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Political making of more-than-fishers through their involvement in ecological monitoring of protected areas

Anastasia Quintana¹ · Xavier Basurto¹ · Salvador Rodriguez Van Dyck² · Amy Hudson Weaver²

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Abstract

One strategy for ecological monitoring of protected areas involves data collection by local resource users instead of external scientists. Growing support for such programs comes from their potential to both reduce costs and influence how resource users perceive and support protected areas, but their effects on participants are only beginning to be understood. We contribute to this growing research area through an in-depth study of how participants, their close kin, and their peers perceived the individual and community-wide effects of an ecological monitoring program. We examined the case of fishers' involvement in ecological monitoring of a marine protected area network in Baja California Sur, Mexico, organized since 2012 by the Mexican non-governmental organization Niparajá. Based on in-depth interviews and participant observation in 2016 and 2017, we found that the most salient effect of the program was personal growth. Participants described becoming "more than a fisher" through newly gained civic and environmental awareness, ecological knowledge, and self-confidence in public speaking skills. Respondents also identified health risks from diving and emotional burdens on participants' families. Overall, other resource users in their communities seem to be supportive through reputational benefits of participants. These effects overlap with but seem more extensive than those documented in other citizen science programs. Environmentality provides a suitable explanation of the processes at play, where the act of monitoring is far more than data collection, intertwining participants' fortunes (for better or worse) with the political fate of the protected area network itself.

Keywords Conservation · Citizen science · Fisheries · Mexico · Local ecological knowledge · Environmentality

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Introduction

There is debate about whether fishers' participation in citizen science and ecological monitoring amounts to fisher empowerment for community-based governance (Aceves-Bueno et al. 2015; Fulton et al. 2019b) that legitimizes and integrates their knowledge (Johannes et al. 2000; Murray et al. 2008), or whether it appropriates their knowledge and labor in support of an agenda that is not their own (Silver and Campbell 2005; Song 2015). Understanding the complexities of how participants perceive ecological monitoring programs is urgent because of the rapid expansion of citizen science programs that produce monitoring data (Guerrini et al. 2018; Hecker et al. 2018), and evidence-based conservation interventions that demand it (Baylis et al. 2016; Salafsky et al. 2019). Understanding these complexities is especially important in the context of community-based conservation and co-management, where resource users like fishers are often involved in monitoring under the premise that this leads to more effective governance (Mancha-Cisneros 2018; Fulton et al. 2018; Lozano et al. 2019). In this paper we contribute to this understanding by exploring how fishers perceive the effects of their participation in monitoring a co-managed marine protected area network in Mexico.

Ecological monitoring sits central in frameworks evaluating the effects of conservation interventions like protected areas (Likens and Lindenmayer 2018). Monitoring data underlies the emergence of protected areas as one of the dominant tools for conserving biodiversity (Campbell and Gray 2019; Gaines et al. 2010; Tittensor et al. 2014), based on evidence of higher biodiversity on average than unprotected areas (Gill et al. 2017; Gray et al. 2016; Lester et al. 2009). Variable performance of individual protected areas further underscores the rationale for regular monitoring (Fox et al. 2014; Gill et al. 2017). At the same time, data shows that most protected areas are not well-managed: studies have argued that only 22% of 4000 terrestrial protected areas had "sound management" (Leverington et al. 2010), and only 21% of 227 marine protected areas met even half of widely-accepted efficacy thresholds (Gill et al. 2017). Here, too, monitoring is proposed as a solution: governance scholars have suggested that ecological monitoring can increase protected area effectiveness by increasing legitimacy (Ostrom 1990; Ostrom et al. 2002a, b) and reducing noncompliance (Keane et al. 2008). Adaptive management scholars have pointed at monitoring as an essential component to aid rectifying poor initial design, ecological change, or socioeconomic change (Armitage 2007; Olsson et al. 2004). Monitoring may also be a legal imperative (Hák et al. 2016; Lu et al. 2015).

Cost has been cited as an impediment to widespread ecological monitoring of protected areas (Sheil 2001). The conservation community has estimated that adequately managing protected areas would cost US \$27–30 billion a year, of which a large portion is monitoring (Molnar et al. 2004). The cost of monitoring is so high because the standard monitoring approach involves external professionals from outside the study area who collect and analyze data (Danielsen et al. 2009; Sheil 2001). External professionals provide legitimacy to the data produced due to their perceived objectivity and recognized expertise (Murray et al. 2006), but are often time-limited, high-salaried, unfamiliar with local ecologies and climates, and require extensive transportation to and from study sites (Danielsen et al. 2009; Schmiedel et al. 2016). One lower-cost option is hiring people living locally to conduct monitoring, which is consistently cheaper than professional monitoring (in one example, sixty times cheaper), even if start-up costs are high (Danielsen et al. 2005a, 2009). The involvement of local inhabitants in ecological monitoring programs initially found significant resistance and opposition in biodiversity conservation circles

(Janzen 2004) but today is an increasingly popular approach (Bonney et al. 2014a; Danielsen et al. 2009).

This increasing support is partly because protected area managers anticipate other benefits from the involvement of local people in ecological monitoring (Danielsen et al. 2005a, 2009). Some researchers have argued that these programs can transform participants through educational, attitudinal, and behavioral outcomes based on findings from some citizen science programs (Basset et al. 2004; Bonney et al. 2009; Cooper et al. 2007; Janzen and Hallwachs 1991; Schmiedel et al. 2016). In some cases, ecological monitors have become advocates seeking to modify their own and others' behavior through increased care for and valuation of wildlife (Bonney et al. 2009, 2014b; Cooper et al. 2007), including individual actions like keeping cats indoors (Cooper et al. 2007) and collective action related to establishing new protected areas and avoiding bycatch (Delgado and Nichols 2004).

There is also evidence that ecological monitoring by local people can support "community-based" or participatory management (Danielsen et al. 2005a, 2005b, 2010). For example, Danielsen and coauthors found that, after several years of local people's participation in monitoring forested protected areas in the Philippines, local norms were institutionalized in park governance through more socially acceptable and effective enforcement techniques (Danielsen et al. 2005b). Such political outcomes from monitoring are aligned with theories of collective action for natural resource self-management (Ostrom 1990, 2005; Ostrom 2002). As the principal recipients of the direct costs and benefits of resource management, local people are often best situated to monitor, adapt, and maintain institutions such as protected areas, and to thus address collective action dilemmas (such as incentives for poaching) that can lead to protected area breakdown (Basurto et al. 2016; Ostrom 1990, 2005). Collective action scholars have found that local participation in ecological monitoring may produce contextualized and relevant data useful for sustainable management (Mellado et al. 2014), contribute to nimble adaptation of rules and boundaries to ecological change (Plummer et al. 2012), and lead to efficient decision-making with data collection assigned to the most relevant actor (Aligica and Tarko 2012).

