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Management of a marine protected area for sustainability and conflict resolution: Lessons from Loreto Bay National Park (Baja California Sur, Mexico)

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ABSTRACT

The Loreto Bay National Park was established to protect the area's ecosystems from habitat destruction and overexploitation. However, the park has not met two of its primary goals: recovery of commercially valuable fish populations and their sustainable use by stakeholders. Based on evidence from the literature, dialogue with stakeholders, a literature review on using recreational fees for marine protected area (MPA) management, and an economic valuation survey, we provide practical guidelines for addressing factors hindering the park's success. These include: 1) the implementation of management based upon ecosystem science, and rigorous monitoring of park ecosystems, 2) increased communication among stakeholder groups, outreach and education, and 3) a re-organization of the park's administrative structure that would allow for more efficient use of funds. Our results also suggest that the park entrance fee could be raised to support these proposed improvements.

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1. Introduction

The Gulf of California, a narrow strip of sea between the Baja California peninsula and mainland Mexico, is an ecologically unique and highly productive ecosystem [1–5]. The Gulf, also known as the Sea of Cortez, is home to one-third of the world's marine mammal species, as well as approximately eight hundred fish species [6]. It supports many important commercial and recreational fisheries [7]. In the early 1990s, the marine and coastal habitats in the Bay of Loreto, located in the southern Gulf of California (Fig. 1), began to noticeably deteriorate and it was recognized that commercially important fish populations were decreasing in number [8], due to over-fishing and fishing practices destructive to the marine habitat [9–12]. In response to concern about this decline as well as several years of petitioning by local communities, tourists, scientists, and the international conservation community, the Mexican government established the 2056 km² Loreto Bay National Park (LBNP), which covers Loreto Bay's coastline, islands, and sea (Fig. 1). The park was formally

established in 1996, while the management plan, which is reviewed and revised every five years, was not finalized until 2000 [13]. Although fishing methods that had a high impact on the area's habitat, such as bottom trawling, are banned in the park's waters, other forms of commercial and recreational fishing are still allowed. As a result, fish populations continue to decline within the park [12,14].

The LBNP exemplifies the challenges faced by managers of marine protected areas (MPAs) worldwide. Although MPAs have received wide attention as potentially useful approaches to recover and sustain exploited marine resources, their management is often impeded by pressure placed on managers by different stakeholder groups, which frequently resist restrictions imposed on the use of the resources [15,16]. In this paper, we examine the challenges that have arisen in Loreto Bay, and discuss potential mechanisms to improve management of the LBNP so that conflicts among different stakeholders are minimized. An overview of the LBNP is presented, including a description of how Loreto's marine resources are used, a description of the park's management plan and administration, and the current ecological and socioeconomic situation in the park. We describe the issues that currently prevent the success of the park and the causes of these issues, as well as propose a number of local-level solutions based upon dialogue with stakeholders, literature on recreational user fees for MPAs, and an economic valuation survey. We conclude with some general suggestions for conflict resolution that could be implemented in other MPAs facing similar challenges worldwide.

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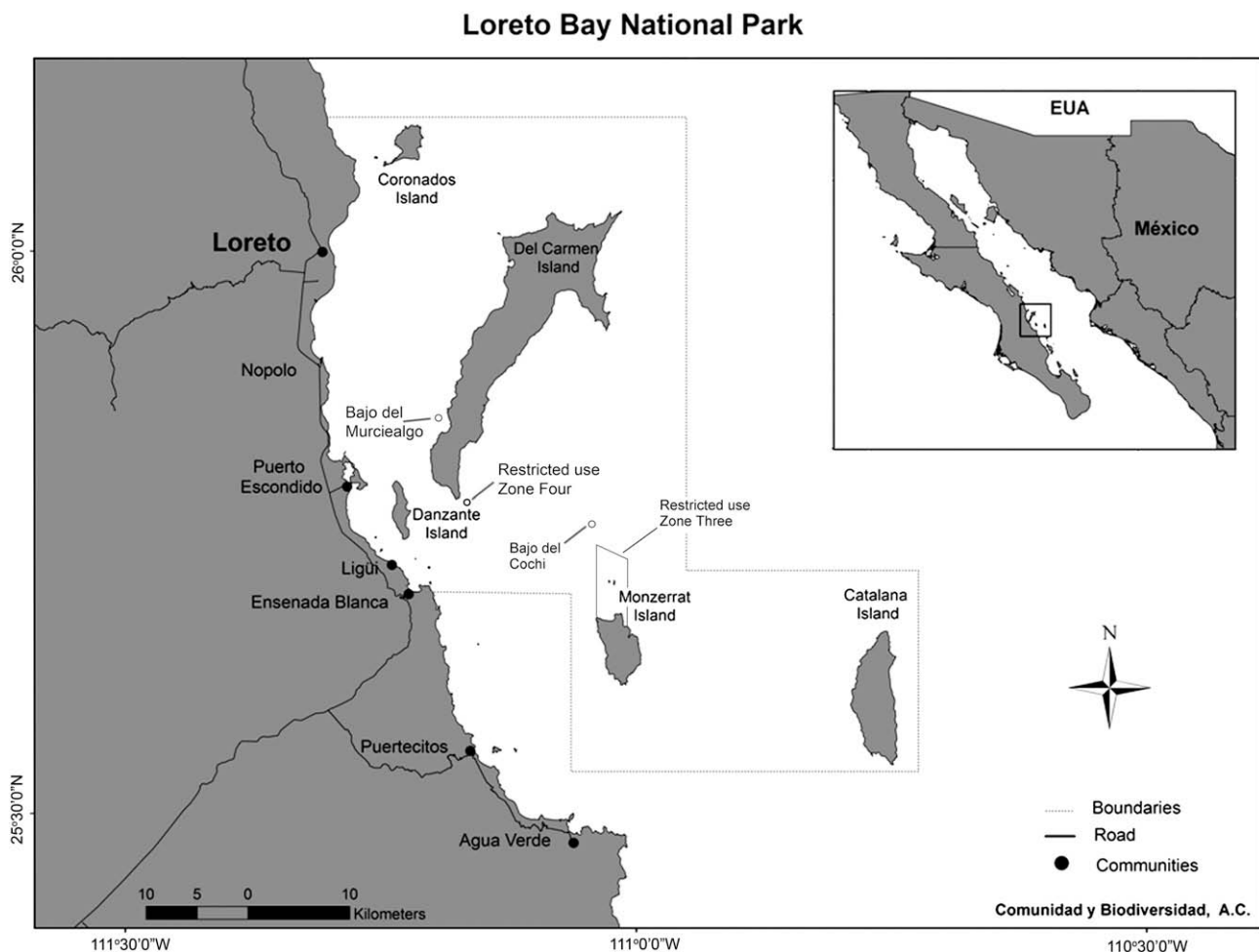


