Engaging Hawai'i Small Boat Fishers to Mitigate Pelagic Shark Mortality

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Executive Summary

This project examines West Hawai'i small boat fisher perspectives on pelagic shark interactions and fisheries management. A recent listing of the oceanic whitetip shark under the Endangered Species Act (ESA) has stimulated interest in poorly documented fisher-shark interactions of Hawai'i. We conducted semi-structured interviews with West Hawai'i small boat fishers to supplement limited scientific understanding of fisher-shark interactions in Hawai'i, elicit fisher perspectives on shark interactions and local fisheries management more broadly, and shed light on the viability of different approaches to mitigate shark mortality and engage with fishing communities. By partnering with and observing a community-based shark-tagging project based primarily in the West Hawai'i community, we illuminated fishers' relationships with one another, fisheries managers and scientists, and the sharks they encounter.

The West Hawai'i small boat fishing community, its pelagic shark interactions, and opportunities to mitigate undesired interactions represent a case study occurring within broader context. These broader contexts include the fishing practices, evolving communities, and sociocultural dynamics of West Hawaii small scale fisheries (III.B.1. Fishing in Kona), challenging economic conditions (III.B.2. Economic context), fishing motivations and meanings (III.B.3. What does it mean to be a fisher?), and information sharing practices of the fishery (III.B.4. Information sharing). While not directly related to fisher-shark interactions, this information lays a critical foundation for understanding fisher perspective and experience in this region. It also provides useful commentary on the feasibility of solutions discussed throughout this report.

We found that upon encountering a shark, a fisher has many behavioral and shark-handling options at his/her disposal (III.C.3.1. Shark-handling options). The appeal of any option depends on a number of individual and situational variables (III.C.3.2. Factors of fisher behavior), including fishing method, shark accessibility, abundance, species, fisher physical capacity to handle the shark, and willingness to risk fishing opportunity (Table 4). The appeal of a given shark-handling option also varies across the fishing community, as individuals perceive sharks differently according to their own experiences and species-specific traits (III.C.4. What is a shark?). A single fisher may perceive and handle different shark species differently based on things like species' interaction frequency, market value, or aggression. Although interviewees described sharks to have a negative, competitive effect on fishing, we found diverse descriptions in sharks across interviewees and shark species (Figure 1). Interviewees also described devoting little observational and conversational focus to sharks prior to engaging in this study or the community shark-tagging project (III.C.5. Sharks (not) on the brain). For many fishers, sharks were described as incidental, non-target species.

Interviewees commonly described frustration over fisheries management that they felt overlooked their capacity for self-management and identities as resource stewards (III.D.1. Fisheries management). In discussions of equity and relative impact, interviewees also perceived 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 (III.D.1.2. Relative impact and III.D.1.3 Equity). Issues of power also arose in descriptions of fisher engagement failing to meaningfully consider fisher perspective and knowledge (III.D.2.1. Fishers' voice). Fishers highlighted failures in process, where managers were perceived to design engagement initiatives to fulfill mandated requirements rather than facilitate participation. They also spoke of power inequities, wherein fishers were unable to access fisheries management discussions due to lack of financial capital, formalized knowledge, or specific language through which input was required (III.D.3. Power and knowledge). Fishers described concerns about

negative outcomes of engagement, namely fishing closures and restrictions, and misrepresentation of fisher input (III.D.2.2 Fears).

No single management tool was recommended by all interviewees (III.E. Solution approaches). The application of information provision, compensation, regulation, and shark-handling alternatives to fisher-shark and management problems was considered variable and conditional (III.E.1-4). However, fishers expressed interest in the development of a shark-handling alternative or shark deterrent, and noted specific barriers to using them(e.g., availability, safety, effective preservation of a quality fishing opportunity), which creates space for fishers, researchers, and managers to pursue this solution collaboratively. Solutions that address fisher perspectives and achieve fisher support are especially needed in the absence of enforcement.

Thus, we find that problems associated with shark-fisher interactions are shaped both directly by factors like shark behavior and economic context, and indirectly by degraded fisher-manager and fisher-researcher relationships, threats to fisher identity, and poor fisher perceptions of management. To avoid exacerbating the current situation, robust shark mortality mitigation solutions should incorporate multiple tools and approaches and bridge disconnects between the knowledge and values of fishers, researchers, and managers. Solutions might apply transparent communication, openly discussing issues of equity, researcher goals, and participant risks (III.E.5. Communication). Useful solutions might utilize existing social structures and influences in the fishing community, particularly those involving key actors and face-to-face interaction. Researchers and managers seeking fisher engagement should also be attentive to the engagement geographies, venues, and fisher schedules that enable participation, and actively seek inclusion of diverse fisher perspectives (III.E.6-7).

Solutions might also recognize and respectfully navigate fishers' identities and previous experiences with researchers and managers. This work and that of the Shark Tagger team suggest collaborative research and knowledge exchange may be useful approaches in pursuit of robust shark conservation solution (III.E.8-9). The Shark Tagger group's collaborative research, for example, has enabled collection of otherwise inaccessible shark interaction data and improved researcher understanding of fisher-shark interactions, 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 perspectives. Multipronged solutions that employ collaborative research and knowledge exchange may thus benefit fishing communities, shark populations, and fisheries researchers simultaneously, while contributing to fisheries management solutions broadly.

In sharing their knowledge, and experiences, West Hawaiʻi small boat fishers participating in this study enhance understanding of shark interaction issues and shark mortality mitigation opportunities. The shark-fisher interaction problem can thus be broadened to include sociopolitical context, economic context, relations of power, unresolved conflict, and fisher identity. This study also identified fishers' perceived social and power inequities in fisheries management. Through fisher engagement, researchers and managers have the opportunity to improve fisher access to management discourse, and consider valuable fisher knowledge and experience in the development of fisheries management approaches.

I. Introduction

This project examines fisher perspectives on pelagic shark interactions and fisheries management. At the time of this project's inception, a recently proposed rule to list the oceanic whitetip shark (*Carcharhinus longimanus*)[1] 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 Honolulu, Hawai'i in April 2019.

Though the oceanic whitetip shark is of particular interest in this study due to its recent ESA listing, the study scope includes pelagic sharks in general. Preliminary "talk story" sessions with fishers revealed that oceanic whitetip shark encounters might be fairly uncommon in the fisheries that handle them. Additionally, discouraging discussions of interactions with other shark species would neglect a valuable opportunity to address wider shark conservation issues. Thus, this research generally explores fisher perspectives on pelagic sharks and local fisheries management more broadly. This broad reference to fisheries management includes local fisheries regulations and politics and the processes that guide them. While often not related to shark management or regulations specifically, our discussion of fisheries management provides important context to understand how fishers relate to fisheries management and its actors.

Case study: West Hawai'i Small Boat Fishery

We examined fisher perspective, shark interactions, fisheries management, and the interconnectedness of these elements through a case study bound to the West Hawai'i small boat fishery and their pelagic shark interactions. We 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, gather their perceptions of shark interactions, and explore the viability of different management approaches.

Although 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.

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[1] A table of species' names can be found in Appendix C (Table 11), including common names used by interviewees, scientific names, and common English names, where possible. It clarifies the identities of focal shark and target species discussed during interviews.

The small boat fishery of West Hawaiʻi is an ideal candidate for this case study for several reasons. The West Hawaiʻi region is home to various fisheries research and management efforts. These include the West Hawaiʻi Regional Fishery Management Area (WHRFMA), which extends from North Kohala to Kaʻū (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 Hawaiʻi 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 Hawaiʻi Division of Aquatic Resources, 2018). Several nongovernmental organizations (NGOs) with West Hawaiʻi-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 Hawaiʻi 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). These assertions of management and diverse stakeholder interests inform the West Hawaiʻi 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 Hawaiʻi 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 Hawaiʻi 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 Hawaiʻi 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).

Stakeholder Engagement

Stakeholder engagement is often used to include more diverse perspectives to improve fisheries management problem framings and solutions (Beierle 2002; Mikalsen and Jentoft 2001; Sayce et al. 2013). 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 improving management strategies of fisheries resources (Reed et al. 2006; Wendt and 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. Mackinson and Nøttestad (1998)

describe fisher insight as valuable for improving the cost-efficiency, comprehensiveness, and approval rating of fisheries science and management. The latter also plays a 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 and 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). Implementation of such engagement tools designed to meet only minimal legal requirements, however, may result in ineffective and stakeholder-inaccessible processes (Mease et al. 2018). Instead, 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 and Caldwell 2015), in which face-to-face dialogue and incremental successes lead to shared understanding (Ansell and Gash 2007).

This study utilizes and examines stakeholder engagement in the context of fishing communities, shark mortality issues, and more broadly within fisheries management. Engaging with fishers allows us to understand the way they experience shark interactions, fisheries actors, and institutions. It also creates opportunity to pursue solutions through more inclusive processes.

Research Objective

In this study, we engaged West Hawai'i small boat fishers to explore their perspectives on shark interactions, fisheries management and science, and potential shark mortality mitigation strategies. By making fishers' experiences and perspectives available to scientific and managerial communities, we generate guidance around engaging fishing communities and reducing shark mortality from fisher-shark interactions.

II. Methods

This study takes a qualitative, inductive approach. Qualitative, meaning that its focus is on descriptive, rather than quantitative data. And inductive, meaning that its goal is to generate new frameworks of understanding from these data, rather than interpreting data through hypotheses established prior to data gathering. The exploratory nature of this approach seeks to answer research questions while avoiding preconceived notions of answers. We collected data primarily through semi-structured interviews. Interview data were supplemented with observational data, collected on an opportunistic basis.

