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## Contrasting perspectives on mangroves in arid Northwestern Mexico: Implications for integrated coastal management

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### ABSTRACT

Mangroves in Northwestern Mexico are vital to maintain coastal environments healthy, to provide nutrients for several food chains, and to supply valuable goods and services that sustain and improve human livelihoods. Many of these values offer a range of opportunities for economic development that attract workers, investors and developers. Recently, federal privatization policies have promoted an accelerated coastal development of this region to obtain large profits in short times, creating competing and overlapping interests to use coastal environments and control key resources. Such intense developments are modifying the ecological conditions of many coastal areas, threatening the provision of important ecosystem services to society. After years of centralized decisions, new paradigms are needed to achieve a coastal management that ensures long-term ecosystem maintenance, fair resource use and social equity. Recognizing the multiplicity of actors involved in coastal management and using a qualitative research methodology, we identified and explored the perspectives of different key stakeholders in the states of Baja California Sur and Sonora, Mexico, to better understand their views on mangroves use and management as well as the interaction among them. We discuss similarities and/or discrepancies found among stakeholders' perceptions by describing their central ideas and identifying overlapping interests that may create conflicts when defining development and conservation programs or formulating policies. This information also intends to encourage further research on the social-ecological system of the coasts in Northwestern Mexico and to contribute to address coastal management issues in integrated ways that consider the social dimension through documenting stakeholders' narratives in the future.

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### 1. Introduction

Mangroves on the Pacific coast of the Americas reach their northernmost distribution in the arid regions of Mexico around the Sea of Cortés (SC), in the states of Sonora and Baja California Sur (BCS). This is a highly biodiverse and productive region where mangroves are vital to supply goods and services that sustain and improve human livelihood (Páez-Osuna et al., 2003; Glenn et al., 2006; Aburto-Oropeza et al., 2008).

The combination of biodiversity, aesthetic features and recreational possibilities found in the mangroves in Northwestern Mexico offers a range of opportunities that attract workers, investors and developers in search of economic profit. Furthermore, for decades the Mexican government has favored private investments around the SC to obtain short-term profits by privatizing the control of

resources and centralizing decision making, creating scenarios of competing and overlapping interests to control the access to key natural resources (Young, 2001). Economic activities performed in this region contribute 10% to the national gross domestic product; 40% of the agricultural production and 65% of the aquaculture in the country (Páez-Osuna et al., 2003; Enríquez-Andrade et al., 2005). Fishing in the Sea of Cortés also generates revenues worth up to USD \$300 million a year (WWF, 2005).

As a consequence of such accelerated and unplanned development these coasts have the fastest population growth rate in Mexico (INEGI, 2005; Glenn et al., 2006), and are currently experiencing intense environmental pressures that are transforming mangrove ecosystems at varying degrees and intensities while threatening also the continued provision of many valuable goods and services to society (Páez-Osuna et al., 1998; Whitmore et al., 2005; Holguín et al., 2006).

Since marginalized communities are more vulnerable to environmental degradation and are sometimes restricted or excluded

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from accessing resources, social inequity, poverty and illegal resource over-extraction are found in many local communities (Agrawal and Gibson, 1999; Young, 2001). For this reason, a growing number of environmental non-governmental organizations (ENGOs) are working in the region directing money and efforts towards community-based management to promote social justice, education, environmental conservation and sustainable development (Cariño et al., 2004). The presence of these organizations reflects the role that society is taking in social and environmental issues, and also the declining capacity of government at its different institutions to deal with these. Thus ENGOs are becoming strong actors that exert a powerful political influence (Clarke, 1998; Bryant and Bailey, 2005).

After years of experiencing governmental centralized decisions, defective planning, and inefficient implementation, new paradigms are needed to achieve an integrated coastal management that may increase the quality of life of local communities while maintaining ecosystems and natural resources at the same time (Young, 2001; Cariño et al., 2004; Basurto, 2005). This endeavor requires the analyses of human and natural systems interaction as well as understanding the complex relationships between natural and socio-economic variables (Fabbri, 1998). Formulation of actions and policies to achieve such management should focus on the complex web of actors involved in decision-making, particularly in how their multiple interests influence decisions and political processes (Adams et al., 2003; Ghimire and Pimbert, 1997; Bowen and Riley, 2003). This could help balancing tradeoffs between social gains, economic profit, and the delivery of ecosystem delivery, allowing fair resources among coastal resource users and the equitable distribution of the costs of conservation. This aimed at providing a “socially desirable” mix of coastal zone goods and services (Bower and Turner, 1997; Agrawal and Gibson, 1999; Brown, 2003).

Based on this scenario of a multiplicity of actors with diverse interests involved in decision-making processes regarding the management of coastal natural resources in Northwestern Mexico, this paper aims to analyze the views of local fishermen, governmental authorities, ENGOs, and scientists in BCS and Sonora about the presence, use, conservation, and drivers of change in mangrove ecosystems. By examining the central ideas, knowledge, opinions and management priorities of these actors respecting mangroves, we intend to identify also possible conflicts of interest about management practices and conservation in the arid regions of Northwestern Mexico. The final aim of the study is to contribute to policy formulation and the construction of alternative management strategies that consider the perspectives of the different actors involved in such a way that mangrove long-term maintenance is feasible. We hope the study will encourage further research on the social-ecological system of the coasts in Northwestern Mexico and provide a useful framework to address coastal management issues.

## 2. Material and methods

In order to gain insight into the diverse actors' perspectives on mangrove ecosystems, we used a qualitative research method. The selection of this approach from the social sciences is based on our research questions which look to understand ecosystem management and conservation issues from an actors' perspective (Long, 1992). Qualitative research is a field of inquiry that crosscuts disciplines and that has a long history. Not without difficulty, it has gained relevance in the last two decades. At its core is the notion of reality as socially constructed system (Berger and Luckman, 1966) emphasizing that people “create reality” based on their perceptions of the real world in which they are immersed by giving meaning to social and natural phenomena (Denzin and Lincoln, 2008). Peoples'

decisions are therefore based on their constructions of reality; and these constructions can have different historical and cultural explanations (O'Brien and Kollock, 2001). Within environmental studies this recognition has been acquiring acknowledgement as environmental problems result from social conflicts and dilemmas which apart from having historical, economical or political roots also rise from cognitive conflicts. That is, different stakeholders may have different knowledge, preconceptions and priorities regarding management issues which create conflicting arenas presenting challenges to alternative practices and policy formulation (Adams et al., 2003). Documentation of “the voices” and analysis of actors' views are becoming essential aspects of new ecosystem management approaches which part from the inclusion of humans in ecosystems (O'Neill, 2001) and recognize the use of collective narratives as part of systematic understandings of particular situations (Waltner-Toews et al., 2003).

The main research techniques used in the study were participant observation and semi-structured interviews (DeWalt et al., 1998). The first field visits to BCS and Sonora were performed in 2007 and 2008. Through participant observation and informal talks with people, we identified key actors and organizations relevant to mangrove use and conservation within 19 localities in both states (Babbie, 1995; Denzin and Lincoln, 1998) (Fig. 1). Based on these initial encounters, guides were constructed to develop semi-structured interviews that were later conducted to four of the main identified actors (Vela-Peón, 2001): fishermen, federal government officials, ENGO representatives, and scientists. It is important to mention that although we also identified actors from the private sector, most of our attempts to contact and obtain interviews from this sector failed.