Many proponents now advocate for further expansion of local people's involvement in ecological monitoring (Schmiedel et al. 2016) as the benefits from long standing programs become better understood in Costa Rica (Campbell 2002; Janzen 1991), Papua New Guinea (Basset et al. 2004; Novotny 2010), South Africa (Araya et al. 2009), Namibia (Stuart-Hill et al. 2005), India (Schmiedel et al. 2016), and China (Van Rijsoort and Jinfeng 2005). However, evidence can also be found showing that ecological monitoring programs involving local resource users may be problematic, especially for the participants themselves. In addition to issues of data inaccuracy and fragmentation (Aceves-Bueno et al. 2017), some programs have led to mistrust between participants and managers (Conrad and Hilchey 2011). One reason mentioned by Moller et al (2004) may be that participatory ecological monitoring programs do not legitimize local people's tacit or traditional ecological knowledge (Moller et al. 2004). Also, some programs have reaffirmed rather than challenged relationships of unequal power between resource users and scientists, managers, or bureaucrats (Nadasdy 1999, 2004). Critical scholars have argued that the way researchers and funders talk about citizen scientists—especially paid ecological monitors with little education—can be paternalistic, and can overemphasize benefits like employment and training (Campbell 2002; Evans 1999). While transformation of participants through behavioral and attitudinal changes particularly regarding the environment is often framed as a desirable outcome of these programs (Bonney et al. 2009; Cooper et al. 2007), critical scholars have questioned the ethics of transforming local people's

relationship to wildlife and protected areas through the creation of Foucauldian “environmental subjects” who may act against their own interests (Agrawal 2005; Foucault 1982; Li 2007).

In sum, the literature on the effects of ecological monitoring on participants is mixed. Previous work has suggested that ecological monitoring may generate new behaviors and attitudes in participants (Bonney et al. 2009; Cooper et al. 2007), as well as bolster environmental governance (Danielsen et al. 2009, 2010; Schmiedel et al. 2016), with some advocating for these changes and others cautious about paternalism and other concerns (Aceves-Bueno et al. 2015; Bonney et al. 2014a; Dickinson et al. 2012). Part of the challenge for researchers to make headway on these issues is that some of the effects are usually subtle and require long-term familiarity and significant rapport with the subjects under study. We contribute to this debate by examining how participants, themselves, understand the effects and outcomes of protected area monitoring programs involving local people, which we identify as a research gap in studies of community monitoring schemes (Conrad and Hilchey 2011; Tredick et al. 2017) although such interpretive approaches have deep roots in the social and political sciences (Yanow 2000). This paper contributes to an emerging body of work using interpretive methodologies in the conservation and sustainability sciences to move beyond the linear ‘knowledge-action divide’ towards knowledge co-production and transformative governance (Schultz et al. 2018; van der Hel 2018; West et al. 2019).

To address the above identified gap in the literature, this paper explores these issues in the context of Baja California Sur, Mexico, where a program has involved commercial fishers since 2012 in monitoring a co-managed protected area network and where we have been working since before the establishment of this program. Our research approach rests on long-term involvement with our subjects and the different roles the authors have played in the community, allowing for a rich set of perspectives emerging from this in-depth study.

Methods

Case study: Buzos Monitores monitoring program in Baja California Sur, Mexico

We studied an ecological monitoring program located in Baja California Sur, Mexico, where fishing is of primary economic and cultural importance (Finkbeiner et al. 2015; Lluch-Cota et al. 2007). The state’s east coast borders the highly productive Gulf of California, which generates 71% of Mexico’s total fisheries volume (OECD 2006). Many coastal communities on the Gulf depend almost entirely on fishing for income and livelihoods, as in the Corredor region where this study takes place (Cinti et al. 2010; Leslie et al. 2015). The Corredor, a 100-mile stretch of rural coastline between the capital of La Paz and the small city of Loreto, is among the most isolated and rural of the state (Leslie et al. 2015). It is accessible only by dirt roads or by boat, and inhabited by thirteen small communities (populations from 2 to 278 inhabitants) whose primary economic activity is fishing (Niparajá 2016).

Fish catches in the Gulf of California are in decline, a trend fishers have noticed with concern (Saenz-Arroyo et al. 2005; Sala et al. 2004). This decline has been largely attributed to the failure of the Mexican government to adequately manage fisheries (Cinti et al. 2010; McGoodwin 1980; Vásquez-León 1999; Young 2001); the high cost of generating fisheries data, frequent exclusion of fishers from decision-making, lack of clear

rules and procedures, and low government capacity to enforce existing laws have led to de facto open access conditions (Finkbeiner et al. 2015), exacerbated by the neoliberal reform of Mexico in the 1980s and 90s (Vásquez-León 1999).

In response to fisheries decline and the limited capacity of the government to respond, non-governmental organizations (NGOs) and fishers' organizations have led the agenda in the design of fisheries management tools in Mexico, including marine protected areas (Cinti et al. 2010; Cudney-Bueno et al. 2009; Sáenz-Arroyo et al. 2005; Velez et al. 2014). One tool that is gaining attention is the Fish Refuge ("Zona de Refugio"; also called Fishing Refugia in English), a closed area usually designed and proposed by fishers themselves, where fishing is temporarily or permanently banned in order to replenish nearby fish stocks (DOF 2014). Fish Refuges are new tools that are rapidly spreading through Mexico (more than 40 created since 2012), but their ecological effects are contested (CONAPESCA 2019; Villaseñor-Derbez et al. 2019). Understanding these ecological effects is important because almost all (> 95%) Fish Refuges are temporary, and must be renewed every five years (CONAPESCA 2019). The Mexican government is legally mandated to produce ecological data and recommend modifications upon expiration, but lacks the capacity (resources, trained personnel, knowledge of sites, etc.) to conduct ecological monitoring at each site (Fulton et al. 2019a). As a result, local fishers supported by NGO partners have taken on a key role in ecological data collection for Fish Refuges across Mexico (Fulton et al. 2018, 2019a).

One place where local fishers have been conducting ecological monitoring is in the Corredor, where Mexico's first Fish Refuges were established in 2012 along with a program to monitor them (DOF 2012), both with the support of an NGO called Sociedad de Historia Natural Niparajá (hereafter, "Niparajá"). The fishers who participate in the monitoring program (labeled "Buzos Monitores" by Niparajá, meaning *monitoring divers* in English) have conducted annual surveys since 2012 of fish and invertebrate abundance, diversity, and biomass within the Fish Refuges and in comparable control sites nearby. Niparajá started the program just before the Fish Refuges were established with an intensive two-week workshop to train nine local fishers in underwater ecological monitoring, including species identification, Latin species names, SCUBA training and certification, and transect methodologies. Since then, program participants have left their homes for about two weeks annually to conduct up to 6 monitoring dives a day on a live-aboard boat, in addition to optional multi-day workshops and trainings held throughout the year. Some trainings build capacity in monitoring tasks (e.g. diving with nitrox; PADI Dive-master certification) and others build a more general suite of professional skills (e.g. public speaking; leadership). Participants are paid for monitoring work to compensate for lost fishing days. The monitoring trips are organized and partly funded by Niparajá, and partly funded by the research branch of the fisheries agency (National Institute of Fishing, "INAPESCA"). Monitoring is collaboratively conducted by the trained fishers, Niparajá staff, and marine biology students from a local university. Niparajá coordinates data analysis and presents the results back to the fishers through several venues, including formal presentations to the Buzos Monitores each year, presentations in the Corredor communities, presentations at meetings of fishing cooperatives, and through mixed media including pamphlets and videos publically available on YouTube.