Data Collection

Data collection began in September of 2017 when colleagues and mentors at the Pacific Islands Fisheries Science Center (PIFSC) organized preliminary meetings between the primary author and members of local fisher-oriented NGOs, and fishing and social science communities. During this time Dr. Melanie Hutchinson, a shark bycatch researcher from the PIFSC International Fisheries Program, connected us to participants of her Shark Tagger project. This community-based shark-tagging effort enlists the help of West Hawaiʻi fishers to deploy tags on pelagic sharks.

These preliminary, unstructured "talk story" sessions allowed us 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, sampling criteria were also defined: small-scale fishers that interact with pelagic sharks. Following recommendations from "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 Hawaiʻi Fishing News magazine provided information about Shark Tagger research and contact info to participate in an interview, they did not connect us to new research participants.

Between September 2017 and June 2018, the primary author interviewed 29 West Hawaiʻi fishers. Participants' ages ranged from 19 to 75 years, and all were male. Two fishers were interviewed together; all others were interviewed individually. Research participants selected their interview locations. Most interviews were conducted in participants' homes or at the Honokōhau Harbor, where many dock their vessels. Only one interview was conducted outside of the Kona area, on the island of Oʻahu. Regardless of interview location, research participants were identified by referral from other interviewees or project advisors, and for their participation in West Hawaiʻi fisheries. Semi-structured interviews and snowball sampling continued until themes in the data reached saturation, concluding in June 2018. All interviews were conducted and analyzed by the primary author.

The interview guide (Appendix A) addressed research objectives indirectly to allow co-direction of the interview and encourage relevant, but unexpected, themes to emerge. As such, it was used only as a guide, to ensure that core topics and related ideas were addressed. However, the interviewee's experiences and interests directed the flow of the interview, and questions were not always asked in the same order or verbatim. Interviews addressed four broad themes:

- participant relationship to fishing and fishing history;
- information sharing in the fisheries of Hawaiʻi Island;

- shark interactions and handling practices; and

- fisher perceptions of local fisheries management and science.

Interview questions embedded 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. The goal was to complete field notes within 48 hours of the interview. Minor revisions were made to the interview guide as needed to accommodate emerging themes and improve interviewee accessibility to question wording (Appendix A). The evolving interview guide enabled pursuit of 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 (version 11 Plus, QSR International, Inc.).

Observational data was collected opportunistically on three occasions. On all three occasions, the primary author 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 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

Interview data were transcribed and coded using NVivo software. Coding consisted of highlighting pieces of transcribed text and dragging them into thematic categories or nodes. Through this process, any given piece of transcribed text could be coded for one or many themes. As an example, the following author-written sentences contain several themes: "*I occasionally land and sell thresher sharks. Threshers can be dangerous, just like mako sharks*." The first sentence could be coded under the theme "Shark market value." The first sentence and a half could be coded under the theme "Thresher," while the second sentence in its entirety could be coded under "Mako." Finally, the second sentence could be coded under "Sharks as… dangerous." This process, called content analysis, allows for the layered tracking of multiple meanings and relevance to different topics.

Content analysis of interview data began with preliminary coding in NVivo during the transcription process. During the preliminary coding phase, our goal was to ensure that all relevant themes were represented in the coding scheme, or codebook. New nodes were created liberally for emerging themes and nested when appropriate. This drafted coding scheme generally followed the major interview guide themes: 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, we reviewed the drafted coding scheme with greater attention to organization and relevance. We 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. Descriptions were added 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 beneath them.

We then proceeded with a comprehensive coding phase, which served to capture all relevant transcript data within the nodes of the coding scheme. We 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 any single 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, we made another organizational pass over the coding scheme. The codebook consists of 17 numbered umbrella nodes, each with up to four generations of child nodes nested beneath them (Appendix B). We numbered these such that those most closely related by theme fell within the same interval of 10. 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.

In February of 2019, the primary author returned to the study site to publicly present 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. Several interviewees made informal comments to the primary author regarding their support in future research endeavors and satisfaction with the way the results were presented.

Human Subjects Review

Institutional Review Board clearance for this human subjects research was obtained through the PIFSC under JIMAR 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 filing cabinet where building and room access is limited.

III. Results

This section delivers a complete report of our findings, including information about fishing cultures of West Hawaiʻi, economics of its small boat fleet, shark interactions and behavior, and fisher perceptions of management. The first two results subsections outline the demographics of research participants and broad context for understanding the small boat fisheries of West Hawaiʻi in their methods, economics, and social dynamics. Together, these provide important context to understand fishers' experiences with sharks, fisheries management, and science. Subsections thereafter align more clearly with this project's focus on shark interactions in small scale fisheries. They include fisher descriptions of sharks and their approaches to shark encounters, perceptions of management, experiences in fisher engagement, dynamics of power and knowledge in fisheries, and potential solutions to mitigate fisher-shark interactions.

Throughout the remainder of this report, numbers in parentheses will be used to indicate the number of interviewees who spoke to the topic in question, unless otherwise specified. 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, nor generalizable beyond this set of interviewees.

As much as possible, illustrative quotes from interviews are reported verbatim to capture interviewee perspective and voice. Author edits, indicated by brackets [], have been made as needed to make quotes accessible to broader audiences in Hawaii and beyond, and in some cases, to protect research participant identities.

Research Participants

Research participants represented diverse experiences in the fisheries of West Hawaiʻi in terms of personal geographies, years of experience, and fishing method. More than half of the research participants were born and raised on the island of Hawaiʻi, with a majority of these hailing from its west coast; 8 traveled to Kona from the continental United States; and the rest came from neighbor Hawaiian Islands. Individual interviewees had from 5 years to more than 6 decades of experience in West Hawaiʻi waters (for an average of 30 years per interviewee). Together, these 29 interviewees accumulated more than 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 we also include them in the total of 17 interviewees that fish commercially. Only 3 in this commercial fishing group self-identified as full-time commercial fishers. The remaining 8 interviewees are primarily recreational fishers, or are pursuing other non-fishing occupations after dabbling in or retiring from fishing careers. Of these, 4 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; n = 20), trolling (n = 21), and live baiting (n = 18). These methods are described in more detail in the "Fishing methods" section below. Overall, though, the types of fishing in participants' repertoire were extensive. They included spearfishing, diving, greenstick, fishing in porpoise,[2] netting, jigging, dangling, longline fishing, and the additional handlining sub-categories of make dog and palu 'ahi. Interviews also covered a diverse range of target species, the most popular of which were bottomfish, 'ahi, marlin, and 'ōpelu (mackerel scad, *Decapterus macarellus*). 'Ahi can refer to either bigeye (*Thunnus obesus*) or yellowfin tuna (*Thunnus albacares*). Other target species cited in interviewees' primary fisheries, past and present, included other pelagics like mahimahi (dorado, *Coryphaena hippurus*), aku (skipjack tuna, *Katsuwonus pelamis*), and ono (wahoo, *Acanthocybium solandri*); reef fish both for consumption and sale in the tropical fish trade; Kona crab (*Ranina ranina*); and black coral.

Broader Context for West Hawai'i Small Boat Fisheries

This section includes broad context for understanding the small boat fisheries of West Hawai'i. It describes the fishing practices employed by research participants, economic context for their operations, and the social dynamics of their fisheries. The latter includes elements of fisher identity, motivation, risks to fishers, and information sharing practices. While not directly related to sharks, this context is important in understanding fishers' experiences and perspectives around sharks, fisheries management, and science. Themes discussed in this section correspond with nodes 0-29 in the codebook.

A.1.   Fishing in Kona

To fully understand interactions with sharks, it was first necessary to gain a broader understanding of the West Hawai'i small boat fishing culture and its evolution. This section describes key considerations through which people navigate their fisheries and evaluate their interactions with sharks. These include Kona fishing practices, changes in the small boat fisheries community through time, and unique aspects of its fishing culture and physical environment. In its broad description of West Hawai'i small boat fishing and culture, this section helps to contextualize shark interactions and potential mitigation strategies within the fishery's tools and methods, changing fish abundance, and competitive and cooperative social dynamics.

A.1.1.   Fishing practices

When asked to describe their fishing methods, many interviewees (n = 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."

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[2] 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 (*Stenella attenuata*). We will refer to them as such for the remainder of this paper, except when used in a direct quote.

A.1.1.a.   Location

Fishers described their activity in various areas across the West Hawai'i coast. "The Grounds," an approximately 2-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 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 (n = 11), and even the Northwestern Hawaiian Islands (n = 2).

A.1.1.b.   Fishing methods

Handlining is a fishing method used to target bottomfish and 'ahi at various depths and times of day. One fisher explained the different bathymetries associated with target species: "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—described interchangeably as make dog or palu 'ahi by interviewees—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. Various handlining techniques can be differentiated by the size of their tackle. Ika-shibi is a nighttime fishery that employs a drifting parachute, and lights to attract ika (squid) as bait for shibi (small yellowfin tuna) and other pelagics. Generally, fishers described palu 'ahi and make dog as daytime fishing practices.

Ika-shibi 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, although 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. Because this method is employed at night when pelagic fishes migrate upward in the water column, ika-shibi 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."

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; 'ōpakapaka (pink snapper, *Pristipomoides filamentosus*), onaga (long-tail red snapper, *Etelis coruscans*), and uku (gray snapper, *Aprion virescens*). Fishers also described targeting ulua (*Caranx* spp.) and kāhala (greater amberjack, *Seriola dumerili*) for charters, or in some cases kāhala for the Kona kampachi[3] farm's (Kampachi Farms, LLC) 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

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[3] Kampachi (also *Seriola dumerili*) refers to the farmed counterparts of wild kāhala.

mobile pelagic fishes like marlin, ʻahi, and ono. Interviewees described using ʻōpelu and aku as live bait. Fishers described trolling and live baiting around buoys, ledges, and in bait schools.

