

When good intentions are not enough . . . Insights on networks of “paper park” marine protected areas

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Abstract

In efforts to protect the world's oceans, the Convention on Biological Diversity has moved the goal of establishing marine protected areas (MPAs) to cover 10% of the ocean from 2012 to 2020. This adjustment suggests that the rush to establish MPAs without proper resources does not resolve conservation problems. In fact, such actions may create a false sense of protection that camouflages degradation of marine ecosystems on regional scales. To exemplify this phenomenon, we reviewed MPA efficacy in the Gulf of California, Mexico, where some 23,300 km² have been decreed as MPAs. With the exception of Cabo Pulmo National Park, MPAs have not met conservation or sustainability goals. We examined MPA budgets and foundations' investment in the region and found that funding for management is not the limiting factor in MPA efficacy, although funding for enforcement may be deficient. We conclude that MPAs have failed because of insufficient no-take zones, lack of enforcement, poor governance, and minimal community involvement. We need a new philosophy to implement MPAs to take advantage of the scientific knowledge and monetary investment that have been generated worldwide and ensure that they complement effective fisheries management outside their borders.

Introduction

Protected areas are a common tool in both terrestrial and marine environments to conserve biodiversity and protect natural resources from overexploitation (Pimm *et al.* 2001; Gaines *et al.* 2010). Although primarily used to protect marine habitats, vulnerable species, and ecological processes from destructive human activities, marine protected areas (MPAs) can simultaneously enhance fisheries stocks via larval and adult spillover (Halpern 2003; Russ *et al.* 2004; Murawski *et al.* 2005; Goñi *et al.* 2010; Christie *et al.* 2010). MPAs can also improve community well-being and provide economic benefits via increased income from fisheries or tourism (social benefits summarized in Pimm *et al.* 2001; Himes 2007; Gaines *et al.* 2010). MPA design varies widely from complete no-take marine reserves where all extractive activities are prohibited to multiuse MPAs that permit certain levels of extraction and use (Halpern 2003; Russ *et al.* 2004; Murawski *et al.* 2005; Dudley 2008; Goñi *et al.* 2010; Christie *et al.* 2010).

As marine ecosystems continue to be damaged and overexploited, MPAs have gained considerable popularity as a management tool to counter these effects. The Convention of Biological Diversity (CBD) calls for the protection of at least 10% of the world's oceans via the establishment of MPA networks by 2020 (extended from 2012 [CBD 2010]); yet by 2010, approximately 6,000 MPAs covering only 1.17% of marine area had been established (Toropova *et al.* 2010). The target date adjustment to 2020 leaves us with a new opportunity to meet the CBD's goals of expanding protection and to reevaluate how we establish and govern MPAs worldwide.

The mere establishment of MPAs does not guarantee their success. When MPAs are simply decreed but insufficient resources are available for effective design, management, or enforcement, these become only “paper parks” that do not effectively restrict exploitation or access (White and Courtney 2004). There has been extensive research on MPA creation, benefits, and measures of success (e.g., Pomeroy *et al.* 2004; McClanahan

Table 1 List of MPAs in the Gulf of California

MPA	Abbrev.	Total area (km ²)	Total no-take area (km ²)	Year decreed	Year management plan	Year management plan published and implemented	International recognition
Cabo San Lucas Protected Area for Flora and Fauna	CSLPA	39.96	0.00	1973	none	n/a	World heritage site
Upper Gulf of California and Colorado River Delta Biosphere Reserve	UGCBR	9,347.56	882.50	1993	1996, renewed 2007	2009	Ramsar site, world heritage site, man and biosphere
Cabo Pulmo National Park	CPNP	71.11	25	1995	2006	2009	Ramsar site, world heritage site
Loreto Bay National Park	LBNP	2,065.80	1.30	1996	2000, in process of review	2003	Ramsar site, world heritage site
Islas Marias Biosphere Reserve	IMBR	6,412.84	148.40	2000	2000	2011	World heritage site, man and biosphere
Isla San Pedro Martir Biosphere Reserve	ISPMBR	301.65	11.1	2002	2007	2011	Ramsar site, world heritage Site, man and biosphere
Isla Marietas National Park	IMNP	13.83	0.8	2005	2008	2011	Ramsar Site, world heritage site, man and biosphere
San Lorenzo Archipelago National Park	SLANP	584.428	88	2005	None	n/a	World heritage site
Espiritu Santo Archipelago National Park	ESANP	587	6.7	2007	None	In review 2011	
Los Angeles Bay, Canal de Ballenas y de Salsipuedes Biosphere Reserve	LABBR	3,879.56	2.10	2007	None	In review 2011	
Total		23,303.74	1,165.90				

et al. 2007; Banks & Skilleter 2009; Hargreaves-Allen *et al.* 2011), but clear examples of success (Russ *et al.* 2004; Aburto-Oropeza *et al.* 2011) are rare. Research findings instead show that MPAs have generally been unsuccessful in meeting their goals; failures far outnumber the successes and are seen around the globe (e.g., Francour *et al.* 2001; Guidetti *et al.* 2008; Frascchetti *et al.* 2009). MPA failure has been linked to community disapproval (Himes 2007), continued overexploitation, lack of enforcement (Byers & Noonburg 2007), insufficient funds (Bruner *et al.* 2004), and inability of MPAs to address exterior issues (discussed in Boersma & Parrish 1999). Good guidelines exist for MPA creation (e.g., Fox *et al.* 2012) but have yet to be effectively implemented to meet the CBD's goal.