Fig. 1. Map of Loreto Bay, indicating the Loreto Bay National Park boundaries, the seamounts that make up the park's Protection Zones (Bajo del Cochi Bajo del Murciealgo), boundaries of restricted use Zones Three and Four, and the towns and islands included inside or adjacent to the park.

2. Context: Loreto Bay National Park

2.1. The use of marine resources at the LBNP

The town of Loreto (population 12,000) (Fig. 1) is home to 80% of the human population of the LBNP [7]. Loreto's economy depends on fishing in three capacities: subsistence fishing for personal consumption, commercial fishing by local fishers for sale in local, national, and international markets, and recreational sport fishing, mostly by foreign visitors [7]. Some individuals engage in multiple types of fishing activities. For example, *pangueros*, local fishing boat captains who take tourists on fishing excursions, often practice commercial fishing in the winter when the demand for sport fishing services is low (R. López-Esinosa, LBNP Management Authority, personal communication). Many commercial fishermen also practice subsistence fishing (K. Stamieszkin, personal observation). In 2001, it was estimated that 1176 residents of Loreto (approximately 10% of the population) fished for a living, making up 12 cooperative societies and more than 15 organized markets for the commercial sale of fish, as of 2001 [7].

Commercial and subsistence fishing are common in much of coastal Baja California, but recreational fishing centers around specific locations. Loreto is world-renowned for its sport fishing and historically has been one of the most visited locations by sport anglers in the Gulf of California [15]. In the 1950s the first sport fishing lodge was opened in Loreto [9,17], paving the way for

a small-scale industry that continues to bloom [7,15]. Today, there is a number of charter fishing companies, as well as numerous individual *pangueros* [7]; in 2007, approximately 3936 visiting anglers fished in the LBNP (R. López-Espinosa, LBNP Management Authority, personal communication). Sport fishing and its associated services bring a large profit into Loreto's economy each year, making fish populations offshore of Loreto an important economic resource for the local population [7]. Although no specific information was found on the contribution of sport fishing to the Loreto economy, it is considered that the region's economy currently depends heavily on sport fishing [11].

The LBNP is also an important ecological resource. Commercially fished bony fish such as grouper, snapper and jack spawn on islands, exposed rocky reefs and seamounts, like those found within the LBNP (Fig. 1), making those geologic features of biogeographical significance [18]. Larger pelagic species of billfish, tuna and dorado, often targeted by sport or commercial fishers, reproduce at the mouth of the Gulf of California [19–21] and then migrate north to feed, aggregating around topographic features such as the seamounts [22] (Fig. 1) protected from fishing pressure in the LBNP (Table 1).

2.2. Management plan and zoning of the LBNP

The park's management plan uses zoning of the land and sea within the park's bounds to achieve its main goal: "To define and

Table 1
Summary of the park's rules and regulations, including prohibited activities.

Zone type	Prohibited activities
Protection zone	<ul style="list-style-type: none"> • All commercial and sport fishing
Restricted use zone I	<ul style="list-style-type: none"> • Sport or commercial fishing with a spear gun/harpoon • Commercial fishing with large-scale commercial fishing vessels • Sport fishing at less than 250 m from commercial fishing vessels • Commercial fishing using nets and/or long lines in rocky bottoms • Commercial fishing using nets in Coronados Island (except in November and December over sandy bottoms) • Commercial fishing using nets in waters adjacent to Carmen Island from April to August • Commercial fishing using any type of net in the South, East, and North parts of the area next to Montserrat Island from April 1 through August 30
Restricted use zone II	<ul style="list-style-type: none"> • Sport or commercial fishing with a spear gun/harpoon • Commercial fishing with large-scale commercial fishing vessels • Sport fishing at less than 250 m from commercial fishing vessels • Commercial fin-fishing using nets from April through August every year • Commercial fishing using long lines
Restricted use zone III	<ul style="list-style-type: none"> • Sport or commercial fishing with a spear gun/harpoon • Commercial fishing with large-scale commercial fishing vessels • Sport fishing at less than 250 m from commercial fishing vessels • Commercial fishing using nets and/or long lines
Restricted use zone IV	<ul style="list-style-type: none"> • Sport or commercial fishing with a spear gun/harpoon • Commercial fishing with large-scale commercial fishing vessels • Sport fishing at less than 250 m from commercial fishing vessels • Sport fishing and commercial fishing, excluding bait collection
Natural resource sustainable management zone	<ul style="list-style-type: none"> • Sport fishing at less than 250 m from commercial fishing vessels • Commercial high impact trawling for shrimp and fish • Commercial night diving • Operations with the following types of large-scale commercial vessels: trawlers, purse-seiners, sargassum and squid boats, and long liners

establish the strategies and mechanisms of management that permit the preservation of the renewable and nonrenewable natural resources present in the Loreto Bay National Park and to restore the critical environments, promoting the social development of the communities within the zone," [13, p. 13]. Mexican environmental law underwent a transformation in the mid-1990s, at the same time Loreto Bay National Park was established. The stated intent of national environmental law changed from "rational development," to "sustainable use," [23]. The LBNP's goals fit within this national agenda.

