OF MANTAS AND MEN:
UNDERSTANDING THE INTERSECTION OF HAWAI'I'S REEF MANTA RAY AND ITS GROWING TOURISM INDUSTRY

A THESIS SUBMITTED TO THE GRADUATE DIVISION OF THE UNIIVERSITY OF HAWAI'I AT MĀNOA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTERS OF ARTS

IN

GEOGRAPHY AND ENVIRONMENT

MAY 2020

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Dedicated to Larry & Sheryl,

who inspired my love for science and the ocean,

and to Ian, for everything else.

Acknowledgment

This research was conducted under the guidance and mentorship of Alison Rieser, whom I would like to thank for helping me arrive at my final thesis topic and for encouraging me to begin my graduate degree program. Prof. Rieser also helped me to connect with my committee members, Dr. Carlie Wiener, Dr. Lars Bejder, and Dr. Lisa Kelley. My committee supported and prepared me to conduct my research and develop questions that were targeted and informative. Their contributions were absolutely critical to my studies and I am sincerely grateful for all that they have done these past years.

I would also like to thank Dr. Reece Jones for his leadership as our Graduate Department Chair and for helping me with my research at a critical junction. Dr. Jones' Theories & Concepts course in the very first semester of my graduate studies inspired my passion for geography, and it is because of his teaching that I enthusiastically call myself a geographer today. The entire Geography Department has been so helpful and welcoming; I am grateful for their instruction, conversations, and encouragement. I will continue to spread the good word about the original science. Both the Department and the Graduate Division provided financial support for my research in Kona, and I could not have conducted my in-person interviews and assessments of the Kona manta sites without their generosity.

I am immensely grateful to my employers at the University of Hawai‘i at Manoa Social Science Research Institute's Hawai‘i Coral Reef Initiative. The dream team, Kristine Davidson, Risa Minato, and Pam Fujii, lifted me up and taught me more about management, governance, and the Hawaiian Islands than anyone else could. I cannot express the depth of my appreciation for all that they've done for me, for others, and for the State of Hawai‘i's natural resources. Furthermore, I wish to thank Clifford Inn, Todd Tashima, and Jeff Milisen for their work on the Kona Manta Management Program and all of the Department of Land and Natural Resources – Division of Boating and Ocean Recreation for doing their part in protecting Hawai‘i's beautiful marine environment.

Finally, I am so thankful for the Kona community, a network of people from different walks of life who are all connected at the manta viewing sites. These friends, colleagues, and new acquaintances work each day towards the same goal of bettering their community. Each one is an advocate for a cause, and while they do not always see eye to eye, their openness, willingness to collaborate, and generosity of spirit make Kona a unique and prosperous place for marine tourism and conservation. I wish them the greatest success in both enjoying and preserving their coastal splendor.

Abstract

In 2014, the Hawai'i state legislature passed House Concurrent Resolution 170 urging the Department of Land and Natural Resources (DLNR) to manage the Kona manta (*Manta alfredi*) viewing sites and address overcrowding, safety, and environmental concerns. DLNR made a thorough analysis of the popular Kona manta viewing sites and decided to implement mooring buoys, limited use permits, and a suite of accompanying regulations. This study examines proposed updates to Hawai'i Administrative Rule §13-256 and the Kona manta viewing sites management plan in comparison to (1) similar "charismatic megafauna" marine wildlife tourism (MWT; e.g. sharks, rays, and cetaceans), and (2) public perceptions surrounding these sites. Using methods from Chung et al. 2019 to systematically rank management tools at similar sites and an analysis of 36 stakeholder interviews, this study evaluates the likely effectiveness of the regulations in terms of impacts, compliance, and perceptions. After more than thirty years of unconstrained manta viewing tourism, proposals for management have included everything from the status quo (no regulation) to complete closure. DLNR's task is to identify which of the many regulatory options should apply to these unique places. The success of the program will depend not only its ability to address the concerns of HCR 170, but also to advance DLNR's mission to protect and conserve Hawai'i's natural resources.

Keywords: *Manta alfredi, marine wildlife tourism, management, Hawai'i, tourism*

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Introduction

Regulating Manta Ray Tourism in Hawai‘i

No marine ecosystem is unaffected by human influence, and the most heavily impacted areas are coastal environments like mangroves, rocky reefs and shelves, seagrass beds, and coral reefs (Halpern et al. 2008). Mitigating the complex diversity of anthropogenic drivers is a priority for resource management, but requires an understanding of the equally complex and often difficult-to-predict ways that government policies and interventions will affect marine ecosystems. As the State of Hawai'i Department of Land and Natural Resources (DLNR) introduces regulation to the Kona reef manta (*Mobula alfredi*) tour industry (**FIG. 1**), it will face many of the same challenges experienced at marine tourism sites worldwide.

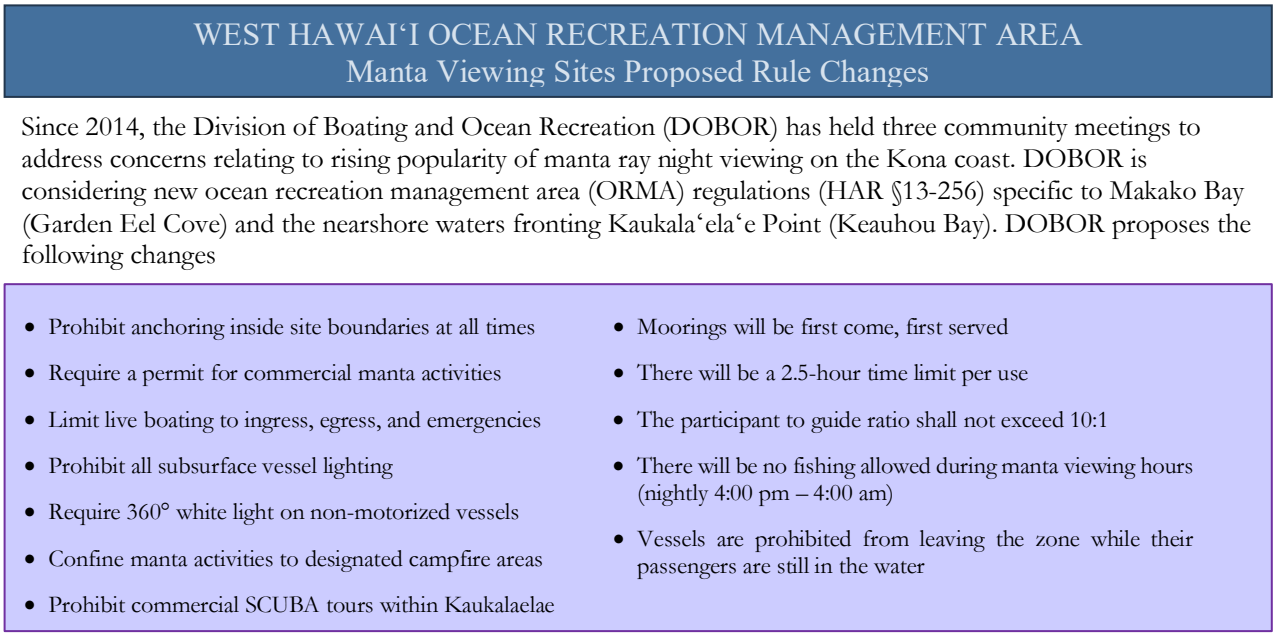

Figure 1. Kona Manta Viewing Site Management Program - Regulations at the Kona manta sites proposed by DLNR in 2018 are summarized in brief in the excerpt from an October 2018 handout provided to the public (Source: DLNR, 2018)

Beginning in 2021, boating and ocean-user conduct would be restricted spatially, temporally, by permit, and by activity. Users accustomed to unregulated access to mantas are currently in conflict with DLNR, wildlife advocacy groups, and each other. This study investigates similar marine tourism industries worldwide to identify potential outcomes and challenges of the regulations. Additionally, stakeholders that use the Kona manta sites were interviewed on the perceived efficacy of the regulations DLNR's Division of Boating and Ocean Recreation (DOBOR) has proposed. As the manta tourism industry in Kona continues to grow, understanding the intersection with management becomes increasingly necessary and urgent. The

purpose of this work is to sift out the regulations that are supported both by the interviewees and by applications elsewhere. This requires answering essential questions:

- What management measures are implemented at marine wildlife tourism sites similar to Kona, and what are their effects on management?
- How do the management measures selected by DLNR compare to those occurring globally?
- What are the perceptions of community groups, both commercial and noncommercial, on the regulations of the Kona manta sites?
- How does a review of marine wildlife tourism measures and community perceptions clarify effective management for the Kona manta ray sites?

In Chapter 1, a review of management measures from peer-reviewed and grey literature scores and ranks their suitability to the Kona manta sites. These case studies are each evaluated based on (1) outcome for management, (2) scale and scope, (3) empirical vs. theoretical evidence, and (4) the relatedness to reef manta rays and Hawai‘i. The scoring process is based on the methods of Chung et al. (2019). The policies and their application to the Kona manta sites are discussed in detail, presenting the components of successful and problematic implementation.

Chapter 2 takes the regulations proposed by DLNR and discusses their perceived efficacy by various community members who self-identify their connections to the Kona mantas. 36 people participated in semi-formal interviews in which they described their experiences at the sites and their perceptions of the regulations. Participants scored the measures listed in **FIG. 1** using a 0 – 10 Likert scale, from very ineffective to very effective in terms of impacts and compliance. Measures were then ranked and evaluated between demographic groups using a Mann-Whitney non-parametric analysis of variance to look for significant differences (Mann-Whitney U-Test Value ≤ 0.05).

The outcomes of the interviews were compared to the ranking from Chapter 1 and used to identify areas for improvement in DOBOR’s management planning process. The State of Hawai‘i (hereinafter “the State”) succeeds in addressing the majority of concerns but has proposed some regulations that are almost certain to exacerbate current conflicts. The best hope for successful management is significant cooperation among permit holders, a state-supported educational program for tour providers, and dedicated enforcement on the parts of the State and site users. Out of this study, I conclude that the holistic approaches to management currently celebrated in frameworks like ecosystem-based management must extend from planning the manta viewing management program to post-implementation monitoring and evaluation, ultimately arriving at an adaptive and inclusive process.

Key Findings:

CHAPTER 1

- Marine wildlife tourism (MWT) management interventions are evaluated in the literature based on three dimensions: (1) interview/survey perceptions, (2) compliance, and (3) impacts to environmental and social systems.
- The most effective MWT measures for the manta sites were *participant education*, *limit boat count*, *limit participant count*, *limit tours spatially*, and *do no harm*.
- *Regulated feeding* and *limit the conduct of boats* were the only MWT measures that were evaluated negatively on average. *No SCUBA*, *Limit the proximity of participants to wildlife*, and *Limit tour duration* were also among the bottom-ranking measure categories.
- The most frequently-cited obstacle for effective implementation was enforcement.

CHAPTER 2

- Among interview participants, the average sentiment for regulations was moderately effective.
- *No anchoring*, *no fishing*, and *no leaving passengers unattended* were scored highest, with all scores as either neutral or effective. All other measures had greater variability in scoring amongst participants.
- The only measure with an average ineffective rating was *moorings are first come first served*. To reduce conflict, the State or users will need to agree on a different mechanism to access the sites.
- The state proposes to use low-efficacy measures *limit site access to 2.5 hours (tour duration)* and *restrict live boating (conduct of boats)* to control crowding. These measures were the lowest-scored in the interviews after *first come, first served*. The State's best hope for effectively reducing crowding will be a well-planned *permitting system*.
- *Mandatory education* was supported and emphasized for tour participants and especially for guides and tour providers.

- The more problematic aspects of the proposed management program can be greatly improved through a more inclusive and community-based approach to management, and all regulations should be monitored and evaluated based on the same dimensions present in the literature: perceptions, compliance, and impacts.

Viewing Mantas

In Hawai'i, manta ray (*Mobula alfredi*) viewing primarily occurs within the West Hawai‘i Ocean Recreation Management Area (ORMA) along the Kona coastline of Hawai‘i Island. These activities take place at two sites, Makako Bay (a.k.a. Garden Eel Cove / Manta Heaven) and Keauhou (a.k.a. Kaukala’ela’e / Manta Village), about 14 miles to the south (**FIG. 2**). Elsewhere in the state, mantas frequent cleaning stations and coastal dive sites, but there are no other known locations in the state that are as reliable and accessible. One third site, Mauna Kea, lies 24 miles to the north of the manta viewing sites and is not included in DLNR’s regulations.

The first site was established in the 1970’s when the Kona Surf Hotel turned floodlights onto the surf for their guests’ enjoyment. The lights unintentionally drew ambient zooplankton into high concentrations that

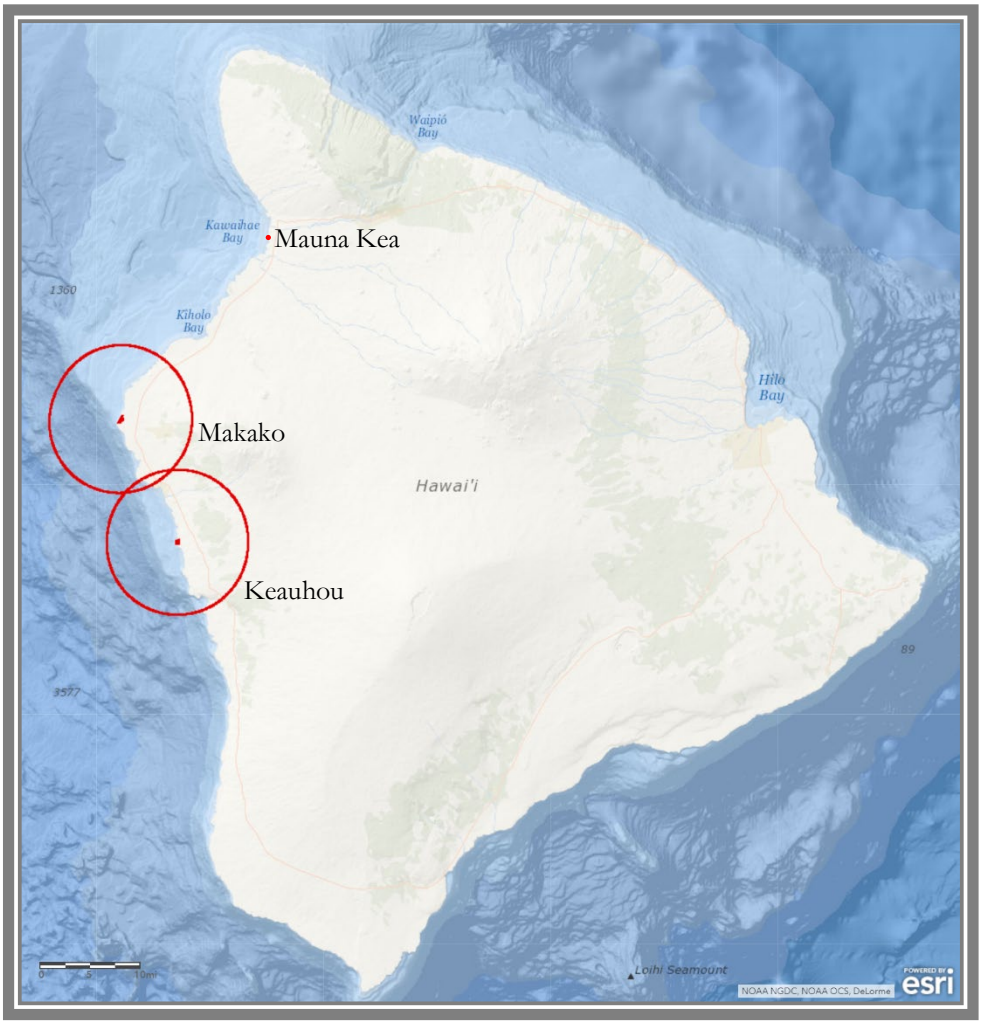

Figure 2. Kona Manta Viewing Sites, located on the west coast of Hawai'i Island at Makako Bay (North) and Keauhou (South).

Rays on the Bay at the Sheraton Kona Resort & Spa at Keauhou Bay is one of the property's restaurants where diners can see manta rays over the edge of its balcony and watch the operations of tour boats just off shore. Tour boats are visible in the left-hand side of the panorama where a couple on the patio look out at three boats assembled for the nightly show.

attracted their predator – Kona's reef manta rays. These feeding giants were easily observed from the hotel and as their reliability became known in the community, an enterprising dive shop sent the first SCUBA group to check it out from under the waves. More dive companies joined in and Keauhou Bay became known as "Manta Village." The number of tour boats at Keauhou grew, which inspired the earliest companies to create and adopt the first guidelines for tour conduct in 1993.

In 2000, the Kona Surf Hotel shut down and the lights went out. By some accounts in this study's interviews, the manta rays had stopped coming to Keauhou before the hotel closed. It was around this time that the second site was established in Makako Bay, named "Manta Heaven." Then in 2004, the hotel reopened as the Sheraton Kona Resort & Spa at Keauhou Bay and turned the lights back on the surf. The tour boats and the mantas returned soon after.

There have since been two reliable sites for night dives with manta rays. The first and original site at Keauhou is outside of Keauhou Bay Small Boat Harbor, about 1500 feet from the boat ramp. The site has the widest diversity of users, from large 30+ passenger vessels to free swimmers. Keauhou is also the only site where Hawaiian canoe (wa'a) tours are offered. The Sheraton's restaurant, Rays on the Bay, provides diners with views of the manta rays in the shallows just beyond the railing. The spectacle of the tour boats and their light-based tours is also visible from the hotel vantage point.

Makako Bay lies further north off of the present-day Kailua-Kona International Airport and the Natural Energy Laboratory campus. Boats access the site from Honokōhau Small Boat Harbor in Kalaoa, about 5.5 nautical miles south of the bay. Due to its location off of a coastline developed for the airport and the Natural Energy Laboratory, land-based access is restricted and the site is primarily accessed by motorized vessels. Recreational swimmers or paddlers are very rarely seen. The site is popular among SCUBA divers because of the reef habitat and the resident garden eels that give the dive site its name, Garden Eel Cove.

For the most part, companies offer tours to one site or the other. However, boats that regularly go to Makako Bay will on occasion switch their tours to Keauhou. The triggers for this vary, but are usually

associated with ocean conditions or the scarcity of manta sightings at the north site. When the boats arrive at a manta viewing site, they typically drop anchor, attach to a mooring, or tie off to a moored boat (rafting). Some captains prefer to live-boat and will run their engine, though they'll typically switch into neutral when loading and unloading passengers.

Tours at both sites run nightly, conditions permitting, from about 4:00 pm – 11:00 pm. Boats place participants in water with either snorkel or SCUBA gear. Artificial lights attract the plankton into thick aggregations where manta rays filter feed. These lights are either handheld dive lights, attached to the vessels, or integrated into floating devices called "manta boards," which resemble a board with handholds for snorkelers as they float face down in the water and watch the mantas below them. The purposes of these devices are many, including a way to keep participants together and afloat under the supervision of one guide, to occupy their hands so they are not motivated to touch a passing ray, and to provide lighting to attract plankton.

Operators at Makako Bay and sometimes at Keauhou will gather around a central "campfire." This campfire model is so named because of the practice of placing a weighted basket on the ocean bottom and filling it with dive lights to create a focal light source, much like a campfire. Divers seat themselves in a ring around the campfire and point their dive lights upward, while snorkelers float at the surface and gaze down. The plankton and the mantas amass in the water column between participants. This method of conducting tours is popular because it provides the mantas with space to feed and avoid coming into contact with any people or obstacles. It also combines artificial lighting efforts of the different tour groups so that mantas are drawn to a central point and all participants are given an equal chance of seeing a ray.

The Kona manta rays have been using these bays for decades, longer than tours have existed. But the introduction of artificial lighting likely caused a behavioral change in their daily routine: the mantas that

SCUBA divers seated around the central campfire (left) and snorkelers on manta boards (right) at the Kona manta ray viewing sites. Their lights attract zooplankton that filter-feeding manta rays swoop through within arm's length of participants.

frequent these viewing sites remain in coastal feeding grounds whereas individuals elsewhere in the state (Clark 2010) and globally will move into deeper offshore waters at night (Couturier et al. 2012). These Kona sites are completely unique in how they use artificial lighting to attract manta rays. Whether the tours can be replicated elsewhere is yet to be seen. If they can, there are significant questions regarding fitness and endangerment that must be addressed before this form of manta viewing scales to other parts of the world.

Biology & Ecology of Mantas

The family Mobulidae of manta and devil rays included the genus *Manta* and *Mobula* until recently when a DNA analysis reclassified the taxonomic arrangement of the family into a single synonymous genus *Mobula*, which includes six species of devil ray and two species of manta ray (White et al. 2018). The genus *Manta* was similarly revised from a single species, the giant manta (*Mobula birostris*; Walbaum 1792), into at least two distinct species that included the reef manta (*Mobula alfredi*; Krefft 1868) due to morphological and genetic assessments (Marshall et al. 2009; Kashiwagi et al. 2012). The reef manta is characterized as the smaller of the two with an average wingspan of about 18 feet, about 4 feet shorter than that of the giant manta, which has been documented to reach nearly 30 feet. Additionally, the reef manta is more commonly sighted inshore than its pelagic cousin (Marshall et al. 2009). Though morphometrically similar, these species have distinctive genetic differences that suggest speciation driven by habitat preference (Kashiwagi et al. 2012). The primary species at the Kona manta sites is *M. alfredi*, though *M. birostris* has been documented on very rare occasion.

Mobulidae family species are circumglobally distributed in tropical, subtropical, and temperate oceans (Couturier et al. 2012; Lawson et al. 2017; Stewart 2018). The manta species have a similar distribution detailed in **FIGURE 3**, with *M. birostris* more widely distributed than its smaller cousin species, *M. alfredi* (Lawson et al. 2017). Movement studies document high and rapid mobility but this varies between species and geographic populations (Couturier et al. 2012). Kona mantas are understood to be residential, as documented through passive acoustic telemetry (Clark 2010) and photo identifications (Deakos et al. 2011).

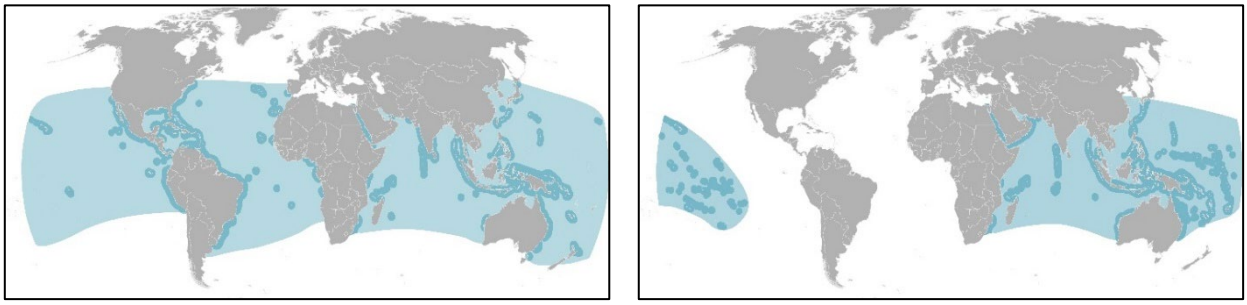

Figure 3. Distribution maps for manta ray species. Extent of Occurrence (EOO, light shaded) and Area of Occupancy (AOO, dark shaded) areas of the (A) Manta birostris and (B) Manta alfredi. Figure from Lawson et al. 2017, Fig. 3.

The individual reef manta rays are easily identified from physical features including ventral markings. Manta Pacific Research Foundation records nightly sightings through their ID catalog that was started in 1979 with the ray, Lefty, who is still observed at the sites forty years later (Manta Pacific Research Foundation 2019). Sightings are reported through the online Facebook group, *Manta Tour Guides and Operators*, email, or the organization's new Manta Ray Tracker app. To date, the site's human visitors have documented 288 distinct individuals in Kona (2019). Unfortunately, *M. birostris* does not share the same distinctive markings as its cousin and population estimates are far more difficult to determine (Couturier et al. 2012).

In his PhD dissertation at the Kona sites, Clark (2010) analyzed some of the photo data collected by volunteer divers from 1992 - 2007 and concluded that the Kona manta population was increasing, despite more boats and visitors at the sites. He acknowledged that surveys may still have been noting resident individuals for the first time rather than documenting new immigrants (discovery bias), similar to the cumulative discovery curve (**FIG. 4**) and conclusion presented in Deakos et al. (2011). In both of these studies, the initial steepness of the discovery curve's slope correlates with the sightings of new previously-unidentified mantas, and as more individuals are documented, the rate of discovery decreases and the slope becomes a better indicator of population change, as in Sprogis (2015). If a population is very large, then the discovery phenomenon will continue to bias conclusions about immigration or emigration based on photo-identification. Expanding the

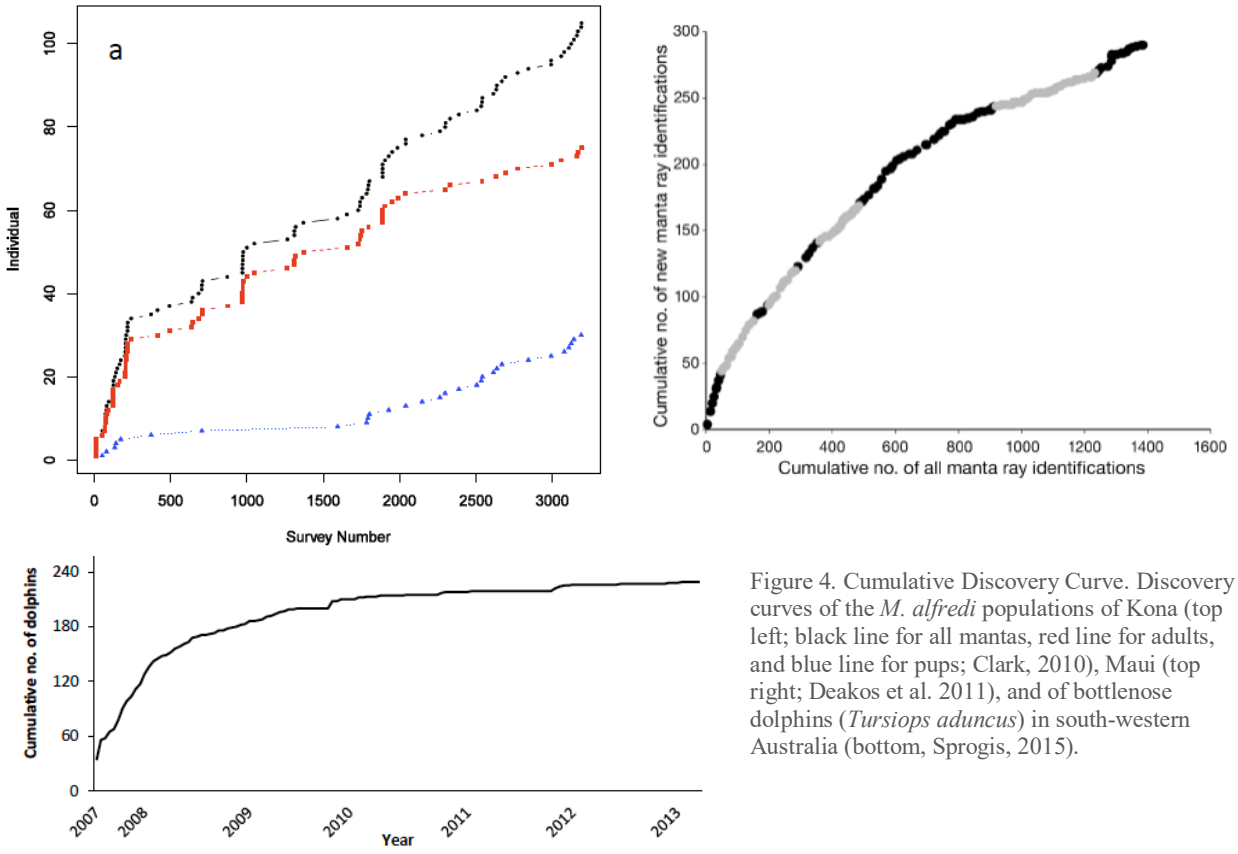

Figure 4. Cumulative Discovery Curve. Discovery curves of the *M. alfredi* populations of Kona (top left; black line for all mantas, red line for adults, and blue line for pups; Clark, 2010), Maui (top right; Deakos et al. 2011), and of bottlenose dolphins (*Tursiops aduncus*) in south-western Australia (bottom, Sprogis, 2015).

analysis to include the past ten years (2008 - 2018) may reveal a plateau similar to the study of bottlenose dolphins in south-western Australia (Sprogis 2015).

The manta species aggregate predictably, driven largely by food productivity (Luiz et al. 2009; Couturier et al. 2012; Rohner et al. 2013). These large predators depend heavily on surface zooplankton for their diet (Osada 2010; Burgess et al. 2016). At the Kona manta sites, the productivity along the shallow shelf region offshore is a likely cause for the relatively high site fidelity of *M. alfredi*. Clark (2010) found that none of the nine mantas tagged with acoustic transmitters moved more than six kilometers from shore during his study, which lasted between 1.7 and 398.3 days (median 25,0, mean 66.8, SD 126.1).

Reef manta rays are one of the best studied of the Mobulidae family, and most studies on their reproduction concern *M. alfredi*. Courtship and mating occur frequently around reef habitats (Marshall & Bennett 2010; Deakos et al. 2011; Stevens et al. 2018). Age at reproductive maturity is not well-studied and is a priority for future research (Stewart et al. 2018), but mobulid rays are generally understood to be long-lived and slow-growing (Couturier et al. 2012) with a long gestation and infrequent pregnancies about every two to four years (Marshall & Bennett 2010; Deakos 2012; Stevens et al. 2018).

The population status of mobulid rays is largely based on diver-reported sightings and photo IDs (Marshall & Bennett 2010; Clark 2010; Deakos et al. 2011; Ward-Paige et al. 2013 p.; Couturier et al. 2014; Stewart et al. 2018). In a study of ninety regions in the world, mobulid sightings from 47% of diver-reported surveys indicated population declines (Ward-Paige et al. 2013). Globally, populations of sharks and rays are in decline (Myers & Worm 2003, 2005; Dulvy et al. 2014b). Hawai‘i’s Kona population appear to be an exception, which is likely increasing (Clark 2010) and represents the one of ninety regions in the global review to exhibit increased sightings (Ward-Paige et al. 2013).