The main interest of this study was to collect data about the social perceptions of the groups of stakeholders mentioned. Therefore, our interviews were structured around three basic themes: (1) changes in mangrove surface and causes of these changes; (2) importance, uses, and threats to mangroves and (3) government and private institutions working with mangrove-related themes. The application of semi-structured interviews allowed us to address the different stakeholders groups adapting the interviews according to respondent, locality and surrounding environment (Robson, 1994).

Using a snowball sampling method, 63 interviews were conducted in the Pacific and SC coasts in BCS and Sonora between 2008 and 2009 (Table 1). This method consisted in meeting someone (e.g. a fisherman) that was previously identified to have relevant information for the study and after interviewing this person, he/she was requested to recommend whom to interview next. Interviews were terminated based on information saturation, which consists to stop interviewing when no new data is identified (Taylor and Bogdan, 1996; Vela-Peón, 2001).

Digital audio recordings of interviews were transcribed and imported into *Atlas.ti* v.5.0 (SSD, 2003) to perform qualitative analyses of texts. Each group was analyzed separately. Transcripts were coded using a line-by-line review of texts and categories were created as they arose from interviews in order to obtain perceptions, ideas, and interests of the different actors and reduce data into manageable formats. The categories were then linked into diagrams that resulted of the analysis, and which then structured the narratives presented in Results section. These diagrams are included since they serve as a graphical summary of the different perspectives and constitute support evidence of our analysis (Figs. 2–5). The number of respondents who expressed the same perception is included in parentheses and narratives are complemented with verbatim quotations, field notes and socio-economic and environmental information to validate and strengthen our findings.

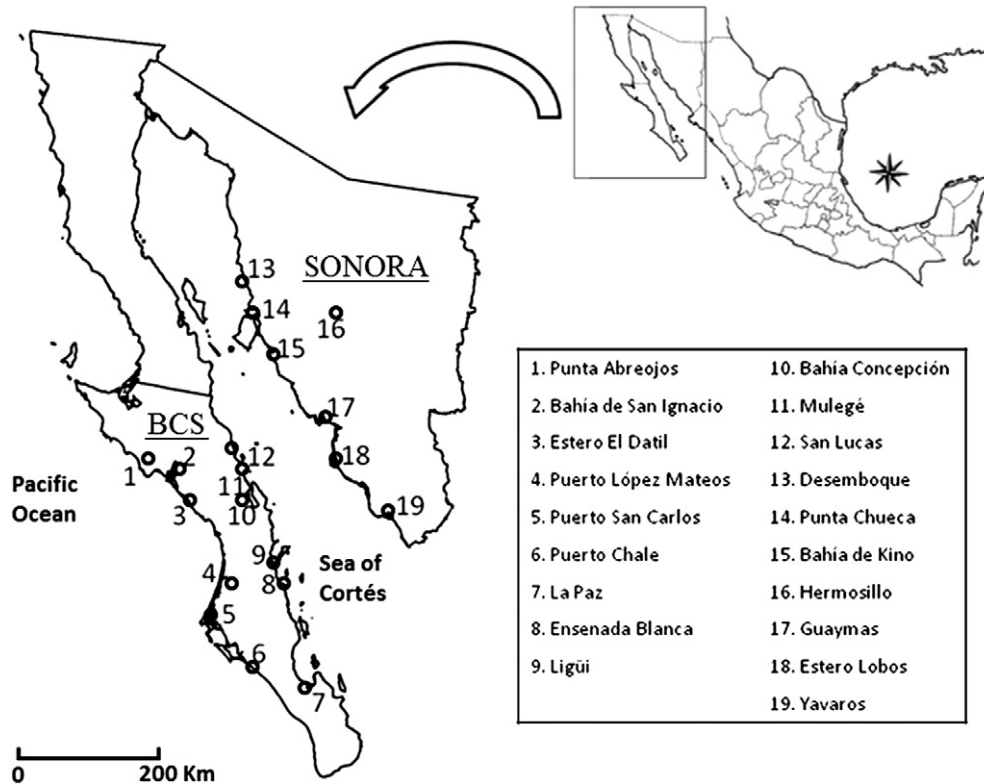


Fig. 1. Localities from BCS and SON where interviews were conducted between 2008 and 2009.

### 3. Results (Table 2)

The following narratives were constructed based on the diagrams presented in Figs. 2–5 (2: Fishermen, 3: Government, 4: NGOs and 5: Scientists).

#### 3.1. The perspective of fishermen

Some fishermen in the Pacific perceived that mangrove surface has increased (6) and others that it remains the same (5). In Puerto Chale one person said: “It [the mangrove] keeps getting larger. When aquaculture ponds were constructed some mangroves were removed, but the responsible party got fined and has not cut more”. In the SC, some fishermen mentioned that mangrove surface was decreasing (5) and a lower number thought that it had remained the same (3). One fisherman in La Paz expressed: “...there are less (mangroves), because they [developers] want more lands for construction, they come and cut trees.” In Sonora, the fishermen had different perceptions: in Bahía de Kino, Guaymas, Estero Lobos, and Yavaros some mentioned that surface was decreasing (6), while others from Bahía de Kino and Guaymas mentioned that it had remained the same (3). Fishermen from the ComCaac (Seri) tribe mentioned that it was increasing by growing landward (3).

In relation to the importance of mangroves, fishermen in the Pacific acknowledged that mangrove sustain fisheries and biodiversity (11), provide aesthetic values that attract tourism (7), and provide shade/shelter (3). Fishermen in the SC mentioned the importance for biodiversity (5) and shade/shelter (2), but one could not recall any importance (1). Fishermen in Sonora accredited their importance in sustaining fisheries and biodiversity (12), aesthetic values (8) and shade/shelter (1) ComCaac fishermen added traditional importance (3); one person in Bahía de Kino did not think they were important at all (1).

Regarding the uses of mangroves, fishermen in the Pacific use them for wood (6), medicine (5), and construction (3); two people did not know any use (2). Fishermen in the SC mentioned medicine (3), wood (2) and tannins (1); three did not recognize any use (3). Interviewees in Sonora acknowledged uses for medicine (6), construction (3), wood (2), food (1), tannins (1) and harpoons (1); two mentioned mangroves had no use (2).

When asked about threats to mangroves, one fisherman in the Pacific mentioned that mangroves are removed for aquaculture, but that they grow back afterwards (1). Two people mentioned that guano produced by birds killed mangroves in nesting areas (2). One mentioned destruction by locals (1), while two recalled industrial pollution in Puerto San Carlos (2): “[the area] near that facility was full of mangroves, but it dumps grease and caustic soda to the water killing many trees”. However, most interviewees in this coast mentioned that mangroves were in good condition and had no current threats (6). Fishermen in the SC said that threats come from construction (6) and hurricanes (3). In Sonora fishermen mentioned threats like trash (5), industrial developments (4), draining channels (3), aquaculture ponds (3), tourism and urban complexes (3); and floods (1). Another person mentioned an insect plague in Yavaros (1).

The presence of institutions working with mangroves was recognized by seven fishermen in the Pacific: two in Puerto San Carlos said that a foreign institution (The School for Field Studies, <http://www.fieldstudies.org/index.cfm> March 2010) was doing environmental education (2); two from Puerto López Mateos and three in Bahía San Ignacio mentioned that one NGO (PRONATURA) and one ecotourism enterprise (KUYIMA) were promoting conservation (5). In the SC one fisherman in Mulegé mentioned that an organization from Sonora was working with environmental education promoting sustainable fisheries (1). Some fishermen in Sonora mentioned that universities visited their areas to make

**Table 1**

Number of interviews within brackets conducted in BCS and Sonora by stakeholder group and locality.

