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Heather Heenehan[a], Xavier Basurto[a], Lars Bejder[ba], Julian Tyne[b], James E.S. Higham[c] & David W. Johnston[ab]

[a] Division of Marine Science and Conservation, Nicholas School of the Environment, Duke University Marine Laboratory, 135 Duke Marine Lab Rd., Beaufort, NC 28516, USA

[b] Murdoch University Cetacean Research Unit, School of Veterinary and Life Sciences, Murdoch University, 90 South Street, Murdoch, WA 6150, Australia

[c] Department of Tourism, University of Otago, Level 4, Commerce Building, Cnr Union and Clyde Streets, Dunedin 9054, New Zealand

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Using Ostrom's common-pool resource theory to build toward an integrated ecosystem-based sustainable cetacean tourism system in Hawai`i

Heather Heenehan[a]*, Xavier Basurto[a], Lars Bejder[b,a], Julian Tyne[b], James E.S. Higham[c]† and David W. Johnston[a,b]

[a]*Division of Marine Science and Conservation, Nicholas School of the Environment, Duke University Marine Laboratory, 135 Duke Marine Lab Rd., Beaufort, NC 28516, USA;* [b]*Murdoch University Cetacean Research Unit, School of Veterinary and Life Sciences, Murdoch University, 90 South Street, Murdoch, WA 6150, Australia;* [c]*Department of Tourism, University of Otago, Level 4, Commerce Building, Cnr Union and Clyde Streets, Dunedin 9054, New Zealand*

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This paper explores the suitability of community-based conservation measures to complement a proposed command-and-control approach for two multi-user bays with spinner dolphins in Hawai`i, USA, which have considerable dolphin watching tourist activities and human−dolphin interactions. The paper uses Ostrom's common-pool resource theory as an analytical lens, with an assessment of the attributes of the resource and the user(s) to explore questions of governance and sustainability. In Hawai`i, spinner dolphins move predictably from offshore overnight feeding grounds into shallow bays for daytime rest, interacting frequently with humans using these bays for tourism and other social, recreational, and subsistence purposes. To reduce the current negative interactions with dolphins, managers are seeking to implement a command-and-control approach, namely time−area closures. Our analysis indicates that viewing the bay as a resource with tourism as one of many human demands, instead of specifically focusing on dolphins, reflects an ecosystem-based approach and acknowledges complex management demands. We found that while unrealistic to expect community-based conservation to spontaneously emerge here, cultivating some of Ostrom's attributes among stakeholders might lead to a more productive set of institutional arrangements that would benefit the dolphin population, with the methodology used potentially leading to a global management model.

Keywords: human−cetacean interactions; community-based conservation common-pool resource; tourism; dolphin watching; ecosystem-based management

Introduction

Ecosystem-based management of marine resources has been promoted as key for the conservation and use of healthy ocean ecosystems (McLeod & Leslie, 2009) and for sustainable marine tourism (Higham, Bejder, & Lusseau, 2009). With the growth, expansion, and diversification of human use of marine resources, this broader ecosystem context and approach to management are critical to understand issues of sustainability. However, it is less clear what specific management approaches might be conducive to the development and implementation of an ecosystem-based approach. Past efforts have included "bottom-up, stakeholder-driven" processes, and "more top-down, government-mandated efforts",

*Corresponding author. Email: hlh18@duke.edu
†Present address: Visiting Professor, University of Stavanger, Norway.

what we call command-and-control (McLeod & Leslie, 2009, p. 10). For common-pool resources, traditional options for management have included privatizing the resource and applying top-down regulations (Hardin, 1968). While privatization and command-and-control governance regimes were considered the only options for many years, in the last 30 years there has been growing interest in management regimes, like community-based conservation, that more closely engage with diverse local stakeholder groups (see Speer, 2012). Calls to use insights from common-pool resource theory to contribute toward the ideals of ecosystem-based management have been made in the past (Imperial, 1999), but there is little published literature that addresses this subject.

In this paper, we analyze the specific case of a non-consumptive common-pool marine resource, spinner dolphin (*Stenella longirostris longirostris*) resting bays, as it relates to a non-extractive use of spinner dolphins via dolphin tourism in Hawai`i. In the main Hawaiian Islands, spinner dolphins have a predictable presence in coastal waters, where they frequently interact with humans engaged in a variety of commercial and recreational endeavors (National Oceanic and Atmospheric Administration [NOAA], 2006). The growth of dolphin watching and other forms of non-extractive use of Hawaiian spinner dolphins have led to concerns regarding the intensity, consistency, and, ultimately, the sustainability of these interactions. Spinner dolphins are a protected species under the USA's Marine Mammal Protection Act of 1972. They are social animals that get their common name from their acrobatic jumps and spins, attracting fascination by visitors. Since these dolphins rest predictably during the day, human−dolphin interactions during this critical time of rest may have serious effects on their populations (Courbis & Timmel, 2009).

This paper uses insights from common-pool resource theory to explore the potential of community-based conservation, thought to be better aligned with principles of ecosystem-based management because local people with high understanding of ecological and biological dynamics can be involved in decision-making processes (Farrell & Twining-Ward, 2004, 2005). We find that, while it is unlikely that a community-based conservation regime can emerge in the study area, insights from common-pool resource theory can inform critical points in which to better engage stakeholders and contribute toward the ideals of ecosystem-based management. Better engagement with stakeholders constitutes the first step toward approaching the ideals of ecosystem-based management approaches for marine megafauna, and thus a potentially productive path to follow. The paper aims to provide experiences and ideas for the management of similar management systems in other parts of the world.

Theoretical grounding

In 1968, Hardin published the "The Tragedy of the Commons" and advocated command-and-control regulation or privatization of common-pool resources. Since 1968, scholars have opposed the generalizability of these solutions (Acheson, 2000; Lam, 1999) and pointed toward self-governance or community-based governance as an alternative, often overlooked approach (Ostrom, 1990).

Common-pool resource theory has been applied to better understand governance arrangements for various extractive forms of natural resource utilization (i.e. fisheries, forestry, water utility) but less so for non-extractive resources like human interactions with cetaceans or other marine mega-vertebrates. Notable exceptions include Moore and Rodger's (2010) work, showcasing the utility of common-pool resource theory to investigate the governance of whale shark tourism in Ningaloo Reef, Western Australia. They

Table 1. Attributes of the Resource (Ostrom 2005, p. 244) published with permission from Princeton University Press.