The current management plan outlines Loreto's marine park into zones of varying management regimes (Fig. 1), mainly by stating what types of activities are forbidden where and at what times of year (Table 1). The first kind of zone is called a "protection zone" [13, p. 46]. All types of fishing are banned in this zone for the entire year. In Loreto's marine park, there are two of these that encompass marine environments. They are cover 1.5 km², or 0.07% of the park's total area, focusing on two submerged seamounts with

high biological diversity and productivity: Bajo del Cochi and Bajo del Murciealgo (Fig. 1).

Another type of management zone is called a "restricted use zone" [13, p.48], with the objective to protect vulnerable species while allowing their sustainable harvest by the local fishermen. There are four categories of restricted use zone used to prescribe specific management plans to particular parts of the park. Restricted use Zone One encompasses the coastline of the park's islands and Zone Two includes the portion of the Baja California Peninsula's shoreline that lies within the park boundaries (Fig. 1). The regulations for restricted use Zones One and Two differ according to the time of year, such that fish species are protected during particularly vulnerable lifecycle stages, and fishermen are not excluded from use of a highly productive area year-round.

The third type of restricted use zone, Zone Three, excludes commercial fishing, but does not limit subsistence or recreational fishing (Table 1). This zone is north of Montserrat Island (Fig. 1). Finally, Zone Four is specified for scientific investigation and exploration, as well as non-extractive tourism activities; recreational and commercial fishing are not allowed in restricted use Zone Four. It is located at the southern tip of the Island of Carmen (Fig. 1). The rest of the park is considered a "natural resource sustainable management zone" [13, p. 54] (Fig. 1). This area was designated mainly to exclude large-scale commercial vessels and shrimp trawlers from entering the park and continuing to adversely affect the benthic habitats.

The park is managed locally by the LBNP Management Authority, which consists of six people who report to the National Commission of Natural Protected Areas (CONANP). The director of the park is responsible for decisions regarding the functioning of the park, and supervises all activities and processes within the park (e.g., enforcement, administration, and education). The National Commission of Aquaculture and Fishing (CONAPESCA), which reports to the Secretary of Agriculture Ranching, Rural Development, Fishing and Nutrition (SAGARPA), also has jurisdiction over the park; they issue fishing licenses, and are supposed to enforce catch limits. The Federal Office of Environmental Protection (PROFEPA) also has jurisdiction in the operation of the park and is also responsible for regulation enforcement. Both PROFEPA and CONANP are under the jurisdiction of Secretary of the Environment and Natural Resources (SEMARNAT) [13].

2.3. Ecological and socioeconomic failure in the LBNP

To date, the LBNP has not accomplished its goal of establishing management that permits the preservation of renewable and nonrenewable resources in the park, as described below. Research conducted inside the park's no-take zones has concluded that the abundance of commercially valuable fish species (snapper, grouper, parrotfish) is not changing [10]. Further, this research showed that these fish are still declining in the restricted use zones and natural resource sustainable management zones. A study on the leopard grouper (*Mycteroperca rosacea*), one of the most commercially important fish species in the LBNP, indicated that the population at Carmen Island (Fig. 1) is unsustainable [12]. Similarly, a study comparing the abundance and biomass of various fish species inside and outside of the park boundaries indicated that the biomass of the leopard grouper has declined in the LBNP compared with areas outside of the park that are completely unprotected [14]. This study also showed that the total biomass of reef fishes and commercial fishes are no different inside compared with outside the park. In short, the park's success in promoting recovery of overexploited fish populations is highly questionable.

In addition to the lack of ecological success in the LBNP, social conflict precludes the park from reaching its community social development goals; socioeconomic elements are at least equally important to MPA success as ecological factors [24,25]. The stakeholder groups that use the LBNP, local commercial fishermen and visiting recreational fishermen for example, and the governing park authority, continue to be in conflict with one another, resulting in a lack of trust between the groups and unlawful use of the park [7,11]. Hence, progress that could be made by the park in protecting Loreto Bay's natural resources is undermined.

3. Aims & methods

3.1. Dialogue with stakeholders and personal observation

We spent approximately 10 weeks in the town of Loreto during the summer of 2006 (mid-May–August) to understand the policy system under which management of the LBNP occurs, as well as the social processes surrounding this policy system. During this time, we engaged sport anglers, commercial fishermen, fishing outfitters, the LBNP Director (R. López-Espinosa, LBNP Management Authority, personal communication), the Director of an active local NGO (F. Arcas, Grupo Ecologista Anteres, A.C., personal communication), a local fishing cooperative and a scientist from a university in the United States who had been studying the LBNP's efficacy in restoring and protecting the local ecosystem for approximately 10 years (E. Sala, Scripps Institute of Oceanography, personal communication), in conversations about the LBNP. The goal of these dialogues was to gain perspective on the many stakeholder point-of-views, and a general understanding of the political forces at play in the LBNP. These conversations were informal and in person.

Semi-structured interviews were conducted with the park director, the director of the local NGO, sport fishermen, a prominent local fishing outfitter, and the scientist mentioned above. Key interview topics raised with each individual included: (1) whether the interviewee perceived that the LBNP was making a difference in what he/she perceived as the park goals, (2) outstanding problems that he/she saw as hindering what he/she perceived as park success, and (3) the sources of and potential solutions to conflicts that he/she perceived surrounding park issues, if any. Data were also collected through participant observation; a meeting of the local fishing cooperative was observed, as were numerous recreational fishing trips, and the behavior and attitudes of recreational anglers inside the park and around the town.

