SUBSTANCE AND DEPTH IN FISHERIES MANAGEMENT:

ENGAGING HAWAIʻI SMALL BOAT FISHERS TO MITIGATE PELAGIC SHARK MORTALITY

A THESIS SUBMITTED TO THE GRADUATE DIVISION OF THE
UNIVERSITY OF HAWAIʻI AT MĀNOA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

IN

NATURAL RESOURCES AND ENVIRONMENTAL MANAGEMENT

MAY 2019

By

Mia A. Iwane

Thesis Committee:

Kirsten L. L. Oleson, Chairperson
Mehana Vaughan
Kirsten Leong

Keywords: West Hawaiʻi, fisheries management, shark conservation, conflict, problem definition, power

Acknowledgements

I thank the insightful women of my thesis committee, Drs. Kirsten Oleson, Kirsten Leong, and Mehana Vaughan, for their expertise and professional guidance on this journey toward and beyond my Master's thesis. I am also grateful for my fellow members of the Oleson Lab, who lent their support and feedback on many presentations to share this work with diverse audiences.

I am very grateful to my research participants, who welcomed me into their community, their homes, and their boats. Generously, they shared their patience, trust, and stories with me, becoming valued teachers to this student. It has been an honor of mine to work with them and to share their perspectives with others.

Thank you to Dr. Melanie Hutchinson, Mark Royer, and other members of the Shark Tagger team, for allowing me to observe and participate in their work. And, for being important advocates for this work in circles it would not have otherwise reached. You have given me a voice I did not realize I had.

I thank the National Oceanic and Atmospheric Administration's (NOAA) Pacific Islands Fisheries Science Center and the Joint Institute for Marine and Atmospheric Research for supporting my graduate assistantship over the past two years. For funding this research, I thank the NOAA Cooperative Research and Bycatch Reduction Engineering Programs.

Even before this research began, countless mentors from the fishing, research, academic, and management communities played critical roles in shaping my passion for this work and helping me to navigate it more gracefully. I thank them, and hope they know what they gave to me.

Finally, I thank my family and friends, who offer their endless support in every way I could hope for. Without them, I would not be where I am today.

Abstract

Fisheries management problems are complex, yet simplified, technical problem definitions often inhibit the management regimes that seek to identify and resolve them. This leads to management solutions that fail to address underlying conflicts and exacerbate social and political inequities. I explore opportunities to engage fishers to address these failures. This work finds footing in a case study of interactions between small boat fishers and pelagic sharks. Semi-structured interviews and a community-based shark-tagging project with small boat fishers on Hawai‘i Island illuminate fishers' relationships with one another, fisheries managers and scientists, and the sharks they encounter. Using a theoretical framework that mobilizes theories of conflict and problem definition, I find that the shark-fisher interaction problem is layered. It is shaped both by substantive factors, like shark behavior and economic context, and deeper-level problems, including degraded fisher-manager and fisher-researcher relationships, threats to fisher identity, and poor fisher perceptions of management legitimacy. Thus, endeavors to mitigate shark mortality require an equally multi-depth solution with substantive, process-, and relationships-based approaches. Such a multi-depth solution might include collaborative research for alternatives to lethal shark-handling practices, wherein fishers and scientists reconcile dissonant values and problem definitions and exchange and co-produce knowledge in pursuit of a transparent goal; and scientists communicate early and often with fishers both directly and using the fishing community's existing social structures. These lessons and the framework used to incite them have applications wherever diverse actors seek solutions to complex, layered problems with variable definitions, in natural resource management and beyond.

Table of Contents

List of Tables

List of Figures

Chapter 1

Introduction

Natural resource management problems are complex, yet the management regimes that seek to identify and resolve them are often inhibited by simplified, technical problem framings. Many state resource management agencies are partial to these problem framings. Agency employees may prefer problem-specific, quantitative, technical information to provide a depoliticized representation of the problem (Young et al. 2016). The integration of socioeconomic data with often-preferred biophysical models leads to somewhat improved understandings of resource problems (Stephenson et al. 2017). But, regardless of focus on social or natural systems, "*radically simplified designs… seem to court the same risks of failure*" (Scott, 1998, p. 7). This is because as our understanding of social and natural systems is simplified for their legibility by managers and policymakers, so are our solutions. As a result, "*The 'letter of the law' is met, the spirit of the law is not. That is a warning about needing to design the law with the whole system, including its self-organizing evasive possibilities, in mind*" (Meadows, 2008, p. 137). The systems-level complexity of natural resource management problems must instead be embraced to improve solution innovation and robustness (Aswani et al. 2018; Palsson et al. 2013).

Natural resource management often neglects issues of power and access as key system components. As state agents judge the reliability of knowledge by its production in a "scientifically objective" political vacuum (Young et al. 2016), underlying social and political conflicts and the stakeholders who endure them may be excluded from the management process. In fact, inattention to the social and power relations that shape a conservation management issue may critically compromise its goals (Clark & Slocombe 2011; Dickman 2010). Technocratic models are rendered inadequate as management problems take various substantive and symbolic forms across stakeholder groups. These models would fail to capture, for example, that wolf protectionist policies could symbolize the assertion of federal power over land management or the preservation of American wilderness (Nie 2001). Left unaddressed, these underlying cultural and political perceptions of management problems defy the assumptions of technical models to the detriment of management objectives (Ginges et al. 2007; May 2013). Reaching beyond simplified, technical framings of natural resource management problems is essential to seeking their resolution.

The process of defining a fisheries management problem represents an opportunity to recognize issues of power in its decisions about who and what to include. Here, the word "process" draws attention to the deliberate design of a series of procedural actions leading to some outcome; in this case, the definition of a problem. A problem definition is "*the organization of a set of facts, beliefs, and perceptions – how people think about circumstances*" (Weiss 1989, p. 118). Defining the problem is an analytical process in policymaking; a first step that dictates how solutions can be developed (Dery 2000; Nie 2001). However, problem definition is also a value-laden, political process as it elevates some narratives and the interests that propel them, just as it mutes others. Narrative dominance and actors' access—or ability to restrict others' access—to management discourse

represents an assertion of power (Bennett 2019; Chapin 2004; King 2010). Dominant problem narratives in resource management, however, may neglect stakeholders' alternative conceptualizations of a problem, which are then omitted from management solutions. Narratives might generally define the problem in terms of resource scarcity (Penney et al. 2017) or people-versus-nature dichotomies (Aswani et al. 2018; Richmond & Kotowicz 2015), missing finer-scale contexts important for fisheries management. Even more narrowly defined problems might neglect important context, focusing for example on certain metrics for species abundance where other metrics could illuminate alternative solution pathways (Leong et al. 2007). Developing solutions can thus benefit from negotiating diverse problem narratives through an inclusive process, and recognizing the values and perceptions that shape them.

Stakeholder engagement is often used to include more diverse perspectives and expand fisheries management problem framings and solutions beyond their technical constraints (Beierle 2002; Mikalsen & Jentoft 2001; Sayce et al. 2013). The process of stakeholder engagement may produce normative benefits to society, improving democratic opportunity and equity for marginalized groups. Common goals of stakeholder engagement include trust building and engaging underrepresented populations (Mease et al. 2018). Stakeholder engagement may also improve access to stakeholders' knowledge and perspectives (Beierle 2002). Increasingly, fisheries scientists and managers are aware of the practical value of fishers' experiential knowledge and perspectives in managing fisheries resources (Reed et al. 2006; Wendt & Starr 2009). Given their intimate relationship with the marine environment, integrating fisher and scientific knowledge can help to develop more successful management strategies tailored to local conditions, where the implementation of scientific knowledge alone would likely fail. Often considered anecdotal, fisher knowledge also offers unique insights to technical scientific endeavors such as stock assessments (Neis et al. 1999). By failing to recognize and apply diverse knowledge types to fisheries problems, Mackinson and Nøttestad (1998, p. 482) posit, "*not only are we missing half the picture, we are also in danger of reinventing the wheel*". They also describe fisher insight as valuable for improving the cost-efficiency, comprehensiveness, and approval rating of fisheries science and management. The latter plays an important role in fishers' perceived legitimacy of management and regulatory compliance (Hønneland 2000). Thus, stakeholder engagement offers both normative and practical benefits to resource management.

Attention to sociopolitical dynamics, however, is critical to reap the benefits of stakeholder engagement. Without it, endeavors to include stakeholder knowledge and perspective often fall short of their theoretical benefits. Failure to address power relations during participatory processes may exacerbate, rather than ameliorate, issues of equity (Akbulut & Soylu 2012). Public hearings, for example, are a popular stakeholder engagement tool used to fulfill the legal public input requirements for U.S. government organizations (NEPA, 1970). The implementation of such engagement tools, however, left to the decision-making and capacity of NEPA-abiding agencies, may result in ineffective and stakeholder-inaccessible processes (Mease et al. 2018). Thus, management tools designed to improve democracy may simply redistribute power in a fishing community, and exacerbate political conflict (Béné et al. 2009). Instead of relying on tool-based stakeholder engagement, Reed (2008)

calls for engagement with a foundation in process rooted in trust, equity, and learning, and guided by explicit goals. The process should be inclusive of affected stakeholder groups, supported by facilitative capacity, and with transparent decision-making (Mease et al. 2018; Reed 2008; Vaughan & Caldwell 2015), where face-to-face dialogue and incremental successes lead to shared understanding (Ansell & Gash 2007).

In this study, I engage fishers to explore opportunities to improve exclusive, scope-limited problem framings and their respective solutions through a case study of fisher-shark interactions in West Hawai'i small boat fisheries. By making fishers' experiences and perspectives available to scientific and managerial communities, I hope to generate guidance around engaging fishing communities and reducing shark mortality from fisher-shark interactions. This guidance will lead to problem definitions and management solutions that better address problem complexity and are more likely to garner support from local, small boat fishers. In subsequent sections of this Introduction, I describe the theoretical framework I apply to understand the layers of depth in management problems and solutions; detail the selection and relevance of my study site and fisheries issue; and define my research objectives.

Theoretical Framework

I examine fisheries management problem definition and solution development using the theories of conflict adapted to conservation management by Madden & McQuinn (2014). Together, these theories offer a unique theoretical lens with which to study problems and solutions in fisheries management more deeply. They illuminate problems beyond the superficial dispute, accounting for historical context and issues of identity, and call for solutions that wrestle with process and relationships in addition to substance. In doing so, these theories create space to address facets of fisheries management problems that lie outside technocratic problem framings. Specifically, as I explain below, I use the Levels of Conflict model (CICR, 2000) to interpret the layered ways fishers perceive fisheries management problems. I then situate potential solution elements within the Conflict Intervention Triangle to evaluate their compatibility with levels of the defined problem (Madden & McQuinn 2014). Below, I first present Madden & McQuinn's applications of the Levels of Conflict model and Conflict Intervention Triangle, then describe my own modifications to them as I apply them to this work.

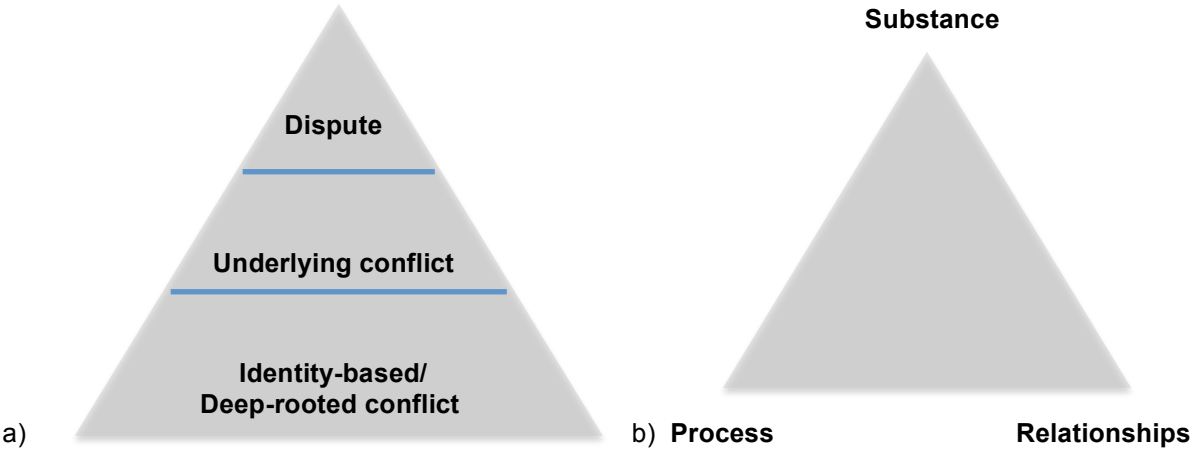

Figure 1. Depictions of (a) the Levels of Conflict model, adapted by Madden & McQuinn (2014) from CICR (2000, 73); and (b) the Conflict Intervention Triangle model, which illustrates sources of conflict and the dimensions of conflict intervention suited to transform them, adapted by Madden & McQuinn (2014) from and Moore (1986) and Walker and Daniels (1997: 22).

Levels of Conflict

The Levels of Conflict model (CICR 2000) identifies three levels of conflict. The first, which sits atop the model's stacked pyramid, is dispute-level conflict (Figure 1a). Dispute-level conflict is understood as the central, presenting conflict, and is usually related to its material elements. An example of dispute-level conflict might be deciding the boundaries of a protected area. Madden and McQuinn (2014) explain that, *"Conflicts can exist solely at the dispute level, but more typically a dispute is also the surface expression of deeper levels of conflict*." Descending into the model's deeper levels of conflict, the conflicts become less tangible. The second level of conflict—underlying conflict—includes involved actors' unresolved disputes, which provide relational and historical context to the presenting dispute. Underlying conflict is attentive to actors' past interactions, which inform the way they navigate current disputes, whether or not they are directly related. An example of underlying conflict is animosity between actors based on past management decisions. The third level of conflict is deep-rooted, identity-based conflict. This level of conflict derives from actor values, culture, and identity, and arises when actors perceive threats to those identities. Deep-rooted, identity-based conflict might arise, for example, from resource users perceiving management as a threat to their autonomy.

Conflict Intervention Triangle

Levels of conflict identified using the CICR 2000 model ideally inform the depth of corresponding conflict interventions. In Madden & McQuinn's Conflict Intervention Triangle (2014)—adapted from Moore (1986) and Walker and Daniels (1997)—substance sits at the triangle's apex, and process and relationships sit at the basal corners of the triangle (Figure 1b). Substance, process, and relationships in the Conflict Intervention Triangle represent the dimensions of both sources of conflict and the interventions to address them. Notably, process and relationships occupy the same level in the triangle, indicating their equal importance. Process refers to, "*decision-making design, equity and authority, and how (and by whom) these are exercised"* (Madden & McQuinn 2014), allowing us to explore relations of power. Relationships refer to those between individual actors or

stakeholder groups, and the levels of trust and respect entwined in them. Madden & McQuinn (2014) describe substance-based conflict interventions as appropriate to address dispute-level conflicts, with process- and relationships-focused conflict interventions better equipped to address underlying and identity-based conflicts. An intervention at one depth applied to conflict at another may fail to address or even exacerbate the initial problem (Ginges et al. 2007; Webber et al. 2007).

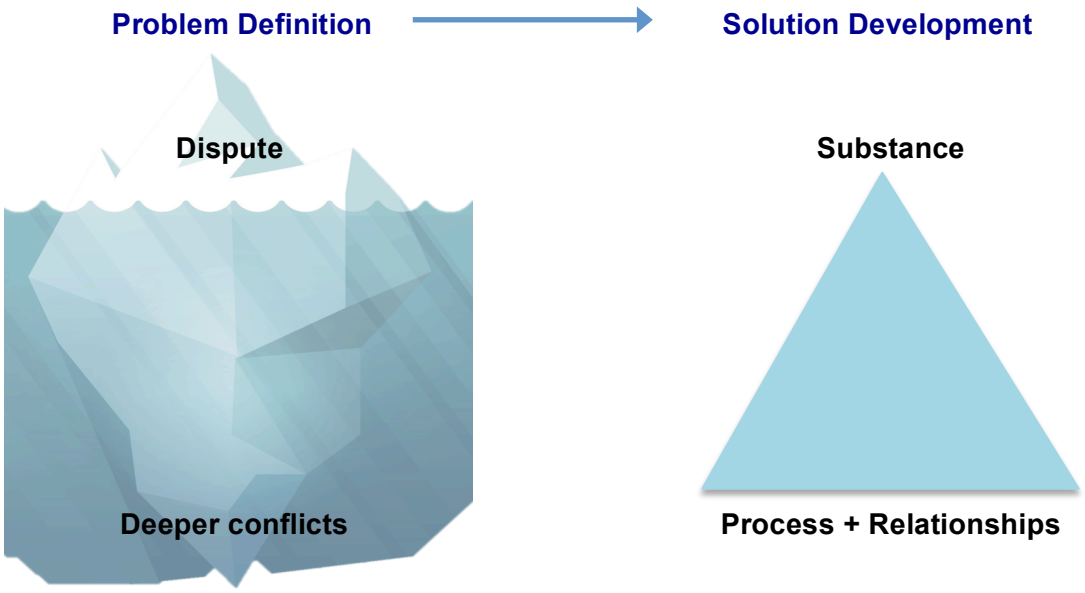

Figure 2. This study's theoretical framework adapts Madden and McQuinn's (2014) conflict theories to examine the processes of problem definition and solution development. I adapt the Levels of Conflict model (left) to understand management problem definitions, and the Conflict Intervention Triangle (right) to develop solutions at the appropriate level. I effectively collapse underlying and identity-based levels of conflict into one problem category, and process and relationships into a single solution category.

Applying conflict theory: Problem definition and Solution development

Madden and McQuinn use the Levels of Conflict model to analyze conflict depth, and the Conflict Intervention Triangle to develop solutions that address various levels of conflict. Researchers have referenced Madden and McQuinn's (2014) model primarily in investigations of human-wildlife conflict and its underlying social conflicts, which merit further attention by management and policymakers (Crespin & Simonetti 2019; Dorresteijn et al. 2016; Hill 2017). I apply these frameworks similarly to study fisher-shark interactions and deeper social and political conflicts between fishers and fisheries management actors. My adaptation of the framework departs from others', however, as I examine the way fisheries management defines its problems and develops solutions (Figure 2). This allows me to examine depth in conflict between actors themselves, but also explicitly in the way their perceptions and definitions of fisheries management problems misalign. Drawing from the literature on problem definition, I explore actors' access and influence in fisheries management discourse, and the way derived solutions evolve with the inclusion of fisher perspectives. Because process and relationships occupy equivalent levels in the framework for solution development, the hierarchy of

underlying and identity-based conflict is not important. Therefore, for the purpose of this work, I refer to underlying and deep-rooted conflict together as “deeper conflict.” Like Madden & McQuinn, I posit that the depth of an effective management solution (or conflict intervention) should align with the depth of the management problem. I expect that substantive solutions alone cannot adequately reconcile the deeper conflicts associated with fisheries management problems, and that deeper conflicts necessitate process- and relationships-based solutions.

I use this adapted theoretical framework to engage with the deeper levels of conflict in defining fisheries management problems and pursuing its solutions. This supplements, rather than devalues, dispute-focused resource debates for a dynamic, multilevel approach to resource management. In illuminating depth in problem definition and solution development, I also explore the ways in which power and access shapes fisheries management discourses. My theoretical framework solidifies around a case study of fisher-shark interactions in the West Hawai‘i small boat fleet.

Problem and Site Selection

A case study of the West Hawai‘i small boat fishery and their pelagic shark interactions, bound by geography, fishery, and a specific management problem, provide a nucleus around which my theoretical investigation solidifies. I interviewed small boat fishers based out of the western side of Hawai‘i Island to supplement limited scientific understandings of fisher-shark interactions in Hawai‘i, add diversity and depth to the definition of this fisheries management problem, and illuminate solutions of equal multidimensionality. At the time of this project’s inception, a recently proposed rule to list the oceanic whitetip shark (*Carcharhinus longimanus*) under the Endangered Species Act (ESA) garnered support for a study around fisher-shark interactions in Hawaiian waters, and its unsettled status created a favorable environment for fisher engagement. In its proposed rule, the National Marine Fisheries Service (NMFS) highlighted significant declines in oceanic whitetip shark abundance throughout its habitat range due to overexploitation (Young et al. 2016). NMFS cited a variety of fishing pressures, including incidental shark bycatch, shark finning, and retention, as the primary drivers for these declines. Midway through the interview process, in January of 2018, NMFS published its decision to finalize the oceanic whitetip shark’s threatened ESA status. NMFS is now tasked with developing a recovery plan for the species. Its first public workshop for the Pacific region was held in April 2019.

While the oceanic whitetip shark is of particular interest in this study due to its recent ESA listing, I broaden my study scope to include pelagic sharks in general because preliminary “talk story” sessions with fishers revealed that oceanic whitetip shark encounters might be fairly uncommon in the fisheries that handle them. Additionally, ignoring mentions of interactions with other shark species would neglect a valuable opportunity to address wider shark conservation issues. Thus, this research provides an opportunity to explore alternative problem definitions and deeper conflicts in the context of mitigating pelagic shark mortality through local fisheries management.

Though the oceanic whitetip shark’s finalized ESA listing and subsequent management measures will likely focus on pelagic high-seas fisheries which inflict high bycatch and mortality rates (Bonfil, 1994; Gilman et al. 2008), there is anecdotal evidence of harmful shark-handling practices in

the Hawai‘i small boat fleet. More importantly, the small boat fisheries of Hawai‘i offer accessible perspectives that capture histories of local fisheries management and science. Working with a subset of this fishing community to understand how they navigate and conceptualize shark interactions and fisheries management processes may elicit lessons in fisher engagement and reducing shark mortality with wider applications.

Several conditions prime the West Hawai‘i small boat fisheries for this case study. The West Hawai‘i region is home to various fisheries research and management efforts. These include the West Hawai‘i Regional Fishery Management Area (WHRFMA), which extends from North Kohala to Ka‘ū (South Point) and encompasses four Marine Life Conservation Districts (MLCDs), seven Fisheries Management Areas (FMAs), and one Bottomfish Restricted Fishing Area (BRFA). Each of these areas has its own regulations, but the WHRFMA generally restricts SCUBA spearfishing and the take of reef sharks and rays (State of Hawai‘i Division of Aquatic Resources, 2019a). Aquarium fishing has been suspended since October of 2017, pending the completion of environmental reviews and an Environmental Impact Statement (EIS; State of Hawai‘i Division of Aquatic Resources, 2018). Several nongovernmental organizations (NGOs) with West Hawai‘i-local (Malama Kai Foundation, Lost Fish Coalition, Kula Naia Wild Dolphin Foundation) and international (e.g., The Nature Conservancy, or TNC) reputations operate in lobbying capacities, contributing to such management measures (Tissot et al. 2009). West Hawai‘i is also a NOAA Habitat Blueprint area, and a focus area for the Pacific Islands Ocean Observing System (PacIOOS) Hawaiian Islands Sentinel Site Cooperative (SSC). All of these inform the West Hawai‘i fishing community’s perspectives on local science and management endeavors.

In addition to its history of fisheries research and management, the calm waters of West Hawai‘i have also encouraged the growth of a fishing community that is diverse in terms of fishing method, the relationship between fishing activity and fisher income, experience level, and ethnicity. Coupled with the fishery’s size, its diversity is conducive to a bound, in-depth examination of its sociopolitical relations. Its calm waters also enable its fishers to accumulate a relatively large number of fishing days per year and quality hours of observation. This positions the West Hawai‘i fishing community well to provide insights into pelagic shark interactions and shark behavior (particularly that of the oceanic whitetip), for which little data has been collected with regard to the Hawai‘i small boat fleet.

Finally, fisher participation in this work is encouraged by their desire to reduce shark-fisher interactions, as shark interactions appear to be largely incidental and associated more with economic cost than benefit. Therefore, the development of viable strategies to reduce shark-fisher interactions would be a positive outcome for virtually all stakeholders. A relatively low-cost qualitative study that promotes collaborative pursuit of an ultimately non-regulatory solution bodes well for the funding limitations of both scientific research and fisheries enforcement (Tissot et al. 2009).

Research Objectives and Questions

The objectives of this study are to a) explore opportunities for fisher engagement to examine the processes of defining problems and developing solutions in fisheries management, and b) apply

the theoretical framework to engage with deeper conflicts and develop innovative solutions that may improve management outcomes. My research questions are underpinned by conflict theory, but grounded in a case study of shark-fisher interactions and fisher engagement. They are as follows:

1. How and at what depth do fishers define fisher-shark interaction and management problems?
2. How might managers develop solutions to better address depth in problem definition? What role might fisher engagement play in defining and resolving multi-depth problems?
3. What insights can we gain by applying this theoretical framework (adapted from conflict theory) to fisheries management?

I expect that problem definition will differ depending on the fishing individual. I also expect that the processes of problem definition and solution development typically neglect fisher perspectives and focus on dispute and substance, neglecting deeper conflict to the detriment of management objectives and the relationships between fishers and fisheries researchers and managers.

Methods

This study takes a qualitative, inductive approach, addressing my research objective and questions through a case study of West Hawai‘i small-scale fisheries. This exploratory work seeks to answer research questions while avoiding preconceived notions of answers. I collected data primarily through semi-structured interviews. Interview data were supplemented with observational data, collected on an opportunistic basis.

Human Subjects Review

I obtained Institutional Review Board clearance for this human subjects research through my Graduate Assistantship (GA) at the Pacific Islands Fisheries Science Center (PIFSC) under exempt project 19449, Socioeconomics of Western Pacific Fisheries. All consent forms, raw data, and transcripts are stored either electronically on a password-protected, encrypted hard drive, or physically in a locked filling cabinet where building and room access is limited.

Data Collection

Data collection began in September of 2017 when colleagues and mentors at the PIFSC organized preliminary meetings for me with members of local fisher-oriented NGOs, and fishing and social science communities. One of my colleagues, Dr. Melanie Hutchinson, was instrumental in this process as she connected me to participants of her Shark Tagger project, a community-based shark-tagging effort that enlists the help of West Hawai‘i fishers to deploy tags on pelagic sharks. These preliminary, unstructured “talk story” sessions allowed me to identify initial research participants, develop an interview guide, and solicit advice about how to broach potentially sensitive issues with research participants. Through these conversations I also defined criteria for my sampling universe: small-scale fisheries that interact with pelagic sharks. Following recommendations from my “talk story” sessions, additional research participants were identified through the snowball sampling method and public shark-tagging workshops. While workshop flyers distributed in Kona tackle shops and harbors and announcements in the local Hawai‘i Fishing News magazine provided information about Shark Tagger research and contact info to participate in an interview, no new research participants were

identified this way. Semi-structured interviews and snowball sampling continued until themes in the data reached saturation, concluding in June of 2018.

My interview guide and its revised versions (Appendix A) addressed my research objective and questions indirectly to allow co-direction of the interview and encourage relevant, but unexpected, themes to emerge. It addressed four broad themes:

a) participant relationship to fishing and fishing history;

b) information sharing in the fisheries of Hawai'i Island;

c) shark interactions and handling practices; and

d) fisher perceptions of local fisheries management and science.

Interview questions imbedded within these themes elicited insights including: a) Who interacts regularly with pelagic sharks?; b) What knowledge, experience, and values are relevant to fishers' interactions with each other, with fisheries management, and with sharks?; c) When are sharks more or less abundant? ; d) Where do these interactions occur?; e) What motivates fisher behavior?; and f) How can this information be synthesized to improve fisher engagement and reduce pelagic shark mortality? Interviews lasted 1-3 hours and were audio-recorded. I aimed to complete field notes within 48 hours of the interview, and made minor revisions to the interview guide as needed to accommodate emerging themes and improve interviewee accessibility to question wording (Appendix A). The evolving interview guide enabled me to pursue interesting patterns in the data during subsequent interviews. This inductive process typical of the grounded theory approach allowed interviewee data to produce an understanding of this case study's geographical and issue specificity. All audio files were transcribed manually and imported into NVivo software, provided to me through my GA.

I also collected observational data opportunistically on three occasions. On all three occasions, I participated as a member of Dr. Hutchinson's Shark Tagger research team. The first of these was a chartered shark-tagging trip on a commercial fishing vessel out of Kona. The latter two were public shark-tagging workshops held in October of 2017 and 2018, almost exactly a year apart. At both these meetings, the Shark Tagger team trained fishers in tagging protocol, distributed shark-tagging gear, and reported on the progress of both shark-tagging research and this study in fisher engagement. These observational data supplemented interview data with respect to fishing practices, exchanges between fishers, and fisher-scientist exchanges.

Data Analysis

All interview data were transcribed and coded using NVivo software. Content analysis on my interview data began with preliminary coding in NVivo during the transcription process. During the preliminary coding phase, my goal was to ensure that all relevant themes were represented in my codebook. I created new nodes for emerging themes liberally, nesting them when appropriate. This drafted coding scheme generally followed the major themes of my interview: fisher identity, sharks, info-sharing, and management. Content that fell outside these categories were retained in separate categories.

After the transcription and preliminary coding processes concluded, I reviewed the drafted coding scheme with greater attention to organization and relevance. I nested thematically related nodes under categories and sub-categories, combined similar nodes, and edited node labels to clarify their contents and contribution to the research. I added descriptions to those nodes whose labels remained ambiguous during this process. The resulting coding scheme included 24 umbrella nodes, with a variable number of node generations nested within them.

I then proceeded with a comprehensive coding phase, which served to capture all relevant transcript data within the nodes of my coding scheme. I reviewed each interview transcript again, coding excerpts to all of the nodes with which they resonated. New nodes were created as needed. Through this process a transcript excerpt could be coded for multiple nodes across categories, with nodes overlapping or separate across the text. After all 28 interviews were re-coded this way, I made another organizational pass over the coding scheme. The final scheme included 17 umbrella nodes. I numbered these such that those most closely related by theme fell within the same interval of ten.

In February of 2019, I returned to the study site to publicly present my results to research participants. Twelve interviewees attended, along with a larger number of shark-tagging collaborators. No oppositional comments were received with regard to the presentation framework, content, or the way it represented interviewees.

The rest of this thesis is organized as such: Chapter 2 follows the format and style of a technical memo in partial fulfillment of a reporting requirement to NOAA's PIFSC, which supported this research. The following results are reported in Chapter 2 in detail: a description of research participants; unique elements of fishing in Kona; relevant economic context; key elements of fisher identity; information sharing patterns in the fishery; and fishers' shark interactions and perceptions. Chapter 3 follows the flow of a manuscript intended for publication, using a subset of the data to examine the utility of my theoretical framework. Expanding on the contextual detail provided in Chapter 2, Chapter 3 draws also on themes of fisheries management, power in knowing and managing fisheries, and fisher engagement.

Chapter 2

In Chapter 2, I present detailed, minimally interpreted results for the following themes: Research Participants; Fishing in Kona; Economic Context; What does it mean to be a fisher?; Information sharing; and Sharks. These sections generally trace the flow of my codebook, which numbers its 17 umbrella nodes according to their subject material. Nodes that provide wider contextual information fall between 0-9. Nodes related to fisher identity and research participant demographics are numbered in the 10s; info-sharing practices in the 20s; and sharks in the 30s. I will report on nodes 0-30s in Chapter 2.

Nodes numbered in the 40s are related to fisheries management, fisher engagement, power, and knowledge, and will be used to illustrate depth in problem definition and solution development in Chapter 3. Node 50 highlights fishers' insights from outside of Hawai‘i. Finally, nodes numbered in the 90s serve tracking and indexing purposes for institutions, names, stories, and quotes.

Throughout the remainder of this thesis, numbers in parentheses will be used to indicate the number of interviewees who spoke to the topic in question. These numbers provide a general idea of themes' relative significance. However, the interview guide's solicitation of certain themes (e.g., information sharing and outreach) inflated some of these numbers, so they should not be interpreted as an accurate quantitative representation of their significance to interviewees.

Research Participants

Between September 2017 and June 2018, I interviewed 29 West Hawai‘i fishers. Participants' ages ranged from 19 to 75 years, and all were male. Two fishers were interviewed together; all others were interviewed individually. I met my interviewees in locations of their choosing. Most interviews were conducted in participants' homes or at the Honokohau Harbor, where many dock their vessels. Only one interview was conducted outside of the Kona area, on the island of O‘ahu. Regardless of interview location, research participants were identified by referral from other interviewees or project advisors, and for their participation in West Hawai‘i fisheries.

