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The Role of Trust in Public Attitudes toward Invasive Species Management on Guam: A Case Study

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ABSTRACT: Public attitudes toward invasive alien species management (ISM) and trust in managers' ability to effectively manage non-native species can determine public support for conservation action. Guam has experienced widespread species loss and ecosystem transformation due to invasive species. Despite Guam's long history with invasives and efforts to eradicate them, we know little about the sociological context of invasive species. Using focused group discussions, we explore public attitudes toward invasive species management. Respondents expressed support for management activities and a desire to participate directly in conservation actions. Participants also expressed frustration with government institutions and lack of confidence in managers' abilities to control invasive species. Perceptions of managers' trustworthiness, communication with managers, and positive personal experiences with managers were related to positive attitudes about management and support for existing initiatives.

KEYWORDS: confidence, distrust, environmental communication, grounded theory, non-native species, values

1. INTRODUCTION

Invasive species have been linked directly to extensive biodiversity loss on island ecosystems (Fritts & Rodda, 1998; Reaser, Meyerson, Cronk, de Poorter, Eldrege, Green, Kairo, Latasi, Mack, Mauremootoo, O'Dowd, Orapa, Sastroutomo, Saunders, Shine, Thrainsson, & Vaiutu, 2007; Leigh, Vermeij, & Wikelski, 2009; Davis, Chew, Hobbs, Lugo, Ewel, Vermeij, Brown, Rosenzweig, Gardener, Carroll, Thompson, Pickett, Stromberg, Del Tredici, Suding, Ehrenfeld, Philip Grime, Mascaro, & Briggs, 2011; Spatz, Zilliacus, Holmes, Butchart, Genovesi, Ceballos, Tershy, & Croll, 2017). Despite scientific consensus that invasive species negatively impact native biodiversity and ecosystem services, the public continues to question whether and how invasive species should be controlled (Marris, 2014). Widespread controversy over the management of non-native animals has routinely delayed control efforts (Selge, Fischer, & van der Wal, 2011). In England, concerned residents worked with animal rights groups to stop the removal, trapping, and shooting of monk parakeets (*Myiopsitta monachus*) (Crowley, Hinchliffe, & McDonald, in press), and legal action and public protests

delayed efforts to eradicate grey squirrels (*Sciurus carolinensis*) in Italy (Bertolino & Genovesi, 2003). Public support is a critical factor that can make or break management initiatives designed to remove or control invasive species (Bremner & Park, 2007). In addition, the successful management of invasive species will require effective engagement strategies that include collaboration and communication between multiple, diverse and actively involved public groups (Kueffer, 2010; Novoa, Shackleton, Canavan, Cybèle, Davies, Dehnen-Schmutz, & Wilson, 2018; Pages, van der Wal, Lambin, & Fischer, in press). Thus, the successful implementation of invasive species control requires greater understanding of the social, political, and cultural factors that influence public support for management actions.

There has been an increased research focus in the last decade on exploring and evaluating public attitudes towards and support for invasive species management (ISM) (Bremner & Park, 2007; Crowley et al., in press; Estévez, Anderson, Pizarro, & Burgman, 2015; Fisher, Lee, Cribb, & Haynes, 2011; Fischer & van der Wal, 2007; García-Llorente, Martín-López, González, Alcorlo, & Montes, 2008; Selge et al., 2011; Sharp, Larson, & Green, 2011). Batel, Devine-Wright, and Tangeland (2013) describe support as a positive attitude that might lead to active intentions favoring a specific action or intervention. In the context of invasive species, support has been measured by asking respondents to agree or disagree with attitude statements (e.g., invasive non-native species should be eradicated; Bremner & Park, 2007), to express support for general invasive species control efforts (e.g., invasive species management should be a top priority; Harvey, Perez, & Mazzotti, 2015), or specific management action (e.g., which one of the four management options do you favor?; Fischer & van der Wal, 2007). We define public support as agreement with or approval of management actions, intentions to support, encourage or engage in management activities, or actual participation in management efforts.

Public support for ISM is driven by a complicated mix of individual, contextual and cognitive variables (Genovesi, 2008). Awareness and knowledge about eradication programs increase public support for invasive species control (Bremner & Park, 2007). Contextual factors, including species-specific characteristics (e.g., is it harmful, charismatic, how quickly does it spread? etc.), shape attitudes about ISM (Selge et al., 2011). Value-based attitudes about the effectiveness of management actions and the humaneness of killing animals also affects support for the management of non-native species (Selge et al., 2011; Wald & Jacobson, 2014). Values form the basis of the cognitive hierarchy, influencing attitudes, which influence behaviors or behavioral intentions (Rokeach, 1973; Fulton, Manfredo, & Lipscom, 1996). Four value types are important for the social dimensions of invasion biology: utilitarian, moralistic, humanistic, and naturalistic values (Estévez et al., 2015). As in the case of invasive woody trees used for firewood in South Africa (De Wit, Crookes, & van Wilgen, 2001; Ngorima & Shackleton, in press; Shackleton, Le Maitre, van Wilgen, & Richardson, 2016), feral pigs that are hunted traditionally in Hawaii (Maguire, 2004), or feral cats that are perceived as beneficial companion animals (Wald, Jacobson, & Levy, 2013), there is more likely to be conflict when control efforts target species that are viewed as useful, culturally important, or charismatic.

In addition to the importance of values, a recent review of scholarship on the social dimensions of invasion biology found that conflicts over ISM are also driven by differences in trust or distrust in conservation managers (Estévez et al., 2015). In the context of natural resource management issues, trust is regularly defined as an individual's willingness to be vulnerable to others' actions (Mayer, David, & Shoorman, 1995; Hamm, 2017). Trust is

influenced by social relationships and the evaluation of others' trustworthiness (the ability, benevolence and integrity of a person or a person-like entity; Hamm, 2017; Siegrist, Earle, & Gutscher, 2003). Trust and distrust are critical elements of effective natural resource management outcomes, especially regarding public support for management decisions (Vaske, Absher, & Bright, 2007; Stern, 2008; Stern & Baird, 2015; Stern & Coleman, 2015). Trust in managers and the institutions involved in management are critical elements of public support for ISM, especially when there is a lack of transparency or involvement from the community in management efforts (Estévez et al., 2015). For example, lack of trust in the government reduced public support for the removal of trees to control the invasive emerald ash borer (*Agrilus planipennis*) (Mackenzie & Larson, 2010). Distrust of the government was cited as a driver of public opposition to the eradication of monk parakeets (Crowley et al., in press) and the use of herbicides to control invasive water hyacinth (*Eichhornia crassipes*) in Florida (Evans, Wilkie, & Burkhardt, 2008). Yet we currently know little about how public perceptions of trust emerge within the context of ISM.

Here, we report the results of a case study of public attitudes toward ISM on the island of Guam. One of the most catastrophic illustrations of the effects of invasive species occurred on this small Pacific island. In the middle of the 20th century, the island experienced an unexplained decline of its native forest birds (Savidge, 1987), the cause of which remained a mystery for several decades. In the 1980s, a researcher working with the local natural resource management agency tested several theories about the disappearance of Guam's birds: avian disease; widespread spraying of insecticides by the military, including DDT, which was documented on Guam during the Vietnam War; habitat loss; overhunting; and the introduction of invasive species. Savidge (1987) identified a single predatory species, the brown treesnake (*Boiga irregularis*), introduced to the island at the end of World War II, as the culprit. To date, 10 of 12 native bird species have been extirpated from the island, declines have been observed in native lizards, bats, and non-native small mammals (Fritts & Rodda, 1998; Savidge, 1988; Wiewel, Yackel, Adams, & Rodda, 2009), and indirect impacts have been documented in spiders and forest trees (Rogers, HilleRisLambers, Miller, & Tewksbury, 2012; Rogers, Buhle, HilleRisLambers, Fricke, Miller, & Tewksbury, 2017; Wandrag, Dunham, Duncan, & Rogers, 2017).