The rush to establish MPAs without proper resources, planning, or governance mechanisms (McCay & Jones 2011) has created networks of paper parks that are intended and anticipated to provide numerous ecological and socioeconomic benefits, such as population connectivity (Planes *et al.* 2009), spillover (Russ *et al.* 2004), and resilience against climate change impacts (McLeod *et al.* 2009) but in actuality may be indistinguishable from surrounding areas. The continued push for MPAs may lead to their hasty creation and a false sense of protection of

marine ecosystems. This is not because of a lack of good intentions, but because of insufficient no-take areas, poor governance and enforcement, few socioeconomic incentives for compliance, conflicts among sectors, and little community involvement in management.'

The aquarium of the world

To exemplify this phenomenon of paper park networks, we have chosen to examine the Gulf of California (GOC), Mexico. Also known as the Sea of Cortés, the GOC was designated a UNESCO World Heritage Site in 2005, has multiple RAMSAR sites, and is globally recognized as a biological hotspot and a priority region for conservation (Roberts *et al.* 2002; Carvajal *et al.* 2004; Enríquez-Andrade *et al.* 2005; Morgan *et al.* 2005; CONABIO *et al.* 2007). Protected areas are a focal point for the Mexican government, managed by the National Commission for Protected Areas (CONANP), and used to protect biodiversity and control extraction of natural resources (CONANP 2007). This dual purpose has led to the creation of ten multiuse MPAs in GOC, covering important fishing grounds and communities, with little total no-take area, in an attempt to balance diverse human uses with protection of ecological processes (Table 1; Figure 1).

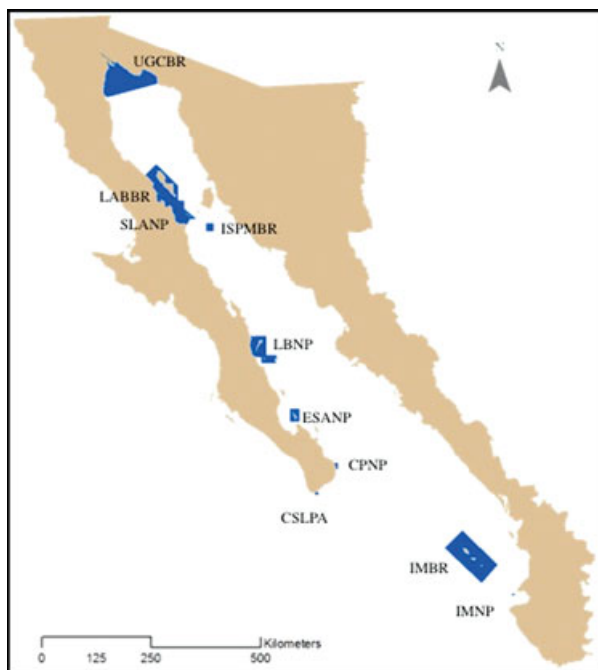


Figure 1 Map of MPAs in the Gulf of California. Blue denotes MPA area.

Specific management objectives fall within these broad categories and may include¹: protection of biological processes, protection of spawning sites and genetic diversity, sustainable use of marine resources, environmental education and the promotion of scientific research, align-

ment of extractive activities with conservation goals, and economic viability of the local community (Figure 2). The establishment of these MPAs occurred in response to different sociopolitical contexts and environmental issues (see “History of Protection” in Supporting Information).

The GOC currently has 23,304 km² of MPAs (ca. 9% of the total marine area) and has received more international recognition than many areas of the world by academics and universities, funding institutions, and approximately 50 conservation-oriented nongovernmental organizations (NGOs; both national and international) that operate in the region. Nevertheless, we find that MPAs have generally been unsuccessful in meeting either their fisheries or conservation objectives. We evaluate MPA success from this interdisciplinary perspective, which encompasses biological and socioeconomic advancements (Pollnac *et al.* 2001; Christie 2004). Biological success is measured by the recovery of the ecosystem (e.g. increased abundance and average body size of fishery resources as compared to outside areas), whereas social success is assessed by standards such as level of stakeholder participation, degree of adherence to rules, community perception of success, conflict resolution, and/or economic benefits. The GOC example illuminates the wider problems that MPAs face globally, and demonstrates that this failure is because of insufficient no-take zones, lack of enforcement, poor governance, and minimal community involvement.

