Perceptions of responsibility for changes in reef and coastal ecosystems among West Hawai‘i beachgoers

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Executive Summary

Coral reefs and nearshore ecosystems are in decline worldwide due to local and global anthropogenic stressors, including climate change, runoff, marine debris, overfishing, and more. In 2014 and 2015, the western portion of Hawai‘i Island, or West Hawai‘i, experienced a coral bleaching event that led to the death of up to 99% of coral in some areas. Understanding how residents and visitors perceive these changes and what is causing them can have important implications for how resource managers and environmental advocates communicate to the public both the risks to reefs and what individuals can do to address them.

This report assesses management-related concepts, including perceived changes in reef condition, causes of those changes, and desired management actions, described by interview participants in West Hawai‘i. We collected data in the summer of 2018 and spring of 2019 using a short, one-question interview with 330 participants at three beaches in West Hawai‘i: Kīholo Bay, Pu‘uhonua O Hōnaunau, and Puakō. Of the 164 resident and 166 visitor respondents, 40% of residents offered unprompted perspectives regarding who or what was responsible for observed changes in the reefs, and 12% of visitor respondents offered the same.

We compared resident and visitor responses, and found statistically significant differences in the frequency of mentions of certain proximate causes of decline (sunscreen, marine debris, and mechanical harm to the reef). We also found that among resident respondents, proximate causes of decline were mentioned at much higher rates than distal causes like climate change. We compared the three survey locations but found no differences in responses between them.

Sunscreen was the most frequently mentioned cause of reef decline among respondents, even outpacing mentions of climate change, despite both the fact that there is no in-situ evidence that sunscreen is causing reef decline in Hawai‘i (Wood 2019) and that climate change has been found to be a more significant cause of reef decline than “direct anthropogenic stressors” (Welle et al. 2017). We suggest that the dominance of sunscreen in the discourse about reef decline in West Hawai‘i at the time of these interviews may be due to the fact that a bill prohibiting the distribution of sunscreens containing oxybenzone and octinoxate in Hawai‘i was passed in the summer of 2018—the same time the interviews we analyze here were taking place. Additionally, the fact that perceived damage from sunscreen is an impact of local origin may make it more present in residents’ minds.

We suggest that environmental managers might adjust public education campaigns to correct misperceptions about the relative impact of stressors like sunscreen (less than perceived) and climate change (perhaps more than perceived), while acknowledging that a shift in the messaging about sunscreen could undermine local trust in government and NGO actors.

Finally, this method demonstrates the potential for brief, one-question interviews like those used here to elicit in-depth information about a topic while being quick enough to obtain a relatively large sample size. Additionally, the anonymity and low commitment required by respondents to participate in these interviews are responsible, we relieve, for the high opt-in rate; almost all of the individuals we approached for an interview agreed to participate.

Introduction

Globally, coral reefs and nearshore ecosystems are in decline due to a variety of local and global anthropogenic stressors (Pandolfi et al. 2003; Hughes et al. 2018). West Hawai‘i, the western portion of the island of Hawai‘i (sometimes called the “Big Island”) has also seen declines in reef and nearshore ecosystem health (Foo et al. 2021; Grossman et al. 2021). In 2014 and 2015, coral reefs around Hawai‘i Island experienced severe bleaching, with some reefs suffering 55−99% coral loss (Hawai‘i Division of Aquatic Resources 2016). Meanwhile, the population of Hawai‘i County has increased by 1% per year for the past decade (U.S. Census n.d.), and development in the region is accelerating to accommodate both tourism and an influx of residents from other Hawai‘i islands, the U.S. mainland, and other countries. Additional threats to these delicate ecosystems include agricultural and sewage runoff (Yoshioka et al. 2016; Foo et al. 2021) and declining fish populations due to fishing pressure and the aquarium trade (Friedlander et al., 2018; Grafeld et al., 2017; Kittinger et al., 2011).