3.2. Literature review: using recreational user fees to support MPA management

In order to assess the feasibility of relying on user fees to support improvements to the LBNP's management, we conducted a review of studies done on the use of recreational user fees to cover costs of MPA management. In May 2007 the keywords "protected areas" and "fees" were searched in the index BIOSIS Previous 1969–Present (Thomson Corporation, Stamford, CT). Only papers that dealt specifically with the charge and use of user fees were considered in the review.

3.3. Economic valuation surveys

Worldwide, recreation user fees are one of the most important financing mechanisms of protected areas [26]. In order to study the potential financial benefits of increasing the current entrance fee to the LBNP, an exploratory study was conducted with recreational anglers at the park. Recreational users currently pay a fee of \$2 per day to enter the park, unless they can prove with written

documentation that they are residents of Loreto, in which case they do not have to pay any fee. Besides this fee, users incur other costs, such as a license fee for fishing (approximately 128 pesos, or US\$4 per day), and the rental of fishing equipment. The entrance fee is administered by CONANP, and is used to help cover the park's management costs.

During June and July 2006, we implemented a preliminary survey of fishermen in Loreto. The objective of these surveys was to elicit a maximum willingness to pay (WTP) value with an open-ended WTP question that could be used as a "grounding value" for a binary-choice WTP question [26] in the primary surveys (see Appendix). It has been observed that open-ended WTP questions illicit chronically lower WTP estimates than binary-choice questions [27]. Therefore, we used an open-ended WTP question to attain a preliminary WTP estimate. This preliminary survey consisted of a brief description of the park and its history, and a plausible management scenario. The surveys were administered at Loreto's marina, in sport fishing outfitters' shops, and at the homes of sports anglers who live for part of the year in Loreto. The management scenario included the possibility of excluding commercial fishing from within the park boundaries, and suggested that an increased user fee could be used to supplement fishermen's income so that they could afford to fish elsewhere. This management strategy was based upon the fact that decreased commercial fishing pressure, especially from the use gillnets, significantly increases fish abundance [28,29], and can enhance species evenness and over-all size [30]. Further, it has been shown that the effects of commercial fishing on target fish populations are generally greater than that of recreational fishing [31,32].

The primary survey (see Appendix), following the preliminary survey, elicited WTP in a binary format that allowed respondents to state their maximum WTP [27,33], while being grounded by the figure determined in the preliminary survey with the open-ended WTP question. It included a summary of the current situation surrounding the LBNP, some background facts, and another management scenario that expanded upon that in the first survey. The scenario suggested multiple large no-take zones, alternative systems for handling and processing park fees to ensure their proper use (i.e. through local environmental non-government organizations), the reporting of illegal fishing activities, and a variety of other ways that increased funding could improve the LBNP's success. This survey also gave examples of successful MPAs in other parts of the world. The primary survey was administered to respondents randomly in a number of ways: displayed in sport fishing outfitter offices for visiting anglers to find and complete, administered personally to fishers at a sport fishing tournament and at the Loreto marina, and completed online at websites frequented by Loreto anglers. The survey also included questions that could be used for a travel cost method analysis, but these data were insufficient to complete a statistically rigorous analysis.

4. Results

4.1. Results of personal observations and dialogue with stakeholders

Our interviews held with stakeholders and personal observations indicated that the park has not accomplished several of its goals in the social arena and that the conflicts observed between the user groups inhibit the park's success (K. Stamieszkin, personal observation) [7]. On some of the economic valuation surveys, respondents added comments indicating their distrust of the local administration and commercial fishermen. Further, local commercial fishermen expressed their belief that visiting sport fishermen

Table 2

References and summary of main conclusions from a literature review of studies on the use of recreation fees to cover costs of MPA management.

Summary of key finding	Key issues in need of further exploration	References
Visitors' WTP is higher than the current fee in particular protected areas.	Identification of most accurate methods for determining maximum WTP	[25,28,29,32]
Visitors are willing to pay fees that support protected area management and/or conservation.	Identification of most efficient uses of visitor fees for enhancing marine conservation. Whether visitor fees can be used to support alternative employment opportunities for local users of overexploited marine resources	[28,38,63,64]
Fees equal to measured WTP could alleviate <i>at least</i> some of, and in some cases more than, the costs of managing particular MPAs.	Identification of tools for mitigating skepticism of some visitors and tourism operators towards potential benefits of using visitor fees towards improving conservation	[26,27,29–31,33]
Fee systems do not decrease the number of visitors to protected areas.	Identify situations in which fee systems limit the number of visitors	[34,35]
Fee systems are an effective tool for decreasing the effects of visitation on protected areas by limiting the number of visitors.	Identify situations in which fee systems limit the number of visitors	[36,37]
Reluctance to pay user fees often stems from distrust of the fee-handling agency.	Identify the groups or agencies that would relieve visitors' wariness of paying a user fee, so that they are comfortable paying their maximum WTP	[27,39]
Non-governmental organizations (NGOs) are a trusted agency for handling user fees at specific locations.	Explore whether NGOs are trusted as management agents for protected areas worldwide	[38]
More local visitors than foreign visitors were willing to pay a user fee, but local visitors were willing to pay less than foreign visitors.	Explore whether a schematic fee system based on residency maximize profits for MPA management	[63]
A major concern with user fees for recreational areas is that low-income citizens will be excluded. This was not the case in the studied locations (local visitors had higher WTP than foreign visitors, despite lower income), and education can dispel this concern.	Investigate whether higher user fees exclude low income and/or local users of protected areas in other geographical settings	[28,39]
An effective network of marine reserves requires a two order of magnitude increase of current MPA investment.	Explore whether user fees for these MPAs could produce this necessary investment increase	[65]
The Trip Response valuation method reduces biases associated with revenue-capture survey questions.	Identify the most accurate methods for determining visitors' WTP	[66]
The Contingent Valuation method provides valid estimates of WTP for entrance fees to protected areas.	Identify the most accurate methods for determining visitors' WTP	[32]

were consistently breaking the park's regulations. Throughout data collection, participants consistently highlighted the need for better enforcement, which is lacking mainly due to inadequate funds for personnel and equipment (R. López-Espinosa, LBNP Management Authority, personal observation) [15].

