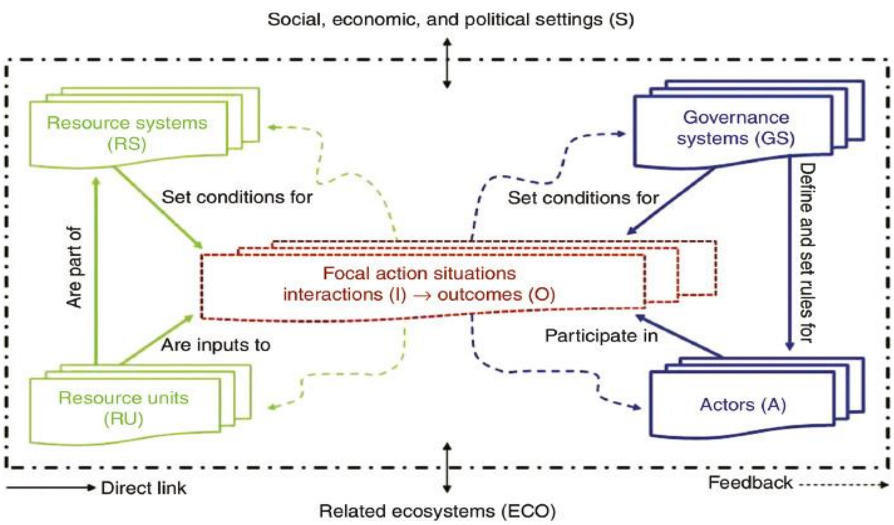

Figure 3.2. Revised social-ecological system framework (SESF) per McGinnis & Ostrom (2014).

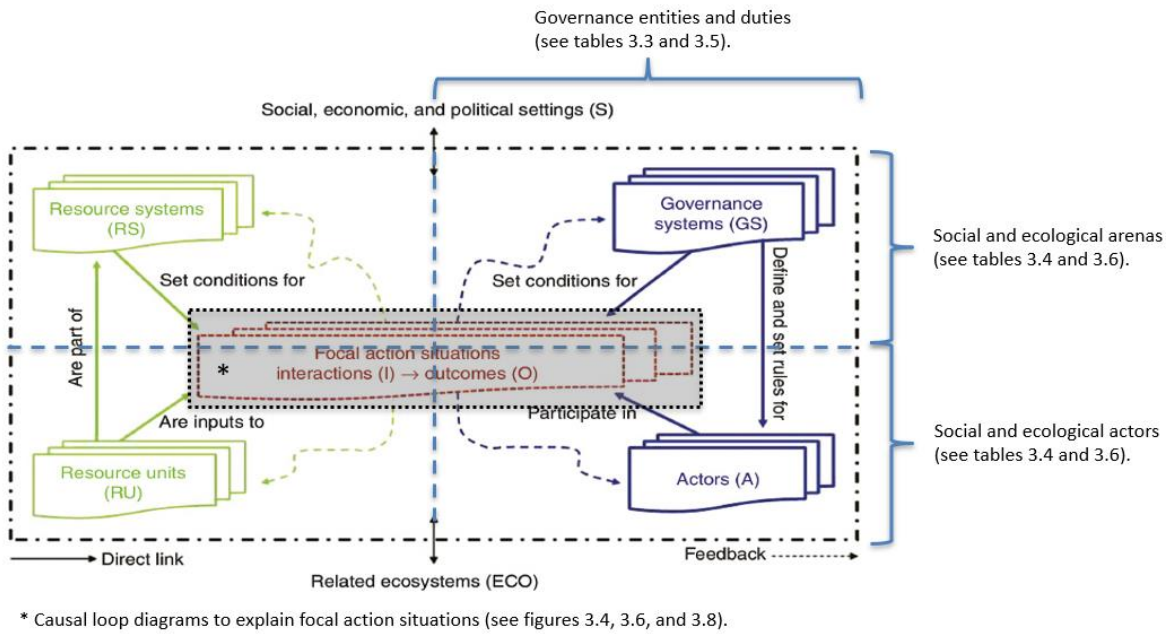

Figure 3.3. Revised social-ecological system framework (SESF) per McGinnis & Ostrom (2014) annotated to reflect conceptual overlay of actors and arenas (Hannigan, 2014), governance entities and duties (Porse, 2013), and causal loop diagrams to further explore the focal action situation (Ford, 2009).

U.S. Marine Fisheries Management - Northeast Multi-species Complex (aka Groundfish)

Management of the Northeast Multispecies Complex (aka New England Groundfish) provides an illustrative case of resource management with intense conflicts and disputes, challenges in the science-policy interface, and a range of cross-sectoral[8] engagement activities. The fishery, which occurs within the marine waters off the New England coast, has a range of social and ecological actors (A) operating in multiple arenas. Its human actors are bounded by political system characteristics at the state and federal level and also drawn from customary international law (all part of the Governance System or GS). Resources that are zero-three miles from the shoreline are managed by the states and those from 3-200 miles are managed by the federal government.

[8] The use of "cross-sectoral" is not a reference to fishing sectors in this case.

Management decisions within the federal fishery are made within the confines of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA or Magnuson Stevens Act) including its predecessor laws as implemented through the New England Fishery Management Council (NEFMC) and the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS or NOAA Fisheries), part of the United States Department of Commerce (GS). Within NOAA Fisheries, there are two major entities that pertain to research on and governance of groundfish: 1) the Northeast Fisheries Science Center (NEFSC) and 2) the Greater Atlantic Regional Fisheries Office (GARFO).

Within state waters, each state promulgates its own related laws and regulations which are then coordinated through the Atlantic States Marine Fisheries Commission (ASFMC) as prescribed in the Atlantic Coastal Fisheries Cooperative Management Act and with the NEFMC per the Interjurisdictional Fisheries Act. While not typically viewed as directly relevant to marine fisheries, other federal and state laws impact these fisheries (including the Coastal Zone Management Act, the Clean Water Act, the Clean Air Act, the National Marine Sanctuaries Act, and related state laws). Taken together, these represent the broader social, economic, and political settings (or S). Table 3.3 describes the governance levels, organizations, and duties related to groundfish in the northeast.

Table 3.3: Fisheries management formal governance levels, organizations, and duties in the New England, USA (adapted from Porse, 2013). The letters denote linkages to the SESF as per McGinnis & Ostrom (2014).

Governance Level (GS)	**Entities (A)**	**Duties**
National	US Congress; DOC/NOAA	Establish national laws and standards Interpret and regional action for adherence to legal standards
Regional (interstate)	New England Fishery Mgmt. Council; Atlantic States Marine Fisheries Commission; NOAA NMFS GARFO + NEFSC	Interpret, implement, and facilitate regional action
State: Maine; New Hampshire; Massachusetts; Rhode Island; Connecticut	Maine DMR; NH F&G; MA DMF; RI DEM; CT DEM	Implement state responsibilities under federal authorities, coordinate with other states, implement relevant state statutes
Municipalities - various	Elected and appointed bodies (councils, etc.); City Depts	Land use planning decisions related to shoreside infrastructure and other elements of the fishery supply chain

Ecologically, the fish (resource units or RU) that are targeted within the fishery occupy habitat at or near the seabed throughout the Gulf of Maine and surrounding areas that are influenced by a range of oceanic patterns and the unique morphology of the area. The fish included in the groundfish complex are managed as a unit but have different life histories including various predator-prey relationships, different spawning areas, and different habitat associations (resource system or RS). The fish are also key parts of the larger Gulf of Maine and Southern New England marine and estuarine ecosystem ("related ecosystems" or ECO). The fishery also exists within a complicated system of multiple uses sharing the same ocean and shore-side areas (whale watching, marine cables, recreational fishing, other commercial fishing, marine research, marine transportation, etc.) which are all pieces of the larger social, economic, and political setting (or S) (Northeast Regional Planning Body, 2016). Table 3.4 further explores some of these elements by also considering the sociological concept of "actors and arenas" (Hannigan, 2014) to characterize the social and ecological characteristics of the system and how they interact. Figure 3.4 presents a causal loop diagram illustrating the focal action situation relevant to this analysis.

Table 3.4. Examples of the social and ecological actors and arenas that make up the New England groundfishery (letters denote linkages to the SESF as per McGinnis & Ostrom (2014)).

Social Actors (A)	**Social Arenas (GS + S)**	**Ecological Actors (RU)**	**Ecological Arenas (RS + ECO)**
Fishermen	NOAA	13 species targeted	Benthos (gear)
Permit holders	DOC	Prey species	Abiotic habitat (rock)
Boat owners	NMFS	Biotic habitat	Shoals and banks
Financiers	NEFMC	Marine mammals	Gulf of Maine
Fish processors	NEFMC Committees	Nutrient cycling	Georges Bank
Fish consumers	US Congress	Non-target species	Tides and currents
Regulators	Courts	Seabirds	Climate variation
Scientists	Groundfish Sectors	Other	Other
Members of Congress	Cooperatives		
Int'l (Canada)	Fishing Ports		
E-NGOs	Stellwagan Bank		
Industry groups	Other		
Educators			
Other			

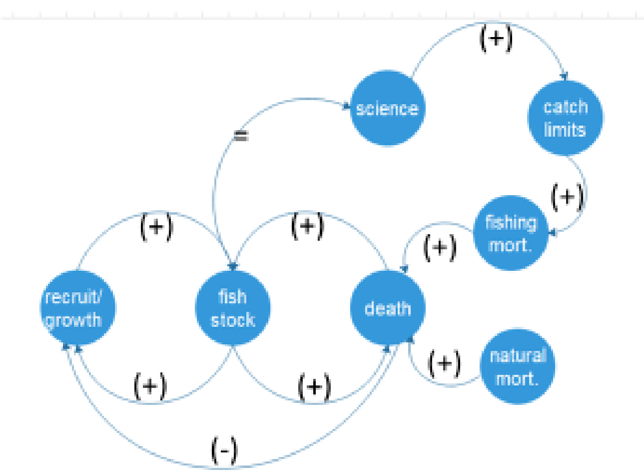

Figure 3.4. New England Groundfishery represented as a causal loop diagram focused on the focal action situation (as described in McGinnis & Ostrom (2014). The arrows indicate the interacting processes and the (+) or (-) indicate the direction of the relationship.

Groundfish, particularly cod, are also historically significant in the U.S. Northeast region and while they have declined in economic importance recently, the fishery continues to have significant social and cultural relevance. The social, cultural, historical, ecological, and economic characteristics of the fishery have been and continue to be the focus of a significant body of research (Acheson & Gardner, 2011; Alexander et al., 2009; Brewer, 2011; Eayers, 2016; Feeney, 2015; Hennessey & Healey, 2000; Iudicello & Lueders, 2016; Layzer, 2006; Lord, 2011; Meng et al., 2016; Murawski, 1995; Pershing et al., 2015), popular literature (Dobbs, 2000; Kurlansky, 1998; Macfarlane, 2018), and more recently multiple documentaries and even theater productions.

The first regional fishery management plan for groundfish in the Northeast was issued in 1986 following the creation of the NEFMC after passage of what became later known as the Magnuson Stevens Act in 1976 (New England Fishery Management Council, 2019b). That plan has changed considerably in the ensuing 30 plus years with 20 Amendments completed (three additional under development) and 58 significant but smaller changes called Framework adjustments (New England Fishery Management Council, 2019b).

Groundfish is also generally perceived to be one of the more contentious and conflict-ridden fisheries in the United States. Facing repeated stock collapses, significant management changes, and extensive legal challenges, groundfish is often lamented as beset with intractable challenges. Specifically relevant to this research, the perceived conflicts over science have permeated the fishery for a number of years. One example often cited is commonly referred to as "trawlgate" when fishing gear was incorrectly used by government scientists on a research survey to collect data to be used in the stock assessment. As summarized by one interview respondent “the immediate repercussion was inappropriate harvest. The longer-term consequences were significant mistrust between government and industry.” Summed up by another respondent, this disconnect over the science continues to be a major issue: “I think there's still a wide gap between what the scientists believe is happening and what the fisherman believe is happening … I think that if the scientists are correct and the fisherman believe them, then it's not a big problem, but that's not where we stand right now.”

These disputes within groundfish have been borne out in research settings, in public at the NEFMC meetings, as well as in legal arenas with cases like the 2013 case in which the State of Massachusetts filed suit against the Secretary of Commerce and NOAA officials noting among other things that “Massachusetts challenges these stock assessments, arguing that they are not based on the best available science and therefore NMFS’s approval of management measures based upon these assessments was contrary to National Standard 2” (“Massachusetts v. Pritzker et al,” 2013). The case specifically challenged the science behind the stock assessments that are used as the basis of making determinations for catch limits within the fishery (Cooper, 2006).

Understanding the context within which disputes in coastal systems exist is a valuable step in moving towards resolution. Visualizing the dispute system enables participants to see where their options rest, and, where appropriate, move parties towards mutual gains and principled approaches to negotiation. Figure 3.5 provides a notional dispute system design visual for groundfish that could serve as a boundary object to enable all parties to better understand the context and conflicts.

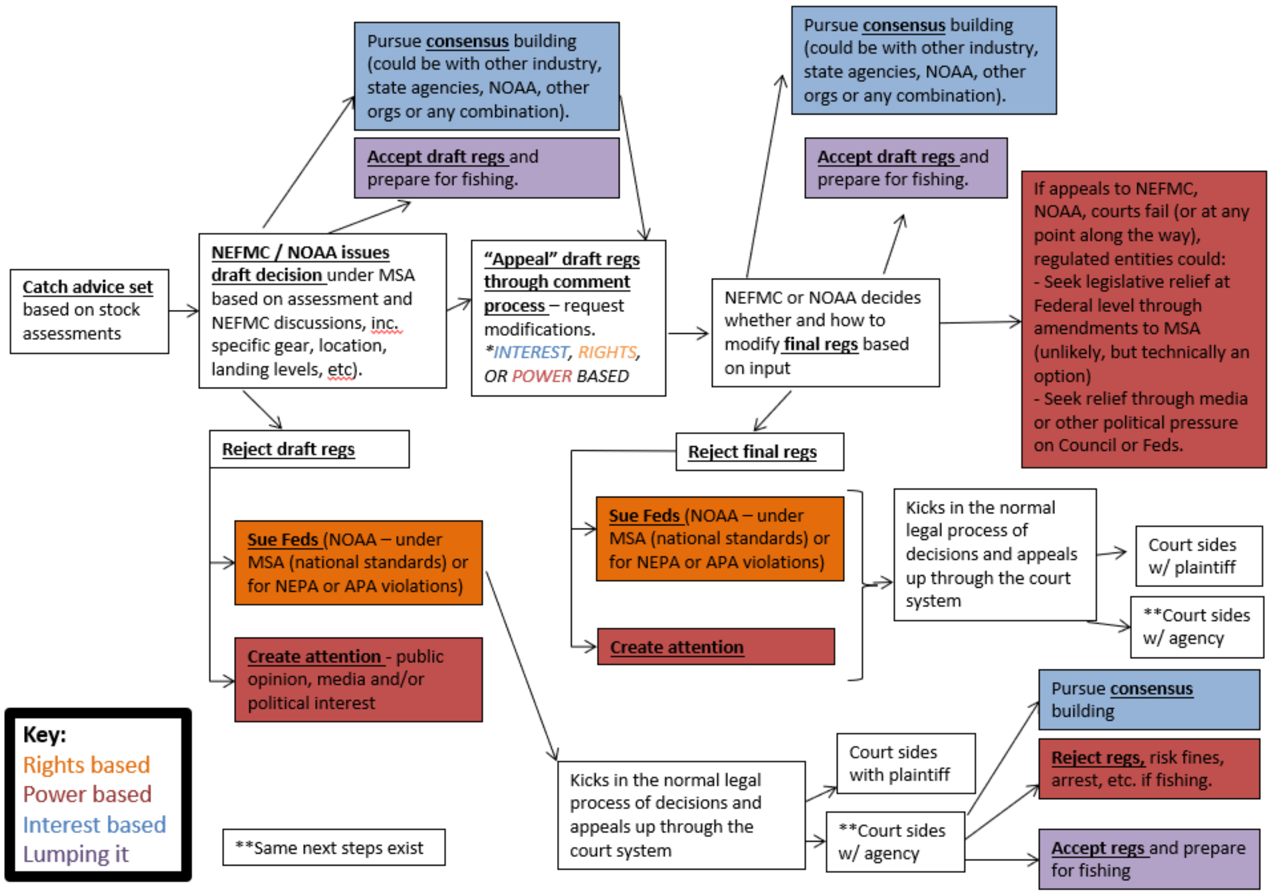

Figure 3.5. Dispute system design for fisheries management (from a regulated entity view).

By nature, fisheries management is designed to include participation of managers, scientists, and the regulated communities. Through the somewhat unique regional fisheries management bodies set up under the Magnuson Stevens Act, there are multiple formal and informal opportunities for engagement. That said, the process is seen by some as overly complex and difficult to navigate for those who do not participate regularly (and even for those who do participate regularly). Given the complexities of the management and science process, a number of venues outside the formal management structure have also been set up to work to enhance the engagement within and across groups. As an additional factor, the 2007 reauthorization of the Magnuson Stevens Act also changed the role of the Scientific and Statistical Committees (SSCs) from an advisory role to a decision constraining role within the catch limit and quota setting process (Crosson, 2013). Taken together, the conflict, science, and engagement characteristics of New England groundfish management and the associated science to support that management are ripe for further analysis.