A.1.2.   Culture

"Fishing is one culture, you know. It's one big part of local tradition."

Many of those who called West Hawaiʻi 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. Another fisher described distinct cultures between the islands, juxtaposing his lifestyle against what he called an "Oʻahu 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 [Oʻahu] 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 Hawaiʻi, 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 Oʻahu where- you know what I'm saying? So, I have a lot of fishing friends. Big part of the culture here.

A.1.3.   Evolution through time: Participation, technology, and fish abundance

Interviewees described an influx of fishers from neighbor islands and the continental United States to the West Hawaiʻi 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 5, 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 lot of 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 lot of 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 for 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 plenty 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 [saw] 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. 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 Galápagos sharks (*Carcharhinus galapagensis*) on floating debris which locally depleted kāhala and Almaco jack (*Seriola rivoliana*). 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… all you [did was] 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 was interviewed in his home, high enough on the mountain 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 them from here, but not anymore.

A.1.4. Visibility

Much of the fishing activity of West Hawai'i occurs in Honokōhau Harbor. Although not exclusively, most interviewees dock their vessels or fish out of Honokōhau. 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 indicate 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, looking out there, and they know that my boat has a red and white light or whatever, 'Oh that's [fisher name], 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.

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One interviewee chuckled at interviewer 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.

A.1.5.   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 is elaborated 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 practiced exclusively by commercial fishers previously.

> 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 ko'as[4] and stuff like that, that some of the commercial guys get kind of ticked off. That they kind of feel like the charter boat's kind of 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, existing between fishers who identified as small-scale vs. longline and purse seine fisheries, and between commercial vs. 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 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 guy's 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 those

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[4] *Ko'a* is a Hawaiian word used commonly to refer to fishing grounds.

targeting fish on relatively distant seamounts, 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 looking 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 lot of marlin there, 'Eh, my project out there's got some marlin hanging out, if you want to go take that run up there and go look.' Kind of like help each other out that way.

A.2.   *Economic Context*

This section summarizes interviewees' descriptions of their fishery's economic contexts. These results are presented according to the following overarching themes: demand, market competition, increasing costs, and participation.

A.2.1.   **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 2 years, but no one sells fish to them 'cause they don't want to 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 the 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 Hawaiʻi 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 them 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 kind of complaints about [sharks] being their ʻaumakua[5], 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."

A.2.2.　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 [for] 50 cents or $10, you know. And the paka's always 5 to 8 [dollars]." 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

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[5] The Hawaiian word *ʻaumakua* refers, in the context of this work, to familial ancestors or gods that take the form of various animals and elements of nature, including sharks.

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 way to maintain a steady flow of business. One charter captain added that diversification of Hawai'i 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."

A.2.3.   Increasing costs

The challenges of market competition were exacerbated by increasing costs of gas, fuel, and ice; 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 because a hundred dollars is 30 gallons in fuel. See, that's how we're going to 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 going to relate to what that thing is worth to me.

A.2.4.   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.

A.3.   *What does it mean to be a fisher?*

This section describes some of the common characteristics across research participants that provide insights into fisher identity. Several shared personality traits emerged from interviews, which are introduced briefly in Table 1. The value of n represents the number of interviewees displaying or describing this trait. Then, fishing motivations and the benefits interviewees derive from fishing are reviewed, before describing the effects of fishing on various aspects of human well-being.

A.3.1.   Personality traits

Table 1. Top five most prevalent fisher personality traits.

Traits (n)	Description	Illustrative quotes
Self-reliance (18)	Descriptions of fishers' partiality toward learning or operating independently, or requiring some level of self-reliance for success.	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. 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.
Stewardship (15)	Descriptions of fisher stewardship or stewarding identities for sustainable resources, fishery participation, and fishing cultures and values.	I think the public a lot of times gets misinformed that all fishermen are just inherently evil, greedy, we want to 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.
Curiosity (12)	Expressions of curiosity and interest in scientific information, and descriptions of fisher acuity for on-the-water observation, experimentation, and data collection.	That kind information might be useful…. So we know what the shark interaction is with the fish. Or with the area that you fish. That might be good to know. That's another tool in our tool bag when we go fishing, ah? I have all of my fishing reports archived on my web page…. You can read the May report for over a decade. And a lot of times you'll find that there are some correlating things that'll happen in, let's say May, that don't happen in September.
Bravado (8)	Descriptions of boastfulness and aggression. Also included descriptions of fishers' affinity for adventure, exploration, and lack of regulation.	All fishermen have an ego, if you don't have an ego you're not a real fisherman…. We all want to be patted on the back at the end of the- Or be known for being a good fisherman. Commercial fishing can be kind of a ride. The thrill of catching a fish is great…. But there's kind of a, I don't know if you call it primal, it's the hunter-gatherer kind of thing. Catch as many fish as you can commercially, and you come back and you're the big hunter, there's that aspect.

Traits (n)	Description	Illustrative quotes
Pride (5)	Descriptions of pride in the context of fisher identity.	Just the idea that so few people can even do it, that I can just makes me feel good. That I can do things that other people can't do. Or I have the fortitude or the whatever. There's just a very few, yeah. Everybody knows my dad, he was a badass fisherman, badass diver, everything. There was books written about him.

A.3.2.   Why fish?

A.3.2.a.   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 tangible and intangible factors that motivate their fishing practice. Intangible motivations were labeled under the theme "pleasure," which was cited most often and by the most research participants (n = 26). This category captured many of the intangible 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. Sub-themes to "Pleasure" 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.

A.3.2.b.   Tangible fishing motives

The second most commonly cited fishing motivation was money (n = 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[6] 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."

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[6] Soldierfish, *Myripristis* spp.

A.3.3. Threats to human well-being

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

Interviewees described layered fishing motives that either incentivized sustained fishing despite its threats to human well-being, or sacrificed to preserve various elements of human well-being. These included financial security (n = 21), physical well-being (n = 15), and family (n = 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 you? 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 got to 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 five 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 referring to certain kinds of fishing, like overnight trips or full-time commercial fishing, as a younger, more resilient fisher's game. Other 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."

A.4. *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, so that managers have a better understanding of how to engage with this network. This section presents 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.

A.4.1. 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.... 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.

The interview guide (Appendix A) 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 relevant to fisheries management was not related specifically to sharks, but instead to policy recommendations or processes, fisheries regulations, and fisheries politics generally. These provide important context for how fishers relate to fisheries management and its actors. Interviewees described information from fisheries management agencies like the Department of Land and Natural Resources (DLNR), the Western Pacific Regional Fisheries Management Council (WPRFMC), and NOAA shared primarily through 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. The limited sharing of information around these topics is discussed further in sections III.C. Sharks and III.D.1. Fisheries Management.

Information sources discussed during interviews included printed media, like fishing magazines or flyers distributed in fishing shops, harbors, and the charter desk at Honokōhau Harbor; social media; encounters at Honokōhau 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, the latter of which identify social media as a modern tool to advertise their businesses to potential clients. 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 want to catch the biggest and you want to get the pictures of it…. As you get older that fades away and you get less, trying to 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,' kind of deal. That's just not my personality….
>
> 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 want to 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 got to take it with a grain of salt."

Social encounters and relationships provided opportunity for the exchange of more reliable and exclusive information. Honokōhau 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. The direction from which vessels return to the harbor reveals their general 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 want to 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?

A.4.2. 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, we provide a summary of 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, a larger info-sharing circle might be beneficial, for example, when a fisher is still learning to fish, has less invested in landing fish for income, or fishes infrequently enough 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 got to find more information from other people because they go once a month kind of 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 that allow exclusive information to be shared regularly and deliberately. This latter category was described by most interviewees as being made up of "*a handful*" of people. As one fisher put it, "There's talking to them, and then there's really talking to them." Out of 17 fishers that provided quantitative estimates of their info-sharing circle sizes, 14 cited 10 or less, and half of those cited 5 or less. Of the remaining 3 interviewees, 1 cited a circle size of 20–25 in reference specifically to the sharing of information relevant to fisheries management generally. The other 2 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."

Table 2 describes the five factors that interviewees (n) use to determine inclusion or exclusion in fishers' info-sharing circles. 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.

Table 2. Determining factors for inclusion or exclusion from fishers' info-sharing circles.

Factors (n)	Description	Illustrative quotes
Info quality (16)	Descriptions of info-sharing as worthwhile for more accurate or exclusive fishing information. Also the tendency of fishers to play "*games*" through exaggeration or info-guarding.	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. You cannot believe all the fishermen you know. Some are fishermen (laughs).
Reciprocity (15)	Descriptions of reciprocity as a factor determining the viability of info-sharing partnerships. This facilitates two-way information exchange, but may also prevent fishers from seeking information from peers.	So it's a lot about communicating back and forth. One way communication [doesn't] work. I wouldn't ask too much information, so being in that position I wouldn't have to give too much information. Those [were] my role models… growing 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 (14)	The relevance of information makes it more valuable to the recipient. Functionally, this can promote info-sharing between fishers using either similar or dissimilar methods. Or, if a fisher occupies a methodical niche, info-sharing may not be necessary.	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. If you want to find out what the current is doing the night before you call a commercial friend and ask him.
Time (12)	Descriptions of fishers determining the viability of info-sharing partnerships with the passing of time.	That's just through the years. Yeah you know like, most of the people that you work with, you definitely know a long time. But there's been a lot of new, younger fishermen… It doesn't take long to see a true color (laughs).