We chose this case because of the authors' long-term research and presence (4–20 + years) in the study region, allowing for deeper and contextualized insights as to how participants perceive effects of the program. The first two authors' other research projects have studied fishing and governance in the Corredor, generating research contacts, local relationships, and trust that facilitated the research presented here, and co-developed

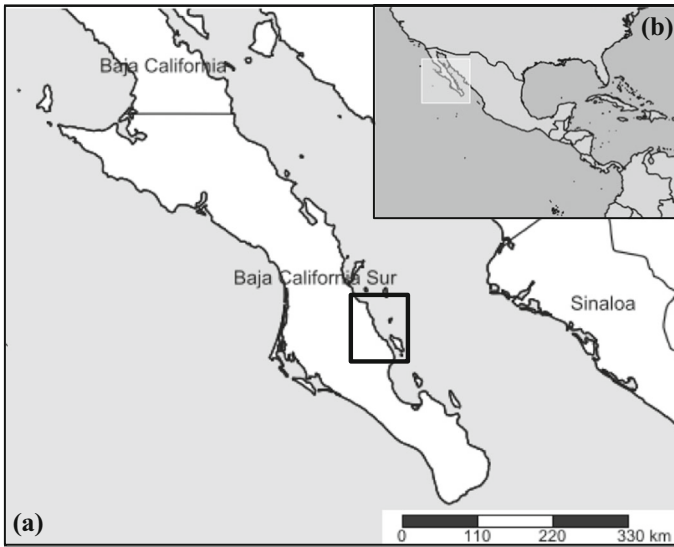


Fig. 1 Map of study site; **a** is an inlay of the white boxed region in **b**. The Corredor San Cosme to Punta Coyote, Baja California Sur (hereafter, “the Corredor”) where the study took place is shown in black square in **a**. Map created by A. Quintana using SimpleMapp

the survey instrument. The second two authors are staff of Niparajá who have been involved with the program since its inception; co-developed the survey instrument, provided access to key respondents, ensured that the results of this study would be presented to participants, and have modified the program because of this study’s results. To reduce the potential for conflict of interest, Niparajá colleagues did not participate in data collection, analysis, or interpretation. However, because researchers worked closely with agencies involved, there was the risk of respondents giving favorable stories about program outcomes. To reduce this risk, researchers assured community respondents that their responses were anonymous and that researchers were not affiliated with Niparajá. Researchers explained to respondents that both they and Niparajá were interested in honest answers, including criticisms. Researchers also drew on years of experience in study region to contextualize and assess respondents’ answers, as well as critical self-reflection in interpretation of results. Indications that respondents felt comfortable giving neutral or negative answers included many respondents’ identification of several critiques discussed below.

Data gathering approach

The data presented below came from in-depth interviews and participant observation over two years (2016–2017). This research was approved by Duke University’s Institutional Review Board (IRB) which governs research on human subjects (IRB permit #2018-0130). At the start of the study (May 2016), the first author accompanied the Buzos Monitores on their annual monitoring trip, closely observing monitoring activities, interactions with Niparajá and fisheries staff, and attitudes and actions of the Buzos Monitores themselves; these observations were recorded in a detailed field journal. While onboard, the first author also conducted unstructured exploratory interviews about the monitoring program with the Buzos Monitores ($n = 6$), the senior Niparajá staff member ($n = 1$), and fisheries agency

staff (n = 2). The second author followed up on initial findings by accompanying the Buzos Monitores on their 2017 monitoring trip, with further observation and six unstructured interviews with Buzos Monitores (n = 4, all overlapping the 6 above), the same senior Niparáj staff (n = 1), and fishery agency staff (n = 1).

The bulk of this study is based on semi-structured interviews conducted by the first author from July to August 2016 (n = 36) during visits totaling one month to the home-towns of the Buzos Monitores (Puerto de Agua Verde, Tembabiche, San Evaristo, and Ensenada de Cortés). Semi-structured interviews started with broad and open-ended questions about perceived changes on topics known to be important to fishers such as income, risk, health, and food security. We adapted the interview tool after the first several interviews to include additional topics that participants identified as important, for example financial effects on cooperatives and the behavioral changes of participants. Table 1 lists the topics we examined, which served as a point of departure to follow emergent issues and

Table 1 Dimensions, variables, and how we operationalized those variables in interview questions and coding responses

Dimension	Variable	Operationalization
Economic	Income	Effects of income from program Income from the program compared to fishing
	Income stability	Stability of the income compared to fishing
	Risk	Risks the Buzos Monitores face during monitoring Risks of participation in program compared to fishing
	Quality of work	Evaluative description of the monitoring work Comparison of type of work between monitoring and fishing
	Economic inequalities	Unequal opportunities or income inequality from program
	Financial effects on nonparticipant kin	Financial effects of the program on families
	Financial effects on fishing cooperatives	Financial effects of the program on fishing cooperatives
	Financial effects on towns	Financial effects of the program on towns, more broadly
Social	Community opinion of participant	Change in how the Buzos Monitores are perceived in their towns as a result of their participation in the program
	Education opportunities	New education opportunities for the Buzos Monitores or their families because of the program
	Health	Change in the Buzos Monitores' health since starting the program as a result of their participation in the program
	Behavioral changes	Behavioral or attitude changes in the Buzos Monitores because of their participation in the program
	Food security	Change in the Buzos Monitores' ability to ensure daily access to food as a result of their participation in the program
	Role of women	Perceived effects of the program on women who are near kin (wives, sisters, and mothers) of the Buzos Monitores (all men)

We developed variables collaboratively with key informants and then iteratively added or removed variables during semi-structured interviews. Variables served as a point of departure to explore themes and issues that respondents identified as important

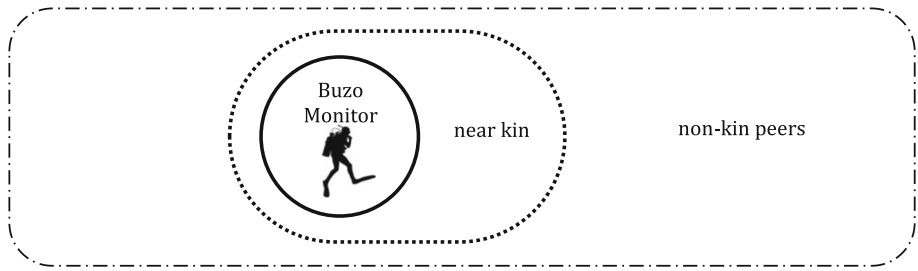


Fig. 2 Types of respondents. We interviewed three types: Buzos Monitores, near kin (parents, spouses, and siblings), and non-kin peers from their communities (includes distant family members and other residents of participants' communities). We sampled from each type using purposive sampling to identify respondents who knew the participants well, selecting at least two near kin and two non-kin peers for each Buzo Monitor whose hometown we visited

themes during semi-structured interviews with interviewees to document how participants and their peers understood the outcomes of the monitoring program.