Research participants represented diverse experiences in the fisheries of West Hawai‘i in terms of personal geographies, years of experience, and fishing method. Over half of my research participants were born and raised on the island of Hawai‘i, with a majority of these hailing from its west coast; eight traveled to Kona from the continental U.S.; and the rest came from neighbor Hawaiian Islands. Individual interviewees had from five years to over six decades of experience in West Hawai‘i waters (for an average of 30 years per interviewee). Together, these 29 interviewees accumulated over 900 years of fishing experience in Hawaiian waters. This number is a conservative estimate, excluding years of shoreline fishing that predate boat fishing ventures, youthful trips taken before formal fishing careers, and rich fishing experiences inherited from generations past. Interviewees' participation in collaborative research and management-related fisher engagement was also variable, with most having limited experiences in either.

Nine interviewees currently captain charter vessels that operate out of Kona. Five of these also described their commercial fishing endeavors. For this reason I also include them in the total of

17 interviewees that fish commercially. Only three in this commercial fishing group self-identified as full-time commercial fishers. The remaining eight interviewees (who fit even less neatly into the charter and commercial fisher groups) are primarily recreational fishers, or are pursuing other non-fishing occupations after dabbling in or retiring from fishing careers. Of these, four described commercial or charter fishing at some point in their career. Across all these groups, 16 interviewees described non-fishing occupations that either supplement their fishing income, or serve as their full-time position. On average, interviewees described fishing for over 160 days per year in the peak of their careers.

The fishing methods described most frequently by interviewees were handlining (primarily ika-shibi; 20), trolling (21), and live baiting (18). Overall, though, the types of fishing in participants' repertoire were extensive. They included spearfishing, diving, greenstick, fishing in porpoise,[1] netting, jigging, dangling, longline fishing, and the additional handlining sub-categories of make dog and palu 'ahi. I describe those most practiced by interviewees in the next section. Interviews also covered a diverse range of target species, the most popular of which were bottomfish, 'ahi, marlin, and 'ōpelu. Other target species cited in interviewees' primary fisheries, past and present, included other pelagics like mahimahi, aku, and ono; reef fish both for consumption and sale in the tropical fish trade; Kona crab; and black coral.

Fishing in Kona

The small boat fisheries of Kona can be described by their fishing practices, the evolution of its participant community through time, and several unique aspects of its fishing culture and physical environment. In this section, I summarize interviewee insights that illuminate these themes. In its broad description of West Hawai'i small boat fishing culture and evolution, this section provides useful context for subsequent results sections.

Fishing practices

When asked to describe their fishing methods, many interviewees (17) described "*[doing] whatever I have to do to catch fish, that's what I do.*" Employing diverse fishing methods and participating in diverse fisheries was a matter of adapting to target species' seasonality and unpredictability: "*I did everything. Gotta be versatile, seasonal time, you know what I mean? Not biting now, you go do something else."*

Location

Fishers described their activity in various areas across the West Hawai'i coast. "The Grounds," an approximately two-mile ledge that runs from the Keāhole airport toward Maui, is a popular fishing region that serves those targeting both bottomfish and pelagics, depending on the

[1] Porpoises are not known to inhabit Hawaiian waters. The fishing community uses "porpoise" colloquially to refer to dolphin species. The daytime "porpoise" fishery, which targets ahi, likely follows Pantropical spotted dolphins. I will refer to them as such for the remainder of this paper, except when used in a direct quote.

current. A subset of commercial fishers described traveling to further, rougher Hawai‘i Island regions to fish, including South Point and Hilo. An even smaller subset of commercial fishers described fishing more distant areas like the offshore weather buoys, Cross Seamount (11), and even the Northwest Hawaiian Islands (2).

Fishing methods

Handlining is a fishing method used to target bottomfish and ‘ahi at various depths and times of day. One fisher explained that, “*Bottomfishing is anywhere from 50 fathoms to 150 fathoms. Where tuna fishing is all outside of 500 fathoms probably.*” While handlining, fishers deploy several lines off their vessels with bait or bags filled with chum. The latter are deployed with weights so that the chum can be released at-depth. The lines are then retrieved either by hand (as the name indicates) or using electric or hydraulic reels. Different handlining techniques can be differentiated by the size of their tackle, but generally, ika-shibi is practiced at night, and palu ‘ahi and make dog are practiced during the day.

Ika-shibi—the nighttime handline fishery which targets yellowfin tuna—was the handlining category described by the most interviewees, and the most frequently cited fishing technique overall. Ika-shibi fishers operate out of Hawai‘i Island’s west coast, and Hilo, though its participation in both regions has declined in the last few decades. This decline can be attributed to decreased fish abundance and the closure of Hilo’s suisan fish auction in the early 2000s, according to interviewees. The method is characterized by shallow baited lines, “*20 fathoms and up,”* which includes an unleaded float line, steady chumming, and squid attracted with lights, which in turn attract ‘ahi to the boat. Fishers describe the ika-shibi season peaking in the late summer to early fall months, despite fish being available outside this period. One fisher estimated that in the season’s peak, “*There’s nights where there could be like 30 to 40 boats. That’s a lot. Every night! But like, they’re only like maybe at the most quarter-mile apart*.”

Twenty-five interviewees described targeting bottomfish, whether generally or in their own practice. Its season peaks in the winter, and so for some, bottomfishing provides fishing continuity when the ‘ahi are less prevalent. Participants’ target species include snapper, like ‘ōpakapaka, onaga, and uku. Fishers also described targeting ulua and kāhala for charters, or in some cases kāhala for the Kona kampachi farm’s brood stock.

Trolling and live baiting necessitate constant motion as artificial lures or live bait, respectively, are towed through the water to attract target species. They are daytime fisheries that target mobile pelagic fishes like marlin, ‘ahi, and ono. Interviewees described using ‘ōpelu and aku as live bait. Fishers described trolling and live baiting around buoys, ledges, and in bait schools.

Culture

“Fishing is one culture, you know. It’s one big part of local tradition.”

Many of those who called West Hawai‘i home described growing up fishing, hunting, and partaking in other outdoor activities with family and friends. *“I guess coming from Kailua was a little village, everybody was fishing on the seawall you know. So I guess fishing was in my blood too,”* said

one interviewee. Other fishers described distinct cultures between the islands, juxtaposing this type of lifestyle against O‘ahu politicians’ “*O‘ahu mentality*”:

> *See all those pictures? That’s what we do, I been doing that since I was born. I have photo albums that are full, hunting pig, fishing, throwing net, catching Kona crab. That’s what we do to eat. These guys, ‘Oh yeah I went to Hy’s last night and I had a $200 lobster plate.’ That’s not subsistence fishing.*

Another fisher emphasized the distinct ecological and cultural function of Hawai‘i, and its therefore distinct fishery management needs. He expressed interest in local people holding positions in fisheries science and management for their ability to navigate their responsibilities with cultural sensitivity and an appreciation of fishing as culturally significant. And, he described what being a fisher means in Kona:

> *Even today like, you know all the young kids in Kona? They wanna own a boat… I mean, you know as a kid, people used to always, ‘*Oh, [fisher name]!’ *You know, they knew me as a fisherman. It’s like I didn’t play football or anything but I was still kinda popular ‘cause I was a fisherman. You know fishing was a big thing here. It’s not like O‘ahu where, you know what I’m saying? So, I have a lotta fishing friends. Big part of the culture here.*

Evolution through time: Participation, Technology, and Fish Abundance

Interviewees described an influx of fishers from neighbor islands and the continental U.S. to the West Hawai‘i fishery in recent years. A few long-time residents had dramatic comparisons of fishing fleet densities past and present: “*I remember when I was little… down at Kailua Pier there would be only like five, maybe 16-foot boats that would go fishing besides the canoes. Now on the weekends there might be at least 30 or 40 trailers here.*" Fishers identified several contributing factors to this increased participation, including the coast’s calm waters: *“‘Cause of the calm waters [you] can actually own a smaller boat that is affordable, and then still be able to catch a lotta fish.*” The availability of new fishing technologies through time and relatively few barriers to entry within state regulatory frameworks were also contributors. These all made entering the fishery more accessible and attractive to wider fishing demographics:

> *The equipment has gotten better, between the engines- we’ve got safety gear, we’ve got cell phones, people… feel safer, it’s easier, more reliable to be out in the water. It’s made it a lot easier for a lotta people to do it, even the people with not a lot of experience can feel like they could do it.*

In the quote above, and in many other interviews, technological advances were identified as beneficial for fisher safety and fishing efficiency. The advent of fish finders, depth recorders, GPS, electric and hydraulic reels, more efficient engines, and even new fishing methods (e.g., greenstick) all provided new advantages to the fishing population. “*So*,” said one fisher, “*mother nature has a*

hard time keeping up." Similar technological advances were described of the purse seine and longline fisheries, to which declines in fish abundance were attributed much more readily by interviewees. One fisher spoke of the arrival of foreign purse seiners to the area in the late '70s, before regulations were created to exclude them from coastal waters:

> *I know when I started fishing years ago, we had plenny fish…. I love to fish, I bought a bigger boat and started going out here and seeing all of those Japan purse seiners, France, they all was way inside, just killing it…. When I seen that, I gave up fishing, picked up another trade.*

Others traced purse seine activity explicitly to local declines in aku, and a subsequent shift from live baiting to trolling with lures. Others related declining fish abundance to displaced longline fishing pressure after the Papahānaumokuākea Marine National Monument was established (3). Other factors that interviewees described as contributing to declining fish abundance included state FADs no longer employing streamers, which translated to their holding less fish; coastal development which affected reef fish; and in one particularly specific case, the arrival of Galapagos sharks on floating debris which locally depleted kāhala and almaco jack. Regardless of the narrative, as one young fisher put it, "*[The stories of] people who've been here their whole lives doing it… Most of the stories are that there used to be more fish.*" One fisher similarly recounted the great abundance of the past:

> *Way back then was like, all you do was, you can troll straight line. You see splash there, splash there, 'ahi, 'ahi, 'ahi. You don't know where to go just go straight! (chuckles) Now, it's like, oh boy. Was that an 'ahi over there? I don't know. You hardly see.*

Another fisher, who hosted me in his home, high enough that the air was cool and misty, said:

> *If we were sitting here, if we had binoculars in the old days you could- that's the Grounds right there, you could see the aku schools from here. You could see the black spots you know where they were jumping… so much that they'd leave a big spot. You could see 'um from here, but not anymore.*

Visibility

Honokohau Harbor concentrates much of the fishing activity of West Hawai'i. Though not exclusively, most of my interviewees dock their vessels or fish out of Honokohau. The concentration of fishing activity in the harbor, a relatively small fishing community, and the homes perched on Kona's mountain slopes to overlook its waters all make for a uniquely visible fishery. For this reason, fishers interviewed in their homes could point seaward to show me where aku schools would jump, where buoys might be observed to determine if currents are running north or south, or where boats are congregating to indicate a good bite. At the harbor, fishers make note of their peers' trucks and empty boat slips, and because the community is small this might tell an experienced harbor-goer

where fish are biting and on what fishing gear. This visibility limits secrecy in the fishery, or perhaps calls for greater measures to protect it:

> *We're a high-profile boat, we're one of the bigger boats out there, and… They put two and two together real quick. Guys watch with telescopes on the mountain, we turn our lights off at night if we find a new area to fish, nobody knows about, we turn the light off man. Because it's not even the fishing boats, there's guys that are fishermen out here in Hōlualoa, lookin' out there, and they know that my boat has a red and white light or whatever, 'Oh that's _____, that's where he is,' so it's gnarly. Because then what happens, as soon as they find out? Boom, coconut wireless goes, 30 guys come.*

One interviewee chuckled at my confusion about how fishers might acquire strategic insights without dialogue. Whether from land or sea, the small boat fisheries of West Hawai'i are visible at many points in their operation.

Competition and Cooperation

The competitive dynamics of West Hawai'i small boat fisheries were described by 24 interviewees, and derive largely from the previously described increase in fishing participation. This increase in participation necessitates some competitive behavior to protect fishing opportunity and fisher livelihoods. Given that information sharing was a focal topic in the interview, most of these behaviors involved the guarding of fishing information, which I elaborate on in the Information Sharing section.

In some cases, the competitive motives of protecting fishing opportunity and income were compounded with issues of identity, values, and changes to the status quo. For example, one fisher spoke to conflicts that arose from the evolution of some charters' fishing methods and target species, which then created competition for fisheries that were in the past practiced exclusively by commercial fishers.

> *There's sometimes a little bit of animosity between the commercial and the charter guys…. especially now that a lot more charter boats are fishing live 'ōpelu in the koas and stuff like that, that some of the commercial guys get kind of ticked off. That they kinda feel like the charter boat's kinda cutting in on their action I guess.*

Others asserted that competition arose from "*charter guys [being] viewed more as a recreational guy… they already made their money on the charter so catching their fish is a bonus, where a commercial guy has to catch fish to make his income.*" This was aggravated by the state enabling charter fishers to sell their catch commercially; something that is illegal in other states' fisheries. Competition was also described as fueled by ego or cultural differences, and existing between fishers who identified as small-scale and industrial longline and purse seine fisheries, and between

commercial fishers and recreational or part-time fishers. Descriptions of competition on the market and with growing tourism businesses will be discussed further in the Economic Context section.

Some fishers described cooperative relationships as more prevalent prior to increases in fishing participation. But, despite these changes, interviewees described the fishing community as relatively harmonious (11), perhaps necessarily so given its size. Partly, though, this was attributed to groups like the charter and commercial fishers not being completely distinct: "*A lot of us commercial fished at one time in our lives… And we all charter, so the charter and the commercial fishery, everybody shares information with each other.*" Fishers described this harmony as transcending on-the-water conflicts:

> *It's funny. It's such a small community, small harbor. There are tensions, but there's not too many where it actually carries over once you're back on dry land…. We know sooner or later we may need that guys' help or something like that.*

Examples of cooperation included the graduated sharing of information according to personal relationships, lending assistance on the water or sharing catch with those in need, and generalized fishing etiquette or civility. For fisheries with very limited participation like the seamount fishery, cooperation was described as beneficial to individual fishers' efficiency. Even between the charter, commercial, and recreational fishers, cooperation is not uncommon:

> *If I'm out there lookin' for porpoise or something I run by and I see, and if there's fish up there… you call like, 'Yeah, there's fish there,'… Just so they don't have to run 30 miles to go check…. Or if there's a tournament and if they're not there and there's a lotta marlin there, 'Eh, my project out there's got some marlin hanging out, if you wanna go take that run up there and go look.' Kinda like help each other out that way.*

Economic Context

In this section, I summarize interviewees' descriptions of their fishery's economic contexts. I present these results according the following overarching themes: demand, market competition, increasing costs, and participation.

Demand

Interviewees described selling their fish locally as well as to the Honolulu fish auction, and to buyers who ship their catch outside the state of Hawai'i. One interviewee described the extensive market for Hawai'i fish:

> *There's buyers from the mainland, there's buyers from Japan, there's hundreds, maybe thousands competing for Hawai'i fish. 'Cause Hawai'i fish is considered one of the premium fish around 'cause it's fresh…. [it's] at a premium, because it's regulated health department-wise and all that. So everybody's competing for our fish*."

This diversity in fish product destinations, however, was not a result of saturated West Hawai‘i markets. One fish buyer described alternative pathways to keeping shelves stocked regardless of local supply: “*If times are really bad out there and they cannot catch anything, then I have to rely on wholesalers basically. Or go to Honolulu*.” Another described the variable origin of various West Hawai‘i fish buyers’ seafood:

> *All you have in Kona is Kona Fish. And you have Suisan but, well that’s the only two wholesalers they have. You have Garden Isle Seafood that came to Kona within the last two years, but no one sells fish to them ‘cause they don’t wanna pay as much as the other person… All their fish is imported. I mean comes from O‘ahu…. And even like Fresh Island Fish, they’re another wholesaler but all their fish is only from O‘ahu.... KTA, Sack ‘n’ Save, you know they buy local fish. So a lot of weekend fishermen, they’ll call the small stores first, so they can get a quick sale.*

With respect to sharks and shark products, fishers described demand (and their subsequent supply) declining through time following legislation that prohibited shark finning:

> *In the ‘90s when I had my bigger boat and we were fishing offshore, we were finning all the sharks we caught… But now nobody buys the fins anymore so, I mean there were people up until probably the early 2000 late ‘90s that were still buying fins…. But after that thing stopped, nobody even retained the sharks anymore.”*

The 2010 Hawai‘i state ban on possession, sale, trade, and distribution of shark fins followed President Clinton’s Shark Finning Prohibition Act of 2000, which banned shark finning in U.S. waters or by U.S.-flagged vessels (State of Hawai‘i Division of Aquatic Resources, 2019b).

Several interviewees described bringing sharks to market in recent years “*just to cover the cost*” when they landed nothing else. Even the local market for shark meat, however, could be elusive. Some fishers sold shark to a subset of West Hawai‘i buyers and to the Honolulu fish auction’s United Fish Agency, while others described the market as non-existent: “*There’s nothing to do with them. There’s nowhere to sell ‘em here.”* Interestingly, one local market ceased its sale of shark meat in response to shark conservation-type critiques from customers. One fisher noted that the market, “*Never had any kinda complaints about [sharks] being their ‘aumakua, anything like that… The person that complained about saving the world with sharks, is another type of person that’s a little bit more loud or… more vocal.*”

Market competition

Despite fishers’ descriptions of local demand exceeding the small boat fishery’s supply, many also described the challenges in maintaining a competitive edge on the market. Several fishers referenced the small boat fishery’s inability to compete with the longline fleet’s higher quality product

and greater political organization. Said one fisher, "*There's a high demand and it's a big money business, longliners and the auction block*." Several fishers also expressed frustration over market competition from part-time, recreational, and charter fishers, for their lesser reliance on fishing income but equal access to markets:

> *When you see these guys who have 9 to 5 jobs, they can afford the big fancy boats, they can afford all their shit, and on weekends they'll go out there and catch the same fish him and I are catching, and go sell it for the same price…. We don't have another second job to go to. This is our only one. So I think there's a divide on that.*

The market's accessibility also effectively lowers the market price and fishers' financial returns. The above quote's depiction of part-time and recreational fishers as having capital advantages and greater financial stability was a common perspective of commercial fishers. It was also frequently connected to discussions of commitment to place, where a fisher's "stake" included not only what proportion of income relied on fishing activity, but also his investment in the community or local resources.

Fishers described different strategies to combat increasing market competition. Some interviewees described targeting species for their improved cost-efficiency or provision of financial stability: "*I target like ʻōpakapaka, ono, you know, little bit smaller species. The market doesn't fluctuate on the price. It's a more steady price. ʻAhi can go 50 cents or $10, you know. And the paka's always 5 to 8.*" The importance of fisher-buyer relationships was also emphasized by several interviewees. One fisher described its benefit in, "*the long term, if you have a relationship with a good buyer that's very consistent in offering a better price."* Three commercial fishers described their transition to roles as fish buyers, either part- or full-time. One fisher described his new business, shipping product from the small boat fishery to California. He explained:

> *We're a dying breed…. We could never make it selling our fish locally. We had to create like specialized markets and make a brand for ourselves…. Every fish we catch, video goes to our buyer, these fishermen harvesting these beautiful fish. And so we get a little bit more money 'cause we sell a story with it. That's the only way we can stay in the game.*

Competition and a growing tourism industry also fostered diversification of the charter fleet, previously known almost exclusively as a big game fishery. Interviewees described charters targeting smaller fish to accommodate client families, or developing specific niches outside big game as a to maintain a steady flow of business. One charter captain added that diversification of Hawaiʻi Island's tourism industry generally has contributed to this challenge: "*There's ziplines, jet ski and parasail, and the manta dive and a whole lot more snorkel boats. So there's just a lot more competition for the tourist's dollar now, than there used to be.*"

Increasing costs

The challenges of market competition were exacerbated by increasing costs of gas, fuel, and ice (10); a trend which resulted in more than a doubling of fishing expenses since the late '80s,

according to one fisher. "*An average day,*" said one fisher, "*would be about $250, hands down. Just to go out.*" The price of fish was described not to have increased proportionally. One fisher noted their decrease: "*Everything went up and fish prices went down.*" One interviewee calculated the value of a shark in terms of fishing expenses:

> *I think if you asked every fisherman and you said, "How much would someone have to pay you to put a tag in it instead of a bullet?" I'd say a hundred bucks. You know 'cause a hundred dollars is 30 gallons in fuel. See, that's how we're gonna look at it. A hundred dollars is 30 gallons in fuel, it's three cases of palu, it's line, it's lead, it's tackle, it's whatever. That's how a fisherman's gonna relate to what that thing is worth to me.*

Participation

Increased fishing participation diluted fishing opportunity across a growing fleet. This, along with market competition, increasing fishing costs, and in some cases, increased regulation, led to "*old-timer*" commercial fishers resigning from fishing completely, downsizing their fishing operations, or searching for farther, less saturated fishing grounds. One interviewee considered the full-time commercial fishers of West Hawai'i extinct: "*There are none. Not on this island,"* he said, referring to virtually all of today's commercial fishers supplementing their income with other jobs.

What does it mean to be a fisher?

In this section, I describe some of the common characteristics across research participants. Several shared personality traits emerged from interviews, which I introduce briefly. I then identify what motivates interviewees to fish and the benefits they derive from fishing, before describing the effects of fishing on various aspects of human well-being.

Personality traits

Self-reliance

Self-reliance was a personality trait that appeared in many interviews (18). This theme included fisher partiality toward learning or operating independently, or simply maintaining the capacity to do so. For example, one fisher described the mechanical skills that his family retains for practical independence on the water:

> *I'm confident in the fact that if either of my boys went out and had issues, they could make it home safely. If something happens wherever they go, they can take care themselves…. You know the biggest thing that my dad taught me and my grandpa taught me is making it on your own because you can't rely on anybody.*

More often, fisher independence was closely related to discussions of information sharing, where after acquiring a certain amount of information or basic skills, independent experimentation was favorable: "*This young boy I'm taking fishing with me, I try and teach him… [he's] trying to figure*

it out yeah? For himself. Which you have to do. You have to find that balance." This departure from the fishing basics to developing fishing skills independently was often described as necessary to maintain an edge in the competitive fishing environment of West Hawai'i.

Stewardship

More than half of the interviewees self-described as stewards or engaged voluntarily in discourse around caring for fisheries resources. These were described in practical terms, for the sustainability of fisher livelihoods, but also related to the perpetuation of fishing culture and values. The latter included avoiding fish waste and appreciating the intrinsic value of fisheries resources:

> *I think the public a lot of times gets misinformed that all fishermen are just inherently evil, greedy, we wanna catch every last scale. And most of the time, I don't think people realize that in general, we're self-managing. We know for a fact we need the resource to last… I've got kids now... We want the fishery to be around for generations.*

Many times, as in the above quote, stewardship discussions arose as a defense against or in response to the depiction of fishers as greedy harvesters.

Curiosity

Fishers demonstrated curiosity or some hunger for fisheries resource knowledge during their interviews (12). These manifested through their own acuity for on-the-water observation, experimentation, and data collection, explicit requests for data collection tools and shark-tagging data, and descriptions of past participation in other collaborative research efforts. Often, fishers' curiosity was closely tied to their affinity for learning in and being challenged by a changing environment.

Bravado

Under this theme, I coded expressions of bravado from interviewees as well as their descriptions of bravado in other fishers (8). These included descriptions of boastfulness or aggression; the latter of which was given context in reactionary decision-making during fishing practice rather than in social situations. One interviewee described the bravado of other individuals in conflict with local identity and etiquette, which might be qualified by experience in West Hawai'i or ethnic identity. I titled a subset of this theme *Frontiersman* (5), under which I coded fishers' descriptions of their affinity for West Hawai'i because of its lack of regulation, or for fishing because of its opportunities in adventure and exploration.

Pride

Somewhat related to bravado, I used this theme to collect fisher expressions of pride related to their identities as fishers. Six interviewees contributed to this theme. They described a sense of fisher pride for their ability to provide for their families, for ancestors' and descendants' fishing reputations, for having sustained fishing participation despite its challenges, and for earning the respect of their peers and community members:

*Even today like, you know all the young kids in Kona? They wanna own a boat… I mean, you know as a kid, people used to always, '*Oh, ____!' *You know, they knew me as a fisherman. It's like I didn't play football or anything but I was still kinda popular 'cause I was a fisherman. You know fishing was a big thing here. It's not like O'ahu where, you know what I'm saying? So, I have a lotta fishing friends. Big part of the culture here.*

The remainder of this section traces fishing benefits that motivate fishers' practice, and challenges to fisher well-being.

Why fish?

Intangible fishing motives

"*Always learning. It constantly changes. You think you have it figured out, but, you don't… That's why I still love to fish*."

Interviewees described several non-tangible and tangible factors that motivate their fishing practice. The fishing motivation cited most often and by the most research participants (26) was pleasure. This category captured many of the non-tangible benefits that fishers derive from the fishing experience. Most fishers described a general love of fishing and enjoyment of the activity, but more specific benefits also emerged from their interviews. These included—in descending order of prevalence during interviews—attractions to the ocean; to the challenges of the fishing process which requires adaptability and continuous learning; to the mental relaxation it provides; to freedom from the restrictions associated with other occupations; to its opportunities to socialize with family and friends; and finally, to the thrill of catching a fish.

Tangible fishing motives

The second most oft-cited fishing motivation was money (20), whether to cover fishing expenses like bait, fuel, and ice, or to turn a profit for part-time or full-time career fishers. "*Now there, there's a good string, you see?*" said one fisher as he pointed to an old spearfishing photo, "*That's menpachi right there… That right there was August's rent (laughs).*" Other tangible fishing motives described by interviewees included sharing of catch, landing trophy fish, and food. Fishers described sharing catch with friends and family for special events like holidays, weddings, or funerals. In two isolated cases the sharing of fish was associated with shared fishing activity and community building, where, "*everybody comes and helps, everybody gets fish to eat*." These practical and social fishing motives recurred throughout the interviews, as did competitive motives. The pursuit and landing of trophy fish have particular relevance in West Hawai'i. One charter fisher described what keeps him fishing as, "*Having a business in a place like Kona. You know, the fishing's year-round here, and there's always a chance at a big fish…. And the fleet itself is a really good fleet. So, if you're at the top of this fleet, you're known around the world*."

Threats to human well-being

"*It's a hard life. It's a wet ass and a hungry gut, and it's somethin' you gotta love to do, not to get rich."*

Interviewees' layered fishing motives were described as either incentivizing sustained fishing despite its threats to human well-being, or sacrificed to preserve various elements of human well-being. These included financial security (21), physical well-being (15), and family (11). One full-time-turned part-time commercial fisher illustrated well the demands of a fishing lifestyle on human well-being:

> *A day to a fisherman is 24 hours. So, you know it's pretty much a 24-hour job, you grab what sleep you can and then you go. And it's a real, you know it's really taxing on the body and all that, and the part-time guys like me and stuff, we've got the experience and knowledge and stuff like that but you know, we can't even pay rent with the amount of fish we catch… I couldn't pay my rent with the amount of fish I catch now….*
>
> *It looks all romantic and everything and that's how it was for me in the beginning and stuff but when I look back on it- you go and you make some money and you get ahead, and you get a house, and you're making your house payments. You get a little money in the bank then the engine blows up, you're out $20,000 and you've missed two weeks of fishing, three weeks of fishing, a month of fishing, where are ya? You know it's just (laughs), it's like a way of life. It isn't a get rich quick scheme, and everybody talks about the rich fishermen and stuff with their nice trucks and all this but… it's kind of a myth….*
>
> *Some of the people over here that work really hard, they fish like maybe 4 or 5 days a week… You gotta have, you know, like a wife that can run your bait for you and kids that can help you and stuff like that, it's like, it's like a family operation, the guys that are making it.*

This fisher and other interviewees described family as a necessary support system for a successful fisher. Family life, however, was also described as being traded-off between certain kinds of fishing lifestyles. Several fishers described friends' or their own transitions away from intensive fisheries and toward those that offer more time at home or greater financial stability, to support growing families. Others described compromised family and financial well-being as a result of fishing lifestyles:

> *When we first started 20 years ago there was like 20 guys that were hardcore, that's all they did was fish. There's like 5 of us now. And most of us are failing, and divorced, and lost their homes, you know.*

For those who can sustain their fishing participation despite these challenges, fishing transitions might then be stimulated by compromised physical well-being. Some described these transitions in relation to age (6), referring to certain kinds of fishing, like overnight trips or full-time commercial fishing, as a younger, more resilient fisher's game. Others interviewees expressed gratitude having survived earlier, more reckless fishing years, recounted stories of friends lost at sea,

or made casual comments about dying on the water. Following my invitation to a presentation, one fisher in his early 40s chuckled, "*Hopefully we're still alive and well then*." Thus, another fisher concluded, "*a good day of fishing is coming home with all your fingers and toes. That's a great day. And then if you catch fish that's extra*."

Information sharing

"*It's everything. Information is everything*."

Information sharing was included in this research to better understand the fishing community's social network structure, identify key actors within it, and learn about how ideas and behaviors propagate throughout the fishery. In this section, I present the types of information deemed useful by interviewees and their sources, the determinants for inclusion or exclusion from an info-sharing circle, and patterns of information guarding.

Information types and sources

The types of useful information that fishers described sharing included fishing techniques, weather and oceanographic conditions, what's biting, where, and who's catching. Information about fishing techniques included fishing methods, gear configurations, how to approach fish; essentially, the "how" of fishing. This information enables fishers to translate all of the other kinds of information they receive into fishing strategies and on-the-water decisions. Interviewees described acquiring fishing technique information through trial and error, mentorship from experienced fishers, and mimicry.

Repeatedly, ocean current was identified as the most critical piece of information to determine fishing opportunity: "*To me the currents are 80 percent of fishing, I think. You know the speed of the currents and the direction of the current, and how long the current was pulling that way*." Like other weather and oceanographic conditions (wind, tide, moon phases, water temperature), day-to-day current information is acquired through direct observation and media tools like NOAA weather radio reports and online applications.

In the West Hawai'i fishing community, insights into the "who" of fishing and catching is useful because it may reveal other kinds of information. One fisher described seeking this information from fish wholesalers: "*I know what fishermen, what he does, what type of fish he does. And I know where, I pretty much know where he fishes. So I use that as a big tool for me*." Another fisher described the importance of the fishing "who" according to their skill level:

> *Who else was there catching fish, is good information. 'Cause you know if certain people are there, then the fish must be there…. If the really good guys aren't there, then maybe it's not that good.*

My interview guide was largely responsible for prompting interviewee discussions about the sharing of information relevant to sharks or fisheries management. Fishers responded that these were

not focal points in their communication with others. Fishers described sharing information about sharks opportunistically, for example, in passing at the harbor or a fish market. Information from fisheries management agencies (like the DLNR, the WPRFMC, and NOAA) comes primarily from printed media like flyers and snail mail, electronic newsletters, and key actors who take it upon themselves to stay informed and share information with other fishers. I discuss the limited sharing of information around these topics further in the Sharks and Fisheries Management sections, found in Chapter 2 and 3, respectively.

Information sources discussed during interviews included printed media, like fishing magazines or flyers distributed in fishing shops, harbors, and the charter desk at Honokohau Harbor; social media; encounters at Honokohau Harbor, fish markets, or elsewhere in the Kona community; and relationships. Printed and social media were described as unidirectional info-sharing pathways, and more accessible to those without access to more exclusive information sources.

Fishers described social media and its various platforms as more popular among younger generations and charter fishers. Some interviewees juxtaposed younger fishers' affinity for social media against older fishers' humility. One fisher described his lack of social media presence as related to his age and personality:

> *When I was younger you're more into, oh, you wanna catch the biggest and you wanna get the pictures of it…. As you get older that fades away and you get less, tryna impress everybody…. I can care less what people know I catch, you know? You know when I have a good trip or a good night or whatever, I'm happy with myself. I don't have to show everybody that, you know, 'Look at me,' kinda deal. That's just not my personality.*

Charter fishers, however, identify social media as a modern tool to advertise their businesses to potential clients. The same fisher also juxtaposed this business strategy against those of older generations':

> *I grew up with that older generation, and it was more your reputation, not necessarily who you are on social media…. You know, people arrive on the island, they go up to the bartender or the bellman and oh, 'Who do you recommend to go fishing?' And your reputation was key…. You can be whoever you wanna be on [social media].*

Because of its manipulability and accessibility, however, the utility of information on social media was also deemed questionable by several interviewees: "*There's games on social media to, you know people post a picture of all these fish and it's from last year…. You gotta take it with a grain of salt*."

