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Recognition of Mangrove Ecosystem Services by the Community and Policy Makers in the Gulf of Guayaquil, Ecuador

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*Recognition of mangrove ecosystem services by the community
and policy makers in the Gulf of Guayaquil, Ecuador*

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University of California San Diego**

M.A.S MARINE BIODIVERSITY AND CONSERVATION

FINAL CAPSTONE REPORT

JUNE 9, 2016



**Center for Marine
Biodiversity &
Conservation**



Capstone Advisory Committee Final Capstone Project Signature Form

Recognition of mangrove ecosystem services by the community
and policy makers in the Gulf of Guayaquil, Ecuador

Jodie Darquea Arteaga

Spring 2016

**MAS Marine Biodiversity and Conservation
Capstone Project**

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Abstract

In 2000 Ecuador created the “Agreements of Sustainable Use and Custody of Mangroves” management for the local communities, helping to stop deforestation of mangroves caused by shrimp farming. With this program, the Ecuadorian government offers economic incentives to support community-based management without taking into consideration the essential role of ecosystem services. This policy fails to encourage the capacity of the communities to grow through monitoring of ecosystem services. This project seeks to understand which aspects of ecosystem services should be integrated into the sustainable management of mangroves in order to ensure that current policies lead to a desirable level of exploitation of resources and support mangrove conservation. An assessment of ecosystem services has not been conducted in the region prior to this project. A total of 96 surveys of stakeholders were conducted in three mangrove concessions in the Gulf of Guayaquil located in Cerrito de los Morrenos, Balao, and 6 de Julio. 96% of the stakeholders agreed that mangroves could deliver services or benefits, such as fisheries, nursery grounds for fishers, and climate regulation, which are the services that stakeholders wanted to maintain most. Additionally, 48% of the stakeholders believed that fishery services have declined in recent years. Stakeholders from 6 de Julio expressed significantly more value for a sense of place than those from the other two concessions. However, fishers in all three locations strongly valued maintaining mangroves for future generations. This study found that these two cultural services were most valued by fishing associations that have a strong leadership, motivated members, and a high level of involvement. This may happen because members of fishing associations which have a high participation level have internalized lessons from these activities. Thus, there is a strong case to include ecosystem services approaches in mangrove concession management. This is especially critical as resources continue to decline. Environmental policies should incorporate investment in participatory monitoring in order to strengthen social capital of mangrove concessions and create a strong platform for an adaptive approach to ecosystem management.

Key words: ecosystem services, mangroves, fishing associations, participatory monitoring, level of involvement, mangroves

Introduction

Over the last several decades, Ecuador has converted much of its mangrove forests to shrimp ponds, and has since become the largest producer of farmed shrimp worldwide, fueled by the ideal tropical conditions, high international demand, and profitable gain from this industry (Hamilton 2012). Unfortunately, this has also resulted in the loss of approximately 40% of the total mangrove cover, along with a loss of biodiversity and the release of more than 7 million tons of living carbon (Hamilton et al 2015). The loss of biodiversity has reduced fishing ground of cockle and crabs and is imposing an uncompensated cost that has been assumed by the government and local communities.

Ecuadorian legislation for wetland conservation was weakly enforced during previous years without rigorous monitoring of mangrove status and use. However, Ecuador is now starting to develop mangrove initiatives that focus on sustainable development and involving local communities.

In 1999, Ecuador took an important step for mangrove conservation by creating a policy entitled “Agreements of Sustainable Use and Custody of Mangroves” for ancestral users of the ecosystems, also known as concessions. This policy allocated property rights to the users as a form of mitigation to decrease the deforestation rates from conversion of mangroves to aquaculture from shrimp farms. Subsequently, the Ecuadorian government conducted a review for its current Forest Law to support the conservation of mangroves.

According to a recent evaluation, concessions are divided between the provinces of Guayas (69%), Esmeraldas (24%), and The Oro 7% (USAID, 2013). During the last 15 years, the concessions also have developed management plans together with the government agency (Ministry of Environment) for sustainable use of the resources. Despite these accomplishments, some problems developed: some of the concessions have expired and not been renewed; others have a lack of financial support for enforcement; and management efforts are hindered by conflicts of interest and technical assistance difficulties. Therefore, the Ministry of Environment adopted a new policy in 2014 through the “Socio Manglar” program that provides economic incentives to the users of the mangroves who voluntarily commit to conserve and protect them. The user of mangroves organized in fishing associations or cooperative should have the legal framework to hold a concession. The goal of the policy is to complement and consolidate the community-based mangrove conservation. It is based on five lines of investment: monitoring and surveillance, administration, technical assistance, organizational strengthening, and productive social projects (Ministerial Agreement 198).

However, the simple designation of economic support does not guarantee successful management. Even if the goal of the incentive is to influence people’s behavior by making it more desirable to them conserve the resource, a wide range of failures and discontinuities may occur. For example, in Indonesia some localities utilized economic incentives to buy material to build more fishing gear and crab traps, causing an overexploitation of resources instead of their conservation. In addition, the “Agreements of Sustainable Use and Custody of Mangroves” and actual economic incentive policy did not consider ecosystem services as an essential part of the management. This fails to encourage the building capacity of the communities through monitoring these services. Ecosystem services are the link between ecosystems and human welfare (Daily et al 2009). Environmental policies increasingly incorporate ecosystem services as important tool to successful management.

For these reasons, this project intends to understand what aspects of ecosystem services should be integrated in the sustainable management of mangroves, to ensure current policies lead to a desirable level of exploitation of the resources while supporting mangrove conservation. The objectives of this project are to: (1) determine the current

strengths of the mangrove concessions program at selected sites; (2) determine the level of awareness among holders of concessions and shrimp farmers regarding the ecosystem services provided by mangroves (3) determine the capacity of the organizations at these sites for participating in monitoring programs; and (4) propose protocols and guidelines for certain aspects of mangrove management. Educational materials on the importance of ecosystem services to the communities will be developed, including a brochure per each location visited.

The final report will be a useful tool for policy makers, NGOs working on mangrove conservation at these sites, and community members. It summarizes the perceptions of ecosystem services among stakeholders, as well as the priority services that stakeholders would like to maintain most. The intent is to help managers to integrate ecosystem services into management policy.

Research questions

This study will determine the ecosystem services that stakeholders consider most important in order to guide the selection of priorities by decision-makers. To investigate mangroves users' perceptions, this project uses semi-structured surveys in mangrove concession communities, as well as relevant NGOs and government authorities, to address each of the key research questions. (Table 1). An ecosystem approach provides a path of recognition of function and services that nature provides to humans, enabling sustainable management. Ecosystem services can help to promote the fair uses of resources among all the actors and could reduce social economic tension in the region. Some previous studies have focused on the calculation of the value of mangroves ecosystem services to the region (Burgess et al 2015). However, these studies are not considered perceptions of the users of the capacity of ecosystem services to deliver benefits. One goal is to enhance participation in mangrove management in this region; this is ultimately the driver behind mangroves custody.

A number of relevant questions can be investigated to develop an understanding of the concession management and awareness of ecosystem services:

1. What is the current strength of the fishing associations? What is the level of involvement? What does it need? What do they need to improve?
2. What is the level of awareness of ecosystem services the mangroves provide to the holders of the concessions?
Which ecosystem services are important to the stakeholders of the concessions and to the decision makers? Which are the less known ecosystem services?
3. What is the capacity of the communities to participate in monitoring programs?
4. What is the most important ecosystem service for the communities to monitor and how do I create guidelines for practical protocols that could be used by the communities?

I hypothesized that fishing associations in the Gulf of Guayaquil have a basic level of capacity to manage mangrove concessions; these organizations can serve as a foundation for improved management practices. I examined the strength of the fishing associations based on the following criteria: leadership, level of conflict resolution, and level of involvement; each of these were evaluated as indicators of fishing association's capacity. However, given the existing problems with management, these communities and organization require additional capacity-building and awareness raising, including information on ecosystem services.

To determine the level of stakeholder's awareness of ecosystem services, I asked each stakeholder to rank the priority ecosystem services that would like to maintain through time, and identify how to incorporate them into current management based on the management capacity of the mangrove concessions, level of involvement and willingness to participate in future monitoring.

Table 1. Description of research and survey questions presented to stakeholders of mangrove concessions in the Gulf of Guayaquil, Ecuador regarding ecosystem services (ES).

Research questions	Survey questions	Response options
What is the current strength of the fishing associations? What is the level of involvement? What are the needs and how can management be improved?	<i>How frequently did you attend association meetings about mangrove management in the last year?</i> <i>Please indicate how frequently you have participated in the following environmental activities; Reforestation; Monitoring; Clean up; Workshops</i> <i>Are you satisfied with the current management of concession?</i> <i>What type of capacity is needed to improve the management of the concession?</i>	Number of times 0; 1-3; 4-7; 8-10; >10 “yes” “no” Why, code according common answer Code according common answer
What is the level of awareness of ES? What are the priority services stakeholder would like to maintain most?	<i>Please indicate how much of each benefit mangroves provide for the community; Provisioning, supporting and regulating services</i> <i>Please indicate how much of each benefit mangroves provide for the community; Cultural and existence values</i>	Scale from 1-5 “5 great deal” “never” 1; “rarely” 2; “sometimes” 3; “most of the time” 4; “always” 5
What is the past and future perception of ES and mangroves changes?	<i>Compared to five years ago, how much of each of the following resources are there now:</i> <i>Compared to five years ago, do you think there has been a change in the “ecosystem services in this area? Please explain why you think the change has, or has not occurred.</i> <i>In your opinion, if the management continues in the same way as now, what will happen to mangrove areas in the next 10 years?</i>	Fish; Crab; Shell “more”; “the same”; “less”; “I do not know” “more”; “the same”; “less”; “unsure” Why? Code according common answer “better”; “the same”; “less”; “unsure”
What is the capacity of the fishing associations for future participation in monitoring?	<i>How willing are you to volunteer in each type of the following local monitoring: mangrove biomass, carbon storage, biodiversity, recording landings,</i> <i>Please indicate what factors influenced your decision not to get involved in the social monitoring of mangroves?</i>	“not at all” 1; “very little” 2; “somewhat” 3; “to great extent” 4 Code according the common answer

Ecosystem services approach

Classification of the ecosystem services were originally suggested by the Millennium Ecosystem Assessment 2003, identifying four categories of ecosystem services (Table 2): Provisioning services are goods we take from the environment with a monetary value; Supporting services provide habitat, food, refuge, nutrient cycling and more; Regulating services maintain the ecosystem in balance; and Culture services are connected to human spiritual and societal well-being in an immaterial way (Table 2). They can include education, research, arts, and religious values.

