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The Dominican fishery of Manzanillo: A coastal system in transition

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1. Introduction

In this paper we present the results of an exploratory analysis of a fishing community in the Dominican Republic. This work is part of a larger project examining the social and ecological dynamics of fishing communities in the province of Montecristi in the North-west Dominican Republic (Wilson et al., 2015; Cox et al., 2016). One primary emphasis of this project has been the social dynamics of fishing use from the perspective of community-based management of common-pool resources (Agrawal, 2003). Here we present our application of this perspective to the Dominican fishing town of Pepillo Salcedo, informally known as Manzanillo, in Manzanillo Bay.

Framing environmental governance as the interaction between a set of interdependent actors and a shared commons is now a well-established approach for analyzing human-environment interactions (Laerhoven and Ostrom, 2007; Poteete et al., 2010). The major environmental commons that have been studied are water resources, pastoral resources, fisheries, and forests (Laerhoven and Ostrom, 2007). The commons concept was popularized in Hardin, 1968 famous essay, and arguably even more so by subsequent criticisms of supposed assumptions that Hardin makes (see Ostrom, 1990).

Much of the work on the commons, including ours, is motivated

by the collective-action problems that commons users face, in which the short-term interests of each commons user conflict with the long-term interests of the group. Each individual gains from their use of the commons in the short-term, but excessive use can degrade a commons and remove the benefits for everyone. Despite whatever problems we may see in Hardin, this is why the idea of a “tragedy” of the commons is a useful concept; because if we do not resolve collective-action problems, we all lose. This scenario leads us to ask, how do we change the incentive structures of those involved such that they act in the interest of the group (and ultimately themselves)?

In this framing human cooperation becomes the key determinant of environmental sustainability. The main independent variables in such analyses have taken the form of institutions (rules and norms) that assign property rights to a resource and create positions for enforcing these rights, and group attributes, such as the number of members and heterogeneities among them (see Ostrom et al., 1994). These theories are all focused on explaining group-level outcomes based on individual-level incentives. As Laerhoven and Ostrom (2007) reflects, it is unsurprising given this framing that much commons work has focused on the dynamics between a single community and shared commons, where the connection between cooperation among community members and environmental outcomes is relatively uncomplicated. However, the commons community has increasingly recognized the need to account for the fact that cases of commons use and management frequently involve multiple conflicting communities and various types of actors interacting with a suite of similarly interdependent resource systems (Agrawal, 2003).

Meanwhile, other scholars have criticized the supposedly idealized community concept, arguing that the win-win scenario among resource users that is frequently envisioned to result from cooperation is misleadingly simplistic given the diversity of interests and subgroups that any real community contains (Turner, 1999). Additionally, other scholars studying the evolution of cooperation have emphasized that cooperation and competition are not simply conflicting forces, but are deeply interdependent in the history of the evolution of cooperation. Collective action problems

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occur at all levels of social and biological organization, and the extent to which cooperation occurs at one level will tend to exacerbate conflicts at the next level, with some arguing that within-group cooperation depends on between-group competition (see Wilson, 2015; Henrich, 2015). This argument relates to the critique of the community concept just mentioned, in that it forces us to recognize that communities can be composed of subgroups of individuals who cooperate internally but then compete against each other.

These arguments complicate the relationship between cooperation and environmental sustainability. Nevertheless, we agree with Jentoft's (2000, 53) argument that "viable fish stocks require viable communities." Human communities remain a critical arena for understanding the governance of the commons, including fisheries. Our challenge is to examine such communities of natural resource users with these dynamics in mind.

In this work we sought to contribute to this area of scholarship by addressing the following set of interconnected research questions. First, how are the Manzanillan fishers using and managing the natural resources available to them? Second, we wanted to

understand the perceptions of the fishers with respect to the status of their natural resources in comparison to previous years. Following this we sought to understand why the fishers believe that different resources that they use are in the state that they are. To answer these questions, we conducted a series of in-person interviews with the Manzanillan fishers during the 2016 summer field season.

2. Study area

Manzanillo is a small coastal city of several thousand residents on the northwestern corner of the Dominican Republic (Fig. 1). It is one of a group of fishing villages in the province of Montecristi, which in our experience fit the description of small-scale fisheries in the Caribbean in Salas et al. (2007): (1) the fisheries tend to be multi-species and multi-gear, (2) the fishing is labor intensive with limited capital investment, (3) fisheries are economically significant to the fishing villages, and (4) fishers have relatively little market power and access to social services.

