

The role of boundary organizations in co-management: examining the politics of knowledge integration in a marine protected area in Belize

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Abstract: Marine protected areas (MPAs) are an increasingly popular tool for management of the marine commons. Effective governance is essential if MPAs are to achieve their objectives, yet many MPAs face conflicts and governance challenges, including lack of trust and knowledge integration between fishers, scientists, and policy makers. This paper considers the role of a boundary organization in facilitating knowledge integration in a co-managed MPA, the Gladden Spit and Silk Cayes Marine Reserve in Belize. Boundary organizations can play an important role in resource management, by bridging the science-policy divide, facilitating knowledge integration, and enabling communication in conditions of uncertainty. Drawing on ethnographic research conducted in Belize, the paper identifies four challenges for knowledge integration. First, actors have divergent perspectives on whether and how knowledge is being integrated. Second, actors disagree on resource conditions within the MPA and how these should be understood. Third, in order to maintain accountability with multiple actors, including fishers, government, and funders, the boundary organization has promoted the importance of different types of knowledge for different purposes (science and fishers' knowledge), rather than the integration of these. Finally, a lack of trust and uneven power relations make it difficult to separate knowledge claims from political claims. However, even if knowledge integration proves difficult, boundary organizations may still play an important role by maintaining accountability, providing space for conflicting understandings to co-exist, and ultimately for governance institutions to evolve.

Keywords: Boundary organization, co-management, local knowledge, non-governmental organization, marine protected areas

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I. Introduction

Marine protected areas (MPAs) have proliferated in recent years, the result of a coordinated global conservation effort (Gray 2010).¹ They are designed to meet a variety of ecological objectives, including the conservation, management, or restoration of species, fisheries, habitats, ecosystems, and/or ecological services, as well as social objectives such as the alleviation of poverty in coastal communities (Fox et al. 2012). However, MPAs pose significant challenges for effective governance (e.g. complex and dynamic ecosystem interactions, heterogeneous social groups with conflicting needs), which must be addressed if they are to fulfill their objectives (Jentoft et al. 2007). Marine protected areas represent a range of governance regimes, including customary sea tenure, community-based management, co-management, centralized state management, and private management (Christie and White 2007). Co-management has been identified as one effective approach to MPA governance (Rudd et al. 2003; Jones 2006; Jones 2014), in part because it has the potential to enable the integration of multiple sources of knowledge (Singleton 2000; Wilson 2002; Moller et al. 2004).

Knowledge integration typically refers to the inclusion of both scientific and local or traditional sources of ecological knowledge in environmental management, in an ongoing process that includes discussion of epistemological differences and collective evaluation of knowledge claims by all participants (Raymond et al. 2010; Bohensky and Maru 2011). In the context of MPAs, there is evidence both for and against the possibility of successful knowledge integration. Aswani and Weiant (2004), for example, describe a community-based MPA in the Solomon Islands where both scientific knowledge and indigenous women's knowledge were successfully incorporated into MPA design and management. Similarly, Ban et al. (2009) demonstrate a method for successfully integrating indigenous knowledge and interests with scientific data in MPA planning, drawing on interviews with knowledgeable resource users as well as scientific priorities identified through a decision-support tool. In contrast, Walley (2002) and Evans et al. (2011) describe the difficulty of integrating local knowledge in MPAs in Tanzania and Kenya, respectively, amidst ongoing power struggles, class conflicts, and lack of trust. In reviewing the MPA literature, Ferse et al. (2010) argue that local ecological

¹ The IUCN defines a protected area [marine or terrestrial] as: "A clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (Dudley 2008, 8).

knowledge is rarely acknowledged or integrated into the design and management of MPAs. Given the continued increase in MPAs and international support for their expansion (Gray 2010), increasing interest in effective MPA governance (Jentoft et al. 2007; Jones 2014), and the potential for lack of knowledge integration to undermine MPA efforts (Jones 2006; Ferse et al. 2010), more attention to the process and challenges of knowledge integration in MPAs is warranted.

This paper considers the role of a boundary organization in facilitating knowledge integration in the Gladden Spit and Silk Cayes Marine Reserve, a co-managed MPA in Belize. Boundary organizations serve to connect knowledge producers (e.g. scientists, fishers) and knowledge users (decision makers) by enhancing communication, translating scientific information into formats that can be used for policy making, and mediating conflicts (Cash 2001; Guston 2001). How do boundary organizations affect the way that different types of knowledge are identified, evaluated, and used in MPAs? What are the consequences of this politics of knowledge for MPA decision making? This paper contributes to the effort to understand the role of boundary organizations in integrating knowledge, both for MPAs specifically and co-management generally. However, while studies of boundary organizations have typically emphasized their role in facilitating communication and enabling joint knowledge production, this paper considers an alternative possibility. I argue that effective boundary organizations may not necessarily facilitate communication or enable knowledge integration. Instead, so long as they remain accountable to actors on both sides of the boundary, they may function by providing space for conflicting understandings, agendas, and ways of knowing to co-exist in a co-management system. Rather than drawing on uncertainty to facilitate communication and knowledge integration (White et al. 2008), boundary organizations may rely on uncertainty as a reason to avoid the difficult task of reconciling competing knowledge claims. In order to maintain accountability with different groups, boundary organizations may be reluctant to pursue knowledge integration where such a process could prioritize some knowledge claims (and political interests) over others.