The threats to Kona rays are considerably less than those populations in other regions, particularly where fisheries pose direct and indirect sources of mortality (Croll et al. 2016). Markets in western Mexico, Mozambique, Sri Lanka, India, Taiwan, Gaza, Palestine, Egypt and Indonesia have domestic fisheries for resident mobulids, and markets in other countries like Malaysia, Sumatra, China and Singapore are known to import ray products (Ward-Paige et al. 2013; Neme 2016; Croll et al. 2016). As many as 30 fisheries in 23 countries were also identified with mobulid bycatch, which makes fisheries the largest threat to the species globally (Nance et al. 2011; Couturier et al. 2012; Ward-Paige et al. 2013; Croll et al. 2016; Lawson et al. 2017). Other threats include boat strikes, entanglement in marine debris and mooring lines, incidental hooking in fishing lines, and contact with people in the water (Marshall & Bennett 2010; Atkins 2011; Deakos et al. 2011; Garrud 2016; Stewart et al. 2018). Ecosystem-scale threats like habitat degradation, climate change, and pollution represent additional pressures on these vulnerable populations (Couturier et al. 2012; Stewart et al. 2018; Germanov et al. 2019). The resounding prescription for threat reduction is protection through

conservation policy and management of both fisheries and tourism industries (Osada 2010; Couturier et al. 2012; Ward-Paige et al. 2013; Dulvy et al. 2014a; Neme 2016; Croll et al. 2016; Lawson et al. 2017; Stewart et al. 2018).

International, national, and local protections for mobulid rays are many, though the efficacy of their implementation is complicated by the multinational nature of these migratory species. All species of mobulid rays are listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Additional protections under global frameworks like the Inter-American Tropical Tuna Commission and the United Nations' Convention on Migratory Species of Wild Animals Appendix I & II attempt to address the challenge of mobulidae species' complex distribution. National governments with protections for *M. alfredi* and *M. birostris* go back as early as the Philippines (enacted 1998), followed by Malta (1999), Israel (2005), Mexico (2007), New Zealand (2010), Ecuador (2010), Australia (2012), Brazil (2013), United Aram Emirates, Maldives, Indonesia (2014), Peru (2016) (Lawson et al. 2017), and most recently the United States, which added *M. birostris* to the list of protected species under the Endangered Species Act (ESA; NOAA 2016). At a local scale, mantas are protected in Florida (2006), the Commonwealth of the Northern Mariana Islands (2007), Hawai‘i (2009), and Guam (2011) in the US, Yap of Micronesia (2008), Christmas Island and Cocos (Keeling) Islands of the Australian Indian Ocean Territories (2010), and Raja Ampat (2012) and West Manggarai/Komodo (2013) in Indonesia. These measures take the form of spatial and temporal closures, protections from direct and indirect harm, and prohibitions on take and trade (HRS §188-39.5 2009; Ward-Paige et al. 2013; "Yap Manta Ray Sanctuary Law - Traditional Conservation" 2014; Lawson et al. 2017).

Despite these formal "best efforts" to reduce threats to the species, populations continue to decline with unregulated and illegal fisheries and impacts of tourism (Ward-Paige et al. 2013; Rambahiniarison et al. 2016). Even in the United States where environmental law is strong, manta protections are criticized for insufficient enforcement. As recently as April 2019, advocacy groups including Earthjustice, Defenders of Wildlife, and the Center for Biological Diversity filed suit against the Trump Administration for the unacceptable levels of whitetip sharks and giant manta ray bycatch in longline and gillnet fisheries operated under federal permits(Ehrensperger 2019). However, the recent listing of *M. birostris* under the ESA is an achievement in federal protections for mantas and provided these plaintiffs with the means to intervene. *M. alfredi* are protected from illegal take by state and territorial laws in Florida, Hawai‘i, Guam, and the Northern Mariana Islands. The federal government denied a petition to list the Maui and Kona reef manta rays under the ESA in 2016 on the grounds of insufficient evidence as to the populations' importance to the overall welfare of the species (NOAA 2016). The most recently enacted protections for rays came about in the 30th State of Hawai‘i Legislature, 2019 when Governor David Ige signed into law Act 252 (19) "*Relating to shark and ray projection."* Act 252 (19) added protections against capture, take, possession, abuse, entanglement, or killing

of any ray (Nishimoto et al. 2019). The implications of this new law are as yet untested, but at the very least the State of Hawai'i is likely to cite Act 252 (19) as support for regulations at the Kona viewing sites.

A Case for Management

Incidences of impacts to rays are well documented in Kona (**FIG. 5**). Between January and April 2018, three mantas suffered severe injuries, most likely by boat propeller and/or rope and line ("Manta Tour Guides and Operators" 2018). Previous to 2018, injuries were documented infrequently and only two deaths have been recorded in Hawai'i, both from entanglement on poorly-constructed moorings (Deakos et al. 2011; "Manta Tour Guides and Operators" 2018). The boating traffic out of harbors in Kona and the proximity of the Keauhou manta viewing site to Keauhou boating channel present substantial risk to these surface-feeding animals. While it is impossible to assign blame to any boat or industry, the number of injuries is evidence that the animals are at risk. The number of commercial manta companies with motorized boats has grown from an estimated 30 in 2007 (Clark 2010) to 42 in 2015 (Marine Science Consulting, LLC. 2015) and 60 in 2018 with the increasing trend of companies sending multiple boats at once (DOBOR 2019). The proliferation of commercial operators in recent years has drawn criticism from stakeholders, conservation groups, DLNR, and the general public.

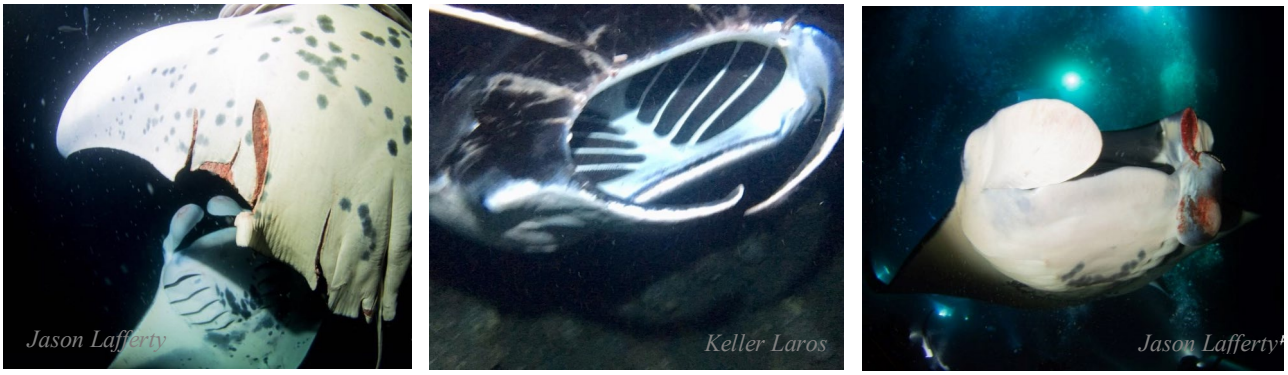

Figure 5: Injuries to Kona mantas (*Mobula alfredi)*) reported on the Facebook group Manta Tour Guides and Operators. Three separate manta injuries to Eli in March (left), Vallaray in late April (center), and Ralph's Ray in early April (right) of 2018.

DLNR drafted emergency regulations in response to the spate of injuries in early 2018, but in lieu of putting a subset of the State's planned regulations in front of the Governor, the DLNR deferred implementation to focus its resources on successfully packaging the management plan in one go (DOBOR, personal communication, July 03 2018). By 2018, the State was four years into a contentious process of public consultations, safety assessments, research, and rule-writing. In 2014, conflict at the Kona manta viewing sites had reached a fever pitch and concerned community members went to their legislators for help. The House of Representatives unanimously passed House Concurrent Resolution (HCR) 170, urging the DLNR to adopt rules to manage the Kona manta ray dive sites and address concerns for safety and the environment (Lowen &

Nishimoto 2014). The Hawai‘i administrative rules (HAR) to provide DOBOR with the authority of regulate conduct at the manta ray viewing sites are found in HAR §13-256 Ocean Recreation Management Areas (ORMAs) and HAR §13-257 Day-Use Mooring Buoys (DMBs). The regulations that pertain most to the manta viewing operations will be listed in HAR §13-256, and are the subject of this study.

FIGURE 1 summarizes the draft proposed rules, first presented in 2015, updated most recently in 2019 and undergoing the State of Hawai'i's public rulemaking process as outlined in HAR Chapter 91, Title 17. The process can take months to years, as it must be approved by the Attorney General, the Small Business Regulatory Review Board, the Board of Land and Natural Resources, and the Governor before going out for public hearing, after which DOBOR will have the opportunity to make revisions and submit the rules through the same chain of approvals. The implementation of DOBOR's manta viewing operations management program is anticipated in Summer 2021.

Using the DMB Program

The backbone of the Kona manta viewing regulations is another State initiative with a legacy equal to that of the Kona manta sites, both in complexity and conflict. Day-Use Mooring Buoys (Previously DUMBs but generously renamed DMBs) is a system of marine moorings consisting of a buoy or float with some manner of attachment anchored to the seafloor (**FIG. 6**). Recreational and commercial mooring buoys are established primarily to prevent anchor damage to the marine environment. There are a number of such programs around the world, including Australia, Egypt, Germany, Italy, Kenya, US Virgin Islands, and Florida (Allen 1992; McClanahan et al. 2005; Jameson et al. 2007; Ostendorp et al. 2009; Demers et al. 2013; La Manna et al. 2015; Venturini et al. 2016). Moorings at these sites provide safe ocean recreation opportunity (when combined with proper maintenance and repair) or may be implemented to limit the number of users in an area (when combined with enforcement and no anchoring rules). The purpose of mooring systems varies, but generally they are prescribed to reduce or prevent anchor damage to the ocean bottom.

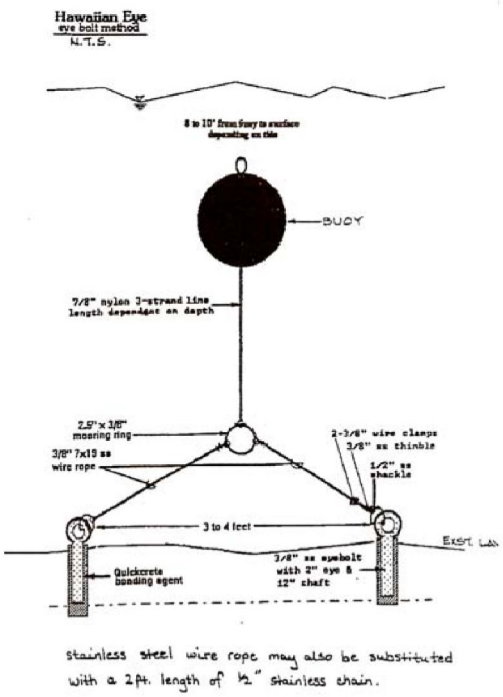

Figure 6. Day-Use Mooring Buoy Diagram. The most common DMB configuration found in Hawai‘i with components labeled. Schematic drawing from O'Halloran 2009

In 1981, John Halas helped the Key Largo National Marine Sanctuary develop a mooring system designed to provide safe mooring opportunities for users and to protect marine resources from boat anchors (Halas, J.C. 1997). Shortly after, the University of Hawai'i Sea Grant College Program began to work with community partners to develop a similar system for the State (O'Halloran & Bourdon 2010). Initial testing and research with the Hawai'i Institute of Geophysics (HIG) helped to develop a pilot study of moorings as discussions of permitting and jurisdiction began. The DLNR and the Department of Transportation (DOT) Harbors Division were at odds in determining which agency should manage a state mooring initiative. The issue was simplified when DOT's Harbors Division moved to DLNR and became the Division of Boating and Ocean Recreation, effective July 1, 1992. A statewide program was formalized into HAR §13-257 in 1995 with permits to install 277 DMBs statewide (HAR §13-257 1995).

While DLNR was named on permits for mooring installations, the work and funding came from a combination of public-private partnerships including a generous donation from the Grateful Dead and Jerry Garcia, funding from the Board of Land and Natural Resources, and countless hours and skilled labor donated by commercial and recreational divers (O'Halloran & Bourdon 2010). The nonprofit Mālama Kai Foundation (MKF) coordinated the effort and developed a Statewide 10-Year Management Plan. Grants, private donations, and in-kind contributions continued to sustain the program, but growing dissatisfaction with the State's noninvolvement and diminishing funds created an environment of unpermitted installations, derelict moorings, and liability conflict for all parties involved. It became apparent to DOBOR that significant changes to the program were needed, and after careful evaluation and consultation with commercial and recreational mooring users, the ambition of a Statewide mooring program shrank. The State would implement moorings as a management tool in specific high-use areas. The first location for new DMBs would be Makako Bay and Keauhou for the Kona manta viewing operations.

The Pilot Study of the Kona Manta Viewing Sites

Thus, two programs with complex and overlapping histories were unified into a sweeping regulatory plan. The Kona manta viewing sites would be managed through the installation and maintenance of 25 DMBs, 13 at Makako Bay and 12 at Keauhou. In addition, the regulations outlined in **FIGURE 1** and additional components such as a permit fee, spatial and temporal restrictions, and vessel size restrictions would further inform access and conduct at the sites. This regulatory management plan is controversial and mired by decades of conflict, though resolution appears imminent. The communities that have long awaited a Statewide mooring program and management of the Kona manta sites will receive both in one pilot implementation. Whether the state will successfully marry the two goals and arrive at a system that is adaptable to other high-use ocean recreation areas is of great interest. Already, DLNR is discussing an integrated mooring management program for Molokini, Maunalua Bay, and Waikiki, and a third Kona manta site is beginning to develop. If the Kona

manta pilot program is a success, then DLNR will have stronger support among community members, leadership, and legislators to fulfil its mandate and manage Hawai‘i’s natural resources.

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Chapter 1: Charismatic Marine Megafauna Tourism Management

Abstract

Marine wildlife tourism (MWT) represents a fast-growing industry in a massive economic sector. The impacts can harm wildlife, habitats, and our ecosystems. Efforts to manage MWT are widespread, though few have considered the effectiveness of their programs beyond implementation. This study identifies the MWT literature that evaluates management interventions and uses a scoring methodology to weight and rank each measure. The process is applied to a case study on the verge of regulations: the Kona manta viewing sites. A total of 115 studies that evaluate 347 measures were scored and then averaged as broader measure categories. "Education for participants" was the highest-ranking category, followed by "count limits for boats and passengers", "protections for wildlife", and "limiting the conduct of tour participants". The least-effective measure categories were "regulated feeding", "prohibitions on SCUBA", "limiting the conduct of boats", and "limiting the proximity of in-water participants to wildlife". Measures were consistently evaluated on the basis of either impacts, perceptions, or compliance. This suggests that a holistic approach to evaluating efficacy is one which considers all three dimensions. The ranking methodology was adapted from Chung et al. (2019) who developed it for coral reef restoration in Hawai'i, and it can be further modified for all manner management planning.

1.1 Introduction

The global rise of marine wildlife tourism has outpaced management, exposing the vulnerabilities of coastal ecosystems everywhere regulatory measures are ineffectual. Tourism is among the fastest growing economic sectors in the world (UNWTO 2019). It generated more global revenue in 2017 than automotive or food industries (UNWTO 2018). The World Travel & Tourism Council predicts that international tourism will increase by 4% per annum in the next ten years (World Travel & Tourism Council 2018). It is a source of conservation, research and funding (Green & Higginbottom 2000; Ballantyne et al. 2009; Burgin & Hardiman 2015; Boyes 2016), education (Diedrich 2007; Mau 2008; Camp & Fraser 2012; Giglio et al. 2018), as well as an economic stimulus (Brunnschweiler 2010; Gallagher & Hammerschlag 2011; O'Malley et al. 2013; Eriksson et al. 2019). However, coastal wildlife tourism at some locations has been implicated in significant environmental and social system declines (Davenport & Davenport 2006; Hall & Lew 2009). These impacts reveal the threats of a mismanaged industry. Around the world, there is ample evidence of tourism's impacts (Blane & Jaakson 1994; Cohun 2005; Bejder et al. 2006b; Njonjo 2007; Atkins 2011; Camp & Fraser 2012; Bentz et al. 2015; Ziegler et al. 2016). In each of these cases, management is reactionary to what is already adversely affecting an ecosystem. Preventative rulemaking is uncommon, though the proliferation of tourism

management literature indicates that there are challenges and impacts managers can anticipate (Graham & Bustamante 2006; Rodger et al. 2010; Lawrence et al. 2016).

Regulatory measures are usually implemented after adverse effects are detected by managers or the public, and in some instances, evaluated for their efficacy in peer-reviewed studies and reports. A systematic evaluation of existing regulatory interventions can help stakeholders and external authorities to prioritize management strategies. This study derives recurring management measures from peer-reviewed and gray literature in which measures are evaluated for their impacts on management goals. The scope is limited to marine wildlife tourism (MWT) for the purpose of maximizing overlap in objectives and strategies with the Kona manta sites. Literature on MWT addresses hundreds of regulations and policies, but lacks consensus or ranking. Trave et al. reviewed nearly 400 MWT publications but found a mere 4.3% (17 of 396) presented evidence of sustainability, i.e. "lack of chronic/irreversible changes in the ecology of the species involved or in the ecosystem" (2017 p.215). They furthermore identified 17 general management recommendations and ranked them by frequency, but did not include efficacy in their evaluation. Through systematic review, the present study (1) ranks the effectiveness of implemented measures in MWT by combining many different evaluations in the literature, (2) discusses each measure in the context of an ecosystem-based management (EBM) framework, and (3) uses an MWT case study in Hawai'i to demonstrate how a broad review can benefit local management. There are valuable lessons to be learned from global MWT. This process of assessing and ranking management measures is performed for a specific locale in this study, but has applicability to developing and adaptive management programs beyond Hawai'i and MWT.

Ecosystem-Based Management of Marine Wildlife Tourism

The realm of coastal and marine tourism includes any ocean-based activities for which participants travel from their residence (Orams 1999). It includes the ever-expanding array of activities such as boating, fishing, swimming and diving, photography, and wildlife viewing (Orams 1999; Hall 2001; Moreno & Amelung 2009). About 50% of all international tourists travel to coastal areas (UN 2017). Many of these tourists will participate in some form of ocean recreation. Given that the ocean covers 72% of the earth's surface and about 37% of the world's population live in coastal area (UN 2017), the prominence of coastal and marine tourism is no surprise.

MWT is a rapidly expanding industry (Hawkins & Roberts 1994; O'Connor et al. 2009; Semeniuk et al. 2009; Catlin & Jones 2010; Newsome et al. 2012; Roche et al. 2016), though the proportion of all coastal and marine tourism it represents is unknown. It has its roots in people's fascination with viewing animals, which is the primary motive for many marine wildlife tours (Davis et al. 1997; Berger 2009; Ballantyne et al. 2009). The Association of Zoos and Aquariums reported over 195 million annual visitors to its accredited institutions in 2016 (AZA 2018), while wildlife tourism has become the leading foreign exchange earner in

several countries (Reynolds & Braithwaite 2001). In recent years, viewing wildlife has sprawled out of zoos and into natural habitats, emphasizing the desire to experience landscapes and observe wildlife in non-captive settings. However, the term *natural* is generously applied; many case studies demonstrate that nature tourism begets unnatural behaviors in its animal subjects (e.g. Dubois & Fraser, 2013; Juliff, 2018; Moorhouse, Dahlsjö, Baker, D'Cruze, & Macdonald, 2015; Thomson et al., 2017; Walpole, 2001). These behavioral changes are perceived as impacts that can and should be avoided or mitigated to the greatest extent possible.

MWT can bring about habitat fragmentation and an overall decline in biodiversity (Davenport & Davenport 2006). Commercial ocean recreation, particularly MWT, may alter natural resting, foraging, and/or reproductive behaviors of marine species (Bejder et al. 2006a; Semeniuk et al. 2007; Heyman et al. 2010; Velando & Munilla 2011; Gil et al. 2015) and expose sensitive environments like coral reefs to anchor damage (Giglio et al. 2017), SCUBA diver-related injuries (Hasler & Ott 2008), and littering and trampling (Wiener et al. 2009). Trave et al. (2017) conducted a review of MWT literature and found nearly 100 species of wildlife disturbed by tourists. Marine and coastal tourism can be a source of significant and enduring environmental strain that diminishes the quality of coastal resources. These have resounding social impacts: coastal communities overrun by development (Gonen 1981; Farrell 1986; Fairhead et al. 2012), local economic vulnerability (Moreno 2005; Moreno & Amelung 2009; Wongthong & Harvey 2014; Mackay & Spencer 2017) and loss of tradition and culture (Gonen 1981; McGoodwin 1986; McKinsey & Company 2017). These environmental and social costs are catalysts for both reactive and proactive management.

There are various approaches to natural resources management that are applied to MWT industries globally. These include *maximum sustainable yield*, in which "harvest" (or tourism pressure on a wildlife population) is maximized for continued resiliency in the harvested population (Croft 2000), *resource scarcity* most notably presented in Hardin's famous if contested parable, the Tragedy of the Commons (1968) that appears to advocate top-down management to protect against overharvesting, and the *ecosystem approach* in which harvest is balanced against the holistic welfare of an entire ecosystem (Beaumont et al. 2007). Maximum sustainable yield is problematic because it neglects inherit values of ecosystem health and focuses on population-level metrics. Similarly, resource scarcity neglects the achievements of common pool resource management worldwide and the value of bottom-up management (Ostrom et al. 1999). The ecosystem approach, also known as ecosystem-based management (EBM), is widely applied to coastal tourism cases (Gilliland & Laffoley 2008; Katsanevakis et al. 2011; Heenehan et al. 2015). According to the United Nations Environment Programme (UNEP) Convention on Biological Diversity, this Ecosystem Approach is defined as, "a strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use in an equitable way" (2000, p. 103-104). EBM explicitly addresses the interdependency of social and environmental dimensions where it defines ecosystems as human-inclusive. Trave et al. (2017)

concluded that this harmony is essential for long-term sustainability. Similarly, Orams (1999) emphasized the marine environment and the tourist experience as priorities for management. Finding a balance of potentially competing priorities is essential for effective EBM.

MWT is commonly managed using the ecosystem approach, in part because of the inherit benefits wildlife protections confer on their habitats. This is known as the *umbrella-species effect*, or the idea that protections for one species can benefit entire ecosystems (Leader-Williams & Dublin 2000). People and institutions are most attracted to certain species, which are labeled *charismatic megafauna*. Preferences are based on characteristics like the species' perceived bio-behavioral similarities to humans, aesthetics, intelligence, economic value, and cultural representations (Czech et al. 1998; Crowley 2009; Batt 2009). Primates are an early example of charismatic megafauna (Leader-Williams & Dublin 2000), as are dolphins that are perceived as emotional and intelligent (Patroni et al. 2019), and exhibit strong maternal and sexualized behaviors (Besio et al. 2008). Also known as *flagship* or *umbrella species*, these ambassadors of their respective ecosystems provide an essential service: they attract tourists, create auxiliary markets for products and services, and promote conservation for a variety of species and habitats (Leader-Williams & Dublin 2000; Richardson & Loomis 2009; Hausmann et al. 2017; Skibins et al. 2017; Patroni et al. 2019). Among marine wildlife, those free-roaming larger species such as whales, sea turtles, and sharks become symbolic of their ecosystems, and can be a primary driver for large-scale protections in marine managed areas (Hooker & Gerber 2004). MWT therefore provides the opportunity for managers to implement holistic and inclusive measures that confer conservation benefits beyond the species on the brochure.

Hawai‘i's MWT Case Study

Mass tourism arrived in Hawai‘i after statehood in the 1950s and has since grown from 250,000 visitors in 1959 (Mak 2015) to 9,888,845 in 2018 (Hawai‘i Tourism Authority 2019). There are more than 80 marine managed areas in state waters and in 2002 alone, more than 200,000 divers and 3 million snorkelers participated in a marine tour (Beukering & Cesar 2004). Presently, some form of marine management exists in about 5% of state waters (Friedlander et al. 2019). At the 2016 IUCN World Conservation Congress hosted by Hawai‘i, Governor David Y. Ige, in response to a local and Pacific-wide conservationist campaign, created the marine 30x30 initiative to effectively manage 30% of Hawai‘i's nearshore marine areas by 2030 (Governor of the State of Hawai‘i, 2016). DLNR will therefore prioritize ocean management in the coming years, as evidenced by House Bill 2591 requesting $250,620 to develop the 30x30 program (Tarnas et al. 2020). With both tourism and resource management predicted to increase, EBM will be essential to ensure sustainable practices are in place in Hawai‘i.

This study focuses on the Kona manta ray viewing sites (*for the history of the site and a description of the tours, see the prior chapter of this thesis)*. Since announcing intent to manage the sites in 2014 (HCR 170),

the State of Hawai‘i has struggled to implement an MWT management program for the sites. Manta tourism continues to be a thriving business with over 60 companies running tours for 100 – 300 guests nightly (Marine Science Consulting, LLC. 2015). The Hawai’i manta viewing industry was valued at over US$4 million in 2011 (O’Malley et al. 2013) when half the number of current businesses were offering tours. The SCUBA dives are among the most popular in the state (Sport Diver Editors 2018) and with a captive audience of thousands each year, the potential for education and conservation outreach is substantial. Yet the tours go largely unregulated (but for a set of guidelines) and the state has no monitoring or research programs for the species.

The State’s goal for management of the Kona manta ray viewing sites is to protect the marine environment, promote safety for continued ocean recreation, and reduce liability for tour providers and the state (Lowen & Nishimoto 2014). The management plan is in draft form at the writing of this document, with proposed regulations detailed in **TABLE 1**. All regulations would be strictly enforced at the manta viewing sites except in cases of emergency (HAR §13-256). In this context, “strictly enforced” is taken to mean all detected violations will be charged with no issuance of warnings by law enforcement officials. These rules as described in the latest draft for HAR §13-256 (DLNR 2019) have not been finalized through public review (Hawai‘i Administrative Rules Chapter 91, Title 17). The rules are anticipated to undergo public hearing in 2021.

Table 1. Regulations at the Kona manta sites proposed by DLNR (Source: DLNR, 2018)

- Prohibit anchoring inside site boundaries at all times
- Require a permit for commercial manta activities
- Limit live boating to ingress, egress, and emergencies
- Prohibit all subsurface vessel lighting
- Require 360° white light on non-motorized vessels
- Confine manta activities to designated campfire areas
- Prohibit commercial SCUBA tours within Kaukalaelae
- Moorings will be first come, first served
- There will be a 2.5-hour time limit per use
- The participant to guide ratio shall not exceed 10:1
- There will be no fishing allowed during manta viewing hours (nightly 4:00 pm – 4:00 am)
- Vessels are prohibited from leaving the zone while their passengers are still in the water

It is critical that management goals reflect the ecosystem’s many components, both biological and social. There is no one-size-fits-all solution for any form of tourism, as these will inevitable vary in scale, location, and target experience. The Kona manta ray viewing sites are unique; they offer reliable manta ray sightings, take place at night, and utilize artificial lights to attract plankton and feeding mantas (Clark 2010). This limits the similarities that managers can identify in MWT locations elsewhere. However, there are many parallels between MWT and the Kona manta ray viewing sites that are found in literature review. Chung et al. (2019) developed a process to systematically rank global management interventions for the specific application to coral reef restoration in Hawai‘i. Using a weighted point system, the study evaluated various measures for their ability to meet management goals and improve coral resiliency. Their review of existing case studies and

research brought valuable insights to resource managers, who integrated the study's findings into Hawai'i policy documents and state initiatives (DAR 2017; Case 2018; Neilson et al. 2018). The general methodology has also been applied to shark and ray provisioning (Brena et al. 2015), cage diving (Bruce 2015), recreational boating (Davenport & Davenport 2006), and licensing nature tourism (Genter et al. 2007). Literature reviews clarify understudied activities and regulatory tools. The purpose of the present study is to provide a systematic ranking method for MWT regulations and to identify high-priority components for the Kona management plan. This will hopefully inform upcoming management for manta ray viewing and promote the most effective aspects of an ecosystem approach for MWT.

1.2 Methods

Identifying Studies for a Systematic Review

The preliminary search for peer-reviewed literature on the topic of marine wildlife tourism yielded over 30,000 papers on Web of Science and OneSearch. Keyword searches were used to filter the results using a combination of themes and species of interest (**TABLE 2**). The papers were selected for those involving focal charismatic, marine megafauna species and some aspect of tourism management. A total of 191 peer-reviewed papers, academic theses, and book chapters were selected and reviewed for management strategies. Cited papers from this preliminary round yielded additional sources, and additional keyword searches were generated from the emergent management categories (ex. *provisioning, feeding, education, briefing, ecotourism, cage-diving, whale/dolphin watch etc.*), which added another 63 papers from both grey and peer-reviewed literature.

Table 2 Peer-reviewed literature keyword search

KEYWORD SEARCH					
Marine tourism	Regulation		elasmobranch	*alfredi*
Coastal tourism	crowding		cage-diving	*birostris*
Code of conduct	perceptions		cetacean	*Mobula*
Self-regulation	sustainable		dolphin watch	*Manta*
nature-based tourism	provisioning	+	dolphin cruise	whale shark
Compliance	feeding		dolphin swim	shark
Management	education		whale-watch	ray
dive	briefing		whale swim	Hawai'i
SCUBA	community-based		whale cruise	whale
snorkel	ecotourism		marine wildlife	elasmobranch

Evaluating Measures for Their Efficacy in Management

Once the papers list was finalized, each measure was described and categorized into twenty general types (**TABLE 3**). This list was generated based on common language and focus, and when applicable, were divided by whether they applied to commercial operators or to participants. Measures included any intervention, policy, or strategy that were implemented and evaluated. A measure was considered to be evaluated if there were metrics and conclusions about the measure's contributions towards management goals within either environmental or social domains, consistent with an EBM approach to effective management. The measures were evaluated as positive or negative. Positive evaluations included a compliance rate of 80% or more (Allen et al. 2007; Quiros 2007; Smith et al. 2008, 2010; Howes et al. 2012). In perception survey studies, this threshold was set at majority support or agreement (>50%). Significant impacts in studies of ecological indicators (e.g., animals' avoidance behaviors increased significantly when two or more boats were present) and social indicators (e.g. revenue to local communities, employment, conservation initiatives) determined whether a measure was positive or negative.