Factors (n)	Description	Illustrative quotes
Loyalty (10)	Descriptions of loyalty as a factor determining inclusion in info-sharing groups (e.g. protecting exclusive information that originated from another fisher). Also important for fish buyer-fisher relationships, which may depend on establishing a precedent of consistent supply and quality.	A: If you get them, tell me. If I get them, tell you. B: But you're not allowed to talk to anybody else. A: And if I get them 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. 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 lot of fish, they might tell you they don't need the fish, then you get stuck with the fish. I won't save a space for somebody that I don't know, 'cause I don't know basically how he takes care [of] his fish… 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.

A.4.3. 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. We 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… If you find the fish you don't want to 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 going to 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 kind of 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, one interviewee related information guarding to ethnic identity and access to financial capital:

> If you one new haole[7] on the block, the old Hawaiian uncle down the corner, if you get to become in his circle of friends, it's got to be something really special. And it's not that they don't want to be friends, but [they're] going to be more reserved. Especially if the guy [has] money. See that's the new thing now. You have lot of 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

As mentioned above, fishing practices, economics, and social dynamics critically define the West Hawai'i fishing community and its fishers' experiences. In this section, we present the themes that emerged as fishers were prompted to discuss sharks explicitly. It summarizes interviewees' descriptions of shark behavior, abundance, and interactions, and sheds light on how fishers understand the "shark problem" and seek its resolution through their own pathways. Themes reported on in this section were taken from nodes 30–39 in the codebook.

A.5.   *Species*

The shark species cited by the most interviewees, in descending order, were the oceanic whitetip (n = 28), tiger (n = 25), mako (n = 25), thresher (n = 22), bronze whaler (n = 20), blue (n = 17), Galápagos (n = 12), hammerhead (n = 11), silky (n = 7), sandbar (n = 6), great white (n = 5), whale shark (n = 3), dusky (n = 2), and oceanic blacktip (n = 1). Please refer to Table 11 in Appendix C for a table of shark species common and scientific names.

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[7] A Hawaiian word meaning foreigner, often used to refer to Caucasian persons.

The number of interviewees (n) that 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. Although qualitative, we believe these species-specific summaries of fisher descriptions are valuable given the poor documentation of shark interactions in Hawai'i small boat fisheries. The remainder of this section focuses 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 fishers' species identifications were not confirmed 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.

Below, we summarize species-specific variations relevant to shark behavior, distribution, and interaction frequency.

A.5.1. 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. Fishers participating in the collaborative shark-tagging program have tagged over 30 oceanic whitetip sharks between October of 2017 and December of 2018 (M. Hutchinson, pers. comm., December 2018), thus providing 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 made up 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.

Interviewees described oceanic whitetip sharks as regularly occupying surface waters. For this reason, one fisher described surface fisheries like those targeting mahimahi to produce more oceanic whitetip interactions. Ika-shibi, troll, and live bait fishers also described oceanic whitetip sightings. In these descriptions, oceanic 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're going to catch them when the most guys are out there fishing for 'ahi right? So from July to September is when guys going to start catching them." 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 them around, you know, 5, 6, 8 a night," and another described seeing 2–3 at a buoy as not uncommon.

A.5.2. Tiger

Tiger sharks (*Galeocerdo cuvier*) were described as an inshore, shallow-water species. Fishers described tiger sharks depredating (partially or completely taking target species) 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 Honokōhau Harbor. One fisher described them, "[coming] in the harbor every day. They start around Easter and leave around November… Sometimes I've seen six in the harbor at once."

A.5.3. Mako

Mako sharks (*Isurus* spp.) 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 relative speed and unique jumping behavior. One fisher noted that, "mainly the more aggressive sharks like the mako will attack a lure." Another said, "As soon as you hook [a mako] it just goes straight in the air. They go straight up. People have leaned over the boat and they've come and broke their nose an all kinds of stuff."

A.5.4. Thresher

Interviewees described thresher sharks (*Alopias* spp.) 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 going to catch them. 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 on bait. "They're always going to bite your deep line," said one fisher. Another commented, "[A] thresher shark, I don't think [you're going to] see them 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, in association perhaps with fisher-shark interactions. 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."

A.5.5. Bronze whaler

"Bronze whalers" were described frequently by interviewees, although the species (*Carcharhinus brachyurous*) is not found in the central Pacific. We believe that in Hawaii, "bronze whalers" refer to Carcharhinid sharks with indistinct features, and likely includes such species as the Galápagos and silky sharks (*Carcharhinus falciformis*). Fishers described "bronze whalers" as sharing some of the oceanic whitetip shark's behavioral 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 lot of 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.

A.5.6. Blue

Interviewees described blue sharks (*Prionace glauca*) 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 them 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."

A.5.7. 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 will get really thick in certain areas. But they're generally around shallow areas within 100 fathoms. So they're going to 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.

A.5.8.   Sandbar

One particular fisher described sandbar sharks' (*Carcharhinus plumbeus*) average size to range from 50 to 150 lb, 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 kn.

A.5.9.   Hammerhead

Several fishers described sighting scalloped hammerhead (*Sphyrna lewini*) schools in the springtime (n = 6). Large schools in the tens to hundreds were described to outside of Hoʻokena, Keauhou, and Miloliʻi, within 100 fm. 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 described his hammerhead-sighting experiences:

> 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 nothing 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.

A.5.10.   Implications for handling

Shark species were described to exhibit variable resiliencies and behaviors. Species variations in aggression, interaction frequency, and abundance were described to influence fishers' perceptions and handling of 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 them go? Probably you can do that 'cause not much whitetip anyway. But the other kind shark, why [would I] do that for (chuckles)? Get so much. They bothering us over here.

Additional factors affecting fishers' shark-handling practices are discussed in the below section, "Factors of fisher behavior."

A.6.   Interaction frequency

In the previous section, some species-specific factors that affect shark interaction frequency were introduced, including time of day, prey size, and moon phase. In this section, we report on interviewee-described changes to shark interactions through time, and expand on previous sections to include more generalized factors affecting interaction frequency (Table 3). The factors affecting shark interaction frequency discussed below are: fishery, location, seasonality, bait, currents, and fisher mobility.

A.6.1. Through time

It is perhaps difficult to understand how and why shark interactions have changed through the years given that some fishers' practices and fishing frequencies have also changed through time. Many fishers noted that they have not applied the same diligence observing sharks as they have to observing target species (see section "Sharks (not) on the brain"), and shark abundance may have changed. 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 them because we don't live bait anymore. So, if the bait fishing comes back then the input will come back on what kind of sharks we see. But for now, I mean, I haven't caught a shark in five years probably." When prompted for their perceptions of changes to shark abundance through time, some fishers described no significant change (n = 10), an increase (n = 8), a decrease (n = 5), or were not confident in describing a trend (n = 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 (n = 3), an increase in shark abundance at South Point through time (n = 1), and an increase in shark and predator (e.g., barracuda) abundance after Kona's kampachi farms were established (n = 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 (n = 4), and a decrease in blue shark abundance (n = 2). Trends in oceanic whitetip shark abundance varied across interviewees.

A.6.2. Shark interaction factors

Table 3. Summary of factors interviewees believed affected the likelihood of shark interactions.

Factor (n)	Description	Illustrative quote
Location (29)	Two fishers described West Hawai'i and Hawai'i Island as areas with relatively low shark abundance compared to other Hawaiian islands. Some locations on Hawai'i Island, like South Point, were frequently described as more shark abundant. Key location-dependent factors associated with increased shark interactions were shallower inshore depths, koʻa, and topographical ledges. Fishers also described the more pelagic oceanic whitetip and 'bronze whaler' type sharks as congregating around offshore buoys and other floating objects, and following pilot whales.	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.

Factor (n)	Description	Illustrative quote
Seasonality (26)	Shark seasonality was not a point of consensus across interviews. Often it was described relative to the arrival of large pelagic fishes like 'ahi or an increase in fishing pressure during summer charter and ika-shibi fishing seasons. However, some bottomfish and tuna handline fishers described the opposite trend: a wintertime increase in shark abundance. Still others described sharks as present year-round, especially at location-dependent hot spots.	Just before tuna season the sharks are all at the buoys in piles… [I've] 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 them, kill them 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. Especially in the winter, it gets just, what we call, sharky. It's just nothing but sharks. 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.
Bait (19)	Bait, whether live or chum (palu) is associated with more sharks, especially in the midst of ika-shibi season when the fleet produces a collective "*scent trail*". Dead bait was described as a lesser attractant compared to live bait or steady chumming. Although 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.	When you're fishing ika-shibi you can't stop throwing palu. You stop throwing palu, there's nothing going to come to you. Or if you've got fish, you stop palu-ing, they're going to leave.

Factor (n)	Description	Illustrative quote
Fishery (16)	Shark interactions were described as infrequent for trollers and those who follow dolphins, moderate for live baiting and ika-shibi fisheries, and frequent for the for the shallower-water ʻōpelu and bottomfish fisheries.	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 [an] onaga pile, ʻōpakapaka. Always. There's a guardian shark on all those piles. There's three ways to catch ʻahi. At the buoys, and the porpoise, or ika-shibi. So if you're at the buoy, I would say probably going to 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 going to deal with a shark probably only 20% of the time…. The most interaction I have with sharks is bottomfishing and ʻōpelu.
Currents (5)	Poor current (or consistent flow across depths) was related to higher predator abundance, including sharks. High current speed might also disable shark retention in an area, depending on the shark species.	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 (4)	Mobile fisheries like trolling and live baiting were described to yield fewer shark interactions compared to bottomfishing or tuna handlining. These latter fisheries, more prevalent among commercial fishers, were described as relatively stationary. Often the relationship between fisher mobility and shark interactions was attributed by fishers to sharks as lazy, opportunistic feeders.	Lot of times on the charter fishing, or the commercial guys that are ʻahi fishing, they're fishing the dolphin schools, the spotted dolphin. And they're kind of just roaming offshore… three to 25 miles offshore sometimes. And they're moving so the sharks-sharks are generally, they're kind of slow movers, they're lazy kind of 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].