Attribute		Description
R1	Feasible improvement	"Resource conditions are not at a point of deterioration such that it is useless to organize or so underutilized that little advantage results from organizing".
R2	Indicators	"Reliable and valid indicators of the condition of the resource system" exist.
R3	Predictability	The "flow of resource units is relatively predictable".
R4	Spatial extent	"The resource system is sufficiently small. . .that appropriators can develop accurate knowledge of external boundaries and internal microenvironments".

described wildlife tourism as a common-pool resource because it is "difficult to exclude tourists, their experiences are affected by others' activities; and adverse impacts on the wildlife occur" (Moore & Rodger, 2010, p. 831). The same argument holds for our case study of spinner dolphin resting bays. Spinner dolphin resting bays are central and critical to the lives of Hawaiian spinner dolphins. The bays are shallow, sandy, close to offshore feeding grounds, provide protection from predators, and a place for dolphins to socialize and rest after expending energy feeding offshore all night (Benoit-Bird & Au, 2009; Norris, Wursig, & Wells, 1994; Thorne et al., 2012). Therefore, both dolphin conservation and dolphin-based tourism depend on the successful management of these bays. It is difficult to exclude a range of potential users from these bays since they are easy to access by both animals and people and there is only a finite amount of space in a bay, and one's use of that space can eliminate it for someone or something else (Ostrom, 2005).

Common-pool resource theory is also useful to identify the potential that community-based conservation in particular has of emerging in a given setting. Researchers working in this tradition have empirically identified the conditions or attributes that increase the likelihood that community-based conservation efforts can develop. Ostrom proposed a number of attributes of the resource (Table 1) and the appropriator (i.e. user) (Table 2;

Table 2. Attributes of the appropriator (Ostrom 2005, p. 244–245) published with permission from Princeton University Press.

Attribute		Description
A1	Salience	"Appropriators depend on the resource system for a major portion of their livelihood or the achievement of important social or religious values".
A2	Common understanding	"Appropriators have a shared image of how the resource system operates (attributes R1, R2, R3, and R4 above) and how their actions affect each other and the resource system".
A3	Low discount rate	"Appropriators use a sufficiently low discount rate in relation to future benefits to be achieved from the resource".
A4	Trust and reciprocity	"Appropriators trust one another".
A5	Autonomy	"Appropriators are able to determine access and harvesting rules without external authorities countermanding them".
A6	Prior organizational experience and local leadership	"Appropriators have learned at least minimal skills of organization and leadership".

Ostrom, 2005). However, the presence of Ostrom's attributes does not ensure the success of community-based conservation, if in fact a community-based regime does emerge. These attributes were later modified and incorporated into the emerging social-ecological system framework increasingly used to explore questions related to resource governance and sustainability (Basurto, Gelcich, & Ostrom, 2013; Cinner et al., 2012; Gutiérrez, Hilborn, & Defeo, 2011; Ostrom, 2009).

Within the context of sustainability, this paper recognizes the complexity of managing nature-based tourism phenomena. It arises because tourism often exists as one of a range of complementary or conflicting uses of natural resources (Higham et al., 2009), and that nature-based tourism activities take place within very specific settings that are physically and socioculturally dynamic (Shelton & McKinlay, 2007). This has given rise to calls for local stakeholder participation in tourism management (Miller & Twining-Ward, 2005), whereby local and indigenous knowledge may make valuable contributions to nature-based tourism management (Farrell & Twining-Ward, 2005).

Inspired by the tradition of the Ostrom's Institutional Analysis and Development (IAD) framework to study common types of issues, we start by organizing the description of the setting by (1) biophysical conditions, (2) rules-in-use, and (3) attributes of the community (Ostrom, 2011). Next, by treating spinner dolphin resting bays as the focal action situation, we use insights from common-pool resource theory to (1) locate spinner dolphin resting bays as a unit of management within an ecosystem-based sustainable management approach; (2) identify interactions and conflicts among users in the bays that might be influenced by rules-in-use: and (3) visualize the outcomes of a community-based conservation approach by invoking Ostrom's attributes of the resource and the appropriator.

Background

Cetacean-based tourism in Hawai`i

Cetacean-based tourism, also referred to as whale watching, is defined as tourism by "boat, air or from land, formal or informal, with at least some commercial aspect, to see, swim with, and/or listen to any of the some 83 species of whales, dolphins and porpoises" (Hoyt, 2001, p. 3). Over the last 20 years, cetacean-based tourism, as a whole, has witnessed tremendous growth and expansion. The last estimate was that whale watching attracts approximately 13 million people in 119 different countries generating US$ 2.1 billion (O'Connor, Campbell, Cortez, & Knowles, 2009). Managers charged with ensuring the protection of cetaceans are concerned about both the short-term and long-term effects of these interactions, and are seeking to implement regulatory schemes (Higham & Bejder, 2008; Higham et al., 2009).

Cetacean-based tourism is an important part of Hawai`i's local economy. In 2008, the estimate for direct expenditures was approximately US$ 17 million with total expenditures estimated to be over US$ 131 million (O'Connor et al., 2009). In Hawai`i, cetacean-based tourism includes whale and dolphin watching, as well as swim-with wild dolphin programs. Dolphin-watching trips accounted for close to US$ 6 million in direct expenditures and over US$ 46 million in total expenditures in Hawai`i (O'Connor et al., 2009). The swim-with dolphin programs rely primarily on free-ranging spinner dolphins and their predictable daily behavior. During many of these programs, tourists interact with spinner dolphins in their resting bays, often chasing them and in some cases touching and restraining dolphins (Heenehan, 2012).

The development of this dolphin-based tourism in Hawai`i started in the early 1990s. By 2001, Hoyt acknowledged that some companies had shifted their focus during "the non-humpback whale season toward... toothed whales and dolphins... reliably seen in Hawaiian waters" (p. 23). Spinner dolphin tours are now the target of a year-round industry (O'Connor et al., 2009). Today, this industry includes at least 27 different companies conducting tours year-round in the waters on the Kona Coast of Hawai`i Island (Carlie Wiener, Hawai`i Institute of Marine Biology, pers. comm.).

The consequences of human−cetacean interactions on the dolphins, whales or porpoises can be both short term and long term, raising concerns about the sustainability of these interactions. Short-term changes include changes in aerial or social behavior and changes in movement patterns (Lusseau, 2006; Lusseau & Bejder, 2007). Long-term changes include reductions in the number of dolphins using a specific area and reductions in reproductive output (Bejder et al., 2006; Lusseau, Slooten, & Currey, 2006). For spinner dolphins specifically, some short-term changes include avoiding or leaving resting bays prematurely and changes in aerial or acoustic activity (Courbis & Timmel, 2009; Lammers, 2004). These short-term changes can lead to longer-term effects on reproduction, survival, fitness, and population abundance (Courbis & Timmel, 2009), although these effects are only now being comprehensively studied.