For the 36 semi-structured interviews, we used purposive sampling guided by key informants to interview three types of respondents, shown below in Fig. 2: Buzos Monitores (active participants only; $n = 5$), near kin (nuclear family members including parents, spouses, and siblings; $n = 14$), and non-kin peers (people who live in the same towns as the Buzos, for example fishing crew members, non-nuclear familial members, and members of the same fishing cooperative; $n = 17$). Of the 36 semi-structured interviews, 29 were recorded, with consent. For the 7 that were not recorded, detailed notes were taken during the interviews and annotated directly afterwards such that all were usable for this study. These semi-structured interviews typically lasted around half an hour, ranging from 16 to 154 min. [Appendix](#) (respondent demographics) shows the number of respondents for each type in each town.

We analyzed interviews through thematic coding into the variables listed in Table 1. Codes were synthesized in memos, which were interpreted in the context of field notes and preliminary research conducted by all co-authors (Bernard 1988; Charmaz 2006). Initial findings were presented to the Buzos Monitores and Niparáj staff on October 9, 2017, in La Paz, Baja California Sur, and feedback from this presentation was incorporated into final analysis and results presented in this manuscript. Analysis and writing were further informed by two fieldwork seasons for a broader research project on the Fish Refuges of the Corredor, from Oct to Dec 2017 and March 2018. During these field stays, the first author continued to observe perceptions and roles of the Buzos Monitores, particularly in relationship to Fish Refuge governance.

Results

Through their participation in the program monitoring the Fish Refuges since 2012, the Buzos Monitores reported having learned new skills, developed a sense of pride in monitoring, become more confident speakers in decision-making forums, and employed new sustainable fishing behaviors. The Buzos Monitores also perceived health risks and both financial and emotional burdens on their families. Their family members and close acquaintances reported that the Buzos Monitores had developed an identity around civic and environmental responsibility, ecological knowledge, and public speaking skills, with one family member describing this as becoming “more than a fisher” and others echoing

this sentiment. Additionally, we found evidence that an ethic aligned with sustainability seems to have spread from the Buzos Monitores to some of their families, fishing crews, and fishing organizations, through observations of their children's interest in marine biology and fishers increasing participation in governance of the Fish Refuges.

Personal growth: learning, knowledge, behavior, and becoming “more than a fisher”

“I don't see it economically at all... I see it as a teaching moment, that he can learn, that he learns to be more than a fisher. That he learns more; that he grows as a person” (family member 019, 7/12/16).

The most talked-about effect ($n = 25$ of 36 semi-structured interviews) of the Buzos Monitores program was personal growth, expressed in different ways related to monitoring, daily life, and fishing. The types of reported effects that we categorized as personal growth included changes like becoming more “responsible” and “respectful” behavior in their daily lives, knowing more about the marine environment (e.g. noncommercial species and benthic habitats), knowing more about diving and monitoring, being more effective communicators, and engaging in sustainable fishing behaviors like releasing undersized fish. All Buzos Monitores ($n = 5$) reported these kinds of outcomes in our interviews. Compared to their near kin and non-kin peers, the Buzos Monitores placed the most emphasis on personal growth, identifying subtle psychological changes like “being more responsible in daily life,” being more able to express themselves in public, and the development of a stewardship ethic towards fisheries resources. One Buzo Monitor told us, “For me, what has changed is how I think” (Buzo Monitor 013, 7/11/16). Another Buzo Monitor reported that he is more confident to participate in fisheries management:

“I used to always come to meetings about the Fish Refuges. I was really interested but I couldn't express myself, I couldn't talk. But now, with all the monitoring trips, with all the trainings, I've learned. It doesn't scare me to talk, or express something. I share now, and they listen. Being a Buzo Monitor has served me quite a lot” (Buzo Monitor 005, 7/8/16).

When we followed up on the reason that this Buzo Monitor was more confident in expressing himself, he replied that it was both because of formal workshops on communication that the Buzos Monitores have received as well as from informal communication with scientists and government officials on the monitoring vessel. Another form of personal growth perceived by the Buzos Monitores was greater trust of “outsiders” (non-residents of the Corredor, especially scientists). Finally, a form of personal growth that the Buzos Monitores were especially proud of was technical training: all Buzos Monitores reported that they had improved in their monitoring, species identification, scientific name memorization, and SCUBA diving.

Near kin perceived personal growth of the Buzos Monitores through attitude, self-expression, and communication (e.g. the Buzos Monitores being more responsible, prepared, and respectful), and described these changes as positive. For example: “My brother [a Buzo Monitor] is more open in talking with you now. He was more serious, less talkative, before. Now, he's more open with people. It's a good thing” (family member 001, 7/11/16). Most kin (88%, $n = 15$ of 17) identified some sort of personal growth. The word “responsible” was mentioned in nearly every interview, and nine near kin perceived a parallel between being a more responsible diver and being a more responsible citizen: “he is more responsible, as much in diving as in life” (family member 017, 7/9/16) and “He behaves better...More responsible. All the time” (family member 009, 7/21/16).

Five near kin emphasized changes in the Buzos Monitores' fishing behavior aligned with sustainable fishing. They told us that the Buzos Monitores now "respect fish more", recognize and value non-commercial species, and undertake actions of environmental care. A very broad conceptualization characterized how our respondents discussed this environmental stewardship, which included direct actions to conserve marine life (e.g. throwing small or commercially valueless fish back in the water alive) as well as more general environmentalism-associated behaviors (e.g. throwing trash in the dump rather than littering at sea or in their towns). Respondents linked these conservation-oriented behaviors to the Buzos Monitores program because of greater knowledge and changing values. For example:

"He was a fisher for his whole life before he was a Buzo Monitor. But now, he has a new perspective on the size of fish he can take. His mentality has changed – now he wants to take care of the fish... he's learning more things, learning how to take care of his fishing areas" (family member 019, 7/12/16).

"He values fish more. I've seen it in him. For example, if he takes out fish, like a "cochi", which is what we call triggerfish [a low-value fish], he throws it back. Before, we would just kill it. But now, that's not the case; he throws it back alive. It's very interesting" (family member 021, 7/11/16).

In contrast to the Buzos Monitores and their families (almost all of whom emphasized some aspect of personal growth as an effect of the Buzos Monitores program, $n = 20$ of 22), half of non-kin peers ($n = 7$ of 14) said that the program has not resulted in personal growth or behavioral changes. These respondents emphasized that the program is just a form of employment: an alternative source of income to fishing.

"The program is just a type of work they are doing. They say, "Let's dive," they mark what they see. "But look, I go to La Paz, I come back." Nothing changes. It's like work for them, extra money" (community member, 029, 7/12/16).