The findings discussed in this report are derived from a series of very brief (usually less than 2 minutes), semi-structured interviews, which we have called “turbo interviews.” Residents and visitors of West Hawai‘i were asked what coral reefs mean to them or how these reefs affect their well-being. During the interview process we found that many participants discussed topics related to management and changes in reef condition despite not being prompted to do so, and these topics were identified as being of particular interest to NOAA Fisheries because of the agency’s role in managing reefs and coastal areas. The purpose of this report is to specifically assess unprompted attributions of responsibility for reef change made by study participants, including both whom and what participants claimed was responsible for changes they had noticed. We also briefly describe the few responses that mention reef and coastal land managers specifically.

Coral reefs and human populations have been intertwined on Hawai‘i Island for millennia. For example, reefs were and continue to be an important source of food for Native Hawaiians, and more recently, Western settlers and others who were brought or have moved to the island. A recent study found that just the small-scale fishery of Kīholo Bay in West Hawai‘i provides more than 30,000 meals worth of seafood per year (Kittinger et al. 2015). Coral reefs also serve as sites of deep cultural importance; many Hawaiian heiaus, or temples, are located on shores near reefs, and several ‘aumākua, or family gods, are reef species. Today, coral reefs are also an important draw for tourists and serve as recreational and social sites for local island residents. As humans interact with, impact, and rely upon reef ecosystems, it is critical to understand their perceptions of reef health and reef management so that managers and reef advocates can correct misconceptions and respond to the public’s concerns.

While managers of reef and coastal areas in Hawai‘i, including the state’s Division of Aquatic Resources (DAR), the West Hawai‘i Fishery Council, NOAA Fisheries, and others often solicit formal input on proposed rules or regulations from engaged and interested publics through processes such as public comment periods, this project engaged an audience managers typically do not hear from—general beachgoers. As such, the findings described here provide important insight into the types of management concerns that are immediately salient to this large and typically under-surveyed audience. It is critical for natural resource managers to understand average users’ observations and opinions of the health and management of the places over which

they have jurisdiction or influence, as these users are the people interacting with those places in the highest numbers and, aggregately, most frequently. As such, they represent a large group of people who are both heavily affected by and can directly affect the condition of those ecosystems; for example, by being careful not to cause mechanical harm to reefs. Furthermore, because they are often less engaged in conversations around environmental condition than resource managers and activists, many may be ill-informed about current ecosystem condition, trends, or agents of change. A formal knowledge-attitudes-perceptions (KAP) survey of coral reef resource users in the South Kohala region of Hawai‘i Island was conducted in 2012 and 2013 (Grace-McCaskey 2016). One of our interview sites, Puakō, overlaps with this study area. The survey found that most respondents reported knowing little or nothing about reef and nearshore ecological health, although a plurality were “satisfied” with ecological conditions in most of the dimensions listed. The majority of respondents thought ecological health indicators were declining or staying the same.

One of NOAA’s responsibilities is stewarding the nation’s ocean resources and their habitat. West Hawai‘i is one of the large marine ecosystems that is part of the Integrated Ecosystem Assessment Program, which strives to support healthy and resilient communities, economies, ecosystems, and human well-being. Understanding West Hawai‘i beach-goers’ perceptions of responsibility for reef and coastal change can help identify topics that may be productive areas for public education campaigns (e.g., if perceptions about the causes of reef and coastal ecosystem condition changes tend to be inaccurate, or inaccurate for certain groups), or areas where management actions could be changed to address beach visitors’ concerns. Deepening understandings of public perceptions of environmental change can help resource managers target public education and outreach campaigns to best build on the audience’s existing knowledge and target specific gaps or inaccuracies (Amadieu et al. 2009; Cooke et al. 2017). Furthermore, understanding users’ interests and concerns can help build trust between resource managers and resource users, and recent work suggests that trust between these parties is a critical component of effective environmental management (Coleman and Stern 2018).