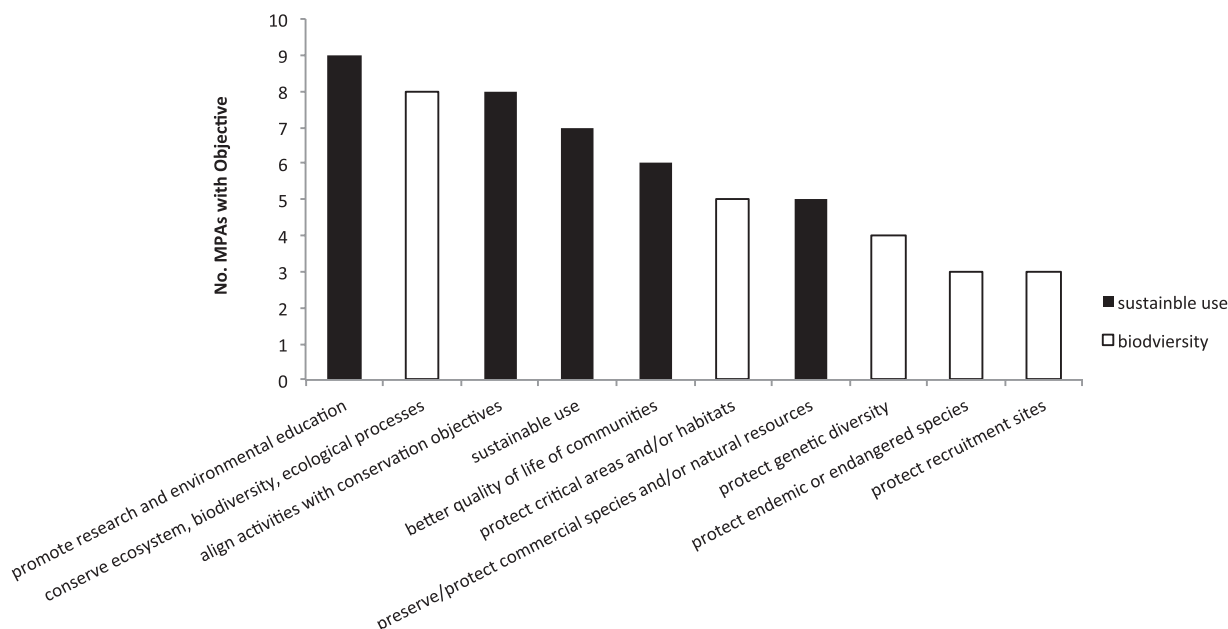


Figure 2 Occurrence of objectives in MPA management plans. Solid shows objectives that fall into sustainable use category and clear of biodiversity conservation.

Table 2 Successes within MPAs (Citations in supporting information)

Success	MPA examples	Sources	Brief description
Ecotourism	CPNP	Weiant 2005; El Universal 9/9/2009	Recreational diving
	BLABR/SLNP ^a	Rodriguez-Dowdell <i>et al.</i> 2007; Cardenas-Torres 2007 <i>et al.</i> ; La Jornada Ecologica 3/30/2009, C. Godinez personal communication, 2011	Whale shark conservation via community efforts
	AESNP	López-Espinosa de los Monteros 2002, La Jornada Ecologica 3/30/2009	Ecotourism contributes to conservation efforts
Community support of MPA and/or conservation	UGCBR	El Universal 8/5/2008	Community driven
	CPNP	Weiant 2005; Aburto-Oropeza <i>et al.</i> 2011; El Universal 9/9/2009	
	LBNP	Sáenz-Arroyo <i>et al.</i> 2005; ANR unpublished data, El Sudcaliforniano 8/16/2011	Belief in need for conservation
Support of science	ISPM	Sáenz-Arroyo <i>et al.</i> 2005	
	all	Danneman 2002; Carvajal 2004; Brusca 2005, Espinoza-Tenorio 2011; BE and OAO personal communication, 2011	
Protection and recovery	CPNP	Aburto-Oropeza <i>et al.</i> 2011	Fish aggregation recovery
Marine mammals	Gulf wide	Szteren <i>et al.</i> 2006; Pompa <i>et al.</i> 2011	Sea lion populations, important region
Sea turtles	Gulf wide	Seminoff 2010	
Seabirds	Gulf wide	Velarde <i>et al.</i> 2004	Populations on Isla Rasa
	UGCBR	Hinojosa-Huerta <i>et al.</i> 2004; Hinojosa-Huerta <i>et al.</i> 2008	Wetland avifauna
Others			
Fisheries regulations advancements	Gulf wide	García-Caudillo <i>et al.</i> 2000	By catch reduction
	UGCBR	CIRVA 2012	Inventive economic incentive buyout program (but see Erisman 2011)
		Pérez-Valencia <i>et al.</i> 2011	Environmental impact assessment

^aWe have grouped BLABR/SLNP together because the parks adjoin and often research does not distinguish between one and the other.

Successes

We examine MPA's management objectives to identify successes in the GOC from both socioeconomic and biological views (Table 2).

Extensive research

Support for and promotion of scientific research within MPAs of the GOC is widespread as evidenced by the number of books and publications generated in the region (Cariño *et al.* 2004; Brusca 2010; Espinoza-Tenorio *et al.* 2011). Numerous groups have worked in the region for decades and have been involved in the development of management regulations and in monitoring changes (e.g., Brusca 2010). There are more than 400 peer-reviewed publications and 50 books on conservation subjects in the GOC².