Spinner dolphins and their resting bays

Hawaiian spinner dolphins display predictable diurnal behavior (Norris et al., 1994). They feed cooperatively at night offshore (Benoit-Bird & Au, 2009) and return to shallow sandy bays during the day to rest and socialize (Norris et al., 1994). Norris (1991) originally hypothesized that an important characteristic of a resting bay was a sandy bottom and that each bay had a carrying capacity, the maximum number of dolphins a bay could support. Norris also proposed that the bays they use are often close to predictable feeding areas and provide protection from predators (Wells & Norris, 1994). These hypotheses were confirmed in a recent quantitative analysis (Thorne et al., 2012). Since the dolphins rest during the day, when humans are most active and do so in places that are attractive to humans, there is great potential for conflict between dolphin rest and human activities. These conflicts have led to growing concern about the interactions between humans and dolphins in resting bays (NOAA, 2006).

Other resting bay user groups

Since spinner dolphin resting bays are accessible by land and sea, they are used by a variety of other user groups in addition to cetacean-based tour operators and tourists. For recreation, people kayak, paddleboard, canoe, sail, fish, swim, and snorkel in the bays. For subsistence, where bays are not protected as no-take areas, people fish in the bays. Akule fishing (*Selar crumenophthalmus*), also known as big-eye scad, is an important subsistence and cultural fishing activity that occurs in some areas where cetacean-based tourism operates (DeMello, 2004). Business operators, visitors to the Hawaiian Islands, residents of the Hawaiian Islands, and native Hawaiians are among those who regularly use spinner dolphin resting bays.

Current management and regulatory framework

Spinner dolphins are protected by the USA's Marine Mammal Protection Act (MMPA) of 1972, 16 U.S.C. 1361 et seq. This legislation aims to protect marine mammals and their populations from injury and harassment. The US National Marine Fisheries Service

(NMFS), a line office in the US National Oceanic and Atmospheric Administration (NOAA) is charged with upholding the MMPA and thus protecting spinner dolphins from negative human effects. Due to the growing concern about interactions between humans and spinner dolphins, the NMFS Pacific Islands Regional Office, with advice from the NMFS Pacific Islands Fisheries Science Center and the US Marine Mammal Commission, is planning to implement time−area closures to reduce interactions between humans and spinner dolphins in four resting bays along the Kona Coast during times when dolphins should be resting (NOAA, 2006). The goal is to minimize interaction by closing certain areas within spinner dolphin resting bays during peak resting time (e.g. 7:00−15:00). Currently, there are no statutory limits on approach distance, only a set of voluntary NOAA guidelines (e.g. should stay 50 yards away and limit time with a group of spinner dolphins to a half of an hour). This is not uncommon: other examples of large, non-compliant, and not-enforced dolphin tourism programs exist (see Filby, Stockin, & Scarpaci, in press).

Since spinner dolphins are not listed under the US Endangered Species Act, the State of Hawai`i is not directly involved in protecting spinner dolphins. However, the state can make decisions regarding the status of its waterways, can close areas of bays, and establish protected areas like Marine Life Conservation Districts. The State of Hawai`i's Division of Aquatic Resources (DAR) is responsible for establishing these districts (Division of Aquatic Resources, 2013a). Kealakekua Bay, one of our two study bays, is one of the five Marine Life Conservation Districts on Hawai`i Island (Division of Aquatic Resources, 2013a). The DAR is also responsible for regulating other aquatic resources including fishing. Hawai`i does not require a recreational fishing permit but does have various other licenses and regulations on catch limits (Division of Aquatic Resources, 2013b).

The two study bays: Makako Bay and Kealakekua Bay

Makako Bay and Kealakekua Bay were chosen for this study since they are two well-known spinner dolphin resting bays on the Kona Coast where people seek to swim with dolphins. Makako Bay and Kealakekua Bay are also two of the four study bays for the Spinner Dolphin Acoustics Population Parameters and Human Impacts Research (SAPPHIRE) Project (http://superpod.ml.duke.edu/johnston/portfolio/sapphire-project/). We chose these two bays specifically because they are the most frequented of the four by the dolphins (and humans). Specifically, we encountered spinner dolphins in these bays during 73% (Makako) and 52% (Kealakekua) of the SAPPHIRE photo-identification surveys, respectively, while only encountering dolphins during 39% or 41% of the time in the two other study bays (Tyne, Pollock, Johnston, & Bejder, 2014). Acoustic encounter rates of dolphins for these bays between November 2010 and February 2012 were 88% (Makako) and 63% (Kealakekua) of days recorded. The other two bays had encounter rates of 39% and 50% of days recorded (SAPPHIRE unpublished data)

People seek to swim with dolphins in both bays, but the bays are very different in size, levels of protection, and distance to important harbors. Kealakekua Bay (2.23 km^2), home to the monument dedicated to Captain James Cook, was established as a protected area, a Marine Life Conservation District, in 1969. Makako Bay, a smaller bay than Kealakekua (0.20 km^2), is not a Marine Life Conservation District; however, it is within the boundaries of the Hawaiian Islands Humpback Whale National Marine Sanctuary, a marine protected area that focuses on conservation and awareness of baleen whales, not spinner dolphins. Kealakekua Bay is 3 km farther from the nearest boat harbor and approximately three times farther from the major embarkation point for swim-with tours, Honokōhau

Harbor, than Makako Bay. In addition to year-round swim-with wild spinner dolphin tours during the day, year-round manta ray dive and snorkel tours also occur in Makako Bay at night.

Methods

We link insights from common-pool resources research with ecosystem-based management to explore the potential of community-based conservation as a governance regime for spinner dolphins in their resting bays in Hawai`i. First, we conducted an assessment of the human uses of the study bays, next, we assessed the interactions and conflicts within resting bays, and finally, we considered the potential for community-based conservation through a preliminary assessment of the role of resource and user attributes (Ostrom, 2001). We utilized a variety of data sources including human use assessments of our two study bays, expert informants, and public scoping materials as described below to support our claims and to understand this complex sustainability issue.