Study Context

The west coast of Hawai‘i Island, often referred to as West Hawai‘i, is home to diverse human and natural communities. Stretching more than 100 miles from the northern to southern tips of the island, West Hawai‘i has a rich coastal ecosystem, including coral reefs, anchialine ponds, and a mix of sandy and volcanic rock beaches, which provide a range of ecosystem services and support a variety of relationships between people and place (Ingram et al. 2018, Pascua et al. 2017). However, during the 2014−2015 global coral bleaching event, coral reefs around Hawai‘i Island experienced severe mortality, with some reefs suffering 55−99% coral loss (Hawai‘i Division of Aquatic Resources 2016). Meanwhile, the population of Hawai‘i County has increased by 1% per year for the past decade (U.S. Census n.d.), and development and marine-based tourism in the region are accelerating, increasing pressures on the island’s ecosystems. The primary resource managers of the marine and coastal system in this region are the State of Hawai‘i Division of Aquatic Resources (DAR), and NOAA.

Tourism is a major contributor to the economy of Hawai‘i, and on Hawai‘i Island, most of the hotels and tourist destinations are located on the west side of the island. In the summer of 2018, when the majority of the interviews assessed in this report were conducted, the Kīlauea volcano in the southeastern

portion of Hawai‘i Island underwent a new large eruption, reducing the number of visitors to the island by approximately 12% (Schaeffers 2018) and causing nearly daily volcanic smog, or “vog,” which is air pollution resulting from the reaction of sulfur dioxide with sunlight, moisture, and oxygen. Most days in Kona, during the volcano eruption, had severely reduced visibility and unhealthy air quality.

Additionally, in May 2018 Hawai‘i became the first state to pass a bill prohibiting the distribution of sunscreens containing oxybenzone and octinoxate in an effort to address one cause of coral bleaching. Oxybenzone and octinoxate have been found to damage corals if present in sufficient concentrations (Danovaro et al. 2008, Downs et al. 2016). The ban went into effect in 2021, but the law received considerable media coverage around the time of its passing, and outreach and education campaigns had already begun when we performed the interviews for this study (Levine 2020).

Methods

The data assessed in this report were originally collected as part of a study to assess experiences of cultural ecosystem services on reefs and nearshore ecosystems in West Hawai‘i. Inspired by free-listing approaches to examining cultural values of nature (Bieling et al. 2014, Jones et al. 2020), we conducted brief, semi-structured interviews with 330 individuals at three beach locations in West Hawai‘i—Pu‘uhonua O Hōnaunau, Puakō, and Kīholo Bay—during June and July 2018, and March 2019 (Figure 1). The study locations were selected with guidance from the West Hawai‘i Division of Aquatic Resources to reach a diverse population of residents and visitors, and because they represent a range of coral reef health.

Freelisting is an approach most commonly used in ethnographic cultural domain analysis to explore how different people conceptualize the ideas, feelings, and experiences associated with a particular cultural domain. The hallmark of the method is asking individuals to freely list (hence the term “freelisting”) all of the ideas, things, or concepts they associate with the topic in question. Some researchers have adapted the approach to better understand the connections between concepts such as cultural ecosystem services and/or well-being in a particular place, prompting respondents with just one question (e.g., Bieling et al. 2014). We took a similar approach, testing two different core questions but asking each respondent only one, plus clarifying follow-up questions. Since we were not asking respondents to list ideas but rather to simply respond to a one interview question, we have referred to this approach as “turbo interviews.”

Because we wished to reach hundreds of respondents for the interviews, it was not possible to get an exhaustive, statistical sample of the population of beachgoers. To most efficiently reach as many beachgoers as possible, we decided to do the interviews at the three beach study sites and use a convenience sampling method. We visited the three beaches at different times of day and different days of the week throughout the study period in an attempt to avoid bias in our sample due to patterns in beachgoer visitation times (e.g., families with kids may be more likely to go to the beach on weekends).

To limit the potential influence of researcher choice of respondents, we asked every individual over 18 years of age or every group (one respondent per group) on the beach whether they would be willing to participate in a one-question interview about coral reefs. If there were more people on the beach than we could speak with in our available time, we started at one end of the beach and approached every individual or group until we were out of time. Those who agreed to participate were given a brief introduction explaining that we were asking people about the reefs and coastal areas, and then asked one question, alternating between “What do coral reefs mean to you?” and “Do coral reefs affect your well-being? And if so, how?” We asked natural follow-up questions to prompt further elaboration on participant responses, continuing the conversation until the participant indicated they had nothing else to share or moved on to unrelated topics.