Species recovery

Quantitative evidence of species recovery because of MPAs is scarce. A community-declared, unofficial MPA

in the UGCBR showed recovery of targeted invertebrates (Cudney-Bueno *et al.* 2009), but the system collapsed because of noncompliance and poaching (Cudney-Bueno & Basurto 2009). A de facto MPA south of UGCBR has higher biomass than nearby areas (Torre, unpublished data). CPNP, the only well-enforced and complete no-take MPA³ in GOC, has experienced dramatic recovery of fish biomass, concentrated in top predators, within a 10-year time period (Aburto-Oropeza *et al.* 2011). CPNP historically faced many of the same problems as other MPAs, but the community's initiative to enforce a strict no-take area has led to its success (Weiant 2005). Ecotourism has become an important alternate livelihood for residents of Cabo Pulmo, where tourism-related activities involve the entire population.

Economic investment

For protected areas to be successful in meeting their objectives, effective management is crucial (Bruner *et al.* 2004), and requires sufficient financial resources. A lack of adequate financial support is often a factor in protected areas failing to meet objectives (Wilkie *et al.* 2001).

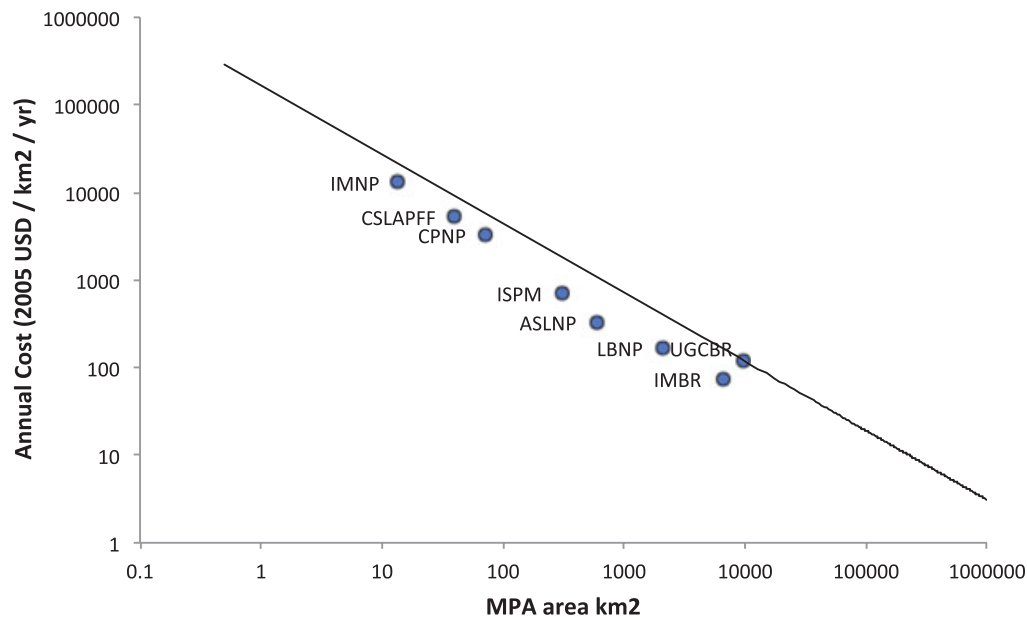


Figure 3 Government budget as compared to theoretical cost of MPA maintenance. Theoretical cost based on McCrear Strub *et al.* 2011 (solid line). Solid circles show annual budget of each MPA.

Costs required for the maintenance of MPAs have been shown to be proportional to the size of the MPA—with smaller MPAs being more expensive to run per unit area (Balmford *et al.* 2004; Gravestock *et al.* 2008; Cullis-Suzuki & Pauly 2010). We obtained budgets from CONANP for GOC MPAs and compared this information to the theoretical cost of running an MPA, using McCrear-Strub *et al.*'s model (Alcala & Russ 1990; Alcala 1998; Steneck *et al.* 2009; McCrear-Strub *et al.* 2011), updated from Balmford *et al.*'s (2004). We found that the average annual budget for MPAs per unit area in GOC is very close to the theoretical cost (Figure 3). The budgets we examined did not include money from other agencies involved in MPA management, so government investment is likely more than we show here.

Supplementation of official budgets can be accomplished via financial contributions from NGOs and foundations (González Montagut 2003; Bruner *et al.* 2004). Many U.S.-based foundations have programs in the GOC that direct money to institutions working within the area (e.g., Schneller & Baum 2010). In addition, the Fondo Mexicano para la Conservación de la Naturaleza (FMCN) organizes and distributes funds from multilateral and international foundations to support protected areas throughout Mexico (see “Budgetary Information” in Supporting Information). These foundations give over USD\$5,000,000 annually to scientists, NGOs, and government efforts in support of research and community-based projects. Combined, these funds represent a suffi-

cient level of investment in MPA management and conservation efforts in the region.

Major challenges

Similar to elsewhere around the world, MPAs in the GOC face a wide range of challenges related to governance, enforcement, overfishing, and social conflict (Table 3) that have thus far impeded their ability to achieve success in protecting biodiversity or creating sustainable fisheries.

