Community responses to Marine Protected Areas in the context of Social-Ecological-Systems in the Gulf of California, Mexico

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December 13th 2013

Introduction

Protected areas remain as one of the most popular tools for the conservation and management of natural resources in both terrestrial and marine ecosystems. The goal of these spatial closures is to regulate human use by restricting and/or prohibiting the harvesting of natural resources in such areas. In the case of marine systems, extensive research has been conducted on MPA design strategies, measures of success, and the benefits of marine protected areas for the recovery of vulnerable species, habitats, and ecological processes (Gaines et al. 2010). This has been well illustrated in case studies where the establishment of the reserves and subsequent enforcement of regulations within has met some level of success that has also allowed the adequate ecological assessments to confirm MPA efficacy. MPAs are known to provide benefits in terms of enhancing fish stock abundances, populations growing to larger sizes, populations attaining broader age and size distributions, spillover effects of increased abundances outside the reserve boundaries, and increased species diversity (Gaines et al. 2010; Lester et al. 2009). The popularity of MPAs as conservation tools is such that international efforts, such as the Convention of Biological Diversity, have called for the protection of at least 10% of the world's marine and coastal areas through the establishment of networks of MPAs by the year 2020 (CBD 2010).

However, risks have been identified with the urgency to establish MPAs without the adequate resources, governance structure, or institutional conditions. For instance, mere establishment of MPAs without the proper design, management, or enforcement tools may give a false sense of security that such MPAs will be enough to sustain marine resources (Rife et al. 2012). It is often the case that a decreed MPA is met with obstacles to accomplish its original objectives, which renders the closure to a mere "paper park" that fails to effectively restrict access and exploitation and thus do not contribute to the recovery of the protected resource (White and Courtney 2004). Some of the most obvious reasons for such frequent failures include lack of enforcement capabilities leading to disregarding of established rules and regulations, insufficient funds towards monitoring and enforcement, non-compliance and disapproval among the community members affected by the closure, and potential vulnerabilities of MPAs to external shocks. Furthermore, even though the social and economic benefits of MPAs have been recognized to improve community well-being via increased income from fisheries or tourism (Gaines et al. 2010), not much research has been done on the conditions of the governance structures that allow successful implementation of MPAs and their effects on the resilience of these coupled social-ecological systems (Cudney-Bueno et al. 2009).

The Gulf of California (GOC), also known as Sea of Cortez, in Mexico, is a great example of a region that well represents the issues raised here. Despite having received a great deal of attention from international and national private foundations, governmental and non-governmental (NGOs) organizations, and academics and universities over the past 20 years as a region where conservation and resource management efforts are badly needed, the measurable

outcomes of such efforts, both in terms of marine resource sustainability and socio-economic well being, still leave much to be desired.

The present study makes use of the frameworks proposed by Ostrom (2007; 2009; 2011), Anderies et al. (2004), and Anderies & Janssen (2013), to decompose the broad social-ecological system of the Gulf of California into its components and to begin a comparative analysis of two case studies in which the establishment of an MPA has been linked in some way to the communities affected by it. The next section explains the overall context of the GOC and the questions that arise for resource managers, followed by a description of the attributes in common as well as a comparison of the most striking differences between the two case studies. The overall goal is, by identifying the most important shocks and vulnerabilities of the system in each case study, to better understand what exactly drives the constant resistance to not only the establishment of resource management tools like MPAs but also the subsequent compliance with the regulations in place once an MPA has been established, particularly for a system like the GOC.

The Gulf of California as a case study

Spanning 34,000 ha of semi-enclosed ocean, the GOC is globally recognized as a hotspot for biodiversity and a priority area for conservation with multiple RAMSAR sites, and was recognized as a UNESCO World Heritage Site in 2005 (CONABIO et al. 2007). It harbors unique habitats such as deep ocean basins, steep slopes, geothermal vents, numerous islands, mangroves, coastal lagoons, rocky and sandy shores, coral and rocky reefs, seagrass beds, bays, and estuaries (Ulloa *et a*l. 2007). The high richness in biodiversity is mostly due to the remarkably wide range of habitats, temperate latitude, complex oceanography that includes tidal currents, sea surface temperature variations, and constant tidal and wind-driven as well as seasonal upwelling systems (Ulloa et al. 2007).