Responses varied in length from a few seconds to 20 minutes, and were either audio recorded or, in instances in which participants wished not to be recorded, transcribed to interview notes (n = 8). Participants also noted their age, gender, primary place of residence, ethnic identity, and highest completed level of education on a small card. We subsequently transcribed and coded the

audio recordings. To ensure we analyzed only the participant's ideas, we stopped coding if the interviewer introduced new concepts or ideas that the participant had not mentioned.

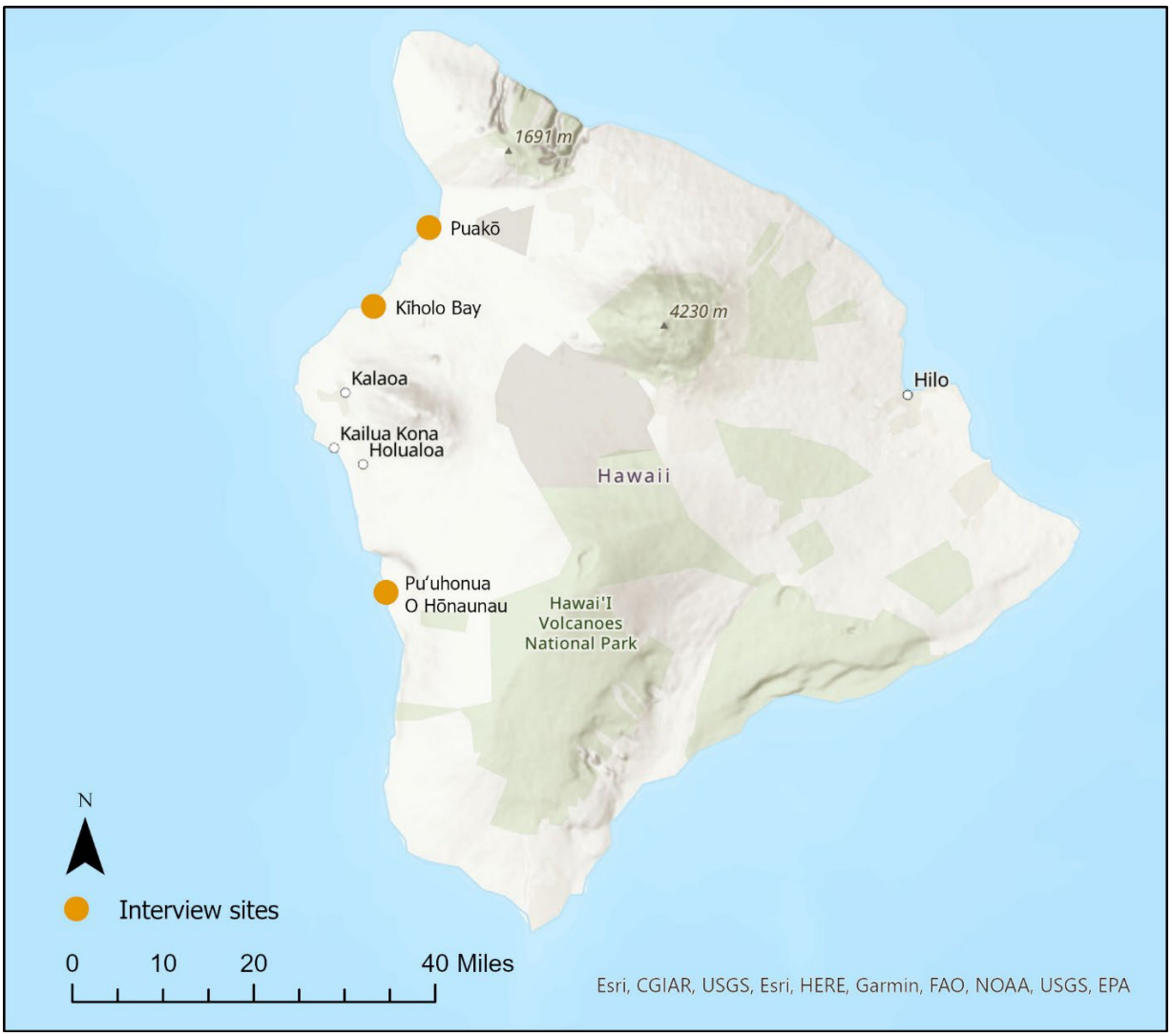

Figure 1. Map showing Hawai'i Island and the three interview sites.