Governance

Governance of marine area and resources in Mexico may confound the potential effectiveness of MPAs. In Mexico, the National Commission of Aquaculture and Fisheries (CONAPESCA) administers fisheries regulations, and CONANP manages protected areas. Fisheries, however, exist within MPAs, which aim to help sustain fisheries resources, resulting in a spatial overlap of jurisdiction between these agencies. However, CONANP does not have the jurisdiction to directly enforce the regulations they create within protected areas. Instead, enforcement of MPA rules is the responsibility of the Federal Agency for the Protection of the Environment (PROFEPA), whereas fisheries regulations are enforced by CONAPESCA, both with support from the Navy (OECD 2006). The division of regulatory and enforcement

Table 3 Challenges and problems within MPAs (Citations in supporting information)

Problem	MPA example	Sources	Brief description
Ineffective and/or insufficient enforcement	Gulf wide	Bezaury-Creel 2005	
	UGCBR	Lecari and Chávez 2007; Rowell <i>et al.</i> 2008; Rodríguez-Quiroz 2008; Cudney-Bueno and Basurto 2009; Aragón-Noriega <i>et al.</i> 2010; Moreno-Báez <i>et al.</i> 2010; Rodríguez-Quiroz <i>et al.</i> 2010; Bobadilla <i>et al.</i> 2011; Gerrodette and Rojas-Bracho 2011; Erisman <i>et al.</i> 2012; El Universal 3/8/2008, El Universal 3/22/2002	Illegal fishing high, fishing in vaquita refuge continues
	BLABR/ASLNP ^a	Danneman 2002	No presence
	LBNP	Cudney-Bueno <i>et al.</i> 2009; Stamies 2009; Wielgus <i>et al.</i> 2009	Insufficient
Overfishing and lack of fishing regulation	ISPMBR	Sonora Insulario March 2005; Cudney-Bueno <i>et al.</i> 2009; Fujitani 2010	Continued fishing in core zones
	Gulf wide	Herandez and Krempton 2003; Carvajal <i>et al.</i> 2004, Brusca <i>et al.</i> 2005; Lluch-Cota <i>et al.</i> 2007; Ramirez-Rodriguez 2011, Kalikoski <i>et al.</i> 2011; Moreno-Báez <i>et al.</i> 2012; El Universal 8/18/2000, El Universal 7/16/2007, El Universal 12/24/2009	
	UGCBR	Barrera Guevara 1990; Cudney-Bueno and Turk-Boyer 1998; All 2005, Lecari and Chavez 2007; Rowell <i>et al.</i> 2008; Rodríguez-Quiroz 2008; Lozano-Montes <i>et al.</i> 2008; Rodríguez Quiroz <i>et al.</i> 2009; Erisman <i>et al.</i> 2010; Moreno-Báez <i>et al.</i> 2010; Rodríguez-Quiroz <i>et al.</i> 2010, Bobadilla <i>et al.</i> 2011; Erisman <i>et al.</i> 2012; Moreno-Báez <i>et al.</i> 2012	High levels of exploitation by too many artisanal fishers
	LBNP	Wielgus <i>et al.</i> 2007; Rife <i>et al.</i> in review	Commercially important species declining
	IMBR	Pérez-Jiménez <i>et al.</i> 2005, Morgan <i>et al.</i> 2005; Mascareñas-Osorio <i>et al.</i> 2011	Low abundance of commercially important species
	ISPMBR	Torre and Sáenz-Arroyo 2005; Cudney-Bueno <i>et al.</i> 2009; Fujitani 2010	Continued fishing in core zones
	BLABR/ASLNP ^a	Danemann 2002; CONANP 2004; Danemann and Ezcurra 2008; Sáenz-Chávez and Danemann 2008; Cinti <i>et al.</i> 2010	Overexploitation
	AESNP	Diaz-Urbe <i>et al.</i> 2007	Low abundance of commercially important species
	Gulf wide	Brusca <i>et al.</i> 2005; El Universal 7/16/2007, El Universal 4/8/2003	
	UGCBR	D'Agrosa <i>et al.</i> 2000; Glenn <i>et al.</i> 2001; Brusca <i>et al.</i> 2005; Carvajal <i>et al.</i> 2004; Rojas-Bracho <i>et al.</i> 2006, Rodríguez-Quiroz <i>et al.</i> 2008; Rowell <i>et al.</i> 2008; Aragón-Noriega <i>et al.</i> 2010; Gerrodette <i>et al.</i> 2010; Ainsworth 2011, Gerrodette and Rojas-Bracho 2011, El Universal 3/8/2008, El Universal 3/22/2002	Vaquita and totoaba populations continue to decline; Damage from trawlers
Ecosystem degradation: loss of biodiversity and/or biomass and habitat damage	LBNP	Sáenz-Arroyo <i>et al.</i> 2005; Cudney-Bueno <i>et al.</i> 2009, Rife <i>et al.</i> in review	Decreased biomass
	CPNP	Reyes Bonilla & Alvarez-Filip 2008	Simplification of community structure
	BLABR/ASLNP ^a	Mascareñas-Osorio <i>et al.</i> 2011	Low abundance of commercially important species
	IMNP	Pompa Mansilla 2007	Extraction