Assessment of human use in resting bays

We used scan sampling data obtained during photo-identification surveys (December 2010 to May 2012) and information provided by expert informants, to characterize human use in Makako and Kealakekua Bays. Dolphin photo-identification surveys were conducted using a 7-m outboard-powered vessel on a specific schedule every month designed to obtain rigorous photo-identification and dolphin abundance estimations (Tyne et al., 2014) The boat generally arrived in a bay by 7:00 am and stayed until 4:00 pm, weather permitting. Scan sampling was carried out each hour to record the number of motorized boats, kayaks, swimmers, snorkelers, and other non-motorized vessels (paddle-boards, outriggers, etc.) within the bay along with information on environmental variables and the presence or absence of spinner dolphins.

Human use assessment data were analyzed using the statistical analysis package JMP Pro 10 (2012). Specifically, we assessed distributions of the number of boats, swimmer/snorkelers, and kayaks every hour in each bay and calculated means and standard deviations. One-way analyses (*t*-tests) were used to assess differences in the number of boats, swimmer/snorkelers, and kayaks between the two bays and between times when dolphins were present and absent within an individual bay, similar to the methods of Courbis (2007).

We also asked research assistants, project managers, principal investigators, and PhD students involved with spinner dolphin research in this region, each with at least three months' experience in the bays, to identify human users in each of the bays. Each person was asked to create an anonymous list via a Google Form of all the human users they saw in each bay to reduce bias on the part of the authors when compiling the results. The different categories of human uses presented in the results emerged through the responses of the 10 informants that participated. Four of the authors of this paper also contributed to the list.

We incorporated human use assessment data and informant data into a set of human use visualizations to illustrate the differences between the study bays and to visualize whether it would make a difference to conceptualize the resource as "the dolphins" or "the bays".

Assessment of interactions and conflicts within resting bays

We conducted a review of public scoping materials from the Environmental Impact Statement process (2007) to understand different types of conflicts that might be taking place in the resting bays and present illustrations of each type of conflict when appropriate. Since the NOAA is a federal agency planning to implement time−area closures to minimize interactions between humans and spinner dolphins, they are required by the National Environmental Policy Act to conduct an environmental impact statement (EPA, 2012). The scoping process is part of the environmental impact statement and offers people the chance to publicly comment on the new rule or project (NOAA Fisheries, 2007). Scoping testimony was collected during five meetings in October and November 2006. All meetings were transcribed and included as Appendix C to the environmental impact statement.

Preliminary assessment of the potential for community-based conservation using Ostrom's attributes

The four authors with experience in the two bays contributed to a preliminary assessment of the presence or absence of Ostrom's attributes of the resource (Table 1) and the user (Table 2) to evaluate the possibility for self-governance in each of the two bays. These four authors discussed each attribute in detail and recorded a zero (absence of the attribute) or a one (presence of the attribute).

To increase the credibility and trustworthiness of our findings, we discuss the types of triangulation as developed by Denzin (1978) and Decrop (2004). We employed data and methodological triangulation by using a variety of data sources and a blend of qualitative and quantitative methods (i.e. human use assessments, literature review, and expert informant testimony) to arrive at our findings. Through the diverse backgrounds and expertise of the six authors, we have also employed investigator and interdisciplinary triangulation as we have "investigators, methods and theories coming from different disciplines" (Decrop, 2004, p. 163). Two of the authors are PhD candidates while the other four authors hold doctorate degrees. Two of these four consider themselves to be social scientists, one specializing on sustainability studies, and the other on tourism. The other two authors are natural science experts in the field of marine mammal science. Four of the authors have had extensive field experience with the spinner dolphin research in the resting bays. Multilevel participant triangulation was also incorporated by inviting field managers, research assistants, PhD candidates, and principal investigators to participate in the assessment of human use and the preliminary assessment of Ostrom's attributes.

Results

Assessment of human use in resting bays

Scan sampling in Makako (33 days; 278 hourly observations) and Kealakekua Bays (65 days; 560 hourly observations) covered 98 different days between 8 December 2010 and 15 May 2012. The mean number of boats, kayaks, and swimmer/snorkelers per hour was significantly higher for Kealakekua Bay than Makako Bay ($p < 0.0001$ for each), but there was no significant difference in the number of boats ($p = 0.24$), kayaks ($p = 0.30$) or swimmer/snorkelers ($p = 0.33$) when dolphins were present versus when they were absent in Kealakekua (Figure 1). In contrast, there were significantly more boats and swimmer/snorkelers in Makako Bay when dolphins were present in the bay versus when they were absent ($p < 0.0001$ for each). The maximum number of boats in Makako Bay during one of the hourly vessel scan observations when dolphins were present was 13 while the maximum during an observation when dolphins were absent was 4. Similarly,

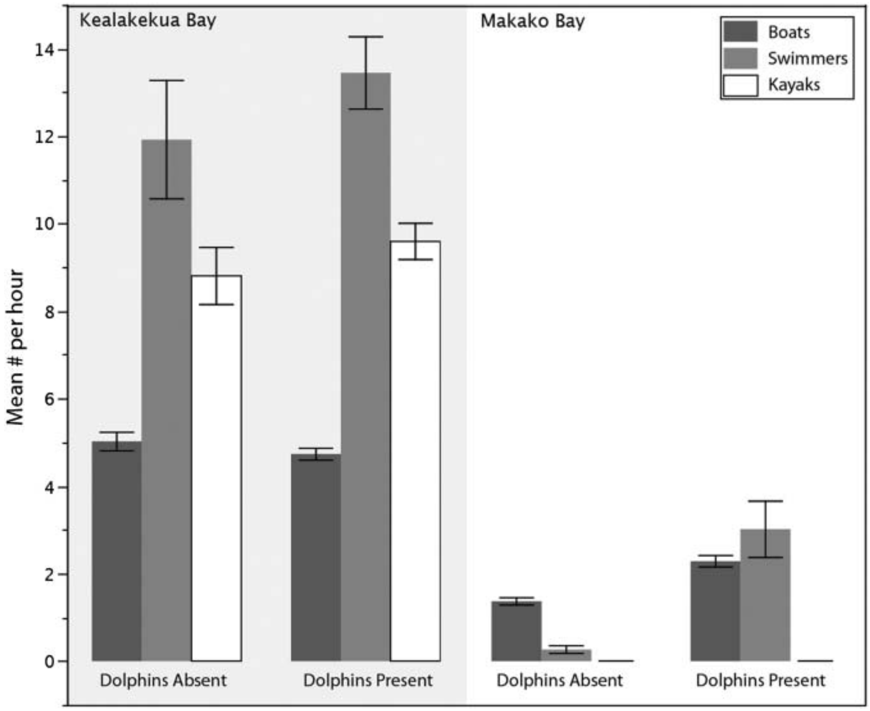

Figure 1. Mean number of boats, swimmers, and kayakers per observation in each of the two study bays (Kealakekua Bay (left) and Makako Bay (right)) from hourly scan sampling during photo-identification surveys separated by times when dolphins were present and absent. Vertical lines indicate standard errors.

the maximum number of swimmer/snorkelers in Makako Bay when dolphins were present was 60, while the maximum when dolphins were absent was 4.