The codebook was developed in collaboration with Rebecca Ingram (NOAA Fisheries), who recently conducted a study as a researcher for the Joint Institute for Marine and Atmospheric Research in partnership with NOAA interviewing conservation leaders in West Hawai'i about their connections to the coastal ecosystems in the region (Ingram et al. 2020). We chose to co-develop a single codebook for both of our analyses to facilitate potential future comparisons across our respective data sets. Codebook development proceeded iteratively, beginning with a set of a-priori codes based on existing literature on cultural ecosystem services, relational values, and well-being (Chan et al. 2016, Gould & Lincoln 2017, Millennium Assessment 2005, Pascua et al. 2017), as well as the interviewers' knowledge about reef and coastal change and governance topics that surfaced during the interview collection phase. Initial codebook development was followed by trial applications to both datasets, followed by refinement and addition of emergent codes. This process was repeated until both Adams and Ingram were

satisfied that the codebook captured the most important themes and topics from both sets of interviews. Throughout codebook development, authors Adams and Leong consulted with two additional PhD students working on related topics, who provided feedback to resolve confusion between the codebook developers about definition and appropriate application of codes.

This combination of deductive (using a priori cultural ecosystem services concepts) and inductive (remaining open to emergent codes) approaches reflects a pragmatic epistemology and recognition of the reality that it is neither possible for researchers steeped in the topic of their research to eschew all prior knowledge and frameworks in developing a codebook, nor reflective of respondents' experiences to disallow emergence of additional themes i.e., codes, (Roberts et al. 2019).

The codebook spanned a wide range of topics, including observed changes in the reefs and coastal ecosystems; responsibility for those changes; and various aspects of well-being such as non-material values or cultural ecosystem services, governance considerations, provisioning and supporting ecosystem services, and others. This analysis explores only the responsibility for change codes, as Adams is analyzing many of the other codes for her PhD dissertation research.

Although our questions did not ask about changes in the reefs, responsibility for those changes, or management of the ecosystem, many participants brought these topics up of their own accord. For the purposes of this report, we analyzed only these portions of the responses to assess whether there were any patterns among the respondent pool about ecosystem management concerns or about participant perceptions of who or what is responsible for changes in the reefs.

Using a Z test for two proportions, we assessed differences between responses of Hawai‘i residents and those of visitors, as well as differences in responses by location. Because there were three locations and many respondents did not mention responsibility for change at all, for the location assessment we used only those categories of responsibility that had at least ten mentions across the entire sample.

Results

Participant characteristics are described in Table 1. The age range is skewed slightly low compared to Census demographics for the county. Just over half of the respondents listed somewhere other than Hawai‘i as their primary place of residence.

Table 1. Respondent characteristics.

	Count	Percent of total (%)
Age		
18−25	37	11.2
25−39	98	29.7
40−59	139	42.1
60−79	54	16.4
80+	1	0.3
Unknown	1	0.3
Gender*		
Men	170	51.5
Women	160	48.5
Place of residence		
Hawai‘i	164	49.7
Other U.S. state	145	43.9
Other county	21	6.4

*Gender was asked as an open-ended question; all participants answered “male,” “man,” “female,” or “woman.”

Respondent attributions of responsibility for changes noticed in the reefs and coastal ecosystems are summarized in Table 2. It is important to note that these results are not generalizable to either the resident or visitor populations of Hawai‘i since the sample was from only three beaches on the west side of Hawai‘i island and was non-probabilistic. Still, they indicate potential patterns that may be able to inform management or education efforts.

