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# The role of stakeholder perceptions and institutions for marine reserve efficacy in the Midriff Islands Region, Gulf of California, Mexico

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ABSTRACT

Governance of marine resources underscores the role of social, economic, and political objectives in achieving conservation outcomes. Marine protected areas, specifically no-take areas (NTAs) where all extractive uses are prohibited, are now widely-used to promote sustainable fisheries and protect marine biodiversity. However, no-take areas have had mixed success, and the governance structures that determine success are not well understood. The institutional, social, economic, and political context of the no-take areas and the response of resource users to their establishment are rarely considered in establishing marine reserves. In developing countries with high levels of poverty and low enforcement capacity, harvest practices rarely adhere to formal laws and regulations. As a consequence, many no-take areas have become "paper parks" that fail to provide ecological and social benefits. In this paper, we use the Coupled-Infrastructure System (CIS) framework to explore the problem of "paper parks" by assessing stakeholder perceptions, preferences, and levels of knowledge on NTAs within a regional system of three no-take areas in the Gulf of California, Mexico. Using structured interviews, we found differences in perceptions about the use of NTAs for conservation of biodiversity and management of fisheries, misconceptions about the location of current NTAs, and problems of non-compliance behavior. We identify a weak relationship between the perception of NTAs by the resource users and the way in which current NTA tools operate in Mexico. Consequently, anticipated success based on the mere presence of the NTA and its regulations is hindered by how the resource users interact with the resource itself, but more importantly by what leads up to this hindrance. A focus on this weakness in the CIS system is critical to achieving NTA objectives.

## 1. Introduction

The governance complexities of marine resources exemplify how ecological objectives for the conservation and protection of species and ecosystems can conflict with social, economic, and political objectives for maximum employment yield, economic efficiency, and livelihood support in small communities. Marine protected areas, specifically no-take areas (NTAs) designed to restrict all extractive uses, are now widely-used to promote sustainable fisheries and protect marine biodiversity (Boonzaier and Pauly, 2016). NTAs have met various levels of success on different countries and under different governance and institutional contexts. In many cases, traditional cultural practices and livelihood dependence on marine resources preclude harvest practices from adhering to the formal laws established, especially in developing countries with high levels of poverty and low enforcement capacities. Consequently, many NTAs become "paper parks" in which established NTAs fail to effectively restrict access and exploitation and do not contribute to the recovery of the protected resource (Rife et al., 2013; White and Courtney, 2004).

An understanding of the importance of institutions (i.e., rules, norms, and strategies that humans use to dictate their interactions) to engage in collective action and avoid resource overexploitation (Basurto and Coleman, 2010; Becker and Ostrom, 1995), as well as the infrastructure through which humans act on the environment (Anderies, 2015) is essential to effective resource management. NTAs regulate fishers directly by restricting their access to designated areas of no-harvesting (Fujitani et al., 2012). NTAs can be established to achieve conservation of biodiversity, recovery fish stocks, or both, and their effectiveness can be measured by whether NTAs have achieved the objectives stated at the time of implementation. However, different stakeholder groups are likely to have different perceptions towards whether existing NTAs are achieving their objectives and the quality of

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management policies and processes in place. These perceptions can influence support for NTAs (Bennett and Dearden, 2014a) and should be considered when assessing their effectiveness (Webb et al., 2004).

Establishing NTAs without consideration of the institutional, social, economic, and political context and governance structure of the region can undermine its objectives and give a false sense of security that such areas will be enough to sustain marine resources (Rife et al., 2013; Fujitani et al., 2012). Regional NTA systems are likely to be more successful when considering the cultural, institutional, and socio-political processes operating in the region (Cudney-Bueno et al., 2009). Understanding these operating conditions calls for a more holistic view of the process through which NTAs are socially perceived, legitimately implemented, and locally accepted by the resource users. In this paper, we explore the problem of "paper parks" by assessing stakeholder perceptions, preferences, and levels of knowledge on NTAs within a regional case study in the Midriff Islands Region (hereafter "Midriffs") in the Gulf of California, Mexico. This paper also addresses the question of whether the perceptions from the different stakeholders with regards to NTAs matches the expectations of what NTAs are expected to achieve in the Gulf. We apply the Coupled-Infrastructure Systems (CIS) framework (Anderies et al., 2016) to identify weak interactions between key social and institutional components within existing NTA systems in the Midriffs, and suggest how the interactions of fishers with areas within NTAs can be influenced to increase NTA effectiveness in Mexico.

Over the last decade, there have been multiple studies on the knowledge and perceptions of fishers in the Gulf towards formal fisheries management policies exclusively regulating harvesting activity. These studies have shared important lessons to improve stewardship of fishery resources (Cudney-Bueno et al., 2009; Basurto et al., 2012; Cinti et al., 2010a, 2014). The need to formally recognize fishers as key stakeholders in local fisheries and include them in the cooperative design of management strategies and regulations has been shown to be critical for effective fisheries management (Cinti et al., 2010b). However, the formal institutional structure of Mexican fishing regulations may not be the most effective strategy to promote responsible fishing behavior (Cinti et al., 2010a). Insufficient government support for the provision of secure fishing rights, lack of effective enforcement and sanctioning mechanisms, and the lack of recognition and incorporation of local arrangements and capacities into management actions has all been shown to undermine sustainable fishing practices in the Gulf (Cinti et al., 2014). More importantly, the disconnection between higher levels of governance and the local practices, realities, and needs have been a major impediment to sustainable fishing practices among small-scale fishers (Cinti et al., 2014). Our results contribute to the understanding of how NTAs are perceived as fisheries management tools within the Mexican policy context.

## 2. Materials and methods

### 2.1. Theoretical framework

We explore the perceptions of NTAs as a fisheries management tool through the Coupled-Infrastructure-Systems (CIS) framework, which was introduced as an extension of the Institutional Analysis and Development (IAD) framework (Kiser and Ostrom, 1982) and the Robustness framework (Anderies et al., 2004). The IAD framework is designed as a conceptual map that identifies a common set of structural variables that are present but variable in different types of institutional arrangement (Ostrom, 2011), but which can be extremely useful when evaluating the role of institutions in shaping decision-making processes and social interactions.

The CIS framework goes one step further by highlighting the complex web of interactions between the exogenous variables identified in the IAD framework (i.e. the biophysical context, the actors, and the rules in use) and the feedbacks generated by linked components within it. The framework emphasizes the interactions between the operational (i.e. actors interacting and implementing practical day-to-day decision) and collective-choice (i.e. institutions are constructed and decisions are taken among a set of authorized actors) levels of a system over time (Anderies et al., 2004). The framework also emphasizes the importance of three types of *infrastructure* (Anderies et al., 2016) for addressing governance of shared resources: *Hard human-made infrastructure* (e.g. private infrastructure such as the boats and fishing gear for harvesting, public infrastructure such as boats for patrolling NTAs), *Soft human-made infrastructure* (e.g. fishing regulations or procedures for the establishment of a NTA, official federal decrees of NTAs and their management programs, or unofficial agreements among fishers to avoid certain practices or not using certain gear to fish for a specified amount of time) and *Human infrastructure* (e.g. knowledge on where to fish or NTA boundaries). Our paper focuses on the latter two types of infrastructure.

In assessing the problem of paper park NTAs through the lens of the CIS framework, we first characterized the NTA system of the Midriffs based on participant observation and literature review, including legal documents and reports elaborated by various federal institutions and civil society organizations, and presidential decrees for NTAs and their management programs. The framework was also used to inform an empirical study (described in section 2.3) on stakeholder perceptions through structured interviews with different stakeholder groups to obtain specific insights into where the main barriers to NTA efficacy lie from an institutional perspective. The use of the framework allowed us to dissect the components of the system, identify weaknesses, and understand what components or interactions need improvement to achieve NTA effectiveness within a system. Fig. 1 shows a description of each of the components of the CIS framework within the context of NTAs in the Gulf (Fig. 1).