1.1. Co-management, knowledge integration, and boundary organizations

Co-management typically refers to any case of resource management in which there is a “power-sharing arrangement between the State and a community of resource users” (Carlsson and Berkes 2005, 65), although it is increasingly recognized that neither the state nor the community are unitary, homogeneous actors and that additional actors (e.g. non-governmental organizations or NGOs) also play an important role in the co-management network (Carlsson and Berkes 2005; Cash et al. 2006). Co-management is promoted as an ideal management approach for complex systems such as marine commons, where assumptions of (relatively) complete biological knowledge do not hold and significant cross-level linkages complicate management (Wilson 2002; Berkes 2006). By enabling the integration of complementary local knowledge and scientific knowledge, co-management may offer a more complete picture of the resource(s) (Wilson 2002). In co-management arrangements, states

and scientific experts typically provide larger scale ecological information and scientific tools and analysis, while resource users contribute detailed knowledge about particular ecosystems and places (Singleton 2000; Moller et al. 2004; Berkes 2009). Olsson et al. (2004) argue that this combination of multiple sources of information and knowledge systems is one key feature of successful adaptive co-management. Co-management institutions can facilitate knowledge integration by enabling the contribution of knowledge from different actors or by providing a forum for the joint generation of new knowledge (Berkes 2009; Robinson and Wallington 2012). Knowledge integration can also build trust between resource users and scientists/managers, thereby helping to ensure that customary uses (of resources/wildlife) are sustainable (Moller et al. 2004). However, while a significant body of research has documented local and traditional knowledge (LTK) of the marine environment and considered how this knowledge could be used to improve management, few studies have demonstrated respectful integration of LTK with science in practice (see Thornton and Scheer 2012, for review).

Despite its promised benefits, the process of knowledge integration is difficult and inadequately addressed in the co-management literature, thus “leaving open the question of how the integration of science and Indigenous knowledge is achieved through co-management in practice” (Robinson and Wallington 2012, 16). Barriers to knowledge integration include: a lack of trust between scientists/managers and local knowledge holders (Berkes 2009); treating local/indigenous knowledge holders as repositories of information rather than active political agents (Brosius 2006); ontological and epistemological differences in what is known and how it is known (Raymond et al. 2010); and the politics of actual knowledge integration processes, including institutional power relations (Raymond et al. 2010). For fisheries management specifically, an historical lack of knowledge exchange between fishers and scientists is a source of conflict that can be difficult to overcome (Johnson 2010). Some authors, while acknowledging the difficulty inherent in integrating different sources of knowledge, are confident that this integration or co-production can be achieved (Berkes 2009; Thornton and Scheer 2012). Others are skeptical, suggesting that ‘knowledge integration’ through co-management is a way for powerful state institutions to subjugate indigenous knowledge and values (Nadasdy 1999; Natcher et al. 2005). There is a danger of assuming that the resource management problem is both obvious and universally understood, though perhaps through different means of knowing, when in fact “the assumptions, knowledge, and understandings that underlie the definition of resource problems are frequently uncertain and contested” (Adams et al. 2003, 1915). Assessments of co-management must therefore consider the political dimensions of problem definition and knowledge integration (Nadasdy 2003).

Thus far, the labels of ‘scientific’ and ‘local’ or ‘indigenous’ knowledge have been used, in keeping with the terminology common in both MPA and co-management literature. Increasingly, however, this dichotomous division is regarded as problematic, as different types of knowledge are often multi-dimensional and overlapping (Agrawal 1995; Negev and Teschner 2013). Drawing on

the insights of the science studies literature, this paper explores how knowledge is identified as ‘scientific’ or ‘local’, evaluated, and deployed in marine protected area policies and practices. Rather than conceiving of science as an inherently and essentially distinct activity, science studies scholars assert that what counts as science, especially ‘policy-relevant’ science, is contingent on time and place (Jasanoff 1987; Gieryn 1999). Many actors, not just scientists, engage in ‘boundary work’ to define what counts as science in any given situation (e.g. Hall and White 2008). In co-managed MPAs, where different types of knowledge should in theory be combined, it is necessary to understand how knowledge is classified, legitimized and used.

Related to the concept of ‘boundary work’ is the ‘boundary organization.’ Boundary organizations exist between two distinct realms of science and decision making, yet are accountable and responsive to both worlds and actively work to negotiate the boundary between them (Cash 2001; Guston 2001). As originally described by Guston (1999), there are three characteristics of boundary organizations: (1) they enable the creation and use of ‘boundary objects’; (2) they include actors from both sides of the boundary; and (3) they are responsible and accountable to two distinct social worlds. The concept has since expanded to “encompass more complex and diverse organizations at the boundary between numerous stakeholder groups” (Leith et al. 2016, 379). In addition, authors have noted several potential features of boundary organizations that are particularly salient for marine resource co-management. First, boundary organizations can facilitate the integration and co-production of knowledge by different groups (Cash et al. 2006; Goldberger 2007; Robinson and Wallington 2012), a purported advantage of co-management. Second, boundary organizations are particularly important in a context of uncertainty, which characterizes most marine resource contexts, as uncertainty offers a bridge for communication (White et al. 2008). Finally, they can play a critical role in facilitating exchange between fishers and scientists, whose relationships are often characterized by mistrust and misunderstanding, a situation reinforced by legal mandates that prioritize science in decision making (Johnson 2010). Boundary organizations are successful if all stakeholders are satisfied and there is “stability of the boundary” (Guston 2001, 401). This paper considers how boundary organizations function in situations characterized by multiple knowledge types and examines whether knowledge integration is necessary for success.