Social encounters and relationships provided opportunity for the exchange of more reliable and exclusive information. Honokohau Harbor, again, was described as unique in its centrality and ability to facilitate fisher interaction: "*Oh yeah, that's the meeting place, down the harbor.*" Some fishers described their interactions at the harbor as coincidental and opportunistic, while others described more routine social congregations at the harbor:

> *Summertime every boat's out. And pretty much every day. We come in and we wash the boats, we come, sit down, have a couple beers. Everybody come around. Or you go there and just talk about what fishing was, where'd you go, what'd you see. How's fishing, you know.*

Given the visibility of the Kona fishing community, fishers can glean other types of information from the harbor through observation. As fishers unload and charter vessels fly colorful flags depicting the day's catch species, they reveal what was biting that day. Vessels returning to the harbor reveal the general direction of their fishing location.

Interviewees identified relationships to facilitate useful information sharing more than specific information sources or forums. These included relationships with friends, family, mentors and mentees, and key actors. Key actors were identified by their prominence in the fishing community and abundance of social connections, by their deliberate sharing of information (e.g., regarding fisheries management and research), or by their occupation. Fish buyers, for example, have the advantage of hearing daily from many fishers about their catch, and also have incentive to share non-proprietary information with their sellers: "*It's in my interest to tell them where fish are 'cause we wanna buy their fish*." Fishers described "*[going] down to the wholesale and talk story down there"* to glean useful information about who's catching.

For types of information that are more proprietary, like fishing techniques and location, information is shared more deliberately through established relationships and private pathways, like cell phones: "*Before we only had CB radios, so now you can just pick up the phone and, you know, your information that you share with that one person is more secure*." Without personal relationships, however, this kind of private information exchange would be impossible. What, then, about interpersonal relationships facilitates this kind of communication?

In or out

This coding theme captured the factors that fishers described as determining who should be included in their info-sharing circles. Before presenting those factors, I provide a summary interviewees' descriptions of the size of their info-sharing circles.

Circle size

Fishers described having info-sharing circles of variable size, depending on factors like fisher experience, relationship between fishing and income, fishing frequency, and season. Fishery and season play a role in determining info-sharing circle size, as their participation imposes an external limit on its maximum: "*It all depends who's out and the time of year… The summer there's a lot more people out. So I might call more people, whereas the wintertime or the spring there's only a handful of people out*." Generally, though, a larger info-sharing circle might be beneficial, for example, when a fisher is still learning to fish, is less invested in landing fish for income, or fishes infrequently such that they are more often info recipients than info sources. Some of these factors were captured well in the quotes below, which separate the recreational, charter, and commercial fishing groups:

Recreational fishing is different, they the ones that gotta find more information from other people because they go once a month kinda thing. Compared to commercial fishermen. And then if they catch they no care, they'll tell everybody else, they not fishing for the next couple weeks anyway.

Each [commercial fisherman] will have their own little group or handful of guys that they talk with, and most of the charter boat captains, they'll help each other out or communicate throughout the day.

These quotes illustrate that in contrast to avid info-sharers, the commercial fisher or the fisher who is on the water very regularly may prefer smaller, more exclusive info-sharing circles. One commercial fisher asserted that, "*Information is everything. So the tighter the circle, the better it is.*"

Another critical factor in determining circle size is the type of information being shared. Most fishers described both large info-sharing circles within which generalist information might be shared infrequently, and smaller info-sharing circles within which exclusive information is shared regularly and deliberately. This latter category was described my most interviewees as being comprised by "*a handful"* of people. As one fisher put it, "*There's talkin' to 'um, and then there's really talking to 'um.*" Out of 17 fishers that provided quantitative estimates of their info-sharing circle sizes, 14 cited ten or less, and half of those cited five or less. Of the remaining three interviewees, one cited a circle size of 20-25 in reference specifically to fisheries management information. The other two described a strategy of consulting with fishers from a large group, and then comparing collected information to make fishing decisions. Regardless of info-sharing circle size, the benefit of cooperation was expressed by many: "*It's a big ocean, it's hard to fish it by yourself out there*."

In the following subsections, I describe the factors that determine inclusion or exclusion from an info-sharing circle. It's notable that when asked to describe how fishers decide with whom to share information, many interviewees responded with intangible, less predictable patterns of friendship and individual personality that are determined with the passing of time. In some cases, info-sharing relationships were forged over years, decades, and lives of trust. But generally, as one fisher responded, "*I don't know how I would separate anybody… It's like human nature I guess.*" The factors discussed here emerged more thematically from fishers' responses: info quality, reciprocity, relevance, and loyalty.

Info quality

"*Fishermen are fishermen*."

Fishers described being misguided by poor quality information at various scales, including unintentional misinterpretation of information, deference to generalized information, and deceit. They spoke about eliminating those who provide poor quality information from their info-sharing circles: "*If you tell me something that I find out wasn't true, or you telling me a story… Fine. You don't hear from me either, you know. It's all about honesty*." Sometimes, as in this example, fishers reflected on poor

info quality with disdain. Often, however, it was attributed to the more acceptable perception of fishers as storytellers, whether secretive or exaggerative. Said one fisher, laughing, "*You cannot believe all the fishermen you know. Some are fishermen*." Three months into my interview process, when one fisher commented on unreliable information by saying, "*Fishermen are fishermen*," I understood his meaning immediately. Where secrecy could be attributed to competitive dynamics and the protection of fishing opportunities and livelihoods, exaggeration could be attributed to fisher ego. As a result of variable info quality, many fishers described the benefit of self-reliance, and fishing independently to avoid info-sharing "*games*."

Reciprocity

"So it's a lot about communicating back and forth. One way communication no work."

In most cases discussions of reciprocity involved the sharing of information of equal quality or value between two fishers. Interviewees described reciprocity in info-sharing as an important part of its etiquette, where relationships characterized by "*one-way streets*" are quickly eliminated. For this reason, reciprocity also played a role in several fishers refraining from seeking fishing information. "*I wouldn't ask too much information, so being in that position I wouldn't have to give too much information*," said one fisher.

One exception to this rule of etiquette is fishing mentorships, wherein a lack information flow from the mentee to the mentor does not lead to exclusion from info-sharing circles. A few fishers who either described themselves as mentors or who were identified by other fishers as mentors matter-of-factly described being sought out regularly for information by younger, less experienced fishers. These descriptions did not have negative connotations. One fisher described the evolution of his relationship with mentors through time*:*

> *Those are my role models. Not even mentors. Role models, growin' up. And then all of a sudden like I went from these guys being role models to always being family and friends…. Now it's like, these guys look up to me now. They ask me questions, you know? So it's been a good circle, of love, and aloha!*

Relevance

"*We do the same type of fishing and we pretty much in the same area all the time. So we keep in contact with each other*."

The influence of information relevance on info-sharing is fairly simple. Those fishers who participate in the same fisheries or fish the same areas are more likely to share information for its applicability to their own practice. By the same token, fishers who occupy niches in the fishing community may be relatively isolated in terms of info-sharing. *Said one charter fisher,* "*A lot of 'um don't really care what I'm doin', 'cause they're not doin' it*." In some cases relevant information is recognized and shared across fisheries for cooperation's sake. Fishery-external information might also be strategically sought after for its relevance. For example, fishers who are on the water regularly

are a valuable source of information given that conditions change day to day: "*If you want to find out what the current is doing the night before you call a commercial friend and ask him.*"

Loyalty

A fisher's loyalty in info-sharing circles is determined in part by all of the aforementioned factors. It is distinct, however, in its extension beyond individual fisher-to-fisher relationships. Several fishers described the importance of loyalty to a fellow fisher, exhibited through interactions with others. For example, one interviewee described his fallout with a newcomer who took it upon himself to "*become the face of the commercial fisherman,*" through social media, after the interviewee introduced him to an exclusive fishery with limited participation and years of history. Two fishers in a joint interview (here differentiated by the letters A and B) described his membership in what he called a "*code group,*" an exclusive, info-sharing circle whose membership requires loyalty and discretion:

> A: *If you get 'em, tell me. If I get 'em, tell you.*
>
> B: *But you're not allowed to talk to anybody else.*
>
> A: *And if I get 'em and I don't tell you? Big offense, as a code boat member... That's not cool. You only get a couple of those.*
>
> B: *(chuckles) Yeah, like two. You're done.*

The concept of loyalty was also discussed in fisher-fish buyer relationships, wherein buyers respect the private information of their sellers, fishers exhibit loyalty to one buyer, and buyers provide them steady access to the market. One fisher advised his son:

> *Don't sell everywhere. Pick one wholesaler, because he will take your fish all day long, where if you jump around, jump around, and then all of a sudden there's a lotta fish, they might tell you they don't need the fish, then you get stuck with the fish. So we sell both to one person, only one person.*

A fish buyer described the benefits of fisher-buyer loyalty with regard to fish quality and, by extension, sale price:

> *I won't save a space for somebody that I don't know, 'cause I don't know basically how he takes care his fish. Simple things like that can make a big difference as far as the market because our regular fishermens, we have trained them, and we have seen their fish. They have the best fish available.*

As discussed in the *Competition and Cooperation* section, patterns of information sharing were often stimulated by the fishery's competitive and cooperative dynamics. In these cases, competition and cooperation were described to stimulate information guarding and sharing, respectively.

Guarding info

"The good commercial fishermen don't speak (laughs)."

The guarding of information between fishers has been a recurring theme threaded in this and other sections. I summarize its key points here, and also elaborate on some of its unique insights, not found in other sections. Guarding fishing information is of course the yin to info-sharing's yang. Both have their benefits, and often a careful balance between the two is required for success in fishing activity and in the fishing community: "*It's a fine line. If you don't stay connected, you miss a bite. But if you don't talk to anybody then you find the good area, you got it to yourself*." Info-guarding and sharing mirror the complementarity and are closely related to competition and cooperation, respectively. Info-guarding and competition are both largely motivated by the protection of fisher livelihoods, quality fishing opportunities, and the time and capital invested to find them. Thus, information like fishing location and technique:

> *They [say] you won't find an honest fisherman. They'll tell you lies (laughs). Cause you know why, it's your livelihood, so… You know if you find the fish you don't wanna call ten other guys to come, and then your odds of catching is one out of ten now. I mean if you spent hours and a lot of work trying to find the fish you're not gonna just give it up easily.*

For this reason, public info-sharing platforms like social media were described as being used sparingly, or not at all, by commercial fishers. Some fishers described delaying info-sharing, including social media posts, to protect fishing opportunities. Often, interviewees described passive and nuanced forms of discretion rather than actively guarding or distorting information. Fishers described providing information only when explicitly asked, or providing generalist responses to inquirers. Because information like weather and oceanographic conditions are relatively public, for example, they are shared more readily and may be used to divert attention from more valuable information:

> *They might not tell you where the fish are, but they'll still say, 'Oh yeah, the current's kinda doing this over here. It's going north,' or, 'Oh the current switched down here.' So there's certain elements of talking to people that you don't always talk to all the time, they give you little pieces of the puzzle.*

As described in the section "Info quality," information guarding is also accepted as a part of fishing etiquette, related to respecting other fishers' privacy, and the preference of many for self-reliance and independent learning:

> *I have to be honest with him, if he asks me I'll tell him, but there's kind of a respect where when fishing gets tough, I can ask him what he caught, but to ask him the GPS coordinates would be offensive, you know. Or to pound him about bait, or what did you- It's a very difficult balance.*

Interestingly, information guarding was related to ethnic identity and access to financial capital in one interview:

> *If you one new haole on the block, the old Hawaiian uncle down the corner, if you get to become in his circle of friends, it's gotta be something really special. and its' not that they don't wanna be friends, but they gon' be more reserved. Especially if the guy get money. See that's the new thing now. You have lotta fishermen and wanna-be fishermen that come in with money. So that makes my chances hard. They can buy triple the bait, bigger boats, the best gear, so you get shy from them*.

Sharks

In this section, I present the themes that emerged from fishers' descriptions of sharks and shark interactions. I summarize interviewees' descriptions of shark behavior, abundance, and interactions, and shed light on how fishers understand the "shark problem" and seek its resolution through their own pathways.

Species

The shark species cited by the most interviewees, in descending order, were the oceanic whitetip (28), tiger (25), mako (25), thresher (22), bronze whaler (20), blue (17), Galápagos (12), hammerhead (11), silky (7), sandbar (6), great white (5), whale shark (3), dusky (2), and oceanic blacktip (1). The number of interviewees who cited each shark is not necessarily representative of interaction frequency or types of prevalence, as the interview guide skewed discussions toward the oceanic whitetip shark and other pelagics. Instead, this list provides an overview of the kinds of sharks that West Hawai'i small boat fishers might encounter. Throughout the remainder of this section, I will focus primarily on those sharks that were referenced more than ten times in the interview data (regardless of how many interviewees contributed to this number). This criterion excludes great white, whale, dusky, and oceanic blacktip sharks.

It should also be noted that I did not confirm fishers' species identifications as a part of this research. Interviewees described some shark species with more distinct morphological features as easy to identify, including the oceanic whitetip, tiger, mako, thresher, blue, and hammerhead sharks. Other shark species' identification might be less reliable. The bronze whaler shark, for example, was described frequently but in fact is not found in the central Pacific. It is a term used commonly among interviewees to describe Carcharhinid sharks with indistinct features, perhaps referring to species like the Galápagos and silky sharks. Thus, interviewees' species descriptions first and foremost shed light on how fishers perceive and talk about their own shark interactions.

Interaction frequency

Interviewees described changes in the frequency of shark interactions through time, and according to several factors. I summarize their perceptions of shark interaction frequency in this section, highlighting general trends in shark abundance, species-specific interaction frequencies, and the factors that influence the likelihood of shark interactions. The latter include fishery, location,

seasonality, bait, currents, fisher mobility, and species. I detail other species-specific factors, including time of day, prey size, and moon phase, in the final "Species" section.

Through time

It is perhaps difficult to understand how shark abundance has changed through the years given that some fishers' practices and fishing frequencies have also changed through time. Some interviewees described retiring from commercial fishing careers, shifting away from FAD-reliant fisheries as they have held fish less reliably, or live baiting less with the decreased availability of aku. Thus, fishers' opportunity to observe sharks has changed. One fisher commented, "*My general sense is that the shark population is not much different than it was in the '70s. And even making that comparison is difficult because the FADs dramatically changed the way fish move on this coast*." Another responded, "*The trend is that no one sees 'um 'cause we don't live bait anymore. So, if the bait fishing comes back then the input will come back on what kinda sharks we see. But for now, I mean, I haven't caught a shark in five years probably*." When prompted for changes in shark abundance through time, some fishers described no significant change (10), an increase (8), a decrease (5), or were not confident in describing a trend (4).

Despite these other sources of variability through time, some fishers presented theories about changes in shark abundance through time with greater confidence and agreement across interviewees. Some of these included an increase in shark abundance following the finning ban, which was implemented in the early 2000s (3), an increase in shark abundance at South Point through time (1), and an increase in shark and predator (e.g., barracuda) abundance after Kona's kampachi farms were established (1). Species-specific changes included an increase in tiger shark abundance, which some fishers associated with the turtle take ban and subsequent increase in turtle populations (4), and a decrease in blue shark abundance (2). Trends in oceanic whitetip shark abundance varied across interviewees.

Fishery

Fishers described the frequency of shark interactions as variable across fisheries and fishing method. Generally, shark interactions were described as infrequent for the relatively mobile trollers and those who follow dolphins, moderate for live baiting and ika-shibi fisheries, and frequent for the shallower-water 'ōpelu and bottomfish fisheries. Several fishers cited sharks (and other predators, like barracuda) as problematic in the nighttime 'ōpelu fishery. Said one fisher, "*The only fishery really, for me anyway, that the sharks affect, is nighttime 'ōpelu fishing. They'll come around and bust up all our gear, and chase the 'ōpelu around so you can't really catch 'um*." Fishers described shark interactions on a bottomfish trip as almost guaranteed, as compared to reduced likelihood of interaction while fishing for tuna: "*When you're bottomfishing it's almost 100%.... You might not see 'um but you gon' have- they gon' be your predator, yeah. But like for tuna fishing, not even 50% you know*." Said another, of shark encounters while bottomfishing:

You'll probably see [a shark] on a recorder almost every time we go out. They hang out at 50 fathom and it's a big straight line. Over a onaga pile, 'ōpakapaka. Always. There's a guardian shark on all those piles.

Several fishers described this "guardian shark" behavior, wherein sharks lay in wait just above the bottomfish, to take advantage of an easy meal after fishers hook up.

One fisher provided a helpful summative comparison of shark interaction frequency across various fisheries, which aligned well with many others' descriptions:

Well let's see, there's three ways to catch 'ahi. At the buoys, and the porpoise, or ika-shibi. So if you're at the buoy, I would say probably gonna most likely see a shark. Say, 75% of the time. If you're in the porpoise school, I'd say you might see a shark less than 1% of the time. And if you're ika-shibi I would say you're gonna deal with a shark probably only 20% of the time. One out of five trips. The most times, the most interaction I have with sharks is bottomfishing and 'ōpelu.

Some of the interaction factors discussed below shed light on the frequency variation among fishing methods.

Where are the sharks?

Two fishers described West Hawai'i and Hawai'i Island as areas with relatively low shark abundance, where other islands' populations pose greater challenges for fishers and opportunity for shark tours. Some locations on Hawai'i Island itself, like South Point, were frequently described as more shark abundant. Most descriptions, however, were based on geographical features. Fishers described sharks in general as more prevalent inshore in shallower depths, in koas, and over topographical ledges:

Certain ledges, you know, South Point or up on the grounds, or on the [sea] mountain. The shallow rises up to 100, 140 fathoms there so it gets a little shallow. So you get sharks there sometimes. But just open water offshore fishing, your interactions are very slim.

Fishers also described sharks as congregating around offshore buoys and other floating objects, and following pilot whales. The majority of these descriptions, however, were made in reference to the more pelagic oceanic whitetip and bronze whaler sharks.

Seasonality

Importantly, shark seasonality was not a variable that could be represented objectively, given that most fisher observations and shark interactions depend on fishing seasons and methods, which vary throughout the year. Many fishers, for example, described an increase in shark abundance during the spring and summer months. Most related this trend either to the summertime arrival of large pelagic fishes like 'ahi or an increase in fishing pressure when charter and ika-shibi fishing

seasons peak. One fisher described the increase in shark abundance at the start of the summer fishing season, and subsequent decrease at its conclusion:

> *Just before tuna season the sharks are all at the buoys in piles. I mean I seen you know piles of maybe 50, 60 sharks. But what happens is, I guess it goes inside and it actually slowly diminishes because you know, people catch 'um, kill 'um and stuff like that. And it's always around April, the sharks all come in…. Maybe September and yeah October would be the worst months to actually try to find sharks. Because it's the end of the ika-shibi season.*

One interviewee hypothesized that this springtime increase in shark abundance was related to the winter whale season:

> *I think the sharks eat a lot of whale after birth and stuff like that after the whales give birth, and it seemed like right after the whales left that the sharks were real ravenous like in the spring, like in March and stuff like that, there was lots of sharks around. And they really impacted the fishing*.

Others described the opposite trend: a wintertime increase in shark abundance. This trend was described with regard to bottomfishing: "*Beginning of the bottomfish season which is like October, November, they more plentiful, as to the ending part like in March, April. Wintertime, during the winter months I think they more active, the sharks are more active*." It was also described by tuna handline fishers: "*Especially in the winter, it gets just, what we call sharky. It's just nothing but sharks*."

Still others described sharks as present year-round, especially at hot spots like offshore buoys, or could not identify trends in seasonality and shark abundance. Comments from one fisher remind us of fisher uncertainty around shark seasonality: "*I wanna say during the, is it wintertime? Let me think about this for a second. No actually I think it's during the summer that they're more prevalent. But you know what, they're prevalent all the time so (chuckles)*."

Bait

The relationship between shark interactions and bait is fairly simple. More bait, whether alive or chum (palu), means more sharks. Dead bait was described as a lesser attractant as compared to live bait or steady chumming. Though some live bait fishers' shark interactions have decreased through time with their transition to artificial lures, the association between bait and sharks makes shark avoidance for most fishers a non-starter: "*Sharks and 'ahi eat the same thing yeah? So, what are you gonna do?*" Fishers described methods ika-shibi relying on steady chumming to land fish: "*When you're fishing ika-shibi you can't stop throwing palu. You stop throwing palu, there's nothing gonna come to you. Or if you've got fish, you stop palu-ing, they're gonna leave*." In the midst of ika-shibi season, the fleet's collective *"scent trail"* attracts sharks as "*everyone's throwing cases and cases of anchovies*." One fisher described the low likelihood of encountering a whitetip outside of the season using the same method because, "*You're the only boat out there. So your palu, you're the only one putting the scent trail in the water. There's no fish in the area*."

Many fishers described sharks' buoy- and koa-associative behavior as related to their ability to hold baitfish. Others generally described the association between shark and 'ahi presence:

> *If an odd school of fish comes in, like if there's a massive migration of, say, something just came around. You gonna see the sharks. guarantee. Guarantee. Like if they're just a school of tuna just came, acres, you're gonna see 'um. They gon' be with 'um. They have to be*."

Currents

Poor current was equated to higher predator abundance, including sharks. One fisher described a "*lousy current*" as:

> *Going one way, and underneath, the bottom side, could be going another way. So you know, you don't have a good flow. Or sometimes… maybe only the top half might be moving and then the bottom might [not] be moving at all.*

High current speed might also disable shark retention in an area. One fisher described the decreased likelihood of hooking sandbar sharks with currents over a certain threshold: "*Our current's normally like half a knot to a knot, and if the current gets above a knot and a half, then yeah, the likelihood of getting a sandbar shark decreases quite a bit*."

Fisher mobility

Mobile fisheries like trolling and live baiting were described to yield fewer shark interactions as compared to bottomfishing or tuna handlining. These latter fisheries, more prevalent among commercial fishers, were described as relatively stationary. One fisher partial to live baiting said, "*If I had a shark I just go find another bait and continue fishing… but like the commercial guys, they're in one spot. So that might affect them, if the shark's around*."

Fishers identified only certain sharks to pursue lures. The most common of these was the mako shark, which was noted for its speed. Bronze whalers and oceanic whitetips were also known to chase lures, and were described as relatively aggressive. Several fishers described a very low incidence of shark interactions while fishing in dolphins. This was attributed to the mobility of the dolphin fishery and sharks being depicted as lazy, opportunistic feeders:

> *Lotta times on the charter fishing, or the commercial guys that are 'ahi fishing, they're fishing the dolphin schools, the spotted dolphin. And they're kinda just roamin' offshore… three to 25 miles offshore sometimes. And they're movin' so the sharks- sharks are generally, they're kinda slow movers, they're lazy kinda opportunists. So they'd rather congregate in the area that the fish are at, holding. Like a buoy, a ledge or shallow water ledge… They can't keep up with [the dolphins].*

Species

In this section, I summarize species-specific variations relevant to the frequency of shark-fisher interactions. I will expand on shark behaviors and fisher perceptions of sharks in a section below: What is a shark?

Oceanic whitetip shark

Four fishers described decreases in oceanic whitetip shark abundance through time. One commercial handline fisher commented, "*I can't even remember the last time I caught a whitetip, and before they were a major player in the game*." Others, however, cited its steady populations and regular sightings. That fishers participating in the collaborative shark-tagging program have tagged over 30 oceanic whitetip sharks between October of 2017 and December of 2018 provides evidence of their presence in West Hawai'i waters. One charter-commercial fisher roughly estimated encountering sharks on 20-50 of 300 fishing days per year. Oceanic whitetips comprised about 80% these interactions. He said, of Kona, "*There are tons of oceanics here*."

Interviewees described interaction with oceanic whitetip sharks during the day and night. They were sighted more frequently offshore in deeper waters. One fisher noted, "*I don't remember ever seeing one in less than 100 fathoms*." Thus they were not associated with fishing areas like shallow ledges, or with the inshore or bottomfish fisheries. Interactions were instead described as common near buoys or floating debris (particularly offshore), and in pilot whale pods, with sightings of free-swimming oceanic whitetips being less common. These kinds of associations specific to the oceanic whitetip shark might lend to fishers' variable sightings:

> *This past year yeah, I really didn't see a lot because the buoys didn't bite. Like I said. So maybe a handful, maybe about 6 or 10 is what I seen. But I know the prior years when the buoys did bite, or when there was something hanging around the buoys, or on the floaters or whatever. Floaters are just debris and stuff like that. Almost every time you go out there you'll see one.*

For their described occupation of surface waters, one fisher said surface fisheries like mahimahi produce more oceanic whitetip interactions. Ika-shibi, troll, and live bait fishers also described oceanic whitetip sightings.

Whitetips were associated with the summer season for its warm waters, and, "*the big fish… the tuna. So when the fishing gets good you usually see more oceanic whitetips…."* The relative frequency of summertime sightings could also be compounded by increased fishing pressure, as mentioned earlier. Said one fisher, "*I mean you gonna catch 'um when the most guys are out there fishing for 'ahi right? So from July to September is when guys gonna start catching 'um."* Several others described the oceanic whitetip as present year-round. Fishers described sighting both singular and multiple individuals at a time. One fisher described "*a handful of nights where you get a lot of 'um around, you know, 5, 6, 8 a night,*" and another described seeing 2-3 at a buoy as not uncommon.

Tiger

Tiger sharks were described as an inshore, shallow water species. Their depredation was cited by fishers targeting bottomfish and inshore pelagics like ono near the Grounds and on ledges. Despite their reputation as depredators, several fishers described them as, "*not real aggressive, but they'll eat your fish. They're slow.*" Tiger sharks are commonly sighted around Honokohau Harbor. One fisher described them, "*[comin'] in the harbor every day. They start around Easter and leave around November… Sometimes I've seen six in the harbor at once.*"

Mako

Makos were described as a fast, aggressive, deep-water shark, more common in the winter season for its cold-water preference. They were not described as commonly encountered, but were perhaps cited frequently during interviews for their unique behavior.

Thresher

Interviewees described thresher sharks as occupying deep waters and targeting small prey:

> *They're a small fish predator. They like small fish, they whip around the tail and catch their prey like that. So they can slap an 'ahi all they want, they not gonna catch 'um. And they have very small teeth. Very small teeth, so very minimum damage they can do on something large.*

Because they occupy deep waters, and are unlikely depredators, thresher shark interactions were described as only occurring after a thresher has been hooked. "*They're always gonna bite your deep line,"* said one fisher. Another commented, "*One thresher shark, I don't think you gon' see 'um unless you hook it. You know what I mean? There's no reason*."

Fishers described their thresher shark interactions occurring at nighttime or daybreak, mostly during ika-shibi fishing of the winter months. Others described thresher interactions as more common in the summer months, during the peak of ika-shibi season. By some, thresher abundance was described to diminish as the season progresses, perhaps as people catch and kill them. Two fishers repeatedly described thresher encounters as more likely near the full moon, when the night is better lit.

Threshers, unlike oceanic whitetip sharks, were not associated with good piles of fish. Said an ika-shibi fisher: *"I always consider those randoms*."

Bronze whaler

Fishers described what they referred to as "bronze whalers," as sharing some of the oceanic whitetip shark's characteristics: an aggressive shark associated with buoys and fish, though not "*necessarily [with] the big fish*":

> *The bronze whalers we see quite a few offshore on buoys or, you get a lot of those and they're aggressive too. Don't really necessarily see those with the big fish. Big fish will be in the area too, but lotta the bait, the aku or the shibi tuna, you know.*

One fisher noted that, "*They could be so thick sometimes, you can't even catch a bait you know. They're so thick between the oceanic whitetips and the bronze whalers*." Unlike oceanic whitetip sharks, bronze whalers interactions were also noted in shallow areas, including ledges at the Grounds and South Point. Some fishers described bronze whalers as more abundant and aggressive than oceanic whitetips, citing their chasing lures more readily, for example.

Blue

Interviewees described blue sharks as offshore, deep water sharks sighted during nighttime ika-shibi fishing:

> *Blue sharks are very- you see those at nighttime and they're very slow-moving and, you know, they're a little easier to get rid of. Didn't see a ton of 'em out there… And it was usually when the fishing was slower that I've found that blue sharks were there.*"

In alignment with the quote above, several fishers cited blue sharks' relative lack of resilience as compared to other shark species. Fishers also noted that blue sharks were not associated with good fishing opportunity: "*Generally fish is not that good when you see them*."

Galápagos

The identification of Galápagos sharks seemed to be a point of uncertainty for interviewees. When they were mentioned, Galápagos sharks were described as common during bottomfishing and nighttime ika-shibi fishing, and abundant at South Point and on shallow ledges:

> *I've noticed the Galápagos'll get really thick in certain areas. But they're generally around shallow areas within 100 fathoms. So they're gonna be close to the 100 fathom ledge. And Gálapagos and sandbars can kind of turn into a bit of a nuisance for sure.*

Perhaps a subset of what many fishers refer to as "bronze whalers," Galápagos sharks were described as a nuisance shark.

One charter fisher detailed a very specific narrative of localized Galápagos shark abundance, based on his own fishing records and fellow fishers' stories. He described the influx of Galápagos sharks to the Grounds, which "*came in on some floating debris*" in 2006. This population of Galápagos sharks wiped out local jack populations before their abundance also decreased.

Sandbar

One particular fisher, who bottomfishes on the Grounds, cited sandbar sharks as his most prominent catch species. He described their average size to range from 50 to 150 pounds, with the odd, "*big pregnant girl… over 200, maybe 250*." This same fisher described the diminished likelihood of hooking a sandbar when currents exceed 1.5 knots.

Hammerhead

Several fishers described sighting scalloped hammerhead schools in the springtime (6). Large schools in the tens to hundreds were described to outside of Hoʻokena, Keahou, and Miloliʻi, within 100 fathoms. This behavior was not perceived as problematic for fishers, as the sharks appear not to be interested in feeding while in these schools. One fisher one of a handful of sightings:

> *It's pretty amazing. There'll be a school of hammerheads and they go around in a circle, and it's almost like the sharknado? I mean as far down as you can see, there's nothin' but hammerheads circling around, and the first time I saw it I actually had an aku, and I threw an aku in the middle of it? And they didn't even look at it…. So I'm assuming it's some kind of breeding mating dance or something.*

Outside of this phenomenon, hammerhead interactions were infrequent. Only one fisher described hooking hammerhead sharks, which represented two isolated incidents in a single season, of decades fishing in Kona.

Decision-making

I use this section to illustrate that shark-fisher interactions are diverse in the types of shark-handling opportunities they offer to a fisher, and complex in the way they interact with fishers' decision-making variables. In the following subsections, I detail the behavioral and shark-handling options available to fishers when they encounter a shark, and the variables fishers consider while navigating those options.

Shark-handling options

Each fishing individual's preference for the following behaviors and shark-handling strategies varies. Here, I present all of the behaviors and shark-handling strategies that emerged from interviews. Note that the numbers in parentheses represent the number of interviewees who discussed each practice, but not necessarily the number who practice it.

Shark-handling

The strategies presented in this section involve physical contact between the fisher and shark. The goal of shark-handling could vary based on the fisher and shark-handling strategy, but generally was described as a last resort to improve fishing opportunity through some pathway that minimizes cost and maximizes benefit. "*If you deal with it,"* said one fisher, *"it's how are you gonna deal with it? You know, what's the most cost-effective and time efficient way of dealing with a shark?*" The most cost-effective way of dealing with a shark may or may not involve lethal action. One commercial fisher made this distinction:

> *I don't know what the end goal is but, you know, it isn't like we're trying to [kill the sharks], it's just what you gotta do to catch the fish sometimes. You got bills, you got fuel and ice and bait,*

and you got a mortgage and food, and you gotta do what you gotta do sometimes. But, very minimal. You're not actively trying to do anything.

Others emphasized that some form of shark-handling to eliminate it from fishing activity was something done for lack of alternatives:

If there's a fish at the buoy and that's the only game in town, then you're makin' the fisherman choose to either go home early and call it a day and maybe not make as much as he wanted to make, or get rid of the shark and keep fishing.

So a lotta times as a fisherman it was hard because if you could wave the magic wand, please go away, you would…. But the way you had to do that was you had to make 'em go away.

The most commonly cited tools for shark-handling were firearms, jugs, and bats.

Firearms (21)

Firearms were described as used primarily during commercial fishing activity, and rarely (if at all) by charter fishers. Firearms included guns and bang sticks, kept on board primarily to handle large target species like 'ahi and marlin when fishing alone. Said one fisher:

It's partly for safety, if you get- fishing by yourself you get the leader caught on your hand, and you've got a Magnum close by, you can stop the fish pretty quickly, so that was part of the theory. It was more of a safety measure than a get-rid-of-the-sharks measure. And frankly I think it's pretty much useless. I mean, to shoot at a shark that's under the water and expect to hit it in a way that hurts it, damages it, kills it, is you know it's not happening.