Continued

Table 3 Continued

Problem	MPA example	Sources	Brief description
Coastal development	Gulf wide	Murray 2007, Sign on San Diego 8/30/2005, El Universal 10/17/2007, 11/23/2001, 8/16/2005, 11/7/2003, 4/8/2003, 8/17/2005	
	LBNP	Steinitz <i>et al.</i> 2005, Lopez-Sagástegui and Sala 2006, El Universal 2/29/2008, 8/16/2005	Mega resorts
	CPNP	La Cronica 7/29/2011, El Universal 5/21/2011, El Sudcaliforniano 7/7/2011, El Sudcaliforniano 5/19/2010, El Universal 8/2/2010, La Jornada 3/10/2011, La Jornada 8/16/2011, El SudCaliforniano 8/19/2010	Planned development
	AESNP	El Universal 8/28/2005	Continued development
	CSLAPFF	CONABIO <i>et al.</i> 2008, El Universal 8/16/2005	High levels development
	Gulf wide	El Universal 4/24/2003, El Universal 8/17/2005, El Universal 8/16/2005, El Universal 11/23/2001, El Universal 12/31/2007	
	UGCBR	Carvajal <i>et al.</i> 2004; Rodriguez-Quiroz 2008; Lozano-Montes <i>et al.</i> 2008, El Universal 4/24/2005, El Universal 8/17/2005, El Universal 8/15/2005, El Universal 4/24/2005, 4/8/2005	High social conflict between user groups (vaquita issue and cucapas)
User conflict and/or lack of community involvement	LBNP	Stamieszkin <i>et al.</i> 2009; Peterson 2010	Exclusion of some user groups, perception of some that park not meeting its goals
	AESNP	El Universal 5/29/2001	Discontent
	CSLAPFF	CONABIO <i>et al.</i> 2008	Tourism, fishers, conservationists
Others			
CO river	UGCBR	Glenn <i>et al.</i> 2001, 2005; Hinojosa-Huerta 2004, All 2005, Hinojosa-Huerta <i>et al.</i> 2008; Rodriguez-Quiroz 2008; Rowell <i>et al.</i> 2008	Lack of flow unknown consequences and habitat loss
Tourism	Gulf wide	Tershy 1998, Young 1999, El Universal 8/2/2008, 8/17/2005	
	IMNP	Pompa Mansilla 2007	Increasing tourism activities
	AESNP	López-Espinosa de los Monteros 2002; Barr and Mourato 2009	
	BLABR/ASLNP ^a	Rodriguez-Dowdell <i>et al.</i> 2007; Cardenas-Torres <i>et al.</i> 2007	Whale shark ecotourism growing, fear of animal mistreatment
	CSLAPFF	CONABIO <i>et al.</i> 2008	High levels of tourism
Pollution	Gulf wide	Mendez <i>et al.</i> 1998; Galiendo <i>et al.</i> 1999a, 1999b; Heredia-Tapia <i>et al.</i> 2002; Alonso-Rodríguez and Páez-Osuna 2003; Cadena-Cárdenas <i>et al.</i> 2008; Ruelas-Inzunza <i>et al.</i> 2008; Ruiz-Fernández <i>et al.</i> 2009	
	IMBR	Morgan 2005; Santos del Prado <i>et al.</i> 2006; OEM 12/13/2009	Human waste
	IMNP	Pompa Mansilla 2007	Insecticide and herbicide contamination
	AESNP	Méndez <i>et al.</i> 1998	Ecotourism costs not sufficient to cover fishers costs
	CSLAPFF	CONABIO <i>et al.</i> 2008	Contamination

^aWe have grouped BLABR/SLNP together because the parks adjoin and often research does not distinguish between one and the other.

responsibility undermines the ability of these agencies to effectively manage and regulate fisheries and MPAs. Combined with low presence (see below), this loose enforcement has spawned a culture of noncompliance by stakeholders.

Enforcement

A large enforcement presence within an MPA system is a critical aspect of its success, as the power of enforcement is in its deterrent effect (Furlong 1991). Conditions

in GOC MPAs (remoteness, large area, zonation, and ill-navigable area) make enforcement particularly difficult. We were unable to measure presence/absence of enforcement in MPAs beyond anecdotal evidence that enforcement simply does not exist (Cudney-Bueno *et al.* 2009; Cudney-Bueno & Basurto 2009). However, in 14 years of reef surveys program along the GOC (see Sala *et al.* 2002; 2004; Aburto-Oropeza *et al.* 2007, 2009, 2011), with some 700-site trips, we have rarely seen vigilance boats.

The institutional design outlined above further complicates efforts to conduct enforcement in MPAs. CONANP must sign an agreement with PROFEPA in order for enforcement to occur in the MPA; currently only four MPAs in GOC have this agreement (UGCBR, CPNP, LBNP, and CSLAPFF). Furthermore, PROFEPA is woefully understaffed (14 people in Sinaloa, Sonora, Baja California, Baja California Sur), especially in light of the enormous workload they are responsible for (23,300 km² within MPAs). Likewise, CONAPESCA has a staff of less than 10 people in the GOC, which has the three most profitable fisheries states in Mexico (Sonora, Sinaloa, and Baja California Sur). In a given year there are nearly 18,000 artisanal boats (*pangas*) that work in the GOC with an average of nearly 36,000 labor days (Cisneros-Mata 2010). With such low presence, these agencies simply cannot provide sufficient enforcement for compliance with regulations. As discussed above, enforcement requires simultaneous participation and coordination between several government agencies. This undermines compliance as rule-breakers are aware of difficulties in punishing offenders resulting from the division of power.