Table 2. Categories of ecosystem services.
Table taken from the Millennium Ecosystem Assessment (2003).

Type of Service	Service
Provisioning service	Food Fiber Genetic resources Bio-Chemicals, natural Medicines, etc Ornamental resources Fresh water
Regulating services	Air quality regulation Climate regulation Water regulation Erosion regulation Disease regulation Pest regulation Pollination
Cultural services	Cultural diversity Spiritual and religious values Recreation and ecotourism Aesthetic values Knowledge systems Educational values
Supporting services	Soil formation Primary production Nutrient cycling Nursery Water cycling

Ecosystem services are a useful tool for promoting sustainable management which the goal to manage healthy and resilient ecosystems that meet the needs of the current and future generations. Understanding ecosystem services can serve as strong motivation to sustainably manage these services, and the ecosystems that provide them, into the future. The ecosystem services approach is a way of looking at the natural environment through the decision-making process that helps you think about the way that natural environment works as a system. (Gutierrez 2010). Christensen et al. (1996) defined ecosystem management as “management is driven by explicit goals, executed by policies, protocols, and practices, and made adaptable by monitoring and research based on our best understanding of the ecological interactions and process necessary to sustain ecosystem composition, structure, and function”.

To move from the concepts to management, the major challenge is to find measures of each service and link the quantity and quality of services to human well-being.

The ecosystem service approach also increases public and private awareness of services. Stakeholders need to be informed that the ecosystem provides important goods and services that benefit a broad range. They must also know that ecosystem degradation may have local, regional and even global negative implications. Moreover, ecosystem

approaches present an opportunity to encourage new conservation policies that without a better understanding, will not be adopted. This approach also serves to evaluate how well conservation programs have been conducted. It may maximize the benefits of the system and encourage governmental agencies to incorporate them into integrated management.

Finally, payments for ecosystem services (PES) is another tool that can be used to enter in the new market of ecosystem services. For example, Reducing Emissions from Deforestation and Forest Degradation (REDD+) has the potential to establish agreements with local government to provide economic benefits to indigenous communities that protect and maintain the forest. Additionally, the carbon market is a mechanism to reduce the greenhouse gases. Carbon credits are issued for the conservation of forests and traded in the international market within the industries that have not reached their reduction of gas emission goals. For example, the blue carbon program uses the value of carbon sequestration services (forest protection) not only to generate payments, but also to promote biodiversity conservation. PES also conserves the function and operation of systems generally and maintains the supply chain and base of operation more specifically. For example, efforts to conserve fish nursery grounds promote biodiversity and support commercial fish populations (Liu et al 2007).

Mangrove ecosystem services

Mangroves are unique ecosystems along the coast and estuary areas of the tropical and subtropical areas. Mangrove ecosystem processes include complex and dynamic interactions that involve the transfer of energy and material elements (Lyons et al 2005). Globally, it is estimated that mangroves extend between 14-24 million ha worldwide and



Figure 1. Mangroves roots hosts important species of commercial fishing. Taken from www.pinterest.com

provide a high number of ecosystem services that directly or indirectly benefit human wellbeing (Kauffman & Donato 2012). For example, mangroves support animal populations in the forest and offshore; their roots serve as nursery grounds for fish, crabs, and mollusks. This protection, along with the abundant food supply that comes from mangrove leaves, supports fisheries production of a wide variety of commercially important species that are the primary source of livelihoods of small-scale fishermen (Figure 1).

Mangroves grow in a saline environment and anoxic substrate, and falling organic materials do not decompose quickly, producing a high rate of carbon (C) sequestration.

Mangroves store an average of 182 tons of carbon above-ground biomass per hectare, and forests can help ameliorate greenhouse gas emissions (Hutchinson et al 2014).

As a transition zone between land and ocean, mangroves are considered to be a buffer area that contributes to the protection of the coastline from flooding and erosion. Mangroves have the ability to retain a considerable amount of water for hydrodynamic processes, regulating flooding and behaving like a natural barrier that can reduced the impact of storm surge, heavy swell, tsunamis and sea level rise. Such benefits have been estimated to be valued around \$8,966-\$10,821 per hectare of mangroves in Thailand (Barbier, 2007).

Additionally, mangrove processes involve trapping and retaining sediments generated by run-off from higher elevations (Parkison et al 1994). They actively consolidate sediment with their roots and help to preserve the structure of channels for navigation and prevent coastal erosion. In addition to the importance of its erosion function service (retaining and trapping sediment), mangroves also accumulate the nutrients responsible for maintaining biological cycling and for water quality improvement, such as nitrogen, further reducing the waste water load and pollution (Ewel et al 1998).

Current status and trends of mangrove concessions in Ecuador

The rapid decline of mangroves from deforestation initiated by shrimp farming since the 70's to mid-90's was influenced by several factors (La Torre & Farrell 2014). First, the government considered that mangrove areas did not provide any benefits, and therefore there was a lack of legislation for the protection of these ecosystems. In addition, the high economic return from aquaculture lessened the governments did not interest in stopping the deforestation of mangroves. However, in the late 80's and early 90's, the government began to understand the ecological function of mangroves and their importance for conservation. Several laws and decrees were then issued that declared mangrove conservation as public interest (Executive Decree 824, 1985) and prohibited the destruction and alteration of mangrove areas (Executive Decree 1907, 1994). Even though these did not decelerate the rates of deforestations, and the government did not designate financial support for enforcement of this environmental legislation.

Another factor that enabled deforestation to continue was that mangrove users were not organized, and thus had little political power to prevent the disappearance of their livelihood. With a reduction in fishing grounds, some fishermen shifted to capture wild shrimp to increase their incomes, but local communities were not opposed to deforestation in the early years of the industry's development (La Torre & Farrell 2014).

It was not until the mid-1990's that pressure for international and local environmental organizations demanded that the Ecuadorian government completely ban expansion of shrimp ponds and deliver mangrove areas to ancestral users of the mangroves. This was driven by a strong Nino event in 1997-1998 that affected the entire Ecuadorian coast caused a drastic decline of shrimp aquaculture and crashed due to the white-spot virus in 1999.

In 1999, the Executive Decree 1102 gave “custodians” of the ancestral users of the mangroves the use right of the mangrove resources through the “Agreements of sustainable use of mangroves” (Marriott 2003); this agreement legally organized communities and proportioned these rights. Communities that voluntarily agreed to participate in this management held “custody” for ten years with an option for renewal, adopting the responsibility to protect the mangroves. In 2000, Ministerial Decree 172 indicated the requirement for access to the concession; Whereby the mangrove gatherers should be first legally organizing, develop a management plan for the sustainable use of the resources, and provide a two-year agreement of technical assistance for external institutions to the Ministry of Environment Subsecretaria de Gestion Marina y Costera which was in charge of the approval and setting up of the agreement (Bravo 2007).

Since 2000, more than 50 mangroves “custodians” have been created, covering an approximate total area of 66,000 ha. The practice of co-management has empowered fishing associations to adopt mangrove conservation. Some concessions, including communication and surveillance, have been strengthened more than others. However, mangrove associations still face significant challenges, such as limited technical assistance. Adding to these challenges, each fishing association's level of mangrove concession management is currently unknown. For these reasons, under Ministerial Decree 198 in 2014 the Ministry of Environment created the Socio Manglar program. This program allocates economic incentives to coastal communities that hold mangrove concessions. The program was created in order to consolidate community-based mangrove conservation and avoid deforestation. This policy is progressive and has integrated more than 50% of the concessions to date. This general approach brings new opportunities to mangrove concessions to enhance current management.