The CIS framework also considers the different types of interactions or links among all components of the system (numbered 1–6 in Fig. 1). This way we can identify where weaknesses or strengths are occurring in the system and what consequences it can bring to the long-term robustness of the system. The purpose of these links is to allow the exploration of how different possible policy processes might function in a dynamic policy context, and assess the fit between the biophysical context, the actors, and the rules and regulations in the system (Anderies and Janssen, 2013). The present study takes a closer look at some of these interactions between NTA-type tools within the Mexican context, direct resource users (e.g. fishers) and public infrastructure providers (e.g. resource managers) through a study of levels of knowledge, preferences, and perceptions on NTA-type tools that can or have been implemented in the region. Specifically, we address two research questions (highlighted in red in Fig. 1). First, does the relationship between direct resource users and existing NTA-type tools (i.e. link 6 within the CIS framework) present noticeable weaknesses? High levels of knowledge about the existing NTAs in the region and constructive monitoring and sanctioning mechanisms for compliance with NTA regulations are likely indicators of a strong link 6. Strengthening this relationship can be beneficial by empowering direct resource users about the appropriate use of existing management options for their natural resource as well as further compliance with these regulations. Second, are current strategies for NTA implementation perceived as effective for achieving biodiversity and/or fisheries management objectives? Shared positive perceptions by both fishers and resource managers about whether existing NTAs contribute to biodiversity and fisheries management can have an influence in shaping expectations these tools and what they can accomplish. They can also foster positive relationships between these two stakeholder groups. These two questions shed light on whether existing and future NTAs in the Midriffs (operating via link 5) can become effective at spatially restricting harvesting activities (link 1), thus being effective fisheries and biodiversity management tools.

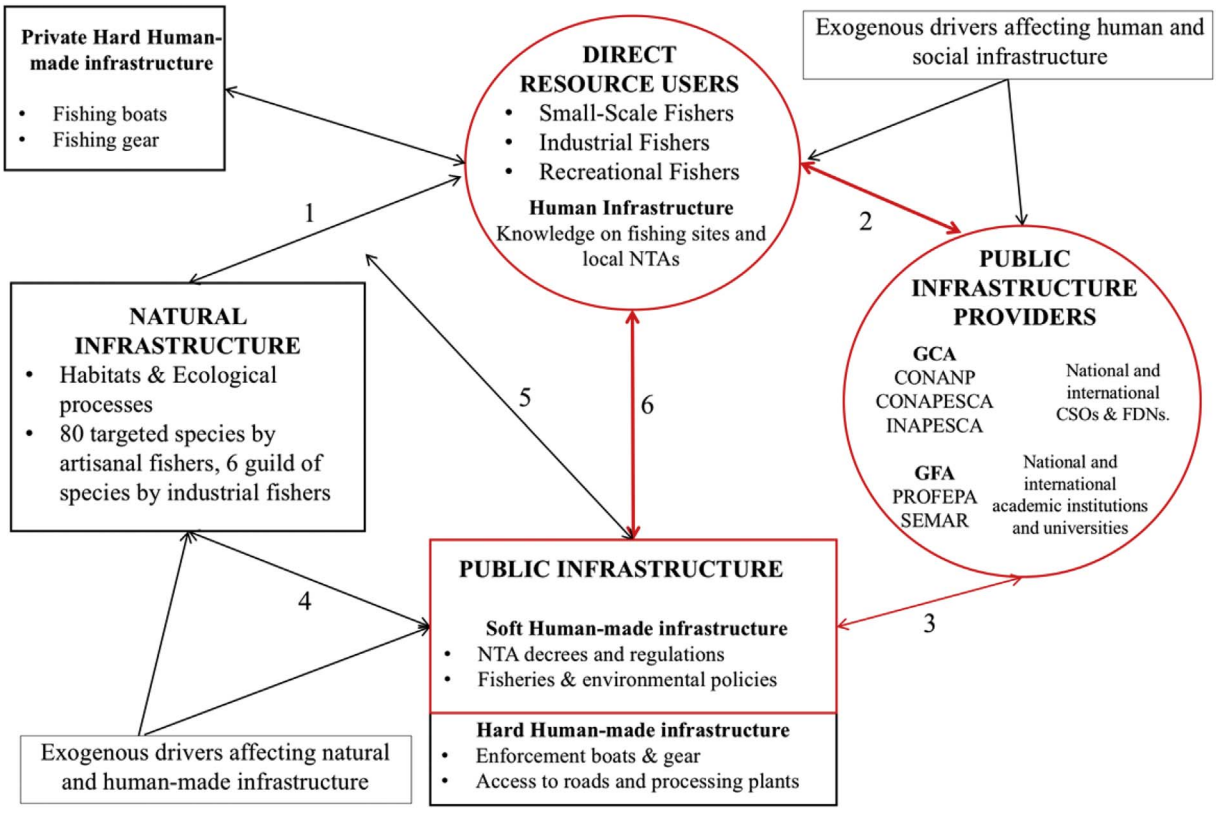


**Fig. 1.** Coupled Infrastructure Systems (CIS) Framework depicted with a NTA system in Mexico. The arrows depict the different links between the components of the system (the numbers serve identification purposes only). CONANP = National Commission of Natural Protected Areas, CONAPESCA = National Fisheries and Aquaculture Commission, INAPESCA = National Fisheries Institute, SEMAR = Mexican Navy, PROFEPA = Federal Agency for the Protection of the Environment, CSOs = Civil society organizations, FDNs = Foundations. The elements in red represent the specific focus of the present study. Adapted from (Anderies et al., 2016). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

### *2.2. Study system: The Midriffs Island Region through the CIS framework lens*

#### *2.2.1. Natural infrastructure, actors, and harvesting activities*

Our study area is the Midriff Islands Region (Midriffs) in the central Gulf, which is well known for its high levels of biodiversity and productivity in terms of fisheries. The region has been identified as a priority conservation site in Mexico (CONABIO et al., 2007), with 29,898.01 km$^2$ of territory including 45 islands and islets, which include two of the largest islands in the country: Isla Tiburón (1224 km$^2$) and Isla Ángel de la Guarda (936 km$^2$). The Midriffs is well known for its diversity of habitats, which include rocky reef systems, *sargassum* forests, rhodolith beds, sand and rocky bottoms, seagrass beds, mangrove forests, and on to a smaller extent sandy beaches and estuaries along the coast.

The region has also been recognized for its importance to both small-scale (artisanal) fishing and large-scale (industrial) fishing (e.g. sardine fishing). Recreational fishers also visit the region frequently, predominantly from the United States and Canada (Fujitani et al., 2012). Most of the artisanal fishing activities in the region occur in the rocky reef ecosystems found all over the coasts of the states of Baja California and Sonora as well as around the islands and islets. Artisanal fishers target at least 80 importantly commercial species in the Midriffs, ranging from ray-finned fish (e.g. leopard grouper, yellow snapper, spotted sand bass), to cartilaginous fish (e.g., hammerhead shark and diamond stingray), to crustaceans (e.g., swimming crab, blue shrimp, and spiny lobster), to mollusks (e.g., octopus and rock scallop), to echinoderms (e.g. sea cucumber). Industrial fishers generally target 6 main species guilds, including squid, anchovy, skipjack, sardine, tuna, and shrimp, with the latter three being the most important (Moreno-Báez et al., 2012). There are eight fishing communities in the region, three in the state of Baja California (Bahía de los Ángeles, San Francisquito/El Barril, and San Luis Gonzaga) and five in the state of Sonora (Puerto Libertad, Bahía de Kino, Puerto Lobos, Punta Chueca, and Desemboque de los Seris). Punta Chueca and Desemboque de los Seris are the only two communities in the MIR that are home to the group of indigenous people called the Comcaac (Seri), who possess exclusive fishing rights over the use of natural resources on the 91,000 ha of coastal area as well as the coastal waters off Isla Tiburón (including the strip of water known as Canal del Infiernillo), granted by presidential decree in 1975 (Basurto et al., 2000, 2012; Carvajal et al., 2010).