The park's user groups vary from local commercial fishermen who rely on the fisheries for a living, to recreational SCUBA divers, visiting for a few days on holiday. Social conflict among the park's user groups hinders the development of a successful conservation program. Within the fishing community, interviews revealed a number of viewpoints that often clashed, creating conflicts that override the progress that could be made by the successful application of the park and its regulations.

Commercial fishermen are local individuals who fish for sustenance and a living. This group tends to have a utilitarian view of the sea and its resources and they relate to the marine environment by extracting from it; to them, a healthy landscape, or seascape, is peopled and productive [34]. Fishing, and living off the sea is a large part of these individuals' identities. Commercial fishermen hope that the park will create a sustainable fishery, from which they can continue to extract as much fish as they need (K. Stamieszkin, personal observation).

As a group, visiting sport anglers have a different point of view. Most of them are United States or Canadian citizens. They seem to expect a wilderness experience like that found in a national park in the United States or Canada. Their goals for the LBNP, as opposed to the commercial fishermen, seem to be more experiential rather than utilitarian. Recreational anglers come to Loreto looking for a sport fishing experience in a pure wilderness that is as untouched and unregulated as possible. This mentality is observed in older sport fishing literature about Loreto [17]. Compared with the United

States, Mexico's protected areas and parks are fairly new; some returning sport anglers have had the experience of fishing in Loreto's waters without rules, regulations, or fees. Some still feel entitled to this experience, and decline paying the required fees to use the park's waters. Others are reluctant to pay fees to use the park because they are skeptical as to whether the money goes entirely to fund the proper management of the park (K. Stamieszkin, personal observation).

The contrasting sets of values between commercial and recreational fishing groups often lead to conflict. Local fishermen accuse the visiting anglers of depleting the fish stocks, and, the latter blame "reckless" local fishermen for any observable fish decline. In fact, there is a minority of both groups that engages in reckless resource use; both groups have been observed breaking seasonal, limit, and gear restrictions in the different zones of the park (Table 1) (P. Bolles, Baja Big Fish Company owner, personal communication; K. Stamieszkin, personal observation). The perception that there is widespread non-compliance by the other group of fishermen occurs mainly due to a lack of communication between the groups. Little opportunity exists for visiting anglers to converse with local fishermen in Loreto.

4.2. Results of the literature review on recreational user fees

The 19 papers reviewed (Table 2) revealed a number of common themes:

- (1) WTP and other analyses show that user fees could be instated and/or raised to collect resources that would greatly aid to alleviate, and in some cases even exceed, the costs of managing protected areas [35–43].

Table 3

Results of a regression analysis between maximum willingness to pay for an entrance fee to the Loreto Bay National Park (dependent variable) and four socio-economic variables. Age is the age of the respondent; Prop is a dummy variable with value of 1 for ownership of property in Baja California; Inc is a dummy variable with value of 1 for annual income of the respondent greater than US\$90,000; Sex is a dummy variable for sex of the respondent with value of 1 for female. S.E. are the standard errors of the coefficients.

Variable	Coefficient	S.E.	t	P
Age	-0.010	0.133	-0.073	0.943
Prop	-6.743	2.844	-2.370	0.031
Inc	4.509	2.591	1.740	0.101
Sex	2.610	3.412	0.765	0.455

- (2) Charging user fees for recreational sites will not significantly decrease visitation rates to certain areas, and will not necessarily exclude groups of a generally lower income bracket [38,44,45]. However, user fees can limit the number of visitors to certain sites [46,47].
- (3) Doubts are frequently observed among protected area visitors as to who would handle the fees collected and what the use of the fees will be [37,48,49].

4.3. Results of the economic valuation survey

The first survey administered to the sport fishing focus group (13 people) revealed a mean WTP of US \$8, which was our grounding value in the main survey. A total of 21 completed primary surveys were obtained between July 2007 and December 2007, most of which were completed online, via websites frequented by Loreto anglers. The mean age of the respondents was 55.5 years (± 9.6 SD). The sample consisted of 18 males (85.7%) and 3 females (14.3%). One-third of the respondents stated that their annual income was at least US\$90,000. A regression analysis conducted with the statistical package R 2.5.0 (R Development Core Team) indicated that the only socioeconomic variable that was a statistically significant predictor of WTP was ownership of property in Baja California (Table 3). The mean maximum WTP for entering the park was US\$7.71 (± 6.03 SD) per day. Seven respondents (33.3%) stated a maximum WTP less than \$8.

5. Discussion

While solutions to the issues we have identified range from local administrative changes to larger-scale changes in stakeholder behavior, only the most feasible, local-level possibilities will be discussed here; these solutions are not exhaustive, but could contribute to the creation of a viable marine park and a sustainable ecosystem management scenario. They are based on the exploratory study described above. The facts that the park was established, protection zones were instated, funds are being provided, and education of the user groups has been attempted, show that there has been a significant interest in creating a sustainable situation for the LBNP. While this is an important first step, a number of key elements must be addressed for the park to become a successful tool for natural resource management.