2. Methods and study site

Belize, home to the world renowned Meso-American barrier reef system, has established 15 MPAs.² Nine of these MPAs are co-managed by the Belizean

² The 15 MPAs include one national park, nine marine reserves, three wildlife sanctuaries, and two natural monuments. In addition, the government has also protected 11 sites as “spawning aggregation site reserves.” Four of these sites are contained within existing marine reserves (see: <http://protectedareas.gov.bz/>; http://www.biodiversity.bz/find/protected_area/).

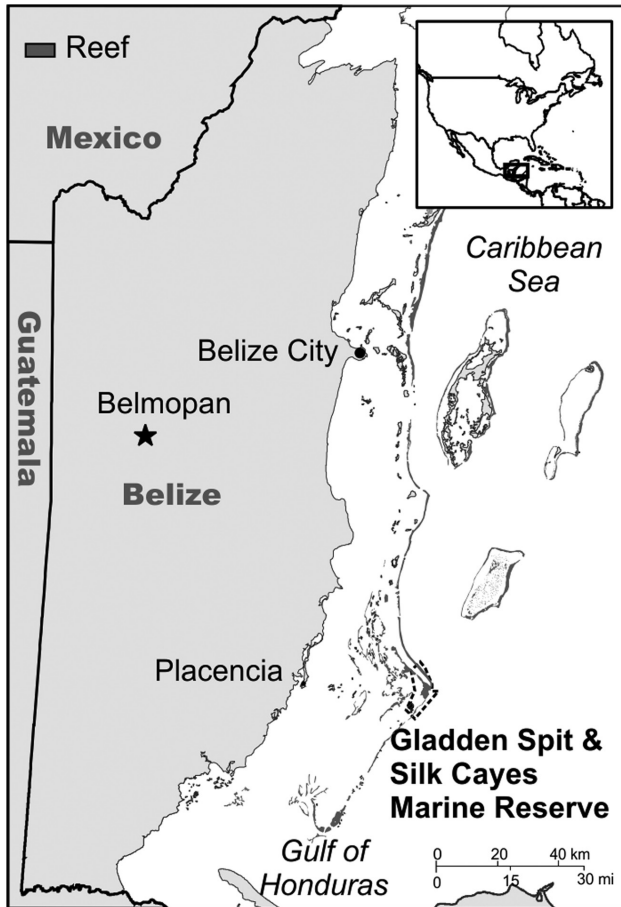


Figure 1: Map of study area in Belize.

government and a local NGO or community-based organization. Friends of Nature is the local co-management partner for the Gladden Spit and Silk Cayes Marine Reserve (hereafter Gladden Spit), which it co-manages with the Fisheries Department (see Figure 1). Gladden Spit has long been an important seasonal fishing ground for communities in southern Belize, especially Placencia. Since the 1920s, fishers have congregated here around the full moon in the spring months to catch large quantities of snapper. In addition, fishers also reported sightings of large sharks in the vicinity. Intrigued by these large fish landings and shark reports, scientists began studying the area in the late 1990s, in cooperation with fishers. They documented a large, multi-species fish spawning aggregation as well as the presence of whale sharks, filter feeders that congregate to feed on the fish eggs (Friends of Nature 2003). In 2000, the government of Belize

declared the Gladden Spit and Silk Cayes Marine Reserve, an 11,000 hectare area (Government of Belize 2000). In 2002, the Fisheries Department signed a co-management agreement with Friends of Nature for Gladden Spit. Friends of Nature is responsible for day-to-day management activities within the reserve, including monitoring both fishing and tourism activities, collecting park entrance fees, maintaining facilities, collecting data, and enforcing regulations.

It therefore acts as a boundary organization, according to Guston's (1999) defining characteristics. First, Friends of Nature facilitates the production of boundary objects, such as maps of the reserve.³ Second, Friends of Nature includes both scientists and policy makers, as well as other stakeholders (e.g. they have scientists as formal advisors and staff members; their board of directors includes representatives of five village councils as well as the fishing and tourism industries). Finally, they are responsible and accountable to distinct social worlds. They must receive approval from the Fisheries Department for any policy changes; they must maintain the support of resources users (e.g. the fishers and tour guides on their board of directors); and they must meet the requirements of various funders, often related to the scientific basis of their work (e.g. international NGOs and donors) (Goetze 2009). Friends of Nature illustrates the expanded concept of the boundary organization as mediating numerous stakeholder groups (Leith et al. 2016).