The social structure surrounding fishing activities in Manzanillo

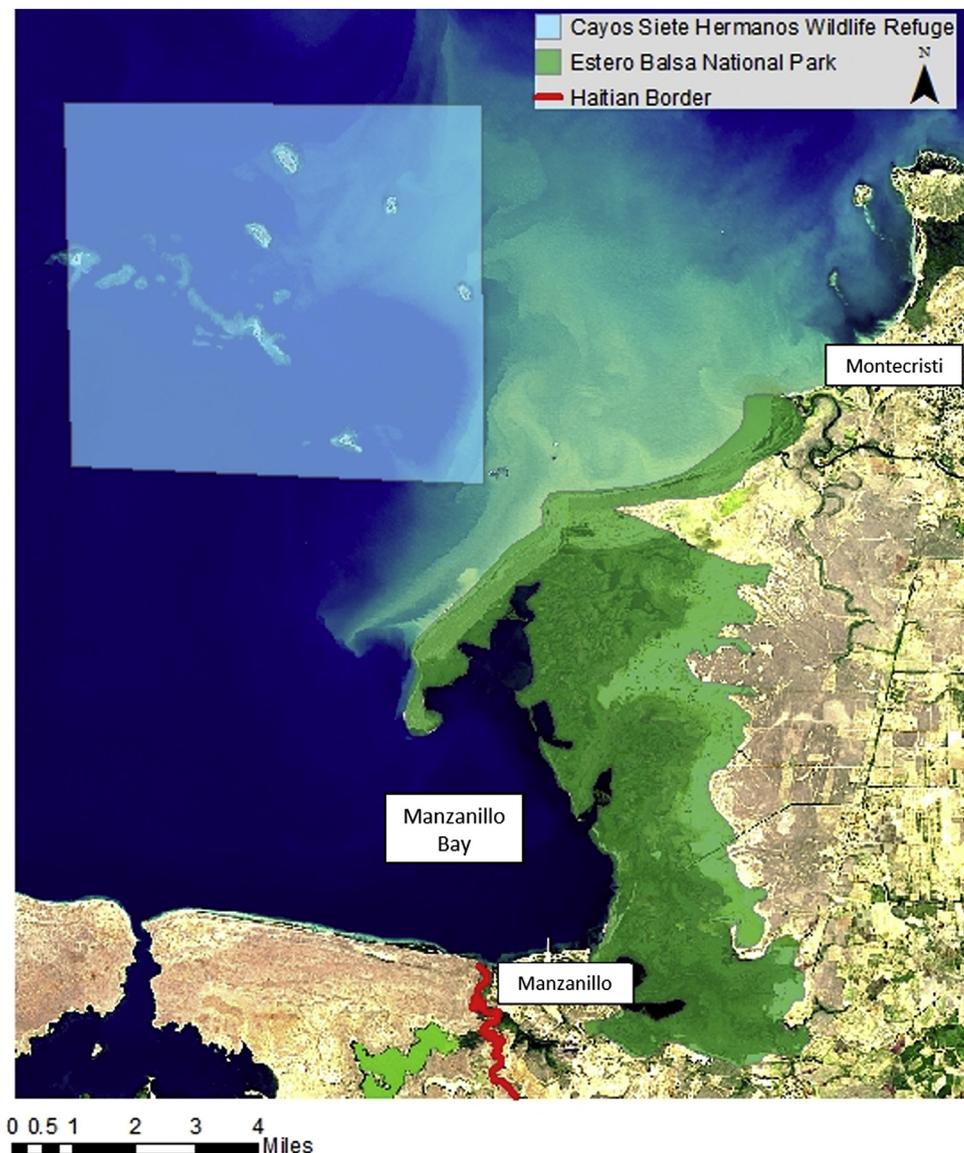


Fig. 1. Study area.

is similar to other towns along the Montecristi coast. First, there is a fishers' association that provides the primary source of local fisheries governance. Second, there are several “pescaderias,” or fish shops, each with an individual owner. These are important actors in the village, as they make most of the purchases of local fish, and in some cases they also supply equipment and financing to the fishers.

On the city's western side lies the Masacre river and the border with Haiti. On its eastern side there is a large complex of mangroves that extend north, forming the eastern edge of Manzanillo Bay. These mangroves are located in the Estero Balsa National Park (81 km²), and are known as the mangroves of Estero Balsa. There is a second protected area surrounding a series of keys, known as the Siete Hermanos Wildlife Refuge (114 km²) located to the northwest of Manzanillo. These parks were established in 2004 by a broad law on protected area governance ([Congress of the Government of the Dominican Republic, 2004a](#)), and each have management plans that have been drafted by the government but not yet implemented.

The marine seascape near Manzanillo contains a diversity of physical habitats and associated organisms. The expansive mangroves of Estero Balsa form wet forests intersected with river and tidal channels and lagoons. At the seaward edge of the mangroves, seagrass beds begin. Occasional patches of coral reef appear within the seagrass. Some stretches of reef have developed, especially in front of the town, though they are less developed than other areas to the east in Montecristi province. The majority of the coral reefs accessed by Manzanillan fishers are located within the Siete Hermanos keys. Beyond the seagrass beds and coral reefs, the Bay of Manzanillo descends to a depth of 400 m. The depth in open water areas creates distinct habitat types at or near the bottom and in the upper parts to the surface. We refer to all fishing that takes place within this heterogeneous area as the fishery of Manzanillo.

There are three governmental agencies that have mandates relevant to fishing in Manzanillo. These are the Dominican Council for Fishing and Aquaculture, (CODOPESCA), the Ministry of the Environment and Natural Resources (Medio Ambiente), and the Dominican Armed Forces (La Armada). CODOPESCA is the main fisheries regulatory body in the Dominican Republic whose aim is to promote sustainable fishing activities throughout the country ([Congress of the Government of the Dominican Republic, 2004b](#)). The law that creates CODOPESCA provides the agency with the mandate to register and regulate fishers, establish and enforce rules to ensure sustainable resource use, and control the seafood imports and exports. The law also establishes some specific fishing rules relevant to fishing in Manzanillo; compressor diving, using beach seines in estuaries and other fish nursery grounds, and using spears or hand hooks to catch lobster is prohibited. CODOPESCA also

establishes closed seasons for all species of lobster, conch, and crab. The law creating CODOPESCA stipulates that any fishing activity that takes place inside of a nationally protected area, such as the mangroves of Estero Balsa and Los Cayos, must be sanctioned and coordinated with the Vice-ministry of Protected Areas within Medio Ambiente. These are prominent examples of a large number of specific rules that seem to be poorly understood and poorly enforced in fishing communities.

Medio Ambiente is charged with safeguarding ecosystems, plants, wildlife, and natural resources in the Dominican Republic. Within this agency, the vice-ministry of Protected Areas administers all national parks, wildlife refuges, and other areas with special protection status. As such they have the strongest claim to regulate extractive activities in the marine protected areas in the area. The Armada Dominicana regulates marine activities in terms of who owns a boat and uses it to leave from a Dominican port and enter Dominican waters. More generally it regulates activities in coastal and inland waters to ensure that they follow Dominican law. It is primarily an enforcement agency with more policing capabilities than the other agencies. It employs “coastal inspectors” whose job is to monitor coastal activities and report illegal activities with respect to transit, fishing, or other laws. The Armada is supposed to provide assistance to CODOPESCA in the enforcement of fishing laws.

3. Methods

The data for this study were collected during the summer of 2016. This work has been done in collaboration with the Dominican NGO AgroFrontera (www.agrofrontera.org), which has been working with the fishing communities in the area for several years. To prepare for the data collection we developed a questionnaire focusing on the individual attributes, activities, and perspectives of the fishers in Manzanillo. This was based on our previous work in the fishing village of Buen Hombre. This questionnaire was field tested with several fishers in the community before undergoing revisions to produce the final version that we ultimately used. A copy of the questionnaire is available as an [Appendix](#).

The data were collected via a set of in-person interviews with Manzanillan fishers that occurred within the village of Manzanillo. Each was conducted by one of three technicians employed by AgroFrontera. Prior to the interviews, the research team met several times with the technicians to train them and establish a common understanding of how the interviews were to be conducted. The research team also accompanied the technicians on the field testing exercises as well as the first several days of interviews to ensure that they were following the necessary protocols (e.g. not leading the respondents, accurately recording responses). Midway through the interview season the research team debriefed with the technicians to review their progress, check for problems, and obtain a common understanding of their individual and shared experiences.