Despite the long-held scientific consensus linking snakes to bird loss, public perceptions of the brown treesnake and of ecosystem restoration efforts on Guam sometimes conflict with conservation managers' goals. For example, the public on Guam and nearby islands have opposed efforts to control invasive animals, even when the control was designed to help reestablish native bird populations. Recent efforts by the Guam Department of Agriculture to use rodenticide to remove Norwegian rats (*Rattus norvegicus*) from a small uninhabited island off the southern tip of Guam in preparation for the introduction of the endangered Ko'ko' (*Gallirallus owstonii*) sparked public protests and concern that applying rodenticide might pose a risk to human and environmental health. In response, a local legislator introduced a bill controlling the use of pesticides on the island (KUAM News, 2008).

Despite Guam's long history with invasive species, this is the first study exploring the social dimensions of invasion biology on the island. Analyzing focus group discussions with public resource users, we explore public concerns about and support for ISM, focusing on the influence of personal experiences, value-based attitudes, and trust or distrust between the public and the individuals and agencies responsible for ISM. This research will help identify (a) the drivers of public support or opposition to ISM, (b) how interpersonal and institutional

trust emerge and influence public support for invasive species control, and (c) alternative management initiatives that could engender public support. While this study focuses on the island of Guam, the findings provide insights that can inform efforts to manage invasive species elsewhere in the world while contributing to our theoretical understanding of the drivers of conflict over ISM. In the following sections, we introduce additional context about invasive species on Guam and the methodology used in this study, before moving on to discuss participants' experiences with and attitudes toward invasive species, management actions, and managers.

2. BACKGROUND

2.1. History of Invasion on Guam

The island of Guam has an extensive history of species introductions, stemming back to when humans first arrived and settled approximately 4,000 years ago (Pregill & Steadman, 2009). Monitor lizards (*Varanus indicus*) likely arrived with the ancient CHamoru (native people of the Mariana Islands), along with Polynesian rats (*Rattus exulans*) (Steadman, 1999). The arrival of Spanish colonizers, beginning with Magellan in 1521, brought domestic pigs that have turned feral (Conry, 1989), Philippine deer (Wiles, Buden, & Worthington, 1999), and domestic pets like dogs and cats, all of which still persist on the island.

The most infamous invasive species on the island is undoubtedly the brown treesnake, which was introduced accidentally after World War II (Savidge, 1987; Fritts & Rodda, 1998). The snake has affected native species like birds and lizards (Fritts & Rodda, 1998) and the people of Guam by causing frequent power outages (Rodda & Savidge, 2007), posing a health hazard from bites to humans, particularly infants (Fritts, McCoid, & Haddock, 1990), and complicating the cargo shipment process because of additional snake-specific inspections.

In the past 20 years, a number of new pest species, mainly arthropods, have also been introduced to Guam. Of note are the cycad scale insect (*Aulacapsis yasumatsui*), first detected in 2003 (Marler & Lawrence, 2013); coconut rhinoceros beetle (*Oryctes rhinoceros*), first detected in 2007 (University of Guam, 2017); little fire ant (*Wasmannia auropunctata*), first identified in 2011 (Raymundo & Miller, 2012); and greater banded hornet (*Vespa tropica*), first detected in 2016 (University of Guam, 2016).

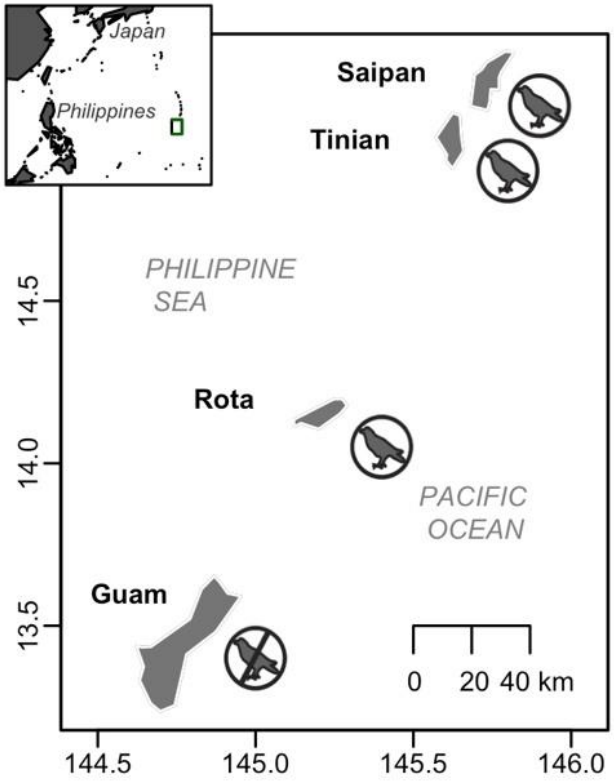

Fig. 1. Guam is the southern-most island in the Mariana Islands, located in the Western Pacific. Of the four inhabited southern islands in the archipelago, Guam is the only one so far that has an established population of brown treesnakes, and, as a result, has lost almost all of its native bird populations.

2.3. The Sociocultural Contexts of Guam

According to the 2010 U.S. census, the island of Guam is comprised of 37% CHamoru people (the indigenous people of Guam and the Mariana Islands), 26.3% Filipino people, 11.5% from other Pacific Islands, and 7% white. What is known of ancient CHamoru culture and society indicates that they were farmers and fishers (Herman, 2017), with a history in the Mariana Islands extending back at least 3,500 years (Hung, Carson, Bellwood, Campos, Piper, Dizon, Bolunia, & Oxenham, 2011). The CHamoru were the first Pacific Island peoples to come into contact with Europeans with the landfall of Ferdinand Magellan's crew in 1521. This encounter resulted in the slaughter of many CHamoru, and a precedence set for Spanish and, eventually, American, conquest and colonialism in the Mariana Islands (Rogers, 1995). Guam was occupied by the United States after the Spanish-American War in 1898, then occupied by Japan during World War II, and reclaimed by the United States in 1944. Many Filipino families in Guam trace their history back to the post-war period when Filipinos moved to Guam to assist with rebuilding efforts. The Organic Act of 1950 designated the island as an

unincorporated territory of the United States and gave Guam residents U.S. citizenship and limited self-governance. The local governor and legislature are democratically-elected; however, residents of Guam are unable to vote in presidential elections and the Guam representative to Congress is a non-voting member. Guam's political status relative to the U.S. has been a consistent point of contention, with support for the range of options from statehood to complete independence.

Modern CHamorus continue to practice unique and ancient fishing (Kerr, 2011), but shotgun and rifle hunting of animals, introduced during the Spanish era, are also popular (Wiles et al., 1999). CHamoru people today struggle with tracing an indigenous identity that was, under both Spanish and American administrations, repressed (Rogers, 1995). In recent decades, efforts have been made to preserve traditions that have survived, and to piece together ancient practices and art from archaeological findings and other Micronesian and Pacific cultures, such as dance and song (Uslander, 2016). The culture and history of Guam and the CHamoru people are likely to be reflected in focused group discussions.