A.7.   Fisher decision-making during an interaction

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. The following subsections detail the behavioral and shark-handling options reported by fishers when they encounter a shark, and the variables fishers consider while navigating those options.

A.7.1.   Shark-handling options

Each fishing individual's preference for the following behaviors and shark-handling strategies varies. This section presents all of the behaviors and shark-handling strategies that emerged from interviews. These include physical handling of the animal, shark avoidance, shark feeding, shark deterrents, and gear modifications. Note that numbers in parentheses accompanying each behavioral and shark-handling strategy subheading represent the number of interviewees who discussed each practice, but not necessarily the number who practice it.

A.7.1.a.   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 going to 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 got to 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 got to do what you got to 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 making 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 lot of 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 them go away.

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

Firearms (n = 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 because 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 kind of 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 (n = 20)

Cutting the line to release a shark was described as a viable alternative in cases when using a firearm might be unsafe or infeasible, 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 them, 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 want to cut my main line… So you got to 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 (n = 5): "Pull on them, make them kind of hurt, like hurt their mouth. Pull on them, get them 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 (see Shark persistence section below).

Many fishers described sighting or recapturing sharks with many hooks in their mouth, evidence of prior 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 them and they just bite through your mono leader."

Jugging (n = 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 other floated object to a baited hook, to occupy the shark and maintain its position at the surface, thus deterring it from your fishing area or target species:

> [Taking] this jug, I tie a leader to it, I throw my bait out. But [I'm going to] 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 going to 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]…. I absolutely believe it's fatal. 90% of the time. And even if it's not, it's going to shorten that shark's life. He's dragging that thing around." The perception that sharks survive after jugging surprised one spearfisher, who described finding a dead, jugged shark: "I've found them 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… They just don't carry on eating their fish, 'cause they've got a jug hanging off of them." 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 (n =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, an area of sensitivity (n = 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 got to whack them a few times on the head to slow them down…. It hurts us, and it hurts the *boat*.

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

Tag it! (n = 6)

Given that many 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. Notably, some

fishers involved in the community-based tagging project described the act of tagging sharks as deterring the animals from their fishing vessel.

Despite the Shark Tagger program's emphasis on tagging animals during incidental interactions, one interviewee described the possibility that compensated shark tagging could incentivize shark interactions where they would otherwise not occur.

A.7.1.b.   Avoidance (n = 20)

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

Shark avoidance was described by interviewees as preferable to shark-handling, but often unfeasible. Said one fisher, "Every commercial fisherman, in fact every fisherman will 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 (n = 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 them 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 farther 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 of fishing areas that could provide better fishing opportunity, or because their fishing method eliminates the aforementioned strategies.

A.7.1.c.   Feeding (n = 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 ʻōpelu 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 food items tossed overboard by crew. 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 ʻahi 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 leave satisfied: "Sometimes they'll take their share. You'd lose couple fish and then sometimes they'll just leave you alone."

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

A.7.1.d. *Shark deterrents (n = 9)*

Fishers expressed interest in developing shark deterrents, citing chemical and electrical deterrents used by recreational ocean users or fishers as seen in the media. In isolated cases not specific to Hawaiʻi, 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.

A.7.1.e. *Gear modifications (n = 8)*

Fishers described gear modifications that weren't directly relevant to West Hawaiʻi 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. Two others, reflecting on the billfish fishery's shift from J to circle hooks, commented on the tendency of J hooks to fall out of fishes' mouths more compared to circle hooks, which snag onto the mouth corner. J hooks are also swallowed more readily, however, so have the potential to increase shark hookings under certain circumstances. One bottomfish fisherman described spray-painting his equipment black, following the advice of a fishing mentor, which significantly reduced his gear losses to sharks.

A.7.2. 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. Table 4 provides a summary of these factors, which are grouped into five categories: shark attributes, landing opportunity, social pressure, physical capacity, and investment in time or finances. Any misalignment between these five categories and their factors was intentional, to indicate that factors belong to multiple categories. The most prominent category was shark attributes, which also contains the most discussed factor: shark accessibility. The relationship of shark accessibility to fisher behavior is elaborated upon in a subsection.

Several less tangible behavioral motivations 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 4, affecting how each fisher takes them into consideration.

Money plays a significant role in how fishers navigate fishing and shark-handling decisions (n = 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 (or landing) 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 (n = 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 (n = 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 them. So the word's getting out that the fishermen, that you know there's a problem with the sharks and stuff and guys are letting them go…. Not everybody, but like the guys that I know anyway…. They're telling me they let them 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 going to try and not kill them, 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 (n = 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 4. Factors that affect fisher behavior during a shark interaction.

Factor category	Factor (n)	Effect on fisher behavior followed by illustrative quote(s)
Shark attributes	**Shark accessibility (20+)**	The degree of access that a fisher has to a shark he/she encounters determines the behavioral options available to fisher.
	Shark persistence (19)	Shark persistence despite fisher handling increases the readiness of fishers to apply alternative behaviors. Tiger, blue, and oceanic whitetip sharks were among those described as more persistent. 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.

Factor category	Factor (n)	Effect on fisher behavior followed by illustrative quote(s)
	Number of sharks (16)	Coupled with shark persistence and aggression, high number of sharks may result in fishers leaving an area. It's just nothing but sharks. And that's just time to quit, because not only are we going in the hole with our gas and our ice and our bait, they're taking our tackle, destroying our stuff, and it's just, stop. We got to stop. We got a thousand dollars in the hole, we just have to let the conditions change out there until those damn sharks move out of here.
	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.
	Shark species (9)	Fishers' response differs according to shark species (e.g., interaction frequency, abundance, aggression).
Landing opportunity	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. 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.'
	Target species 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 lot of tuna and a lot of sharks, you find different ways to kind of get around the sharks.
	Fish on the line (6)	If a fish is on the line, fishers may be receptive to short-term strategies that otherwise are unattractive (e.g., shark feeding, jugging).

Factor category	Factor (n)	Effect on fisher behavior followed by illustrative quote(s)
Social pressure	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. 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…. Dusk or dawn, yeah. You see the first crack of grey…. Our movements, the way we chum, the way we check our baits, becomes ten times as critical.
	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 given already occupied fishing spots. Lot of marlin, aku, so they catch an aku. They live bait it, ok?.... So, when there's a lot of charter boats out there live baiting… Then there's less shark predation on my side. You don't know who's in the other boat too, so you no like just shoot them.
Physical capacity	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.
	Gear (10)	Fishers' typical gear configurations are limited in the shark accessibility and handling practices they enable. When we go out for fishing, we're just rigged for fishing…. So you kind of use what you got, and what you got to work with.

Factor category	Factor (n)	Effect on fisher behavior followed by illustrative quote(s)
Time/financial investment	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.
	Vessel size (4)	Increased vessel size makes more behavioral options accessible to fishers and enables handling of larger sharks.
	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).
	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.

A.7.2.a.   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 to 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, Table 5 below shows 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 5. Handling options according to shark accessibility.

	At surface	At depth
Hooked	Gun Jug Bat Cut the line	Cut the line Bring up Tag it!

	At surface	At depth
	Feed Tag it! 1	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 lot of the times too, they'll never come up because they don't want to be caught or they're just smart.

This scenario is an example of quadrant 4, which yields relatively limited shark-handling options (Table 5). As one fisher put it, "You can't hook them, you got to move."

Fishers also described sighting free-swimming sharks at the ocean's surface, a scenario which orients us in quadrant 3 (Table 5). 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 relatively shallow-set lines:

> When you're fishing ika shibi, you're fishing on the surface. Your deepest line is 20 fathoms…. [At nighttime] the fish come up. Like in the daytime, when you're in the porpoise school or you're fishing the buoy, you're fishing 40 fathoms and down. Ika-shibi you're fishing 20 fathoms and up. So everything's on the surface.

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 5). Daytime troll and live bait fisheries might present opportunities in quadrant 1. 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'm not] going to move, so I'm going to 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 nothing 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!

Given its deep-set hooks, bottomfishing may also position a fisher in quadrant 2 of Table 5.

Of course, the four quadrants in Table 5 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: "Lot of 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 5 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 him 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 cut a shark free if it 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 5 therefore lies in its demonstration that shark accessibility is an important factor in determining how fishers select their behavior or shark-handling practice.

A.8.   What is a shark?

Table 6 presents themes coded under the node, "Sharks as…," which captures the various ways that interviewees perceive sharks according to their behavior and impact to fishing. These perceptions were sorted into three general categories: negative, positive, and neutral. Within each of these categories, Table 6 lists perceptions of sharks in descending order according to how many interviewees described each concept (n).

Table 6. Interviewees' perceptions of sharks.

	Sharks as… (n)	**Descriptions of…**	**Illustrative quote(s)**
Negative	Depredators (26)	Sharks taking catch directly from fishers' lines. Frequency varied according to fishery.	Especially if you're doing bottom, certain time get lot of sharks. And it's not worth it dropping down because every time you hook one a shark [will] get them….
	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

	Sharks as… (n)	Descriptions of…	Illustrative quote(s)
			could be 50 pounds of fish.
	Generalist competitors (20)	Sharks as providing generalized competition for fishers (e.g., fish, livelihood).	I'm not really interested in killing them but I don't want them eating my bait, and if it comes between supporting my family, and the one shark, I'm going to 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)	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

	Sharks as… (n)	Descriptions of…	Illustrative quote(s)
			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 trying to 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 lot of 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 [go] hand-in-hand. They like eat right? They know where the fish is, so sometimes sharks are a good sign.