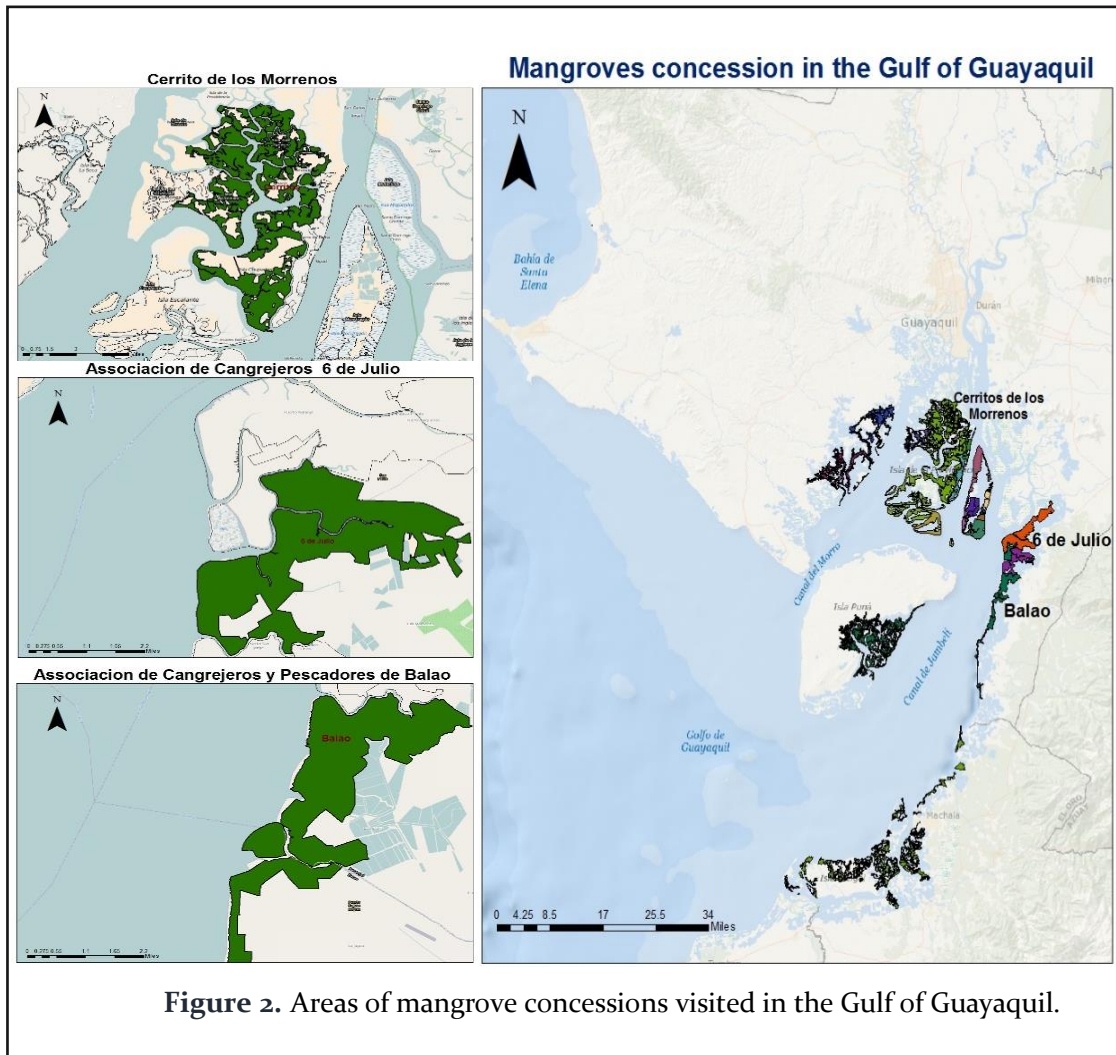
Methods

Mangrove concessions in the Gulf of Guayaquil.

For this study, I focused on the mangrove concessions of the Gulf of Guayaquil. I visited three sites and conducted surveys with stakeholders, focusing on the fishing associations of crab collectors in the communities of 6 de Julio, Cerrito de Los Morrenos and Balao (Figure 2). The Gulf of Guayaquil is an estuarine ecosystem with a high load of the river system of coastal lowlands that forms the Guayas River. This area includes the largest

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aggregation of mangrove concessions, 44,436 ha managed by a total of 23 fishing associations.



The members of the concession depend on the extraction of mangrove resources, including crabs, cockle shell, oyster, mussels, shrimp and different species of fish, for their livelihoods (Figure 3); with the main resource being red crab (*Ucides occidentales*). According to USAID (2012), more than 2215 fishers extract approximately 11 million of crabs per year in the Gulf of Guayaquil, contributing USD \$16 million to the GDP.

Generally, the limits of the concessions area bordered with shrimp farms where the habitat fragmentation that the mangrove forest has suffered is evident. However, a few areas have regenerated. Mangrove stakeholders are distributed differently across the concessions. Some of them live near mangrove areas and travel every day by boat to reach

the fishing ground, while other stakeholders live on islands in the Gulf of Guayaquil surrounded by mangroves. These individuals typically use a wood boat with paddles to

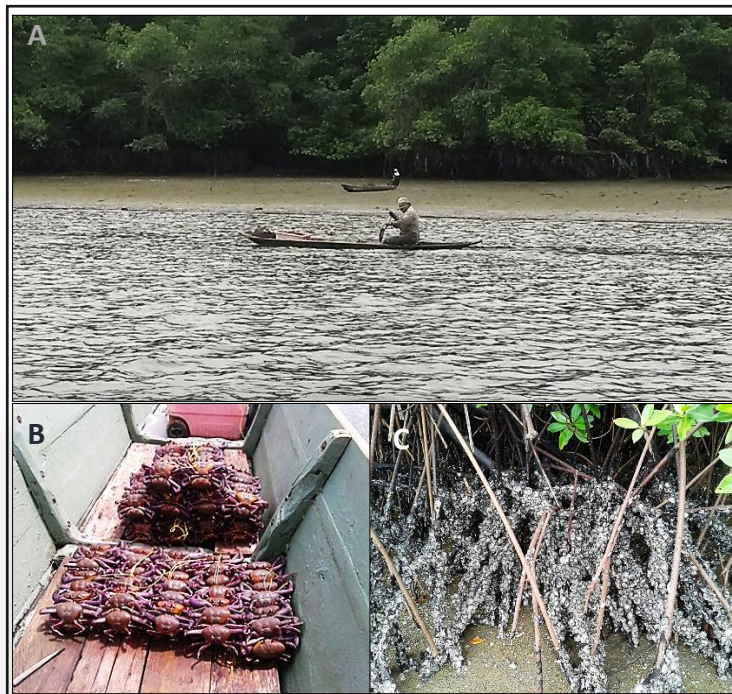


Figure 3. A) Traditional user of mangroves navigating in river Chupador Grande - Cerritos. B) Transportation of red crab to Caraguay market. C) Oysters clinging to mangrove roots.

navigate the mangrove channels (Figure 3).

All three concessions studied in this research have been part of the Agreement of Sustainability Use of Mangroves during the last 14 years, but only 6 Julio is receiving economic incentives for the conservation of mangroves since 2014 (Table 3). As part of the fishing associations management, they conduct meetings once a month to promote the reforestation programs and internal rules of management of resources. The organizational structure of the association/cooperative is similar among all three concessions. It consists of a president,

administrator, secretary, and director that are also members of the monitoring board that coordinates the actions for surveillance. Usually, stakeholders work from Monday to Saturday around 4-5 hours harvesting wild-caught species for food. The concession de Cerrito de los Morrenos covers 10,856 ha in one of the largest mangrove concessions granted in the country. It is divided in three sites: Puerto Libertad, Santa Rosa and Cerritos de los Morrenos. The community of Cerritos is an island in the heart of the Gulf of Guayaquil, with an average population of 500 people that only depends on mangrove resources. Cerrito also has the permanent assistance of the foundation Cerro Verde which has volunteers that work in social and health programs. The foundation also assisted the community with the administration and legal assistance.

The communities of Balao and 6 de Julio are close to shrimp farms and field crops of banana and cacao and are different from Cerritos in their proximity to urban areas, resulting in better prices for the crabs, e.g. USD10-12 (6 de Julio) and USD10-8 (Balao). The difference in price is based on the fact that 6 de Julio extracts crabs that are larger (shell crab above 7cm wide) than the average in the market. In these concessions, crab fishers share fishing ground with fishermen using encircling and fixed gillnets that capture fish in more open waters of the river. According to the survey conducted, the

association 6 de Julio, includes 15 fishermen that mainly work in in the creeks and seven fishermen that mainly collect shell cockle. In the case of Balao, there are around 300 independent fishers or members of other associations that use active gillnets and fixed gillnets as fishing gears

Table 3. Description of mangrove associations in the Gulf of Guayaquil.

	6 de Julio	Cerrito de los Morrenos	Balao
Number of members	147	140	117
Hectares	1,248	10,896	2,653
Area	Rural	Inland	Rural
Mangrove concessions	Since 2000	Since 2000	Since 2002
PES	Since 2014 (\$18,854)	In process	In process
Commercialization	Intermediaries, direct sales	Caraguay market (Guayaquil), intermediaries	Intermediaries, direct sales
Mobilization to sale points	Motorcycle	Boat (2 hours)	Motorcycle
Crab pulp process	Artisanal, small procession plant	No	Artisanal

Research Protocol

My study draws on field research completed between April and May 2016. I conducted exploratory interviews and observations in three mangrove concessions, managed by *La Asociacion de collectors de Cangrejo 6 de Julio*, *Asociacion de colectores de Cangrejo y Pescadores Balao*, and *Usuarios del Manglar Cerrito de Los Morrenos*, respectively. I conducted semi-structured surveys together with three interviewers from the organization Ecuador Mundo Ecologico that assisted me in the collection of information (Appendix I). The survey examined the perceptions of members of the local associations: fishermen, crab and shell cockle collectors of a set ecosystem services considering important in the region (Table 4). I conducted interviews from a total of 96 fishermen, crab and shell cockle collectors and community leaders. The surveys were designed to elicit responses pertaining to the management of mangrove concessions. The questionnaire to members of the fishing associations was divided into seven sections: 1) basic information; 2) economic incentives; 3) ecosystem services; 4) management of mangrove concessions; 5) historical questions; and 6) future questions. I asked stakeholders where they perceive the challenges, opportunity, and risk to the mangrove concession of moving to a sustainable management and how their organization may contribute to this goal.

To gain a broad understanding of the management of mangrove concessions and approaches of the government, I completed key informant interviews with government

officials from the REDD+ program, Camara Nacional de Acuacultura, Subsecretaria de Gestion Marino Costera, Ministry of Environment, Conservation International, Foundation Cerro Verde and El Manso. The initial goals of these semi-structured interviews for the site visit were as follows:

- (1) Upcoming management opportunities: Gain information on the general perception of the mangrove concession and the ecosystem services approach to manage mangroves, current regulations imposed on the shrimp industry, the status of Ecuador's move to an ecosystem market, and key and upcoming management actions.
- (2) Organization priorities: Characterize the perception of the shrimp industry about mangroves concessions, the benefits received from the mangroves, the current status of the industry, and the interest to collaborate with mangrove concessions in some way.
- (3) Gaps and challenges: Determine future sustainable alternatives to users of mangroves, the collaboration of organizations to acquire technical assistance and capacity for local communities that highly depend on the harvest of wild goods, future application of successful management of crab fisheries.