The respondents in Manzanillo were selected based on their status as a fisher in the community, and were accessed via a local fishing leader that AgroFrontera had been working with for several years. Based on our knowledge that most the fishers in the community belong to the local fishers' association, we attempted to ensure that our respondents reflected the distribution of members and non-members in the communities. Eventually this led to targeting non-members to ensure that our sample reflected this population as well.

The questionnaire data were compiled into a Microsoft Access database and then exported for analysis in the Stata statistical analysis software package. Qualitative data produced from open-ended questions were frequently coded to quantitatively capture patterns in these responses as well. To construct the categories for the codes of qualitative variables, an iterative process was

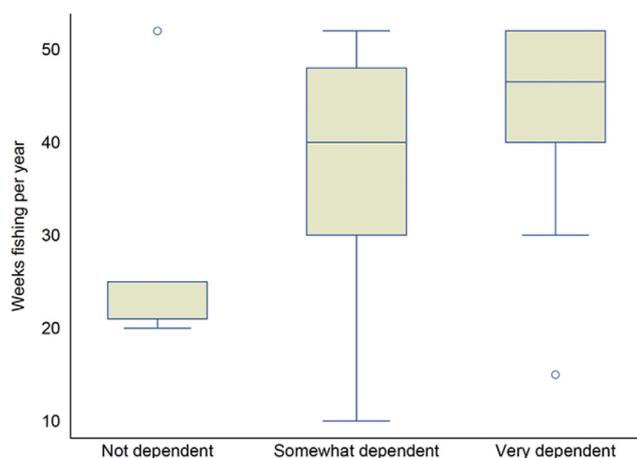


Fig. 2. Distribution of fishing effort in weeks per year by fishing dependence.

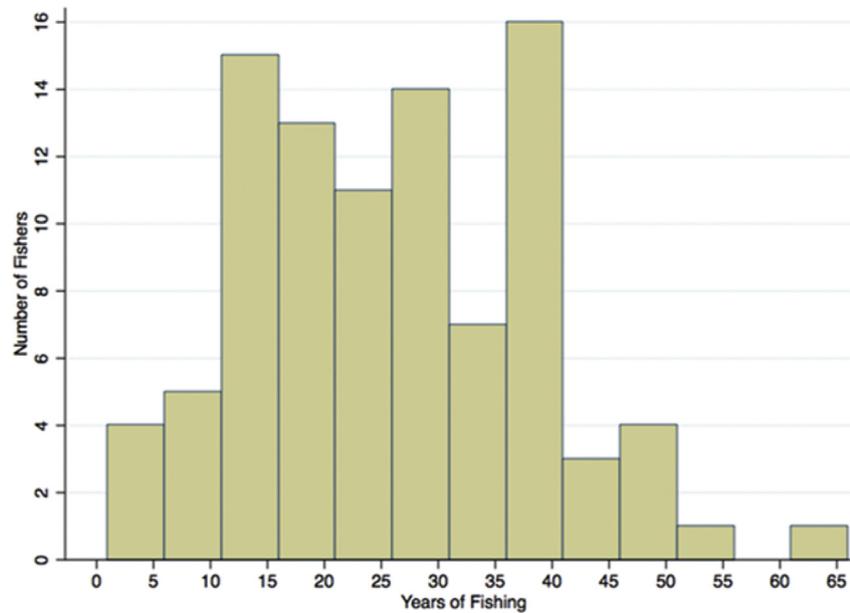


Fig. 3. Histogram of fishers' number of years fishing.

Table 1
Gear types, species caught (top three), and location.

Gear type	Description	Habitat(s) where used	Main species caught
Handline	Spool of fishing line with a baited hook that is thrown into the water and retrieved by hand.	Mangroves, coral reefs, open water (surface and bottom)	Snapper (49), Jack/mackerel (49), Grouper (9)
Gill net	Mesh net made with fishing line. Passively catches fish.	Mangroves, seagrass, near coral reefs	Mullet (40), Snapper (35), Mojarra (24), Snook (21), Jack (12)
Compressor diving	Spearfishing underwater while tethered to an airline supplied by a gasoline-powered air compressor on a boat. Allows access to deeper reefs. Dangerous to human health and technically illegal.	Coral reefs	Snapper (26), Lobster (21), Grouper (17), Parrotfish (17)
Freediving	Spearfishing while breath-hold diving.	Mangroves, seagrass, coral reefs	Snapper (22), Mojarra (10), Parrotfish (10)
Lobster/fish pot	Large, baited, plastic and wooden trap that attracts and captures lobster and reef fish.	Seagrass, near coral reefs	Lobster (5), Snapper (3), Grouper (3)
Fish aggregating device (FAD)	Floating material (typically tethered buoys, empty bottles, and/or palm fronds) anchored to the ocean floor with concrete weights. Placed in deep open water where density of fish is low. Attracts small fish, which attract larger fish. Fishers use handlines to capture fish around FADs.	Open water	Jack/mackerel (1), Dolphinfish (1), Tuna (1)
Beach seine	Long, very fine mesh net deployed near beach and dragged to haul in fish. Collects many fish of diverse species including very small and juvenile fish. Technically illegal to use in estuaries and seagrass beds.	Mangroves, seagrass, near coral reefs	Snapper (1), Jack/mackerel (1), Mullet (1)

employed whereby an initial set of prominent categories was constructed based on a first pass through the responses for each variable. Following this, we examined the responses several more times, constructing additional categories as needed if nuances were not being sufficiently captured by the existing set of categories.

The resulting data were examined quantitatively in Stata to address our research questions. Spatial data that were recorded as a part of the interviews were entered into an ArcGIS file and analyzed separately. Finally, we collected a set of satellite images that were used to analyze the change in land cover in the Estero Balsa mangroves, as well as in the province of Montecristi as a whole.

4. Results

4.1. Basic descriptive results

We interviewed a total of 95 fishers, 90 of whom are male and

70 of whom are members of the fishers' association. Based on more informal discussions with fishing leaders as well as direct observations, we believe that this sample represents the great majority of the fishers in Manzanillo itself, and as such the results we report here are highly representative of the slightly larger population. The average age of our interviewees is 45 years. Most the fishers in our sample are from Manzanillo itself (48), or from the nearby cities of Montecristi (11) and Dajabón (13). Roughly half of the fishers (54) completed primary school, with another 29 completing secondary school and five graduating with a university degree.