The size of a gun could affect its ability to harm a shark, especially if the shark was not above the water's surface. Some fishers hypothesized or offered stories of sharks' resilience after being shot: "*I shot a shark one time with a 22 over in Hilo and two hours later he came back and I know it was the same shark 'cause I could see, I was using a hollow point, and it just hit his head and stopped and there was a white spot right on the top of his head.*"

Bang sticks provided an alternative to guns, with their ability to deploy below the water's surface. The relative safety of bang sticks and guns varied according to interviewee. One fisher cited an onboard bang stick accident that led to hospitalization. Others described the dangers of using guns on rocking, fuel-filled boats in a high-participation fishery: "*You just watch the other fishermen because, you know, bullets fly far, so once in a while you go, 'Oh, whoa! That was kinda close.'*" Overall, though, firearms were described by many interviewees as a relatively easy and safe way to handle a shark at-vessel, typically with the intention of killing the animal. But in many cases, using a firearm was not deemed feasible: "*Number one for us is safety. And there are times you got a shark, you got it up to the boat, you have it on leader, and it's not safe to shoot it.*"

Cut the line (20)

Cutting the line to release a shark was described as a viable alternative in cases like these, and as a first choice in others. For charter fishers, for example, cutting a hooked shark loose was described as the most common handling option, for its ability to maintain their reputation with clients, and because the need to get rid of the shark is not as dire as for other fishers. Some fishers, citing both commercial and recreational activity, described releasing the shark as preferable to spending any additional effort on it: "*We don't have anything to do with 'em, so we just cut the leader and get back on [fishing]. Nobody wants to waste time on that.*" But, fishers' desire to salvage gear sometimes required reeling in the shark first: "*I don't wanna cut my main line… So you gotta get it 20 feet to the boat before you can cut it*." Several commercial fishers also described fighting or intentionally agitating a hooked shark while bringing it in, before cutting the line, to deter it from their fishing area (5): *"Pull on 'em, make them kinda hurt, like hurt their mouth. Pull on 'em, get 'em tired, then he'll swim away."* This was a more physically intensive strategy, and some interviewees described its effectiveness to depend on the shark's persistence post-release.

Many fishers described sighting or recapturing sharks with many hooks in their mouth, evidencing past interactions that resulted in release: "*I've seen sharks with 3 or 4 hooks in their mouth from guys letting them go."* Releasing a hooked shark could thus be intentional, but it was also described as a common involuntary outcome based on fishers' gear configurations: "*Sometimes you're fighting 'em and they just bite through your mono leader*."

Jugging (18)

Interviewees described jugging as a shark-handling practice used by commercial and charter fishers alike. Jugging consists of rigging a Clorox bottle, jug, or floater to a baited hook, to deter the shark from your fishing area or target species:

> *[Taking] this jug, I tie a leader to it, I throw my bait out but I gon' fill it halfway up with water. So then the thing sinks the sharks away and then the thing just irritated with this, next thing you know it's away from my boat.*

One fisher described it being a temporary solution to shark presence in fishing area and an important window of opportunity to land target fish:

> *This is for the day yeah? Or maybe two. Because it has this floater on him, it doesn't have the ability to eat my fish because it's actually dragging this along. And it's a big annoyance to him…. And fishermens don't have time to kill sharks. So what I do is I bait the kāhala, just throw it in. And sooner or later he's actually gonna bite it.*

Fishers described variable effectiveness with the jugging technique, but most relied on it to temporarily deter a shark from a landed fish or fishing area. Jugging was described as a relatively low time investment given that the baited jug could be released independently of the vessel. Some fishers described rigging multiple jugs in preparation for sharks in a fishing area and using them as a

preventative measure for problematic shark interactions; others described using them as an alternative measure following the failure of other handling practices.

Most fishers who described jugging hypothesized that sharks survive after being jugged as they bite through the leader or old hooks rust out. One fisher disputed this assumption, saying, "*No, they won't [bite it off]. The way that J-hook is, it's right in the corner, like, yeah, I absolutely believe it's fatal. 90% of the time. And even if it's not, it's gonna shorten that shark's live. He's draggin' that thing around."* The perception that sharks survive after jugging surprised one spearfisher, who described finding a dead, jugged shark: "*I've found 'um dead. You see the floating jug and then you look below, and jump in, and there's a dead shark on the end of it.*" He and one other interviewee also described seeing live, jugged sharks in the water.

Two fishers suggested developing a sort of biodegradable jugging rig for fishers, to increase the likelihood of sharks' survival and decrease pollution.

Bats (11)

Bats were described as an alternative to firearms for those who prefer not to use them, or, in some cases, prefer a potentially non-fatal approach to shark-handling. Like firearms, bats are kept onboard primarily to handle target species. Fishers described batting the sharks in their nose, for the area's sensitivity (2). Bats, however, were described as imposing greater physical challenges to fishers:

> *I've fished with a few people that didn't like to have a gun on board and, it's really dangerous and hard on us, on the crew, to get [sharks] up and try to- you gotta whack 'um a few times on the head to slow 'em down…. It hurts us, and it hurts the boat.*

And, several fishers described clubbing as an ineffective shark deterrent.

Tag it! (6)

Given that many of my interviewees were involved in the community-based shark-tagging study, tagging sharks was described by some fishers as an alternative to other shark-handling practices. For some, this was directly related to its opportunities in financial compensation. Anecdotally, however, some fishers described the potential of tagging a shark in deterring it from the vessel. Tagging may, however, incentivize shark interactions where they would otherwise not occur (for example if a shark does not pose a threat to fishing activity).

Avoidance (20)

"*Where there's sharks, there's fish.*"

Shark avoidance was described by interviewees as preferable to shark-handling, but often infeasible. Said one fisher, "*Every commercial fisherman, in fact every fisherman'll tell you the same thing: Least amount of interaction as possible. If there's no reason to, there's no reason to. Unless they're harassing you or stuff like that."* The simplest form of shark avoidance is to leave the fishing

area (20). Leaving or moving was often described as a last resort in extreme cases of shark imposition on fishing opportunity, and where sharks were inaccessible to fishers:

> *I mean you could drop it down there all day and have [the sharks] bite off every bottomfish that you catch and try to bring 'em up and say, well I lost 100% of my bottomfish that way. But nobody's stupid enough to do that, they just stop fishing.*

The best insights into avoiding shark interactions were fishery- or area-specific. For example, fishers described fishing up-current or further from a buoy, maneuvering gear or a fishing vessel itself to land a fish more quickly, fishing in deeper waters, or switching from live bait to trolling with a lure, as producing fewer shark interactions.

In some cases, fishers described learning about shark depredation at a potential fishing area stimulating their preemptive avoidance of the area, especially for distant fishing areas. When asked if learning that an area is shark-abundant would deter them from fishing it, however, many responded negatively: "*No, we just go and try*." This could be attributed in part to the unpredictability of sharks and the fact that not all shark interactions result in impeded fishing ability. Generally, fishers described shark avoidance as difficult or impossible, given the association between sharks and target species or bait, a limited number fishing areas that could provide better fishing opportunity, or because their fishing method eliminates the aforementioned strategies.

Feeding (9)

Several fishers described shark feeding as a strategy to satiate them, or momentarily distract them from target species. Feeding was described as effective for the nearshore 'ōpelu fishery and for big game charter fishing, wherein bait might be used to distract the odd shark from your hooked fish while it is being landed. Already-depredated catch and old fish parts might be retained for this specific purpose. Two fishers recounted separate stories of charter fishers reeling in their catch as sharks were distracted with the odd sandwich. Interestingly, one fisher described evading sharks in areas with high fishing effort by capitalizing on sharks' focus on other fishers: "*The buoy's not too bad… because sometimes you get lucky ah? Although you get sharks, another guy might be catching an 'ahi and the shark might be harassing that guy while you bring up yours.*"

Shark feeding may also occur unintentionally through depredation of a target fish. Some fishers described this as leading to shark satiation and continued fishing opportunity. These fishers referred to sharks as the "tax collector," as they collect their tax, then leaves satisifed: "*Sometimes they'll take their share. You'd lose couple fish and then sometimes they'll just leave you alone*."

Other interviewees either didn't endorse the feeding strategy or described it as uncommon. One commercial tuna handline fisher siad, "*You can't feed 'em too much, they'll stay there and eat*."

Shark deterrents (9)

Fishers expressed interest in developing shark deterrents, citing chemical and electrical deterrents used by recreational ocean users or fishers in the media. In isolated cases not specific to Hawai'i, fishers referenced an aluminum streamer, "*[hooked] on the line that slides down to the fish*,"

and a TV special which featured dead sharks deterring shark interactions. One fisher described using Dawn soap as a shark deterrent while diving. One fisher expressed explicit interest in working with Dr. Hutchinson to develop an effective shark deterrent. "*I'd be down for field testing,*" he said, laughing.

Gear modifications (8)

Fishers described gear modifications that weren't directly relevant to West Hawai'i small boat fisheries or sharks, but that could provide some insights into potentially relevant gear modifications. One interviewee described longliners using smaller leaders and hooks to reduce shark bycatch. Another reflected on the effect of J hooks versus circle hooks on shark interactions. One bottomfisherman described spray-painting his equipment black, which significantly reduced his gear losses to sharks.

Factors of fisher behavior

Some of the factors that fishers consider when deciding how to proceed after encountering a shark were previewed in the above descriptions of fisher behaviors and shark-handling practices. I identify and describe these factors more explicitly in this section. Table 1 provides a summary of these factors. Those in bold will be elaborated upon in subsections.

I first call attention to several, less tangible behavioral motivations that appear throughout the remainder of this Decision-making section: money, social pressure, understanding, and cultural upbringing. These motivations vary by fishing individual and cross-cut the factors listed in Table 1, affecting how each fisher takes them into consideration.

Money plays a significant role in how fishers navigate fishing and shark-handling decisions (14). Those whose financial well-being depends on landing fish—particularly for those whose primary source of income is fishing—have greater incentive to protect fishing opportunities, employ a wider range of shark-handling practices, or receive fishing income through alternative pathways; for example, in selling marketable shark species or tagging sharks for collaborative research. Social pressure also plays a role in fisher behavior (13), as fishers seek to preserve their reputation in the eyes of their charter clients, community members, and fishing circles. Fishers described discontinuing their targeting of sharks for sport and consumption, fish buyers removing sharks from fish markets, and releasing sharks when possible to mitigate social conflict or in milder confrontations with other groups' value systems. Fishers also cited acquiring greater understanding of sharks as influencing their shark-handling practices (11). Two fishers involved in the tagging program described personal and peers' shifts toward releasing threshers after learning of their vulnerability:

> *We told them that these sharks, threshers are kind of endangered, they used to blast the threshers when they came up too, but now they're cutting the line on 'em. So the word's getting out that the fishermen, that you now there's a problem with the sharks and stuff and guys are letting 'em go…. Not everybody, but like the guys that I know anyway…. They're telling me they let 'em go (laughs), I don't, I don't know what happens.*

Most others' comments with regard to the influence of increased understanding on shark-handling practices were hypothetical or related to increased consideration of releasing sharks among their other decision-making factors: "*Now, doing these things and understanding that they're endangered, I'm gon' try and not kill 'um, but if I got to I got to*." A few interviewees also discussed people's shark-handling practices being shaped generally by the culture in which they learned to fish (4). "*I think the standard for many years here was kill every shark you hook because then they won't take your catch next time you hook one,"* said one fisher.

Table 1. Factors that affect fisher behavior during a shark interaction

Factor	Effect on fisher behavior
Shark accessibility (20+)	Increased accessibility diversifies behavioral options available to fisher.
Shark persistence (19)	Shark persistence despite fisher handling increases the readiness of fishers to apply alternative behaviors.
Number of sharks (16)	Coupled with shark persistence and aggression, high number of sharks may result in fishers leaving an area.
Target spp presence (15)	If target species are present, a fisher is less likely to leave and more likely to attempt to actively handle a shark: "*If there's a lotta tuna and a lotta sharks, you find different ways to kinda get around the sharks.*"
Safety (14)	Shark-handling is a physically demanding activity. Tools can reduce its physical stresses, but also pose additional bodily risks. The way safety considerations affect each fisher's behavior varies according to personal preference, physical ability, and gear/vessel configuration.
Shark market value (15)	If a shark has market value (e.g., mako and thresher), it offers fisher the added opportunity to land it for sale.
Survivorship (12)	Some fishers described their shark-handling preferences based on the perception that they do not result in shark mortality or significantly impact shark populations.
Other boats (10)	Presence of other boats in an area may discourage fishers from using certain shark-handling practices, redistribute shark impacts, or inhibit a fisher's ability to move to a new location.
Gear (10)	Fishers' typical gear configurations are limited in the shark accessibility and handling practices they enable.
Ease (10)	The ease and convenience of handling practices make them more attractive to fishers, but perceived ease differs according to fisher preference, physical/gear capacity, and fishing motive (e.g., recreational, commercial, charter).
Shark species (9)	Fishers' response differs according to shark species (e.g., interaction frequency, abundance, aggression).
Fish on the line (6)	If a fish is on the line, fishers may receptive to short-term strategies that otherwise are unattractive (e.g., shark feeding, jugging).
Crew (6)	More hands on deck make physically challenging handling practices more accessible for some fishers. It may also discourage the use of some tools (e.g., guns) for safety reasons.
Time of day (5)	Small windows of opportunity for fish bites make fisher decisions more critical and reduce behavioral options. Increased likelihood of being observed in daylight may also restrict behavioral options.
Vessel size (4)	Increased vessel size makes more behavioral options accessible to fishers, and enables handling of larger sharks.
Distance traveled (2)	Fishers may be disinclined to travel to distant fishing grounds if they know there are sharks in the area. Fishers may also consider a wider range of behavioral options if they are already fishing a distant area.

Shark accessibility

Shark-fisher interactions might be understood to occur on a spectrum of shark accessibility. At one end the spectrum, a shark may be completely inaccessible to the fisher (e.g., if it is remotely detected). At the other end of the spectrum, a shark may be readily accessible by the fisher (e.g., as it is being handled at-vessel). The number of fisher behaviors and shark-handling options available to the fisher increase and evolve as sharks' accessibility increases. To illustrate this concept, I present fisher behaviors and shark-handling options as a two-by-two matrix based on two critical accessibility factors: a) whether or not a shark is hooked, and b) whether the shark is at-surface or at-depth (Table 2).

Table 2. Handling options according to shark accessibility

	At surface	At depth
Hooked	Gun Jug Bat Cut the line Feed Tag it! 1	Cut the line Bring up Tag it! 2
Not hooked	3 Jug Bang stick Feed Leave	4 Leave

Fishers described detecting sharks remotely on their depth recorders prior to or in the absence of physical interaction with a shark. This was described as a common occurrence especially while bottomfishing, as in the aforementioned example of the "guardian shark" (see Interaction frequency section). A shark's mark on the recorder was described as distinct from those of 'ahi or dolphins:

> *You can tell in the depth recorder if it's a shark, it's a big, slow-moving mark like this. It's like a big line…. So I don't have to see it to know. And then a lotta the times too, they'll never come up because they don't wanna be caught or they're just smart.*

This scenario is an example of quadrant 4, which yields relatively limited shark-handling options (Table 2). As one fisher put it, "*You can't hook 'em, you gotta move*."

Fishers also described sighting free-swimming sharks at the ocean's surface, a scenario which orients us in quadrant 3 (Table 2). When sharks are at the surface, it allows the fisher to select from a greater number of shark-handling options than if a shark is detected at-depth. These might include jugging and using a bang stick. At-surface interactions were described as common during ika-shibi fishing, because of its shallow-set lines.

A subset of shark detections results in a hooked shark, which positions a fisher in quadrants 1 or 2, depending on the shark's depth (Table 2). Daytime troll and live bait fisheries might present opportunities in quadrant 1. The ika-shibi fishing might present opportunities in quadrants 1 and 2, as a fishery that operates at fairly shallow depths, and which may require fishers to hook sharks in defense of a specific fishing spot: "*If I'm ika-shibi fishing I ain't gonna move so I'm gonna try and hook that one shark that's bothering me.*" The process of hooking a shark at the surface was described as simple by many fishers, who referenced sharks' affinity for bait. But, in other cases, shark intelligence was a complicating factor. One fisher described oceanic whitetips' intelligence enabling their hook evasion:

> *They were just too darn smart. Yeah, you throw a bait in the water with a hook on it, and sometimes they would get hooked (chuckles). And other times, they wanted nothin' to do with it. Could put it right in front of their nose, and they wouldn't take it. Unless you took the hook off!"*

Bottomfishing may also bring a fisher to quadrant 2 of Table 2.

Of course, the four quadrants in Table 2 represent simplified scenarios. For example, if a shark is hooked, it could break free, which is not uncommon given that fishers' gear is usually not rigged to bring sharks to the surface: "*Lotta times we'll get a bite and we'll be fighting it and all of a sudden all we get is the leader back and the shark bit right through it. Yeah that happens quite often.*" The options that Table 2 offers to fishers are not equally preferable, either. Given the opportunity, commercial fishers described using shark access to actively handle the animal rather than feeding or immediately releasing it: "*You got him already, so to speak. So you might as well deal with 'um and just get on with your fishing.*" This is particularly true if the shark is known to be resilient and persistent, which will be discussed further in subsequent sections. In another example specific to quadrant 2, a fisher may prefer to shark that is at-depth and hooked to avoid hassle and commotion among target species. Or, a fisher may decide to reel the shark in not realizing it's a shark, or to salvage fishing gear. The value of Table 2 therefore lies in its demonstration that shark accessibility is an important factor in determining how fishers select their behavior or shark-handling practice.

Shark persistence

If negative effects of shark presence persist after an initial fisher behavior is implemented, a fisher may proceed to alternative behavioral options, whether related to avoidance (e.g., leaving an area) or shark-handling practices that are more effective in eliminating a shark's negative impacts on fishing.

Some fishers described shark persistence as a factor of shark species. For example, one fisher described hooking, agitating, and releasing sharks as an effective deterrent, except for tiger sharks. He also cited a repeated jugging incident wherein, "*[we] hooked a tiger three times once with three jugs. And it still came back to eat our onaga.*" Other fishers also described tiger sharks as being persistent through space. Oceanic whitetip and blue sharks were described as relatively resilient and persistent. The persistence of blue sharks in particular was attributed to a perceived lack of

intelligence by several fishers, while oceanic whitetips were perceived as more intelligent. For their coupled persistence and intelligence, one fisher described oceanic whitetips as posing greater risks after release:

> *One of the worst things that can happen though, is that you hook [an oceanic whitetip] and it breaks off immediately. It stung it a little bit but not enough for him to run away, and then now he'll stay with you 'cause there's still a food source there, but he won't leave you and you can't hook him again 'cause he's smart. But it depends on the type of shark.*

Threshers, in contrast, were described by several fishers as unlikely to return after being hooked and released.

Others described shark persistence as a factor of shark behavior, unrelated to species. Many described sharks as persistent for their predatory instinct. Said one fisher, "*I don't think they're quite the cognitive thinkers like we are, so they can't be like, 'Well, maybe I'll eat later,' or whatever… That's their main focus, is eating.*" For example, the disturbance produced by shark-handling was hypothesized by some interviewees to draw additional sharks to an area, and by others to refocus sharks' attention away from fishing activity and on the distressed shark.

Number of sharks

When coupled with high shark persistence, shark abundance was described to lead to fisher resignation. In some cases, shark persistence and aggression seemed to follow from a high number of sharks in a fishing area: "*More than 99% of the time, the more sharks there are the more aggressive they are.*" The only exception to this was for large hammerhead schools, in which hammerheads appeared not to be food-interested. Otherwise, fishers this combination of factors as eliminating almost all options except to leave, for the high costs of handling multiple sharks. One fisher described this decision as resulting from his weighing of other fishing benefits and costs:

> *It's just nothing but sharks. And that's just time to quit, because not only are we goin' in the hole with our gas and our ice and our bait, they're takin' our tackle, destroyin' our stuff, and it's just, stop. We gotta stop. We got a thousand dollars in the hole, we just have to let the conditions change out there until those damn sharks move outta here.*

If the benefit of landing a fish was probable, however, fishers described a greater willingness to pursue different behavioral and shark-handling strategies to try to salvage the fishing opportunity. The same fisher added, "*But then there can also be times, yeah! You're gonna catch three whitetips, but dude, you're gonna also catch four 'ahi, you know.*"

Shark market value

"All the ones that you can eat, most guys are gonna wanna sell it. Unless it's too big… they just gotta let it go."

Two shark species are occasionally sold in local markets: mako and thresher. Interactions with these species thus offer fishers one additional option that other shark species do not: retaining the shark for sale. Several fishers described selling sharks opportunistically to local fish buyers to offset fishing trip costs. As one fisher put it, "*It's really a bycatch. You going for 'ahi and all of a sudden a thresher bites, and then you look at this thing, you don't have anything in your box, you go, 'Oh I can make money killing this shark.'*"

One fisher who recounted his recent shark landings said later that shark retention was uncommon: "*Most of us, and even the sharks that you can eat, most people don't even deal with it*." In alignment with his comment, many fishers described several reasons why they would not retain these sharks. Among them, the stench produced by a shark on their vessel (2), social stigma against landing sharks (1), the dangers of handling thresher and mako sharks (2), their decreasing marketability (1), and the hassle of dressing a shark (2). One interviewee recounted his conversation with a fish buyer:

> *I said, 'Hey, you guys interested in keeping a thresher?' And they go well, 'If you dress it out and give it to us, we'll see if somebody wants to buy it, but if nobody buys it then it goes in the garbage.' And I said, 'You know what? Never mind, I'm letting it go' (laughs)."*

Other boats

The relevance of other boats to fisher behavior during a shark interaction took several forms during interview. One was that the presence of other boats in a fishing area can redistribute shark attention, allowing a fisher to land his catch. Three interviewees described this interplay between high participation, competition, and shark depredation, in the context of high-pressure fishing areas like buoys and the Grounds. One fisher described his experience at the latter: "*Lotta marlin, aku, so they catch an aku. They live bait it, ok?.... So, when there's a lotta charter boats out there live baiting… Then there's less shark predation on my side.*" Reflecting on this same interplay between fisher-fisher competition and shark interaction, others commented that leaving a fishing spot to avoid shark interaction was less feasible given that high participation in alternative areas could lead to fisher-fisher conflict. So, said one fisher, "*You're better off dealing with the shark where you're at*."

Another effect that other boats' presence had on fisher behavior operated through social pressure. Fishers described avoiding certain handling practices that may be perceived negatively by other fishers or tour operators. One recreational art- fisher said: "*You don't know who's in the other boat too, so you no like just shoot 'um.*" The third influence of other boats on fisher behavior was related to safety. Two fishers described the safety considerations that arise when other boats are in the vicinity.

Gear

"*When we go out for fishing, we're just rigged for fishing…. So you kinda use what you got, and what you got to work with*."

Sharks often bite through mono leader during handling: "*I've caught a [blue] shark with seven hooks in its mouth…. 'Cause they'll break a leader right?*" An exception to hooked sharks breaking free by biting through the leader is the thresher shark, which is unable to for its small teeth. Fishers also described reeling threshers in to reclaim their gear. Wire leaders provide an alternative to mono leaders for specialized shark-tagging trips, for example. But one fisher who has participated in several tagging trips noted that, "*For some reason after you catch a few and there's a bunch of 'em around they won't bite on the wire leader or on a big hook.*"

Species

Shark species were described to exhibit variable resiliencies and behaviors. Species variations in aggression, interaction frequency, and abundance, for example, overlay the aforementioned variations in shark persistence to influence fishers' responses to different shark species. Many described a unique willingness to tag and release oceanic whitetips, for example, for their relatively infrequent interactions and threatened status. One fisher described releasing thresher sharks because, he said, "*They're so majestic (laughs). Nice, big creature, and harmless.*" In contrast, many fishers described their frustration with bronze whalers, which are encountered frequently, in numbers, and exhibit aggressive and depredatory behavior. Said one fisher:

> *I mean if you tell… Can you guys tag whitetip only and let 'em go? Probably you can do that 'cause not much whitetip anyway. But the other kind shark, why I gon' do that for (chuckles)? Why gotta do that? Get so much. They bothering us over here.*

Time of day

Fishers described certain temporal windows of opportunity during fishing, wherein target species' bites are more likely. During these periods, fisher decision-making becomes more critical and behavioral options are narrower. Moving to a new fishing area, for example, is unfeasible within these windows:

> *It gets to the point in the night, 3 in the morning, you can't be moving around. That's prime time. So if you're gonna move you gotta do it earlier. If [the sharks] come and get you at prime time, you're done…. 'Cause as you get closer to dawn with the ika-shibi thing, every second becomes so critical, and the closer you get to that grey light dawn…. Dusk or dawn, yeah. You see the frist crack of grey…. I mean our movements, the way we chum, the way we check our baits, becomes ten times as critical as it was at ten o'clock.*

One fisher also pointed out that the darkness of night offers more discretion for a wider number of handling practices that may not be endorsed by other fishers or marine tour operators.

What is a shark?

In Table 3, I present themes coded under the node, “Sharks as…,” which captures the various ways that interviewees perceive sharks according to their behavior and impact to fishing. I sorted these perceptions into three general categories: negative, positive, and neutral. Within each of these categories, Table 3 lists perceptions of sharks in descending order according to how many interviewees described each concept (in parentheses). Parent themes are presented in grey below their child themes, where applicable.

Table 3. Interviewees' perceptions of sharks

	Sharks as…	Descriptions of…	Illustrative quote(s)
Negative	Depredators (26) <Competitors	Sharks taking catch directly from fishers' lines. Frequency varied according to fishery.	*Especially if you're doing bottom, certain time get lotta sharks. And it's not worth it dropping down because every time you hook one a shark gon' get 'um….*
	Hassle (22)	Sharks as a pest or nuisance; shark interactions as an investment in time, gear, physical effort, etc.	*I don't have time to like actually deal with a shark…. I mean it could take an hour. Or maybe half an hour. That could be 50 pounds of fish.*
	Competitors (20)	Sharks as competitors for fishers (e.g., fish, livelihood). Subthemes include "Depredators" and "Fish deterrents."	*I'm not really interested in killing 'um but I don't want them eating my bait, and if it comes between supporting my family, and the one shark, I'm gonna put a bullet in it.*
	Aggressive (19)	Sharks behaving aggressively, typically in pursuit of food.	*The one [that was] the most aggressive was like bronze whalers. They're the most as far as eating our fish. Even for whitetips it was more bronze whalers, they're more aggressive, as far as eating.*
	Dangerous (18)	Physical threats that sharks pose to fishers and other ocean users; public perception of sharks as dangerous.	*Makos are dangerous 'cause they jump…. I've had friends that've had them jump in the boat.* *Between silky, bronze whaler, or whatever other kind shark, I don't know. Just like eat fish! (chuckles) You fall in I think they bite you.*
	Fish deterrents (13) <Competitors	Shark presence preventing target species from biting fishers' lines.	*I can count the number of times on one hand that a shark's actually attacked my fish. The problem is when they're in the area, we can't catch fish. They create a barrier. They put out a vibe, or whatever they do… effectively the tuna will not come to our boat when they're around.*
	Too abundant (10)	Shark numbers as excessive, whether generally or in specific situations, fisheries, or locations.	*It's when I'm hooking 'ōpelu, they're the most prevalent, so that's the one that's the most pesky. There's so many, yeah, there's so many.* *There are probably a few occasions throughout the years that there's… something's wrong like there's too many sharks.*
Positive	Economically valuable (21)	Sharks having economic value, whether through sale on the market, benefit to charter or tour businesses, or incentivized tagging efforts.	*[The charters] don't have to worry about tryna catch that fish… So the sharks are there for them as more of a bonus. They swing by, they catch a shark, the tourists are all happy, they get a couple of extra bucks, tips, and the tourists are all happy.*
	Keystone species (15)	Sharks playing important roles in ecosystem function.	*It's highly overlooked how important they are. If you have a lotta sharks you have a very healthy ocean…. They're the white blood cells. They clean the sick, the dead, the wounded.*
	Fish indicators (14)	Sharks associated with fish abundance and good fishing opportunity.	*Where get shark, get 'ahi, 'cause they hand-in-hand. They like eat right? They know where the fish is, so sometimes sharks are a good sign.* *Sharks are a good sign that fish are there, so if a guy says, 'Yeah dude its' super sharky, but it's biting!' Ok.*

Table 3. (Continued) Interviewees' perceptions of sharks

Positive	'Aumakua (13)	Sharks as 'aumakua or sharks' general importance in Hawaiian culture. I provide several quotes here to illustrate the diversity in how people related practice to cultural value.	*Your 'aumakua isn't a tiger shark, it's not a Galápagos, oceanic whitetip, or anything you know of. It's a shark. Whatever it is, if you believe in that jazz, your Hawaiian family way back when, it's its own thing. Just like you and me right now.* *If you understand a little bit about culture then you gon' have respect for the shark. 'Cause he's one of our gods yeah? 'Cause he's the powerful of the sea. I wanna have respect for them so, if I do have to kill one I always say, 'I'm sorry, but I have to do this.' Say one prayer, yeah.* *The Hawaiians said release all the sharks that you catch because you know it was their cultural practice or something. So, I just brought 'em up to the boat and the line, let 'em go.*
	Beautiful (6)	Admiration in response to a shark.	*It's taking from your living, but there's a point where it's like, dude, they're really pretty, and very important…. They're awesome and they're cool. And I hate them, and I love them.* *Big mako sharks in the porpoise school. Just, ho! Most beautiful thing you ever seen. 'Cause they're incredible! 10, 20 feet out of the air with thte porpoise in their mouth, unbelievable! Just, spectacular.*
Neutral	Non-target species (17)	Sharks as incidental to the focal fishing activity.	*It's inevitable to have some bycatch, but it isn't what we're really focused on catching. So it isn't like we're actively, you know, we do have interactions with sharks. We don't want to. We want to avoid 'em.*
	Part of the deal (16)	Sharks as an unavoidable, inevitable part of the fishing experience.	*I mean I just think it comes with the territory. Its part of the job to deal with it.*
	Not a big problem (15)	Sharks not posing a significant problem to fishers.	*The impact is so minimal in our fishery here on West Hawai'I that nobody really even thinks about it.*
	Unpredictable (14)	Sharks exhibiting variable behavior or interaction patterns over time and space.	*Sometime they come, sometime they go, you know what I mean? Sometime one day get shark, next day, nothing. You just gotta go and check it out…. Sometimes they around and they don't eat.*
	Smart (13)	Sharks as intelligent or exhibiting learning behavior.	*My encounters with the [oceanic] whitetips…. They're extremely smart, and they have really good eyesight. So you can put a bait with a hook and line on it, right in front of their nose, and they won't touch it…. You can bring that bait in, take the hook off, throw that fish back in the water, and that shark'll be on it in a heartbeat.* *[We] turn on the lights so the 'ōpelu comes to the lights. I'm not sure if the sharks come to the light or the fish. I'm assuming they get trained though, the sharks get trained to follow the boats around…. I don't think there's any increase of sharks. I think they're learning, so they find you quicker.*
	Instinctual predators (9)	Sharks driven primarily by predatory instincts.	*Shark, their brain is kinda small ah? They're eating machines is what they are.*

Table 3. (Continued) Interviewees' perceptions of sharks

Neutral	Fighters (9)	Hooked sharks as strong fighters. Some comments were matter-of-fact observations, some described sharks a hassle, and some described sharks as a good sport fish.	*[Threshers are] the hardest fish to bring up. Harder to bring up than, probably than anything out there.* *The bronze whalers are a tough shark. They're the meanest. A blue shark just lays there. They don't even fight. But the bronze whaler, and the whitetip. They give you a lotta bang for your buck.*
	Resilient (7)	Sharks as resilient to physical trauma.	*Makos don't die. I caught a mako that we took and we gutted it, and left it outside the boat, and pulled it back into the boat about an hour later and it was still trying to get us.* *Basically if there's tuna at the buoy there's a whitetip at the buoy, with lots of hooks in their mouth (laughs)*
	Sensational (6)	Sensational images of sharks.	*If we do get charters that they do wanna just catch sharks, just kinda the Jaws mindset, people wanna catch this big sea monster.* *People only imagine that it's a man eater, but basically they're not. They just a source of food basically. But people kinda got away from that because they seen too many Jaws movies (laughs).*
	Lazy opportunists (4)	Sharks as relatively slow, opportunistic hunters.	*They won't catch any marlin or ono without it being sick or hooked up. They have to be at a disadvantage…. Other than that I don't know if they can catch anything that easily. 'Cause saltwater fish is fast.*
	Not smart (4)	Sharks as unintelligent, or failing to learn.	*Those blue sharks don't seem all that bright, so you'll get 'um. You know, you may hook the same blue shark for 6 or 7 times.* *I don't know if you can train a shark, with that primitive mind.*
	Sympathetic (4)	Sharks requiring defense or protection.	*This tiger shark was here, and I think they were tryna tag 'um or do something here…. There was a big protest on that point, they all went out there… [Protesting against] hurting, hurting sharks. Even the tagging.* *Every day [the sharks are] hunted by somebody. Maybe not from something in their own water, but humans. Poor thing. So if the resource doesn't find ways to where the people can work more in touch with nature then eventually, we both die.*
	Temporary (2)	Sharks as a fleeting problem, given their variable abundance through time.	*If there are a lotta sharks, there are a lotta sharks. And then it's not gonna be a prolonged thing, you know. It won't last, it's just certain days there are lots of sharks, then it'll be ok again.*

To demonstrate that fishers' observations of shark behavior and their perceptions of sharks varied by shark species, I highlight the diversity in the "Sharks as…" coding frequencies for oceanic whitetip, tiger, and thresher sharks (Figure 3). The three most prominent descriptors for oceanic whitetip sharks were as fish indicators, competitors, and aggressive. The top three descriptors for tigers were similar, but also included the perception of sharks as dangerous. Often fishers' perceptions of sharks as aggressive and competitors, whether generally or in the capacity to depredate or deter fish from biting, went hand in hand. This was the case for oceanic whitetip sharks (Figure 3a), bronze whalers, and tiger sharks (Figure 3b), the three species most frequently described as aggressive competitors by interviewees. Aggressive, competitive behavior was also described to lead more frequently to shark mortality: *"An aggressive, hungry shark is probably gonna die*," said one fisher. But, as Table 3 illustrates, the way fishers perceive sharks are not wholly negative.