BCS	SON
<b>Fishermen (19)</b> 8 from the SC coast	<b>Fishermen (12)</b> Desemboque (N29 37.928 W112 21.810)
San Lucas (N27 13.094 W112 12.819)	Punta Chueca (N29 00.826 W112 09.637)
Mulegé (N26 53.895 W111 58.039)	Bahía de Kino (N28 48.466 W111 55.601)
Bahía Concepción (N26 32.986 W111 45.852)	Guaymas (N27 57.640 W110 58.673)
Ligüi (N25 44.662 W111 15.698)	Estero Lobos (N27 21.183 W110 27.292)
Ensenada Blanca (N25 43.523 W111 14.807)	Yavaros (N26 42.491 W109 32.656)
La Paz (N24 09.382 W110 19.572) 11 from the Pacific coast	
Punta Abreojos (N26 43.939 W113 36.697)	
Bahía de San Ignacio (N26 49.256 W113 10.872)	
El Dátil (N24.24224 W111 31.129)	
Puerto López Mateos (N25 11.389 W112 07.211)	
Puerto San Carlos (N24 47.751 W112 06.887)	
Puerto Chale (N24 25.346 W111 33.236)	
<b>Government officials (4)</b> Secretaría de Medio Ambiente y Recursos Naturales Comisión Nacional Forestal Comisión Nacional de Áreas Naturales Protegidas	<b>Government officials (6)</b> Secretaría de Medio Ambiente y Recursos Naturales Comisión Nacional Forestal Procuraduría Federal de Protección al Ambiente
<b>Scientists (7)</b> Centro Interdisciplinario de Ciencias Marinas Centro de Investigaciones Biológicas del Noroeste Universidad Autónoma de Baja California Sur The School for Field Studies	<b>Scientists (8)</b> Universidad de Sonora Centro de Investigaciones Biológicas del Noroeste Prescott College Center
<b>Environmental NGOs (4)</b> Centro Mexicano de Derecho Ambiental PRONATURA Noroeste The Nature Conservancy Natureserve	<b>Environmental NGOs (3)</b> Conservation International Asociación Mangle Negro

studies around mangroves (7), but never interacted with them. Two fishermen in Guaymas acknowledged the presence of NGOs protecting mangroves, but could not recall their names (2). Finally, two ComCaac fishermen acknowledged interaction with scientific institutions like Prescott College of the US and the University of Sonora in Mexico, which hired their services as guides when performing local research (2).

In relation to the government presence, fishermen in the Pacific mentioned that fishing authorities were issuing permits and monitoring illegal activities (7); some recalled the presence of environmental authorities to prevent poaching (6). As one fisherman in Puerto López Mateos mentioned: *"It is forbidden to use mangroves, because soldiers are constantly patrolling"*. One fisherman in Puerto San Carlos mentioned that government was performing water studies (1). In contrast, some fishermen in the SC said that government was absent between Santa Rosalia and Bahía Concepción (3), others near Loreto expressed that government was only issuing permits around the Protected Area and pursuing free fishermen instead of the large fleets from Sonora that overharvest local resources (2). Finally, fishermen in La Paz mentioned that government was issuing fishing permits and supporting them with incentives to substitute their reduced catches (2). In Sonora, ComCaac fishermen said they receive support from governmental programs, but since such programs had no continuity the money was wasted or not useful (2). Fishermen in Bahía de Kino expressed resentment

towards government, mentioning that they were not taken into account at all (2), and that the government made arrangements with aquaculture developers to overlook environmental problems (2). Near Guaymas, some argued that government was present to prevent mangrove damage (2); in Estero Lobos, interviewees mentioned that government only issued fishing permits and regulated environmental problems from their offices (2). Finally, some fishermen in Huatabampo acknowledged that government was regulating fishing activities (3) and developing tourism (2).

### 3.2. The perspective of government

Interviewed officers in BCS considered that the surface of mangroves remained the same (4); however some acknowledged that tourism developments have removed or damaged some mangroves in the SC (2). Some respondents in Sonora said the construction of dams in 1950 impacted mangroves, but that at present they were growing back and expanding in some areas, and that recently created conservation laws and current projects were not damaging them (3). Others mentioned that mangroves were removed occasionally to construct aquaculture channels, but they grew back afterwards (2). However, another officer mentioned that mangroves were being depleted by poorly applied economic programs that promote aquaculture without considering environmental impacts (1).

The perceived importance of mangroves was similar in both states: all acknowledging their role in sustaining biodiversity, providing ecosystem services and aesthetic values that attract tourism (10).

When asked about the use of mangroves in BCS, one respondent said they were used for handicrafts (1), while others said that they were not used (3). Officers in Sonora mentioned uses for construction (4), wood (3), and tannins (2); or none (1).

The perceived threats to mangroves varied between states. BCS interviewees mentioned that pressures came from urban development (4), or environmental degradation (2) and removal by population (1). Officers in Sonora mentioned more threats like destruction and pollution by aquaculture (4) and drainage channels (4), urban and industrial construction (3), environmental degradation (2), and destruction by locals and tourism (3). Another person mentioned damages from tourism and aquaculture developments. However he did not know which mangrove species were protected by law and he said that mangroves were present in areas far away from their distribution (1).

Interviewees in BCS thought that government is working with scientists by requesting their technical advice (4). They expressed also that governmental institutions do communicate and work together on environmental issues (4). Officers in Sonora mentioned they work closely with scientists to develop monitoring and restoration projects (6). Some acknowledged the work of international NGOs, like Conservation International and the World Wildlife Fund, and local organizations like *PRONATURA* and *Mangle Negro*, to promote conservation with local communities (3). Regarding the coordination with other governmental institutions, some expressed the existence of communication conflicts, and different, often contradictory agendas (3), adding a lack of capacity to work together and accomplishing goals (2). Another mentioned that the functions and jurisdictions of each institution were clear and without conflicts (1).

### 3.3. The perspective of NGOs

According to some NGOs representatives in BCS, the surface of mangroves is naturally increasing in some areas and decreasing in some others in the Pacific (2), while decrease in the SC is explained