The island of Guam has a long and complicated relationship with the U.S. military. Roughly 25,000 adults on Guam serve in the U.S. military (Hicks, 2014). "Military service is a generations-old tradition for many families" (Letman, 2016b). The military occupies approximately 28% of the island, including Andersen Air Force Base (AAFB), Naval Base Guam, and a terminal high-altitude area defense (THAAD) missile defense battery (Letman, 2016b).

In 2010, the Department of Defense (DoD) proposed relocating 8,600 Marines and 9,000 dependents to the island over the course of five years (USDoN, 2015; Letman, 2016b), dredging more than 70 acres of coral reef, and building a new firing range in a culturally important area on private and land owned by the federal government (Letman, 2016b). After public outrage during the National Environmental Policy Act (NEPA) process, the buildup plans were scaled back with 5,000 Marines and fewer dependents planned to be relocated. In addition, the location of the firing range was re-evaluated and the proposal to dredge the reef was deferred. After re-evaluation of potential firing range locations, the DoD selected an area on AAFB that did not require additional land acquisition. The range's Surface Danger Zone, the ground and airspace exposed to debris resulting from firing, launching, or detonating weapons (USACE, 2015), would encompass most of the Guam National Wildlife Refuge Ritidian Unit and limit access when the range is active. DoD is in the midst of planning and carrying out a number of large-scale mitigation efforts for the construction and disturbance involved, making them one of the biggest funders of ecological and conservation work in the Marianas today. Much of these conservation actions are mitigation for environmental damage, and the DoD has been criticized for not adequately protecting environmental resources in Guam and the other Mariana Islands (Letman, 2016a; Cruz, 2017).

3. METHOD

Focus group discussions were conducted with residents of Guam from July 2017 through October 2017. We employed a qualitative approach (Strauss & Corbin, 1994; Glaser, 2008) which allowed us to identify factors that influence public attitudes toward ISM measures rather than test a priori hypotheses. This qualitative emphasis encouraged the research team to be prepared for the emergence of new insights during data collection that could influence our interview guide and methodological approach.

3.1. Interviewees

We sought to include participants with a diversity of backgrounds, including heterogeneity in gender, age, education, ethnicity, livelihood, and experiences with natural resources. In addition, we targeted participants who were long-time residents or had lived on Guam for more than 10 years. We did not interview individuals who are currently enlisted in the military, although nearly all the participants have had family members and friends affiliated with the military. We recruited participants through local resource-related social media groups, mayor's offices, senior centers, and recreational areas. We continued to collect data until we reached data saturation. Groups ranged in size from two to six members, with more than 67 participants taking part in in-depth focused group discussions. Participants ranged in age from 20 to 90 and represented the following groups: environmental educators (6), environmental technicians/managers (14), environmental scientists (3), passive (e.g., hiking, biking, running) or limited (i.e., individuals who spend limited to no time in natural areas) users (35), active (e.g., fishers, hunters) resource users (11). One interviewee was a member of both the educator and passive user groups. While not intentional, most of the participants representing active users were of CHamoru heritage, while most of the participants representing passive groups were not CHamoru. Because individuals who use or access natural areas are the most likely to be affected by ISM actions in natural areas, the analysis below focuses only on interviews with passive or limited (35) and active resource users (11) for a total of n=46 participants. To protect participants' identities, we use numbers to identify participants.

3.2. Procedure

Data collection involved interviews and focused group discussions that were guided by a semi-structured list of questions (Berg, 2001). Prior to data collection, the first and last author met to identify research questions. These questions guided the development of our interview guide. However, throughout the study we remained open to emergence of new questions and topics during group meetings.

Interviews began by providing participants with maps of the island and asking interviewees to identify natural areas on the island and personal experiences in these areas. This exercise was included as a warm-up to encourage interviewees to contribute to the discussion. Next, participants were asked about changes to natural areas, experiences and opinions regarding invasive species, and attitudes about management actions. To understand how concerns about specific invaders influenced support for management actions, we asked participants to identify concerns related to invasive species on Guam and environmental issues. After developing a list of concerns, we asked participants to list their top three concerns about environmental issues on Guam. Finally, participants were asked where they learn about news and information concerning Guam's environmental problems and resources and if they trust these sources (the full interview script is available in Appendix A). For this study, we define sources as scientists and managers affiliated with organizations and institutions focused on research or management of Guam's terrestrial ecosystem. Each group meeting lasted approximately 1 to 2 hours. All the interviews were recorded and transcribed.

3.3. Analysis

The analysis strategy for this study was adapted from Berends and Johnston (2005) and MacQueen, McLellan, Kay, and Milstein (1998). To analyze the transcripts from the small-group meetings, we employed a multi-coder approach. Our team consisted of two primary coders, one secondary coder, and an expert in ecology and wildlife on Guam. The primary coders have a background in communications and the human dimensions of wildlife while the secondary coder has a background in wildlife ecology. The subject expert spent the last 16 years working on Guam and the secondary coder grew up on Guam and is familiar with natural resource issues on the island. Both provided critical ecological expertise and cultural knowledge that informed our data analysis process.

Our study implemented the constant comparative method (Glaser, 2008), an approach under the broader domain of Glasers's and Strauss' Grounded Theory (Strauss & Corbin, 1994). This approach relies on simultaneously generating theoretical frameworks and identifying codes that arise solely from the available data. During the process of constant comparison, data is regularly compared to create categories, define categories, and delineate relationships between categories to develop a larger idea of the phenomenon being studied (Glaser, 2008). Theoretical saturation must be reached in order to complete the final step of the constant comparative method (Glaser, 2008). In other words, the categories created must contain a purpose and meaning behind the generated theory of study. It should also be noted that this method only creates substantive theory, not one that can be generally applied (Glaser, 2008). In order to create a general theory, the categories we develop in this study must hold up in other similar situations. In other words, the categories we develop in this study are unique to the environment we are analyzing.

This method is also beneficial for working in teams because it allows the coder to check their codes and notions against their team members, helps "bring out points missed, add points they have run across in their own coding and data collection," and develop theoretical relationships (Glaser, 2008, The Constant Comparative Method section, para. 7).

(1) *Open coding:* The primary coder screened the full text of four small-group interviews to identify text related to the research questions. Notes taken from the close readings were used to create a first draft of the codebook, including categories and codes. Categories were defined according to the available data and the a priori research questions. The primary coder identified 32 codes and seven categories. The primary coders met to discuss the first draft of the codebook. Based on this discussion, the first draft of the codebook was updated to 46 codes and 12 categories.

(2) *Axial coding*: After another meeting, all three coders and the expert agreed to begin coding with three thematic categories in order to capture various types of information. The three categories included comments about the jungle, human influence on wildlife, and credibility. The qualitative analysis software NVivo was used to code the transcripts. To ensure consistency across coders, the three coders independently coded the same two interviews, selected at random, using the three thematic categories. During this step, coders annotated questions and comments. When a category was unclear, coders asked for clarification and suggested a better description of what text fits into the category. Once the coders completed coding two transcripts, Nvivo was utilized to run a coding comparison query to check for coder agreement. Agreement

among the three coders was above 90%, meeting the necessary levels to continue coding individually.