Overall, climate change (especially coral bleaching), and pollution (especially sunscreen), were the main processes to which respondents attributed reef decline. The majority of respondents who attributed change to a group of people simply blamed “society or people generally,” though a handful of participants (n=6) blamed politicians. Hawai‘i residents were much more likely to attribute change to pollution rather than climate change, as compared to visitors who attributed to change to each of those processes at nearly equal rates. This aligns with recent work that found nitrogen pollution to be the dominant driver of decreases in fish biomass, when compared with fishing pressure and habitat factors (Foo et al. 2021).

The residents who did mention climate change often mentioned their *own* observations of changes in the reefs, using phrases such as "the reef looked good today," or "when I see [the reefs]," or "when I go diving." For example, one resident, an 80-year-old man, stated: "I've been diving all my life and it's the worst I've seen the coral reef. […] last year the worst I've seen the coral reefs cuz I do a lot of diving, the free diving and I can see it." In contrast, visitors would speak about climate change in more general terms, often bringing up the Great Barrier Reef or things they had heard about the impact of climate change on reef health.

Across the entire sample, sunscreen was brought up as a cause of reef and coastal changes as often as climate change, though the vast majority of mentions were by island residents. Many residents' responses indicated that sunscreen was a leading—or at least very salient—cause of decline in their minds. For example, a 55-year-old male resident said, "…that's why they're worried about the sunscreen and stuff killing [the reef]." Another (56-year-old male) used similar wording: "…[the reefs are] being damaged by, you know, suntan lotion and all that, that I know." Across the sample, these kinds of statements occurred relatively often; respondents would bring up the declining health of the reefs and mention only one or two specific causes, very frequently including sunscreen.

Hawai‘i resident respondents were significantly more likely to make attributions of responsibility for changes—whether to a process or system or a group of people—than visitor respondents. These results are at least in part due to the fact that residents were more likely to mention change at all, although the difference between residents and visitors in terms of mentions of change were less stark (60 residents mentioned changes, while only 44 visitors did).

Only 5 respondents brought up specific management concerns. One respondent, a local resident man in his twenties, mentioned that increased access to Kīholo Bay has affected their experience of the shoreline by making it more crowded: "We used to come here years ago and there used to be a road where you couldn't even come down here. I used to dive out here and my dad used to park his boat right here." The concept that increased access to the beaches has affected some longtime residents' experiences of these areas was an important theme in longer interviews with residents conducted during the same time by Adams and a research assistant (Gould et al. 2020), even though it was mentioned infrequently in the turbo interviews.

Additionally, 2 respondents (0.6%) expressed a desire for more regulations; one was not specific about the kinds of regulations they desired, while the other wished for stricter regulations for boat moorings. Finally, 2 respondents expressed support for conserving reef areas and propogating and planting corals.

Notably, several respondents mentioned their own efforts to police the behavior of others to protect the reefs. For example, one respondent, a 36-year-old woman who lives near one of the interview sites said "I'm the first person that actually goes over there and says 'Hi guys! I see you're using your Coppertone… can you please read this?' " Another (35-year-old female) mentioned the frustration of having to tell people not to stand on the reef: "I have to kind of like, um, scold or yell at [people] several times a day to stop standing on it. […] It's kind of hard, you know?" These respondents recognize the harm being done, attribute it to uneducated visitors, and feel that it is incumbent upon them to address the issue themselves.

There were no significant differences (at $p < 0.05$) between mentions of responsibility for change between the three survey locations.

Table 2. Participants' unprompted attributions of responsibility for changes in reefs and coastal ecosystems.

	Hawai'i residents	Visitors	Total
What is responsible for changes**	53	18	71
access issues	2	0	2
certain fishing practices	3	1	4
climate change	15	11	26
coral bleaching	9	5	14
ocean acidification	0	2	2
sea level rise	0	1	1
warming water	2	2	4
development	2	1	3
economics	2	0	2
invasive species	1	1	2
management or regulations	5	1	6
mechanical harm to the reef*	11	3	14
overfishing	3	1	4
pollution**	38	9	47
ag or other fertilizer runoff	3	0	3
*marine debris**	9	1	10
plastics	0	1	1
sewage	3	0	3
storm water runoff	1	0	1
*sunscreen***	20	6	26
population increase	2	0	2
volcano	0	2	2
Who is responsible for changes**	13	2	15
government or politicians	3	3	6
immigrants	1	0	1
recreationalists	2	0	2
society or people generally	7	8	15
tourists	1	4	5