The visit was overall successful. Fishers of the associations collaborated during all of the visits, showing us the area and border of the concession by boat, and helping me to navigate through the creek channels, and observe the extent of platforms of sediment on the open river together with recruitment of small mangroves on its borders, and formation of reefs of oysters during low tide in Cerritos de Los Morrenos. In addition, I went together with the president of the Balao fishing association (Felix Lopez) to collect crabs in the mangroves and learned the process of recognizing the burrows (female and male) and the use of hooks to extract crabs. This experience helped me gain a broader understanding of the challenging daily work required for collecting resources in the mangroves.

Table 4. Selected ecosystem services as understood in the study.

Ecosystem services	Definitions
Flooding mitigation	Protect communities and cities from extreme raining and heavy swell
Climate regulation	Helping to maintain temperature (microclimate) and protect of extreme weather with its property to sink Carbon
Main source of wild goods	It is the main source fishing resources (crab, cockle shell, shrimp)
Water quality	Capacity of mangroves to purify surface and ground water with its roots
Erosion regulation	Mangroves avoid the loss of land and protect creek channels to collapse
Provision of wood	Provide timber and fuel
Soil formation	Trapping sediment and building new land
Main nursery ground of fish	Serve as refuge of larvae and juvenile of fish
Reduce pollution	Helping to reduce pollution by soil regeneration and water recirculation

Results

Characteristic of the respondents

Of the 96 survey participants analyzed, 33 corresponded to the organization 6 Julio, 30 Cerrito de los Morrenos, and 33 to the fishing association Balao. The majority of the participants were among the age group of 35-44 years old (30%), following by the age group of 24-34 years old (28%) and then the youngest category from 18-24 years old (11%). (Figure 4). Most respondents who intensively participated in the harvesting of wild products and commercialization were men. From 6 de Julio, we interviewed three women from a group of seven that work on the crab meat processing and are members of the fishing association. In Cerrito de los Morrenos and Balao, a large group of women also are engaged in this work, but they are not members of the associations and thus were not interviewed. 84 % of the participants indicated their main occupation or livelihood was crab collector, the second most common was fishermen (12%), and the last was shell cockle collector (5%). 55 % of the participants switched between those occupations, especially during the fishing restriction season of crabs, “veda”, where 24% of the crab collectors switched to fishing, 13% working as farmers (specific to 6 Julio), 7% working as shell cockle collectors. A total of 47 % of the participants did not have a second occupation. 81% did not have a third occupation which makes them highly dependent on the mangrove resources (Figure 4).

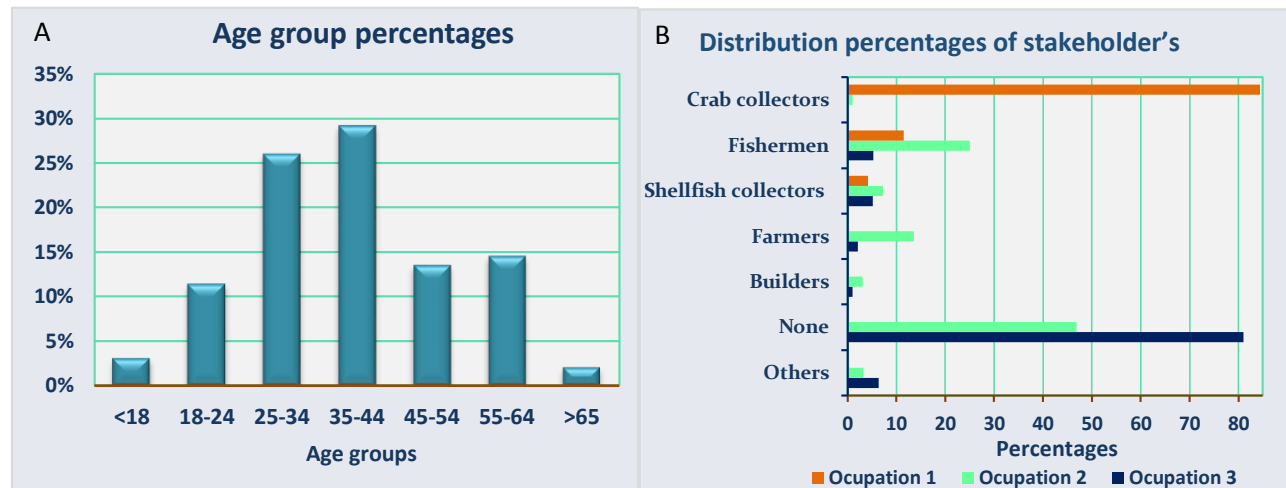


Figure 4. a) Percent average of age groups of stakeholders across the sites. b) Distribution percentages of stakeholder's occupations.

Fishing associations co-management and involvement.

As part of the community co-management of mangroves, the fishing associations regularly self-organized meetings to address issues about the concessions and coordinate actions for monitoring and surveillance. According to the responses, 75 % of the

stakeholders attended an average of 8.6 ± 3.2 meetings per year. (Figure 5). Activities such as reforestation are performed by an average of more than 85% of the participants (1.8 ± 1.5 activities per year). The low number of reforestation activities conducted among the associations is primarily due to lack of space. Concessions are bordered by shrimp farms and open waters. Therefore, stakeholders use the small areas of the natural space that form continuously with open tidelands.

In addition, I found significant differences comparing 6 Julio (receiving financial incentives) with Balao and Cerritos (not receiving economic incentives) in terms of participation in their reforestation activity ($p=0.001$, Fisher's exact test). 92% of the stakeholders from 6 de Julio participated in reforestation compared with 63% for Balao and 52% for Cerritos. Another part of the participation activities are workshops; 58% of the participants attend an average of 4 ± 1.3 workshops per year. Statistical differences were found only between 6 de Julio and Cerritos ($p=0.042$). Based on the overall scheme of stakeholder involvement in current activities, three levels of involvement were categorized: low (0-40%), moderate (40-60%) and strong (60-100%). 6 de Julio demonstrated a strong level of participation, with 77 ± 11 % average percentage of involvement, Balao had 64 ± 11 % and thus also a strong level of participation. Cerritos de los Morrenos at 58 ± 14 %, had a moderate a grade of participation (Figure 6).

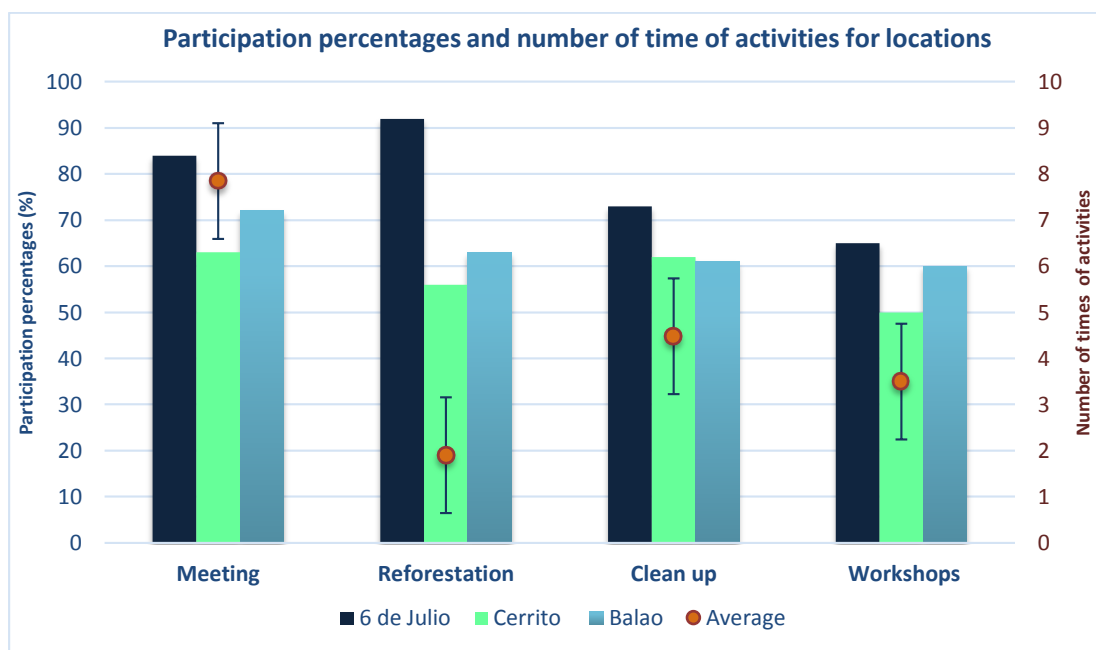


Figure 5. Percent involvement of the stakeholders and number of times of engagement of activities regarding mangroves management. Average point refers to the average number of activities across all the sites.

Factors such as leadership seemed greatly to influence peoples' involvement in co-management activities (Gutierrez et al 2011). The mangrove co-management group,

president and council of the organization are responsible for conducting meetings, motivating members to act, applying sanctions and resolving conflicts. All the concessions have determined some internal rules to manage the resources such as; regulating number of fisherman, defining a limited number of crabs to harvest, and overseeing compliance during the time of fishing restriction, “vedas”. The main complaint is enforcement because they only enforce rules for members of the fishing association, presenting conflicts when non-associated fishermen enter the areas under concession. (Table 5).