(3) *Selective coding*: A second round of screening identified comments related to emerging key categories and themes. Of the remaining eight transcripts, each of the primary coders analyzed three transcripts, while the secondary coder analyzed two. Finally, the primary coders met one more time to discuss findings.

The codebook was recorded in a Microsoft Excel spreadsheet located in a shared cloud folder. It was accessible to all members of the research team involved with coding. The layout of the codes followed the approach of MacQueen et al. (1998). The codebook includes the code name, description, when to use the code, and text examples.

4. RESULTS AND DISCUSSION

4.1. Perceptions about Invasive Species

Broadly, environmental concerns on Guam included global warming, apathy about environmental issues, lack of enforcement, regulation and maintenance, invasive species, illegal dumping, and water quality. Many participants voiced their concerns about the amount of trash on beaches and recreational areas on the island. Participants expressed a desire for action focused on cleaning up the island to help keep the island beautiful and environmentally healthy, and to also help boost tourism.

> P43: "I would especially say the people that rely on say, coconut for either their nutrition or their livelihoods. I mean Guam has a lot more industry and other ways in which to support, but if it spreads to the other islands, we're talking significant livelihood impact."
> P18: "Who ever heard of the Pacific Isles with no coconuts?"

Many residents worried if coconut trees were destroyed, their island may not be seen as tropical and beautiful to tourists. There was also concern for the coconut tree's survival because of its significance as an iconic symbol of the island and its depiction on the flag of Guam. The loss of the tree seemed to threaten their cultural identity for some participants. Many participants remember coconuts being integrated into their lifestyle when recalling memories, and how past generations also valued the coconut tree.

> P11: "My father died...and he's the one who warned me. He goes, 'If they don't, if the government does not take care of the coconut [beetle], that means it'll wipe it [coconut trees] out.'"

4.2. Personal Experiences

Personal experiences with wildlife, nature, and the management of nature was a prominent theme that emerged and appeared to influence perceptions of management agencies and government institutions. Many older respondents recounted vivid memories of seeing the military spray insecticides.

> P3: "They were spraying Guam, DDT…I was scared, I observed from down in Umatac. I can see over the bunkers and they were flying over, they're spraying DDT."

Older respondents connected these memories to the decline of bird populations on Guam. Several respondents described their experiences and personal accounts as evidence that contradicted the dominant scientific narrative connecting the brown treesnake with the loss of birds on Guam.

> P6: "It's unbelievable that right now everybody is blaming the snakes for the destruction of all the birds, but it's not. That is where it started, in 1976….They used to go around with these big trucks with these blowers coming out with pesticide, and they announced that they were coming through the village. This thing would just spray the whole road, and your house is right there. They were doing this and all that toxin was killing those birds. That's where the majority of the birds vanished, '76 and '77, and then the snakes took the rest of whatever was remaining. That's how the story should be told, but they're blaming the snakes. Somebody had to pinpoint something, right?"

Recent introductions of the little fire ant and the coconut rhinoceros beetle have garnered media attention on Guam. The effects of recent invaders are obvious, especially for anyone who has been stung by little fire ants or who has watched coconut rhinoceros beetles spread throughout the island, damaging Guam's coconut trees. Respondents frequently mentioned seeing and catching coconut rhinoceros beetles.

> P5: "You know, when the rhino beetles came out, they did have something for the rhino beetles. I don't know how well those buckets work. I've never seen one in a bucket and I always check when I pass by a bucket. I've never seen one in there, but at night time they're definitely hitting my screen door and I find them on their backs doing that, you know?...I notice all my coconut trees on the property where I'm staying at are getting damaged."

Frequent experiences and observations of beetles were mentioned as evidence supporting scientific claims of negative impacts of coconut rhinoceros beetle on coconut trees.

> P13: "That's the thing, we've seen it first-hand. All the trees, then you do see the rhino, so okay."

4.3. Perceptions about Management

There was disagreement among participants about which procedures and management actions were being used and whether any of these efforts had been successful. The complexity of the network of agencies responsible for natural resource management on the island created confusion and ambiguity about who was responsible for specific actions or objectives. In addition to regularly citing the military as an agency involved in the management of natural resources, respondents also mentioned specific local and federal agencies like the Guam Department of Agriculture, the U.S. Department of Agriculture, and the U.S. Environmental Protection Agency. There was widespread confusion about which agency was responsible for specific actions or areas and it wasn't clear if participants always understood which organization or agencies had made the decisions they were upset about. This lack of clarity may also have contributed to participants' voiced concerns over a lack of enforcement and investment in environmental issues and ISM on Guam.

When asked about efforts to manage invasive species, participants regularly referenced the release of mice filled with acetaminophen, toxic for snakes, into the jungle. Once the snakes consume the mice, they die. Due, in part, to the novelty of this approach, there was widespread media coverage of this initiative.

> P26: "Well, we all like the parachutes with the little mouse, with the Tylenol."

Overall, there appeared to be confusion about the kinds of management initiatives that were being employed and whether these efforts were successful.

> P18: "I think they've put aspirin in little mice and then they kill them with that because they drop…'Didn't work; we didn't really follow through.'"

> P43: "No, it did. They are following through and it did work. They tested the square, you know they had a control square and a non-control square, you know, it's another thing, it's not island-wide, obviously, but it was a pilot project."

Participants frequently cited lack of information and confusion about how management decisions are being made and how management actions are being implemented.

> P2: "'What are we doing with the beetles, what are we doing with this?'...'We're trying to control it' 'But how far have you gone?'...They're not even replying back…They don't even reply back because it's the same old issue."

Participants also discussed the management of non-native ungulates, including the removal of wild pigs from private land and fenced areas controlled by federal agencies. The wild pigs on the island are known to damage small farms, personal gardens, and landscaping when traveling through residential areas.

> P26: "I think it's the feds have a program now where if you have lot of pig in your yard you can call them and they'll bring traps and trap some."

> Moderator: "And then don't they study the droppings, I think, to see if they have any disease?"

> P26: "I don't know. I understand that they'll kill 'em, and if you want 'em they'll give 'em to you. And if you don't want 'em they'll take 'em away."

4.4. Views on federal control of land on Guam

Although land access remains controversial, respondents regularly described areas that are under military or federal control as some of the most pristine areas on the island and recognized that the military implements many of the federal mitigation requirements.

> P10: "Right now, they're [the military] doing some clean up. Some of the militaries are helping."

There was widespread recognition that limited public access to military lands has contributed to their protection. Yet as one participant suggested, the creation of "de facto, restricted conservation areas" has also created tension because Guam "is an island with finite resources." While participants recognized the importance of protecting natural resources from degradation, many also expressed concerns about the lack of access:

> P5: "Even though the military is controlling the land, the resources belong to the people of Guam. We need to follow that avenue and make sure that the government…make sure that the military provides access in some way. That's how they do it. They justify it. 'We are providing you access. We're giving you these four little, winky dink areas…' when we used to have over 5,000 acres."

Participants from both resource user groups described public anger over the military buildup and the proposed additional loss of access to natural areas.

> P5: "How can you justify the use of millions of federal tax dollars to fund a program that is being done voluntarily and by law, which says that the base needs to provide access to the people of Guam so that they have access to their resources, to their cultural sites? The military, even though in the beginning they say with the range, 'Oh no, the range will go up, but we'll still - when it's not 'hot,' we'll still provide it [access].' Yeah, let's believe that."