Artisanal fisheries are the most important source of income for the majority of inhabitants of the coastal communities in the region (Ulloa et al., 2007), and multiple communities converge on their fishing activities year-round, mainly around the Midriffs (Moreno-Báez et al., 2012). In terms of *private hard human-made infrastructure*, artisanal fishers work with hand-operated gear such as gill nets, diving, hook and line, hand fishing line, traps, and longlines, operated in small 6–8 m long small skiffs (pangas) made of fiberglass with outboard gasoline motors (55–150 hp). Industrial fishers operate on diesel-run industrial vessels of ~150 metric ton capacity that can operate more mechanized gear such as purse seine nets, trawl nets (paired, bottom, and midwater), long lines, and gill nets (Cisneros-Mata, 2010). In the northern Gulf, some communities like Bahía de Kino have been reported to travel long distances between 180 and 200 km for dive fishing, gill net and longline fishing (Moreno-Báez et al., 2012). Furthermore, Bahía de Kino is located near (100 km) the state capital Hermosillo and 400 km from the USA-Mexico border, thus having access to better *public hard human-made infrastructure* such as good access to major roads and processing plants. The fisheries' dynamics in the Gulf are driven by seasonality and

*de facto* open access, and fishery catch data and statistics are highly uncertain in Mexico (Cisneros-Montemayor et al., 2013), which make actual fishing effort difficult to evaluate. However, it is estimated that ~50,000 small-scale fishers operate 25,000 pangas in the region, with nearly 90% operating during the shrimp season (September to March) to then shift to other resources or stop fishing at the end of the season (Cisneros-Mata, 2010). Local artisanal fishers have vast knowledge on ecological processes responsible for spawning seasons on which they base their decisions of where and when to fish (particularly for the shark, rays, and swimming crab fisheries) (Moreno-Báez et al., 2012). In terms of industrial fishing, some 10,000 fishers work on approximately 1300 industrial vessels with crews ranging from five (on shrimp trawlers) to eleven people (in squid and sardine vessels) (Cisneros-Mata, 2010).

#### 2.2.2. Public infrastructure and existing NTAs in the Midriff Islands Region

Public Infrastructure within the CIS framework includes any formal or informal arrangement that establishes a NTA and all the regulations that come with them. While NTAs have been established in Mexico, an explicit regulation to design, establish, monitor and evaluate NTAs as a whole unit in the marine realm has not been created within the Mexican legislation (CEMDA and COBI, 2010). Therefore, multiple tools within both the conservation and environmental protection legislations are used with extension to the marine environment to function as NTAs, as well as tools within the fisheries legislation. The three NTA-type tools currently used in the Gulf include: Core Zones within Natural Protected Areas (hereafter *NPAs*), Fishing Refuge Zones (hereafter *refuge zones*), and Voluntary Marine Reserves (hereafter *voluntary reserves*) (Table 1) (Torre et al., 2016). These three tools are established and managed by different agencies and governing bodies. At the time of the present study, only three NPAs had been established within the MIR (Fig. 2, Table 2), each with their own NTAs (Fig. 3). However, the perceptions and preferences for the other two NTA-type tools by the different stakeholder groups was also explored.

Public Infrastructure Providers in the context of the Gulf and the Midriffs include stakeholder groups that provide support for legislation changes, conservation and management programs, capacity-building programs and organizational, communication, and collaboration support for conservation and management activities as well as for scientific research. This group includes both conservation and fisheries management government agencies as well as other government bodies in charge of monitoring and enforcement of all natural resources, civil society organizations working in the region as well as national and international foundations and scientific researchers.

The Gulf is considered one of the most well-studied regions in Mexico in terms of its natural history and biodiversity, and it has gone through seven marine planning exercises in the past 18 years highlighting conservation priorities (Álvarez-Romero et al., 2013). However, despite of a long tradition of conservation planning, it has also lacked effective fisheries governance and marine planning, which has led to highly uncertain catch data and fishery statistics (Cisneros-Montemayor et al., 2013). Mexican civil society organizations as well as international non-governmental organizations funded by both national and international foundations have been active on conservation and management of natural resources projects within Mexico since the 1980s (Herman, 2004). These groups have provided some of the infrastructure to aid in the application of conservation and fisheries management actions in the region, and have supported the scientific compilation of much of the local knowledge from local users in the region. Over the years, civil society organizations have expanded their work from having mostly focused on environmental issues (e.g., protection and recovery of endangered species, habitat protection, and natural protected areas) to also working on issues of sustainable fisheries management (Espinosa-Romero et al., 2014), promoting the use of traditional knowledge (Basurto et al., 2012), improvement of scientific information (García-Hernández et al., 2015) and its integration with traditional knowledge (Cinti et al., 2010b; Moreno-Báez et al., 2012), supporting the development of new management plans for commercial species (Cisneros-Mata et al., 2014; Zepeda-Domínguez et al., 2015), supporting environmental education as well as education on existing fisheries management tools and regulations (Meza-Monge et al., 2015), and promoting community-oriented processes (e.g. strengthening fishers' organization and participatory processes, local capacity-building, etc.) (Basurto et al., 2000; Espinosa-Romero et al., 2014).

### 2.3. Empirical study on stakeholder perceptions

To better understand the dynamics of the NTA system at a local scale, we carried out an empirical study on key actor perceptions towards the use of NTAs for conservation of biodiversity and management of fisheries in three local communities in the MIR. Between the months of October 2014 and March 2015, we conducted structured interviews based on previously identified potential caveats within the NTA systems, according to the CIS framework. A total of 184 interviews were carried out among the three communities to members of the most relevant actor groups in the Midriffs (Table 3) from two key actor group categories: 1) *Direct Resource Users (DRUs)* and 2) *Public Infrastructure Providers (PIPs)*. Public infrastructure providers included representatives from fisheries management (GFA) and environmental agencies (GCA) as well as civil society organizations (CSOs) and foundations (FDNs) that frequently sponsor research and conservation programs in the region. Respondents from these groups were sampled based on their time and experience working in the region. Direct resource users (hereafter *fishers*) included artisanal (SSF) and industrial

**Table 1**
Characteristics of the three NTA-type tools used within Mexico.

| NTA-Tool | Management organization | Characteristics | Existing in the Midriffs/Gulf |
|---|---|---|---|
| Core Zones within Natural Protected Areas (NPA) | National Commission of Protected Areas (CONANP) | • Emphasis on protection of biodiversity and/or fish stock recovery<br>• Core Zones considered NTA within the NPA<br>• Permanently decreed<br>• Enforcement and sanctioning done by the Federal Agency for the Protection of the Environment (PROFEPA) and the Navy (SEMAR) | • Reserva de la Biosfera Isla San Pedro Mártir (RBISPM)<br>• Reserva de la Biosfera Bahía de los Ángeles, Canal de Ballenas y Salsipuedes (RBBACBS)<br>• Parque Nacional Archipiélago San Lorenzo (PNASL) |
| Fishing Refuge Zones (FRZ) | National Aquaculture and Fisheries Commission (CONAPESCA) | • Stronger emphasis on fish stock recovery<br>• Temporal (2–6 years) or permanent closure<br>• Partial or total closure | • South of the Midriffs: Corredor San Cosme-Punta Coyote in the Baja California Sur peninsula |
| Voluntary Marine Reserves (VMR) | Local resource users, typically cooperatives and/or concession holders | • Via community agreements<br>• No initial legal backing within the Mexican environmental or fisheries legislation, but can be extended as other legal NTA-type tools | • None currently in the Midriffs but some in the Baja Pacific Region (Cudney-Bueno et al., 2009; Micheli et al., 2012; Revollo-Fernández, 2012)<br>• Previously in the Upper Gulf (Cudney-Bueno et al., 2009) |