Estuarine Water Quality Management - Great Bay, New Hampshire

Management of estuarine water quality in New Hampshire's Great Bay serves to illustrate common challenges, disputes, and opportunities for cross-sectoral engagement in coastal systems. Great Bay[9], Little Bay, and other associated water bodies make up an estuarine system fed by a watershed containing several major rivers across 52 municipalities (10 in Maine and 42 in New Hampshire) (NHDES, n.d.) creating a complex social-ecological system with multiple components of governance systems (GS) and actors (A). Once the site of a major battle for local control in land use decisions when the world's largest oil refinery was proposed to be located along its shores (Moore, 2018), the bay was also on the receiving end of the pollution from major brick and textile industries in the region (Bolster, 2002) and later from growing local population and development pressures (Piscataqua Region Estuaries Partnership, 2018). At times overlooked by the residents of the region given its relatively undeveloped shoreline, Great Bay is still important ecologically, economically, and socially to the area (S). The governance and legal framework (GS) for water quality management is set up under the auspices of the Clean Water

[9] I use Great Bay to refer to the larger watershed as well. References to Great Bay alone should not be construed as referring only to that portion of the system.

Act (CWA), but unlike most states in the U.S., New Hampshire does not have delegated authority to directly manage discharges of pollution at a state level so staff from the U.S. Environmental Protection Agency (EPA) are involved to an extent only seen in two other states (Massachusetts and New Mexico), the District of Columbia and several U.S. territories. Under the CWA, direct regulatory control of point sources of pollution falls under the regulations associated with the National Pollutant Discharge Elimination System (NPDES) (Water, n.d.-b). In addition, as of the 1987 amendments to CWA, non-point source pollution discharges are addressed through CWA section 319 (Water, n.d.-a) augmented in 1990 by amendments to the Coastal Zone Management Act (CZMA) to further facilitate reduction of pollution in coastal waters (NOAA Office for Coastal Management, 2019). In 1989, the Great Bay National Estuarine Research Reserve was established under the authority of the CZMA to work to enhance research, education, and stewardship activities (NH Fish and Game, n.d.). The 1987 CWA amendments also created the National Estuary Program (Water, n.d.-c), and in 1995 what is now known as the Piscataqua Region Estuaries Partnership began as the New Hampshire Estuaries Project to connect research and management around water quality and related issues in the region (Piscataqua Regional Estuaries Partnership, 2019). In 2001, New Hampshire's coastal non-point pollution program was approved by NOAA and EPA under section 6217 of the CZMA (NOAA Office for Coastal Management, 2019).

In addition to the federal laws and designations, the state Department of Environmental Services (NH DES) is charged with supporting and working with local governments. Each municipality likewise has its own responsibilities for water quality stemming from EPA and DES. While not directly implementing CWA in New Hampshire, the NH DES plays a key role in the system (A) in working with EPA, conducting studies, and interfacing with the municipalities. Taken together, this suite of laws and organizations make up the governance system (GS) and actors (A) for estuarine water quality management in Great Bay (as described in the SESF). Discharges of pollutants into Great Bay and its associated waters are managed based on this suite of laws and organizations (further described in table 3.5). The parameters and levels that are managed vary by municipality and whether the issue at hand is point source (typically waste water treatment plants) or non-point source pollution. In the recent past, indicators of water quality in Great Bay have focused on nitrogen and eelgrass as proxies for the overall health of Great Bay.

Table 3.5: Water quality management formal governance levels, organizations, and duties in the Great Bay region, USA (adapted from Porse, 2013). The letters denote linkages to the SESF as per McGinnis & Ostrom (2014).

Governance Level (GS)	**Entities (A)**	**Duties**
National	US Congress US EPA	"Establish nat'l laws and standards (Clean Water Act, Safe Drinking Water Act); Delegate NPDES reqs" (Porse 2013) + MS4
Regional (interstate)	US EPA Region 1	Interpret, implement, and facilitate regional and state action
State: New Hampshire Maine	NH DES* ME DEP	Implement state responsibilities under federal authorities, implement relevant state statutes; *Note that NH is one of only three states that do not have delegated authority from EPA
Municipalities - various	Elected and appointed bodies (councils, etc.); City Depts: (Public Works, Planning, etc.)	Set City level policies and standards "Serve as lead agency for design, operations, and maintenance of water, wastewater, and stormwater systems" and "Maintain NPDES requirements" (Porse 2013)

While not typically viewed as directly relevant to water quality management, other laws pertaining to air quality, transportation, military bases, and other resources also have bearing on water quality management in Great Bay and are considered part of the larger social, economic, and political settings (S).

Given the somewhat complicated interweaving of the social and ecological components of the Great Bay System, table 3.6 further explores these elements through the lens of the sociological concept of "actors and arenas" (Hannigan, 2014). Figure 3.6 represents estuarine water quality challenges (the focal action situation) as a causal loop diagram.

Table 3.6. Examples of the social and ecological actors and arenas that make up the Great Bay.

Social Actors (A)	**Social Arenas (GS + S)**	**Ecological Actors (RU)**	**Ecological Arenas (RS + ECO)**
Regulators Non-regulatory managers Municipal leaders ENGOs Scientists Educators Aquaculturists Recreators Developers Other	EPA NHDES PREP GBNERR Municipal Coalition Municipal gov'ts Courts Other	Eel grass Nitrogen Oysters Algae Juvenile marine sp. Waterfowl WQ parameters Other	Great Bay Little Bay Major Rivers (Bellamy; Cocheco / Salmon Falls / Great Works / Piscataqua; Oyster; Lamprey; Exeter/ Squamscott; Winnicut) Other

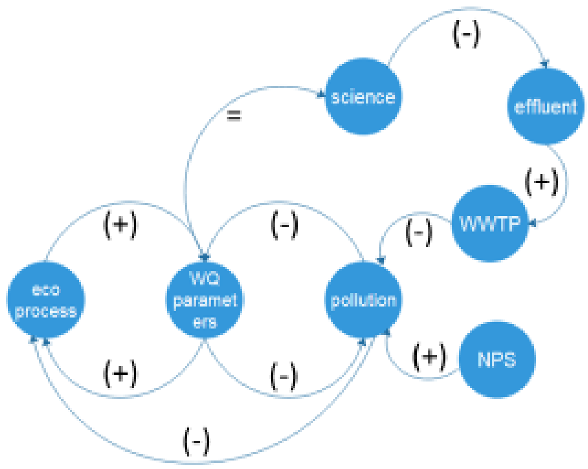

Figure 3.6. Great Bay Water Quality represented as a causal loop diagram focused on the focal action situation (as described in McGinnis & Ostrom (2014). The arrows indicate the interacting processes and the (+) or (-) indicate the direction of the relationship.

While there have been issues in the past, the context of this current water quality management dispute came to a head around 2009 with the issuance of the scientific report titled *Numeric Nutrient Criteria for the Great Bay Estuary* (Trowbridge, Burack, Walls, & Stewart, 2009) and the subsequent declaration of impairment by EPA that same year. This triggered required action by the municipalities with waste water treatment plants discharging into waterbodies in the Great Bay watershed (NHDES, n.d.). Followed shortly by lawsuits threatened by several of the impacted municipalities in 2012 along with an appeal of the associated permits, a joint peer review of the numeric nutrient criteria was agreed to in 2013 and their final report was issued in 2014 (Cook, 2012; NHDES, n.d.).

Figure 3.7 provides a notional dispute system design visual that could serve as a boundary object to enable all parties to better understand the context and conflict.

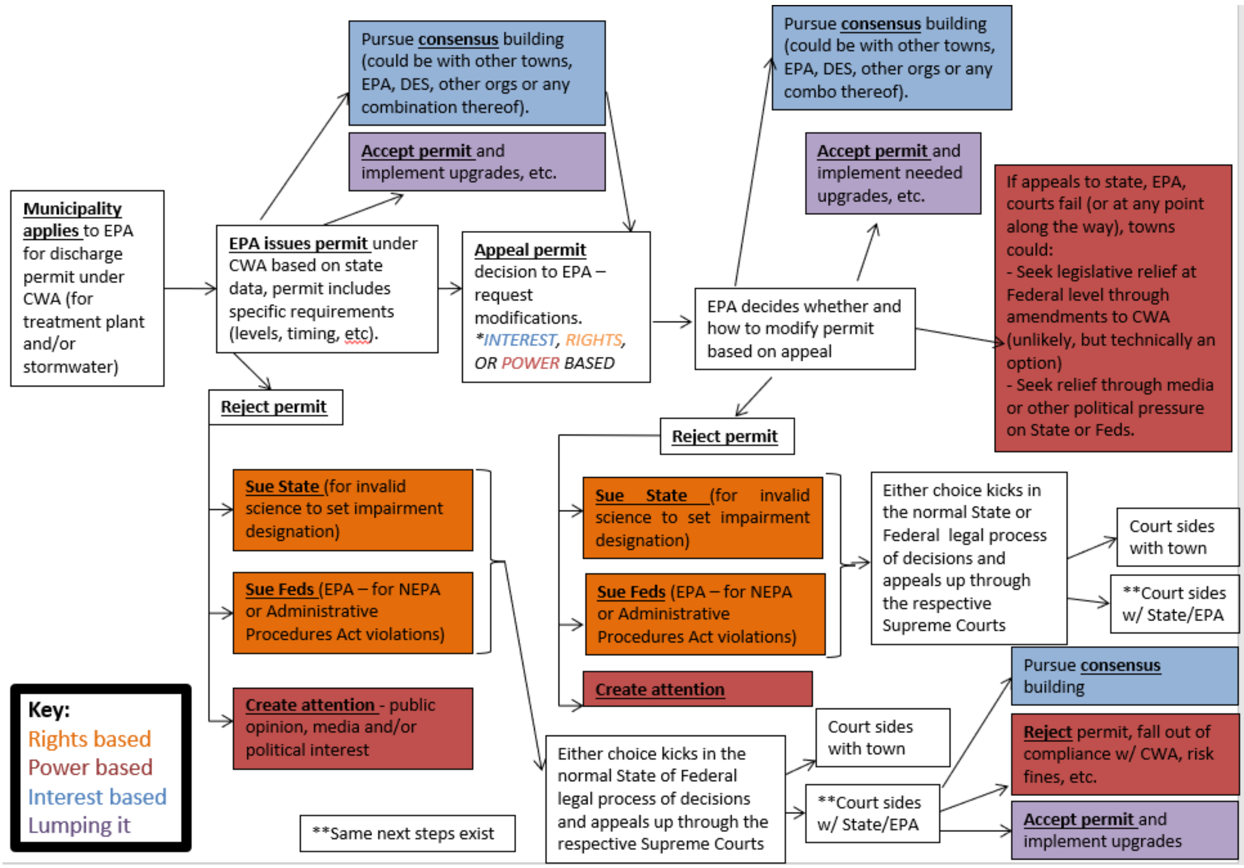

Figure 3.7. Dispute system design for estuarine water quality management in Great Bay (from a regulated entity view).

The Great Bay system also has a complex web of formal and informal engagement opportunities in part given the breadth of organizations present. While some groups that host these activities work together collaboratively, they each also have their own purview and goals and expectations of funders. For example, there are activities and meetings hosted by GBNERR, PREP, NHDES, UNH, municipalities, non-profits and others.

Conclusion

The methods presented here along with the case overviews serve as context for the analysis presented in later chapters. Great Bay and New England groundfish have unique characteristics, but also share parallels with many other cases and as such, lessons here can inform other cases as well. The analysis is informed by the conceptual model presented in Figure 3.8.

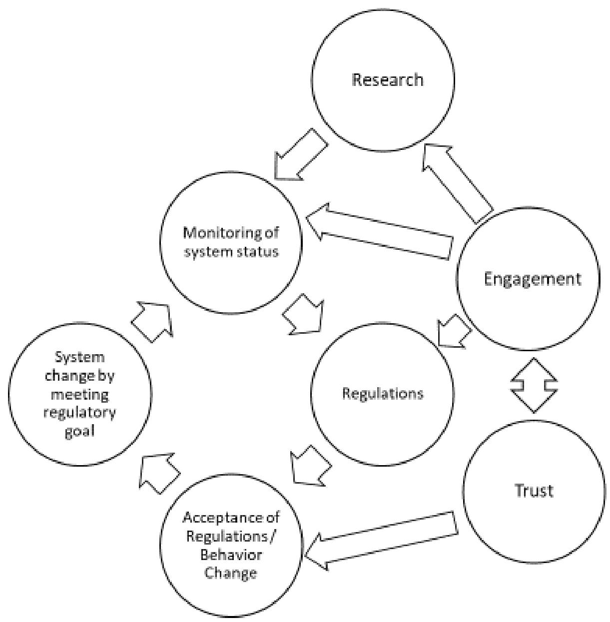

Figure 3.8. Conceptual model of the interaction of science, management, and engagement in complex social-ecological systems.

CHAPTER 4

CAN YOU LIVE WITH IT? USING NEGOTIATION THEORY TO BETTER UNDERSTAND DISPUTES IN COASTAL AND MARINE SOCIAL-ECOLOGICAL SYSTEMS

Introduction

Coastal and nearshore areas provide tremendous value to humans and the other species who reside there, but they are also the setting for at times intense conflicts over resource use. Examples include contentious processes around siting of marine protected areas (most recently the Northeast Canyons and Seamounts Marine National Monument, but also historically areas like the Florida Keys National Marine Sanctuary), disputes over the placement of coastal energy facilities (ranging from examples like the Durham, NH opposition to an oil refinery in the 1970's to coastal liquefied natural gas facility siting disputes in Massachusetts to placement of offshore windfarms), and the balancing of industry and protected species needs (for example whale interactions with shipping vessels or fishing gear). These patterns of disputes and conflicts over management of ocean and coastal resources occur repeatedly around the United States and the world. With coastal populations projected to continue to increase (NOAA National Ocean Service, 2013), and demands on these nearshore areas growing for both extractive and non-extractive uses, conflicts over resource use are also likely to increase unless new approaches to balancing and negotiating different perspectives are considered going forward.

While each dispute and the associated components of the ecosystem can be viewed separately, there is value at taking a systems perspective given the interconnected nature of the human and “natural” components (Liu et al., 2007). For example, thinking specifically about the coastal system context, actions taken in the upper watershed around waste-water treatment have implications for uses of estuarine and nearshore areas. Likewise, activities in the nearshore and close offshore areas (like fishing) are driven by needs and demands from onshore populations for protein food sources. Although these systems exist within different regulatory, political, and social structures, they all ultimately influence the larger outcome of continued use of resources balanced against long-term health of the ecosystem (both human and natural system components).

Disputes in the context of natural resource management can occur about a range of issues. For example, they can be about what you manage, how you manage, who gets to participate in decision processes, what information you use to decide (i.e. what types of science guide decisions, etc.), as well as the ultimate decisions about how resources are allocated. While there are a range of approaches to negotiation, I focus here on two approaches that have potential to assist in disputes that have a significant scientific component to them: principled negotiation (Fisher et al., 2011) and the mutual gains approach (Susskind & Field, 1996). Susskind and Field (1996) define six components of the mutual gains approach:

- “Acknowledge the concerns of the other side
- encourage joint fact-finding
- offer contingent commitments to minimize impacts if they do occur, promise to compensate knowable but unintended impacts
- accept responsibility, admit mistakes, and share power
- act in a trustworthy fashion at all times
- focus on building long-term relationships.”

Fisher et al. (2011) outline four elements of principled negotiation:

- “Separate the people from the problem

- Focus on interests not positions
- Invent options for mutual gain
- Insist on using objective criteria."

Here I explore how these two theories of negotiation can help provide insight into natural resource conflicts and how they might provide lessons for the processes involved in conducting science to support management decision-making along with those connected to engaging across groups. Negotiating what data and analyses get presented and how they are presented influences how information is interpreted, used, trusted. In this line of thinking, science for management use is a form of negotiation. Deciding what science gets conducted, what gets presented, what gets used to make a decision, what gets credited, etc. has significant implications. As such, the analysis here, using negotiation lens to look at science conflicts, fills a gap in thinking more critically about how to continue to improve efforts to bring science into decision making spheres.

Methods

This research uses the case study approach (Burawoy, 1998; Yin, 2013) to analyze two illustrative science dispute cases in coastal and ocean systems. Data was collected through semi-structured interviews and participant observation related to two cases in New England - marine fisheries management (Northeast Multispecies Complex aka groundfish) and estuarine water quality management (Great Bay, New Hampshire). I used two negotiation approaches – principled negotiation as outlined by Fisher et al. (2011) and the mutual gains approach as described by Susskind and Field (1996) as the a priori theoretical coding structure along with grounded theory (Strauss & Corbin, 1998) to explore emergent themes. These concepts served as the analytical frame to analyze the data using NVivo 12 (Adu, 2016; Bazeley & Jackson, 2013) and the framework method (Gale et al., 2013). The goal of this analysis was to find meaning across the two cases to better understand what can be learned from negotiation theories to help advance progress within these and similar cases.

Taken together, the components of the mutual gains approach to resolving disputes and the concept of "principled negotiation" provide an analytical lens through which to consider disputes over natural resources, but also a possible structure to consider recommendations for the future.

Results

Results from this analysis are presented below grouped by analytical approach. Findings related to principled negotiation and the mutual gains approach are presented first, followed by findings from the broader grounded theory-based coding. Additional findings related the impacts of legal processes on the disputes and perceived impediments to progress are also presented. To get a better sense of the perceptions of the disputes in case, all interview respondents were asked to rate the current divisiveness (see table 4.1 for a summary).

Table 4.1. Summary of interview responses on how divisive the disputes over management of the resources in their respective cases are (scale of 1-5, 1 = not very divisive, 5 = very divisive).