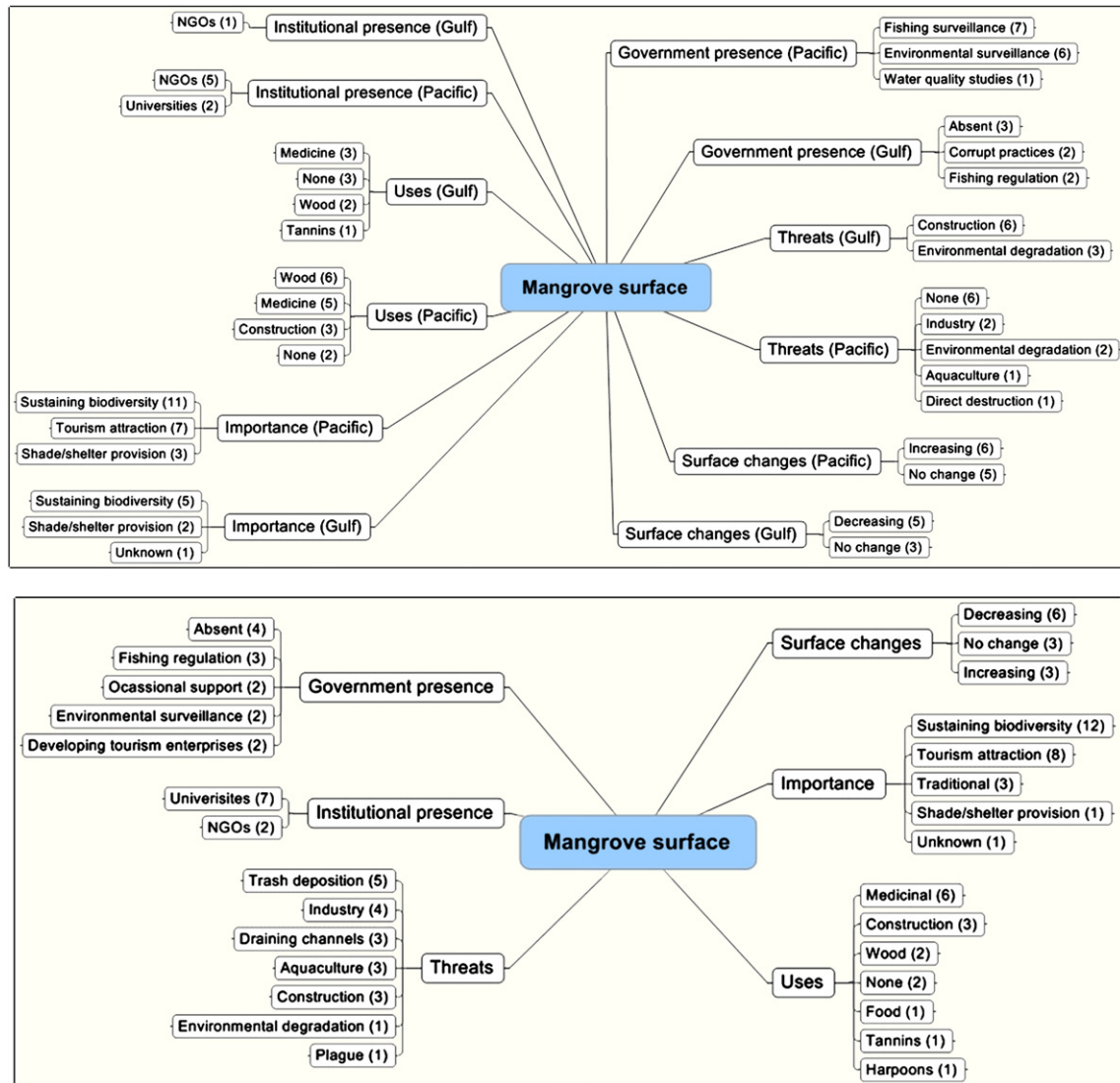


Fig. 2. Diagrams constructed based on the topics of the interviews conducted with the Fishermen. Upper: BCS. Lower: Sonora. In parenthesis the number of interviewees that expressed the same perception.

because of an accelerated coastal encroachment (4). Members of the same organizations in Sonora expressed that mangrove areas were decreasing (3).

All interviewees acknowledged the importance of mangroves to sustain biodiversity, provide ecosystem services, shade/shelter, and to have recreational values (7). The only difference was the traditional values for ceremonies given by indigenous groups in Sonora (1). In terms of uses, interviewees from BCS mentioned construction (3) and wood (2); while those in Sonora mentioned construction (2), wood (2) and medicine (1).

Perceived threats to mangroves by ENGOs in BCS derive from the construction of tourism developments (4), roads (3), direct destruction (1), lack of legislation knowledge (1) and land use change (1). In Sonora threats were aquaculture (3), drainage channels (2), unawareness from local people (1), developments (1) and land use change (1).

Interviewees in BCS considered that their work with scientists have contributed to the creation of new protected areas (3). However, some acknowledged that scientists frequently work separately and do not share information, weakening their strength as ENGO sector (2). The relation between ENGOs and scientists in Sonora was

perceived as adequate, since scientific knowledge is considered when planning agendas and activities (3). Some mentioned that no links existed between scientists and government, and/or private agencies to stimulate exchange of ideas and facilitate actions (1).

When asked about the coordination of government institutions, ENGO representatives in BCS said there was none, and that each has its own agenda (4). One interviewee expressed: "What coordination?. This lack of coordination is one of the principal threats to mangroves!". Another person considered that problems derive from erroneous interpretation and application of laws, since mangroves are located in a coastal zone and disputes arise regarding jurisdiction (1). ENGO representatives in Sonora perceived government as fragmented, having different agendas and interests, which complicate their work to reach the necessary consensus to promote conservation, education and sustainability (3).

### 3.4. The perspective of scientists

Scientists in BCS said that mangrove surface in the Pacific was expanding landward in some areas, while reducing in others due to natural changes; overall it remained the same (3). Some considered

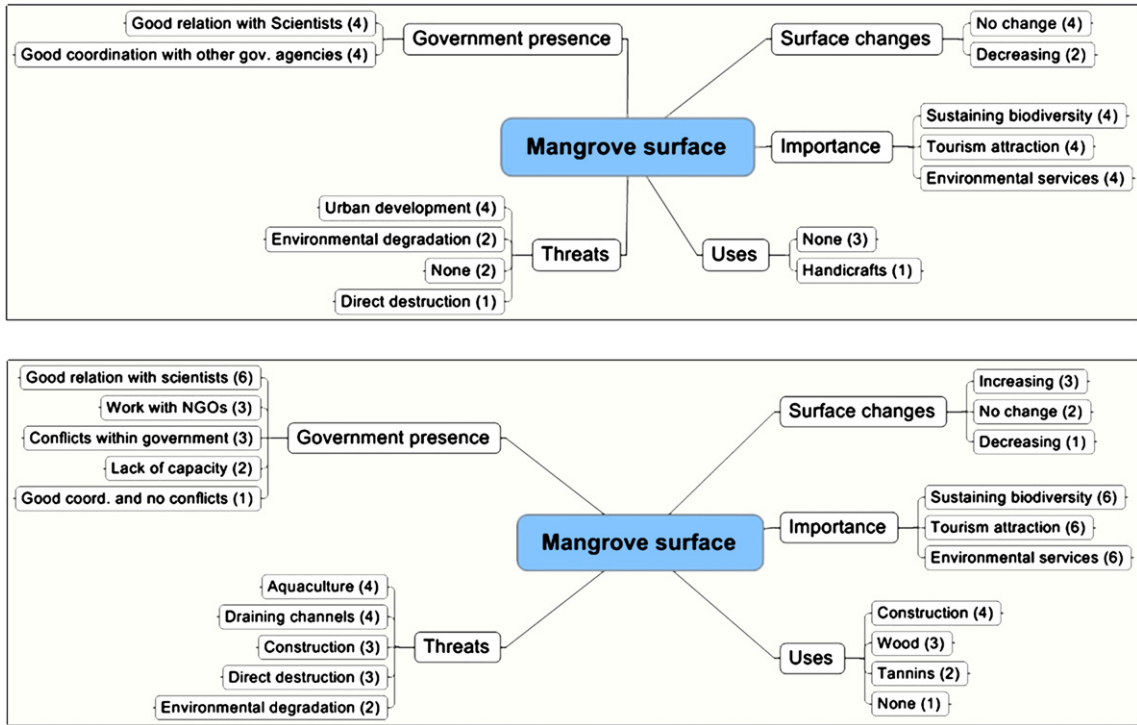


Fig. 3. Diagrams constructed based on the topics of the interviews conducted with the Government. Upper: BCS. Lower: Sonora. In parenthesis the number of interviewees that expressed the same perception.

a reduction close to cities and developments in the SC (5). In Sonora most interviewees said their surface was shrinking (6), while others thought it had remained the same (2). They mentioned, however, that since mangroves were constantly receiving drainage and wastes, they might experience future reductions (2).