	Sharks as… (n)	Descriptions of…	Illustrative quote(s)
			Sharks are a good sign that fish are there, so if a guy says, 'Yeah dude its' super sharky, but it's biting!' Ok.
	'Aumakua (13)	Sharks as 'aumakua or sharks' general importance in Hawaiian culture. Several quotes are provided 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'll] have respect for the shark. 'Cause he's one of our gods yeah? 'Cause he's the powerful of the sea. I want to 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 them up to the boat and the line, let them 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.

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	Sharks as… (n)	Descriptions of…	Illustrative quote(s)
			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 the 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 them.
	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. It's 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 got to 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

	Sharks as… (n)	Descriptions of…	Illustrative quote(s)
			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 will 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 kind of small, ah? They're eating machines is what they are.
	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 lot of bang for your buck.

	Sharks as… (n)	Descriptions of…	Illustrative quote(s)
	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 want to just catch sharks, just kind of the Jaws mindset, people want to 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 kind of got away from that because [they've] 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 them. You know, you may hook the same

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	Sharks as… (n)	Descriptions of…	Illustrative quote(s)
			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 trying to tag them 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 lot of sharks, there are a lot of sharks. And then it's not going to 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.

The "Sharks as…" coding frequencies for oceanic whitetip, tiger, and thresher sharks highlight the diversity of fishers' observations of shark behavior and their perceptions of sharks (Figure 1). These species were among the four most frequently mentioned shark species during interview (the third most mentioned being the mako), but were selected because they demonstrate diversity in the positive, negative, and neutral descriptors with which they were described. 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 1a), bronze whalers, and tiger sharks (Figure 1b), 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 going to die," said one fisher. But, as Table 6 illustrates, the way fishers perceive sharks are not wholly negative.
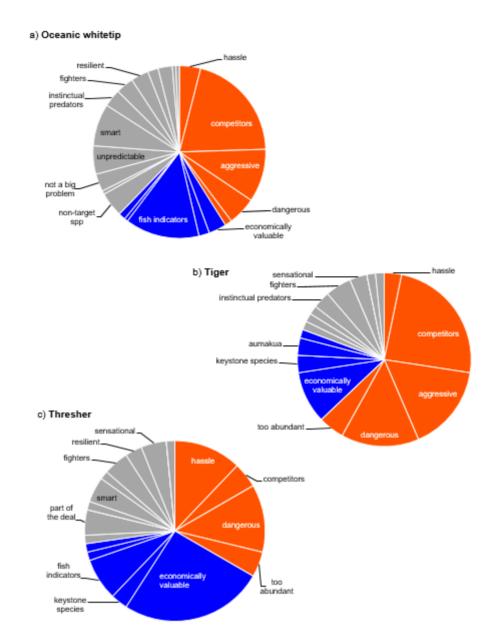
One of the most prominent differences between the oceanic whitetip and tiger sharks' descriptor charts result from the whitetip's positive reputation as a fish indicator. One fisher said, "It's a good sign too. When you're getting the interactions with the oceanic whitetips there's more fish around normally." 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' descriptor 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 interacting with thresher sharks *only* after they had been hooked, as opposed to seeing them swimming freely, for example. 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 going to take you at least an hour to deal with. And you're not going to 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 want to break it off." Threshers are also unlikely to break away on their own given their small teeth and that they are often hooked by the tail via their tail-whipping hunting behavior. For all these reasons, fishers often expend a lot of 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 1. 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. Labels are provided for wedges representing more than 3% of the species' influences.

A.9. *Sharks (not) on the brain*

This theme 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 (n = 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 thought to it," referencing shark interactions and observations being incidental to their focal target species.

Interviewees cited one section in the Hawaii commercial fishing reports as the only mechanism to report shark interactions. In this section, fishers can indicate whether or not catch was lost to a predator, indicate how many pieces were lost to a predator, and indicate the type of predator involved. However, filling out these fields is not required. A few interviewees described the improbability that fishers submit this data given the effort required and lack of returns:

> If we knew where the data was going then it might be worth our time. But if they just want to know how many shark encounters and they don't tell you what the end result is going to be, then why should I waste my time?

Fishers' shark interaction data are therefore largely undocumented. Following engagement in this study and the cooperative Shark Tagger project, however, several fishers commented on a new incentive to observe sharks and report their interactions more diligently:

> There was no reason for me to like, kind of 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 them, then now I'll definitely store whatever information I encounter, yeah?

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 them 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, encouraging reporting, and perhaps even in shaping fisher behavior.

Experiences in fisheries management and science

Interviewees' perceptions of fisheries management, fisher engagement, and the dynamics of power and knowledge in fisheries are presented in this section. These themes provide important insight into fishers' receptivity to any potential fisheries management or research strategies that may be used to mitigate fisher-shark interactions. They also reflect on issues of equity and access in fisheries management. Themes presented in this section were derived from nodes 40–49 in the codebook.

A.10.   Fisheries management

The fisheries management theme included interviewees' descriptions of local fisheries management, including their experiences with its actors and perceptions of its efficacy. Most interviewee commentary on fisheries management was not related to sharks, given the scarcity of shark management measures applicable to the Hawai'i small boat fleet. Discussing fisheries management was important for this research since fisher perceptions of management processes, tools, and actors are critical for understanding their relationships with managers and scientists, and their potential responses to management measures. 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 7 below, in descending order according to the number of interviewees who described each concept (n). Themes accompanied by an asterisk were described by interviewees

to affect their perceived legitimacy of fisheries management. Themes in bold require explanation beyond their illustrative quotes (Table 7). We elaborate on these in subsections below, providing examples of their connection to issues of power and other themes in Table 7.

Table 7. Problematic aspects of fisheries management described by interviewees.

Management themes (n)	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 perceived 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 every day. 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 going to make more sense…. You're talking 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)** | Belief in 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 want to 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) | Perception that management and regulations are based on public sentiment and special interests rather than science and rationality. | Unfortunately a lot of 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) | Interviewees questioned validity of data collected for fisheries management, its use in decision- | I'm all for proper management if I can see the results. You know, show us where those numbers came from. |

Management themes (n)	Descriptions of…	Illustrative quote(s)
	making, and the ways that might be improved.	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)	Interviewees described a lack of transparency or clarity around 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 got to deal with the public a lot more before you instill some kind of regulation…. It's good to bring [the fishermen] in at the early end, and then let them know what you're doing. There's no hiding anything.
Compromise (8)	Management discourse and processes perceived as 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 lot of times 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 seen as permanent and non-adaptive.	It's like they had that 10-year ban in Kaʻūpūlehu, that thing is never going to open. I mean, it's never going to 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 going get a million sharks around you, you can't even fish. There's got to be a balance…. Because in the future you might not be able to retract that law yeah?
Equity* (6)	Perceived 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 want to- What rules they want to push, what rules they want to enforce, to kind of pick on a specific group of people.

Management themes (n)	Descriptions of…	Illustrative quote(s)
Science as a political tool* (5)	Belief that 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].

*Described by interviewees to affect their perceived legitimacy of fisheries management.

First, before expanding upon Table 7's bolded themes, we present the theme "Self-management." This theme describes fishers' resource management outside of scientific and state regulatory endeavors and provides important context for understanding fisher identity and perspectives of management.

A.10.1. 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 7). 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 (n = 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 got to be about seven years old before they can breed, and they have like one pup every year, or two?... it'd be like shooting 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, chasing that almighty dollar, hell to the resource, kind of deal.

The quote above also illustrates another common frustration among interviewees, who felt that fisheries management discourses often deny fishers' capacity for self-management and challenge their identities as resource stewards.

A.10.2. Relative impact

About half of the 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[8].

> 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 most 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:

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[8] Participant numbers in the Hawaii longline fishery have been estimated to range between 124 and 143 since the early 2010s (NOAA Fisheries 2019). Quantitative estimates provided in these quotes represent interviewee perceptions.

> They came back to the pier, they were at the wash rack, and I guess they caught like 20 or 30 of them. They're washing the boat, guess what they do with the fish? Walk to the dump and throw them away. That pissed the shit out of 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 WestPac[9], 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 coming 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."

A.10.3. Equity

Equity was a crosscutting theme that appeared in discussions of fisheries management and fisher engagement. In their discussions of equity, interviewees described a belief in 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, kind of 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:

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[9] Western Pacific Regional Fisheries Management Council (WPRFMC), or "the Council."

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 going to be a statewide ban, not a ban on just us.

A.11.   Fisher engagement

Interviewees described different themes as deterring and motivating their engagement in fisheries management and science. These are presented in Table 8, once again in descending order by the number of interviewees (n) who described each theme, with themes in bold described in greater detail below.

Table 8. Fisher motivators and deterrents for engagement in fisheries management and science.

Fisher engagement themes (n)		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 going to have to stop commercial fishing in porpoise, ho! [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 effect meaningful change. Often this was a fisher goal that they felt went unmet during engagement.	You guys are probably going to be fisheries managers or advising fisheries managers and stuff, and at least you listen. You got to 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	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.

Fisher engagement themes (n)		Descriptions of…	Illustrative quote(s)
		management, or relevance.	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 whoever, but we still most of the time end up being just us. Getting 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 them, 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 kind of 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 going to 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?

A.11.1. 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 as 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 [going to] 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.

Although 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."

A.11.2. 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 these 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 [fisher name] [comes] across like you guys are going to turn it around and you guys are going to screw us over? Those guys are ten times worse than [fisher 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 nothing.