Gladden Spit is a multi-use marine reserve, meaning that extractive activities are still permitted within the reserve (except for a small no-take zone). Current regulations dictate that fishers must obtain a special 'traditional' fishing license to fish the spawning aggregation; only fishers from nearby communities, who have historically fished at this location, are eligible for the special license. Other forms of fishing (e.g. for lobster/conch) are permitted within the reserve with a regular Belizean fishing license. In addition, whale shark tourism (scuba diving and snorkeling) has become a popular tourist activity at Gladden Spit and helps to provide revenue for reserve management (via entry fees) as well as for tour operators and tour guides based in Placencia. Whale shark tourism has displaced some of the fishing activity at the spawning aggregation, by providing an alternative source of income.

This paper draws on research conducted in Belize from June 2006 to July 2007, including semi-structured interviews and informal interviews, participant observation, and a review of relevant documents. Purposeful sampling was used to identify respondents that offered 'information-rich cases' (Patton 1990). This included: respondents in relevant positions of responsibility (e.g. leaders of tour guide and fisher organizations, NGO staff and board members, Fisheries Department staff), respondents with detailed knowledge of Friends of Nature and the history of the marine reserve (e.g. individuals who had lobbied for or against

³ The very concept of the 'marine protected area' functions as a boundary object, as the concept takes on different meanings and purposes for different groups (Gray et al. 2014). Friends of Nature certainly tailors its discussion of marine reserves to suit different audiences.

the reserve, individuals who use the reserve regularly such as tour guides and tour operators, scientists who have conducted research there), and respondents who are impacted by the reserve (e.g. fishers who fish the spawning site). I interviewed a total of 82 respondents; 67 of these respondents are based in Placencia, including 26 fishers (current and former, full-time and part-time), 16 tour guides, 12 Friends of Nature staff and board members (former and current), and other local residents. The remaining 15 respondents included scientists (5), staff of international NGOs and foundations (7), staff of other Belizean NGOs (2), and representatives of the Fisheries Department (2).⁴ The majority of respondents were consulted multiple times over the course of fieldwork (including casual conversations, interactions in meetings, and/or formal interviews), while some respondents were only consulted once, during a formal interview. Formal interviews were semi-structured, tape-recorded, and transcribed, and focused on a range of topics such as the marine reserve (its history, policies, and resource conditions), resource use and livelihoods, and perceptions of governance and decision making. In addition to interviews, field notes were taken during participant observation at various meetings and events (including community meetings, NGO meetings and staff training workshops, NGO-led community consultations, two scientific meetings in which fishers participated, tourist outings, and social gatherings).

Overall, the research design included multiple verification strategies (Creswell 1998), including: triangulation of both methods and sources (many respondents were consulted multiple times in various settings); prolonged engagement (one year of immersion in the research site, including participation in a variety of events and activities); and negative case analysis (alternative view points were purposefully sought out and considered, such as fishers who agreed with scientific findings). I analyzed the data by searching for key themes related to knowledge production and interpretation, looking specifically for areas of commonality and contradiction. This follows the practice of 'constant comparison' from constructivist grounded theory, which refers to the comparison of: (1) different individuals' views; (2) different pieces of data from the same individual; (3) different incidents; (4) data to the categories in which they are coded; and (5) different categories (Charmaz 2000). In order to preserve confidentiality, respondents are cited by code (e.g. I4, I39). Quotations are used to illustrate key themes that emerged through analysis.

3. Results

Respondents identified multiple challenges for knowledge integration in the context of policy-making and management of the Gladden Spit and Silk Cayes Marine Reserve. First, actors had divergent perspectives on whether and how knowledge

⁴ The five scientists were also associated with either Friends of Nature or an international NGO, but are listed separately specifically because they have formal scientific training and conduct scientific research, unlike other NGO staff.

was being integrated. Second, there were ontological and epistemological differences; actors disagreed on what is known (especially regarding resource management 'problems' at Gladden Spit) and how it should be known, demonstrating the important distinction between general knowledge types and specific knowledge claims. Third, in order to maintain accountability with multiple actors, including fishers, government, and funders, Friends of Nature has promoted the importance of different types of knowledge (science and fishers' knowledge), rather than knowledge integration. Finally, a lack of trust and awareness of the broader social context in which knowledge production is embedded highlights the need to attend to power relations. These challenges are reviewed below.

3.1. Is knowledge integration occurring?

The establishment of Gladden Spit was widely portrayed as an exercise in science-based policy making. As one scientist explained, the "creation of Gladden Spit was driven by science. Community was more of an afterthought" (I70). More precisely, it was driven by the concerns of scientists; the same respondent described it as an excellent piece of "precautionary work", in that it was based in part on the scientists' concerns for what might happen if the site was not protected. Local fishers agreed that community had been an 'afterthought'; fishers and other local resource users and residents were not consulted about the MPA until late in the designation process. "[There were] only two consultations we had before they established that area [Gladden Spit]" (I13, fisher).