Furthermore, the GOC's year-round high productivity makes it a region of extremely high economic importance for Mexico. It produces approximately 50% of the landings and 70% of the value of national fisheries in Mexico (Carvajal et al. 2004; Ulloa et al. 2007). Both large and small-scale commercial fishing constitute the predominant economic activities in the region, with the small-scale fishery sector being operated by 50,000 fishers and 250,000 boats, while the large-scale, industrial fishery sector is comprised by 10,000 fishers and 1,300 boats (Cisneros-Mata. 2010). The commercial activity of these fisheries dates back to the 1920-1930s, but the small-scale fishery sector has grown dramatically to become a high-impact harvest activity in the past 50 years (Bahre et al. 2004; Cudney-Bueno 2000; Saenz-Arroyo et al. 2005; Saenz-Arroyo et al. 2006). This sector has also become increasingly multi-specific as there is an enormous diversity of fishery resources, with at least 80 importantly commercial species being targeted (Moreno-Baez et al. 2012). These species range from ray-finned fish (e.g. leopard grouper, yellow snapper, spotted sand bass), to cartilaginous fish (e.g., hammerhead shark and diamond stingray), to arthropods (e.g., swimming crab, blue shrimp, and spiny lobster), to mollusks (e.g., octopus and rock scallop), to echinoderms (e.g. sea cucumber). Most fishers economically depend on the resource year-round, and much of the catch is exported to U.S. and Asian markets. All fished with 4 main different methods: diving, gillnets, longline, traps, hand fishing line. Under the present harvesting levels and lack of strict regulation, it is not uncommon for an appropriation of the resources to allow the resource to be locally overharvested at any given time. Eventually, a specific resource (i.e. a species or group of species) becomes locally

depleted, and the users simply switch to another one (Jorge Torre, pers. comm.). Regardless, the general perception among fishers is that catches keep declining overtime.

For the last 20 years, the GOC has been receiving international recognition and plenty of resources from private foundations, approximately 50 conservation-oriented national and international NGOs, and governmental institutions (Rife et al. 2012). These institutions have carried out conservation initiatives, biological monitoring programs, data collection programs, workshops, and region-wide priorizations of conservation sites that select areas of most biological importance and conservation concern for the purpose of servings as guidelines to where conservation action should take place. There have been more than 400 peer-reviewed publications and 50 books on conservation-related topics in the GOC (Rife et al. 2012). The GOC has seen seven marine planning exercises in the last ten years, which have lead to multiple conservation plans that identify the more or less the same general priority areas on a coarse scale, but identify important differences among them on a finer scale (Alvarez-Romero et al. 2013). The region has begun to be viewed as one with an over-priorization problem, and an overflow of resources and time that have been granted for conservation (Jorge Torre, pers. comm.). However, when it comes to actual, measurable outcomes in which the already identified priority conservation sites are set aside for total protection or strict regulation, or in which the already established regulations remain strong to allow user compliance, resource management efforts are met with little success. As of 2012, the GOC has 10 existing multi-use MPAs covering 23,304 km^2 (9% of the total marine area) (Rife et al. 2012). Nonetheless, they have generally been unsuccessful in meeting either their fisheries or conservation objectives. In general, enforcement is low throughout the region. For instance, in the Northern Gulf of California alone, evidence has been found that at least ten communities utilize 79% of the total area established for MPA year-round (Moreno-Baez et al. 2012). Furthermore, it is perceived that often times implementation of an MPA happens in response to different sociopolitical contexts and/or pressing environmental issues, (i.e., mainly opportunistic). An unfortunate consequence is that foundations seem to be tired of pouring money for conservation and resource management efforts in the GOC because very few concrete actions come to fruition (Walton Foundation, pers. comm.).