Table 3. Categories and example measures from the MWT Efficacy Literature

TYPE	CATEGORY	EXAMPLE MEASURES
ACCESS	Fee for site access	Paid by tourists, paid by operators, for access, tour type
	Limit access through permits	Limit number available, required to offer tours or access sites
	Limit time by allowable access periods	Seasonal closures, access by hours, rest period closures
	Limit time by tour duration	Limit time of encounter, in water, in site
CONDUCT	Feeding - regulated	No hand feeding, food type/amount, frequency, areas
	Limit - equipment	No flash photography, use of floats/lines, moorings
	Limit boating speed	Slow-no-wake, 5 knots, speed of approach
	Limit the conduct of boats	No head-on approach, chasing, quick direction changes
	Limit the conduct of participants in-water	No free diving, no chasing, passive observation
	No SCUBA	Ban SCUBA from area
COUNT	Limit the count of boats	Limit boats with wildlife, in an area, at a time, per day
	Limit the count of participants	participants per guide, people in water, with wildlife, on boat
EDUCATION	Education for commercial operators	Mandatory workshops, certifications, staff trainings
	Education for participants	Mandatory education, outreach programs, briefings
ENFORCEMENT	Enforcement - official	On-board observers, park rangers, marine patrols,
	Enforcement - self	Code of conduct, voluntary eco-certifications, guidelines
LOCATION	Limit tours to spatially-confined areas	Zones of exclusion, entry/exit points, MPAs,
	Limit proximity of boat to wildlife	100 m, 90 m, 50 m minimum distance from wildlife
	Limit proximity of participant to wildlife	Minimum 3 m, 2 m proximity to wildlife
WILDLIFE	Do no harm	Prohibited to touch, chase, harass, take/kill

Measures were then evaluated using a weighted scoring equation (**FIG. 7**) similar to that of Chung et al. (2019). Papers that evaluated a measure to have a positive or effective outcome were positively scored (+1), and measures with outcomes that were negative or ineffective were scored negatively (-1; **FIG. 7** Part A). Each management intervention was scored based on three criteria: scale (local vs. global/regional; *B*), evidence (empirical vs. theoretical; *C*), and in-kind subject (family and geography; *D*). Regional and global studies covering multiple populations, like review papers, scored higher than studies confined to a single location, population, and/or locality. Empirical Evidence (ex. direct observation) was scored higher than theoretical evidence (ex. hypotheticals and models). The final criteria of In-kind can be modified to fit the specific management site. In this study, for the Kona manta ray viewing tours, in-kind geography was defined as Hawai'i (1) and in-kind family as the mobula ray species (1). The three criteria scores were added together for a possible range of 0 – 4. To prevent multiplying the outcome value (±1) by zero (and losing the ± designation of the measure's score), the sum was weighted by +1 (*E*).

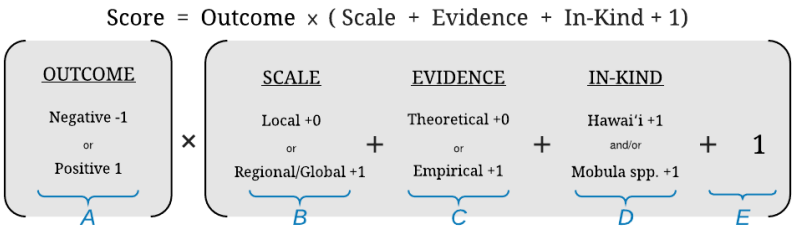

Figure 7. Scoring Equation for Measures. Equation used to calculate scores for each management strategy included in the systematic review. Score was based on the outcome (*Equation Part A*), scale of the study (*B*), type of evidence (*C*), and whether it took place in Hawai'i or included Mobula spp. (*D*), and weighted by + 1 to prevent a zero value (*E*). Adapted from Chung et al. 2018.

Once each measure had a weighted score, a mean score was calculated for the measures by category. Total counts for measures in each category were normalized along with the average scores, and these numbers were multiplied to arrive at a final Efficacy value. The measure types were then ranked from greatest to least according to their Efficacy value to the Kona manta ray viewing MWT.

1.3 Results

Papers

A total of 347 measures were identified from 115 studies. Papers were not excluded on the basis of date due to the low instances of suitable studies. The oldest study included was from 1994, and only 4 studies were pre-2000. The 115 studies all addressed some component of the EBM approach to evaluating efficacy, inclusive of environmental and/or social dimensions. The outcomes of MWT measures were positively or negatively evaluated based on three metrics: impacts (like those to wildlife behavior or the local economy), compliance (of boats and participants), and perceptions (of interviewed tour providers and their customers; **FIG. 8**). No individual measure was evaluated using more than one metric: 46.7% were evaluated on the basis

of impacts, 38.3% by compliance, and 15% by perceptions. The three metrics together comprise the overall efficacy of a measure, and emerged as useful indicators for evaluating management.

Eleven studies involved more than one country (global/regional). Given that thirteen studies included more than one nation, there were 201 country-level sites total, distributed across 39 different countries (**FIG. 9**). Oceania and North America represented more than 50% of the sites (33.3% and 20.4%, respectively); 22.4% of the sites were in Australia alone and 12.4% in the US. Only one country was represented in West Asia (Saudi Arabia). Twelve studies (5.97%) were based in Hawai‘i and evaluated twenty management measures.

Studies were categorized by target wildlife (**FIG. 10**). Seven papers addressed multiple families – MWT of elasmobranchs were assessed in one study, cetaceans in another four, and one study included both cetaceans and elasmobranchs. Another study addressed only sharks and whales. There was nearly an even split between cetaceans (50.7%) and elasmobranchs (49.3%). Cetaceans included two categories: dolphins (29.0%) and whales (21.7%). Elasmobranchs were further subdivided between sharks (25.7%) and rays (23.6%). Whale sharks were nearly as common (12.2%) as all other species of sharks combined (13.6%). Rays were primarily mobula species (18.2%) with non-mobula rays representing the smallest category (5.40%).

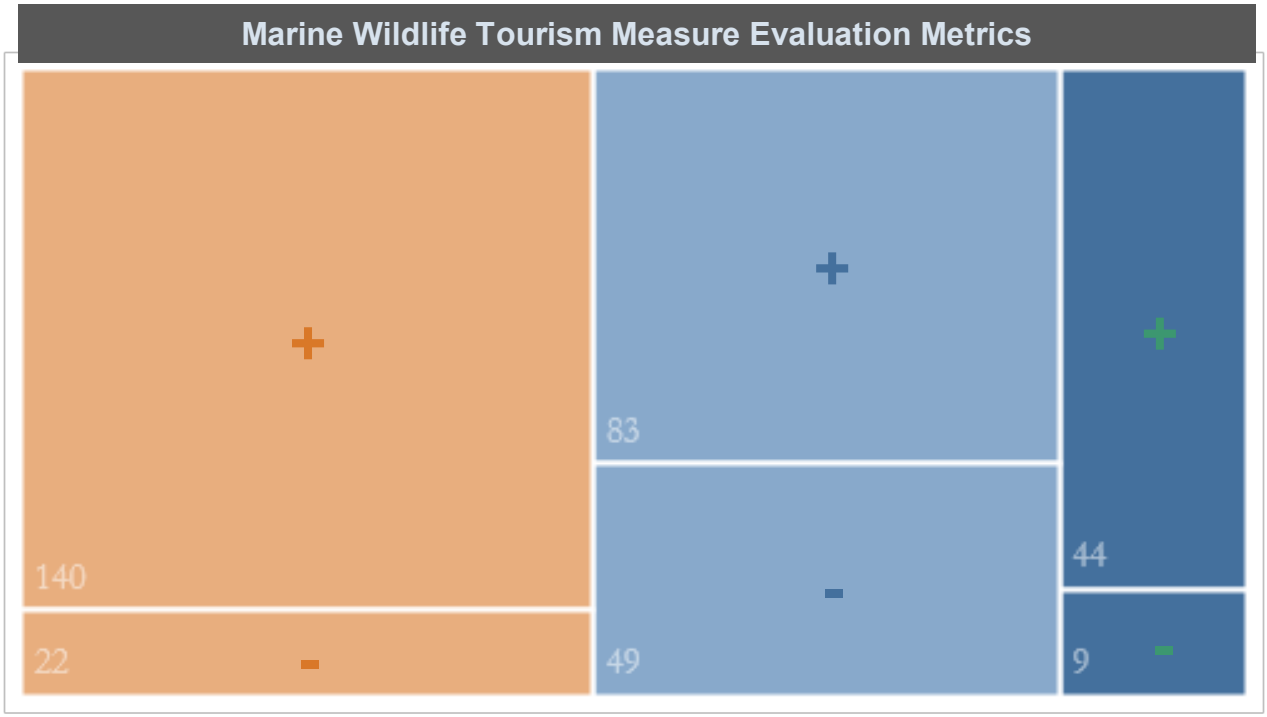

Figure 8. Measure Evaluation Types (Impact, Compliance, Perception) and Outcomes (Positive, Negative) in the MWT efficacy literature. The counts of measures are given in the bottom left corner of each box. The size of each box is proportional to the percentage of the 347 measures evaluated.

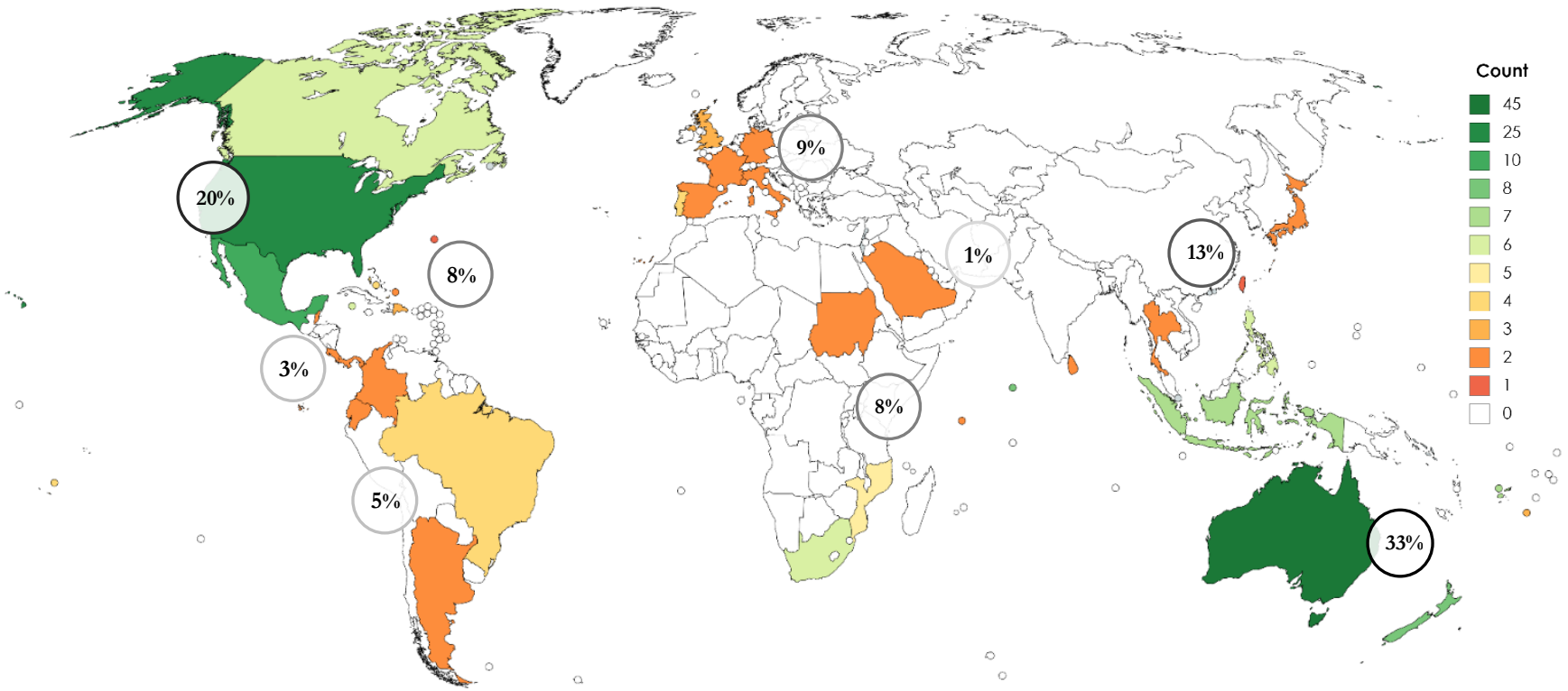

Figure 9. Map of study sites in the review. Study site counts are: Oceania (33 %): Australia (45), New Zealand (8), Fiji (7), French Polynesia (4), Tonga (3); North America (20%): US (25), Mexico (10), Canada (6); South and East Asia (13%): Maldives (8), Indonesia (7), Philippines (6), Sri Lanka (2), Thailand (2), Japan (1), Taiwan (1); Europe (9%): Azores (4), UK (3), France (2), Germany (2), Italy (2), Monaco (2), Spain (2); South and East Africa (8%): South Africa (6), Mozambique (5), Seychelles (2), Sudan (2); Caribbean (8%): Cayman Islands (6), Bahamas (5), Dominican Republic (3), Turks & Caicos (2), Bermuda (1); South America (5%): Brazil (4), Argentina (2), Colombia (2), Ecuador (2); Central America (3%): Belize (2), Costa Rica (2), Panama (2); West Asia (1%): Saudi Arabia (2).

Measures

Forty-nine studies (43.8% of the literature) evaluated only a single management measure. One global management report included several case studies that represented 18 evaluated measures, the maximum encountered in this study (Lawrence et al. 2016). The average number of evaluated measures in a study was 3.14 (median value 2). The ratio of positive to negative outcomes was 266:81; the literature was largely supportive of management measures. Evidence was theoretical in 99 cases, and empirical in the other 248. Single-site studies included 317 measures, and 30 were multi-population, regional, and/or international in scale.

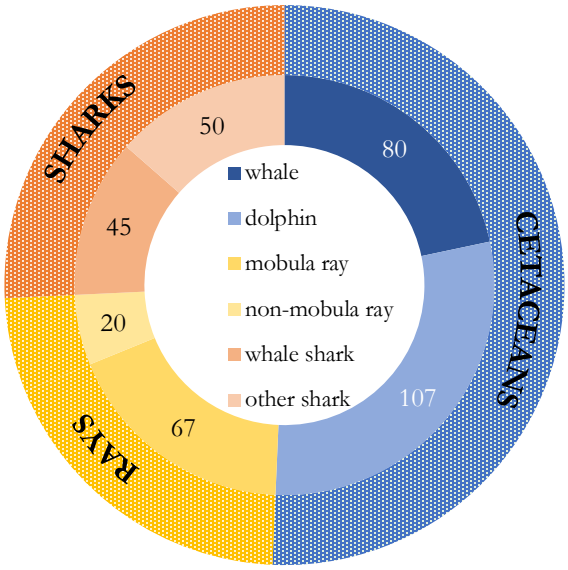

Figure 10. Measure frequency by wildlife: Cetaceans (80 whale, 107 dolphin) and Elasmobranchs, subdivided between Sharks (45 whale sharks, 50 other sharks) and Rays (67 mobula, 20 other rays).

Ranking by Count, Score, and Efficacy

The measures were classified into twenty categories that included variations of access, conduct, counts, education, enforcement, location, and wildlife protections (**TABLE 3**). Counts ranged from 30 to 7 measures per category, with an average 17.4 measures per category (**FIG. 11**). *Education for participants* was the most frequently evaluated measure (30, 8.65%). *Limit the count of boats* (28, 8.07%), followed by *self-enforcement* (i.e. code of conduct (27, 7.78%) were the next more frequent. *Prohibit SCUBA* was the least common measure (7, 2.02%). The second and third least frequent measures were *limit proximity of participants to target wildlife* (9, 2.59%) and *education to commercial operators* (10, 2.88%).

Measure categories were scored between -4 and 4 using the scoring equation (**FIG. 7**) and the distribution of scores within the measure category are displayed in **FIGURE 12**. The average score for a measure was 1.07 out of a possible score range of -4 to 4. The measure with the lowest score (-4) was in the category *Limit – equipment*, which was an evaluation of mooring balls identified as ineffective due to poor construction that ensnared and killed two manta rays at a site in Hawai‘i, (Deakos et al. 2011). The *Feeding – regulated* category had the lowest average score (-0.42). The highest scoring measures (average score of 5) were in the categories *Do no harm, Education for participants, fee for site access*, and *limit the tours to spatially-confined areas*.

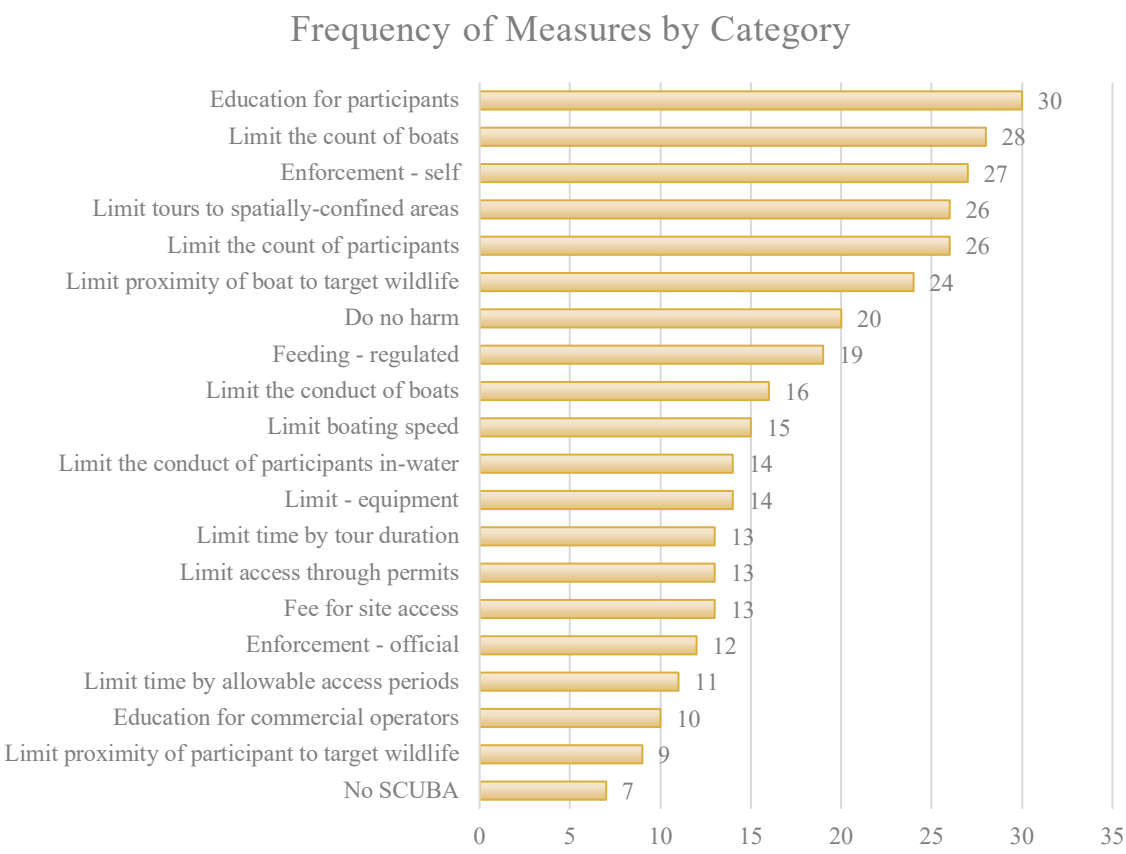

Figure 11. Count frequency of evaluated measures by nineteen categories. Multiple studies evaluated more than one measure.

Measures were ranked by efficacy value (**TABLE 4**). *Education for participants* was once again in the top-ranking categories with the highest efficacy score and frequency, and the third-highest average score. Efficacy ranking also placed *limit the count of boats*, *limit the count of participants*, *limit tours to spatially-confined areas*, and *do no harm* in the top five measure types. Similar to the *education for participants* category, *feeding - regulated* was ranked in the bottom five for count, average score, and efficacy. Categories that represented the minimum of count or average score were given efficacy values of 0. These were *feeding – regulated* and *no SCUBA*.

1.4 Discussion

MWT management is similar across species and geographies, but requires special attention to local environmental and social settings, as evidenced by the diversity of regulatory systems in the literature. There are hundreds of studies on MWT, but few contain theoretical or empirical evaluations of management measures. During the review, many items of peer-reviewed literature were not used because the focus was on the broader impacts of MWT rather than any specific measure from management. The studies that did isolate some aspect(s) of MWT management, on occasion, merely presented regulatory laws or guidelines without any

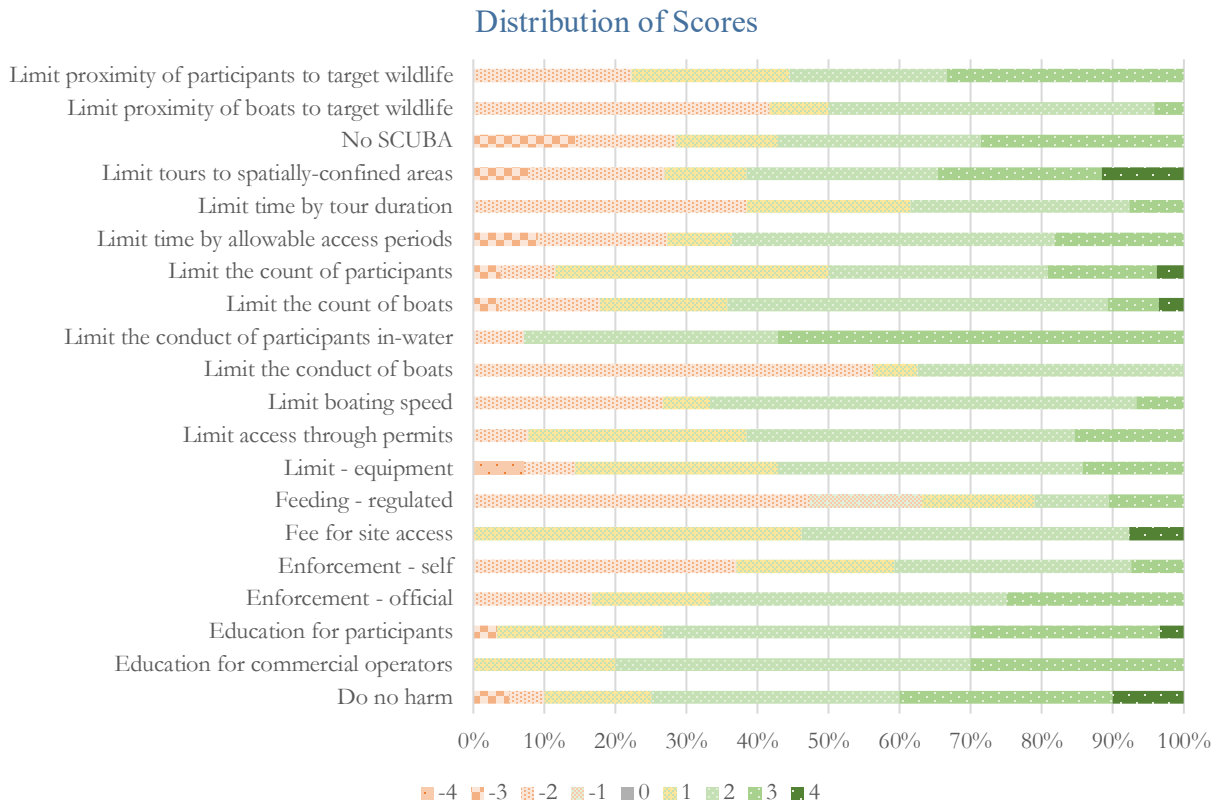

Figure 12. Distribution of Scores by Category. Scores ranged from -6 to 6. Negative scores are shaded orange; positive scores are shaded green.

evaluation of their efficacy by impact, compliance, or perceptions (ex. mention of the existence of a code of conduct without commentary on compliance, use of permits without evaluation of boat counts). For this reason, the number of relevant studies was low compared to the topic of MWT impacts and benefits. Only studies that explicitly addressed the outcomes of a particular measure were included. Measure categories were selected based on summary descriptions of the various regulations, policies, and recommendations that emerged from this review. Their diverse components and outcomes are discussed in this chapter, and their more specific implications for the state management program at the Kona manta sites are detailed in the following chapter. The contents of this section are relevant for MWT more broadly, and provide a roadmap for management programs seeking to evaluate efficacy of their measures for their unique tour conditions.

The Value of Education

The highest efficacy value was for management programs with *visitor education and engagement*. These included pre-encounter briefings before the tour (Arnold & Birtles 1999; Wiener et al. 2009; Lynam 2012; Bentz et al. 2016), during the tour (Kessler & Harcourt 2010; Atkins 2011; Bentz et al. 2013; Jaspers 2014; Knecht 2015), and debriefings at the tour's end (Filby et al. 2015; Lawrence et al. 2016; Geldenhuys et al. 2019). MWT presents a unique opportunity to educate a captive audience; groups that book a boat tour are

Table 4. Measures ranked by efficacy values. 351 measures as reported from 114 papers. Average scores (Avg Score) and the total count of measures were normalized and multiplied to produce an efficacy score (Efficacy).

Rank	Measure	Count	Avg Score	Efficacy
1	Education for participants	30	1.93	0.8698
2	Limit the count of boats	28	1.21	0.5516
3	Limit the count of participants	26	1.35	0.5393
4	Limit tours to spatially-confined areas	26	1.19	0.4924
5	Do no harm	20	1.90	0.4847
6	Limit the conduct of participants in-water	14	2.29	0.3043
7	Enforcement - self	27	0.37	0.2542
8	Fee for site access	13	1.69	0.2037
9	Limit proximity of boat to target wildlife	24	0.29	0.1946
10	Limit access through permits	13	1.54	0.1889
11	Limit - equipment	14	1.14	0.1758
12	Limit boating speed	15	0.93	0.1740
13	Enforcement - official	12	1.42	0.1476
14	Education for commercial operators	10	2.10	0.1215
15	Limit time by allowable access periods	11	0.91	0.0855
16	Limit time by tour duration	13	0.31	0.0702
17	Limit proximity of participant to target wildlife	9	1.22	0.0528
18	Limit the conduct of boats	16	-0.31	0.0157
19	No SCUBA	7	0.86	0.0000
20	Feeding - regulated	19	-0.42	0.0000

especially accessible when there are no wildlife activities happening. Key opportunities occur in the idle moments such as prior to departure from the harbor, during transit, while preparing to jump into the water, or in between wildlife sightings. Participants on dolphin swim tours in Australia's Port Phillips Bay were most interested in facts about dolphins after viewing and swimming with them (Filby et al. 2015), suggesting education can be targeted in its timing as well as content.

However, educational programming is not ubiquitous across tours (Lück 2003; Christensen et al. 2007; Brooks 2010; Atkins 2011; Jacobs & Harms 2014) and may neglect environmental aspects, focusing instead on tour instructions, equipment, and safety (Wiener et al. 2009; Atkins 2011). Visitors on both New Zealand and Fiji dolphin tours reported that they expected education about dolphins and their habitat, but complained that larger conservation issues were lacking (Lück 2003; Pratt & Suntikul 2016). Many studies noted that participants were either satisfied with or wanted additional information on the target species, their habitats, and relevant conservation issues (Lewis & Newsome 2003; Lück 2003; Christensen et al. 2007; Zeppel & Muloin 2008; Kessler & Harcourt 2010; Filby et al. 2015; Knecht 2015; Lawrence et al. 2016; Delorenzo & Techera 2019; Geldenhuys et al. 2019). Such briefings could significantly benefit MWT. Wildlife

sightings are not guaranteed and education around the volatile nature of wildlife could manage unrealistic expectations and potential disappointment (O'Neill et al. 2004; Bentz et al. 2016).

These interpretive programs were also assessed for their ability to educate and engage visitors in conservation. Several studies conducted knowledge checks on tour participants immediately and long after the tours, noting that education was linked to greater awareness of the ecology and environmental issues of target species and their ecosystems (Christensen et al. 2007; Bentz et al. 2013). Participants also reported increased conservation actions (Jacobs & Harms 2014; Filby et al. 2015), similar to the observations of Powell and Ham (2008) that visitors to Galapagos National Park were more supportive of management issues, more inclined to donate to conservation initiatives, and demonstrated increased knowledge of the area. Studies that compared participants on tours where educational programming was present or absent could not control for customer attitudes and predispositions, but Sutcliffe and Barnes (2018) found that despite the preexisting environmental leanings of shark dive participants, the tours significantly increased knowledge of conservation issues and support for shark conservation.

Critically for effective management, educational programs had the benefit of improving compliance to other measures. Enforcement staff at whale shark tours in Australia issued significantly less warnings to visitors for inappropriate conduct when education was provided beforehand (Orams & Hill 1998). Atkins (2011) observed that pre-dive briefings were of high value in the Maldives where mantas were more likely to be disturbed at distances within 5 meters, but noted an overall low level of compliance (44%) for the tour's 3-meter minimum distance guideline. This reaffirmed a prior study that measured compliance as low as 50% when education was absent (Brooks 2010). The same study also noted the critical role of educating both participants and crew in increasing compliance. Educational briefings require an educated crew, and few studies emphasizing visitor education evaluated the efficacy of *educational programs for tour providers*. Dolphin tours in Florida suffered from low compliance, and a series of professional workshops were prescribed to improve business operations (Whitt & Read 2006). At present, manta tour provides in the Maldives and whale shark tour providers in Mexico are required to pass an exam on regulations and relevant biology for their permits (Suárez et al. 2007; Lawrence et al. 2016). Guide education is a critical first step to providing enriching interpretation to visitors.

Education fits into the ecosystem-based framework by promoting multiple uses, integrating the commercial opportunity of MWT into conservation objectives and even improving philanthropy among participants. Educational programming measures are of potentially the greatest value for resource managers, tour operators and communities. If implemented with intentional learning objectives and strategic timing, it can substantially improve the overall efficacy of a management program. This measure should be integrated into every MWT site globally.