The other half on non-kin peers ($n = 7$) did perceive personal growth in the Buzos Monitores because of the program, such as greater knowledge, skills, and responsibility. These respondents associated such changes with a whole new identity as a 'Buzo Monitor': "They're not just fishers – they're 'Buzos' now... They're not simply fishers. They have other responsibilities" (community member 003, 7/12/16). Like near kin, several non-kin peers ($n = 4$) linked personal growth in diving or monitoring to personal growth in life more generally (communication, wisdom, responsibility). One respondent noted that the Buzos Monitores know more about overexploitation of fisheries, and three identified changes in fishing behavior.

While personal growth in the Buzos Monitores was the most-discussed effect of the program across our interviews, not all respondents perceived this equally. Respondents that were more distant from the Buzos Monitores (non-kin peers) were more likely to report no changes, while closer respondents (close family members) did perceive changes like sustainable fishing behavior, new ways of thinking, and greater wisdom. For instance, all of the Buzos Monitores ($n = 5$) mentioned being able to communicate better as an outcome of their participation in the program. Yet, only half of their near kin ($n = 8$ of 17), and a fraction of non-kin peers ($n = 3$ of 14), perceived this change in the Buzos Monitores. Overall, all Buzos Monitores ($n = 5$) said that they had experienced personal growth because of their participation in the program. Most ($n = 15$ of 17) of near kin, but only half ($n = 7$ of 14) of non-kin peers perceived this same change.

Monitoring stipend: good for Buzos, perceived mixed effects on families and towns

The Buzos Monitores were paid for each monitoring trip. Daily payments were equivalent to a modest day of fishing. Most respondents ($n = 33$ of 36) agreed that the Buzos Monitores make more money monitoring than fishing in the low fishing season, and a quarter of all respondents ($n = 9$) said that monitoring is more lucrative in any season. The Buzos Monitores we asked about payment ($n = 5$) were generally pleased, although two respondents said the income is insufficient for the risks they take. Overall, it was the timing rather than amount that respondents emphasized. For most years (2012–2018), monitoring occurred in late October, just before the seasonal winter winds that reduce fishable days by 20–80%. Most of the Buzos Monitores and their families ($n = 16$) reported that this guaranteed income is important in the low fishing season, and in some cases it “keeps food on the table”. The contribution of this income to their ability to buy food for their family was especially emphasized by some of the Buzos Monitores’ wives.

In contrast to positive economic outcomes at the conclusion of the two weeks of monitoring when the Buzos Monitores are paid, families mentioned struggling financially during the time their husbands are away conducting the monitoring. Households in the Corridor often have little savings, and the Buzos Monitores were in most cases the principal income earner for the household. Because compensation was paid at the conclusion of the monitoring cruises, families struggled to feed themselves during those two weeks, especially the more marginalized families without access to credit via fish buyers or fishing cooperatives:

“When the Buzos Monitores leave, it can be for 12 days... We live day to day. You fish, you bring money back. But for the 2 weeks when they leave [to monitor], they bring money at the end... When the Buzos Monitores return, everything goes back to normal” (family member 027, 7/10/16).

Since these findings were presented to the Buzos Monitores and Niparajá personnel on October 9th, 2017, the organization has explored alternative payment schemes to mitigate the financial struggles of the Buzos Monitores’ families.

At the level of the towns where Buzos Monitores live, perceived direct economic effects were small but noticeable. One respondent reported that the town’s general store benefits when the Buzos Monitores pay off their store debt following the monitoring cruises. A few respondents ($n = 6$) reported that the fishing cooperatives are hurt by the loss of productive workers during the monitoring cruises; the fishing crews of the Buzos Monitores are typically able to continue fishing during the weeks of monitoring, but in these small cooperatives, every worker contributes valuable fish. Yet respondents stated that these economic losses were not resented because of strong bonds of friendship and mutual support. Similarly, all (100%) of respondents said that the program had not created inequalities in these towns.

“The Buzos are also fishers, and we’re all generating money for the cooperative, so the cooperative does lose when they leave. Not much, but it does lose... but [the cooperative] does not resent it. It’s just that they don’t fish in that time. But we see them as friends and they make good pay there [monitoring]” (community member 029, 7/12/16).

Indirect costs of participation: risk, worry, health problems, and reputation

In addition to families' lack of money when the Buzos Monitores leave and slight negative economic effects on fishing cooperatives, participants perceived other indirect costs of the program: risk (and attendant worry of family members), health problems, and reputation linked to the Fish Refuges. Risk was a principal concern; more than half of respondents ($n = 22$ of 36) brought up concern about diving-related dangers during the interviews before we asked about risks, including all women we interviewed ($n = 13$). Monitoring underwater using SCUBA presents risks that the Buzos Monitores are unaccustomed to because fishers in the Corredor use hook and line or nets to fish, rarely free diving and never diving with a SCUBA tank. Most respondents (72%, $n = 26$ of 36) said that being a Buzo Monitor was more dangerous than fishing, identifying risks like decompression sickness, equipment failures, running out of air, and sharks.

"It's risky, very dangerous – there are sharks, your air goes out, you can come up too quickly. But yes, there are people who really like diving, they like it. Going under the water, they don't think about the danger beyond diving. All the Buzos Monitores feel this way" (family member 009, 7/21/16).

Four respondents associated these diving-related risks with several health problems that the Buzos Monitores have developed since the start of the program, including a severe leg infection, inner ear problems, and the development of Type 2 diabetes.

Nine interviewees alluded that the personal reputations of the Buzos Monitores has benefited the reputation of the Fish Refuges and six respondents explicitly stated the good reputation of the Buzos Monitores leading to greater confidence within the fishing community in the benefits of the Fish Refuges to fish populations. One Buzo Monitor posed a contrasting view, saying that disenchantment with the Refuges' poor enforcement has hurt the reputation of all the Buzos Monitores within their respective towns. Another respondent with a very negative personal relationship with the Buzo Monitor from his own town opposes and resists anything related to the Fish Refuges.

Indirect effects of participation: opportunities, high quality work, and community pride

Respondents also identified new livelihood and education opportunities as well as other indirect benefits (high quality of work, health, and increasing trust, reputation, and pride within their towns) for the Buzos Monitores and their families. All types of interviewees (Buzos Monitores, their families, and non-kin), agreed in suggesting that an important outcome of the program was the opening of the possibility for the Buzos Monitores to find new alternative livelihoods (such as dive tourism and local government jobs) from their dive certifications, knowledge of marine science, and perceived leadership, and improved communication skills. Our respondents repeatedly indicated the importance of such indirect benefits, often redirecting us to such benefits when we asked about direct benefits like monetary compensation. For example:

"I see it more as an opportunity for them; they have more knowledge. It's an economic gain for the family, but more than anything, it's a personal gain of knowledge...they have an alternative and as divers, they have the capacity to train others. If some tourists come, they can take them out to dive" (community member 003, 7/12/16).