The scan sampling helped to determine the general classes of different user types and what these users are seeking to access in Makako and Kealakekua Bays. Makako Bay's human use assessments revealed three categories: swimmer/snorkelers, non-fishing boats (pleasure-craft), and fishing boats and open-ocean aquaculture infrastructure. Kealakekua Bay's assessments revealed eight categories of human use including motorized (boats) and non-motorized vessels (sailboats, surfboards, paddleboards, paddleboats, swimmer/snorkelers, kayaks, and outrigger canoes). We supplemented the scan sampling information gathered during spinner dolphin photo-identification surveys with informant information. Visualization of the user types present in the bays and what they are seeking to access are presented in Figure 2(a) (Makako Bay) and 2(b) (Kealakekua Bay).

There are a total of 11 user types for Makako Bay and 16 user types for Kealakekua Bay. Both bays have two user types, the dolphin tour operators and the tourists, who are always seeking access to the dolphins (dark gray boxes in Figure 2). The same cannot be said for the rest of the user types (white boxes in Figure 2).When the users from both bays are combined, we find 20 different user types of the bays including the dolphins themselves (Figure 3(a)). Note that if we were to conceptualize dolphins as the resource, a more narrow view, we would find fewer users of the resource, which would obscure identifying potential conflicts and solutions to these conflicts (Figure 3(b)). The other bay

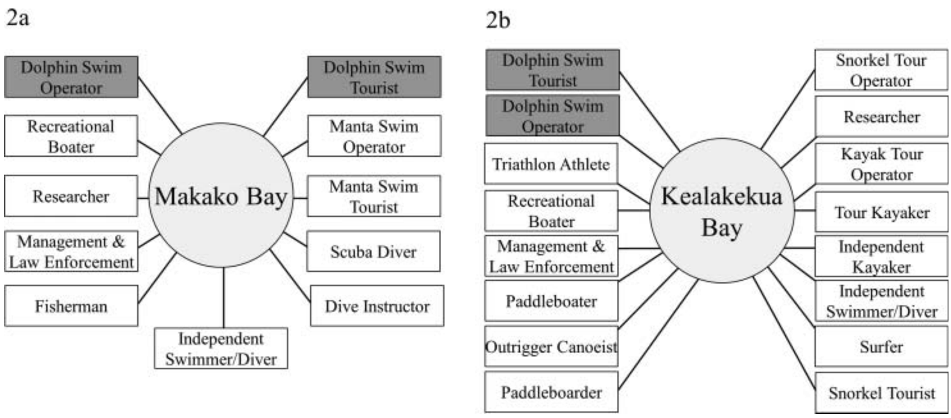

Figure 2. Eleven different user types in Makako Bay (a) and sixteen different user types in Kealakekua Bay (b) determined through scan sampling and informant information. Dark gray boxes indicate users that always seek to access the dolphins in a bay. White boxes indicate users that sometimes or never seek access to the dolphins in a bay.

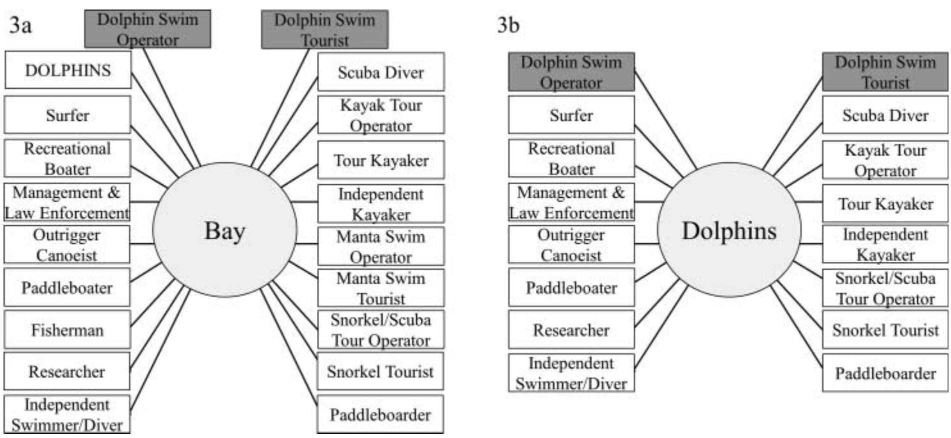

Figure 3. Combined users of the bay as the resource (a) and for comparison, users of the bay, if the dolphins were characterized as the resource (b). Dark gray boxes indicate users that always seek to access the dolphins in a bay. White boxes indicate users that sometimes or never seek access to the dolphins in a bay.

user types that disappear when shifting to defining the resource as the dolphins are fishermen, manta swim operators, and tourists.

Assessment of interactions and conflicts within resting bays

Common-pool resources exhibit two key qualities: excludability and subtractability (Ostrom, 2005). Excludability refers to the difficulty of excluding other potential users of the resource (i.e. the resting bays) (Ostrom, 2005). Subtractability conveys the notion that once a unit of resource is taken by a user (i.e. space in the bay), that unit of resource is not available for others to use (Ostrom, 2005). We found three clear types of conflict generated by the subtractability quality of spinner dolphin resting bays and these types are described below.

Conflicts within and among human user groups

The first example of conflict within human user groups involves the dolphin-based tourism industry and the fishing industry, as recorded in Appendix C of the Public Scoping Meeting Transcripts (2007) from which all direct quotes shown below were extracted.

A resident of O`ahu stated, with reference to areas with kayak dolphin tours, "that there were changes to natural fishing activities" and that the tours "started to affect livelihoods of commercial fishermen" (pp. 18−19). Two commercial fishermen seconded this idea. One from O`ahu stated that dolphin tours made him change his style of fishing and says, "I don't foresee my kids can fish just because of these kind of operations" (p. 248). The other commercial fisherman described the economic effects of the dolphin-based tourism industry as "a cancer to... what we target" (p. 265) and encouraged the NOAA to "balance the tours so the fishermen can continue to fish and have their livelihoods, too" (p. 270).