In terms of livelihoods, 40 fishers reported being very dependent on local fishing for their financial livelihood, while 50 reported being somewhat dependent. Fishers who reported higher dependence on fishing generally reporting fishing more (Fig. 2). Additionally, the distribution of weeks fished per year is negatively skewed, with most fishers fishing most weeks out of the year, but with a significant subset that fishes substantially less than this. The

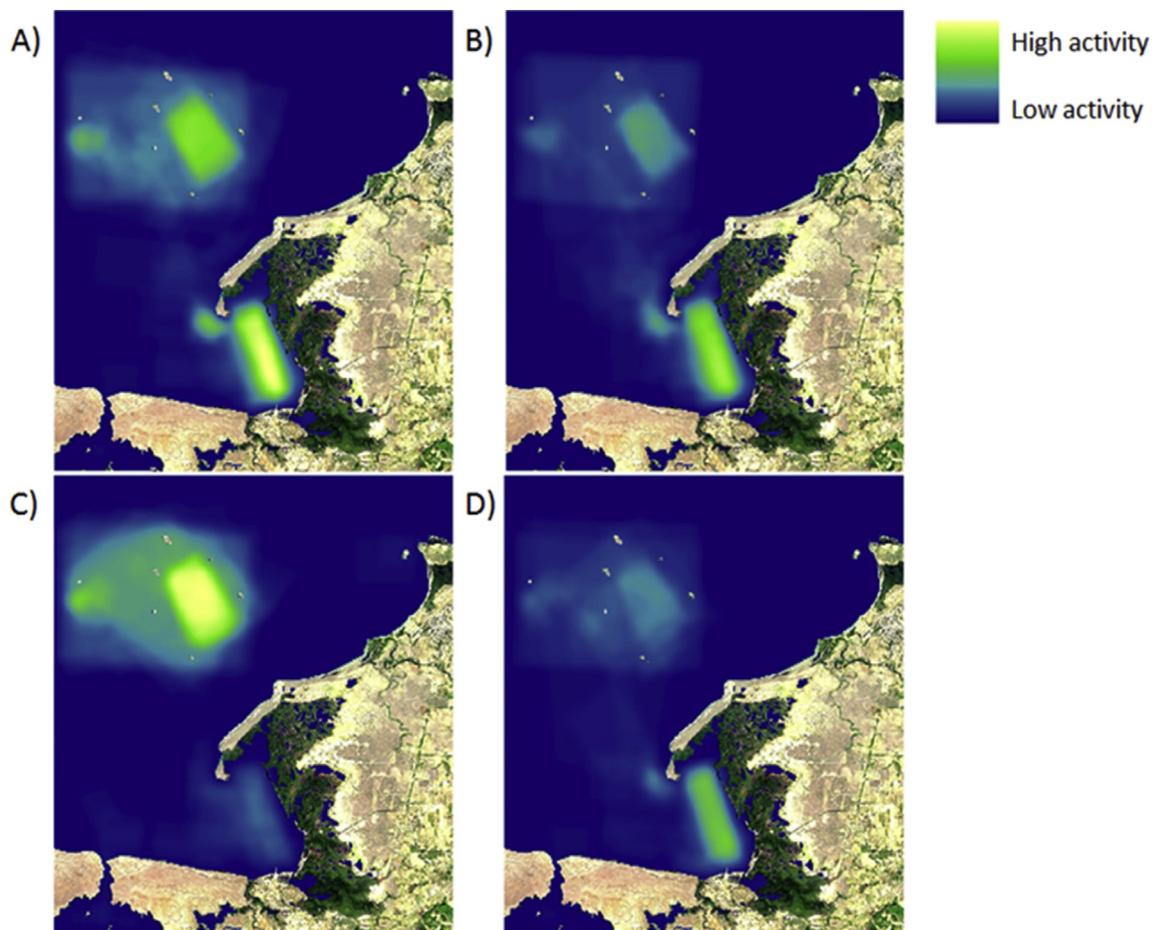


Fig. 4. Distribution of four major gear types over space: A) Handline (171 reports), B) Gill net (151 reports), C) Compressor diving (107 reports), D) Freediving (101 reports). This figure was produced after fishers were asked to outline areas where they currently fish and areas where they fished when they started fishing. In many cases, fishers reported fishing with multiple gear types in the same area. Note that highlighted areas in the figure should be considered approximate locations as reported by fishers.

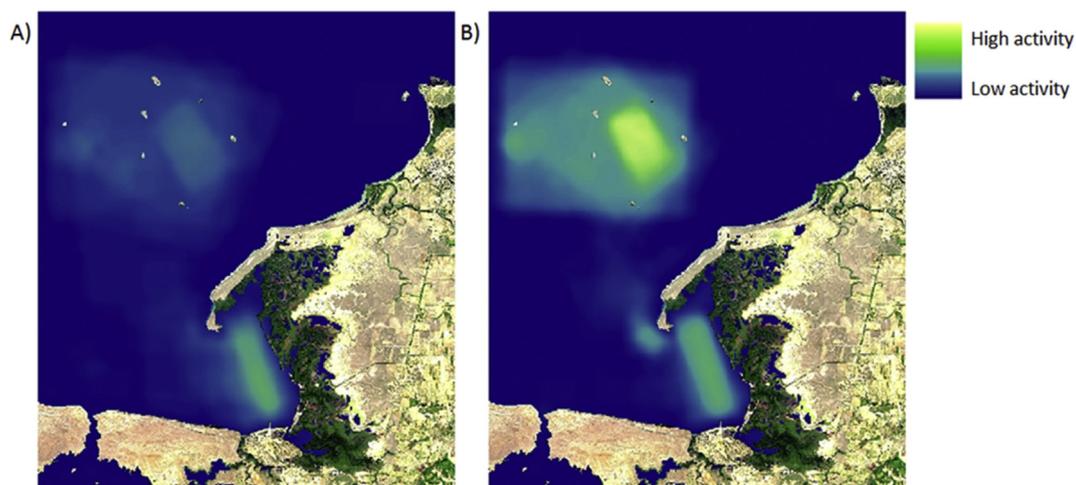


Fig. 5. Change in Fishing Locations: A) **Past** (33 reports in the Cayos; 43 in Manzanillo Bay), B) **Present** (115 reports in the Cayos; 53 in Manzanillo Bay). We can see in this figure that there has been a large increase in the number of people who fish in the Cayos region, and that this has been added to previous activity in the Estero Balsa area, which has remained fairly constant over time. In other words, people reported fishing in more places now than they did in the past.

distribution of years fished is roughly normal, with most fishers (78) starting to fish 10–40 years ago (Fig. 3). Only seven interviewed fishers have been fishing for under ten years and only nine interviewed fishers have been fishing for over forty years.