One of the most prominent differences between the oceanic whitetip and tiger sharks' hierarchy charts result from the whitetip's positive reputation as a fish indicator. One fisher said, "*It's a good sign too. When you're getting the interactions with the oceanic whitetips there's more fish around normally."* The tiger sharks' uniquely prominent descriptors were dangerous and economically valuable. Both of these were related more to their interactions with non-fishers. Their image as dangerous came primarily from fishers' descriptions of their threat to recreational ocean users, and their positive economic value was contextualized by their charismatic or sensational image in the tourism industry.

The composition of the threshers' hierarchy chart differed more drastically from oceanic whitetips than tigers. Like tiger sharks, threshers were also perceived as economically valuable and dangerous, but for different reasons. Threshers' economic value derives from their value on the market rather than in the tourism industry. Their depiction as dangerous (and a hassle) derives not from their threat to recreational ocean users, but from their imposition to fishers once hooked. Uniquely, fishers described hooking thresher sharks as a precursor to all of their thresher interactions. Threshers were always hooked at-depth and at night, and were often brought to the surface for several reasons, exemplified by these fishers' comments:

> *A good size thresher's gonna take you at least an hour to deal with. And you're not gonna just cut your line when it takes that much out of your basket or your reel*.

> *[Threshers are] mellow. Yeah. They're a fish eater so- Actually I haven't had one attack a fish. I never seen one eat a fish. We just always caught them on the line. Every time I've had an encounter with them, was always hooked…. Yeah, they just grab the bait. And so now you have to fight them. And take forever 'cause they so damn big.*

For their being hooked at depth and their tendency to run downward after being hooked, cutting the line on a thresher means losing valuable gear. Fishers also described not cutting the line on a hooked thresher for their inability to identify it as a shark prior reeling it in: "*'Cause all the guys, they think it's an 'ahi running, you know, so they don't wanna break it off*." Threshers' relatively small teeth also

impede their ability to break away on their own. For all these reasons, fishers often expend energy bringing them to the surface. Once at the surface, threshers' long tails, which may equal the length of their body, pose an added risk to fishers. These attributes of a thresher shark and its fisher interactions contributed to their being perceived as a hassle and dangerous. And, as the quote above explains, threshers' preference for small prey also contribute to their *not* being perceived prominently as competitors. Therefore, a shark's behavior and physical attributes, its value in various industries, even its reputation in the media may shape the way a fisher perceives and handles it.

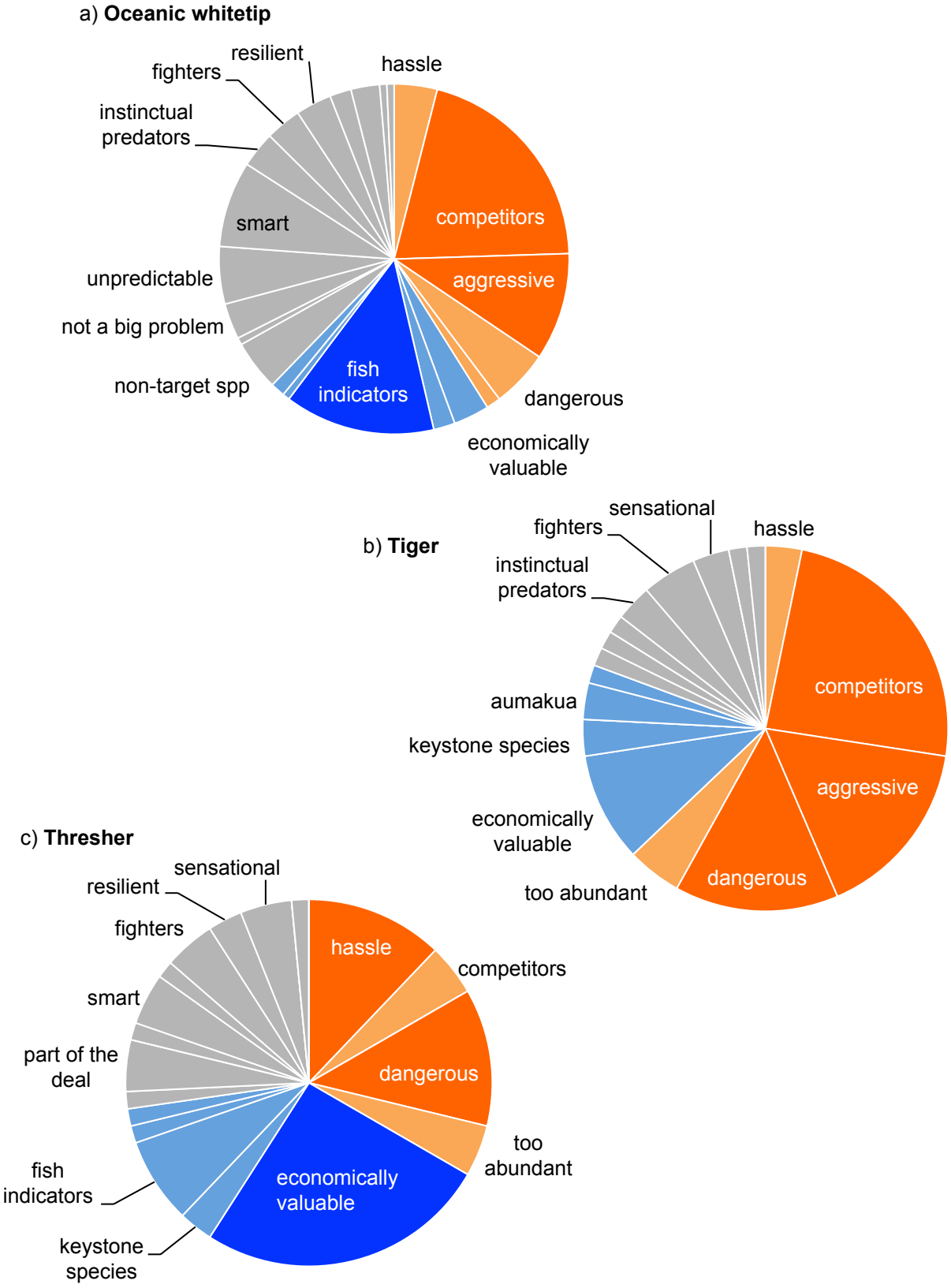

Figure 3. Interviewees' thematic descriptions of a) oceanic whitetip, b) tiger, and c) thresher sharks. Wedge size indicates the number of references across all interviews that contribute to each descriptive theme. Themes are color-coded to indicate negative (orange), positive (blue) and neutral (grey) descriptors, with the three most prominent descriptors for each species highlighted in brighter color. Labels are provided for wedges representing more than 3% of the species' references.

Sharks (not) on the brain

I conclude this synthesis of interviewees' descriptions of sharks with this theme, which demonstrates that for most fishers, sharks have not been a focal point in their fishing activities or info-sharing practices. Conversations between fishers about sharks are limited, infrequent, and coincidental. Many fishers described their inattention to sharks and shark trends prior to participating in this research or the collaborative shark-tagging project (12). When prompted for patterns in shark observation, many interviewees provided answers like, "*Hm, never kept track*," or "*This is the first time I've actually [thought] about sharks. I never gave much though to it,*" referencing shark interactions and observations being incidental to their focal target species.

Following these engagements, several fishers commented on new incentive to observe sharks more diligently:

> *There was no reason for me to like, kinda store the information that maybe now I might start storing. I had no interest at the time. But now, being involved in tagging projects and understanding about 'em, then now I'll definitely store whatever information I encounter, yeah?*

One fisher described our opportunity to engage with fishers for improved data collection. He also noted:

> *[Sharks are] just incidental to what we're doing, so it's hard to- My data is not the best data…. The fishermen out there all the time. But they need to know what they're looking for, right? 'Cause we not there to look for sharks, we're there to catch fish. So if you kinda jog our memory, then we might start paying attention to some of those things.*

In some cases, fishers even described the effect of these dialogues on their shark-handling practices. Two fishers' described peers' and their own release of threshers following engagement, and in one comical comment, a fisher described a fellow interviewee's response to an oceanic whitetip sighting after our conversation: *"[He] told me that, 'Ho I kill 'um but then I thought about Mia, I thought, ahh, no."* Thus, interviewees identified the role of fisher engagement in shaping shark-related dialogues where before there were none, and perhaps even its role in shaping fisher behavior.

Chapter 3

To its detriment, fisheries management often builds solutions from problem definitions constrained by their technical, but simplified character. These problems are often defined through exclusive processes as certain types of information and their bearers are given preference by management regimes. Recognizing power inequities and the multiplicity of problem definitions can offer depth to limited framings of fisheries management problems and solutions. Fisher engagement may offer a process-based solution in its ability to consider fisher knowledge and alternative perspectives of the problem, and improve fisher access to management discourse. It may also improve solution robustness when deeper-level problems, contextualized within relations of power, are appropriately addressed.

In this study, I provide a unique examination of substance and depth in defining and resolving fisheries management problems. I apply the theories of conflict adapted to conservation management by Madden & McQuinn (2014). Their Levels of Conflict model (CICR, 2000) and Conflict Intervention Triangle provide a framework to understand depth and sociopolitical context in fisheries management problem definition and solution development, respectively (Figure 1). Madden & McQuinn's framework illuminates historical, unresolved, and identity-based conflicts, and the potential for process- and relationships-based solutions to reconcile them. Researchers have applied the framework to conflict resolution and reconciliation in human-wildlife conflict (Crespin & Simonetti 2019), reframing it instead as human-human conflict imbedded within underlying social conflicts (Hill 2017) and highlighting opportunities for human-wildlife coexistence (Dorresteijn et al. 2016)." My work contributes to this body of literature as it shines light on the deeper sociopolitical contexts that underlie the substance of human-wildlife conflict. But, expand beyond conflict theory to explicitly examine the way fisheries management defines problems and develops solutions. I therefore also engage with discussions of the politics of problem definition (Adams et al. 2003; Bond & Morrison-Saunders 2011; Nie 2001), as I explore actors' access and influence in fisheries management discourse, and the way derived solutions may evolve with the inclusion of fisher perspectives.

Through a case study of fisher engagement and fisher-shark interactions in West Hawai'i small boat fisheries, I explore opportunities to improve exclusive, substance-focused problem framings and their respective solutions. I take a qualitative, inductive approach, collecting data through semi-structured fisher interviews and opportunistic observations of the Shark Tagger team's community-based shark-tagging study. I transcribed and analyzed interview data using NVivo software, performing content analysis through an iterative coding process. This study illuminates alternative definitions of the shark-fisher interaction and fisheries management problems. Accounting for those problem definitions in solution development, it also cautions against simplified solutions, instead offering multipronged solutions to address substance and depth for the collective benefit of sharks, and fishing, research, and management communities.

In Chapter 3, I build upon Chapters 1 and 2, using the conflict theories adapted to my theoretical framework to answer my research questions:

1. How and at what depth do fishers define fisher-shark interaction and management problems?
2. How might managers develop solutions to better address depth in problem definition? What role might fisher engagement play in defining and resolving multi-depth problems?
3. What insights can we gain by applying this theoretical framework (adapted from conflict theory) to fisheries management? How can we improve the processes of problem definition and solution development?

Chapter 1 provided the framing for this research, and introduced its theoretical framework and approach. Chapter 2 presented detailed results for the following themes from my interviews: Research Participants; Fishing in Kona; Economic Context; What does it mean to be a fisher?; Information sharing; and Sharks. Throughout this chapter, I refer back to results presented in Chapter 2, elaborating on themes of fisheries management, fisher engagement, and power to illuminate depth in defining and solving fisheries management problems. I first present the substance that defines the fisher-shark problem and informs its solution development. Then, I present deeper levels of problem definition and solution development.

Substance

Understanding the substantive discourse that contextualizes the shark-fisher interaction problem and informs its solutions is essential to address the needs of both fisher well-being and shark conservation. This discourse might include shark mortality rates and the economic benefit or costs associated with shark interactions, highlighting gear modifications, shark-handling guidelines, or fishing restrictions as solution components (Gilman et al. 2008; Tolotti et al. 2015; Ward-Paige et al. 2012). It could also illuminate the relationship between fishers' perceptions of shark species and abundance, shark-handling practices, and attitudes toward shark conservation (Drymon & Scyphers 2017; McClellan Press et al. 2016). The substantive context that frames the shark-fisher interaction problem in this case study is extensive. I elaborate on select themes that contribute to the substance of problem definition and solution development below.

Substance in Problem Definition

Much of the substance defining the fisher-shark problem has already been laid out in Chapter 2. It includes everything from sharks' habitat use and behavior, to the conditions under which sharks interact with fishers and their gear, to the way a fisher's financial needs relate to his fishing activity and behavior. Importantly, much of the information required for robust substantive solutions is still being pursued, for example as fishers and researchers collect shark interaction data and learn about their movements through time. In this section, I summarize key contributions that this research makes to the substantive definitions of the shark-fisher problem.

Upon encountering a shark, a fisher has many behavioral and shark-handling options at his disposal. The appeal of any option, however, depends on a number of individual and situational variables (see Decision-making section). These include fishing method, shark accessibility, a fisher's physical capacity to handle the shark (e.g., vessel size, age, crew) and willingness to risk reduced fishing opportunity, and how many sharks are in the area (Table 1). Some of these are subject to

species-specific shark behavior and habitat use, and may benefit from the collection of biophysical data through work like the shark-tagging project. The variables' relative significance according to fishers' perceptions, however, may benefit from qualitative assessments that uncover other important shark associations (Figure 3) and the ways they interact with fisher behavior. The most prominent depiction of sharks during interviews was as competitors. All 29 interviewees described sharks as competitors for their fish either through depredation or fish deterrence. Competition for fish, in turn, translated to competition for income and fisher livelihoods.

Despite the negative, competitive effect that sharks have on fishers' fishing activities, many interviewees described not devoting much thought to sharks prior to engaging in this or the community shark-tagging project. For many fishers, sharks were described as incidental, non-target species. This resulted in fishers dedicating relatively little observational attention to sharks, and discussing them peripherally with others in the fishing community.

Substance in Solution Development

In this section, I highlight key interview themes that contribute to substance in solution development. Several substantive solutions emerged from interviews, including information provision, compensation, regulation, and shark-handling alternatives. I present them below, using interview data to illustrate their applicability, and lack thereof, in the context of the fisher-shark problem in my study area.

Information provision

Many outreach and education initiatives frame resource management issues as problems of information deficit, and highlight info provision as a solution. The assumption that acquiring new information leads to a change in attitude or behavior may be true in some cases. In the section "Factors of fisher behavior" I provided examples of how new understandings of shark biology or shark significance leads to behavior change. One fisher, upon learning from Dr. Hutchinson about thresher sharks' vulnerability in Hawaiian waters, said, "*Now I will not shoot a thresher shark that I catch.*" Another fisher highlighted the utility of shark information tools, requesting explicitly that the Shark Tagger team design a shark identification guide or poster that advertises species' threatened statuses, where applicable. Referring to the first step in raising awareness within the fishing community, he said, "*You guys should have an endangered species list of sharks! That's the least you guys can do.*" Other interviewees shared this fisher's sentiment that education is a first step for researchers to take, and that its impact on individual's perspectives and behaviors will vary across the fishing community.

Though the scientific, management, and fishing communities' understandings of shark interactions and biology is still developing, and some interviewees described clear benefits from learning more about these things, the assumption that acquiring new information leads to behavior change is not always true. One behavioral alternative, shark avoidance, was described in preliminary talk story sessions as a possible outcome of information provision. I asked fishers if they would avoid a shark abundant area if provided that information in real time. Most replied negatively, because sharks are indicators of good bait and target fish: "*Where there's sharks there's fish*." Though sharks

as indicators of fish varies by species, fishing opportunity is necessarily entwined with shark interactions. Many fishers also described their optimism for fishing opportunity despite the odds that a shark-prone area may present:

> *Never, "Oh there's too much sharks I'm not gonna fish." No, you gonna try. There's always a chance that they're just there and they might not take your fish. Fishing is like that, you know, it's just like tuna fishing. Could be full of tuna, but they won't bite. Porpoise school can be full of 'ahi in there, and no matter what you do you can't get it to bite. And then some days they'll just, as soon as you get a bait out there they'll bite. I think sharks is the same way.*

The link between sharks and good fishing makes information provision an ineffective tool to promote shark avoidance, specifically. The only exception that interviewees provided was for distant fishing areas, where the investment to reach fishing grounds might be high enough to discourage fishing in a shark-abundant area.

Perhaps the greatest failure in applying education to the issue of shark interactions is that sharks, for most interviewees, are competitors for fish and income. And, as one fisher put it, "*If it comes between supporting my family and the one shark, I'm gonna put a bullet in it.*" Commenting on researchers requesting that fishers tag sharks instead of harming them, one fisher said, "*What? Why don't you start paying my bills?*" This competition between sharks and fishers' financial well-being or the well-being of their families renders education irrelevant.

Though the perception of sharks as competitors is prominent, their competitive impact on fishing individuals varies. For example, those whose financial well-being depends on landing fish—particularly for those whose primary source of income is fishing—have greater incentive to protect fishing opportunities, employ a wider range of shark-handling practices, or receive fishing income through alternative pathways (e.g., in selling marketable shark species or tagging sharks for collaborative research). What is consistent across the West Hawai'i small boat fleet, however, is increasing costs of fuel, bait, and ice, the upfront cost to depart for a fishing trip that does not guarantee landings, and a rapidly growing fishing community in recent years. The latter translates to increasing competition for fishing spots, and a decent price at which to sell catch, should a fisher land it. More than two-thirds of interviewees described fishing as a "lifestyle" associated with financial insecurity. For most interviewees, learning about a shark's ecological value or biology is irrelevant to this prominent problem framing, which juxtaposes fishers' well-being against sharks'.

The other thing that an educational approach assumes is that fishers' values and capacity for behavior change is fairly constant across the population. This is untrue anywhere, but particularly in Kona, where fishery participation is so diverse. Its fishers include both first-generation fishers and generations of fishing history, fishers who arrived from states or outer islands with different fishing cultures; who identify as recreational, part-time or full-time commercial, and charter fishers; and who employ a wide range of fishing methods. All of these variables layer to determine each fisher's capacity for behavior change. Those related to financial well-being have already been discussed. In another example, fishers who are live baiting have a relatively minimal spatial commitment to their

fishing area as compared to handline fishers. Upon encountering a shark while live baiting, one fisher described his opportunity to switch from live baiting to an artificial lure, or continue moving through the area. A handline fisher, in contrast, is committed to his fishing spot and his chances of landing a fish depend on chumming consistently. Other variables relevant to behavior change are less straightforward. Some interviewees, for example, described their receptivity to modify shark-handling practices as a function of their level of fishing experience or age.

Compensation

The lesson that getting rid of a shark for many fishers is a problem framed by financial cost highlights the value of financial compensation as a substantive solution. It should be noted that money was the only consideration that interviewees identified guiding their fishing practice, shark-handling decisions, and information sharing practices. Compensation as a substantive solution, however, was derived primarily from two coding themes: "Money" as a motivator for fishers' shark-handling decisions, and "Incentives" as a fisher engagement strategy. One fisher recommended:

> *You get the grant, and there has to be some type of reward. There has to be. 'Cause if not, everything comes down to the end of the month. You pay your mortgage, you pay your college loan or whatever.*

This interviewee, along with others versed in collaborative research, described the importance of acquiring funds through formal processes like grant writing and acquisition. These fishers recognized that access to this specialized kind of capital has the potential to create new opportunities for fishing, managing, and scientific communities. Through financial compensation, collaborative research becomes a viable alternative to harmful shark-handling practices. Said one fisher, "*You give me x amount of dollars to go tag every single shark that comes by the boat, they'll live. I'll spend all day tagging sharks.*" More generally, financial compensation, by offsetting some fishing costs and contributing somewhat to financial security, may legitimize and make a greater number of behavioral and shark-handling options accessible to a fisher.

Though no interviewees opposed compensation as a solution component, one fisher expressed his concerns for the potential of incentivized tagging to endanger inexperienced or insufficiently equipped fishers. There is also potential for incentivized tagging to encourage shark interactions that would otherwise not occur.

Importantly, financial compensation, though generally supported by interviewees, was not the only incentive for behavior change or fisher engagement described by fishers. One fisher contacted a member of the Shark Tagger team directly, offering to tag sharks for free if funds were scarce, and thanking her for her inclusion of fishers in this research endeavor to gather "*real true data*." Another substantive incentive for engagement identified by interviewees was the development of a useful shark deterrent or handling alternative. Additional incentives and motives are discussed in the section below titled "Depth."

Regulation

"*A law with no enforcement is merely a suggestion… Over here, there's zero enforcement."*

Regulation is another common substance-based solution to fisheries management problems, particularly for agencies that are best equipped to manage fisheries through formal legislative and regulatory pathways. Interviewees described the variable success of regulatory measures for lack of enforcement. One fisher described the lack of enforcement in Hawai'i as universally understood. Interviewees with experience outside of Hawai'i, in particular, commented on its relative absence of enforcement and management measures. Most fishers described the region's poor enforcement in terms of its lack of capacity, including funds and manpower. Two fishers, however, referenced enforcement officers' turning of the cheek on the rare occasions where illegal behavior could be prosecuted. One noted, "*In Hawai'i, it's all about who you know, not what you now. In Alaska, it doesn't matter. The rules is the rules.*"

Lack of enforcement, in addition to crippling regulatory effectiveness, has greater implications for the perceived legitimacy of managing institutions and their relationship with those being managed. As one fisher put it, regulations with neither enforcement nor buy-in accomplish very little: "*All it does is piss people off*." These kinds of deeper conflicts may inform the development of solutions around shark interactions, and will be discussed further in the section titled "Depth."

Shark-handling alternatives

"A lotta times as a fisherman it was hard because if you could wave the magic wand, please go away, you would."

This above sentiment was echoed by several interviewees: That when fishers use harmful shark-handling practices, shark mortality is not the goal. Instead, it is viewed as the most efficient or only available option. The pursuit of an alternative shark-handling practice that increases shark survivorship and efficiently preserves the fishing opportunity is a common goal that may unite fishers, researchers, and managers. Interviewees expressed interest in developing such a practice or tool, raising the ideas of a biodegradable jug and providing anecdotal evidence of the shark-tagging process as an effective shark deterrent. One fisher identified shark deterrents as the only topic that would incentivize his engagement. "*I don't know what else could be done,"* he said, *"That's the only thing I would listen to. If you had a deterrent. Other than that I wouldn't go to listen to anything else.*" The Shark Tagger project, in its 2017 and 2018 workshops, initiated discussions around non-lethal shark-handling practices with attendees and recruited some of its participants to tag jugged sharks to determine their survivorship post-handling. A viable shark-handling alternative remains elusive, but fishers' receptivity to work like this could be leveraged for the collective benefit of fishers, sharks, and those invested in shark conservation.

Depth

Substance-level problem definition and solution development is critical to fisheries management, but the deeper levels of problem definition and their resolution beyond substantive approaches are essential for robust, sustainable solutions (Crespin & Simonetti 2019; Penney et al. 2017; Shiffman et al. 2017; Webber et al. 2007). The discussion above provided the substance-based solution examples of information provision, compensation, regulation, and shark handling alternatives. In this section I describe the deeper levels of problem definition that contextualize this case study, using the three coding categories that contributed heavily to their framing: fisheries management, fisher engagement, and power. Then, in "Depth in Solution Development," I identify key considerations for recognizing relationships and process in order to develop solutions for deeper-level problems. Note that the fisheries management and fisher engagement categories encompass interviewees' discussions of all relevant themes, both at substantive and deeper levels. For example, substance within these categories includes discussions of enforcement, regulatory measures, education-based initiatives, and financial compensation. Overwhelmingly, however, their content resides within the deeper levels of perceived problems and solutions. I define and discuss these below.

Depth in Problem Definition

Fisheries management

The fisheries management theme included interviewees' descriptions of local fisheries management, including their experiences with its actors and perceptions of its efficacy. Some of these descriptions were substantive, but because they were rarely directly related to shark management, I consider them relevant to this case study's deeper contexts. Though most commentary on fisheries management was critical, interviewees' perceptions of fisheries management were neither strictly positive nor negative. Initially, two coding sub-categories under fisheries management were "Over-regulation" and "Lack thereof." These contained fishers' descriptions of too much and not enough management, respectively. Upon further examination, text coded under the "Over-regulation" and "Lack thereof" themes highlighted specific aspects of management that fishers identified as problematic. These descriptions of problematic management elements are captured in Table 4 below, in descending order according to how many interviewees described each concept (in parentheses). Themes accompanied by an asterisk were described by interviewees to affect their perceived legitimacy of fisheries management. Themes in bold, which require elaboration beyond their illustrative quotes (Table 4), are described further in subsections below.

Table 4. Problematic aspects of fisheries management described by interviewees

Management themes	**Descriptions of…**	**Illustrative quote(s)**
Disconnect* (17)	Disconnect between fishers and managers or scientists; often between managers' or scientists' logic and fishers' on-the-water experiences. Also a lack of consideration or empathy for how management and research decisions affect fishers.	*Go to the fishermen that are in the water and actually interact with the animals everyday. Ask them, first. Before you go to Land Board, all those other people that think they know what they're doing. If people that generally made laws could do that, I think it would open their eyes a lot more, as to what actually goes on. Instead of just reading what is on the piece of paper that they receive and signing it off.* *Get people that are in the industry to do the job, not scientists from a school room. You know what I mean? Like people that feel it and get it and know it, so when they ask you questions it's gonna make more sense…. You're talkin' the same language that way…. They'll come ask some dumbass questions.* *You know they make these decisions for this stuff without really knowing the impact of what it has on our life.*
Relative impact* (14)	Misplaced focus of research or management. Often related to another fishing group with greater resource impacts and/or lesser regulatory oversight.	*Most of these laws are people bored and they wanna blame fisheries for the depletion of fish, or hunters for depletion of animals in the forest, even though they don't see the real issue.* *We're not the ones depleting our fish supply, it's the predators and it's those outside guys. Not us. We cannot catch tons of fish in a day (chuckles).*
Unfounded regs* (13)	Management and regulations based on public sentiment and special interests rather than science and rationality.	*Unfortunately a lotta regulations are made not by science but by emotion.* *Hopefully [researchers] can save it but, we'll see. Get some rational fisheries management anyway.*
Data quality* (11)	Questionable validity of data collected for fisheries management, its use in decision-making, and the ways that might be improved.	*I'm all for proper management if I can see the results. You know, show us where those numbers came from.* *The fishermen are out there all the time. They're out there in fact more than the scientists I think, in numbers. So they can be an asset.*
Transparency* (8)	A lack of transparency or clarity with regard to managers' or scientists' motives and goals.	*All we know is that you guys just want us to try and tag [sharks]. And that they may be on the endangered species list…. What more are you looking for?... What's your objective? What's your goal?* *Government work is more transparent now. Which is good. Before if you're in government, ho, nobody questioned you…. So, consequently you gotta deal with the public a lot more before you instill some kinda regulation…. It's good to bring [the fishermen] in at the early end, and then let 'em know what you're doing. There's no hiding anything.*

Table 4. (Continued) Problematic aspects of fisheries management described by interviewees

Compromise (8)	Management discourse and processes as being biased and unwilling to compromise or consider other perspectives.	*You've got the total left that just want regulation… and then you've got the other side that is just all or nothing. There's nothing in the middle…. There's no management.* *A lotta time the decision is already made and they just have these public hearings and all these things… It's so one-sided that it just goes always one way already.*
Permanent (7)	Management measures as permanent and non-adaptive.	*It's like they had that 10-year ban in Kaʻūpūlehu, that thing is never gonna open. I mean, it's never gonna have a review after five years. It's because the state don't got any money.* *If you make it a law that you cannot kill this, and then now it's a law, now you gon' get a million sharks around you, you can't even fish. There's gotta be a balance…. Because in the future you might not be able to retract that law yeah?*
Equity* (6)	Inconsistencies across management logic, varying to afford benefits to certain groups and target others disproportionately for regulation.	*It really seems like they pick and choose what they wanna- What rules they wanna push, what rules they wanna enforce, to kinda pick on a specific group of people.*
Science as a political tool* (5)	Researchers and their science applied selectively to support politically driven management.	*Just like every scientist I know [does], they only take the information that proves [their] fact. And [name] does that all the time. Every single scientist.* *I said, "So, [name], you get rid of that fictitious blue line you got up there, and you'll have your reduction of catch." 'Cause it was total bullshit that the recreational catch outdid the commercial catch by 2-3 times…. And that's all that was, was a foot-in-the-door technique [to make the first ever recreational fishing license].*

First, I present the theme “Self-management” which describes fishers’ resource management outside of scientific and state regulatory endeavors.

Self-management

To recognize resource management as coming only from regulatory bodies would be to deny fishers’ agency and capacity to care for fisheries resources. Many fishers’ descriptions of a lack of management were related to their call for more of a different kind of formal management (Table 4). But, fishers also highlighted their own self-management practices. Many interviewees described self-imposed size limits, and a subset of these called for an increase in the state’s minimum size for the take of ‘ahi (4). Two fishers described their self-imposed bag limits per fishing area, and their practice of rotating between fishing areas to avoid depletion. One of these referred to the ocean as his bank account, describing self-management practices as ensuring (to the extent possible) his financial security. Another fisher whose charter business relies on a healthy shark population, noted:

> *And I get people [who] ask, ‘Oh, can we keep that?’ No, absolutely not! They gotta be about seven years old before they can breed, and they have like one pup every year, or two?... it’d be like shootin’ myself in the foot.*

Thus, self-management was described by interviewees as a practical tool to steward their resources and ensure their livelihoods. But, interviewees also expressed a desire to preserve fishing culture for future generations: One fisher said:

> *Most of the time, I don’t think people realize that in general, we’re self-managing. We know for a fact we need the resource to last… I’ve got kids now... We want the fishery to be around for generations, so I think it would definitely help that any management ideas, if they would actually get more of us involved, and not in such a- You know the meetings that I have gone to and stuff, they’ve always been fairly hostile, cause I think it’s that public perception that we’re just there, chasin’ that almighty dollar, hell to the resource, kinda deal.*

The quote above also illustrates another common frustration among interviewees, that fisheries management discourses often deny fishers’ capacity for self-management and challenge their identities as resource stewards. This informs the deeper levels of problem definition that must be accounted for in solution development.

Relative impact

About half of my interviewees, at some point, described their impact on fisheries resources as relatively low compared to that of other fishing communities, or described being disproportionately regulated. Often, discussions of relative impact were related to interviewees’ fishing identities. Interviewees asserted their small-scale fishing identities as they described the relatively large impact of longline and purse seine fleets on fisheries resources and pelagic sharks:

The longliners and purse seiners. I mean the numbers that we kill, I mean I might interact nowadays- I might take all year maybe 10 or 12 sharks. Maybe 15, maybe 20, I don't know. Those guys (chuckles), every single trip, hundreds! And there's 200 boats, there's 220 longliners operating out of Honolulu.