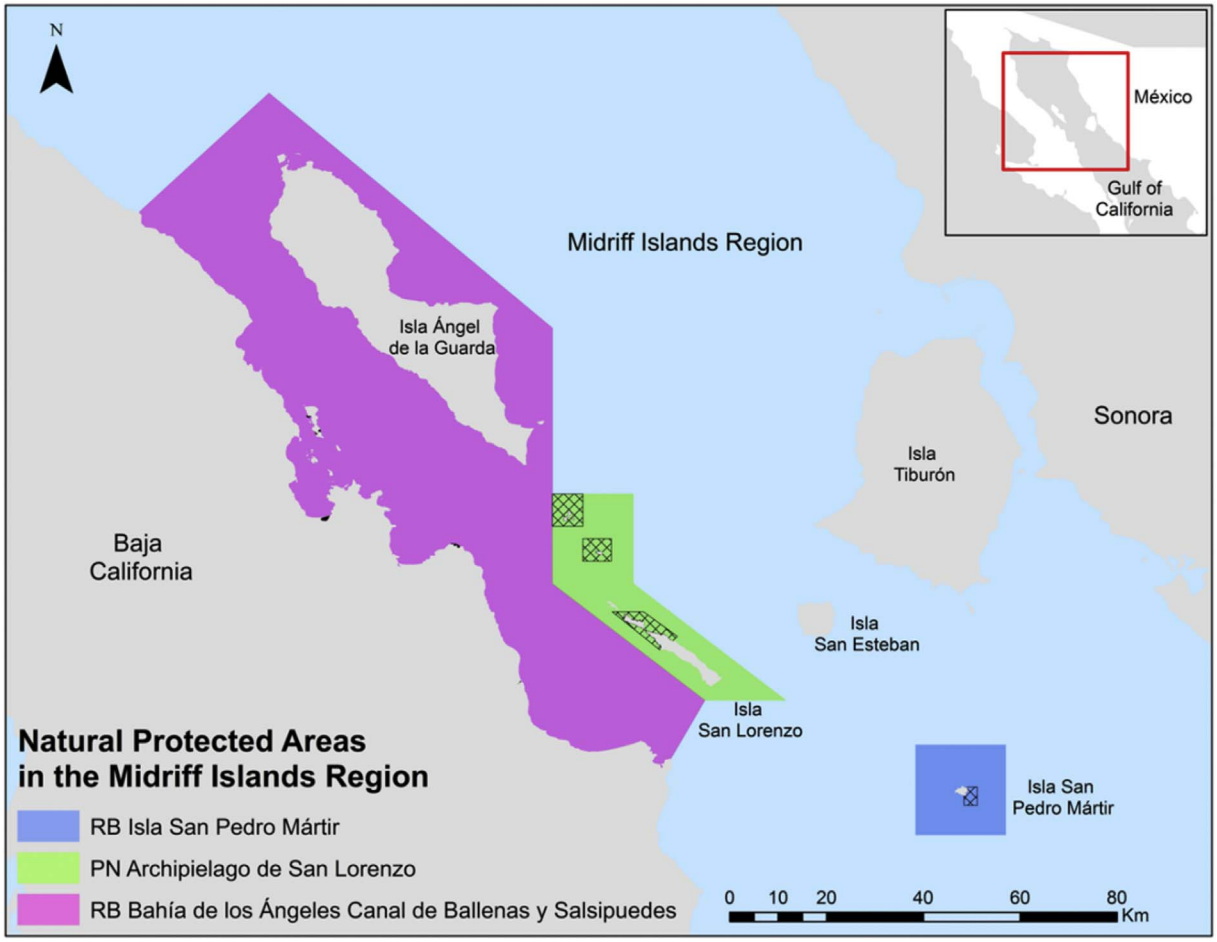


**Fig. 2.** NPAs within the Midriffs region of the Gulf. RB = Reserva de la Biósfera, PN = Parque Nacional.

**Table 2**
Natural Protected Areas (NPAs) in the Midriff Islands Region in the GOC (Rife et al., 2013; Moreno-Báez et al., 2012; Bourillon and Torre, 2012). MP = Management Program.

| NPA | RBISPM | PNASL | RBBACBS |
|---|---|---|---|
| Name | Reserva de la Biósfera Isla San Pedro Mártir | Parque Nacional Archipiélago de San Lorenzo | Reserva de la Biósfera Bahía de los Ángeles, Canal de Ballenas y Salsipuedes |
| Total NPA area | 298.76 $km^2$ | 584.42 $km^2$ | 3879.57 $km^2$ |
| Total no-take area | 8.21 $km^2$ 2.74% | 88.05 $km^2$ 15.06% | 2.07 $km^2$ 0.05% |
| Year NPA decreed | 2002 | 2005 | 2007 |
| Year MP decreed | 2011 | 2014 | 2014 |

(IFS) fishers who are active, retired, registered, independent (non-registered), permit holders, and representatives of fishing cooperatives, as well as members of the general community (GC) whose source of income is to a lesser extent linked to fishing activities (e.g. catch processing, gear mending). To sample the fisher stakeholder group, respondents were first identified with the help of civil society organizations working with community groups in each of the three communities, followed by randomly approaching fishers on the beach and processing plants. Industrial fisher respondents were mainly from the city of Guaymas south of the Midriffs coastline, although these fishers operate within the Midriffs region. Artisanal fisher respondents were individuals operating in the three main local communities within the Midriffs: the Sonoran villages of Puerto Libertad (pop. 2782) and Bahía de Kino (pop. 6050), and the village of Bahía de los Ángeles in Baja California (pop. 800) (INEGI, 2010). A pilot study was implemented in Bahía de Kino in July 2014 with representatives from the general communities, conservation agencies, and artisanal fishers to test and adapt the interview protocol.

Data from interviews were used to characterize stakeholder perceptions about NTAs, including the level of understanding and support for NTAs among the key actor groups, and how this support varied among these groups. The structured interviews included: demographic information about respondents (age, sex, place of birth); employment (*for fishers:* history of fishing, alternative livelihood options or sources of income); organization (membership in formal or informal groups, and attendance to capacity-building workshops related to NTAs); and perceptions on current state and threats for biodiversity and fisheries management, benefits from NTAs, compliance with NTA regulations, and the process and performance of existing tools for NTAs in Mexico and their regulations. We assessed perceptions through open-ended questions and statements with a five-point Likert scale (strongly agree, agree, neutral, disagree, strongly disagree).

## 3. Results

Out of the 136 direct resource user respondents, 46 belonged to a given conservation or capacity-building working group (e.g. community biological monitoring teams, fishing committees, and regulation monitoring groups). Fifty-five fisher respondents had also been involved in recent capacity-building workshops with respect to NTAs, how they work, and what has been learned through the use of NTAs for both biodiversity and fisheries management in Mexico and around the