16 fishers reported fishing abroad in addition to fishing locally. In addition to fishing for income, fishers also reported consuming fish themselves, on average 3.4 times per week. Fishers do not seem to rely on the natural environment for other sources of income (e.g.

Table 2
Change in Fishing Locations and Gear Type Over Time, based on the major gears used and major habitats used: Estero Balsa park, or “Manzanillo Bay”, and the Cayos de Siete Hermanos.

	Past Manzanillo Bay	Present Manzanillo Bay	Past Cayos	Present Cayos	Additional Reports in Cayos
Hand line	26	33	13	53	47
Gill net	17	34	5	38	50
Compressor diving	7	8	11	61	51
Freediving	13	17	6	32	30
Total	64	96	36	190	186

Table 3
Fishers' perceptions of natural resource conditions over time. This table shows the number of respondents who reported on the various conditions of the four main resources in the study area. These were effectively five-value ordinal variables. The final column shows the average value of each variable.

	Much worse (1)	Worse (2)	No change (3)	Better (4)	Much better (5)	Average
Fishery	68	18	0	5	3	1.48
Reefs	38	12	12	17	5	2.27
Seagrass	30	22	7	17	11	2.5
Mangroves	21	14	5	21	32	3.31

agriculture or livestock), but seven fishers reported having work related to the shipping port in town, which is the other primary source of income for community members.

4.2. Fishing, gear and catch

Fishers access several habitat types and use a variety of gears to catch many different species of fish in these habitats (Table 1 and Fig. 4). The use of a gear or fishing strategy has large implications for where a fisher fishes and what they catch. The entirety of the fishery area includes mangrove estuaries, seagrass beds, coral reefs, and open, deep water areas with unknown seafloor structure. Each habitat has an associated suite of targeted fish, with some species occurring in multiple habitats.

The species captured by each gear type has important implications for its ecological impact. Among the many stressors threatening coral reefs is the depletion of herbivorous fish, namely parrotfish, through fishing (Mumby et al., 2006). When reefs do not have robust herbivore communities, they become susceptible to overgrowth of macroalgae and collapse of the coral-dominated ecosystem. In Manzanillo, mostly compressor divers and freedivers reported parrotfish as one of their most commonly caught species, making these gear types the primary drivers of this phenomenon in the Manzanillo fishery. The other targeted species pose less of a concern in terms of undesirable ecosystem or biodiversity impacts. However, none of these species are immune to overfishing, and unregulated harvest could be a problem for any of them.

4.3. Changes over time

The most striking response from the fishermen was an almost universal response to the question, “do you catch more, less, or the same than you did 10 years ago?” 91 fishers responded that they catch less, three said they catch more, and one reported that they catch the same amount. Moreover, 88 of the 91 fishers said that they now “they catch less with the same effort.” Of the fishers who stated that they catch more, two reported using new equipment that enabled this, and one fisher said it was because there were more fish.

Fishers also reported fishing in different locations now than when they began to fish (Fig. 5). Overall fishers reported a total of 127 past fishing sites and a total of 234 present fishing sites. When asked why they switched fishing sites in the case that they did, by far the most common response (42 fishers) was that it was because there were no longer sufficient fish in their previous sites. This change in fishing sites also relates to patterns in the fishing gears that fishers adopted (Table 2). The most common gear strategies ten years ago are still the most common today: line fishing, gills nets, compressor diving, and freediving. Each of these has increased over the last ten years, with most of the increases coming in the Cayos region, as seen in Fig. 5. The only gear that saw a sizable increase in the Estero Balsa area is gill nets.

Fishers also perceive substantial changes in the condition of marine resources (Table 3). The great majority of fishers feel that the fishery is declining. We examined the relationships between these variables and the age of the fisher to see if older or younger fishers had a different perspective of the status of the resources over time, and found no patterns in these relationships.

We asked the fishers to explain their responses to these questions. Before discussing the fishery as the main resource the fishers use, it is noteworthy that many fishers think that the mangroves are improving overall, although a group of fishers expressed concern about Haitians coming into the area to cut trees down for firewood, or for pollution coming into the system from upstream agricultural systems. Those that felt the system was improving (53 fishers), mostly credited this to their own efforts to care for the trees and ensure that they weren't degraded, although they generally did not get more specific than this. These impressions are confirmed by a land cover change analysis that we conducted of the larger Montecristi province, which included the Estero Balsa area (Fig. 6).

Turning to the fishery, several sources of information corroborate fishers' claims that fishery resources have declined. Two ecological assessments conducted by Dominican researchers conclude that fishing has diminished the abundance and frequency of large individuals of commercially pursued species (Lopez and Silva, 2012; Autoridad Nacional de Asuntos Maritimos, 2013). Large-bodied parrotfish species – blue, midnight, and rainbow parrotfish – are no longer encountered while diving nor in fishers' catch (Robinson Jimenez, local dive operator and ANAMAR representative, personal communication). While we do not have records of catch or fish abundance over time, popular and scientific consensus is that there are many fewer fish than there used to be.

Of the fishers that described the fishery as declining, 54 said it was because of fine-mesh nets (beach seines), 32 reported that it was because of fishers from Haiti who illegally enter Dominican waters to fish, and nine mentioned pollution, either in the rivers or in the Cayos de Siete Hermanos. When asked what were the main barriers to confronting these threats to the fishery, 45 fishers mentioned a lack of support from “the authorities”, this referring to the governmental agencies described earlier. Of particular note was La Armada, which was mentioned by name by 23 fishers as a barrier to effective change in the fishery. This is notable as La Armada is the primary marine enforcement body in the area. The specific complaints leveled at this agency were (1) it is mostly not present, but will only appear to enforce rules when it is called; (2) it does not sanction offenders when it does catch them; and (3) most strongly, that it colludes with the Haitians/offenders. Otherwise, nine fishers said they need more support in the form of economic resources, such as fuel for patrols, and eight fishers said that the fault lied with the fishers themselves and their lack of effort/initiative.