Please, to your higher ups or whatever- I see a lot of generalization… Make a distinction between the fisheries. You got handline, longline, purse seine, whatever. And that we're not all the same deal… Even though we're both tuna fishermen, longliners and handliners? You can't even compare, we're so night and day to how we do it…. A tuna fisherman is not a tuna fisherman. There's many different kinds. And we have such a different impact on the resource. That's important to me.

In the context of pelagic shark mortality in the industrial versus small boat fisheries, most interviewees referred to the longline and purse seine fleet as belonging to the "other" group. It was notable that one fisher, retired from the longline fleet, emphasized purse seiners' depletive role and grouped the longline and small boat fleet together as having relatively minimal impact:

The purse seiners do 99 thousand percent the majority of the fish depletion and damage to the ocean. Nobody goes after them! They go after the longliners. They go after the nearshore fishermen. We do 2% of the damage…. So it just seems redundant to go after the smallest population of damage. The must regulated! You know?

High seas fisheries' relative impact was a prominent interview topic because of our research focus on pelagic sharks. Comments were often related to interviewees' identities as small-scale fishers and as stewards of their resource. Some of their comments were defensive in light of the much larger impact that high seas fisheries have on pelagic sharks. Others expressed concerns for its lack of practicality, and questioned our research focus on the small boat fishery. Some of these will be elaborated upon in the Fears section of Fisher Engagement.

In other descriptions of other fisher groups' relative impact on the resource, interviewees asserted local value systems as they described "outsider" groups disregard for them. For example, one fisher described the wasteful dumping of sport-caught fish by new members of the fishing community:

They came back to the pier, they were at the wash rack, and I guess they caught like 20 or 30 of 'em. They're washing the boat, guess what they do with the fish? Walk to the dump and throw 'um away. That pissed the shit outta me! And in the meantime, I'm being overregulated but they're not?... I brought that up to the Land Board member, I brought that up several times at WesPac, and [manager] told me, "What am I supposed to do about it?" Don't fuckin' act like I'm killing everything, 'cause I eat everything. They're wasting it.

This interview excerpt and other quotes captured by this theme demonstrate that the issue of relative impact is closely tied to equity and the perceived legitimacy of management. Some interviewees described unjust regulations that target populations because they are simply easier to regulate. In some cases this was discussed in terms of managing bodies' regulatory jurisdiction. In others, equity was discussed in terms of fishery visibility. One fisher commented, in reference to high seas fisheries:

> *We're visible, they're invisible. They're out there… in the middle of the ocean, no enforcement... We're visible, we're comin' in every day, people see us out there. So we become the enemy, and those guys just go on, business as usual.*

Importantly, this theme was tied to issues of power, where fisheries with greater political influence or economic impact are perceived to be regulated less. Often this was in reference to the longline fishery, with its political organization and ability to supply for the high demand of a local seafood industry. Said one fisher, "*It's not about science, it's about who's got the power. Who's got the most influence and strength behind them.*"

Equity

Equity was a crosscutting theme that appeared in discussions of fisheries management and fisher engagement. In their discussions of equity, interviewees described the tendency of fisheries management to afford certain groups benefits while targeting others disproportionately for regulation. For this reason, the theme of equity overlapped heavily with relative impact. Both of these affected how fishers perceived management legitimacy because unrecognized fisheries problems led to interviewees doubting management logic and efficacy when they were targeted:

> *I think that's where a lot of our management goes wrong, and I think they don't necessarily look at the way they* should *do stuff. A lot of us fishermen have talked to different state agencies at times about them raising the minimum weight for tuna for sale…. And for the state to close off certain stuff but then have such huge gaps in that type of stuff, to me, says it's more- A lot of us think it's more driven by the tourism more than anything else. Save the pretty reef fish, you know, kinda forget about the other stuff.*

Comments about equity in fisheries management were also laced with discussions of power, which the above quote illustrates in its reference to special interests influencing management agendas. The variable access that different actors have to guide the distribution of management benefits and costs are discussed further in the section below, titled Power.

Importantly, fishers expressed greater receptivity to management that would affect everyone equally even when the alternative affected them the same way:

> *We tried to get the sale of billfish outlawed… So when they finally turned around and said, "Ok, we're thinking about doing this, but for West Hawai'i only," oh, oh hell no! No, no, no, no,*

no. These people signed the petition because they thought it was gonna be a statewide ban, not a ban on just us.

Fisher engagement

To highlight the deeper levels of problem definition relevant to fisher engagement, I present the themes which interviewees described as deterring and motivating their engagement in fisheries management and science. These are presented in Table 5, once again in descending order by the number of interviewees who described each theme (in parentheses), with themes in bold described in greater detail below.

Table 5. Fisher motivators and deterrents for engagement in fisheries management and science

Fisher engagement themes		Descriptions of…	Illustrative quote(s)
Motivators	Fighting for fishing (19)	Engagement for its opportunities to defend or improve fishing opportunities; often in response to fishers feeling their individual fishing activities would be threatened.	*I would think something like, oh ok we gonna have to stop commercial fishing in porpoise, ho! They, quickly, they'll come (chuckles). But other than that, it's hard.* *I realize over a lifetime of [fishing], it's so special… And it needs to be protected…. That's my dream in the whole thing of working with you is to- …there's just nothing as pure as this (chuckles).* *That's the only thing I would listen to. If you had a [shark] deterrent. Other than that I wouldn't go listen to anything else.*
	Fishers' voice (19)	A need for fishers' voices to be heard by fisheries management actors and to affect meaningful change. Often this was a fisher goal that went unmet during engagement.	*You guys are probably gonna be fisheries managers or advising fisheries managers and stuff, and at least you listen* *You gotta get everybody's opinion, please. Because I also believe in fairness…. Make sure now! Because that's what I want you to do. Not only one side of the story. So please capture everybody.*
Deterrents	Indifference (12)	Fishers' low participation rate in management discussions, e.g., for lack of motivation, perceived legitimacy of management, or relevance.	*It's not often that fishermen in Hawai'i actually attend meetings… or try to do anything about regulations or new laws that are set in place, just because they have a carefree attitude, and they see that… not many laws that get put into place get enforced.* *Everywhere I went, they went. Everywhere they went, I went. We all did it together type of thing…. We did our best to try and rally whoevers, but we still most of the time end up being just us.* *Gettin' word out to the fishermen, basically as long as their ox isn't the one being gored, they don't care.*
	Fears (6)	Fishers' concerns for or fears related to fisher engagement motives and outcomes.	*I had to ask… about your goals and intent because… I go to meetings now, I know what they're trying to do to Kona. They're trying to make this an aquarium…. This would be a place but they have to also think about the culture. And the local people here.* *That's where everybody shuts up… 'cause we get these things that end up out of our control. And then next thing you know it's a law, and we can't go near 'um, or we can't fish these areas.*
	Giving up (5)	Fishers giving up on engagement opportunities given their past experiences.	*I told him, "No dude, I'm done with that kinda deal."… At the end, I felt like it was so much effort coming from our side, with no end result. Or meaningless time that we spent there… No matter what we say or do, there's gonna be no results.* *Oh I go off and on, but not taking interest like I used to because it doesn't matter. That's the sad part…. Why have people go over there and have issues where somebody really care about something, voice their opinion, and don't matter?*

Fishers' voice

This theme captured interviewees' call for fishers' perspectives and knowledge to be heard by fisheries management actors and considered as management is developed. Fishers often described engagement opportunities failing to provide genuine opportunities for their voices to be heard. Interviewees perceived of engagement outcomes as pre-determined—with engagement fulfilling a procedural requirement for managers—or leading to outcomes that didn't support fishers' needs: "*We're discouraged to give our input because it doesn't even matter! It makes no sense to support something that's not gon' support you. And that's exactly what we find.*" This led to some fishers' lack of faith in the engagement process, and others giving up on it completely.

In other cases, fisher voice was described in terms, again, of power and access. One fisher described money being the key to being heard: "*As fishermen, it's known all across the state and the country, politicians don't listen to anything that we have to say. Unless we give them money to listen to us."* Others described fishers being dismissed because of the way fisheries management prioritizes knowledge that is formalized by academic credentials, for example, and communicated in a specific way. Said one fisher:

> *The rough and ready guys, the best fishermen you know probably didn't graduate high school. The best guys out there. So, when their voice is heard… It's ignored anyway. Whether we speak up and whether we give good info, it usually doesn't even matter.*

Though in its early stages, fishers responded positively to being included this and Dr. Hutchinson's research, describing it as a unique opportunity: "*This is the first time I've been approached in my entire life, about any of this stuff! By Melanie, through [fisher name]. We haven't had the option to be approached."*

Fears

"*And that's our biggest fear is by talking to you, we're vulnerable!"*

This theme captured fears and concerns that interviewees expressed with regard to fisher engagement. Most of these were prompted either by my interviews or by the Shark Tagger project, and were related to engagement leading to fishing closures and restrictions: "*The deeper you guys go into it, you're feeding Nature Conservancy to actually shut down fisheries. If you think about it, because that's the only way to do it."* For his concerns about our motives as researchers, one fisher inquired about our funding, intent, and how we expected tagging data to influence management. Some interviewees were hesitant to refer additional fishers for interview, recognizing that it may not be a position that peers would be willing to occupy. One interviewee laughed, "*I don't think he'd talk with you. You know how [name] come across like you guys are gonna turn it around and you guys are gonna screw us over? Those guys are ten times worse than [name]!*"

Interviewees also expressed concerns about the loss of control they experience after providing their input to managers or scientists: "*So that's why we not big on sharing information.*

Because it's always turned." One fisher connected his fears, as in the section Relative Impact, to researchers' misdirected focus on small boat fisheries:

> *That's our biggest fear too… is that by talking to you, and we're vulnerable, "Ok, we told them that we catch whitetips." "Ok, let's close down Kona for three months because these guys catch whitetips more during those months." Well on paper that looks alright, but then (chuckles) all the damn longliners are still- You can't touch them! So you just killed us, you just destroyed us for nothin'.*

He concluded his interview with the following words: "*It's exciting to work together, we just hope that we can trust that you'll do the right thing for everybody, the ocean, by us. Do the best you can, it's not a perfect science.*"

Power

Power and its emergence in fisher interviews appear throughout discussions of depth in problem definition and solution development. Here, I summarize some of the key ways that certain types of knowledge and actors are afforded greater power in fisheries management discourses; particularly in their access to and influence in the processes of problem definition and solution development.

Interviewees identified formal, academic, and scientific knowledge as having greater clout in fisheries management discussions. This was described to elevate the voices of managers and researchers over fishers', who offered experiential knowledge instead. The denial of fishers' input for their presentation of a different type of knowledge compounded limited opportunities to be heard, poor incentives for fisher participation, and the representative advantages provided to those with financial capital. Interviewees recognized the benefit of access to both a formal education and funding:

> *I've had people come from Chicago who don't know their left foot from their right foot in the water. But they get the degree. And I'm like, "Oh god." SO I don't know in the political world if that's the kinda idiots they deal with in those matters, but in the ocean, the fishermen know. That's what we do! You don't need to have one degree to know what's going on… To fix all the problems, you have to get your degree, do your thing, and find one route to the money. Tellin' you.*

Fishers provided many examples of managers and researchers asserting power in fisheries management (Table 6). Managers' power was depicted by interviewees who described their quick and uninformed decision-making for issues in which they are minimally invested; asserting their correctness or denying fishers answers when fishers' knowledge challenged their own; and hosting public meetings with limited advertisement or accessibility. Researchers' power was depicted through a lack of transparency and communication in their science; their representation of fisheries systems and fisher data to managers; and, like managers, through their influence over issues in which they have relatively little investment.

Interviewees generally described fishers as occupying a position in fisheries management of relatively little power and representation. But, I provide an example of the influential power of key actors (Table 6), who play an important role in sharing information with fishers and recruiting them to potential engagement opportunities.

Fishers also described the ability of certain actors to influence fisheries management discussions through different types of leverage. Beyond managers and researchers, these included the tourism industry, high seas fisheries, environmentalists, the wealthy, and NGOs (Table 6). Fishers described these groups greater access to financial capital and influence on public perception. Fishers described environmental NGOs, in particular, as being directly involved in state fisheries management. One fisher noted: "*The DLNR Board is I think made up of all Nature Conservancy, which is not good. In some ways. They make decisions with I think people actually lacking the knowledge of the situation*."

As introduced in the theme of Relative Impact some actors' power was described in terms of their ability to divert management focus, namely the high seas fisheries and tourism industry. One fisher elaborated on what he referred to as, "*the real issue*," (see relative impact in Table 4), describing tourism's development interests:

> *This is an example we had for the SCUBA spearfishing ban. We have pictures of pāpio in Kona Village before all of the development and golf courses up there. And the reefs were amazing, the fish were everywhere, there was still limu kohu and ogo and everything growing up there. And then we have pictures from six months after development started. Everything's dead, the water's murky, the reef is dead. There's no fish in the area. And it's just, it's not something you can control, just 'cause development's always gonna happen. But, it's the truth that people don't like to see.*

In the discussion of equity, another fisher guessed that the "*huge gaps*" in management might be attributed to the tourism industry, which prioritizes the protection of "*pretty reef fish*" and ignores the small boat fleet's concerns for species like 'ahi.

Table 6. Powerful actors and interest groups in fisheries management

Actor/Group	Illustrative quote
Managers (14)	*We request [the DLNR Board] to come here and listen, or we actually request these board members for a meeting, like you know the Hawai'i one is that guy [name]. He actually came and he listened to us, but he didn't know a lotta things that was really happening. And he voted already.* *I flew to Honolulu. Whoever wrote that up, as far as what fish were allowed… they left out major species. Because whoever came up with the list of fish was not a fisherman, obviously!...The marine reserve thing was in its final stages, and they said, "Well, why didn't you come around with this earlier?" I said, "Well, because I did not know!" Simply did not know.*
Researchers (13)	*I stood up, I said, "How did you get that blue line since it's not reported?" And [name] says, "We have our ways."* *We just hope we're represented properly by giving you this information…. We just hope that we can trust that you'll do the right thing for everybody, the ocean, by us. Do the best you can, it's not a perfect science.* *That's why he's so adamant about going to the meetings, because he said most of the regulations are just from a bunch of scientists that don't really know about the industry.*
Fishers (13)	*We have no voice. The fishermen have no voice.* *If you gonna find out something, [name]'s gonna let us know. So we don't need to all be in tune as much as he is, 'cause he's always letting us know. "Hey, by the way this is coming out." Every little thing, like this whole shark-tagging thing, no one woulda known about it if it wasn't for [name]. He gets the flyers and he passes it out, he's like, he's a politician. Which is good though.*
Tourism industry (12)	*Well [tiger shark researchers] also got a big bundle of money from the state, because the state wants to figure out how not to eat tourists.* *A lot of us think it's more driven by tourism than anything else. Save the pretty reef fish, you know, kinda forget about the other stuff.*
High seas fisheries (10)	*[Purse seining is] big money business too, lotta politics in all of that. So it's interesting to see if they'll ever try limit those- that type of fishery.* *Sportfishing and the local commercial fishermen are minute compared to like, the big corporation or big fishing companies, in the state of Hawai'i. The longline fleet takes top priority, I mean from what I used to see before, over everybody else. And they get away with a lot more than anybody else could, and if the smaller fishermens came in there to voice what they thought about the tuna, and whatever, they just went in one ear out the other ear.*
Environmentalists (10)	*[They wanted] to get some people that knew nothing about fishing that were, what do you say, more environmentalists than fishermen, into the Council.* *They're trying to make [Kona] an aquarium. Because they wanna preserve a spot…. All that conservation thing, here people get their way, because Kona was one small, small local community here… You know the local population is super small here.* *[They] stopped [selling sharks] actually several months ago. Actually, because some person grumbled about, we should be saving sharks.... The person that complained about saving the world with sharks, is another type of person that's a little bit more loud or- I wouldn't say loud, but more vocal.*

Table 6. (Continued) Powerful actors and interest groups in fisheries management

Wealthy (7)	*They closed it… And this happens to be that it's the most wealthy area in the coast. So they just don't want locals down there fishing. And you know, shoots, we grew up down there.* *The rich always win. It doesn't make me feel very confident about the fishery's future.*
Media (5)	*I don't think one fisherman would spend the time to go learn about sharks, when they can watch Discovery Channel Shark Week, that's about the only education they gonna have (laughs).*
NGOs (3)	*The Nature Conservancy. They're preservationists, and they have a whole different thinking you know, they'll go to the Nick's fish market and order 'ōpakapaka on the plate and stuff like that and eat that, but yet they wanna close bottomfishing in the leeward islands.* *Fishermen aren't stone-age killers that go out there and just murder everything. You know the thing that the NGOs and the Pew Trust and everything want everybody to believe, that's a mistaken image.* *I think most of the time, we're a lot more in touch with what's going on out there anyways, than necessarily these big conservation groups that are coming in. So, I think that's what makes it a little hard sometimes.*

Depth in Solution Development

In most cases it is difficult to separate the part of a solution that is attentive to process from that which is attentive to relationships. I will discuss them in tandem as I navigate the process- and relationships-based solutions which emerged from interviews. These provide opportunity to address deeper conflicts, including disconnect between fishers, researchers, and managers; perceived and actual data quality; transparency; lack of compromise; fisher voice; and power inequities. Below, I present three critical considerations for deeper-level solutions that emerged from interviews: communication and trust-building, convenience, and inclusion. Then, as strategies for fisher engagement, I share the value of collaborative research and knowledge exchange.

Communication and Trust-building

Communication and trust-building are crucial elements of solutions attentive to process and relationships. They build humanity and understanding between groups that might otherwise not interact (Madden & McQuinn 2014). Interviews and Shark Tagger public workshops allowed fishers to voice their concerns about researchers' motives and goals, and researchers to recognize and respond to them explicitly. This process was critical to build trust with participating fishers, encourage their continued support in data collection and interviewee referral, and even shift their perspectives and behaviors. Interviewees described both situational and more general shifts in their own shark-handling practices following conversations with Dr. Hutchinson and myself, including the release of certain shark species.

As a practical tool, communication can also incentivize fisher participation and improve data quality. One fisher recommended reporting results and outcomes of collected data back to the fishing community at regular intervals. Of the field relevant to shark interactions on the state's reporting form, he recommended, "*A short thing they can send to the fishing public, so that they know that all this reporting was not done in vain. But right now, it's a bottomless pit.... At the end, you don't know where that information is going.*" Another fisher's comment also emphasized the value of transparent communication as a solution to the data quality problem: "*If you can get that transparency between the both camps and more trust, you know. I think that's a really important part of a scientist working with fishermen. Because we are the best data collectors.*"

Interviewees highlighted researchers' and managers' opportunity to utilize existing social structures in the fishing community to build trust and facilitate the sharing of information. Key actors, respected and in communication with large numbers of fishers, were instrumental in identifying and encouraging the participation of additional interviewees and shark taggers: One fisher noted:

> *If you can somehow get the support of the iconic guys… Then they'll spread the word ah?... If they get buy-in, then certainly their friends will probably get buy-in, and they got a wide range of friends…. So you can talk to them about, "Hey, we should be doing this you know. We should be helping these guys do this." Rather than the scientists coming over telling, "Eh you guys should be doing this you know." Guys go, "What?" (chuckles) Yeah. So it's good to garner some support in-house.*

Interviewees identified another type of social influence as affecting fisher behavior, stemming not from key actors but larger communities and social norms: "*Peer pressure, or peer agreement is a really valuable resource that I don't think is utilized often enough.*" Fishers attributed the shift in the billfish fishery from killing to tagging and releasing billfish to this influence. Interviewees also described reductions in shark landings following pushback from the Honokohau Harbor or larger shark conservation community, and avoiding harmful shark-handling practices following confrontation with Hawaiian value systems or while participating in visible. In the relatively visible charter and daytime fisheries, shark-handling practices are more likely to be influenced by social norms for their observability (Nyborg et al. 2016). Interviewees also described a local fish market ceasing its sale of shark meat in response to confrontation by shark conservation interests.

Several fishers asserted that fisher behavior and regulatory compliance was an individual decision, rather emphasizing social influences. The reliance of fisher behavior and compliance on individual preference was also a result of lack of enforcement. Said one fisher:

> *It's up to the person alright? When it comes to that. You're on a big, heavily, big ocean. It's not heavily regulated in terms of like all the guys that could be out there. So it's up to us, or up to you, to do your best. And then hopefully you can put some knowledge to the next person.*

Particularly in scenarios where decisions are more critical, and an individual's capacity for behavior change is low, trust-building may aided by recognizing and respectfully navigating fisher identity. For example, solutions that recognize fishers' identities as self-managing stewards, their connection to fishing culture, and the various elements of human well-being that put fishers at disproportionate risk, may have better success than those that do not.

Drawing from Table 4, which summarizes the aspects of management described as problematic by fishers', other important characteristics of process- and relationships- based solutions might include compromise, transparency, and ultimately a genuine effort to bridge disconnects between the knowledge of fishers, researchers, and managers. This requires that certain imbalances in equity and power are recognized, for example, in the way that researchers' and managers' knowledge and voices are elevated in fisheries management, and aspects of their well-being are not threatened by engagement or management processes in the same way fishers' are. One interviewee provided the following example of a friend's negative experience with managers:

> *My friend, he's like going through the bottomfishing BRFA because he wants to fish on the other side of this spot that is closed up in Kohala, so he seen the whale that was entangled. And he said there was a whale with big rope around it with like two tiger sharks following it, so he called DLNR and they were so offensive because they just ask, "So, are you in that BRFA [bottomfishing]?" More worried about the BRFA bottomfish.*

Challenging the extractive, antagonistic approach that some interviewees described of their interactions with researchers and managers, one fisher suggested a gentler approach to fisher engagement, which he called a "*local approach*":

> *You know, starting a conversation, feeling 'em out before you even ask 'em what you're gonna do. Not just say, "Hey, I'm here, I'm a scientists, and I wanna get- where'd you get that and how was the current?" You know. Like, "Hey brah, how'd you do today?" and just feel 'em out.... Not come from the top and nīele and just sneak up on 'em. Do unto others, you know.*

Thus, a combination of transparent communication, compromise, and sensitivity to fishers' identities and previous experiences with researchers and managers, may build trust and relationships between groups.

Convenience

Another important part of process-based solutions is making engagement accessible to and convenient for fishers. One fisher said of his friends who are actively engaged in fisheries discussions, "*They're retired and have time to make a difference*." Engaging in fisheries management and its participatory processes exerts high transaction costs on its participants, requiring investments in time, energy, and money (Vaughan & Caldwell 2015). Some fishers described paying their way to attend management meetings on outer islands, and rearranging their fishing schedules on which their livelihoods depend, to meet researchers' and managers' needs. Following these investments, engagement regularly failed to recognize fishers' input in ways they felt was meaningful.

As scientists and managers seek meaningful engagement with fishing communities, they must be attentive to fishers' needs and schedules, the geographic dispersal of fishing communities in vast areas like West Hawai'i, and the kinds of environments that are accessible to the target community. One interviewee noted, "*[Fishers have] been to lotta formal things, and people tend to not show up.*" For example, one fisher who played a significant role in recruiting participants to the shark-tagging project hosted an informal meeting in his home. Several of his fishing friends, difficult to sit down with for their busy commercial fishing schedules, attended along with Dr. Hutchinson. Other interviewees' suggestions for accessible and convenient engagement included restricting the duration of engagement events, hosting them in central locations or multiple locations across large areas like West Hawai'i, and enabling data submissions through phone and text.

Inclusion

Interviewees' comments about inclusion also illustrated the diversity in perspectives across the fishing community. These of course differed according to variables like age, experience level, fisher identity, and fishery. But they also vary across geographies. One fisher pointed out that we had primarily engaged with the fishing community based around Kona: "*I think you should get more people tagging.... We had only the north people here, and the people from the harbor, that fish outta this harbor. But like you folks didn't have people from the south.*" Interviewees also described variations in fisher perspective and shark abundance across the island chain. This study provides a

foundation in understanding the way perspectives differ across some of these variables, while others, like variation across neighbor islands, very clearly present opportunities for future studies.

Interviewees' also highlighted the responsibility of researchers and managers in gathering fishers' perspectives and including them in fisheries management discussions. Many fishers described their lack of awareness regarding management discussions and engagement opportunities. One interviewee described the lack of information received directly from management agencies:

> *Basically you're gonna hear it from soembody else, that heard it from somebody else (chuckles). You're not gonna see a DLNR guy standing over tehre saying, "Eh you know, we got new rules."... It's never really intentional. And most times it catches you off guard.*

Another emphasized the role of early inclusion in managers' self-interest: "*Bring them into the loop, and just let 'em know what you're doing.... If you wanna go down that road, because otherwise invariably they're gonna stop you in public hearings.*" Beyond participation in management and research discussions, one fisher suggested elevating fishers so they are directly involved in management and science: "*Get people that are in the industry to do the job.*"

Collaborative research

Collaborative research is one type of process-based solution. The Shark Tagger project has demonstrated the ability of collaborative research to build relationships and trust, and collect valuable data that might not otherwise be available. Its first public tagging workshop in October of 2017 was attended by six ocean users, most of them fishers. A year later at its second tagging workshop, about 30 were in attendance. One fisher contacted me afterward to congratulate the team on the workshop's attendance. He said, "*It's typically hard to get that many fishermen to meet for anything. One of the things I got from what you said last Saturday was that getting this kind of participation was a main point of your interest. If that's true, you succeeded*." When I returned to Kona in February of 2019 to share my interview results with research participants at a joint Shark Tagger workshop, about 30 ocean users were in attendance, 12 of which were interviewees.

Of course, participation is not the only metric for a successful endeavor in fisher engagement. The Shark Tagger project's community-based tagging component equips fishers with the materials they need to tag sharks opportunistically while they are on the water. Since its first public workshop in 2017, the team's fishers have deployed 37 tags on oceanic whitetip, thresher, blue, and silky sharks. Prior to this, the Shark Tagger team independently deployed 15 tags in a comparable two-year period beginning in 2015. Fishers participating in the collaborative tagging effort have shared their shark-handling practices with the research team in its endeavor to brainstorm and develop non-lethal shark-handling practices. Some participants have also been equipped with special tags to track the survivorship of an animal post-handling, with particular interest in survivorship after jugging.

Participating fishers are compensated with monetary rewards for tag deployment. But, they have also described learning about shark behavior and habitat use as a useful tool for a fisher:

So that kind of information might be useful. Then certain times of the year maybe they not around, and the fish are biting, that's when you go, kinda deal. So we know what the shark interaction is with the fish. Or with the area that you fish… That's another tool in our tool bag when we go fishing ah?

Others identified developing a deterrent or some alternative handling practice as an incentive for collaborative research. Collaborative research may also benefit the way data quality is perceived by those involved in its collection (Wendt & Starr 2009). One fisher demonstrated this in his correspondence with Dr. Hutchinson, in which he thanked her for her including of fishers endeavor to gather "*real true data*." Finally, both fisher and scientist participants in this collaborative work have benefitted from shifts in perspective and, in some cases, behavior. As one participant put it:

For once someone's actually going out there with commercial fishermen. Not just one commercial fisherman, with multiple. You guys are kinda seeing everyone's point of view. And at the same time, getting everyone to change a little bit toward what you guys see.

Thus, a solution in collaborative research may require the overlap of several things, including a topic relevant to all parties, inclusion, fieldwork, funding, and a willingness to learn from one another. It may not be simple, but its benefits have been significant in this case of community-based shark-tagging in West Hawai'i.

Knowledge exchange

Another deeper-level solution that exposes involved actors to new information and encourages reconciliation of knowledge types and problem definitions is knowledge exchange. One fisher pointed out its potential benefits for the fishing, science, and management communities:

I think if you create an opportunity that's non-threatening that has nothing to do with taking away their rights, that the science and the managers are gonna get a lot of valuable information that they might not otherwise hear and the fishermen that come… their knowledge and understanding of these species that are important are gonna be dramatically increased.

The practical benefits of knowledge exchange are complemented by its ability to begin to address power and how different types of knowledges are valued. When knowledge is exchanged, groups involved are forced to reconcile the different types of knowledge they possess and the narratives they produce. As the fisher illustrated in the last quote from the "Collaborative research" section, this process of reconciling different types of knowledge and problem definitions may also be seen as a form of compromise, wherein, "*You guys are kinda seeing everyone's point of view. And at the same time, getting everyone to change a little bit toward what you guys see."* In the Shark Tagger project, both fishers and researchers have benefitted from the exchange of knowledge, whether acquired through decades of fishing experience or decades of scientific research. One fisher provided

examples from his conversations with Dr. Hutchinson, in which she learned that some of her tagged sharks were repeatedly visiting a specific offshore buoy. He also highlighted an important difference between the shark-fisher interaction problem definitions of researchers and fishers like himself:

> *Most of the scientists feel that we are, "Oh the fishermen don't like the sharks 'cause they eat their fish." I can count the number of times on one hand that a shark's actually attacked my fish. The problem is when they're in the area, we can't catch fish. They create a barrier.*

He noted, "*It was really neat though, sharing your knowledge. Like I pointed out to Melanie about the buoy thing, and she pointed out to me about all the things that I wasn't aware of.*" Though this exchange of knowledge might not have been a primary goal of the Shark Tagger project, its potential benefits have been supported by interviewee commentary. It has provided learning opportunities for fishers and researchers, elevated fisher voice through its recognition of value in both experiential and scientific knowledge, and adjusted both groups' shark-fisher problem definitions such that they are now more closely aligned.

Discussion

Fisheries resource problems are complex, yet the management regimes that seek to identify and resolve them often develop solutions in reference to oversimplified, depoliticized problem definitions shaped by exclusive discourse. Recognizing deeper conflicts, such as social and power inequities, and the multiplicity of problem definitions can offer depth to these technocratic framings of fisheries resource problems and their solutions. Engaging fishers may improve fisher access to management discourse, and consider valuable fisher knowledge and alternative problem definitions. It may also improve solution robustness when deeper-level problems—often contextualized within relations of power, unresolved conflict, and identity—are appropriately addressed. This case study of fisher engagement and fisher-shark interactions in West Hawai'i small boat fisheries created space to explore opportunities in improving exclusive, substance-focused problem definitions and their solutions.

In this discussion, I return to my three research questions to examine the utility of my theoretical framework in recognizing depth in fisheries management problem definitions and solution development. The remainder of this thesis is organized into three sections that address each research question in succession. "Problem Definition" answers 1) How and at what depth do fishers define fisher-shark interaction and management problems? "Solution Development" answers 2) How might managers develop solutions to better address depth in problem definition? What role might fisher engagement play in defining and resolving multi-depth problems? "Reflections on the Theoretical Framework" answers 3) What insights can we gain by applying this theoretical framework (adapted from conflict theory) to fisheries management? How can the process of problem definition be improved to benefit its depth and the depth of its developing solutions?

Problem Definition: *How and at what depth do fishers define fisher-shark interaction and management problems?*

Interviewees defined the fisher-shark interaction problem primarily at the substance level. These substantive problem definitions included the conditions under which sharks interact with fishers and their gear, fishers' financial and physical capacities to access different behavioral and shark-handling options, and sharks' habitat use and behavior. The appeal of any option to a fisher depends on situational variables like fishing method, shark accessibility, and shark species. It also varies across the fishing community, as individuals perceive sharks differently according to their own experiences and species-specific traits. A single fisher may perceive and handle different shark species differently based on things like interaction frequency, market value, or aggression. Surveys of recreational fishers in the United States demonstrated a lack of concern, similar to interviewees', for "nuisance" shark species frequently caught as bycatch (McClellan Press et al. 2016). Interviewees' most prominent depiction of sharks was as competitors for their fishing opportunities and livelihoods. This association between sharks and a threat to fishing opportunity could have negative implications for fishers' direct support of shark conservation (Drymon & Scyphers 2017). However, fishers described devoting little observational or conversational focus to sharks given their characterization as incidental, non-target species. Much of the information required for robust substantive solutions is still being pursued as fishers and researchers collect shark interaction and movement data. As fisher-researcher partnership and discourse around sharks continues, sharks will occupy greater focus in fishers' observations and discussions. How this focus develops depends on managers' and researchers' attention to the deeper levels of problem definition.

Substance-level problem definition is critical, but depth in problem definition and solution development is essential for robust, sustainable fisheries management solutions (Penney et al. 2017; Shiffman et al. 2017; Webber et al. 2007). A common frustration among interviewees was that fisheries management discourses often deny fishers' capacity for self-management and challenge their identities as resource stewards. In their discussions of equity and relative impact, interviewees also described the tendency of fisheries management to afford benefits to certain groups with greater organizational capacity and economic leverage, while targeting less powerful and more visible groups for regulation. When regulatory focus did not seem to correlate with resource impact, and prominent fisheries problems were left unregulated, interviewees doubted management logic and efficacy.