Other conflicts mentioned are among native Hawaiians and between native Hawaiians and visitors in terms of their ideas about swimming with dolphins. Some native Hawaiians consider spinner dolphins to be `aumakua ("family or personal gods" [Pukui & Elbert, 1986]) or part of their ocean `ohana ("family" [Pukui & Elbert, 1986]) and visit the bays to swim with them. One woman who describes herself as a cultural teacher and Hawaiian spiritual Kahu-priestess voiced her unease about proposed time−area closures by stating: "Proposed regulations...would prevent me, my `ohana, family and others, from engaging, interacting and swimming with our ocean `ohana, our dolphins" (p. 173).

Another woman who was "born and raised" on the Island of Hawai`i and grew up at Hōnaunau, another spinner dolphin resting bay, said in reference to who belonged in these bays: "As a keiki", ("child" [Pukui & Elbert, 1986]), "we were taught by our parents and our kupuna" ("grandparent, ancestor, relative or close friend of the grandparent's generation" [Pukui & Elbert, 1986]), "to respect everything that was around... The nai`a" (i.e. spinner dolphins) "has always been in the bay and they always were left alone.... As keiki, we understood that this ocean belonged to them as well as all other marine sea life and we were entering their environment. Not ours. Theirs" (pp. 209−210).

This same person then voiced her anger about the attitude visitors bring to Hōnaunau, "People...cannot respect the living things in the ocean...they give us this attitude, like, I paid my ticket to come here so I have every right to do whatever I want" (p. 210).

Conflicts among dolphins

The next example illustrates conflict among dolphins for access to the bays. The use of a bay by a group of dolphins can actually limit the use of that bay by other dolphins, as each bay has a given carrying capacity. The idea of a carrying capacity of a bay was originally hypothesized by Norris (1994). This carrying capacity is most likely related to physical aspects of the bay such as those quantified by Thorne et al. (2012), including the amount of sandy bottom in addition to the depth of the bay, and distance to deep water foraging locations. Therefore, the conflict among dolphins for access to the bays is governed by these biophysical aspects as well. This concept that the abundance of dolphins and whales is limited by the area of coastal bays was also supported by Braithwaite, Meeuwig, and Jenner (2012) for humpback whales in Western Australia.

Conflicts between humans and dolphins

As these examples illustrate, when there are too many human users, the humans limit the use of the bay by dolphins that choose to rest there. One resident of Ho`okena Beach stated, "I, myself, have seen people chasing them, hanging on to their fin and just pursuing them until they leave the bay" (p. 150).

If dolphins are greatly disturbed in their bay, especially while descending into rest, they can leave (Danil, Maldini, & Marten, 2005; Norris, 1994). In Appendix C of the Public Scoping Meeting Transcripts (2007), a NOAA employee citing Danil et al. (2005) stated that researchers "have illustrated that these animals can be disturbed in their resting habitat and it can have negative impacts on these animals" (p. 92). In an area of O`ahu where swim-with tours also exist, "the resting behavior of spinner dolphins. . .was delayed and compressed when there were lots of people. . . . In fact, the more. . .people that were in the water, the faster the animals would leave" (p. 91).

Norris (1991) also cautioned readers about the threat human interactions pose to the dolphins in resting bays stating that:

> Kealakekua's waters are a reserve now, but many boats continue to use the bay. . .and if their number increases, if the dolphins' needs aren't considered, the animals will leave and their span of tenancy, which began before that of any man will end as they quietly slip away into the offshore sea. (p. 67)

Finally, dolphins can also theoretically limit the use of bays by humans, a conflict arising from the US MMPA. Under the Act, it is illegal for people to "take" marine mammals without legal authorization (see Section 101a). The concept of "take" was originally defined under Section 3(13) of the Act as any actions that "harass, hunt, capture, kill or collect, or attempt to harass, hunt, capture, kill or collect" any marine mammal (p. 7). Furthermore, the term "harassment" was defined in the 1994 amendments to the MMPA as:

> Any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal. . . or (ii) has the potential to disturb a marine mammal. . . by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering. (p. 8)

These definitions explicitly acknowledge that dolphins in resting bays should not be harassed by humans and clearly indicate that human activities are legally limited when dolphins are there.

Preliminary assessment of the potential for community-based conservation using Ostrom's attributes

Having gained a basic understanding of the different user types (amount and diversity) and conflict patterns of human and dolphin uses of both study areas, we incorporated this knowledge into the authors' long-term knowledge of the two study sites to complete a preliminary assessment of the presence or absence of Ostrom's attributes (Table 3). We recorded four of Ostrom's attributes present in Makako Bay and eight in Kealakekua Bay. The four attributes present in Makako Bay were also present in Kealakekua Bay (Table 3).

A short summary of the authors' discussion of each of the attributes of the resource and the appropriator (user) is included here.

Feasible improvement (R1)

The authors agreed, as supported by the pending NOAA regulations, that for both bays the conditions of the resource are not past the point of no return and are still worth the effort

Table 3. Presence or absence of Ostrom's attributes of the resource (R) and the appropriator (user) (A) in Makako and Kealakekua Bays. The presence of an attribute is marked with a 1 and the absence with a 0. Descriptions from understanding institutional diversity by Ostrom (2005, p. 244−245) published with permission from Princeton University Press.

Attribute	Description	Makako Bay	Kealakekua Bay
R1: Feasible improvement:	"Resource conditions are not at a point of deterioration such that it is useless to organize or so underutilized that little advantage results from organizing".	1	1
R2: Indicators	"Reliable and valid indicators of the condition of the resource system" exist.	0	0
R3: Predictability	The "flow of resource units is relatively predictable".	1	1
R4: Spatial extent	"The resource system is sufficiently small. . .that appropriators can develop accurate knowledge of external boundaries and internal microenvironments".	1	1
A1: salience	"Appropriators depend on the resource system for a major portion of their livelihood or the achievement of important social or religious values".	1	1
A2: Common understanding	"Appropriators have a shared image of how the resource system operates (attributes R1, 2, 3 and 4 above) and how their actions affect each other and the resource system".	0	0
A3: Low discount rate	"Appropriators use a sufficiently low discount rate in relation to future benefits to be achieved from the resource".	0	1
A4: Trust and reciprocity	"Appropriators trust one another".	0	1
A5: Autonomy	"Appropriators are able to determine access and harvesting rules without external authorities countermanding them".	0	1
A6: Prior organizational experience and local leadership	"Appropriators have learned at least minimal skills of organization and leadership".	0	1
Total number of attributes present		4	8

to try to improve the situation; thus, the attribute R1 was recorded as present for both bays.