Crowding Control & Spatial Management

When MWT management is first discussed, it is often in response to overcrowding conditions (Semeniuk et al. 2009; Catlin & Jones 2010; Newsome et al. 2012; Roche et al. 2016; Needham et al. 2018). Participants in Australia reported crowding as a cause for concern on their whale shark tours (Catlin & Jones 2010) and dolphin tour boat passengers gave the lowest satisfaction score for the number of other boats (Mayes & Richins 2008). MWT guests supported *vessel count restrictions* for whale, dolphin, and manta tours (Hughes & Carlsen 2004; Kessler & Harcourt 2010; Chion et al. 2013; Avila-Foucat et al. 2013; Knecht 2015). Part of the reason that crowding diminishes the tour experience is that it elicits increased avoidance behavior by wildlife (ex. greater bottom time, more time spent traveling, ceasing to forage) and can potentially reduce sightings (Williams & Ashe 2007; Matsuda et al. 2011; Steckenreuter et al. 2012b). The number of boats or participants also correlates with greater impacts to the social, foraging, and resting behaviors of wildlife with potential long-term impacts to these marine species (Arnold & Birtles 1999; Constantine et al. 2004; Semeniuk et al. 2009; Visser et al. 2011; Lynam 2012). From the ecosystem-based approach to management, controlling tourism pressure has benefits for the ecological and commercial wellbeing of MWT. It's no surprise that measures to address crowding were among the most common in the review.

Regulations on *passenger counts* were set at ten participants in the majority of cases, though the numerical limit ranged from 4 with humpback whales in Tonga (Kessler & Harcourt 2010) to 80 with mantas in the Maldives (Brooks 2010). For vessels, one boat with target wildlife was the most common restriction (Arnold & Birtles 1999; O'Neill et al. 2004; Stamation et al. 2007; Quiros 2007; Kessler & Harcourt 2010; Steckenreuter et al. 2012a; Avila et al. 2015; Meissner et al. 2015), but elsewhere, the measure would be as complex as no more than ten boats within a ½ nautical mile of any other boat actively observing wildlife (Chion et al. 2013). Scarpaci et al. noted in their 2004 study that for regulations to be effective, they needed to be well-written so that they're easily understood, practical for implementation, and enforceable (2004). More variables in a regulation add levels of complexity that can interfere with compliance. A little over half of the studies that evaluated compliance found these measures to be effective. Non-compliance was attributed to a lack of enforcement, emphasized by authors even in studies where high levels of compliance were measured (Brooks 2010; Kessler & Harcourt 2010; Avila et al. 2015; Schleimer et al. 2015; Sitar et al. 2016).

The number of boats or people with an animal or group of animals was set to a fixed number in most count restrictions. These measures were spatially confined to the variable location of a roaming animal or group and ignore the complexity of both complying and enforcing a regulation at the whim of a wild animal. A maximum allowable number is set for tour boats near dolphins (Constantine et al. 2004; Allen et al. 2007; Matsuda et al. 2011; Visser et al. 2011; Steckenreuter et al. 2012a; Sitar et al. 2016), whales (Arnold & Birtles 1999; Williams & Ashe 2007; Kessler & Harcourt 2010, 2013; Chion et al. 2013; Avila et al. 2015), and whale

sharks (Quiros 2007), but not rays. Instead, stingray feeding in the Cayman Islands and for manta ray viewing sites in the Maldives and Hawai‘i (Brooks 2010; Knecht 2015) apply to a static zone where tours take place. It isn’t clear in the literature why regulations specify the area around the actual animal or group of animals for dolphins, whales, and whale sharks but not rays, though it could be in part that stingrays are not as wide-ranging (Le Port et al. 2008; Branco-Nunes et al. 2016) and both stingrays and mantas aggregate at spatially restricted artificial feeding sites (Newsome et al. 2004; Semeniuk et al. 2009; Clark 2010). This is not uniquely true of nor is it exclusive to rays. MWT is successful because of the spatial reliability of its target wildlife like whale sharks at Ningaloo Reef and spinner dolphins in Hawai‘i, though the habitat range may vary from a small bay to several nautical miles.

Limiting tours through an established spatial zone was the fourth top-ranked measure category in the review. These managed areas have multiple benefits of reducing crowding, as discussed previously, and also focusing protections around critical habitat. Hawaiian spinner dolphins, for example, resting in sandy-bottom bays along the Kona coastline would benefit from time-area closures during peak resting hours to reduce impacts of dolphin-centric activities (Tyne et al. 2015; Heenehan et al. 2015, 2017). Creation of marine managed areas in Brazil similarly reduced boating impacts on resident dolphins (Tosi & Ferreira 2009). Newsome et al. (2004) noted that once stingray tourism was confined to a designated area, conflicts with recreational and commercial fishers decreased. Tourism is similarly regulated at Australian grey nurse shark aggregations where populations are more vulnerable (Department of the Environment 2014). When a species’ habitat is protected, this reduces the risk of disturbance and possibly driving the species elsewhere (Smith et al. 2010; Clark 2010; Couturier et al. 2014). These managed areas have the essential benefits of conveying environmental protections beyond the target species (Hooker & Gerber 2004), reducing user conflicts (Papageorgiou 2016), and ultimately implementing an ecosystem approach.

Do No Harm

Effective management is defined by its ability to achieve its goals and objectives, and the goals of many MWT sites include protections for the target species. Measures like limiting the number of boats have the benefit of reducing impacts, but they are insufficient for this purpose. The first objective is always compliance to the measure; i.e., was the number of boats reduced? The impacts to wildlife are secondary and are not always evaluated. It is therefore important to include measures that directly benefit the wellbeing of wildlife and habitats. These most commonly take the form of *no touching*, as evaluated in 75% of the measures of *do no harm*, but also include protections from riding, harassing, and killing. Such regulations received overwhelming support from tour participants in Tonga whale-watches (Kessler & Harcourt 2010) and Australia dolphin swims (O’Neill et al. 2004). It was ranked as the most important measure by shark tour providers globally (Richards et al. 2015) and prioritized by ray tour providers in Australia (Ward-Paige et al.

2013). In every study that evaluated the measure by compliance, the level exceeded 80% (Davis et al. 1997; Quiros 2007; Kessler & Harcourt 2010; Sitar et al. 2016). Furthermore, Whitt and Read (2006) found that dolphin-watching operators failed to recognize potential disturbance behaviors and end their encounter with a group 100% of the time. Without proper training, it is ineffective to rely on industry staff to intervene on behalf of wildlife. The immediate benefit and simplicity of *Do no harm* measures and the high levels of compliance support this category as the fifth most effective, and indicate the high value for such policies in MWT.

Harm is controversial at feeding tours within the realm of MWT. As the least-effective measures in this study, *regulated feeding* struggles to manage potential harm to wildlife and tour participants. Five studies included measures that prohibited feeding completely (Samuels & Bejder 2004; Donaldson et al. 2010; Pinto de Sá Alves et al. 2013; Richards et al. 2015). Measures were implemented to reduce aggression from provisioned dolphins (Samuels & Bejder 2004; Smith et al. 2008), sharks (Richards et al. 2015), and stingrays (Newsome et al. 2004). French Polynesia shark dives allow hand-feeding, but this has led to sharks biting divers' hands (Clua & Torrente 2015). Provisioned stingrays in the Cayman Islands had significantly different fatty acid profiles compared to non-provisioned populations elsewhere (Semeniuk et al. 2007). Schleimer et al. (2015) observed that fed whale sharks in the Philippines displayed less avoidance behavior to touches or boat contact, exposing the sharks to injury. This may have also altered migratory habits, as some whale sharks were observed for increasingly longer periods (Araujo et al. 2014; Thomson et al. 2017). In a global review of provisioning sharks and rays, Brena et al. concluded that most impacts appeared to be either neutral or detrimental (2015).

Regulated feeding should be carefully considered before deciding to authorize it. In ecosystem-based management, economic benefit and visitor satisfaction carry value for evaluating efficacy. Feeding tours create reliable wildlife viewing opportunities, especially helpful to attract visitors to remote and logistically challenging locations (Green & Higginbottom 2000). Given that MWT participants are primarily driven by a desire to encounter wildlife (Davis et al. 1997; Ziegler et al. 2012; Filby et al. 2015; Pratt & Suntikul 2016; Hani et al. 2019), provisioning uses food to attract wildlife and increase visitor satisfaction. The net benefits of visitor satisfaction and economic opportunity at feeding versus no-feeding sites is not evaluated, however, and is disputed as unclear (Ziegler et al. 2019). Two-thirds of the literature in this review evaluated regulated feeding negatively. Without further research, feeding programs should not be recommended for MWT.

Additional Considerations

While other measure categories were less frequent or scored lower in this efficacy calculation, there are valuable lessons to be highlighted from the literature. *Limit the conduct of boats* was the third-lowest scoring category due to the mixed evaluations. Only one study documented satisfactory levels of compliance

(>80%) for permissible boat activity (Kessler & Harcourt 2013). Restrictions against approaching calves and mothers, approaching animals head-on, and chasing were disregarded on average 49% of the time (Scarpaci et al. 2003, 2004; Whitt & Read 2006; Howes et al. 2012; Kessler & Harcourt 2013; Filby et al. 2015; Sitar et al. 2016). On the other hand, the other conduct category, *limit the conduct of participants in-water,* had one of the highest average scores and ranked 6th in efficacy. All but one evaluation was positive, generally observing that participants adhere to the measure or wildlife avoidance behaviors lessened (Birtles et al. 2001; Kessler & Harcourt 2010; Smith et al. 2010; Lynam 2012; Garrud 2016). These policies all advocate for passive swim behavior with no diving, splashing, rapid movements, or attempts to block an animals' path and are likely suitable to most water-based MWT experiences. *Limit boating speed* was evaluated in the literature either by compliance or by impacts to wildlife. There was ample evidence that boat speed correlated positively with animal avoidance behaviors (Blane & Jaakson 1994; Jensen et al. 2009; Tseng et al. 2011; Chion et al. 2013; Houghton et al. 2013) and two studies showed that when vessels complied with speed limits, there was no significant impact to whales (Stamation et al. 2007) and dolphins (Tosi & Ferreira 2009). Compliance was on average 67%. Speeds, when specified, were 2 – 5 knots or "slow no-wake".

Limiting proximity to target wildlife for participants and for boats relate to the spatial and conduct categories. Many studies document the relationship between tour distance and impacts to target wildlife. Dolphins exhibited significant increases in avoidance behaviors when boats came within 50 m in Brazil (Tosi & Ferreira 2009) and Taiwan (Tseng et al. 2011), and mantas were more likely to cease feeding or leave an area when swimmers came within 3 m (Atkins 2011; Lynam 2012; Garrud 2016). Three studies positively evaluated a limit of 90 - 100 m when approaching whales (Stamation et al. 2007, 2010; Kessler & Harcourt 2013). Similar to boat count limits around wildlife, compliance with proximity measures was about 50%. One likely layer of complexity for tour boat operators is the contradictory objectives of getting their guests a close encounter with target wildlife while also minimizing their impacts. 93.1% of participants in Mexico whale shark tours listed proximity as their most important motivation for joining the tour (Ziegler et al. 2012), which was also ranked as one of the most important aspects of the MWT experience by tourists in Australia (Catlin & Jones 2010). Given the evidence that proximity can increase avoidance behaviors in target wildlife, there should be an effort to reconcile visitor satisfaction with minimal impacts.

Tour activities are further regulated through *limiting equipment* and *prohibiting SCUBA* at MWT sites. The most common measure in these categories was a ban on flash photography, which is implemented on whale tours at the Great Barrier Reef (Arnold & Birtles 1999; Birtles et al. 2002) and Tonga (Kessler & Harcourt 2010) with marginal support on both counts and both studies noting that flashes triggered reactions from the whales. The measure is similarly in place at whale shark tours in Donsol, Philippines where 99% of observed tours complied (Quiros 2007). Restrictions against flashes are relatively enforceable; they're either a

large part of a camera setup or "flashy" by nature and easy to recognize and correct. The other most common type of equipment measure involved a flotational device for in-water participants, described for dolphin tours and whale tours. These floating lines function to corral participants so they are easier for guides to manage, provide a safe handhold, and reduce the urge to disturb wildlife by touching or swimming near them (Arnold & Birtles 1999; Birtles et al. 2002; O'Neill et al. 2004; Scarpaci et al. 2004). Bans on SCUBA were proposed in response to a perceived impact on wildlife (Brooks 2010; Rodger et al. 2010; Garrud 2016), but when industry and participants were consulted on various measures for whale tours in Australia, it was given one of the lowest scores in the survey (Birtles et al. 2002). In Mozambique, a ban would be problematic as SCUBA was listed as the most popular activity for tourists visiting the province (Venables et al. 2016). There are few evaluations on the efficacy of SCUBA bans. More research is needed to determine if they are effective at achieving management goals and whether the potential loss of business and revenue is sustainable.

Measures that address crowding can work synergistically to achieve target numbers and/or decrease wildlife disturbances, though the selected measures must be carefully designed so as to ensure effective levels of compliance. Time is a potentially useful means of regulating tours. It should be noted that both temporal measures, *limit time by allowable access periods* and *limit time by tour duration,* were among the lowest-scoring categories in this study. Tour duration measures were primarily evaluated using compliance. When the duration for time spent with a particular dolphin group were set to 30 minutes, compliance was as high as 87% in Port Stephens, Australia and 100% compliance in Florida (Whitt & Read 2006; Allen et al. 2007). However, this same 30-minute threshold had less than 50% compliance in Colombia's whale-watching tours (Avila et al. 2015). In Port Phillips Bay, Australia, dolphin tours were restricted to no more than 20 minutes and this period was exceeded by 61% of tours in one study (Scarpaci et al. 2003) and by 58% of tours in a follow-up (Scarpaci et al. 2004). Over the course of 2.5 years, Haskell et al. (2015) demonstrated that there was no significant correlation between the duration of a swim and the probability of disturbing whale sharks in Mozambique, further challenging the efficacy of such measures based on the impact metric. Limiting tour duration and boat counts in Bay of Islands, New Zealand forced tours to stagger their interactions with the dolphins and exposed them to a longer overall period of disturbance (Constantine et al. 2004). Thus, temporal measures were shown to have low levels of compliance and unintended negative impacts to wildlife, two signs of an ineffective measure.

Instead of limiting tours by duration, some MWT sites implemented restrictions on designated time periods for access. But even these measures were evaluated negatively in Kaikoura and Hauraki Gulf, New Zealand where there was no significant reduction in the number of interactions during the rest period, i.e., compliance was low (Duprey et al. 2008; Stockin et al. 2008). With enforcement and education, temporal area closures can protect wildlife during essential feeding or resting periods and reduce MWT impacts, an ongoing

effort in Port Stephens and Ningaloo, the Azores, Hawai‘i, and in New Zealand (Allen et al. 2007; Mau 2008; Duprey et al. 2008; Stockin et al. 2008; Visser et al. 2011; Steckenreuter et al. 2012b; Tyne et al. 2015; Heenehan et al. 2015). There is otherwise little to be recommended from the literature on temporal measures.

Limited permits can reduce the pressure of many companies attempting to comply with temporal and boat count limits by reducing the overall number of operators. Permitting is evaluated for its ability to manage visitor numbers and increase the quality of tours. In Australia, an original fifteen permits for whale shark tours were issued in 1993 (Catlin & Jones 2010). Permits were good for a period of one year, but the cost of investment and equipment were prohibitively high-risk to small tour providers. The industry advocated for an increase from one to three years, and eventually permits were set at five years with an opportunity to extend another five with good behavior (Davis et al. 1997; Catlin & Jones 2010). Mexico’s Banderas Bay requires a permit to approach whales within 240 m and the number of licenses are effective in limiting concurrent permitted tours (Avila-Foucat et al. 2013). However, the efficacy of permits in Banderas was undermined by low levels of compliance, notably due to a lack of enforcement and unlicensed boats conducting whale-watching tours (2013). Elsewhere in the Yucatan Peninsula, the government issued unrestricted numbers of permits and smaller companies were outcompeted by the larger companies with multiple revenue streams (Ziegler et al. 2012). Permitting is a useful tool on paper and the effect of limiting crowding has documented benefits for wildlife and their habitats, but implementing a permit program is rife with potential conflicts.

Financing & Enforcing Management

Throughout the review, low compliance was largely attributed to a lack of enforcement. Lawrence et al. noted in their assessment of shark and ray tourism that "in locations where enforcement is weak, marine sites can become overcrowded, safety standards compromised and target populations and their habitats repeatedly disturbed or harmed” (2016 p. 30). When implemented, enforcement quickly identified numerous violations in Florida dolphin tours (Samuels & Bejder 2004) and onboard inspections by maritime police increased compliance among whale-watch tours in the Azores (Bentz et al. 2013). Manta ray tours in Mexico implemented a policy that allowed the government to deny a company’s permit for non-compliance (Lawrence et al. 2016), and daily tours in the Maldives reduced abuse of their permitting system (Manta Trust et al. 2016). A well-implemented enforcement program has the power to legitimize management efforts and reward compliance from within the industry. It should not be used, however, as the only tool for creating effective regulations.

The Maldives MWT site has the benefit of government support and a *visitor permit fee* to fund enforcement, but elsewhere limited resources impair enforcement. Shark tours in South Africa went largely unenforced for the simple reason that fuel and maintenance costs for their boat limited their patrols (Dobson 2006). Panama’s government was urged to enforce regulations by the International Whaling Commission, yet

the agency charged with management proves ineffectual at deterring violations (Sitar et al. 2016). Management programs must prioritize enforcement, and without resources or funding, these efforts inevitably fall short. When governments cannot provide adequate support for patrols, fee collections are a proven means to sustain management priorities. At Australia's Ningaloo whale shark tours, operators pay a fixed deposit annually to support monitoring and management costs (Catlin et al. 2012). This sum, $750 in the late 1990's, is drawn down by a fixed amount for every passenger escorted that year (Davis et al. 1997). By paying the deposit up front, operators are funding the management program at the start of the season. Operators know the maximum amount they will pay in fees, and those who do less business are refunded the difference. This arrangement presents a sophisticated solution to many of the uncertainties around funding a management program. MWT permits are sold to tourists to generate conservation funding in the Maldives (Lawrence et al. 2016) and in Belize (Cohun 2005). Shark diving companies in Fiji pay a fee per dive to the local community with traditional rights to the reef, and in return these communities steward their natural resource and are direct beneficiaries of developing tourism (Brunnschweiler 2010; Lawrence et al. 2016). The operators also fund rangers and provide free trainings and dive master certifications (2010). These funds benefit conservation priorities and local economies, funding enforcement to prevent overexploitation of natural resources and providing professional opportunity.

Enforcement and fee collection are top-down approaches to management, both scoring lower efficacy values than the former's counterpart: *self-enforcement*. Codes of conduct and guidelines can mobilize local stakeholders to take ownership of their MWT. They were the second most common type evaluated in this review. Effective self-regulation in tourism works under the assumption that all parties agree on the long-term and short-term benefits. Williams and Montanari (1999) identify three benefits that make a case for self-regulation: (1) to maintain independence and a free market, (2) to reduce the burden on limited state resources, and (3) to avoid state-control and negative perceptions associated with it. Each of these helps ease conflicts and improve stakeholder engagement, which is critical to successfully integrate social metrics and impacts consistent with an EBM approach. In fact, codes of conduct are an excellent starting point for formulating a management program and scoping the complexity of MWT. At Koh Tao in Thailand, a fully integrated community voluntary management program filled gaps and deficiencies in the top-down approach of the regulatory authority (Wongthong & Harvey 2014). For Kaikoura's dolphin tours, companies created voluntary guidelines that stood in for official regulations during the long process of rulemaking (Duprey et al. 2008). Companies conducting shark tours in South Africa created a code of conduct and held one another accountable, reporting violations and successfully ousting one repeat offender (Dobson 2006).

Duprey et al. (2008) noted that companies were not incentivized to adhere to guidelines without proper external pressures, such as those from their peers and the public. Compliance with codes of conduct

were low (Whitt & Read 2006; Wiley et al. 2008; Avila et al. 2015; Gallagher et al. 2015), but the commitments from operators are an excellent step towards an inclusive management program. Planning must be inclusive and facilitated fairly, or conflicts between stakeholders can weaken the integrity of an agreement. In South Africa, this inter-operator conflict arose when operators accused one another of inserting regulations that were self-serving or that targeted rival operators (Dobson 2006). With low compliance, the code of conduct is recommended to accustom operators to regulation and also provide them with a role in developing and implementing the management program. Enforcement does not necessarily need to come from government officers, but it should be implemented with integrated rewards and consequences to hold members accountable.

Developing a Management Program

Measures that reduce impacts while maintaining a level of satisfaction among ocean users are key to sustainable and effective management (Orams 1999). The MWT evaluation literature primarily made their conclusions based on three dimensions: (1) tourist sentiment, (2) industry compliance, and (3) wildlife impacts. No single evaluation of a measure's efficacy included a comprehensive review of these three dimensions, though they appeared separately in this review many times. Just as these three factors should be considered when evaluating a measure for efficacy, Higham et al. (2008) found that the key to an integrated, dynamic and adaptive management is inclusion of commercial tour operators, management agencies, and scientific researchers. Similarly, Trave et al. (2017) emphasized an adaptive management framework that would integrate ecological and biological research, monitoring and evaluation of regulations, visitor education, and stakeholder engagement.

The need to develop a management program frequently arises from unrestrained growth of an MWT site (Hawkins & Roberts 1994; Semeniuk et al. 2009; Catlin & Jones 2010; Gil et al. 2015). More tourists beget more companies and more development, which in turn increases the demands on and threatens the social and environmental systems supporting the industry. The arguably consumptive aspects of tourism conform with common-pool resource theory (Ostrom et al. 1999; Moore & Rodger 2010; Heenehan et al. 2015; Higham et al. 2016). Common-pool resources (CPRs), as described by Ostrom, are depletable and subject to appropriation and exclusion (1994). Hardin's highly influential (and controversial) conclusions in *The Tragedy of the Commons* were that CPRs would be driven to overexploitation by the inherit self-interest of human beings, justifying the strictest form of government regulation and advocating for population control (1968). His conclusions can be scaled down to tourism sites undergoing rapid expansion where conduct and access need limits. A similar argument is made in self-enforcement literature, that companies and tourists fail to do right by their resource without top-down regulations to compel them. The challenge for regulators is implementing a fair and effective program, and a top-down approach is often insufficient and, in some cases, detrimental

(Ostrom et al. 1999; Heenehan et al. 2015). Hardin fails to acknowledge the importance of a bottom-up approach that is resoundingly prescribed in present day reforms (Ostrom et al. 1999; Oracion et al. 2005; Spiteri & Nepalz 2006; Choi & Sirakaya 2006; Tissot et al. 2009; Eriksson et al. 2019). Ostrom et al. (1999) recommended a collaborative and decentralized form of resource management that would include stakeholders and external authorities in the decision-making process. This conclusion is fundamental to MWT management planning.

The proposed management program at the Kona manta viewing sites is an amalgamation of existing codes of conduct, state agency priorities, and social science research (MPRF n.d.; Marine Science Consulting, LLC. 2015; Hawai'i Ocean Watch 2016; DLNR 2018). There is an opportunity for regulations to incorporate MWT research as the final rule amendment to HAR §13-256 is in draft form. The results from this analysis present a review of peer-reviewed and grey literature evaluating the efficacy of MWT management measures around the world. While the present draft HAR §13-256 represents integration of bottom-up policies and stakeholder support, it can be improved from perspectives outside of the Kona manta sites as well.

While ray tourism (US$140 million in 2012; O'Malley et al. 2013) is relatively less popular than cetacean tourism (over US$2 billion in 2009; Syneca Consulting Pty Ltd 2009) or shark tourism (over US$314 million in 2010; Cisneros-Montemayor et al. 2013), it has the potential to develop into a larger industry, particularly if the Kona manta sites are seen as a model globally for artificially illuminated foraging areas that concentrate mantas into accessible and predictable feeding aggregations. At present, there is no site quite like the Kona manta sites. Similar MWT like those with cetaceans and elasmobranchs are the best comparisons for developing effective regulatory measures in Kona. Where examples of mobula tourism around feeding sites is limited, there are many cases with shared management priorities to inform development and implementation.

1.5 Conclusion

MWT is an underregulated industry with demonstrated impacts to wildlife. The efficacy literature on MWT management evaluated these regulations using one of three metrics: impacts, compliance, and perception. By examining the effectiveness of a measure, management programs can implement an adaptive approach that is critical in a changing system. Tourism is a growing sector and ecosystems struggle to keep pace with global climate change. Not only are wildlife and their habitats put under strain by the industry, but local communities and economies must be vigilant in advocating for their best interests as sites develop. This is particularly true where local resource extraction conflicts with tourism, where foreign business interests outcompete local entrepreneurs, and where communities shift to represent a service industry largely dedicated to providing for tourists and not the community.

Within this context, the EBM framework becomes essential. Human society is taken to be part of the larger ecosystem, and evaluating the efficacy of management practices involves environmental and social dimensions. The review of MWT efficacy literature revealed a process where researchers and managers look at one or two metrics for evaluating management. This study has demonstrated the need for a holistic approach to evaluating efficacy. Managers are urged to adopt this three-pronged approach to monitoring their management programs. Managing impacts to wildlife and communities, measuring compliance by tour providers and participants, and gathering feedback and perceptions from all stakeholders are each necessary a component of adaptive EBM.

For those management programs still in the early phases of development, like the Kona manta sites, there is value in the methodological review of existing measures. This study highlighted the importance of an education program, as it is highly valued by surveyed participants, improves compliance, and reduces impacts to wildlife and their habitats when people understand the basis for regulations. There was ample evidence in the literature that crowding measures are among the most prevalent and most effective approaches to management, though there are scenarios where crowding control may create more conflict than it solves. This is especially true where enforcement is lacking, and enforcement similarly emerged as one of the most important aspects of effective management. Enforcement is not strictly limited to officials issuing citations, but should be expanded to include a code of conduct, an empowered community that self-polices for a shared interest in the ecosystem.

These measures, whether in the form of laws, permit conditions, or guidelines, provide structure and limitations that are essential to a growing industry. In a survey of dolphin MWT in Australia, the majority of participants admitted that their behavior would have been different had they been on an unmanaged tour, and that they would have attempted to chase or touch wildlife (O'Neill et al. 2004). Regulation is an important tool for prioritizing the health of an ecosystem, which must include both environmental and human dimensions. Reconciling the oftentimes conflicting interests of industry, environment, and local people is a major obstacle for management. The best solution is to implement an inclusive and thorough program using the EBM framework, and to ensure that evaluations are as holistic as the EBM management planning process. The systematic review of MWT efficacy literature can help managers and stakeholders identify best practices among their peers. Given that nearly 25% of the measures in this review identified negative outcomes, there is much to be learned from unexpected consequences, loopholes, and other challenges. The most successful managers will look to the measures with positive outcomes and do their best to replicate them as it suits their particular MWT program.

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Chapter 2: Stakeholder Perceptions and Management Measures at the Kona Manta Viewing Sites

Abstract

The State of Hawai‘i’s natural resource agency (Department of Land and Natural Resources) is at the verge of implementing the first marine wildlife tourism rules at the Kona manta sites. This marks an important moment in the agency’s history as its Division of Boating and Ocean Recreation shifts more resources into managing coastal industries and programs in the state. The rules are based on consultations with tour operators, but can be much improved through analysis of similar marine wildlife tourism measures evaluated around the world, and from the perceptions and experiences of stakeholders both in and outside of the industry. This chapter uses the efficacy ranking and literature review of Chapter 1 to examine the concerns and suggestions that emerge from 36 interviews. Participants were supportive of regulations, though significant conflicts between companies and the resource agency reduced all stakeholders’ confidence in the management program. Including these diverse stakeholders in decision-making and enforcement will improve compliance, perceptions, and its capacity to reduce environmental impacts.

2.1 Introduction

Detailed in the beginning of this thesis, Kona manta ray viewing is a complex and hugely popular industry for Hawai‘i tourism. Its growth spurred the state to action when the 2014 House of Representatives unanimously passed HCR 170. DLNR was urged to adopt rules to manage the Kona manta ray dive sites and address concerns for safety and the environment (Lowen & Nishimoto 2014). But attempts to manage the sites began long before that. The Kona manta sites have been largely developed and managed through industry cooperation, and the sense of ownership at these sites is high. Back in the early 1990’s when there were no more than five boats, these companies got together and developed what they refer to as a “gentlemen’s agreement.” The industry continued to grow at a steady linear rate between 1985 – 2009 (R^2=0.97) but the popularity of the tours increased dramatically around 2010 (**FIG. 13**). This dramatic rise coincided with more snorkeling tours and an increased supply of permits that are required by the State to offer commercial tours. As the number of companies increased, methods to conduct the tours began to fracture. For the second time, operators gathered to agree on a code of conduct, which would standardize practices and improve the industry. The US Coast Guard and DOBOR hosted an initial meeting to encourage operators to form a working group (DOBOR pers. comm. Oct. 2018). Thirty-six participants representing 21 companies gathered at a series of

workshops and developed a first draft for industry standards and guidelines. The standards were then voted on by company owners and those with majority support were made into the Manta Tour Operator Standards for possible state rulemaking in the future. Unfortunately, the threshold for support was set at the minimum 51% for a majority, exposing the code of conduct to considerable discontent. Without the rule of law, companies were under no obligation to comply and the Operator Standards further segmented the industry.

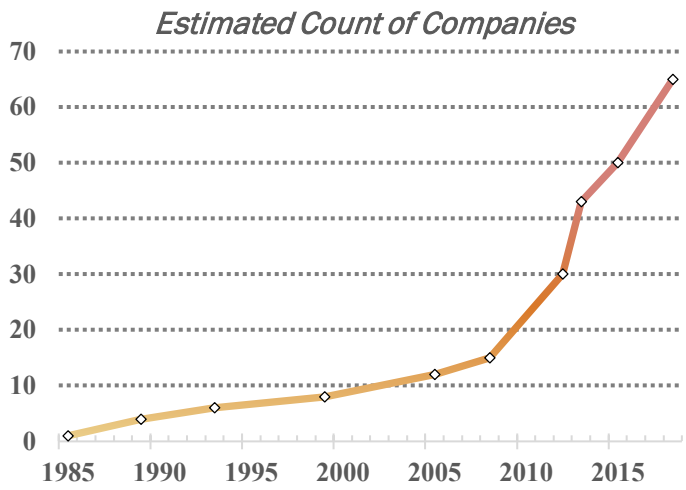

Figure 13. Estimated counts of companies offering manta tours. Numbers estimated from participant interviews, Marine Consulting Ltd., and DLNR-DOBOR commercial permit records.