The emphasis on science-based decisions continues to inform the management of Gladden Spit by Friends of Nature. "From the time we started we wanted to set up a management regime that was based on good sound scientific information" (I24, Friends of Nature). Friends of Nature respondents presented science as the primary basis for decision making, followed by community consultation and government input. When asked about the process for the potential expansion of the no-take area within Gladden Spit, for example, a Friends of Nature respondent said, "first we have to locate the areas and justify them scientifically, then put them up for consultation with the fishing communities, then after we've discussed it with them and come to some sort of an understanding then we take it up to Fisheries [Department]" (I24). In this view, science is essential both to ensure that management is effective and to convince fishers of the appropriateness of management practices. "How can we justify closing certain areas to fishing or setting bag limits if we cannot sit down with the fishermen and give them a scientific basis for doing so?" (I24). Other scientists echoed this view. For Friends of Nature and scientists, scientific information is not only necessary for directing policy changes, it is seen as an appropriate basis for justifying such changes to fishers, tour guides, and other resource users. In particular, any policy changes proposed to the Fisheries Department must be scientifically justified. As one Fisheries staff commented, "science is very important, and it's necessary to make decisions" (I81).

Scientists and Friends of Nature also discussed the importance of local knowledge. For example, a Friends of Nature respondent emphasized that they had worked to include fishers in their research efforts through informal consultation and conversation, particularly in identifying potential no-take areas. One scientist also emphasized the important contribution of fishers' knowledge to scientific research at Gladden Spit, citing the interviews with fishers that first led to the documentation of the spawning aggregation and the role of fishers in supporting subsequent research at the site (including as boat captains/guides). Several of the scientists also highlighted the importance of fishers' local knowledge insofar as it could help to identify topics or areas for scientific research.

Local respondents also recognized the role of scientific research and monitoring in informing Friends of Nature's management practices: "I think it [scientific research] does a lot of the decision making... It made the decision on limiting the fishing in that spawning zone to just the traditional fishermen" (I19). However, there was a widely shared sentiment among fishers that their experience-based knowledge is not adequately accounted for in decision making, in contrast to scientific knowledge. For the fishers, science was questionable because it is presented to them by people who 'work in an office'. They contrasted this with the knowledge they gain from working on the water, which they see as a better justification for management decisions, such as identifying no-take areas.

"I was trying to show them [Friends of Nature] different thing that I know, 'cuz I'm an experienced fisherman, especially like conch, area that should be protected, they didn't want to listen to me... you can't be working in an office and say to the fishermen 'I see what's going on', because you don't" (I7, fisher).

Even fishers who were generally supportive of marine reserves and Friends of Nature echoed this sentiment. "They need to come in with more local knowledge... asking we who know it from working out there" (I54, fisher). These views were widely held among fishers, who drew a clear boundary between their own knowledge and that held by those 'in the office'. Unlike Friends of Nature and several of the scientists, fishers did not believe that their local knowledge was adequately incorporated into Friends of Nature's management practices and proposed policy changes.

In discussing the role of knowledge in MPA establishment and decision making, all respondents drew a clear boundary between scientific knowledge and fishers' knowledge. Scientists acknowledged the value of fishers' knowledge, but as a means of supporting scientific research. Fishers, in contrast, were suspicious of scientific knowledge and did not agree that their knowledge was integrated into MPA decision making. Friends of Nature advocated science-based decision making while also emphasizing their attempt to incorporate fishers' knowledge into their planning efforts. Although Friends of Nature highlighted the importance of communicating scientific findings to fishers, they did not identify formal

mechanisms for integrating the knowledge produced by both scientists and fishers. Overall, while all actors acknowledged the role of distinct knowledge types, there was no evidence of either formal or informal processes to integrate these different sources of knowledge.

3.2. Boundary work: knowledge types and competing knowledge claims

Perhaps the single most important fishing location for Placencia fishers is ‘the drop’ at Gladden Spit, the site of the multi-species spawning aggregation. This fishery is important to Placencia fishers both economically and symbolically. It has historically been a reliable way for Placencia fishers to earn a significant amount of money in a short period of time. “That place is Placencia’s gold, that place is everybody’s livelihood” (I6). It is especially important because it provides a source of income for fishers in the months when the lobster season is closed. Only a few fishers still regularly fish the spawning aggregation, as many of them now work in the tourism industry and prefer the ‘easy’ labor of tour guiding to the physically challenging work of fishing the spawning aggregation. However, many fishers agree that it is important to them to be able to fish there, should they so choose. “I would like to reserve the right to fish out there, even if I don’t go out there now, I would like to be able to if I wanted to...” (I53).

When Gladden Spit was declared a marine reserve in 2000, one of the main purposes was to protect the spawning aggregation. Since research had only just begun at Gladden Spit, there were no long-term scientific data available to establish the status of these particular fish populations. However, it is frequently argued in the scientific literature that fishing should be prohibited at all spawning sites, because of the vulnerability of spawning aggregations of fish to overfishing (see Claydon 2004, for a review). It has therefore been a question since the establishment of the Gladden Spit Reserve as to whether fishing should be permitted, and if so, how to assess whether this use is sustainable.