.	**Case / Group**	**Avg. Score**
Regulated Community	Great Bay	2.5 (n=4)
	Groundfish	4.75 (n=4)
Scientists	Great Bay	3.5 (n=7)
	Groundfish	3.9 (n=7)
Managers	Great Bay	3.75 (n=4)
	Groundfish	3.7 (n=7)
Summary	Great Bay	3.3 (n=15)
	Groundfish	3.9 (n=18)
	RegCom	3.6 (n=8)
	Mangers	3.7 (n=11)
	Scientists	3.7 (n=14)
Overall	all	3.67 (n=33)

Principled Negotiation

In exploring principled negotiation there were examples of positive efforts to separate the people from the problem, but also several cases where it became clear that poor relationships among individuals has an impact. For example, one respondent noted "we may disagree but it's a healthy disagreement, perhaps. I certainly don't really have any negative feelings towards anybody, I just think we want to do the right thing." Conversely, another shared a challenge stating that "You can only negotiate with people if they want to negotiate with you. If their starting position is, we want you gone, there's nothing to negotiate. And I don't care how they sugar coat it." There was also a mix of ability to look for interests as opposed to positions. For example, one respondent described the dispute being at its worst when "they staked out their positions and they said, 'This is right.' They created their talking points and stuck to them for a while, and I think [group] and others have done a good job in having them come to the table and give up some of those positions." Between the two cases there were interesting challenges associated with developing creative solutions for possible mutual gain and setting objective criteria. In the groundfish case, while there were many venues to explore and invent creative solutions, many parties appear to only know about or chose to attend in the final stages when it is too late to shape the solutions. In the Great Bay case, there was more space for creative solutions, but the fear of lawsuits was clearly impacting some party's willingness to put ideas on the table. For example, one respondent noted "The only way you can move forward is to create a space where it's okay to explore alternatives before you decide things. There's a deep hesitancy to do that." Lastly, as it pertains to setting objective criteria, while not a specific focus of my interviews and therefore not present in concept in my data, this may be a significant challenge across both cases where parties hold different views and my struggle to even agree to criteria.

Mutual Gains Approach to Negotiation

In the context of mutual gains, many engagement efforts are a way to learn about and seek to acknowledge concerns of others, and many of the existing collaborative approaches to science parallel joint fact finding. One respondent described their personal experience with others beginning to acknowledge their input as follows: “So I go to these meetings and I say, ‘You guys missing the point.’ And then everyone says, ‘Oh, he's insane. We're not gonna talk to him.’ And then other times they ask me questions and I tell them what's going on with this and that, and it's like, ‘Oh, he doesn't sound insane.’” Conversely, it appears that contingent commitments to minimize impacts are difficult in complex coastal social-ecological systems and it is hard for parties to accept responsibility, admit mistakes, and share power. This was one area were respondents had different perspectives of the same efforts based on what group they were part of. For example, one scientist discussed a controversial error and noted their view that “the scientists, I thought, were honest and took responsibility for what happened and did their best to explain why” whereas members of the regulated community did not feel the same way and felt if they had been involved early on the mistake could have been avoided. It is clear that people appear to try to act in a trustworthy fashion, but their actions are not always perceived as such. One respondent summarized this challenge stating: “… the reason there is no trust is because you can't possibly be right all the time. ... in order to trust the system, [regulated community has] got to see that their input is taken into account. Not all the time, but at least once in a while.” Lastly there are key challenges in looking at the long-term as developing relationships is key to building trust, but many respondents acknowledged this need. As an example, one respondent shared "We … realize that in order to be effective … and in order to have good management, it really requires folks to reach across the table and reach across the aisle and be willing to work with folks that have different perspectives." Using principled negotiation and the mutual gains approach as a lens to look at these disputes provides insights into the issues at hand, but also the potential role that a negotiation frame might play in seeking a path ahead. There is potential for all parties to gain from these interactions and rethinking of the approaches. For example, scientists can gain access to new research questions, new data sources, and venue for application of their research. Regulated community members can gain connections to the science and management processes, contribute their own understanding into theses processes, and have a greater voice in the selection of what science gets funded and what management outcomes are selected. Management entities can gain better understanding of the functioning of the system and access to science that is more directly relevant to management needs.

Emergent themes

Several additional themes emerged during the analysis that intersect with the concepts above. One theme that emerged was the concept "acknowledging efforts" which links to the concepts of building relationships and acknowledging other views. A number of interview respondents across groups made explicit or passing references to the fact that either they could see that people and groups were trying or that they wanted others to acknowledge those efforts. For example, one scientist noted "I hate to say it's management that's not going well because I think that we're doing our best to manage everything properly." A member of the regulated community commented that "I know there are some pretty serious advocates that are out there, and I don't think they acknowledge the efforts that people that live and work in this environment deal with on a daily basis." The concept of "blame" also emerged which shares links to the idea of separating the people from the problem. In a number of cases, respondents named specific people for the cause of the current issues, while in others they blamed the science and management process or natural phenomenon.

Impacts of legal processes

The perceptions of what drives lawsuits also provides interesting insight into these conflicts and what might be done to continue to move forward. There was some variation in responses across cases, but several themes emerged in what interview respondents felt drove lawsuits like those in the two cases researched here (fisheries management and estuarine water quality). These included views that lawsuits where driven by:

- perceived imbalances in impacts of a decision (typically financial),
- frustration (feeling unheard, perceived failure of process),
- lack of transparency or communication, feeling caught off guard,
- not getting outcome you wanted, or
- perception that it's less costly to pay lawyers than accept financial impact of change.

Other respondents noted a view that lawsuits are used:

- as a tool for policy action,
- as a tool to push certain views,
- as a way to keep agencies accountable, or
- to deal with underfunding of government services.

The legal aspects of these disputes (actual lawsuits, threat of lawsuits, fear of possible lawsuits) also had implications for the relationships within these and similar cases. Legal issues also impact how science is conducted, presented and debated. There are different motivators for individual participants in the various processes. Several respondents noted the challenges of having some representative in various processes there who were specifically paid to poke holes in the science or process versus those who were there to have a collaborative discussion to improve the credibility of the science. One scientist noted that “when the lawyers started becoming involved … we held our cards very close to the vest and so we shared less information than we probably would have otherwise. We were very careful about what we said or what we wrote.” In addition, interview respondents raised the concept that the specter of legal challenges also means that government based scientists behave differently than other scientists. For example, one manager comment on the perceived high stakes role of government scientists noting that “I think that impacts the way they present themselves in meetings. It breeds a very certain black-and-white type of approach to things, … they don't have the luxury of being like, ‘Well, maybe. I don't know. Maybe I was wrong. I don't know.’”

Disputes over science (negotiation and the use of science)

Disputes that contain a scientific component are a unique subset of conflicts. They also provide opportunity to learn. Blending theories from negotiation fields with theories of the use of science provides additional insight that can be applied in other cases as well. Taken in tandem with the exploration of the themes of credibility, legitimacy, and salience of science (Cash et al., 2003), negotiation theories provide another lens to understand these cases (see table 4.2).

Table 4.2. Negotiation theories (Fisher et al., 2011; Susskind & Field, 1996) and science for sustainability (Cash et al., 2003) theme intersections with illustrative quotes.

		Science for Sustainability (Cash et al., 2003)		
		Credibility	Legitimacy	Salience
Mutual Gains (Susskind and Field, 1996)	"acknowledge the concerns of the other side"	Tension in accounting for other scientific perspectives and generating repeatable outputs for decision makers impacts credibility of science within the scientific community. "our stock and system process is very rigorous, and our scientists are very keen on pointing that out. Having said that, they're also not very willing to flex a little bit to get new data sources or to learn new things." - Groundfish scientist	Inability to account for differences impacts perceptions of the legitimacy of science among stakeholders. "I think currently the science is very divisive. I think industry is not seeing on the water what our assessments are showing. And in some cases, I feel like we have a good answer for that and in other cases, we don't. Industry has lost more faith in our science. And then it makes it hard for them to accept policy." - Groundfish manager	Acknowledgement of concerns can lead to science that is more salient to the actual management issues at hand. "Even though you may not quite agree with them, I set that aside, and I'm cognizant of that issue." - Great Bay scientist
	"encourage joint fact finding"	Joint processes can create spaces for scientists who might otherwise poke holes in each other's work to bring their knowledge together. Several participant observation events included JFF-like discussions (e.g. presentations of in process analyses that the researchers could then go back and adjust).	Joint processes benefit the acceptance of the results by increasing the perceived legitimacy of the process. "Even if the outcome is bad, if the fisherman participated in it, they're more likely to believe it." Groundfish manager	Joint processes have the benefit of being tied directly to management needs, but risk hyper focus on certain concerns. "They want to collaborate in a way that gets to the heart of their issue ... but they have a hypothesis of their own, and they are only interested in testing for that."
	"offer contingent commitments to minimize impacts if they do occur, promise to compensate knowable but unintended impacts"	Thinking of science as a negotiation can increase the credibility by helping scientists prepare for system responses that don't match expected outcomes.	Involvement of other groups can improve the perception of science by building in contingencies based on other groups concerns.	Science that already accounts for the possibility of unexpected outcomes is more likely to maintain a seat at the table in management processes.

	"accept responsibility, admit mistakes, and share power"	Sharing power can be difficult in settings with very different structures of perceived authority (i.e. scientists, managers, regulated entities). "You guys need to appreciate ... I'm trying to appreciate the responsibility you have. You need to appreciate the power you have." - Groundfish scientist referring to government scientists	Sharing power in a scientific setting opens up the black box and can increase perceived legitimacy. "Everyone in that room was a coauthor, it was about half industry, half scientist." Groundfish scientist	Sharing power is essential to designing research and monitoring that meets applied needs.
	"act in a trustworthy fashion at all times"	Acting in a trustworthy manner builds opportunities for enhanced credibility	Acting in a trustworthy manner with other scientists as well as with managers and regulated entities builds legitimacy	Acting trustworthy may increase the likelihood of people invited into applied venues that can increase the salience of future work for scientists.
	"focus on building long-term relationships"	Processes that remind participants (inc. scientists) of the importance of building relationships can enhance credibility. In several meetings, the facilitator revisited ground rules for objective experts to remind them where their "lane" was.	A transparent and inclusive scientific process builds relationships that can be drawn on in the long term. "One of the most effective forms of science I've found is cooperative research, where a scientist goes to speak with a fisherman, and they have very heartfelt talks in the wheel house while they're doing the science. That's one of the most effective forms of communication, I've found." Groundfish regulated community member	Different models of funding science/research lend themselves to different relationship structures and relevance to the issue at hand. One respondent (a manager) described the role that engineering consulting firms played in conducting research to address specific municipal challenges.

Principled Negotiation (Fisher, Ury, and Patton, 2011)	"Separate the people from the problem"	Differentiating disagreements about science questions from those about policy solutions can open doors. "And they're given a lot of hard questions at these meetings, so they have to know exactly how the data was pulled, what it means, to be ready to answer everything, and they are. And they do an amazing job that if they didn't have the experience, they didn't put the work in, then, you know, it would show." - Groundfish scientist	While people connected with an issue may exhibit behaviors that make them difficult to involve, their inclusion is essential to the perceived legitimacy of the process and outcomes (including science). "those open meetings, I think they are actually more valuable, it takes longer ... it's a bigger sink of time, but I think we get to see more different viewpoints." - Great Bay scientist	The researchers most regularly involved may not be the ones who actually have the right expertise to provide science that is salient to the issue at hand. "I didn't understand what we were really asking of science and how hard that is to do. ... No, it definitely changed my perceptions of the science, particularly in terms of precision and accuracy and complexity and really how much of a related system we don't even look at because we don't know how." Groundfish manager
	"Focus on interests not positions"	"Positions" exist in science and can decrease credibility if perceived to outlive the weight of evidence. "There are still scientists ... that are pretty adamant that it's mainly nitrogen ...To me, it's an area of research that's needed." Great Bay scientist	"Positions" in science can also derail efforts and decrease views of the legitimacy of the work "You can only negotiate with people if they want to negotiate with you. If their starting position is, we want you gone, there's nothing to negotiate. And I don't care how they sugar coat it." - Groundfish regulated community member	There is a tension between research to support positions and research that is "salient" to the issue at hand. "They basically, want to collaborate in a way that gets to the heart of their issue, and they may be treating it as science ... but they have a hypothesis of their own, and they are only interested in testing for that." - scientist
	"Invent options for mutual gain"	Science can be the source of new ideas that benefit the system if developed in ways that are viewed as credible.	Science can be the source of new ideas that benefit the system if developed in ways that are viewed as legitimate.	Science can be the source of new ideas that benefit the system if developed in ways that are viewed as salient to the issue at hand and the local context.
	"Insist on using objective criteria"	Objectivity and transparency build credibility "if we do end up going down the path of leaving out data. If we go down that route, we should have criteria since throwing out data or illuminating data is a really big deal. " Great Bay Scientist	Objectivity and transparency build perceptions of legitimacy by helping those impacted see how science decisions were made.	Objectivity and transparency can help build connections to conduct science that is more salient to the issue at hand. Scientists hired on contract provide a level of transparency of expectations and perceived salience (evidence in both cases).

Impediments to progress in disputes

To better understand perceptions of what was impacting progress towards resolution of these disputes over science, respondents were asked to provide a rating for a list of possible issues and provide their own additions to the list provided. Table 4.3 shows the ratings of items that could be impacting the ability to move through the conflicts in each respective case. Interestingly, a significant portion of respondents later in the interview process noted funding as a key item impacting the ability to make progress through the conflict (primarily in the Great Bay case).

Table 4.3. Respondent rating of their perception of how much certain items were impacting the ability to move forward through the conflicts in each of their respective cases (scale of 1-5, 1 = low impact, 5 = significant impact)

		Scientific Uncertainty		**Stakeholder engagement**		**Regulatory structure**		**Dispersed governance**		**Narrow focus**	
		Avg	n=	Avg	n=	Avg	n=	Avg	n=	Avg	n=
RegCom	GB	2.6	4	2.4	4	2.6	4	2.3	4	2.1	4
	GF	4.4	4	4	4	4.3	4	3.3	4	4.5	4
Scientists	GB	2.3	6	2.8	6	2.8	6	3.5	6	4.2	5
	GF	3.6	7	2.9	7	3.3	7	2.6	7	3	7
Managers	GB	3.8	4	2.25	4	3	4	2.8	4	3.4	4
	GF	3.9	6	3.3	6	3.7	6	2.5	6	3.4	6
Summary	GB	2.8	14	2.5	14	2.8	14	2.9	14	3.3	13
	GF	3.9	17	3.3	17	3.7	17	2.7	17	3.5	17
	RegCom	3.5	8	3.2	8	3.4	8	2.8	8	3.3	8
	Mangers	3.9	10	2.9	10	3.4	10	2.6	10	3.4	10
	Scientists	3	13	2.8	13	3.1	13	3	13	3.5	12
Overall	n/a	3.4	31	2.9	31	3.3	31	2.8	31	3.4	30

Discussion

One of the areas that I was curious to explore was whether interviews would elicit if there were other underlying factors that might be driving the conflicts even while they were framed and discussed as disputes over science. While the interviews and observation can't answer this definitively, I found evidence to support that there are other contributing factors. Science can become the face of the conflict, but factors like personalities, treatment of individuals, process, access to financial resources, etc. also appear to contribute to both the perpetuation of the conflicts and the movement to more collaborative approaches. Some was also tied to willingness to accept other viewpoints and work together towards shared interests versus standing firm on one's own position (including science positions).

Taken together, the patterns that emerge by looking at what negotiation theory can help bring to light in cases of disputes over science help provide insight on what might be happening (or missing) from these two cases and can also inform other disputes over science. While there is evidence of mutual gains and principled negotiation in both my cases, there are also elements that make it difficult to move away from traditional hard bargaining approaches. As explored further in chapter 6, cross-sectoral activities also tie to building relationships (part of mutual gains) and part of separating the people from the problem (principled negotiation).

Concepts from principled negotiation also help as explore the idea of science as a negotiation. Science also has positions as much as many people would like to think it is fully objective, scientists also face challenges moving from positions (based on what their disciplinary focus or personal research findings tell them) to interests (moving the system forward). It might mean that their particular skill set or research goals are not what is needed which can be hard if you've invested time and energy and research dollars. One way ahead is to continue to advance efforts for scientists to be trained more on the social and civic aspects of conducting applied science and to train managers and regulated communities on possible ways to approach disputes that favor collaboration and development of creative solutions.

When it comes to the impact of legal processes on these disputes, it is important to acknowledge that the threat of legal action can be a double-edged sword where legal pressure can bring players to the table to avoid someone else deciding for them, or it can drive people to make rushed decisions or preclude certain groups. Legal frameworks may also be limiting creative solution development where individuals are afraid their words will be used against them or their organizations and at the same time the threat of lawsuits may be limiting ability to speak freely about what the actual interests are and the willingness to try something new. The reliance on the adversarial elements of the legal system to resolve science disputes that may actually be resource allocation disputes may also be driven by behavioral and psychological theories that show that individuals tend to view their own personal preferences as the best outcome for all (Thaler & Sunstein, 2008).

While they certainly have their place at times, money spent on legal processes defending or challenging decisions and actions by public agencies could also be spent on research to help better understand the exact topic at issue in a lawsuit: “Money poured into defending past actions cannot be used to improve future performance” (Susskind & Field, 1996). There is an opportunity cost to the specter of legal action always hanging over head. As noted above, participants in the system are less willing to try creative solutions, or explore new ideas out of fear of being sued (Susskind & Field, 1996) which was evidenced in the data in this study. Instead they stick with the “tried and true” approach, and still in many cases get sued. Given this, it might be worth government agencies taking a new approach and trying other processes, especially if they are likely to get sued either way.