Without proper enforcement capabilities, illegal fishing is rampant, with estimates of unpermitted fishers around 50% (personal communication), pervasive fishing in the no-take zone of the UGCBR (Erisman *et al.* 2012) and up to 20% of illegal fishing in the region (Agnew *et al.* 2009). Ainsworth *et al.* (2011) show that full compliance of regulations in the UGCBR would allow for increases in protected species biomass and slow degradation that results from overfishing. As MPAs cannot succeed without some form of vigilance and enforcement of rules (Byers & Noonburg 2007; Fujitani *et al.* 2012), and given the small staff and limited enforcement budgets of both CONAPESCA (OECD 2006) and PROFEPA, the current arrangement must change to effectively enforce MPA regulations as well as fishing regulations outside park borders.

Overfishing and ecosystem degradation

Causation of degradation of ecosystems is difficult to prove, but is most often related to overfishing (Jackson

et al. 2001) and demonstrated by the “fishing down the food web” phenomena (Pauly *et al.* 1998). Fisher anecdotes are used to measure the extent of overfishing in the GOC and indicate that degradation has occurred along the coast throughout the region (Sala *et al.* 2004; Sáenz-Arroyo *et al.* 2005a, b; Lozano-Montes *et al.* 2008). Capture in LBNP follows this trend, and the trophic group distribution there (Rife *et al.* in review) is characteristic of a degraded ecosystem (DeMartini *et al.* 2008). In UGCBR, several fish species caught by small-scale fishers are maximally or overexploited (Erisman *et al.* 2010). The collapsed totoaba fishery drove the creation of UGCBR (Bobadilla *et al.* 2011), but populations have not been shown to improve since its federal protection in 1974, and other important fisheries may soon follow. This is likely to be occurring for many reef fish species in other MPAs, as fishers target the species during its spawning aggregation season (Erisman *et al.* 2010). Biological monitoring of reefs throughout MPAs find few top predators and significant fish biomass reductions (e.g., Moncayo-Estrada *et al.* 2006; Cudney-Bueno *et al.* 2009; Mascareñas-Osorio *et al.* 2011; Aburto-Oropeza *et al.* 2011; Erisman *et al.* 2011). Fishing places the largest stress on marine resources in the region and is therefore of the greatest need to enforce and regulate properly, both within and out of MPAs.

Social conflict

Using MPAs as fisheries management tools is inherently challenging, often related to fishers’ resistance to increasing regulation in the midst of an already difficult livelihood (McCay & Jones 2011). The success of MPAs is linked to the involvement and support of stakeholders and local communities in MPA management (Cudney-Bueno & Basurto 2009). However, conflict abounds in fishing communities in the GOC and a general lack of community cohesiveness threatens many coastal communities, including those located near MPAs (Cudney-Bueno *et al.* 2009; Cinti *et al.* 2010b). There is little incentive to comply with rules (Cinti *et al.* 2010b), assuming that the community is even aware of MPA regulations and objectives. Stakeholder participation in management may be low or restricted to a few individuals, for example in BLABR (Ramírez-Sánchez 2007) and LBNP (Peterson 2010). This may be because of the top-down management approach, which can result in a disconnect between stakeholders and managers (Nava & Ramírez-Herrera 2011). In UGCBR, conflict between small-scale fishers, indigenous groups, and authorities over dwindling fisheries stocks and the endangered vaquita has undermined management and conservation efforts (Ezcurra *et al.* 2009; Bobadilla *et al.* 2011).

Conclusions

Effective governance must be in place to ensure that paper parks with little hope of achieving any measurable success do not continue to be established (discussed in Toropova *et al.* 2010; Jones *et al.* 2011; McCay & Jones 2011; Cressey 2011). Although the specifics outlined in this study are unique to the GOC, the challenges and problems themselves pervade MPAs worldwide. Despite significant investment in implementation, research and monitoring, and many good intentions, GOC MPAs function as paper parks due primarily to the governance and related enforcement issues outlined above. This analysis has illuminated major, intertwined challenges in MPA management that are faced worldwide: community support, balance of fisheries and conservation goals, governance, and enforcement.

Funding by foundations and for CONANP is allocated for projects that are often geared toward the education of stakeholder groups regarding proper use, regulations, and benefits of MPAs, but this investment simply cannot compensate for the lack of enforcement. Enforcement presence is low throughout the region, and this may be related to lack of financial resources (Sutinen 1999) for CONANP and PROFEPA (OECD 2006), even though we have shown that funding for conservation and MPA management is not a restriction in the GOC. Current governance structure has made proper enforcement practically impossible, diminishing the ability of MPAs to be successful. Without a proper arrangement between the involved agencies to distribute management resources, the continued establishment of MPAs by CONANP will continue to burden CONAPESCA and PROFEPA. Before 2001, the fisheries and protected area agencies were both within the Environment Secretariat, which has since been dissolved. As MPAs have significant overlap with fisheries, this set-up would likely result in a more streamlined and efficient governance structure. Direct involvement of the community in MPA management via the establishment of community-based enforcement groups and sharing of enforcement jurisdiction with CONANP (Cudney-Bueno *et al.* 2009; Cudney-Bueno & Basurto 2009; Cinti *et al.* 2010b; 2010a) and the creation of proper economic incentives could be the most probable way to confront these problems (McCay & Jones 2011) and consolidate a true network of protected areas.