Respondents further elaborated on the diverse education opportunities that the Buzos Monitores have had through the program, including but beyond formal training. All Buzos

Monitores interviewed and most near kin (65%, $n = 11$ of 17) and non-kin peers (57%, $n = 8$ of 14) said that the Buzos Monitores' access to formal education regarding SCUBA theory and technique, species basic biology, ecology and taxonomy, communication and leadership training, etc.) had improved. Respondents also noted the Buzos Monitores are now pushing their children to get more educated, and seem to devote more financial resources to support their children further in education. For example, one Buzo Monitor (who dropped out after primary school) said that seeing more of the world has made him more interested in having his children go to college. Another Buzo Monitor prioritized financially supporting his son high school expenses – a large financial burden because the nearest high school is two hours away in the city.

“We, ourselves, have more knowledge, we've been educated. There is also more interest in our families to push our kids to study, I believe” (Buzo Monitor 011, 7/22/16)

The Buzo Monitor program seems to have created new opportunities for women: while it has not directly employed women, the circumstances created by the program have led to women taking on different roles than they traditionally have. In the Corridor, women typically stay home while the men fish, preparing food, taking care of the home, and taking care of children. When the Buzos Monitores (all men at time of research) leave to do the monitoring cruise, this is often the longest continuous time they have ever spent away from their families. Three women that we interviewed reported expanded duties and decision-making power because of their autonomy during the monitoring time. For example, the wife of a Buzo Monitor took on his duties as cooperative president for 18 days and landed catch (keeping accounts and managing payments) from all cooperative members while her husband was monitoring. This was the first time a woman had received fish for this cooperative.

Some respondents ($n = 13$ of 36) perceived that the program has led indirectly to positive health outcomes. Three respondents said that during the research cruise the Buzos Monitores make healthier eating choices because of the physical demands of diving. Three additional respondents reported that the program has incentivized positive health-related life choices because of the expectation of being physically fit for diving throughout the year, for example leading to voluntary self-care for diving like quitting cigarette smoking. Another respondent reported more health-related awareness among the Buzos Monitores through the First Aid certification provided by the program. As mentioned above, however, four other respondents disagreed, reporting negative health outcomes associated with diving.

Respondents overall framed monitoring labor as 'good work but dangerous', with risk especially emphasized by the Buzos Monitores and their family members. When we asked respondents to qualify the monitoring work, a large majority (86%, $n = 31$ of 36) of respondents across types used positive adjectives like “pretty”, “fun”, “exciting”, “excellent”, and “great”. Buzos Monitores themselves all spoke excitedly about their work, one calling it “a vacation,” and another, “I wish it were the whole year”. At the same time, more than half of all respondents, including all of the Buzos Monitores and most near kin ($n = 12$ of 17), mentioned risk in addition to describing it with the positive adjectives above:

“I really like the monitoring work. There are times when the [sea] current is strong: when there is danger and you have to be really vigilant. But, doing the monitoring, I think that you also have an idea of what there is under the water. You have firsthand knowledge about fishing conditions. You have your own vision about what is going on with the Refuge, whether we definitively should close them, or open them, if we should select another area” (Buzo Monitor 011, 7/22/16).

Finally, almost all respondents (97%, $n = 35$ of 36) said communities' opinion of the Buzos Monitores was the same or higher because of their participation in the program. Respondents also indicated increasing trust in the data they produce. For example, one Buzo Monitor stated, "Always, the community is having more and more trust in us". 92% ($n = 33$ of 36) of our respondents reported that they trust the data that the Buzos Monitores produce, and 78% ($n = 28$ of 36) reported that they trust the data produced by the Buzos Monitores the same or more than by a scientist. When we probed respondents about the reasons for this increased trust and reputation, they indicated better communication skills, greater knowledge of fish and the Fish Refuges, greater knowledge of diving, better relationships within their towns and cooperatives, and the sense that the Buzos Monitores are monitoring the Fish Refuges to benefit the community.

Discussion

Our results support previous findings suggesting that local people involved in professional ecological monitoring of protected areas may experience and perceive personal changes associated with their participation in these programs (Conrad and Hilchey 2011; Fulton et al. 2019b; McKinley et al. 2017; Schmiedel et al. 2016; Tulloch et al. 2013). In our study area, participants in the Buzos Monitores program emphasized personal growth as the main benefit and noticeable effect. Participants and their peers also mentioned additional benefits such as increased participation in fisheries management, development of better communication skills, and incorporation of sustainable fishing techniques, as well as the direct payments they receive from monitoring which occasionally supported their ability to sustain their household when fishing was poor. Overall, most respondents indicated that indirect benefits are most important, including informal education opportunities through trainings and workshops and the possibility of new alternative livelihood opportunities, like dive tourism.

Similar outcomes have been documented in other citizen science programs (Bonney et al. 2014b; Conrad and Hilchey 2011; Cooper et al. 2007). Frequently reported effects of volunteer citizen scientist programs on participants include the development of social capital and leadership skills (Kinchy et al. 2014; Lawrence 2006; Overdevest et al. 2004; Stedman et al. 2009) and empowerment through democratization of science (Kinchy et al. 2014). A recent synthesis found also increased knowledge, engagement in the scientific process, awareness of environmental issues, and behavioral changes towards environmental stewardship (Stepenuck and Green 2015). This synthesis identified what they describe as negative outcomes (viz., feeling burnt-out, minimized by the decision-making process, or powerless), but overwhelmingly emphasized what they call positive outcomes of citizen science programs on the participants (Stepenuck and Green 2015). The authors caution that their meta-analysis may be biased by papers presenting the positive outcomes of citizen science, and call for in-depth studies of the effects of such programs on their participants.

Our study responded to this call and found similar effects: leadership skills, empowerment, increased knowledge, engagement in the scientific process, and a behavioral change towards environmental stewardship. More specifically, participants in Baja California sur seem to have taken on new identities in their communities and their reputations have brought support and legitimized novel conservation policies such as Fish Refuges (Quintana et al. in prep, Quintana and Basurto in review). In contrast to the citizen science literature, respondents did not report feeling burnt out or powerless (Stepenuck and Green

2015), although interviewees were not explicitly asked to reflect on these feelings. Instead, respondents emphasized decompression sickness, running out of air, sharks, and other dive-related risks even before they were prompted. The high risk perception may be because fishers primarily fish using hook and line from the boat, rarely free diving and never diving with a tank or hookah (compressor and hose). In contrast, fishers involved in a similar program in Bahia de Kino, Sonora (300 miles to the north of the Corredor), who fish by diving with hookah gear, did not discuss dive-related risks in informal interviews about the effects of their program (unpublished data). Monitoring programs whose data collection mirrors participants' professional activities may be perceived as less dangerous.