For scientists in BCS, the main roles of mangroves were to sustain biodiversity (8), provide ecosystem services (8), increase productivity (4), provide shade/shelter (4) and aesthetic values (3). In Sonora perceptions were similar, acknowledging their importance for biodiversity (7), ecosystem services (4), tourism (3),

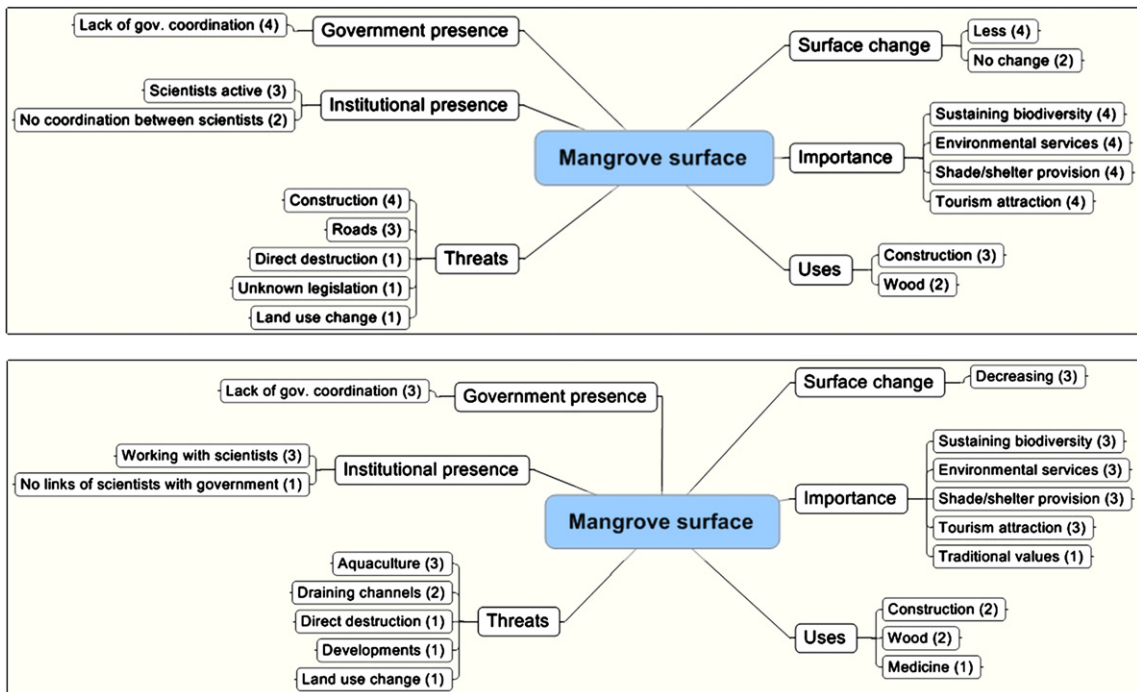


Fig. 4. Diagrams constructed based on the topics of the interviews conducted with the ENGOS. Upper: BCS. Lower: Sonora. In parenthesis the number of interviewees that expressed the same perception.

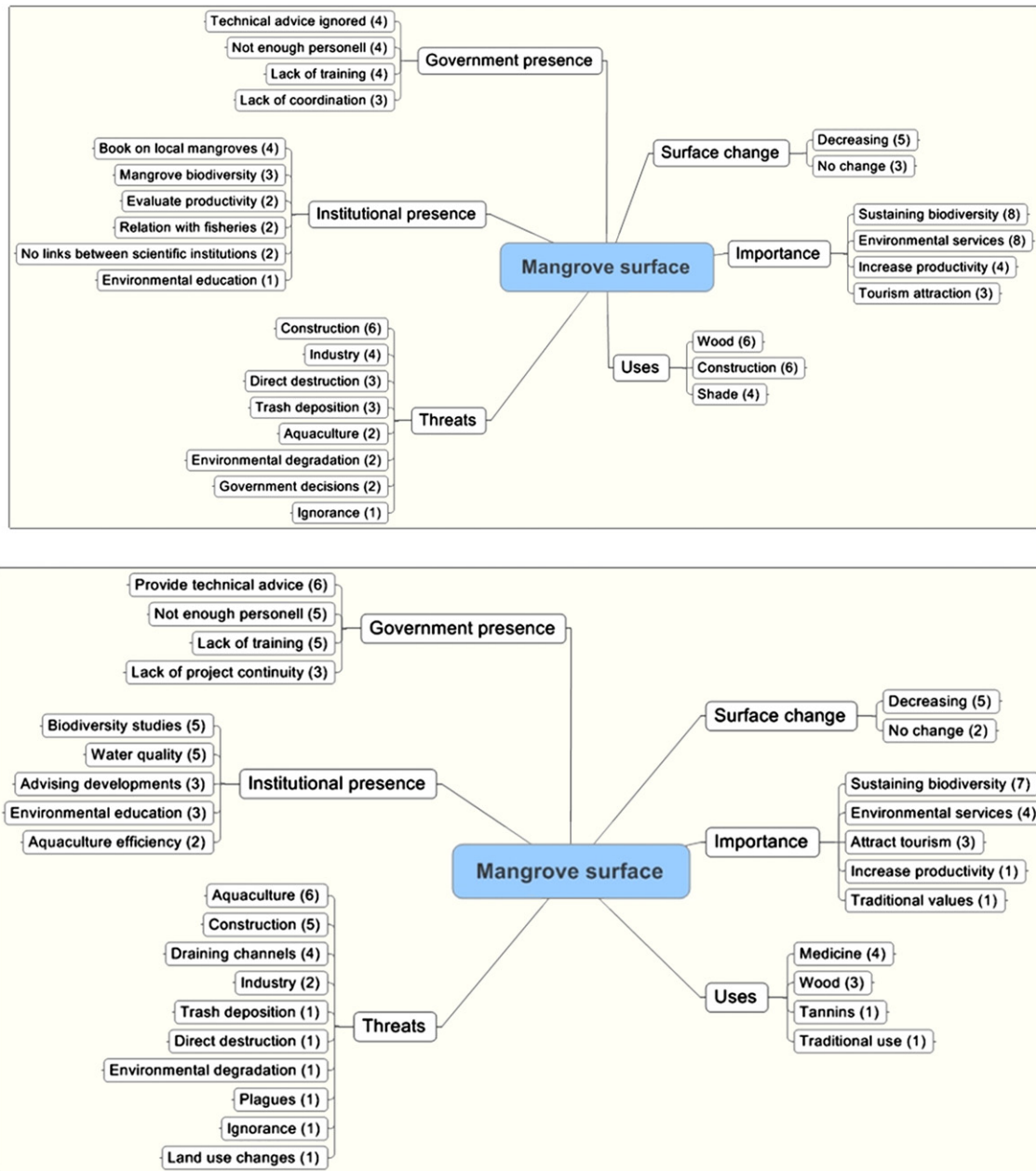


Fig. 5. Diagrams constructed based on the topics of the interviews conducted with the Scientists. Upper: BCS. Lower: Sonora. In parenthesis the number of interviewees that expressed the same perception.

increasing productivity (1), and also in providing traditional values for indigenous groups (1).

Among the uses of mangroves, BCS scientists mentioned wood and construction (6). In Sonora respondents acknowledged medicine (4), wood (3), tannins (1) and ceremonial uses (1).

The perceived threats to mangroves differed between areas. Respondents in BCS mentioned urban development (6), industrial complexes (4), aquaculture (2), direct destruction (3), waste and trash (3), environmental degradation (2), bad government decisions (2), and lack of environmental awareness (1). Interviewees in Sonora mentioned aquaculture (6), urban and tourism developments (5), drainage channels (4), industrial discharges (2), trash (1), destruction by tourism (1), environmental degradation (1), lack of environmental education (1) and land use change (1).