Looking at past practice around legal frameworks and the requirements of the law, there can be a tendency to say “the law only requires x” or “the law only allows y.” But laws are always interpreted, and their interpretation often evolves over time. More specifically though, the legal principle of Chevron deference says that the courts must defer to the agency interpretation of the law unless it is an unreasonable interpretation (Jasanoff, 1997). Therefore, there is some flexibility that agencies should consider when designing their approaches and their balancing of different views. It is not essential to just mirror past practice. It should be considered, but also continuously reviewed and revised as appropriate. A willingness to think more creatively about legal interpretations and the impact that has on creating space for flexibility within the law might also open up new pathways and opportunities to worth to better address these disputes. While adversarial legal approaches are focused on where parties are unable to agree, dispute resolution approaches, joint fact finding and other collaborative solutions are focused on finding the areas where there is agreement (Adler, 2017). None of this is to say that there are not times when lawsuits are necessary. Based on our legal system and our socialization to lawsuits as a means of change, there are times when lawsuits become the only means by which to protect rights or advance important interests.

Legal resolutions to disputes include the added challenge that the courts might decide the immediate dispute but not the underlying conflict. For example, in the fisheries management case I was left with the overall sense that many feel that available data is not used, scientists have agendas, and that there are poor relationships all around. In the estuarine water quality case, I was left with the sense that whatever the outcome, the municipalities would bear all the costs which contributed to concerns over taxpayer reactions, a feeling of lack of respect across groups, and a level of poor relationships due to past legal tactics. None of these underlying issues can be resolved through a court decision, as such, other more collaborative approaches need to be part of the path ahead.

The cases presented here may also exhibit an additional challenge. Some of the participates appear to be highly motivated to "resolve" the disputes (perhaps due to time or money concerns, or exhaustion of dealing with the same issues). Given this interest, there may be efforts moving perhaps too quickly out of the creative value generating phase and into the distribution of value.

Negotiation thinking can also help explore ways to create space for people to feel heard and acknowledged. Using the conceptual steps and processes from principled negotiation and the mutual gains approach provides an analytical lens and reminder that the processes are equally important to individuals as the products. Processes should be designed to enhance relationships and create value, but process can also become a tool to hamper efforts if the effort becomes focused on taming the group as opposed to tapping into the potential of the participants (Susskind, 2014)

One of the other concepts that is discussed in both mutual gains and principled negotiation is the idea of back tables and face saving measures (Fisher et al., 2011; Susskind, 2014; Susskind &

Field, 1996). All parties in these discussions need to be thinking about this as it impacts the science, the resources allocation decisions, and the acceptance of outcomes.

The mutual gains approach also includes a focus on the idea that it is important to "accept responsibility, admit mistakes, and share power." That seems to be an issue in both cases as noted earlier. It also ties to a concept raised in Susskind (2014) around the impact of surprises in negotiation. It might lead to a "win" in that round of negotiation, but it is overall detrimental to the relationships and system. In both cases here (fisheries management and estuarine water quality) there are examples of surprises or mistakes that may not have been adequately acknowledged by the responsible parties and having a lasting impact on the relationships across the system. What may be perceived by scientists as small methodological errors that are easily corrected for can be perceived as major failures by other parties. Whether or not they have a true impact on the validity/ accuracy of the science they can have impacts on the credibility and the legitimacy of the science. Two instances in the fisheries management case illustrate this point. First, the incorrect use of a trawl as part of a data collection survey has have reverberating impacts on perception of the scientists. Secondly, when scientists later conducted a new stock assessment off schedule and ultimately surprised both managers and the regulated community with new findings about the status of the stock, there was significant consternation and distrust generated. Two additional examples from the estuarine water quality case provide some parallel lessons. Early work to assess the status of algal communities in Great Bay came into play when trying to understand trends in the health of the system and while sufficient methodologically to provide a general assessment of the status, the methods were later called into question. Likewise, there was a perception that early efforts in Great Bay were collaborative but switched to an internal regulatory process where people were surprised by the outcomes ultimately presented in the Numeric Nutrient Criteria report. Humans are inevitably going to make mistakes at some point, the best systems are those that acknowledge that and account for that inevitability in their structures and processes (Thaler & Sunstein, 2008).

Ultimately the lessons here point to the idea that science can be a source of surprises in management and ultimately efforts to engage across groups through a collaborative process can help avoid science surprises that damage relationships and future opportunities to find creative solutions. By being part of the process and being aware that advances to understanding might change the landscape, managers and the regulated community can be more prepared for change. This could help avoid the perception that scientific findings are changing arbitrarily and therefore can't possibly reflect the reality of the ecosystem state. On the flip side, managers need to be ready and willing to act when the science is updated and the regulated community has to be there to help come up with creative solutions (this has implications for process because it is so complex). If management entities included an example timeline on when scientific info was needed or would be used, how to engage more generally and when the opportunities to bring ideas to the table might actually be acted upon. Those who don't know the process can feel daunted by trying to figure it out and then feel ignored because they brought an idea to the table too late to actually change things.

Overall, I was left with the sense in the estuarine water quality case that there is a general sense that while there are disagreements, the end goal is protecting and improving water quality. In the fisheries management case, there seems to be less shared view of the goal and a perception that some are out to stop fishing. While in the estuarine water quality case actions are perceived to impact the financial resources of the regulated communities, in fisheries management actions are viewed as impacting (and in some cases attacking) the livelihoods of the regulated community. That said, there does seem to be a shared interest by the regulated communities in both cases to be treated with respect and viewed as the professionals that they are.

Conclusion

Analyzing science disputes through a negotiation lens can shed light on the possible drivers of a dispute and can also bring new ideas to the table about how to work within and through disputes. Principled negotiation and the mutual gains approach provide ways to address key areas highlighted as valuable paths ahead: engaging in collaborative problems solving and moving away from expending effort (time and money) trying to debunk science but instead working to make sure that it can be readily used and trusted by those impacted by decisions based on that science. In both cases analyzed here there is evidence of some of these two negotiation approaches but there is still significant reliance on legal resolutions that may actually be hampering progress. Stepping back to explore these lessons and the current state of the system is an important part of finding a path ahead. It is also beneficial for scientists to think about lessons from negotiation processes as a way to have science at the table. Viewing science as the product of negotiations among scientists and the inclusion of scientific findings in the management process as a negotiation as well may shed light on further questions about how to continue to bring science to bear on public policy questions.

CHAPTER 5

A SEAT AT THE TABLE FOR SCIENCE: COLLABORATIVE APPROACHES TO BRIDGE THE SCIENCE-POLICY DIVIDE

Environmental policy decisions therefore should be—and in the United States by statute typically must be—informed by the best available scientific information and judgments. Because they are matters of public policy they should—and, again by statute, typically must—also take into account the knowledge, values, and preferences of interested and affected parties. -(National Research Council, 2008b)

Introduction

"Science" is not merely a body of facts, or a practice, it is also something that is conducted every day by a legion of scientists who exist as individuals and communities as part of and apart from their roles as scientists. Science (and scientists) can be a source of conflict or dispute generation (Bruckmeier, 2005) but also of resolution of conflicts or disputes. Scientific findings can be the catalyst to start a dispute and they can serve as a mediating force to resolve a dispute,[10] but the process of "doing science," can also play a role in the process of working *through* an environmental dispute or negotiation[11] (Ozawa, 2009). Science conducted during the process of a dispute can be used to pit sides against each other when conducted separately, or it can be used to seek to resolve a dispute when conducted jointly. Science can also be used to cloud the true causes of a dispute or conflict or delay decisions (Karl et al., 2007; Ozawa & Susskind, 1985).

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[10] I differentiate between "conflict" and "dispute." Conflict is used to refer to the "underlying basis for the disagreement" and can include perceptions of unfairness in the distribution of resources, space, power, etc. Dispute on the other hand is used to refer to the actual disagreement over what "ought to be done" (Ozawa, 2009).

[11] A negotiation is "[a] form of decision making in which two or more parties chose to talk with one and other in an effort to resolve their conflicting interests." (Pruitt & Rubin, 1986)

Ozawa (2007) goes as far as to refer to science as a “prop” in the hands of actors within a dispute.

Scholars and practitioners alike argue for the value of science to inform decisions, they argue that everyone is better off when science and/or technical advice is not ignored (Susskind, 2017), but it has to be trusted to not be discounted. At times scientists exhibit frustration when “the public” or “managers” don’t act on new findings, but scholars have written on the importance of developing science that is credible, legitimate, and salient (Cash et al. 2003; Posner, McKenzie, and Ricketts 2016) in order for it to be used. This is further underscored by the need to be clear when a decision is a science or technical decision or when it is a resource allocation decision (Susskind, 2017).

Science plays an essential role in policy problem definition, development of policy options, and monitoring and revision, but it is one of many factors to be considered in the selection of policy decisions. This has implications not only for policy-makers but also for how scientists conduct their work, in particular to help ensure that policy decisions are informed by the latest science. Scientific findings and modeling scenarios can help explore what *might* happen in the future, but science cannot make the ultimate decision about what *should* happen, that is a societal question to decide (Susskind, 2017). A range of efforts have been pursued to bring science to bear on public policy[12] challenges. Examples of approaches range from Pasteur’s quadrat (Matsuura, 2017) to transdisciplinary or comprehensive approaches (Dyball & Newell, 2015; Eigenbrode et al., 2007) to ecosystem based management (McLeod & Leslie, 2009) to joint fact finding

[12] Public policy has been defined broadly as the action (or inaction) of government to address the public good (Theodoulou, 2013).

(Ehrmann & Stinson, 1999; Karl et al., 2007; Matsuura & Schenk, 2017b; Susskind & Field, 1996).

Analyzing illustrative dispute cases through the lens of credibility, legitimacy, and salience (Cash et al., 2003), this research presents further support for the relationship of this frame to the use of science while also considering the relationship between these concepts and collaborative approaches to science. Taken together, efforts to understand the use of science in dispute cases provides lessons for the practice of science and its use in management settings.

Methods

Using the case study approach (Burawoy, 1998; Yin, 2013), this research analyzes two dispute cases in New England - marine fisheries management (Northeast Multispecies Complex aka groundfish) and estuarine water quality management (Great Bay, New Hampshire). Data from semi-structured interviews and participant observation were analyzed using NVivo 12 (Adu, 2016; Bazeley & Jackson, 2013) and the framework method (Gale et al., 2013). The results are based on both open coding to explore emergent codes through grounded theory (Strauss & Corbin, 1998) and a priori codes to analyze for the presence of indicators of credibility, legitimacy, and salience (Cash et al., 2003) as they relate to the science at issue in these two dispute cases (stock assessments and impairment determination respectively). Findings are summarized to explore the applicability of this theory of use of science in the context of these dispute cases as well as other related cases.

Results

Science for sustainability

While not referenced using the same terms as Cash et al. (2003), the concepts they raise are present throughout how interview respondents discussed their experiences with the science and management process.

In exploring the concept of "credibility" one scientist described the challenges within the scientific community when one scientist challenges others. Observing the tension, this scientist noted their feeling that "other scientists feel that we're just making what's a difficult job even more difficult. And managing [issue] is difficult. When you don't accept the science, it just makes the job more difficult. And so, they think it's making trouble." Another respondent noted "we made fun of state and federal scientists because we felt they weren't doing real science. No offense to the federal biologists, I've got friends who do it, but we just felt from an academic level, that state and fed scientists weren't keeping up with research." Another respondent noted their view that "government scientists have such a difficult job, because they are the ones that have to pick a number. [They] do not have the luxury of punching holes at it, which is exactly what academics are going to do." While credibility is generally discussed in the literature as the perception of the science among other scientists, one theme that emerged in the interviews I conducted is how closely some in the regulated community observe these processes and how much that impacts their own perceptions of the science. For example, one regulated community interview respondent noted their view that "there are a handful of obstructionist, fierce defenders of the status quo, which is not to me what science is about. I mean, science evolves constantly as your knowledge increases, you have to change your views." Another noted a concern that peer review panels are made up of people who will agree with government scientists “it's like kind of getting a yes-panel together” versus those who might “ … challenge their way of thinking or challenge their assumptions or challenge them in the data sets they use or they don't use.”

The concept of legitimacy occurred most prominently out of the three themes. Some of this discussion highlighted the benefits of efforts like collaborative research to increase the perceived legitimacy of the science, but many of the instances were linked to gaps respondents observed. For example, one member of the regulated community noted “they haven't been involved enough in the research to actually trust the science” while another noted the need for data that was already being collected to be incorporated into management processes. Interview respondents from the scientific and management community also noted similar challenges and opportunities to incorporate more of this data. One scientist noted “They want to be involved … mostly because they want a positive outcome [but] whatever we reconcile, they want to know that they had a hand in it.” There was extensive evidence on the part of the regulated community in the groundfish case of a desire to be move involved in data collection whereas in the water quality case the desire for involvement was more generally stated as a need for more monitoring collectively. As an additional example, one of the events included the following statement by a member of the regulated community in response to their feelings about scientists distrusting the data gathered by the regulated community: “if you don't believe our data, imagine how we feel about your science.” This further underscores the linkages between perceptions of legitimacy as it relates to trust in and use of science.

Lastly, respondents across all groups discussed the importance of efforts being connected to management question or “salience”, particularly around the concept of monitoring to better understand the state of the systems. “I think it's worked best when whatever mechanism there is for gathering data is designed in a way to answer the management question. And that's not always been the case especially in [x] where a lot of policies have been put into place based on monitoring programs which are not designed to answer the questions.” Interviewees discussed the mismatches between the research conducted and data collected and the problems as they saw it (ties to salience), as well as a tension between the need for science to evolve to stay relevant in scholarly circles but to stay consistent to build management decision (ties to credibility).

These concepts also interact with each other. For example, one example discussed by a scientist exemplifies the concept that efforts to increase the credibility of the science within the scientific community, in this case by changing the model, ending up improving the model and the credibility, but decreasing the perceived legitimacy within the regulated community because the model output showed a system in far worse shape than previously reported by the same scientists. Additionally, a speaker at one event I participated in noted that “sometimes simpler is better, but unfortunately as a scientist, you don’t get a lot credit for simple” underscoring the tension between credibility of the science and the perceived legitimacy. These intersections are further explored in the discussion section.

Emergent themes

Several themes emerged from the grounded theory analysis that pertain directly to the concepts of credibility, legitimacy and salience and the use of science. First, the challenges associated with balancing the iterative nature of science with the iterative nature of management were evident in several interviews and participant observation events. Additionally, there was considerable discussion of funding and resource challenges which directly impact the science that is conducted and how the management processes are set up to incorporate those findings. Lastly, an overarching theme emerged about science, including concept of precision (or lack thereof) in science, and the perceived authority of science. One interesting subtheme that arose was the idea that management processes are asking more of the science than what it can deliver. Interestingly this came up across all three types of interview respondents:

- "My general feeling on the science is that it's fine. But it was not and cannot serve management today." - Management community respondent
- "… the state of the science simply is not there. It is not good enough, it is not accurate enough, it has very poor predictive capabilities …" - Regulated community respondent.
- "we are asking more of the science, specifically in [x], than it can give us." - Management community respondent
- "The science is not sufficient to support the [management] system." - Scientific community respondent

These general science themes also link back to credibility, legitimacy, and salience and their linkages are further explored in the discussion section.

Opportunities for collaborative approaches to science

Analysis of interview transcripts and participant observation notes show examples of collaborative approaches to science throughout both cases as well as significant interest in these types of efforts. The interviews were designed to elicit perceptions of issues that were viewed as most essential to help determine whether there are further opportunities for collaborative approaches like joint fact finding (see chapter three for in depth discussion) to help address the dispute situation in these cases or in others like them.

Considering the noted importance of confidential interviews to explore interests and possible value for joint fact finding to address disputes over science, Tables 5.1, 5.2, and 5.3 below summarize the themes that emerged from my research interviews in response to three questions designed to elicit their interests and perspectives in a succinct manner. These questions were also designed to explore whether there was a possibility of moving into the "trading zone" (Susskind, 2014)and seeking resolution to some elements of the disputes. These summaries indicate that there is likely opportunity in both cases to pursue more collaborative approaches and possibly formal joint fact finding.

The issues summarized in table 5.1 show patterns that indicate a recognition of the evolving and complicated nature of both science and management. While the general pattern is that this is a view that things are improving, it is not shared across all respondents. Overall there is a consistent view that more data, new approaches, etc. are needed, indicating an opportunity for further efforts to use science as a mechanism to work together to improve relationships and system outcomes.

Table 5.1. Themes emerging from interview questions asking respondents to use only three words/phrases to sum up the state of management and the state of science in their respective cases.

		Three words to describe Mgmt. – Themes	**Three words to describe Science – Themes**
RegCom	GB	in slow transition, positive trend, needs more improvement	evolving/progressing, has gaps, more data needed
	GF	broken, in need of repair, unresponsive	more data needed, too complex, inconsistent
Scientists	GB	improving, lacks resources, difficult	needs better organization, misaligned, pretty good
	GF	improving, troubled, inefficient	more data needed, good people, biased
Managers	GB	complicated, collaborative, heading in right direction	evolving/in flux, under resourced, incomplete
	GF	evolving, resource limited, contentious	improving but still incomplete, inconclusive
Summary	GB	complicated; improving; needs more improvement	Incomplete; progressing
	GF	contentious; challenging; uncertainty	needs more (data, comprehensive approach, coordination, resources, etc.)
Summary	RegCom	needs improvement	needs more data
	Sci	contentious; work in progress	needs to be more comprehensive; needs more data
	Manage	complicated; contentious; needs more science	incomplete; in flux; evolving

Table 5.2 shows patterns in the desire to continue and/or start more collaborative approaches and opportunities to work together. While there is some variation across groups, this was a consistent pattern overall.

Table 5.2. Themes emerging from interview questions asking respondents to share one thing they wanted to see stopped, one thing they wanted to see started, and one thing continued in their respective cases.