The challenges the manta industry faced in Kona were similar to those elsewhere at marine wildlife tourism (MWT) sites. At New Zealand's dolphin tours in Kaikoura, only one of three companies consistently adhered to the code of conduct negotiated amongst licensed operators (Duprey et al. 2008). Whale-watching guidelines were seldom followed in Bahia Malaga, Colombia (Avila et al. 2015) and Stellwagen Banks National Marine Sanctuary, Massachusetts (Wiley et al. 2008), just as dolphin tour guidelines had low levels of compliance at Port Phillips, Australia (Howes et al. 2012) and Clearwater, Florida (Whitt & Read 2006). Garrod and Fennell conducted a review of more than 50 codes of conduct around cetacean tourism and concluded that for peer pressure to drive compliance, it requires a thorough understanding of the reasoning behind the measures (2004). As discussed in Chapter 1, a code of conduct can reinforce legally-mandated regulations as a testing ground for developing rules, engage stakeholders in the management process, and fill in gaps of slow rulemaking processes and enforcement (Arnold & Birtles 1999; Garrod & Fennell 2004; Dobson 2006; Njonjo 2007; Duprey et al. 2008; Wongthong & Harvey 2014). However, this requires substantial industry buy-in and a presumption that operators are motivated by ethical and moral reasoning to self-enforce.

When motivating a group to comply with a social compact, especially an industry with a bottom line, money is a powerful driver. Eco-certification programs can be government-run like the NOAA Blue Star charter in the Florida Keys National Marine Sanctuary (Roche et al. 2016) or the Green Fins certification through the UNEP, which promoted compliance with environmental best practices in the Philippines and significantly reduced diver-related impacts to corals (Camp & Fraser 2012; Hunt et al. 2013; Roche et al. 2016). The basis for eco-certification is to celebrate companies with an environmental mission, and to drive

more business towards those companies. The Dolphin SMART guidelines developed for US dolphin tours held operators to a combination of federally-mandated regulations and guidelines, yet had a lackluster implementation among companies (Goss 2013; Jaspers 2014). In interviews, dolphin tour providers complained that there wasn't sufficient advertising to the public to create a demand for their brand of tours. Empirical studies of consumer choice between "eco-labeled" tourism services found that the certifications had little economic benefit (Rivera 2002; Karlsson & Dolnicar 2016) and that the proliferation of such programs created distrust among consumers (Font 2002). A group of people directly involved in the Kona manta industry incorporated a nonprofit organization, Hawai'i Ocean Watch, to offer an eco-certification called the Green List (Hawai'i Ocean Watch 2016). Operators following the code of conduct were added to this list so that conscientious customers could make an informed choice between tours. The nonprofit attempted to collect a "Nature Fee" that went towards overhead costs of maintaining the list on a website, supplementing the effort with free public education and resources, and offering trainings for captains and crew (Hawai'i Ocean Watch 2017), but industry satisfaction with the effort decreased over time. As of January 2020, only four companies maintained the eco-certification out of at least 57 permitted tour providers. Similar to the code of conduct, only a handful of companies agreed with the intentions of the Green List.

The challenge for DOBOR is to manage a diversity of tour practices while protecting the marine resources. Their first attempt at management was to empower the industry to self-regulate, but compliance fell short and dissatisfied operators and community members asked the state legislature to compel the agency to intervene. Given the low success of codes of conduct in MWT elsewhere absent some level of government reinforcement, the outcome should not be surprising. Beneath the façade of industry self-regulation, the exercise ended up providing the state with justification to assume control. The shortcomings of self-regulation created yet another point of division within the industry (those who comply voluntarily and those who do not), diminished authority among operators to set rules, and increased government oversight.

This is best contextualized using the Ladder of Citizen Participation, which presents a hierarchy of citizens' power from its highest levels to the lowest (Arnstein 1969; **FIG. 14**). DLNR's process of engaging manta tourism stakeholders has slipped from citizen control, to placation, and finally to consultation. Initially, companies worked internally to standardize best practices between 1993 - 2013. There are some guidelines that the industry has field tested for decades, which the state incorporated into official rules under the advisement of a second working group in 2015. The code of conduct served as the foundations of the state's present draft update to HAR §13-256 (**FIG. 15**). At this point in the engagement process, citizen participation was limited to written comments and public meetings as the industry was demoted to an advisory role.

The MWT efficacy literature demonstrated that co-production yielded higher compliance with codes of conduct (Whaley et al. 2008; Techera & Klein 2013; Smith et al. 2014; Lawrence et al. 2016). Unlike self-

regulation at the Kona manta sites, local-scale management efforts rooted in *Partnership* had high levels of self-enforcement in Indonesia's manta ray tourism industry (Stewart et al. 2016). This bottom-up approach is the same that is championed in resource management, most notably in Elinor Ostrom's work on common pool resources (CPRs) (Ostrom et al. 1999; see also Chapter 1 section 3.6). There are similarities between CPRs and tourism that validate Ostrom's theories as a solid foundation for developing sustainable MWT (Heenehan et al. 2015). Co-production then is an empirically-proven tool to improve both perceptions and compliance around regulations, two of three metrics for efficacy that emerged in Chapter 1.

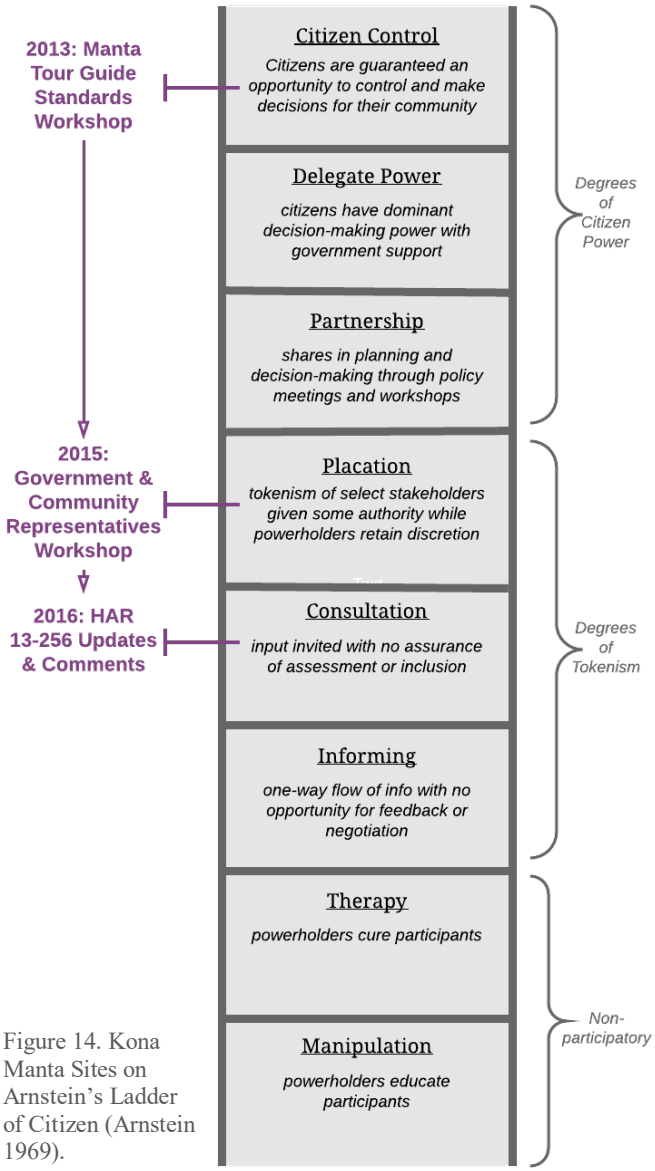

Figure 14. Kona Manta Sites on Arnstein's Ladder of Citizen (Arnstein 1969).

Public engagement represented only a limited sample of industry actors at the Kona manta sites. This shortcoming is seen in many fisheries co-management efforts, which generally follow the *Partnership* model but may not represent the full range of stakeholders impacted by regulations (Arnstein 1969; Jentoft 2000; Nunan et al. 2015). In East Africa and Malawi, boat crew, fish sellers, and other non-company owners were largely excluded from co-management committees (Nunan et al. 2015). There is broader public interest in fisheries management as well, as the industry plays in important role in local, regional, and national economies (Jentoft 2000). During the 2013 Manta Tour Operator workshops, those without a commercial permit (e.g. captains, guides, videographers) were not given a vote. Non-industry community members were excluded entirely from the working group until 2015 when they were invited to public meetings and to submit comments (*Consultation;* Arnstein 1969). These underrepresented community groups are also affected by the industry, whose unrestrained growth has increased visitor pressures at the sites, developed economic opportunities for local markets, and impacted nearshore marine resources.

WEST HAWAII OCEAN RECREATION MANAGEMENT AREA
Manta Viewing Sites Proposed Rule Changes

Since 2014, the Division of Boating and Ocean Recreation (DOBOR) has held three community meetings to address concerns relating to rising popularity of manta ray night viewing on the Kona coast. DOBOR is considering new ocean recreation management area (ORMA) regulations (HAR §13-256) specific to Makako Bay (Garden Eel Cove) and the nearshore waters fronting Kaukalaelae Point (commonly known as Keauhou Bay). DOBOR proposes the following changes:

- Prohibit anchoring inside site boundaries *at all times*
- Require a permit for commercial manta activities
- Limit live boating to ingress, egress, and emergencies
- Prohibit subsurface vessel lighting
- Require 360° white light on non-motorized vessels
- Confine manta activities to designated *campfire* areas
- Prohibit commercial SCUBA tours within Kaukalaelae
- Moorings will be first come, first served
- There will be a 2.5 hour time limit per use
- The participant to guide ratio may not exceed 10:1
- There will be no fishing allowed during manta viewing hours (nightly 4:00 pm - 4:00 am)
- Vessels are prohibited from leaving the zone while passengers are still in the water

MOORING DESIGNATION

West Hawaii ORMA commercial permit holders would have use of moorings during manta viewing hours every night, with one buoy reserved for non-commercial use. Outside of this time frame, all users would have access to these moorings and conduct themselves in accordance with HAR §13-256.

MOORING INSTALLATION + MAINTENANCE

A total of 13 day mooring buoys (DMBs) would be installed at each of the two sites in the first year. In subsequent years, annual maintenance and repair would be conducted to ensure the integrity of the moorings.

MANTA PERMITS

Only one commercial permit would be issued per company associated with one HA number. The permit applicant must produce records that show continuous manta tours (≥ one tour weekly) since June 2015 to be eligible. Permits would be specific to one site only. Recreational users would not be required to obtain a special permit.

WEST HAWAII ORMA FEE

Commercial operators would pay $200 per month for an annual manta tour permit. 51 companies have expressed interest in applying for an initial permit at one of the two sites. The annual manta tour permit fee would go to the following recurring costs:

- Maintenance and repair
- Manta observer program
- Supplemental enforcement
- Education + outreach
- Administrative

NEXT STEPS: The formal rule-making process is underway. There will be public hearings (est. Early 2019).

To receive updates on the Manta Viewing Sites, email DLNR.BD.DMB@hawaii.gov with subject: subscribe

Figure 15. DLNR-DOBOR Public Handout 2018. Document distributed by DLNR-DOBOR to introduce the basic components of the upcoming rule amendments to HAR §13-256

In this chapter, I address the gaps in the engagement process by targeting both industry and non-industry community members in stakeholder interviews. The process of gathering community feedback and checking perceptions is an important part of establishing a pre-management baseline and evaluating the efficacy of regulations in the future. Members of the public can identify gaps in impact research, speculate on compliance, and generally clarify management targets. These interviews highlight the diversity of perceptions concerning the state process, the Kona manta viewing industry, and the proposed management program. There are deficiencies in all three areas that can be remedied before regulations are institutionalized under HAR §13-256. Recommendations are discussed with reference to the MWT efficacy ranking from Chapter 1 and provided for the purpose of immediately benefiting the Kona manta regulations, but also to demonstrate the value of public opinion for resource management

2.2 Methods

Study Location

Manta ray viewing tours are conducted on the Kona coast of West Hawai‘i Island. Hawai‘i county has seen a population increase of about 20% since 1990, but Kona has grown by 75% in that same time (DBEDT 2018). Kona is split into two districts along West Hawai‘i: North Kona and South Kona, measuring approximately 490 mi^2 and 335 mi^2, respectively (**FIG. 16**). The communities linked to the Kona manta sites at Makako and Keauhou Bays extend beyond the district boundaries, but the study's focus was geographically centered around these two sites.

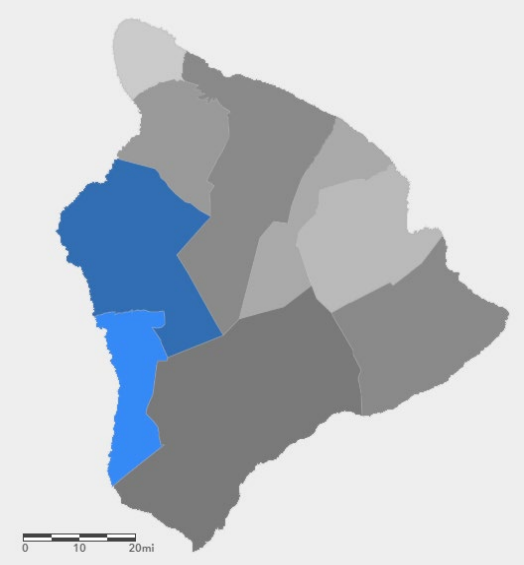

Figure 16. North Kona (dark blue) and South Kona (light blue) districts in Hawai‘i County on Hawai‘i Island.

Interview Recruitment

Interviewees were recruited for semi-structured interviews using a snowball methodology and purposive recruitment to ensure individuals with specific attributes were represented (Wiener et al. 2009). Commercial manta tourism companies and their staff, affiliated businesses, community organizations, nonprofits, researchers, and educational institutions were among those invited to participate. All invitees were encouraged to refer potential participants for the study. Flyers were posted at Honokōhau and Keauhou harbors and dive shops in Kona, and an electronic flyer was distributed via email. Invitees were informed that the purpose of the interview was to learn how those with connections to the Kona manta ray sites perceive various marine tourism management strategies and how useful they would be for management goals.

Semi-structured Interviews

The interviews were voluntary and participants could stop or skip questions at any time. Demographic data was collected on profession, age, gender, SCUBA activity, and ethnicity (Native Hawaiian). Interviews were scheduled for 45 – 60 minutes. An audio recording was made for each interview for the purpose of transcription at a later time. The semi-structured interviews were divided into three parts. The first segment began with an introduction to the study and the purpose, and then participants were asked to describe their connection to the Kona manta sites. Follow-up questions were used to draw out information like profession, relationship with others at the site, history of involvement, and connections to Makako Bay, Keauhou, or both. The second part of the interview focused on the participants' familiarity with the commercial tours at the sites and efforts to manage them. Participants were asked whether they were aware of or involved with any meetings, workshops, or other forums about the mantas or the sites. If they were familiar with the public process, they were asked to expand on any memories of these events. In the third part of the interview, the participants were presented with the DLNR-DOBOR public handout (**FIG. 15**) and given time to review it. The topics of *Mooring designation, Mooring installation and maintenance, Manta permits,* and *West Hawai'i ORMA fee* were discussed generally and then participants were invited to go through the text box of bulleted measures and discuss their efficacy. Participants were instructed to consider how the industry and communities would react to measures, compliance, and impacts to the industry and the environment when evaluating a measure. Scoring used a Likert scale from 0 – 10, with 0 defined as Very Ineffective, 5 as neutral, and 10 as Very Effective. After scores were assigned, participants were asked if they had any intention to participate in future meetings about the regulations and if they had any additional thoughts on the sites.

Interview Analysis

Survey responses on the Likert scale were assessed using a Mann-Whitney non-parametric analysis of variance (Greiner & Gregg 2011) p-value ≤ 0.05 to test whether the probability of the ranking distributions of the groups for two classes (ex. commercial vs. non-commercial) were identical (Ho). The test assumed the two ordinal samples were random and independent, and that the probability distributions from which the samples were drawn were continuous. Data analysis was carried out in Minitab® 19 (Minitab, LLC 2020) and then displayed using the graphical software Prism 8 for Windows 64-bit (GraphPad 2019).

Additional analyses of interview transcripts were conducted in the software NVivo 12 Plus (2019). Transcripts were coded into four parent topics that followed the structure of the interviews: (1) Site & participant background, (2) Upcoming regulations, (3) Current site settings, and (4) Related concerns. Comments were examined in the context of the conversation and in relation to other interviews for common observations and concerns.

2.3 Results & Discussion

Participation & Demographics

Initially, 72 participants were contacted through email to DLNR-DOBOR's West Hawai'i commercial operators contact list, researchers with published reports, dissertations and/or peer-reviewed studies at the sites, departments in marine sciences at the universities of Hawai'i at Hilo and at Manoa, and to relevant organizations in Kona that included the West Hawai'i Fisheries Council, Manta Pacific Research Foundation, and Manta Ray Advocates. An additional 35 people were referred to the study for a total of 107 invitations. 48 participants responded (44.9% response rate of direct invited sample) and of those, 37 were interviewed (34.6% of invited sample). The total number of the population that were invited to be interviewed is unknown, due to the undisclosed referrals and publicly-posted invitations. The anticipated participation level, particularly among tour company owners, was low due to the likely fatigue of being contacted and questioned about the manta tours on multiple occasions. Within the past five years, DOBOR had requested public comments on proposed regulations at least three times, held public meetings or requested comments in 2015, 2016, 2017, and 2018, and commissioned a research study on safety conditions in 2015 where all boat operators were contacted and asked about their commercial operations (Marine Science Consulting, LLC. 2015).

In a small sample of 36 participants, there is more exposure to response bias and the opinions expressed in the interviews may not be representative of the larger population. This phenomenon was furthermore reaffirmed during the interviews, as multiple participants complained that public meetings they'd attended in the past were dominated by the loudest opinions in the room. Fifty-eight per cent (58%) of those interviewed had participated in public meetings and/or submitted comments on the regulations before the present study. Also of interest, a handful of companies and their owners were named by five different participants for exhibiting bad behavior, though these individuals did not respond to requests for interviews. Those inclined to share their opinions and participate in the management planning process are more likely to support regulation in the first place. Those inclined to oppose regulations may be more strategic in choosing when to make their objections known. The interview sample thus includes people with professional and financial investments in the industry. It is therefore important to keep in mind that while the concerns and opinions in these interviews are valid, they may not fully represent the greater diversity of perceptions within the industry.

The study was also limited by the author's history at the sites and her relationship with the state agency, DOBOR. The author's employer, the Hawai'i Coral Reef Initiative, is part of the University of Hawai'i at Manoa's Social Science Research Institute and provides research and support for many state agencies and divisions, including DOBOR. Prior to the research presented in this study, the author had

provided the state with research for regulations of mooring buoys and the Kona manta sites. This role was disclosed to interview participants, who were guaranteed that their participation and opinions would remain anonymous. Due to the existing relationship between the researcher and DOBOR, and the professional requirements of a civil service position for state officials, government employees were not invited to participate. Their opinions, though valued as part of the community, would be better presented by a non-colleague to ensure an impartial and unbiased assessment.

In-person interviews were scheduled for 33 respondents, and an additional 1 interview was conducted in situ by referral and 3 interviews over the phone. Interviews were conducted on Oahu in 2018 and over three-day sessions in Kona on October 2018, January 2019, and May 2019. No developments in DOBOR's management at the sites occurred between the first and last interviews that would have impacted participant perceptions. One phone interview was discarded due to a failure of the recording software (*Call Recorder - ACR* 2018), which recorded only the caller's side of the conversation when headphones were plugged in after the call had been initiated. The audio recorder and transcription service Otter.ai (2018) was used for in-person interviews. The software failed to correctly match edited transcripts to original audio and in three cases, caused more than 50% loss of the original audio recording. These interviews were included in the qualitative analysis but excluded from the Likert scale survey portion of the analysis. Two interviews were minimally affected with no more than 33% loss of content and contained the survey portion of the interview.

The estimated number of commercial manta ray tour companies is 57, according to DOBOR commercial license records (DOBOR pers. comm., Nov. 2019). Fifteen commercial tour providers responded to an invitation to participate and ten companies (17.5% of the estimated population) were represented in the interview sample: three were represented by their owner(s) and employee(s), three were represented only by owner(s), and four were represented only by employees. The commercial tourism industry included twenty-three interviews: ten guides, nine owners, and four fringe services that included photographers, videographers, and concierge service providers (**FIG. 17**). Other participants identified themselves as researchers (6) and site users (7).

The proportions of the 36 respondents by each reported demographic are summarized in **FIGURE 17**. The interview sample was 61% male and 39% female. The ages of participants were 19% under the age of thirty-five, 36% thirty-five to fifty, and 44% over the age of 50. Twenty-eight participants (78%) identified as SCUBA-certified. Six (17%) identified as Native Hawaiian. Participants were asked if they had connections to Keauhou, Makako Bay (a.k.a. Garden Eel Cove, GEC), or both. Experiences in both sites was the most common response (21 participants, 58%). Eleven participants reported experience with Keauhou but not Makako Bay (31%), and four participants (11%) reported experience only with Makako Bay but all four had some familiarity with Keauhou and two had previously conducted tours there but no longer did so.

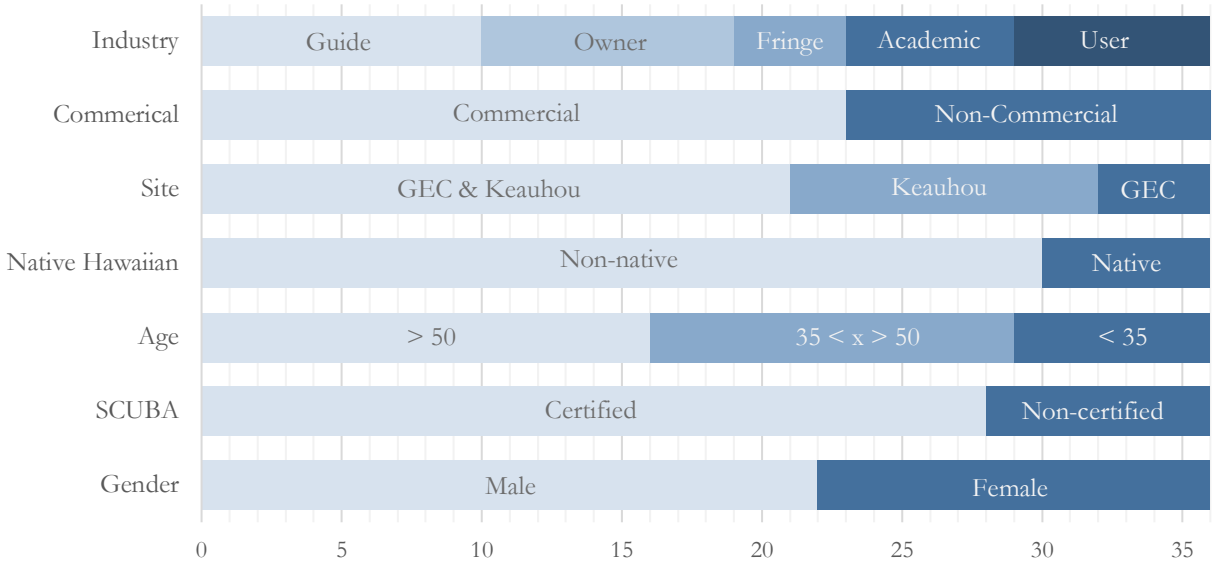

Figure 17. Interview demographics. Six types of demographic data were collected. Profession was used to determine if the participant was involved in the commercial manta tourism industry and if yes, in what capacity (guides, owners, and fringe services). Familiarity with one or both of the two sites (Site), Native Hawaiian ethnicity, approximate age, SCUBA diving experience, and gender were reported for each of the 36 participants.

During the introductory portion of the interview, participants provided background on their relationships to the sites. Most participants had been on a manta swim tour or worked in the industry. Several users had previously worked in the industry, and many industry participants had first experienced the manta sites as a tourist. The experience was described with awe and passion, and several guides emphasized that the magic of the tour hasn't changed for them even after years in the industry. One participant described it, "I love seeing the look on people's faces when they see that ginormous animal almost eat them, and then at the last minute, turn away. I love it." Two participants, both Native Hawaiian, emphasized the historical significance of Keauhou Bay:

> *"I wanted to do business down there because of the history and the love of the area. You know that that was the end of old Hawai'i and the beginning of new Hawai'i. That was where King Kamehameha III was born and revived, not just born. But he was stillborn when he was born. So he was brought back to life. But I love the history of the whole place."*

These connections to the manta sites were inspired by love for the animals, the experience, the place, and the community. Three participants emphasized the Hawaiian values *kuleana,* akin to responsibility, and *pono,* or what is right, as core personal philosophies. Other participants repeated strong values for safety, protecting the environment, advocating on behalf of the mantas, and preserving the commercial integrity and investments of the community. Within the industry, opinions about fellow operators were mixed. "I would say everyone wants to work cooperatively for the most part. There's some people, right, who care about the

industry as a whole." Operators spoke fondly of those who "play by the rules" and were quick to disparage others, particularly operators who were viewed as new to the industry. Accusations of violence, drug abuse, and death threats were mentioned by more than eight participants. Similar industry conflict undermined cooperation in MWT at Ningaloo Reef (Catlin et al. 2012) and South Africa (Dobson 2006) where operators undercut one another's prices, used regulations to target rival operations, and exhibited varying commitments to industry codes of conduct. Overall, the percent coverage of negative sentiments about the industry was three times greater than positive sentiments. All participants were able to identify problematic behaviors; a handful of industry participants admitted to aspects of their own activities they'd be open to changing.

The conflicts at the Kona manta sites have been developing over the course of decades. Participants described the breaking point somewhere around 2010 as the number of companies increased and cooperation faltered. DOBOR, DAR, and USCG hosted an initial industry standards meeting in November 2012, and there have been at least five public meetings since. Fifty-eight per cent (58%) of participants attended at least one meeting, describing them as highly contentious with the loudest voices in the room dominating the conversation. The majority of participants who attended public meetings said they didn't make any comments, though a few submitted them later by email.

> *"[DOBOR] had some proposed rules. And there were some really pissed off operators. And it's usually the ones that are operating really poorly, the most money-grubbing greedy operators, the ones that will go out in the worst conditions possible just because they want to make money."*
>
> *"They (DOBOR) have no idea. And you know, a lot of people brought up valid points and questions... But it's just very unorganized. And the scope is so much bigger than I think anybody realized."*

Though the state has consulted with the community on regulations, several participants had the impression that regulations were set and their only recourse would be a lawsuit. Dobson (2006) described the "litigious nature of modern society" as a significant obstacle for state regulations in both Florida and South Africa, which at worst, faced 36 separate legal challenges. The Kona MWT industry had recently undergone a similar management planning process for the protection of the Hawaiian spinner dolphin population, which was discussed in eight interviews. Participants felt that similar attempts to regulate spinner dolphin tours were ineffective and enforcement lacking. A published study of the spinner dolphin regulations warned that a top-down approach would be detrimental to management objectives and that increased education, understanding, and trust was needed (Heenehan et al. 2015). This underlying conflict likely influence community expectations for all regulations, just as similar conflicts mentioned from aquarium-fish trade regulations to harbor improvements have impacted the overall perception of Hawai‘i's natural resource management. Madden and McQuinn (2014) recommend that conflict intervention emphasize relationship-building and process as much as the outcome. In Western Australia, Genter et al. concluded that the effectiveness of a program is highly

dependent on the role the industry plays, advocating for a partnership where operators function as part of the solution (Genter et al. 2007). Government agencies used regional workshops to break down misconceptions like apathy from state officials and adversarial aggression from operators. With plans in 2021 to host at least one more public meeting before rules are finalized, the state had at least one more opportunity to engage in a meaningful co-productive process.

Scoring HAR §13-256 Proposed Measures

Participants commented on the efficacy for measures listed on DOBOR's HAR §13-256 handout (**FIG. 18**) using the Likert scale and/or observations and perceptions. Participants opted not to rate some measures due to uncertainty or unfamiliarity. Each measure had between 30 – 32 responses. Two interviews did not include the survey portion due to recording software errors. Overall, average sentiment for the evaluated regulations was positive (average score of 7.74 on 0 to 10 Likert scale). The different opinions and scores among participants varied between ineffective and effective for all but three measures (**FIG. 18**), which were all rated as effective: *No anchoring at the manta viewing sites, no fishing during manta viewing hours,* and *vessels are prohibited from leaving the manta viewing zone while their passengers are still in the water*. Out of the twelve measures proposed, none were scored as ineffective by all participants.