Scientific research has continued since the creation of the reserve in 2000. Scientists agree that their own data have documented “a decline in the mutton snapper” (I75). Furthermore, they argue that Gladden Spit was established “with the understanding that... if we could really document decline using long term study, that they [Fisheries Department and Friends of Nature] would be supportive of changing laws and potentially close it altogether” (I75). However, several scientists argue that “Friends of Nature does not want to hear it... they want to produce their own data” (I70). By relying on their own data, which do not indicate a decline, Friends of Nature justifies the continuation of fishing at the spawning aggregation. Scientists are “dubious about their [Friends of Nature’s] data” (I70), suggesting the data are not valid because they are “not nearly as well managed as it could be... [Friends of Nature] has been changing who’s collecting the data and how it’s collected” (I75).

Friends of Nature staff follow standard protocols for assessing the spawning aggregation, as trained by several of the independent scientists who have worked

at Gladden Spit. Their data collectors include both staff scientists as well as ‘community researchers’, local residents who have been trained in scientific data collection techniques. They collect observational data and estimates of the size of the spawning aggregation in the water, and have also begun to collect fish landings data from the fishermen. Based on this work, a representative of Friends of Nature disagreed with the scientists’ assessment, saying:

“There are people who would like to see fishing [of the aggregation] discontinued at Gladden Spit... I would be the first to agree, and to comply, if the data was showing us that in fact there was some damage being done, but so far we haven’t seen it, we monitor the numbers annually, and it’s not showing change” (I29).

The Nature Conservancy (TNC), an international NGO, is one of the main funders of work at Gladden Spit, including Friends of Nature’s data collection for the spawning aggregation. When asked about Friends of Nature’s data, a TNC respondent said:

“It’s really hard for me to say... [the data are] very preliminary. But if you know something is in decline, and it’s declining very quickly, you can see it just by looking at the numbers, and I haven’t seen anything like that. I would like to say it’s stable” (I71).

So while less confident in the data than Friends of Nature seemed to be, the TNC respondent also supported the conclusion that the science, as conducted by Friends of Nature, indicates that there is not a decline. While scientists, international NGOs and Friends of Nature all agree that science is an essential basis for management decisions, they disagree as to whose data count and what kinds of management decisions the science for Gladden Spit supports. They are all actively engaged in drawing boundaries around what counts as science for Gladden Spit – the assessments of independent scientists or the research conducted by Friends of Nature.

While scientists dispute the validity of Friends of Nature’s data, fishers similarly question the validity of the scientists’ knowledge. One fisher was particularly detailed in his critique of the scientific research conducted at the spawning site, contrasting it with his own experience-based knowledge.

“I understand [a scientist] said the size of the fish is getting smaller because the population is declining, that’s not true... We don’t see that now, all we see is big fish biting there... I don’t believe in these [scientific] reports” (I13).

However, several local residents (tour guides and former fishers, but no current fishers) indicated that they agreed with the scientific assessment of the situation at Gladden Spit – that the fish population is declining and that fishing should be prohibited.

“I don’t think they should be doing it [fishing the spawning site]. Now that we’re all educated about it, we should know better, the human impact is great... I would say maybe 50% [of fishers] agree. A lot of them now know what’s happening with the area” (I48).

Each knowledge type or group of knowledge holders was associated with multiple knowledge claims; there was no consensus on what either ‘science’ or ‘local knowledge’ indicates.

3.3. Knowledge politics: knowledge integration or accountability?

Although Friends of Nature uses the language of science to defend their decision to continue to permit fishing at the spawning aggregation, they do acknowledge the broader social context in which this decision is made. While espousing science-based management, they must also work to maintain the support of fishers and other local residents. For example, Friends of Nature did not support a nationwide initiative to prohibit fishing at all spawning aggregations in Belize, “because we knew that our fishermen were not ready, neither economically or mentally, to accept such a decision” (I24). In addition to justifying ongoing fishing at the spawning aggregation based on their data, Friends of Nature also highlights the political and social significance of the decision:

“It indicates to the population, to local communities, that we are not about conservation at the expense of humans... It might be at odds with some other people who have this alarmist approach to management, who say, by virtue of their very nature, spawning aggregations should not be fished” (I29).

One scientist questioned whether Friends of Nature genuinely believes that the data do not indicate a decline, suggesting they are using the language of science to disguise political motives. “I don’t know if Friends of Nature is afraid of treading on fishermen, but [they] are well aware... of how bad things really are” (I22). Another local respondent similarly described Friends of Nature’s decisions as political rather than science-based.

“I think scientifically you could present a really good case for that [closing fishing at the spawning site], but it would be wildly unpopular... I don’t think [Friends of Nature] is serious about it... it would be too hard to sell” (I18).

The closure of fishing at the Gladden Spit spawning site would indeed be a ‘hard sell’, given the response of fishers to such a possibility. As one experienced fisher explained: “He [a scientist] wanted to close the area down, the spawning site, but we said no, because we need to survive... We going to take this to court every time because that’s our living, that’s our livelihood” (I6). Even several of the tour guides, who do not rely on fishing for their livelihoods, generally agreed with this stance. “That’s the income for the fishermen. If they lock it off completely, that’s being greedy... You would have a riot” (I47).