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."

A.12. Power and knowledge

Power was an important emerging theme in fisher interviews. Here, we summarize some of the key ways that certain types of knowledge and actors are afforded greater power in fisheries management discourse and decision-making.

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 what they felt were 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 kind of 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. Telling you.

Fishers provided many examples of managers and researchers asserting power in fisheries management (Table 9), whether or not it was intentional. Decision-making processes were perceived to be quick and uninformed decision-making, and with few consequences for the managers or researchers involved. Interviewees also experienced a tendency of researchers and managers to assert their correctness or deny fishers answers when fishers' knowledge challenged their own. Interviewees also felt that public meetings often had limited advertisement or accessibility. Researchers were perceived to assert their power when their goals were not communicated clearly. Their representation of fisheries systems was seen as incomplete or inaccurate, which was perpetuated as they delivered data to managers.

Interviewees generally described fishers as occupying a position in fisheries management of relatively little power and representation. But, some key actors hold influential power (Table 9), and 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, interviewees included the tourism industry, high seas fisheries, environmentalists, the wealthy, and NGOs (Table 9). Fishers believed these groups had 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 seen as able to 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 7), describing tourism's development interests:

> This is an example we had for the scuba spearfishing ban. We have pictures of pāpio[10] in Kona Village before all of the development and golf courses up there. And the reefs were amazing, the

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[10] Juvenile trevally, *Caranx* spp.

fish were everywhere, there was still limu kohu and ogo[11] 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 going to 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 9. Powerful actors and interest groups in fisheries management.

Actor/Group (n)	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 lot of 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 [researcher 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 going to find out something, [fisher name]'s going to 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 would've known about it if it wasn't for [fisher 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.

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[11] Limu kohu (*Asparagopsis taxiformis*) and ogo (*Gracilaria parvispora*) are edible seaweeds found in Hawaii. Ogo is an endemic seaweed.

Actor/Group (n)	Illustrative Quote
	A lot of us think it's more driven by tourism than anything else. Save the pretty reef fish, you know, kind of forget about the other stuff.
High seas fisheries (10)	[Purse seining is] big money business too, lot of 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 want to 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.
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 going to 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 want to 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.

Solution approaches

In this section, we highlight key interview themes that provide commentary on fisheries management tools and approaches to shark mortality mitigation and fisher engagement. As these tools and approaches are presented below, we use interview data to illustrate their applicability, and lack thereof, in the context of the fisher-shark problem in the study area. We present tangible management tools first, including information provision, compensation, regulation, and shark-handling alternatives. Then, we present less tangible approaches to fisheries management and fisher engagement; namely, communication, trust building, convenience, inclusion, collaborative research, and knowledge exchange. These provide opportunities to address problematic management and engagement themes identified by interviewees, including disconnect between fishers, researchers, and managers; perceived and actual data quality; transparency; lack of compromise; fisher voice; and power inequities.

A.13. Information provision

Many outreach and education initiatives frame resource management issues as problems of information deficit, and highlight information provision as a solution to changing behaviors that harm the environment, even though there are many cautions to using this as a standalone approach (McKenzie-Mohr, 2000). This research documents instances in which information provision may help to mitigate fisher-shark interactions, and others in which providing information may not be appropriate. In the section "Factors of fisher behavior" we provided examples of how new understandings of shark biology or shark significance leads to changes in attitudes and behavior. 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.

Although 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 topics, 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 providing information on shark locations. We 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." Although 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 going to fish." No, you going to 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 providing information about sharks' movement 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 going to 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.

Although 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 Hawaiʻi 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 their 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. During an encounter with 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.

A.14.   Compensation

The lesson that getting rid of a shark for many fishers is a problem framed by financial cost highlights the solution role of financial compensation. 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 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.

Interviewees did not oppose compensation as a solution component; however, 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, 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 incentive for engagement identified by interviewees was the development of a useful shark deterrent or handling alternative.

A.15. Regulation

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

Regulation is another common approach 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 support accomplish very little: "All it does is piss people off."

A.16. Shark-handling alternatives

"A lot of 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: 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.

A.17.   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 and 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 these interviews, 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 Honokōhau Harbor or larger shark conservation community, and avoiding harmful shark-handling practices following confrontation with Hawaiian value systems. 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 more an individual decision than influenced by social pressures. They also believed that 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 be 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 7, 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 them out before you even ask them what you're going to 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 them out.... Not come from the top and nīele and just sneak up on them. 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.

A.18. 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 and 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 lots of 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.

A.19. 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 out of 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 for 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 going to hear it from somebody else, that heard it from somebody else (chuckles). You're not going to see a DLNR guy standing over there 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 them know what you're doing.... If you wanna go down that road, because otherwise invariably they're going to 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."

A.20.   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 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 results from this project were shared in February 2019 at a joint Shark Tagger workshop in Kona, about 12 of the 30 ocean users who were in attendance 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 2-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. However, 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, kind of 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 and Starr 2009). One fisher demonstrated this in his correspondence with Dr. Hutchinson, in which he thanked her for including fishers in gathering "real true data." Finally, both fisher and scientist participants in this collaborative work have benefitted from shifts in perspective, with potential to affect fishers' shark-handling practices. 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 kind of 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 collaborative research approach 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.

A.21. Knowledge exchange

Another approach that exposes involved actors to new information and encourages reconciliation of knowledge types 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 going to 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 going to 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 their narratives may also be seen as a form of compromise, wherein, "You guys are kind of 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 ways researchers and fishers like himself understand shark-fisher interactions:

> 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." This exchange of knowledge might not have been a primary goal of the Shark Tagger project, however, 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' understandings of shark-fisher interactions such that they are now more closely aligned.

IV. Discussion

This examination of fisher perspective on fisher-shark interactions in West Hawai'i and local fisheries management broadly makes key contributions to our understanding of shark-fisher interactions and the sociopolitical viability of management tools and approaches. We illuminated fishers' relationships with one another, fisheries managers and scientists, and the sharks they encounter to shed light on the viability of different approaches to mitigate shark mortality and engage with fishing communities. While no single management tool was identified as applicable among all interviewees, this study identifies important aspects of the management context that will be crucial for any approach to be successful.

First, upon encountering a shark, a fisher has many behavioral and shark-handling options at his disposal (section III.C.3.1. Shark-handling options). The appeal of any option, however, depends on a number of individual and situational variables (section III.C.3.2. Factors of fisher behavior). 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 the number of sharks in the area (Table 4). The appeal of a given shark-handling option also varies across the fishing community, as individuals perceive sharks differently according to their own experiences and species-specific traits (section III.C.4. What is a shark?). A single fisher may perceive and handle different shark species differently based on things like species' interaction frequency, market value, or aggression. For example, 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). The relative significance of shark interaction and contextual socioeconomic variables according to fishers' perceptions merits further exploration. Future qualitative assessments may uncover other important shark associations (Figure 1) and the ways they interact with fisher behavior, highlighting species-specific handling and management strategies. Interviewees' most prominent depiction of sharks, however, was as competitors for their fishing opportunities and livelihoods. 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. This association between sharks and a threat to fishing opportunity could have negative implications for fishers' direct support of shark conservation (Drymon and Scyphers 2017).

Despite the negative, competitive effect that sharks have on fishing, fishers described devoting little observational or conversational focus to sharks prior to engaging in this study or the community shark-tagging project (section III.C.5. Sharks (not) on the brain). 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. 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 how managers' and researchers' actions shape fishers' symbolic associations with sharks. Failure to adequately address the sociopolitical context of other species management regimes, gray wolves for example, have promoted stakeholders' perception of these species as a symbol of state governance (Naughton-Treves and 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).

Recognizing and incorporating sociopolitical contexts into robust, sustainable fisheries management solutions is essential (Penney et al. 2017; Shiffman et al. 2017; Webber et al. 2007).

A common frustration among interviewees was that fisheries management discourses were felt to deny fishers' capacity for self-management and challenge their identities as resource stewards (section III.D.1. Fisheries management). 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 (sections III.D.1.2. Relative impact and III.D.1.3 Equity). 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 (section III.D.2.1. Fishers' voice). This resulted either from failures in process, where managers were perceived to design 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 (section III.D.3. Power and knowledge). Most fishers' engagement-related fears were of engagement leading to fishing closures and restrictions, and manager or scientist misrepresentation of fisher input (section III.D.2.2 Fears).

No single management tool was identified as applicable among all interviewees (section III.E. Solution approaches). Information provision, compensation, regulation, and shark-handling alternatives demonstrated variable and conditional applicability to fisher-shark and management problems (sections III.E.1-4). Some interviewees described their shifts in perspective or behavior after learning about shark biology or species' threatened status, but the diversity of fishers' values, attitudes, and capacity for behavior change across West Hawai'i necessitate multipronged solutions (Reddy et al. 2017; Stern 2000). For example, interviewees described diverse information-sharing pathways to reach different members of the fishing community (e.g., social media, paper media, key actors), a need to make information meaningful to fishers through subject relevance, and the importance of relationships in successful information-sharing (e.g., loyalty and reciprocity). These very different components of information delivery and acceptance by the fishing community highlight a need for such multipronged solutions. Additionally, 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 the tangibility of their 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. Importantly, much of the technical information required to build tool-based solutions around shark mortality is still being pursued. Useful information might include shark mortality rates and the economic benefit or costs associated with shark interactions, and 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 might also illuminate the relationship between fishers' perceptions of shark species and abundance, shark-handling practices, and attitudes toward shark conservation (Drymon and Scyphers 2017; McClellan Press et al. 2016). This provides a further opportunity for collaborative research, which was viewed positively by interviewees. As fishers and researchers collect shark interaction and movement data, and as they brainstorm and field test gear modifications to reduce shark mortality, they bring us closer to a viable, collectively beneficial solution. If solutions fail to address fisher perspectives and therefore achieve fisher support, the

utility of management tools like regulation may be limited, especially in the absence of enforcement (Tissot et al. 2009).