		Stop – Themes	**Continue – Themes**	**Start – Themes**
RegCom	GB	Pitting communities against each other; working individually	Working together; PREP	More opportunities to exchange ideas and learn; collect data across parties; have one guiding plan
	GF	Complexity of regulatory process; sectors; current assessment process	NEFMC; Collaborative research; Research on interactions	Collecting/using localized data; using fisheries dependent data; multi-species mgmt.
Scientists	GB	Fighting / $ on lawsuits / legal arguing; discharges / releases; development	cooperation/ collaboration; PREP; optimizing treatment	comprehensive but adaptive approach; education; LID as standard
	GF	illegal activities; inaccurate reporting; inaccurate behavior w/ observers	MREP; cooperative research / collaboration	Incorporation of collab research; venues for sharing perspectives; centralized landings data; Monitoring improvements
Managers	GB	fighting / $ on lawsuits; questioning the science; hyper focus on one pollutant	Being sincere about collaboration; SOOE process; public engagement	More holistic science; more investments; more non-point focus
	GF	excessive lawsuits; micro managing; misreporting of data	Cooperation/collaboration; spawning protections; public input	Expand collab research; improve monitoring; incorp industry data meaningfully
Summary	GB	Fighting	PREP, SOOE, broad engagement	Comprehensive/holistic science; opportunities to exchange / collab
	GF	No pattern	Cooperation / Collaboration across all (research, MREP, etc.).	Using industry data; expanded collab research; venues for sharing perspectives
Summary	RegCom	No pattern (case specific items)	Opportunities to work together	Involving regulated entities; using data from mult. Sources
	Sci	No pattern (case specific items)	Collaborative approaches	Collaboration
	Manage	Time/$ on lawsuits	Collaborative approaches	Sincere and expanded collaboration

Table 5.3. Themes emerging from interview questions asking respondents to describe one thing they wanted to see changed about management and one about science in their respective cases.

		Mgmt. Change -Themes	Science Change – Themes
RegCom	GB	$; stormwater/nonpoint approach	$; timely publications; communication
	GF	Stock assessments; communication; data collection; MSA-NOAA-Council roles	Year round / continuous / localized sampling w/ fishing vessels; use fishery dependent data
Scientists	GB	Comprehensive look; $ to involve stakeholders; reduce Nitrogen	Comprehensive assessment; research to address mgmt. needs; stable / increased $; improve monitoring/modeling feedback
	GF	Stock assessment process / accuracy; sectors; integrated data collection; monitoring	Stock assessment process; more collab w/ industry; more $ and more/better data
Managers	GB	Focus on more than just WWTP; more resources	More $, research, groups, monitoring, etc.
	GF	Alternative assessment methods; American consumer habits; increase collaborative research; monitoring	Alternative assessment methods; $ for EBM; increase collaborative research; monitoring and industry surveys
Summary	GB	More resources ($ for mon, $ for loans, $ for stakeholder engagement)	More funding (long-term monitoring, etc.).
	GF	Stock assessment process	Include industry and industry data
Summary	RegCom	No pattern (case specific items)	more data (and more use of existing data)
	Sci	No pattern (case specific items)	More comprehensive; more tie to mgmt.; more $; more monitoring
	Manage	More monitoring and research	More collaboration; use of other data sources; more resources

Table 5.3 presents ideas about areas that could end up being the focus on future efforts to work together given the shared interests. Particularly the general interest in more data, more monitoring, and more collaboration.

Discussion

When presented with a conflicting set of facts or findings, people are largely skeptical which can lead to ignoring scientific information. Decision makers find it hard to translate and filter through the information they receive and then scientists end up feeling ignored. In these situations it is not that decision-makers do not understand what is shared with them, it is that they are presented conflicting information with no way to determine what is accurate (Matsuura & Schenk, 2017a). These settings risk science being left out of the process entirely and as such, processes to minimize this conundrum are essential.

The findings presented here provide a more complete understanding of how the concepts of credibility, legitimacy and salience can shed light on understanding disputes over science. In addition, the series of questions designed to elucidate respondent interests and presented in tables 5.1, 5.2, and 5.2 provide evidence that there is an opportunity to design (or continue) efforts to work together more, whether through formal joint fact finding or other related approaches.

Further exploring the intersections of the three components Cash et al. (2003) set out, provides additional insight into both the scientific process and the process of bringing science into management processes. Figure 5.1 presents a notional flow of how credibility and salience (and the elements that contribute to them) build together to contribute to the perceived legitimacy of the science. Legitimacy has been found in other studies to be the most important of the three elements (Posner et al., 2016). This graphic is also intended to underscore that actions within the scientific community are not invisible to the management/regulatory community and regulated entities. These internal scientific community debates have a direct impact on perceived legitimacy of the science.

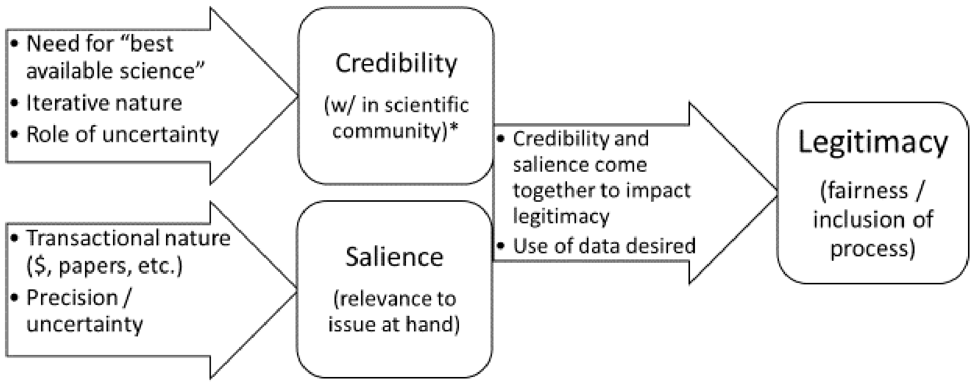

Figure 5.1. Conceptual model for intersection of credibility, legitimacy, and salience in support of use of science. *While credibility is generally viewed as the perception within the scientific community, these elements are visible to others and impact the overall perception.

Collaborative efforts to incorporate science into dispute resolution approaches and engagement efforts are also in line with the conclusion of the 2008 NRC study that found that if done well, public participation improves the capacity of those involved. In this case they define capacity as:

> "participants, including agency officials and scientists, (1) becoming better informed and more skilled at effective participation; (2) becoming better able to engage the best available scientific knowledge and information about diverse values, interests, and concerns; and (3) developing a more widely shared understanding of the issues and decision challenges and a reservoir of communication and mediation skills and mutual trust" (National Research Council, 2008a).

These characteristics underscore additional reasons for and potential benefits from collaborative approaches that support bringing science to the table throughout decision processes.

As noted in the results section, one issue that emerged from the data is the idea that management is asking more of the science than it can deliver. This is a particularly interesting challenge given that noted desire for other non-science groups' data and knowledge to be used and/or for individuals to be included in the process. Even with the science challenges at hand, it appears that these structures are at the same time insular about who can engage in the scientific process and whose voice matters in thinking about how to make it better. This is a missed opportunity not only to improve the science, but also to improve the outcomes of management processes and potentially compliance with management outcomes. These ideas are also prevalent in the thinking behind joint fact finding and many collaborative approaches. These more inclusive structures are designed to meet immediate scientific and management needs, but also have larger cultural and democratic values (Matsuura & Schenk, 2017a). Given many of the pressures faced by the scientific community right now, it continues to be imperative that we open up the processes to help people (who are acting in good faith) understand what is going on. That said, there is an ongoing challenge that all are not operating in good faith, but that topic is better addressed outside of this discussion.

For science to be effectively used, broad science literacy is needed (individual and structural) (National Academies of Sciences Engineering and Medicine, 2016). One way to do that is through increased engagement of the science enterprise with the wider public. In addition, as we see in the context of science in dispute resolution, science can also be viewed as a tool to share, educate, and build relationships and not solely to influence (Ozawa, 2009). Collaborative processes are one way to do this. We see evidence in these cases that there is a desire to do so across all three categories of actors.

These approaches are not without issues. For example, challenges can arise in attempts at inter and transdisciplinary research and collaborations when participants “mistak[e] different research approaches and competencies for faulty or unintelligible scholarship” (Khagram et al., 2010). Andersen (2016) discusses the importance of speaking truthfully in developing trust within interdisciplinary collaborative teams. Trust needs to move to the forefront in these efforts and not be viewed as an afterthought. Value of other skills and characteristics is also seen as essential including “honesty, loyalty, cooperativeness, fairness, or consideration for others” (Andersen, 2016). These factors complement the focus on credibility, legitimacy, and salience as factors relating to the use of science (Cash et al., 2003). In particular, credibility ties to trust across disciplines as well. The concept of “disciplinary chauvinism” where certain researchers hold research conducted within disciplinary bounds to a higher esteem than research across disciplines (Younglove-Webb, Gray, Abdalla, & Thurow, 1999) has real potential to impact researchers willingness to engage in such inter and transdisciplinary projects. To counter this, one should also consider the applicability of the findings. While new and sophisticated approaches might hold weight in academic circles, they may not assist managers in on-the-ground situations which is also becoming more highly valued (Ferguson et al., 2016). In interdisciplinary work, it becomes easy to undermine the credibility of another scholar by questioning their approaches even if it’s not something they are familiar with. Trust is not just an issue across groups but within groups too. For example, different science fields must trust each other and work together to deal with complex systems. Both cases presented here are complicated systems and are in some ways hamstrung by over simplified science and discounting of other views (including within science disciplines).

The analytical usefulness of the sociological concept of communities also has value when thinking about communication of scientific information and relationships across groups. For example, in the context of marine resource management, it has been found that decision-makers "rely on individual experiences or other secondary sources of information … in isolation from scientific information" in part due to the fact that they are at times "unaware of the full breadth of existing scientific information they could use" (Cvitanovic et al., 2014, 2015). This presents opportunities to engage (not just share data) that may lead to more use of science as well as an overall increase in science literacy (National Academies of Sciences Engineering and Medicine, 2016). It is also important to be careful of falling again into the deficit model of education and assuming that sharing a paper is the same as engaging a decision-maker. The shared context is critical to understanding the implications of the research and that back and forth exchange develops the context that is needed (Dyball & Newell, 2015), but also the credibility, legitimacy, and reliability of that information is critical for its use (Cash et al., 2003).

Scholars and practitioners both point to the importance of an "iterative process between scientists and science users" to create science that is more useful and useable (Ferguson et al., 2016; Posner et al., 2016). This applies within the context of science intensive disputes, but also social-ecological systems more broadly. Ozawa (2009) also points out that in settings like joint fact finding or other co-production of knowledge/ collaborative approaches, those with technical knowledge may need to be reminded that their role is to "educate not intimidate" the other participants in the effort.

There are additional challenges with pursing collaborative approaches. While intended to enhance the role of science in decision processes, some critics have articulated a concern that "arrangements granting equal status to citizens and scientists may weaken the influence of science on policy" (Layzer, 2002). Other challenges related to who will serve as the convener of a collaborative approach, especially when there is limited capacity and/ or those with convening power are distrusted. Additionally, academic reward structures for faculty typically do not value or even recognize joint fact finding or collaborative process or if they do, they come with a perception that it is less rigorous than other approaches to research and therefore given less credit in academic circles. While outside the scope of this research, the challenges around organizational change in academia and in some government circles and decision bodies are not to be taken lightly and will not come overnight.

There may also be a generational aspect at play in these issues (Kuhn & Hacking, 2012; Wootton, 2015). Older scientists may be pushing back on challenges to their methods and past approaches. These challenges in some cases come not from a desire to discount their work, but from an evolution of methods and thinking over time. In most cases they did the best they could with what was available, but the science and methods have evolved. It doesn't necessarily mean it was bad science then, just that available tools have changed. This will continue to be a challenge going forward as there is a need to tap into older and established expertise without having it hamstring efforts or appear that questions that are raised are intended to discredit past work. This must be looked at as the evolution of science – findings and methods stand until something new confirms or replaces it. The human element of this challenge cannot be understated, being questioned about scientific work is not (and should not be) about discrediting, it should be about moving the scientific enterprise forward. Joint fact finding and other collaborative approaches may provide beneficial tools to address this tendency as questioning and discussion of the methods, data, and findings is all part of the process. In these processes, questions are not designed to embarrass experts, but rather to help all parties understand the findings and their implications (Susskind et al., 2017).

One of the challenges in environmental management and decision-making, is the proliferation of approaches that go by different names but are fundamentally quite similar. While it is useful to have a diversity of options and approaches and a cadre of scholars and practitioners from different backgrounds seeking to improve these processes, it can be overwhelming in practice and can lead to wasted energy, inefficiencies, and scattered focus. Where possible and appropriate, scholars and practitioners should endeavor to explain how their approaches are similar to and different from related efforts and where possible use concepts from across the approaches to facilitate dispute resolution and decision-making. In particular, these approaches might be more or less challenging in the context of certain federal and state laws and experts in these approaches should consider this context. This should take into consideration the specifics of who has management authority in each situation. Existing approaches could be built upon by agencies and partners who already use these approaches as they are already familiar processes to them. Karl et al. (2007) argue that incorporation of joint fact finding or other collaborative approaches would require the modification of the "institutional frame of government agencies" but these examples show that similar processes are already underway. While not called joint fact finding, they show that such approaches are possible even within the current bounds of U.S. federal government systems. These collaborative processes build relationships that are key to the current situation but also lay the groundwork for the future, which is important given the perspective that long time scales are needed to actually see the change (Cash et al., 2003).

Conclusion

Based on the perpetuation of conflicts and the proliferation of disputes over natural resources, it is clear that the approaches framed into our current institutions in the U.S. and globally are not adequately integrating "science, values, and interests" into decision-making (Karl et al., 2007). In the context of climate change, Hoffman (2012) discusses three paths ahead for how we as a society respond – the optimistic approach ('we can solve it'), the pessimistic approach ('we can't'), and lastly, the consensus-based approach. In some ways, this parallels the thinking of many other scholars and brings most closely in ideas that have been circling in other parts of the literature for years (Ozawa and Susskind 1985; Susskind and Field 1996; others).

There are several ways science comes into play in the resolution of science intensive public policy disputes, whether it's the often used "adversarial" approach or more collaborative approaches like joint fact finding, they all point to the role of science in informing public policy debates. That said, there is also opportunity for more shared understanding and a collective way ahead.

Drawing from the literature and practice in these areas, my recommendation going ahead is that scientists and practitioners look carefully at each context and draw from the existing work already underway in the particular organizations involved. Considering what approaches are already underway in a system, how they align with a range of established practices (regardless of what it is called), and exploring gaps creates the opportunity to move organizations towards more robust approaches without risking wasted energy realigning to what might be perceived as yet a new idea. Advocating for a specific approach without understanding the efforts already underway can at minimum waste time and at worst breed distrust and hostility. Considering the literature and practice on organizational change when seeking to install new approaches would be a valuable step as well. There should also be consideration given to the differences between recommendations for organizational process changes and those for *individuals* in an effort to consider both the near-term disputes at play and the larger context of at times on-going conflicts. Where appropriate, efforts should be made to institutionalize practices so that that are not "one-offs" and can be repeated or built upon within existing financial and personnel resources.

More specifically, the frameworks used will also depend on the time available to act and the desired context for the "solution." If it is an effort to move out of the court room but there is still the pressure of a legal or regulatory deadline, perhaps a more structured and bounded process should be selected. If the players include those who can influence larger policy debates, it might also be wise to consider approaches that give fodder for larger systemic changes (Kingdon, 2002). To get at this larger question of approaches, I suggest the following:

1) Seek to understand the larger the social-ecological context within which the issue sits
2) Determine the scale and relevant authorities for action
    a. Consider bringing in others if the authority lies outside your purview
3) Determine external bounds on your process
4) Consider existing efforts and gaps
5) Select or adapt existing frameworks

6) Implement with continual review

In these types of disputes, it is incumbent on the participants to recognize that there are often two issues at play, the science and the distribution of value. It is key to separate them out so the issues of the dispute do not become conflated. By looking at the questions of science separately from the questions of distribution of gains and losses, we can begin to tease apart seemingly intractable public policy disputes (Ozawa & Susskind, 1985). This context also enables us to see larger opportunities for change.

In a future of limited financial and personnel resources, it becomes ever more essential to build on what already exists with shift within the confines of existing programs as opposed to the advocacy of what can be perceived by those who are hesitant as a "new" way. Going forward, these efforts should recognize where there are existing approaches that might go by different names, suggest alternatives or course corrections, and where possible institutionalize the approaches to collaborative thinking for joint development of durable solutions. "Enabling co-creation, then – or operationalizing it – means finding practical ways to work together, to deal with our different experiences, aspirations and expectations as well as the uncertainties of the future" (van Kerkhoff, 2017).

CHAPTER 6

AN "ANGRY PUBLIC" NO MORE? ENGAGEMENT ACROSS GROUPS AS A TOOL TO ADDRESS DISPUTES OVER SCIENCE IN COASTAL AND MARINE SOCIAL-ECOLOGICAL SYSTEMS

"For community and stakeholder engagement to matter and serve as more than just window dressing, scientists and funders need to relinquish some of their power and authority by allowing stakeholders—including historically marginalized groups that are traditionally excluded from governance spaces—to influence problem framings, program goals, and other key decisions."
- (Delborne, Kokotovich, & Barnhill-Dilling, 2018)

Introduction

Processes for public engagement in decision-making run the gamut from merely being informed of a decision to actually being involved in collaboratively developed the outcomes of such a decision (Creighton, 2005). Public input is baked into the concepts that European settlers brought with them when they arrived in what is now the northeast region of the United States and hence has since become an underlying facet of our system of government at the local, state, and federal levels. While included in concept, its actual execution has varied greatly over time and across institutions. It is critical to account for the human component in decision making about social-ecological systems. People are not just units to be managed, they have agency and roles and ideas about how these systems should function. They all experience the systems differently and have valuable input into how to go forward.