Two broad questions arise from the current situation in the GOC:

1) What exactly is driving the constant resistance to the implementation of harvest-regulation policy tools like MPAs?
    - In other words, what should conservation efforts be sensitive to? The right political time? Ineptitude? Corruption? Fear of social conflict?
2) What exactly is driving the constant resistance to compliance with current MPA regulations/enforcement

Applied robustness analysis for the Social-Ecological-System of the GOC

The present study focuses on two case studies of two of the largest fishing communities in the GOC: a) the community of Puerto Peñasco (PP) and its community-based efforts to establish a network of no-take MPAs; and b) the community of Bahia de Kino (BKI) and its involvement in the federal initiative to re-categorize the Island of San Pedro Mártir as a wholesome biosphere reserve including a marine MPA. These two case studies were described by Cudney-Bueno et al. (2009) in detail, but complemented in the present study with other works that include structured interviews with community members and fishers. In order to carry out a more thorough analysis, I decomposed each case study into its separable components according to both the Social-Ecological-Systems (SES) framework proposed by Ostrom (2007; 2009) and

the Applied Robustness Framework proposed by Anderies et al. (2004), and elaborated on the shared insights from looking at both case studies under the light of both frameworks. The first step consisted in following the nested multi-tier framework from the SES framework to identify the main attributes of the four high-tier variables: the Resource System, the Resource Units, the Governance System, and the Users (Ostrom 2007). This provided a nice, methodological, more systematic articulation of the elements in the framework that allowed the careful characterization of each case study by identifying the multiple second-tier variables that were most relevant to each system or to both (Figure 1). These variables were then related to the components of the Robustness Framework, which emphasized the structure among the relationships between the across and the infrastructure in order to identify where the vulnerabilities lied and how these relationships would enable the SES to cope with shocks (Anderies & Janssen 2013) (Figure 2).