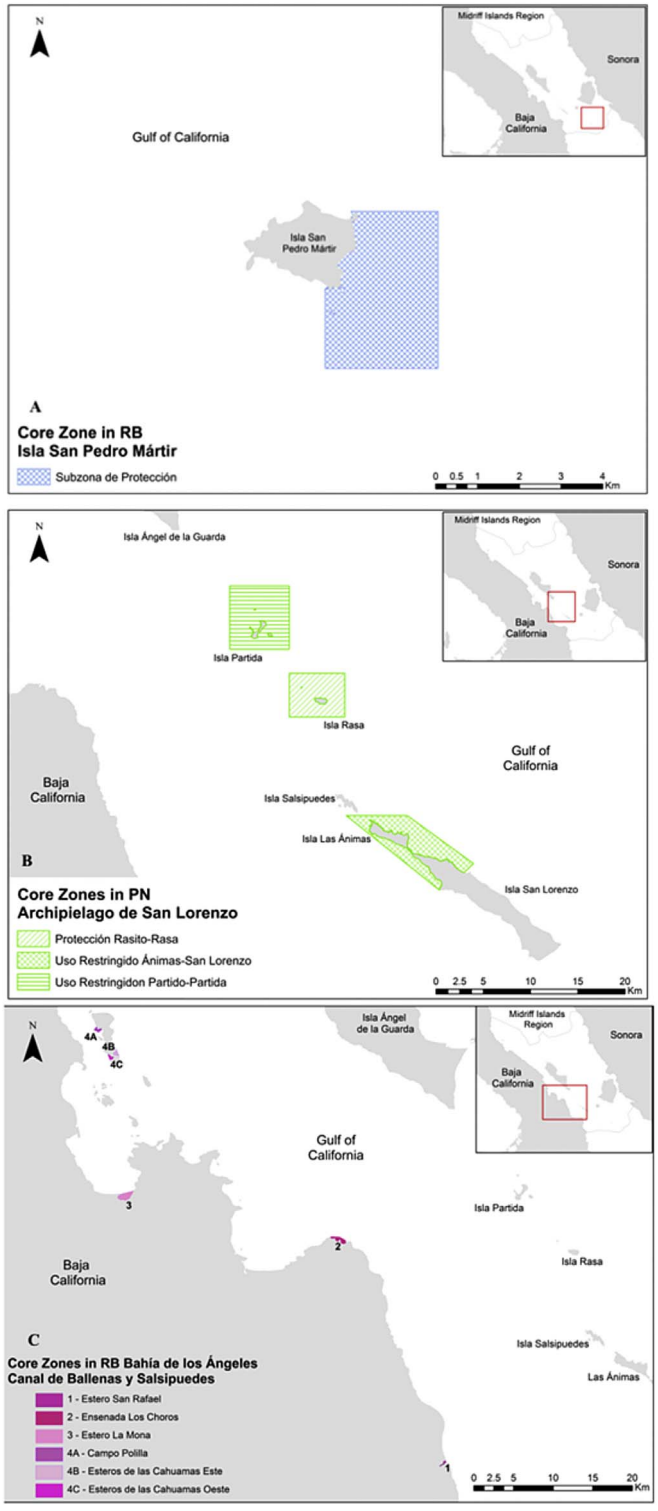


**Fig. 3.** Existing NPAs with core zones (NTAs) within the Midriff Islands Region. A) Reserva de la Biosfera Isla San Pedro Mártir (RBISPM), B) Parque Nacional Archipiélago San Lorenzo (PNASL), and C) Reserva de la Biosfera Bahía de los Ángeles, Canal de Ballenas y Salsipuedes (RBBACBS).

world. Direct resource users were on average 40 years of age (17–70 age range) employed in the fisheries sector an average of 22 years (up to 58 years) of and a male/female ratio of 33:1. Public infrastructure providers were on average 45 years of age (25–71 age range) in their respective employments as members of environmental or fisheries management agencies an average of 15 years (up to 40 years) of and a male/female ratio of 2:1.

**Table 3**
Respondent sample distribution for the 184 interviews carried out among two key actor groups for the interview process. CONANP = National Commission of Natural Protected Areas, CONAPESCA = National Fisheries and Aquaculture Commission, INAPESCA = National Fisheries Institute, CEDO = Intercultural Center for the Study of Deserts, EDF = Environmental Defense Fund, GIZ = German Corporation for International Cooperation, WWF = World Wild Fund for Nature, FMCN = Fondo Mexicano para la Conservacion de la Naturaleza, and TNC = The Nature Conservancy.

| Key actor group | n | Sample distribution (n) | | | |
|---|---|---|---|---|---|
| *Public Infrastructure Providers (PIPs)* | 48 | *Specific Agency/Organization/Foundation* (48) | | | |
| Conservation agencies (GCA) | 19 | CONANP (19) | | | |
| Fisheries agencies (GFA) | 13 | CONAPESCA (7), INAPESCA (6) | | | |
| Civil Society Organizations (CSO) | 8 | CEDO (1), NIPARAJA (2), PRONATURA (3), SuMAR (1), EDF (1) | | | |
| Foundations (FDN) | 8 | GIZ (1), Resource Legacy Fund (1), Packard (1), Walton (1), WWF (1), FMCN (1), TNC (2) | | | |
| *Direct Resource Users (DRUs)* | 136 | *Specific community* | | | |
| | | *Puerto Libertad* | *Bahía de los Angeles* | *Bahía de Kino* | *Guaymas* |
| Small-scale fishers (SSF) | 124 | 46 | 11 | 73 | – |
| Industrial fishers (IFS) | 4 | – | – | 1 | 3 |
| General community (GC) | 8 | 1 | 1 | 6 | – |

### 3.1. Relationship between fishers and existing NTA-type tools

Our results indicate two major issues with regards to the current relationship between fishers and existing NTAs: knowledge on local NTAs and non-compliance with NTA regulations. For each individual NPA in the MRI region, fishers were asked if they were aware that such NPA existed, and if so, if they knew the location of the NTA within the NPA. Fishers were also asked if they believed that such NPA had been successful for the conservation of biodiversity as well as for fisheries management. Fishers showed gaps in their knowledge on NTAs within the current established NPAs in the region, with 15.4% of respondents not knowing about the existence of any of the three NPAs, yet of those who knew about them 44.4% of the respondents did not know the precise location of the NTAs. Only 21.3% of respondents knew about all three NPAs, yet only 7.5% of them knew the location of all three NTA systems.

The NPA of RBISPM was the most well-known NPA, while PNASL was the least well-known despite having the largest area with no-take regulations (Table 4). The NTA of RBISPM was decreed after the establishment of the terrestrial NPA as an extension of the terrestrial NPA, and the process was accompanied by a large community-involvement campaign in the community of Bahía de Kino with the goal of empowering the community members as stewards of their environment.

**Table 4**
Percentage of respondents who are aware of the existence of NPAs and the boundaries of the NTAs. PNASL = Parque Nacional Archipiélago de San Lorenzo; RBBACBS = Reserva de la Biosfera Bahía de los Ángeles, Canal de Ballenas y Salsipuedes; RBISPM = Reserva de la Biosfera Isla San Pedro Martir. Sample size = 136 fishers (SSF & IFS).

| | RBISPM | PNASL | RBBACBS |
|---|---|---|---|
| Aware the NPA exists | 63.2% | 37.5% | 52.9% |
| Knows NTA location | 44.1% | 15.4% | 22.1% |

Not surprisingly, of the fisher and community member respondents belonging to a conservation or fisheries management group, 67.4% were more knowledgeable about the exact location of RBISPM than those not belonging to a particular group. Although the NPAs of PNASL and RBBACBS, were decreed at different times and each has its own Management Program, they are jointly managed by CONANP's administrative offices, and they are considered to serve different objectives. Within NPAs, biosphere reserves and national parks mainly differ by the former's inclusion of community participation and exclusive fishing rights for the nearby local communities on zones where sustainable fishing is allowed (called *buffer zones*) within the NPA. Also, the NTAs within RBBACBS harbor mainly coastal and mangrove habitat that work as nursery grounds for important commercial species, but these areas are usually not harvested by fishers. The NTAs are also within proximity of the nearby village of Bahía de los Ángeles. Of the respondents that belonged to a conservation or fisheries management group, 28.3% knew the exact location of RBBACBS. The NTAs within PNASL surround four of the islands harboring some of the most important seabird breeding colonies in the GOC. Of the respondents that belonged to a conservation or fisheries management group, 19.6% knew the exact location of PNASL.

Multiple public infrastructure providers operate in the Midriffs in various ways, including through the provision of capacity building workshops that train and educate fishers and community members in different areas. Some of these workshops include training on the different tools available for fisheries management, including seasonal closures, gear and fish size restrictions, as well as NTAs. Among the resource user respondents, 40.4% of them had attended at least one workshop specific to NTAs in the Midriffs in the last three months. However, not all of these workshops specifically addressed the topic of location of current NTAs in the region. Civil society organizations and CONANP also work with volunteer fishers or community members (or on occasions employed through specific projects) as part of conservation or fisheries management groups that meet regularly and partake in scheduled conservation actions. Among the resource user respondents, 34.6% belonged to one of ten groups, which included monitoring of exotic species, monitoring of fish species and climate change, sea turtle conservation, sea lion monitoring, fishing permit holders group, town fisheries committee, community leadership, and a surveillance committee for compliance with NPAs.

In terms of perceptions of non-compliance with NTA regulations by fishers who knew the location of NTAs, 83.2% of respondents believed there were problems of non-compliance within one, two, or three of the NTA systems in the region (10.6% responded to not believe there were issues of no-compliance, and 6.2% were not sure). Fig. 4 shows responses when fishers were asked what their usual reaction to the observation of non-compliance to no-fishing restrictions within known NTAs was.