In 1996, Susskind and Field released a book titled *Dealing with an Angry Public: the mutual gains approach to resolving disputes.* The title aptly sums up a concern that often drives public officials to shy away from public engagement (Susskind & Field, 1996). While the book is broadly focused on business and government, there are important lessons to be drawn for senior public officials, those who advise them, those in the trenches of these public organizations, and for the public at large. In the context of environmental issues, where tensions can run high and "factions" often appear deceptively clear, it is all the more important to listen to and engage with the public to ensure that decision-makers have not only heard the input of those directly affected by the decisions, but also created space to be open to different solutions. It is this latter aspect, being open to different solutions, that is often lost and, in many cases, critiqued by those in the public who are seeking to be heard.

Susskind and Field set out two dire consequences for decision-makers not concerning themselves with the "angry public:" 1) a decline in American competitiveness on the international stage, and 2) "an erosion of confidence in our basic institutions" (Susskind & Field, 1996). While the first is an important concern, the second has profound implications for how our public institutions address a whole range of societal challenges, not the least of which include issues relevant to social-ecological systems. If there is no confidence in the institutions designed to maintain the health and productivity of these coupled systems, then those institutions are hamstrung in actually being able to execute their functions. Public engagement and participation efforts create the framework and the opportunity for public institutions to create (or re-create) these connections between the institutions and the public they are designed to serve. Twenty years after the release of their book, the arguments and proposed solutions presented by Susskind and

Field bear as much if not more relevance to the task at hand in decision-making within social-ecological systems.

The overarching goal should not be to “solve” challenges facing social-ecological systems as that is not fully possible. Rather, these systems need to be rendered manageable (Dyball & Newell, 2015). Management is about accounting for and controlling human behavior in systems because “environmental problems are the result of human social organization” (Gould & Lewis, 2015), and if we are to render these problems and systems manageable, we must account for the people in these systems. And with that, we must acknowledge that “people” aren’t a uniform group. They have different values, different motivations, different relationships with the environment around them, and different impacts on the social and ecological components of the systems within which they live.

There is little remaining debate that science and broader public input (on values, priorities, and interests) are both critical to environmental decision-making; what is debated is how much input, when, and by whom (National Research Council, 2008b). The National Research Council argued that it is not an all or nothing tradeoff between engagement and quagmire, but rather a matter of designing processes that offset the costs so that on balance, these social-ecological systems benefit from public engagement as it is foundational to our democratic society (National Research Council, 2008b).

Decisions made by government bodies are fundamentally political decisions. If designed well, those relevant to social-ecological systems (and others) are informed by the best available science, but they must also balance the values, interests, and expectations of those directly impacted by the decision, and increasingly, the public at large. In this context, it is helpful to consider that solutions can be better or worse, but not right or wrong, it all depends on perspectives of those in the system (Dyball & Newell, 2015). This is where public engagement in social-ecological decision-making can provide valuable insight to help reach manageable solutions for complex issues.

It is within this context that this research explored the role of cross-sectoral engagement activities in disputes over science. For the purposes of this research, I define cross-sectoral engagement as opportunities for individuals working in or representing different stakeholders or groups within a social-ecological system to interact in a meaningful way. This could include (but is not limited to) training workshops, public councils/forums, cooperative research, etc.

Methods

To better understand the role that cross-sectoral engagement opportunities might be playing in science intensive disputes over management in coastal and ocean systems, two case studies were selected: marine fisheries management (Northeast Multispecies Complex aka groundfish) and estuarine water quality management (Great Bay, New Hampshire). Using case study approach (Burawoy, 1998; Yin, 2013), data from semi-structured interviews and participant observation was analyzed using NVivo 12 (Adu, 2016; Bazeley & Jackson, 2013) and the framework method (Gale et al., 2013). Interview respondents were asked a series of questions to explore their participation in cross-sectoral engagement activities and their perceptions of the impacts of those experiences. Analysis was primarily focused on synthesizing responses and exploring emergent themes from the data (Strauss & Corbin, 1998).

Results

To better understand the nature of and lessons from cross-sectoral engagement opportunities, the interviews conducted as part of this research asked respondents to elaborate on their experiences and reflect on their perceptions of what impact those experiences had on them as individuals as well as on the overall system.

Types of activities

Respondents were asked to share the types of activities they had participated in that included a range of attendees outside their own groups. Table 6.1 summarizes these activities and groups them further into different types for further consideration. Respondents were also asked about the typical settings for the activities they participated in; the overwhelming response was that they occurred in hotel or agency conference rooms. Some reported activities at local libraries and other "neutral" venues. A few had participated in activities that included field trips or on water activities but still underscored that the vast majority of activities they participated in were in conference rooms.

Activities tied to the New England Fishery Management Council (NEFMC) and the Piscataqua Region Estuaries Partnership (PREP) were each mentioned 11 times in their respective cases. I expected a large number of participants to have had experience with role-play exercises or mock-negotiations given the contentious nature of the issues at hand and previous knowledge of existing efforts in the region, but none of the Great Bay respondents and only four of the groundfish respondents had participated in these types of activities, three of which were done as part of the Marine Resources Education Program (MREP).

Table 6.1. Typology of “cross-sectoral engagement activities” described by interview respondents

Type	**Examples**
Tech/Sci Advisory	PREP TAC; NEFMC SSC; Witch Flounder Workgroup; NE Trawl Advisory Board
General Advisory	NEFMC Advisory Panels; Stock Assessment Workshops; SBNMS; Lamprey River Advisory Committee; PREP Committees
Research Projects	Oyster River Watershed non-point study; catchability studies; Electronic monitoring demos; multiple collaborative research projects; PTAPP; WISE
Workshops	Island Institute / Climate; MREP; GMRI Fish Tank; general groundfish workshops; NEFMC hosted workshops; supply chain discussions; Gear workshops; NHDES hosted seminars for municipalities
Conferences / Forums	Maine Fishermen's Forum, Seafood Forums, general training sessions, Lamprey River Symposium, scientific symposium,
General Public Events	Lectures, Seafood events, Expos
Associations	Groundfish Sector, Lamprey Watershed Association, Save the Bay, Municipal Coalition
Outreach Events	Port Meetings, NH Aquaculturists Meeting;

Impact of activities

Three sets of results pertain to understanding the overall impact of cross-sectoral engagement activities. First, respondent ratings of their perceived impact of their own participation provide an overview of potential impact (table 6.2). Second, table 6.3 presents a summary of how respondents characterized the impacts of these activities on their interactions with other groups. And last, respondents’ perspectives on what their biggest takeaways from participating in these activities sheds further light on how cross-sectoral engagement activities might be impacting science intensive disputes such as those represented by the cases in this research.

Table 6.2. Respondent ratings of their perception of how participation in cross-sectoral events impacted their engagement with others (scale of 1-5, 1 = no impact, 5 = significant impact).

		Avg	**n=**
RegCom	GB	3.5	4
	GF	4	4
Scientists	GB	4.4	5
	GF	4.1	7
Managers	GB	4.3	3
	GF	4.6	7
Summary	GB	4.1	12
	GF	4.3	18
	RegCom	3.75	8
	Mangers	4.5	10
	Scientists	4.25	12
Overall	n/a	4.2	30

In addition, to sharing their perceptions of how the cross-sectoral activities impact their interactions with others, respondents were asked to summarize their overall thinking into that they viewed as their biggest take-away from participating in these activities. While a range of case specific details were shared, several themes emerged. These themes included: an increased understanding of the environmental and social complexities at hand, an appreciation for the power of in person meetings and distance from a decision, a reflection on the importance of self-awareness and an open mind (for example "check your attitude, your ego, your whatever"), the value of one on one interaction, an acknowledgement of the stressful nature of these issues, concern that even with all the discussion there is still a lot of "stuck viewpoints," that collaborative and joint processes move slowly, and lastly the overwhelming importance of actually listening to other people.

Table 6.3. Themes of responses when respondents were asked to reflect on the impact of the various cross-sectoral engagement activity on their interactions with subsets of types of people.

		RegCom	Gov't Sci	Non-profit Sci	Academic Sci	Managers	Non-profits
RegCom	GB	Work together; respect for peers; formed bond / safety in numbers	Not a lot of interaction; Helps to hear perspective; Easier to collaborate than be isolationist	None; not sure	Helpful; Lot of respect; some ivory tower / some dogmatic; very little interaction	Opportunity to learn what's coming; creates relationships; better understand roles/goals	Challenging; not broad enough view; lack of understanding of local gov't; tried to develop healthy relationships
	GF	Some good connections; lots of different opinions; talking to each other more since so few left.	Good relationship with some; some open, some closed and defensive; some don't like being questioned; need better comms	Lots of variation across types; worked pretty well	Generally positive; views are listened to; a little more open minded and objective than gov't	Learned specific issues; separate the org from the individuals; build relationships; love sharing how industry feels	Lots of variation; some good, some false prophets; national agendas and preconceived notions; challenging
Scientists	GB	Trying to figure out; if they are at the meeting, view as interested; positive with some, negative with others; some narrowminded approach to science; caused to hold cards close.	They care about work; strive to compliment and not duplicate; wear multiple hats; depth of knowledge challenges; already work together	variable	Some are aloof, some engaged; hamstrung by budgets; learn about each other's work; peers can get into debates; NSF $ doesn't allow for engagement; mixed	They care about work; not interested in piecemeal science; provided context and contacts; didn't change	Varied; some trying to bring together; some trying to influence policy; caused to hold cards close

	GF	Hard to generalize; newer interactions / need more; move from conflict to understanding; come to know these are people	Top notch but constrained; high stakes; rigorous but not willing to adjust; collegiality; varied	Similar to academic scientists; generally open; some cliques	Mixed interactions; different perspectives on what is valuable	Helpful to observe; learned about their Q's; new respect for decision makers; Mixed	Wide variation; have different objectives and different strategies; some make grand conclusions on a few pieces of data; heart in the right place, but…
Managers	GB	Learned decision processes, constraints, politics; saw depth of bench challenges w/ science; ebb & flow; healthy respect for motives; most formal level of conversations	Difficult job, they have to pick #; don't have luxury to poke holes; depth of bench challenges; facilitates connection	Do good work, remain non-political [note this was view of PREP]	Learned about their expertise and projects; constrained by grant $ and cycles; frustratingly slow and expensive; gave creative brainstorming time	learned about their structures (siloed); enhanced comms; facilitates connection	learned how they do work; challenge - can't work with the person suing and being sued at the same time; creates touch points
	GF	build capacity for dialog; increased level of respect; time on boat gave genuine understanding of what they do	approachability; built knowledge about assessment process; built relationships / better understand their work; respect; see treated poorly; pay more attention now	Not all agenda based; lowered opinion; very few outside certain orgs; NGO scientists don't have policy angle; try to understand end game	willing to be approached; some good at comms, some not; good connections via collab research; see as a stakeholder; some agenda driven; industry funded are more approachable	Helped see common ground; didn't change; same generally; empathize; increased respect; view as partners	Gained more respect for individuals; had less interaction; allowed to dig deeper into concerns; have stance; try to understand end game; willing to consider alternatives even w/agenda

Summary	GB	Some neg / some pos interactions; learned decision processes	Difficult job; care about work	Variable	Learned about work; funding challenges; mixed interactions	Learned about structures; see what's coming	Varied
	GF	Hard to generalize; capacity for dialog	Varied views	Varied views	Generally positive; impact of funding/ training on efforts	Learned about views;	Wide variation; different objectives and strategies
Summary	RegCom	Respect for peers; lots of different opinions; talking more	Need more interaction; varied	Varied	Generally positive; mixed views	Learn what's coming; build relationships; understand roles/goals	Variation; national agendas & preconceived notions
	Sci	Hard to generalize; still figuring out	High stakes; multiple hats; can be narrow view	Variable	Mixed; different views.	Provided context and contacts; Mixed	Wide variation in roles and objectives
	Manage	Increased respect; better understanding	Difficult job; increased respect; facilitated connections	Not all agenda based	Better understanding of work; impact of funding; opportunity to connect	Learned about structures; helped see common ground; increased respect	Learned how they work / what concerns are.

Emergent themes

Several more general themes emerged from the open coding process that are relevant to the concept of cross-sectoral engagement and how these approaches are impacting science intensive disputes. Four emergent themes have particular relevance: empathy and humility, respect, and trust. Several respondents either discussed the concept of empathy directly or in concept when they talked about their experiences with cross-sectoral engagement activities. For example, one respondent noted in the context of fisheries that the experience of hearing the impacts of decisions had an impact on them: “people are putting their personal stories out there [and that] definitely changed my perception.” The concept of humility also came up and has links back to credibility, legitimacy, and salience (Cash et al., 2003) as well. This was evident in several stories of lack of humility in some scientists “They're dogmatists. They defend, their way is the only way. ‘There's only one true path forward, and I know what it is’” but also in others exhibiting humility in recognizing that they do not have all the answers “So part of me says, yes, maybe we should get back to the drawing board and throw away our pride for a minute and just say it's fine. That didn't work. Let's start something new.”

The concept of respect emerged both in how others talked about those they were interacting with, but also how they talked about themselves and their own backgrounds. For example, one scientist noted that “what I have learned from them is that they really care about their work and I respect what they do, that they are an important part of the system.” Another respondent noted the value of relating to people in a one on one way and showing respect for their work: “One of the most effective forms of science I've found is cooperative research, where a scientist goes to speak with a fisherman, and they have very heartfelt talks in the wheel house while they're doing the science." Overall, the concept of respect tied closely with people treating others with respect for the jobs they were doing. For example, one shared "I think I've gained more knowledge, more respect for scientists and for how hard some of them work. And for how hard they really try to do right for a whole collective process" while another noted "This is our profession, this is what we went to school for, this is what we do daily. And it really can be taken personally, when you have an advocate just pounding on why this has to be done." These activities can also be a source of consternation when disagreements do arise. For example, one respondent shared the observation that "I've seen people be so rude to each other, it's astounding. When they disagree over the science, they have to personally attack each other" and another noted a negative experience from an event reported back to them: "He impugned my integrity in a place that I couldn't defend myself." Overall, the concept of respect is summarized well by one respondent's comment on the importance of recognizing across all that "they're just people trying to do a job."

Lastly, the concept of trust was repeated often when respondents talked about their experiences interacting with others or about how trust was needed in the processes. For example, one respondent noted "no one wants to look in the mirror and say, 'If we don't have a communication problem, we got a trust problem. People don't trust our results.'" Others discussed incidents that broke trust or contributed to a lack of trust across groups highlighting things like "it takes a long time to rebuild trust once it's been violated" and "it takes a while because collaboration, embedded in that word is relationships, embedded in that word is trust, and that takes time." Others did not explicitly use the word trust but talked about the ability to find ways to work together that were notionally based on the ability to find some element of trust.

Discussion

Cash et al (2003) discuss the importance of "active, iterative, and inclusive" efforts to *communicate* between experts and decision-makers, mutual understanding between experts and decision-makers through *translation*, and when needed active *mediation* of conflicts with a particular relevance of mediation to the concept of legitimacy. In addition, regular interaction builds trust and ultimately believability if structured well (Susskind, 2014). The building of trust through regular interaction is also key in dispute context as those relationships can be leaned upon to work through disagreements before they escalate (Susskind, 2014). These concepts are underscored by the findings in this research.

There are benefits and challenges mixed in together when it comes to cross-sectoral engagement activities. While one is exposed to others and other ways of thinking, this can serve to open new ideas or further solidify perceptions and stereotypes. There is also a risk that those who participate with little self-awareness might make matters worse. Similar concepts have been raised by other scholars, for example in the idea that humans tend to be easily "blind" to our own hypocrisy even while feeling that the faults and hypocrisy in others is clearly visible (Hochschild, 2016).

Additional challenges include the issue of size in designing a process as Levin et al. (2013) note that while cooperation can emerge "spontaneously" in small groups of participants, it is likely to "break down in larger groups, where social networks are harder to maintain" (Levin et al., 2013). Others argue that having interests in common is an enabling characteristic, increasing the likelihood of success of collaborative processes in environmental decision-making (Wondolleck

& Yaffee, 2000). When deciding what type of process to use, it is critical to think about what the goals are (Creighton, 2005).

Being in a room together and interacting also creates the processes by which perceptions can change and discussions can move forward (Thaler & Sunstein, 2008). Cross-sectoral engagement opportunities provide opportunities for these changes to occur when they are carefully structured. A potential challenge exists, especially when a venue such as those described here is the first time an individual or group has been given a chance to be heard. There is often an element of "airing if grievances" that needs to be accounted for before productive discussions can move forward. Building relationships is key in these settings as there is a difference between having a chance to speak, being listened to, and being heard. One respondent noted the evolution of seeing those that initially seemed part of the "other" as part of their own group through working together in these activities.

Cross-sectoral engagement opportunities are also valuable in the context of wider negotiations and dispute contexts as well as in thinking about the conduct of science to support decision-making. Figure 6.1 provides a notional graphic of various potential levels and types of engagement across groups. It is meant to show that low or lopsided engagement creates smaller "value" or creative decision-making space than at higher and more uniform levels. While accommodating a wide set of interests and perspectives can be challenging, it can also provide valuable space to generate new creative solutions. Ultimately there needs to be a robust process and structure to balance these challenges.