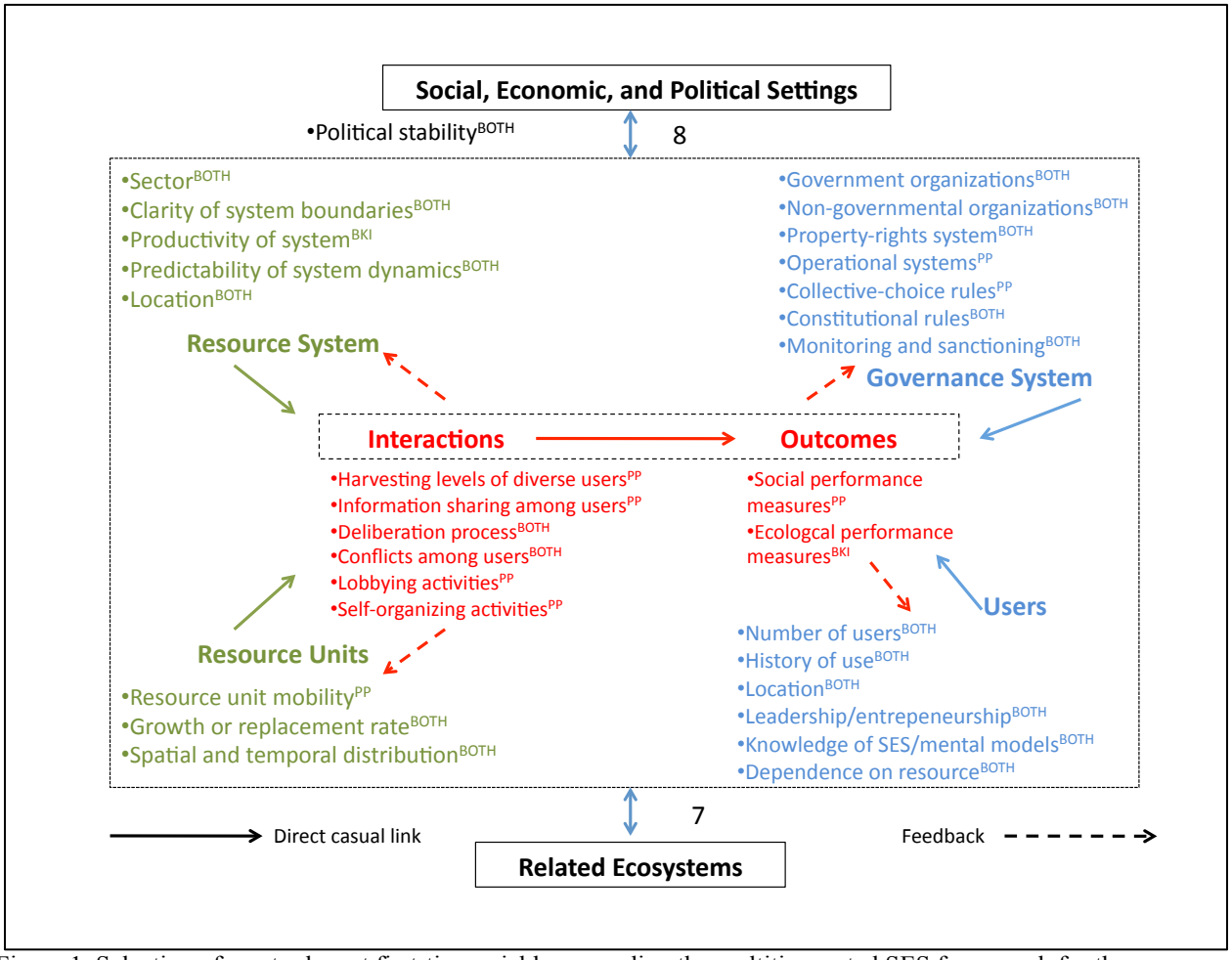

Figure 1. Selection of most relevant first-tier variables according the multitier nested SES framework for the communities of Puerto Peñasco (PP) and Bahia de Kino (BKI). Superscripts indicate whether the variable is of relevance to either community or to both. Following Ostrom 2007, 2009; and Anderies & Janssen 2013.