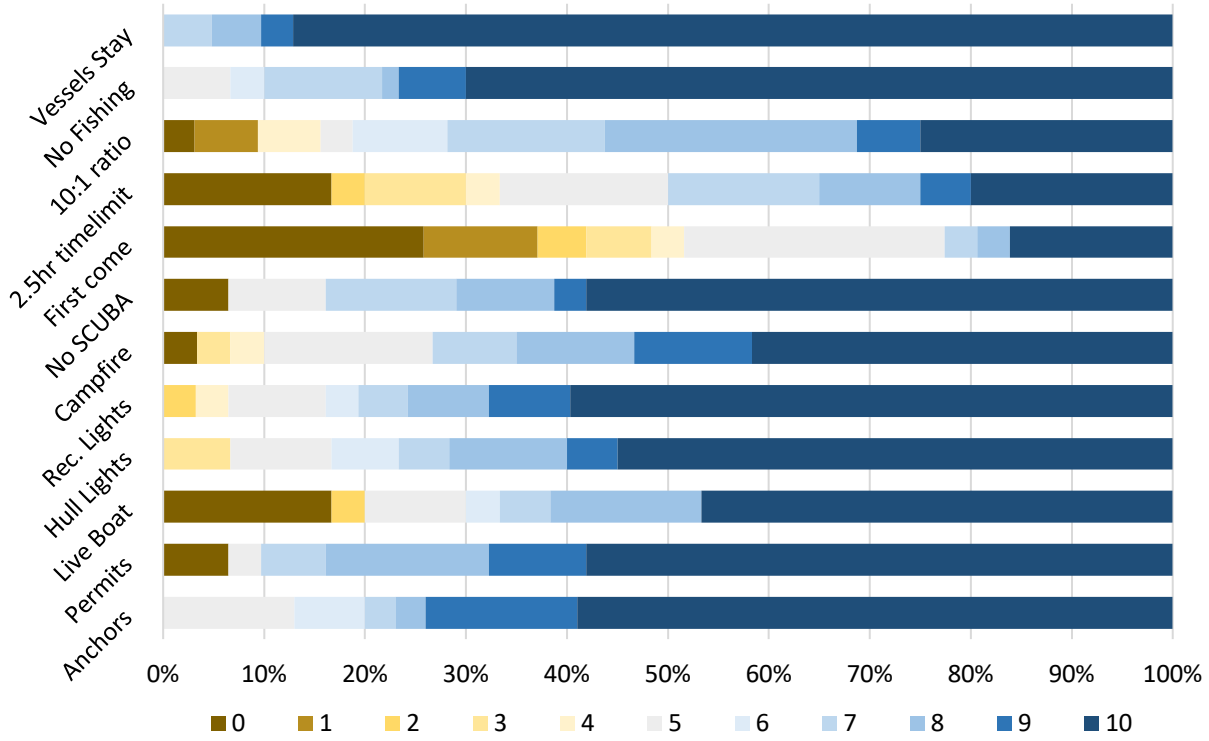

Figure 18. Proportion of scores by measure. Participants scored measures from HAR §13-256 on a Likert Scale from 0 to 10, with 0 as "very ineffective", 5 as "neutral", and 10 as "very effective." The count of responses to each measure varied between 29 to 31.

Eight demographic comparisons were made using the Mann-Whitney U Test: Test A: Industry (Owner vs. Non-owner); Test B: Profession (Commercial manta tourism vs. noncommercial); Test C: Non-Industry (Academic vs. user); Test D: Site Experience (Keauhou only vs. GEC/GEC + Keauhou); Test E: SCUBA (Certified vs. Non-certified); Test F: Age (Lower ≤ 35 years, Middle $35 < x < 50$, and ≥ 50 years); Test G: Gender (Male vs. Female); Test H: Ethnicity (Native Hawaiian vs. Non-Native Hawaiian (**TABLE 5**). Each test looked at the center of the ranking distribution for scores by measure. Average response scores ($\bar{x}$) with standard error bars (SEM) are shown for the eight demographic comparisons in **FIGURE 19**. The test results for demographic comparisons of Industry, Profession, Gender, and Ethnicity showed no statistically significant differences in the median value of scores (Tests A, B, G, H).

Anchoring and Live Boating

Measures discussed:

- *Prohibit anchoring inside site boundaries at all times*
- *Limit live boating to ingress, egress, and emergencies*
- *Confine manta activities to designated campfire areas*

At the center of the manta viewing sites is the issue of anchoring. There are several studies that draw a distinct correlation between anchoring intensity and damage to the marine environment (Davis 1977; Allen 1992; Milazzo et al. 2004; Dinsdale & Harriott 2004; Saphier & Hoffmann 2005; Jameson et al. 2007; Forrester & Flynn 2015; Venturini et al. 2016; Giglio et al. 2017). There have been documented cases of anchors impacting benthic habitat at the manta viewing sites as well (**FIG. 20**). Nine participants recounted stories from personal experience of seeing anchors on corals. Commercial tour owners, staff, and recreational site users described shouting matches between boats over moorings and anchoring, a few of which resulted in confrontations back at the harbor and physical threats. The state currently prohibits anchoring in coral and there is a fine, but enforcement is low at the sites. There was a common exasperation among commercial users with the process for reporting coral damage. Without conservation enforcement officers present, anyone reporting a boat for anchoring in coral must collect video from the name of the boat, its registration number, to its chain and down to the anchor, the impacted coral, and back up to the boat. Despite several people describing this process, none who had submitted evidence had been asked to testify nor knew of any cases that resulted in a fine.

The measure, *prohibit anchoring inside site boundaries at all times*, had no statistically significant variation among demographic groups (Tests A-H, p-value > 0.05) and was rated as potentially effective with the caveat that it is enforced. By restricting anchoring full stop, the measure becomes easier for enforcement officers to identify without the need for a dive team or photo documentation of impacts to corals. Anyone from the surface could correctly identify an anchor line and write up the violation. However, a complete ban of

	Mann-Whitney U Test A							Mann-Whitney U Test B						
	Owner			Guide/Fringe			Test	Commercial			Non-Commercial			Test
Measure	Mean	SEM	n	Mean	SEM	n	P-val	Mean	SEM	n	Mean	SEM	n	P-val
Prohibit anchoring	8.588	0.696	8	8.100	0.690	10	0.929	8.317	0.482	18	9.417	0.417	12	0.133
Require permit	7.667	1.106	9	8.600	1.002	10	0.348	8.158	0.731	19	9.182	0.325	11	0.796
Live boating	5.000	1.667	9	7.000	1.269	9	0.480	6.000	1.045	18	8.318	0.549	11	0.369
Subsurface lights	7.556	0.930	9	9.050	0.474	10	0.270	8.342	0.522	19	8.150	0.775	10	0.872
360° white light	9.333	0.553	9	8.950	0.797	10	0.775	9.132	0.483	19	7.773	0.685	11	0.067
Campfire areas	6.778	1.115	9	7.800	0.892	10	0.568	7.316	0.697	19	8.700	0.533	10	0.422
No SCUBA	7.444	1.180	9	8.150	1.054	10	0.744	7.816	0.770	19	9.045	0.384	11	0.667
served	2.889	0.949	9	4.682	1.345	11	0.403	3.875	0.858	20	4.300	1.001	10	0.567
2.5 hr time limit	3.222	1.152	9	6.450	1.184	10	0.072	4.921	0.890	19	7.250	0.664	10	0.142
10:1 ratio	8.278	0.383	9	5.364	1.047	11	0.058	6.675	0.675	20	8.409	0.499	11	0.143
No fishing	9.556	0.338	9	9.400	0.499	10	0.967	9.474	0.300	19	8.750	0.523	10	0.359
Vessels stay	10.000	0.000	8	9.800	0.200	10	0.722	9.889	0.111	18	9.458	0.311	12	0.363
Average Sentiment	7.150	0.363	9	7.812	0.377	10	0.289	7.499	0.267	19	8.224	0.234	11	0.078
	Mann-Whitney U Test C							Mann-Whitney U Test D						
	Academic			User			Test	Keauhou			Keauhou and/or GEC			Test
Measure	Mean	SEM	n	Mean	SEM	n	P-val	Mean	SEM	n	Mean	SEM	n	P-val
Prohibit anchoring	9.167	0.833	6	9.667	0.211	6	0.749	9.814	0.142	7	8.435	0.426	23	0.220
Require permit	8.500	0.428	6	10.000	0.000	5	0.023	8.000	1.380	7	8.696	0.485	23	0.883
Live boating	7.583	0.841	6	9.200	0.490	5	0.144	4.286	2.020	7	7.705	0.607	22	0.221
Subsurface lights	7.250	1.138	6	9.500	0.500	4	0.166	8.875	0.743	8	8.048	0.517	21	0.272
360° white light	7.083	0.935	6	8.600	0.980	5	0.201	10.000	0.000	8	8.136	0.518	22	0.024
Campfire areas	8.500	0.548	5	8.900	0.980	5	0.296	6.750	1.319	8	8.190	0.475	21	0.450
No SCUBA	8.333	0.558	6	9.900	0.100	5	0.100	8.625	0.706	8	8.136	0.658	22	0.815
served	2.800	1.020	5	5.800	1.530	5	0.144	2.500	0.945	8	4.568	0.801	22	0.189
2.5 hr time limit	7.100	1.145	5	7.400	0.812	5	0.917	4.875	1.517	8	6.048	0.706	21	0.542
10:1 ratio	8.083	0.664	6	8.800	0.800	5	0.465	8.375	0.420	8	6.913	0.628	23	0.269
No fishing	8.900	0.678	5	8.600	0.872	5	0.754	9.625	0.375	8	9.071	0.342	21	0.407
Vessels stay	9.083	0.583	6	9.833	0.167	6	0.522	10.000	0.000	9	9.595	0.200	21	0.415
Average Sentiment	7.717	0.247	6	8.833	0.197	5	0.014	7.659	0.450	8	7.803	0.221	22	0.725

Table 5. Mann-Whitney U-Test Results. 8 demographic comparisons were made between the center of the distribution of scores for each measure and for average score. Participants were asked to rate each measure for its ability to achieve management goals at the sites. A 0 - 10 Likert scale was used with 0 as very ineffective, 5 as neutral, and 10 as very effective. Significant p-values (> 0.05) are highlighted in orange and p-values < 0.10 were highlighted in light yellow. TEST A: Industry (Owner vs. Non-owner); TEST B: Profession (Commercial manta tourism vs. noncommercial); TEST C: Non-Industry (Academic vs. user); TEST D: Site Experience (Keauhou only vs. GEC/GEC+Keauhou); TEST E: SCUBA (Certified vs. Non-certified); TEST F: Age (Lower ≤ 35 years, Middle $35 < x < 50$, and ≥ 50 years); TEST G: Gender (Male vs. Female); TEST H: Ethnicity (Native Hawaiian vs. Non-Native Hawaiian

	Mann-Whitney U Test E							Mann-Whitney U Test F: Lower vs. Middle, Lower vs. Upper, Middle vs. Upper										
	Certified Diver			Non-Certified			Test	Lower (≤ 35)			Middle (35<x<50)			Upper (≥50)			LvM	LvU	MvU
Measure	Mean	SEM	n	Mean	SEM	n	P-Value	Mean	SEM	n	Mean	SEM	n	Mean	SEM	n	P-val	P-val	P-val
Prohibit anchoring	8.560	0.400	25	9.740	0.194	5	0.504	8.000	1.225	4	8.427	0.571	11	9.200	0.449	15	0.497	0.287	0.366
Require permit	8.462	0.550	26	9.000	0.577	4	0.903	9.750	0.250	4	8.615	0.446	13	8.077	1.016	13	0.712	0.961	0.744
Live boating	7.580	0.632	25	2.500	2.500	4	0.077	7.500	1.893	4	6.000	1.206	12	7.500	0.990	13	0.308	0.657	0.271
Subsurface lights	7.917	0.484	24	10.000	0.000	5	0.043	8.000	1.378	5	8.583	0.557	12	8.083	0.709	12	0.725	0.657	0.442
360° white light	8.360	0.471	25	10.000	0.000	5	0.095	8.600	0.980	5	7.750	0.863	12	9.462	0.237	13	0.514	0.930	0.325
Campfire areas	8.208	0.449	24	5.800	1.855	5	0.175	6.600	1.364	5	7.091	0.948	11	8.846	0.514	13	0.551	0.066	0.278
No SCUBA	8.240	0.589	25	8.400	1.030	5	1.000	8.300	0.624	5	8.500	0.657	12	8.038	1.023	13	0.802	0.511	1.000
served	4.420	0.727	25	2.000	1.225	5	0.164	2.400	0.872	5	2.773	0.835	11	5.571	1.088	14	0.688	0.044	0.043
2.5 hr time limit	6.167	0.631	24	3.600	2.227	5	0.273	6.400	1.503	5	3.318	1.180	11	7.500	0.513	13	0.357	0.219	0.035
10:1 ratio	7.077	0.562	26	8.400	0.678	5	0.452	8.400	0.748	5	7.083	0.709	12	7.071	0.867	14	0.075	0.693	0.277
No fishing	9.062	0.316	24	10.000	0.000	5	0.248	8.750	1.250	4	9.417	0.336	12	9.192	0.390	13	1.000	0.921	0.885
Vessels stay	9.646	0.177	24	10.000	0.000	6	0.534	9.600	0.400	5	9.727	0.273	11	9.750	0.187	14	0.914	0.967	0.930
Average Sentiment	7.815	0.211	25	7.512	0.586	5	0.540	7.663	0.363	5	7.292	0.280	12	8.240	0.314	13	0.599	0.174	0.058

	Mann-Whitney U Test G							Mann-Whitney U Test H						
	Male			Female			Test	Native Hawaiian			Non-Native			Test
Measure	Mean	SEM	n	Mean	SEM	n	P-Value	Mean	SEM	n	Mean	SEM	n	P-val
Prohibit anchoring	8.585	0.453	20	9.100	0.504	10	0.708	8.520	0.050	30	9.950	0.050	6	0.147
Require permit	8.333	0.600	18	8.833	0.824	12	0.320	8.846	1.855	25	7.200	1.855	5	0.361
Live boating	7.028	0.852	18	6.636	1.281	11	0.893	7.280	2.291	26	5.500	2.291	5	0.504
Subsurface lights	8.294	0.585	17	8.250	0.641	12	0.894	8.300	1.000	25	8.500	1.000	5	0.889
360° white light	8.500	0.478	18	8.833	0.747	12	0.330	8.519	0.831	25	8.700	0.831	5	0.957
Campfire areas	8.235	0.660	17	7.167	0.767	12	0.250	7.820	0.800	26	7.700	0.800	5	0.597
No SCUBA	8.000	0.791	18	8.667	0.512	12	0.832	8.308	0.949	25	8.000	0.949	5	0.555
served	4.333	0.897	18	3.542	0.956	12	0.703	4.442	0.970	26	1.200	0.970	5	0.057
2.5 hr time limit	4.853	0.838	17	6.958	0.970	12	0.101	5.660	1.718	26	5.500	1.718	5	0.978
10:1 ratio	7.632	0.551	19	6.750	0.922	12	0.557	7.185	1.068	25	7.200	1.068	5	0.755
No fishing	8.853	0.406	17	9.750	0.250	12	0.144	9.200	1.000	27	8.500	1.000	5	0.636
Vessels stay	9.528	0.230	18	10.000	0.000	12	0.310	9.760	0.417	25	9.583	0.417	6	0.861
Average Sentiment	7.698	0.270	18	7.865	0.295	12	0.626	7.830	0.417	26	7.739	0.417	6	0.664

Table 5 continued. Mann-Whitney U-Test Results. 8 demographic comparisons were made between the center of the distribution of scores for each measure and for average score. Participants were asked to rate each measure for its ability to achieve management goals at the sites. A 0 - 10 Likert scale was used with 0 as very ineffective, 5 as neutral, and 10 as very effective. Significant p-values (> 0.05) are highlighted in orange and p-values < 0.10 were highlighted in light yellow. TEST A: Industry (Owner vs. Non-owner); TEST B: Profession (Commercial manta tourism vs. noncommercial); TEST C: Non-Industry (Academic vs. user); TEST D: Site Experience (Keauhou only vs. GEC/GEC+Keauhou); TEST E: SCUBA (Certified vs. Non-certified); TEST F: Age (Lower ≤ 35 years, Middle 35 < x < 50, and ≥ 50 years); TEST G: Gender (Male vs. Female); TEST H: Ethnicity (Native Hawaiian vs. Non-Native Hawaiian

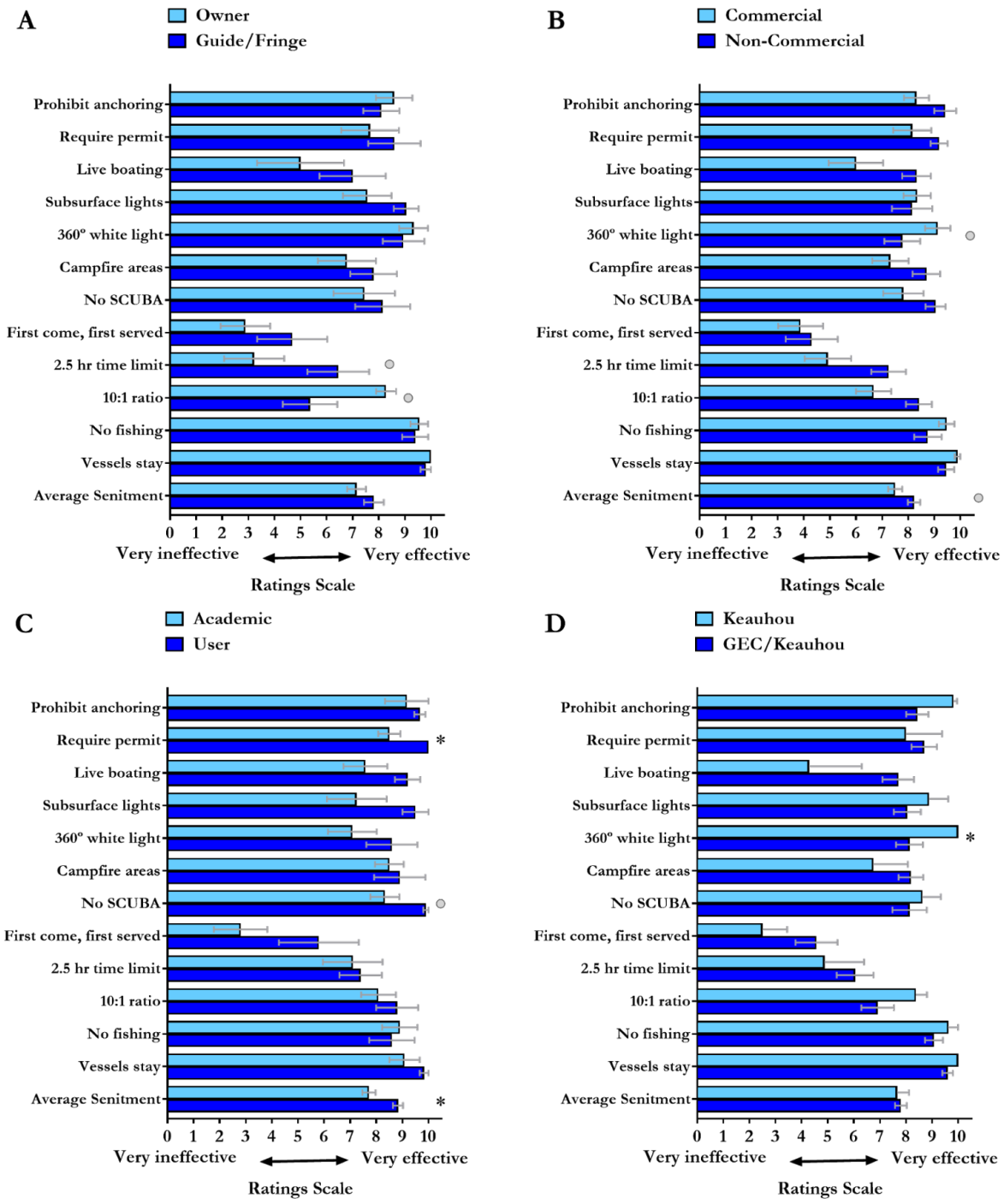

Figure 19. Mann-Whitney U Tests by demographic partition. Average response scores ($\bar{x}$) with standard error bars (SEM) are shown for the eight demographic comparisons. Significant p-values (p-value > 0.05) are denoted by asterisk (*). Nearly-significant test results (p-value < 0.10) are denoted by light gray bullet (○). TEST A: Industry (Owner vs. Non-owner); TEST B: Profession (Commercial manta tourism vs. noncommercial); TEST C: Non-Industry (Academic vs. user); TEST D: Site Experience (Keauhou only vs. GEC/GEC+Keauhou); TEST E: SCUBA (Certified vs. Non-certified); TEST F: Age (Lower ≤ 35 years, Middle 35 < x < 50, and ≥ 50 years); TEST G: Gender (Male vs. Female); TEST H: Ethnicity (Native Hawaiian vs. Non-Native Hawaiian

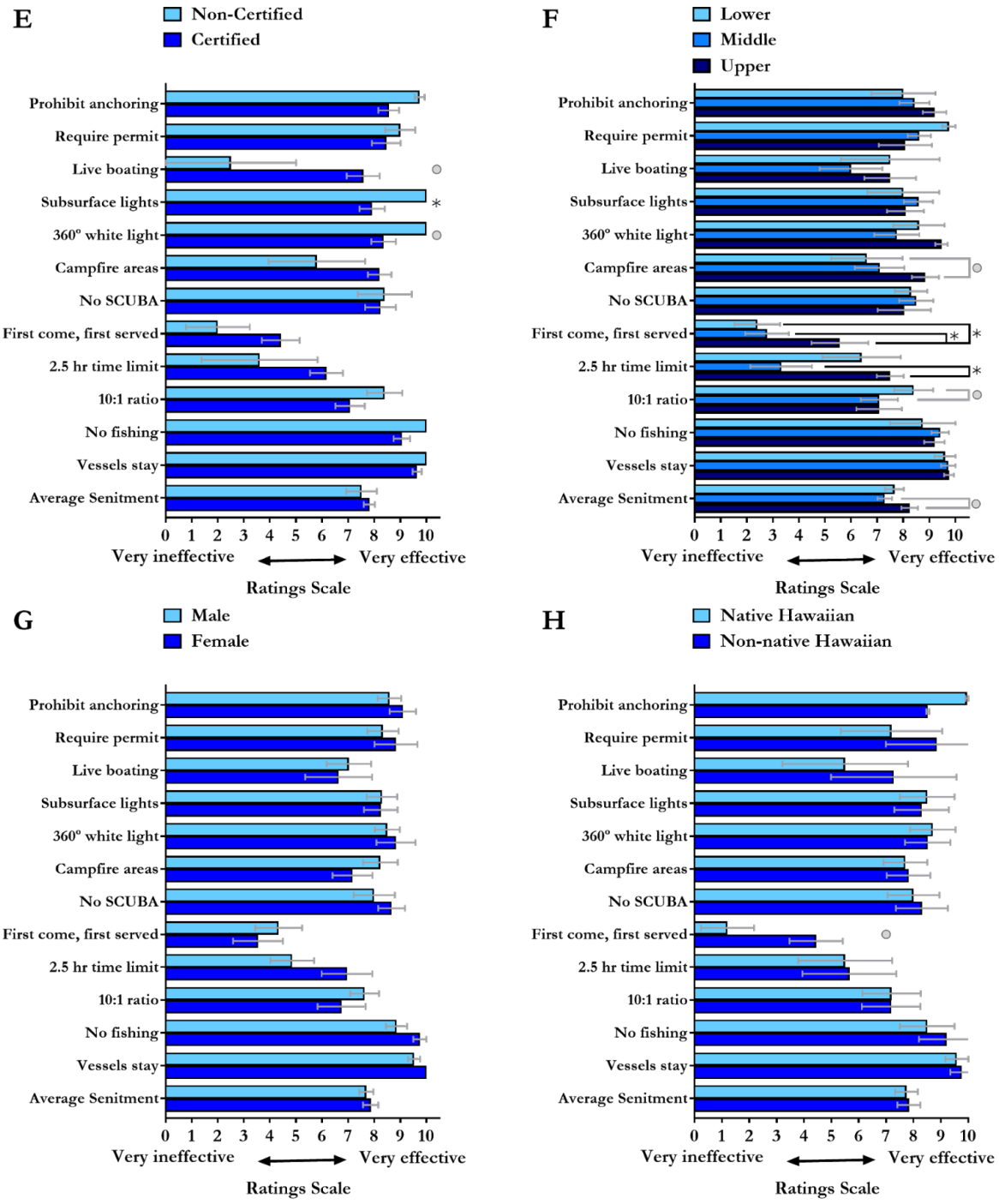

Figure 19 continued. Mann-Whitney U Tests by demographic partition. Average response scores ($\bar{x}$) with standard error bars (SEM) are shown for the eight demographic comparisons. Significant p-values (p-value > 0.05) are denoted by asterisk (*). Nearly-significant test results (p-value < 0.10) are denoted by light gray bullet (○). TEST A: Industry (Owner vs. Non-owner); TEST B: Profession (Commercial manta tourism vs. noncommercial); TEST C: Non-Industry (Academic vs. user); TEST D: Site Experience (Keauhou only vs. GEC/GEC+Keauhou); TEST E: SCUBA (Certified vs. Non-certified); TEST F: Age (Lower ≤ 35 years, Middle 35 < x < 50, and ≥ 50 years); TEST G: Gender (Male vs. Female); TEST H: Ethnicity (Native Hawaiian vs. Non-Native Hawaiian

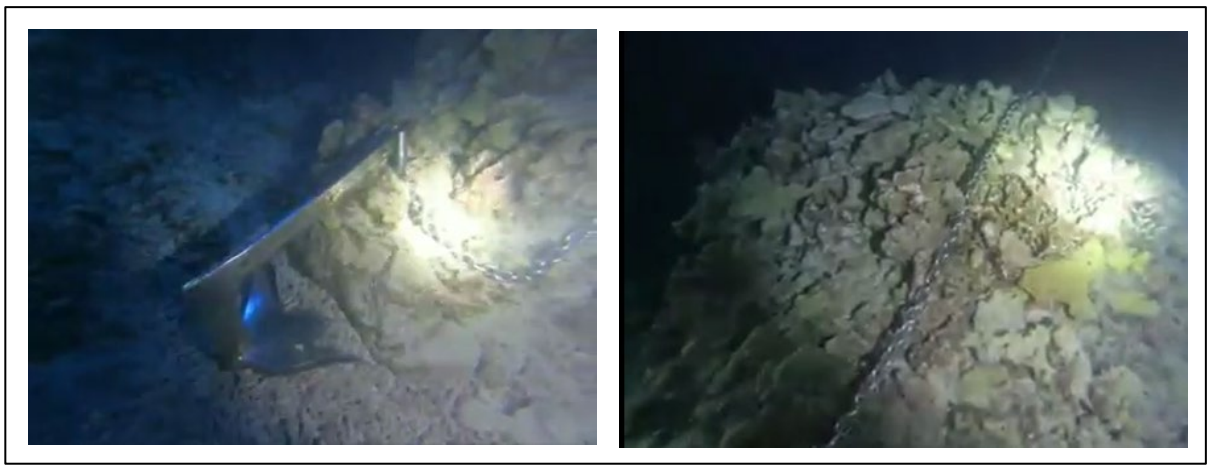

Figure 20. Footage collected at Keauhou in 2019 shows a boat anchor and chain in corals. The video shows large pieces of the coral boulder becoming dislodged and tumbling into the rubble (Source: Facebook)

anchoring at the manta sites may not be necessary or appropriate. As one participant described it, "your anchor is one of your safety features." Anchoring in cases of emergency would be permissible under the proposed rules, but there are other scenarios where anchoring can be done safely and effectively. Alongside the manta viewing area in Makako Bay, there is sandy bottom habitat where boats currently anchor to avoid impacts to corals. These areas are well-known among experienced captains and crew and could serve as a suitable alternative to mooring at the site. Commercial tour providers were mostly in agreement that anchoring was less of a problem in Makako Bay. Keauhou, on the other hand, is mostly live coral, coral rubble, and hard bottom habitat where anchoring is not suitable. Operators based in Keauhou were, on average, more supportive of the measure.

Without the ability to anchor at the sites, operators would be forced to tie off to a mooring or live boat (run their motor). The state anticipated these alternatives and created policies to further restrict site access. All vessels would be required to attach directly to a state-provided mooring to conduct their tours. Boats would be prohibited from "daisy-chaining" or tying off to a boat that is attached to a mooring, effectively limiting the number of boats concurrently offering manta viewing tours to the number of moorings. The measure, *limit live boating to ingress, egress, and emergencies* was one of the most divisive with an average score that ranked third lowest, and 20% of respondents rating it as ineffective. Industry professionals were the only respondents to rate the measure as ineffective, and each of those six participants reported personally live boating without incident at the sites. Among Keauhou operators, this was far more common. The camaraderie among unanchored, free-drifting Keauhou operators was described by several participants. Operators argued against the restriction from a human safety standpoint, worried about ocean currents that carry snorkelers, many of whom are inexperienced swimmers, far from a moored or anchored vessel. After many years of observing

ocean conditions at the sites, these six participants were confident that live boating was a greater asset in Keauhou than a risk.

Yet the safety argument was made in favor of the measure to prohibit live boating as well. Twenty participants described their concern for the practice of running an engine near snorkelers, divers, and feeding mantas. At marine wildlife tours outside of Hawai‘i, provisioned whale sharks were documented to be less sensitive to boats and people, placing them at greater risk of injury (Schleimer et al. 2015). The propeller scars and maimed appendages observed among Kona mantas demonstrates the possibility of harm to both wildlife and swimmers. While there have been no recorded incidences of boats injuring people, one guide complained of nearly being hit by a boat four times and another guide witnessed an anchor land right next to a seated dive group. From the standpoint of safety, live boating is a questionable practice, but regulations should consider the industry's injury record. Despite the high number of participants over the years and the nighttime conditions, there have been no reports of boats hitting or injuring swimmers. Similarly, a manta tour boat has never been reported for striking a manta. Those who supported live boating were not convinced that the measure is justified.

Related to the issue of live boating, the measure, *confine manta activities to designated campfire areas* received mixed support and some opposition. All participants connected to Makako Bay believed the campfire to be very effective, though several pointed out that when conditions are too rough for the primary campfire spot, tours use alternate sites within 500 m. Keauhou operators expressed conditional support for the idea behind a campfire: a central gathering place for tours to concentrate their artificial lights and draw mantas for everyone's enjoyment. Ten guides and owners complained of sprawling tours where boats refuse to bring their participants to the campfire. These boats, referred to by two participants as the "blue light mafia" or specifically by company name, use their artificial lights to draw mantas away from the central group and out to a private show for their customers. This splintering isn't problematic on nights when eight or more mantas are at the sites, but when just one or two mantas are present, the campfire becomes even more important for a successful sighting. Whether the campfire takes the form of a permanent or shifting central viewing area, it received the third-highest average rating for efficacy and is generally supported by all users with no significant difference between demographic groups (Tests A-H, p-value > 0.05). It is important to note that some of the supporters of the campfire measure maintain that this could be accomplished with live boating or more than one campfire, if all boats were required to congregate together in a group or if small six-passenger boats were the only ones allowed to live boat at the sites.