Indicators (R2)

The indicators present for this system are lacking; even though this might change as the SAPPHIRE Project research is aiming to reduce this lack of indicators (e.g. dolphin abundance estimate, see Tyne et al. [2014]), we recorded the attribute R2 as absent for both bays.

Predictability (R3)

Systematic observations through vessel scan data have contributed to our view of the predictability of this system, given the frequency and prevalence of the human users and the well-understood daily behavior of the dolphins. Thus, attribute R3 was marked as present for both bays.

Spatial extent (R4)

The small size of the two bays individually and the relatively short distance between the two bays are “sufficiently small”; thus, R4 was marked as present for both bays.

Salience (A1)

The argument for salience emerged in our assessment of human use, using both the vessel scans and informant information, and applies to many different user types. For Makako Bay, wildlife tour operators visit the bay for dolphin and manta ray tours, and both depend on the bay for a major portion of their livelihood. In Kealakekua, the tour operators also depend on the reef and the bay for a major portion of their livelihood. In addition, the bay as a place of rest and socialization is essential to the survival of the dolphins. Thus, A1 was marked present for both bays.

Common understanding (A2)

From our own observation, there is some understanding among users on how the bays operate and perhaps more understanding in Kealakekua Bay than in Makako Bay as evidenced by existing undocumented but well-known “gentlemen’s agreements” on how the bay gets used by different groups. However, Ostrom (2005) states that this attribute requires the presence of R1, R2, R3, and R4. Thus, the absence of attribute R2 (indicators) made it such that this attribute was also marked as absent for both bays.

Low discount rate (A3)

In Makako Bay, users of the bay depend on the resource for a major portion of their livelihood (A1). However, coordination among different user groups is visibly lacking compared to other bays, and tour operators visit the bay and disturb the same group of resting dolphins three times a day, suggesting a high discount rate. Users in Kealakekua appear to have a lower discount rate based on user behavior and actions to protect the bay (e.g. enforcing no anchoring), preserve future value (e.g. no take reserve), and protect the spinner dolphins (e.g. should not approach dolphins in a certain portion of the bay). Thus, attribute A3 was marked as absent in Makako Bay and present in Kealakekua Bay.

Trust and reciprocity (A4)

Trust and reciprocity are evident at Kealakekua. Users show this trust through “gentleman’s agreements” about the use of the bay and trust each other to obey the rules of the bay (i.e. cannot anchor, cannot disturb dolphins past the keyhole); thus, the attribute A4 was marked present in Kealakekua. This same level of trust and reciprocity is not evident in Makako Bay and thus the attribute A4 was marked absent in Makako Bay.

Autonomy (A5)

In Kealakekua, as evidenced by the gentlemen’s agreements and rules-in-use, there is some control over actions taken in the bay. However, in Makako Bay, there is no evidence that the users are able to establish rules to govern their behavior in that bay. Thus, Kealakekua was marked as having attribute A5 but was marked absent in Makako.

Prior organizational experience and local leadership (A6)

In Kealakekua, there is some evidence of prior leadership experience given the existing agreements on appropriate use and behavior in the bay (see above). In Makako Bay, evidence is lacking for this prior experience and leadership. Thus, attribute A6 was marked present in Kealakekua and absent in Makako Bay.

Discussion

The results of our study illustrate the limited potential for community-based conservation and support a more ecosystem-based approach to managing conflicts among user types in spinner dolphin resting bays in Hawai`i. Our results point at clear differences in the diversity and amount of human use between the two study bays. Makako Bay showed a higher amount of human use when dolphins were present versus when they were absent (Figure 1). While Kealakekua Bay showed a higher diversity of human users and more human activity overall, uses in Kealakekua Bay are not driven by the presence of dolphins. Using a similar method to assess human use, Courbis (2007) also found that the presence/absence of dolphins had no effect on activity levels in Kealakekua Bay. Kauhakō Bay, from Courbis' study, showed a significant increase in human use when dolphins were present, similar to Makako Bay in this study. This directed human activity in Makako Bay has the potential to have a negative effect on spinner dolphins' ability to rest in the bay. In addition, the level and diversity of activity in Kealakekua Bay, even though it is not necessarily directed at the dolphins, also has the potential to have negative effects. This complexity and these differences between these two geographically close resting bays should be recognized. Farrell and Twining-Ward (2005) emphasized that managing human activity in a complex system, as in the case of spinner dolphin resting bays, first requires the acknowledgement of this complexity and an understanding that places are unique and that the success of an idea or approach for one area does not guarantee success in another. In addition, by focusing on the bay as the resource, a broader resource than the dolphins themselves, and incorporating relevant user groups that are missed when the resource is more narrowly defined, we support ecosystem-based management with our analysis.

Moore and Rodger (2010) examined the presence of a set of enabling conditions to understand a complex common-pool resource issue, whale shark tourism at Ningaloo Reef, Western Australia. Similarly, we utilized the attributes outlined in Ostrom (2005) to understand another complex issue regarding tourism and marine megafauna. Our comparison of the presence or absence of Ostrom's attributes suggests that Kealakekua Bay with eight of Ostrom's attributes present might have higher potential for the emergence of a community-based conservation regime than Makako Bay with only four present. The two bays have the same three attributes of the resource present, feasibility, predictability, and spatial extent (R1, R3, and R4, Table 1). The two bays also share the presence of salience (A1) and share the absence of common understanding (A2); an attribute linked to the presence of all four attributes of the resource (Table 2). The two bays differ in four attributes of the appropriator: low discount rate, trust and reciprocity, autonomy and prior organizational experience, and local leadership (Table 2). However, the higher amount of human usage in Kealakekua challenges the view that community-based conservation can emerge, as large groups are thought to face higher challenges to look after the public good, given higher costs of coordination (Olson, 1965). “As groups become larger and more heterogeneous, social norms for monitoring and enforcing rules of access become harder to sustain, and formal laws, contracts and institutions become essential” (Levin, 2012, np).

Consequently, our results suggest that the federal government has a role to play in the management of different user access to these bays. After all, the NMFS Pacific Islands Regional Office is required, under the MMPA, to protect spinner dolphins. However, the NMFS’ sole determination of the bay’s usage patterns without input of local stakeholders is likely not conducive to gain support of government-mandated regulations. The results of our work suggest that relying solely on command and control approaches would not be acceptable to many stakeholders. Given budgetary and time constraints, Ostrom’s attributes could, therefore, serve as useful pointers for key considerations in deciding how to increase stakeholder engagement and support for management of spinner dolphins’ resting bays. Here we used the experience of four of the authors and our vessel scan data to assess the presence of Ostrom’s attributes.