Interviewees also described a lack of opportunity for their perspectives and knowledge to be meaningfully considered in fisheries management discussions. This resulted either from failures in process, where managers designed engagement initiatives to fulfill mandated requirements rather than to best facilitate stakeholders participation, or from power inequities, wherein fishers were unable to access fisheries management discussions for their lack of financial capital, formalized knowledge, or specific language through which input was typically deemed valuable. Most fishers' engagement-related fears were of engagement leading to fishing closures and restrictions, and manager or scientist misrepresentation of fisher input.

Solution Development: *How might managers develop solutions to better address depth in problem definition? What role might fisher engagement play in defining and resolving multi-depth problems?*

No single substance-based solution was identified as applicable among all interviewees. Information provision, compensation, regulation, and shark-handling alternatives demonstrated variable and conditional applicability to fisher-shark and management problems. Though some interviewees described their shifts in perspective or behavior after learning about shark biology or species' threatened status, the diversity of fishers' values, attitudes, and capacity for behavior change across West Hawai'i necessitate multipronged solutions (Reddy et al. 2017; Stern 2000). Financial compensation, in its ability to address issues of fisher financial security, may play a role in incentivizing fisher engagement and increasing fisher access to a greater number of behavioral and shark-handling options. A viable, non-lethal shark-handling alternative has not yet been identified. However, fishers' desire to develop such an alternative or a shark deterrent, and their substantive barriers to adopting one (e.g., availability, safety, effective preservation of a quality fishing opportunity) create space for fishers, researchers, and managers to pursue its development collaboratively. If solutions fail to address fisher problem definitions and therefore achieve fisher buy-in, the utility of substantive approaches like regulation may be limited, especially in the absence of enforcement (Tissot et al. 2009). Deeper-level problems born from inappropriate or singular substance-based solutions like these may obstruct parallel solutions around shark-fisher interactions. They also critically affect future solution development for fisheries management problems involving the same actor groups, regardless of substance similarity. In the same way that deeper-level problems may be addressed to build relationships, trust, and collaborative potential for the benefit of future problem-solving endeavors, unresolved conflict and the degradation of relationships and trust inhibits them (Ansell & Gash 2007; Schuckman 2001).

To avoid generating new conflict and exacerbating existing deeper-level problems, robust fisheries management solutions should incorporate multiple strategies grounded substance, process, and relationships. Depth in these multifaceted solutions should represent a genuine effort to bridge disconnects between the knowledge and values of fishers, researchers, and managers. This research indicates that a robust solution might invest in regular, transparent communicative efforts, both in-person and using electronic and social media platforms. These might include efforts to increase awareness of shark biology and management statuses, share outcomes of collaborative research, or hear fishers' concerns about researchers' motives and goals, then recognize and respond to them explicitly. A robust solution might utilize existing social structures and influences in the fishing community, particularly those that involve key actors and face-to-face interaction, to encourage behavior and facilitate the sharing of information (Abrahamse & Steg 2013; Mbaru & Barnes 2017). It might be attentive to the engagement geographies, environments, and schedules that enable participation, and actively seek inclusion of diverse fisher perspectives (Vaughan & Caldwell 2015). Of course, inclusion, like many components of participatory processes, provides conditional benefits to problem solving and the perceived legitimacy of engagement facilitators. For example, limiting factors to its benefits include engagement facilitators' capacity to meet participants' expectations, and criteria

for participation that might include "*those whose cooperation is crucial for the implementation of the decision made*" (Jentoft 1999). A robust solution should also recognize and respectfully navigate fishers' previous experiences with researchers and managers, and fisher identities. I might hypothesize, for example, that financial compensation might at once extrinsically motivate some fisher behaviors and diminish their existing intrinsic motivations, which rely on fishers' autonomous, self-managing identities (Deci et al. 1999). Finally, deeper-level solutions must recognize imbalances in equity and power, for example, in the way that researchers' and managers' knowledge and voices are elevated in fisheries management discourse despite its outcomes having a greater impact on fishers' well-being. Or, in the way actors from industry and environmental groups wield greater organizational capacity, financial capital, and access to local decision-makers to exert power over fisheries management discourse (Chapin 2004; Schuckman 2001).

Two fisher engagement strategies identified by this research have potential to meet the above criteria: collaborative research and knowledge exchange. These deeper-level solutions are rooted in process and relationships, but offer benefits to both substance- and deeper-level problem definitions. The Shark Tagger group's collaborative research, for example, has enabled the collection of otherwise inaccessible shark interaction data and substantive problem definitions, both through interviews and tagging. Collaborative research and knowledge exchange have also exposed its participants, both fisher and researcher, to new information and facilitated reconciliation of different knowledge types and problem definitions. These engagement strategies, however, require participant willingness to compromise as they learn from and adapt to one another. Søreng (2006) emphasized that the effectiveness and legitimacy of participatory processes depends on its employment of a communicative process that provokes "*objections and counterarguments,*" enables conflicting values and interests to emerge, and in which participants are willing to compromise and adapt when presented with valid arguments. Recognizing explicitly the partiality and diversity in knowledge types and the plurality in problem definition across stakeholders is also crucial to productive discourse (Adams et al. 2003). In the case of this and the Shark Tagger project, collaborative research and knowledge exchange have provided learning opportunities for fishers and researchers, elevated fisher voice by recognizing value in both experiential and scientific knowledge, and adjusted both groups' shark-fisher problem definitions such that they are now more closely aligned. Collaborative research and knowledge exchange have also built trust between researchers and participating fishers, encouraged fishers' direct participation and peer recruitment, and shifted both researcher and fisher participants' thought processes and behaviors.

Reflections on the Theoretical Framework: *What insights can we gain by applying this theoretical framework (adapted from conflict theory) to fisheries management? How can we improve the processes of problem definition and solution development?*

The insights that this research provides regarding problem definitions and solutions development related to fisher-shark interactions and fisheries management in West Hawai'i is by no means exhaustive. Instead, it highlights the prominent problem definitions and potential solutions that

emerged from interviews, and lays an important foundation for applying this theoretical framework to other fisheries management problems. By applying this theoretical framework to this case study, I have discovered its value in embracing, rather than avoiding, complexity in the processes of problem definition and solution development; providing a framework with which to build multipronged solutions that address problems' substance and depth together; recognizing deeper-level problem definitions that may not appear to be directly related to the substantive problem definition; and identifying management pathways to avoid, given their likelihood of failure upon implementation and injury to process and relationships. All of the above are critical to the success of substantive management goals and in improving managers', fishers', and researchers' ability to navigate deeper-level management problems together.

The utility of the theoretical framework lies in its ability to recognize and embrace the complexity of problem definition, particularly as problems are defined at multiple depths and vary according those who define it. It does not advocate for singular solutions or claim neatness in fisheries management problems or solution development. This research has demonstrated, in fact, that substance-level problems may find resolution at depth in process and relationships. For example, the importance of addressing deeper-level problem definitions is especially true for a region with notoriously poor enforcement, which makes it a necessary candidate for fisher engagement and multipronged solution development. Though a lack of enforcement may be considered a substantive problem of capacity and resources, it may be neither possible nor beneficial to the resource to seek resolution through increased enforcement capacity. In some cases, enforcement may displace cooperative behavior with self-interested behavior associated with increased resource harvest (MacColl et al. 2018). The viability of regulation as a substantive solution also hinges on buy-in from the fishing community (Tissot et al. 2009). Solutions must tackle deeper-level problems through transparent communication and decision-making processes; recognition of value in knowledge regardless of financial capital, political leverage, or knowledge type; and sensitivity to participants' identities and risks to well-being (Hicks 2001). Transparency, communication, equity, and resource user representation in engagement and management processes are recognized by both resource users and managers as relevant to compliance levels (Bose & Crees-Morris 2009; Reed 2008), and may benefit management legitimacy (Hønneland 2000). Applying the theoretical framework, I am able to challenge the notion that fisheries management problems and solutions exist in either the realm of substance or depth. In this way, the framework encourages multipronged solutions that acknowledge dissonance and systems complexity in fisheries management problems.

The theoretical framework also allows us to recognize the relevance of deeper-level problems that at first may not seem relevant to the dispute under examination. Though interviewees described shark-fisher interactions primarily at the substantive level, critical deeper-level problem definitions emerged from interviews that require solutions based in relationships and process. Fishers perceive shark interactions as problematic, for the nuisance or a threat to personal livelihoods or safety that they pose. But, fishers have agency: independent ways of handling sharks that inherit new meaning when fisheries managers and researchers overlay dissonant problem definitions upon shark-fisher interactions. I have seen that through this process, researchers' and managers' intervention conjures

fishers' concerns for shark research and management threatening their cultures and identities, and leading to fishing restrictions. How well fishers' concerns and conflicting problem definitions are accounted for by fisheries management as they develop solutions will determine whether managers' and researchers' insertion into the fisher-shark problem exacerbates or ameliorates deeper conflicts between them and the small boat fishing community. This will also determine whether the substantive fisher-shark interaction problem—shark mortality being one metric—improves or worsens.

Finally, applying the theoretical framework in this study highlights both need and opportunity to avoid conflict-generative management pathways that other fisheries management patterns have followed. The danger of implementing solutions that fail to recognize depth in problem definition is not only in their substantive ineffectiveness, but also in exacerbating deeper-level problems and sociopolitical conflicts between and within the fishing, research, and managing communities (Akbulut & Soylu 2012; Béné 2009). Other species management regimes have experienced these failures for their focus on substance, for example leading to stakeholders' perception of managed species as a symbol of state governance (Naughton-Treves & Treves 2005; Nie 2001) or distant, privileged interests (Skogen et al. 2008). For these deeper-level problems, animosity and human-wildlife conflict may persist beyond the resolution of negative human-wildlife interactions themselves (Dickman 2010).

Though fisher engagement already elicits fishers' concerns, researchers and managers have a unique opportunity in the West Hawai‘i small boat fishery—and perhaps throughout Hawai‘i —to engage with the fishing community and develop new shark-related dialogues where before there was none. Developing shark discourses benefit from a lack of preconceived associations between the animal and antagonistic management. Thus, discourse can be developed away from negative, deeper-level problem associations and toward collaborative solutions development, respectful dialogue, and improved relationships between fishers, researchers, and managers. If solutions can be developed in reference to problem definitions for their illustration both of what an effective solution is and is not, their substantive and deeper-level outcomes have a better chance at success. Fisher well-being, shark research, and shark survivorship may benefit, as researchers' and managers' ability to address management problems both at-hand and in the future improve.

Limitations and Future work

In consideration of the project timeline and the time required to collect and analyze interview data, my interview sample of the West Hawai‘i small boat fishery derived primarily from Kona's fishing community. This research also benefitted greatly from key actors and the Shark Tagger's parallel community-based tagging project, which connected me to many of my interviewees as per the snowball sampling technique. Future work might expand sampling to compare my interviewees' problem definitions and shark interaction experiences to fishers based out of other West Hawai‘i boat ramps, out of other Hawai‘i Island regions like Hilo, or to fishing communities from neighbor islands.

Future research might apply this theoretical framework to other substantive fisheries management problems in the state of Hawai‘i or the Pacific region. These studies would explore the framework's utility in other contexts beyond shark-fisher interactions or the geography of this

research. Importantly, they would illustrate the external validity (or lack thereof) of the problem definitions and proposed fisher engagement solutions highlighted in this research.

Conclusion

Through a case study of fisher engagement and fisher-shark interaction in West Hawai‘i small boat fisheries, this research sought opportunities to improve the way fisheries management defines and resolves its problems. By broadening the scope of problem definitions to include sociopolitical context, diverse stakeholder perspectives, and existing conflicts, we may also improve the viability of solutions developed in their image. I adapted theories of conflict to examine substance and depth in fishers' problem definitions of shark interactions and fisheries management, how solutions might be developed to better address those definitions, the role of fisher engagement in solution development, and the utility of the theoretical framework adapted from conflict theory (Madden & McQuinn 2014) to shark conservation and fisheries management. Though others have applied this framework to examine conflict in various contexts, including human-wildlife conflict, I mobilized it uniquely with the concept of problem definition. This facilitates reflection around the politics of problem definition, and how defining a problem both illuminates and eliminates solution pathways. By applying this framework, I holistically examined the connections between mitigating pelagic shark mortality and deeper-level problems, and provided tangible solution examples to address both substance and depth in complex problems.

I found that fishers' problem definitions varied as expected, as a factor of diversity in fishing method, the nature of the relationship between fishing and income, and fishers' experiences with sharks, researchers, and managers. These factors, along with fishers' physical and financial capacity and species-specific shark traits, also shaped fishers' shark perceptions and handling practices. Fishers provided insights into both the substance- and deeper-level problems associated with shark-fisher interactions and fisheries management that would have otherwise been unaccounted for in researchers' definitions of the same problems. Importantly, these insights revealed that singular substantive solutions like regulatory or educational initiatives may fail to address (and even generate) deeper conflict, threatening shark conservation goals. If addressed properly, deeper conflicts and features of management and fisher engagement that fishers perceive as problematic will improve relationships between fishing, research, and managing communities, and mitigate shark mortality more successfully.

This study also illustrated that diversity in fishers' perceptions and capacity for behavior change necessitates multipronged solutions (Reddy et al. 2017; Stern 2000). In an effort to bridge disconnect between the knowledge and values of fishers, researchers, and managers, solutions should recognize fishers' identities, risks to well-being, and limited access to fisheries management discourse. Key factors in solution development include regular, transparent communicative efforts, the use of existing social structures and influences in the fishing community, respectful navigation of fishers' previous experiences with researchers and managers, and recognition of imbalances in equity and power. These may be exercised through larger fisher engagement processes like collaborative research and knowledge exchange. In this research and that of the Shark Tagger group, these

processes built trust between researchers and participating fishers, facilitated fishers' participation and support through peer recruitment, and elevated fisher voice by recognizing value in both experiential and scientific knowledge. For the benefit of problem definition and solution development, different perspectives coalesced to yield improved, shared understandings of the shark-fisher problem and even alter some fishers' shark-handling practices. Although these endeavors in fisher engagement were met with concerns for its threat to fisher livelihoods and cultures, they also highlighted a unique opportunity to develop shark management dialogues with positive, collaborative associations. This process has the potential to deliver wide-ranging benefits to fisher well-being, shark research, and shark survivorship, satisfying the diverse goals of many stakeholders. Resulting relationships between fishers and researchers may also benefit their ability to address fisheries management problems in the future.

Finally, this research demonstrated the utility of the theoretical framework in illuminating depth and diversity in problem definition, and identifying viable pathways of solution development. When these processes in fisheries management are inclusive and recognize value in different types of knowledge (Adams et al. 2003), they serve normative benefits, enabling fishers' access to fisheries management discourse. They also serve practical benefits, improving the comprehensiveness of problem definitions and providing solutions a better chance of success with exposure to political realities and fishers' agency in their own community and on the water. Problem definition and solution development that embraces system complexity and conflict—particularly when its participants exhibit flexibility and willingness to compromise—build capacity to resolve future problems collaboratively and improve the adaptivity of solutions to changing environments (Ansell & Gash 2007; Reed 2008; Schuckman 2001).

By being attentive to who defines the problem, who is included in developing solutions, and how they are afforded that access, we can begin to shed light on the power relations, inequities, and unapparent dimensions of conflict informing fisheries management. In any fisheries management endeavor, a robust solution requires deliberate reconciliation of researchers', managers', and managed populations' diverse and complex problem definitions (Adams et al. 2003; Bond & Morrison-Saunders 2011). It requires recognition of the deeper-level problems that may at first seem tangential to the substantive problem, but give critical context to solution development. This framework allows us to do so, while also connecting those deeper-level problems to problems of substance. Employing these strategies, fisheries management is better equipped to conceptualize the complex problems it faces and develop solutions to address them.

My novel adaptation of this framework also enables us to connect discussions of substance and depth explicitly to issues of equity, power, and access. I coupled theories of conflict and the politics of problem definition, allowing me to digest complex problem elements often considered intangible and difficult to resolve. Employing this framework, we may better understand and navigate conflict. And, adopting conflict-mediating principles like transparent communication and respect for identity may enable the discovery and pursuit of collective goals, delivering wide-ranging benefits to human and non-human elements of the ecosystem. Certainly, future research might examine the external validity of the problem definitions relevant to shark-fisher interactions and fisheries

management highlighted in this research. This theoretical framework, however, has applications beyond fisheries and natural resource management. Where diverse actors seek solutions to a problem with variable definitions, this framework can be mobilized to navigate degraded relationships between actors, threats to identity and well-being, and differential access to power (whether through capital or knowledge). We may thus pursue solutions better equipped for the messy, complex problems we so often encounter.

Appendix A: Interview Guide[2]

Introduction

1. Please tell me about yourself as a fisherman.
    a. How did you get into fishing?
    b. How long have you been fishing?
    c. How did you learn to fish?
    d. What kind of fishing do you do?
    e. What motivates you to fish/What do you enjoy most about fishing?
    f. Where do generally you like to fish out of (e.g., port)?
    g. Is fishing your only source of income?

Social networks

2. Can you tell me about the way you share or acquire useful fishing information (e.g., fishing techniques, conditions, regulations and management)?
    a. What kind of information is shared?
    b. With whom and how is that information exchanged?
    c. Do fishermen communicate with one another about the presence of sharks in a fishing area?
3. ~~Are there any barriers to communication or cooperation between certain groups of fishermen?~~ Are there certain groups of fishermen that communicate or cooperate less than others?
    a. Why? (identify barriers, e.g., protecting fishing areas, distinct fisheries)
    b. Where do these different groups like to hang out?
4. Could you suggest primary contacts for the different groups that you mentioned?

(Oceanic whitetip) Sharks

5. Please describe the types of interactions you've had with sharks.
    a. How often do you detect sharks while fishing?
    b. In what fraction of these instances…
        i. Do you see the shark?
        ii. Is the shark at the surface?
        iii. Is catch affected?
        iv. Do you have an opportunity to interact with the shark?
    c. Have you noticed a change in the nature or frequency of these interactions through time?
        i. (If yes) Why do you think that might be?
    d. How much of your catch is affected by sharks versus other predators?
    e. Have you noticed that certain things affect the likelihood of attracting or catching a shark while fishing (e.g., variations by time, season, area, gear, method)?

[2] Text with strike-through or in blue represent amendments made to the guide throughout the interview process.

f. What kinds of strategies are used to avoid catching sharks or get rid of sharks in a fishing area?
    i. ~~Have these changed through time? How/why~~? Why? (e.g., values, shark perceptions, etc.)
g. Are there other fishermen or fisher groups whose attitudes or handling practices differ from your own?
    i. Who see sharks more or less frequently than you?

6. Aside from those groups we've discussed, does anyone else interact with these sharks?

Mitigation strategies

7. Do you think there are any strategies to reduce the impact sharks have on fishermen and vice versa?
8. In what capacity do you think outreach might be successful in reducing the impact sharks have on fishermen and vice versa?
    a. Are there gaps in fishers' understanding of sharks or ecology that you think need to be addressed?
    ~~b. Who would fishermen trust to provide that information?~~
    ~~c. What venues or formats do you think fishermen would be receptive to?~~
    d. What is the best way to share information with fishermen? (e.g., messenger, venue, format)
9. Can you describe local protected species management (e.g., process, personal/community response)
    a. Based on the way local fishermen have been approached with regard to protected species issues in the past, what do you think could be done differently here to promote cooperation? (e.g., approach versus regulatory measures)

Conclusion

10. Is there anyone you haven't already mentioned that I can contact to learn more about the things we've discussed?
11. Is there anything else that you think is relevant to this discussion?
12. Do you have any questions for me?

Appendix B: Data analysis codebook

Table 7. Data analysis codebook, exported from NVivo

Name	Description
01 Fishing in Kona	Descriptions of important contextual dynamics of the fishing community in Kona, including fishing practices, fishing grounds, changes through time, and social contexts.
A. Fishing practices	Descriptions of the material and logistical attributes of fishing practice in Kona, including fishing methods, gear, processing methods, target species, trip length, and time of day.
a. Fishery	General descriptions of fisheries that operate within, out of, and near West Hawai‘i. Distinguished by fishing method or license.
i. Trolling	Descriptions of the troll fishery.
ii. Charter	Descriptions of the charter fleet's fishing repertoire.
iii. Live bait	Descriptions of the live bait fishery.
iv. Little bit of everything	Descriptions of diverse fishing (e.g., different target species, using different methods) to stay successful through time.
ix. Commercial	Descriptions of the commercial fleet's fishing repertoire.
v. Longline	Descriptions of or references to the longline fishery.
vi. Handline	Descriptions of handline fisheries and their more specific classifications.
Ika-shibi	Descriptions of the ika-shibi fishery and fishing method, a type of handlining.
Make dog	Descriptions of the make dog fishing method, a type of handlining.
Palu ‘ahi	Descriptions of the palu ‘ahi fishing method, a type of handlining.
vii. Purse seine	Descriptions of or references to the purse seine fishery.
viii. Spearfishing	Descriptions of the spearfish fishery.
x. Netting	Descriptions of net fishing.
xi. Porpoise	Descriptions of the daytime ‘ahi fishery that follows (likely) spotted dolphins.
xii. Diving	Descriptions of the dive fishery.
xiii. Greenstick	Descriptions of fishing with greenstick.
xiv. Dangling	Descriptions of the dangler fishing method.
xv. Shortline	Descriptions of the local shortline fishery.
xvi. Jigging	Descriptions of the jigging fishing method.
xvii. Aquarium	Descriptions of the aquarium/tropical fish fishery.
b. Target species	Parent node to all target species described during interview.
i. Bottomfish	Descriptions of bottomfish as target species.
ii. ‘Ahi	Descriptions of ‘ahi (tuna) as target species.
iii. Marlin	Descriptions of marlin as target species.
iv. Mahimahi	Descriptions of mahimahi as target species.
ix. Other baitfish	Descriptions of miscellaneous types of baitfish.
v. Aku	Descriptions of aku (skipjack) as target species.

Name	Description
vi. Ono	Descriptions of ono (wahoo) as target species.
vii. Nearshore	Descriptions of nearshore target species.
Kona crab	Descriptions of Kona crab as a target species.
ʻŌpelu	Descriptions of ʻōpelu (mackerel scad) as target species.
Reef	Descriptions of various reef fish as target species.
viii. Black coral	Descriptions of black coral as target species in the dive fishery.
c. Gear	Descriptions of various gear configurations.
d. Time of day	Descriptions of fisheries as operating primarily during the daytime or nighttime.
i. Night	Descriptions of fisheries that operate primarily during the nighttime.
ii. Day	Descriptions of fisheries that operate primarily during the daytime.
e. Trip length	Descriptions of fishing trip duration.
f. Processing methods	Descriptions of how catch is processed after it is landed.
B. Location	Descriptions of fishing grounds and areas used by the small boat fleet.
a. Kona	Descriptions of fishing in the Kona region.
i. The Grounds	Descriptions of fishing surrounding a ledge that extends out from the Keāhole area, referred to as,"The Grounds."
b. South Point	Descriptions of fishing around Hawai'i Island's South Point.
c. Hilo	Descriptions of fishing in Hilo.
d. (p)FADs	Descriptions of fish aggregating devices (FADs) or buoys owned both privately and by the state or federal government, which retain fish.
e. Sea Mount	Descriptions of fishing at the sea mount, likely referring to Cross Seamount. Also referred to as "the mountain."
f. Miloli'i	Descriptions of fishing around Miloli'i and the Miloli'i fishing community.
g. Neighbor islands	Descriptions of fishing around neighbor islands.
i. O'ahu	Descriptions of fishing around O'ahu.
h. NWHI	Descriptions of fishing in the Northwest Hawaiian Islands.
C. Competition	Descriptions of competition within West Hawai'i fisheries, and between its fishers and high seas fisheries (e.g., longline and purse seine).
D. Cooperation	Descriptions cooperation within West Hawai'i fisheries.
E. Culture	Descriptions of West Hawaii culture, often in reference to fishing. Sometimes juxtaposed against that of neighbor islands or state-external cultures.
F. Visibility	Descriptions of the West Hawai'i fishing community and its activities as visible.
G. Through time	Descriptions of changes in the West Hawai'i community through time, mostly in reference to fishing.
Development	Descriptions of increased development in the West Hawai'i area through time (e.g., infrastructure, tourism, etc.).
Fish abundance	Descriptions of changing fish abundance through time, both increased and decreased.
Shifting baseline	Descriptions of fishers or fisher groups having different understandings of fish abundance or trends given historical knowledge.

Name	Description
Fishing strategy	Descriptions of evolving and emerging fishing strategies through time.
Natural variability	Descriptions of natural variability and cycles, detached from anthropogenic factors, for example.
Oceanography	Descriptions of changes to oceanography through time, whether local (e.g., currents, bathymetry) or larger scale (e.g., El Nino).
Participation	Descriptions of changes in fishing participation through time.
Technology	Descriptions of evolving and developing technologies through time, which affect fishing practice.
02 Economic context	Descriptions of the West Hawai'i fishing community's economic contexts and considerations.
A. Demand	Comments about demand for various fisheries products and consumption of fish. Includes comments about fish as a healthy food.
B. Market competition	Many of these are descriptions of how competition makes being a fisherman more difficult, including identifications of "them" in an us vs. them mentality (e.g., the rich, the non-locals, the weekend warriors, the industrial fisheries)
C. Increasing costs	Descriptions of the inputs to fishing activity increasing through time (e.g., fuel, ice, bait).
D. Participation	Descriptions of changes or challenges in fishery participation.
E. Food security	Descriptions of food (in)security in the West Hawai'i community or its parent economies.
10 Identity	Descriptions of various aspects of fisher identity.
A. Demographics	Parent node to various demographic variables.
a. Fishing identities	Parent node to important variables that shape fisher identity.
i. Income	Parent node to fisher classifications based on how fishing contributes to their income.
Charter	Descriptions of charter fishers, either in self-identification or based on non-charter fishers' perceptions.
Commercial	Descriptions of commercial fishers, either in self-identification or based on non-commercial fishers' perceptions.
Part-time and Recreational	Descriptions of part-time and recreational fishers, either in self-identification or based on non-PT/rec fishers' perceptions.
Private captain	Descriptions of fishers whose income comes primarily from managing private vessels.
ii. Commitment to place	Parent node to variables that shape fishers' perceived commitment to place.
Generational fisher	References to interviewees or other fishers descending from fishing families.
Local	Descriptions of local identities or identities rooted in commitment to place and its history.
iii.. Small-scale	Descriptions of small-scale fishers, primarily as in the context of interviewee identities.
b. Years fishing	References to interviewees' years of fishing experience.
c. Fishing frequency	References to interviewee fishing frequency (e.g., days/year on the water), or general references to fishing frequency in the context of other

Name	Description
	discussions.
d. Starting out	Descriptions of interviewees starting out as fishers, learning to fish, etc.
e. Age	References to interviewee age, or general references to fisher age in the context of other discussions.
f. Ethnicity	References to interviewee ethnicity, or general references to ethnic identity in the context of other discussions.
i. Native Hawaiian	References to interviewees identifying as native Hawaiian, or general references to native Hawaiian identity in the context of other discussions.
g. Education	References to interviewee educational level, or general references to education in the context of other discussions.
h. Gender	Descriptions of fishers' gender.
i. Other occupations	Descriptions of interviewees' occupations, which may supplement or be alternative to primary fishing occupations.
Ecotourism	Descriptions of interviewees working in ecotourism.
B. Personality traits	Parent node to various personality traits that emerged from fisher interviews.
a. Self-reliance	Descriptions of fishers' self-reliant tendencies, or requiring some level of self-reliance for success.
b. Steward	Descriptions of fisher stewardship and interviewees self-identifying as stewards.
c. Scientist's curiosity	Expressions of curiosity and interest in scientific information. Sometimes related to expressions of humility from interviewees (e.g., "I don't know everything and I'd like to learn more about x"). Important opportunities for fisher engagement!
d. Bravado	Descriptions of male ego and aggression.
e. Frontiersman	Descriptions of fishers' affinity for adventure, exploration, and in some cases, lack of regulation.
f. Pride	Descriptions of pride in the context of fisher identity.
g. Humility	Descriptions of fishers' self-identifying as humble, or expressions of humility.
h. Showman	Descriptions of showmanship in (charter) fishing.
i. Patience	Descriptions of patience as a necessary attribute in fishing.
11 Motivation	Descriptions of the underlying, value-laden motivations for behavior and behavior change relative to info-sharing, shark-handling, and fishing.
A. Fishing motivation	Parent node for various fishing motives.
a. Money	Descriptions of fishing for money, either to cover fishing expenses or generate a profit.
b. Pleasure	Descriptions of fishing for various positive and intangible reasons and benefits.
i. Ocean's pull	Descriptions of enjoying fishing for fishers' affinity for the ocean.
ii. Challenge	Descriptions of enjoying fishing for the challenge of finding and landing fish.
iii. Freedom	Descriptions of enjoying fishing for the sense of freedom it provides.
iv. R&R	Descriptions of the mental rest and relaxation that fishers derive from the fishing experience.

Name	Description
v. Socializing	Descriptions of enjoying fishing for its opportunities to socialize (e.g., with fishing partners or charter clients).
vi. Thrill	Descriptions of enjoying fishing for the thrill of fighting fish on the line.
c. Sharing	Descriptions of fishing to share the catch with members of the community, family, and friends.
d. Trophy fish	Descriptions of fishing to land large, trophy fish.
e. Food	Descriptions of fishing to obtain food.
B. Info-sharing motivation	Parent node for various info-sharing motives.
a. Big ocean	Descriptions of info-sharing for its cooperative benefits, which makes fishing easier for fishers navigating a "big ocean."
b. Money	Descriptions of financial considerations guiding info-sharing practices.
c. Self-advertisement	Descriptions of info-sharing for the purpose of self-advertisement, especially for charter businesses.
C. Behavioral motivation	Parent node for various behavioral motives, primarily as they are relevant to shark-handling practices.
a. Money	Descriptions of financial considerations determining fisher behavior and shark-handling practices.
b. Social pressure	Descriptions of shifts in fisher behavior or shark-handling practices in response to social pressure.
c. Understanding	Descriptions of the effect of new understanding on fisher behavior or shark-handling practices.
d. Cultural upbringing	Descriptions of fisher behavior and shark-handling practices being inherited from a fisher's parent culture.
12 Values and beliefs	Descriptions of miscellaneous value and belief systems that guide fisher practices.
A. No waste	Explicit discussions of fishers using all parts of their catch, or chastising others for wasting catch.
B. Good energy good fishing	Descriptions of karma acquired through social interactions and fishing practices as affecting one's own fortune, especially with regard to fishing.
C. Return to past	Descriptions of mismatches between contemporary resource management contexts/needs and traditional management strategies relying on an idyllic return to the past, especially in reference to Hawaiian resource governance structures.
13 Human well-being	Descriptions of the relationship between small boat fishers' experiences in Hawai‘i fisheries and human well-being.
A. Financial security	Descriptions of the relationship between fishing and financial well-being, or security.
B. Physical well-being	Descriptions of the relationship between fishing and fishers' physical well-being.
C. Family	Descriptions of the relationship between fishing and family well-being.
20 Info-sharing practices	Descriptions of info-sharing practices in the West Hawai‘i small boat fishery.
A. Types of info	Parent node to the types of information discussed during interview.
a. Sharks	Descriptions of the sharing or acquisition of information related sharks.
b. Location	Descriptions of the sharing or acquisition of fishing location information.

Name	Description
c. What's biting	Descriptions of the sharing or acquisition of information about what fish species are biting.
d. Conditions	Descriptions of the sharing or acquisition of information related to fishing conditions.
e. Management	Descriptions of the sharing or acquisition of information relevant to fishing regulations and management.
f. Who's catching	Descriptions of the sharing or acquisition of information about who's out fishing and catching.
g. Techniques	Descriptions of the sharing or acquisition of information related to fishing techniques and methods.
B. Methods and sources	Descriptions of the various methods and sources of useful information; primarily fishing information, but also related to management.
a. Printed media	Descriptions of various types of printed media (e.g., magazines, newspaper, flyers) as a source of information.
b. Phone	Descriptions of fishers using phones to share information with one another.
c. Social media	Descriptions of social media as a tool for information sharing.
d. Harbor	Descriptions of interactions and activity at the harbor (primarily Honokohau Harbor) as a source of information.
e. Relationships	Descriptions of relationships playing a role in information sharing.
i. Key actors	Descriptions of key actors (e.g., respected fishers with wide info-sharing circles or access to specialized fishery niches) playing a key role in information acquisition or sharing.
ii. Mentorship	Descriptions of mentorship playing a key role in information acquisition, especially learning to fish.
iii. Friendship	Descriptions of friendship playing a key role in information acquisition or sharing.
iv. Family	Descriptions of familial relationships playing a key role in information acquisition or sharing.
f. Fish buyer	Descriptions of fish buyers a sources of information.
g. Tech and apps	Descriptions of various types of technology and electronic applications as a source of information (e.g., fishing conditions).
h. Email	Descriptions of emails from personal and organizations' accounts as sources of information.
i. Shops	Descriptions of fishing shops as hubs for information sharing.
j. Tournaments	Descriptions of fishing tournaments as hubs for and providing opportunity in information sharing.
k. Radio	Descriptions of fishers using the radio to share or acquire useful information.
l. Mail	Descriptions of receiving information through snail mail.
m. TV	Descriptions of TV as a source of information.
C. Circle size	Descriptions of the size of fishers' info-sharing circles (e.g., the number of fishing peers with which information is shared regularly).
D. In or out	Descriptions of how partners in info-sharing are identified and/or weeded out.