*Significant difference between resident and visitor respondents at $p < .05$
**Significant difference between resident and visitor respondents at $p < .01$

Groups responsible for changes are based on language used by interviewees. For example, though tourists and recreationalists may overlap, it was not clear from interviewee language whether "recreationalists" were also "tourists," or vice versa. Thus, these categories were kept separate. Additionally, please note that some interviewees mentioned more than one cause or responsible actor for reef decline. For example, an interviewee may have mentioned both overfishing and development as causes of reef decline, counting as 1 in each of those rows, but would still only count as 1 interviewee (rather than 2) bringing up any cause of decline in the "What is responsible…" row. Thus, the values in the "What is responsible…" and "Who is responsible…" lines are lower than the sum of their constituent rows.

Discussion

Sunscreen and salience

Sunscreen was the most frequently mentioned cause of reef decline. This is additionally interesting because of the significant difference in focus on that topic by residents compared to visitors, and because of the outsize emphasis on sunscreen as a cause of decline compared to other important causes of decline, such as climate change. Indeed, there is a lack of in-situ evidence of sunscreen concentrations causing coral death (Wood 2019), and recent research on the 2005 global bleaching event found that "climate stressors far outweighed direct anthropogenic stressors in driving coral health outcomes" (Welle et al. 2017). Climate change was the second-most mentioned cause of reef decline in this study, but a high frequency of mentions of climate change is to be expected due both to its close connection with reefs in the media (Abelson 2020), and the fact that reefs in West Hawai‘i had suffered significant mortality due to high water temperatures only a couple of years prior to this study.

The fact that sunscreen was a dominant response at the same time that a ban on sunscreen chemicals was passed and outreach and education campaigns regarding harmful sunscreen chemicals were launched may lend support to the idea that attributions of responsibility for reef decline in these interviews better indicate issue salience than importance. However, studies of media agenda setting and environmental issues found a moderate correlation between personal importance and media salience of issues, suggesting that even if respondents in this study had been asked directly for the causes they felt were most important, their answers might have been similar (Atwater et al. 1985).

As previously mentioned, the passage of the bill prohibiting the distribution of sunscreens containing oxybenzone and octinoxate the same summer that most of the interviews were performed likely affected our results. Levine (2020) found that outreach efforts to educate the public about the impact of oxybenzone and octinoxate on coral reefs had been "extremely successful," as indicated by the fact that the vast majority of Hawai‘i residents and the majority of visitors she surveyed were aware of the issue. Our results corroborate the finding that these efforts were very successful with residents, but suggest that they had not had as significant an impact on visitors. The perceived effect of sunscreen chemicals on reef health was present enough in residents' beliefs about reef decline that 20 resident respondents brought up the issue unprompted.

An additional possible explanation for the comparatively high number of resident respondents mentioning sunscreen as a cause of decline is that doing so may comfortably locate blame for the issue on others. Respondents who mentioned sunscreen consistently referred to users other than themselves, or, when they mentioned themselves, said that they use reef-safe sunscreens or try to do so. A recent study in a different part of Hawai‘i on sunscreen use and awareness of sunscreen harm to reefs found that 80−90% of non-resident surveyed beachgoers were wearing sunscreen, compared to 70% of residents. Furthermore, of these respondents, visitors used sunscreens containing oxybenzone and/or octinoxate at higher rates than residents (although the difference was only 2.7−11.3 percentage points) (Levine 2020).