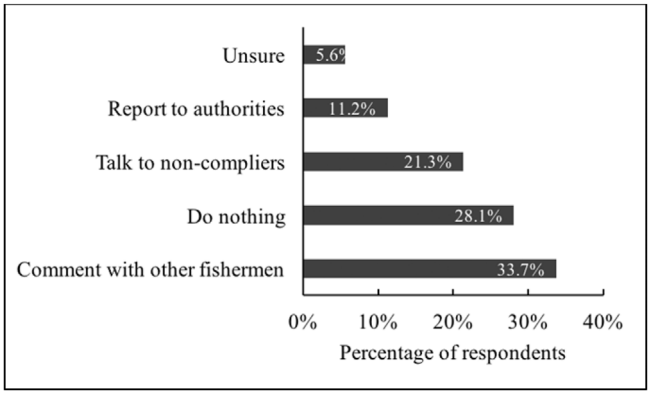


**Fig. 4.** Responses from fishers to the question "What action do you usually take when you observe non-compliance within the NTA?". Sub-sample size = 89 fishers who did observe non-compliance with no-take regulations in any of the NTAs of which they knew the location.

When asked about what could be done to improve compliance with NTAs, fisher respondents mainly reported on the need to improve enforcement of existing NTA regulations by increasing surveillance. Some fisher respondents also raised concerns of corruption getting in the way of proper enforcement and sanctioning mechanisms. Furthermore, some public infrastructure provider respondents also raised concerns about lack of surveillance capacity by the responsible authorities in the form of personnel, patrolling boats and equipment (*hard human-made infrastructure*). Both groups of respondents recommended mechanisms to disseminate information and increase awareness about existing NTAs to other resource users, including through awareness campaigns, workshops, and participation in community groups.

### 3.2. Levels of success of current NTAs and preferences for NTA-type tools

Fishers and public infrastructure providers had different levels of agreement on the level of success that existing NPAs have had for the management of biodiversity and fisheries within the region. Public infrastructure providers stated more confidence in NPAs in the region being successful for the conservation of biodiversity (60.4% stating they are successful, 12.5% stating they are not, and 27.1% unsure) than for fisheries management (43.8% stating they are successful, 22.9% stating they are not, and 33.3% unsure). Among the different key actor groups within the public infrastructure providers, both government agencies and foundations seemed most optimistic than civil society organizations about the level of success NPAs had for both conservation of biodiversity and fisheries management, although these organizations seemed to be less optimistic about the ability of the current NPAs in the MIR to achieve successful outcomes with respect to fisheries management (Fig. 5).

Government agencies are the main public infrastructure provider responsible for carrying out continuous monitoring and evaluation efforts of existing NTAs (via underwater census within and outside of NTAs) and other fisher management tools (by analyzing landing statistics, mainly) to ensure they are working effectively. Therefore, we expected less uncertainty among government respondents with respect to success level of existing NTAs. However, this information is not always frequently communicated to other sectors. Civil society organizations and foundations do not always have direct or timely access to monitoring and evaluation results carried out by NPA managers, thus present more uncertainty. This lack of communication might explain the large amount of "unsure" answers from these two groups as well as the fisheries government agencies. On the other hand, civil society organizations tend to work more closely with the local communities through their various research and operational programs and capacity-building workshops. Therefore, they are generally better informed on the fishers' perceptions about the state of the fisheries. Foundations also operate at a different level than the former two stakeholder groups, with less direct connection to the communities and a stronger interest in more large-scale regional outcomes than those of individual NTAs. These differences in levels of operation and interests with respect to perceived successful outcomes might explain the differences between the answers of these two groups.

Within government agencies, representatives from the fisheries management agencies had a strong perception that current NTAs were either not successful or were unsure about the current achievement or potential of NPAs for effective fisheries management outcomes. Among the reasons for their skepticism are the nature of NPAs as biodiversity conservation tools and their overarching goal to protect populations from anthropogenic threats. Representatives from the conservation-oriented agency CONANP were more optimistic, mainly because NTAs within NPAs also target the protection of commercially important fish and invertebrate species.

Fishers were specifically asked about their perceived level of success

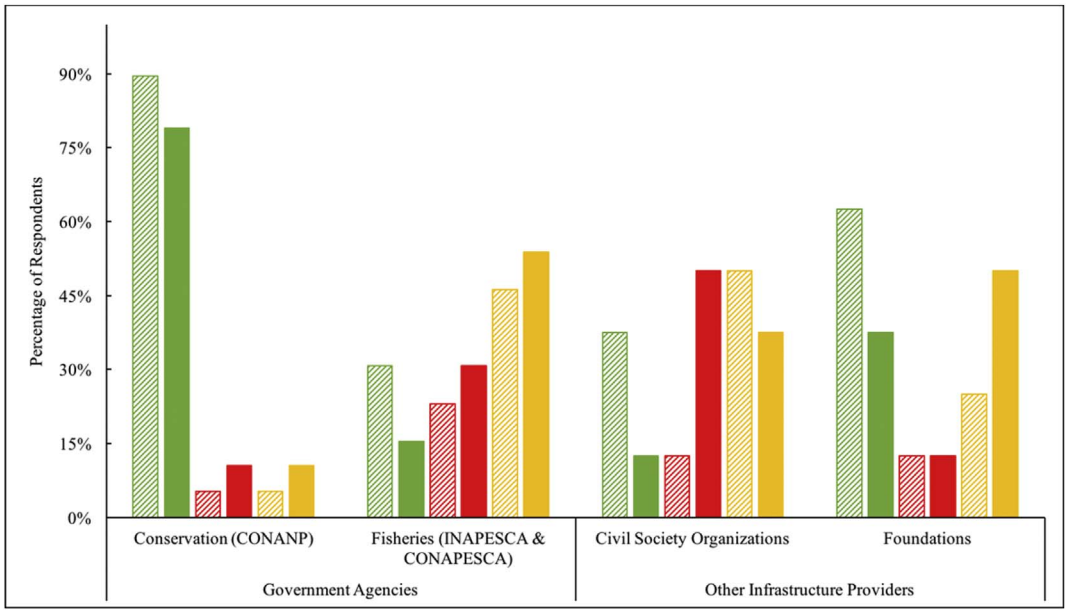


**Fig. 5.** Perception among infrastructure providers about whether existing NPAs, in general, have been successful for the conservation of biodiversity (*striped*) and for fisheries management (*solid*). Green = Yes, Red = No, Yellow = Unsure. Sample size = 48 representatives from all public infrastructure providers (Table 1). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

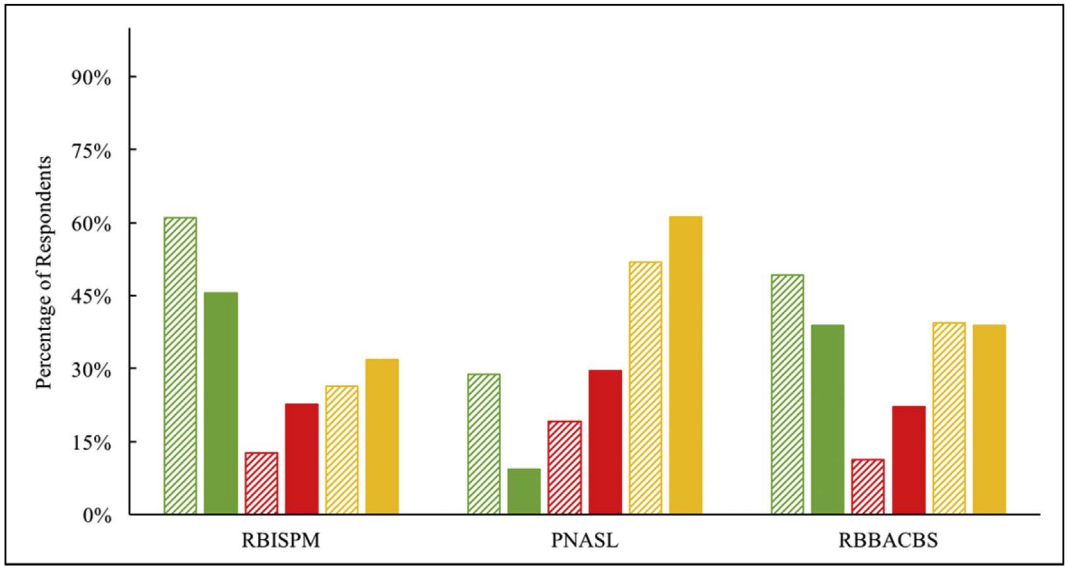


**Fig. 6.** Perception among fishers (mostly SSF) about whether the existing NPAs that they are aware of (sub-sample sizes: $N_{RBISPM}$ = 88, $N_{PNASL}$ = 54, and $N_{RBBACBS}$ = 72) have been successful for the conservation of biodiversity (*striped*) and for fisheries management (*solid*). Green = Yes, Red = No, Yellow = Unsure. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