Name	Description
a. Info quality	Descriptions of the quality of shared information as a factor determining the viability of info-sharing partnerships.
b. Reciprocity	Descriptions of reciprocity as a factor determining the viability of info-sharing partnerships.
c. Relevance	Descriptions of the information relevance as a factor determining the viability of info-sharing partnerships.
d. Time	Descriptions of fishers determining the viability of info-sharing partnerships with the passing of time.
e. Loyalty	Descriptions of the loyalty as a factor determining inclusion in info-sharing groups.
E. Guarding info	Descriptions of fishers guarding information, whether actively or passively (e.g., by not volunteering info).
30 Sharks	Parent node to all shark-related discussions during fisher interviews.
A. Species	Parent node to all species of shark discussed during interviews. Child nodes basically function as a tracking index for species-specific shark descriptions.
a. Oceanic whitetip	Descriptions of the oceanic whitetip shark.
b. Tiger	Descriptions of the tiger shark.
c. Mako	Descriptions of the mako shark.
d. Thresher	Descriptions of the thresher shark.
e. Bronze whaler	Descriptions of what fishers refer to as "bronze whalers."
f. Blue	Descriptions of the blue shark.
g. Galapagos	Descriptions of the Galapagos shark.
h. Hammerheads	Descriptions of the hammerhead shark.
i. Silky	Descriptions of the silky shark.
j. Sandbar	Descriptions of the sandbar shark.
k. Unidentified	Descriptions of shark species of unknown identity.
l. Great white	Descriptions of the great white shark.
m. Whale shark	Descriptions of the whale shark.
n. Dusky	Descriptions of the dusky shark.
o. Oceanic blacktip	Descriptions of the oceanic blacktip shark.
B. Interaction frequency	Descriptions of shark interaction frequency.
a. Over time	Descriptions of how shark interaction frequency has changed through time.
C. Interaction factors	Descriptions of the factors that affect the likelihood of shark interactions.
a. Location	Descriptions of various fishing locations (including geographies, bathymetric characteristics, and object-association) producing more shark interactions.
i. Buoys + floaters	Descriptions of increased shark interactions around buoys and floaters.
ii. Pilot whales	Descriptions of shark association with pilot whales (namely oceanic whitetip sharks).
iii. Offshore	Descriptions of certain types of shark interactions being more likely offshore.

Name	Description
iv. Inshore	Descriptions of certain types of shark interactions being more likely inshore.
v. Ledges	Descriptions of certain types of shark interactions being more likely on bathymetric ledges.
vi. Kampachi farms	Descriptions of certain types of shark interactions being more likely near the Kona kampachi farms.
b. Seasonality	Descriptions of seasonal patterns in shark interactions and abundance. Note that the frequency of fishers' observations correspond with their fishing seasons (e.g., where there are more boats, eyes, lines, and bait out in the water).
c. Bait	Descriptions of bait as positively affecting the likelihood of shark interactions.
d. Depth	Descriptions of the relationship between depth and the likelihood of shark interactions.
e. Time of day	Descriptions of the relationship between time of day and the likelihood of shark interactions.
f. Currents	Descriptions of the relationship between currents and the likelihood of shark interactions.
g. Fisher mobility	Descriptions of the mobility of a fishery or fishing method affecting the likelihood of shark interactions.
h. Prey size	Descriptions of the relationship between prey size and the nature of shark interactions.
i. Moon	Descriptions of the relationship between moon phase and the likelihood of shark interactions.
j. SST + height	Descriptions of the relationship between sea surface temperature and height, and the likelihood of shark interactions.
k. Turbidity	Descriptions of the relationship between turbidity and the likelihood of shark interactions.
D. Decision-making	Descriptions of fishers' decision-making processes with regard to shark-handling.
a. Goal	Descriptions of fishers' shark-handling goals.
i. Kill	Descriptions of killing sharks as the goal of shark-handling.
ii. Improved fishing	Descriptions of improved fishing as the goal of shark-handling.
b. Options	Descriptions of fisher's shark-handling options during interaction.
i. Handling	Descriptions of various handling practices involving close or direct contact between shark and fisher.
Agitate	Descriptions of agitating the shark somehow to deter its return, usually after hooking and fighting the animal.
Bat	Descriptions of a bat as a shark-handling tool.
Firearms	Descriptions of firearms as a shark-handling tool.
Hook	Descriptions of hooking the shark during shark-handling.
Jugging	Descriptions of the jugging strategy as a shark-handling practice.
Knife	Descriptions of knives/blades as a shark-handling tool.
Release or	Descriptions of cutting the line to release the shark as a handling practice.

Name	Description
cut line	
Shark v. shark	Descriptions of facilitating shark-shark aggression as a handling practice.
Tag it!	Descriptions of shark-tagging as a handling practice.
Weights	Descriptions of using weights to sink or agitate a shark.
ii. Avoidance	Descriptions of shark avoidance as a preventative measure for fisher-shark interactions.
iii. Leave	Descriptions of fishers leaving a fishing area after encountering a shark.
iv. Deterrents	Descriptions of various shark deterrents.
v. Feeding	Descriptions of intentional or unintentional shark feeding as a behavioral option for fishers during a shark interaction.
vi. Gear modification	Descriptions of gear modification strategies during shark interactions.
vii. Wait	Descriptions of fishers allowing time to pass to avoid shark interactions.
c. Factors	Factors under consideration as fishers decide how they will handle a shark when encountered.
a. Shark accessibility	Descriptions of variable fisher access to sharks as a decision-making factor for fisher behavior and shark-handling.
a. Detection	Descriptions of sharks remotely detected, rather in direct fisher contact, during an interaction.
b. At surface	Descriptions of sharks at water's surface.
c. On the line	Descriptions of sharks hooked on a fisher's line during an interaction.
b. Shark persistence	Descriptions of the resilience and persistence of a shark during a fishing trip as a decision-making factor for fisher behavior and shark-handling.
c. # of sharks	Descriptions of the number sharks in an area as a decision-making factor for fisher behavior and shark-handling.
d. Fish present	Descriptions of the presence of target species in the area as a decision-making factor for fisher behavior and shark-handling.
e. Safety	Descriptions of safety as a decision-making factor for fisher behavior and shark-handling.
f. Market value	Descriptions of a shark's market value as a decision-making factor for fisher behavior and shark-handling.
g. Survivorship	Descriptions of fisher assumptions about post-handling shark survivorship
h. Ease	Descriptions of the ease of a shark-handling practice as a factor in fisher decision-making.
i. Gear	Descriptions of available gear as a decision-making factor for fisher behavior and shark-handling.
j. Other boats	Descriptions of the presence of other boats in the area as a decision-making factor for fisher behavior and shark-handling.
k. Species	Descriptions of shark species as a decision-making factor for fisher behavior and shark-handling.
l. Fish on the line	Descriptions of whether or not a target fish is on the line as a decision-making factor for fisher behavior and shark-handling.
m. Crew	Descriptions of the presence of crew during a fishing trip as a decision-making factor for fisher behavior and shark-handling.

Name	Description
n. Time of day	Descriptions of the time of day during a fishing trip as a decision-making factor for fisher behavior and shark-handling.
o. Vessel size	Descriptions of vessel size as a decision-making factor for fisher behavior and shark-handling.
p. Distance traveled	Descriptions of the distance traveled to reach a fishing location as a decision-making factor for fisher behavior and shark-handling.
E. Sharks as...	Descriptions of fishers' various perceptions and concepts of what a shark means to society, to them, and to their fishing opportunities.
a. Negative	Perceptions of sharks with negative connotations.
i. Competitors	Descriptions of sharks as competitors for fish and fisher livelihoods.
Depredators	Descriptions of sharks as depredators, taking target fish directly from fishers.
Fish deterrents	Descriptions of shark presence as deterring target species' interaction with fishers' gear.
ii. Hassle	Descriptions of shark interactions as a nuisance or hassle, wasting fishers' opportunity to land fish, gear, energy, etc.
iii. Aggressive	Descriptions of sharks behaving aggressively.
iv. Dangerous	Descriptions of sharks as posing a physical threat to humans, man-eaters.
v. Too abundant	Descriptions of sharks as overabundant, including potential for future overabundance.
vi. Symbol of management	Descriptions of sharks as a symbol of fisheries management.
b. Positive	Perceptions of sharks with positive of fisher-beneficial connotations.
i. Economically valuable	Descriptions of sharks as having economic value, whether through market value or its benefits to the charter and ecotourism industries.
ii. Keystone species	Descriptions of sharks playing important roles in ecosystem function.
iii. Fish indicators	Descriptions of sharks associated with fish abundance and good fishing opportunity.
iv. ‘Aumakua	Descriptions of sharks as ‘aumakua, or of their significance in Hawaiian culture.
v. Beautiful	Expressions of admiration for sharks.
c. Neutral	Perceptions of sharks with neither strictly negative nor positive connotations.
i. Non-target spp	Descriptions of sharks as non-target species.
ii. Part of the deal	Descriptions of sharks as an inevitable part of fishing.
iii. Not a big problem	Descriptions of sharks as not posing a significant problem to fishers.
iv. Unpredictable	Descriptions of sharks exhibiting variable behavior or interaction patterns over time and space.
ix. Sensational	Descriptions of sensationalized images of sharks.
v. Smart	Descriptions of sharks as intelligent or exhibiting learning behavior.
vi. Instinctual predators	Descriptions of shark behavior driven primarily by shark instinct (e.g., to kill, hunt).

Name	Description
vii. Fighters	Descriptions of hooked sharks as strong fighters.
viii. Resilient	Descriptions of sharks as resilient to physical trauma.
x. Lazy opportunists	Descriptions of sharks as relatively slow, opportunistic hunters.
xi. Not smart	Descriptions of sharks as unintelligent, or failing to learn.
xii. Sympathetic	Descriptions of sharks as sympathetic, and requiring defense or protection.
xiii. Temporary	Descriptions of sharks as a temporary problem given their variable abundance and presence through time and space.
F. Sharks on the brain	Comments about not devoting much thought or conversational energy sharks or shark observation prior to interview.
G. Behavior	Descriptions of shark behavior.
H. Size	Descriptions of shark size.
I. Other predators	Descriptions of non-shark predators affecting fishing activity.
a. Porpoises	Descriptions of "porpoises" affecting fishing activity.
40 Management	Parent node to all management-related discussions during fisher interviews.
A. Lack thereof	Descriptions of not enough regulation or management, or user groups/areas that are relatively unregulated.
B. Over-regulation	Descriptions of too much regulation or an overconcentration of management focus.
C. Self-management	Descriptions of sustainability or stewardship-minded practices that fishers impose upon themselves.
D. Legitimacy	Descriptions of characteristics of management that affect the way fishers perceive its legitimacy.
a. Disconnect	Descriptions of nonsensical management/regulatory logic or justifications. Also descriptions of managers and scientists' disconnect from fisher realities.
b. Shifting blame	Descriptions of user groups or fishing communities that are disproportionately regulated, or of their relative impact on resources. Sometimes identifying groups that are more difficult to regulate for whatever reason (e.g., power, visibility, jurisdiction), which inhibits productive stakeholder engagement or compliance.
c. Unfounded regs	Descriptions of regulations and management with incomplete or insufficient justifications.
d. Data quality	Comments about the quality of data collected by managers, or skepticism over the quality of data used in management.
e. Transparency	Descriptions of transparency, or lack thereof, in fisheries management.
f. Equity	Descriptions of inconsistencies across management logic that affords benefits to certain groups while targeting others disproportionately for regulation.
g. Science as political tool	Descriptions of science compromised by politics, or wielded as a political tool.
E. Compromise	Descriptions of a lack of, and therefore a need for more compromise in resource management. Some call for utilitarian approach ("greatest benefit for most people") in pursuit of win-win solutions.

Name	Description
F. Permanent	Descriptions of regulations and management as stagnant or lacking adaptivity.
G. Tools	Descriptions of various regulatory tools used by fisheries management.
a. Enforcement	Descriptions of enforcement as a management tool.
b. Exclusion	Descriptions of exclusion or permitting as a management tool.
c. Finning ban	References to the shark finning ban.
d. Licenses	Descriptions of fishers' licensing programs as a management tool.
e. Fines	Descriptions of fines as a management tool.
f. Catch limits	Descriptions of catch limits as a management tool.
I. Externalities	Descriptions of secondary, unexpected ouotcomes resulting from management or regulations.
a. Aquaculture	Descriptions of externalities produced by aquaculture.
b. Imported fish	Descriptions of management producing externalities related to fish imports.
c. PMNM + LL reg	Descriptions of externalities resulting from the PMNM and other regulations affecting the distribution of longline fishing pressure.
d. Protected spp	Descriptions of externalities resulting from protected species management.
e. Shark-tagging	Descriptions of externalities produced by shark-tagging efforts.
J. Protected species	Descriptions of protected species management.
41 Fisher engagement	Examples of and opportunity for fisher engagement.
A. Fighting for fishing	Descriptions of fisher engagement driven by fishers' defense of fishing access or activity.
B. Fishers' voice	Descriptions of opportunity (and lack thereof) for fishers' voices to be heard. Includes descriptions of what follows after fishers provide their input.
C. Indifference	Descriptions of fishers' lack of motivation to engage with researchers/managers or voice their opinions.
D. Fears	Descriptions of fears held by fishers when engaging with researchers or managers.
E. Giving up	Descriptions of fishers ceasing to participate, or losing hope in fisher engagement opportunities.
F. Strategies	Thoughts on the effectiveness and ineffectiveness of different engagement strategies.
a. Research	Descriptions of collaborative research as a fisher engagement strategy.
b. Education	Descriptions of education and information provision as a fisher engagement strategy.
c. Communication	Descriptions of communication as a component of fisher engagement.
d. Trust building	Descriptions of trust building as a component of fisher engagement.
e. Incentives	Descriptions of various incentives for fisher engagement, including but not limited to financial compensation.
f. Knowledge exchange	Descriptions of knowledge exchange as a fisher engagement strategy.
g. Convenience	Comments on making fisher engagement strategies more convenient for and accessible to fishers.

Name	Description
h. Inclusion	Descriptions of inclusion as a component of fisher engagement.
i. Social influence	Descriptions of leveraging social influence to encourage fisher engagement.
G. Forums	Descriptions of various forums for fisher engagement.
42 Power dynamics	Descriptions of social relationships and power relations between individuals and groups based on capital, political power, visibility, etc. Themes are organized by actor groups.
A. Managers	Descriptions of the managers' power.
B. Fishers	Descriptions of fisher groups' power, or lack thereof.
C. Researchers	Descriptions of researchers' power.
a. Role of the Researcher	Commentary on my role and biases as a researcher.
D. Tourism	Descriptions of power in the tourism industry.
E. Environmentalists	E. Descriptions of environmental interests' power.
F. Industrial fisheries	Descriptions of industrial fisheries' power.
G. Wealthy	Descriptions of the wealthy as powerful.
H. Media	Descriptions of power and influence in the media.
I. NGOs	Descriptions of the power exercised by NGOs.
J. Funding	Descriptions of funding affording power to those who can access it.
43 Knowledge types	Parent node to various types of knowledge identified during interview.
A. Experiential	Descriptions of experiential knowledge.
B. Collaborative	Descriptions of knowledge that is shared and co-produced between groups (e.g., fishers, scientists, managers).
C. Formal	Descriptions and perceptions of the knowledge held by scientists and managers, acquired through research or formal education.
D. Inherited	Descriptions of knowledge that is passed from fisher to fisher, often between generations.
E. Bioecological	Descriptions of knowledge contributing to bioecological understanding.
F. Cultural	Descriptions of cultural knowledge.
50 Insights from outside	Descriptions of fisheries (management) and the marine environment from Hawai‘i-external geographies.
90 Institutions	Index of institutions discussed during interviews.
A. DLNR	References to made to the Hawai‘i State Department of Land and Natural Resources during interview.
B. WPRFMC	References to made to the Western Pacific Regional Fisheries Management Council during interview.
C. NOAA	References to made to National Oceanic and Atmospheric Administration during interview.
D. HFACT	References to made to HFACT during interview.
E. TNC	References to made to The Nature Conservancy during interview.
F. PIFG	References to made to the Pacific Islands Fisheries Group during interview.
G. West Hawai‘i Fishery	References to made to the West Hawai‘i Fishery Council during interview.

Name	Description
Council	
H. Coast Guard	References to made to the Coast Guard during interview.
I. Hawai‘i Boating Association	References to made to the Hawai‘i Boating Association during interview.
91 Names	Index of names brought up regularly during interviews. Child nodes hidden from Codebook for confidentiality.
92 Stories	Tracking node for noteworthy stories encountered during interview.
93 Quotes	Tracking node for illustrative quotes that emerged from interviews.

References

Abrahamse, W., & Steg, L. (2013). Social influence approaches to encourage resource conservation: A meta-analysis. *Global Environmental Change*, *23*(6), 1773–1785. https://doi.org/10.1016/j.gloenvcha.2013.07.029

Ansell, C., & Gash, A. (2007). Collaborative governance in theory and practice. *Journal of Public Administration Research and Theory*, *18*(4), 543–571. https://doi.org/10.1093/jopart/mum032

Aswani, S., Basurto, X., Ferse, S., Glaser, M., Campbell, L., Cinner, J. E., … Christie, P. (2018). Marine resource management and conservation in the Anthropocene. *Environmental Conservation*, *45*(2), 192–202. https://doi.org/10.1017/S0376892917000431

Beierle, T. C. (2002). The quality of stakeholder-based decisions. *Risk Analysis*, *22*(4), 739-749. https://doi.org/10.1111/0272-4332.00065

Béné, C., Belal, E., Baba, M. O., Ovie, S., Raji, A., Malasha, I., … Neiland, A. (2009). Power struggle, dispute and alliance over local resources: Analyzing 'democratic' decentralization of natural resources through the lenses of Africa inland fisheries. *World Development, 37*(12), 1935-1950. https://doi.org/10.1016/j.worlddev.2009.05.003

Bennett, N. J. (2019). In political seas: Engaging with political ecology in the ocean and coastal environment. *Coastal Management*, 1–21. https://doi.org/10.1080/08920753.20c9.1540905

Bond, A. J. & Morrison-Saunders, A. (2011). Re-evaluating sustainability assessment: Aligning the vision and practice. *Environmental Impact Assessment Review, 31(*1), 1-7.

Bonfil, R. (1994). Overview of world elasmobranch fisheries*. FAO Fisheries Technical Paper, 341*, 119.

Canadian Institute for Conflict Resolution. (2000). Becoming a third-party neutral: Resource guide. Ridgewood Foundation for Community-Based Conflict Resolution (Int'l).

Chapin, M. (2004). A challenge to conservationists. *World Watch, 17*(6), 17-31.

Clark, D. A., & Slocombe, D. S. (2011). Grizzly bear conservation in the Foothills Model Forest: Appraisal of a collaborative ecosystem management effort. *Policy Sciences*, *44*(1), 1–11. https://doi.org/10.1007/s11077-010-9118-y

Crespin, S. J., & Simonetti, J. A. (2019). Reconciling farming and wild nature: Integrating human-wildlife coexistence into the land-sharing and land-sparing framework. *Ambio*, *48*(2), 131-138. https://doi.org/10.1007/s13280-018-1059-2

Deci, E. L., Koestner, R., & Ryan, R. M. (1999). A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological Bulletin, 125*(6), 627-668. http://dx.doi.org/10.1037/0033-2909.125.6.627

Dery, D. (2000). Agenda setting and problem definition. *Policy Studies*, *21*(1), 37–47. https://doi.org/10.1080/014428700114008

Dickman, A. J. (2010). Complexities of conflict: the importance of considering social factors for effectively resolving human-wildlife conflict: Social factors affecting human-wildlife conflict resolution. *Animal Conservation*, *13*(5), 458–466. https://doi.org/10.1111/j.1469-1795.2010.00368.x

Dorresteijn, I., Milcu, A. I., Leventon, J., Hanspach, J., & Fischer, J. (2016). Social factors mediating human-carnivore coexistence: Understanding thematic strands influencing coexistence in Central Romania. *Ambio*, *45*(4), 490–500. https://doi.org/10.1007/s13280-015-0760-7

Drymon, J. M., & Scyphers, S. B. (2017). Attitudes and perceptions influence recreational angler support for shark conservation and fisheries sustainability. *Marine Policy*, *81*, 153–159. https://doi.org/10.1016/j.marpol.2017.03.001

Ginges, J., Atran, S., Medin, D., & Shikaki, K. (2007). Sacred bounds on rational resolution of violent political conflict. *Proceedings of the National Academy of Sciences of the United States of America, 212*(18), 7357-7360. https://www.jstor.org/stable/25427491

Gilman, E. L., Clarke, S., Brothers, N., Alfaro-Shigueto, J., Mandelman, J., Mangel, J., … Werner, T. (2008). Shark interactions in pelagic longline fisheries. *Marine Policy, 32*(1), 1-18.

Hicks, T. (2001). Another look at identity-based conflict: The roots of conflict in the psychology of consciousness. *Negotiation Journal*, *17*(1), 35–45. https://doi.org/10.1111/j.1571-9979.2001.tb00225.x

Hill, C. M. (2017). Primate crop feeding behavior, crop protection, and conservation. *International Journal of Primatology*, *38*(2), 385–400. https://doi.org/10.1007/s10764-017-9951-3

Hønneland, G. (2000). Compliance in the Barents Sea fisheries: How fishermen account for conformity with rules. *Marine Policy 24(1)*, 11-19.

King, B. (2010). Conservation geographies in Sub-Saharan Africa: The politics of national parks, community conservation and peace parks. *Geography Compass*, *4*(1), 14–27. https://doi.org/10.1111/j.1749-8198.2009.00288.x

Leong, K. M., Decker, D. J., Forester, J., Curtis, P. D., & Wild, M. A. (2007). Expanding problem frames to understand human-wildlife conflicts in urban-proximate parks. *Journal of Park and Recreation Administration, 25*(4), 62-78.

MacColl, S., Onyango, P., Reimer, M. N., & Stopnitzky, Y. (2018). Unintended consequences of enforcement in a cooperative institution: Experimental evidence from Tanzanian fishers. *Ocean & Coastal Management*, *162*, 158–169. https://doi.org/10.1016/j.ocecoaman.2017.10.021

Madden, F. & McQuinn, B. (2014). Conservation's blind spot: The case for conflict transformation in wildlife conservation. *Biological Conservation, 178*, 97-106. http://dx.doi.org/10.1016/j.biocon.2014.07.015

May, C. K. (2013). Power across scales and levels of fisheries governance: Explaining the active non-participation of fishers in Two Rivers, North Carolina. *Journal of Rural Studies*, *32*, 26–37. https://doi.org/10.1016/j.jrurstud.2013.04.002

Mbaru, E. K. & Barnes, M. L. (2017). Key players in conservation diffusion: Using social network analysis to identify critical injection points. *Biological Conservation, 210*, 222-232. http://dx.doi.org/10.1016/j.biocon.2017.03.031

McClellan Press, K., Mandelman, J., Burgess, E., Cooke, S. J., Nguyen, V. M., & Danylchuk, A. J. (2016). Catching sharks: recreational saltwater angler behaviours and attitudes regarding shark encounters and conservation: Saltwater angler behaviors and attitudes regarding shark encounters. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *26*(4), 689–702. https://doi.org/10.1002/aqc.2581

Meadows, D. H. (2008). *Thinking in systems: A primer.* White River Junction, VT: Chelsea Green Publishing.

Mease, L. A., Erickson, A., & Hicks, C. (2018). Engagement takes a (fishing) village to manage a resource: Principles and practice of effective stakeholder engagement. *Journal of Environmental Management*, *212*, 248–257. https://doi.org/10.1016/j.jenvman.2018.02.015

Mikalsen, K. H., & Jentoft, S. (2001). From user-groups to stakeholders? The public interest in fisheries management. *Marine Policy*, *25*(4), 281–292. https://doi.org/10.1016/S0308-597X(01)00015-X

Moore, C. W. (1986). *The Mediation Process: Practical Strategies for Resolving Conflict*. San Francisco, CA: Wiley.

National Environmental Policy Act of 1969, 42 U.S.C. § 4321 et seq., 1970.

Naughton-Treves, L., & Treves, A. (2005). Socio-ecological factors shaping local support for wildlife: crop-raiding by elephants and other wildlife in Africa. In R. Woodroffe, S. Thirgood, & A. Rabinowitz (Eds.), *People and Wildlife* (pp. 252–277). Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511614774.017

Neff, C. (2012). Australian Beach Safety and the Politics of Shark Attacks. *Coastal Management*, *40*(1), 88–106. https://doi.org/10.1080/08920753.2011.639867

Neis, B., Schneider, D. C., Felt, L., Haedrich, R. L., Fischer, J., & Hutchings, J. A. (1999). Fisheries assessment: what can be learned from interviewing resource users? *Canadian Journal of Fisheries and Aquatic Sciences*, *56*(10), 1949–1963. https://doi.org/10.1139/cjfas-56-10-1949

Nie, M. A. (2001). The sociopolitical dimensions of wolf management and restoration in the United States. *Human Ecology Review*, *8*(1), 12.

Nyborg, K., Anderies, J. M., Dannenberg, A., Lindahl, T., Schill, C., Schluter, M., … de Zeeuw, A. (2016). Social norms as solutions. *Science*, *354*(6308), 42–43. https://doi.org/10.1126/science.aaf8317

Palsson, G., Szerszynski, B., Sörlin, S., Marks, J., Avril, B., Crumley, C., … Weehuizen, R. (2013). Reconceptualizing the 'Anthropos' in the Anthropocene: Integrating the social sciences and humanities in global environmental change research. *Environmental Science & Policy*, *28*, 3-13. https://doi.org/10.1016/j.envsci.2012.11.004

Penney, R., Wilson, G., & Rodwell, L. (2017). Managing sino-ghanaian fishery relations: A political ecology approach. *Marine Policy*, *79*, 46–53. https://doi.org/10.1016/j.marpol.2017.02.008

Reddy, S. M. W., Montambault, J., Masuda, Y. J., Keenan, E., Butler, W., Fisher, J. R. B., … Gneezy, A. (2017). Advancing conservation by understanding and influencing human behavior: Human behavior and nature. *Conservation Letters*, *10*(2), 248–256. https://doi.org/10.1111/conl.12252

Richmond, L., & Kotowicz, D. (2015). Equity and access in marine protected areas: The history and future of 'traditional indigenous fishing' in the Marianas Trench Marine National Monument. *Applied Geography*, *59*, 117–124. https://doi.org/10.1016/j.apgeog.2014.11.007

Sayce, K., Shuman, C., Connor, D., Reisewitz, A., Pope, E., Miller-Henson, M., … Owens, B. (2013). Beyond traditional stakeholder engagement: Public participation roles in California's statewide marine protected area planning process. *Ocean & Coastal Management*, *74*, 57–66. https://doi.org/10.1016/j.ocecoaman.2012.06.012

Scott, J.C. (1998). *Seeing like a state: How certain schemes to improve the human condition have failed.* New Haven, CT: Yale University Press.

Shiffman, D.S., Macdonald, C., Gan, H.Y., & Hammerschlag, N. (2017). Fishing practices and representations of shark conservation issues among users of a land-based shark angling online forum. *Fisheries Research,* 196, 13-26. http://dx.doi.org/10.1016/j.fishres.2017.07.031

Skogen, K., Mauz, I., & Krange, O. (2008). Cry wolf!: Narratives of wolf recovery in France and Norway. *Rural Sociology*, *73*(1), 105–133. https://doi.org/10.1526/003601108783575916

Søreng, S. U. (2006). Moral discourse in fisheries co-management: A case study of the Senja fishery, northern Norway. *Ocean & Coastal Management*, *49*(3-4), 147-163. https://doi.org/10.1016/j.ocecoaman.2006.02.008

State of Hawai'i Division of Aquatic Resources. (July 26, 2018). *Update of court rulings regarding aquarium fishing, including FAQs*. Retrieved March 5, 2019, from http://dlnr.hawaii.gov/dar/announcements/update-of-supreme-court-ruling-regarding-aquarium-fishing/

State of Hawai'i Division of Aquatic Resources. (2019a). *Regulated Fishing Areas on Hawai'i Island.* Retrieved March 5, 2019, from http://dlnr.hawaii.gov/dar/fishing/fishing-regulations/regulated-areas/regulated-fishing-areas-on-hawaii/

State of Hawai'i Division of Aquatic Resources. (2019b). *Threats to sharks*. Retrieved March 5, 2019, from http://dlnr.hawaii.gov/sharks/about-sharks/threats-to-sharks/

Stephenson, R. L., Benson, A. J., Brooks, K., Charles, A., Degnbol, P., Dichmont, C. M., … Wiber, M. (2017). Practical steps toward integrating economic, social and institutional elements in fisheries policy and management. *ICES Journal of Marine Science*, *74*(7), 1981–1989. https://doi.org/10.1093/icesjms/fsx057

Stern, P. C. (2000). New environmental theories: Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues*, *56*(3), 407-424. https://doi.org/10.1111/0022-4537.00175

Tissot, B. N., Walsh, W. J., & Hixon, M. A. (2009). Hawaiian Islands marine ecosystem case study: Ecosystem- and community-based management in Hawai'i. *Coastal Management*, *37*(3-4), 255–273. https://doi.org/10.1080/08920750902851096

Tolotti, M. S., Filmalter, J. D., Bach, P., Travassos, P., Seret, B., & Dagorn, L. (2015). Banning is not enough: The complexities of oceanic shark management by tuna regional fisheries management organizations. *Global Ecology and Conservation, 4*, 1-7. http://dx.doi.org/10.1016/j.gecco.2015.05.003

Vaughan, M. B. & Caldwell, M. R. (2015). *Hana pa'a:* Challenges and lessons for early phases of co-management. *Marine Policy, 62*, 51-62.

Walker, G. & Daniels, S. (1997). Foundations of natural resource conflict: Conflict theory and public policy. In B. Solberg & S. Miina (Eds.), *Proceedings: Conflict Management and Public Participation in Land Management*. Joensuu, Finland: European Forest Institute.

Ward-Paige, C. A., Keith, D. M., Worm, B., & Lotze, H. K. (2012). Recovery potential and conservation options for elasmobranchs. *Journal of Fish Biology*, *80*(5), 1844–1869. https://doi.org/10.1111/j.1095-8649.2012.03246.x

Webber, A. D., Hill, C. M., & Reynolds, V. (2007). Assessing the failure of a community-based human-wildlife conflict mitigation project in Budongo Forest Reserve, Uganda. *Oryx*, *41*(02), 177-184. https://doi.org/10.1017/S0030605307001792

Weiss, J. A. (1989). The powers of problem definition: The case of government paperwork. *Policy Sciences 22*, 97-121. https://www.jstor.org/stable/4532164

Wendt, D. E., & Starr, R. M. (2009). Collaborative research: An effective way to collect data for stock assessments and evaluate marine protected areas in California. *Marine and Coastal Fisheries*, *1*(1), 315–324. https://doi.org/10.1577/C08-054.1

Young, C. N., Carlson, J., Hutchinson, M., Hutt, C., Kobayashi, D., McCandless, C. T., & Wraith, J. (2016). *Status review report: Oceanic whitetip shark (*Carcharhinus longimanus*). Final report to the National Marine Fisheries Service, Office of Protected Resources.* Retrieved

from https://www.fpir.noaa.gov/Library/PRD/oceanic_whitetip/oceanic-whitetip-status-review-report-2016.pdf

Young, N., Corriveau, M., Nguyen, V. M., Cooke, S. J., & Hinch, S. G. (2016). How do potential knowledge users evaluate new claims about a contested resource? Problems of power and politics in knowledge exchange and mobilization. *Journal of Environmental Management*, *184*, 380–388. https://doi.org/10.1016/j.jenvman.2016.10.006