5.1. Scientific solutions to unsustainable resource use

Attributes often cited as important to MPA success include: reserve size [50–52], habitat diversity [53–55], species mobility and lifecycles [50,51,54,55], and monitoring [54–58]. In 1999 a Working Group on Marine Reserves (WGMR) at the National Center for Ecological Analysis and Synthesis (NCEAS) produced a set of

guidelines and considerations, based on available evidence, for establishing marine reserves; marine reserves were defined by the group as “areas of the ocean completely protected from all extractive and destructive activities,” [54]. According to this definition, only the two “protection zones” (Table 1) are “marine reserves.” The LBNP’s protection zones encompass two similar seamounts: Bajo del Cochi and Bajo del Murciealgo (Fig. 1).

It has been shown that increasing the size of a marine protected area, such as LBNP’s protection zones, can reduce the negative effects of over-fishing [51,52]. In areas that are over-fished, larger zones of *complete* protection equate to decreased fishing effort, thereby increasing fish stocks [50,51]. In Zone Three, commercial fishers are excluded, but recreational fishing is still allowed. While recreational angling, especially the practice of catch-and-release, is considered consistent with conservation regimes, a number of studies have shown that recreational fishing often has impacts on marine and aquatic communities that can hinder conservation efforts [59–65], and that can be nearly, if not as deleterious as commercial fishing [59,62,65]. It has been documented that recreational fishing can alter age and size structure of fish communities [59,63], species density and individual abundance [59,65], and can decrease genetic diversity, impacting evolutionary changes in fish populations [63]. Catch-and-release, a theoretically benign angling method, often increases fish mortality post-release [60,61,64], and is therefore not necessarily compatible with no-take MPAs [61]. Many of these effects make an ecosystem less appealing for non-extractive recreational uses like snorkeling and SCUBA diving. The LBNP’s marine protection zones make up only 0.07% of the entire park (Fig. 1) and given that over-fishing is one of the primary causes of depleted fish populations in the area [9–12], the park would benefit from larger protection zones.

Further, the larger a protected area is, the more different habitats it may encompass. Habitat diversity is a critical component of successful marine parks [51–55]. The seamounts that make up the LBNP’s protection zones, while highly productive due to the upwelling of nutrients that they facilitate, are similar in formation, and therefore do not represent the variety of habitat that would benefit the ecosystem. In addition, because fishing is allowed throughout most of the park, habitat degradation is a problem [8]; even recreational fishing has been shown to have indirect effects on marine ecosystems such as destructive habitat alteration [62,63]. The LBNP would benefit from an expansion of its marine protection zones that exclude any type of fishing, to encompass and protect a greater diversity of habitats.

Species mobility and lifecycle are also important factors in the sustainability of an MPA. Marine reserves are more appropriate for less mobile species [50,51], as their protection is contingent on the individuals staying inside the zone’s boundaries. Larval dispersal must be taken into account for a marine reserve to preserve target species [50,51,54,55] because some level of larval retention within a protection zone is necessary for a sustainable sub-population. MPAs can create sustainable situations for both biodiversity and fisheries [54], but fish lifecycle and mobility factors, in combination with size and placement of protection zones, make up the dynamic balancing act between biodiversity conservation and fisheries sustainability [50,54]. The LBNP’s protection zones do not appear to be created based on these complex population dynamics; if they were, however, they would have a more positive impact on Loreto Bay’s fisheries and biodiversity.

Finally, long-term monitoring and evaluation are critical to the success of MPAs [54,57,58,56]. Rigorous monitoring allows for management to adapt as the ecosystem and local needs change and new information is collected. Adaptive management strategies are part of management schemes for marine resources elsewhere [24,56,66]. While some attempts to monitor the trends in the

populations of commercially important fish species have been made [10,12,14], there is no specific long-term monitoring scheme used by the park that would enable adaptation of the management plan.

The LBNP's management plan is revised every five years [13]. General indicators written into the plan suggest items that should be monitored to evaluate its effectiveness. These include: local quality of life, the state of commercially important fish populations, community attitudes towards the park, development of activities that are beneficial to conservation, recovery of essential habitats and populations of protected species. While our study addressed the attitudes of one stakeholder group (sports fishermen), future research focused on the monitoring of other important indicators would also be of benefit to the management of the Park. There is no framework in the management plan for how the monitoring of these indicators is to be supported or conducted. While the park is currently the target of research by several external academics and institutions, it would greatly benefit from a framework under which a consistent self-monitoring of its resources could be directed. The lack of funding is the greatest hurdle that must be overcome for such a monitoring program to become a reality (R. López-Espinosa, LBNP Management Authority and F. Arcas, Grupo Ecologista Antares, A.C., personal communication) [15].

Given the level of uncertainty that remains about the intricacies of Loreto Bay's marine ecosystems and the current lack of capacity for such studies to be completed, further designation of protection zones could focus on habitat diversity and replication, rather than exact species distribution and abundance. It has been shown that the use of habitat as a surrogate for biodiversity and individual species can help in the delineation of MPAs when a lack of resources does not allow for more advanced studies of an area [67,68].

5.2. Community-based solutions to unsustainable resource use

Communication and education initiatives, in both the local community and among visitors, must become a priority for the LBNP [10]. Stakeholders have to be involved, at some level, in management processes to create consensus on the park's goals, and standardize individuals' expectations [24]. User groups such as local fishermen and long-term visiting anglers have a vested interest in being directly involved in the development of the park's management plan. Other user groups, for example anglers visiting for short periods of time, will probably not be involved in management planning, but would benefit more from targeted education. Therefore, a regularly scheduled forum for communication between stakeholders such as the Park Authority, commercial fishermen, recreational anglers, and local charter fishing business owners, coupled with education campaigns targeting all groups with information about the ecology of the area, the needs of other user groups, and the marine park's objectives and regulations, could decrease conflict between stakeholders and potentially increase compliance with regulations.