The results regarding the status of the fishery are further confirmed the responses of the fishers when asked about the effects that different groups had on their fishery (Table 4). The fishers are universally critical of the fishers from Haiti, and when asked

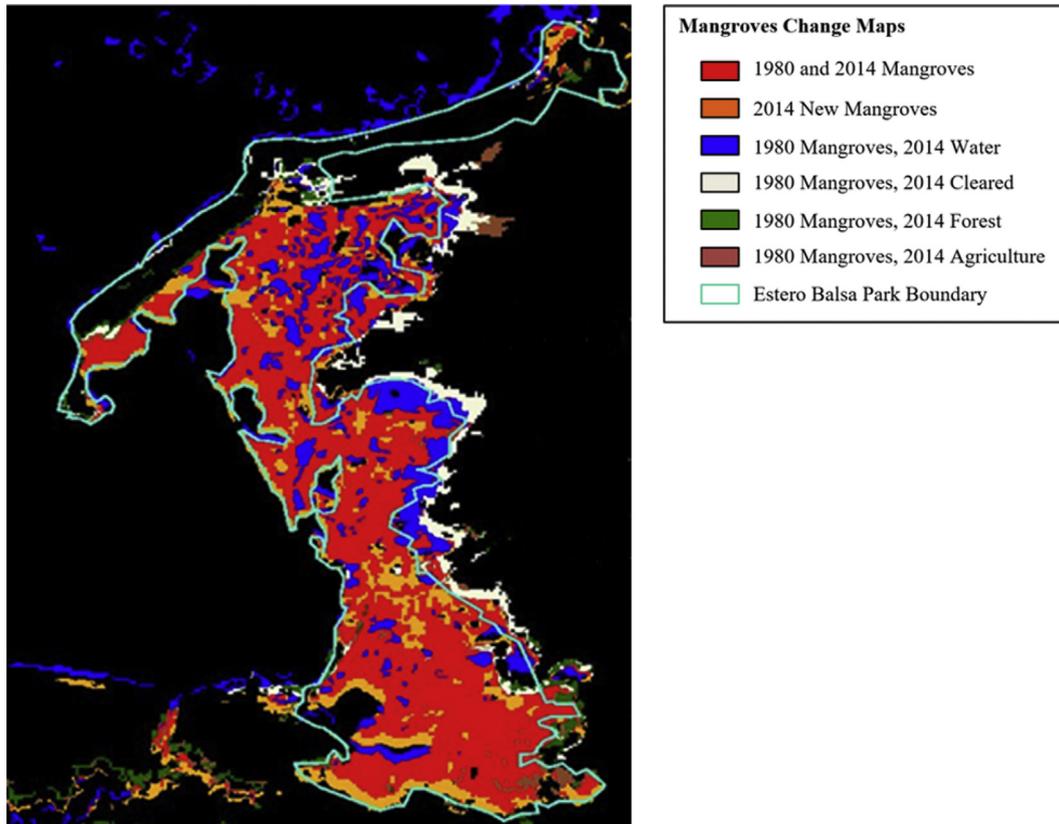


Fig. 6. Land cover change in Estero Balsa Park from 1980 to 2014. Colored areas indicate the presence of mangroves in either 1980 or 2014 or both, while the remaining areas indicate other marine or terrestrial areas. Numerical analysis of figure six shows that, while there has been a slight net loss of mangrove cover from 1980 to 2014, this has mostly occurred because of clearing processes on the landward side of the park, because of factors that are that are out of the fishers' control and probably their perception. The primary factors that seem to have led to such landward clearing are conversion to shrimp ponds and salt ponds (Kauffmann et al., 2014). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

why, their primary concern is that it is the Haitians that are the primary users of the harmful beach seines. The effects of the Manzanillan fishers themselves are more ambiguous. Fishers generally reported that there are more Manzanillan fishing boats and fishers now than there were ten years ago, so local fishing pressure seems to have increased as well.

4.4. Fishing institutions

4.4.1. Agencies

The issue of blaming the Armada for the decline of the fishery leads to the following question: what do the fishers perceive to be the legal responsibilities of the three relevant government agencies? In response to this question we received the following responses. With respect to the Armada, most fishermen (63) thought the Armada's primary role was patrolling the marine area, with 23 specifically mentioning the issue of border protection and the Haitian fishers. When asked about CODOPESCA, (the agency that is in fact in charge of issuing and managing fishing permits)

permits were not mentioned. Instead, the most common response (39) was that fishers simply don't know what CODOPESCA's responsibilities are. Finally, regarding Media Ambiente, the most common response by far (40) was the protection of the mangroves, which is correct.

These accounts are largely confirmed by our team's own strong impression that the governmental agencies have historically been absent from these systems. In our experience, it is seldom that an agency official is seen actively engaging with the fishing sector in Manzanillo or another of the coastal fishing communities in the province.

4.4.2. Local rules, activities and the fishers' association

When we asked each fisher what activities they engage in to prevent deterioration of their fishery resource, the most common response (39) was that they directly or indirectly participate in regular boated patrols of the area, presumably to watch mostly for Haitian fishers. 24 fishers explicitly mentioned working with the association, and many of these indicated that the association organizes many of the patrols (by and large without the participation of government authorities). 14 fishers mentioned informally denouncing those who break rules, while another 12 explicitly reported doing nothing to ameliorate the situation.

The fishers of Manzanillo reported a relatively small number of rules when asked to identify those that affected their fishery. Foremost among these is a prohibition on fishing with beach seines, which was reported by 80 fishers. 81 fishers also reported on the presence of a closed season for turtles. Interestingly, (and

Table 4

Fisher perceptions of effects of various groups on the fishery.

	Negative effects	Neutral effects	Negative and positive effects	Positive effects
Manzanillan fishers	1	9	47	37
Other Dominican fishers	17	8	65	4
Haitian fishers	92	1	1	0