Scientists in BCS said they are working with mangroves around La Paz, conducting research on biodiversity, ecosystem productivity

and fisheries (4). One person from The School of Field Studies mentioned they were doing environmental education campaigns (1). However, some scientists mentioned that no links existed between scientific institutions: each working in isolation and competing for funds, thus duplicating efforts (2). In Sonora scientists mentioned they worked in monitoring biodiversity and water around mangroves (5), evaluating development projects (3), developing technologies for water efficiency and waste treatment (2), and on environmental education (3).

Regarding their relation with government, interviewees in BCS said this sector continuously requested their technical opinion but it was hardly taken into account (4), as one interviewee mentioned: "I have been asked to give my opinion, but it has never served any purpose, it is simply a procedure." They mentioned that government lacked training and personnel to cover the necessities of the entire state (4), and some said there was no coordination among



**Table 2**

Summary of categories that rouse from interviews with the four groups of stakeholders from BCS and Sonora. In brackets the number of persons of each category.

Area		Importance		Uses		Threats	
BCS	SON	BCS	SON	BCS	SON	BCS	SON
<b>Fishermen</b>							
No change (8)	Decreasing (6)	Biodiversity (16)	Biodiversity (12)	Medicine (8)	Medicine (6)	Construction (6)	Trash (5)
Increasing (6)	No change (3)	Tourism (7)	Tourism (8)	Wood (8)	Construction (3)	None (6)	Industries (4)
Decreasing (5)	Increasing (3)	Shade/Shelter (5)	Traditional (3)	None (5)	Wood (2)	Environmental degradation (5)	Waste drainage (3)
		None (1)	Shade/Shelter (1)	Construction (3)	None (2)	Industries (4)	Aquaculture (3)
			Unknown (1)	Tannins (1)	Food (1)	Direct destruction (1)	Construction (3)
					Tannins (1)	Development (1)	Environmental degradation (2)
					Harpoons (1)	Aquaculture (1)	
<b>Government</b>							
No change (4)	No change (5)	Biodiversity (4)	Biodiversity (6)	None (3)	Construction (4)	Urban development (4)	Aquaculture (5)
Decreasing (2)	Decreasing (1)	Tourism (4)	Tourism (6)	Handicrafts (1)	Wood (3)	Environmental degradation (2)	Drainage (4)
		Environmental services (4)	Environmental services (6)		Tannins (2)	Direct destruction (1)	Construction (4)
					None (1)		Direct destruction (3)
							Environmental degradation (2)
<b>Environmental Non-governmental Organizations</b>							
Decreasing (4)	Decreasing (3)	Biodiversity (4)	Biodiversity (3)	Construction (3)	Construction (2)	Construction (4)	Aquaculture (3)
No change (2)		Environmental services (4)	Environmental services (3)	Wood (2)	Wood (3)	Roads (3)	Draining channels (3)
		Shade/shelter (4)	Shade/shelter (3)		Medicine (1)	Direct destruction (1)	Direct destruction (1)
		Tourism (4)	Tourism (3)			Unknown legislation (1)	Developments (1)
			Traditional (1)			Land use change (1)	Land use change (1)
<b>Scientists</b>							
Decreasing (5)	Decreasing (6)	Biodiversity (8)	Biodiversity (7)	Wood (6)	Medicine (4)	Construction (6)	Aquaculture (6)
No change (3)	No change (2)	Environmental services (8)	Environmental services (4)	Construction (6)	Wood (3)	Industry (4)	Urban/Tourism construction (5)
		Productivity (4)	Tourism (3)		Tannins (1)	Aquaculture (2)	Waste drainage (4)
		Shade/Shelter (4)	Productivity (1)		Traditional (1)	Direct destruction (3)	Industry (2)
		Tourism (3)	Traditional (1)			Trash (3)	Trash (1)
						Environmental degradation (2)	Direct destruction (1)
						Bad government (2)	Environmental damage (1)
						Ignorance (1)	Ignorance (1)
							Land use change (1)

governmental institutions (3). Scientists in Sonora also mentioned that their technical opinion was often requested (6), and they shared opinions about the lack of training and scarcity of personnel (5). They also mentioned that government invited them to different projects, but none of these was ever concluded (3).

## 4. Discussion

### 4.1. Methodological aspects

The first issue that should be emphasized is the use of a qualitative research approach in this study. The analysis presented here is part of a research project on the situation of mangroves in this part of Mexico and first results on biophysical aspects are published elsewhere (López-Medellín et al., 2011). From the recognition that conservation issues are related to human interaction with ecosystems, our interest was to analyze the importance stakeholders confer to mangroves. The use of semi-structured interviews using mainly open-ended questions and the fact that it was possible to audio-record the interviews, allowed us to document the perspectives of each interview. When there is no previous research conducted on a particular subject as this was case, this research approach allows finding ideas of interviewees that would not be possible to obtain with techniques such as surveys with closed questions. In this way, our study contributes with information that could be useful when designing integrated coastal management plans or when formulating policies (Bowen and Riley, 2003; Garmendia et al., 2010).

Mangroves in Northwestern Mexico differ in their degree of degradation or maintenance according to factors such as the history of human population colonization, and the intensity of its expansion. Taking these into account, Sonora can be divided in two regions: the southern-central region, with the highest population density and human activities practiced since the 1700s by first European settlers; and the northern region, with lower population density and a history of settlement mainly occurring during the 20th century (Almada, 2000). BCS can also be divided in two regions: the SC coast with a low population density and settlements established in the 20th century, and the Pacific coast with even less population and scarce development (Del Río and Altable-Fernández, 2000).

We have divided the rest of our discussion into three other sections: Section 4.2 examines mangrove surface since different perspectives arose in our results regarding such a basic and important topic; Section 4.3 covers ecosystem services provided by mangroves as this reflects the importance given to them by the different stakeholders and Section 4.4 discusses coastal integrated management issues as aroused from our aims and findings regarding stakeholders perspectives for the long-term use and conservation of mangroves in Northwestern Mexico.

### 4.2. Mangrove surface: in expansion or at risk?

Most fishermen, ENGOs and scientists interviewed in the southern-central region of Sonora claimed that the surface of mangroves was shrinking due to the combined effects of accelerated urban and coastal settlement expansion, intense agriculture

and ranching activities, resource overharvesting, as well as the construction and operation of aquaculture and other industrial complexes. However, other fishermen, scientists and government officers stated that mangrove surfaces remained basically the same in this region, even in those areas with severe contamination. Some scientists mentioned that this was due to a high resilience of mangroves and their capacity to cope with pollution.

In the north of Sonora, mangroves reach their northern distribution border within the ComCaac territory. According to local fishermen, the area still maintains good environmental conditions that allow the presence of healthy mangroves because there are no major developments and settlements. All fishermen interviewed in this region mentioned that mangroves were even expanding in surface by growing landward. Other fishermen and scientists from northern Sonora claimed that the surface of mangroves was definitely reducing in the vicinity of the city of Bahía de Kino, just south of the ComCaac territory, this mainly due to aquaculture activities and the construction of tourism developments.