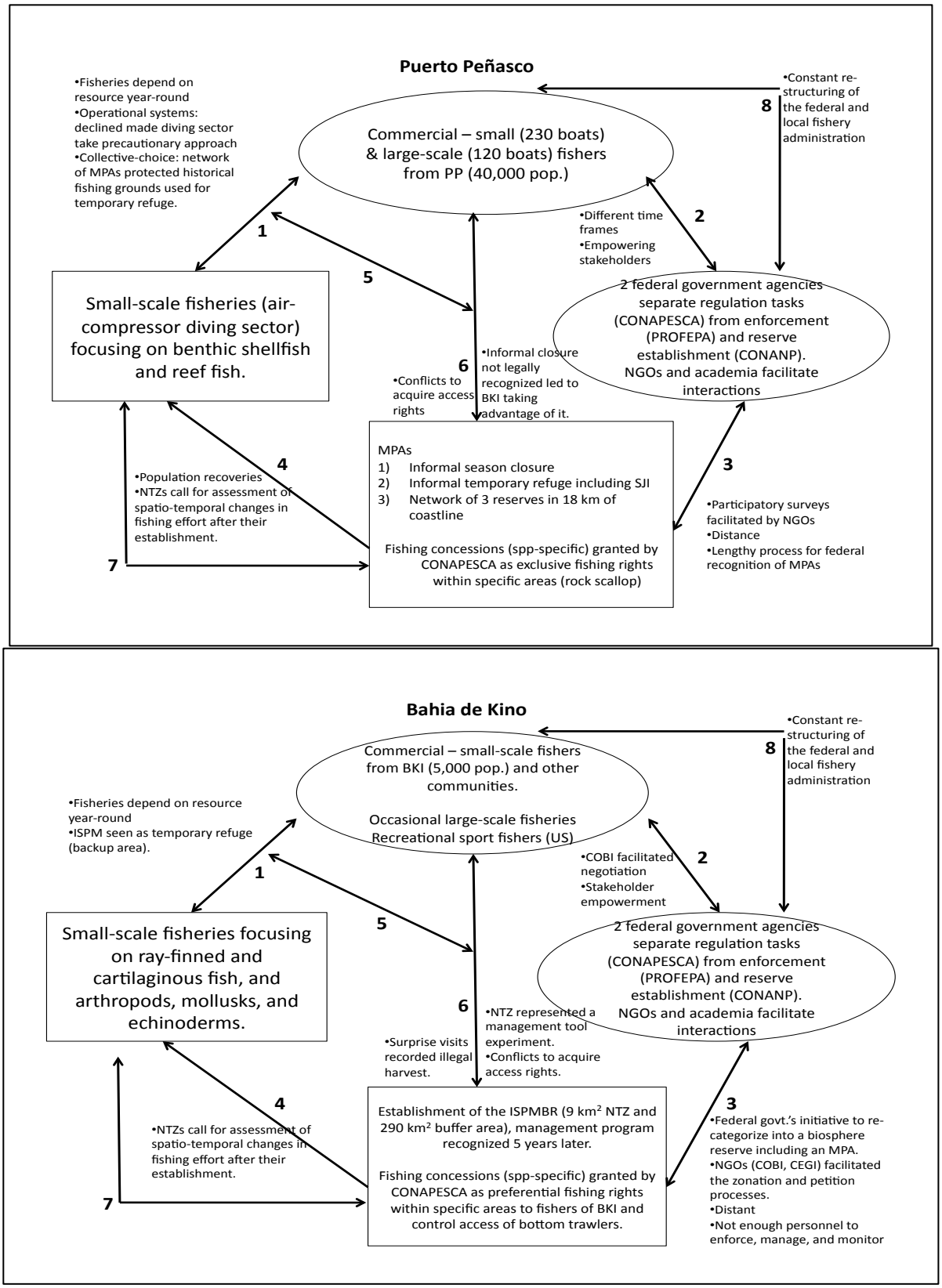

Figure 2. Top: System representation for Puerto Peñasco (PP); Bottom: System representation for Bahia de Kino (BKI). Rectangles represent infrastructure and ovals represent actos. Following Anderies et al. 2004.

General characteristics of both Social-Ecological-Systems

As it is the case for most communities harvesting fishery resources in the GOC, the main activity relates to small-scale fisheries and both communities heavily depend on harvesting the resources year-round. In terms of the resources being harvested, the community of Puerto Peñasco depends more heavily on benthic (bottom-dwelling) organisms that are mostly stationary, whereas the community of Bahia de Kino takes advantage of reef fish as well, including ray-finned fish (e.g. leopard grouper, yellow snapper, spotted sand bass), cartilaginous fish (e.g., hammerhead shark and diamond stingray), arthropods (e.g., swimming crab, blue shrimp, and spiny lobster), mollusks (e.g., octopus and rock scallop), and echinoderms (e.g. sea cucumber). As already mentioned, local over-harvesting of a given resource is not uncommon given the wide range of resources available at any given time. It is simply a matter of changing gear and fishing location.

In terms of the public infrastructure providers, Cinti et al. (2010) describes in extensive detail the government organization of fisheries regulation in Mexico and the perceptions of small-scale fisheries to it (Figure 3 here, see Figure 4 in Cinti et al. 2010). All marine fisheries regulation is shared by two federal agencies: SEMARNAT (Secretary of the Environment and Natural Resources), and SAGARPA (Federal Agency for the Protection of the Environment). SEMARNAT is the agency in charge of regulating species listed only under 'special protection'. It also houses the enforcement body called PROFEPA (Federal Agency for the Protection of the Environment). SAGARPA houses the National Fisheries Commission (CONAPESCA), which is in charge of enforcing regulations that fall under SAGARPA's jurisdiction, issuing licenses for fishing in the form of permits, concessions, or authorizations. The Navy is allowed to provide enforcement aid if needed to both CONAPESCA and PROFEPA. SAGARPA also houses a National Commission of Natural Protected Areas (CONANP), which is in charge of the establishment and management of MPAs.