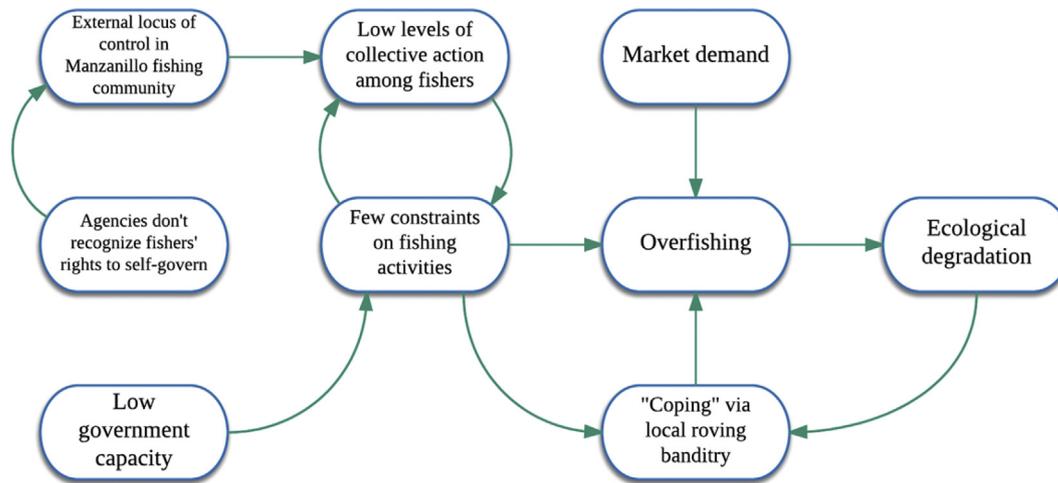


Fig. 7. Summary of hypotheses. Governmental agencies don't recognize Manzanillian fishers' rights to govern their own fishery, while lacking a capacity to govern the fishery themselves. This disincentives the fishers from cooperating with each other to enact and enforce their own constraints on fishing behavior. An absence of such institutional constraints has a self-reinforcing relationship with low levels of collective action, making it hard switch the system into a more cooperative state. These dynamics, when combined with strong market demand for fish, lead to overfishing and ecological decline. Finally, fishers cope with such declines in part by moving to additional resources, which is enabled by the lack of fishing constraints, and which in turn exacerbates overfishing over time.

unsurprisingly since the fishers do not have fishing permits) none of the fishers mentioned needing a permit to fish (issued by CODOPESCA), or anything else that might serve as a barrier to entry and limit the number of fishers who can access the resource, although they clearly view the Haitian fishers as illegitimately doing so. Additionally, the fishers did not mention other important gear-based restrictions that CODOPESCA is formally charged to implement (such as a prohibition on using compressors that are known to be particularly ecologically damaging if used in excess). So while we could not characterize the governance and property rights system here as being entirely open access, it seems dangerously close to this, with very few rules dictating who is allowed to fish and how they may do so.

5. Discussion and conclusions

The Manzanillo fishery governance system is not a totally chaotic regime—both the Armada and the fishers' association engage in patrols. And there is a notable gear-based rule that prohibits beach seines. In our discussions with Manzanillo fishers, we encountered several important leaders who clearly are trying to change the current situation, and the fishers' association represents significant local governance.

Still, much of the fundamental challenges of fisheries governance are not being met in this case. Here we suggest two primary reasons for this, one we call the “locus of control” hypothesis, and the other we call the “local roving bandit” hypothesis. In the following discussion we also relate each of these hypotheses to several of *Ostrom's (1990)* design principles for community-based natural resource management to explain our current understanding of the Manzanillo fishery. Our argument is summarized in Fig. 7.

5.1. Locus of control

Research on “locus of control” may suggest that the lack of effective governance could be due to the placement of authority with governmental agencies rather than the fishers themselves. The term is based on its use in the field of psychology on the determinants of personal motivation (*Ajzen, 2002*). This literature distinguishes “internal” loci from “external” loci of control based on

where the control of, and therefore responsibility for, outcomes is seen to reside. Applying this concept to our setting, we hypothesize that Manzanillo fishers may have developed an external locus of control, believing that much of what affects outcomes for their fishery is beyond their own control. This could also be expressed as the fishers lacking a sense of their own agency (*McLaughlin and Dietz, 2008*). Borrowing from the literature from self-determination theory, we hypothesize that some of the “autonomous motivation” of the fishers to set up their own rules and enforce them has been diminished by the disempowerment inherent in the locus of control residing in formal authorities (*Deci and Ryan, 2000; Gagné and Deci, 2005; Rode et al., 2015; Marshall et al., 2017*).

There are very few rules that govern the Manzanillo fisheries, and while there is some type of enforcement in the form of the patrols, it appears that many fishers do not feel comfortable sanctioning offenders beyond verbally denouncing them. There are anecdotes of Manzanillo fishers confiscating Haitian boats and gear, but for the most part there is a sense that sanctioning must primarily be done by the Armada, and several fishers reported that their main role in governance was reporting infractions to this agency. If nothing else, this enforcement mechanism that requires the government be called in to implement enforcement is costly in comparison to one that could empower fishers to engage in more enforcement activities themselves. Moreover, the subsequent sanctioning process is almost entirely non-transparent from the perspective of the Manzanillo fishers, with several accusing the Armada of taking bribes from the (usually Haitian) offenders.

This isn't to say that there should not be an enforcement role for governmental agencies, but in effective systems this role has tended to be in resolving intractable conflicts or repeated offenses that cannot easily be sorted out by resource users themselves (*Ostrom, 1990*). Transparent, low cost enforcement (monitoring, sanctioning, and conflict resolution) is somewhat of a holy grail for natural resource governance, and the current set-up of authority in this system seems far from ideal in its ability to minimize these costs or maximize this transparency.

In the context of work on the commons, this situation represents a violation of the seventh of *Ostrom's (1990)* seminal design principles for successful community-based natural resource management. This principle states that “the rights of appropriators to

devise their own institutions are not challenged by “external governmental authorities.” In this case these rights do seem to be challenged.

This may be a worst-case scenario in the case of the government's role, in which it may be preventing the fishers' from developing their own institutions, thus creating a governance gap that itself is not filling with its own action. This is not an altogether uncommon scenario, as [Finkbeiner and Basurto \(2015\)](#) have noted, “fisheries agencies in developing countries often lack the monetary, personnel, and political resources for adequate implementation and enforcement ... pointing to the inadequacy of centralized approaches to ... governance and to the need of more involvement of local stakeholders.” Informal interviews we conducted with several agency officials confirm the impression that the agencies, particularly CODOPESCA, may not historically had the resources to act as reliable partners in coastal governance in this system.

Furthermore, this situation enables the fishers to hold the government and the Haitian fishers responsible for problems that local fishers are also playing at least some part in creating. With respect to the Haitians, their presence in the system represents a violation of the first of Ostrom's principles (also [Cox et al., 2010](#)), which states that the boundaries of a user group must be established to motivate users to act collectively and protect a resource. Cultural multilevel selection theory ([Waring et al., 2015](#)) would predict that the Haitian incursions into areas the Manzanillans consider to be their own would motivate them to respond by acting collectively to defend their group-level interests. That they are apparently not doing this sufficiently can also be hypothesized to result from the unhelpful position the government has taken in this case.