Proximate vs. distal causes of decline

Perceived origin of pressures may also have affected local respondents' tendency to mention local pressures, like sunscreen, mechanical harm to the reef, and marine debris, at higher rates than those mentioned by visitors. Horowitz et al. (2018) found that local direct users (fishers) of a resource perceived more proximate pressures (5) on the fishery than distal pressures (1). Residents in our study mentioned these local causes of decline more than three times as frequently as climate change causes. This may simply reflect that local users are more likely to be aware of pressures of local origin or visible local impact. An alternative potential explanation is that local users mention causes of decline over which they have more perceived control. According to the theory of planned behavior (Ajzen 2002), perceived control has a significant impact on whether individuals take action on a particular issue; whether it also affects perceptions of causes of environmental decline bears further investigation. A recent study by Ingram et al. (2018) provides some evidence that local pressures have or are perceived to have a particularly strong effect on the health of West Hawai'i coral reefs: in a series of workshops and surveys, three of the four strongest ecosystem pressures identified by marine resource experts and stakeholders were locally manageable. Importantly, while sunscreen pollution and mechanical harm to the reef, whether real or perceived, are both of local *origin*, much marine debris is not (but it can be managed locally—at least theoretically—with clean-ups).

Management and public education implications

Respondents did not often mention specific management actions, but these findings still have potential implications for management of marine resources, and particularly for communication and public education campaigns.

The prevalence of topics like marine debris and sunscreen in the responses suggests that campaigns by resource managers and conservation non-profits to increase public awareness on these topics are having an effect, particularly on residents. However, these results also suggest that more attention could be paid to the role of other stressors in causing coral reef ecosystem decline, and that more work may be needed to both educate tourists about stressors and correct resident misperceptions about the importance and scientific evidence supporting the effects of various stressors, particularly sunscreen. Educating tourists may be especially important to help mitigate the sense among some residents that they must police the behavior of others to ensure protection of the reefs.

The heavy focus among respondents on sunscreen as a cause of reef decline could be promising, if it means that individuals are actually changing their behavior in response to public education campaigns. Research on pro-environmental behavior (PEB) suggests that there may be a "positive spillover" effect, in which one PEB leads to more PEBs. If this is true, it may behoove resource managers to continue to focus on easy-to-change behaviors addressing proximate causes in their public education and outreach efforts, with the hope that changes in these behaviors will "spill over" into other additional pro-environmental actions. However, results from studies on spillover have been mixed, with some evidence that in some cases there may actually be a *negative* spillover effect, because undertaking one PEB may reduce the sense that one is morally obligated to perform another (Miller et al. 2010; Truelove et al. 2014). Furthermore, given the lack of in-situ evidence that sunscreen is harming reefs in Hawai'i (Wood 2019), managers risk losing credibility with residents in the long term if the narrative changes.

"Turbo" interviews for natural resource management research

Finally, this study demonstrates that very brief interviews featuring just one open-ended question—an approach which our team frequently referred to as "turbo" interviews—can be an effective way to investigate public perceptions of resource management issues. We did not seek to examine the perceived causes of reef decline, but many participants enthusiastically shared information beyond that for which they were specifically prompted, allowing us to glean insights that otherwise would not have been available to managers. Additionally, almost everyone asked to participate in the study agreed without hesitation. Combined, these details suggest that this method is an important tool to elicit complex and detailed thoughts on a topic from members of the general public. This approach allows researchers to quickly obtain the sort of in-depth, qualitative information that can be an important component of effective natural resources management (Barclay et al. 2017), while not compromising sample size as much as longer interview methods often do. Furthermore, we hypothesize that more people may be willing to participate in studies with this design because they are both brief and maintain a very high level of anonymity: even the researchers themselves do not know the participants' names or contact information, except in instances where participants offer them.

Employing this "turbo interview" method allowed the authors to reach an audience managers typically do not hear from to learn about perceptions of reef management and decline. However, "turbo interviews" cannot exhaustively explore a topic the way lengthy interviews can, and thus often leave some questions unanswered. For example, because perceived causes of reef decline were offered by the respondents, rather than being asked for directly by the interviewers, we cannot determine whether respondents brought up the issues that were most important to them, or simply those that were most salient to them when they were interviewed. Results may have been different if management questions were the main focus of the original research design. Nevertheless, this study demonstrates the potential of this approach to balance multiple, often-conflicting research goals (e.g. in-depth, qualitative information, and sample size) in exploring natural resource management questions. Further investigation into beachgoer perceptions of reef decline, its causes, and management actions to address decline—through "turbo" or longer interviews—could aid development of education campaigns and management approaches to address public misconceptions and concerns.

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