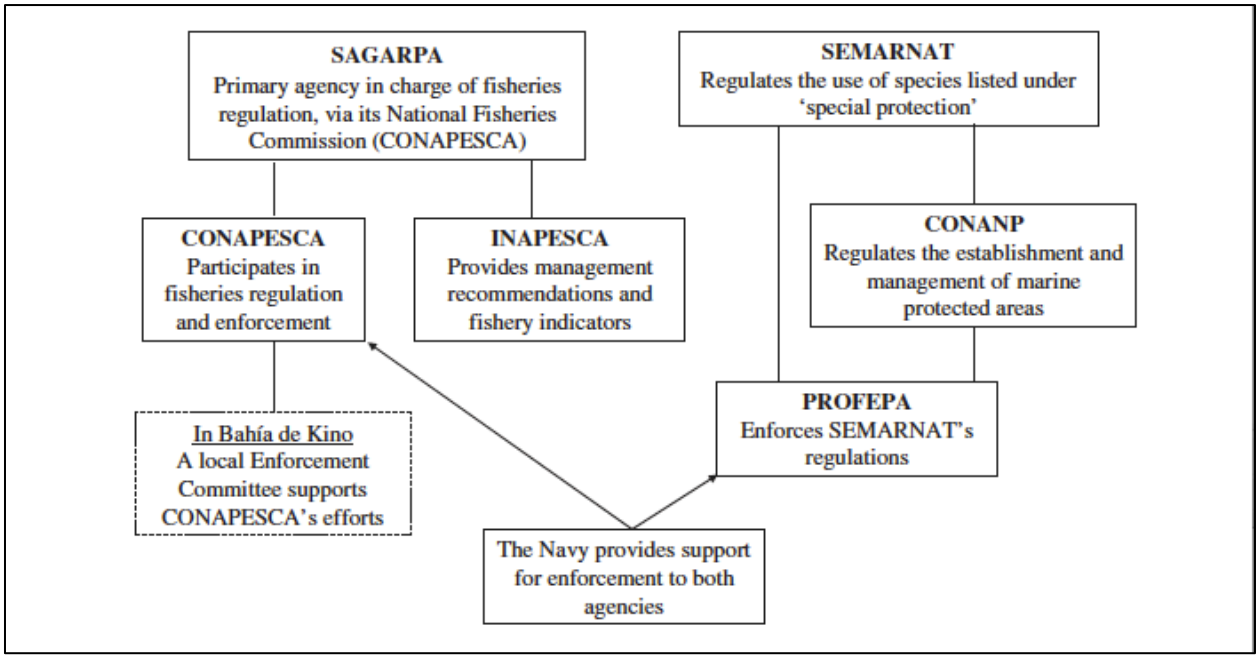

Figure 3. Federal agencies involved in fisheries regulation in Mexico and their main attributes as they relate to fisheries management (Cinti et al. 2010, Figure 4).

As already mentioned, the GOC receives attention from multiple NGOs and academic institutions that heavily participate in conservation and resource management efforts apart from government organizations. These include NGOs like Comunidad y Biodiversidad (COBI, A.C.), GECI (Grupo de Ecologia y Conservacion de las Islas), and CEDO (Centro Intercultural de Estudios de Desiertos y Oceanos), with the help from academic institutions such as Prescott College Center for Cultural and Ecological Studies and the University of Arizona. These institutions (via Link 2) have played an important role in empowering stakeholders, facilitated obtaining funds for monitoring as well as designing monitoring techniques, trained divers for ecological data acquisition, and all while also producing data and proposals with scientific backup that can help bridge and validate fisher's local ecological knowledge and actions with policy actions at the higher local and federal government entities (Cudney-Bueno et al. 2009).

Case-specific characteristics

In terms of the resource users, the number varies between the communities (Figure 2), but in both cases they depend on the fisheries year-round. In the case of Puerto Peñasco, Link 1 was strengthened by the hookah (air compressor) diving sector's decision at the operational level to take a more precautionary behavior given the evident decline in availability of benthic resources, specially the black murex snail (Cudney-Bueno et al. 2009). At the collective-choice level, they also decided to establish an informal network of 3 reserves around historical fishing grounds that had been treated as temporary refuge. In the case of Bahia de Kino, the area where the MPA was established had also been historically considered a temporary refuge because of its distant location and it was considered a backup area. However, even though the community did have a say in the zoning process, the decision to expand the terrestrial reserve into a biosphere reserve that would include the MPA did not come from within the community, but from the federal government itself (Link 3).