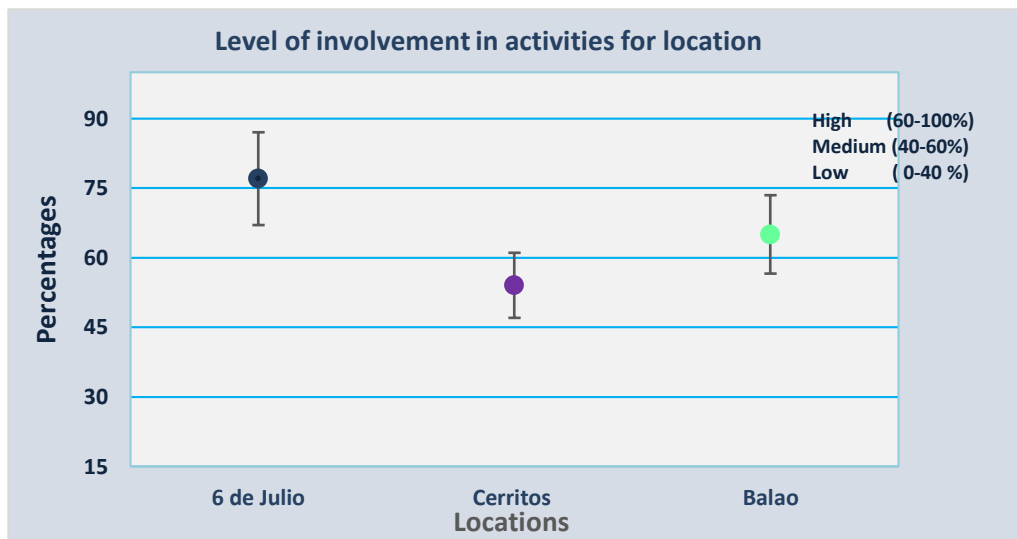


Figure 6. Level of involvement in current activities across sites. Percent average of all activities for location. The error bars are the standard deviation of the average of participation across sites.

Overall, 6 de Julio has a well-defined leadership, compliance of internal rules and members who are highly motivated to continue working in the conservation of mangroves and resources. For example, they are trying to harvest quality (>6 cm minimum size of crab shell) crabs instead of quantity. In the case of Balao and Cerrito, members are moderately motivated, however, there is not a strong agreement among the members about activities and future projects (Table 5)

Despite this, 80 % of participants are satisfied with the current level of management based on the obstacles that have already been overcome. However, they reported that mangroves management needed improvements, specifically mentioning the need for more government support, better coordination of actions among concessions, strengthened member capacity and increased surveillance.

Additionally, when asked which type of capacity is most needed, the main request across all three sites was for alternative sources of livelihood to generate better incomes. Having

alternative sources of income would help specifically during the time restriction of fishing “veda”.

Other stakeholder responses included: Technical support to the fishing associations, leadership, problem resolution and ecotourism (most frequently mentioned) (Table 5). The technical assistance involves cooperative development, accountability, and legal assistance.

Table 5. Description of the current strength of association and explanations of the stakeholders to improve management of the organizations across the three sites.

Mangrove management of custody		
6 de Julio	Cerrito de Los Morrenos	Balao
Leadership		
Strongly encourage stakeholders to act, daily monitoring and surveillance.	Conducting the general administration process, surveillance twice per month.	A new directory, monitoring approx. three times per month.
Overall organization structure		
Motivated members, consensus and agreeing to activities and future projects.	Moderately motivated members. Moderated agreement about activities and future projects.	Moderately motivation, considering the management “ <i>it is not the same that before</i> ”. Few future projects, but some members are not interested it.
Current management satisfaction (%)		
95	67	84
Problem resolution		
Partial	Partial	Partial
Projects status		
<u>Functional</u> : Radio system, some points of direct commercialization, building a new meeting room, capacity for culture of tilapia.	<u>Partial</u> : Radio operation maintenance and repair, have small cyber, social and health projects (Foundation Cerro Verde and Government).	<u>Functional</u> : Radio acquisition definitive frequency, partial direct commercialization of resources.
Priorities to strength better function of organizations in order and frequency (stakeholder opinions)		
1) Governmental support (control non-associated fishermen, regulate shrimp industry water contamination, and cut down mangroves).	1) Better coordination among the member of organization. 2) Surveillance and monitoring.	1) Strengthen member skills for management, more alternatives: a) Technical assistance, b) Ecotourism, c) Problem resolution.
2) Strengthen member’s skills for management, having more alternatives: a) Technical assistance; b) Ecotourism, c) problem resolution.	3) Governmental support.	2) Governmental support.
3) Establishing point of surveillance and looking for financial support to build tourist sites nearby mangroves area.	4) Strengthen members skills for management, having more alternatives: a) Leadership, b) Ecotourism, and c) Technical assistance.	3) Surveillance and monitoring.

Ecosystem services capacity to deliver benefits to society

The 96% of the users agreed that mangrove have the capacity to deliver services or benefits. They were asked to rank them on a scale from 1-5 (5 greatest) for perceived level of benefits received from ecosystem services. The highest rates of perceived benefits are: fishery service (79 responses ranking it as 5), climate regulation service (63 responses ranking as 5), and nursery service (61 responses ranking as 5). Those services also agree with the three top ecosystem services that stakeholder would like to maintain most through time. (Figure 7).

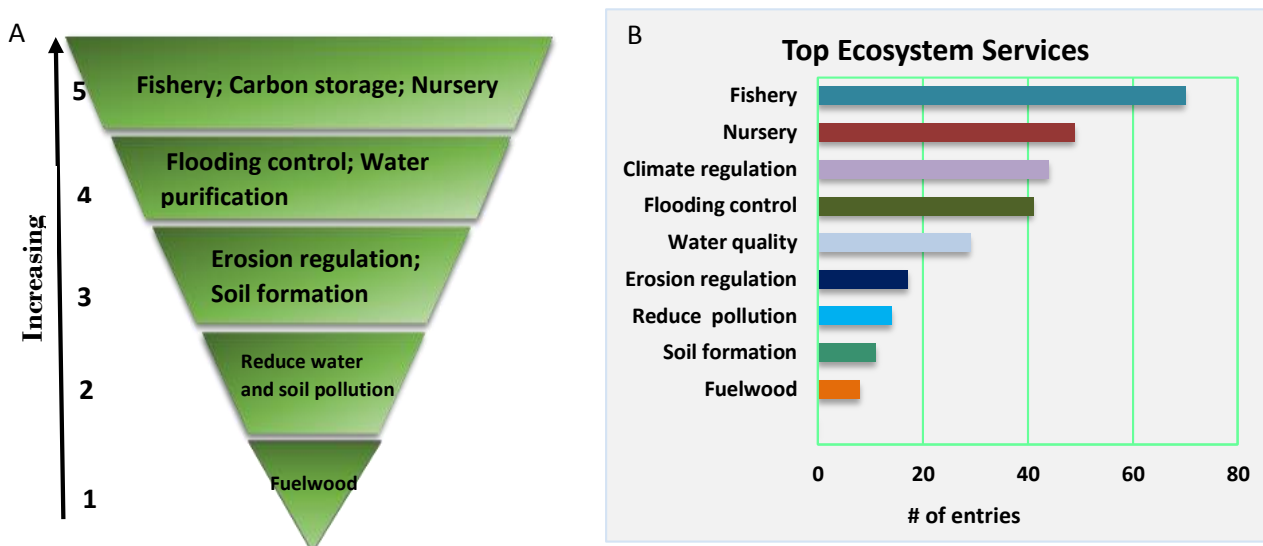


Figure 7. a) Stakeholder's perceived level of benefits provided by ecosystem services of mangroves in the Gulf of Guayaquil. b) Top ecosystem services nominations to stakeholder perceptions.

Fishers perceive benefits from flooding control and water purification corresponding to scale 4, with 44 and 29 entries, respectively. Additionally, the processes of soil formation and regulation of erosion were a 3 and 2, respectively, in the scale of the stakeholder's perception of ecosystem capacity to deliver benefits. Participants recognized these processes usually occurred at the river mouth areas. Soil formation benefits them by providing more space for reforestation; however, these processes are dynamics and large areas of sediment with mangrove seeds could be completely covered during strong surge and also completely disappear. Moreover, mangrove fuel and timber services were placed lowest on the scale. Participants recognized the value of this service, but cutting down mangroves is a prohibited activity and exploitation of wood for the local community is limited to issued permits from the Ministry of Environment.

In the case of Cerrito de los Morrenos, stakeholders ranked flooding mitigation service as one of the top three mangrove ecosystem services rather than climate regulation. This may be due to its location (in the center of the Gulf along of tidal creeks and rivers),

which results in daily tidal floods. Additionally, erosion regulation services were higher to Balao than Cerritos de los Morrenos ($p=0.0004$). In addition, fuel and timber services were more important to Cerrito de los Morrenos than Balao ($p=0.002$) (Figure 8). This was partly because participants from Cerritos are living on an island, far from the main city and may use mangroves to replace pilings for docks or houses.