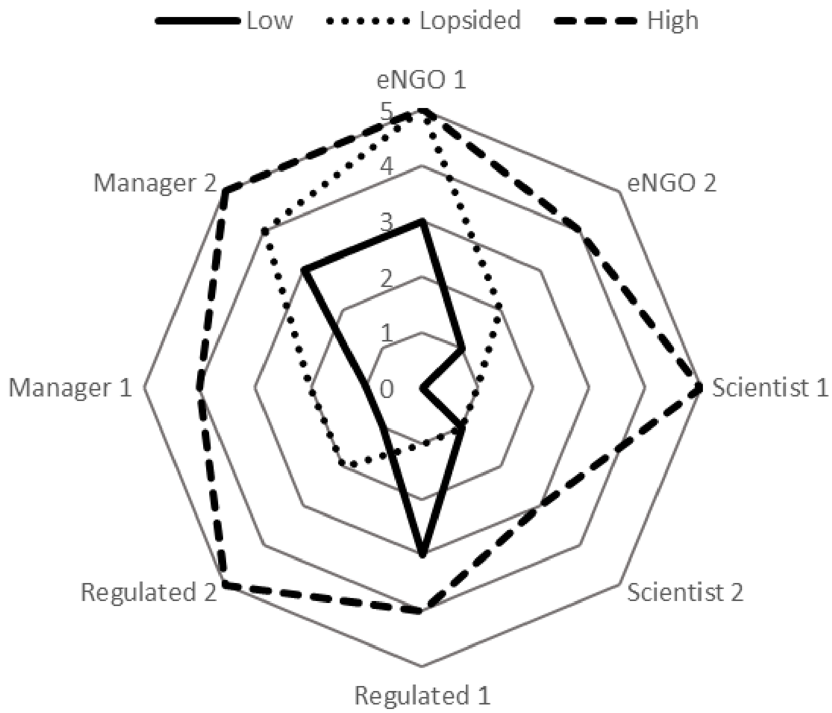

Figure 6.1. Conceptual model of creating value based on differing levels of engagement.

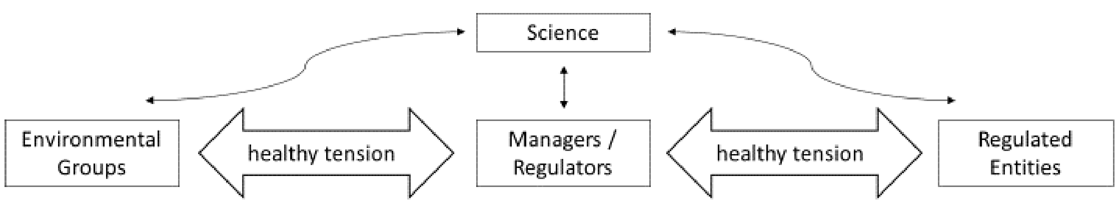

Figure 6.2. Conceptual model of the healthy tension between different perspectives and the role that science can play in interacting with and supporting all sides.

Figure 6.2 builds on the idea of creating value and the concept of healthy tension across groups (that conflicts aren't necessarily all bad). This includes an idealized view that collaborative processes can support science that is built off of and contributes to the needs of all parties. In this model, science is not sitting squarely within the purview of one group or being used as a cudgel between parties, but rather it is collectively serving the larger needs of the system.

Cross sectoral engagement activities become places to come to collective or shared understanding of the context to hopefully get closer to same page before info is presented to the wider public and/or before a decision is made. Cross-sectoral activities tie to building relationships (part of mutual gains) and part of separating the people from the problem (principled negotiation).

The content of these activities makes up a significant focus of process design and preparations of participants, but locations can be an important component as well. As noted earlier, the overwhelming majority of activities described by respondents were hosted in conference rooms. While important for many aspects of the science – policy interface, it must be acknowledged that these are settings that are home turf to a certain subset of the group, primarily managers. Developing true collaboration through improved relationships would also need to account for the different settings that are most comfortable for certain subgroups – whether that is on a boat, in a lab, at a waste water treatment facility, or elsewhere depending on the group – these settings are part of what makes different groups more or less comfortable and can contribute to perceptions of value placed in their perspectives. In addition, meeting in different venues can also contribute to creative solutions that might not otherwise become apparent. As part of conducting the confidential interviews for this research, I asked respondents to select their preferred location. While several interviews were conducted by phone, most where at the workplace of the respondents or a location of their choosing. This enabled me to see a slice of their world, the communities where they live and or work, and the places that they feel comfortable. One manager that I interviewed noted that they "always prefer the dock" when seeking out opportunities to engage with others. Taking time to meet and engage at those different places is valuable as it shows others that their work is valuable enough for others to take the time to show up and learn about their world.

As Susskind and Field (1996) point out, one key challenge is that each public interaction is not just about the issue at hand, but also carries with it the weight of what has come before and what people are concerned will come after. When public officials and in some cases scientists are not prepared for or fail to take into account the past history in the immediate case or other similar ones, they are not likely to be believed by the public they are seeking to engage with and they risk exacerbating distrust and conflict (Susskind & Field, 1996). Conversely, when public engagement processes are designed to account for and where possible acknowledge the past issues (including the possibility of past bad actors), there is a greater likelihood that they will be perceived as successful (Susskind & Field, 1996). Each negotiation or engagement carries with it the scars of past and the hope for the future.

Conclusion

Susskind and Field reminded readers in 1996 that the feeling of alienation of the general public from government intuitions leads to desires to upend our whole system of government. These same sentiments and concerns ring equally true today. Based on their studies of and participation in public disputes, Susskind and Field (1996) frame anger as a "defensive response to [real or perceived] pain or threat of pain" and advocate for a rethinking of corporate and government approaches to interacting with the public. This idea of anger as a driver along with the idea that the most powerful interests we have are the basic human needs of: "security, economic well-being, sense of belonging, recognition, and control over one's life" (Fisher et al., 2011) we can see the recipe for what scholars have warned – a fundamental breakdown of trust in public institutions. Failure to acknowledge these can be part of what causes public engagement processes to become exceedingly contentious and in some cases can cause the efforts to fail which can have lasting impacts on both the social and ecological components of these systems.

There is real opportunity for a new set of relationships across public institutions (government and academic) and the public they are designed to serve. Engagement with the general public can contribute new scientific knowledge through a range of mechanisms including (but not limited to) developing new and novel questions, access to data previously unknown to researchers, and integration of qualitative data and observation with experimental data, and engagement can also lead to increased relevance of findings, support for conclusions drawn from the research, and broader community awareness of the scientific process and the issues at stake (National Academies of Sciences Engineering and Medicine, 2016). There is an increasing focus not only on the engagement of the public in the formal decision-making process, but also in the design, interpretation, and application of scientific studies in all sectors (Cash et al., 2003; Ferguson et al., 2016; Karl et al., 2007; National Research Council, 2008a). NRC argues that there has been sufficient study of public participation processes to learn and seek to design and implement effective approaches. That said, continued research is needed to assess, adapt, and reflect on processes as they go forward (National Research Council, 2008b).

Susskind & Field (1996) argue that by viewing public engagement as a "multi-party, multi-issue negotiation," those involved in designing, implementing, and participating in these efforts should approach them differently than most lawyers, public relations professionals, business professionals, and agency staff have been trained (formally or informally) in the past. Often people engage in public participation fora to stake a claim to a position which puts them in an intractable spot (Fisher et al., 2011). If instead participants joined more direct engagement efforts, there might be the opportunity to focus more on interests and the creation of new ideas. The idea of "'can you live with it?' Not, 'do you like it'" as a bar for solutions also comes into consideration as does a focus on "desirable and achievable change as opposed to absolute consensus (Zurlini et al., 2008). "[C]ollaboration is epistemically beneficial because it enables knowledge to be developed and used by many people in different fields, and that research in which more people direct their attention to the same puzzles tend to provide more desired results as well as better error detection" (Andersen, 2016).

Taken together, this all points to the relevance of incorporating knowledge from a range of social science disciplines into both the design of public engagement in management processes, but also into the design of research projects and the communication and engagement elements during the conduct of research, not just at the end. Consideration of this body of knowledge has the potential to greatly increase the use of social and natural science in management decision-making with likely benefits for all.

CHAPTER 7

CONCLUSION

"Now is no time to think of what you do not have.

Think of what you can do with that there is."

- Hemingway, 1952

Introduction

Scholars across the spectrum of issues related to social-ecological systems call for an acceleration of efforts to understand social-ecological systems and to use all manner of tools to do so (Bennett et al., 2016; Chen, 2015; Cigliano et al., 2016; Dyball & Newell, 2015; Heberlein, 1988; Parsons et al., 2014). Many point out the long history of calling for this type of research and the frustrating lack of progress in adopting systems approaches and interdisciplinary efforts (Dyball & Newell, 2015; Heberlein, 1988, among others). "[N]o one person can have expert knowledge of the whole of a complex social ecological system" and as such, collaboration is essential (Dyball & Newell, 2015).

There has been a call across the research and management community for "new flexible, integrated, holistic forms of management and governance that can deal with the complexity of social-ecological systems and their associated service" (Cvitanovic et al., 2015). In order to support these "flexible, integrated, holistic" approaches, research that acknowledges the interconnectedness of social-ecological systems is needed. Using the frames of social-ecological systems, science for sustainability, and conflict and negotiation, this research focused on addressing the question: ***How do cross-sectoral engagement opportunities influence science intensive disputes over the management of coastal and ocean resources?*** through analyzing two cases in New England - marine fisheries management (Northeast Multispecies Complex aka groundfish) and estuarine water quality management (Great Bay, New Hampshire).

Summary of Findings

Findings from this research were presented in three analyses, informed by in-depth understanding of the context of each case (see chapter three). By examining the potential role negotiation theory can play in better understanding these dispute cases (chapter four), it becomes possible to see other drivers for the disputes that expand out beyond just science and include resource allocation and impact questions that are influenced by the science in these and other related cases. This can also be used to enable participants to look for new approaches in how they interact with the science but also with other parties when viewed as a multiparty, multi-issue negotiation. Understanding how science is used (chapter five) within the existing processes as well as whether there is interest in and potential for more collaborative approaches also opens up doors to think about how science can have a better seat at the table (or a seat at all in cases where it has been excluded). Lastly, understanding the impacts of engaging across groups (chapter six) provides important insights to learn from each other, but also about the possibilities of designing approaches that more readily address the needs of participants and issues at stake. There continues to be a need to focus on using the best available science, while also acknowledging that the iterative nature of science can be a source of conflicts. These findings show that cross sectoral engagement efforts can help science be viewed as more credible, legitimate, and salient while also exposing more people to the practice of science, ideally increasing trust and therefore improving science without getting mired in unnecessary conflict.

When done well, cross sectoral engagement activities help to develop relationships, open lines of communication, expand individual and collective understanding of the issues at hand (not driven by just one group view). They also create space for creative solutions. While decisions will ultimately still need to be made and "value claimed" processes that enable a more complete picture and an expansion of the ideas at the table will ultimately be more resilient and adaptive in the face of change. These approaches can be hampered by poor process design, power imbalances, lack of resources, use of legal tools in adversarial as opposed to collaborative approaches, limited familiarity with potentially beneficial approaches from negotiation (mutual gains and/or principled), and lack of training and/or exposure to other perspectives or ways of thinking. Figure 7.1 further explores these concepts through a conceptual model of interactions across the scientific, management, and regulated communities and their relation to different approaches to research and engagement.

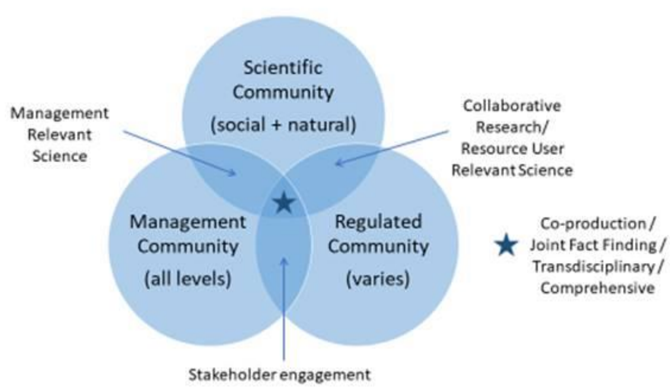

Figure 7.1. Conceptual model of interactions across the scientific, management, and regulated communities and their relation to different approaches to research and engagement.

Recommendations

The cases presented in this research have significant history and invested actors. While respondents were asked what they would do if they could completely clear the slate (an unrealistic proposal), few noted that they would want to go back and fully change the system. While there are incidents and issues that they would approach differently in hindsight, there was an overall feeling that the structures in place set up the opportunity to do what needed to be done. It's not possible to go back and change the past, but it is possible to assess the landscape and look for paths ahead within the bounds of where these and cases like them have been. Several generalizable recommendations based on this work include:

- Enhance systems thinking and nesting of issues within their larger context. For example, in the two cases presented here, broader use of the *State of our Estuaries* report and the *Status of the Ecosystem* reports might serve to underscore the interlinkages between system processes within and across the social and ecological components.
- Conduct mutual gains and principled negotiation training more widely, including with scientists to explore the view that science discussions and other settings are negotiations and it is possible to be more prepared.
- Increase use of existing data from multiple sources. This can serve to increase the understanding of the system, but also increase perceived credibility and legitimacy.
- Ensure that funding structures and academic hierarchies reward collaborative approaches.
- Continue to move away from the deficit model of education and engagement to one that engages more productively and on more equal footing across parties.

- Managers should acknowledge other impacts and be transparent when management action is being taken because it is the most expedient way to bring change as opposed to the only impact. For example, in the two cases presented here, there was a sense that going after WWTF and after fishermen is the easiest thing to do. It may be the most expedient management lever even when there are other impacts.
- Consider mediation as a first step in collaboration approaches versus a last-ditch effort. Use the tools of legal training but to build value, not tear the system apart.
- Consider the needs for predictability in management and science. In both cases analyzed here, the negative repercussions of “surprises” were felt because both cases need predictability – one for taxpayers (are they going to have to upgrade again?) and one for fishermen/industry (what can they target / market, etc.).
- Consider how managers and scientists are trained and the role of supervisors and mentors in exposing new actors to developing an understanding of the system. Early exposure to those who have different views can be foundational in developing an ability to work together and find solutions in the future. A large portion of respondents noted that they first attended an event or activity with participants from a range of groups because they were told to by a boss. It would be beneficial for people to attend these events as part of their schooling when there is more opportunity to explore.

This work also points to more specific recommendations relevant to each case, highlighting the value of conducting in-depth research within each of these systems. While not presented here, case specific recommendations will be shared back with interview respondents as well as made publicly available as part of case summaries published at a later date.

Challenges

When we hold scientists up as wholly objective and value neutral, entire disciplines are put at risk. One glimmer of a scientist with an opinion, and opponents of the side they fall down on can use that to attack their whole line of work, if not the rest of their discipline. Alternatively, if more consideration were given to scientists as social beings that exist within a broader context and more acknowledged within and outside the scientific sphere, perhaps it would become easier for scientists to engage in policy and public debates without risking their careers and the reputation of their field. It may be easier to claim bias or fraud when the purpose the science was conducted is not clear than when that purpose is put out in the open. There might still be questions, but the acknowledgment might serve to increase trust. This is certainly an area of possible inquiry to examine whether "truth in advertising" or rather honesty in purpose would increase trust in science. The very choice of the things we chose to study includes values, but we need to ensure that process by which we study it is defensible.

In the context of interdisciplinary research, Khagram et al. (2010) highlight three core areas that need to be addressed in order to effectively collaborate: "the types (forms and functions) of theories, the underlying philosophies of knowledge, and the combination of research styles." They argue that "oversimplified distinctions" across disciplines and practices are an impediment to interdisciplinary environmental research, these including the distinctions between "qualitative/quantitative, deductive/inductive, normative/descriptive, subjective/objective and theory/practice" (Khagram et al., 2010). Instead they suggest focusing on how to understand the differences and bring efforts together. Others use the parable of the three blind men and the elephant story (all think it is something different). Differences can lead to complications such as missing the forest for the trees, but they can also be the source of new insights that each alone might miss (Dyball & Newell 2015, p35).

Decisions can be based on "sound science" and still take into account politics. The elusive focus on "sound science" precludes the discussion and acceptance that values do come into play and also clouds the fact that neither scientific inquiry, nor policy making are entirely rational processes (Karl et al., 2007). It is within that context that scholars and practitioners present and encourage collaborative approaches, including joint fact finding, as a way to account for these nuances, while still bringing science to bear on these important decisions (Karl et al., 2007; Ozawa, 2009; Ozawa & Susskind, 1985; Susskind, 2014; Susskind & Field, 1996; Susskind, Field, & Plumb, 2009).

There is certainly much interest in developing collaborative solutions to science intensive disputes, but it may be that the interest is centered within certain sectors and not translated to others. This opens the door for thinking more broadly about the role that education, training, and public engagement play in these areas. For example, are business majors, lawyers, political science, and public administration students also being exposed to these ideas? Are they included in agency training and professional development efforts? There appears to be a real opportunity to change the mindset of how public disputes are addressed, but it can't change with one-off application of new approaches that are bound to a select few scholars and practitioners.

When dealing with social-ecological systems, there is also a tension between advancing academic fields and theories and "solving" or "rendering manageable" the problems. This has implications for the use of science and the connections with perceived credibility, legitimacy, and salience (Cash et al., 2003). The path ahead needs to include the acknowledgement of this tension when designing processes and structures that seek to account for it (Andersen, 2016; Khagram et al., 2010).

One of the challenges with the structure of how scientific disciplines evolve between what Kuhn described as "normal science" and "revolutions" is the fact that at any given point only a few members of a given field share the "new cognitive resources" that are emerging into a new way of doing things (Andersen, 2016). As such, the move towards collaborative approaches and interdisciplinary work, while shared by many, is not recognized as "normal science" and therefore still faces the struggle of being considered legitimate scholarship in some circles. That said, given the timeframes that we've seen discussion of interdisciplinary approaches for social-ecological systems in the literature, it would seem we would be further along.