Without a serious reevaluation of governance, the ability of MPAs in the GOC to contribute to conservation efforts or sustain fisheries is highly limited. As discussed, the current jurisdictional design in GOC is ineffective in balancing the needs of the protected area and fisheries. This situation is not unique to Mexico; indeed in many

countries, including the United States, there is significant overlap among agencies and division of responsibilities is not always clear or of the most efficient design. Failure to clearly delineate or coordinate efforts among agencies has likely resulted in this failure of governance. Co-management has been suggested as a way to increase compliance and effectiveness of fisheries management (Ostrom 1990; Gutiérrez *et al.* 2011) and this cooperation is also critical in allowing MPAs to function at the local level (Lundquist & Granek 2005). Jones *et al.* (2011) show that balance between top-down and bottom-up mechanisms is necessary for effective marine governance. A co-management arrangement would create the necessary incentives (discussed in McCay & Jones 2011) for improving MPA governance and allow for the creation of locally appropriate adaptive regulations whereas remaining within the larger institutional framework already present. Co-management can also ensure that the rights and needs of indigenous groups be considered directly, rather than separately as is currently the case (CDI 2009). Official concessions to permit community groups to enforce areas or regulations exist on the Pacific coast of Baja (Cota-Nieto 2010; Revollo Fernández & Sáenz-Arroyo 2011) and are called for by many groups (Ezcurra *et al.* 2009; Cudney-Bueno & Basurto 2009; Cinti *et al.* 2010a), but this has not been widely applied in GOC or most areas globally. The community involvement demonstrated in CPNP demonstrates that if this system is embraced, we can expect MPAs to achieve success. If co-management is established, then we expect the community to resolve the issues surrounding institutional design and improve MPA functionality, including in enforcement (Fujitani *et al.* 2012) and monitoring and evaluation for adaptive management strategies.

Once effective governance is in place, we suggest that no-take zones be expanded to allow for ecosystem recovery. On average, only 5% of each MPA in the GOC is no-take; this has not led to the recovery of targeted resources as often promised to fishers. Current no-take zones are simply not large enough to allow recovery of fish assemblages or provide social benefits and are indistinguishable from open access areas (as shown in LBNP [Rife *et al.* in review]). By expanding no-take areas, we expect recovery to occur so that benefits may spillover into surrounding areas, thus fulfilling societal expectations and building social support for MPAs. Optimal size for no-take zones is difficult to define, but CPNP (only 71.11 km²) has been large enough to permit recovery and the rocky reef environment and fish composition is similar to other MPAs (Hastings *et al.* 2010). Likewise, co-management of surrounding buffer, multiuse zones will prevent further degradation and allow social objectives to be

met. Expanded well-enforced no-take zones and comanagement multiuse MPAs will fulfill both conservation (recovery and protection of biodiversity) and fisheries (productivity and sustainability) goals.

The 2020 timeline set forth by the CBD is a renewed opportunity to conserve the marine environment via MPAs, but we should not rush to establish more “paper park” MPAs that contribute to the false sense of protection of marine resources and ecosystems. We need a new philosophy to implement MPAs to take advantage of all the scientific knowledge and monetary investment that have been generated worldwide and ensure that they complement effective fisheries management outside their borders (Hilborn *et al.* 2004). We expect that MPAs with increased no-take area, comanaged buffer zones, effective enforcement, and an improved governance structure will meet the CBD’s goal with a higher probability of demonstrated ecological recovery and social benefits. Future design of MPAs should be based in biological as well as social dimensions: where is the community interested? Where can comanagement schemes be established? And when the system recovers, how can we increase socioeconomic incentives to continue to protect the area? The incorporation of the local community into management practices has occurred in other regions (e.g., Apo and Sumilon [Alcala & Russ 1990; Alcala 1998; Steneck *et al.* 2009]), but we have not seen this proven successful model turned into a worldwide strategy. MPAs new philosophy should be supported by investments from financial institutions to establish large no-take areas managed under comanagement schemes with better intragovernment cooperation, enhance socioeconomic incentives, and improve enforcement.

Who will lead this strategy? What is the first step? How will governments and communities come together to create effective MPAs? If we do not answer and then act upon these questions, we will likely reach 2020 without accomplishing the CBD’s goal, and with only more networks of paper parks that require significant resources to maintain yet provide little ecological, social, or economic benefits.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher’s web site:

History of Protection.

Budgetary Information. (Tables 2 and 3).

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Notes

- (1) We obtained drafts of the management plans for AESNP, BLABR, and ASLNP from the directors of these Parks as the plans have not yet been published.
- (2) We performed a web of knowledge search for the terms "conservation" and "Gulf of California" revealing 431 publications and a search on non-fiction science books related to GOC on Amazon.
- (3) Officially, only 35% of the area is no-take, but the community enforces a 100% no-take area. However, subsistence fishing by local residents is permitted.