One popular justification for continuing to permit fishing at the aggregation is the declining number of fishers who use the site. Even those fishers who do not dispute the science, and agree that the spawning aggregation is declining, argue that the current number of fishers is not sufficient to actually have a negative impact. They also highlight their use of passive gear (the hand line), in contrast to the nets used by illegal fishers. As one fisher said, "...there used to be 100 fishermen out there, but now there are maybe 10 boats, 2 people per boat... [and they fish with hand lines, so] if the fish aren't hungry, they won't bite" (I13). Overall, an economic shift in Placencia from fishing to tourism is indirectly displacing most fishers from the spawning site.

"Some guys will always want to fish out there, but fewer guys out there now because there's easier money to be made [in tourism]... A guy with a handline, two weeks out of the year, I don't see how it hurts anything. Mostly because it will regulate itself, there are fewer and fewer people out there and fewer in the future" (I53).

One scientist disagreed with this assessment, saying "even at 10 fishers a year, we are seeing declines" (I70).

Since 2005, fishers have been required to have a special fishing license to fish at the spawning aggregation at Gladden Spit. This license is reserved for 'traditional fishermen' – those fishers who are known to have been fishing at Gladden Spit for a long time. In 2007, 52 fishers held a special license, although only a few of these fishers fish at Gladden Spit regularly. Despite their insistence that the data do not suggest a decline in the snapper spawning aggregation, Friends of Nature was nonetheless supportive of reducing fishing pressure at the spawning site through the use of the special license. "We are hoping in that way we can phase fishing out, on its own... a moratorium... might become necessary in the future... but certainly for the near term, people can continue to fish" (I29). Friends of Nature developed this 'special license' policy in cooperation with the Fisheries Department. As a Fisheries staff member explained, because of the 'traditional permit,' there "is a manageable number of qualified fishermen and the amount of fish they can take out, so there is no impact on the fishery" (I82). Fishing thus continues at Gladden Spit, at least for the time being, and the question remains of whether or how a closure of the spawning site might occur.

With respect to the status of the spawning aggregation, neither 'science' nor 'local knowledge' offers consistent, uncontested interpretations. Friends of Nature makes no attempt to resolve these differences through the integration of scientific research and fishers' knowledge. Instead they gather their own data, which allows them to maintain accountability to all groups. By basing their policy recommendation (of continued access for local, 'traditional' fishers) on their own scientific data, they are accountable to fishers, who demand continued access, as well as to those groups that demand science-based decision making – namely, the Fisheries Department, the foreign NGOs that fund their work, and other scientists.

3.4. Knowledge integration, power and trust

Many fishers are suspicious of the data produced by scientists because, in their experience, scientists want to restrict fishers' access to resources. They thus view scientific research as simply confirming a predetermined conclusion. "Some [scientists] come already with that mindset... 'I'm going to Belize and I'm going to Gladden Spit, I'm going to close that place down,' they already come with that mentality" (I7). This same fisher also commented on scientific research as an economic activity. Fishers observe scientists and NGOs operating, noting in particular the amount of money flowing through research and conservation projects, and evaluate research results in that context. "Some of the guys who does the research projects, some are looking at it for money, to see what they could make. If you've got a program coming up and somebody's going to fund it, they're going to try to take as much money as they can" (I7). Another fisher, commenting on one scientist who had done research at the Gladden Spit spawning aggregation, said: "He [a scientist] getting paid, if he shut it down he get more money" (I6). Other respondents also commented on the interpretation of research activities in terms of local economic conditions. One tour guide, who had worked with Friends of Nature, described the importance of fisher involvement in research this way:

"Fisherfolks are important partners, but you have to motivate them. Paying some of them – that would really be a problem – how do you decide who to pay? Do we pay all of them? We are talking about a lot of money, they might stop fishing! That would give them a really good reason to stop fishing, we could just do research! That would be cool. But where is that money going to come from?" (I23).

Although this respondent was joking, several fishers suggested that they would be more than willing to give up fishing if they were financially compensated. One fisher (I5) commented that this would be a more effective way to spend the money, instead of on research. Another fisher agreed: "It was a point of constant battle and we told them [scientists], you want it to stop, just ask for some money and each and every one of us, give us one hundred thousand dollars each, and close it down" (I7). One scientist even agreed with this proposal, saying that although the few fishers still fishing the aggregation were doing damage, they were also few enough in number that they could be bought out. "Buy them out. It's that easy" (I70). Another scientist did not suggest a buy out, but did soften his interpretation of the data based on recognition of local economic conditions.

"You live with these guys and see their kids, and realize they have to go to school, and mutton [snapper] reproduces after 3 years, and they reproduce a lot, and that fishery had been fished since the 20s, and the number of boats used to be 100 and now it's 10, and they're still catching big fish, so there's some social interpretation of scientific data and its influence and impact" (I75).

Knowledge integration therefore remains a challenge given this lack of trust between fishers and scientists and divergent perceptions of the social and financial context for research activities.