During the 1980s, aquaculture activities began incipiently in this city; by 1997 changes in policies allowed private enterprises to freely enter and develop the coast, massively expanding this industry (Moreno et al., 2005). Páez-Osuna et al. (1998) found that this industry has altered local estuarine conditions by releasing chemicals and sediments, which further affect local fishermen through a consequent reduction in biodiversity and sediment deposition. Tourism was the other activity recognized to be posing strong impacts on mangroves in Northern Sonora; mainly as consequence of construction of facilities or by pollution and trash deposition. Tourism started in the area in the 1930s when sport fishermen from the US started to visit, and at present it is one of the main economic activities promoted in Bahía de Kino (Gobierno de Sonora, 2005).

Interviewing government officers in Sonora, we obtained contrasting responses regarding mangrove surface, which may reflect a lack of communication and/or coordination among government institutions. A possible explanation could be that as the state of Sonora grew and developed, more offices were formed to work and find solutions to the multiplying environmental problems. Because each office tends to maintain structures that protect their interests and follow objectives without consultation with others, conflicts arise. Often this results in having agencies working at cross-purposes which may also produce contradictory tasks (Huggett, 1998; Brechin et al., 2003).

In order to work towards sustainable development and specifically to achieve an integrated coastal management, it is fundamental that governmental institutions related to environmental issues become more organized, carry out coordinated activities, and most importantly, make use of good quality information (Hewawasam, 2000). However, it is important to mention that no scientific studies that analyze the changes in the surface of mangroves in the state of Sonora have been published to date. Such studies are urgently needed to provide baselines that will strengthen decision and policy making, and also help identifying areas where environmental conflicts are likely to be severe in the light of the accelerated development rates in this coastal region (Ruiz-Luna et al., 2008).

In BCS most interviewees agreed that the surface of mangroves in the SC coast was shrinking mainly because of the development of tourism facilities. Some fishermen also added that coastal encroachment is restricting shore access, a fact that is challenging social structures and the local economy in other coastal regions of the state as well. This situation was also noted by Presenti and Dean (2003), who mentioned that tourism facilities were being developed in rural areas, and the local population was either turned into labor force for tourists or displaced in order to construct more developments.

A contrasting scenario occurs in the Pacific coast of BCS, which has the largest mangrove surface and is the less inhabited and developed area in Northwestern Mexico (Whitmore et al., 2005; CONABIO, 2008). The few settlements here are located in sites where waters are very productive and biodiversity rich, and the small population lives from fishing highly priced species such as abalone and lobster (Young, 2001). Fishermen and scientists asserted that mangroves in this coast are in good condition and that their surface was the same or even expanding inland. Such mangrove landward expansion was confirmed by our own analysis of satellite imagery and aerial photographs from the region, in which we relate mangrove expansion in the Bahía Magdalena region with oceanographic anomalies and sea level rise (López-Medellín et al., 2011).

Governmental officers in BCS mentioned that mangrove surface remained basically the same throughout the state, but acknowledged that in some areas few mangroves were damaged by construction. However, they also recognized that the lack of personnel and budget make it difficult to perform the monitoring of the entire state and therefore they cannot be aware of environmental problems in all areas. The government of BCS is based in La Paz, a large city where growing tourism and industrial facilities have deteriorated or even removed entire mangrove stands within or near the city, as mentioned by some fishermen, scientists and ENGOs personnel. Government however, does not acknowledge such reductions, which have been previously identified in scientific publications (Holguín et al., 2006; Acosta-Velázquez and Ruiz-Luna, 2007). This indicating a lack of communication between government and the scientific sector, showing perhaps the incapacity of scientists to make visible and useful their findings or reflecting as well that governmental authorities promote a discourse directed to protect their interests and directives (Brechin et al., 2003).

ENGOs from both states shared the perception that in general the surface of mangroves was reducing. All interviewees from these organizations mentioned that they work closely with scientists to obtain accurate information on the present state of natural ecosystems, which might be the reason why similar perceptions in terms of mangrove threats and present surface were obtained from both sectors. Since ENGOs actions aim to influence policies and practices to promote conservation, sustainability, environmental awareness and social equity, they try to include all stakeholders in their conservation processes through broadening communications, reaching consensus and improving the management of the coastal regions in Northwestern Mexico. For these reasons, ENGOs seem to have broader perspectives on how power relations are established among actors in the management of coastal areas (Sanyal, 1994) and consider these aspects when conducting projects.

These contrasting perceptions about a relevant and basic issue such as changes in mangrove's cover may reflect the lack of communication channels and spaces for information exchange among the different stakeholders, which is fundamental in order to construct consensus and reach an integrated coastal zone management that contribute to sustainable development (Fabbri, 1998; Hewawasam, 2000).

#### 4.3. Mangroves and ecosystem services

Mangroves were extensively recognized by most interviewees as providing a variety of services that benefit human livelihoods and that are related to ecosystem integrity and biodiversity. Although our study provides a qualitative valuation of such services and an economic valuation is still needed, these findings show the relevance of documenting how direct users of ecosystems (such as fishermen) as well as those responsible for regulating their use and promoting their conservation (Government and ENGOs)

understand the society–ecosystems interaction (Garmendia et al., 2010). Scientists as generators of information emerge here again as an important sector that needs to get involved in management decisions (at different scales) providing the knowledge needed to support the conservation of mangroves in the long term because of their relevance to provide services (tangible such as fish, but also due to their role in climate regulation or natural processes such as natural waste decomposition in wetlands). Ecosystem services cannot only be prized when society has to compensate their loss (Ewel et al., 1998; Gilbert and Janssen, 1998). Undervaluation of these services has been one of the major factors driving the conversion of mangrove ecosystems to human-dominated systems (Costanza et al., 1997; Daily et al., 2000), because these are difficult to translate into economic currency. Studies are needed to better understand the linkages between coastal ecosystems such as mangroves and the social benefits associated with them. It is also necessary to determine which are the most important goods and services provided by mangroves within an area, in order to better allocate their local economic, ecological and cultural values. Determining the impacts that particular activities are imposing on mangroves will help to identify priority areas that ought to be preserved and/or restored.

Fishermen in the SC of BCS gave less importance to mangroves than fishermen in the Pacific and Sonora regions. Such contrasts might relate to the uneven distribution of mangrove surface between the two coasts which make some fishermen live in closer contact with these ecosystems than other groups (CONABIO, 2008). However, this may also indicate a lack of environmental awareness and regulations in these coasts, because while the fishermen in the SC of BCS did not acknowledge institutions working with mangroves, those in the Pacific coast recognized the presence of some institutions working in the area with environmental issues.

Nevertheless, even though the perception of fishermen in the Pacific coast of BCS and Sonora was that mangroves were important to sustain fisheries and biodiversity, as well as providing aesthetic values, their perception seemed not to be shared by other inhabitants in cities like Puerto San Carlos or Guaymas, where pollution, waste disposal and destruction of mangroves reflected the lack of interest that local inhabitants pay to this ecosystem evidencing also the absence of local environmental conservation actions and regulations.

In the central-southern region of Sonora, on the other hand, intensive activities such as aquaculture, agriculture and industrial complexes have had consequences on mangrove ecosystem services that were previously provided to society, in exchange for economic profits that benefit a few individuals or corporations. Some fishermen and scientists interviewed mentioned that mangrove surface in this area remains the same. However, it is important to mention that the mere presence of mangroves is not indicative of healthy coastal conditions and there is no guarantee that provision of ecosystem goods and services provided by healthy mangrove ecosystems continues (Alongi, 2008). For these reasons, there is a severe reduction of fisheries that were once plenty and supported many families, and presently fishermen are forced to switch between jobs or have to migrate to other regions in search of economic alternatives (Aburto-Oropeza et al., 2008). A similar scenario is occurring on the SC coast of BCS, where tourism developments are deteriorating or removing natural environments.