With the variable current in Keauhou Bay, and ocean conditions sometimes too rough for the usual spot off of the Sheraton, some operators moved their tours into the boating channel. Five participants brought up this relatively new practice of conducting tours inside Keauhou Bay and stressed the dangers of putting

people in the water in an active boat harbor. Two participants called the operators' judgment into question and emphasized the moorings as the only way to prevent unsafe practices, while another two worried that it would bring unwanted scrutiny on the tours and force DOBOR's hand with undesirable regulations. In January 2020, DOBOR posted a notice to Keauhou operators warning them that any manta viewing activities taking place in the channel and harbor were considered illegal and could result in sanctions for civil penalties or permit revocation. The practice had the unintended consequence of undermining the Keauhou operators' case that they could live boat safely without moorings or a designated campfire area. The state now has evidence that in the absence of regulations, tours are conducted without adequate regard for safety.

Moorings for Management

Measures discussed:

- *There will be a 2.5-hour time limit per use of moorings*
- *Moorings will be first come, first served*

A mooring system is a useful tool to prevent anchor damage to seagrass beds and coral reefs (Walker et al. 1989; Hocevar 1993; Marbà et al. 2002; Jameson et al. 2007; Levrel et al. 2012). Hawai‘i's mooring buoys were developed for ocean users in the 1980s and Kona was the testing grounds for its genesis. It is therefore no surprise that the state chose moorings as a management tool in the manta viewing sites, or that several participants brought up the state mooring program. However, moorings can be a source of user conflict and environmental harm. In Keauhou, commercial industry participants were quick to point out the dangers mooring lines pose to mantas: "When I think about all these mooring lines, it's like a freaking giant net," one participant worried. Another protested the moorings based on the same concern: "You put artificial obstacles in the ocean, mantas swim like this [gestures in a sweeping, open-handed motion]… they're going to run into those lines." There have been two documented manta entanglements on mooring lines that resulted in the animals' deaths (Deakos et al. 2011). Both instances involved "bridal" or "leading lines," a slack line that hangs off the buoy for boats to more easily moor. In response to the risk, the proposed moorings at the manta viewing sites will not have slack leading lines. Elsewhere in the Maldives, the Manta Trust developed guidelines for minimizing mooring line impacts by securing an array of zip ties, which would stick out perpendicular to the taut mooring line and provide a buffer to help the animals from coming into contact with the mooring line (Manta Trust 2019). Furthermore, the Hawai‘i state Day-Use Mooring Buoy program has the stated benefit of increasing recreational opportunity at popular ocean resources (HAR §13-256 1995; O'Halloran & Bourdon 2010). At Makako Bay, the industry and mantas make use of the bay at night and Hawaiian spinner dolphins use it as one of four primary resting areas (Tyne et al. 2015). Researchers documented that boating and snorkeler/swimmer activity had a positive correlation with dolphin whistles, suggesting recreation has an impact on resting behavior within the bay (Heenehan et al. 2017). If the Kona manta tours install more moorings at Makako Bay, there could be impacts to these protected species from

increased daytime recreation. A consultation with industries and research outside of Hawai‘i proves a valuable resource for innovation and improvement upon the proposed rules.

There are seven moorings installed in Makako Bay and six in Keauhou, spaced 18’ – 150’ apart. DOBOR plans to modify spacing to 25’ – 60’ and incorporate a maximum thirteen moorings at either site (**FIG. 21**). One mooring will be designated for recreational users. Permitted vessels would be required to attach to a mooring before engaging in manta viewing activities. With the current estimate of qualified companies over 60, an even split between the two sites would mean two or more companies for every one mooring. The challenge of using moorings as a management tool is in this unequal ratio. To control site access, permit holders are excluded from the site through a vessel count limit. DOBOR determined which companies have access to the moorings, when, and for how long by defaulting to the state administrative rule HAR §13-257: moorings are first come, first served and there is a 2.5-hour time limit per use (HAR §13-256 1995). The measure, *there will be a 2.5-hour time limit per use* received the second-most total ratings of very ineffective (0) and had the second lowest average score of 5.63, which was fractionally effective on the Likert scale. Participants pointed out that 2.5 hours was both too much for snorkel tours and too little for dive tours. Eight participants reasoned that snorkel tours are generally no more than 60 minutes of in-water activity, and another six

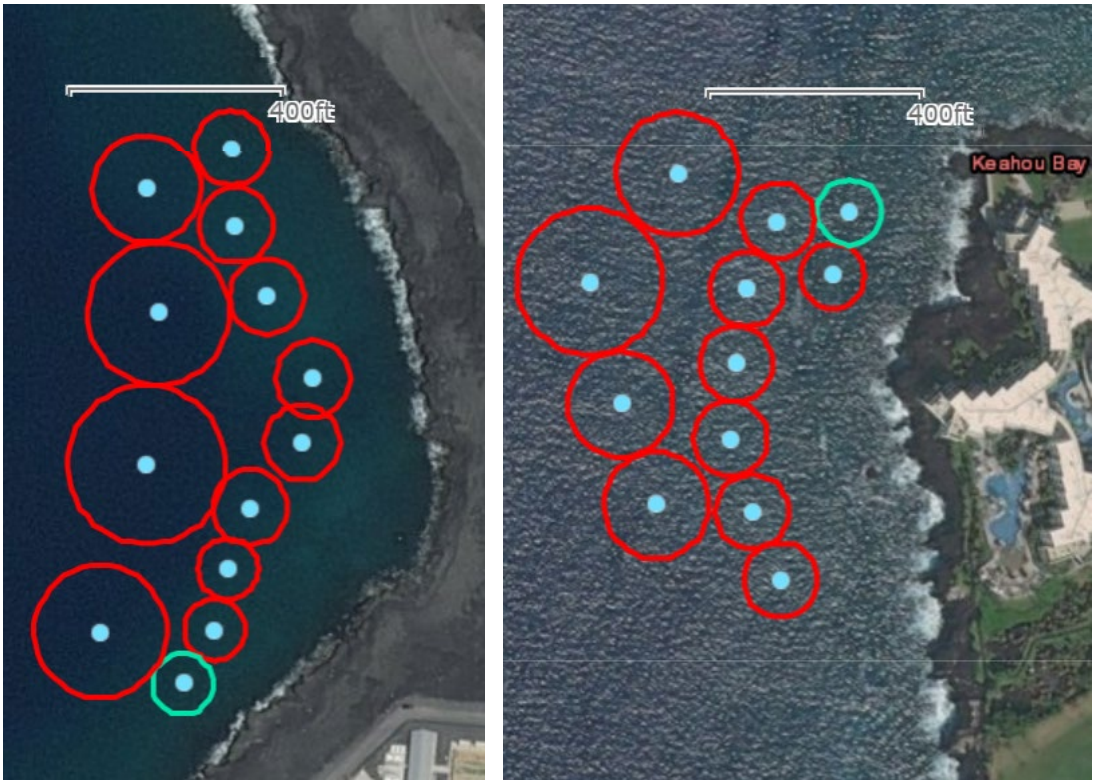

Figure 21. Mooring field arrangements. Sites Makako Bay (left) and Keauhou Bay (right) with the planned arrangement of moorings. Mooring installation points are drawn with the swing circles showing the full scope of an attached vessel. Circles correspond to maximum vessel scope: large (60’), medium (35’), and small (25’). The recreational moorings are drawn with a lighter-shaded (teal) swing circle.

participants felt that SCUBA tours required 3 hours. They worried that the 2.5-hour time limit would change the nature of the manta dives. Manta SCUBA tours typically consist of a two-tank dive for the purposes of providing greater value, introducing divers to the site during the daytime, and most importantly, assessing the skills of a dive group so guides know who may need more help. With a typical bottom time around 45 – 60 minutes and a minimum 45-minute surface interval to avoid medical complications, 2.5 hours in insufficient for a two-tank dive tour. Enforcement of a 2.5-hour time limit was also raised as a potential obstacle to efficacy, as someone would have to document the moment a boat attached to a mooring. Technology such as check-in apps on smartphones could present the state with a possible solution, but development and training for such a tool would be costly. It could be a simpler option to set different time limits based on the activity, whether it's SCUBA or snorkel. Acknowledging the different natures of these two tours would be appropriate in regulations and more effective in encouraging compliance, minimizing impacts to industry, and promoting safety with the pre-manta show checkout dive.

With a time limit set, the question of who attaches to a mooring and when must be decided. *Moorings will be first come, first served* received the lowest average score of all measures, 3.92 on the 0 – 10 scale, with only 23% of participants rating the measure as effective. It received the highest percentage of "very ineffective (0)" ratings – 26% of participants. There was no significant variation between demographic groups with the exception of age, where the older age group had a significantly higher median efficacy score (Test F, p-value < 0.05) and an average rating of 6. Those participants aged 50 or older were the same participants who discussed the state's mooring buoy program and were familiar with day-use moorings' history. Several of these participants also reported participating in past public meetings where first come, first served or assigned moorings was first discussed. Two participants recalled the industry rejecting assigned moorings and calling for first come, first served. Their support for the measure is likely due in part to their experiences with its development.

Concerns over *first come, first served* were many and repeated often. Businesses could suffer from disappointed customers who end up waiting, potentially for an hour or more, before a mooring becomes available. Participants feared the measure would create a race between boats, forcing captains to drive faster and less safely. Even now with the limited number of moorings at the sites, boats will sit on a mooring until an "allied" boat arrives, which will switch onto the mooring even if a rival boat has been waiting longer. This potential source of conflict could create or worsen rifts within the industry. Some put it into more dire terms, using words like, *chaos, brutal, ugly, disaster,* and *bloodbath*. One participant reasoned,

> *"Why institutionalize a suboptimal solution when you don't have to? Because that's not solving any problems. And it may create more problems than there are now."*

When participants were asked what they'd propose as an alternative, four suggested assigned moorings. One issue is that there are more and less desirable moorings and companies could be dissatisfied with their assignment. Deeper moorings require longer swims to the central campfire viewing area. Shallow moorings are less safe during high wave conditions. Assigned moorings also exposes companies to targeted acts of sabotage, as a company may find their mooring cut and their boats unable to conduct tours. DOBOR is unlikely to entertain the measure given it was rejected during previous community meetings, but a potential compromise would be to assign moorings to two to three permits and let those companies work out sharing amongst themselves. Companies could even be given the option of being randomly assigned a different mooring at the end of a term in case they're dissatisfied with their mooring partner(s) or position, or be assigned not one but two moorings in case shallow-set moorings become unsafe in harsh ocean conditions.

Another three participants suggested a dispatcher who would be present at the site and direct boats to a mooring. This suggestion was based off of similar marine wildlife tours in Mexico where an officer coordinates the boats and controls crowding. The challenge would be the labor required for such a role, though permit fees could be designated for such a purpose. Similar arrangements to reduce the count of boats are in place in Bunbury (O'Neill et al. 2004) and Port Stephens (Allen et al. 2007), Australia where companies are limited in the number of tours they run daily. Whatever measure is selected to control crowding and mooring, enforcement is one of marine wildlife tourism's greatest challenges and a solution that requires minimal monitoring will likely have the most success.

Some participants suggested adding additional moorings to reduce competition and make compliance easier. The difficulty of moorings at the Kona manta sites is that they must be sufficiently close to the manta viewing area and distant from other vessels. DOBOR maintains that thirteen and twelve moorings are the maximums those sites can support. Given this, a possible solution that would increase the number of moorings, control the number of boats, and reduce the boat race mentality is to create a second campfire area at each site and install additional moorings there. Interview participants in both Keauhou and Makako Bay identified secondary locations where tours are occasionally conducted. Companies would not have to stress over arriving at the site with a boatload of passengers and being unable to moor. The creation of an alternate campfire could also provide for tours when conditions are less ideal at the primary campfire, and operators would be forced to coordinate their trips less frequently. This option would not completely resolve the issue with splintering and competing campfires when mantas are few in number, but it could potentially reduce the number of competing campfires and operators could put their guests in the water at the alternate campfire while they wait for a position at the primary campfire to become available.

The Permitting Puzzle

Measures discussed:

- *Require a permit for commercial manta activities*
- *Participant to guide ration may not exceed 10:1*
- *SCUBA is prohibited in Keauhou*

With the third-highest average score in the interviews, the measure, *require a permit for commercial manta activities* was viewed as potentially effective. Outside of the Kona manta sites, permitting was supported by 90% of whale-watching tourists surveyed in Tonga (Kessler & Harcourt 2010) and 81% of tour operators licensed in Western Australia, who agreed permits were necessary to protect the marine environment (Hughes & Carlsen 2004). Participants of the present study were supportive generally, but disagreed or were unsure of specific aspects of a permit program. These included fee amount, eligibility, total number, transferability, and enforcement. DOBOR proposed a $1,200 annual fee for a manta viewing activity permit that would be specific to one boat per company, and to one of the two sites. The permit would be non-transferable with the sale of the business, and companies would be prohibited from increasing their vessel capacity by more than a small percentage of their permitted vessel size. There were concerns that limiting the number of boats or trips for a company would drive businesses to upscale their capacity by investing in larger and larger boats, but participants were supportive of restrictions prohibiting an "arms race" of boat size. Several boat owners took issue with the one-boat-per-company policy, as boats need maintenance and last-minute switches may be necessary. If a company can't fill its larger-capacity vessel, it is more efficient for them to use one of their smaller boats. Commercial participants requested this level of flexibility and several suggested that each company should be given designated alternate vessels for such cases.

Thirteen participants, eleven of which are or were involved in the industry, perceived permitting as a threat to businesses. One participant pointed out that if a company has invested in three boats to run manta tours and then they're told they can no longer run tours from two of those boats, they'll take substantial economic losses. Similarly, if that company is doing two less tours than before, that not only corresponds to a loss in revenue for the business but a decrease in taxes collected from gross receipts. The economic uncertainty around reduced trips was too high for some participants to endorse a permit program. Four participants were completely opposed to paying a fee for permits. Another five felt that a flat fee would be unfair as no matter what amount the fee is set to, it will always represent a much larger percentage of revenue for smaller businesses than those with greater capacity running more trips. Similarly, in Western Australia, operators felt that the flat fee licensing system was inequitable and suggested that fees match business size (Hughes & Carlsen 2004). A fee based on gross receipts or passenger counts was a favored alternative. This solved participants' concerns that they'd be charged a flat amount regardless of how much business they did in a year.

Currently, manta viewing activity permits would be valid for one year. In Australia, Ningaloo whale shark tour permits were initially for one year, but this was amended to three years because operators argued it limited their ability to plan for the following season, and did not encourage investment in the industry (Davis et al. 1997; Catlin & Jones 2010). Operators were furthermore required to pay US$750 in the form of a pre-season deposit, and were then charged a fixed amount per passenger that would be subtracted from their deposit (Davis et al. 1997). Any deficit would be returned to them, and they would not be charged if they exceeded the US$750-threshold. The fees were transparent to participants, who would be provided with a "validation pass" for swimming with whale sharks that doubled as a souvenir and tipped them off to nature fees being collected by the government. Surveys of participants found that the fee was unlikely to negatively impact demand for the tours (Catlin & Jones 2010). While the idea of a permit deposit was not brought up during the interviews, it could be a middle ground for the state's proposed flat fee and the desire for a more equitable fee based on business size. Overall, permit conditions are incredibly complicated and must be thoroughly evaluated so as to maximize their effectiveness at reducing boat counts and indirectly, impacts to the environment, while at the same time ensuring the permitting process is fair with minimal negative impacts to businesses.

The measure, *the participant-to-guide ratio may not exceed 10:1* would further limit the number of participants on each tour. There was no significant difference by the Mann-Whitney U Tests, but the comparison of Industry was nearly significant (Test A, p-value = 0.058). The 10:1 ratio was rated lower on the 0 – 10 scale for distinctly different reasons, as some respondents felt that ten participants were too many, while others believed too few. The "too few" group suggested up to sixteen as an acceptable number, while the "too many" group favored no more than 6:1, the original ratio that DOBOR suggested to the community in 2018. After public comment, the number was adjusted to ten to accommodate smaller vessels. Three participants brought up the potential impact to businesses:

> *"The participant to the guide ratio: that doesn't impact the structure [of the tours] at all, right? That only kind of dictates what that tour costs an operator to run it. It doesn't change the COI on your boat. All it does is add labor costs, the smaller that ratio gets. Which is something that everybody would put up with, but then you'd have to charge more."*

Smaller vessels taking out seven or eight passengers, potentially on a 10-capacity boat, would be forced to take on a third crew member (two guides and one captain), potentially reducing their revenue-generating seat count by as much as 14% (one out of seven). Larger vessels with eighteen passengers on a 20-capacity boat would similarly lose one seat to bring out a third crew member, but the proportion would be only 6% (one out of eighteen). The economic consequence of the measure was outlined for DOBOR in 2018, which was the reason it was amended to 10:1. Support for the measure was strong with 81% of participants rating it as effective, and 44% suggesting 6:1 as a more effective ratio. Similarly, a study of whale shark swim tour

participants reported that 71% thought six or less divers should be in the water at one time, while less than 13% suggested that 10 or more would be acceptable (Davis et al. 1997). There was agreement over the risk of managing multiple people, particularly in emergency situations. Participants worried that in circumstances where tour groups are far from their boats at the campfire, the risk of an unsafe scenario increases. There are environmental consequences as well. A study of SCUBA divers in the Philippines found that dive guides were less able to correct environmentally-damaging behaviors with larger dive groups (Roche et al. 2016). The measure has the capacity for significant environmental and human safety benefits, but the economic consequence will be greater for smaller businesses already disproportionately impacted by a flat permit fee. The flat fee is therefore that much less effective for the Kona manta tours.

Businesses will find themselves further restricted by site-specific permits, meaning operators will be allowed to conduct their tours in either Makako Bay or Keauhou. This policy was developed to reduce crowding and to prevent the current scenario where "north boats" that would normally run tours in Makako Bay choose to head south to Keauhou. As one participant put it,

> *"none of the boats down at Keauhou go up to Garden Eel Cove. But when Garden Eel Cove doesn't have mantas, all of those boats come down to Keauhou and crowd out the place."*

This was described as a problem and a source of crowding by five of the eleven responding Keauhou operators. The two operators running tours exclusively in Makako Bay described the scenario also and cited it as the reason they refuse to go south to avoid what they perceive as a dangerous and overcrowded situation. Fifty-three per cent (53%) of interviewees expressed dissatisfaction with north boats at Keauhou. One participant did caution that restricting boats to one site or the other will be potentially problematic for those companies based out of Honokōhau harbor, which is nearly 10 miles from Keauhou Bay. Boats launching from Keauhou Boat Harbor, just 2,000 feet from the manta viewing site, can offer lower costs and faster access to their guests. Given the conflict at Keauhou when north boats run their tours south, site-specific permits may be inevitable. Companies running tours only in Keauhou from Honokōhau will have a difficult time competing with closer companies' prices.

Additionally, the measure, *prohibit SCUBA tours within Keauhou* would mean that all Keauhou permit holders would be limited to snorkel tours. Eighty-three per cent (83%) of respondents rated the measure as effective. 10% were neutral and 7% rated the measure as very ineffective (0). One guide from Keauhou complained that diver bubbles impair the snorkelers' experience; in Needham et al.'s study of user conflict at Makako Bay, 69% of participants reported feeling crowded by scuba divers (2018). Fifteen participants were strongly opposed to SCUBA at Keauhou based on personal experience, mostly because of concern for the reef and bottom habitat. Thirteen of fifteen of such respondents were scuba divers and compared the site to Makako Bay where the sandy bottom area of the campfire location is appropriate for divers. These participants felt that

there wasn't a suitable location for divers to participate in the manta ray viewing activities. However, one participant maintained that the coral rubble field at the current campfire spot in Keauhou is suitable for up to 15 divers. Another participant was passionately opposed to the regulation:

> *"[Tours] should be out at the campfire that just keep it in that area. But definitely there needs to be [SCUBA] diving down there for sure. I mean, what? Did the snorkel providers that are down out of Keauhou now don't want the divers down there? That'd be really silly because divers are the ones who started all this. And then they wouldn't even have an industry if it wasn't for divers."*

The history of the Kona manta tours has its beginnings in SCUBA; divers were the first to take their boats into Keauhou Bay in the 1970s, and it was a dive company that implemented the first campfire in the 1990s. Only about thirty years later did the second site at Makako Bay begin where many SCUBA guides prefer to take their tour groups. With the development of the second site, SCUBA became less popular at Keauhou. Similarly, the demographic shift of MWT at Australia's Ningaloo Reef represented a substantial decrease in the proportion of SCUBA divers to snorkelers, and as a result, most operators stopped offering SCUBA due to the higher complexity and costs (Catlin & Jones 2010). Keauhou snorkel tour providers reported that they rarely see divers at the site, and usually only when conditions at the north site bring the north boats down to Keauhou. If SCUBA is prohibited at Keauhou and permits become site-specific, many of the operators offering mixed tours (snorkel and SCUBA) or flexible locations (Keauhou or Makako Bays) will be forced to make a choice, or the choice will be made for them.

Under the new regulations, permits would be limited in their availability. A finite number will be issued per site, and with the measure prohibiting SCUBA in Keauhou, only a fraction of those will be available for SCUBA providers. Operators with commercial permits that describe manta tours as one of their activities will qualify for the new manta permits. DOBOR struggled to identify the exact number of potential permits, as many companies have multiple subsidiary or affiliate companies associated with their commercial license. Owners of larger operations have amassed a portfolio of marine tourism companies, with three or more boats running manta tours under different company names or booking services in a night. Two participants described a scenario in which DOBOR issued an excessive number of commercial permits, and the result was many new entrants rushing into the manta tour business. A local site user whose family have been in the area for generations noted drastic changes in his lifetime:

> *"You go down to the pier…at Honokōhau: I look at all these new boats I've never heard of them. Never seen these captains or whatever they are. I guess everybody can go on the internet, they read about it, and they figure this is a good place to do business. And that's what I see happening…kind of impacts the local people that's been here paying taxes for years and here's these guys just come in and just jump on the train ride… it's big money."*

These concerns were echoed in the Maldives where new entrants were observed complying significantly less with codes of conduct (Brooks 2010), and operators at the whale shark industry in Australia

complained of the lack of experience in new operators (Catlin & Jones 2010). A tour guide operating out of Keauhou and Garden Eel Cove described the problem in more serious terms:

> *"there are some of them (operators) that are just trying to make as much money as they possibly can and they don't care about the mantas, and they don't care about these rules and regulations and they're probably not going to follow them because they just want to make money and get out."*

In common-pool resource theory, Ostrom et al. (1999) describes four categories of users of common-pool resources: (i) free-riders who always behave in self-interest, (ii) those unwilling to cooperate if others undermine the process, (iii) those willing to cooperate and hope others follow, and (iv) those who behave truly altruistically. The behavior of the collective industry has significant influence over the actions of individuals. The Kona manta tour operators had different opinions on who would belong to which group, and the state cannot retroactively punish or exclude commercial tour providers based on the accusations of their peers. DOBOR determined that it lacked authority to set eligibility by a retroactive cutoff date to target newcomers, and so they're forced to either issue permits to all operators when the rules are adopted, or they can set a limit and issue the permits by a nondiscriminatory process like auction or lottery. The risk is that those who have strived to follow the code of conduct and support regulations may not get a permit. Enforcement and attrition then are the default tools for the state to address unsafe and potentially harmful practices.

At a similar ocean recreation site at Molokini Marine Life Conservation District off the island of Maui , permits were implemented in 1981 and issued and limited to 42 businesses conducting tours in 1995 (Chung et al. 2014). Resource managers anticipated that the number of these nontransferable permits would slowly decrease through attrition, but as of 2019, only two permits became unavailable with the closure of a business (Philips et al. 2019; DAR pers. comm. 2020). A user crowding study suggests that the maximum number of boats at the site should be 15 – 16 (Bell et al. 2011), and that once 12 boats are at the site, the proportion of bluefin trevally present is reduced by more than 50% (Filous et al. 2017). No carrying capacity study has been done for the Kona manta sites, though Needham et al (2018) interviewed 444 participants and found that the average tolerance for boat traffic was 11 boats at Makako Bay. Sixty-eight per cent (68%) reported the number of boats in 2012 exceeded their tolerance and as a result, felt more crowded, less satisfied, and less likely to repeat the experience. Three participants in the present study suggested that a carrying capacity assessment is needed prior to promulgation of regulations, or at a minimum, to evaluate and adapt regulations in the future.

Permits, like the moorings and anchoring policies, are a means for reducing crowding at the sites. When limited, they can shield permitted businesses from an overcrowded industry and protect the environment. But in a growing industry, the number of permits may not reflect the capacity of the site. Operators of whale shark swim tours at Ningaloo, Australia cited fear of increasing number of licenses as their greatest issue they'll face over the next decade (Catlin et al. 2012). Five participants, all from the commercial

industry, saw permits as a useful enforcement tool to give the state the ability to suspend or revoke manta tour permits and control the growth of the industry. However, one participant worried that a permitting system would enable companies to force out competitors they dislike. South Africa's shark tour industry faced a similar conflict where operators were accused of supporting regulations that would benefit them and negatively impact their competitors (Dobson 2006). Permits also have the unfortunate tendency to become financial barriers, and two participants worried that a permitting system would exclude young, local entrepreneurs from going into the manta tourism business. The implementation of yet another fee and set of regulations irked participants. As one put it, "DOBOR is all about limitation. They've never asked about how can we grow the industry?" The challenge for the state will be reconciling the competing interests of businesses, the environment, and balancing the needs of the larger socio-ecological system.

Protections & Safety

Measures discussed:

- *Subsurface vessel lighting is prohibited*
- *Non-motorized vessels must use a white light that is visible from 360°*
- *No fishing during manta viewing hours (4 p.m. – 4 a.m.)*
- *Vessels are prohibited from leaving the zone while their passengers are still in the water*

Permits, moorings, and anchoring are all forms of crowding control. As discussed previously in Chapter 1, these regulations are essential for marine wildlife tourism (MWT) but are not sufficient on their own. Explicit protections for wildlife and the marine environment are needed to ensure their wellbeing is prioritized. Fortunately in Hawai'i, state laws were passed in 2009 and in 2019 to make it illegal to knowingly capture, take, possess, abuse, or entangle a manta ray (Coffman et al. 2009; Nishimoto et al. 2019). Similarly, it is illegal in the state of Hawai'i to take, break, or destroy stony corals and live rock (HAR §13-95; 2014). Participants remained concerned that the manta tours needed regulations beyond "no harm" legislation at the state level. These additional regulations could institutionalize in-water conduct already adopted in the code of conduct: no diving down for snorkelers, divers remain seated on the ocean bottom, no touching, etc. There are no regulations for participant conduct, though in Chapter 1 such measures did score sixth overall in the efficacy ranking.

Additional concerns focused around the conduct of boats. The tour companies have used artificial lighting to attract plankton and in turn, mantas since the tours began. It wasn't until recently, sometime around 2012, that boats installed high-lumen lights on the underside of their hulls to attract mantas to their boats. The measure, *subsurface vessel lighting is prohibited* arose from two separate issues: that vessels were creating their own private campfire and drawing mantas away from the other tour boats, and that mantas would become dangerously comfortable near boats and their propellers. Thirteen participants brought up the risks that boat

motors pose to these surface-feeding giants. This was particularly apparent in 2018 when five rays were reported with injuries from boat strikes within the span of two months ("Manta Tour Guides and Operators" 2018; Howard 2018). The impacts of indirect feeding using artificial lights are unknown, but participants speculated that the frequency of injuries observed on these mantas indicates mismanagement, overexploitation, and behaviors that put the mantas at risk.

The human safety measure, *Non-motorized vessels must use a white light that is visible from 360°*, was created primarily in response to the accessibility of the Keauhou site, as the median of the score distribution was significantly greater among Keauhou operators (Test D, p-value = 0.024). Participants of every demographic expressed concern for recreational swimmers entering the bay without any identifying lighting to alert boat captains of their presence. The risk for an incident is substantially greater at night and when there are many boats in a small area. Only two participants rated the measure as ineffective, pointing out that Keauhou Bay is well lit at night and that enforcing the policy, especially on tourists, could be a challenge for the state. A public campaign to bring attention to the requirement would likely include online messaging, signs at the access points, and information at hotels. This could have the unwanted side effect of alerting people that they can swim out to the manta sites in the first place. The industry wants to discourage visitors from attempting a manta swim without a professional guide.

Two measures were rated as effective by nearly all participants: there will be *no fishing allowed during manta viewing hours* and *vessels are prohibited from leaving the zone while their passengers are still in the water*. The exception was one participant gave a neutral rating to no fishing. These measures had the highest average ratings overall (9.08 and 9.73, respectively) and no significant differences in the Mann-Whitney U-tests between demographic groups. The measures required little discussion compared to the other measures. Participants provided anecdotes of fishing at the manta sites, from spearfishing while participants were in the water to trawling fishing lines behind the tour boat. Fishers are more common at Keauhou due to its accessibility. Three participants were concerned for local fishers, but agreed with the reasoning that the area was small and temporary, and conditions would be less than ideal with multiple boats and up to hundreds of people in the water. Two guides admitted that they fish at the sites and that they saw sense in the regulation. Another fisher and site user added that there's little fishing at the manta sites regardless.

The story behind the last and most highly-rated regulation, *vessels are prohibited from leaving the zone while their passengers are in the water*, was summarized by 15 participants when asked whether they thought the measure would be effective or ineffective. At least one company at Keauhou, potentially more, were taking advantage of the relative proximity of the manta viewing site and running a group out from the harbor, dropping them off in the water with a guide, returning to the harbor for another group, and then dropping them off and picking up the first group. The US Coast Guard talked to the operators and the practice

stopped, though no known regulation at the federal or state level prohibits the practice. While a captain and boat are absent from the site, if their participants have a medical emergency, they cannot respond without relying on other companies. As one participant described it, people get seasick on the tours but captains can't run those people back, even if it's only two minutes away, because of the risk for the other passengers. Companies minimize their risk by encouraging their passengers to be truthful about their medical conditions, checking in on passenger comfort levels, and recommending anti-nausea medications and remedies at the time of booking.