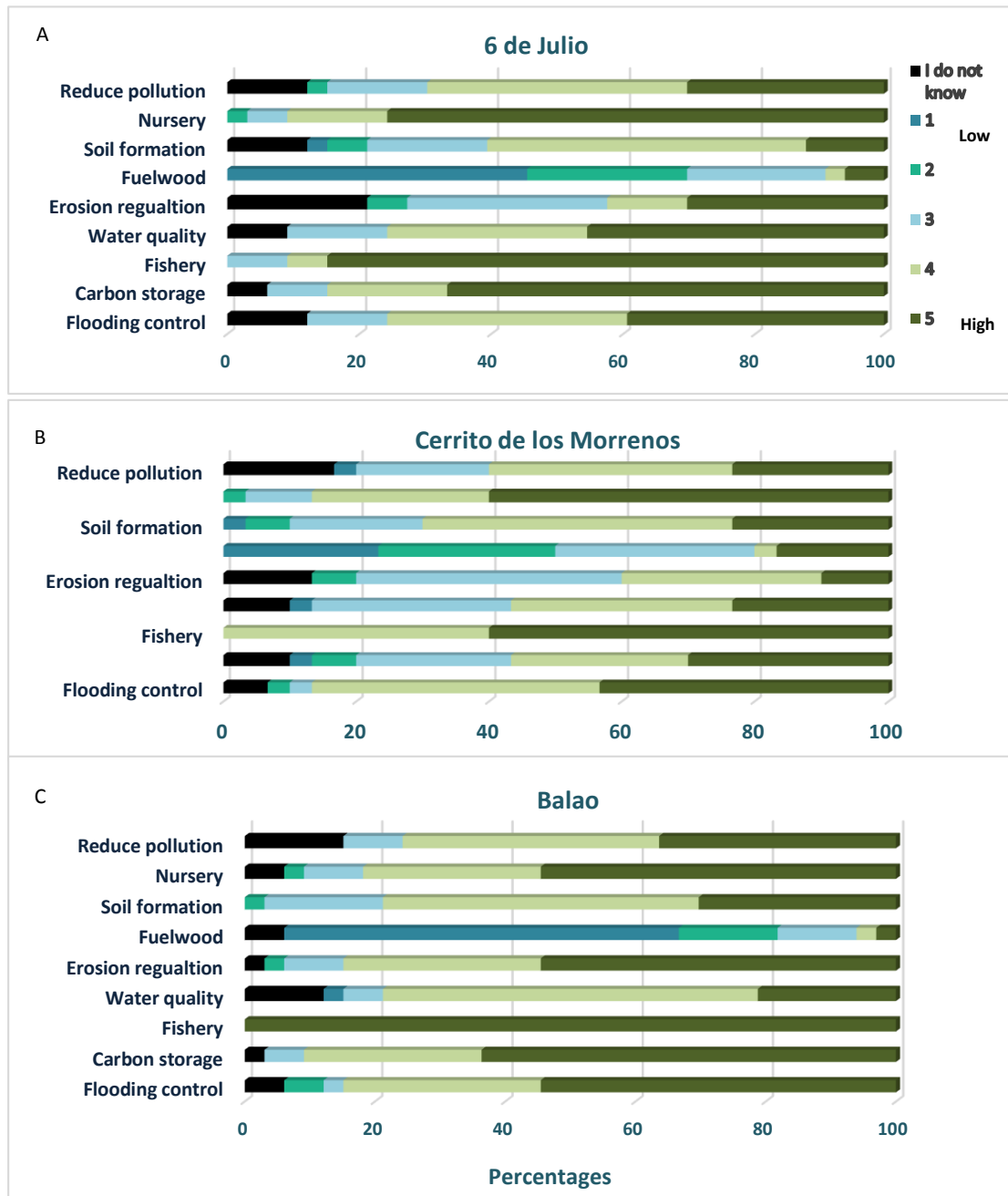


Figure 8. (a) Perception of the stakeholders regarding the level of benefits provided by ecosystem services. (a) 6 de Julio (b) Cerrito de los Morrenos, and c) Balao.

Perception of cultural services

Stakeholders from the three sites firmly believed that mangroves “always” (86%) should be protected for future generations as a reflection of existence values. On the question of if they had enough money, would you be willing to donate to protect mangroves, stakeholders from 6 de Julio were more willing to donate money “most of the time” (49%), in comparison with Cerrito and Balao. However, a large number of participants from Balao (58%) and Cerrito de los Morrenos (43%) considered donated money “sometimes” (Figure 9)

When asked about if there is a sense of place or personal connection to mangroves, 36% of the participants from 6 de Julio reported “always,” compared with 6% in Cerrito de los Morrenos, and 12% in Balao ($p < 0.05$). More than 40% of the respondents from Cerrito and Balao “sometimes” felt a personal connection with mangroves. Members of the fishing association have been working in the management of these areas for more than 14 years, overcoming many limitations to empower the community for the protection of mangroves.

Moreover, most participants considered that mangroves could be used as a tourism attraction; they see this input as a potential service to develop. 6 de Julio intends to focus on developing a tourism program to visit the “route of crabs” and make improvements on landing places. 40% of the participants indicated “most of the time” that mangroves may serve as tourist attractions. Also, Cerrito de los Morrenos and Balao thought that “sometimes” (50%) mangroves could serve as tourist attractions (Figure 8). Cerritos de los Morrenos members are also currently trying to develop tourism for the communities in the Gulf of Guayaquil

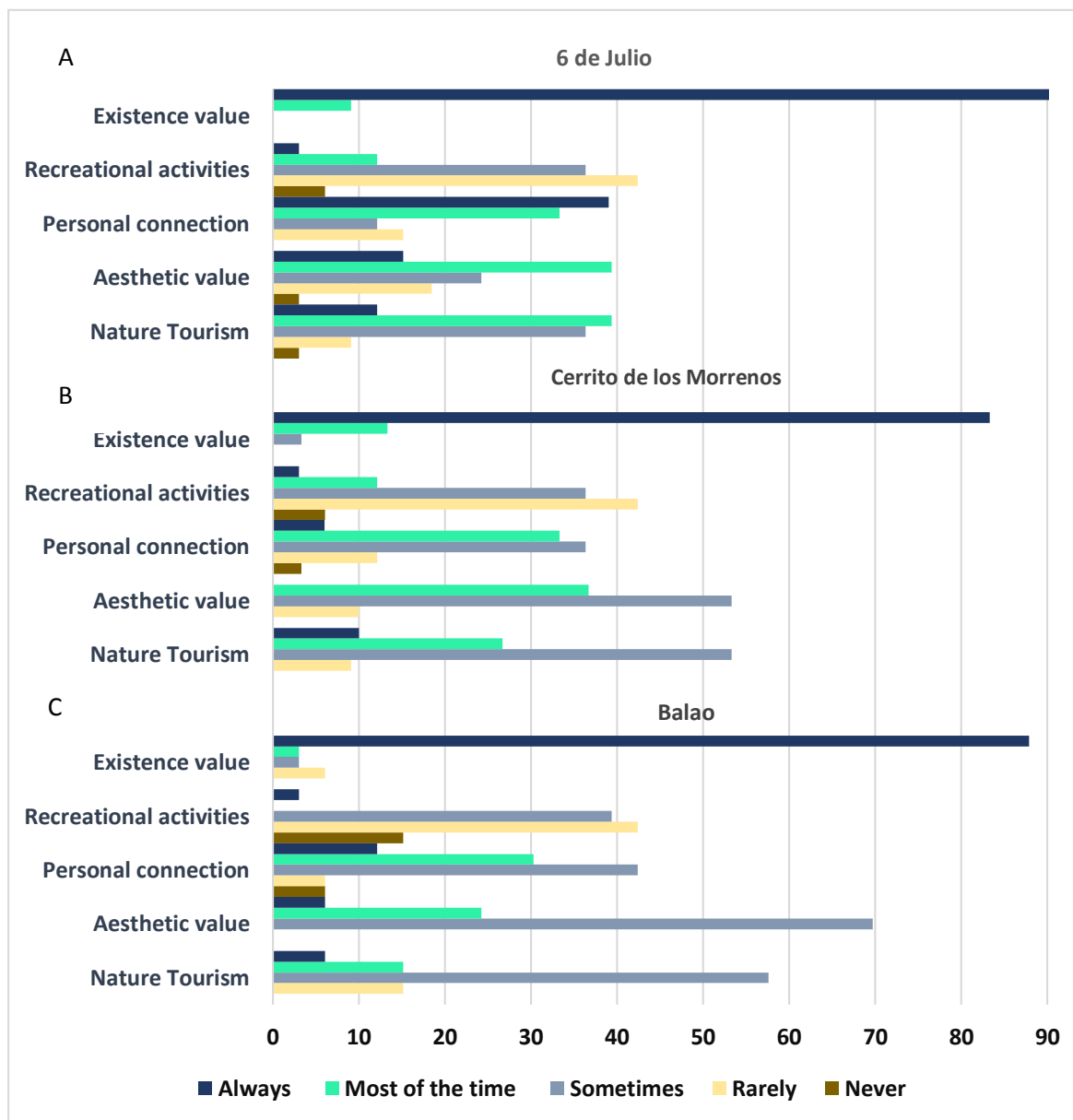


Figure 9. Perception of the stakeholders regarding the level of benefits provided by cultural ecosystem services in (a) 6 de Julio, (b) Cerrito de los Morrenos, and (c) Balao.

Past perceptions of mangroves and resources

86% of stakeholders perceived that resources were “more” abundant in fish, crabs and shell cockle five years ago. Cerritos de los Morrenos and 6 de Julio recognized a recovery of cockle shell, but it is still collected regardless of its harvested size. Some participants were not satisfied with the management of the concession, because it does not take into consideration the minimum catch size of cockle shells (Table 6). However, the status of

the resources is unknown and little information is generated based on nonsystematic monitoring of landings, which makes it difficult to establish adaptive management.

Table 6. Description of responses about status of resources in the last five years across the sites.

<i>Resources</i>	<i>Locations</i>	<i>Categories</i>			
		More (%)	The Same (%)	Less (%)	I do not know (%)
Fish	6 de Julio	94	0	6	0
	Cerrito de los Morrenos	90	7	0	3
	Balao	94	0	6	0
Crab	6 de Julio	82	0	18	0
	Cerrito de los Morrenos	93	0	0	7
	Balao	88	12	0	0
Cockle shell	6 de Julio	30	15	18	36
	Cerrito de los Morrenos	52	18	3	27
	Balao	64	18	9	9

On the other hand, when asked about if there has been a change in the mangrove areas in the last 5 years, the majority of the participants (45%) perceive that mangroves are expanding, providing them with more areas for collecting wild goods. Twenty- four percent of the participants did not perceive any changes in the mangrove ecosystem, but the mangroves area is maintained. However, a minority of the participants did perceive that mangroves are declining in cover. Thus, stakeholder perceptions agreed

there is a positive recovery of the mangroves in the last years because mangroves do not face a direct threat from logging. However, members of the association believed that even though mangroves are recovering, there are fewer resources to collect. The decline of resources is attributed to contamination from the shrimp industry and overfishing.