Concerns about military activities, both past and present, and frustration over lack of access to natural areas were more frequently described by active users. Active users have been directly affected by previous Air Force actions to control non-native pigs and deer on the island. In 2012, AAFB contracted with an outside company who used "live trapping, snaring, baiting, and ground shooting to" remove deer and pigs from several fenced areas that had previously been used as local hunting grounds (Joint Region Marianas Natural Resources Staff, 2012, p. 5). Moreover, the military buildup and proposed firing range would result in changes to areas that were previously used as local hunting grounds.

4.5. Trustworthy Sources

Public perceptions of information appeared to be intrinsically linked to public evaluations of the trustworthiness of the sources of information about management — broadly defined as the perceived ability, benevolence and integrity of a person or a person-like entity (Hamm, 2017; Siegrist et al., 2003). Respondents questioned whether managers and institutions involved in the management of invasive species were providing the public with full and accurate information. According to Susskind and Field (1996), one of the ways individuals can engender trust is to "mean what they say" (p. 40). When participants are asked to call an agency number and report a sighting of invasive species, managers are asking for public action, but they are also implying that they will respond and address public concerns. By not responding in a way that meets the expectations of the public, managers and agencies are perceived as not meaning what they say. Agencies' lack of response to public reports engendered frustration:

> P5: "I called up the Department of Agriculture and could never really get through to anybody. I left voicemail and never — I called the number that they left, you know? Then the same thing. I was in Tumon and I spotted a yellow banded hornet. That's another invasive one that is recently here, and now they're saying that it could already be established. I called on that as well, and there again, no pick up and no call back on the message that I left. I can't throw a dart and say, but out of the four times that I've called I've never had a live person pick up the phone and I've never had anybody call me back with any type of a concern, even though on the website they say, 'If you see this guy, call this number.' I did my job. I called, you know?"

In the example above, the participant suggests that he/she believes the agency cannot act on the information he/she provides, but they still continue to call. This finding supports what Hamm (2017) described as actions motivated by trust-as-choice rather than trustworthiness. Despite the respondent's expressed lack of confidence in the trustworthiness of the agency (ability, benevolence, and integrity) he/she continues to cooperate with the agency's request to report invasive species. In this case, the participant may be motivated by a desire to reduce invasive

species on Guam and a belief that the Department of Agriculture is the best possible agency to address this issue, even though it lacks the ability to respond directly to public calls.

Participants' skepticism about military promises to provide public access to their lands after the firing range is built is an example of what can happen when the public loses confidence that a source is saying what they mean. Confidence is a belief or expectation that "certain future events will occur as expected" (Siegrist et al., 2003, p. 706). This loss of confidence in the military as a reliable and trustworthy source of information, was evident in participants' expressed concerns about previous military actions, including the spraying of pesticides on the island. Former military employees have alleged that in addition to the use of DDT and polychlorinated biphenyl (PCBs), the military also used Agent Orange on Guam (KUAM News, 2017). DoD officials contend that Agent Orange was not "used on, stored or transshipped through Guam during the Vietnam War" (Bordallo, 2017), but a Senate task force has been launched to investigate these allegations and explore when, where, and how much of these chemicals may have been used (KUAM News, 2017). A U.S. Government Accountability Office investigation into where the federal government stored, transferred, and used Agent Orange at locations in the U.S. and its territories began in late 2017 (Daily Post Staff, 2017), making this topic particularly salient during the study period. Lack of information about the use of chemicals was described as a significant concern by participants. Previous research does not support a significant role for DDT in disappearance of Guam's birds (Savidge, 1987). Yet participants regularly connected DDT to bird loss.

> P3: "They [the military] don't want to admit to it, they don't want to admit that they did that here [sprayed DDT], [so they say] that it's because [of] the brown treesnake."

According to the asymmetry principal, it is easier to destroy trust through negative events than it is to create it through positive news (Slovic, 1993). Cvetkovich, Siegrist, Murray, and Tragesser (2002) extended this finding by providing evidence that individuals' responses to news (e.g., an attention or amplification of trust) depend on a priori evaluations of trust or distrust. Cvetkovich et al. (2002) describe this as the perseverance of trust. Individuals who distrust a source are less likely to trust that source when presented with positive or negative information about that agency (Cvetkovich et al., 2002). For example, if an individual who believes that an agency is not honest about their motivations, actions, etc. reads a news headline about new efforts that the agency is pursuing to be more transparent, he/she is more likely to discount the new information by explaining it away (e.g., they were required to do this, but nothing will change; this is all a publicity stunt, etc.). In addition to the rejection of positive information, negative information is also more likely to be accepted. Thus trust, once lost, is almost impossible to regain (Susskind & Field, 1996). Our results suggest that existing beliefs about agencies' trustworthiness may influence individuals' interpretations of new information. While some participants questioned public concerns about the use of chemicals to manage wildlife, others suggested that current concerns about the use of chemicals to control the brown treesnake are related to previous experiences with agencies' application of chemicals and prior beliefs about the trustworthiness of agencies and managers as information sources. When asked why the public might oppose efforts to eradicate the snake using acetaminophen, one respondent suggested:

> P30: "You know I don't, but I've heard people saying, 'Oh, you know, is it going to poison the water?' All that stuff and again this ties into the whole transparency and community buy-in thing and

> telling people what you're doing. I think a lot of the opposition would come from people just not knowing what's going on."

While several respondents were critical of the agencies as a whole and skeptical about their actions, motivations and commitment to Guam, numerous respondents suggested that they trusted the specific managers and scientists working directly to control and eradicate invasive species.

> P2: "Well, actually, the people who do the studies, you know? They're the ones you usually trust. They're the ones that should tell you, what does this do, what does this animal do? What does this endangered species – I mean like the rhino beetles, what do they do? What harm do they do? Okay? Those are the people."

The perceived ability of managers to address the issue of invasive species was also addressed by respondents. Perceptions of ability are related to public perceptions that government employees and agencies responsible for ISM understand what needs to be done and are able to implement effective management actions. There was concern that managers didn't really understand the best way to approach a problem, citing some plans of action were just meant to make the public feel management was doing something. In other words, management efforts were not only perceived as ineffective, but they were perceived as an effort by the government and agencies to maintain a level of control over the issue of invasive species, even if the methods they were proposing were destined to fail.

> P26: "I'm not doing the things they tell you to do for the rhinoceros beetle because they don't have – I don't think they'd be effective. I think they're more of a 'make me feel good if I do that.' And I just don't see that chopping down your tree, or covering the – you know the –"
>
> P44: "The net?"
>
> P26: "Yeah, the net. They say cover your compost pile. Or if you cut down your coconut tree, put it in the sections and put it over that. And I just see that as adding more landfill to the environment, cause it's just gonna grow over the jungle and who's gonna remove that net? So what do I do? I don't think I do much."

Agency legitimacy and authority can encourage the public to comply with directives and management actions (Hamm, Pytlik Zillig, Herian, Tomkins, Dietrich, & Michaels, 2013; Tyler & Degoey, 1995). Political support for management initiatives on Guam is likely tied to public perceptions of agencies' authority and legitimacy as a source of information and an institution responsible for ISM. There were several respondents who suggested managers were trying several strategies for management, but so far efforts to manage certain species had failed. When participants were asked what managers or individuals should be doing to control invasive species on Guam, several participants suggested that managers were trying several things.