In 2002, a Mexican NGO, Comunidad y Biodiversidad (COBI), performed a public survey to assess the public's awareness of the park's rules and regulations, and to inform the community of the park and its set of laws. One year later, after COBI initiated a communication program that involved informative pamphlets, posters, signs, and talks, a second survey was administered [10]. The percentage of park users that could accurately identify the park's and no-take zones' boundaries was significantly higher in the second survey [10]. A local NGO, Grupo Ecologista Antares, A.C. (GEA), works to educate Loreto's youth, as well as other local and visiting users of the park, about conservation of the area's natural resources and ecosystems. Education and information campaigns of this type are likely to increase the compliance with the park

regulations, and they should be made a priority by the LBNP Management Authority.

As in the case above, more educated park users tend to be more compliant with rules [10]: (1) because they know them and (2) because they may also understand the rationale behind them, thereby contributing to the over-all success of the management plan. It has also been shown that marine protected areas are more successful when all stakeholders' goals are addressed by the management plan and reflected by the management instated [57]. Realistically, each need and desire of every stakeholder cannot be incorporated into one management plan; however with more open discussion and the inclusion of more user groups in the management plan revision process, a maximum number of stakeholder needs may be met, thereby alleviating conflict. For those park users who are not reached by inclusive resource management and education, regulation enforcement is necessary.

Finally, a reorganization of the park's management may lead to a more efficient use of the funds that are made available by user fee collection (see next section). Currently, funds collected in Mexico's system of protected areas are transferred to CONANP, which then re-allocates funds to the different protected areas [69]. If the collection system were decentralized, all funds raised by the LBNP could stay in the hands of the LBNP Administration, resulting in more efficient use of a possibly larger funding base. These funds could be used, for example, towards better regulation enforcement in the park or more education initiatives. Stakeholders often express concern that user fees are not used properly for protected area management (K. Stamieszkin, personal observation) [37,48,49]; if the fee system were decentralized, it might appear more trustworthy to recreational visitors, making them less skeptical of paying the park entrance fee.

5.3. Possible solutions to inadequate funding via user fees

The proposed solutions require greater funding than is currently available to the park's Management Authority. An increase in the daily entrance fee that visitors pay to use the park could secure more funding to improve its management [35–43]. Approximately 3936 recreational anglers visited the LBNP in 2007 (R. López-Espinosa, LBNP Management Authority, personal communication). A typical fishing trip by a recreational angler to the LBNP is 10 days long (J. Wielgus, unpublished data), so the additional revenue that could be generated by increasing the daily entrance fee from US\$2 to US\$8 is US\$236,160.

Our economic valuation survey showed that people who live part of the year in Baja California are generally willing to pay less than others for using the park's resources. They may believe that they should not be charged for using a local resource, and their low WTP may reflect "protest responses" [70] for the idea of having to pay an increased fee. In their study, Lindsey and Holmes (2002) reveal a similar phenomenon: local tourists were willing to pay less than foreign tourists to support an MPA. However, the study also showed that a higher proportion of local visitors, as opposed to foreign visitors, were willing to pay a user fee at all. A multi-tier fee system may work in this case; currently Loretanos do not have to pay to enter the park. Likewise, Mexican nationals could pay less than international guests. Grewell [49] suggests that protests expressed by individuals against user fees, like those collected from visitors of the LBNP, are often due to an information gap that leads to invalid concerns about such costs, and that could be closed via education.

While it has been shown that increasing recreational user fees does not always decrease visitation rates [44,45], it is feared that increasing the current entrance fee to the LBNP may reduce its number of visitors, as has been observed in other similar situations

[46,47]; for example, anglers may fish for fewer days, or may choose a different travel destination [71]. In the economic valuation survey, 33.3% of the respondents stated a maximum WTP less than \$8. In the extreme case that an increase of the entrance fee to \$8 would lead to a 33% reduction in the number of anglers that currently visit Loreto, the revenue generated by the increased fee (\$209,920) would still be 2.7 times larger than the revenue generated by the current fee (\$78,720); any reduction in the number of anglers fishing in the park would eliminate an equivalent amount of impact that those anglers would have had on the ecosystem. The additional funds could be used for education campaigns, increasing capacity for regulation enforcement, much needed ecological monitoring, and possibly to subsidize start-up costs for commercial fishermen who are willing to switch professions into the eco-tourism business, mainly recreational fishing, snorkeling and SCUBA diving, further decreasing fishing pressure and potentially habitat degradation in the LBNP [72].

6. Concluding remarks

Despite the protection provided by the LBNP for Loreto's marine resources, fish populations continue to decline. And despite well-planned efforts to educate the public of the issues surrounding the park, user groups continue to be uncooperative and lack mutual respect. The main objectives of the park-sustainable resource use and strong local community are not being met. Factors that inhibit the achievement of these goals include: conflicts between dominant stakeholder groups' values, and a lack of resources for education and communication efforts, especially those that increase understanding between user groups. Administrative problems such as poor enforcement and monitoring also contribute to the park's ineffectiveness. Many of these activities necessitate funding beyond that which is available to the park administration. We found that an increase from a \$2 to \$8 fee would yield a significant increase in funds available to the park, even when considering a possible decrease in visitation due to the increased fee. While the local-level solutions discussed are not exhaustive, they are necessary steps to improving the sustainability of the LBNP.

The LBNP's ecosystems and natural resources are affected not only by the local community and visitors, but also by larger-scale issues. For example, despite protection in Loreto's waters, large migratory fish species such as marlins and sailfish may be exploited elsewhere. While these factors are important to consider, the smaller, more approachable issues are equally crucial. Without communication, education, enforcement, and monitoring, the LBNP will not reach its potential for stewardship and conservation of Loreto's marine resources. Time and money need to be spent improving communication between user groups and the park's Management Authority, as well as educating users about the park. Visiting anglers must learn to trust and respect the park's regulations and the needs of Loreto's local community. On the other hand, the park and other government agencies involved must improve monitoring and enforcement programs. All stakeholders in the park's resources must understand that their impacts carry further than their individual actions, and that they share the common goal of sustainable resource use. Through communication and subsequent understanding, stakeholders may both demand and reciprocate respect for alternative perspectives, and successfully pursue the sustainable use of the Loreto Bay marine ecosystem.