Future perceptions of changes in mangrove ecosystems

A large proportion of stakeholders (43%) had a positive perception that mangroves will be “better” in the future. Others suggest that they “will stay the same” (36%) or “become worse” (15%), and 6% replied that they “do not know” what change could occur with mangroves in the future. Of the participants who considered that mangroves will be better in the future, 48% believe that resources found in the mangrove habitat will decline in the future. They further responded that this would likely be caused by three main factors: non-associated fishermen who frequently invade the concession areas, a lack of management, and a lack of livelihood alternatives to members of fishing associations.

Comparing across sites, 6 de Julio showed a more optimistic position than the other concessions. Fifty-eight percent of the participants considered that mangroves would be better in the future, showing significant differences with Cerrito de los Morrenos (37%,

$p=0.0045$) and Balao (30%, $p=0.001$). Also, participants suggested that the management of the concession would determine if the mangroves will be better in the future.

Participation in community-based monitoring

Five different types of social monitoring programs were categorized for stakeholders to assess their willingness to participate in each one. Across the sites the programs in which members are more willing to participate, in order of willingness, are: Recording fishing landings, recording mangroves biomass, monitoring biodiversity, and measuring carbon storage. Members of the association from 6 de Julio reported the highest percentages among the groups to the category “great extent” for the programs of mangrove biomass, estimation of carbon storage, and recording landings comparing with the other associations. Moreover, there was a significant difference with Cerritos de los Morrenos in all the programs ($p<0.05$). Participants from 6 Julio indicated that they are interested in learning more about the programs, but they only agreed to participate in one or two programs because they needed time to fish. Similar answers were given by stakeholders from Balao; they were interested in participating in reporting fishing landings to a “great extent” (39%) and “somewhat” interested in the mangrove biomass (45%) and carbon storage (42%) programs (Figure 10).

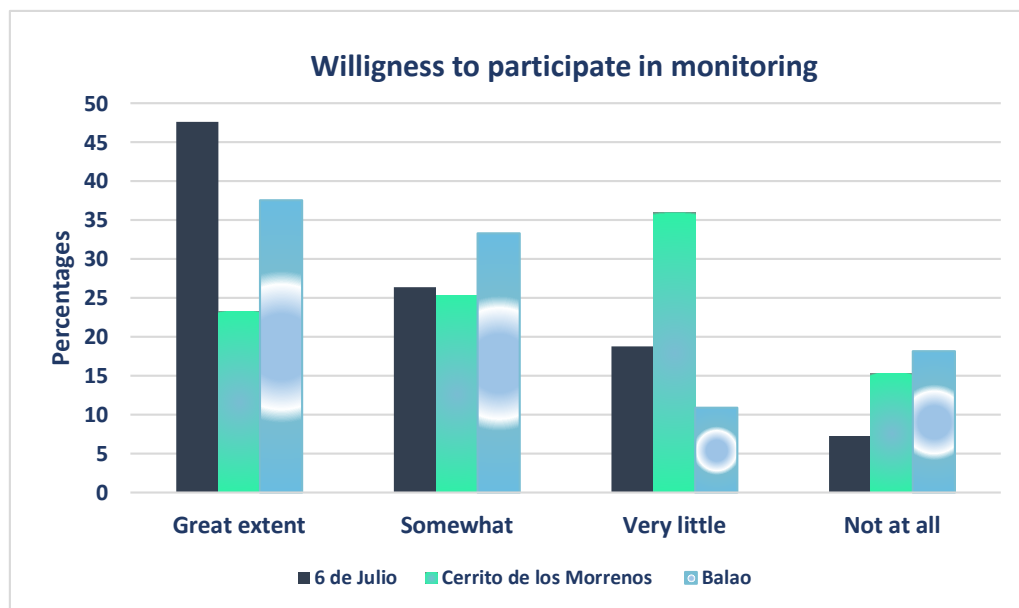


Figure 10. Average percentages of willingness to participate in future monitoring across the three locations.

Cerritos de los Morrenos members preferred to participate “very little” in reporting landing, carbon storage and the mangrove biomass programs. When asked about what factors may influence their decision to get involved in social monitoring programs, 49% of the participants responded that they are willing to participate, 33% responded that they do not have time, 9% indicated that they are not interested at all, and 6% indicated that monitoring is an expensive activity that should be compensated.

Factors that influence ES perceptions

A group of regressions was run to determine if there were some factors that influenced stakeholder perception of the ecosystem services, the level of involvement, and willingness to participate in social monitoring. There was no correlation between the level of awareness of the ecosystem services with the reported age group and number of years working. However, people older than 25 years, were more willing to participate in social monitoring (t-test, $p=0.0004$). When current involvement was greater than 65% (reforestation, workshop, clean up and surveillance), people were more willing to participate in social monitoring (t-test, $p=0.008$).

In addition, based on a high number of positive answers about the future of the mangroves, I investigated whether any relationships existed between with the variables of willingness to participate, awareness and involvement. I found that people that are more optimistic participated more in the fishing association activities (t-test= $p\ 0.009$).

Discussion

This study sought to determine the ecosystem services stakeholders consider most important in order to guide the selection of priorities by decision-makers. This study provided an initial assessment of stakeholder’s perceptions of ecosystem services in the Gulf of Guayaquil. The interviews revealed a general awareness among stakeholders about the capacity of mangroves to deliver ecosystem services. This study demonstrated that stakeholders should focus on the mangrove services they use most, such as fisheries. Interestingly, this study also showed that stakeholders perceived a decline in fishery services in recent years. This trend may demonstrate that optimal sustainable use of mangrove resources has not yet been achieved. However, many factors other than over-exploitation may contribute to this decline. This might suggest that maintaining mangrove habitats is even more important than initially thought, as mangroves may help to maintain stocks that are threatened by other impacts. The study also showed that many fishing associations regulated harvests without government evaluation.

The project also demonstrated the value of water quality to stakeholders even though they did not recognize that mangroves main help to maintain it. However, water quality was one of the main concerns across all three sites. Many stakeholders attributed declining water quality to chemicals in runoff from shrimp ponds. Some studies have indicated that farm effluents affect biochemical processes and damage the aquatic health of coastal ecosystems (Barraza-Guardado et al 2013). They may also result in toxicity to non-target species, causing them to develop antibiotic resistance and accumulate residues (Primavera 1998). Moreover, there is a poorly regulated release of industrial waste to the Guayaquil River, where it could disturb mangrove ecosystems and resources. Mangroves have been affected by anthropogenic impacts determined due to high concentrations of heavy metal Cd, Co and N in Malaysia (Sandy et al 2013), Zn in Puerto Rico (Mejia et al 2013) and others. These studies showed that concentration of these metal in mangrove sediments, may also directly affect the primary productions of the ecosystems (Bai et al 2011).

This study also showed that members of different fishing associations perceived cultural services differently and that sense of place, existence value, and ecotourism were highly valued by stakeholders. This showed that cultural services potentially indicated the social capital of community-based mangrove management. This assessment also demonstrated the influence interaction with nature has on fishers. Fishing associations which have strong leadership, a high level of involvement and motivated members placed greater value on a sense of place and future generations. However, the findings also showed differences among sites regarding the social-capital of the fishing association; these differences may be attributed to the fact that 6 de Julio stakeholders receive compensation (PES) mangrove protection. This economic compensation helps them to accomplish projects that are not funded in other sites. Roe et al (2009) indicated that these payments enable local groups of people to make better decisions about land and resource use, and alleviate poverty. PES implementation is based on community participation; this provides opportunities for individuals to get involved in the decision-making process. Moreover, optimistic members of fishing associations were more likely to have a high level of involvement in current activities. The experimenters concluded that members of fishing associations with high participation levels had internalized their management experiences. Several authors have highlighted participatory approaches that could be used to improve environmental decision-making (Ban et al 2013). These adaptive social-ecological management methods have the potential to bridge policy-making and community management.

Challenges and guidelines

One of the main difficulties faced by fishing associations across the sites studied involves controlling non-associated fishermen. The pressure from these outsiders may undermine

social-ecological management because they invade concession areas, taking resources below size and using illegal traps. Although association stakeholders patrol mangrove areas, they do not have the authority to enforce fishing regulations. In order to regulate this practice, Ecuador should establish a systematic patrol in the area based on collaboration between the Office of the Undersecretary of Fishing Resources and members of fishing associations. A similar approach should be taken to control shrimp farming waste discharge. The government should regulate pollution from shrimp farms, establish water quality monitoring of discharge channels, and impose strong sanctions on farms that ignore regulation.

Another important aspect of implementing participatory monitoring is leadership. This factor may determine the success or failure of a program. The majority of members of the association do not have detailed knowledge about resource management, group leadership, or problem resolution. In the absence of education and knowledge, strong leadership is imperative to program success; without these leaders, the programs have a higher risk of failure. The government should establish together with NGOs a systematic training program for community leaders. This program should include cooperative development, conflict resolution training, and provide opportunities for stakeholders to share their management experiences with other associations. In order to ensure the success of a systematic monitoring program, governments must commit to investing in ecosystem maintenance. This investment should include institutional agreements and policies that guarantee funding for monitoring programs. Not must we only conserve areas of mangrove forest to maintain its ecosystem services, the status of the resources must be known. Fishers should be an integral part of the data gathering activity as their involvement plays a significant role in sustainable management. However, institutions should also realize that fishers' time is limited; conservation activities take valuable time from the tasks necessary for maintaining their livelihood. Thus, social monitoring programs are seen as very demanding in terms of time and team effort. This approach can be complemented with other more specific strategies that provide fishers equitable compensation for the time expended in some monitoring activities

Adaptive management through participatory monitoring

The challenge may appear great but members of fishing associations have shown a level of social-ecological adaptive management under the platform of mangrove concessions. Fishing associations with high levels of involvement in current activities have internalized these experiences and are more willing to continue working on conservation. The platform to develop social monitoring programs is already in place and only requires action to define and strengthen the program. This action must work to define the economic policies and strengthen the social capital of fishing associations.