> P21: "I think they're trying in our place and some other place also that have this wild pig. Sometimes they go catch these pigs and then they cook it…they're working…I think they're doing the rhino beetle…yeah because the government is looking for that. The coconut trees are getting all down."
>
> P23: "Yeah. I think they thought it came from Yap [another island in the region] but the beetles here, they were getting rid of the beetles in Yap, using a virus, but the ones here, it doesn't affect them."
> Moderator: "Did it work?"

> P23: "No…they have to come up with something else."

Despite efforts to manage invasive species, several respondents suggested that there were few clear solutions to the current issues on Guam. One participant suggested that managers are just as frustrated as the public:

> P26: "Well, I don't think anybody knows, and that's one of the problems. Biological controls on these beetles are not working like they have in other places. And the things they tell you to do I'm just not optimistic at all that those things are gonna do anything to reduce the numbers. I mean the whole jungle's out there you know, and palm trees fall in the jungle."

Public perceptions of managers' integrity, or concern for the interests of the public (benevolence), was another recurring theme. Personal stories or experiences about seeing managers engage in actions to control invasive species were regularly cited as evidence of managers and scientists working to prevent the spread of invasive species.

> P4: "I heard that [manager name] used to do [management action] ... from the university … even got this net to catch it from the tree but –"

According to several participants, there are managers who are trying to do a good job, but the culture of the institutions on Guam or specific individuals within the institutions make this difficult:

> P26: "There is a lot of them that are doing a good job. But sometimes they seem to be a little more political than, protection. Well, you know, with every agency you name, you've got people who are doing a nice job and then you've got people who are, 'Please, take them away.'"

However, several respondents questioned whether management was willing or interested in implementing effective management actions. Specifically, lack of interest in working and lack of commitment to solving the invasive species problem were suggested barriers to management initiatives.

> P2: "But you think that those people, the agriculture, are doing something? I'm gonna tell you truthfully…they're not moving."

It was also suggested that the lack of noticeable action was the result of ulterior motives or a focus on different priorities. Scientists, managers, the military, and some of the federal employees were also described as outsiders. As outsiders, some participants suggested that they were not as concerned about the long-term conditions on Guam.

> P44: "Some of the scientists maybe are more worried about their particular research project or their grant, that maybe they're not seeing the big picture of the quality of the island. And maybe some of the scientists aren't long term residents so maybe they don't have the same…investment in the island."

Embedded in these comments was the idea that some managers are not responding to public concerns in the way that certain members of the public expect them to.

> P6: "I think environmental on this island should do their job when they're called upon to come out and inspect something instead of giving us an excuse. Saying, 'Hey, we've only got one vehicle. It's

> down at Umatac or Merizo'…. Take my note, come out here, but they never show…. You guys do your jobs. Do your job and do it the right way, you know?…I think they're just stretching it out as long as they can, through their retirement. That's the way I feel."
> P5: "'Hey, we've got four snakes in this trap. Let three of them out and we'll kill one. Then we can catch them again'...it seems like job security. It seems to be to not lose federal funding. It's a possible reason why we're not going after and totally trying to do a better job to eradication."

Participants questioned the motivation and underlying values of decision makers by suggesting that they were more focused on economics than environmental values.

> P8: "For me, it's the lack of respect for nature because if they had any then none of that would…they'd really consider everything that's going to happen with the buildup instead of money, money, money, money….Our government hasn't paid attention to anything that has bothered our island."
> P11: "Period."
> P8: "The snakes are not gone, the coqui[1] frogs are still here, the vines are still here. And we have the rhino beetle."

The skepticism and frustration described above could delay or derail future management initiatives and public support for policies aimed at preventing future invasive species. Perceptions of agency fairness, defined as respectful treatment and agency responsiveness to stakeholder concerns, is likely to affect public willingness to accept management decisions (Hamm et al., 2013; Herian, Hamm, Tomkins, & Pytlik Zillig, 2012; Lind & Tyler, 1988). Lack of public confidence in agency decisions could lead citizens to explore alternative legal or political avenues to address their concerns (Schroeder & Fulton, 2016).

4.6. Relationships

If trust perseveres, it may be harder to build trust when there is a history of distrust. The perseverance of trust also means that individuals with positive prior beliefs about managers are likely to interpret managers' actions as consistent with their existing attitudes. In other words, positive interactions with sources often reinforce existing positive levels of trust (Poortinga & Pidgeon, 2004). In addition to pre-existing positive beliefs about sources, interpersonal interactions and experiences with them could help to build confidence. Confidence is influenced by familiarity, experience, and evidence (Siegrist et al., 2003). Thus, it makes sense that participants who expressed positive relationships with managers and scientists also expressed confidence that there are smart people working on this and managers who really want to make a difference.

Support for management sources and government institutions was expressed by participants who were directly familiar with management actions or had friendly relationships with management sources.

> P43: "I trust my friends in the field. And that's a – I mean – I personally know them. I know they're good at what they do, believe what they say. And then the University. I think there are some very smart people here that have been working on some of these issues and researching them for many

[1] Coqui frogs were intercepted on Guam before they were able to spread (Hauswirth, 2009; Invasive Species Compendium, 2017).

> years. And I, especially because it's a local resource, I believe they know what they're talking about because they see it firsthand."
>
> P29: "I have a lot of people that I know that are working with different stuff. So, talking to them and what's going on with them and they talk about what they're doing. I feel like I'm getting straight from the source when you talk to those folks."

Both of the participants above praised managers that they had relationships with, describing their confidence in the information provided by their preferred sources and the importance of relationships in building trust and encouraging acceptance.

Direct experience with military sources and perceptions that the military provides benefits to people and families on Guam reduced one participant's willingness to criticize the military:

> P10: "Some of the militaries are helping, I'm not going to put them down."

As another participant suggested, relationships with sources, even complicated ones, can create tensions that have implications for public attitudes toward management actions:

> P30: "I guess there's a fraught relationship, or an ambivalent view, for a lot of people because a lot of people are in the military and a lot of people know people who are in the military."

4.7. Solutions

When asked whether managers are effectively controlling invasive species, individuals described first-hand experiences that influenced their own attitudes about whether or not management efforts were working.

> P23: "I see fewer of them now [snakes] than I used to see 10 years ago, nine years ago, when I came here….and I see more birds now than I did nine years ago."

Regardless of whether they perceived specific management techniques as effective, there was widespread hope that politicians, agencies and individuals could find a solution to this problem.

> P24: "Because if they allow businesses to continue to do what they're going to do, then the businesses are concerned about profit….and I wish that some more of our leaders would be gutsy enough to do that but they want to get re-elected as well and it's a really tough thing for them, I guess."

Participants also expressed a desire to see managers talk more about these issues and voice concerns that might encourage action. Studies of public engagement in environmental assessments have consistently indicated that "broad participation increases not only the scientific credibility of assessments, but also their effects on policy" (NRC, 2008, p. 85). To increase trust, engagement efforts should be transparent and inclusive of local expertise, have clear purposes and procedural fairness, and focus on the coproduction of knowledge (NRC, 2008). One of the frequently proposed solutions to public concerns about ISM actions on Guam was to increase transparency and develop effective outreach initiatives implemented by management and government officials. Transparency was considered a key factor in successful management in one group:

> P30: "People want to know what's happening and if they don't know what's going on or what people are doing about things, then they get upset."

Participants also stated the importance of "community buy-in" and the need to create a conversation with the community to create support. Participants recommended public engagement efforts that would involve the community directly in management activities. The aim would be to create a positive and direct relationship between the public and agency representatives that would build confidence and encourage direct and achievable actions by community members:

> P19: "I think maybe more outreach. I definitely think that things that we—I mean just to be—for the community to be much more proactive, so we're not sitting around waiting for our leaders to come up with a plan. That's not realistic."