Effects beyond participants: reformulating relationships with the state, manifestations of the caring economy, and opportunities for the disruption of gender roles

In addition to the personal changes discussed above, our case study suggests that resource users' participation in protected area monitoring can have much broader effects beyond the participants, such as new opportunities for engagement in resource governance. This effect is widely invoked as a potential benefit of citizen science (Kinchy et al. 2014; Lawrence 2006; Overdevest et al. 2004; Stedman et al. 2009), with programs claiming to bolster social capital, increase trust among resource users and managers, and lead to political actions to protect the environment (Stepenuck and Green 2015). In the case of the Buzos Monitores, ecological monitoring has created an opportunity for fishers to work alongside fisheries officials in the pursuit of a common goal (collecting data). Fisheries officials interviewed for this study told us that because of interacting with the Buzos Monitores, they now think that "sometimes the fishers know more about the marine environment, even when it goes against the [scientific] literature" (government fisheries scientist, 6/24/16) and that "fishers and authorities do not have to be enemies... I've learned that if you train fishers to care for their fisheries products, they are capable of doing it" (government fisheries scientist, 6/24/16). Despite the fact that monitoring is premised on scientific knowledge rather than fishers' knowledge, the repeated opportunities to interact seem to have led to government scientists' increasing respect for fishers' knowledge and role in managing fisheries.

We were able to identify several other broader effects not discussed in the citizen science literature related to family income and the burden of worry. Some of these may be idiosyncrasies of the Buzos Monitores program. For example, because monitoring often coincides with the season when strong winds often prevent fishing, the program has contributed a source of income at times when fishing can be limited. A lesson for other paid monitoring programs to maximize broader benefits may be to plan monitoring around resource harvest, where possible. Paid programs may also wish to consider how and when payments are given, especially where participants' families typically live day-to-day with limited access to credit: in this case, monitoring created a financial burden for several families who were left without their primary income earner for up to two weeks.

Because of the perception that diving is high-risk as discussed above, there is also a burden of worry on the families of the Buzos Monitores. The high perception of risk associated with SCUBA diving means that the families of the Buzos worry for the extent of the monitoring cruise. This worry is compounded by the lack of phone signal in the region where monitoring takes place, meaning that it is challenging for families to get news. Worrying is often trivialized but is part of the caring economy (Eisler 2007; Jochimsen and

Knobloch 1997; Ulrich 1990, 1993). The caring economy (also called maintenance economy) is a concept from feminist and critical economics, and includes all labor undertaken out of affection or a sense of responsibility for other people, with no expectation of immediate pecuniary reward (such as consoling coworkers and cooking for families) (Folbre 1995). The caring economy supports the income generating economy, and often includes (unpaid) labor by women that supports (paid) labor by men (Jochimsen and Knobloch 1997); this has been well-documented in fishing towns where gender determines income and status (Harper et al. 2020; Kilpatrick et al. 2015; Yodanis 2000). In the case of the Buzos Monitores, some (but not all) the female near kin of Buzos Monitores described worrying throughout the whole monitoring cruise, distressing them and hampering their sleep. This worrying is a hidden cost of ecological monitoring where participants engage in behavior perceived as risky by their families.

At the same time, families of participants have benefitted from new informal and formal education opportunities for their children, through increased income and increased commitment of the Buzos Monitores to the education of their children. Overall, we found evidence of increased interest in marine science and education more generally, particularly among the families of the participants, as well as instances of increased education opportunities. There is also evidence that the participants' communities are willing to sacrifice for the monitoring project. Even though the fishing cooperatives of the Buzos sometimes lose income during the 2-week monitoring period, cooperative members that stayed behind told us that they do not resent the loss of income because of the importance of the monitoring work in assessing the Fish Refuges.

In some select cases, monitoring has created new opportunities for women by disrupting routine life in the Corredor. Monitoring operates on a different schedule from the rhythm of daily fishing, requiring the Buzos to leave their families for up to two consecutive weeks. In some cases, this has led the Buzos' wives to take on new roles, as in the most visible example of the wife who received fish in lieu of her husband's role in the fishing cooperative, and was later recruited to participate in a Gender Equality in Fisheries program organized by a Mexican civil society organization, 'Comunidad y Biodiversidad' (Torre et al. 2019). Furthermore, the latest training of Buzos Monitores in 2018 conducted in La Paz included two women from the Corredor.

We asked interviewees to discuss a closed set of broader effects (e.g. food security, education, gender roles), and so these were the types of effects our participants discussed. However, it is possible there are other broader effects of the Buzos Monitores program that we did not learn about because we did not ask about or observe them. Further study of broader effects, including direct measurement of these effects and random sampling of respondents from a larger population pool, would be necessary to quantify the broader effects of participatory ecological monitoring. A longitudinal panel approach would also be needed to understand the effects of the social disruptions caused by professional ecological monitoring programs, such as challenging gender roles, and the concomitant effects on local communities.

Should local people monitor protected areas? environmentalty and implications for governance

Our results suggest that programs involving local people like fishers to monitor protected areas have the potential for transformative personal growth of participants amounting to them being more than "just" fishers: as one respondent told us, "they're not just fishers –

they're Buzos now [*no son solo pescadores; ahora son Buzos*]" (community member 003, 7/12/16). Here we briefly discuss these statements and potential implications for protected area governance.

Responses from the Buzos Monitores suggest participation in the program has left an impression. Some expressed that, "What has changed for me is how I think" (a Buzo Monitor) and family members mentioned, "He values fish more, now" (a family member, speaking of a Buzo Monitor). Many respondents perceived the Buzos Monitores as having a new dimension of their identity associated with characteristics like civic and environmental responsibility, wisdom, knowledge, and public speaking skills. However, the way our respondents talked about the Buzos Monitores emphasized new skills and opportunities, rather than a reversal of previous habits. The Buzos Monitores were nominated by their communities and selected to participate in the program because they were already respected and perceived as responsible. If a transformation has taken place, it is not from fisheries exploiters to environmental stewards, but rather in the personal development of fishers who were already locally respected.

These changes perceived by the Buzos Monitores and their peers are similar to reports of the development of conservation-associated attitudes and behaviors from ecological monitoring in volunteer citizen science programs (Bonney et al. 2009; Dickinson et al. 2012; Toomey and Domroese 2013). Attitudes, it seems, change more than behaviors, but citizen science tends to produce changes in both (Toomey and Domroese 2013). Cooper has argued that the same should be true where local people monitor protected areas (Cooper et al. 2007). In this case, respondents told us that the Buzos Monitores altered their behavior in ways we associated with sustainable fishing: releasing captured small and low-grade fish while fishing. The Buzos Monitores' attitudes have changed in parallel ways, in valuing diverse species of fish and participating more in formal management of their fisheries.

In rural communities where conservation organizations provide diverse benefits and have close relationships, there is a high risk of "environmentality", wherein participants internalize environmental concern not necessarily in their own interest, ultimately becoming advocates for the (environmental) interests of others (Agrawal 2005). While the Buzos Monitores may have a new identity, the attitudinal and behavioral changes that our respondents focused on were not centered on the environment, but instead on building professional and communication skills, with links to sustainable fishing. Here it does not seem like the Buzos Monitores are acting against their own interest, as has been found in some fishing communities (Song 2015). However, the personal reputations of the Buzos Monitores have become entangled with the project of the Fish Refuges. In a way, the Buzos Monitores are environmental subjects of the Fish Refuge project, but the project is also a subject of the reputations of the Buzos Monitores.