Shocks and vulnerabilities of the system

According to the records held by CONANP, the costs required for the maintenance of MPAs have been shown to be proportional to the size of the MPA (Rife et al. 2012). Based on this, a comparison of actual average annual budgets for MPAs per unit area in the GOC with the theoretical cost of running an MPA revealed that the actual budgets are very close to the theoretical ones (Rife et al. 2012). Therefore, it doesn't seem likely that underbudgeting is the only cause for which CONANP and PROFEPA fail to enforce MPA regulations in the GOC.

The second-tier variables relating to the location of the resource system and of the users are also likely to represent complications in terms of monitoring and sanctioning. In both case studies, one of the most productive areas for the communities constitutes an island 30 km (SJI for PP) to 60 km (ISPM for BKI) offshore, which is a relatively distant fishing ground. Given the concerns already mentioned with respect to enforcement capabilities, this can lead to a weakening of Link 3 as it gives way to mistrust among the resource users in terms of whether the area is being poached in or not. The distance from shore also makes monitoring difficult, which increases transaction costs associated with enforcement (Cudney-Bueno et al. 2009).

In the case of public external social, economic, or political shocks, because of the complicated institutional network in charge of regulating access to fishery resources, any unanticipated socio-political disturbance (via Link 8) can throw the system off balance. For instance, with changes in the Presidential Administration in 2000, there was constant re-structuring of both the federal (going from a Secretariat to a Commission) and local fisheries

administration (change of directorship that brought personnel from outside the region who were unaware of existing local institutional arrangements in the community of PP, and thus were less supportive of the fishers' management initiatives). Problems that followed included budget reductions, confusion as to which agency was held accountable, and basic inefficiencies in the bureaucratic processes (Cudney-Bueno et al. 2009).

Another serious vulnerability is the distinctive time lag between community initiatives and federal action. Community initiatives operate on very different time frames than those of the government, and a slow response might actually lead the community to stop believing in the seriousness of the federal government to address their concerns and suggestions. In the case of Bahia de Kino, the formal recognition of the new biosphere reserve took over 2 years to be published in the Federal Register, even though this was a federal initiative. Furthermore, the official management program for the reserve was not authorized nor published until 2007, almost 5 years after the MPA was formally established, which prevented many of the regulations to be properly enforced during that time. This time lag represents a weakening of Link 3 that in turn can weaken Link 2 as well as Link 6 in a positive feedback than can quickly lead to local overharvesting of the resources and a deterioration of the trust relationships between resource users and government public infrastructure providers. For instance, in the case of Puerto Peñasco, information traveled quickly on the informal refuge the diving sector had set up in San Jorge Island (SJI) which led divers from the community of Bahia de Kino (600 km south by road and 8h away by boat) to take advantage and harvest rock scallops. Given the weakness in Link 3 with respect to federal recognition of the reserves and the quick spread of the word on harvest refuges, divers from Puerto Peñasco also headed to the island in frenzy to harvest as many rock scallops as possible and collectively fish on the island before others would continue free-riding on their efforts. (Cudney-Bueno et al. 2009).

Conclusion

The questions asked here are of relevance to on-going conservation efforts in the GOC, particularly in the Midriff Islands Region (MIR). As part of a 5-year *Strategic Plan for Conservation and Sustainable Management*, the National Commission of Natural Protected Areas (CONANP) in conjunction with NGOs like Comunidad y Biodiversidad (COBI) and Pronatura (PNO) have been commission to initiate the process of establishment of a network of no-take zones in the MRI region to restrict access to industrial, artisanal, and recreational fisheries with the aim of allowing the recovery of overexploited sites as well as sites of high productivity and biodiversity in the region. However, the general perception among these institutions is that these types of conservation efforts have reached a plateau in which they are likely to hear the same story over and over again. In other words, they know what to expect in terms of the implementation process, but they unsure how to increase the likelihood of success.

Natural resource managers who have been working in the GOC hypothesize that people are likely to do nothing with respect to their resources being overharvested until they see a clear crisis at their doorstep. This begs the question on whether new approaches can be used to better understand the underlying causes for community discouragement and resistance to compliance. A closer look at specific case studies of different communities in the GOC might shed some light into what specific components are most likely to be affected by new policy tools such as MPAs, and which components should be maintained strong to facilitate success.

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