There was a desire for direct public engagement and more opportunities for public to voice concerns, be involved directly and even collaborate with managers over efforts to eradicate invasive species. One respondent suggested managers could lead public or private demonstrations about how to use nets that collect coconut rhinoceros beetles. Participants expressed skepticism about one-way education or communication efforts.

> P43: "I'm also kind of sick about marketing outreach and educational efforts. There's effective ones and ineffective ones. And if I see another poster that just tells me to call a number that won't do anything."

Instead of top-down, one-way initiatives, participants expressed an interest in managers engaging the public in a conversation about experiences, public concerns, and actions that the public could take to implement or support management strategies.

> P25: "But I'm wondering if coming at it, at a more, I want to say local approach, versus a scientific – am I saying this right? Do you know what I'm saying? Like a, talk to the people about their land, versus talking to the people about this kind of scientific names for what's going on cause you're doing something bad."

> P44: "Talk to the diver who goes out and doesn't see any fish on the dive or sees dead corals. Does the general public know what is being seen underwater? And what are scientists doing and how are our scientists contributing back to the community by saying, 'Do you realize what's happening right here at home?'"

These suggestions indicate that a community-management partnership could be achieved if managers and agencies seek to broaden inclusion of community members in their wildlife initiatives. The suggestions also imply participants feel hopeful about their ability to improve the wildlife on the island, as well as a willingness to bring their surroundings to the pristine state they expect Guam to display when others visit.

5. CONCLUSION

Invasive species and native species extinctions are considered by scientists and conservationists as two of the most pressing ecological concerns globally (Stokestad, 2010). The island of Guam is one of the most human-altered places on earth, with the invasive brown treesnake having caused the loss of nearly all forest bird species and declines in other

vertebrate species. In addition, recent introductions of invasive pests such as the coconut rhinoceros beetle, little fire ant, and greater banded hornet have directly affected people and natural areas. While our focus group respondents recognized which species are not native to Guam, and identified negative impacts of invasive species, their understanding of and support for management actions was complicated. We identified several reasons for this nuanced support: personal experience and perceptions of invasive species differ from recommendations from natural resource managers; there is a general distrust for the government; and there is widespread confusion over roles, responsibilities, and mandates of government agencies and scientists. However, there is also a sincere desire to contribute to a solution. While direct public engagement initiatives – including extension presentations on how to control the coconut rhinoceros beetle – are currently happening on Guam, our findings suggest that there is both public interest in and opportunity for greater public engagement regarding ISM. It is possible that focus group participants are more interested in public engagement than the general public, a common limitation of engagement initiatives in the sociological context of invasive species (Shackleton, Adriaens, Brundu, Dehnen-Schmutz, Estévez, Fried, & Richardson, in press); therefore, future research should explore public interest in participatory initiatives using methodological approaches that are more generalizable.

Agencies on Guam have a mandate and extensive funding to manage the brown treesnake. Yet the public was focused more on the current invasion of the coconut rhinoceros beetle. Our results suggest that public concern is influenced by a combination of cultural and economic concerns, personal experiences, and characteristics of the two invaders. The brown treesnake is a cryptic nocturnal creature that is rarely encountered by members of the general public unless they keep chickens or birds and few respondents had many direct experiences with live snakes. Conversely, the coconut rhinoceros beetles are regularly found in human areas, and both the beetle and the damage it causes to the trees are easy to spot. Habitation to the coqui frog (*Eleutherodactylus coqui*) on the island of Hawaii significantly decreased negative attitudes toward the coqui (Kalnicky, Brunson, & Beard, 2014). The brown treesnake has been around for more than fifty years, so it is possible that residents have become accustomed to the snake's presence and the loss of birds. Additional research should explore the potential habituation of residents of Guam and its effect on public support for ISM.

Different assessments of the importance of a specific object or approach can create communication failures that can hamper management objectives (Schenk, Hunziker, & Kienast, 2007). First, if the public does not understand or believe the connection between snakes and the loss of birds, snake control efforts could be seen as unnecessary. This study provided preliminary evidence to suggest that some members of the public questioned the connection between snakes and birds and viewed management efforts as unnecessary and a waste of taxpayer money. In addition to differences between public concerns and funding/agency priorities, the public also questioned whether management efforts were successful, whether management was possible and whether managers knew what to do about snakes and coconut rhinoceros beetles. These factors may also create barriers for communication and public support for management, which can delay effective management (see Shackleton et al., 2016). For example, invasive control efforts may require access to private lands in the future, and private landowners who don't believe scientific explanations or trust scientific sources may decide to control or prevent efforts to manage snakes on their property.

While it may be tempting to assume that public perceptions about snakes need to be 'corrected' through one-way communication or transmission of information, it is important to recognize that the deficit model, which assumes that public rejection of scientific information is driven by lack of knowledge or understanding, is particularly problematic when the goal of a communication campaign is conservation action by the general public (NASEM, 2016). In these cases, it is important to recognize that public concerns are often driven by a complex network of values, beliefs, opinions, and experiences. As a result, knowledge alone will not motivate behavior or correct misperceptions. Moreover, poorly designed efforts to counter 'misperceptions' with more scientific knowledge can lead to a backfire effect, where messages that challenge strongly-held beliefs contribute to strengthened support for misperceptions (Nyhan & Reifler, 2010). Therefore, to address beliefs that hinder conservation action, it is critical to develop strategies that incorporate social science methods, address the cognitive drivers of human behavior, and rely on sources that are perceived as trustworthy.

Independent of the context and the characteristics of the species, the quality and effectiveness of communication and outreach information can influence public support for ISM (McNeely, 2001). Poor communication can result in public rejection of management initiatives (Schenk et al., 2007). Effective communication depends on confidence and will be more effective if messages and outreach campaigns are delivered by trusted sources. Our interviews indicated that lack of confidence in the agencies and people involved in ISM may be a major barrier to public support for management actions on Guam.

Our interviewees had diverse views on whether individual managers and scientists were trustworthy. There was a general lack of trust in military sources, often attributed to a history of implementing management actions without concern for public safety. Lack of transparency related to the use of chemicals and toxic substances was regularly described as a factor that reduced public trust in military sources. This confirms previous research suggesting that trust in institutions and government is related to public perceptions of herbicides as a management tool (Norgaard, 2007). There was a lack of trust in agency managers managing invasive species as well, with respondents suggesting that managers are trying but maybe not hard enough. Many respondents indicated skepticism about the ability of managers to effectively control invasive species. Participants also questioned whether local and federal employees were doing enough, using the right approaches to make progress, or even tackling the important questions.

Public trust in science is one important cognitive shortcut, or heuristic, that people use when forming opinions about science (Brossard & Nisbet, 2007). While our results suggest that respondents are skeptical of managers' abilities to effectively control invasive species, they appeared supportive of the need for ISM. Traditional approaches to trust building often focus on efforts to enhance public trust in managers' abilities (Hamm, 2017), but given existing distrust and the perseverance of distrust (Cvetkovich et al., 2002), these efforts may not be enough to engender higher levels of trust. Instead, efforts that continue to build public support for the benefits of ISM and highlight the role that management institutions can play in contributing to these initiatives might open the door to new opportunities for collaboration and trust (Hamm, 2017; Stern & Baird, 2015).