In this case, our analysis of the attributes (Table 3) points at the need to increase common understanding (A2) of the nature of the problem as a first step toward finding ways to sustain the resource (Burger, Field, Norgaard, Ostrom, & Policansky, 2001). Establishing processes that decrease conflict and encourage positive interactions to build trust and reciprocity (A4) is another avenue of potential action supported by Ostrom’s attributes. Education and outreach efforts can increase the number of people who know that the dolphins go to these bays to rest. A recent study on Kaua`i found that more than half of all tourists consulted guidebooks to learn about the area before their visit, and that residents were more concerned and more responsible for their resources, and took more action targeted at changing the behavior of other users than tourists visiting the area (Vaughan & Ardoin, 2014), suggesting the potential for local residents to manage local resources or spearhead efforts to educate others. In addition, emerging efforts, such as web-based interactive timelines (e.g. From Norris to Now: www.spinnerdolphin.net/Timeline), public service announcements targeting unsustainable dolphin-based tourism activities, and educational smartphone and tablet applications (e.g. The Nai`a Guide: http://www.naiaguide.org/), are novel ways to help establish a common understanding and appreciation for this species and target tourists in ways that they are already using to gain information about an area.

Tapping into the prior organizational experience and leadership (A6) of individuals within the stakeholder group to develop common understanding or trust and reciprocity-based relationships constitutes another alternative outlined by this analysis of Ostrom’s attributes. One dolphin operator from the Nāpali coast, Kaua`i, stated in Appendix C that there used to be meetings where users got together and that “it would be a great help for you to resume those ocean users meetings” (NOAA, 2007, p. 44). Supporting opportunities for human users of spinner dolphin resting bays to interact on a repeated and regular basis could lead to better outcomes as it has been shown in other settings (Ostrom, 2011). Working to build trust during these meetings could result in “lower expected costs in monitoring and sanctioning one another over time” (Ostrom, 2001, p. 26). If users can self-enforce regulations or trust each other to follow them, then the capacity for official monitoring and enforcement from agencies might be lessened.

In addition, research currently being conducted on the Hawaiian spinner dolphins can help users understand the status of the Kona population of spinner dolphins and provide a baseline to compare future estimates and other indicators (R2) for the resource. This could help stakeholders value the future use of the bays in a different way, i.e. lower their discount rate of the future (A3), which constitutes a hindrance toward creating sustainable long-term solutions.

Limitations and further research

We acknowledge that our assessment of Ostrom's attributes should be considered preliminary and warrants further investigation. We suggest implementing a survey that incorporates more of the different user types to include different experiences and thoughts. Since the four authors who contributed are scientists with extensive experience doing research in the bays, we realize that our assessment of these attributes could be quite different than a tourist, dolphin tour operator or an employee of NOAA's assessment of the attributes, and suggest that further research could investigate how different user groups see these attributes. We have been cautious about drawing conclusions directly from this preliminary assessment and have included only those recommendations that we argue would be useful, no matter the results of the assessment. Further research on place dependence and sources of environmental learning similar to the work done on Kaua`i by Vaughan and Ardoin (2014) could also be illustrative in determining potential for engagement in community-based natural resource management in the two study bays and beyond. In addition, it would be important to determine the level of community interest in being involved in this issue and actively engaging in community-based conservation at some level.

Conclusion

Ecosystem-based management is increasingly advocated as a guiding principle for sustainable human−environmental interactions, although challenges for its implementation are also acknowledged (Lubchenco, 2009). Part of the issue is that it is not yet clear which conservation governance arrangements might be compatible with ecosystem-based management principles in particular contexts. Community-based conservation is thought to hold particular promise because locals with high understanding of ecological and biological dynamics can be involved in decision-making processes (Farrell & Twining-Ward, 2004, 2005). In many settings, however, including dolphin resting bays in Hawai'i, sustainable tourism is complicated due to the existence of multiple human demands on limited natural resources. Furthermore, giving full autonomy to local communities to take charge of conservation activities related to marine mammals like spinner dolphins is not feasible, nor permitted by the MMPA. What options are left toward the implementation of ecosystem-based management in cases like spinner dolphin resting bays in Hawai`i? We view genuine stakeholder engagement as the first step toward building ecosystem-based management approaches, because it can bring the needed local ecological and biophysical knowledge to make decisions compatible with conservation needs. Genuine stakeholder engagement also allows locals to become part of the decision-making process, which increases the likelihood that local regulations will be followed, and monitoring and enforcement costs will remain reasonable for all involved. Ostrom's attributes can help elucidate key considerations in decisions on how to increase stakeholder engagement, inform critical points to better engage stakeholders, help generate ideas for informal ways to manage human−dolphin interactions, and build support for management action. Identifying stakeholders and conflicts can help in the development of a model to evaluate management approaches, including different options for time−area closures.

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Notes on contributors

Heather Heenehan is a doctoral candidate in the Division of Marine Science and Conservation at the Duke University Marine Laboratory, USA. Her work focuses on the soundscape ecology of Hawaiian spinner dolphin resting bays.

Dr Xavier Basurto is an assistant professor of sustainability science in the Division of Marine Science and Conservation at the Duke University Marine Laboratory, USA. His experience lies in the governance and theory of common-pool resources, community-based management, and institutional analysis of social-ecological systems.

Dr Lars Bejder is a professor and leader of the Cetacean Research Unit at Murdoch University, Australia, and adjunct associate professor at Duke University, USA. His main research interests are analyzing and developing quantitative methods to evaluate complex animal social structures, evaluating impacts of human activity on cetaceans, and fundamental biology and ecology of marine wildlife.

Julian Tyne is a doctoral candidate in the Cetacean Research Unit at Murdoch University, Australia. His dissertation research focuses on quantifying the effects of human interactions on spinner dolphins in resting bays in Hawaii, and assessing the effectiveness of time area closures as a proposed mitigation approach.

Professor James Higham is in the Department of Tourism at the University of Otago, New Zealand, and visiting professor, University of Stavanger, Norway. His research focuses on tourism and global environmental change.

Dr David W. Johnston is an assistant professor of the practice of marine conservation and ecology in the Division of Marine Science and Conservation at the Duke University Marine Laboratory, USA. His experience lies in marine conservation and ecology, with a focus on oceanography, climate change, marine protected areas, and population assessments.

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