5.2. Local roving banditry

The “local roving bandit” hypothesis is based on arguments by [Berkes et al. \(2006\)](#) in their discussion of global roving banditry in the fisheries sector. Our argument shares their concern about the technologically-enabled mobility of natural resource users, which results in the sequential deterioration of the resources they use. The dynamic we see in Manzanillo seems to be one in which resource users, rather than confronting the politically thorny and individually costly process of limiting resource use via rule development and enforcement, have expanded their range of resource use activities ([Fig. 5](#)). This delays the feedback they would otherwise be provided by the diminishing stocks in their historical fishing sites, which would in turn provide clearer incentives to conserve the resource. While most Manzanillan fishers are not currently fishing abroad, this may become the next logical step for some of them as a reaction to the potential depletion of the fishery in the Cayos area.

[Berkes et al. \(2006, 1557\)](#) also argue that the resource degradation occurs because “new markets can develop so rapidly that the speed of resource exploitation often overwhelms the ability of local institutions to respond.” Considering the role that markets in fish play in our case, we know that much of the resource extraction that is occurring is going to meet market demand. Essentially all of the fishers we talked to sell to a local fish buyer, or pescaderia, and they sell the majority of the fish they catch rather than consuming them for subsistence. A particularly tricky aspect of fish markets here is that some fish are sold to Haitian markets via Dajabón, a nearby border city. There is apparently a greater demand for smaller fish in Haiti, which the Haitians themselves are accused of catching is a well, with negative ecological consequences. So it is true that market dynamics here have outstripped institutional capacity to respond to the demand they place on natural resources.

A third element in the roving bandit story is a lack of an “attachment to place” on the part of the roving bandits, which lessens their incentive to conserve local resources. While we didn't

specifically measure the concept of “attachment to place” in our questionnaire, we have several reasons to infer some aspect of this in the fishers. First, the overwhelming majority of the fishers are from the town of Manzanillo or nearby towns. Second, the great majority of them have spent several decades fishing in the area. And third, in their descriptions of the conservation of the mangroves, several fishers implied that there was a conservation ethic of sorts behind the preservation of this resource. Each of these at least imply an attachment to place on the part of the fishers. So this part of the roving bandit story does not fit our case.

Finally, an alternative interpretation of this situation is that the behavior of the fishers is in fact adaptive, in that the fishers are demonstrating flexibility in availing themselves of alternative resources. This interpretation partly relies on the basic value of diversity in conferring resilience to disturbance. Moreover, in the pastoral sector, seasonal fluctuations in resource use, enabled by some degree of mobility, have been frequently argued to be critically important as encapsulated by the concept of “transhumance” ([Niamir-Fuller, 1998](#)). While some of this reflects seasonal fluctuations in resource availability, some of the adaptive behaviors of pastoralist reflect longer-term trends that would be more comparable to the situation in Manzanillo.

Overall, however, we find this alternative less compelling than the roving bandit interpretation, mostly because the fishers can only be seen to be adapting in the short term. In the long run they have not lessened their fishing pressure in the areas closer to shore as they have extended their activities offshore. So they are not alternating between different resources, allowing one to recover as they turn to another. And there are not additional areas they could move to if and when they degrade the Cayos fishery, other than fishing abroad. Meanwhile they experience the fishery to be declining but are not implementing strong controls on fishing pressure. As such we conclude that the Manzanillan fishers are “coping” with, rather than adapting to, increased resource scarcity ([Berman et al., 2012](#)).

5.3. Conclusions

In the future the situation we have just described may change, given that management plans for the MPAs in the area will supposedly be put into force in the coming years. Ideally this would help implement Ostrom's eighth and final principle, which requires that, in complex systems, there exist multiple levels of coordinated governance. This in turn relates to an extensive literature on the benefits of co-management between governments and resource user groups in fisheries systems and other commons settings (e.g. [Pomeroy et al., 2001](#) [Finkbeiner and Basurto, 2015](#)).

But the news here is not wholly encouraging, as the official language describing these MPAs explicitly refers to the upcoming “management”, as opposed to “co-management”, regime. In other parts of the world there has been long-standing conflicts between traditional fisheries and MPAs ([de Freitas et al., 2017](#)). We would also refer to [Jentoft \(2000\)](#) here, who argues that governmental schemes to manage fisheries have often diminished the role of fishing communities in self-fulfilling ways as natural resource users internalize the norms implied by the management regime (e.g. that they are involved in a zero-sum game with each other). This could take place both within the Dominican fishing communities, but across the international border, as it is unclear how the new MPA rules will affect the Haitians and how these fishers will respond.

What is needed here, we would argue, is that aspect of co-management that [Jentoft \(2000, 57\)](#) highlights:

“Of particular interest in this context is that co-management is supposed to strengthen, or if lost, restore social integration

among users and within and among local communities. Thereby, co-management will establish a basic condition for a management system, functioning not only top-down but also bottom-up in a dialectic process.”

Related to this argument is the importance of the legitimacy of the upcoming management system. Currently there is a level of discontent among fishers in several of the fishing villages with respect to the upcoming regulations, particularly with respect to a series of zones that will be put in place, several of which will be no-take zones. If such rules are not perceived to be legitimate, fishers are unlikely to comply with them and the system will not be effective. Brewer (2012) expresses several concerns that can arise with the use of such zones:

“Prioritization of boundary clarity without deliberation among prospective and marginal resource beneficiaries might help sustain a target resource per se but simultaneously encourage narrower distribution of resource benefits among a smaller collectivity and shift social dynamics and ecological incentives toward less equitable outcomes.”

Further governmental engagement and presence in the communities will likely help this. More specifically, we believe that a function the government could take would be to produce ecological knowledge on the state of the fishery, to better document its likely decline. This has been an important role of government in both the fisheries sector (Pinkerton and John, 2008) as other natural resource sectors (Cody et al., 2015). Ideally this approach would be complemented by a continued engagement with the fishers' own perceptions of their resources, building on the analysis conducted in this paper (Bennett, 2016).

These final observations point to a need for future research to engage more formally with officials from the three Dominican agencies, to understand their own incentive structures and perspectives, as well as with the Haitian fishers to understand their own traditions and incentives that affect their own fishing activities. To many of the Manzanillan fishers, each of these groups is seen as actively antagonizing internal efforts to sustainably manage and use their resource. But these groups' perspectives are likely to be different, and ultimately the story we tell here is incomplete in this way until we expand our work to better understand their own incentives and cultural and economic motivations. In the future we hope to expand this research and practical work across the border in collaboration with Haitian organizations with which we have already begun to discuss such activities. Hopefully a cross-border research project could also help promote a cross-border approach to marine governance.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.ocecoaman.2017.06.018>.

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