People with a direct connection to a manager or scientist tended to express more confidence in that person and their work, even if they expressed skepticism that the government or agency at a whole was acting with integrity and benevolence. This finding supports previous research suggesting that direct contact and relationships are critical to successful communication because they influence confidence (Siegrist et al., 2003) and the

interpretation of information by key sources (Schenk et al., 2007). More frequent and effective communication between members of the public and trusted experts may reconcile personal experiences with the knowledge/claims by scientists and managers, which was identified as another barrier to public support for ISM. When building connections between groups on Guam, it will be important to identify sources that already have widespread support. The University of Guam was described as a source of reliable information about environmental issues, as well as a source for more general environmental and natural history knowledge. However, skepticism about recommendations from University of Guam Cooperative Extension programs, such as using nets to cover green waste, were mentioned, without explicitly naming the university itself. This suggests that it would be worthwhile to investigate what programs, university departments, or individual professors are seen as trustworthy by the community and include them in outreach efforts. We should note that there are community members who are very active in environmental issues (e.g. beach cleanups, tree plantings, land use protests), and in doing so, interact frequently with managers and scientists, but they were not well represented in our respondent group.

In addition to increasing public interaction with trusted sources, we suggest that natural resource managers draw on social science research to develop strategies for engagement. Two promising approaches are storytelling and citizen science. Storytelling can be useful conservation tool, especially if there is a strong tradition of it in a particular community (DeGroot & Zwaal, 2007; Moezzi, Janda, & Rotmann, 2017). There is a rich tradition of storytelling in Guam, as well as many other Pacific Islander communities (Salas & Indalecio, 2000), and has even showed promise as a tool for behavior change and education (Manglona, Robert, Isaacson, Garrido, Henrich, Santos, Le, & Peters, 2010). Many of our participants, especially older (over 50 years of age) active users, harbor extensive traditional ecological knowledge and were eager to share their knowledge with us through storytelling. Instead of having agency figures "correcting" misperceptions through public outreach, future outreach efforts could incorporate respected community leaders and their approach to sharing knowledge. In addition, opportunities for active involvement in research and management show promise as a tool for engagement, as demonstrated by the success of many citizen science programs (McKinley, Miller-Rushing, Ballard, Bonney, Brown, Cook-Patton, Evans, French, Parrish, Phillips, Ryan, Shanley, Shirk, Stepenuck, Weltzin, Wiggins, Boyle, Briggs, Chapin III, Hewitt, Preuss, & Soukup, 2017). Many of the environmental groups on Guam seen as successful by the community are those that provide opportunities for active participation, such as planting trees in areas subject to erosion (Loerzel, 2013). While engagement can be a challenge for citizen science initiatives (Wald, Longo, & Dobell, 2016), focus group participants expressed interest in additional engagement with ISM efforts. These results suggest that resource users on Guam might be willing and interested in new participatory or citizen-led initiatives to control invasive species.

In conclusion, our focus groups uncovered a complex view from local residents and natural resource users regarding ISM that will likely limit public support for agency actions that rely on top-down, agency-led efforts. Rather than engaging in yet another information campaign that is likely to run into barriers related to lack of trust, skepticism about scientific information, and backfire effects, we believe that identifying and promoting sources that are perceived as trustworthy and developing strategies to generate public engagement will lead to a higher likelihood for success. While there is a long history leading to distrust of the government, particularly the federal government, there is also a widespread desire to

effectively manage invasive species on Guam and for the residents to be part of the solution. Any proposed approach must acknowledge the complex historical relationships between the federal government and local residents, include trusted sources, and engage residents and communities in a participatory and inclusive strategy for invasive species control.

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APPENDIX A: INVASIVE SNAKE AND BIRD EXTINCTION DISCUSSION GUIDE

1. GREETING

- Hello and welcome to this focus group. We really appreciate your participation in this project.
- Introduction – Introduce all facilitators and observers in the room.
- Logistics – Where restrooms are, help yourself to refreshments, etc...
- Purpose
    - The purpose of this research is to better understand your perception of plants, animals, and forests on Guam.
- Group rules
    - Recording equipment – The focus group discussion will be recorded. The tapes will be used to create a transcript of the conversation. Names and personal information will not be used in data analysis or in any of the written research reports. The tapes will be destroyed at the conclusion of this study.
- Individual opinions
    - We are very interested in your opinions. The session is open to everyone, all of your views are important. There is no right or wrong answer.
    - We ask that if you have a comment to make you wait until no one else is talking and that you speak as clearly as possible. It is very difficult to hear the answers when more than one person speaks.
    - We'd like to remind you that your participation in this study is voluntary. There is no penalty for not participating and you have the right to withdraw from the focus group at any time.
    - We will start with introductions, continue with a discussion of experiences with snakes and birds and then move on to a series of questions related to this subject. The survey will take approximately one hour.
    - Are there any questions at this time?
- Brief get acquainted
    - Participant names, positions (if you have them) and any organization affiliations.

2. EXPERIENCE WITH THE OUTDOORS, NATURAL AREAS

- Can you identify the areas on your island that have native tree species or are the most pristine?
- What are the characteristics you would use to identify these areas?
- Have any of you been in these areas? What brought you there?
- What types of experiences have you had? Does anyone have a different experience?
- How many of you share that experience?
- What types of wildlife have you seen in these areas?
- Over your lifetime, have you noticed any changes to the trees or wildlife in these areas?
- (If people are speaking about birds.) What do you think has caused the jungle to change?

- (AsK them to list management challenges.) Of the challenges listed here, which ones are you most concerned about? (Rank them individually, then as a group.)
- What do scientists/managers say about how the jungle has changed?
- How much to you agree, or disagree, with what scientists say about these changes or challenges? Do you think that any of the impacts/claims been exaggerated or under-emphasized, etc.?

3. EXPERIENCE WITH INVASIVE SPECIES

- How frequently do you see invasive wildlife? What do you see? (Write the list on the board.)
- How concerned are you about these on your island? How concerned are you about these species on neighboring islands? How concerned are you about these species spreading to Hawaii?
- On a piece of paper, please indicate which of the invaders on this list are the most concerning to you. (Rank them from 1-end of scale.) Who or what is the top of the list?
- For the top 3 IS listed, what is driving your concern?
- Which species do you think scientists/managers are most concerned about?
- Who do you think will be negatively affected by the continued spread of IS on Guam? On Saipan? Is this likely to impact you or people like you?

4. MANAGEMENT PREFERENCE

- What do you think will happen to the jungle if we don't do anything about IS?
- What do you think about the management strategies that have been used on your island to manage snakes?
- What else should we do to manage IS? What would successful management look like? Are there management strategies that you would strongly oppose?
- How would you benefit from this approach?
- Is there anything that you could do, or are currently doing, to manage IS on your island?

5. TRUSTED SOURCES

- Where do you learn about news or information concerning Guam's plants, animals and environmental problems?
- Do you trust those sources?
- Are there specific individuals or organizations on Guam that you would go to for information about plants and animals or Guam's environmental concerns?
- Why do you trust these individuals or groups?
- Are there specific sources you are skeptical of? Why?

6. CLOSE

- Thank you again for your participation. The information you have provided today has been extremely helpful. This information will be used to help us develop a larger public survey on these issues. If you have additional questions about this research, we encourage you to ask them at this time. If you have questions about your rights as a participant, please contact [Name] at [Email] or [Phone].