Participants' subtle transformations and entanglements through participation in ecological monitoring programs may not be universally, or even widely perceived. Many of the results presented above showed a similar pattern: changes were reported by all of the Buzos Monitores themselves, by most of their near kin, but by much fewer of their non-kin peers. Qualitatively, Buzos Monitores gave elaborate and emphatic descriptions of how they had changed in various ways; near-kin often described in detail a number of changes they had noticed; while non-kin peers frequently gave one-word or minimal answers if they did notice a change. All Buzos Monitores and family members perceived at least some degree of personal change from the program; non-kin peers were the only ones to tell us things like "it's just a job" and "he goes [to monitor], he comes back: nothing changes". This could be interpreted in two ways. One possibility is that the Buzos Monitores' detailed

and emphatic testimonies resulted from their desire to support and strengthen their close interpersonal and financial relationships with Niparájá, by explaining the changes they have gone through, while their peers (with no such incentives) simply describe the program as “just a job”. If this is the case, the Buzos Monitores’ behavior according to several sources (e.g. releasing small fish that they catch fishing) does seem to align with their described personal changes, suggesting that this identity is performative (Butler 1990). An alternative explanation is that many of the more subtle personal impacts of ecological monitoring programs may not be noticed in these communities beyond the participants and their immediate family circle. In this case, near-kin peers were purposely selected because they knew the Buzos Monitores well; if even they often perceived no changes, such changes would be even less likely to be detected by more distant social connections.

How do our results speak to the question of whether local people are best situated to monitor protected areas? Danielsen and colleagues have advocated for involving local people in monitoring because it leads to faster policy responses, addresses immediate environmental concerns, and produces more locally relevant policy outcomes (Danielsen et al. 2005a). From our results, involving local people in monitoring the biodiversity of protected areas also increases local communities’ trust in the data produced and can build capacity in leadership and communication. It can be a source of income, professional skills, and knowledge. However, as a different form of livelihood from fishing, monitoring can be disruptive, for example challenging gender roles and potentially generating an ‘environmentality’ in participants. When monitoring requires tasks that are perceived as dangerous or risky, it can generate substantial worry and stress for families of participants. An awareness of these challenges could help practitioners implementing similar programs to prepare for them.

The broader implication for protected area governance is that involving local people in ecological monitoring can have disproportionately wide effects. Since there are only nine Buzos Monitores, individual behavioral and attitudinal transformation seems unlikely to have a large direct impact on biodiversity and environmental outcomes. However, despite their limited numbers the Buzos Monitores program has had much wider effects on the communities where the participants live. Local residents have a high level of trust in the data that the Buzos Monitores produce – higher than their trust in data produced by scientists. Furthermore, the program has led to a process of trust building between rural fishers and urban bureaucrats. Overall, from the perceptions of people living close to protected areas, local ecological monitoring is about far more than the data produced.

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Author contributions AQ and XB conceived of the study and iteratively worked on the linkages between theory and study design. AHW and SRV provided key ideas to support the study design and substantive fieldwork facilitation and assistance, without which the project would have been impossible. AQ collected the data. AQ and XB analyzed the data and wrote the manuscript. All authors approve of the manuscript in its final form.

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Appendix 1

See Table 2.

Table 2 Demographic breakdown of 36 study participants of semi-structured interviews conducted in 4 communities in the Corredor region of Baja California Sur between La Paz and Loreto (Puerto Agua Verde, Ensenada de Cortez, San Evaristo, and Tembabiche) from July to August 2016

		# of Buzos Monitores	# of immediate family members*	# of wider community members	Total
Town	Puerto Agua Verde	2	6	8	16
	Ensenada de Cortez	1	1	2	4
	Punta Alta		1		1
	San Evaristo	1	3	4	8
	Tembabiche	1	3	3	7
Total		5	14	17	36
Gender	Male	5	5	13	23
	Female		12	1	13
Fishing	Fisher	5	7	10	22
	Non-fisher**		10	4	14
Coop	Fisher in cooperative	3	3	7	13
	Fisher not in cooperative	2	1	3	6
Avg. time living in community		34 years	34 years	33 years	33 years
Avg. number of Buzos Monitores known by respondent category		8	3	4	4

*Immediate family includes mother, father, siblings, and spouse

**Anyone who said that they fished, even part-time, was considered a fisher

Appendix 2

See Table 3.

Table 3 List of trainings, workshops, and monitoring activities that the Buzos Monitores participated in during the study period (2012–2017)

Year	Month	Activity type	Description	# days	# Buzos Monitores involved
2011	Nov	Dive training	Open Water dive training and certification	4	12
	Nov	Scientific methodology	Species identification; underwater monitoring methods	6	12
2012	Mar	Monitoring	Corredor monitoring site selection and reconnaissance	8	5
	May	Scientific methodology	Refresh species identification, underwater monitoring methodology	4	9
	May	Monitoring	Monitoring of Corredor Fish Refuges	15	9
2013	May	Dive training	Advance Open Water dive training and certification	7	9
	Oct	Scientific methodology	Refresh species identification, underwater monitoring methodology	3	9
	Oct	Monitoring	Monitoring of Corredor Fish Refuges	15	9
2014	Jun	Dive training	Rescue Diver training and certification	5	9
	Oct	Scientific methodology	Refresh species identification, underwater monitoring methodology	3	9
	Oct	Monitoring	Monitoring of Corredor Fish Refuges	15	9
	Oct	Monitoring	Divers exchange: Contracted monitoring in Guaymas, Sonora	5	2
2015	Apr	Scientific methodology	Fish Refuge Diver certification (through Niparaja)	4	8
	Oct	Scientific methodology	Refresh species identification, underwater monitoring methodology	3	9
	Oct	Monitoring	Monitoring of Corredor Fish Refuges	9	9
2016	May	Scientific methodology	Refresh species identification, underwater monitoring methodology	3	9
	May	Monitoring	Monitoring of Corredor Fish Refuges	9	9
	Jul	Scientific methodology	Underwater transect methodology with UC San Diego	4	2
	Oct	Scientific methodology	Refresh species identification, underwater monitoring methodology	3	8
	Oct	Monitoring	Monitoring of Corredor Fish Refuges	9	8
	Nov	Monitoring	Research trip with Dr. Adrian Munguia in the Gulf of California	5	1
2016–17		Dive training	Dive Master training and certification	8	7

Table 3 continued

Year	Month	Activity type	Description	# days	# Buzos Monitores involved
2017	Apr	Monitoring	Fish Refuge divers exchange: Contracted monitoring in Quintana Roo	4	3
	Oct	Dive training	Nitrox diving training and certification	2	7
	Oct	Scientific methodology	Refresh species identification, underwater monitoring methodology	3	7
	Oct	Monitoring	Monitoring of Corredor Fish Refuges	10	7
		Broader training	Strategic communication course	2	7

Year and month are on left. 'Activity type' column categorizes activities (dive training, scientific methodology, monitoring, and broader training). '# days' column gives length of time of activity; each day represents the majority of a day (> 4 h). '# Buzos Monitores involved' describes number of Buzos Monitores from the Corredor who participated fully in each activity

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