Lessons from Marine Wildlife Tourism

In the prior chapter's review of MWT, the most effective measures were identified for the Kona manta viewing sites. These included education, limiting boat counts, limiting passenger counts, spatially-confining tours, and "do no harm" protections. Education is the most glaring omission from proposed regulations at present. As discussed in Chapter 1, MWT participants reported they were either satisfied with or would have enjoyed more education and outreach on their tours. When whale shark tour operators at Ningaloo were asked what three pieces of advice they'd offer other nature-based tour operators starting a business, 5 out of 6 listed providing a quality tourism experience as the single most important component (Catlin et al. 2012), which is improved substantially with knowledgeable guides. Mandatory educational programming does not need to be explicitly established in administrative rule; it could be included as a condition of permit eligibility and incorporated into the budget of the management program. However, by including some measure in reference to education, the program prioritizes what emerged from Chapter 1 as the most effective tool available to MWT management.

One of the limitations of the industry is the turnover and lack of experience among guides. Participants described a hierarchy at some companies where the late nights and long shifts on the manta tours are given to new (and less experienced) employees while veteran employees have a choice of non-manta shifts. Others complained of companies with low standards for guides, noting that these people are in charge of six to twelve customers who may have no prior experience with the ocean, let alone a snorkel.

> *"You need to be able to give [operators] the tools where they can do the right thing, where they can teach the right-[sic] some of the problems I've seen firsthand are people getting hired to work on the water who have no experience at all, who have no ability… these guides need to be trained. They need to be certified lifeguards to supervise people in the ocean."*
>
> *"There's such burnout. There's such frustration. And again, I don't blame the guides. It goes to the companies; the companies are the ones that ultimately put these people in the water."*

The problem was similarly described among whale shark tour guides at Ningaloo Reef in Western Australia (Mau 2008). The seasonal nature of the tours meant work wasn't consistent enough to keep staff

year-round, leading to high turnover and low experience. The government agency developed a Whale Shark Guiding Course which includes health and safety training as a way of standardizing training across the industry. Four participants suggested mandatory trainings for guides at a minimum: "You can't teach all 150,000 people (visitors) a year, but what you could do is possibly make an impact by teaching the teachers." The content most commonly requested in the interviews was safety-related; companies should be required to keep at least one crew member certified in ocean rescue and lifeguarding. The participants who either guided or had been on a manta tour recently reported satisfaction with the educational content of their tour, but one participant mentioned that a debriefing would be valuable and is more effective at framing the experience. Another said the briefings focus primarily on safety and equipment, and could have a richer ecological and conservation component. This was observed on dolphin tours in Hawai'i as well (Wiener et al. 2009) and suggests that companies are not prioritizing conservation outreach for their guests.

A combination of trainings and presentation of tourism research could encourage operators to implement a broader outreach program without the state regulating content. The state could then monitor visitor compliance with guidelines like *no free diving* and *no touching* to evaluate the efficacy of the educational programs. Operators in the Philippines with the *Green Fins* eco-certification offered richer, environmentally-responsible programs for their divers and as a result, had significantly lower reef contact rates (Roche et al. 2016). Studies of visitor satisfaction and knowledge checks would further help gauge the quality of education and where it could be improved. The most effective measure for the state then is to first certify companies and their staff, then monitor the tours for visitor satisfaction and compliance, and adapt policies as needed. The benefit is less state-controlled regulations but using proven strategies of education to promote best practices.

The degree of the state's involvement in manta viewing tours was a polarizing topic. Some participants interviewed wanted no additional regulations, while others welcomed it. One of the more apparent themes was that Keauhou and Makako Bay should be regulated separately. The difference in their benthic habitats, accessibility, ocean conditions, and histories distinguish the two sites as two very different experiences. MWT around the world struggles to find a one-size solution at the international and regional levels. It's consistent then to assume MWT is site-specific as well.

On the other side of the discussion, several participants pointed out that the manta tours were not confined to two sites; a third spot about 20 nautical miles north is developing and has an estimated six boats off of Mauna Kea Beach Hotel. The concern is that regulations shouldn't be specific only to the Keauhou and Makako Bay sites, but should apply to manta ray viewing tourism in general. If companies can offer a similar experience without permit fees or regulations elsewhere, then tours will inevitably spread to new sites. Spatial management must be applied carefully and deliberately, for it has the potential to trigger such unintended

consequences. In Florida, prohibitions on shark feeding drove operators to continue bad practices elsewhere in the unregulated Caribbean (Dobson 2006). DOBOR proposed that the regulations would prohibit all manta viewing activities outside of the sites within a 7-mile radius. The zone of exclusion is meant to protect commercial activity at the regulated tourism sites, but not impede business opportunity elsewhere. With two sites regulated under administrative rule, it will be easier for the state to incorporate future sites into the manta viewing activities program. Given the years of planning that have gone into developing the two primary manta viewing sites, it may benefit the state to begin evaluating the third site at Mauna Kea Beach Hotel before problems arise. With the other two sites serving as a model, the state can reasonably predict that tourism will continue to grow.

Regulations at the two Kona manta viewing sites are imminent at the state level. The phase following planning and initial implementation is likely to be costly. Managers will need to monitor and evaluate conduct, compliance, and environmental impacts. As discussed in Chapter 1, enforcement plays a crucial role in this process and legitimizes efforts to regulate. Lack of enforcement was an emergent theme from the interviews, identified as a weak spot for the state and undercutting participants' confidence in regulations.

> *"The regulations for human safety and no anchoring in coral, we can enforce. Give operators the ability to self-enforce. The other regulations are all just laws no one will be able to enforce. DLNR doesn't have the resources. It's setting themselves up for failure."*

The DLNR Division of Conservation and Resource Enforcement (DOCARE) officers are charged with upholding the laws that protect natural, cultural, and historic resources held in public trust. The agency branch office on Hawai'i island is approximately 23 officers spanning an island with a total area over 4,000 mi^2 (DOCARE, pers. comm. 2018). The north and south Kona districts alone comprise over 75 miles of coastline and typically have less than ten officers divided across multiple shorelines, parks, forests, and conservation areas. Three participants commented on the shortage of officers and the enormity of their responsibilities. Sixteen participants said more enforcement was critical. Participants were supportive of random and frequent enforcement checks in the early phase of implementation:

> *"When they pave a new road, speed limit drops, and the cops are watching it, right? Same thing. We're going to make these new rules now. We're going to enforce it. And then eventually, everybody knows to stop at the stop signs."*

Though divided on the specific measures, the opinions expressed in the interviews were all supportive of more enforcement. In the literature, non-compliance was attributed to a lack of enforcement, emphasized even in studies with high levels of compliance over 80% (Brooks 2010; Kessler & Harcourt 2010; Avila et al. 2015; Schleimer et al. 2015; Sitar et al. 2016). When enforcement capacity is limited, operators can be a useful resource for self-enforcement as proven by the number of reports for illegal anchoring at the sites. However, the state was limited in its follow-through with penalties, exemplifying the challenges it will likely face with

additional manta site regulations. Sanctions and deterrents are not sufficient motivators; education and positive incentives are shown to have more sustainable and lasting influences (Sirakaya & Uysal 1997; Genter et al. 2007; Howes et al. 2012). One participant who studies coastal and marine tourism described an ideal process:

> *"At first you have a lot of enforcement, up front. Train everyone. Catch the bad behavior right away. Then you can cut it back. The operators will mostly self-enforce… you develop the relationship. And it's the relationship that really carries it. Because to enforce, you'd have to have above- and below-water enforcement, which costs, which is time and money. So what you want to develop is a culture of ethical responsibility."*

Overall, despite the prevalence of negative sentiments and the concern over the state's capacity to manage tourism at the manta sites, participants were supportive of the regulations. Average sentiment (7.74) was about halfway between neutral (5) and very effective (10). Members of the community recognized a need to coordinate their tours in the early 1990s. They managed to grow the industry and adhere to a set of best practices written in 1993 and revised annually since 2012. The same companies that founded the tours also gave rise to conservation organizations like Manta Pacific Research Foundation and Manta Ray Advocates Hawai'i. These individuals have played critical roles in promoting legislation such as Act 92 (2002) that protected manta rays from illegal take, and Act 252 (2019) that prohibited all forms of abuse of the animals in Hawai'i's waters. Mantas ray populations are in decline around the world (Ward-Paige et al. 2013). The Kona manta sites are a unique experience where thousands of people are privileged to share an intimate encounter with these marine giants. It is within the capacity of this MWT social environment, from state policy makers to commercial operators to wildlife advocates, to co-produce a management program that works for everyone's benefit.

2.4 Conclusion

During the initial phases of the developing industry, the community took management into their own hands. SCUBA companies were the only operators on the water, and they found common ground between them. The tours were safest for people and mantas if divers sat on the bottom of the ocean and viewed the spectacle in the water column. Combining their artificial lighting into a campfire created a central viewing area, assuring a mutually-successful experience for all participants when mantas were scarce. And companies held each other to an environmental standard to minimize disturbances, prevent their guests from touching the rays, and avoiding injury to the benthic habitat. The coordination and trust among SCUBA companies grew over time as their informal agreement worked for them and their guests. As their alliance strengthened, unfortunately so did their conviction that their way was the best way to conduct the tours. Newcomers arrived at the sites and these attitudes gave rise to new conflicts. The rise of snorkeling companies threatened the integrity of the former standards. Operators wanting to use the sites and the artificial light method splintered off due to crowding, which compromised the campfire model and spurred censure by the established industry.

There was division in the safety of live boating, with those confident in their skills as captains unwilling to change their behavior to assuage concerns. Crowding led to reduced mooring availability, risky daisy-chaining practices, and anchoring on top of corals. These and other issues engendered loud and public confrontations on the water, threats, accusations of dirty dealings, and sabotage.

The industry and government authorities recognized the mounting tension. They attempted to intervene with the best tools at their disposal: stakeholder participation in rulemaking. Facilitated by government agents but steered by community members, the companies tried to revise their standards to reflect the changing nature of tours, but the heavy hand of established practices and the power of a majority outvoted rather than reformed the industry. Not to be convinced by peer pressure, those who rejected the code of conduct continued business as usual. Opinions differ on whether this was the failure of education, process, or moral character. Regardless, intra-industry conflicts eroded the goodwill behind the Manta Tour Operator Standards until the operators behind them decided government regulation was the only way to compel cooperation.

From studies of MWT and co-production of management programs, the top-down approach of enforcement and sanctions is not the most effective. Managers should attempt to understand the positions of everyone involved, and invite their participation in a safe and non-coercive setting. Some participants reported that they were uncomfortable speaking at public meetings, and despite the rich insights and perspectives from all 36 interviews, only 58% had shared their thoughts with DOBOR. There needs to be wider advertising at the beginning of the process so as to bring in a diversity of perspectives, not only among different companies but also among researchers, nonprofits, community organizers, and site users. Processes should be devised to protect those expressing minority viewpoints.

Had a wider diversity of participants been included in the past few years, some of the more controversial measures may have never made it into the final draft. The most problematic aspect of the program is attached to its mooring buoys. In combination with measures like *No live boating* and *No anchoring*, the moorings become the only position from which boats can offer tours. The demand for moorings will exceed the supply, with dramatic implications for the industry and the satisfaction of their guests. Boats could potentially be waiting outside of the sites for an hour or more. In the absence of an organized scheduling or dispatching system, the measure, *regulations will be first come, first served* could increase unsafe boating practices, confrontations between companies, and injuries to mantas as a result of a race to moor. Though assigned moorings, time slots and early/late shifts were rejected in public meeting, the default mooring rule from HAR 13-257 that moorings are first come, first served is a far less desirable alternative, as it is likely to create more conflict than it resolves.

The state should pass only the measures that they are confident will be effective: that it will concurrently improve conditions at the sites without negatively impacting environmental and social systems, that the measure will improve tourist, industry, and community perceptions of the management program, and that compliance will be at a satisfactory level (80% in most MWT efficacy literature). The important thing is that the state does not overextend itself and create more conflict that it solves. There are many social and environmental aspects that have gone understudied, from carrying capacity for the reefs to economic impacts of a permitting system. Overall, care and attention to the efficacy criteria will help identify the measures that have support today, and those that require additional research and discussion. There is an opportunity to co-produce solutions with the diverse expertise in the Kona community. This extends beyond the commercial industry, as many resource managers, conservationists, researchers, fishers, kupuna (elders), and business owners can provide valuable insights. These people should be empowered to suggest solutions, and to research and test their ideas together. DOBOR has limited resources, but by working with community groups who want the best for their marine resources, they have unlimited potential.

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Conclusion

The contents of these pages provide the first methodical assessment of marine wildlife tourism management at the Kona manta sites. Using a combination of MWT literature, industry insights, and community knowledge, the assessment evaluates the regulatory process and content of the management plan. This comes at a critical junction in time when the state is compiling comments on the first institutionalized set of regulations for the manta tours. At the precipice of regulating a growing industry, rife with as much conflict as good intentions, the State of Hawai‘i will establish the foundations for ocean recreation management. DOBOR announced in its 2019 Strategic Plan, *Modernizing Ocean Recreation Management in Hawai‘i*, that it would move away from management and operations of state boating facilities and shift more of its limited resources ocean recreation (DOBOR 2019). Not only will public engagement strategies developed during the Kona manta tours have a direct impact on the effectiveness of the program itself, but these lessons will inform future endeavors in the Division's upcoming transformation.

While it is impossible to know what measures will be most effective in achieving management goals to protect the marine environment and manta rays, and to improve user safety, there are myriad examples to extract from the MWT efficacy literature. The three metrics, impacts, perceptions, and compliance, emerged as the basis for evaluating suitability of a management strategy. No study attempted to address all three of these dimensions at once, but assessing the variety of studies and using a systematic ranking methodology provides a comprehensive means of prioritization. It is beyond the scope of most peer-reviewed works to study all three dimensions, though multiple studies of similar sites and measures improve the depth of knowledge about the multifaceted implementation of MWT management.

Rethinking Measures

Measures should be implemented together to diversify controls and improve the resiliency of the management program. The best tool with the greatest potential benefit is *education for participants and commercial operators*. It has the capacity to improve perceptions, increase compliance, and reduce harmful impacts to marine ecosystems while improving positive impacts like increased philanthropy for conservation causes. Out of a review of 347 measures, education for both tour participants and providers had the most positive evaluations out of any other measure category and the most numerous examples of how such programs can benefit MWT around the world. Education reinforces more direct measures like *self-enforcement (codes of conduct)*, *do no harm*, and *limit the count of boats*. Impact research from the MWT efficacy literature can provide evidence to back some of the measures, and basic facts about the ecology, biology, and

conservation status of these species and ecosystems would enrich site user appreciation for the management program.

While education was lacking and would represent a relatively innocuous addition to the management program. there are other aspects and rules that present significant problems. Introducing moorings as a means to limit site access was the most condemned measure during the interviews. The primary objection was surrounding the measure, *moorings will be first come, first served*. MWT sites use a variety of policies to control crowding, some as simple as numerical caps to the number of boats at the site. These locations face a similar problem whereby limiting access created scarcity and demand that exceeded permitted levels. Evaluations at these MWT locations can provide beneficial insights into the effective implementation of crowding control measures. The use of dispatchers has been successful for the whale shark boats in Donsol, Philippines (Graham & Bustamante 2006) and Mexico (from participant interviews). Scheduling in Placencia, Belize uses a lottery system for a limited number of time slots daily (Graham & Bustamante 2006). Crowding control measures like *limit the count of boats or participants, limit time by tour duration or access periods*, and *limit access through permits* were among the most effective.

The state is limited in its authority to permit manta viewing activities. Permits are one of the most complicated management strategies, complicated by eligibility, conditions, count, cost, duration, and plenty more. The Kona manta permit is no exception. Originally the state planned to enact a cutoff date, which they announced in 2014 that starting in 2015, all operators would need to document consistent weekly manta viewing tours (or justify any lapses due to unforeseen circumstances like boat repairs) to be eligible for a manta permit. The attorney general's office determined that this was outside the division's authority, and they would need to use the tools currently in statute like auction and lottery. If there are less permits available than there are operators who want one, there is a risk that big businesses will dominate the auction process, and that companies leading the industry in best practices and those with multimillion-dollar investments may not receive a permit if issued by lottery. To avoid industry backlash, the division is currently proposing to give permits to all operators with commercial permits that describe manta tours as part of their permitted activities. Total permits available will be reduced by attrition when businesses close, by enforcement if they're consistently violating regulations, and through permit conditions to ensure they remain eligible for permit renewal.

Attrition was unsuccessful in reducing the number of permits for Molokini Marine Life Conservation District of Maui, as only two permits became unavailable over the course of 25 years (Philips et al. 2019; DAR, pers. comm. 2020). To reduce permits within the confines of DLNR's authority, they will need to implement aggressive monitoring and enforcement. This method is imperfect, as eventually the crackdown will have corrected or removed repeat offenders, and the remaining companies will represent those doing their best

to comply. This point will have nothing to do with the site's social and environmental carrying capacity; it's entirely possible the measure will fall short of improving site conditions. The total number of permits is similarly set at the number of companies currently offering tours, without any confirmation that this number is sustainable for the environment and the industry. In a review of licensing nature tourism in Western Australia, these permit caps weren't necessarily the same as what the environment could support, nor what the market could sustain without profits becoming too diluted (Genter et al. 2007).

At the Kona manta sites, it may be too late to effectively cap permits at sustainable levels, but the lessons learned at this rapidly-growing industry are significant for DOBOR's future shift into ocean recreation management. With at least two domestic case studies, the state should know its first step is to commission carrying capacity studies before the industries become overdeveloped. Even before a full regulatory management program is developed, DOBOR can start with permits. The industry asked for the state to close the industry to newcomers in 2014, and six years later, the more complex aspects of the management program delayed the state and compromised the efficacy of its solutions. The slow bureaucracy of rulemaking was a problem for New Zealand's dolphin tours as well. This is problematic for adaptive management, as program managers, their supervisors, and the Chair of the agency are less inclined to engage in the slow rulemaking process. Broader reforms to expedite rulemaking are needed for the state to embrace adaptive management.

Closing the Knowledge Gap

Understanding the scientific basis and social and environmental impacts of the industry can greatly improve perceptions of management, compliance, and reduce some of the negative impacts discussed in this thesis. On the matter of science and research, an important point should be made about the Kona manta sites. DOBOR commissioned a safety assessment in 2015 that concluded, "given the large number of vessels and in-water persons participating in this night-time activity, a severe accident will likely occur in the future without significant mitigation of the existing risk factors (Marine Science Consulting, LLC. 2015 p. 3). This successfully documented the problem, but there is insufficient scientific basis for the proposed solutions. Five years prior, Clark studied the movements of Kona manta rays and concluded that artificial lights from the tours likely cause reef mantas to extend their usual daytime feeding behaviors into the night and delay offshore migration patterns (Clark 2010). One researcher during the interviews voiced the same concerns, and lamented the understudied extent of the industry's impacts. A company owner and boat captain similarly complained that the regulations lacked scientific evidence that their conduct was harmful. These three participants had opposing concerns, but all three called urgently for more research. MWT sites where impact research is conducted documented high incidences of propeller injuries on wildlife (Araujo et al. 2014) and 1 out of 10 mantas with disfigurements (Deakos et al. 2011), more significant behavioral impacts when wildlife is feeding (Blane & Jaakson 1994), and significant disturbances when boats exceeded a critical threshold (Constantine et

al. 2004; Matsuda et al. 2011; Anderson et al. 2011; Chion et al. 2013). These studies all represent knowledge gaps for manta rays using the Kona sites.

As a relatively understudied species compared to cetaceans, corals, and sharks, there is much more the state could learn about the mantas. Hawai‘i legislators passed state protections for the species with testimony on the importance of sharks and rays in tourism, ecosystems, and Hawaiian cultural beliefs and practices (Coffman et al. 2009; Nishimoto et al. 2019). While the role of rays (hīhīmanu; hāhālua; hailepo; lupe) in Hawaiian culture were not discussed in depth during the interviews, they are named in the kumulipo (a Hawaiian creation chant) and kin to sharks (manō) who are important deified ancestors (‘aumakua) in Hawaiian culture (Miner 2015; Nishimoto et al. 2019). Impacts to Native Hawaiian culture and traditions are understudied in MWT development. These can arise from the practice of privatizing submerged lands, institutionalizing western property rights, and creating areas of exclusion (Watumull 1994; Martin et al. 1996). Hawaiian traditions and values persist in natural resource management today, like in watershed management through the *ahupua‘a* mountain ridge to sea approach (Mackenzie 2010). Research that is inclusive of traditional knowledge can complement western science. Dive sites in Fiji incorporated traditions and taboo into reef management (Brunnschweiler 2010). The Shark Reef Marine Reserve management planning included local villages with traditional ownership of the reefs and offered compensations through user fees in exchange for a fishing moratorium where dive operators would have exclusive access. In addition, the dive operators acted as intermediaries between the village and relevant authorities, provided professional Dive Master training, helped monitor the reef, maintain moorings and markers, and training fish wardens. Native Hawaiians used the religious and political *kapu* system, similar to taboo, which was undone in the 1819 Battle of Kuamo‘o between the armies of Liholiho (Kamehameha II) and his cousin Kekuaokalani. This historic battle occurred just south of Keauhou Bay, the birthplace of King Kamehameha III. These systems and other significant values from Hawai‘i’s native people were discussed by several interview participants, some of whom identified as Native Hawaiian. Those in the industry emphasized the importance of representing Hawai‘i in the tours and sharing the significance of Keauhou with visitors. The management program should be carefully assessed to ensure the preservation of these values.

In federal law, the reef manta is not protected like its cousins the giant manta, which was listed as Threatened under the Endangered Species Act (ESA; NOAA 2018). The agency determination outlined a scenario of deficient data, low fisheries impacts, and understudied genetic isolation that could not provide adequate support for listing under the ESA (NOAA 2017). Similarly, Maui and Kona reef mantas lacked scientific evidence to support their status as distinct population segments (DPS), or one that is geographically limited and holds significant value to the adaptive, ecological, or genetic diversity of the taxon (NOAA 2016). When asked about the need for research to reconsider the Kona reef manta’s listing under the ESA, two

industry participants noted that regardless of conservation status, an ESA listing would cause irreparable harm to the industry and should be avoided. Privatization and financialization of the environment have commodified these ecosystems as resources, creating the potential for inequality through a phenomenon labeled "green grabbing" (Fairhead et al. 2012). Conservation is driven by market value; "nature must pay its way (p. 245)". This manifests in the industry's efforts to protect spatially-defined habitat where tours take place, but to oppose conservation protections for species that could threaten the very nature of their industry. Protecting nature is only tolerable to the degree that it preserves or improves its economic potential. As state protections in Acts 092 and 252 prevented only harm and killing, these were in the best interest of the industry and received written and in-person testimony in support of their respective bills. This information should not detract from the contributions the manta viewing industry has made for the species; its purpose is to emphasize the value of a research program both outside of and at the Kona manta sites, and further support the importance of including non-industry perspectives in the planning process.

The lack of research is not only true of the mantas themselves, but also important questions about diver pressures on coral reefs and the carrying capacity of the bays, on the economics of the industry, and the importance in different aspects of the tours on customer satisfaction. How do the artificial light-based tours compare to manta ray viewing in other parts of the world? Could Hawai‘i support the industry on natural feeding and cleaning aggregations alone, if the artificial lighting was found to be ecologically or biologically problematic? There are significant knowledge gaps at the site that partner agencies and organizations could help the state to explore further. Within DLNR, just as the Division of Boating and Ocean Recreation was compelled to manage tourism at the sites, the Division of Aquatic Resources should develop a monitoring program to study the basic ecology and biology of the species. Partnerships with nonprofits, academic institutions, and industry This is an essential part of effective management, and it is unrealized at present.

Reforming the Process

In a previous review of MWT programs, the authors concluded that the greatest obstacles for effective management were a suitable framework, research, enforcement, and best practices (Trave et al. 2017). The Kona manta sites program is currently lacking resources for an adaptive and comprehensive ecosystem approach that uses research to evaluate effectiveness. Enforcement is similarly limited, as the DLNR Division of Conservation and Resource Enforcement (DOCARE) had just 23 officers to cover all of Hawai‘i island in 2018 (HCRI 2018). No more than ten officers are stationed in the Kona districts, and far less than that will be patrolling its 70-plus miles of coastline. Independent of DOBOR's shift to ocean recreation, DOCARE is also investing more resources into its marine patrols program to remedy coverage in nearshore waters. The Department's enforcement division was severely constrained by a requirement that their officers must already be trained in law enforcement police academies. In recent years, DOCARE began to develop and recruit cadets

to its own DOCARE Academy, which will train conservation resource officers with no prior law enforcement experience starting in 2019 (Dennison 2018). For many years, DLNR has fielded concerns from the community regarding enforcement and the low capacity for implementing their rules. This point, repeated in the interviews, is well known to DOBOR and the Division investigated the feasibility of an independent contracted observer to document violations at the sites, similar to a security guard or fisheries observer. Unfortunately, the Attorney General's office notified the Division that this, too, was outside of their authority.

With enforcement falling heavily on overburdened law enforcement officers, management programs will need to use creative and innovative methods to promote compliance and self-enforcement. This starts in the earliest phases of scoping. When regulations are representative of all viewpoints and all stakeholders are included in the discussion, there is more personal investment in a regulation. This is noticeable from the interviews, as the participants who were involved in formulating *moorings are first come, first served* scored the measure as very effective compared to those who were not, and scored it much lower. But involvement in the planning process alone is not sufficient. Some operators who participated in the manta tour guide standards workshops in 2012 – 2013 left unsatisfied and rejected the majority consensus. Part of the issue could be ameliorated by raising the standard of the majority from 51% to 80%, taken from the MWT efficacy literature that evaluated compliance positively at this higher threshold. Research for more controversial measures can help inform the process, and should be at the foundations of all measures being considered. When regulations are co-produced in this way, and stakeholders are not only given a vote but also a role in policy research and formulation, efficacy is increased by all three metrics (perceptions, impacts, and compliance). Official enforcement can then be applied to legitimize the process, and sanctions should be gradual to encourage correction before more severe punishments are used (Ostrom 2012 p. 90).

Ostrom, whose work on CPRs won her the Nobel Prize in Economics in 2009, identified seven essential principles for long-enduring management: (1) defined boundaries, (2) appropriate customized rules, (3) inclusion of all stakeholders in rulemaking, (4) monitoring conditions and behaviors, (5) graduated sanctions, (6) conflict-resolution tools, and (7) rights to organize (Ostrom 2015). Ostrom goes on to emphasize that monitoring and sanctions should be carried out by stakeholders themselves instead of relying on an external authority. These theories are useful for tourism, which very often depends on a CPR of a non-traditional form. The exhaustible ecosystem services that sustain tourism can become compromised by pressure imbalances, particularly in the absence of regulations and monitoring. The Kona manta sites satisfy the conditions for CPRs described by Ostrom (1999) and Moore and Rodger (2010): Hawai‘i's nearshore resources are accessible to everyone (non-excludable) but the spatial limitations of these manta viewing bays create conditions of subtractability. Only so many boats, snorkelers, and divers may access these sites before perceptions of crowding, unsafe conditions and environmental harm manifest. Moore and Rodger go on to

include non-compliant operators who conduct their businesses illegally as evidence of Ostrom's free-rider user group (those who act in their own self-interest to the detriment of the community) and tourism sites' non-excludability. By treating the Kona manta sites as a CPR, managers can apply Ostrom's seven principles to the effective management of the industry.

The state of tourism in Hawai'i is at once increasing and deteriorating (HTA 2017, 2019). The Hawai'i Tourism Authority (HTA) documented steady growth in both its annual visitors and their spending since 2012 (HTA 2019). Despite the significant role tourism plays for Hawai'i's economy, residents reported declining support for the sector due to overcrowding and a rising sentiment that tourism does not benefit residents (Foster 2018). Hawai'i island residents reported the lowest satisfaction in the state with the HTA's performance in overcoming obstacles for sustainable growth (OmniTrak Group Inc. 2017). The island received 1,761,489 visitors in 2017 (an increase of 13.6% from the previous year) (HTA 2019). This trend likely indicates a corresponding rise in marine tourism, and with it the need for proper ocean recreation management systems. While the number of these visitors who participate in the Kona manta ray viewing tours isn't quantified in any study to date, three out of five of the most popular tours on Hawai'i island are manta ray viewing tours (TripAdvisor 2019) and the Travel Channel included the experience in its roundup of the top ten things to do in a lifetime (Yu 2015). In 2012, O'Malley et al. calculated the direct economic impact of the Kona manta ray tours to be US$3.4 million dollars (2013). If the industry's growth was proportional to that reported by the Hawai'i Tourism Authority (2019), then a crude estimate accounting for annual inflation (Bureau of Labor Statistics 2019) would put the Kona manta tours' economic value closer to US$6.2 million dollars in 2017. In this study's interviews, one of the larger companies reported US$2 million gross annual revenue from the manta tours alone. Like tourism statewide, the Kona manta sites run the risk of rapid expansion that compromises the integrity of the industry and the environment.

The scope of this thesis was to develop an MWT policy evaluation tool, apply it to the Kona manta sites, and identify the best path forward for effective management. The state's best resource for effective management is the ecosystem-based approach. Through an inclusive and empowered co-production process, top-down supplemental enforcement, and recurring research and monitoring, the state can overcome many of the limitations discussed in this thesis. Its greatest underutilized resource is its community, which shares the department's values of preserving Hawai'i's natural resources for present and future generations. Study participants reported advocating for manta ray protection bills in the state legislature, providing environmental education to visitors, and sharing concerns for the marine environment. Several studies have documented environmental attitudes among Hawai'i's visitors, residents and Native Hawaiian and Pacific Island groups (Shapiro 2006; Choy & Prizzia 2010; Needham & Szuster 2011; Wiener et al. 2016; Sutcliffe & Barnes 2018). For many years, DOBOR engaged in a conversation with segments of the industry, but their expertise can be

substantially supplemented by the collective knowledge of the greater community. Stakeholders have a shared interest to develop a functional management program. The state can yield some of its discretionary powers to community groups and build partnerships this way. Collaboration will help the state to restore the people's trust and confidence in the agency, and to legitimize the management program they choose together. The particulars of regulatory measures will vary from case to case, but the underlying recommendation is to establish a partnership and dismantle misconceptions and conflicts. "In every bit of honest writing in the world, there is a base theme. Try to understand men, if you understand each other you will be kind to each other… try to understand each other" (Steinbeck 2000).

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