4. Discussion and conclusion

One of the ostensible advantages of co-management is that it allows the combination of science and local knowledge. In the case of Gladden Spit, this is not the case. Many fishers do not feel that their knowledge is accounted for in policy making, and although Friends of Nature and scientists all refer to the value of local knowledge, they insist that MPA policy making should be science-based. Several authors have acknowledged the challenges associated with integrating knowledge in practice. There is a need for more attention to the challenges of integrating knowledge in contexts where 'knowledge holders' and 'knowledge types' cannot be divided into neat categories (Negev and Teschner 2013). The political challenges and opportunities of specific knowledge claims may require more attention than knowledge types (Hall and White 2008). In this case, all actors distinguished between science and local knowledge, suggesting two 'knowledge types'. For example, fishers agreed that local knowledge comes from working on the sea, whereas science is suspect because it comes from people who spend most of their time 'working in an office'. It is common for resource users not to trust biologists' observations because they lack experience-based knowledge (Nadasdy 2003). However, it is notable that fishers and other resource users disagreed as to whether their experience-based knowledge indicates that the spawning aggregation is declining. Similarly, Friends of Nature, international NGOs, and scientists all agreed that policy making at Gladden Spit is, and should be, based on science. However, they disagreed as to whose data count as science and what science indicates regarding the status of the spawning aggregation. Each knowledge type or group of knowledge holders was associated with multiple knowledge claims; there was no consensus on what either 'science' or 'local knowledge' indicates.

While there is a need for agreement on the validity of different forms of knowledge in the context of MPA management (Jones 2006; Ferse et al. 2010), this agreement may not be sufficient. All actors in this case agreed that both science and local knowledge are valid, yet disagreed over the specific knowledge claims associated with each of these types of knowledge. Disputes over knowledge cannot be easily separated from disputes over values, policy preferences, and the interpretation of knowledge in a context of uneven power relations. For MPAs specifically, this case confirms the observation that fishers' objections to MPAs are likely to be stronger if they believe that scientists are acting as advocates (Jones 2006). As Jentoft et al. (2012, 187) suggest, "stakeholders may have problems distinguishing the images they have about MPAs from the images they have about those who promote them." Fishers object to scientists' preference for fishing closure, yet frame this as an objection to scientists' knowledge claims and a perceived lack of knowledge integration. In discussions of knowledge, it

is difficult to disentangle epistemological and political claims (Brosius 2006). By focusing on the potential role of boundary organizations to integrate different types of knowledge, scholars may be overlooking their role in mediating political differences. In some cases, boundary organizations may integrate knowledge, or facilitate joint knowledge production, as a means to develop mutually agreeable policies (Robinson and Wallington 2012). However, I argue that in order to maintain accountability to different groups, boundary organizations may also forego knowledge integration. In doing so, they mediate the intersection of uncertainty and power relations, a role that deserves more careful scrutiny. Science or 'technical expertise' is typically used to maintain and justify the power of professionals or experts (Negev and Teschner 2013), and scientists often use uncertainty to justify their policy preferences (Campbell 2002). Similarly, knowledge integration may subjugate local knowledge and values, reinforcing the interests of scientists and state institutions (Nadasdy 1999). In contrast, this case illustrates that a lack of knowledge integration may coincide with a defense of local interests. In a context of scientific disagreement and uncertainty, the policy of maintaining access for traditional fishers can be justified as 'science-based' while also serving the interests of the very fishers who challenge science.

Boundary organizations serve a variety of functions. At a minimum, they enable the creation and use of 'boundary objects,' include actors from both sides of the boundary, and are accountable to two distinct social worlds (Guston 1999). They may also facilitate the integration and co-production of knowledge by different groups (Cash et al. 2006; Goldberger 2007; Robinson and Wallington 2012), support communication in a context of uncertainty (White et al. 2008), and facilitate exchange between scientists and fishers (Johnson 2010). Friends of Nature does not neatly map onto this checklist of criteria. Rather, they accomplish core tasks (maintaining accountability, including actors from both sides of the boundary) only by evading the task of knowledge integration (whether strategically or unintentionally). Friends of Nature collects scientific data (in cooperation with local residents and as trained to by scientists), although several independent scientists dispute their findings. They espouse an ideal of scientifically informed management while also supporting continued access for fishers to the spawning aggregation. The policy of limiting fishing at the spawning site to 'traditional fishers' does not require any consensus on whose data are accurate, what counts as science or local knowledge, or how different sources of knowledge should be integrated and used. Instead, this strategy reflects Friends of Nature's efforts to maintain accountability to groups on either side of the boundary and to mediate conflicts regarding fishing at the spawning aggregation.

If knowledge integration is required for a boundary organization to be effective, then Friends of Nature is not effective. However, success for boundary organizations is typically marked by stability at the boundary and stakeholder satisfaction (Guston 2001; Leith et al. 2016), not by knowledge integration. In this case, Friends of Nature has been effective at remaining accountable to actors on both sides of the knowledge-policy boundary, maintaining different groups'

support for existing co-management institutions and policies. While there may be cause to expand the definition of success for boundary organizations to include more substantive outcomes beyond ‘boundary stability’ (Leith et al. 2016), there is need for further reflection on whether this ought to include knowledge integration in those contexts characterized by multiple knowledge types. In situations where knowledge integration is difficult, owing to mistrust and divergent perspectives on knowledge legitimacy, boundary organizations may nonetheless play an important role in maintaining space for conflicting understandings, agendas, and ways of knowing to co-exist. In the long term, this may enable knowledge integration processes to emerge and facilitate adaptive co-management.

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