for each of the NPAs of which they knew they existed in the region since their harvesting activity is very localized and they have direct feedback on the effects of conservation and management actions in the area. Fishers who were familiar with the RBISPM seemed more confident about the level of success of the NTA with regards to conservation of biodiversity, and to a lesser extend to fisheries management (Fig. 6). On the other hand, fishers who were familiar with the PNASL seemed most skeptical about the success of NPAs for conservation, but even more greatly about their success for fisheries management (only 9.3% of respondents perceived the NPA successful for fisheries management). Biosphere reserves are generally less restrictive in terms of fishing grounds than national parks, and they also include buffer zones where local fishers from nearby villages have preferential access to these fishing grounds. Therefore, from the fishers' perspective, NPAs that simultaneously offer preferential fishing access while closing off other areas to fishing is more likely to succeed as a fisheries management tool. Thus, fishers prefer biosphere reserves over national parks because they can also benefit from their establishment while helping the recovery of commercially valuable stocks. Overall, there was also a large amount of "unsure" answers from the fisher respondents. While CONANP and some civil society organizations do provide some dissemination of information on the current state of the existing NTAs and whether they are working, it is likely still not enough to inform the fisher population. Nonetheless, 79% of fisher and community member respondents recognized that in theory, NTAs are generally beneficial for allowing more reproduction of commercially important species, and thus more catches and higher economic benefits for them.

In general, fishers and community member respondents had little knowledge with respect to the process for establishing NTAs in Mexico, but they had a similar perception to the public infrastructure provider

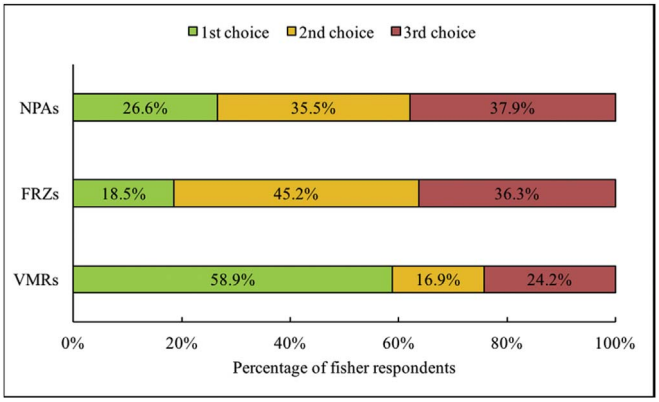


**Fig. 7.** Fisher response to question: Which NTA tool would be your first, second, and third choice for the establishment of a network of NTAs? NPAs = Natural Protected Areas, FRZs = Fishing Refuge Zones, and VMR = Voluntary Marine Reserves. Sub-sample size = 124 fishers.

respondents on the usual timeline for the establishment of NTAs. Most fisher respondents perceived the establishment of NTAs would take from two to five years (42.1% of fishers, 60.4% of public infrastructure providers), although more of them expressed uncertainty with this estimate than public infrastructure providers (33.9% of fishers, 10.4% of public infrastructure providers). Half of the fisher respondents also expressed that the establishment of NTAs should only take a year or less, and the other half believed it should not take more than 5 years.

In terms of the fisher preference with respect to which NTA-type tool would be most appropriate for the establishment of future NTAs in the Midriffs, voluntary reserves were preferred as first choice for 58.9% of the fisher respondents, with 26.6% preferring NPAs and 18.5% preferring fishing refuges, whereas fishing refuges were chosen as 2nd choice by 45.2% of the respondents (Fig. 7). When asked this question, fishers were given a brief description of each NTA-type tool in terms of who is responsible for establishing and managing each one. Although every respondent indicated some knowledge about each tool, it is likely that fishers were not fully aware of all the different rules and legislation specifics of each tool.

## 4. Discussion

Previous institutional analyses for some of the communities in the GOC have suggested potential weak interactions (links on Fig. 1) on how direct resource users and public infrastructure providers perceive and interact with NTAs, and how it has led to shortcomings when using this tool for fisheries management (Mancha-Cisneros and Gerber, 2015). Through our results, we narrow down these weaknesses to (a) different levels of knowledge and support for NTA-type tools in the region; (b) non-compliance and apathy from fishers towards NTAs (even when they do have knowledge about the existing NTAs); and (c) differences in perceptions between the fishers and the infrastructure providers with regards to the success of NTAs and what they can accomplish.

Previous studies have shown how the NPAs in the northern Gulf are often used by fishing communities from all different communities within the region (e.g. 83% of RBBACBS is used by six communities, 38% of PNASL is used by five communities, and two communities use RBISPM), with some fishers even traveling long distances to reach the NPA (Moreno-Báez et al., 2012). Although the present study is not able to directly evaluate the influence of the presence of multiple public infrastructure providers in the region, our results indicate that there are still information gaps with regards to levels of knowledge and support for NTAs in the region. We observe these results despite efforts from civil society organizations and some government agencies to provide workshops, organize working groups, and disseminate relevant information among the various fishing communities. In other words, there is a weak presence of soft human-made infrastructure that leads to knowledge on no-fishing restrictions, boundaries, and the consequences of noncompliance. While many fishers are actively involved in community-based programs hosted by environmental authorities like CONANP or local civil society organizations working in the region, many are still misinformed about the boundaries of current NTAs in their region and the restrictions around them. Link 6 determines how fishers view and support NTA regulations, which is crucial for NTA effectiveness. Lacking knowledge about current NTAs further weakens the relationship between the fishers and the support for no-fishing restrictions. Even if fishers chose to abide by the regulations, they cannot do so if they are misinformed about the NTAs boundaries. However, the value of NTAs in general for fisheries recovery seems to be increasingly recognized (Suárez-Castillo et al., 2017). Over two thirds of the fishers included in our study acknowledged the value of NTAs for species reproduction, higher abundances, and in general higher catches.

With regards to noncompliance and apathy issues, even when fishers have a good understanding about the boundaries of NTAs, they can easily choose not to comply with the restrictions of no-fishing inside the NTA. Reasons for noncompliance may include a lack of other employment alternatives (the most commonly cited response by fishers when asked if they had other livelihood alternatives besides fishing), skepticism about whether NTAs can work in providing them with benefits in the short or long term, or the fear that others will free ride on the efforts of a few to comply and will this take advantage of the situation. Although varied by NTA, our study shows high levels of perceived non-compliance behavior among fishers, even from the local public infrastructure provider perspective. This also represents a weakness in link 6 because the more fishers become non-compliant with NTAs, the less other fishers believe and support their implementation.

Recent studies have hypothesized that the problem with noncompliance begins with the complicated division of monitoring and enforcement responsibilities among the appropriate federal agencies as well as a lack of capacity for properly carrying out these responsibilities, all of which undermines their ability to properly ensure compliance (Rife et al., 2013). However, while most respondents in our study indeed had a perception that there is a lack of monitoring and enforcement by formal authorities in the region, we also show that the practice of reporting non-compliance activity to the appropriate federal authorities is also not prevalent in the region. Most fishers opt for talking about doing nothing or who is not complying rather than reporting it (Fig. 4). Furthermore, our results also show a lack of belief in the system and the perception that corruption is constantly present when it comes to proper monitoring and sanctioning of NTA restrictions, thus leading to a culture of apathy towards both complying with NTA regulations and reporting noncompliance of others (a weakness in link 6). While understaffing and underfunding on the public infrastructure provider side are real issues (a weakness in link 3), there is little that can be done via the government authorities already operating at capacity and with limited resources to provide the necessary hard human-made infrastructure for increasing monitoring and enforcement. Moreover, strengthening link 3 may not necessarily contribute to solving noncompliance issues unless the fishers perceive a change in the perception of *corruption* and noncompliance that has permeated the system, or unless the prospect of alternative livelihoods provides fishers with other choices that allows them to comply with regulations without affecting their livelihoods.