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Appendix

Primary survey used to elicit a maximum willingness to pay (WTP) of sport fishermen to enter and use the LBNP. An economic valuation scenario and question were presented, as were travel cost and demographic questions. Not enough data was collected on travel cost to complete an analysis, but the answers to the demographic questions served as indicators as to why certain groups of people have a higher or lower WTP.

Your participation in this 5- to 10-minute survey will help to improve the management of Loreto's marine park and the quality of fishing in this area. This is part of a collaborative study between Arizona State University and Yale University.

Introduction:

- A nine-year study recently completed by Scripps Institute of Oceanography shows that many fish populations are declining inside Loreto Bay National Park.
- The goal of the park is not only to preserve biodiversity and the unique ecosystems in the area, but also to preserve and regulate sustainable fisheries.
- Under the current management scheme, the park's fisheries are not sustainable.
- The purpose of this survey is to study the attitudes of sport fishermen regarding fishing in Loreto Bay National Park, and about management activities in the park.

Some facts about the park:

- The park was established in 1996.
- The park encompasses the five islands in the waters of Loreto Bay: Coronado, Carmen, Danzante, Montserrat, & Catalana.
- The current management scheme for the park relies on zoning. Each type of zone has different regulations and restrictions with which fishermen are supposed to be in compliance when fishing in each zone.
- Enforcement of park regulations is the responsibility of the Park management authority, the National Department of Fisheries, and the National Environmental Police.
- Park fees are supposed to be paid daily by every visitor to the park. The revenue collected from the fees is used to pay park salaries and administrative costs, purchase equipment, support park activities and projects, and promote conservation.
- Despite the current attempts at managing the park, the park's fisheries are not sustainable and may collapse in the near future.

Below, you will find a proposal for a park management scheme. please read the scenario carefully and then answer the willingness to pay question that follows.

While a perfect marine park management scenario is not possible to implement *all at once*, there are a number of steps that can be taken towards better management, right now, that will help prevent the collapse of the fisheries in the park. The most important is the establishment of a number of sizable no-take zones. No-take zones allow depleted fish stocks to recover and then spill over into the surrounding waters, helping to create a sustainable fishery. Further, as the park's fish populations and

ecosystems become healthier, prey for sport fish will become more abundant, attracting species like dorado, sailfish, marlin, and yellowtail. The implementation of these no-take zones would require increased use of park rangers and/or work hours for their enforcement.

In addition to the essential no-take zones, increased revenue from park fees, handled by a non-governmental organization, could be used to train commercial fishermen in (1) sustainable fishery practices and (2) reporting illegal fishing activities. Examples of successful marine protected areas can be found worldwide, for example, off the coast of mid-western Australia, the Philippines, as well as Tanzania and Kenya. The funds could also allow commercial fishing boats to be outfitted with radios for reporting illegal activities. Additionally, the money collected could also contribute to start-up funds for commercial fishermen who wish to change occupation, taking more pressure off of the local fishery.

A minimum park fee of \$8 per day would make the above management scenario possible, compared to the \$2 fee that is in place now. Would you be willing to pay \$8 US for this scenario? When responding, please keep in mind the number of days that you fish in Loreto and all of the other costs that you incur during your trip to Loreto.

1. Yes, I would pay the \$8 fee to support fisheries management in the park.
2. No, I wouldn't pay the \$8 fee to support fisheries management in the park.
3. If you answered no, what is the maximum daily entrance fee that you are willing to pay to contribute to the management scheme?
4. If you answered yes, would you be willing to pay a daily fee that is higher than \$8, and what would that fee be?

Please answer the following background questions, which are important for the statistical analysis of this survey.

1. Where is your permanent home?
2. Do you have a home in Loreto or elsewhere in Baja?
3. Where did you start your trip to Loreto?
4. How did you travel here (flew, drove, etc.)?
5. How long did it take for you to get here?
6. In total, how much did the travel cost *per person*?
7. Before this visit, how many times had you been to Loreto and when were you here?
8. Where are you staying while here?
9. How long are you staying in Loreto?
10. Are you going anywhere else on this trip?
11. If yes, where and for how long?
12. Do you intend to return to Loreto?

Fishing & other recreational activities

1. If you have fished in Loreto's waters: on average, how would you rate your most recent fishing experiences (keeping in mind numbers and sizes of fish caught, environmental quality, etc.)?
 - a. Poor
 - b. Average
 - c. Good
 - d. Excellent
2. (If yes to question 1) Where did you fish in Loreto (name of island, inside or outside the park)? What was the best and the worst spot where you fished in Loreto? (*Please see map at end of survey*).
3. If you have fished for sport fish elsewhere, where did you fish?

4. On average, how would you rate the experience in that location/those locations (keeping in mind numbers and sizes of fish caught, environmental quality, etc.)?
 - a. Poor
 - b. Average
 - c. Good
 - d. Excellent
5. In this/these other place(s), did you pay a daily entrance fee similar to Loreto's park entrance fee? If yes, how much did you pay?
6. Is sport fishing your primary activity and purpose for coming to Loreto?
 - a. Yes
 - b. No

Information about yourself:

1. What is your age?
2. What is your gender? M F
3. Please circle the income range in which you fall:
 - a. Less than \$30,000/year
 - b. \$30,000–\$49,999/year
 - c. \$50,000–69,999/year
 - d. \$70,000–89,999/year
 - e. \$90,000–\$120,000/year
 - f. More than 120,000/year

Many thanks for your participation!

(A map of the park was included that delineated the boundaries of the park, as well as displayed the names of the islands.)

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