At this time, mangrove concession, through ecosystem services, can offer benefits not only to direct users of the mangroves, but also to shrimp farmers, urban populations, and coastal fishermen. Socializing these benefits across stakeholders is crucial to determining compensation policies for fishing associations' efforts to protect mangrove areas. Integrating compensation policies will strengthen support for participatory monitoring. In addition, an attractive and legal environment for the private and public sector participation in mangrove conservation is needed. A shared vision of the desirable condition of mangroves and resources must be developed; monitoring the indicators of mangrove ecosystem services will provide a tool to quantify those services, help users understand their structure and productivity, and clarify how these services are interconnected and should be maintained. This program will also provide information to create policies to make mangroves and communities more resilient to environmental changes. Failing to take this approach may risk failure of the concession process and its social capital structure because fishermen and other stakeholders will lose the benefits delivered from mangrove forests.

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Appendix 1

Record Number:

Name of interviewer: _____ Date: _____ Place: _____

Background

My name is _____. We are conducting an academic survey to collect information about mangrove management. Your participation is voluntary and confidential. This project aims to learn more about your thoughts on the new policy from the Socio Manglar program, which provides economic incentives to fisheries associations to help them with mangrove management. This survey also seeks to learn more about community awareness of the different benefits that mangroves provide. Your responses may be used to influence the management of mangroves.

Information

1. How many years have you lived here?
☐ 0-1 ☐ 1-3 ☐ 4-10 ☐ 11-20 ☐ 21-50 ☐ > 50
2. What age group do you belong to?
☐ Under 18 ☐ 18-24 ☐ 25-34 ☐ 35-44 ☐ 45-54 ☐ 55-64 ☐ >65
3. What is your highest level of education?
☐ Primary ☐ School ☐ High School ☐ University ☐ Not applicable
4. Which is your occupation(s)? (Rank each of the following in order of importance, 1 is the greatest importance)
____ Fisherman _____ Collector of crabs
____ Farmer _____ Collector of cockles
____ Builder Other: _____
5. How many years have you been working in your main occupation?
☐ 0-1 ☐ 1-3 ☐ 4-10 ☐ 11-20 ☐ 21-50 ☐ > 50

Mangrove Concession management

6. Are you a member of a fishing association? () Yes () No
If the answer is "No", go to #9
7. What is the name of the organization? _____
8. Does this association/community hold mangrove concessions? () Yes () No () Unsure
9. Is legal to clear mangroves? () Yes () No () Unsure
10. Do you know if the community is receiving economic incentives for protecting the mangroves?
() Yes () No
11. To what extent do you think this policy is important?
☐ Not Important ☐ Somewhat important ☐ Very important ☐ It is essential ☐ Unsure
For the option you chose, please explain _____
12. Who do directly benefit from this policy? *Mark all that apply*
☐ Community ☐ Government ☐ Mangroves ☐ Fishers ☐ Other: _____

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13. How do you think the money provided for protecting mangroves should be use to benefit the community? *(Rank the following choices in order of importance)*

Benefits	1	2	3	4	5
Improvement of basic services					
Infrastructure improvement (e.g. schools, roads, and health care centers)					
Technical assistance to fishing association					
Improved fisheries equipment (gear/traps/materials)					
Environmental activities (reforestation and forest nurseries)					
Monitoring and surveillance for mangrove conservation					
Direct distribution of seafood products					
Valued added to fishing products					

Ecosystem Services

14. How much do you agree that mangroves could give services /benefits to the community?

☐ Strongly disagree ☐ Disagree ☐ Neither agree or disagree ☐ Agree ☐ Strongly agree

15. Which mangrove resources have you taken in the last year, how frequently did you take them, and what did you do with them?

For example, if you spend 6 hours per day collecting a sack of 100 cockles 5 days per week, your answer would be as follows:

Resources	Unit	Days per week collecting the resources	Number of hours per day	Value per unit	Consumption/Use, Sold or Other
Shell Cockle	Sack (100units)	5	6	\$15	Sold

Resources	Unit	Days per week collecting the resources	Number of hours per day	Value per unit	Consumption/Use, Sold and Other, please list----- -----
Crab					
Shell cockle					
Fish					
Firewood					
Other:					

16. Which are the most important areas where you fish, collect crabs and shell cockle? Please Show on the maps:

17. To what extent you agree or disagree that if the more mangroves are protected, there will be more fish, crab and shell cockles to collect?

☐ Strongly disagree ☐ Disagree ☐ neither agree or disagree ☐ Agree ☐ Strongly agree

18. On the scale of 1-5, please indicate how much of each benefit mangroves provide for the community *(1 means very little and 5 is a great deal)* Please choose the top three “ecosystem services” That you would like to maintain most.

a) Protection of villages and cities from flooding ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Unsure

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- b) Regulate and reduce extreme weather ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Unsure
- c) It is the main source of harvested wild good ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Unsure
- d) Improving water quality of the estuary ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Unsure
- e) Protection of rivers and costal shores from collapsing (erosion) ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Unsure
- f) Wood (fuel/fishing gear) ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Unsure
- h) Trapping sediment and buiding land ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Unsure
- i) Fishing nursery habitat ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Unsure
- j) Reduce soil and water pollution ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Unsure
19. Do you think mangroves could serve as tourist attractions?
☐ Always ☐ Most of the time ☐ Sometimes ☐ Rarely ☐ Never ☐ Unsure
20. Does the community use mangrove products for medicinal use?
☐ Always ☐ Most of the time ☐ Sometimes ☐ Rarely ☐ Never ☐ Unsure
21. Do you feel a personal connection to the mangroves or the mangrove forest?
☐ Always ☐ Most of the time ☐ Sometimes ☐ Rarely ☐ Never ☐ Unsure
22. Do you think that mangroves could serve as a place to have nature-based recreational activities (hiking, walking, catch and release fishing (i.e. not for food)?
☐ Always ☐ Most of the time ☐ Sometimes ☐ Rarely ☐ Never ☐ Unsure
23. Do you think it is important to conserve the mangroves from future generations?
☐ Always ☐ Most of the time ☐ Sometimes ☐ Rarely ☐ Never ☐ Unsure
24. If you had enough money, would you be willing to donate to protect mangroves?
☐ Always ☐ Most of the time ☐ Sometimes ☐ Rarely ☐ Never ☐ Unsure

Local Capacity -Participation

25. How frequently do you attend association meetings about mangrove management in the last year?
☐ 0 ☐ 1-3 ☐ 4-7 ☐ 7 -10 ☐ > 10
26. Please indicate how frequently you have participated in the following environmental activities in the last year. *List all that apply*
- | | | |
|--|-------------------------------------|---|
| ☐ Reforestation | ☐ Monitoring | Other: <input type="text"/> |
| ☐ Cleaning | ☐ Workshops | ☐ I do not participate |

Management

27. How much do the following environmental problems affect your community? (*Check the box indicating the importance of the problem*)

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Problem	A lot	A little	None	Don't know
Water pollution				
Air Pollution				
Garbage disposal				
Habitat loss to shrimp ponds				
Loss of coastal areas				
Other:				

28. Which of the following are the major threats to mangrove ecosystems in your community?
_____ Overfishing _____ Loss of mangroves for erosion
_____ Mangroves clearance _____ Pollution Climate change _____

29. Which has been the main reason why these mangrove areas have been cut?

30. How often do members of the association respect the closure areas and time restrictions on fishing during the last year?

☐ Always ☐ Most of the time ☐ Sometimes ☐ Rarely ☐ Never

31. What other measures do you think should be taken in order to improve mangrove management?

32. How willing are you to volunteer in each type of local monitoring?

Programs	To a great extent	Somewhat	Very little	Not at all
Mangrove biomass (counting mangroves)				
Carbon storage (taking sediment samples)				
Biodiversity (counting groups of seabirds, sea turtles and marine mammals)				
Fisheries (recording landings)				
Surveillance & monitoring				
Other: _____				

33. Please indicate what factors influenced your decision not to get involved in social monitoring of the mangroves.

Historical questions

34. Which resources did you take from mangroves **5 years ago**, how frequently did you take them, and what did you do with them?

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Resources	Unit	Days per week	Number of hours per day	Consumption/Use, Sold or Other
Firewood				
Charcoal				
Fishery				
Crabs				
Shell Cockle				

35. Compared to five years ago, how much of each of the following resources are there now?

- | | | | | |
|-----------------|-------------------------------|-----------------------------------|-------------------------------|--|
| 1) Fish | ☐ More | ☐ The same | ☐ Less | ☐ I do not know |
| 2) Crabs | ☐ More | ☐ The same | ☐ Less | ☐ I do not know |
| 3) Shell Cockle | ☐ More | ☐ The same | ☐ Less | ☐ I do not know |

36. Compared to five years ago, do you think there has been a change in the “ecosystem services” (i.e. benefits that you receive from the nature) in this area? You could also explain why you think the change has, or has not occurred.

- ☐ More ☐ The same ☐ Less ☐ Unsure

For the option you chose, please explain _____

Future Questions

37. In your opinion, if the management continues in the same way as now, what will happen to mangrove areas in the next 10 years?

- ☐ Much better ☐ Better ☐ Stayed the same ☐ A little worse ☐ Much worse ☐ Unsure

For the option you chose, please explain _____

38. What do you think will be the main reasons for changes in the ecosystem services over the next 10 years?

- ☐ Population growth ☐ Climate ☐ Biological factor ☐ Aquaculture industry ☐ More fishermen

Questions only for the interviewer

39. How open and honest did the people seem about answering questions?

- ☐ Very open/honest ☐ Somewhat open/honest ☐ Not honest

40. How interested did the people seem with interview?

- ☐ Very interested ☐ Moderately interested ☐ Bothered/Not interested

41. How certain did the people seem about answers to numerical questions?

- ☐ Very sure ☐ Reasonably sure ☐ Unsure