The negative perceptions towards the monitoring and sanctioning systems for NTAs sometimes change when fishers are actively engaged in the process of monitoring and sanctioning. In Bahía de los Ángeles, community-based surveillance groups have proved successful for certain periods of time (i.e. the fishers become public infrastructure providers by being agents of monitoring and enforcement of regulations). Fishers from Bahía de los Ángeles often mentioned their concern and

disapproval of outsiders coming into the buffer zones of the NPA to fish and threatening their fishing grounds, which was enough to maintain interest in being part of the surveillance group. However, these programs often require continuous funding to pay for subsidies to participants in the program, which limits their long-term subsistence and thus effectiveness. In other communities of the Gulf like Cabo Pulmo in the Baja Peninsula, voluntary monitoring and surveillance programs have proven successful when there is enough interest, leadership and social cohesion within the community (Ibáñez et al., 2008; Mancha-Cisneros, 2017). These characteristics encourage fishers and community members to participate in these programs in the interest of protecting their natural resources. In the Midriffs, the effects of past conflicts between different communities with regards to fishing grounds territoriality (see (Cudney-Bueno et al., 2009; Cinti et al., 2010a)) and the attributes of the communities (e.g. community-dynamics, historical context, and social conflict) should also be carefully considered when seeking to implement these voluntary monitoring programs.

Finally, the difference in perceptions between resource users and infrastructure providers with respect to how NTAs have been successful and what the best way to implement them has been a significant setback for NTAs in the region. Since NTAs have only been established as NPAs managed by CONANP in the Midriffs, most fishers associate them with the concepts of conservation and preservation of ecosystems and threatened species. Our results also show how the current NPAs are perceived to be more successful for the purposes of conservation of biodiversity than for fisheries management (a weakness in link 6 if NTAs are to be employed as a strong fisheries management tool). The Gulf's history of prioritization efforts without achieving enough management outcomes could be contributing to the increased skepticism by civil society organizations and foundations towards the success of current NPAs for fisheries management. The rest of the public infrastructure providers tend to base their perceptions on a shifting baseline.

We find that there is little collaboration between the different conservation and fisheries management agencies due their seemingly opposing mission statements (i.e. CONANP's mission is to protect and conserve biodiversity and natural resources, whereas CONAPESCA's mission is to support the development of harvesting, albeit through sustainable practices). The need for collaboration platforms and strategies between the relevant public infrastructure providers become even more relevant for the appropriate implementation of the higher-level mandates to local-level management actions. Consequently, new routes and strategies for the establishment of new NTA networks are currently being proposed by civil society organizations and supported by larger foundations and federal public infrastructure providers (including CONANP and CONAPESCA). These strategies involve inclusive, transparent, and participative processes through the recognition of all stakeholder positions towards NTAs and the incorporation of the small-scale fisheries sector's input towards the design and planning of future NTAs (Suárez-Castillo et al., 2017).

Different NTA-type tools represent different types of soft human-made public infrastructure, each with its own set of processes, rules, and responsible parties. While voluntary marine reserves were often preferred over all other NTA tools, fishing refuge zones were the second most popular choice, which shows a great deal of interest for this new policy for establishment of NTAs managed by CONAPESCA. Voluntary marine reserves have had significant failures in other regions of the Gulf in the past due to the lack of formal recognition from the federal authorities. One example is the case of the voluntary reserves in San Jorge Island, which successfully began as part of a community-based network of reserves in Puerto Peñasco, but was dissolved soon after to avoid free-riding problems due to unachieved expectations and changing directorship of local fisheries offices (Cudney-Bueno et al., 2009). However, the example of a voluntarily-proposed fishing refuge zone in the village of Puerto Libertad showed how a bottom-up process involving local fishers of all different types of organizations (e.g. independent fishers and cooperatives) can bring about positive social interactions and strong support for the establishment of NTAs for fisheries management (Espinosa-Romero et al., 2014; Espinosa-Romero and Torre, 2012).

Voluntary marine reserves seem like a good way to begin the process of community-participation in the establishment of a NTA, although we recommend that the non-governmental public infrastructure providers aiding these efforts (e.g. civil society organizations working with the communities) seek the federal recognition of these areas via fishing refuge zones or NPAs (or extensions of NPAs to include NTAs). This would improve the credibility and acceptance of the NTA as well as the operational capacity of its management. Furthermore, we urge public infrastructure providers to carefully consider the governance context and history of the region where NTAs are being proposed to identify the most appropriate NTA-type tool for each specific region. For example, a negative past experience with other NTA-type tools would easily dissuade fishers from participating in efforts to implement the same type of NTA. Assessing the levels of organization among local fishers (e.g. independent fishers vs. a cooperative) as well as their trust on local infrastructure providers can also help determine the challenges of working with the community during the implementation process. In other words, the choice of which type of soft public infrastructure will be more effective on the long-run highly depends on the careful consideration of the history of the region, the attributes of the community, the interactions between the different actors in the system (link 2) and the characteristics of the NTA-type tool being proposed.

Close attention to the relationship between fishers and infrastructure providers (link 2) would ensure that trust issues do not become a problem on the long-run, that there is sufficient and constructive communication between the two groups, and that collaboration and cooperation between and among these two groups happens in a conducive manner towards the successful establishment and subsequent functioning of the NTA. Timelines and continued engagement with the communities and all the relevant stakeholders are critical for the success of future NTAs. Past exercises that have attempted to establish NTAs in the Midriffs or elsewhere in the Gulf have struggled to maintain the stakeholders and fishers engaged in the process to establish NTAs (a weakening of link 6) when it becomes too lengthy, which consequently can undermine the prospects for the acceptance of the NTA within the fishing community (pers. comm.). As shown in our results, most stakeholders expect the process of NTA establishment to delay for no more than five years, on average, in order to ensure the expectations are met and that the establishment of NTAs remains relevant in the face of ongoing resource overexploitation problems. Finally, our study recognizes the need to develop parallel strategies to implement alternative livelihood and environmental education programs. These programs can mitigate the negative impact on small-scale fishing communities' livelihoods and strengthen knowledge and support for NTAs at a local scale, respectively, thus increasing stakeholder participation throughout the process (Suárez-Castillo et al., 2017; Bennett and Dearden, 2014b). In order for NTAs to be effective, they have to influence the way in which fishers interact with the natural resource (link 5). In the case of the Midriffs, this outcome could be achieved if the critical weaknesses occurring in link 6, which are often affected by poor communication among fishers and public infrastructure providers (link 2) and by poor coordination among public infrastructure providers themselves to implement NTAs (link 3), are addressed.

## 5. Conclusion

This study elucidates how incorporating the current level of stakeholder understanding and support for the use of NTAs into the establishment and management processes of NTAs is a crucial strategy for both biodiversity conservation and fisheries management in the Midriffs, highlighting important weaknesses in the way in which NTAs have operated in the region. Our results suggest mechanisms for

improvement of NTA effectiveness by taking a closer look at some of these caveats and how they impact the dynamics of the whole SES from a governance perspective.

The shortcomings of current NTAs in the region occur due to major differences in levels of knowledge from the fishers and of perceptions between fishers and public infrastructure providers towards NTAs as tools for fisheries recovery zones, which is further hampered by a culture of apathy towards such management tools given the problems of corruption and free riding. In order for future NTAs to effectively succeed as fisheries recovery zones, we propose a careful consideration of specific NTA-type tools available within the Mexican context such as voluntary marine reserves as an initial step towards the formal implementation of legal NTA-type tools so that fishers have a first-hand experience with how NTAs work and why they are necessary, so that their perceptions and subsequent support for these tools might change. We expect this analysis to set the stage for assessing putative management actions specific for each type of tool that can be applied as NTAs in the Midriffs as well as the rest of the Gulf. Collectively, this work demonstrates ways to incorporate appropriate contextual biophysical, social, and governance characteristics into their planning processes to improve stakeholder response to these tools and policies.

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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.2018.01.024.

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