While there is a place for theoretical and conceptual development, an over reliance on reward for developing new instead of testing old has incentivized a proliferation of solutions to the interdisciplinary challenge that may seem overwhelming to practitioners. There is a tension inherent in the current approach to science that pulls between the need to advance scientific fields and disciplines, but also applying what is already known to pressing societal challenges. In addition, since many practitioners are not incentivized to report their approaches in scholarly journals, the literature may be missing a large swath of knowledge about how these approaches are implemented in practice.

As academic disciplines push the boundaries of what their own theories, methods, and even questions can address, it is inevitable that the edges of the disciplines become looser and scholars and practitioners alike seek ideas from new places. This is particularly true in research and practice regarding social-ecological systems as we grapple with efforts to understand the nature of the world and the approaches to addressing the challenges of the present and future. While this means that new ideas are formed, it also creates challenges in tracing the history and robustness of certain lines of inquiry and approaches. While some critique this as a flaw, others embrace it as the evolution of thought and the opportunity to explore new areas. As the lines become blurred, we are faced with a conundrum: embrace the evolution or seek to enforce strict boundaries between ways of thought prevalent in certain disciplines and in applied settings.

Conclusion

> *"Although there are no simple "best practices" that provide universal guidance in designing participation, there are principles and "best processes" that can enhance the effectiveness of participation."* (National Research Council, 2008a).

The above quote sums up one of the primary ways I see this research contributing to larger societal challenges. Specifically, I see the findings of this research contributing as follows:

1) Advancing understanding of dispute systems in coastal areas
2) Providing context for stakeholders and policy practitioners working in these areas

3) Providing recommendations that will be shared with the audiences involved:
    a. Regulated communities in thinking about how they want to participate in regulatory processes and how they want to engage with academic and non-academic researchers
    b. Funding agencies in thinking about what to ask of their grantees
    c. Natural and social scientists (regardless of institutional location) in thinking about how best to engage across sectors
4) Training me as an effective researcher and practitioner and training undergraduates in systems thinking and interdisciplinary approaches

Ultimately, I see this research contributing to the larger dialogs on the intersection of science and public policy in the context of complex social-ecological systems.

There are many lessons that can be drawn from this research for the systems analyzed, for others like them, but also for me personally. This research has exposed me to new ways of thinking, developed new and honed existing skills, and raised new questions. I met fisherman, resource managers, municipal staff, scientists, and others throughout this project and the overwhelming sense that I got is that they're all trying to do their best, but they continue to be skeptical of each other and of each other's motives. I was left with optimism in both cases that there are opportunities for improvement, but also felt frustration at entrenchment of certain views, and a sense of unwilling to view the world from different angles in some.

A benefit can be seen in work that is oriented towards real world challenges and results that are tied towards direct application to those challenges. Risks include that the “reward” structure of academia is not set up for it (Andersen, 2016), but others argue that use of research is rewarded in academic circles (Ferguson et al., 2016) which may counter the perceived limits to other outputs like publishing.

An additional challenge in how we think about “science” and interdisciplinary work comes from the fact that much of the seminal scholarly literature on the practice of science stems from the 1960s and 1970s and is focused on disciplinary science and how they evolved over the preceding two centuries (Andersen, 2016). Given the important role that collaboration and interdisciplinary research has come to play in the ensuing half century, it is time also to revisit and rethink these “philosophical analyses of the structure of science and its development” (Andersen, 2016).

Ultimately, this research seeks to contribute to a better understanding of how efforts to engage across groups may impact science-intensive disputes over coastal and ocean management and - where appropriate - provide recommendations to adjust approaches to seek to build resilience and create more durable solutions to move forward through disputes in these systems.

Both cases presented here are examples where science was saying something was going on, but no action was taken (80s/90s for groundfish, 90’s/2000’s for Great Bay) – some of those same managers are around, but some aren’t. There is a lesson here to take action when you can and not punt as action is so much harder when you’re in a deeper hole. Action would have hurt earlier, but it would not have been in crisis mode and could have been spread out a bit over time? Now it feels like crisis mode, exacerbated by limited resources and deteriorated relationships. There is also a lesson for other cases is to work to keep relationships strong, work together to take action, before crisis mode.

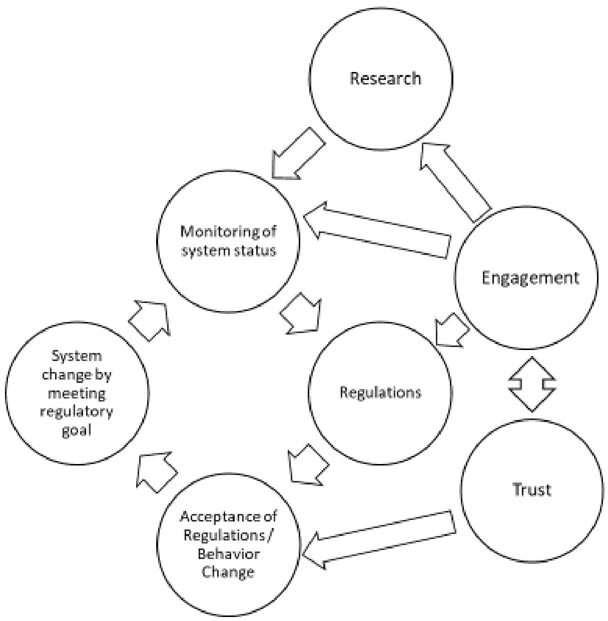

Figure 7.2. Conceptual model of the interaction of science, management, and engagement in complex social-ecological systems.

The tools are there for interdisciplinary and transdisciplinary work, what remains is the willingness to apply them and the willingness to train new scientists to work across sectors and fields. Disciplinary specialization continues to be important, but when it is supported to the detriment of interdisciplinary work, the whole system loses (Heberlein, 1988). Done well, interdisciplinary and transdisciplinary research is highly relevant to applied settings because of the nature of being driven by questions from the management community. This is also evident in the understanding of the importance of credibility, legitimacy, and salience of science described by other scholars (Cash et al., 2003) and explored in this research.

While there are challenges to doing this type of work (funding, training, etc.), there is also great opportunity for policy relevant, applied, "comprehensive" research to change the way science is used in social-ecological systems. Through multiple models and approaches to better integrating the practice of "science" into these management settings, we not only have the opportunity to address pressing, complicated challenges, but to also expose more people to the role that science can play in helping to address these challenges. The power of collaboration is evidenced in the enhanced ability to identify a broad range of factors relevant to a research or decision problem, including critical explanatory details (Ferguson et al., 2016).

We can also learn lessons that might benefit public participation from the negotiation literature if we think broadly of public engagement in environmental decision-making as a multi-party, multi-issue negotiation (Susskind & Field, 1996). For example, looking at the elements of principled negotiation might benefit how public engagement processes are approached. Specifically, the four elements outlined by Fisher, Ury, & Patton (2011) as part of principled negotiation are of particular relevance in social-ecological systems. Scientific input and joint processes can also serve to resolve and in some cases avoid escalating conflicts over resources. In particular, the elements of direct interaction and trust building are considered key to negotiation and are likely to have direct relevance to public engagement in social-ecological systems too.

Cash et al., (2003) underscore that without changes to our approach to the interface between knowledge and action we will continue to accelerate along the bath to "degradation of human life and the earth system." We know the stakes, and we know the way ahead, it's incumbent upon us all to move out of the silos and understand the interconnected social and ecological system that we are all a part of. With that understanding, we can pursue our unique and individual roles in it, but we must ensure our actions, knowledge generation, and decision approaches are all undertaken with that larger system in mind. The importance of "integrated knowledge systems" has already been accepted in other sectors like "agriculture, defense, and health." It's time that the environmental sciences and studies sectors accept that as well.

Systems concepts all acknowledge that there is an interconnected nature to all that we do. While there is the need to put bounds around what we study or the policies we make, we must acknowledge that these connections exist. Recognizing inter and trans disciplinary work as a source of legitimate contributions to the understanding of these systems and the solutions to complex problems is one step towards moving all these systems to a more robust, just, and resilient state. This is not to say that there is not immense value in understanding things from a single disciplinary perspective, quite the opposite. Those trained in the minute details of a particular discipline are also essential to the way ahead, but they must also understand that there are other valuable ways of knowing and other valuable sources of information outside of the academy and outside of western scholarly thinking. That is not to discount the contributions of these scholars, but to couch it in a larger system that is more complex than any one discipline alone can account for. To truly tackle the challenges facing social-ecological systems, we must have an all hands on deck approach. That doesn't mean that all hands have to do all tasks, but rather that all are in it together.

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APPENDICES:

A. INSTITUTIONAL REVIEW BOARD APPROVAL (ORIGINAL AND MOD)

B. SEMI-STRUCTURED INTERVIEW GUIDE

APPENDIX A. INSTITUTIONAL REVIEW BOARD APPROVAL (ORIGINAL AND MOD)

University *of* New Hampshire
Research Integrity Services, Service Building
51 College Road, Durham, NH 03824-3585
Fax: 603-862-3564

13-Sep-2017

Williams, Lindsey
NRESS, Mc Connell Hall
45 Mast Rd
Dover, NH 03820

IRB #: 6754
Study: Coastal Conflicts and Cross-Sectorial Engagement: Learning from Disputes Over Science in Coastal and Marine Resource Management
Approval Date: 13-Sep-2017

The Institutional Review Board for the Protection of Human Subjects in Research (IRB) has reviewed and approved the protocol for your study as Exempt as described in Title 45, Code of Federal Regulations (CFR), Part 46, Subsection 101(b). Approval is granted to conduct your study as described in your protocol.

Researchers who conduct studies involving human subjects have responsibilities as outlined in the document, *Responsibilities of Directors of Research Studies Involving Human Subjects.* This document is available at http://unh.edu/research/irb-application-resources. Please read this document carefully before commencing your work involving human subjects.

Upon completion of your study, please complete the enclosed Exempt Study Final Report form and return it to this office along with a report of your findings.

If you have questions or concerns about your study or this approval, please feel free to contact me at 603-862-2003 or Julie.simpson@unh.edu. Please refer to the IRB # above in all correspondence related to this study. The IRB wishes you success with your research.

For the IRB,

Julie F. Simpson
Director
cc: File
Safford, Thomas

University *of* New Hampshire

Research Integrity Services, Service Building
51 College Road, Durham, NH 03824-3585
Fax: 603-862-3564

02-Feb-2018

Williams, Lindsey
NRESS, Mc Connell Hall
45 Mast Rd
Dover, NH 03820

IRB #: 6754
Study: Coastal Conflicts and Cross-Sectorial Engagement: Learning from Disputes Over Science in Coastal and Marine Resource Management
Study Approval Date: 13-Sep-2017
Modification Approval Date: 01-Feb-2018
Modification: Changes per submission 1/31/18

The Institutional Review Board for the Protection of Human Subjects in Research (IRB) has reviewed and approved your modification to this study, as indicated above. Further changes in your study must be submitted to the IRB for review and approval prior to implementation.

Researchers who conduct studies involving human subjects have responsibilities as outlined in the document, *Responsibilities of Directors of Research Studies Involving Human Subjects.* This document is available at http://unh.edu/research/irb-application-resources or from me.

If you have questions or concerns about your study or this approval, please feel free to contact me at 603-862-2003 or Julie.simpson@unh.edu. Please refer to the IRB # above in all correspondence related to this study.

For the IRB,

Julie F. Simpson
Director

cc: File
Safford, Thomas

APPENDIX B. SEMI-STRUCTURED INTERVIEW GUIDE

Section I: Intro

1) Very briefly describe how you got involved in [groundfish management in New England, water quality management in Great Bay].

2) How would you identify yourself professionally (ecologist, fisherman, regulator, etc.)? - self describe, then pick just top two/three (in order).

3) Which of the following most closely aligns with how you view your role? [If struggle with picking one, ask to order them]
A: Government; Non-profit; Academic; Private sector
B: Resource user/regulated community; Manager/Regulator; Scientist; Other (ask to define)

Section II: Dispute Exploration (inc. use of science)

4) Overall, how do you think things are going in [groundfish management in New England, water quality management in Great Bay] right now?

5) Could you describe a time when [groundfish management in New England, water quality management in Great Bay] was or is at its best? Probe: Why do you think that is? How do you think science helped or hindered that?

6) Could you describe when [groundfish management in New England, water quality management in Great Bay] was or is at its worst and what you think lead to that? Probe: How do you think science helped or hindered that?

7) Can you describe a time when you think science was used effectively to make decisions about [groundfish management in New England, water quality management in Great Bay]? Probe: Why do you think that is?

8) What about a time when science was not used effectively [to address management needs]? Why do you think that is?
Probe: Can you reflect on the idea of uncertainty versus error in science?

9) Can you describe a time when relationships among all the different groups of people in [groundfish management in New England, water quality management in Great Bay] were or are at their best? Probe: Why do you think that is?

10) What about a time when the relationships were or are at their worst? Probe: Why do you think that is?

11) On a scale of 1-5, how divisive do you think the disputes over [groundfish management in New England, water quality management in Great Bay] are right now? (1 = not divisive, 3 = midpoint, 5 = very divisive)

12) I understand there have been a number of lawsuits by different parties, can you reflect a little on what you think leads to initiation of the lawsuits?

13) [for those who conduct or support research] Does working on an issue with the potential for conflict impact how you design or conduct your research?

Section III: Cross-sectoral engagement

14) Have you participated in events and activities that include other stakeholders or sectors related to [groundfish management in New England, water quality management in Great Bay]? Probe: Can you elaborate a little? What are some examples of activities you've participated in?

15) Would you say that you participate in activities like this:
    a. Never (0)
    b. Once (only 1 event ever)
    c. Rarely (2-3 times/year)
    d. Sometimes (4-5 times/year)
    e. Often (6+ times/year)

[Section prompt] for the following questions, if possible, please indicate which event/activity you are referring to when answering.

16) When did you first participate in [specific cross-sectoral engagement activity]?

17) How did you learn about [specific cross-sectoral engagement activity]?

18) Why did you decide to attend/ participate in [specific cross-sectoral engagement activity]?

19) In what type of settings were the activities you participated in conducted/hosted? Probe: Inside, outside, hosted by certain organization?

20) What was your biggest take-away from participating in [specific cross-sectoral engagement activity]?

21) How did [this experience/these experiences] impact how you interacted with (ROTATE ORDER):
    A) Government managers/regulators
    B) Government scientists
    C) Non-profit/NGO managers / policy staff
    D) Non-profit/NGO scientists
    E) Academic scientist
    F) Resource users

22) Do you think you applied these lessons to your interactions at different times (right away, a few years later, long-term)?

23) If you had to rate how your participation impacted your interactions with others on a scale of 1 to 5, what would it rate? (1 = no impact, 3 = some impact, 5 = significant impact) Probe: Did it change relationships in the short term? In the long term?

24) Do you think the experience impacted how you are perceived by colleagues? By other people you interact with?

25) Can you think of any examples of how [cross-sectoral engagement activity] changed your perception of the people in the system?

26) Can you think of any examples of how [cross-sectoral engagement activity] changed your perception of the problem in the system?

27) Can you think of any examples of how [activity] changed your perception of the science in the system?

28) Did [cross-sectoral engagement opportunity] reinforce your existing perceptions of the people in the system? How so?

29) Did [cross-sectoral engagement opportunity] reinforce your existing perceptions of the problem in the system? How so?

30) Did [cross-sectoral engagement opportunity] reinforce your existing perceptions of the science in the system? How so?

31) What do you think is different in the system because of efforts to engage across sectors?
Probe: Are they improved? Worse?
Probe/Alternate wording: Can you think of an example where [cross-sectoral engagement] had a direct impact (positive or negative) on the science in support of [groundfish management in New England, water quality management in Great Bay]?

32) Did [cross sectoral engagement activity] include any exercises where you played different roles? Can you describe that experience a bit?

Section IV: Policy Recommendations

33) If you had to use three words to sum up the state of [groundfish management in New England, water quality management in Great Bay], what would they be?

34) If you had to use three words to sum up the science being used to make decisions about [groundfish management in New England, water quality management in Great Bay], what would they be?

35) To what degree do you think the following items are impeding progress on [groundfish management in New England, water quality management in Great Bay]? 1 = not at all, 3 = some, 5 = major impediment [CHANGE ORDER OF READING]
    a. Scientific uncertainty

b. Stakeholder engagement [too much or too little - ask which]
c. Regulatory structure
d. dispersed governance
e. Narrow focus on issues (ask to elaborate)
f. Other items (ask to elaborate)

36) If you could change one thing to improve [groundfish management in New England, water quality management in Great Bay], what would it be?

37) If you could change one thing to improve the science behind [groundfish management in New England, water quality management in Great Bay] what would it be?

38) Could you describe one thing you'd want to see stopped, one thing you want to see continued, and one thing you want to see started in [groundfish management in New England, water quality management in Great Bay]? Probe: Anything specific to the science?

39) If you could clear the slate on how [groundfish, water quality] is managed, would you change it and if so how? If not, why not?

Part V: Respondent Characteristics/ Demographics

40) How do you finance your time to participate in activities we discussed earlier? [Open ended first then confirm]: Federal, State, Municipal, Non-profit, Industry [private sector], Volunteer/not paid

41) Have you ever been part of a lawsuit specifically related to this issue [fishery, water quality]. Can you elaborate?

42) Have you submitted a public comment to state or Fed agency (in person or in writing?)

43) Have you served on a community board or agency panel, etc.?

44) Were these activities before, during, or after you participated in [cross-sectoral engagement opportunity]?

45) Is there anything else about your past that you think draws you [toward or away from] cross-sectoral efforts?

46) Demographics questions: City, State of residence; City, State of employment; Age; Years experience

47) Are there other individuals you would recommend I reach out to? Those who share a similar view to you? Those who you think would have a different view?

48) Anything you were expecting me to ask or that you wished I'd asked?