In contrast, the coast of the Pacific of BCS has not been subject to major developments, and fishermen earn good incomes and enjoy better livelihoods. Nevertheless, this coast is gradually being developed through tourism and aquaculture, which threaten coastal environmental conditions and may create the same scenarios of natural depletion and social inequity and poverty as in Sonora and the SC coast.

#### 4.4. *Managing perspectives for the long-term maintenance of mangroves in NW Mexico*

In order to achieve an integrated management of the coastal area (Fabbri, 1998) in Northwestern Mexico, the development and implementation of a coordinated strategy to allocate environmental, socio-cultural and institutional resources is urgently needed. Such a process can take considerable time, since it requires continual information updating and adaptive management strategies. It also requires effective governmental policies and the establishment of active arrangements among stakeholders in order to make decisions, as well as management strategies which are based on the interconnections between coastal natural and social systems (Sorensen, 1993). Our study provides a first baseline of information regarding the perceptions of the key social actors whose decisions are directly related to their views and opinions. These views act as windows to understand the interplay of economic, political, cultural and ecological issues. As it has been emphasized in the ecosystem management literature, understanding these actors' perspectives and constructing narratives is seen as an essential part of the social system diagnosis (Grimble and Chan, 1995; Christensen et al., 1996; Waltner-Toews et al., 2003; Fletcher, 2007; Garmendia et al., 2010).

Managing ecosystems involves capacities of governance; that is reaching arrangements (prescriptions, rules, regulations) to organize sets of repetitive activities in order to obtain desired outcomes (Ostrom, 1990, 2005). Establishments of such arrangements and creation of rule systems need the participation of those stakeholders involved in the specific situation. For the case of mangrove sustainable management, it is necessary to revise the role of Government. Our findings agree with the idea that failure to promote environmental stewardship in many countries has been related to some high ranking officers that base political decisions on personal economic gain and prioritize activities that produce large profits in the short term by allocating vital resources to private parties and without considering environmental consequences (Bryant and Bailey, 2005).

A dissimilar presence of governmental authorities in BCS is of great concern to improve management practices of coastal areas. Fishermen of the Pacific coast recognized an active presence of government which works as a constant reminder that mangroves are protected. In contrast, fishermen in the SC stated that environmental authorities were totally absent, this representing a lack of interest on environmental issues. Government was seen also as concentrating its efforts in areas with better social organizations and where economic activities such as fishing or tourism provide good profits, neglecting highly marginalized and less organized communities where environmental impacts due to resource over-extraction are higher.

Furthermore, in regions where the operation of large aquaculture or tourism developments are producing large economic profits, such as central-southern Sonora or the SC coast in BCS (SAGARPA, 2006, [www.sectur.gob.mx](http://www.sectur.gob.mx) March 2010), the government is inclined to benefit a few private parties by granting them access and control of vital resources. Since such enterprises can only be sustained by wealthy and powerful individuals or corporations, local communities cannot compete with them and are excluded from resource use, increasing local social inequity, conflicts over appropriation of resources and resource poaching (McGoodwin, 1980; Luers et al., 2006). Poverty and environmental degradation derive from unplanned decision-making processes where impact of growing populations upon coastal ecosystems have negative effects on mangroves' health and productivity, as was evidenced from our interviewees.

Filling the gaps left in many cases by governmental inefficiency, ENGOs have proved effective in promoting sustainable practices by

bringing together local inhabitants with other stakeholders, strengthening decision making and improving their quality of life (Castillo, 1999). By questioning the government as promoter of social and environmental interests and by working with different actors to seek common objectives and empower local communities, ENGOs build institutions that can challenge local, regional or national elites and exert pressure on governments and businesses to change degrading practices by including scientific information (Clarke, 1998; Bryant and Bailey, 2005). For this reason, the presence of such organizations is critical to achieve a successful coastal management in Northwestern Mexico (Brechin et al., 2003).

In the case examined here, ENGOs emphasized problems of coordination with different governmental institutions because of their different agendas and interests, but acknowledged that cooperation was possible when creating new protected areas. When interviewing other social sectors, however, they stated that ENGOs sometimes work in isolation, compete for funding with other organizations rather than pooling resources in common efforts, a situation that fails to hasten political change. A similar situation aroused when interviewing ENGOs representatives regarding their relationship with scientists; recognizing no communication interactions between scientific institutions or even between scientists within a same institution.

Technical capabilities are extremely needed to accomplish conservation and local peoples' sustainable livelihoods. Having accurate knowledge of natural resources and the systems that produce them is considered relevant for construction of strong governance systems (Ostrom et al., 1999). Assistance and commitment of international and national organizations is crucial to support information exchange, feasibility studies, pilot projects, and funding (Sorensen, 1993; Brechin et al., 2003). Consequently the participation of scientists is essential to formulate management and conservation policies (Miller and Hobbs, 2002) and this has been a constant demand from different social sectors (Castillo et al., 2005). Scientific information regarding ecosystems functioning could be crucial to determine thresholds when using natural resources and to respond to environmental contingencies. Scientific institutions should work closely with the different stakeholders not only to facilitate the application of research results but also to identify information needs and to establish research agendas (Castillo, 2000). Our results show that sectors such as fishermen who are direct users of mangroves services shared an alien perception towards research institutions; and their interactions with these were at best scarce (Kriebel et al., 2001).

Despite the importance of scientific studies, most information is almost exclusively published in scientific journals and rarely reaches local communities and other stakeholders (Castillo and Toledo, 2000). This situation was evidenced here through the perception of government regarding mangrove surface in BCS, which has been reported to be diminishing by scientists but this view has not moved outside academic circles. It is crucial that scientific knowledge is communicated to the diversity of social actors and decision makers to raise awareness on environmental problems in order to define research projects and agendas in a two-way process according to local and regional priorities (Castillo et al., 2005; Perdomo-López, 2007). This could foster social participation and encourage local population to manage and conserve natural ecosystems in such ways that these can be maintained in the long term and provide society with benefits (Castillo, 2000; Miller and Hobbs, 2002).

## 5. Conclusions

Different actors with varying interests and sometimes strong power differences are involved in the management of mangrove

ecosystems in northwestern Mexico. Achieving an integrated coastal management in this region is a difficult task. However, an initial step is the identification of stakeholders' perspectives. The use of a qualitative research approach in this study has proved useful since it allowed documenting actors' views from an open and inductive approach.

The governmental sector is crucial in order to design integrated coastal management plans and strategies. In this study it was found that the different environmental institutions and officers have different agendas and objectives and cannot act therefore in a coordinated way. Furthermore, the lack of budget and personnel complicates the scenario because it is impossible for this sector to cover large areas such as those of the coastal states in northwestern Mexico. On the other hand it was recognized that although the scientific sector plays a relevant role as provider of accurate information regarding ecosystems and their long-term conservation; this sector is poorly communicated with the rest of stakeholders. Scientific information should strengthen decision and policy making processes from the local to the national and international levels. Consequently, it is of the utmost importance to broaden the channels of communication among stakeholders to achieve an integrated coastal zone management. An important actor that can promote such communication is the environmental NGOs sector. Their actions often aim at promoting communication among stakeholders and influencing policies and practices. However, these organizations frequently work in isolation, competing with each other for funding and doubling their efforts, failing in cases to contribute to the needed changes.

Fortunately, a growing awareness in taking urgent action to protect ecosystems in Northwestern Mexico has been detected, as well as an increase in national and international efforts. Nevertheless, there is still much to be done to bring local and regional actors together in order to construct an endogenous development model that can transit to sustainability, allowing future generations to enjoy the benefits of mangrove ecosystems.

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