Deeper-level problems born from the application of management tools lacking fisher support, like regulation, may obstruct the success of parallel management approaches around shark-fisher interactions. They also critically affect future solution development for fisheries management problems involving the same actor groups, regardless of their relevance to sharks. 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 and Gash 2007; Schuckman 2001).

Insights for researchers and managers

Research has shown that to avoid generating new conflict and exacerbating existing sociopolitical inequities, robust natural resource management solutions should incorporate multiple tools and approaches that represent a genuine effort to bridge disconnects between the knowledge and values of fishers, researchers, and managers (Akbulut and Soylu 2012; Madden and McQuinn 2014). This research indicates that for this fishery, a robust solution would 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. One fisher suggested that sharing research outcomes, particularly, would incentivize participation and data reporting by demonstrating its value to the community. Sharing research findings may also help to build reciprocity and trust between researchers and fishers. In addition to clarity, communication efforts should also be transparent, including the open discussion of researchers' and managers' limitations to effect change where issues of equity arise (e.g., jurisdictional limitations or issues with enforcement). Managers and research should also discuss the goals and risks of fisher engagement early and openly with fishers.

Another robust and efficient solution might also 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 and Steg 2013; Mbaru and Barnes 2017). The support of key information sharing actors in the fishing community and utilization of existing social structures was instrumental in recruiting participants and gathering data for this study and the Shark Tagger project.

Where other engagement and management tools such as financial compensation are used, alternative outcomes should be considered carefully. For example, compensation may increase participation and fisher access to alternative shark-handling practices (e.g. tagging), but it may also encourage shark interactions that would otherwise not occur.

Researchers and managers seeking to engage fishers should be attentive to fisher geographies, schedules, and the venues most accessible to the fishing community. In this way, engagement will better include diverse fisher perspectives (Vaughan and Caldwell 2015). Of course, like many components of participatory processes, the benefit of inclusion for problem solving and the perceived legitimacy of fisheries research and management hinge on certain conditions. For example, 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).

Finally, researchers and managers seeking to resolve fisheries management problems should also recognize and respectfully navigate fishers' identities and previous experiences with other researchers and managers. The importance of fishers' identities as resource stewards with a capacity to self-manage, for example, was highlighted in this study. Finally, robust solutions recognize imbalances in equity and power. One example is the way that researchers' and managers' knowledge and voices are elevated in fisheries management discourse despite fishers being the party whose well-being is most affected by potential outcomes. Actors from industry and environmental groups also wield greater organizational capacity, financial capital, and access to local decision-makers to exert power over fisheries management (Chapin 2004; Schuckman 2001). Designing engagement to increase access and participation for groups that possess alternative forms of knowledge, capital, or language, can help to address these power imbalances.

Two fisher engagement approaches identified by this research have potential to meet the above criteria: collaborative research and knowledge exchange (sections III.E.8-9). These approaches may offer benefits to shark conservation, fisher well-being, and the relationships between fishers, managers, and researchers. The Shark Tagger group's collaborative research, for example, has enabled the collection of otherwise inaccessible shark interaction data and improved researcher understanding of shark interactions, both through interviews and tagging. Collaborative research and knowledge exchange have also exposed participants, both fisher and researcher, to new information and facilitated reconciliation of different knowledge types and perspectives. Joint fact finding, with its more formal structure, may provide a useful framework to conduct collaborative research in pursuit of collective knowledge (Karl et al. 2007).

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. Explicitly recognizing that knowledge types across stakeholders are partial and diverse is also crucial to productive discourse (Adams et al. 2003). In this case study 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' understanding of shark interactions 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.

Given that fishers' perceptions and shark-handling practices vary according to species-specific behavioral and biological characteristics and socioeconomic values, future collaborative research initiatives might further explore the relative significance of such biological, social, and economic contextual variables in shaping fisher behavior. This could define the importance of such variables in shaping fisher behavior more clearly, and identify species-specific shark-handling and management strategies.

In sharing their knowledge, and experiences, West Hawai'i small boat fishers participating in this study enhance understanding of the shark interaction issues and shark mortality mitigation opportunities. The shark-fisher interaction problem can thus be broadened to include sociopolitical context, economic context, relations of power, unresolved conflict, and fisher identity. This study also identified fishers' perceived social and power inequities in fisheries

management. Through fisher engagement, researchers and managers have the opportunity to improve fisher access to management discourse, and consider valuable fisher knowledge and experience in the development of fisheries management approaches.

V. Acknowledgements

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Appendix A: Interview Guide

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 <u>useful</u> fishing information (e.g., fishing techniques, conditions, regulations and management)?

    a. What kind of information is shared?

    b. With <u>whom</u> and <u>how</u> 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)?

  f. What kinds of strategies are used to avoid catching sharks or get rid of sharks in a fishing area?

       i. 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 10. 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 Hawaiʻi. 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 ʻahi	Descriptions of the palu ʻahi 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 ʻahi 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.

Name	Description
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. ʻAhi	Descriptions of ʻahi (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.
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 Hawaiʻi Island's South Point.
c. Hilo	Descriptions of fishing in Hilo.

Name	Description
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.
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.

Name	Description
Technology	Descriptions of evolving and developing technologies through time, which affect fishing practice.
02 Economic context	Descriptions of the West Hawaiʻi 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 Hawaiʻi 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.

Name	Description
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 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.

Name	Description
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.
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."

Name	Description
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 Hawaiʻi 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 Hawaiʻi small boat fishery.

Name	Description
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.
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 Honokōhau 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.

Name	Description
f. Fish buyer	Descriptions of fish buyers as 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.
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

Name	Description
	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.
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.

Name	Description
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.

Name	Description
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 cut line	Descriptions of cutting the line to release the shark as a handling practice.
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-

Name	Description
	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.
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.

Name	Description
i. Generalist 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.

Name	Description
vi. Instinctual predators	Descriptions of shark behavior driven primarily by shark instinct (e.g., to kill, hunt).
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" (dolphins) 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

Name	Description
	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.
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 outcomes 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.

Name	Description
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.
h. Inclusion	Descriptions of inclusion as a component of fisher engagement.

Name	Description
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.

Name	Description
90 Institutions	Index of institutions discussed during interviews.
A. DLNR	References made to the Hawai'i State Department of Land and Natural Resources during interview.
B. WPRFMC	References made to the Western Pacific Regional Fisheries Management Council during interview.
C. NOAA	References made to National Oceanic and Atmospheric Administration during interview.
D. HFACT	References made to HFACT during interview.
E. TNC	References made to The Nature Conservancy during interview.
F. PIFG	References made to the Pacific Islands Fisheries Group during interview.
G. West Hawai'i Fishery Council	References made to the West Hawai'i Fishery Council during interview.
H. Coast Guard	References made to the Coast Guard during interview.
I. Hawai'i Boating Association	References 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.

Appendix C: Species' names

Table 11. Species' interviewee, scientific, and common English names.

Interviewee language	Scientific name	Common English name
Aku	*Katsuwonus pelamis*	Skipjack tuna
Almaco jack	*Seriola rivoliana*	
Blue shark	*Prionace glauca*	
Bronze whaler shark	*Carcharhinus brachyurus*	This species not found in Hawaiian waters, but used colloquially to refer to Carcharhinid sharks with indistinct physical features.
Dusky shark	*Carcharhinus obscurus*	
Galápagos shark	*Carcharhinus galapagensis*	
Great white shark	*Carcharodon carcharias*	White shark
Hammerhead shark	*Sphyrna* spp.	Scalloped hammerhead (*S. lewini*) and smooth hammerhead shark (*S. zygaena*)
ʻAhi	*Thunnus albacares*	Yellowfin tuna
Shibi	*Thunnus albacares*	Yellowfin tuna (small)
ʻŌpakapaka; "paka"	*Pristipomoides filamentosus*	Pink snapper
ʻŌpelu	*Decapterus macarellus*	Mackerel scad
Kāhala	*Seriola dumerili*	Greater amberjack
Kona crab	*Ranina ranina*	Spanner crab
Mahimahi	*Coryphaena hippurus*	Dorado; dolphinfish
Mako shark	*Isurus* spp.	Shortfin mako (*I. oxyrinchus*) and longfin mako (*I. paucus*)
Marlin		Used to refer to different billfish species
Oceanic blacktip shark	*Carcharhinus limbatus*	Blacktip shark
Oceanic whitetip shark	*Carcharhinus longimanus*	
Onaga	*Etelis coruscans*	Long-tail red snapper

Interviewee language	Scientific name	Common English name
Ono	*Acanthocybium solandri*	Wahoo
Sandbar shark	*Carcharhinus plumbeus*	
Silky shark	*Carcharhinus falciformis*	
Thresher shark; "thrasher"	*Alopias* spp.	(pelagic, bigeye, and common)
Tiger shark	*Galeocerdo cuvier*	
Uku	*Aprion virescens*	Gray snapper
Ulua	*Caranx* spp.	Trevally
Papio	*Caranx* spp.	Trevally (juvenile)
Whale shark	*Rhincodon typus*	
Porpoise; dolphin	*Stenella attenuata*	Porpoises are not known to inhabit Hawaiian waters. The fishing community uses "porpoise" colloquially to refer to dolphin species, likely the Pantropical spotted dolphin in the context of this work.
Menpachi	*Myripristis* spp.	Soldierfish